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SCHOLAR Study Guide

# Higher (CfE) Computing Science

## Unit 2

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SCHOLAR Study Guide Unit 2: Higher (CfE) Computing Science

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# Topic 1

## Structures and links (Databases)

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### **Prerequisite knowledge**

*From your studies at National 5 you should already know about:*

- *Database Structure*
- *Field Types*
- *Searching and Sorting*
- *Flat Files*
- *Linked Tables*
- *Primary and Foreign Keys*
- *Validation*

### **Learning objectives**

*By the end of this topic you should be able to:*

- *explain the structure of a database;*
  - *explain what is meant by the term relational database;*
-

- *describe the purpose of a table;*
- *explain why tables have relationships;*
- *know the differences between one-to-one, one-to-many and many-to-many relationships;*
- *describe complex data operations, including using queries, forms and reports.*

In this topic you will learn about the different features and functions of a database. You should be familiar with the concept of a basic database already. This topic looks at **forms, reports, user interfaces and relationships** in more detail.

## 1.1 Introduction

### Learning objective

By the end of this section you should be able to:

- understand and describe the structure of a simple database.

A **database** is used to store information. Databases can contain thousands of pieces of information, stored in a variety of formats. Databases are used as they can be searched and sorted very efficiently and they can allow a number of people to use the same information simultaneously.

Databases contain tables. Each **table** contains records. One **record** is all the data stored about one person or one object. The records contain fields; a **field** is one single piece of information. All the records in a table must have the same fields. Fields can have many different data types.

Databases can contain more than one table and these tables can be linked using **primary keys** and **foreign keys**.

### Activity: Database table keywords

**Q1:** Match the following Keywords to the Definitions in the following table.

- Data Type
- Field
- Table
- Record



5 min

Keyword	Definition
	If a field is to be an integer, Boolean, image etc.
	A single piece of information
	All the records together
	All the data about one object or person

.....

## 1.2 Database structures: relational

### Learning objective

By the end of this section you should be able to:

- describe a relational database;
- describe a web-based database.

In the previous section you learned how a simple database is constructed and the concept of a table. If a database only has one table then it can be referred to as a flat-file database.

A **relational database** is a database which contains more than one table. The tables are linked together by using primary and foreign keys.

### Advantages of a Relational Database:

Relational databases were developed to avoid unnecessary duplication of data in the database. Let's look at a Flat-file database to see what we mean by unnecessary duplication:

Library Loans:

Borrower No	Borrower Name	Borrower Address	Borrower Phone	Book No	Title	Author	Loaned Out	Due Back
1001	Egdar Codd	12 High Street, Scholarville	01234 985443	F1301	Wuthering Heights	Bronte, C	12 Jan	11 Feb
1002	Raymond Boyce	6 Castle View, Scholarville	01234 983458	F1301	Wuthering Heights	Bronte, C	12 Feb	11 Mar
1001	Egdar Codd	12 High Street, Scholarville	01234 985443	F1109	To Kill a Mockingbird	Lee, H	14 Jan	13 Feb

As you can see, all the fields about the lender (Lender No, Name, Address...) have to be inserted for each book the lender loans, and the same is also true of the book details each time it is loaned out. This is unnecessary duplication, and can cause problems:

- It is time consuming for the database operator (this is a simplified example - a real lender may need many fields).
- Mistakes can be made (can you see any in the table above?).
- What if the lender leaves the library? The Data Protection Act would mean the library would have to remove the lender's details from the database - how would this work if they have loaned hundreds of books!
- What if you want to add book details to the library database - ideally you would need someone to lend the book so the record is complete.

Let's take a look at a relational version of this database now:

Lender:

Lender No	Lender Name	Lender Address	Lender Phone
1001	Egdar Codd	12 High Street, Scholarville	01234 985443
1002	Raymond Boyce	6 Castle View, Scholarville	01234 983458

Book:

Book No	Title	Author
F1301	Wuthering Heights	Bronte, E
F1109	To Kill a Mockingbird	Lee, H

Loan:

Lender No	Book No	Loaned Out	Due Back
1001	F1301	12 Jan	11 Feb
1002	F1301	12 Feb	11 Mar
1001	F1109	14 Jan	13 Feb

As you can see now:

- all the information about books are stored only once;
- all the information about lenders are stored only once;
- all the information about loans are stored only once.

Each loan is linked (related) by the book No and lender No to the record in each table. This solves all of the above problems (well, all bar the mistake problem. However, at least if an operator enters the wrong value for some book or borrower data it only needs to be changed once and all loan records will be correct).

### Quiz: Databases

**Q2:** Explain the difference between a flat database and a relational database.

.....



10 min

## 1.3 Primary keys

### Learning objective

By the end of this section you will be able to:

- describe the purpose of a primary key;
- explain what is meant by the term compound key.

A **primary key** is a field in a table that contains a piece of data that is unique for every record. This could be a phone number, email address (e.g. CustomerService@Amazon.com), national insurance number (e.g. HMRC records) or even a student's Scottish Candidate Number (e.g. SQA Record of Attainment). A unique field is identified and set as the primary key for each table. A table can only have one primary key and this field should never be left blank. A primary key is used to ensure that every record is different from every other record. This is to avoid records being overwritten, or the wrong record being selected. Primary keys are used when linking tables together.

A **compound key** combines more than one field in order to make a unique key.

In some databases one field is not enough data to uniquely identify a record. In a pack of cards, there are four different suits, hearts, diamonds, spades and clubs. For example, in a pack one single primary key would not be able to identify each different card based on the suit, or on the card value. See Figure 1.1

Figure 1.1: Card example

Suit	Value	Number of times played
Hearts	Ace	5
Diamonds	1	4
Spades	3	3
Clubs	5	8
Clubs	Jack	5

However, if a primary key was made out of the suit and the value then this would be a unique field and could be used as a primary key.



10 min

### Quiz: Primary keys

**Q3:** What is primary key?

.....

**Q4:** What is a compound key?

.....

## 1.4 Relationships

### Learning objective

By the end of this section you should be able to:

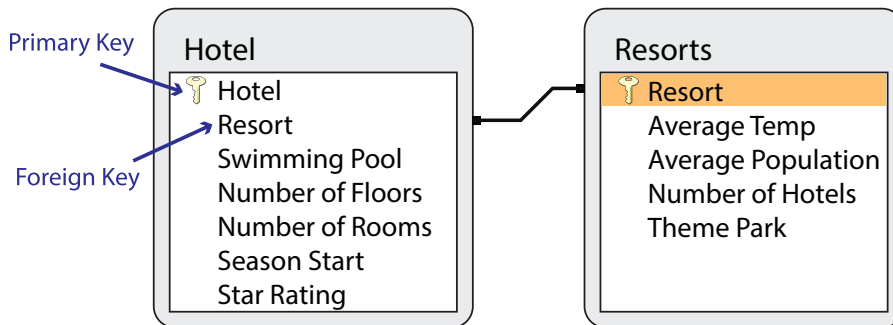
- explain what is meant by the term relationship in a database;
- explain the terms ‘one-to-one’, ‘one-to-many’ and ‘many-to-many’.

Tables can be linked for different reasons. It may be simpler to have two smaller tables and link them than to have one very large table. Linking tables together may also avoid the unnecessary duplication of information.

In order for tables to be linked together they must each have a primary key.

Once a primary key has been set in one of the tables they can be linked together using the primary key. A primary key can be identified by the key symbol that appears next to it. This sets up a relationship between the two tables.

Figure 1.2: Relationship between two tables



### Foreign Keys

A **foreign key** is a field in a table that is the primary key of another table. A foreign key can be used to cross reference information in tables. In Figure 1.2 you will see that Hotel is one primary key and Resort is another primary key. The foreign key is Resort as it also appears in the Hotel table. In a database package like MS access, when you view two tables that have been correctly linked together you will see that + signs appear next to the foreign key. See Figure 1.3.

Figure 1.3: Tables linked together, shown by + sign

	Resort ▼	Average Temp ▼	Average Population ▼	Number of Hotels ▼	Theme Park ▼
+	<b>Amalafi</b>	<b>24</b>	<b>486000</b>	<b>365</b>	<input type="checkbox"/>
+	Capri	22	250000	156	<input type="checkbox"/>
+	Florence	25	521000	450	<input type="checkbox"/>
+	Portofino	23	270000	225	<input checked="" type="checkbox"/>
+	Positano	24	300000	85	<input checked="" type="checkbox"/>
*					<input type="checkbox"/>

.....

If you click on one of the + signs it will expand to show that particular resort information. See Figure 1.4.

Figure 1.4: Table expanded to show linked information

	Resort ▼	Average Temp ▼	Average Population ▼	Number of Hotels ▼	Theme Park ▼		
+	<b>Amalafi</b>	<b>24</b>	<b>486000</b>	<b>365</b>	<input type="checkbox"/>		
	Hotel ▼	Swimming Pool ▼	Number of Floors ▼	Number of Rooms ▼	Season Start ▼	Star Rating ▼	Picture ▼
	<b>Roma</b>	<input checked="" type="checkbox"/>	<b>3</b>	<b>456</b>	01/05/2013	Five	
	Capri	<input checked="" type="checkbox"/>	5	295	01/05/2013	Four	
	*	<input type="checkbox"/>					
+	Capri	22	250000	156	<input type="checkbox"/>		
+	Florence	25	521000	450	<input type="checkbox"/>		
+	Portofino	23	270000	225	<input checked="" type="checkbox"/>		
+	Positano	24	300000	85	<input checked="" type="checkbox"/>		
*					<input type="checkbox"/>		

.....

Consider the following example. A car garage has one table to store the details of customers who bring their cars in, and another to store the details of the type of car and repairs carried out. The Customer table could have a primary key as the customer's phone number and the Car table could have a primary key as the car registration. The Customer table could then have the car registration field included in its table as a foreign key. When an employee accessed a car record they could use the car registration field to bring up details of the customer.



Figure 1.5: Car database linked to Customer database

	Registration ▼	Make ▼	Model ▼	Colour ▼									
[-]	P999 SYU	Toyota	Celica	Black									
	<table border="1"> <thead> <tr> <th>Phone Number ▼</th> <th>First Name ▼</th> <th>Surname ▼</th> </tr> </thead> <tbody> <tr> <td>07545369258</td> <td>Kevin</td> <td>Burns</td> </tr> <tr> <td>*</td> <td></td> <td></td> </tr> </tbody> </table>				Phone Number ▼	First Name ▼	Surname ▼	07545369258	Kevin	Burns	*		
Phone Number ▼	First Name ▼	Surname ▼											
07545369258	Kevin	Burns											
*													
[+]	SV07 NRZ	Nissan	Xtrail	Red									
[+]	V096 DRZ	Jaguar	XKB	Red									
*													

.....

A **one-to-one** relationship is when there are two tables, both having the same number of rows. One row from table 1 relates directly to one row in table 2. This could be relevant if you have two tables in a database, one for customer names and one for customer details. See Figure 1.6.

Figure 1.6: One-to-one relationship

Customer name table

<b>customer_id</b>	Primary key, link to customer_id of customer details table
lastname	
firstname	

Customer details table

<b>customer_id</b>	Primary key, link to customer_id of customer details table
height	
weight	
date_of_birth	

<b>customer_id</b>	<b>lastname</b>	<b>firstname</b>
0001	wilson	jordan
0002	smith	jessica
0003	black	kevin
0004	gardiner	paul

<b>customer_id</b>	<b>height</b>	<b>weight</b>	<b>date_of_birth</b>
0001	183	75	09/11/1981
0002	156	83	01/12/1967
0003	179	72	21/01/1986
0004	167	93	17/03/1989

.....

You will notice that each row is related to one row in the other table. This design relationship does not bring any benefits to the database. All the fields could be included in one table. However, if some of the fields, such as the height and weight were not regularly used it might make sense to keep the fields in a separate table so that the table is quicker to load. In a small database this would not have a big impact.

In a **one-to-many** relationship each row in-between table 1 can be related to many rows in table 2. This allows information that is regularly used to be saved only once in one table and referenced many times by other tables. It is saved once in one place but can be accessed many times, from different tables. See Figure 1.7.

Figure 1.7: One-to-many relationship

singer table

<b>singer_id</b>	primary key
firstname	
lastname	

album table

<b>album_id</b>	primary key
title	
singer_id	foreign key, link to singer table

<b>singer_id</b>	<b>firstname</b>	<b>lastname</b>
0001	gary	barlow
0002	robbie	williams
0003	cheryl	cole
0004	dolly	parton

<b>album_id</b>	<b>title</b>	<b>singer_id</b>
01	Since I saw you last	0001
02	Open road	0001
03	Escapology	0002
04	Better day	0004

.....

Each row in the singer table can be related to many rows in the album table, hence to the name one-to-many. If you turn this relationship around the album table has a many-to-one relationship with the singer table.

Using a one-to-many relationship can reduce the amount of information that needs to be stored as duplicate information does not get stored. It can mean that there are two small tables, which are easier to manage than one large table. It requires a primary key in one table which is linked to a foreign key in the other one.



### Activity: Foreign keys

How a foreign key is used to relate data in separate tables

Two separate tables:

Student_num	Fname	Sname
20001	Gerry	Sutherland
20002	Fiona	McGhee
20003	Sally	Fultness

School_name	Town	Telephone
Jura High	Bute	01432 123456
Coll Academy	Balimartine	01352 878787

'School\_code' keys are added to each table:

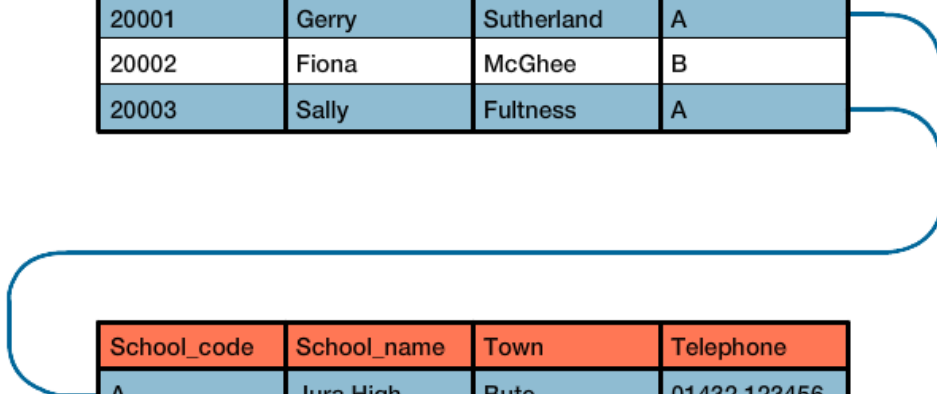
Student_num	Fname	Sname	School_code
20001	Gerry	Sutherland	A
20002	Fiona	McGhee	B
20003	Sally	Fultness	A

School_code	School_name	Town	Telephone
A	Jura High	Bute	01432 123456
B	Coll Academy	Balimartine	01352 878787

Key A relationship:

Student_num	Fname	Sname	School_code
20001	Gerry	Sutherland	A
20002	Fiona	McGhee	B
20003	Sally	Fultness	A

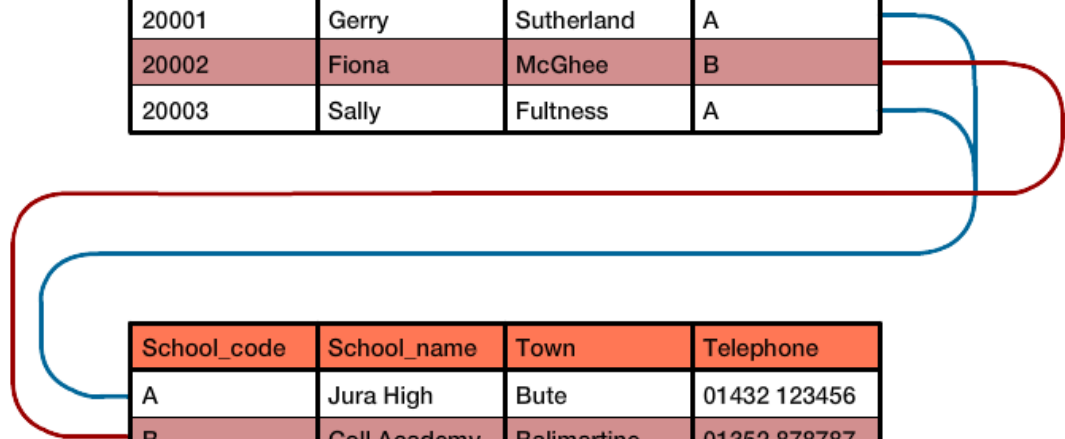
School_code	School_name	Town	Telephone
A	Jura High	Bute	01432 123456
B	Coll Academy	Balimartine	01352 878787

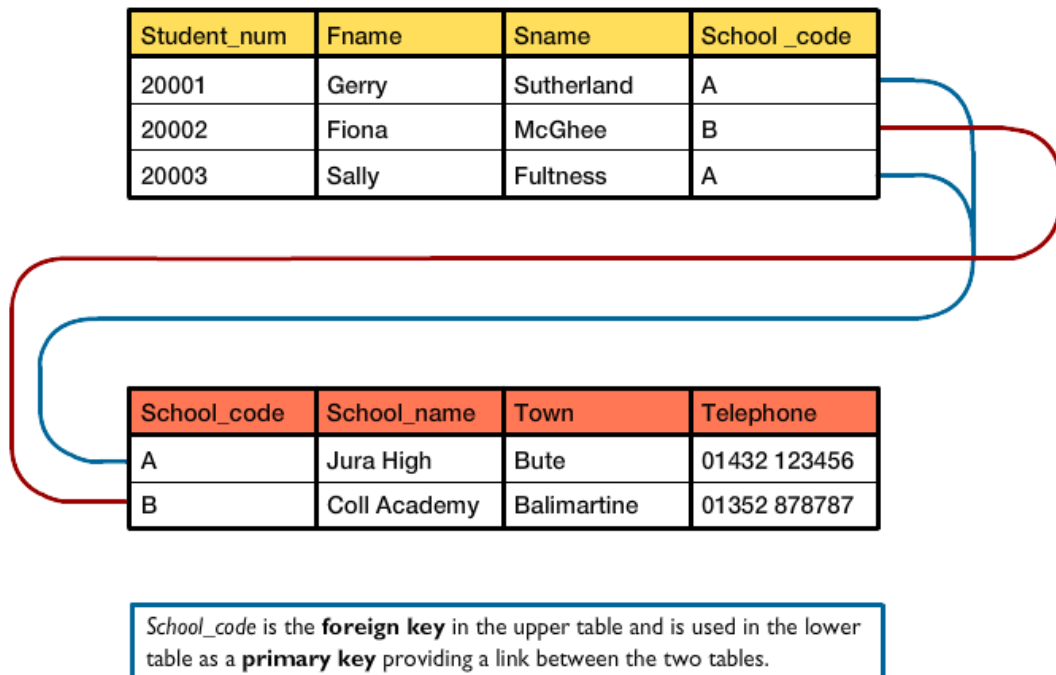


Key B relationship:

Student_num	Fname	Sname	School_code
20001	Gerry	Sutherland	A
20002	Fiona	McGhee	B
20003	Sally	Fultness	A

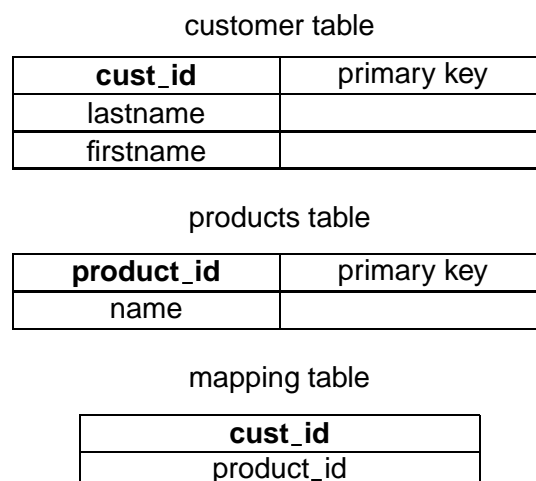
School_code	School_name	Town	Telephone
A	Jura High	Bute	01432 123456
B	Coll Academy	Balimartine	01352 878787





In a **many-to-many** relationship one or more rows in a table can be related to one or more rows in another table. In a many-to-many relationship between tables 1 and 2, each row in table 1 is linked to one or more rows in table 2 and vice versa. A third table is required to implement this type of relationship and is called a mapping table. See Figure 1.8.

Figure 1.8: Many-to-many relationships



If we assume that there are only two customers and two products:

cust_id	lastname	firstname
0001	smith	simon
0002	brown	james

product_id	name
0001	savings
0002	credit card

cust_id	product_id
0001	0001
0001	0002
0002	0002

You will notice from the mapping table that Simon Smith has 2 products with the bank, a saving account and a credit card. You can see that both customers own credit cards.

The way that the database has been designed means that customers can have more than one product and products can have more than one customer.

**Quiz: Relationships**



30 min

**Q5:** Why are both primary and foreign keys necessary in a relational database?

.....

**Q6:** Give two advantages of linking tables.

.....

**Q7:** When might a one-to-one relationship be useful in a database?

.....

**Q8:** What two items do you need to create a one-to-many relationship?

.....

**Q9:** Explain how a one-to-many relationship is different to a one-to-one relationship.

.....

**Q10:** What is the purpose of a many-to-many relationship?

.....

**1.5 Data, Entities and Relationships**

A data **entity** is something that information will be recorded about in a database. This could be a person, an object, or something abstract like a holiday booking.

Examples of entities about *persons* include:

- a customer
- airline passenger

- a library borrower
- an employee
- a school pupil
- a college student.

Example of *objects* include:

- a product
- a flight
- a book
- a job
- a course at school or college.

Examples of *abstract entities* include:

- a borrowing,
- a booking,
- a rental.

An **entity set** is a collection of entities of the same type and is represented as a table in a database system.

Each entity has a set of **attributes** which describe examples or **instances** of that entity.

For example, the **attributes** of a school pupil might include the following: forename, surname, address, date of birth, year group, tutor group.

An **instance** of a school pupil might be Joanna Hamilton, whose attributes are: Joanna, Hamilton, 10 Main Road, Kinglass, 01/04/1990, 5, SW.

The **attributes** of a DVD Rental entity are code, title, cost, date out, date due and member number, and the attributes of the Member entity are member number, name and telephone number.

Attributes can be single-valued or multi-valued. Multi-valued attributes are where there are more than 1 possible entries in a field for a given primary key. As you will see later, the relational database model requires attributes to be single-valued.

Attributes will have constraints on what is permitted. For example, an attribute representing a person's name will contain characters only. This is called the **domain** of an attribute and will define the type and value of data that the attribute can hold.

Examples of data types that attribute may use are:

- **Text** - e.g. a person's name
- **Integer** - e.g. the number of books borrowed from a library



- **Real** - e.g. the conversion rate for foreign currency
- **Object** - a photographic image
- **Boolean** - a True or False value
- **Date** - someone's date-of-birth
- **Time** - the departure of a train

**Activity: Attributes and Data Types**




**Q11:**

Select the correct data types you would use to store the following:

**Data types:**

- Boolean
- Date
- Integer
- Object
- Real
- Text
- Time

Attribute	Example	Data type
Surname	Toner	
First name	Geraldo	
Postcode	TD7 0EG	
SQA candidate number	2311447853	
Enrollment fee paid	£27.50	
Passport photo		
All documents received	Y	
Enrolment date	23/03/14	
Course begins at	19:30	

.....



### Activity: Entities

From this invoice image, answer the following four questions:

<b>BOWMORE SPORTS COMPLEX</b>						
<b>Invoice</b>						
<b>Date:</b> 27 July 2005						
<b>Client:</b> Eastdyke Youth Club				<b>Client No:</b> 16523		
<b>Contact Name:</b> Alasdair Donnelly						
<b>Contact Telephone Number:</b> 0141 912 9562						
<i>Bookings for September 2005</i>						
<b>Date</b>	<b>Time</b>	<b>Facility Code</b>	<b>Facility</b>	<b>Duration (hours)</b>	<b>Charge per 30 mins</b>	<b>Sub-Total</b>
1/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
3/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
7/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
10/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
14/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
15/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
17/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
21/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
24/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
28/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
29/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
<b>Total Due:</b>						<b>£138.00</b>

**Q12:** Which items are attributes?

.....

**Q13:** Which items are instances?

.....

**Q14:** Which attributes are single-valued?

.....

**Q15:** Which attributes are multi-valued?

.....

#### 1.5.1 The Relational Model

The relational data model was developed in the 1970s and is currently the most common database model. Example database management systems based on this model include Oracle, Ingres, IBM DB2, MySQL and Microsoft Access.

In the relational model, data is stored as records in **tables** and is interrogated using the Structured Query Language (SQL).

Before a designer can create a database using any model, an understanding of the requirements of the system is necessary. This analysis of the data will lead to the choice of tables, identification of **keys**, and an understanding of the requirements of users of the database. At this early stage of the design process the system is considered in terms of concepts and ideas to produce an abstract model of the required system.

In the relational model, this design makes use of **Entity-Relationship** (E-R) modelling. This modelling is independent of the choice of relational database used to implement the database so it does not matter at this stage whether the system is to be implemented on a large scale using something like Oracle or Microsoft SQL server, or on a small scale using a system such as mySQL, Microsoft Access or Filemaker.

The modelling of the requirements is separate from the final implementation so that important design decisions can be taken independently of a particular product.

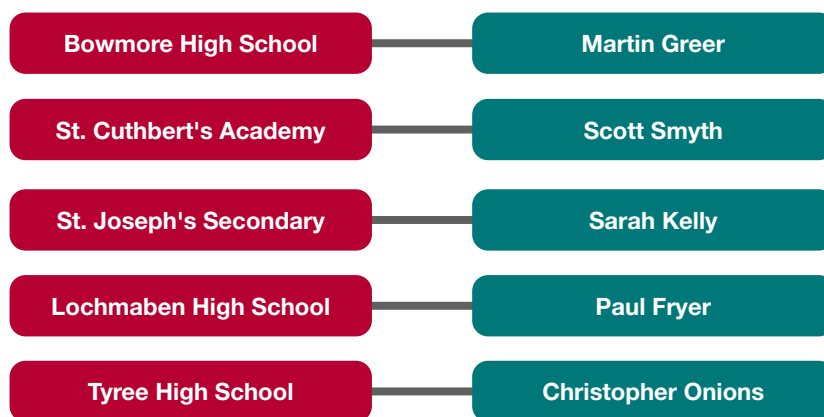
### 1.5.2 Relationships

Entities can be associated with each other by relationships. The number of entities that another entity relates to is known as the mapping **cardinality**, or the degree of the relationship, and can be one of the following:

- **One-to-one** An entity is related to at most one other entity, written as a **1:1** relationship
- **One-to-many** An entity is related to more than one other entity, written as a **1:M** relationship
- **Many-to-one** A number of entities are related to one entity, written as a **M:1** relationship
- **Many-to-many** Many entities relate to many other entities, written as a **M:N** relationship.

#### One to One Examples

*Figure 1.9: An example of various One to One relationships*



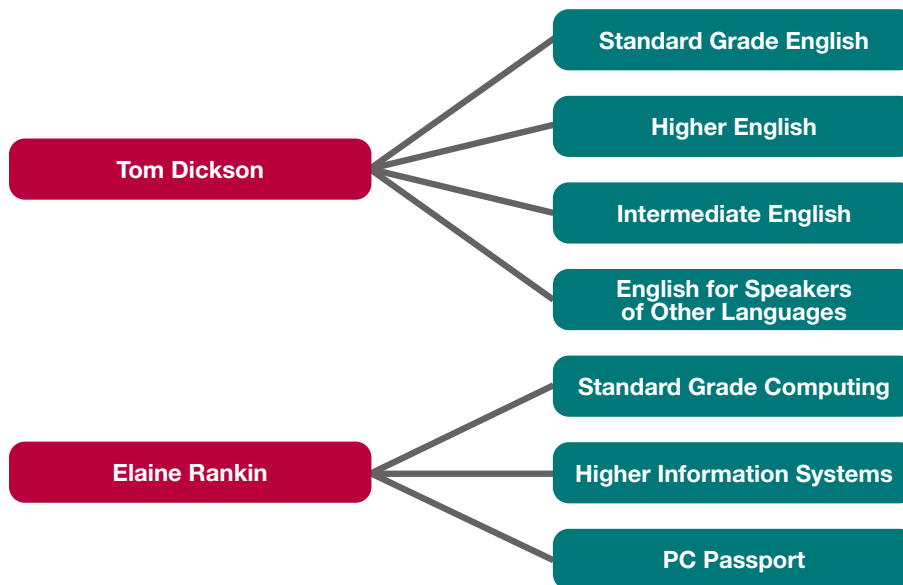
Each School has one Head teacher and each head teacher has one school. This can be represented in an ERD (Entity - Relationship Diagram) as 1:1

Figure 1.10: One to One (1:1)



### One to Many Examples

Figure 1.11: A few examples of One to Many relationships



Here a teacher can teach many courses and each course is taught by one teacher.

This can be represented in an ERD as a one to many relationship

Figure 1.12: One to Many (1:M)



### Many to Many Example

On the online course you can see an interactive example of a Many-to-Many relationship.

This can be represented in an ERD as a many-to-many relationship.

Figure 1.13: Many to Many (M:N)



**Activity: Entity relationships**



The table below shows some entities that can be linked by a relationship. For each one, determine if the relationship is one-to-one, one-to-many or many-to-many.

**Q16:**

Entity 1	Entity 2	Relationship
School	Head Teacher	
Teacher	Course	
Classroom	Desk	
School	Swimming pool	
Pupil	Exam	

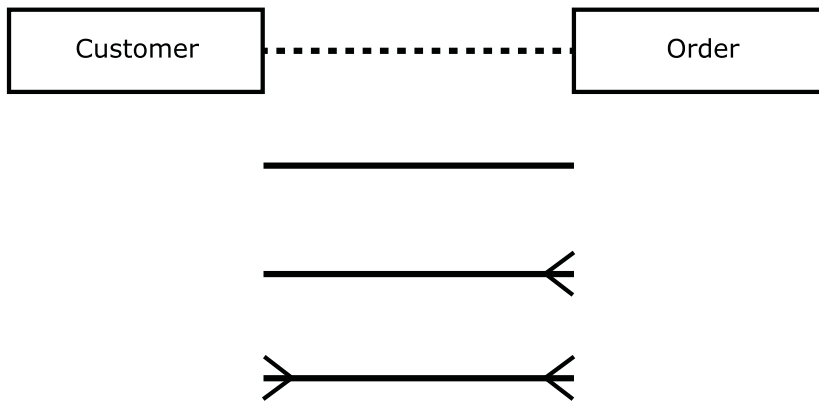
.....

**Activity: ERD Exercise**



An online ordering system needs to be designed. It will always have at least one customer and each customer may place multiple orders.

Complete the following ERD to describe such a system by selecting the correct relationship symbol between the entities:



.....

**1.5.3 Keys**

It is important to be able to distinguish between different entities. This is achieved by using one or more attributes of that entity as the key that identifies an entity. A **key** is a set of attributes that uniquely identifies an entity.

For example, the *order\_number* attribute of an order entity is a unique identifier thus *order\_number* is a key.

When looking for the key to an entity, there may be more than one attribute or combination of attributes that could uniquely identify the entities. These attributes under consideration are referred to as candidate keys. Once a key is chosen from the candidate keys as the principal identifier for an entity set, this becomes the **primary key**.

## 1.6 Complex data operations

### Learning objective

By the end of this section you should be able to:

- explain the differences between tables, forms and reports;
- describe the purpose of a query;
- discuss the uses of forms and reports;
- understand the purpose of a calculated field.

A **user interface** is what the user sees when they are using a program or application. When a creating a database there are different interfaces that can be created, depending on the purpose of the database. For a very simple database the user may use a simple table, the advantages of a table are that if there is not a huge amount of data in the database then it can all be displayed on the one screen. Tables are usually used for entering and editing data.

Figure 1.14: A table

Hotel	Resort	Swimming Pool	Number of Floors	Number of Rooms	Season Start	Star Rating
Canal	Capri	<input type="checkbox"/>	7	755	01/04/2013	One
Diva	Portofino	<input checked="" type="checkbox"/>	2	197	01/06/2013	Two
Gondola	Florence	<input checked="" type="checkbox"/>	2	185	01/06/2013	Three
Gorgonzola	Amalafi	<input checked="" type="checkbox"/>	5	295	01/05/2013	Four
Mozarella	Positano	<input checked="" type="checkbox"/>	4	333	01/04/2013	Five
Opera	Positano	<input checked="" type="checkbox"/>	1	56	01/04/2013	One
Parmesan	Portofino	<input checked="" type="checkbox"/>	5	435	01/05/2013	Two
Pizza	Capri	<input type="checkbox"/>	12	1560	01/04/2013	Three
Ragu	Florence	<input checked="" type="checkbox"/>	5	455	01/05/2013	Four
Roma	Amalafi	<input checked="" type="checkbox"/>	3	456	01/05/2013	Five
*		<input type="checkbox"/>				

A second alternative is to create a **form**. A form has the advantage that it is graphical and may look more professional, or interesting. A form might be easier for novice users to enter information. The drawback to forms is that they can only display one record at a time. Forms are used to provide a 'front end' to the user. They can be used to add records to a database, or to display individual records. They can have buttons, which run different queries or searches when pressed. Forms are useful to help avoiding mistakes when transferring data from paper forms which have been filled in; the database form can be laid out in the same way as the paper one.

Figure 1.15: Two examples of forms

The figure consists of two screenshots of a web application interface. The top screenshot shows a form titled 'Hotel' with the following fields: 'Hotel' (text input with 'Cana'), 'Resort' (text input with 'Capri'), 'Swimming Pool' (checkbox), 'Number of Floors' (text input with '7'), 'Number of Rooms' (text input with '755'), 'Season Start' (text input with '01/04/2013'), 'Star Rating' (text input with 'One'), and 'Picture' (empty text input). The bottom screenshot shows a 'Home Form' with a yellow background and three buttons: 'Add Hotel', 'Rating One', and 'Add Resort'.

.....

The usability of forms can be increased by using drop down menus to allow users to select from a choice of options, or using buttons that allow the users to enter yes or no.

A third option could be to create a **report**. Reports are an excellent way of arranging the data in an easy to read format. Reports can show some, or all of the information in a database and you can have more than one record showing at a time. Reports can also include graphics to make them more appealing to users. Reports are most commonly used to generate a printable version of a database table or query.

Figure 1.16: A report

Title	Director	Certificate	Rating	Library Ref	Cost
A Nightmare on Elm Street	Wes Craven	18	5	14	£2.99
Conair	Simon West	18	5	9	£2.99
Dirty Dancing	Emile Ardolino	15	5	5	£5.99
Evan Almighty	Tom Shadyac	PG	3	2	£11.99
Fantastic Four	Tim Story	PG	4	3	£9.99
Harry Potter: Goblet of Fire	Mike Newell	12	5	4	£9.99
Harry Potter: Order of the Phoenix	David Yates	PG	3	8	£9.99
In Her Shoes	Curtis Hanson	PG	5	10	£4.99
Jay and Silent Bob Strike Back	Kevin Smith	18	5	13	£1.99
Michael Myers (Halloween)	Fred Walton	18	5	11	£4.99
Moulin Rouge	Baz Luhrmann	15	4	6	£3.99
Romeo and Juliet	Baz Luhrmann	15	4	15	£2.50
Spiderman 3	Sam Raimi	12	4	7	£15.99
Surf's Up	Ash Brannon	PG	4	1	£4.99
The Simpsons Movie	David Silverman	PG	5	12	£9.99

Page 1 of 1      £103.36

.....

A **query** is when you extract information from a database using searching and sorting tools or language built into the database management software. Queries often involve searching for specific items and/or sorting the resultant data into order. In the example above, a query could be used to compile a list of all the films rated PG, only showing the title and rating in order of title. In a hotel booking system, a query could be used to find a list of all today's expected 'check-ins' for the staff. Queries are ultimately what makes a database useful: users can get access to the specific information they need quickly and have it in a useful layout and order for their purposes.

A **calculated field** in a database is when the value of a field is calculated by using the values in other fields. This calculation is performed by the database and so will update itself if the information in a database is updated. Work through the following practical task to create a calculated field.



60 min

### Practical task: Complex data operations

Please note that this task uses MSAccess 2013 as an example database.

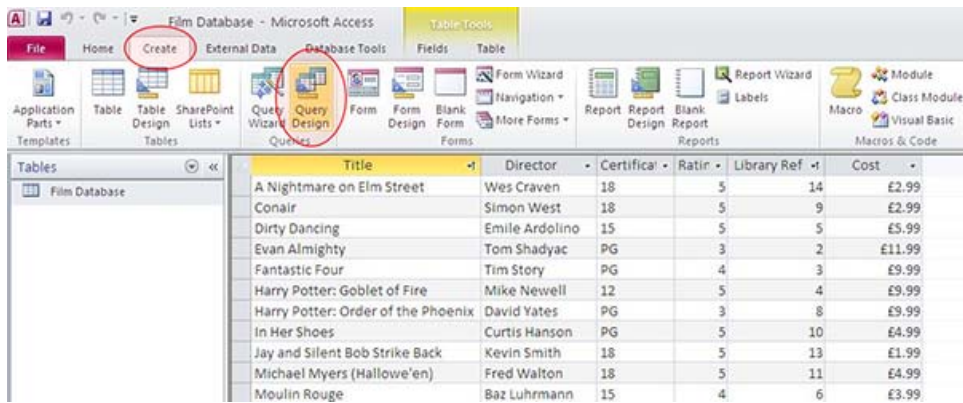
1. Create the following table in your database software:



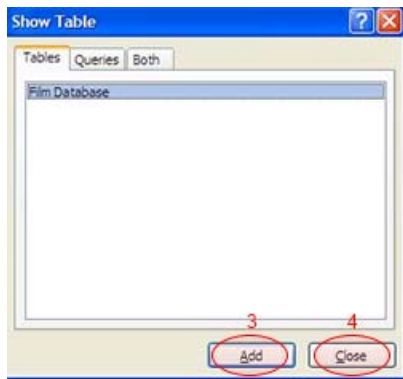
Title	Director	Certificate	Rating	Library Ref	Cost
A Nightmare on Elm Street	Wes Craven	18	5	14	£2.99
Conair	Simon West	18	5	9	£2.99
Dirty Dancing	Emile Ardolino	15	5	5	£5.99
Evan Almighty	Tom Shadyac	PG	3	2	£11.99
Fantastic Four	Tim Story	PG	4	3	£9.99
Harry Potter: Goblet of Fire	Mike Newell	12	5	4	£9.99
Harry Potter: Order of the Phoenix	David Yates	PG	3	8	£9.99
In Her Shoes	Curtis Hanson	PG	5	10	£4.99
Jay and Silent Bob Strike Back	Kevin Smith	18	5	13	£1.99
Michael Myers (Hallowe'en)	Fred Walton	18	5	11	£4.99
Moulin Rouge	Baz Luhrmann	15	4	6	£3.99
Romeo and Juliet	Baz Luhrmann	15	4	15	£2.50
Spiderman 3	Sam Raimi	12	4	7	£15.99
Surf's Up	Ash Brannon	PG	4	1	£4.99
The Simpsons Movie	David Silverman	PG	5	12	£9.99
			0	0	£0.00

Save as *Film Database*.

2. Click on the Create tab. Now click on Query Design.

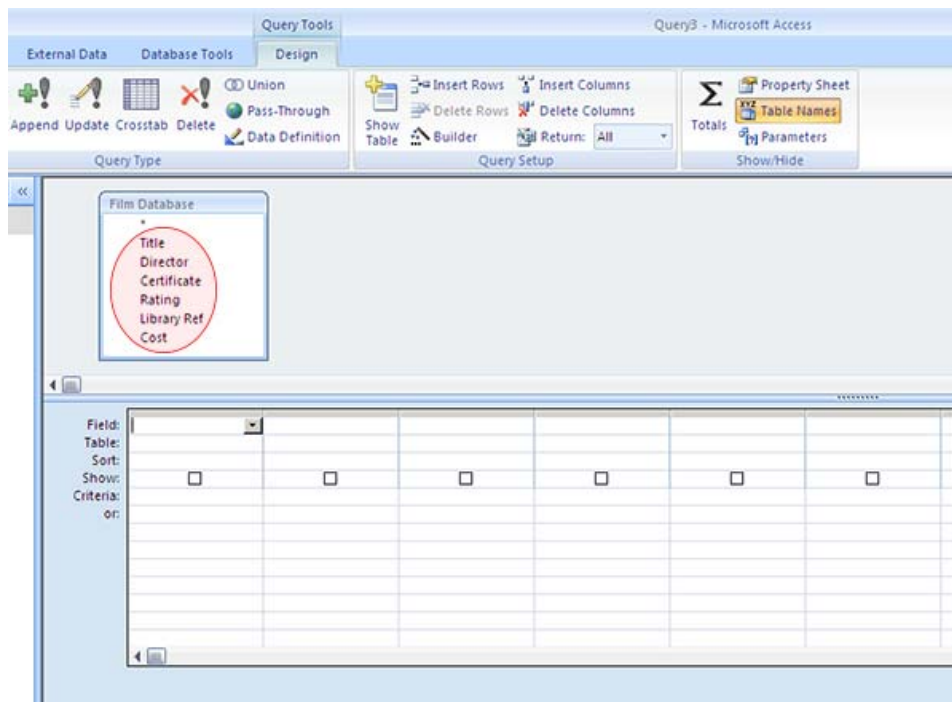


3. Make sure the Film database is highlighted and click on Add.



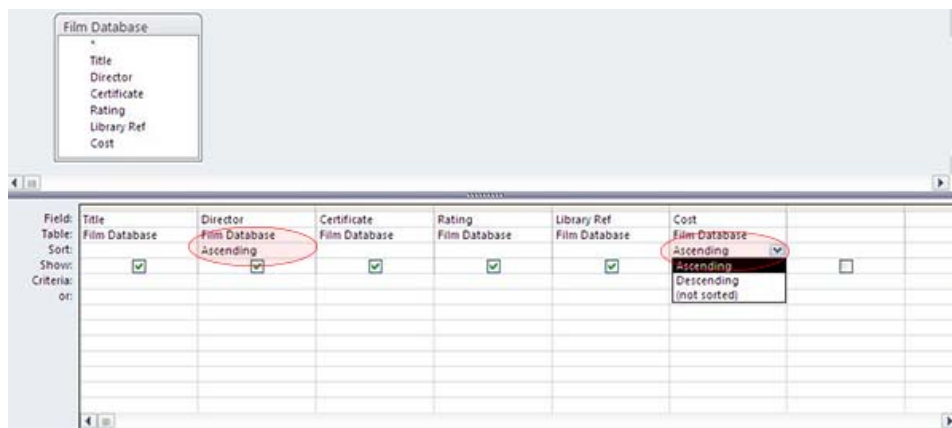
4. Then click on Close.

5. The Query table will now be displayed. Double click on the field names in the table to add them to the query. Click on each field to add them all.

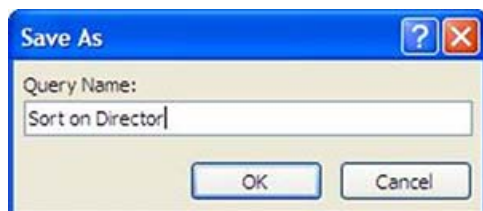


By adding the fields to the query it means that you can search the fields and that they will be displayed on the results. If you only want certain fields to be displayed then you only select the ones that you want.

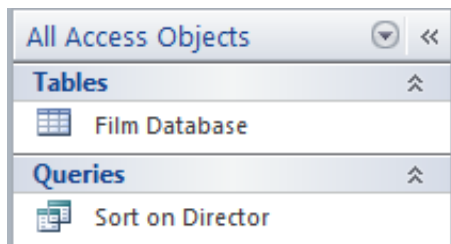
- The table is added automatically when you insert your fields. Now we want to sort on the Director and Cost fields. Underneath the Director field, in the Sort row, click Ascending. Do the same for Cost.



- Close the query and it will prompt you to save. Call the query Sort on Director.



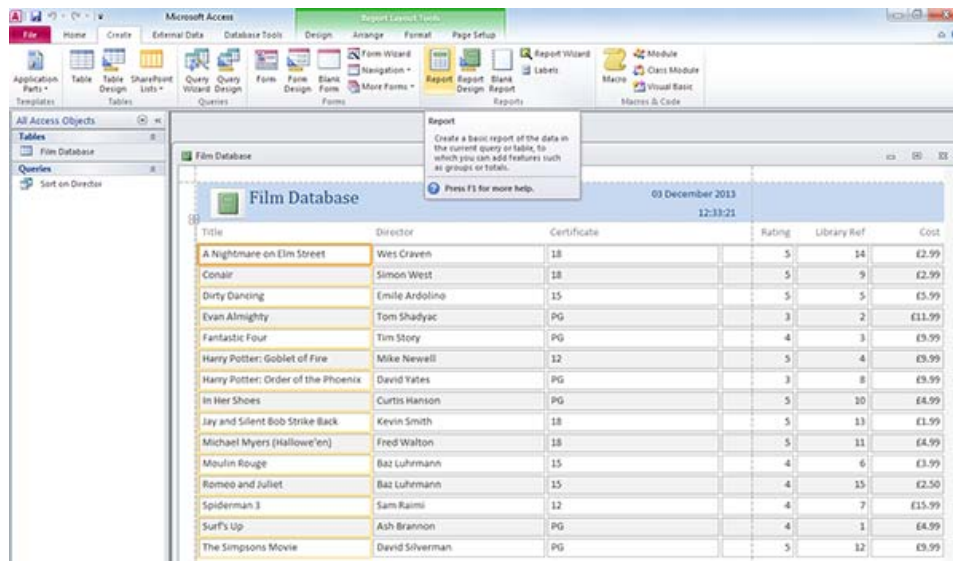
It will now appear at the left hand side of your screen. Click on the query to open it and check that it has worked correctly.



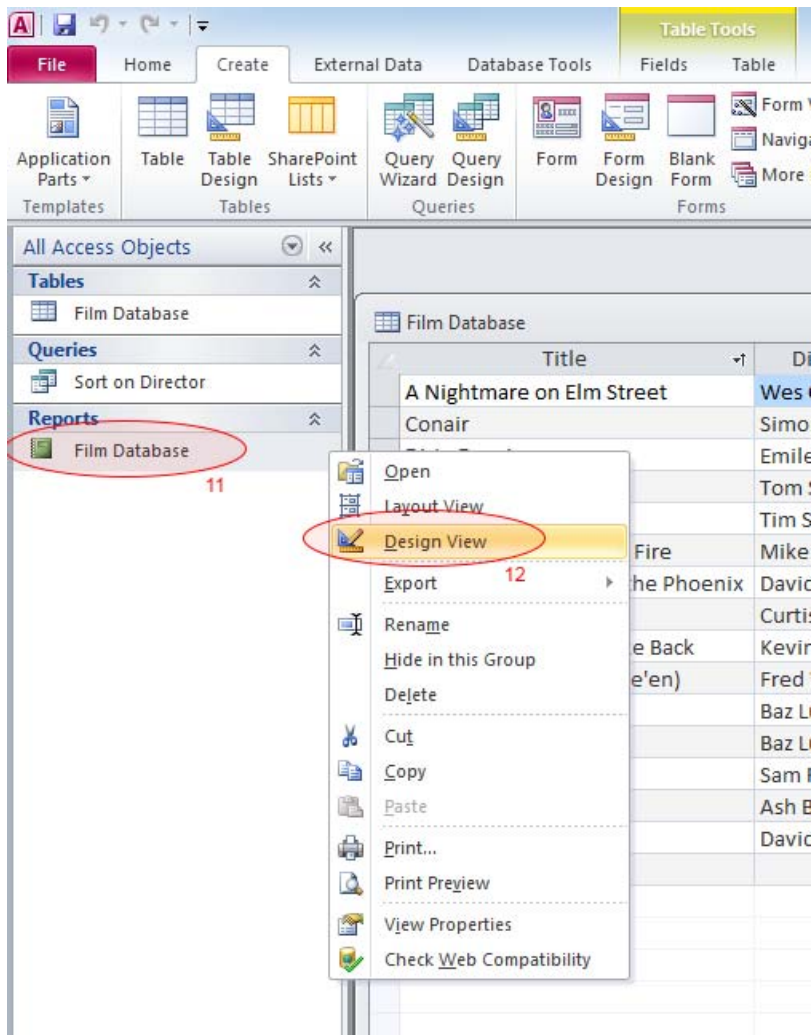
You should now see that the records in the table are listed in alphabetical order by Director. When the director has more than one film, it will be ordered by cost, low-to-high. Note that the sorting order will depend on the order of the field columns from left to right. If you have added the fields in the wrong order you can 'grab' each column at the top and drag them left/right as required.

Title	Director	Certifica	Ratir	Library Ref	Cost
Surf's Up	Ash Brannon	PG	4	1	£4.99
Romeo and Juliet	Baz Luhrmann	15	4	15	£2.50
Moulin Rouge	Baz Luhrmann	15	4	6	£3.99
In Her Shoes	Curtis Hanson	PG	5	10	£4.99
The Simpsons Movie	David Silverman	PG	5	12	£9.99
Harry Potter: Order of the Phoenix	David Yates	PG	3	8	£9.99
Dirty Dancing	Emile Ardolino	15	5	5	£5.99
Michael Myers (Hallowe'en)	Fred Walton	18	5	11	£4.99
Jay and Silent Bob Strike Back	Kevin Smith	18	5	13	£1.99
Harry Potter: Goblet of Fire	Mike Newell	12	5	4	£9.99
Spiderman 3	Sam Raimi	12	4	7	£15.99
Conair	Simon West	18	5	9	£2.99
Fantastic Four	Tim Story	PG	4	3	£9.99
Evan Almighty	Tom Shadyac	PG	3	2	£11.99
A Nightmare on Elm Street	Wes Craven	18	5	14	£2.99

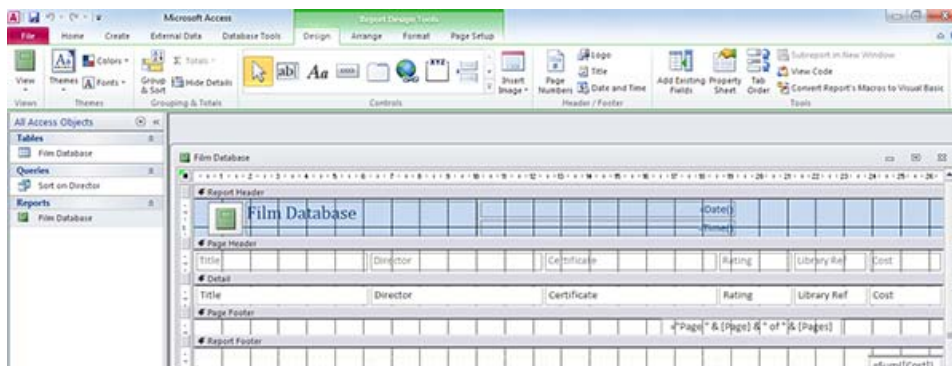
8. Return to the table by closing the Query View.
9. Create a new query that displays only the Title and the Director fields. The records should be sorted into alphabetical order by Title, ascending to descending. Save the query as Sort On Title.
10. You are now going to use this table to create a report. Open up the Film table and click on Create - Report. You should see the following report created for you:



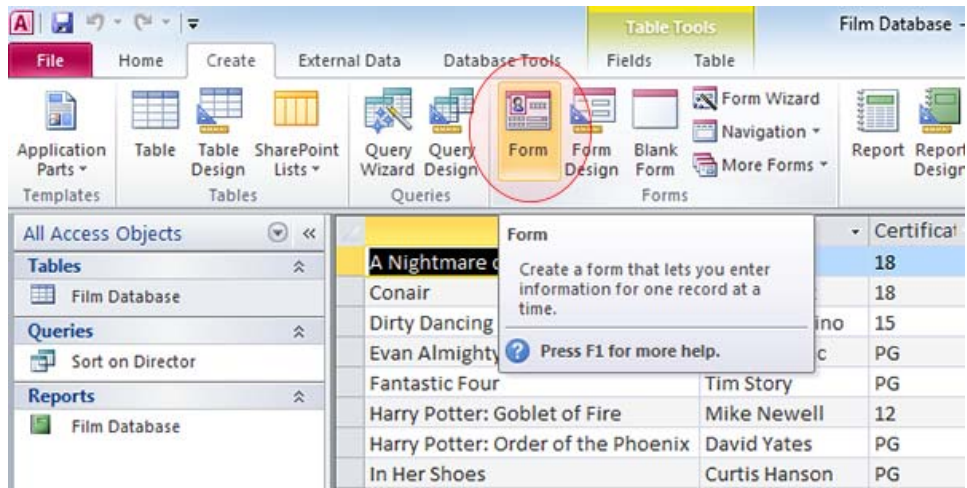
11. To save the report close down the open window and you will be prompted to save the report. Save it as Film Database. You will see that a new object has appeared in the column on the left hand side.
12. Click on the Film Database under the Report heading. Right click and select Design View. This will show you the following screen:



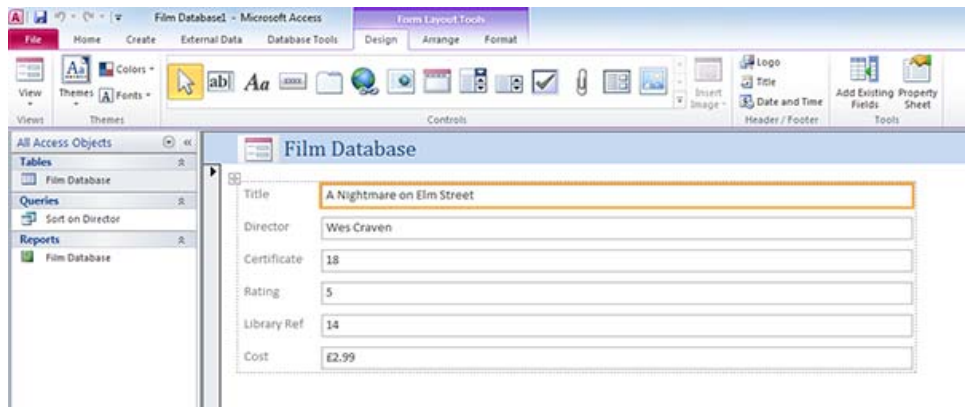
- From this screen you will be able to remove any fields and labels that you do not require, or change the order and spacing of the fields. Spend 10 minutes creating a different layout for your report. To save the changes close the design view window. Click on the Film Database under Reports to view your updated report.



- To create a Form open up the Film database. Go to the create tab and select Form.



15. You will see the following screen appear. The Form has been created for you.



16. You will be able to flick through the records one at a time. You can edit the appearance of the form by saving it and then going into the design view, as you did with the report. Spend 10 minutes altering the appearance of your form. Remember to check the appearance of your new form.

.....



30 min

**Practical task: calculated field task**

1. Create a database called **Criminals**. It should have the following fields and data types:

Field	Data type
Record Number	Number
Height	Number
Age	Number
Conviction	Text
Nickname	Text

Add in the following records:

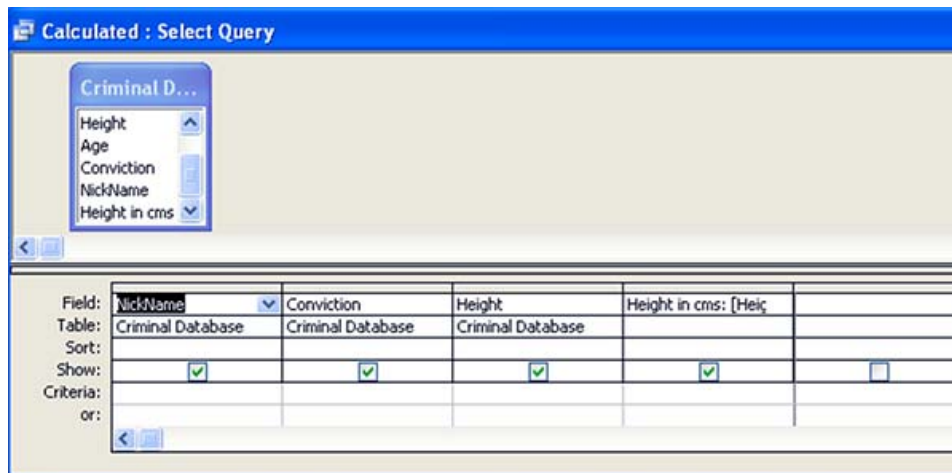
Record Numt	Height	Age	Conviction	NickName
23651945	1.71	62	Burglary	Harry
453445347	1.89	31	Drugs	Yorkie
663366331	1.50	36	Robbery	Dutch
40008000	1.45	23	Assault	Edd The Duck
35722140	1.15	38	Fraud	Doc
398798723	1.75	32	Assault	Tug
565676761	1.64	26	Assault	Hawkeye
912939496	1.76	28	Computer Fraud	Panther
403098412	1.96	37	Drugs	Sniffer
454545245	1.96	47	Assault	Poker
224565222	1.75	28	Arson	Wall Eye
556667347	1.96	47	Robbery	Smiler
111001067	1.67	35	Robbery	Sparkie
454443567	1.60	37	Assault	Scar Face
666778111	1.80	24	Drugs	Smiler
292934561	1.80	19	Assault	Old Mo
50569406	1.50	61	Computer Fraud	Grandad
100097675	2.05	28	Robbery	Tony
878845534	1.45	28	Assault	Mac
787768532	1.70	35	Burglary	Birdie
919293457	1.89	28	Assault	Piggy
905665341	1.87	38	Burglary	Lucifer
451998765	1.87	49	Robbery	See-See
86858439	1.86	15	Assault	Boy
400100300	1.95	28	Burglary	Plug
616235965	1.75	36	Burglary	Elvis
56238954	1.65	44	Assault	Buggy
787958642	1.79	23	Computer Fraud	Jo Jo
458965412	1.85	55	Burglary	Useless
785496523	1.95	31	Burglary	Cheepy

You can also download a csv file for this data: [/vle/asset/Downloads/H-CCMP/Worksheets/2551F656-DDC6-6FE1-A238-99D3BE5681FE/hg-2013cmp2-1-38CriminalDB.csv](#).

You are going to use the Criminals database to set up a calculated field to find the height of criminals in cms.

The steps to set up a calculated field are:

2. Open up the **Criminals** database.
3. Insert a *new field* and call it '**Height in cms**', put the data type as number.
4. Open a *new query* in **Design View**. Add the Criminal table.
5. Double click on the fields you want include in your query. (Nickname, Conviction, Height and Height in cms.) Look at the example below:



6. You need to add a formula to the Height in cms field. The formula that you add will take the contents of the Height field and \* by 100. This will put the height of the criminal into cms.
7. Click in the Height in cms field and type in the following, after the field name: [Height]\*100.
8. Close and save the query as **Calculated**.
9. Double click on the **Calculated query** to open it up. The calculated field should be full of new data, calculated by the formula.

	NickName	Conviction	Height	Height in cms
▶	Harry	Burglary	1.71	171
	Yorkie	Drugs	1.89	189
	Dutch	Robbery	1.50	150
	Edd The Duck	Assault	1.45	145
	Doc	Fraud	1.15	115
	Tug	Assault	1.75	175
	Hawkeye	Assault	1.64	164
	Panther	Computer Fraud	1.76	176
	Sniffer	Drugs	1.96	196
	Poker	Assault	1.96	196
	Wall Eye	Arson	1.75	175
	Smiler	Robbery	1.96	196
	Sparkie	Robbery	1.67	167
	Scar Face	Assault	1.60	160

Record: 1 of 30

.....



**Quiz: Databases**



15 min

Answer the following questions:

**Q17:** Explain the differences between a table, a form and a report?

.....

**Q18:** Describe a possible use for the three different types of interface?

.....

**Q19:** What is a calculated field?

.....

**Q20:** Give an example of a query that may be run on your school's pupil information system.

.....

**Practical task: Complex database operations**



Using a database package with which you are familiar, create a database for the Kirklee Vegetable Club based on the notes below.

Kirklee Vegetable Club is a club of gardeners keen on growing vegetables in the allotment plots that are leased from the Council.

- Each member can rent more than one plot to grow vegetables.
- Each year the club records details of the amount of vegetables that are grown on each plot (i.e. its produce). There are prizes awarded to the plot that produces the largest yield of each type of vegetable.
- Each plot has a unique number and members are identified by their membership number.
- The vegetables that are grown are identified by the VegetableName (e.g. carrot, potato etc).
- Any vegetable type may be grown in any of the plots.

For every vegetable season the Club secretary keeps card records for each plot. An example is shown below:

**Kirklee Vegetable Club 2006**

<b>PlotNumber</b>	5	
<b>PlotSize</b>	1.2ha	
<b>Member No</b>	102	
<b>Member Name</b>	James MacArthur	
<b>VegetableName</b>	<b>Yield</b>	<b>ClubRecord</b>
Carrot	5.5Kg	10.4Kg
Potato	23.2Kg	36.8Kg
Onion	12.3Kg	16.4Kg

Note that vegetable name and plot number are both marked as (PK). This means that together, they form a compound key. If you are unsure how to set this up in your database package, you should ask your tutor.

At the end of the season, a card similar to this will be produced for all 64 plots on the allotment site.

**Notes:** This is a simplified example that would have limited use in reality.

Following a process of Normalisation, four tables have been designed as follows:

<b>PLOT</b>
Plot Number (PK)
Plot Size
Member Number (FK)

<b>MEMBER</b>
Member Number (PK)
Member Forename
Member Surname

<b>PRODUCE</b>
Vegetable Name (PK) (FK)
Plot Number (PK) (FK)
Yield

<b>VEGETABLE</b>
Vegetable Name (PK)
Society Record

The finished database should have the following features:

- Four tables with suitable test data entered.
- A form for adding details of a new member.
- A form for adding details of a vegetable grown by a member.

- A query that shows all the vegetables grown by a particular member.
  - A report like the card shown above, showing the plot, member and vegetables grown.
- .....

## 1.7 Learning points

### Summary

You should now know:

- How to describe the structure of a database in terms of tables, records and fields.
- The advantages of using relational databases.
- The purpose of primary and foreign keys.
- The differences between one-to-one, one-to-many and many-to-many relationships.
- The purpose and uses of tables, forms and reports.
- What is meant by a relationship in a database.
- How to perform complex operations, such as performing a query, creating a form, creating a report.
- A calculated field is one which is created using a formula from one or more existing fields.

## 1.8 End of topic test



10 min

### End of topic test

**Q21:** Which of the following is the correct definition of a primary key?

- a) The longest field within a record.
  - b) The shortest field within a record.
  - c) The unique field within a record.
  - d) The field that is the same for all the records.
- .....

**Q22:** Which of the following is the correct definition of a foreign key?

- a) The unique field within a record.
  - b) A field that is the primary key of another table.
  - c) The most important field in a table.
  - d) A field in a foreign language.
- .....

**Q23:** Which of the following is NOT a type of relationship?

- a) Many-to-many
  - b) One-to-many
  - c) One-to-several
  - d) One-to-one
- .....

**Q24:** How is a **form** commonly used within a database?

- a) Several records can be viewed at a time on a form.
  - b) A form can be used as a front end.
  - c) A form is often used for printing.
  - d) All the records can be included in a form.
- .....

**Q25:** Which of the following is an advantage of a relational database?

- a) Several tables make it harder to hackers to steal information.
  - b) Data duplication is eliminated, reducing the chance of errors.
  - c) A mistake in one table will not affect your database's accuracy.
  - d) Data is held in multiple tables, making it less likely to be lost.
- .....

---

## Topic 2

# Structures and links (Web-based)

---

### Contents

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Internal and External Hyperlinks*
  - *Relative and Absolute Addressing*
  - *Navigational structures, e.g. Linear and Hierarchical*
  - *Web Browsers*
  - *Search Engines*
  - *Usability*
  - *Accessibility*
  - *User Requirements*
    - *Visual Layout*
    - *Consistency*
    - *Interactivity*
    - *Readability*
-

**Learning objectives**

By the end of this topic you should be able to:

- *explain multi-level structures;*
- *describe a web page structure;*
- *explain the purpose of a style sheet;*
- *explain how Cascading Style Sheets work;*
- *discuss the advantages of using style sheets;*
- *explain the purpose of metadata and meta tags;*
- *describe what information is contained in the metadata of a web page;*
- *compare a static and dynamic web page;*
- *describe a database-driven website;*
- *explain the advantages of using dynamic websites;*
- *explain what is meant by interactive web page.*

In this topic you will learn how websites can be structured and created, and the different types of website that can be created.

## 2.1 Introduction

### Learning objective

By the end of this section you should be able to:

- explain the terms commonly used in web design.

In this topic you will look at how web pages are structured and the different types of websites that are commonly used.

A website is a group of web pages that are linked together. They are usually about one topic. Web pages are normally linked by either hyperlinks, or hot spots. The first page in a website is called the homepage. A homepage gives a description of what the rest of the site is about and has links to all the other pages.

Web pages use a combination of multimedia elements, including text, images, videos, sound and animation. This helps to make the website interactive and encourage visitors.

### Quiz: Introduction

Answer the following questions:

**Q1:** Explain the difference between a website and a web page.

.....

**Q2:** Describe a homepage.

.....



10 min

## 2.2 Site structure: Multi-level

### Learning objective

By the end of this section you should be able to:

- explain a multi-level structure.

Navigation of a website describes how the user moves around the website, and what order they will visit pages in. Navigation can be achieved by the user clicking on hyperlinks or hotspots, clicking on buttons, or selecting options from a menu.

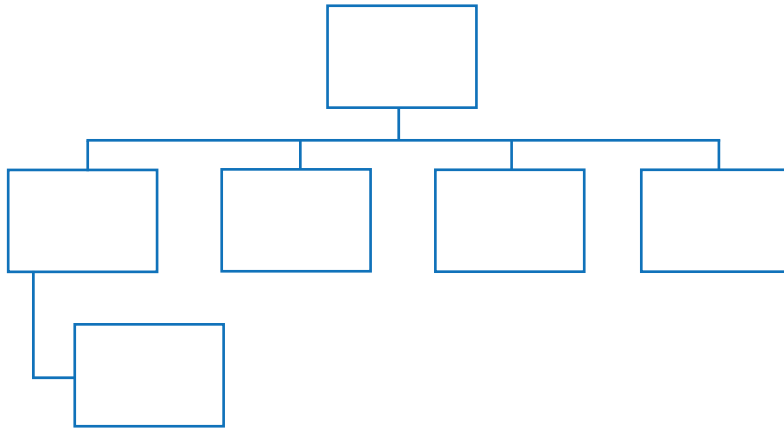
From your studies at National 5, you may have learned about **linear** and **hierarchical** navigational structures.

Figure 2.1 shows a linear structure

*Figure 2.1: Linear structure*

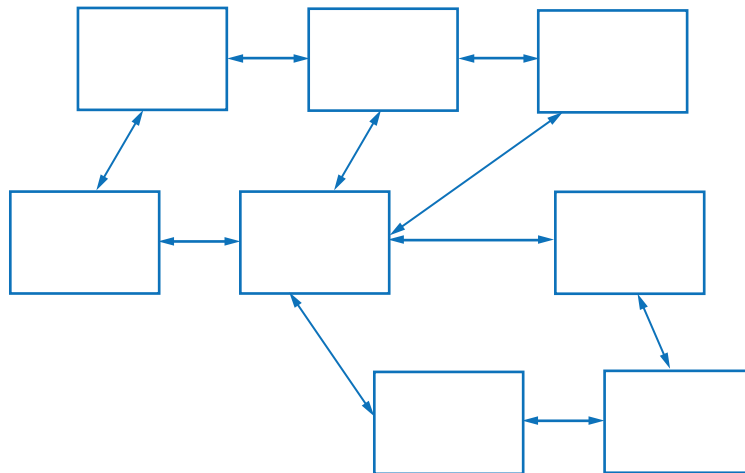
.....

Figure 2.2 shows a hierarchical structure

*Figure 2.2: Hierarchical structure*

.....

Linear and Hierarchical navigation structures are simplistic models of how pages can be organised in a website. In reality, links between pages (and even external sites) can be much more complex. A hierarchical structure may underlie the site, but in reality there will be many ways of navigating through the content.

*Figure 2.3: A more realistic site structure*

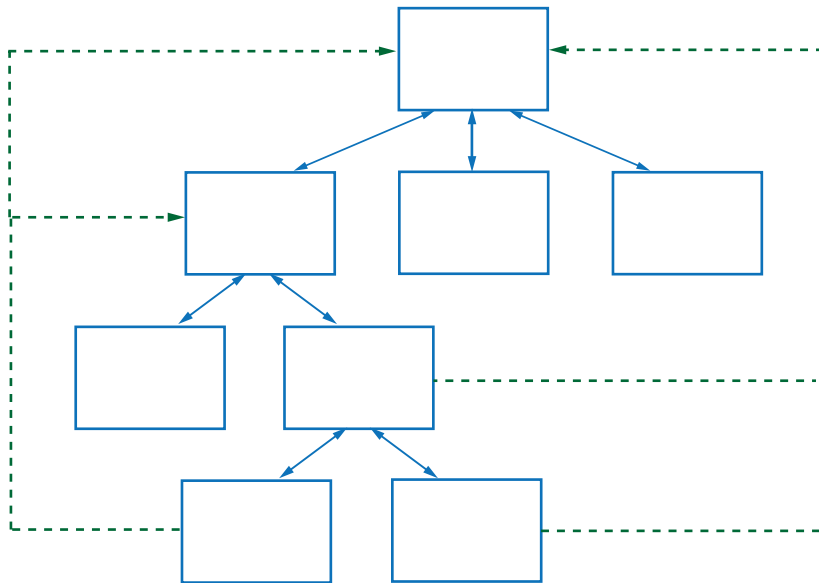
.....

'Multi-level' navigation is often used to organise pages in a logical fashion, meaning that



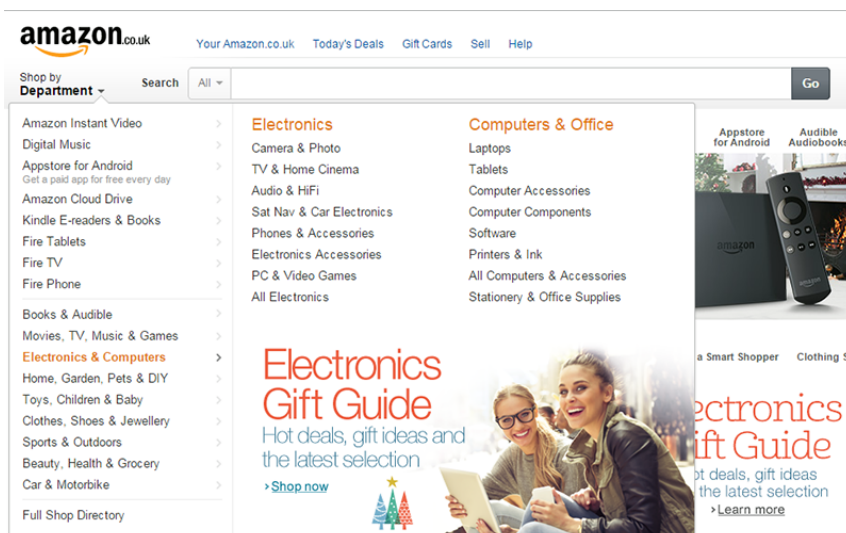
hierarchical structures are extended to include sub-pages, sub-sub-pages, and so on. Often it is possible through the use of menus to return 'up' several layers in one click, though it may have taken several clicks to get to the page you are on. (As a general rule of thumb, most users get fed-up if it takes more than 3 clicks to find the page required - another challenge for designing a good navigation structure).

Figure 2.4: Multi-level navigation, showing the multiple return paths



Database-Driven websites are discussed in more detail later in this chapter, however it is worth mentioning at this stage that the navigation structure presented to the user is often 'artificial'.

Consider the menu shown on this well-known online retailer:



If you were looking for a page about 'Software' it would appear that it is organised

hierarchically: Home page > Electronics & Computers > Software. In actual fact however each hyperlink in the menu is an in-built database query. When the user clicks on the 'software' hyperlink, a generic 'results' page is loaded and populated with results from the Amazon database where the category = 'software'. Further options will be presented if the user wishes to refine the results.

### 2.2.1 Navigational aids

A major aspect of designing navigation structures is considering how users will be informed of their location within the website. There are a number of techniques to achieve this.

You need to ensure that the presenters cannot get confused when navigating your website. With this in mind you will have to consider a number of navigational aids to ensure the presenters cannot get confused.

**History** - A complete list of all nodes or links that have been visited. Each previous screen is represented once in the history file. The user can return by simply clicking on the relevant highlighted link. The history file will only contain recently visited links and will not contain older links.

**Breadcrumbs** - A 'trail' which has been left and can lead the user back to wherever they have originated.

**Highlighting (nodes/links)** - Clicking on hyperlinks to follow links to different screens. They will change colour once they have been selected.

**Backtracking**- Use of a back button which will link to the last screen visited.

**Bookmarks** - A list of pages that have been selected and saved by the user so that they can visit these pages again.

---



5 min

#### Quiz: Site structure

Answer the following question:

**Q3:** Explain the difference between a linear structure and a hierarchical structure. You may include a diagram.

.....

**Q4:** Explain what is meant by a 'multi-level' structure.

.....

**Q5:** Explain why 'breadcrumbs' may be useful in a multi-level navigation structure.

.....

## 2.3 Basic page structure

### Learning objective

By the end of this section you should be able to:

- describe the structure of a web page.

When you are using HTML to create a web page it is important that the page is structured correctly in order for the page to be displayed properly. All web pages should include a head, title and body.

HTML code breaks a document down into two main sections, the head and the body. You will have used these tags before when you have created web pages. The title tag is a compulsory tag that is contained inside the head section.

The **head** section contains metadata (covered in more detail in section 1.5), which is data that describes the document, and may link it to a style sheet or javascript file.

The **title** is a compulsory part of a document as it identifies the document's name. The title will also appear in the window title of the web browser when it is viewed. It is a very important piece of information in terms of providing a meaningful summary of the page for the search engines, which display the title content in the search results.

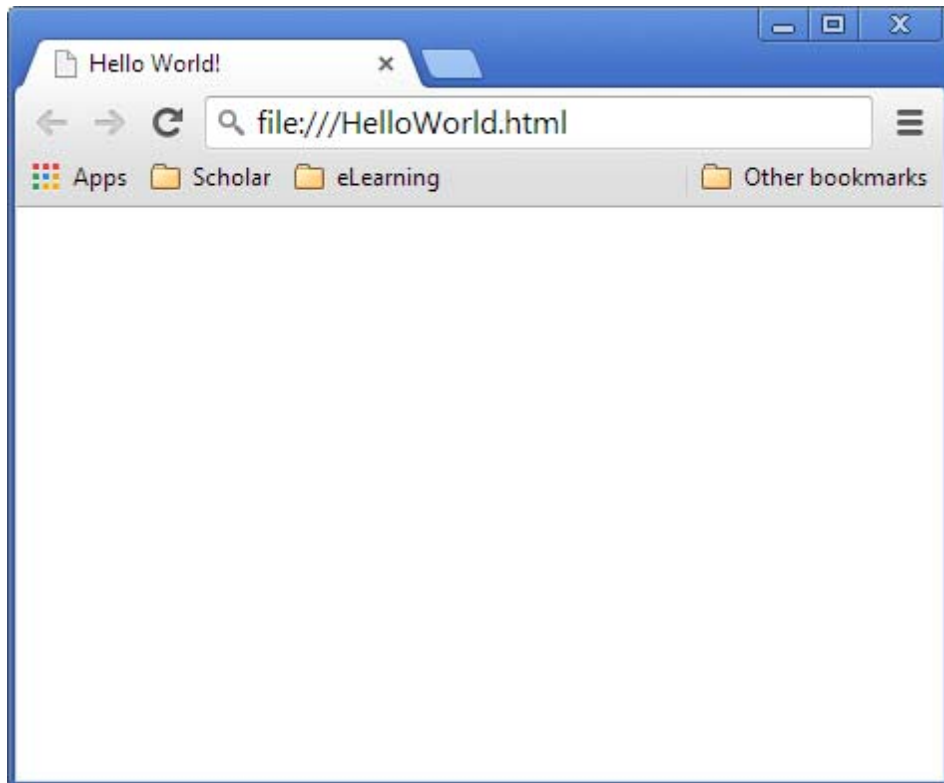
For example, the following HTML code:

```
<html>
  <head>
    <title>Hello World!</title>
  </head>
</html>
```

*This file (hg-2013cmp2-2-3htmlhelloWorld.txt), can be downloaded from the course web site.*

Displays the following web page:

Figure 2.5: What the web page should look like



.....

The **body** element of the html code is where all other information is contained. Anything that the user wishes to be displayed on the web page should be contained in this section. This section can contain paragraphs, lists, images, tables and many other elements.

This is a very basic introduction to the HTML markup language used. If you are not fully familiar with this from a previous course, it would be a good idea to use one of the many free on-line resources for learning HTML. Two particularly good ones are:

An in-depth, step-by-step tutorial - [www.codecademy.org](http://www.codecademy.org)

Reference guides and focussed tutorials - [www.w3schools.com](http://www.w3schools.com)

**Practical task: Basic page structure**



10 min

1. Using a text editor, create the following code:

```
<html>
<head>
<title>My First HTML Web Page!</title>
</head>
<body>

<h1>My First Heading</h1>

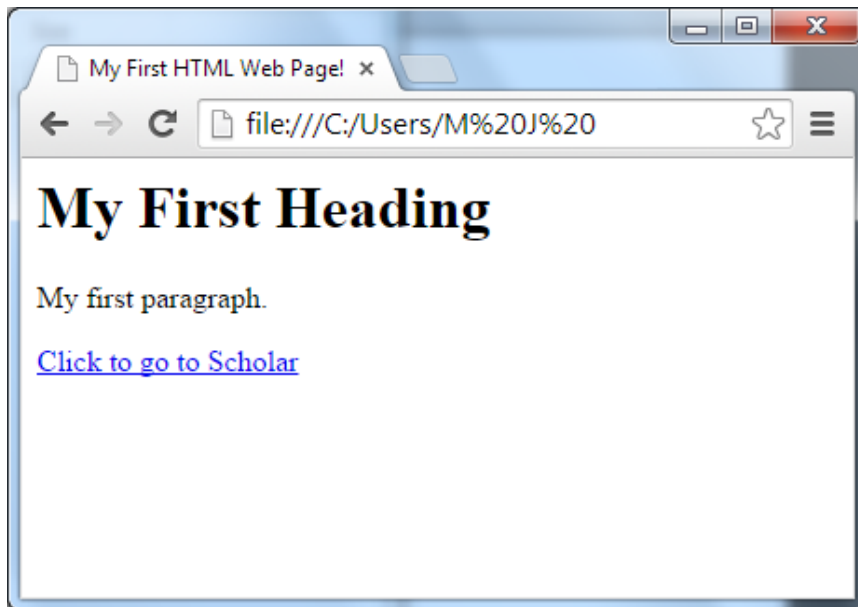
<p>My first paragraph.</p>

<p><a href="http://sholar.hw.a.uk/scotland/">Click to go to Scholar</a></p>
</body>
</html>
```

2. Save as structure.html

3. Preview in your browser. Check that the hyperlink works correctly. Check that the title is displaying correctly in the title bar.

Figure 2.6: What the web page should look like



.....

**Quiz: Basic Page structure**

Answer the following questions:



5 min

**Q6:** What can be included in the head tag?

.....

**Q7:** Where would you find the title tag and what is its purpose?

.....

**Q8:** What is included in the body tag?

.....



### Activity: Web page structure

**Q9:**

5 min

Use the words to complete the sentences:

- Metadata
- Web page
- Title
- Head
- Body

The \_\_\_\_\_ is the first section of an HTML page. It contains the \_\_\_\_\_ tag, which is a compulsory tag.

This section can also contain \_\_\_\_\_.

The \_\_\_\_\_ section contains all the information that is to be displayed on the \_\_\_\_\_.

.....

## 2.4 Content structuring

Page contents (the text between the `<body>` and `</body>` tags) also need to be structured correctly. Our first example only had two areas on the page - a level 1 heading (`<h1>`) and a paragraph (`<p>`). These are fine for simple text pages, but modern web pages allow different areas of the page to be defined.

Here is an example of a page that contains a heading, navigation, the main content, a sidebar and a footer.

```
<html>
  <head>
    <title>Example of a structured HTML page</title>
  </head>
  <body>

    <header>
      <h1>Scholaria Coin Collectors Club</h1>
    </header>

    <nav>
      <ul>
```

```
<li><a href="index.html">Home page</a></li>
<li><a href="meetings.html">Meetings</a></li>
<li><a href="location.html">Find Us</a></li>
</ul>
</nav>

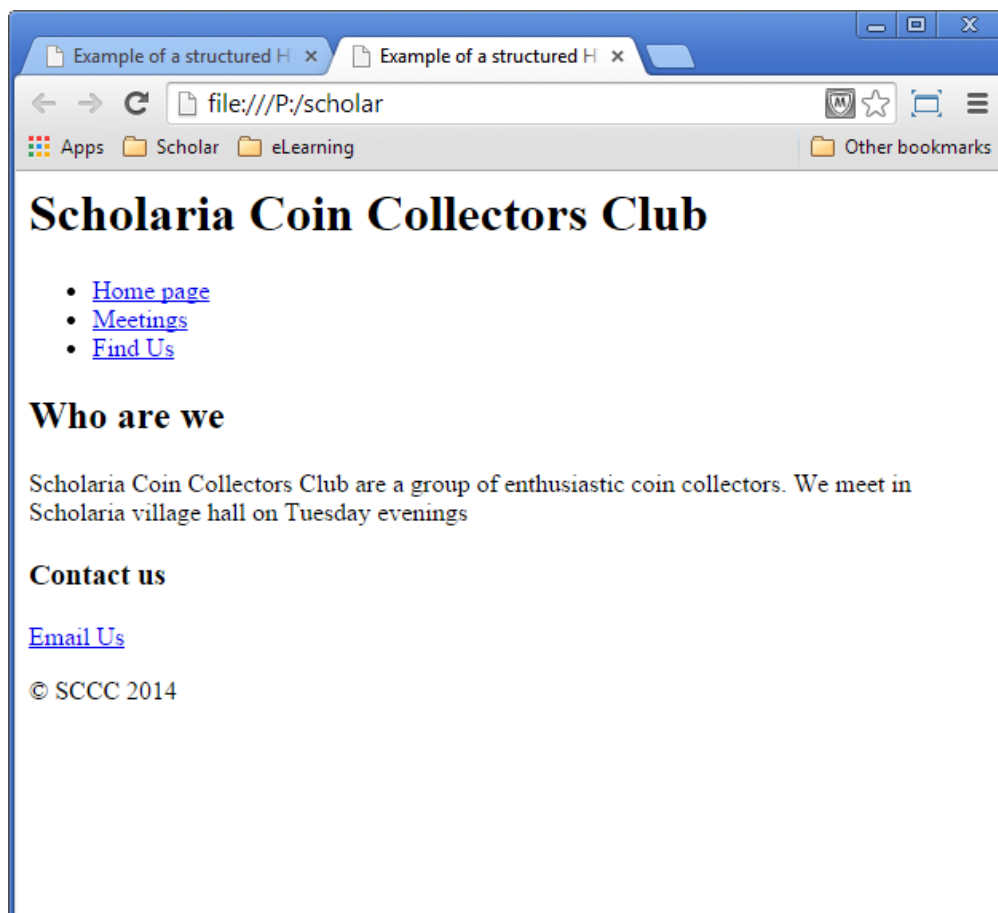
<main>
  <h2>Who are we</h2>
  <p>Scholaria Coin Collectors Club are a group of enthusiastic coin
    collectors. We meet in Scholaria village hall on Tuesday evenings</p>
</main>

<aside>
  <h3>Contact us</h3>
  <p><a href="mailto:mail@sccc.co.sc">Email Us</a></p>
</aside>

<footer>&copy; SCCC 2014</footer>

</body>
</html>
```

Here is the rendered page in a browser:



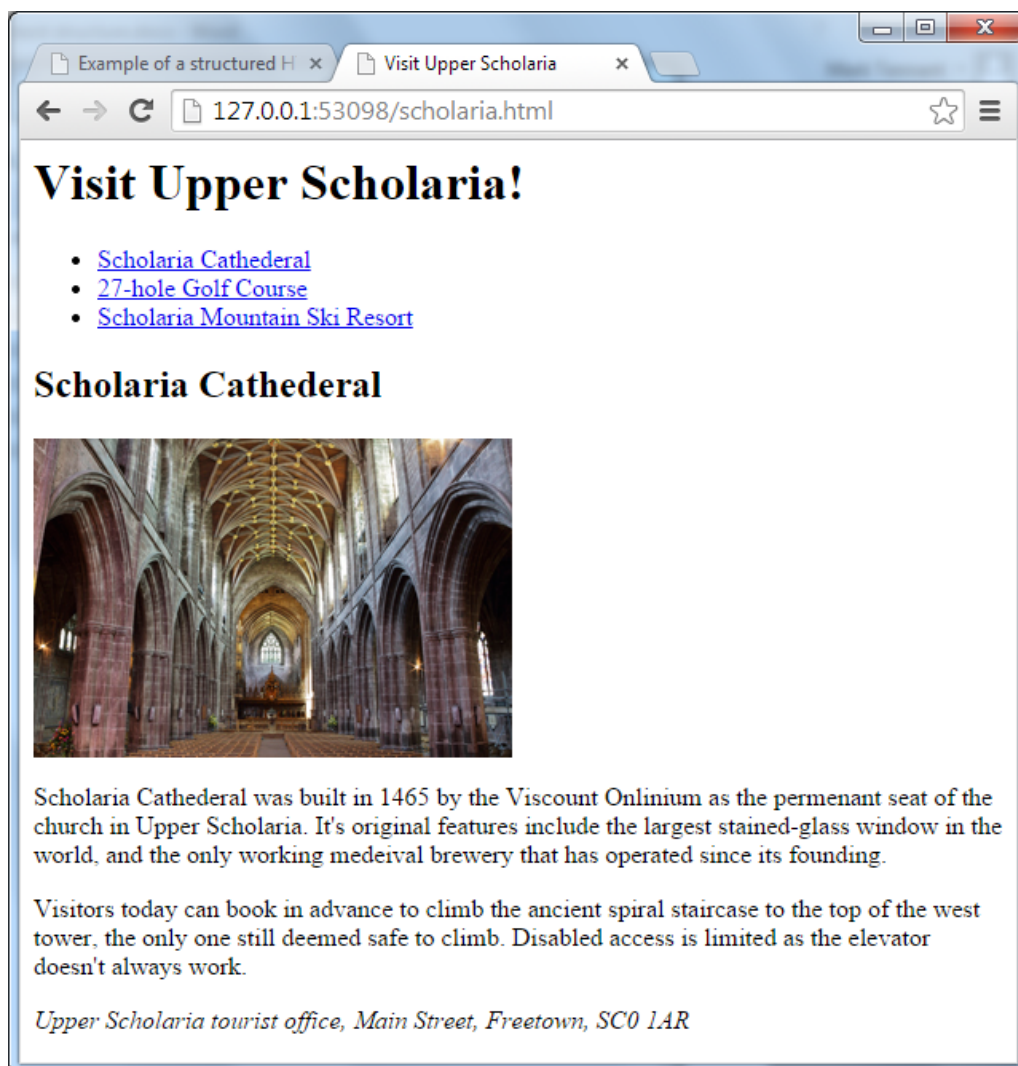
You will notice that the page still looks very plain and 'linear' when viewed in a browser. That's because HTML is only used to describe the structure and contents of the page. To change the layout and looks of the page another supporting language called CSS - Cascading Style Sheets - is needed. There is more about this language coming up in this topic.



30 min

### Practical task: Visit Upper Scholaria!

Using a text editor, create a 3 page website encouraging visitors to explore the (fictitious!) region of Upper Scholaria's best landmarks: The Cathedral, the Crazy Golf Course and the Ski Resort.



You should include the following:

- A suitable heading area
- A navigation menu for each of the 3 pages
- A main area with a picture
- A footer with the tourist board address and email.



Let your imagination go wild! (The place is fictitious, after all!).

Later on, we will use CSS to make the pages look more appealing.

.....

## 2.5 Cascading Style Sheets (CSS)

### Learning objective

By the end of this section you should be able to:

- explain the purpose of a style sheet;
- explain how Cascading Style Sheets work;
- discuss the advantages of using style sheets.

HTML is designed to define the content of a web page but not the format. So the World Wide Web Consortium (WC3) created CSS. All modern browsers support CSS files so they should always be able to display the web pages correctly. CSS is a standard way of implementing and displaying web pages that use style sheets.

CSS stands for **Cascading Style Sheets** and they define how the different elements of a web page are to be displayed. In effect every web page created in this way has two files. One which contains **what** is to be displayed and another that explains **how** it is to be displayed. Styles are saved in a .css file.

The advantages of CSS are:

- The layout of many documents can be controlled from one style sheet.
- The user gets a more precise control over layout than by using HTML tags.
- The user can apply different layouts to different media types, screen or print etc.

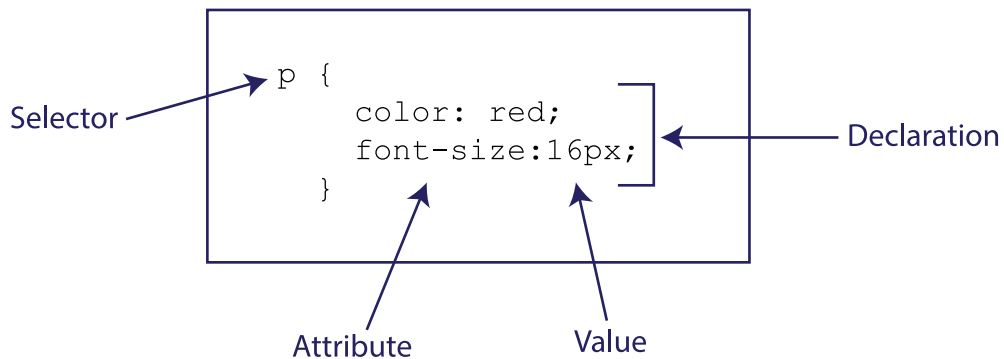
Websites have to be able to be viewed on a variety of different devices and screen sizes and CSS can help with this. CSS can create rules for different devices that have different screen widths so that the website will display slightly differently on each device. This ensures that the user is always viewing the website correctly.

If a style sheet is created for a web page then the programmer does not need to insert hundreds of different tags for formatting. If the design is to be changed then it is only the style sheet that needs to be changed - not the entire website.

### How CSS works

CSS is a formal language - like any programming or markup language - that has a defined syntax. CSS is made up of rules which define how a particular part of the page will look. A CSS rule is made up of a selector (which identifies the part of the HTML page affected), followed in 'curly brackets' by a declaration. The declaration consists of one or more attributes and the value for each attribute.

Figure 2.7: CSS structure



There are many types of selector, though the 3 most common ones are:

- **Element selectors:** These directly affect an HTML tag of the same name, so they are simply the name of the tag as a piece of text. The example in Figure 2.7 would be applied to all the `<p>` tags in the page.
- **ID selectors:** These start with a # symbol and will only affect an HTML tag where the ID attribute matches the text following the # symbol. They are normally only used to affect one particular tag, so the ID should be unique to that tag. For example:

```
#offer { font-weight: bold; font-size: 20px; }
```

would affect only this paragraph section in the HTML document:

```
<p id="offer">New offers on flights to Upper Scholaria</p>
```

- **Class Selectors:** These start with a full-stop (.) and apply to HTML tags where the class attribute matches the text following the full-stop. They are similar to ID selectors, but can apply to multiple HTML sections. For example:

```
.centered { text-align: center; }
```

could be applied in the HTML document like this:

```
<h1 class="centered">This heading will be centred</h1>
<p class="centered">This is also centred text</p>
```

Although it is best to keep CSS styles in a separate .CSS file, it is possible to apply styles to elements within a single web page if required. There are three ways that you can apply CSS to a web page. Firstly, you can use the style attribute in an HTML tag. An example of this is shown in Figure 2.8

*Figure 2.8: HTML style attribute*

```

<html>
  <head>
    <title>Option 1</title>
  </head>
  <body style="background-color: #FF0000;">
    <p>This is a red page</p>
  </body>
</html>

```

*This file (hg-2013cmp2-2-7htmlStyle.txt), can be downloaded from the course web site.*

.....

Notice that there is no need for a selector here - the declaration is placed between the speech marks and will only apply to the current tag (in this case, the <body> of the document).

Secondly, you can include the HTML tag <style> in the <head> section, as shown in Figure 2.9

*Figure 2.9: HTML style tag*

```

<html>
  <head>
    <title>Option 2</title>
    <style type="text/css">
      body {background-color: #FF0000;}
    </style>
  </head>
  <body>
    <p>This is a red page</p>
  </body>
</html>

```

*This file (hg-2013cmp2-2-8htmlStyleTag.txt), can be downloaded from the course web site.*

.....

However, if the web site contains several different pages or a lot of information then this could be a lot of work for the creator. If it was then necessary to change the theme of a web site then thousands of tags would need to be changed individually - causing a lot of work and stress! HTML was never really designed to include formatting tags and so a different approach is necessary.

The third option is that you can create your external (separate) **style sheet** and then link the style sheet to each HTML page. This is the recommended method.

For this example let's say that you have a style sheet called style.css and it is located in a folder called style. Linking the style sheet to the HTML code only uses one line of code:

```
<link rel="stylesheet" type="text/css" href="style/style.css" />
```

Which needs to be inserted in between the <head> and </head> as shown in Figure 2.10

*Figure 2.10: HTML link to style sheet*

```
<html>
  <head>
    <title>My document</title>
    <link rel="stylesheet" type="text/css" href="style/style.css"/>
  </head>
</html>
```

*This file (hg-2013cmp2-2-9LinkhtmlStyle.txt), can be downloaded from the course web site.*

.....

This link tells the browser that it should be using all the style information that is stored in the .css file to display the web page. As several HTML documents can all be linked to the same .css file developers can save themselves a lot of time and effort.

### 'Cascading' rules

The three methods of using CSS above have an order of priority, can be used to over-rule each other (this is where the 'cascading' part of the name comes from).

The linked style sheet (Figure 2.10) is the 'least' important - any attribute changed in the <head> section or a tag's style attribute will over-rule a definition here. The style sheet in the <head> section is the second most important; only attributes changed in the tag's style attribute will over-rule these. The style attribute is the most important - anything here will over-rule all other CSS rules. You can try this to test the theory:

```
<html>
<head>
  <style type="text/css">
    body { background-color: blue; }
  </style>
</head>
<body style="background-color: red;">
  <p>What colour page am I?</p>
</body>
</html>
```

When loaded you should see a red page background. delete the style attribute from the <body> tag - the page should now be blue, as specified in the head section.

## Practical task: Scholaria Coin Club CSS

Here is an example of a style sheet that could be applied to the Scholaria Coin Collectors Club website shown earlier. To link it to that file, you would have to add in the line



30 min

```
<link rel="stylesheet" type="text/css" href="styles.css">
```

into the <head> area.

```
header {
    background-color: #000;
    height: 80px;
}
h1 {
    font-family:sans-serif;
    color: #acf;
    text-align: right;
    padding: 10px;
}
nav {
    background-color: #acf;
    color: #000;
}
main {
    width: 79%;
    float: left;
    background-color: cff;
}
aside {
    float:right;
    width: 20%;
    background-color: #acf;
}
footer {
    clear: both;
    background-color: #000;
    color: #fff;
    height: 30px;
    text-align: center;
}

h2, h3 {
    font-family: cursive;
}
p {
    font-family: sans-serif;
}

nav ul {
    list-style-type: none;
```

```

}
nav ul li {
display: inline;
}
li>a {
float: left;
width: 100px;
background-color: #acf;
color: #000;
font-family: sans-serif;
}
li>a:hover {
background-color: #00f;
}

```

*This file (hg-2013cmp2-2-10htmlStylesheets.txt), can be downloaded from the course web site.*

**Note:** One of two of the items in the above example aren't obvious. 'li>a' is a special selector that means 'Apply this rule to only the <a> tags that immediately follow a <li> tag (i.e. only the navigation ones). :hover only applies when the mouse is hovered over the link, giving feedback to the user via a colour change. 'Float:' is a property that lets content wrap around the section, and is used here to display the main section on the left and the sidebar (aside) on the right.

.....



30 min

### Practical task: CSS Style Sheet for 'Visit Upper Sclaria' website

Using the example above, and online reference material (such as [www.w3schools.com](http://www.w3schools.com)), create a style sheet for your 'Visit Upper Sclaria' website from the previous practical activity. Feel free to experiment with different properties for sections, fonts, colours and effects.

Remember to save the CSS file with a sensible filename, ending with .css and add in the <link> tag to the head section of each of the 3 pages to apply your CSS file to each page.

.....



5 min

### Quiz: Style sheets and CSS

**Q10:** Describe three advantages of using a style sheet in a website.

.....

**Q11:** What is meant by a selector when writing CSS rules?

.....

**CSS Media Queries**

One last area of CSS that is worth considering is the ability to write rules that will apply to particular types of media: screen, print, screen reader software, etc. This has become an increasingly important area of design as web designers strive to create sites that are not only accessible, but can re-adjust themselves to best suit the device the user is using. This is called **responsive web design**.

**Practical task: Scholaria Coin Collectors Club on a mobile screen!**

If you look back at the Coin Collectors Club task earlier, you will notice that the page is presented as two columns: a main area (79% of the width) and a sidebar (20% of the width). This layout is common - and practical - for traditional computer screens, but not really a good idea on a smartphone; 25% of a 500 pixel-wide screen is not very wide!



10 min

*Figure 2.11: Not very good layout on a mobile browser*



.....

We can use CSS media queries to identify a set of rules that will only apply to screens over a particular size. Edit the main { } and aside { } rules so that they are inside a media query like so:

```
@media screen and (min-width: 500px) {
  main {
    width: 79%;
    float: left;
    background-color: cff;
  }
  aside {
    float:right;
    width: 20%;
    background-color: #acf;
  }
} /* end of media */
```

Figure 2.12: Media query removes the two columns on a mobile device



Now, the layout rules will only apply on screens wider than 500 pixels. You can try this by resizing your browser window; drag one side so that it becomes narrower than 500 pixels and see what happens.

Responsive sites are usually built for mobile devices first, with media queries being used to add-in additional layout features to make the most of larger screens. 'Blocks' or sections of the site can be stacked on top of each other when displayed on a mobile screen, but arranged into columns on a desktop screen.



## 2.6 Metadata

### Learning objective

By the end of this section you should be able to:

- explain the purpose of metadata;
- describe what information is contained in the metadata of a web page.

You will already have learned about Metadata in the Structures and Links (Databases) topic.

**Metadata** is data that is used to describe other data and can be found within the head section of a web page. A web page might include metadata about what language it was written in, file size, time and date of creation, and a link to a style sheet or author. It is easier to find a specific document if you can search through the metadata instead of having to search the entire internet.

Metadata for web pages contains descriptions of the page contents, as well as keywords linked to that content. These are usually expressed in the form of meta tags. The metadata containing the web page's description and summary is often displayed in search results by search engines, making its accuracy and details very important since it can determine whether a user decides to visit the site or not.

### Practical task: Metadata

1. Go to <http://scholar.hw.ac.uk/Scotland>
2. Select the View Source option in your browser. (Right-click in most browsers - ask your teacher if this does not work).
3. See if you can find the metadata for this web page.
4. Try to find the metadata on two other websites of your choice.



20 min

.....

Meta tags are often evaluated by search engines to help decide a web page's relevance to a search, and were used as the key factor in determining position in a list of returns until the 90s. The increase in search engine optimization towards the end of the 1990s led to many websites "keyword stuffing" their metadata to trick search engines, making their websites seem more relevant than others. Since then search engines have reduced their reliance on meta tags, though they are still factored in when indexing pages. Many search engines try to stop web pages from manipulating results by regularly changing their criteria for rankings, with Google being notorious for frequently changing their ranking algorithms.

Metadata can be created manually, or by an automated process. Manual creation of metadata tends to be more accurate, allowing the user to input any information they feel is relevant or needed to help describe the file. Automated metadata creation can be much more elementary, usually only displaying information such as file size, file extension, when the file was created and who created the file.



10 min

### Quiz: Metadata

Answer the following questions:

**Q12:** Explain what is meant by the term metadata.

.....

**Q13:** Why should web pages include metadata and meta tags?

.....

**Q14:** Where would you find metadata?

.....

**Q15:** What is keyword stuffing?

.....

**Q16:** Is it more accurate to create metadata manually or automatically?

.....

**Q17:** Why do some companies choose to manipulate their web pages metadata?

.....

## 2.7 Dynamic web pages and database-driven websites

### Learning objective

By the end of this section you should be able to:

- compare a static and dynamic web page;
- describe a database-driven website;
- explain the advantages of using dynamic websites.

In order to understand **dynamic web pages** it is first necessary to understand a static web page. A **static web page** is one that does not change every time it is loaded, or if the user clicks on a button. They look the same and the content does not change unless the hyperlink is clicked or a new version of the web page is uploaded.

A dynamic web page is a web page that displays different content each time it is viewed. For example, the web page may change with the time of day, the user that accesses the web page, or the type of user interaction. A user searching for flights to Madrid may find that prices and availability change regularly.

Dynamic web pages will respond to information that is entered by the user, should always be up to date and will contain information specific to every user.

There are two types of dynamic web pages:

- Client-Side Scripting
- Server-Side Scripting

More information on client side scripting and server side scripting can be found in the Coding topic.

One of the most common ways to implement a dynamic web page is to use a database-driven website. A **database-driven website** is one that pulls information from a database each time that it is loaded. If the information in the database were to change then the information on the web page would change, without anyone having to manually change the web page.

For example, if you log into your online banking account you will see up to date information about your bank account - recent transactions, balance. This information has not been manually added to a web page and displayed to the user - that would take a long time and involve too much work. The information has been pulled from a database and added to the web page automatically.

Database-driven websites are very useful if the content of the website is likely to change regularly, perhaps on websites where users want to check stock levels, or book flights. Having up to date information is essential for most websites.

**Quiz: Dynamic web pages and database-driven websites**

Answer the following questions:



10 min

**Q18:** Explain the difference between a dynamic and a static web page.

.....

**Q19:** Give an example of a web site that would need to be dynamic.

.....

**Q20:** How does a database-driven website allow web pages to be dynamic?

.....

## 2.8 Interactive web pages

### Learning objective

By the end of this section you should be able to:

- explain what is meant by the term interactive website.

When web pages were first designed they only included text. Nowadays even a simple web page will contain colours, a background, formatted text, pictures, hyperlinks, hotspots, tables, videos and sound. This makes a web page more interesting to look at and can encourage people to read the information if it is displayed in a user-friendly way. The inclusion of multimedia elements in web pages has made information more accessible to a greater range of users.

An **interactive web page** is one that the user can interact with. This means that the user can click on buttons and links, watch videos and animations or play simple games. A user will spend more time on an interactive website.

For example, if one of the questions in this topic is an interactive activity, such as dragging and dropping words, or matching pairs, then the user (you) is more likely to enjoy the activity and to take part in them.



10 min

### Quiz: Interactive web pages

**Q21:** What do you think makes a website interactive? Give examples.

.....

## 2.9 Learning points

### Summary

You should now know:

- That websites can be structured in a linear format, or in a hierarchical format.
- Website structures can be very complex, multi level formats.
- All web pages will contain a head, title and body.
- Style sheets allow us to separate the look and feel of a web page from its content and structure.
- Style sheets allow us to make sure web pages are consistent in appearance.
- Web pages can be structured into different sections using specific tags such as `<header>` `<main>` and `<footer>`.
- CSS is a standard way of implementing style sheets.
- CSS consists of rules. They are made up of a selector and a group of attributes called the declaration.
- Metadata is found in the head section of a web page.
- Metadata is used to give information about a web page, date created, author, contents etc.
- Static web pages do not change very time they are loaded.
- A dynamic page is one that contains information that will change each time the page is loaded.
- Database-driven websites are a simple way of changing the information that is displayed in a web page.
- An interactive web page is one that requires the user to click on buttons or other elements and interact.

## 2.10 End of topic test



10 min

### End of topic test

**Q22:** Cascading Style Sheet rules consist of which items?

- a) A selector and a closing tag.
- b) An opening and closing tag.
- c) A selector followed by attributes with values.
- d) A value followed by selectors.

.....

**Q23:** Which of the following could be included in the metadata for a web page?

- a) The author's birthday.
- b) The date created.
- c) Information for search engines.
- d) The author.

.....

**Q24:** Dynamic web pages have data that can change every time it is loaded?

- a) True
- b) False

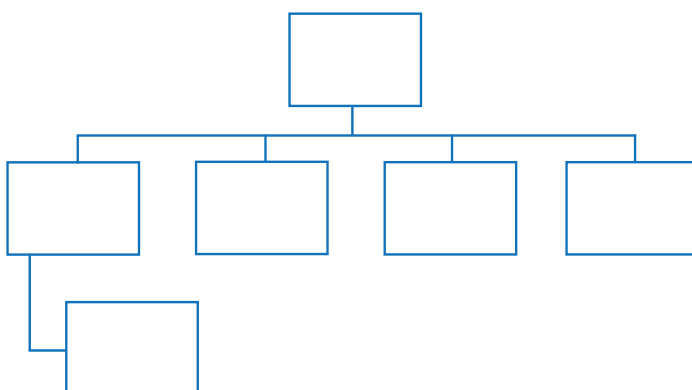
.....

**Q25:** Interactive web pages are a way of involving the user in a web page and encouraging them to spend more time on the website.

- a) True
- b) False

.....

**Q26:** What kind of structure design is the following?



- a) Linear
- b) Hierarchical

.....

**Q27:** Meta tags can include keywords that are picked up by search engines.

- a) True
- b) False

.....

.....





---

## Topic 3

# Media types

---

### Contents

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Standard file formats:*
    - *Sound, wav, mp3;*
    - *Graphics, bmp, gif, jpeg, png;*
    - *Video, mp4, avi;*
    - *Text, txt, rtf;*
    - *Pdf.*
  - *Graphic properties:*
    - *Resolution;*
    - *Colour depth;*
    - *Calculating file sizes for colour bitmaps.*
  - *Sound properties:*
    - *Sampling rate;*
    - *Sampling depth.*
  - *Factors affecting file size and quality;*
  - *Need for compression.*
-

**Learning objectives**

By the end of this topic you should be able to:

- *explain the need for standard file formats;*
- *discuss the reasons why compression is necessary;*
- *know the possible effects of applying compression to media files;*
- *explain the difference between lossy and lossless compression;*
- *know the advantages and disadvantages to each type of compression;*
- *discuss factors affecting the size of sound files;*
- *explain how sound files can be compressed;*
- *explain how the file size of images can be reduced;*
- *state which file types use lossy or lossless compression;*
- *explain how the size of a video file could be reduced;*
- *describe the mpeg video file format.*

In this topic you will look at the different types of media that are stored in memory and the different ways that they can be compressed. You will look at two different types of compression, lossy and lossless, and the reasons for compression.

### 3.1 Introduction

**Learning objective**

By the end of this section you will be able to:

- explain the need for standard file formats.

Computers are used to store many different media types, including, text, sound, graphics and video. All forms of media are stored using different file formats and these file formats often have **compression** applied in different ways.

As information is passed between many different types of computers standard file formats were invented. A **standard file format** is a way of saving a file so that it can be opened up in different programs, without loss of quality. This can be especially useful if files are being emailed or downloaded over the internet.

For example, a word processing document could be stored as a txt file, or an rtf (rich text file) file. These are both standard file formats and they would allow the document to be opened up in any word processing package. A txt file is a basic word document, whereas an rtf (rich text file) would allow all the formatting information about the document to be passed and displayed correctly.

**Practical task: Standard file formats**

**Q1:** Match the media types to the standard file types in the following table.

- Txt
- gif
- wav
- jpeg
- rtf
- mpeg
- png
- Mp3
- Avi
- Bmp



5 min

Media Types	File type
Sound	
Video	
Graphics	
Text	

.....

## 3.2 Compression

### Learning objective

By the end of this section you will be able to:

- discuss the reasons why compression is necessary;
- know the possible effects of applying compression to media files.

Graphics, sound and video files can often have a very large file size and this means that they can take up a large amount of memory. In order for these files to be emailed, downloaded over the Internet, or to be saved to backing storage devices they are compressed. If a web page contains several uncompressed images then it may take a long time to load. If it takes a long time to display the images the viewer may become bored and click onto another web page.

Here is an example of why compression is important. Consider a HD movie being streamed to a smart-tv device. HD movies will have a resolution of 1920 by 1080 pixels, using 24 bits per pixel for colour and a frame rate of 50fps. This means:

$$1920 \times 1080 \times 24 \times 50 \text{ bits per second}$$

$$= 2488320000 \text{ bits per second}$$

$$= 2.3\text{Gbps.}$$

Oh, and that figure doesn't allow for the soundtrack which must also be included.

The bandwidth available in your home is probably measured in the order or a few Mbps (Mega Bits Per Second) , which is why compression must be applied to successfully stream the movie. (Or even download it in a reasonable amount of time).

Compression means that the overall size of a file is reduced. This means that files are faster to download or transmit and that more files can be stored on a backing storage device. You will learn about two compression types, lossy and lossless in Topic 3.3.

Compression will reduce the size of a file but it may also have other, unwanted effects. If a file is compressed too much then the quality of the file may be affected. If a picture has too much compression applied then it will become pixelated or blurry (depending on the compression type). It may not display clearly as it no longer has enough colours available. If a sound has too much compression applied then it could sound tinny or of very low quality. If a video has too much compression applied then it might become jerky and difficult to watch. It is important to find the balance between reducing the file size and not reducing the quality of a file too much. Compression will also take up processor time, meaning media may be slower to display on less powerful hardware.



10 min

### Quiz: Compression

**Q2:** What is file compression?  
 .....

**Q3:** Give two reasons why media files often need to be compressed.  
 .....

**Q4:** What are the possible disadvantages of using file compression?

.....

### 3.3 Lossy versus Lossless

**Learning objective**

By the end of this section you will be able to:

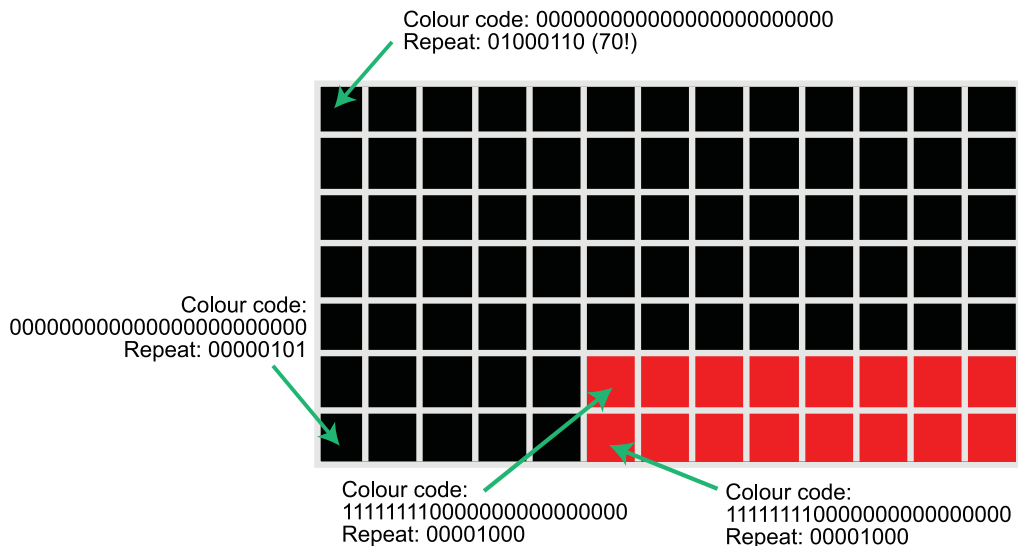
- explain the difference between lossy and lossless compression;
- know the advantages and disadvantages to each type of compression.

As mentioned in the previous topic (Compression) there are two types of compression used on media files, **lossy** and **lossless**.

Compression is a way of reducing the size of a file and both lossy and lossless compression achieve this but in different ways. Lossy compression will reduce a file's size by removing information from the file; lossless compression reduces a file's size but the original file contents can always be reconstituted from the compressed data. Lossy compression also uses compression i.e. it compresses as well as removing information.

To demonstrate the difference, consider the following graphic:

*Figure 3.1: Lossless compression*



.....

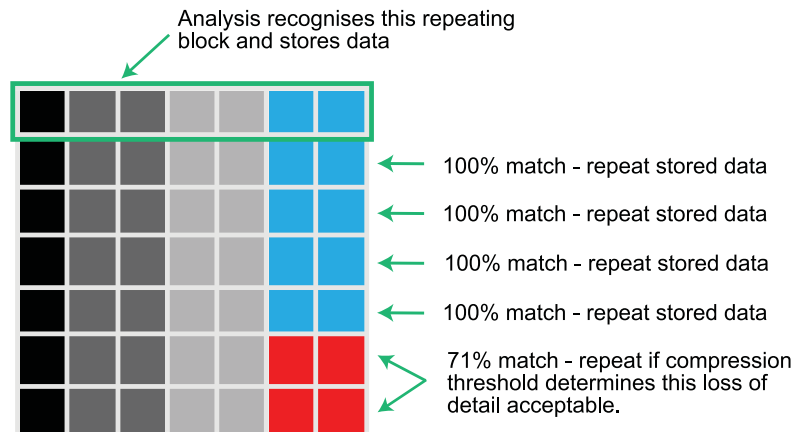
In this example, there is a large area of repeating pixels of the same colour. This would suit a lossless compression system well: you could specify the colour code of the first pixel then the number of times to repeat it.

Size without compression : 91 pixels \* 3 bytes = 273 bytes

Size with compression : 4 colour changes =  $4 * 3 \text{ bytes} + 3 \text{ repeat numbers} = 12 + 3 = 15 \text{ bytes}$ .

Now consider this second graphic.

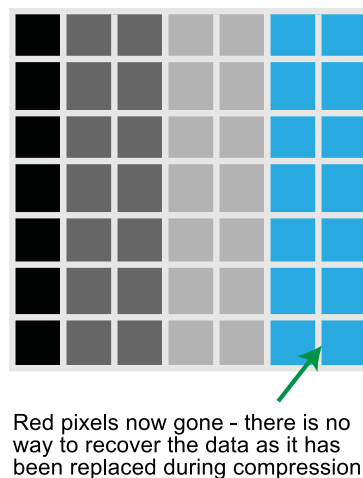
Figure 3.2: Lossy Compression source



.....

In this example, lossless compression would not work so well, as there are no blocks of repeating pixels. Here, a lossy compression algorithm may analyse the image and decide that most of the rows look similar, so it will store the first block of pixels and repeat this on the remaining rows. You will lose the detail about the pixels in the lower right forever, but this may not be noticeable unless inspected closely. Here is the resultant graphic:

Figure 3.3: Lossy compression applied



.....

Lossy compression works well on photographic images where there are not likely to be

solid colours. Simple graphics and logos would benefit from lossless compression.

The type of compression used may also depend on the task. For example, if you were trying to email a few holiday pictures to your Granny in Australia, it would not matter too much if lossy compression was used and the quality was affected slightly. However, if you were creating a sound recording that you wanted to submit to a music company, you would want to use lossless compression so that the quality would not be compromised.

**Quiz: Lossy vs Lossless**



10 min

**Q5:** Explain the difference between lossy and lossless compression.

.....

**Q6:** Give two advantages of using lossy compression.

.....

**Q7:** Give one advantage of using lossless compression.

.....

**3.4 Sound**

**Learning objective**

By the end of this section you will be able to:

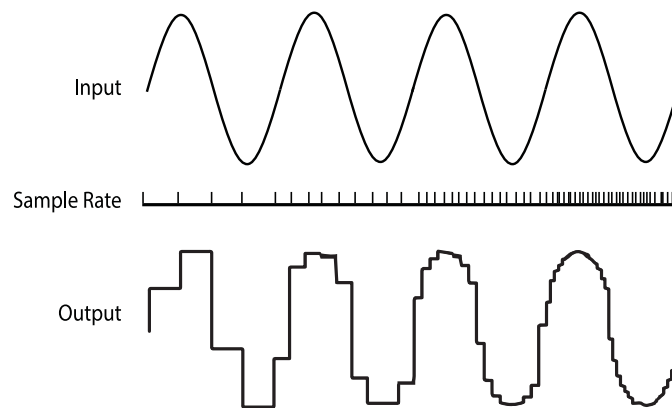
- discuss factors affecting the size of sound files;
- explain how sound files can be compressed.

Sound files can become quite large as they contain a lot of information. There are several factors that can affect the size of a sound file:

- The length of the recording - the longer the recording the more information there is to be stored.
- The **sampling depth** - the number of bits used to store a sound sample. The more bits are used the better the sound quality, but the greater the file size.
- The **sampling frequency** - how many times per second that a sound is sampled. The more samples per second are taken the better the quality of the sound, but the greater the file size.

Figure 3.4 shows how the quality of a sound is improved if the sampling rate is increased.

Figure 3.4: Quality of a sound versus sample rate



.....

To reduce the size of a sound file the length of the recording could be cropped, or the sampling depth or frequency reduced. Cropping the recording will mean that part of the sound is removed, which could make the recording useless. Reducing the sampling depth or frequency will both lower the quality of the recording.

There are many different file formats that can be used to store sound files. This topic will only cover a few of the possibilities.

An uncompressed sound file can be stored as a wav file. As it is an uncompressed file type they can be very large. When a sound is recorded, before it is compressed, it would be stored as a wav file. Wav is the standard for Windows, AIFF (Audio Interchange File Format) is the equivalent standard file type for Apple computers.

One of the most common formats for compressing sound files is an MP3 file. MP3 is short for MPEG-1/2 Layer 3. An MP3 file uses lossy compression to reduce the file size. MP3 files do not seriously affect the quality of a sound as they filter out parts of the recording that the human ear cannot recognise. The MP3 format allows a compression ratio of 1:12, would still sound almost as good as 'CD' quality. This is the reason for the popularity of MP3 files.

More modern algorithms for lossy compression of audio have been invented which give better results than MP3, but because MP3 was the first widely used format, most software still uses and supports it. Lossless compression techniques do exist for sound, but because of the nature of natural audio not consisting of repeating data, they often do not reduce the file size by anything like as much as lossy techniques.

There is more detail about sound in Unit 1, Storing Data topic.



20 min

### Practical task: Sound file types

Use the Internet to research different sound file types and make your own notes.

.....



**Quiz: Sound**

**Q8:** Describe four different ways to reduce the size of a sound file.

.....

**Q9:** Explain the differences between a wav and an mp3 file.

.....



10 min

### 3.5 Graphics

**Learning objective**

By the end of this session you will be able to:

- explain how the file size of images can be reduced;
- state which file types use lossy or lossless compression.

There are many factors that can affect the file size of a graphic:

- Size
- **Colour depth** - how many colours are present in the image.
- Resolution - how many pixels are used to create an image.

The file size of images can easily be reduced by cropping the image. Cropping the image means that part of the image is chopped off, or removed. This makes the image that is to be saved smaller, but may remove important parts of the image.

The colour depth of an image can also be reduced to make the file size smaller. If the colour depth is changed from 24bits to 16bits then the amount of colours that are available for the image is decreased. This means that the file size will be smaller but the quality may not be as good.

The resolution of an image can be reduced. This means that the number of pixels available to create an image is reduced. There will be less information to be saved, but the quality of an image will be affected. If the resolution is decreased too much the image will become pixelated. Figure 3.5 shows an image that is pixelated.

Figure 3.5: Pixelated image



.....  
A fourth alternative is to apply compression to the image. There are many different file types that can be used to apply compression to images

**Bmp** - Bitmap. Bitmaps are uncompressed files and the colour depth available can be adjusted to suit the requirements of the image. Bitmaps can be compressed using RLE (Run Length Encoding). RLE looks at images and instead of storing every individual pixel, it looks for stretches of the image that are the same colour. These sections can be stored by using a keybyte, which tells the software how many pixels are of the same colour.

**GIF** - Graphics Interchange Format. GIFs use a lossless compression technique called 'LZW compression' and they support 8bits, or 256 colours. GIFs support **transparency** and **animation**.

**JPEG** - Joint Photographic Experts Group. JPEGs use a lossy compression technique and support **true colour**. JPEGs are the standard for photographs and they do not support transparency or animation. Jpeg compression works in a very similar way to that of an mp3 file. Parts of the image that will not be noticed by the user are removed to reduce the amount of information that needs to be stored. This leads to a smaller file size. The amount of compression applied in JPEG can be adjusted: this is usually a setting in a graphics package, or may be accessed via a menu system on a digital camera.

**PNG** - Portable Network Graphics. PNG was designed as a replacement for GIF and it uses a lossless compression technique. It supports true colour (24 bits per pixel / 16 million colours), supports **streaming**, interlaced images and multiple transparency values (so pixels can be 'translucent' rather than just transparent or opaque).

**TIFF** - Tagged Image File Format. Tiff files can be saved without compression or can have compression applied. They are a lossless file format and are platform independent, which means that they should display correctly on all types of computer. Tiff files are preferred to jpeg files when saving line drawings as they do not lose quality as they are a lossless file format.

The compression type that is chosen for a graphics file will depend on the purpose that the image is to be used for. If the quality is very important, perhaps for wedding

photographs then a jpeg is likely to be used as it supports true colour and is a standard file format.

If the image is to be used as a small animation on a website then a gif might be more appropriate. The smaller amount of colours will mean that it is not top quality but the smaller file size will make it faster to download when users are accessing the web page.

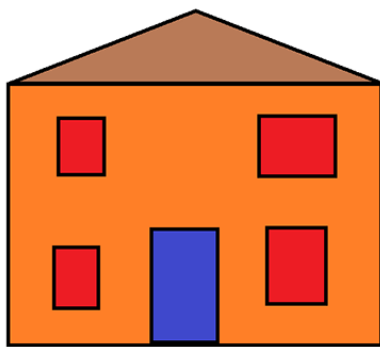
There is more detail about graphics in Unit 1, Storing Data Topic.

**Practical task: Graphic file types**

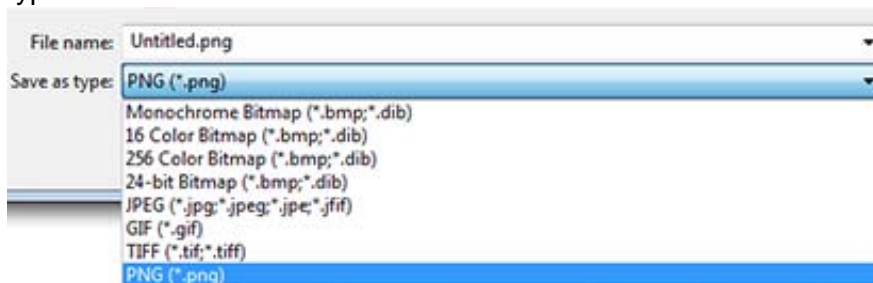
1. Use the Internet to research different graphic file types and make your own notes.
2. Open up Paint and draw a simple picture of a house. Colour the image.



40 min



3. Save the image 8 times (or as many times as Paint will let you), changing the file type each time.



4. Look at the size of each of the files. The same image was saved each time but are all the files of the same size? Were the results what you expected?
5. **Extension:** if you have a more advanced graphics package (Photoshop, PhotoPlus, G.I.M.P.) find out how to adjust the JPEG compression ratio (often this is in the 'save as' or 'export' options). Try saving two or 3 versions of the image as a JPEG with low, medium and high compression. Compare them on the screen.

.....

**Quiz: Graphics**

**Q10:** What advantage does a gif file have over a jpeg file?

.....



20 min

**Q11:** If an image is described as pixelated, what does this mean?

.....

**Q12:** Explain the term 'true colour'.

.....

**Q13:** How does compression on a bitmap work?

.....

**Q14:** How are jpeg files compressed?

.....

### 3.6 Video

#### Learning objective

By the end of this section you will be able to:

- explain how the size of a video file could be reduced;
- describe how mpegs store videos.

There are several factors that affect the file size of a video:

- The resolution
- Length of film
- **Frame rate**
- Frame size (height and width)

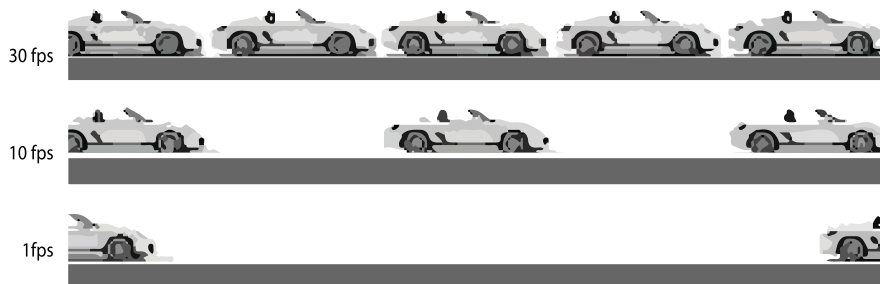
The resolution of a video is the number of pixels that are used to display the recording to the user. If the resolution is decreased then the amount of data to be stored will be reduced, meaning that the file size will be smaller. Reducing the resolution will reduce the quality of the image.

The length of the video could be reduced by removing scenes from the film. This will mean that part, or parts, of the film would be lost, which might not be acceptable.

The frame rate of a video is the number of frames that are displayed per second. Videos are stored as a series of still images and then shown together one after another to give the effect that they are moving. The more images, or frames, that are displayed per second the better the quality of the video. However, the more frames there are to be saved, the larger the file size. If the frame rate is reduced then the file size will be smaller, but if it is reduced too much then the video will appear jerky when it is played.

Figure 3.6 shows how the frame rate affects the number of images displayed per second.

Figure 3.6: Frame rate



.....

Another alternative is to compress the video file. Many uncompressed videos are stored as an avi, or Audio Video Interleave file. Avi was developed by Microsoft and is used with windows applications like Media Player. Avi is an uncompressed file type and it limits the size of files to 2 GB.

Wmv, or Windows Media Video is a newer file type than AVI and it does support compression.

Mov is the Apple equivalent of avi.

MPEG, or Moving Picture Experts Group is a very common file type that supports lossy compression. Mpeg works by storing key frames as a jpeg file. Then for the next few frames it only stores the changes between the two frames, not the entire frame. You may find that Mpeg files are often called Mp4.

You can read more about MPEG video format in Unit 1, Storing Data Topic.

**Practical Task: Video**

Use the Internet to research different video file types and make your own notes.

.....



20 min

**Quiz: Video**

**Q15:** Explain four ways that you can reduce the size of a video file.

.....



10 min

**Q16:** How does an mpeg store a video file?

.....

.....

### 3.7 Learning points

#### Summary

You should now know:

- A standard file format is one that will open and display correctly on all platforms.
- Compression on media files is necessary as they can be very large files. Compressing files means that more files can be saved on to backing storage devices, they will be faster to transmit and download over the Internet.
- Compression reduces the size of files.
- Lossless compression reduces the size of files but does not lose any information in the process.
- Lossy compression additionally reduces the size of files by removing some information.
- The size of sound files can be reduced by cropping, lowering the sampling depth or sampling frequency.
- The size of graphics files can be reduced by cropping the image, lowering the resolution or changing the colour depth.
- The size of video files can be reduced by trimming the length of the video, altering the resolution or reducing the frame rate.

### 3.8 End of topic test

#### End of topic test



10 min

**Q17:** Which of the following is true of JPEG images?

- a) JPEG supports true colour.
- b) JPEG uses lossless compression.
- c) JPEG is a popular format for photographic images.
- d) The amount of compression in a JPEG can be varied.

.....

**Q18:** Which of the following is the correct definition of lossy compression?

- a) Size of the file is reduced and information is lost.
- b) Size of the file is increased and information is added.
- c) Size of the file is not changed.
- d) Size of the file is reduced and no information is lost.

.....

**Q19:** Which of the following is the correct definition of lossless compression?

- a) Size of the file is reduced and information is lost.
- b) Size of the file does not change.
- c) Size of the file is reduced and no information is lost.
- d) Quality of the file is improved.

.....

**Q20:** Which of the following affect the file size of a video?

- a) Frame rate
- b) Sampling depth
- c) Resolution
- d) Length of the video

.....

**Q21:** Jpegs use lossy compression.

- a) True
- b) False

.....

**Q22:** Give two reasons why media files often need to be compressed.

- a) The resolution needs to be increased.
- b) This would take a long time to transmit over a network connection.
- c) The quality needs to be higher.
- d) They may take up too much space on backing storage devices.

.....

**Q23:** The most colours that humans can recognise uses the term 'true colour'; how many bits is this?

- a) 8 bit colour
- b) 16 bit colour
- c) 24 bit colour
- d) 48 bit colour

.....



---

## Topic 4

# Coding

---

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Scripting Languages*
- *JavaScript*
- *Mark-up Languages*
- *HTML*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *understand the purpose of scripting languages;*
  - *explain the difference between a scripting language and a mark-up language;*
  - *explain how a scripting language can be used in a database;*
  - *understand and describe what is meant by the term client-side scripting;*
  - *know the advantages and disadvantages of client-side scripting;*
  - *understand and describe what is meant by the term server-side scripting;*
-

- *describe what is meant by optimisation of coding;*
- *describe Search Engine Optimisation.*

In this topic you will look at how scripting languages are used to develop information systems, and the difference between server-side scripting and client-side scripting.

## 4.1 Introduction

### Learning objective

By the end of this section you will be able to:

- understand the purpose of scripting languages.

In the Structures and Links (Web-based) Topic, you learned that websites are increasingly interactive with dynamic content, often provided by a database. To achieve this, scripting languages are used to add functionality and interactive features, validate data and access the data behind database-driven websites. In databases, scripting languages are used to create and edit queries and **macros**.

A macro uses a scripting language within the application to automate a repetitive or complex process and is activated by a keyboard shortcut or assigned to a user interface component like a button. Macros can also be created by recording the user's actions. Most modern office packages and high-end multimedia software offer scripting languages to create macros with.

### Quiz: Introduction

**Q1:** Why are scripting languages used with websites?

.....

**Q2:** What is a macro?

.....



5 min

## 4.2 Scripting

### Learning objective

By the end of this section you will be able to:

- explain the difference between a scripting language and a mark-up language.

A **scripting language** has many uses. They can be used to create a **macro**, or to add extra functionality to an application. Scripting languages offer all the functionality of a programming language, but must be run inside a larger application such as a web browser. Scripting languages are covered in the Design notations topic of the Software Design and Development unit.

A mark-up language can be called the language of the web and is used to create web

pages. HTML stands for Hypertext Mark-up Language. HTML uses pairs of tags, which a browser interprets to know how to display a web page. Importantly, markup languages only contain information about the content of the page. They do not offer the sort of constructs found in programming languages, for example: data structures like variables; repetition with loops; selection using IF statements; arithmetical and logical operations. This is where a scripting language like JavaScript can be useful.

Javascript can be used for a number of tasks in a web page:

- Create a more active page than regular HTML (things happen based on user interaction)
- Validate input on forms (check someone has entered all the required fields)
- Customise page content based on
  - The time of day
  - Browser being used
  - Location
  - Cookies previously set
- JavaScript can control the web browser (so you've got JavaScript to thank for all those annoying popups!)
- JavaScript can be used for pop-up menus, image galleries, collapsible 'accordion' areas and much more!

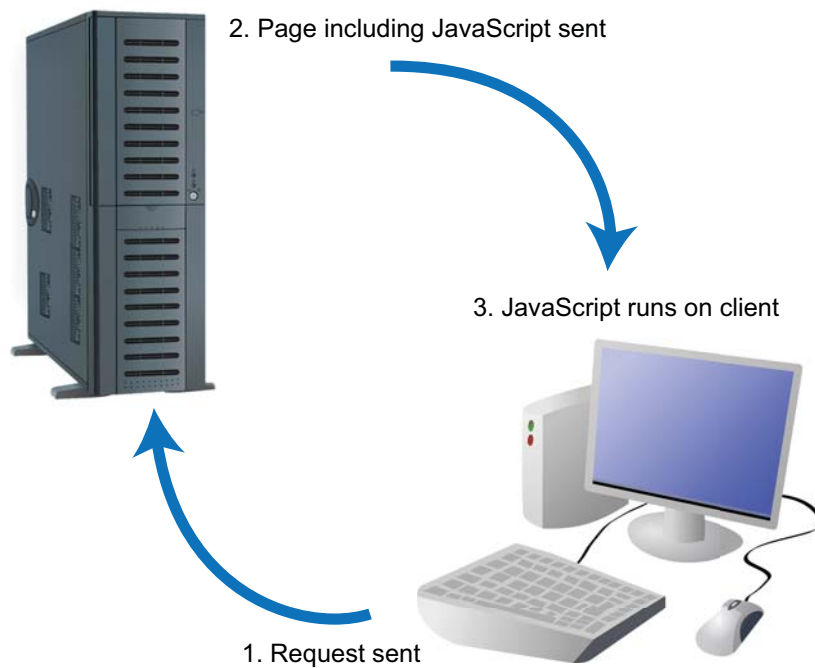
Javascript also has some limitations:

- It cannot connect to a web-based database on its' own
- It cannot access files on your computer, apart from cookies
- It cannot keep track of settings long-term (except with the help of cookies); if you leave the page or hit reload, any stored data the user has typed in will be gone.

JavaScript is called a **client-side scripting language** because the program is run by the 'client' - your browser. This saves the **web server** having to do all the processing, which reduces the overall demand on it. It can also make web pages quicker to respond: for example if you validate a form in the browser with JavaScript, you don't need to transmit the information back to the server to find out if it's correct or not.

There are also **server-side scripting languages**. As you might have worked out, they need to be run by the server, and send the finished results to you. This is useful as they can interact with databases of information based on the web server, making up database-driven web pages on the server and sending finished HTML code to your browser.

Figure 4.1: Client-side scripting process



.....

Client-side scripting and server-side scripting are two different ways to customise web pages and allow scripts to run. A script is a set of instructions for a web page and they provide a change to the way that a web page is displayed. Any page that changes every time you visit it will probably be using scripts. Logging into a website or selecting from a menu uses scripts. You will learn more about client-side scripting and server-side scripting in the rest of this topic.

**Quiz: Scripting**

**Q3:** What is a mark-up language?

.....

**Q4:** What does HTML stand for?

.....

**Q5:** When considering a web page, what is a script?

.....

**Q6:** Give three examples of what a scripting language can be used for in a web page.

.....



10 min

### 4.3 Client-side scripting

#### Learning objective

By the end of this section you will be able to:

- understand and describe what is meant by the term client-side scripting;
- know the advantages and disadvantages of client-side scripting.

The client is the system that is running the web browser. If you are viewing a webpage on your laptop then the laptop you are using is the client. In client-side scripting all the scripts are translated by the browser, which is on the client. In client-side scripting the most common language used is JavaScript. The process has three stages:

1. The user requests a web page from the server.
2. The server finds the page and any associated scripts if they are in a separate file, and sends them to the user.
3. The page is displayed on the browser with any scripts running during or after display.

**Client-side scripting** relies on the user's computer. If the user's computer is slow then they may run slowly. They may not run at all if the browser does not understand the scripting language. As they have to run on the user's system the code which makes up the script is there in the HTML for the user to look at. As the script is present in the source code it is available for other users to view and copy. This form of scripting means that changes can be made to the web page whilst it is being used. For example, if the user clicked on a button, or answered a quiz question then the page would change. The date and time could be displayed, or a question's answer could be shown. This is why client-side scripting encourages interactivity.



5 min

#### Quiz: Client-side scripting

**Q7:** In client-side scripting where are the scripts executed?

.....

**Q8:** Give two examples of what client-side scripting can be used for.

.....

**Q9:** Give two disadvantages of using client-side scripting.

.....

## Practical task: Client-side scripting

This activity will explore adding a simple function to a web page.

Using a text editor, create a file called 'function1.html' with the following code:



15 min

```
<html>
<head>
<title>JavaScript Function Example</title>

<script>
function message()
{
alert("This is a function being called");
}
</script>
</head>

<body onload="message()">
<h1>Press the button to call the function again!</h1>
<button type="button" onclick="message()">Click here</button>
</body>
</html>
```

Open the file in a web browser. Explore what happens if you reload the page and click the button. You should see an alert box pop up with the message "this is a function being called".

### Adding a parameter

A parameter is a piece of data we can pass into the function. We need to change our code slightly:

- Change the function start to:

```
function message(WhatToSay)
```

This will create a variable (storage location in memory) called WhatToSay. This will store the parameter being passed in.

- Change the alert line to:

```
alert(WhatToSay)
```

This will now display an alert with the WhatToSay variable contents.

Calling the function: change the body tag to:

```
<body onload="message('hello world!')">
```

- Now try yourself! Can you change the button to call the message function with a different message?

.....

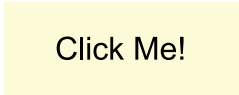


15 min

### Practical task: Interactivity and external scripts

Just like CSS, it is possible to have your JavaScript code in a separate file and then link it to your HTML page. This way, you can use the same code across multiple pages.

Open a bitmap editing program and create two small, equal sized rectangle buttons with different background colours, e.g.




Save the images as 'button1.png' and 'button2.png'. Start a new document in your text editor and enter the following code:

```
function MouseOver(MyImage) {
    MyImage.src = "button2.png";
}

function MouseOut(MyImage) {
    MyImage.src = "button1.png";
}
```

Save this file as "scripts.js" Now create an HTML document in a text editor with the following code:

```
<html>
<head>
<title>External JavaScript Example</title>

<script src="scripts.js"></script> <!-- attach scripts file -->

</head>

<body>

</body>
</html>
```

Save this file as "extscript.html". Load the file in a browser. If all is correct, you should now have a 'rollover' image that gives feedback when the user moves the mouse over the 'button'.

.....



15 min

### Practical task: Extension

There is an example of how JavaScript can read/write data to/from an HTML form in the Scripting Languages section of the Software Design and Development Topic. You should explore this example if you have not studied this section of the course yet. (It also



demonstrates the use of variables - an important programming language construct).

### JavaScript Module Libraries

The ability to link scripts from external files has also led to the development of a number of open-source module libraries for JavaScript. A popular example is 'jQuery' which can be downloaded from [www.jquery.com](http://www.jquery.com). jQuery contains a number of functions for common tasks such as form validation and user interface components.

.....

## 4.4 Server-side scripting

### Learning objective

By the end of this section you will be able to:

- understand and describe what is meant by the term server-side scripting.

The server is where a published web page and other content resides. The server sends pages to the user, or client on request. The process has three steps:

1. The user requests a web page from the server.
2. Any scripts in the web page are interpreted by the server, creating or changing the page content to suit the user and the occasion.
3. The web page in its final form is sent to the user as a completed HTML page, which will be displayed as normal by the user's browser.

PHP and ASP.net are the two main technologies for server-side scripting. (other server-side languages do exist, but these two currently count for about 90% of websites using server-side scripting).



10 min

### Practical task: PHP demonstration

You will need to have access to a web server. Your teacher will be able to assist you with this. Most likely, it will be running on your own machine, and pages can be accessed in your browser at `http://localhost/<filename>`. If a server on the web is being used, you will need to transfer your files with FTP software, and access it using the full URL of the server.

Type the following into a text editor:

```
<html>
<head>
<title>Today's date</title>
</head>
<body>
<p>Today's date (according to this web server) is
<?php
echo( date("l, f ds y." ) );
?>
</body>
</html>
```

Save this file as 'test1.php' in your web server's public folder (usually called htdocs or www). Access the page in a browser (eg 'http://localhost/test1.php'). View the source of the resulting page. You should get something like this:

```
<html>
<head>
<title>Today's date</title>
</head>
<body>
<p>Today's date (according to this web server) is Thursday, March 26th
2015.
</body>
</html>
```

Most of the original file is made up of html tags, so you can see they have remained. The code between `<?php` and `?>` have been replaced however; this was interpreted by the PHP software on the web server and replaced with suitable text. HTML tags can also be generated and included within PHP. For example:

```
<?php echo("This string contains <strong>HTML</strong> tags too"); ?>
```

.....

### Sending data back

PHP programs can also receive data sent from the client. This is essential to build applications such as social media platforms or e-commerce sites; you need to get data from the user! There are two ways to do this:

#### GET method.

This method includes the data being sent to the server attached to the URL of the PHP file, after a '?' symbol. A special array called \$\_GET is filled with this data.

Figure 4.2: example of GET method

<b>URL sent</b>	http://getDemo.php?user=Bob
<b>PHP file interpreted on server</b>	<pre> &lt;html&gt; &lt;head&gt; &lt;title&gt;GET demo&lt;/title&gt; &lt;/head&gt; &lt;body&gt; &lt;?php \$user = \$_GET[user]; echo("Welcome to our Website, \$user!");?&gt; &lt;/body&gt; &lt;/html&gt; </pre>
<b>HTML sent to client</b>	<pre> &lt;html&gt; &lt;head&gt; &lt;title&gt;GET demo&lt;/title&gt; &lt;/head&gt; &lt;body&gt; Welcome to our Website, Bob &lt;/body&gt; &lt;/html&gt; </pre>

.....

**POST method**

This method is used if you are likely to send a large amount of data back to the server; it is not always technically feasible to include this with a URL as the browser often has a maximum length for URLs that would be way short of, say, a product review on an e-commerce site. POST is normally used from HTML forms (which can be pre-validated with JavaScript to save the server processing invalid data) and received in an array called \$\_POST.



15 min

### Practical task: using POST

Type the following into a text editor and save it as 'welcome.html' in your web server's root folder (usually htdocs or www):

```
<html>
<head>
<title>Posting Page</title>
</head>

<body>
<form action="welcome.php" method="post">
First Name: <input type="text" name="firstname" /><br />
Last Name: <input type="text" name="lastname" /><br />
<input type="submit" value="Submit" />
</form>

</body>
</html>
```

As we're no longer sending the variables as part of the query string, they no longer appear in PHP's `$_GET` array. Instead, they are placed in another array reserved especially for 'posted' form variables: `$_POST`.

Type the following into a text editor and save it as 'welcome.php' in your web server's root folder again:

```
<html>
<head>
<title>Receiving Document</title>
</head>

<body>
<?php
$firstname = $_POST['firstname'];
$lastname = $_POST['lastname'];
echo( "Welcome to my Website, $firstname $lastname!" );
?>

</body>
</html>
```

Now load the first page from your server (eg `http://localhost/welcome.html`) and fill in the form.

The form should submit the two fields back to the `welcome.php` file, which will then generate a suitable page using the php code and return it to your browser.

You can check the received page's code by viewing the source in your browser.

.....

**Server-side scripting** can be used to access databases based on the server. This can allow users to have individual accounts and query databases. E-commerce, and social networking sites all rely heavily on server-side scripting to provide the functionality required.

The script is interpreted by the server meaning that it will always generate the same results - in regular HTML - guaranteeing maximum compatibility. Server-side scripts are never seen by the user, so the code cannot be copied. They run on the server and generate results which are sent to the user. Running all the scripts server-side puts all the workload onto the server, and none onto the user's computer.

Sites such as Google, Amazon, or Facebook use both types of scripting options, for different features.

- Server-side scripting handles logging in, personal information and preferences and provides the specific data which the user wants (and allows new data to be stored). For example, remember and displaying a user's name when they return to a website.
- Client-side scripting makes the page interactive, displaying or sorting data in different ways if the user asks for, or by clicking on elements with event triggers. For example, if the user clicks on a video to view it the page will change in order to display the video.

### Quiz: Server-side scripting

**Q10:** In server-side scripting where are the codes executed?

.....

**Q11:** Do you think that server-side scripting is more or less secure than client-side scripting? Explain your answer.

.....

**Q12:** Explain where you think server-side scripting can be used.

.....

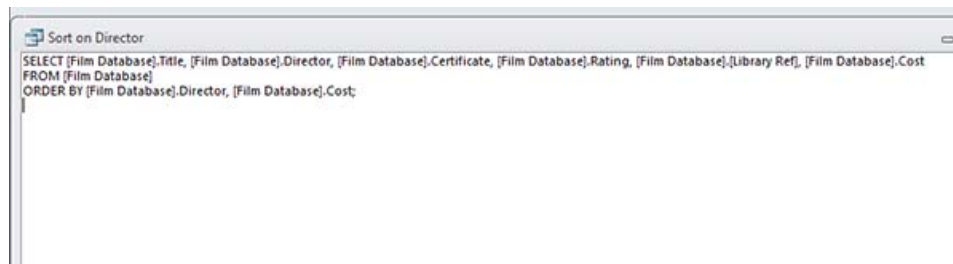


15 min

## 4.5 Structured Query Language

As well as a server-side scripting language like PHP, modern database-driven websites also use a language called SQL to edit the database. **SQL** commands can be built into the server-side scripting language, allowing it to manipulate a database. SQL stands for Structured Query Language. An example of SQL code in Microsoft Access is shown below in Figure 4.3.

Figure 4.3: Example of SQL



```

Sort on Director
SELECT [Film Database].Title, [Film Database].Director, [Film Database].Certificate, [Film Database].Rating, [Film Database].[Library Ref], [Film Database].Cost
FROM [Film Database]
ORDER BY [Film Database].Director, [Film Database].Cost;

```

.....



15 min

### Practical task: SQL

Follow the steps below to create and edit a query in Microsoft Access using SQL:

1. Open up the Films Database that you created in the Structures and Links (Databases) topic.
2. Create a new query and add in the Director, Certificate and Rating fields. Sort the Certificate field into Ascending order and the Rating field into Ascending order. Under the Rating's field put in the search criteria of > 3. It should look like the

Field:	Director	Certificate	Rating
Table:	Film Database	Film Database	Film Database
Sort:		Ascending	Ascending
Show:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Criteria:			>3
or:			

following:

3. Save the query as SQL and view. You should see the following:

Director	Certificate	Rating
Sam Raimi	12	4
Mike Newell	12	5
Baz Luhrmann	15	4
Baz Luhrmann	15	4
Emile Ardolino	15	5
Wes Craven	18	5
Kevin Smith	18	5
Fred Walton	18	5
Simon West	18	5
Ash Brannon	PG	4
Tim Story	PG	4
David Silverman	PG	5
Curtis Hanson	PG	5
*		0

4. Now go to the view menu and select SQL view. You should see the following:

```

SELECT [Film Database].Director, [Film Database].Certificate, [Film Database].Rating
FROM [Film Database]
WHERE ((([Film Database].Rating)>3))
ORDER BY [Film Database].Certificate, [Film Database].Rating;
    
```

5. Edit the SQL code by changing the 3 to a 4. Save the query and view again to make sure that the result has changed. If you have edited the code correctly it will

Director	Certificate	Rating
Mike Newell	12	5
Emile Ardolino	15	5
Wes Craven	18	5
Kevin Smith	18	5
Fred Walton	18	5
Simon West	18	5
David Silverman	PG	5
Curtis Hanson	PG	5
*		0

look like the following:

.....

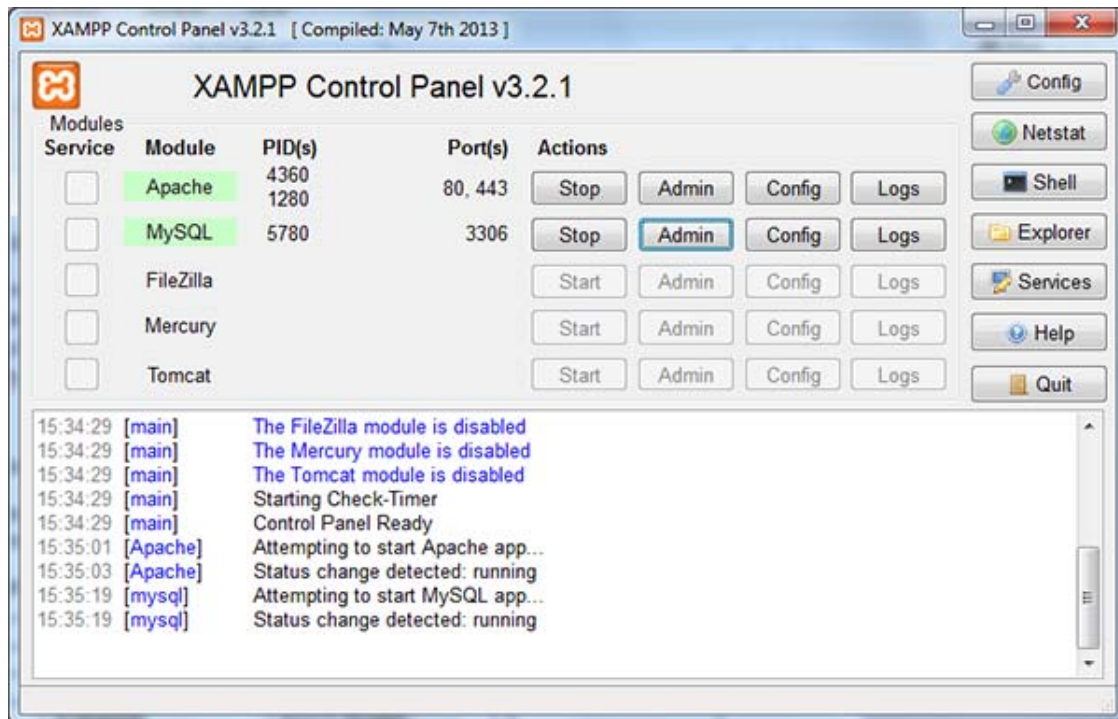


20 min

### Extension task: SQL Database on a Server

For this task, you will need access to a Web Server running software called **phpMyAdmin**. Your tutor will be able to show you how to access this in your class. If you are doing this on your own hardware, XAMPP is a free Web Server package available for Linux, Windows and Mac which includes phpMyAdmin. You can get it (and support) from [www.apachefriends.org](http://www.apachefriends.org).

Figure 4.4: XAMPP Control Panel



.....

phpMyAdmin is a popular, open-source, database management system written in PHP. It provides a graphical user interface, but also lets you directly execute SQL commands.

For this task, we are going to set up the following (simple) database:

Figure 4.5: Database source

First Name	Last Name	Tel No	Number of Pets
Homer	Simpson	0141 2212345	1
Ned	Flanders	0131 6659326	0
Edna	Krabapple	01573 665800	2
Seymour	Skinner	01224 401298	5

.....

Open phpMyAdmin - this is available on the XAMPP control panel (admin button) if you are using this software, or can be accessed from a web address (eg <http://localhost/phpmyadmin>).



## 1. Create a new database.

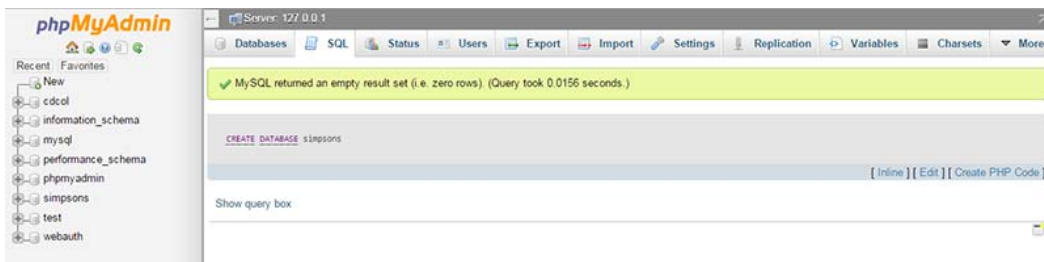
To Execute an SQL command, select the SQL tab in phpMyAdmin:



Enter the following SQL command:

```
CREATE DATABASE simpsons;
```

This will create an empty database on the MySQL server. You should see the following screen confirming this:



We now need to set up a table with the fields we want to use, and their data types. Select the `simpsons` database from the left-side column of phpMyAdmin and select the SQL tab again. Enter the following command:

```
CREATE TABLE pets
(
    first_name text,
    last_name text,
    tel_no text,
    number_of_pets int
);
```

This will create an empty table for the data with 4 fields:

- `First_name` with data type text (SQL doesn't like spaces in fieldnames, hence the underscores)
- `Last_name` with data type text
- `Tel_no` with data type text
- `Number_of_pets` with data type integer.

## 2. Add the records.

To create our first record we execute the following SQL command:

```
INSERT INTO pets
VALUES ('Homer', 'Simpson', '0141 221 2345', 1);
```

Be careful to ensure each piece of textual data is enclosed in single quotes!

You should get a green message confirming this has been successful.

**Now write and execute three more rules to add the remaining records into your database. When you are finished, enter the following SQL statement to check your table:**

```
SELECT * from pets
```

You should see all 4 records lists with appropriate field names. Well done - you have just created a database entirely in SQL!

### 3. Search Queries.

We are going to search for the records of anyone who owns a pet (this should exclude Ned Flanders). The SQL statement to do this is:

```
SELECT * FROM pets
WHERE number_of_pets>0;
```

Enter this into the SQL tab and check you get the expected results.



*SELECT \* FROM pets - This means that the SQL database should return all the fields (\*) in the table pets.*

*WHERE number\_of\_pets>0; - This is the condition. The records being returned must match the criteria (in this case, the value in the number\_of\_pets field must be greater than 0).*

You can also specify which fields you would like returned by a search, handy for large tables where you only wish to display certain data. For example:

```
SELECT first_name, last_name FROM pets
WHERE number_of_pets>0;
```

Try writing one or two of your own queries such as:

- Searching for a surname,
- Searching for a telephone number.

### 4. Sorting.

Sorting can be done in SQL using the ORDER BY command. Here is an example (try it yourself):

```
SELECT * FROM pets
ORDER BY number_of_pets DESC;
```

first_name	last_name	tel_no	number_of_pets
Seymour	Skinner	01224 401298	5
Edna	Krabapple	01573 665800	2
Homer	Simpson	0141 221 2345	1
Ned	Flanders	0131 665 9326	0

This query sorts the data into Descending order on number of pets. We can sort into ascending order simply by omitting the 'DESC' command - try it!

**Can you write a query to sort the data into alphabetical order of last name? Lets add another record to the database to see how we can sort on multiple fields:**

Lets add another record to the database to see how we can sort on multiple fields:

```
INSERT INTO pets
VALUES ('Lisa', 'Simpson', '0141 221 2345', 1);
```

Now let's try sorting on last\_name, then by first\_name:

```
SELECT * FROM pets
ORDER BY last_name, first_name;
```

Lastly, you can combine searching and sorting functions:

```
SELECT * FROM pets
WHERE number_of_pets<3
ORDER BY number_of_pets DESC, last_name, first_name;
```

Well done, you can now create, search and sort SQL databases on a web server!

SQL is a vital tool in modern web development. When used with Server-side scripting languages they provide the functionality behind all social media platforms, e-commerce sites and content management systems.

.....

**Quiz: SQL**

**Q13:** What does SQL stand for?

.....

**Q14:** Which of the following SQL statements would add a record into a table called 'cars'?

- a) SELECT \* FROM cars WHERE INSERT ('ford','fiesta','1.4l',23345)
- b) INSERT INTO cars VALUES ('ford','fiesta','1.4l',23345)
- c) SELECT \* FROM cars WHERE make='ford'
- d) ORDER BY cars INSERT INTO ('ford','fiesta','1.4l',23345)

.....

**Q15:** Which of the following SQL statements would return the rankings in a golf tournament, winner (lowest score) first?

- a) SELECT player\_name, score FROM tournament ORDER BY score;
- b) SELECT player\_name, score FROM tournament ORDER BY score DESC;
- c) SELECT player\_name, score FROM tournament WHERE score <>0;
- d) INSERT INTO tournament VALUES winning\_score;

.....



## 4.6 Optimisation

### Learning objective

By the end of this section you will be able to:

- describe what is meant by optimisation;
- know how to increase the optimisation of a web page;
- explain how crawlers work.

**Website optimisation** can mean a number of different things, but generally there are two broad areas:

- Search Engine Optimisation;
- Optimisation of loading times.

Sites also can be optimised for different viewing platforms, (which was discussed in the Structures and Links (Websites) topic), and for users with special requirements such as screen readers for blind/partially sighted users.

### 4.6.1 Search Engine Optimisation (SEO)

Search Engine Optimisation (SEO) is trying to ensure that your website is returned to users when they are using a search engine. When a user uses a search engine they enter a **keyword**, or keywords. The search engine then goes through its database looking for matches to the keywords. The search engine will then return a list of possible websites to the user.

The user then has to read the returns and decide which link to click on. Even a simple search for the word “chocolate” will return thousands of pages. Users are unlikely to read more than the first few returns, and very few will click onto the second page of returns. Therefore if the creator of a website wants to attract visitors then they need to get their website at the top of the list of returns.

One way to achieve this is to pay the search engine to display your website at the top of the returns. This costs money and may put off some visitors as they will know it is a paid for link.

Figure 4.6: Returns for the keyword 'shoes'

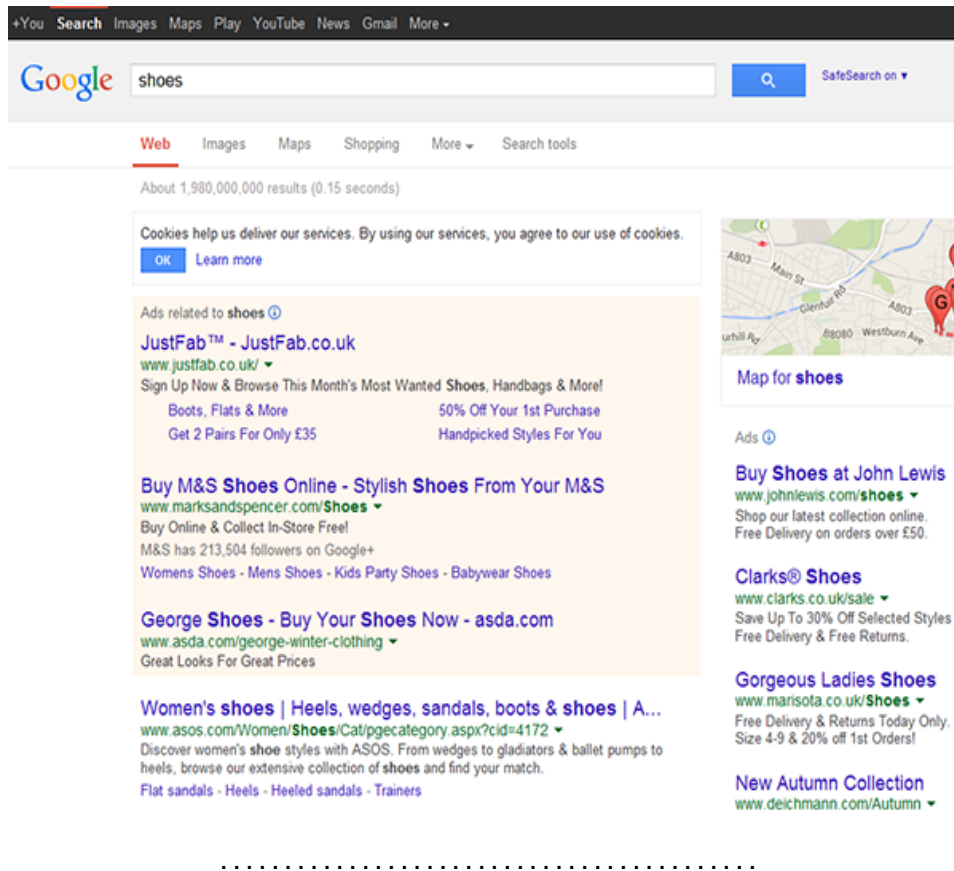


Figure 4.6 shows the returns for the keyword shoe. Note the Adverts at the top and at the side.

A more cost effective solution is to use **search engine optimisation (SEO)**.

Search engine optimisation is trying to manipulate the returns of a search engine so that your page has a higher ranking than others. Search engines use the metadata of a web page that is included in the meta tags. This data is a description of what the page is about and should include keywords. If a user types keywords into a search engine and they match what is in the metadata then the website would be in the list returned to the user. So, if the metadata contains lots of common keywords then the website is more likely to be a match.

It is likely that there will always be several websites that match a keyword, so how does the search engine determine the order in which they are displayed to the user? They rank the websites. The more keywords that are matched in the meta tags, the more likely it is that the web page is relevant to the user. Therefore the search engine looks at how many matches a website has and ranks the page accordingly. This can lead to some web designers 'stuffing' the meta tags with all sorts of keywords to try and get their website ranked as highly as possible. This is called **keyword stuffing**.

Another trick that is commonly used is to place keywords throughout the website, in particular the homepage. The homepage is particularly important as this might be the only page that some search engines look at when gathering information. Including commonly searched for keywords can improve the ratings of a website. It may also

help if the keywords are grouped together as this makes it look like a website is more relevant and will increase the ranking position.

Building incoming or **back links** can help to increase a website's ranking. Most search engines factor into their algorithms the number of links that point to a website and the quality of these links. You can place links on all of your web pages that point to the homepage. This will allow the search engine to count these links.



Search engines are not ignorant of the fact that companies are trying to manipulate the results of searches. Google, Yahoo and Bing will now not disclose the algorithms that they use to rank web pages and they change their algorithms regularly to avoid manipulation.

#### 4.6.2 Optimisation of Loading Times

Because websites have to be fetched across the Internet, with varied transmission speeds that are outwith the web developers control, it is important that websites are efficiently coded and structured for minimum loading time. Firstly, the website must be coded efficiently.

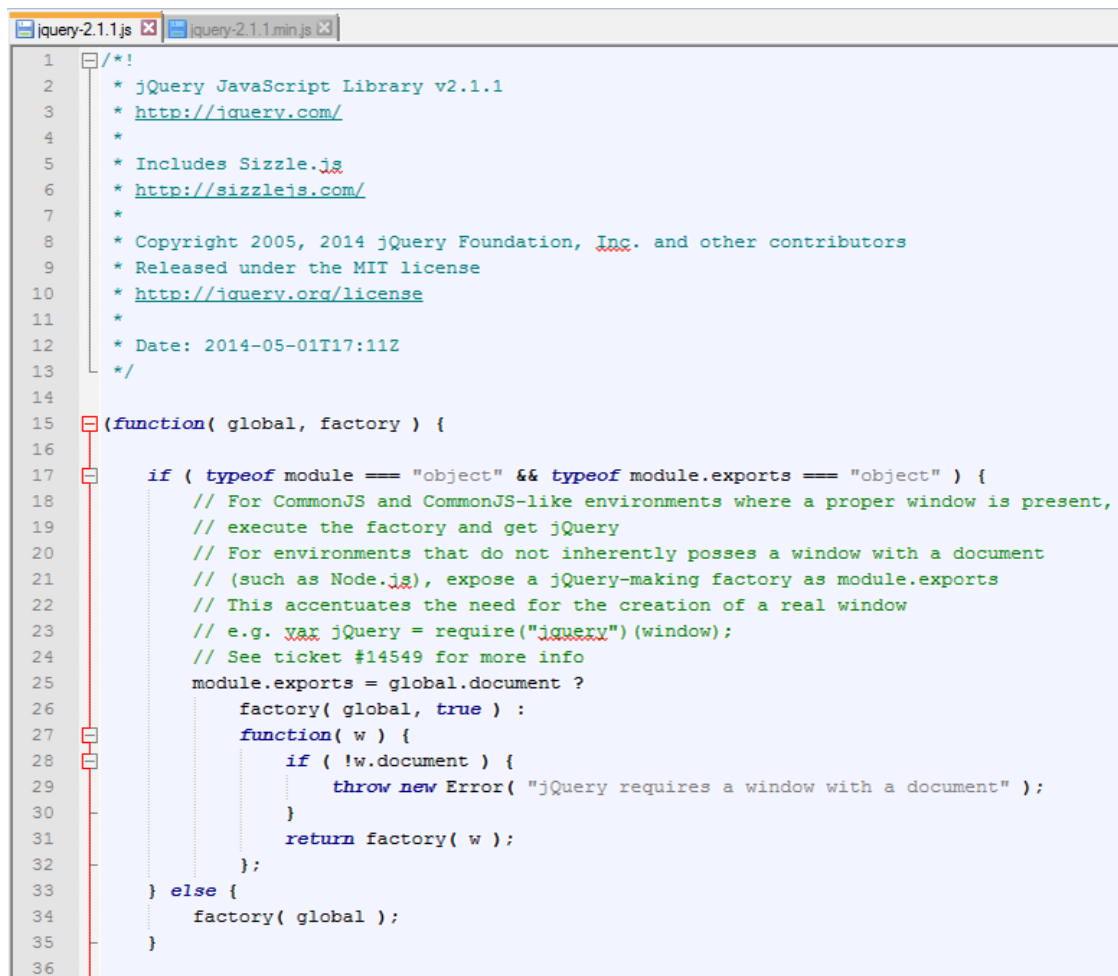
A website is said to have efficient code if there are no unnecessary lines of code. Lines of code that are present but not used waste precious bandwidth. Even stripping out internal commentary at the end of development can save a few bytes. If using external module libraries, you should only link essential ones, and 'minified' (minimised) versions are often available that have all non-essential code stripped out, white space removed and shorter variable names used. (If using your own code, there are free tools online to do this task automatically, e.g. <http://jscompress.com/>).

*Figure 4.7: jQuery libraries before and after minimising*

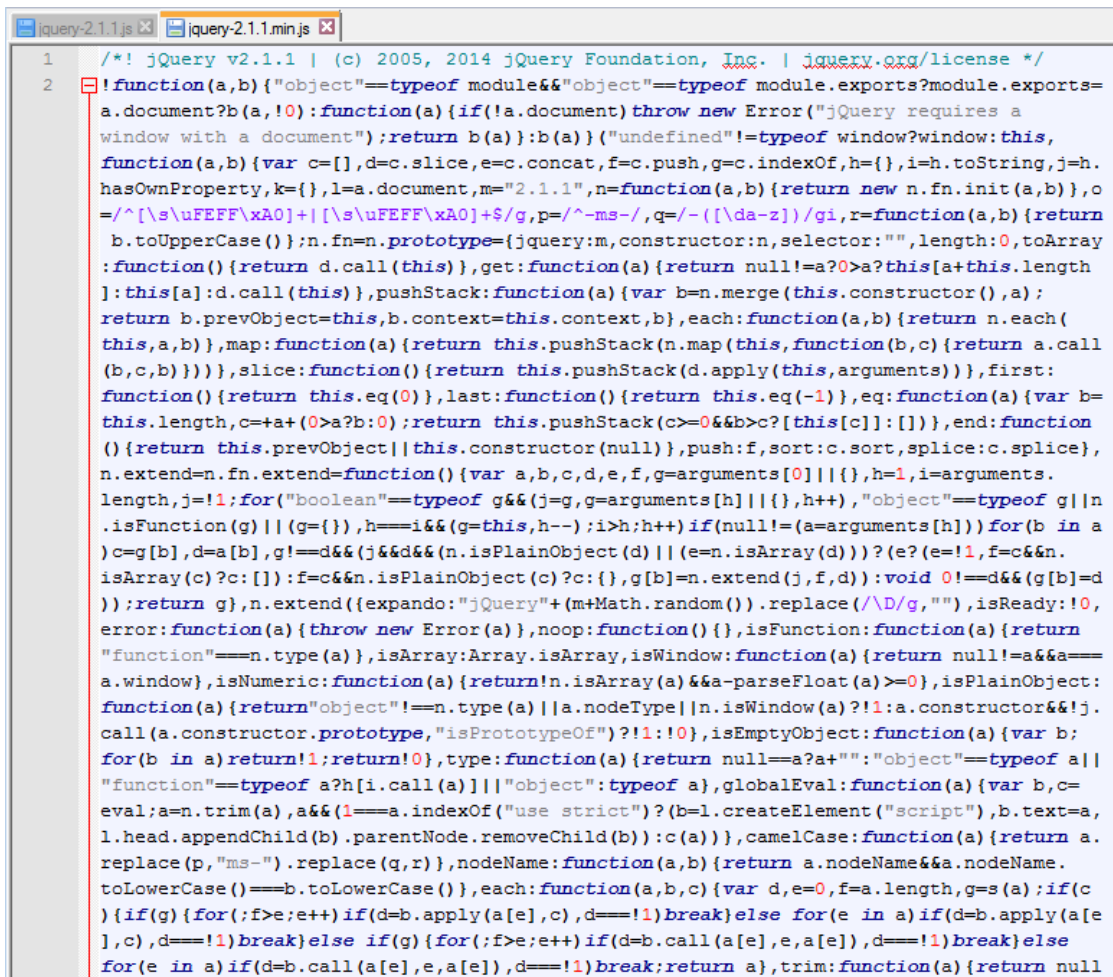
 jquery-2.1.1.js	04/12/201...	JScript Script File	242 KB
 jquery-2.1.1.min.js	04/12/201...	JScript Script File	83 KB

.....

Figure 4.8: Comparison of normal jQuery and minimised jQuery



```
1  /*!  
2   * jQuery JavaScript Library v2.1.1  
3   * http://jquery.com/  
4   *  
5   * Includes Sizzle.js  
6   * http://sizzlejs.com/  
7   *  
8   * Copyright 2005, 2014 jQuery Foundation, Inc. and other contributors  
9   * Released under the MIT license  
10  * http://jquery.org/license  
11  *  
12  * Date: 2014-05-01T17:11Z  
13  */  
14  
15  (function( global, factory ) {  
16  
17      if ( typeof module === "object" && typeof module.exports === "object" ) {  
18          // For CommonJS and CommonJS-like environments where a proper window is present,  
19          // execute the factory and get jQuery  
20          // For environments that do not inherently possess a window with a document  
21          // (such as Node.js), expose a jQuery-making factory as module.exports  
22          // This accentuates the need for the creation of a real window  
23          // e.g. var jQuery = require("jquery")(window);  
24          // See ticket #14549 for more info  
25          module.exports = global.document ?  
26              factory( global, true ) :  
27              function( w ) {  
28                  if ( !w.document ) {  
29                      throw new Error( "jQuery requires a window with a document" );  
30                  }  
31                  return factory( w );  
32              };  
33      } else {  
34          factory( global );  
35      }  
36  }
```



```

1  /*! jQuery v2.1.1 | (c) 2005, 2014 jQuery Foundation, Inc. | jquery.org/license */
2  !function(a,b){"object"===typeof module&&"object"===typeof module.exports?module.exports=
a.document?b(a,!0):function(a){if(!a.document)throw new Error("jQuery requires a
window with a document");return b(a)}:b(a)}("undefined"!==typeof window?window:this,
function(a,b){var c=[],d=c.slice,e=c.concat,f=c.push,g=c.indexOf,h={},i=h.toString,j=h.
hasOwnProperty,k={},l=a.document,m="2.1.1",n=function(a,b){return new n.fn.init(a,b)},o
=/^\s\uFEFF\xA0+|[\s\uFEFF\xA0]+$/g,p=/^-ms-/ ,q=-([\da-z])/gi,r=function(a,b){return
b.toUpperCase()};n.fn=n.prototype={jquery:m,constructor:n,selector:"",length:0,toArray
:function(){return d.call(this)},get:function(a){return null!=a?0>a?this[a+this.length
]:this[a]:d.call(this)},pushStack:function(a){var b=n.merge(this.constructor(),a);
return b.prevObject=this,b.context=this.context,b},each:function(a,b){return n.each(
this,a,b)},map:function(a){return this.pushStack(n.map(this,function(b,c){return a.call
(b,c,b)})),slice:function(){return this.pushStack(d.apply(this,arguments))},first:
function(){return this.eq(0)},last:function(){return this.eq(-1)},eq:function(a){var b=
this.length,c=+a+(0>a?b:0);return this.pushStack(c>=0&&b>c?[this[c]]:[])},end:function
(){return this.prevObject||this.constructor(null)},push:f,sort:c.sort,splice:c.splice,
n.extend=n.fn.extend=function(){var a,b,c,d,e,f,g=arguments[0]||{} ,h=1,i=arguments.
length,j=!1;for("boolean"===typeof g&&(j=g,g=arguments[h]||{}),h++),"object"===typeof g||n
.isFunction(g)|| (g={},h=i&&(g=this,h--);i>h;h++)if(null!=(a=arguments[h]))for(b in a
)c=g[b],d=a[b],g!==d&&(j&&d&&(n.isPlainObject(d)|| (e=n.isArray(d)))? (e=!1,f=c&&n.
isArray(c)?c:[]):f=c&&n.isPlainObject(c)?c:[]),g[b]=n.extend(j,f,d):void 0!==d&&(g[b]=d
));return g},n.extend({expando:"jQuery"+(m+Math.random()).replace(/\D/g,""),isReady:!0,
error:function(a){throw new Error(a)},noop:function(){},isFunction:function(a){return
"function"===n.type(a)},isArray:Array.isArray,isWindow:function(a){return null!=a&&a===
a.window},isNumeric:function(a){return!n.isArray(a)&&a-parseFloat(a)>=0},isPlainObject:
function(a){return"object"===n.type(a)||a.nodeType||n.isWindow(a)?!1:a.constructor&&!j.
call(a.constructor.prototype,"isPrototypeOf")?!1:!0},isEmptyObject:function(a){var b;
for(b in a)return!1;return!0},type:function(a){return null==a?"": "object"===typeof a||
"function"===typeof a?h[i.call(a)]||"object":typeof a},globalEval:function(a){var b,c=
eval;a=n.trim(a),a&&(1===a.indexOf("use strict")?(b=l.createElement("script"),b.text=a,
l.head.appendChild(b).parentNode.removeChild(b)):c(a)),camelCase:function(a){return a.
replace(p,"ms-").replace(q,r)},nodeName:function(a,b){return a.nodeName&&a.nodeName.
toLowerCase()===b.toLowerCase()},each:function(a,b,c){var d,e=0,f=a.length,g=s(a);if(c
){if(g){for(;f>e;e++)if(d=b.apply(a[e],c),d===!1)break}else for(e in a)if(d=b.apply(a[e
],c),d===!1)break}else if(g){for(;f>e;e++)if(d=b.call(a[e],e,a[e]),d===!1)break}else
for(e in a)if(d=b.call(a[e],e,a[e]),d===!1)break;return a},trim:function(a){return null

```

.....

Combining multiple script (or stylesheet) files into one file is also an advantage, as it then required only one HTTP request to initiate the transfer, rather than multiple requests.

External Script files can also be linked at the end of the HTML code so that the page structure and layout can be rendered by the browser first whilst the scripts are still downloading in the background.

Compression of media items is also important.

Compression can be used to reduce the amount of data that is sent between clients and servers, reducing the loading time of web pages.

This is especially important for multimedia-heavy sites using video and audio.

Style sheets can also be used to specify different versions of images and backgrounds for different screen resolutions. There's no point wasting time (bandwidth!) downloading an 'iMac retina'<sup>TM</sup>-compatible high resolution image if the user is accessing the page on a small smartphone.



**Quiz: Optimisation**



10 min

**Q16:** Explain what the term optimisation means.

.....

**Q17:** Why do websites try to manipulate search engine results?

.....

**Q18:** What is keyword stuffing?

.....

**Q19:** What is the significance of back links?

.....

**Q20:** Name three ways of optimising the load time of a web page.

.....

## 4.7 Learning points

### Summary

You should now know:

- A scripting language can be used to automate a complicated process, automate a repetitive action, create macros or to add functionality to an application.
- Scripting languages can be used to add interactive features to web pages.
- A script is code for a website that allows for changes every time the web page is visited. Scripts also provide interactivity.
- Client-side scripting is where the code for scripts is executed on the user's computer.
- Client-side scripting means that the codes used are available for the user to see and copy.
- JavaScript is commonly used for client-side scripting.
- Server-side scripting is where the code for scripts is executed on the server, not on the user's computer.
- Server-side scripting allows for more security as it does not allow user access to the scripts.
- Server-side scripts can access and edit a database on the server.
- Databases can be modified and Queried using SQL, which can be built into a server-side script.
- PHP or ASP.net are commonly used in server-side scripting.
- It is possible for websites to use a combination of both client and server-side scripting.
- Search Engine Optimisation is trying to achieve a high ranking for a website within a search engine. This helps to encourage visitors to the website.
- Keyword stuffing can be used to try to influence the results of a search engine.
- Websites will have their code and media files optimised to reduce loading time.

## 4.8 End of topic test

### End of topic test



**Q21:** What does HTML stand for?

- a) High Text Markup Language
  - b) HyperText Missing Language
  - c) HyperText Markup Language
  - d) High Tea Markup Language
- .....

**Q22:** Which of the following is correct for server-side scripting?

- a) Processing for the website is all performed on the client's computer.
  - b) Processing for the website is all performed on the server.
  - c) Server-side scripting allows users to copy code.
  - d) Server-side scripting places large demands on the client's computer.
- .....

**Q23:** What does SQL stand for?

- a) Sequel Query Language
  - b) Server Query Language
  - c) Structured Query Language
  - d) Sequenced Query Language
- .....

**Q24:** In client-side scripting where are the scripts executed?

- a) On the clients computer.
  - b) On the server.
- .....

**Q25:** In server-side scripting where are the codes executed?

- a) On the clients computer.
  - b) On the server.
- .....

**Q26:** Which of the following could reduce the loading time of a web page?

- a) Compressing the background image
  - b) Combining two .js files linked to the page
  - c) Using jQuery
  - d) Linking external scripts at the end of the HTML page
- .....



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## Topic 5

# Testing

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following:*

- *Links and navigation*
- *Creating a website that matches a user interface design*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *discuss the need to test information systems;*
  - *explain why there are different forms of testing;*
  - *explain the purpose of beta testing;*
  - *describe who carries out beta testing;*
  - *explain why an information system should be tested in terms of usability;*
  - *discuss compatibility issues including memory, storage requirements and Operating System compatibility.*
-

In this topic you will look at the different types of testing that are necessary when you are testing an information system. You will learn about the importance of usability testing of an information system.

## 5.1 Introduction

### Learning objective

By the end of this section you will be able to:

- discuss the need to test information systems;
- explain why there are different forms of testing.

All computing projects follow an iterative pattern. One such common example is the Software Development Process:

1. Analysis
2. Design
3. Implementation
4. Testing
5. Documentation
6. Evaluation
7. Maintenance

You may already know from studying the Software Design and Development unit at National 5 that after the implementation stage of the software development process comes testing. All stages of the software development process are important but testing is essential to ensure that a project has been completed to the highest standard possible. Errors can be detected at the testing stage and fixed before the project is published, or handed over to the client.

You may also have heard of different types of methodologies such as rapid application development or agile programming. Here, testing is also important but may be organized differently. Much of the testing will be done in small parts during implementation, with larger-scale beta testing coming near the completion.

At National 5 you will have learnt that a website should be tested to ensure that all the hyperlinks work as expected, that there are no spelling or grammar errors, that pictures display correctly and that any other features, such as a JavaScript application work correctly. This type of testing is usually performed by the same team that created the website. This is sometimes called 'in-house testing' or **alpha testing**. Some developers may involve the client at this stage, though this is not strictly necessary.

## 5.2 Beta testing

### Learning objective

By the end of this section you will be able to:

- explain the purpose of beta testing;
- describe who carries out beta testing.

**Beta testing** is a type of testing that is not performed by the developer. Beta testing is when the project, is released to a limited number of users for 'real world' testing. These users then provide feedback to the developers and any necessary changes can be made.

Beta testers are separate from the developers to ensure that the feedback they give is not biased. This will probably be completely unintentional; the developers will be very familiar with the software so might not think of mistakes or invalid operations that normal users will make. Beta testers are used in an attempt to find as many bugs, or errors, as possible. Beta versions of software can be made available to the general public so that the developers can gain as much feedback as possible. This is important as there can be many different permutations of hardware and software that can never be tested inside an organization, but will likely be suitably varied amongst a large group of beta testers.

Beta testing has the advantage that the project can be tested by users who are familiar with a similar project and so know what the expected standard is, or are able to use the project with real life data to see if it works as expected. The theory is that beta testing will uncover more errors than testing a project internally. If a project is being tested with 'real world' data it is more likely to identify errors that may not have been picked up previously.

Beta testing may save the developers money as many testers will be willing to test a website or piece of software, free of charge. However, some users may not be impressed with the number of errors in a project and may not wish to use the product in the future, so care is needed to ensure users are aware of the beta status and the improvements that are implemented.

### Quiz: Beta testing

**Q1:** What is meant by the term beta testing and how is it different from alpha testing?

.....

**Q2:** Who performs beta testing?

.....

**Q3:** Give two possible advantages of beta testing.

.....

**Q4:** Give one possible disadvantage of beta testing.

.....



15 min

## 5.3 Usability

### Learning objective

By the end of this section you will be able to:

- explain why an information system should have good usability;
- be able to explain how to evaluate an information system's usability.

An information system can be described as having good usability if it has clear and concise information and it is easy to navigate for a range of users. Websites can be evaluated using the following criteria:

- Are the screens laid out appropriately, with a consistent User Interface?
- Are navigation and features obvious and working correctly?
- Have you catered for your target audience appropriately?
- Can the user find the information or features easily?

Once a website has been completed then it is good practice to try to evaluate the questions above and evaluate the success and appropriateness of the website.

**Screen layout** - There should be a consistent layout throughout the product. Navigation menus, headings and controls should always appear in the same place. Screens should not be too cluttered with information. Where a large amount of information needs to be presented, it should be possible to hide areas of the information (eg by using collapsible headings).

**Navigation** - Are there enough visual clues to aid navigation? Are navigation links obvious? Are menus and sub-menus organized into sensible categories? Does the interface provide feedback about the navigation? such as "breadcrumbs" or identifying previously visited pages.

**Target audience** - You may remember from National 5 that during the analysis stage a target audience will have been identified. This will give demographics such as the age group of the potential users and their level of technical expertise. Usability testing will try to evaluate whether the target audience have been catered for, looking at the use of colours, navigational complexity and amount of information on each screen. Often an early version of the product - or even a mock-up - will be trialled with a small selection of the target audience to ensure the interface is satisfactory. Feedback will be collected and given to the designers to act upon.

**Finding information** - There is a whole set of theories around identifying how to construct information systems so that users can navigate the product efficiently and find information on the resulting screens. Research involving eye-tracking software has been carried out so that important information (or adverts!) are placed in the optimum position. Trends in User Interface (UI) design also influence how Information Systems are built or updated. In the early days of the World Wide Web, every link would consist of underlined text, this is now rarely the case, with colours, shapes and even the position of elements reflecting their intended purpose.



### Evaluating usability

A number of techniques will be used to try to evaluate the usability of a product. These may provide quantitative data about the user experience (such as how long it takes to locate a piece of information on a mobile interface vs a desktop one) or qualitative data, such as a narrative of how the user accomplished a task in an unfamiliar product ("I saw the destinations menu on the airport website and figured there may be another link from there to a flight schedule for Alicante. This was easy to find on the new page.")

### Activity: Usability testing

1. Ask your teacher/lecturer for a website to evaluate. (If they are not available, use your school/college site).
2. Complete the table below with your thoughts on each area.
3. Get together with 3 or 4 of your colleagues. Compare all your answers. Note down areas where opinions differ.
4. Discuss the areas in which your opinions differ from each other. Make notes on why some of your group may have come to different conclusions.



Screen Layout	Are all the page elements in the same place on each page?	
	How consistent is the visual layout?	
	Is the screen cluttered?	
	Are headings and different sections used effectively	
	Does the site adapt for mobile devices? ( <i>If you don't have a mobile device, you may be able to simulate this by making your browser window narrow</i> )	
	Are the fonts used readable and appropriate?	
Navigation	Are links and controls obvious?	
	Are there clear sections and sub-sections to the website?	
	What features to help navigation are included such as site maps, breadcrumbs or search facilities?	
	Is it easy to return to previous pages, or to go to related information?	
Target Audience	Who are the target audience of the website you are studying?	
	Is the information presented relevant to the target audience?	
	Is the visual layout and navigational features appropriate to the target audience?	
Finding Information	Are navigation features in an area of the screen you would expect?	
	Are navigation features obvious?	
	Does the site contain options for accessibility? (e.g. high contrast colours, text size adjustment)	
	Can you clearly identify the contents of each page?	
	Are there any novel or unique ways that help to find information on the site?	

.....

**Quiz: Usability**



25 min

**Q5:** Explain two factors that will affect the usability of a product.

.....

**Q6:** State one way in which you can make your interface more appealing to young children.

.....

**Q7:** Give an example of how a user interface you are familiar with has changed over time.

.....

**5.4 Compatibility issues**

**Learning objective**

By the end of this section you will be able to:

- discuss how compatibility issues impact on information systems.

Users now view information systems on a variety of different devices, often via websites - desktops, laptops, notebooks, tablets and smartphones. Whilst all of these devices are able to display web pages they are still very different and have different features. For example, a smartphone has different input devices to a laptop, a different operating system, a smaller memory, smaller amount of RAM and a slower processor. This means that not all devices can display the same version of a website. Even on the same type of computer, different browsers can render page elements differently, and use different technologies.

**Practical task: Compatibility**



20 min

Use the internet to complete the table below:

Device	Screen Size	Amount of RAM	Backing storage	Processor Speed	Input Devices	Operating System
Desktop						
Laptop						
Tablet						
Smartphone						

.....

You will find that the different types of devices all have different specifications. When you compare the more traditional devices, desktops and laptops, with the more current devices, tablets and smartphones, you will find that tablets and smartphones have less memory and processing power, and use different operating systems and input devices.

If you have used a smartphone before you may have found that when you try to view a web page you are directed to an app, or the smartphone version of the website. This

is because the 'normal' version of the website cannot display on the smartphone for several possible reasons. Perhaps the screen size is too small? Is there enough space in main memory? Is there bandwidth constraints or is it costly to use mobile data? Is it compatible with the mobile browser? Is the processor powerful enough?

When you are creating a website it is important to think about who is going to use the website and what type of device they are going to use. You might find that it is necessary to create different versions of the same website that are suitable for different devices. If your website cannot be viewed from a smartphone or a tablet then you are limiting the number of potential users and customers that you will receive.

Obviously, maintaining different versions of the same website would be inefficient, so there has been a gradual move towards 'responsive web design'. This means that one website can be coded in HTML where each element's size and position can then be controlled by CSS. The platform can be detected by a script on the page and the appropriate style sheet selected. Modern browsers usually support media-type definition in CSS by default.



15 min

**Quiz: Compatibility**

**Q8:** Why is the amount of space in memory that a website uses important to viewers?

.....

**Q9:** How can you ensure that your website can be viewed on all types of computer?

.....

**Q10:** Why do style sheets aid usability?

.....

## 5.5 Learning points

### Summary

You should now know:

- Testing a website is essential to ensure that all hyperlinks work correctly, that pictures display clearly and that there is no spelling or grammar errors.
- Beta testing involves users outside of the design process using real world test data in order to test the website.
- A website has good usability if it contains clear information and is easily accessed by a range of users.
- Usability testing helps companies to get feedback and make improvements based on real users as well as interface design research.
- Usability depends on the target audience as well as technical factors such as navigation and screen layout.
- Using style sheets can improve the maintainability of a website and platform compatibility.
- Different devices may not be able to correctly display a website if they do not have enough RAM, hard drive space or the correct browser.
- Modern websites make use of responsive design where the style sheet rules will differ for different platforms.

## 5.6 End of topic test



### End of topic test

**Q11:** Which of the following is the correct definition of what is included under usability?

- a) Screen Layout, Use of HTML5, Style sheets, Help Guide.
  - b) Ease of Navigation, Screen Layout, Target Audience, Ease of locating information.
  - c) Robustness, navigational aids, accessibility, use of standard file formats.
  - d) HTML5, CSS3, JavaScript, PHP
- .....

**Q12:** Which of the following can help usability on a website:

- A. Designing separate mobile and desktop versions.
  - B. Using Responsive Web Design methods.
  - C. Training users properly in school or college.
  - D. Varying the design of screens frequently.
- .....

**Q13:** Which factors may affect the compatibility of an information system?

- a) User preferences.
  - b) Bandwidth, Screen size, Web Server type.
  - c) Screen Size, RAM, Processor Speed, browser.
  - d) How useful the user finds the information.
- .....

**Q14:** Style sheets help to aid maintainability by making it simpler to edit the style or format of an entire website.

- a) True
  - b) False
- .....

**Q15:** What is an advantage of beta testing?

- a) Testers are biased
  - b) Less errors may be found as real world data is being used.
  - c) Errors that can only be found when running a project may be discovered.
- .....

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## Topic 6

# Purpose, features and functionality

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following:*

- *describe the main features and functionality of an information system;*
- *description of purpose of an information system;*
- *the need to cater for both expert and novice users.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *state the difference between data and information;*
  - *explain what is meant by the term information system;*
  - *explain why it is necessary to have a detailed description of purpose for an **information system**;*
  - *describe the different types of users that may use an information system;*
  - *explain why it is important that information systems can interact with other software.*
-

In this topic you will look at the purpose, features, functionality and range of users that use information systems. You will learn the importance of being able to describe the purpose of an information system and why it is important to appreciate the range and type of users that will be using an information system.

## 6.1 Introduction

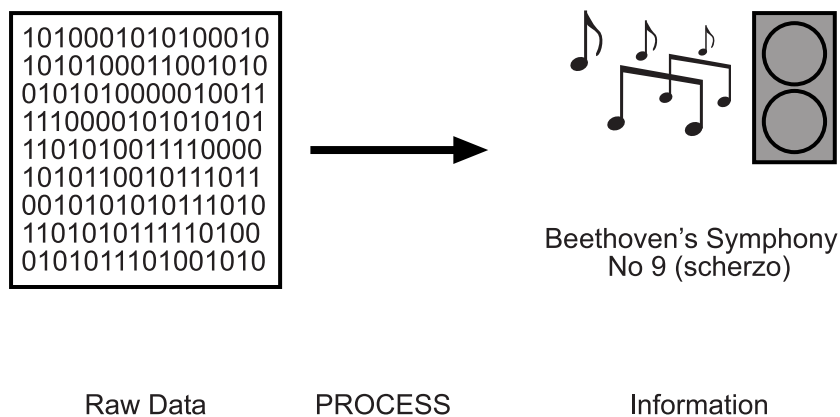
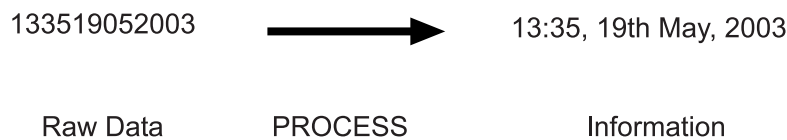
### Learning objective

By the end of this section you will be able to:

- state the difference between data and information;
- explain what is meant by the term information system.

Data is unprocessed and has no purposeful meaning. Information is data that has been entered into a computer system, processed and stored and now has meaning. For example the data 09111981 has no meaning. If the data is processed, 09/11/1981 then you can see that it is a date and has meaning.

Data consists of raw facts and figures which can be coded, structured, and organised for processing by computer. When processed, formatted and put in a **context with meaning**, the data becomes information that can be interpreted and understood by someone.





**Activity: Data or Information?**



**Q1:** Place the following items in the correct place within the table:

- raw facts and figures
- a bit-mapped image stored on a memory card in my camera
- 00101110110101101010011111001010001100010100100
- can be coded, structured and stored in a computer system
- the date 25th Feb 2009
- can be interpreted and understood by a human
- 250209
- processed facts and figures, put in a context
- the password I use to log in to my emails
- Xg34Rtz

	<b>Data</b>	<b>Information</b>
Definition		
How it can be used		
Date example		
Password example		
Graphic example		

.....  
 .....

Businesses and organisations can have a huge amount of data that they wish to store and use as information. They need to be able to access the information quickly and efficiently. Many organisations will require the information to be stored in a way that allows **multi-user access**.

An information system is a way in which people, or an organisation, collect, process and manage information. Previously information was collated on paper and stored in filing cabinets. This meant that there was only one copy of data and that it was very hard to sort it into a different order. Nowadays information is stored on a computer. Information can be stored in a database, spread sheet or website. In this unit you are looking at two types of information systems:

1. Websites
2. Databases

Information systems should allow:

- Multi-access
- Fast access to information
- Information to be sorted by different criteria

- Information to be presented in different formats
- Information to be inserted, deleted or amended.



15 min

### Quiz: Introduction

**Q2:** Explain the difference between data and information.

.....

**Q3:** Why do businesses require information systems?

.....

**Q4:** What is an information system?

.....

## 6.2 Descriptions of purpose

### Learning objective

By the end of this section you will be able to:

- explain why it is necessary to have a detailed description of purpose for an information system.

All information systems will have a detailed description of their purpose. This allows prospective users to understand the purpose of the information system and what it will be capable of.

This could include the following information:

- What information is to be stored
- Why the information is to be stored
- How the information is to be stored
- How the information will be used
- Who will be using the information system.

The purpose of an Information System needs to be established at an early point in the development process; clients will often have a clear idea of what they want the information system to achieve, but will require specialist input from **Systems Analysts** and Designers to firm up the points above. A poor decision at this stage could make it very difficult to further adapt the information system or add new features in future.

There are two types of users of information systems that should be considered: humans and other software. This will be discussed in more detail in sections 6.3 and 6.4.

**Quiz: Description of purpose**



10 min

**Q5:** Why is a description of purpose necessary for an information system?

.....

**Q6:** What information do you think would be contained in a description of purpose and why?

.....

**6.3 Interaction of information systems with human users**

**Learning objective**

By the end of this section you will be able to:

- describe the different types of users that may use an information system.

When you are developing an information system that is to be used with humans then you should consider the type of users that are going to use the system. There are two main questions that should be asked:

1. What is the age range of the target audience?
2. What is the experience level of the target audience?

The age range of the **target audience**, or intended users, is very important as this will significantly influence the design of the database or website. If the website is to be used by pre-school children then it will have a graphical design, lots of bright colours and images. Any buttons or links would be large and easy to click on. If a website is to be aimed at teachers then it will contain a lot more text and have a more refined design. It may be colourful but will be easy to read. If the website is to be aimed at someone with limited technological experience then it may contain a medium amount of text, broken into screens with very obvious navigation features then it may contain a medium amount of text and perhaps be in a slightly larger than normal font.

Users fall into two types of category for their experience: novice and expert. A novice user is one that does not have a lot, or any experience with the type of information system that they are to be using. An expert user is one that is very familiar with the type of information system being used and will have used them before. An expert is likely to be familiar with all the common features of an information system.

If you were creating a database that was to be used by novice users then it would probably be appropriate to include a graphical user interface so that they were not overwhelmed by a large table. If you were creating a database for an expert user then it might be appropriate to use a form that allows the user to select what feature they require via a button. A well designed system should cater for both novice and expert by offering an interface which can be customized. In addition, the amount of online help and how to access the online help will be varied depending on the experience level of users.



10 min

### Quiz: Interaction of information systems with human users

**Q7:** What two questions should be asked when designing an information system?

.....

**Q8:** Why are these two questions important?

.....

## 6.4 Interaction of information systems with software

### Learning objective

By the end of this section you will be able to:

- explain why it is important that information systems can interact with other software;
- give an example of how this can be achieved.

As well as thinking about the human users that will interact with an Information System, it is also important to consider whether other software, such as another Information System, should be able to access and use the Information System.

The ability for Information Systems to interact with each other without human intervention is becoming increasingly important in a connected world, and is made possible by carefully designing and standardising the structure of the data being held. We will look at two examples of how Information Systems may interact with other software.

### 6.4.1 Internet search engine

You are already aware that the structure of web pages are defined by a standard language called HTML, which is a good starting point if you want to write a program to search through all the content!

Internet search engines work by automatically creating a database linking key words and phrases to the **URLs** of individual pages. This is done by software called 'crawlers' or 'bots' that are designed to scan through the HTML structure (just like a browser would do when rendering the page) and pick out the text, links, images and **metadata** that make up the page. This information is then written into the search engines database by the crawler automatically. This is only possible because of the standard structure of all web pages.

**Metadata** can be used to 'help' the crawler software by providing an easily identifiable piece of information. If you look at the source code for a web page, you will usually see this type of metadata in the <head> area of the document:

```
<meta name="description" content="Amazing Scarves at sensible prices"> - This gives text that the search engine (may) use as a description under the link to your site.
```

```
<meta name="keywords" content="Scarves, Hats, Coats, Thermals, Scottish
```

Weather"> - This gives a list of possible search terms which a web crawler would add to its index for the site.

#### Womens Scarves at Debenhams.com

[www.debenhams.com/women/scarves](http://www.debenhams.com/women/scarves) ▼

99 products - Buy Scarves from the Womens department at Debenhams.com. You'll find the widest range of Scarves products online and delivered to your door.

[Lightweight scarves](#) - [200](#) - [Scarves](#) - [Occasion scarves](#)

#### Women's Scarves | Scarf & snood styles | ASOS

[www.asos.com](http://www.asos.com) › [Women](#) › [Accessories](#) ▼

Wrap up your style with our outfit-perfecting range of scarves, from labels including Moschino, Jonathan Saunders and Spirit Hoods whose cute animal designs ...

#### scarves | notonthehighstreet.com

[www.notonthehighstreet.com](http://www.notonthehighstreet.com) › ... › [hats, scarves & gloves](#) ▼

Items 1 - 30 of 1126 - Searching for beautiful scarves? With our range including cashmere scarves, you need search no further. Discover now.

Description

Of course things move on: Many search engines now don't bother using the 'keywords' metadata because people deliberately used misleading words to improve their chances of appearing at the start of a search! Because HTML is a standard language though leading search engines have developed other techniques. Google analyses which sites link to yours (using the <a> tag), to give your site an importance ranking. Search engines also give links to a page different values according to the "trustworthiness" of the site linking to it.

### Search Engine Optimisation

Learning how search engines rank pages and how to make the most of this process is called 'Search Engine Optimisation' - or SEO for short. Specialists who take time to work out how to best structure a site to maximise its ranking are in high demand, with a good placement near the top of search results meaning a likely spin-off in increased traffic and custom.

There are many factors that will affect a search ranking which an SEO specialist will use to ensure a good placement, such as:

- ensuring you use proper structure for your text, e.g. headings - integrate your keywords (sensibly) into headings, titles, etc.
- integrating with social media to share content
- ensuring metadata is available to describe images and other media ()

### 6.4.2 'Aggregating' comparison sites

Today, websites that search through a number of other sites are becoming very popular. Whether you want to book a holiday for the end of your studies, or insure the car you own (or hope to in the future), the chances are you'll be heading to a site that pools results from a number of other websites. For example:

All of this has been made possible due to good Information Systems design. In the above example, booking a flight and hotel to Orlando will involve searching a huge number of airline reservation databases and an equally huge number of hotel databases! In the background, huge efforts have gone into designing, documenting and sharing the structure of all this data. This makes financial sense for the companies involved: with no human input your product can appear in front of many more potential customers than just those visiting your own website. If a customer decides to book via the third party site (in this case, Expedia™) then a small arrangement fee will be charged to the airline or hotel, covering the costs of running Expedia™. Want to hire a car too? Guess what - standardised Information Systems allow Expedia™ to search those too, all from the original locations and dates you entered onto a single website.

The general trend currently is for making sites as structured as possible. New markup is being invented all the time under the name of the 'semantic web'. The idea behind the semantic web is that it should be possible to determine exactly what each element of a page is from the structure information. This will inevitably have to go beyond HTML, which only focusses on page structure (e.g. if you add a price to a standard HTML document, there is no way of denoting that it is a price from any other piece of text). Standards such as RDF are already in place and being used to ensure the trend towards increased interoperability between information systems continues to develop.



20 min

### Activity: Comparison sites

Use the internet to access a comparison website for insurance, travel or money products. Answer some of the questions and see what products are suggested.

Now, compare this site's questions to the questions on an individual company's site.

(N.B. you might not want to use your real email/contact details, unless you fancy being the next member of several mailing lists for the product you are searching for).

.....

**Quiz: Interaction of information systems with software**

**Q9:** Why do information systems need to be able to interact with other software?

.....

**Q10:** Give an example of two information systems interacting with each other.

.....



10 min

## 6.5 Learning points

### Summary

You should now know:

- Data is unprocessed and has no meaning.
- Information has been processed and has a meaning.
- An information system is where data can be collected, processed and stored on a computer.
- When developing an information system you should consider the age range of the prospective users and their level of experience.
- Information systems can be designed so that they can interact with other software as well as with users.

## 6.6 End of topic test



15 min

### End of topic test

**Q11:** What is data?

- a) Processed and has meaning
  - b) Random facts
  - c) Unprocessed and has no meaning
  - d) Processed facts
- .....

**Q12:** What is information?

- a) Processed and has meaning
  - b) Random facts
  - c) Unprocessed and has no meaning
  - d) Processed facts
- .....

**Q13:** What is a target audience?

- a) People watching a show
  - b) People who the website is aimed at
  - c) The person who is designing the website
  - d) People who create the web design software
- .....

**Q14:** What is **not** contained in a description of purpose?

- a) Who will be using the information system
  - b) Why the information is being stored
  - c) Who wrote the information
  - d) Date it was created
- .....

**Q15:** Which of the following are examples of data?

- a) 410490
  - b) ID Number: 410490
  - c) 1st December 1967
  - d) 01121967
- .....



---

## Topic 7

# Technical implementations (Hardware)

---

### Contents

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Input and Output devices;*
- *Processor type and speed;*
- *Memory (RAM and ROM);*
- *Device type (including supercomputer, desktop), portable devices (including laptop, tablet, smartphone).*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *name and describe the purpose of different input devices;*
  - *name and describe the purpose of different output devices;*
  - *understand the purpose of a processor;*
  - *be able to compare different processors;*
  - *explain the difference between RAM, ROM and cache memory;*
-

- *explain why each type of memory is necessary;*
- *understand how cache can be used to compare different computer systems;*
- *explain the differences between different types of devices;*
- *give examples of tasks that each device could be used for.*

In this topic you will look at the different parts of the computer that make up the hardware, and the different types of computer that are available. If you have studied National 5 Computing then you should already be familiar with most of the terminology.

## 7.1 Introduction

This topic looks at the **hardware** that makes up a computer: the **Processor** and **Main Memory**; the **peripherals**; and the different types of computer that can be made from these. You should be familiar with these terms already, but just to be clear:

Hardware is anything physical that makes up the computer, as opposed to software that is made up of binary data. Both are essential for a computer; without software you would just have a very expensive and pretty arrangement of plastics, metals, glass and silicon dioxide.

The Processor and Main Memory are often referred to as the Central Processing Unit of C.P.U. They carry out most of the functionality of a computer: the main memory stores the program(s) being executed by the processor, and the processor follows the instructions fetched from memory. Data can also be held in memory that programs are working with.

Peripherals are technically anything outside of the CPU (though the term is often only applied to items plugged into the system unit). They will access the CPU via an interface which will make up for speed, voltage and format differences in the data signals. Some peripherals are vital to the operation of the computer, e.g. a backing storage device to hold all our programs and data, a keyboard to issue commands and a monitor to see the results.

### Quiz: Introduction

**Q1:** Which of the following are hardware?

- a) Microsoft Windows
  - b) USB Flash Drive
  - c) iOS
  - d) Motherboard
- .....

**Q2:** Explain what is meant by the term **peripheral**.

.....



10 min

## 7.2 Input devices

### Learning objective

By the end of this section you will be able to:

- name and describe the purpose of different input devices.

The purpose of an input device is to put data into a computer. The data can then be processed and then displayed using an output device. There are many different input and output devices available and this topic will only concentrate on a few of them.



**Digital Cameras** - a camera that takes photographs and stores them digitally on a memory card. The data can then be transferred to a computer, where it can be saved and edited, or sent directly to a printer. Digital cameras have several features, optical zoom, LCD screens, flash, ability to correct red eye, anti-wobble technology and much more. Digital cameras can be compared in terms of resolution, zoom capabilities, battery life and extra features.

**Touchscreens** - touchscreens are now found on smartphones, laptops and some desktop monitors. They are a monitor that you can touch and where you touch controls a mouse, or opens icons. Touchscreens are very useful in devices where space is limited, such as tablets and smartphones as they combine the purpose of an input device and an output device in one. Touchscreens are very user friendly as they are very instinctive to use. They are also good for users that have coordination or motor control problems. Touchscreens are robust as they have no moving parts.



**Scanners** - scanners are used to copy a paper document and save a copy onto a computer. Photographs or documents are placed face down on a scanner and they are copied and then saved to a file on a computer. The digital copy can then be edited or printed as required. Scanners always create an image that is saved as a graphical file.

**OCR - Optical Character Recognition.** This involves using a scanner to scan a

document and then save those parts containing text as ASCII code. Pattern matching is used to pick out the individual characters. The text file can then be edited. This is different from scanning as you would not be able to edit a text document that you had scanned using a scanner that did not have OCR software, as it would be saved as a graphical file.

**Optical Mark Reading (OMR)** - OMR is used with scanners as a method of inputting large amounts of data into computers, often into databases. Cards are filled in, usually using a black pen, and then the marks on the card can be picked up by the scanner. When filling in the card it is important to stay within the lines on the card or the computer may not be able to recognise the marks correctly.



OMR is different from OCR in that complicated pattern matching technology is not required. OMR can often be used in multiple choice exam questions as this method allows them to be marked very quickly. They are also used in shops when people wish to play the lottery.

**Bar code readers-** are often used in shops. Products are marked with a barcode and the barcode is read by a scanner. The barcode contains a lot of information about the product, such as the country of origin and the manufacturer.



The barcode links the product to a record in a database and the database contains a huge amount of information about the product, such as the price and the number of products that are in stock. The database can be used to keep track of stock levels and to ensure that a product does not sell out.

**Mobile platforms**

With the advent of smaller form-factor computers such as smartphones and tablets there are an even wider array of input devices used. Consider a typical smartphone: as well

as relying on the touch screen mentioned already, it will also have a microphone linked to voice recognition software (e.g. Apple's Siri), a GPS receiver that can detect an exact location, tilt-sensors, gyrometers and a digital camera (or two!) which can capture images, video or even be used with image recognition software for augmented reality or QR code / bar code scanning.



20 min

### Practical task: Input devices

Use the internet to research all the input devices named above and make your own notes.

.....



15 min

### Quiz: Input devices

**Q3:** Give two possible advantages of using touchscreen monitors over standard input devices such as a mouse and keyboard.

.....

**Q4:** Explain the difference between image scanning and OCR scanning.

.....

**Q5:** Explain how mark sense readers work and give an example of where they can be used.

.....

**Q6:** Why are barcodes linked to databases?

.....

## 7.3 Output devices

### Learning objective

By the end of this section you will be able to:

- name and describe the purpose of different output devices.

Output devices are used as a way to view, or get information out of a computer. Two of the main types of output device are monitors and printers. Other output devices are available, often created for specialist purposes.

Monitors are used for several different purposes, to allow users to view films and websites, to let users see what they are typing, or to play games. Depending on the device that you are using there are a few different types of monitor available.



**LCD - Liquid Crystal Display**, much thinner than old fashioned CRT (cathode ray tube) screens and use a lot less electricity. LCD displays work because the liquid crystal has a polarisation effect when affected by an electrical current. This can be used to block out or show a light source.

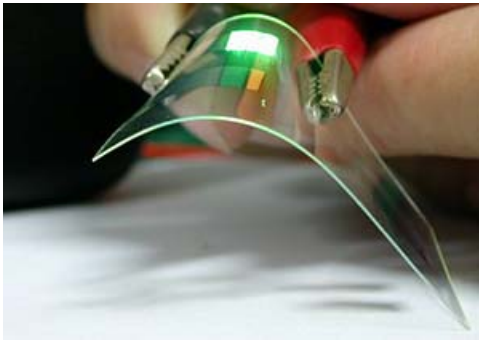
There are several technologies available for LCD 'flat screens'. TFT or Thin Film Transistor screens work by controlling a grid of pixels using a layer of transistors built into the display. This allows each Liquid Crystal cell to be individually switched very quickly to give a high quality display with a fast response time. TFT displays need a backlight - typically a florescent tube - to emit the light which will pass through the LCD grid and a RGB colour filter grid to make up the picture.

More recently, the florescent tube technology has been superseded by LED light sources, which produce a better quality, more even light.

Electrophoretic - or ePaper - screens have become popular on eBook products due to their low power consumption and viewing similarity to regular print (they rely on reflected light, rather than emitting their own). ePaper works by trapping a solution of liquid containing charged ink particles which can be attracted to 'pixels' using electrical charge, causing them to group together. ePaper screens are very energy efficient since they only require power when the screen is being updated.

**Touchscreen** - the monitor can also be used as an input device. Found in smartphones, tablets and some laptops. The surface of the LCD screen is covered by a transparent electrical layer. The user's finger completes an electrical circuit and the location is pinpointed from this.





**OLED - Organic Light Emitting Displays**, thinner and brighter than LCD and can be used on transparent surfaces, such as glass.

### LCD Projectors

Digital LCD projectors have been developed to allow very large images to be projected onto a screen or other flat surface. You probably have one in your classroom just now.



The technology works in a similar way to an LCD screen, except you need a very bright light source and a focussing lens. The very bright light is shone through a small, transparent LCD 'screen' towards a lens. The lens focusses the image on the LCD onto a surface some distance away. The quality of the image will depend on both the resolution of the LCD element and the power of the light source (usually measured in lumens).



30 min

### Practical task: Monitors

Use the internet to research current monitor technologies.

Make a set of notes up covering the main technologies.

.....

### Printers

Printers are used to obtain a hardcopy of pictures and text. Depending on your purpose there are different types of printer available. Printers can be compared by the resolution of a printout, measured in dpi (dots per inch), or the speed at which they can print ppm (pages per minute).





**Inkjet**- cheapest type of printer available and the most common found in homes. Inkjets are usually colour and are slow at printing. They are cheap to purchase but they may have high running costs as the ink cartridges are expensive to replace. Often they will have features targeted at home users, such as photo-realistic printing, specialist media like T-shirt transfers, Flash Memory card slots and wi-fi connectivity (an important feature due to the limited physical connectivity of smartphones and tablets).

**Laser** - can print up to 18 pages per minute. Often found in schools or workplaces where a large amount of printing takes place. They are expensive to buy, especially if they are colour, but may have lower running costs than inkjets as the toner cartridges last for a long time. Laser printers are typically targeted at business users, and have feature sets to reflect this: 'duplex' (double sided) printing; multiple paper trays for different colours / letterheads; high speed network connectivity; and high capacity toner cartridges.



**Practical task: Printers**

Use the internet to research how laser and inkjet printers create an image. Make a diagram or notes to demonstrate this.



45 min

You might want to try the following web pages:

- <http://www.howstuffworks.com/laser-printer.htm>
- <http://www.howstuffworks.com/inkjet-printer.htm>

Use the internet to complete the following table. Find two examples of laser printers and inkjet printers.

Printer Name	Colour Y/N	DPI	PPM	Type	Price

.....



5 min

### Quiz: Output devices

**Q7:** Explain why CRT screens have been superseded by technologies such as TFT. Give as many reasons as you can.

.....

**Q8:** State whether someone buying a printer for a large office would be better buying an Inkjet or a Laser printer. Justify your choice.

.....

## 7.4 Processors

### Learning objective

By the end of this section you will be able to:

- understand the purpose of a processor;
- be able to compare different processors.

The processor is a very important part of the computer as it contains the control unit, arithmetic and logic unit (ALU) and registers. You can learn more about the structure of the processor in the computer architecture topic.

All types of computer require a processor and as there are many different types available then there has to be a method in which they can be compared. You are going to look at three methods of comparing processors:

1. The type of processor
2. The number of processors
3. The speed of the processor (Hz)

You should think about where a processor is going to be used. Is it going to be used in a laptop or desktop computer, or perhaps in a smartphone? If a processor is to be used in a smartphone then it must not use as much power as a processor chip in a desktop, or generate as much heat. The size of a smartphone restricts the size and type of processor that can be used.

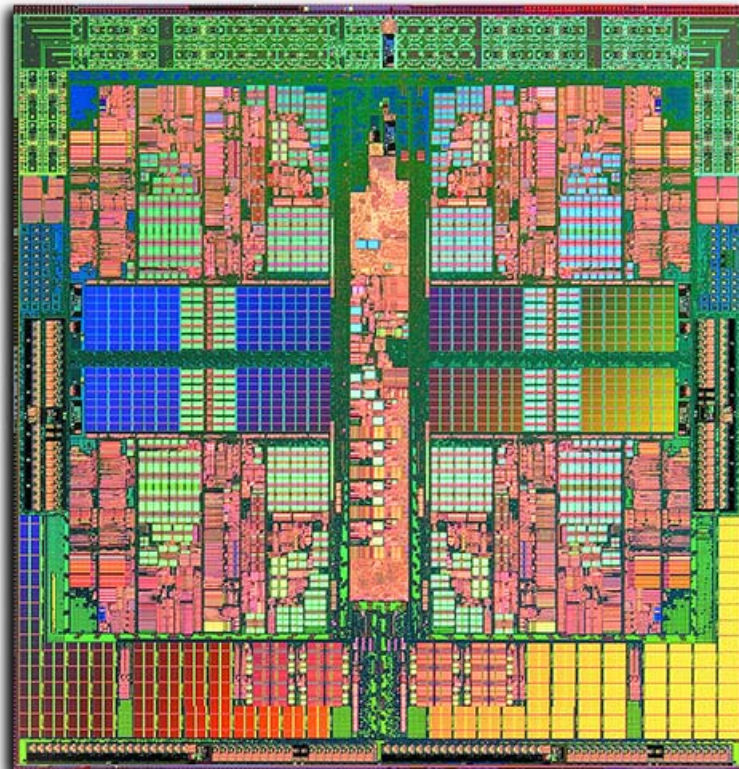
The first computers that were available had only one processor and were called single core processors. As technology has advanced dual core and quad core processors became widely available. A dual core processor has two processors,

*Figure 7.1: Dual Core Processor*

.....

and a quad core processor has 4 processors. If a computer has more than one processor available then it should be able to decode and execute instructions quicker, improving the performance of the computer.

It is likely that the number of processors in a computer will continue to increase as technology continues to develop.

*Figure 7.2: Quad Core Processor*

.....

The speed of the processor is measured in hertz (Hz), usually Megahertz (MHz) or

Gigahertz (GHz). The speed of a processor is measured by the number of clock cycles that occur each second. The clock cycles keep everything in the processor working in synchronisation. The more clock cycles that are completed every second the more instructions that can be decoded and executed per second, the faster the computer should be able to run.

1 MHz = 1 million cycles per second

1GHz = 1 billion clock cycles per second

The speed of processor is likely to continue to increase in the future as technology advances.

A fourth and final way of comparing processors is to look at the cache memory. The cache memory stores the information that a processor has most recently used. As the cache is located on, or next to the processor it provides very quick access to information, speeding up the fetch-execute cycle and improving computer performance. More information about cache memory can be found in topic 7.5, Memory.

*You will learn more about processor technology in the Computer Architecture topic in the Software Design & Development Unit.*



10 min

### Quiz: Processors

**Q9:** Explain the difference between a single, dual and quad core processor.

.....

**Q10:** What is the speed of a processor and how is it measured?

.....

## 7.5 Memory

### Learning objective

By the end of this section you will be able to:

- explain the difference between RAM, ROM and cache memory;
- explain why each type of memory is necessary;
- understand how cache can be used to compare different computer systems.

You should be aware that a computer has several different places for storing information. One of these places is the Main Memory. Main memory is the term for storage that is not backing storage. Backing storage is used for saving programs and data when the computer is turned off. Main memory is used for storing programs and data when they are being used. Main memory consists of two different types of memory: RAM and ROM.

**RAM - Random Access Memory.** This is memory that is used to store programs and data whilst the computer is turned on. The information in this area of memory can be

edited and changed, but any changes must be saved before the computer is logged off, or they will be lost. Any data stored in RAM is lost when the computer is switched off, so RAM is described as volatile. Data in RAM can be accessed in any order. There are many different types of RAM memory; DRAM, SRAM and VRAM.

**ROM - Read Only Memory.** This is an area of memory that holds data permanently. When the computer is turned off any data that is stored in ROM is saved. ROM is a permanent memory and described as non-volatile. Data that is in ROM cannot be changed, it can only be read. Data can be accessed in any order. In many computers ROM is used to store the bootstrap loader. The bootstrap loader is a small program that is used to load the operating system and is the first program to open when a computer is turned on.

**Cache Memory** was briefly mentioned in section 7.4. Cache memory is a relatively small area of memory that is located either on or next to a processor. Cache memory is faster memory as well as being closer to (or part of) the processor. The location of the cache means that it can reduce the time needed for a fetch-execute cycle as it is much closer to access than backing storage. Cache is used to store frequently used or recently used instructions and information. This means that they can be accessed again very quickly, helping to improve the computers performance. The larger the cache is, the more information it can store and can potentially improve computer performance.

*You can learn more about cache memory in the Computer Architecture topic in the Software Design and Development unit.*

**Quiz: Memory**

**Q11:** What is main memory used for?

.....

**Q12:** Explain the difference between RAM and ROM.

.....

**Q13:** What is cache memory?

.....

**Q14:** Why can cache memory improve the running performance of a computer?

.....



20 min

**7.6 Types of computing device**

**Learning objective**

By the end of this section you will be able to:

- explain the differences between different types of devices;
- give examples of tasks that each device could be used for.

Computers used to be desktop computers. This gradually changed to include laptop

computers as technology advanced. Smartphones were created as mobile phone technology converged with computer technology and then tablets were created to meet consumer demands. There are other types of devices available but this topic will concentrate on desktops, laptops, smartphones and tablets.

**Desktop** - non-portable type of computer that gets its name from the fact that it sits on a desk. Often used in schools, universities and offices for a variety of tasks. They have powerful processors and large memories. Consist of a monitor, base unit, mouse and keyboard. Desktops need a constant supply of electricity in order to run. Information Systems that are designed for this type of computer typically can call upon a large screen space, powerful processors, large amounts of RAM and Gigabytes or Terabytes of backing storage. This allows some very powerful software to be accessed.



**Laptop** - smaller than a desktop and portable, can also run from batteries instead of needing to be connected to a constant power supply. Often used by people who wish to work in a variety of places, or perhaps whilst they are commuting. A laptop folds in half and all components are built-in. Like desktops, an information system will still have access to a fairly large screen and powerful processor. Often laptops do have to cut back on processor power to save battery charge, but RAM and backing storage will be very similar to a desktop.





**Smartphone** - a combination of a mobile phone and a computer. Very popular with users of all ages due to their portability and ability to access the internet from anywhere. They usually have a small qwerty keyboard, or a touchscreen interface. They are used for listening to music, sending and receiving emails, browsing and social networking. Most have high quality built in cameras.

**Tablet** - is larger than a smartphone but still very portable and can connect to the internet using 3G. Unlike a smartphone they are not used for making phone calls. Tablets come with a touchscreen interface and often have a built in camera. They do not have very powerful processors, large amounts of RAM and have limited backing storage (usually flash ROM-based). Some smartphones and tablets allow you to expand the backing storage using 'MicroSD' Flash ROM cards.



Designing an information system for a smartphone or tablet can be challenging, mostly because of the smaller screen sizes (particularly in smartphones) but also because of the limiter processing power, RAM and backing storage available. Many app developers have called upon cloud-based storage - or load data directly from a web server - to get around the storage issue. One sure-fire way to get your app deleted from a user's smartphone is to make heavy use of the limited backing storage available!

**Practical task: Types**

Using the internet or computer magazines available to you, carry out a comparison of the main types of computer mentioned above. You could present the information in a comparison table, like the one below. You may also wish to try and create an 'infographic'-type illustration showing some of the comparisons visually.



20 min

Type of Computer	Processor Details	Backing Storage	Screen Size	Connectivity (e.g. network facilities, interfaces)
Desktop				
Laptop				
Smartphone				
Tablet				

.....

### Converging technology

Converging technology is when two different types of technology come together to create a new product. An example of this is smartphones. A smartphone is a combination of a mobile phone and a portable computer. Another example is Internet televisions. They are a combination of televisions and computers. New products and types of devices are constantly being created as technology advances and consumers make demands. Future example of this include Google glass and computers in wristwatches.



20 min

### Practical task: Trends

Use the internet to research a recent trend in computing devices. Make up a handout for others in your class about the trend you have investigated.

.....

## 7.7 Learning points

### Summary

You should now know:

- The purpose of input and output devices.
- How digital cameras can be compared.
- How touchscreens are used.
- The different forms of scanning.
- How barcode scanning can be linked to database inputs.
- The different types of monitor available.
- How printers can be compared.
- How to compare processors.
- The difference between main memory and backing storage.
- The differences between RAM and ROM.
- The purpose of cache memory and how it can improve a computers performance.
- Different types of computers currently available.



## 7.8 End of topic test

### End of topic test



10 min

**Q15:** Which of the following factors can be used to compare processors?

- a) The size of the chip
  - b) The clock speed
  - c) The number of cores
  - d) Whether it is a mobile or desktop processor
- .....

**Q16:** Which of the following statements are true for RAM?

- a) RAM is volatile
  - b) RAM uses sequential access
  - c) RAM is used to store the bootstrap loader
  - d) RAM is editable
- .....

**Q17:** Which of the following statements are true for ROM?

- a) ROM is volatile
  - b) ROM uses random access
  - c) ROM is permanent
  - d) ROM is editable
- .....

**Q18:** Which of the following is NOT an advantage of cache memory?

- a) Cache is very large
  - b) Cache is fast access
  - c) Cache is loaded on or close to the processor
  - d) Cache is expensive
- .....



---

## Topic 8

# Technical implementations (Software)

---

### Contents

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Operating Systems;*
- *Web browsers;*
- *Utilities.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *describe what is meant by the term software;*
  - *describe the functions of an operating system;*
  - *understand the purpose of a software licence;*
  - *explain the difference between proprietary and open source software;*
  - *explain what is meant by the term transferability;*
  - *discuss current trends in the design of operating systems.*
-

In this topic you will look at the different software that is essential to the running of a computer system. You will look at the different types of licence available and how operating systems are changing.

## 8.1 Introduction

### Learning objective

By the end of this section you will be able to:

- describe what is meant by the term software.

As discussed in the previous topic (Technical Implementation: Hardware), software is the instructions and data that allow the computer to run and allow the user to be able to accomplish tasks with it. A computer can run more than one program at a time, some programs are essential for the computer to be able to function; some programs allow the user to perform tasks. One of the most important programs on a computer is the operating system. Without an operating system a computer cannot run.



5 min

### Quiz: Introduction

Q1: Explain why software is needed as well as hardware to make a computer system.

.....

## 8.2 Operating systems

### Learning objective

By the end of this section you will be able to:

- describe the functions of an operating system.

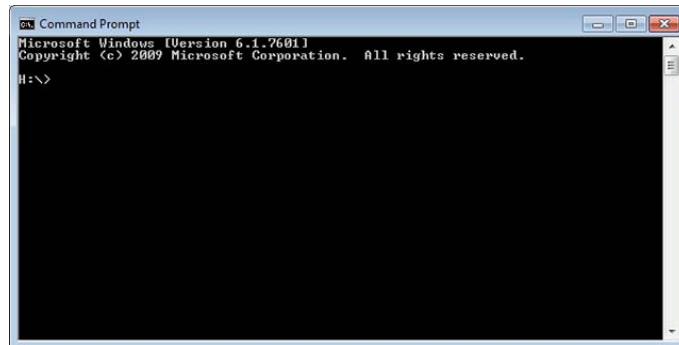
When a computer is first switched on the bootstrap loader, which is a small program stored in ROM, is loaded. It also checks where to load the OS and runs a set of simple diagnostic tests. The bootstrap loader is responsible for loading the operating system. Without an operating system a computer cannot function.

There are several types of operating system available, depending on the make or model of computer. These will be discussed later. Firstly, let's look at what the operating system actually does. The main functions of an operating system are:

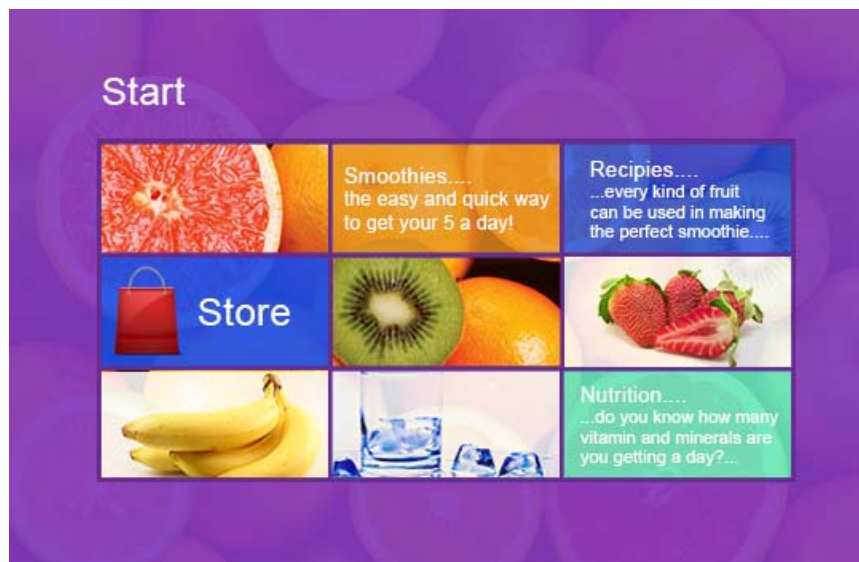
1. Interpreting user commands
2. File management
3. Memory management
4. Input/output management
5. Error reporting
6. Resource allocation

**Interpreting User Commands** - the computer may have a menu-driven or a command-driven interface and this is how the user can give commands. Command-driven interfaces require specific commands to be correctly entered. This can be challenging for novice users, but useful for experienced users, who know what commands they want executed. An example of a command-driven interface is the MsDos command prompt, see Figure 8.1. A menu-driven interface is suited to all types of user as the options available are presented to the user and can be selected. The user does not need to know specific commands. Menu-driven interfaces can form part of a larger Graphical User Interface (see Figure 8.2) or may represent the user interface in its entirety: a Sky TV box's menu system, for example.

Graphical User Interfaces use pictures to represent actions and normally have a pointing device to select activate each action. The most common type of GUI has been a Windows, Icons, Menus and Pointer (WIMP) system, such as that provided by Microsoft Windows or Mac OSX. More recently, directly manipulated touch-based GUIs have become popular on smartphones and tablets. Here, software typically runs in full screen mode and there is no pointer as you can press directly on the screen to activate an action.

*Figure 8.1: Command-driven interface*

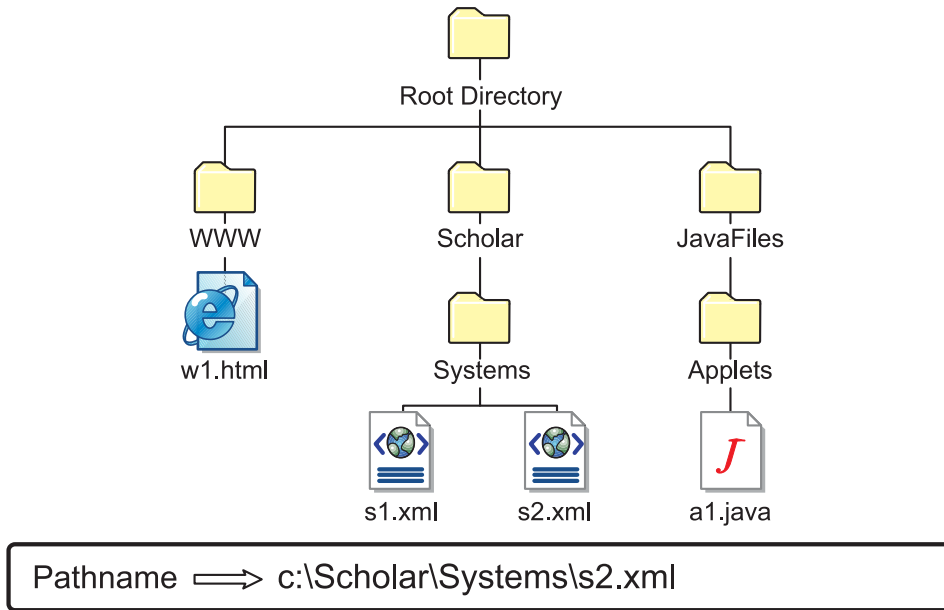
.....

*Figure 8.2: Menu-driven interface*

.....

**File Management** - This is the part of the operating system that is responsible for managing the backing storage devices. When a file is to be saved the file management system will create an entry on the disk to store details of where the file is stored. This would include information such as the date it was saved and address. The file management system organises files into a hierarchical filing system, which allows the creation of folders and sub-folders. This is helpful to users as it allows related files to be kept together. As different files would have different path names (the path is the technical term for the folder names you need to navigate to access the file) it allows for two files to have the same name, so long as the paths are different. The file management system will ensure that no files are overwritten.

Figure 8.3: Path name

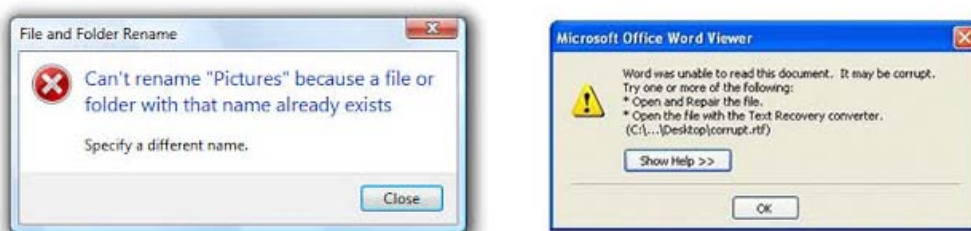


**Memory Management** - the memory management system controls where programs and data are placed in the computers main memory. The memory management system keeps track of how much space is in main memory and what programs and data are currently in main memory. If the user attempts to open up a program and there is not enough free space in the main memory then an error message would be displayed. Most modern computers allow for more than one program to be in main memory at the same time and the memory management system ensures that they do not interfere with the running of other programs, including the Operating System itself.

**Input/Output Management** - The I/O system communicates directly between the peripherals and the processor. The I/O system handles the transfer of data between the peripherals and the processor. It will check to see that devices are ready for data transfer and check that errors have not occurred during data transmission.

**Error Reporting** - if an error occurs during execution then the operating system will display a message to the user. For example, if data was lost during a transfer then an error message would be displayed to the user so that the data could be retransmitted. See examples in Figure 8.4.

Figure 8.4: Example error messages



**Resource Allocation** is responsible for ensuring that a process has adequate resources to allow it to complete. For example, a program that the user opens up is a process. It will require an area in memory, processor time and perhaps access to other programs. Resource allocation ensures that all processes are allocated a share of the processors time and resources so that they are all able to function. One resource will not be allowed to 'hog' the memory or processor time.



30 min

### Practical task: Operating systems

Use the internet to research operating system tasks and make your own notes.

.....



30 min

### Quiz: Operating systems

**Q2:** Write a short explanation on what the operating system function **Interpreting User Commands** is responsible for. Give examples from an operating system with which you are familiar.

.....

**Q3:** Write a short explanation on what the operating system function **File Management** is responsible for. Give examples from an operating system with which you are familiar.

.....

**Q4:** Write a short explanation on what the operating system function **Memory Management** is responsible for. Give examples from an operating system with which you are familiar.

.....

**Q5:** Write a short explanation on what the operating system function **Input/Output Management** is responsible for. Give examples from an operating system with which you are familiar.

.....

**Q6:** Write a short explanation on what the operating system function **Error Reporting** is responsible for. Give examples from an operating system with which you are familiar.

.....

**Q7:** Write a short explanation on what the operating system function **Resource Allocation** is responsible for.

.....

**Q8:** Explain the advantages and disadvantages of using a Graphical User Interface instead of a command-driven interface.

.....



### 8.3 Licencing

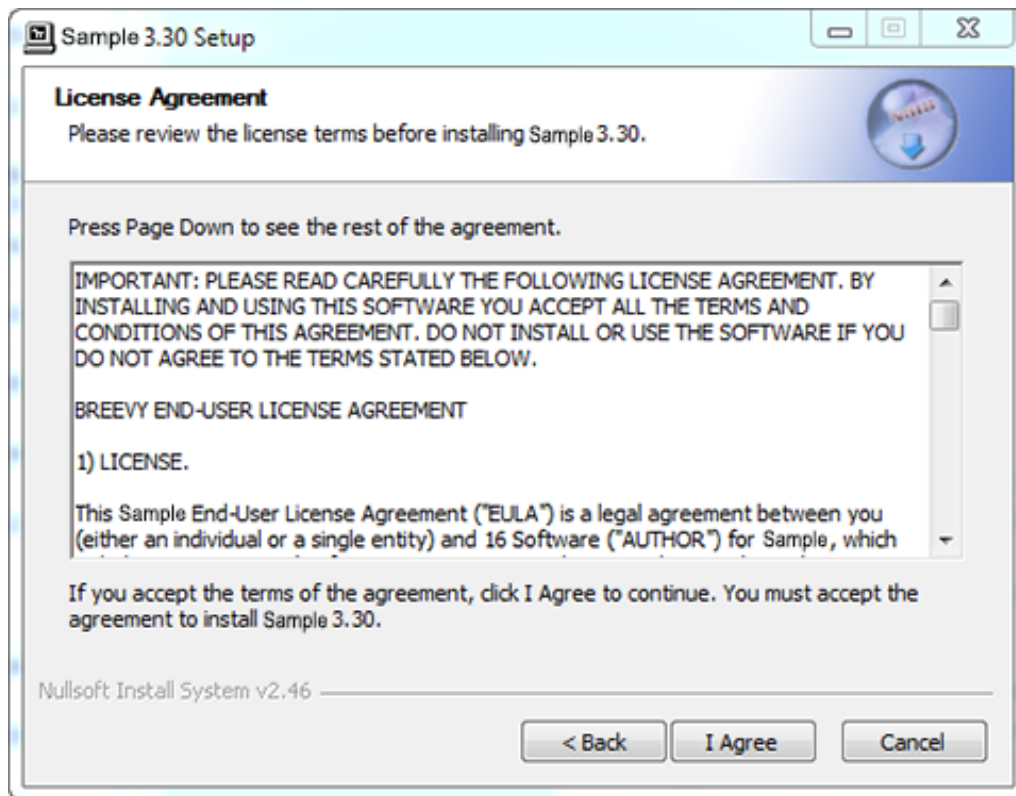
**Learning objective**

By the end of this section you will be able to:

- understand the purpose of a licence.

Figure 8.5 Sample of a licence agreement

*Figure 8.5: Sample of a licence agreement*



.....

If you are using an operating system on a computer then you should have a licence. A licence means that you have permission to have a copy of the operating system and you are using it with the manufacturer's permission. It is against the law, Copyright, Design and Patents Act, to use software without a licence. Not all operating systems require you to purchase a licence, for example Linux, can be downloaded for free.

A licence may ask you to agree to certain terms before you are allowed to use the software. You may have found this if you use an iPad, iPhone or iPod. When you update the operating system Apple will ask you to agree to the terms of the software before you are allowed to install the update.

There are many different kinds of licence available. Some programs that you purchase may come with only one licence, meaning that the software is only to be used on one computer. Some pieces of software come with multiple licences, meaning that the program can be installed on several computers. Businesses, schools included,

often purchase a site licence. A site licence means that all the computers within that organisation can have permission to use the software.

Freeware is software that is available to use at no cost. It is not usually open source but is usually fully functional for an unlimited time frame. Freeware is usually distributed without source code; this is to prevent it from being modified.

Shareware is similar to freeware but the user is obligated to pay once the trial period ends, or pay to get extra functionality. Shareware can be useful to get users interested in a game or product. Trial versions can be downloaded so that the user can play them for free. If the user likes the product then they can pay to receive the full version.



20 min

### Quiz: Licencing

**Q9:** Explain the purpose of a licence.

.....

**Q10:** Explain the difference between a site licence and a single user licence.

.....

**Q11:** What is the difference between freeware and shareware?

.....

**Q12:** Why do some developers make use of shareware?

.....

## 8.4 Proprietary versus Open Source

### Learning objective

By the end of this section you will be able to:

- explain the difference between proprietary and open source software.

There are two types of software available: **proprietary** and **open source**.

Proprietary software can also be known as closed source. This means that the software is licenced to only be used under certain conditions and is not able to be shared, copied, redistributed, modified or **reverse engineered**. The **source code** for proprietary software would not normally be made available.

Proprietary software is not to be confused with commercial software. Commercial software is software that is sold for a profit. Proprietary software is software that is written by a closed development team who will maintain it. Freeware and Shareware are also usually proprietary software: the key is that the author(s) retain full copyright of proprietary software and keep the source code private.

The use of proprietary software is often limited by the owner in an attempt to prevent it being passed around. The owner of proprietary software may use technical measures, such as activation keys or product keys to restrict use.

**Advantages of proprietary software:**

- You will be able to take advantage of the software company's customer service department for troubleshooting and setup purposes.
- Software is often very high quality as it has been developed by professional teams.

**Disadvantages of proprietary software:**

- You will usually have to pay for the software as the company that produced it will be trying to make a profit.
- The software will not be adaptable; you cannot change it to meet your individual needs.
- If the software is not compatible with the operating system, or other program, then you cannot modify the proprietary software to enable it to run.
- You are often 'locked in' to a particular software 'eco-system': you might end up relying on a proprietary file format or OS feature.

**Open source software**

Open source software is software that has its source code available. The licence allows the user to look at the code, make changes to the code and to distribute the code as they choose. Often open source software is developed in the public domain and is developed collaboratively, by a group of users.

**Advantages of open source software:**

- Is free to use, distribute, and change. It has lower costs, and in most cases this is only a fraction of the cost of their proprietary counterparts.
- It is more secure as the code is accessible to everyone. Anyone can fix bugs as they are found, and users do not have to wait for the next release. The fact that is continuously analysed by a large community produces secure and stable code.
- It not dependent on the company or author that originally created it. Even if the company fails, the code continues to exist and be developed by its users. New, different versions can be separately developed ('forked') alongside the original code to meet different needs.
- It uses open standards accessible to everyone; it does not have the problem of incompatible formats that exist in proprietary software.
- Companies using open-source software do not have to think about complex licencing models and do not need anti-piracy measures like product activation.

**Disadvantages of open source software:**

- It may not always be straightforward to use. Open source operating systems like Linux cannot be learned in a day. They require effort and possibly training from your side before you are able to master them.

- There is a shortage of applications that run both on open source and proprietary Operating Systems; therefore, switching to an open source **platform** involves a compatibility analysis of all the other software used that run on proprietary platforms. (For example, much of Adobe's design software is not available on Linux).



5 min

### Quiz: Proprietary versus Open Source

**Q13:** Explain the difference between proprietary and open source software.

.....



20 min

### Practical task: Proprietary and Open Source examples

Use the internet to find two examples of operating systems that are proprietary and two operating systems that are open source.

Compare the systems in terms of User Interface, File Management, Cost and hardware support. Alternatively you could try out an open source Operating System. There are a number of ways you can do this:

- Download an .iso image, (a file containing an exact copy of a CD's contents), burn this to a CD-R and install it onto a standalone machine.
- Create a bootable USB Flash Drive ([www.pendrivelinux.com](http://www.pendrivelinux.com)) and 'try' the OS by booting from the USB Flash Drive.
- Use a **virtual machine**: try VMware player or Oracle Virtualbox. Your classroom may already have one of these installed.

.....

## 8.5 Portability of software

### Learning objective

By the end of this section you will be able to:

- explain what is meant by the term portable in relation to software.

Portability of software is if the software is able to run on other computer platforms. For example, can a program be taken from a mac desktop and run on a windows laptop?

Developers and manufacturers will be able to sell more products if their software is able to be transferred from one type of computer platform to another. The more products they can sell the more money they are going to make.

A program is said to be portable if it can run on a computer, other than the one it was designed for, with little or no change.

Truly cross-platform software is rare; although solutions such as web-based software is perhaps a good development in this area. Java has also offered the ability to run

software across multiple platforms for a number of years, though this does require the user to have a Java Virtual Machine (software to translate Java code) available on their Operating system.

Often, manufacturers will make changes to cope with different platforms or operating systems at the implementation and testing phases of development, so that the source code can be adapted ('ported') by the programmers. Usually, proprietary software will be targeted at Windows and Mac OSX because of their large market share, which has the unlikely benefit of encouraging more open source development on linux. On mobile platforms, iOS and Android are the main targets, with (as of writing) few developers investing time and effort to port apps to less popular mobile Operating Systems.

**Quiz: Portability**

**Q14:** What is meant by the term portability?

.....



5 min

**8.6 Current trends**

**Learning objective**

By the end of this section you will be able to:

- discuss current trends in the design of operating systems.

Operating systems are continually being developed and updated to keep up with user demands and new technology. Operating systems have already migrated from being command-driven to having rich Graphical User Interfaces. This was in response to user demands to make them more user friendly, especially for novice users, and was made possible as more powerful hardware capable of processing the graphics required for GUIs became cheaper.

One of the more recent trends in operating system development has been moving from systems that are controlled by a keyboard and mouse to touchscreen interfaces. At first touchscreen interfaces were only available on smartphones, which themselves require different operating systems to desktops because of their size and processing power. Now touchscreen interfaces are becoming more common on laptops and desktop computers. An operating system for a touchscreen device is going to be very different to that of a 'normal' desktop computer.

As the size of computers has decreased the operating system has had to change. It would not be possible for the operating system that controls a laptop to be able to fit onto a smartphone as there would not be enough storage space and it would require too much processing power. The different interfaces will require different operating systems.

As technology continues to advance different types of computers are being developed. 'Wearable tech' is a phrase that is becoming more common and refers to technology that a user actually wears, for example, glasses or a wristwatch. As different products are developed they will require different operating systems.

Google have recently created Google Chrome book, which is a portable computer that claims to go from being switched off to on the internet within 3 seconds. This is an example of a browser and an operating system being combined.



Open source Operating Systems such as Linux variants are still a niche market, but have some surprising strengths: almost all web servers run a version of Linux, and when games developer Valve wanted to make their own Operating System they chose to base it around the open source 'Debian' linux. One last thought: if you're thinking "I've never used linux" you're almost certainly wrong; the Android mobile OS is built around linux!



20 min

### **Practical task: Current trends**

Use the internet to research recent trends in operating systems and make your own notes.

You may wish to focus on:

- User interfaces.
  - Hardware platforms and the design considerations.
  - Increasing touch-based interactivity.
  - Newer Operating Systems.
  - Popular Linux-based Operating Systems.
- .....

## 8.7 Learning points

### Summary

You should now know:

- The operating system is responsible for interpreting user commands, file management, memory management, input/output management, error reporting and resource allocation.
- All software should come with a licence.
- There are different types of licence available, single use or site use.
- Freeware is software that is free but cannot usually be modified.
- Shareware may be free for a trial period but then the user is expected to pay to continue to use the program, or to access full functionality.
- Proprietary software is also known as closed source software. It means that the source code is not available and the software should not be modified.
- Open source software means that the source code of a program is available and can be modified.
- Commercial software is software that is sold for a profit. It may be open source or proprietary.
- Portability is if the software can run on more than one platform or device.
- Different hardware configurations such as mobile and wearable devices require different types of operating system.

## 8.8 End of topic test



10 min

### End of topic test

**Q15:** Which of the following is always true for open source software?

- a) It is free
  - b) Source code is available
  - c) It is more robust
  - d) It is easier to use
- .....

**Q16:** Which of the following are functions of the operating system?

- a) File management
  - b) Voltage conversion
  - c) Protocol conversion
  - d) Error reporting
- .....

**Q17:** What is the advantage of using proprietary software?

- a) The software will be adaptable; you can change it to meet your individual needs.
  - b) You can modify the proprietary software to enable it to run.
  - c) You will be able to take advantage of the software company's customer service department for troubleshooting and setup purposes.
  - d) You will usually have to pay for the software as the company that produced it will be trying to make a profit.
- .....

**Q18:** Which interface presents options to the user to pick from?

- a) A command-driven interface.
  - b) A menu-driven interface.
  - c) Graphical user interface.
  - d) Command menu interface.
- .....

**Q19:** True or false: Shareware is free to download but the user will need to pay after a trial period.

- a) True
  - b) False
- .....



---

## Topic 9

# Technical implementations (Storage)

---

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Local, Web, Cloud storage;*
- *Capacity of storage devices;*
- *Rewritable versus Read-only storage media;*
- *Storage Device Interface type;*
- *Data transfer speed between storage devices and the processor/main memory;*
- *Built-in, External, Portable storage devices;*
- *Magnetic, Optical, Solid State storage devices.*

### **Learning objectives**

*By the end of this topic you will be able to:*

---

- *describe what is meant by the term backing storage;*
- *describe the difference between distributed and off-line storage;*
- *state the purpose of a backup system;*
- *explain how backups are created;*
- *explain what a backup strategy is;*
- *understand how the storage capacity of backing storage devices is measured;*
- *explain the difference between rewritable and read only storage media;*
- *discuss the differences between the different interfaces;*
- *discuss and compare data transfer speeds;*
- *discuss the differences between built in, external and portable storage devices;*
- *discuss the differences between magnetic and optical backing storage devices;*
- *understand what is meant by the term solid state storage device;*
- *discuss current trends in backing storage devices.*

When your computer is switched off there is a need for the programs and data to be stored, this is done on backing storage devices. This topic will look at the different types of backing storage devices available and how they work.

## 9.1 Introduction

### Learning objective

By the end of this section you will be able to:

- describe what is meant by the term backing storage.

When a computer is running a program it is stored in the computers main memory, which we know is volatile and lost when the computer is turned off. In order for programs and data to continue to be available backing storage devices are used to store the programs and data when the computer is switched off.

### Practical task: Storage

#### Q1:

Use the words below to fill in the blanks:

1. memory cards
2. rewritable
3. optical
4. hard drive
5. portable
6. terabytes
7. solid state storage

An internal hard drive is not \_\_\_\_\_. A USB flash drive is a portable device. CD-ROMs are not \_\_\_\_\_ but a CD-RW is.

The capacity of backing storage devices varies greatly, a CD is 700 MB, a hard drive could be measured in \_\_\_\_\_.

A \_\_\_\_\_ is a magnetic device, CDs and DVDs are \_\_\_\_\_. USB flash drives are \_\_\_\_\_ devices, as are \_\_\_\_\_.

.....

### Quiz: Introduction

Q2: What is the purpose of backing storage?

.....



5 min



5 min

## 9.2 Distributed and off-line storage

### Learning objective

By the end of this section you will be able to:

- describe the difference between distributed and off-line storage.

When you create a file, you would usually save the file to your hard drive, or perhaps a portable storage device. For large companies and organisations this is not an option; they need to ensure the data is accessible by many users and that it is safe from being lost through hardware failure or malicious software. Two large-scale storage methods used in industry are distributed storage and off-line storage.

Distributed storage is a computer network where data is stored on more than one computer, and it can be replicated. This could be used to describe a distributed database, where the users store information on several different computers. You could imagine a very large database being saved over twenty different computers. In this example, users have access to the portion of the database at their location so that they can access the data relevant to their tasks without interfering with the work of others. However, the management of the database is centralised using distributed database management system (DDBMS). The DDBMS manages the database as if it were all stored on the same computer. The DDBMS synchronizes all the data periodically and, in cases where multiple users must access the same data, ensures that updates and deletes performed on the data at one location will be automatically reflected in the data stored elsewhere, and that the same record is not edited at exactly the same time.

Distributed storage is becoming a favourite with large companies such as Amazon, Facebook and Google. Large companies like these require huge amounts of data storage and processing. If data is stored over several different machines then they have access to more storage and processing power than if all the data was shared in-between on one machine.

Distributed storage is also crucial because it ensures their data is essentially 'backed up' almost instantaneously; if a data centre gets hit by an outage another can seamlessly take over, updating the affected data centre when it comes back online later. There are also benefits to the user: when you update your status on a social media platform you access a fairly 'local' version of the database, which can respond rapidly to your request and make the update. This helps manage demand. When there is spare bandwidth and processing time the DDBMS will write these changes to data centres around the world so that when your cousin in California logs on they can see your new words of wisdom.

Off-line storage can be thought of as a way of storing data that has physically been removed from a network. Backup tapes can be made and the tapes are stored off-line and often somewhere separate from the network. It cannot be accessed unless it is physically connected to the computer again.



Off-line storage can be used as a method of transporting data, or as a way to create backup copies. Off-line data is very secure as it cannot be accessed digitally, as it is not connected to any networks. Storing data off-line is cheaper than storing it online but it is not as easy to expand.

**Quiz: Distributed and off-line storage**

**Q3:** Explain the differences between distributed storage and off-line storage.

.....

**Q4:** What do you think the advantages of a distributed storage system are?

.....

**Q5:** What do you think is an advantages of off-line storage?

.....



15 min

**9.3 Backup systems and strategy**

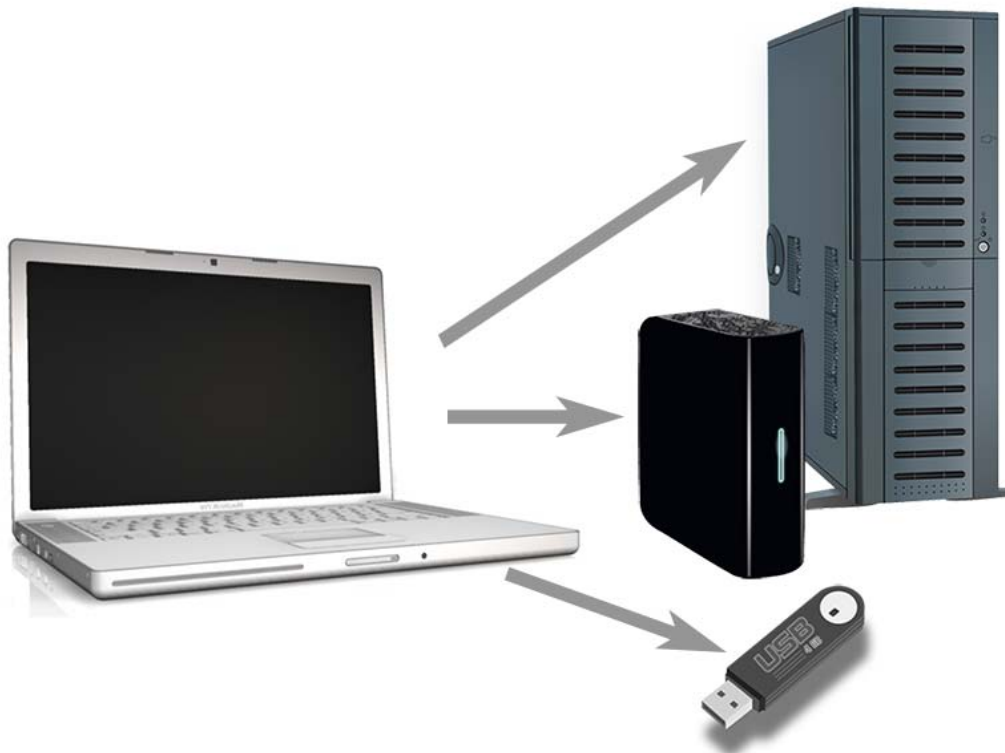
**Learning objective**

By the end of this section you will be able to:

- state the purpose of a backup system;
- explain how backups are created;
- explain what a backup strategy is.

You may already know that a backup copy is a second copy of data. It is created and then stored separately from the original. If the original copy is damaged, then the backup copy can be used and no data should be lost.

Companies and organisation's store a huge amount of data and they do not want to lose any of this data. To a company data is information and information is money. A bank would not like to lose all their customer records as they would not know who owed them money and who had any savings! Companies therefore have a backup system that they can turn to if their network ever encounters a problem.



A backup strategy is necessary as despite all precautions system failures do sometimes occur. Every network should have a backup strategy so that data can be successfully recovered. A good backup strategy would start with what data needs to be backed up, although in some organisations it would be necessary to have a complete backup of all data. Programs and operating systems should be able to be reinstalled from the original installation disks and so do not need regular backups.

Individuals may find it advantageous to have a backup copy of all the files on their personal computer and smartphone. We all know someone who has dropped their smartphone in water and had to get a new one! If the person has a backup, possibly using iCloud or similar, then this is straightforward. When the person gets a new smartphone they can simply restore the latest backup to their new phone, hopefully not losing any data. If they do not have an up to date backup then they will lose all the information that they had stored on their smartphone since they last backed up. One big benefit of cloud-based services like iCloud is that regular home users are now far more likely to have a backup in place. (Please see the next topic - Technical implementation: Networking / connectivity for more information on cloud-based services.)

The storage requirements of a backup system can be very large. If you are backing up your laptop then your storage may go up to hundreds of gigabytes. If you are backing up the data for a large multi-national company then the storage requirements will be much larger. Magnetic tapes or external hard drives are common backup storage devices.

Backup systems can be stored online, for example iCloud or OneDrive, or they can be offline, as mentioned in section 9.2.

For a backup to contain relevant material there should be a regular schedule of when a backup is made. For a business they may wish to make a backup every hour or at the end of every working day to ensure that they don't lose any data. Individual users may

feel that once a week or a month is frequent enough.

There are three types of backup that can be made: full backup, differential backup and incremental backup.

A **full backup** is when all the data on a system is copied regardless of whether or not it has changed since it was last backed up. This is the simplest type of backup but it takes a long time.

**Differential backup** is where only data that has changed since the last full backup is stored. This saves space and time.

**Incremental backup** is where only changes made since the last backup of any kind are stored. This is the fastest type of backup but will take the longest time to restore data.

**Disk mirroring** is when a constant backup of a network is made. Every time data on the network changes, or is added, a second copy is made. The second copy 'mirrors' the original copy and so no data should ever be lost.

A company may wish to employ more than one method to ensure that they do not lose any data and perform efficiently. For example, they may wish to take a full backup on a daily basis, but include an incremental backup after every customer order. This would ensure that no data is lost.

**Quiz: Backup systems and strategy**

- Q6:** What is a backup?  
.....
- Q7:** Why is a backup so important to a business/organisation?  
.....
- Q8:** Where can backups be stored?  
.....
- Q9:** How often should backups be made?  
.....
- Q10:** Explain the three types of backup.  
.....
- Q11:** What is disk mirroring?  
.....



30 min

**9.4 Capacity**

**Learning objective**

By the end of this section you will be able to:

- understand how the storage capacity of backing storage devices is measured.

All data that is stored on a backing storage device is represented by 0's and 1's. This is called machine code or binary. A 0 or a 1 is called a binary digit or bit. 8 bits make a byte. 1024 bytes make a kilobyte. . .

0 or 1	Bit
8 bits	Byte
1024 Bytes	Kilobyte
1024 Kilobytes	Megabyte
1024 Megabytes	Gigabyte
1024 Gigabytes	Terabyte
1024 Terabytes	Petabyte
1024 Petabytes	Exabyte
1024 Exabytes	Zettabyte
1024 Zettabytes	Yottabyte

**Note:** although Computer storage is often expressed using the normal SI prefixes (Kilo, Mega, etc) they actually mean 1024 times bigger than the previous unit, not 1000 ( $10^3$ ) as per normal decimal. 1024 is  $2^{10}$ , which is a nice round number in binary.

Different storage devices have different storage capacities. This is an area of computing that is subject to change due to advances in technology so the information in this topic may not be completely up to date. Your tutor may advise you of some changes.

Device	Capacity
CDs	700 Megabytes
USB flash drive	32 Gigabytes
DVDs	8.5 Gigabytes
Hard drive	3 Terabytes
Memory card	32 Gigabytes



20 min

### Practical task: Capacity

Use the internet to check the capacity of the storage devices in the table above. Make your own table in your notes.

Try to find out the capacities of Blu-Ray disks - a recent optical disk and 3.5" Floppy Disks - a somewhat less recent magnetic disk! Add these to your table for comparison.

.....



## 9.5 Rewritable & Read Only

**Learning objective**

By the end of this section you will be able to:

- explain the difference between rewritable and read only storage media.

If you purchase a CD or a DVD you will find that you have a variety of choice over which type of disk to buy. There are three types of CDs and DVDs that you can choose from, CD-ROM, CD-R, CD-RW, DVD-ROM, DVD-R and DVD-RW.



ROM stands for read only memory and it means that you cannot save to the disk. The disk already has data stored on it and you cannot change it. An example of this is if you buy a DVD to watch or a computer game to play. The information is already on the disk and you watch or install it on your own computer. You do not need to change the information.

R stands for recordable. This means that the disk is blank when it is purchased and the user can then store information onto it, but only once. After it has been saved to the disk it cannot be deleted or amended.

RW stands for rewritable. This means that the disk is bought blank and can be saved to as many times as the user requires. The information can be edited and deleted as required.

**Quiz: Rewritable & Read Only**

**Q12:** Explain the differences between CD-ROMs, CD-Rs and CD-RWs.

.....



5 min

## 9.6 Interface type

**Learning objective**

By the end of this section you will be able to:

- discuss the differences between the different interfaces.

An **interface** is a point of interaction between a computer and a peripheral, for example, between a backing storage device and a desktop computer. An interface has several functions:

- Buffering/temporarily storing data - data can be stored temporarily whilst in transit

between the processor and peripheral in an area of memory called the buffer.

- Data format conversion - this could be converting data from serial to parallel and vice versa, or from an analogue signal to a digital signal.
- Voltage conversion - many peripherals operate at a different voltage to the motherboard and this is changed by the interface.
- Protocol conversion - a standard that allows the connection, communication and data transfer between computers and peripherals.
- Handling of status signals - checks to see if devices are ready to send or receive data.

USB, or Universal Serial Bus, was designed as a standard method of connecting computer devices, such as keyboards, digital cameras, mouse, scanners etc. to computers. This would allow the devices and the computers to communicate and to receive a power supply. USB successfully replaced earlier interfaces, such as serial and parallel ports.

USB cables usually have two different connectors. One connector that connects to the USB port in the computer and the other that varies depending on which device is being used. USB 1 was released in the mid 90s and was quickly replaced by USB 2 in 2000. USB 3 is the most recent version of USB available and it boasts a data transfer rate of up to 5 Gigabits per second.

*Figure 9.1: USB 1*



.....

*Figure 9.2: USB 2**Figure 9.3: USB 3*

Bluetooth is a wireless method of electronically transmitting data over a short distance. Many mobile phones use a Bluetooth connection to transfer data to other phones, or to link a phone to a wireless earpiece. If you are using Bluetooth devices with a computer then you will often plug a USB dongle into the USB port on your computer. This will allow the Bluetooth keyboard or mouse to communicate with the computer.

Figure 9.4: Bluetooth dongle and earpiece



.....



15 min

### Quiz: Interface type

**Q13:** What is the current range of transfer for Bluetooth devices? You may use the internet to help you.

.....

**Q14:** What are the main differences between USB 2 and USB 3? You may wish to use the internet to help you.

.....

**Q15:** What makes USB different to Bluetooth? You may wish to use the internet to help you.

.....

## 9.7 Data transfer speed

### Learning objective

By the end of this section you will be able to:

- discuss and compare data transfer speeds.

The data transfer rate is the speed at which data can be transferred from one device to another. This is usually measured in megabits or gigabits per second. The data transfer rate may also be known as throughput. Two things will affect data transfer to/from a backing storage device: the speed of accessing the data on the device itself (for example, how fast a hard disk can spin round to a particular sector) and the type of interface the device is connected to the computer with.

When a data transfer rate is listed this is the maximum possible rate of data transfer. The actual rate of data transfer is often limited by different factors, such as: noise or

interference affecting the cabling, needing to resend data due to errors, or overheads such as start/stop bits and error detection and correction codes.

**Practical task: Data transfer speed**

Use the internet to complete the table below:



20 min

Device	Data Transfer Speed
USB 3	
Bluetooth	
FireWire	
eSATA	
IDE	

.....

**Quiz: Data transfer speed**



10 min

**Q16:** What is data transfer speed and how is it measured?

.....

**Q17:** What factors can affect the maximum data transfer speed?

.....

**9.8 Built in & External storage**

**Learning objective**

By the end of this section you will be able to:

- discuss the differences between built in, external and portable storage devices.

If a backing storage device is built in then it is included inside the computer, for example, a hard drive. Built in storage devices are not portable as they cannot be moved around to be used with other devices.

External storage devices are devices that are separate from the computer, for example an external hard drive.

Portable storage devices are storage devices that can easily be moved around and be used with other computers. For example, USB Flash Drives.

**Quiz: Built in & External storage**



10 min

**Q18:** What is the difference between built in, external and portable backing storage devices?

.....

**Q19:** Complete the table below:

Device	Built in	External	Portable
Internal hard drive			
External hard drive			
USB flash drive			
DVD-RW			
CD-RW			
Memory card			
Solid state hard drive			

.....

## 9.9 Magnetic & Optical storage

### Learning objective

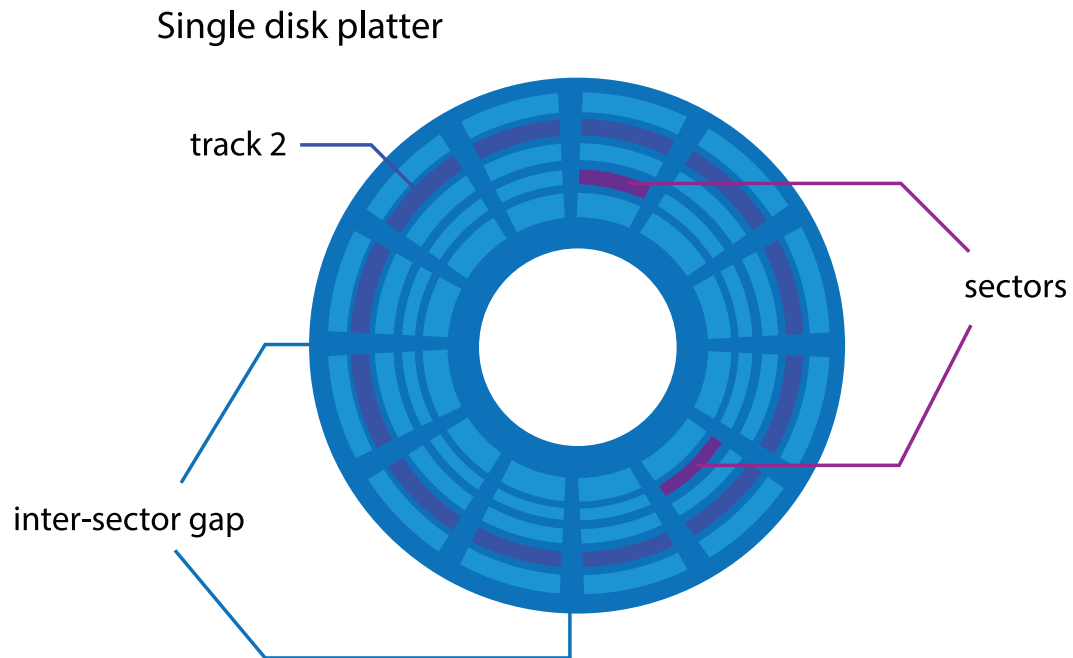
By the end of this section you will be able to:

- discuss the differences between magnetic and optical backing storage devices.

The first backing storage devices that were developed used magnetic storage techniques. This includes hard drives, floppy disks and magnetic tape. Floppy disks are now obsolete but they used to be used to transfer information between different computers. They were replaced by other storage devices as they could only store 1.4 megabytes of data.

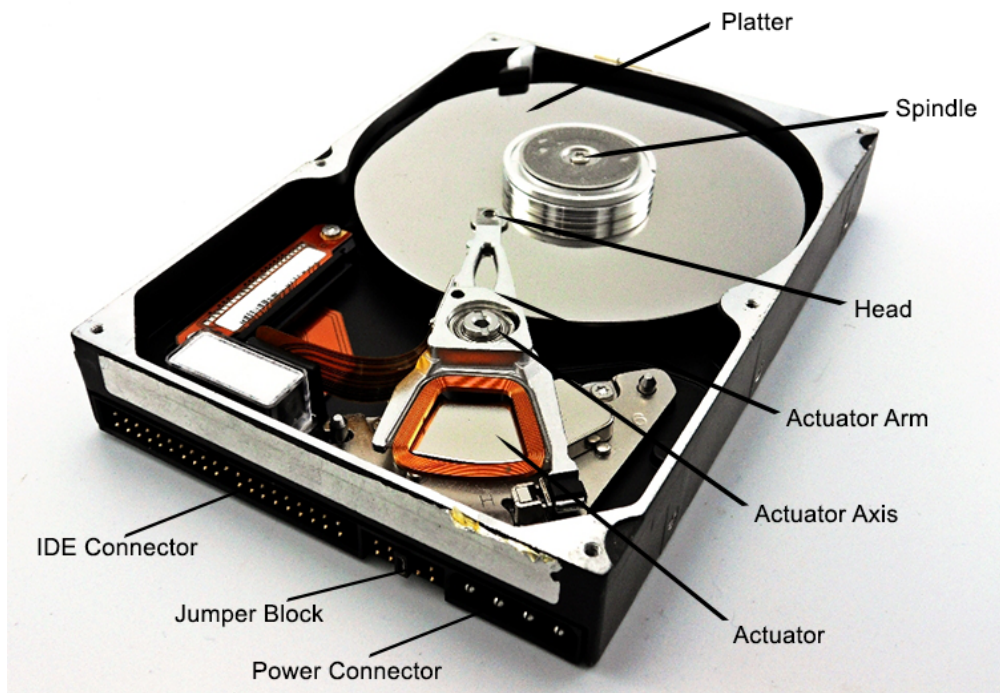
Magnetic storage devices store data on a surface coated with metal oxide that can be magnetised. The '1's and '0's which make up the binary data are encoded as north and south magnetic charges. They are written using a tiny electromagnet and read using a magnetic sensor.

In the case of magnetic tape the charges are arranged along the length of a long plastic strip which has been coated with the metal oxide. In the case of magnetic discs (e.g. hard drive), the charges are arranged in circles - called tracks - on the surface of a plastic, metal or glass disk that has been coated. Each track is broken into sectors (areas) which store the data.

*Figure 9.5: Hard disk - Tracks and sectors*

.....

Hard drives have a very large storage capacity. Hard drives are random access devices and can be used to store all types of information. Data access speeds are very fast. Data is stored inside a hard drive on rotating metal or glass disks, called 'platters'.

*Figure 9.6: A hard drive*

.....

Fixed hard drives act as the main backing storage device for almost all computers since they provide almost instant access to files - random access at high access speeds.

A portable or external hard drive is one that is placed into a small case along with some electronics that allow the hard drive to be accessed using a USB or similar connection. Portable hard drives allow very large amounts of data to be transported from computer to computer.



Figure 9.7: Parts of an external hard disk drive

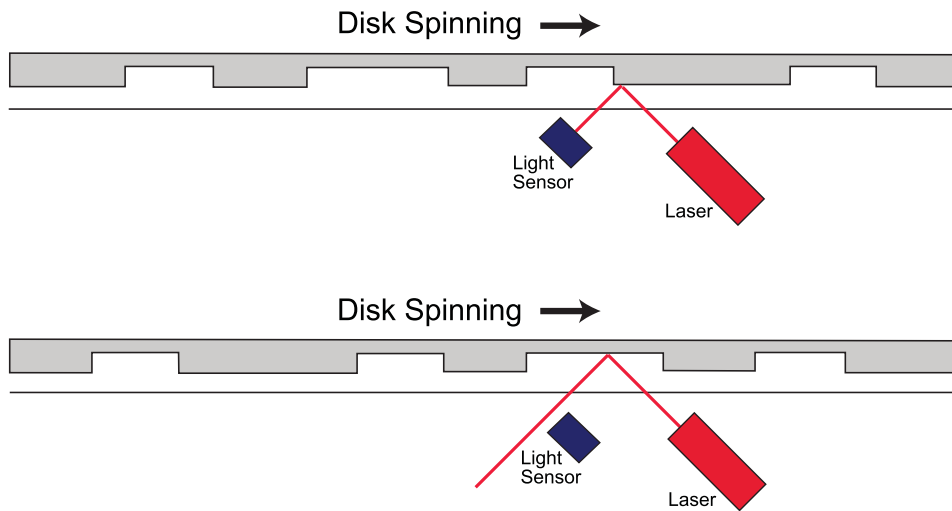


.....

Many portable music players, such as iPod, contain tiny hard drives. These miniature devices are just not much bigger than a stamp, but can still store many Gigabytes of data.

Optical storage devices include CDs, DVDs and Blu-ray disks. Optical storage relies on a laser being shone at reflective surface. The reflective surface is covered in flat areas called 'lands' and recessed areas called 'pits' which are arranged in a long, spiral track. As the disk spins and passes under the laser, a light sensor detects whether light is reflected back or not. Pits will not reflect light back at the sensor, and so a binary pattern is achieved.

Figure 9.8: CDRom Reading



Recordable optical storage works slightly differently. Instead of physical pits (which cannot be changes, hence the read-only nature of normal CDs) the surface is coated with a light-sensitive dye. A secondary - high powered - laser is turned on and off to change the colour of the dye, making a dark mark on the disk surface. This is called 'burning' though it fact it is just the dye changing colour. When the normal 'read' laser hits the dark mark, less light is reflected and so the mark registers as a '0'.

Re-Writable technology is similar, except this time the dye is designed to change transparency based on the temperature of the writing laser. This way, a high power laser can be applied to 'reset' the dye back to a clear state, and a medium power laser can the re-write data.



5 min

**Quiz: Magnetic & Optical storage**

**Q20:** Name two backing storage devices that use magnetic storage.

.....

**Q21:** Name two backing storage devices that use optical storage.

.....

**Q22:** Explain the difference between magnetic and optical storage techniques.

.....

## 9.10 Solid State

### Learning objective

By the end of this section you will be able to:

- understand what is meant by the term solid state storage device.

A solid state storage device is a storage device that does not have any moving parts. This includes USB flash drives and memory cards. They are made from memory chips called EEPROMs - electrically erasable programmable read only memory. They appear to act almost like RAM, but do not need constant power to retain data.

Memory cards are mainly used in digital cameras and tablets or smartphones. There are several different makes of memory cards and they can also be known as flash storage. Devices will often only take a specified type of memory card. Digital cameras use memory cards to store images and tablets can use memory cards to extend the amount of available memory space.

Memory cards can be removed from the devices and 'slotted' into other devices. For example they can be removed from digital cameras and used with printers to print images. They could be plugged into a computer to transfer the images.

The physical size of memory cards varies depending on make, as does the actual capacity.

Figure 9.9: Memory cards



USB flash drives can be known by many names - memory sticks or pen drives. They are called USB because they plug directly into the USB port on computers or portable devices. They are used to transfer information between different computer devices.

Solid state storage devices have several advantages:

- They are small and so are easy to carry around.
- They are robust (hard to break) because they do not have any moving parts.

- They use less power than hard drives, which means that batteries can last longer in portable devices.
- They are available in a range of capacities to suit all needs and budgets.
- They can be used with security software, passwords or fingerprint scanners.
- They have fast access speeds, in fact the speed of reading or writing data is more often constrained by the interface than by the 'flash' memory.

Figure 9.10: USB flash drive with fingerprint scanner



.....



15 min

### Quiz: Solid State

**Q23:** What is a solid state storage device?

.....

**Q24:** What are the advantages of using solid state storage devices?

.....

**Q25:** Use the internet to investigate the current storage capabilities of memory cards and USB flash drives.

.....

**Q26:** Use the internet or recent magazines to compare the price of solid state storage to magnetic and optical storage options. You may need to use your numeracy skills to work out a 'cost-per-GB' figure so you can directly compare them.

.....

## 9.11 Current trends

### Learning objective

By the end of this section you will be able to:

- discuss current trends in backing storage devices.

Backing storage devices are getting smaller in physical size, but larger in storage capacity. They are also becoming cheaper to buy. Consumers are demanding that

backing storage devices come with a degree of security, whether that is software-based encryption or a fingerprint scanner.

An example of a current trend is the move towards solid-state storage in high-end laptops. As the cost of solid-state memory has decreased, it has become viable to replace hard disks. This is particularly attractive in laptops because of the advantages of solid state storage:

- Lower power consumption means longer battery life.
- Robustness means they will survive a drop or shock.
- They can access data at speeds faster than a hard disk.
- Ideal if you have to start up and shut down a portable computer several times as you move around.

### **Practical task: Current trends**

Use the internet to research recent trends in backing storage devices and make your own notes.



20 min

.....

## 9.12 Learning points

### Summary

You should now know:

- Backing storage devices are necessary to store programs and data when they are not being used.
- Distributed storage uses several computers to store all the information in a network.
- Off-line storage is very secure as it cannot be accessed electronically.
- A backup is a second copy of information in case the first is lost or damaged.
- Backups can be stored on separate backing storage devices or using cloud computing.
- A backup strategy is a plan of how an organisation is going to manage its backups, what information will be backed up, how often backups are made and where they will be stored.
- Backing storage devices can be read only, writable or re-writable.
- An interface is necessary to compensate for the differences between in data transfer speed and voltage peripherals and computers.
- Data transfer speed is the rate at which information can be transferred between devices.
- Magnetic storage uses magnetic charges stored on metal oxide to represent data.
- Optical storage uses the reflection of light from a surface or lands and pits to represent data.
- A solid state storage device has no moving parts.

## 9.13 End of topic test

### End of topic test



10 min

**Q27:** Which of the following is the fastest type of backup, but will take the longest time to restore data?

- a) Full backup
  - b) Differential backup
  - c) Incremental backup
- .....

**Q28:** USB has a shorter range than Bluetooth but a faster transfer rate.

- a) True
  - b) False
- .....

**Q29:** What can affect data transfer speeds?

- a) Interference
  - b) Errors during transfer
  - c) Lost packets
  - d) Length of cable
- .....

**Q30:** Which of the following devices are portable?

- a) Internal hard drive
  - b) USB flash drive
  - c) DVD-RW
  - d) Memory card
- .....

**Q31:** Which of the following are true about solid state storage devices? You may choose more than one option.

- a) They are small and so are easy to carry around.
  - b) They are robust (hard to break) because they do not have any moving parts.
  - c) They are available in a range of capacities to suit all needs and budgets.
  - d) They use less power than hard drives, which means that batteries can last longer in portable devices.
  - e) They cannot be used with a digital camera.
- .....





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## Topic 10

# Technical implementations (Networking/connectivity)

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *stand-alone or networked;*
- *LAN/Internet;*
- *peer-to-peer, client/server;*
- *Wired, optical, wireless.*
- *Cloud storage.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *describe what is meant by the term networking;*
  - *describe what is meant by the term connectivity;*
  - *describe the purpose of cloud systems;*
  - *explain the purpose of a server;*
  - *state the differences between public, private and hybrid cloud systems;*
-

- *explain the services provided by cloud systems;*
- *explain the term web hosting;*
- *discuss current trends in networking and connectivity.*

In the previous topic you learned about the different methods of storing data and backups. This topic looks at the ways that computers can be connected in networks to allow data sharing to take place and the different places that this information can be stored.

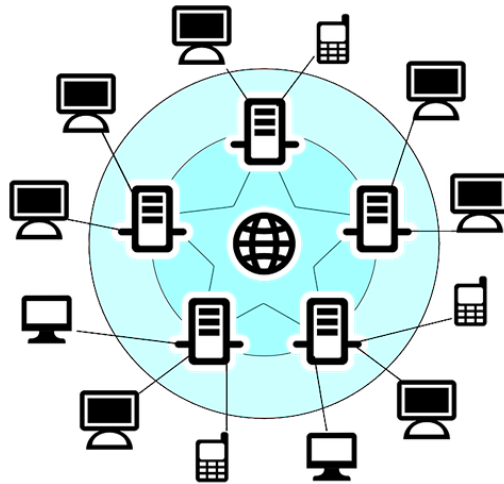
## 10.1 Introduction

### Learning objective

By the end of this section you will be able to:

- describe what is meant by the term networking;
- describe what is meant by the term connectivity.

A **network** is two or more computers connected together, using cables or wirelessly. The connections allow devices to pass information between each other. This includes users connecting to the Internet in their house using wireless connectivity or large companies that have several hundred users on the same network.



**Connectivity** is how a connection is made and maintained between two, or more, computers. Networks can be connected using Bluetooth, Wi-Fi, USB cables, fibre optic cables or Ethernet cables.

### Quiz: Introduction

**Q1:** Explain the terms networking and connectivity.

.....



5 min

## 10.2 Cloud systems & Server provision

### Learning objective

By the end of this section you will be able to:

- describe the purpose of cloud systems;
- explain the purpose of a server.

**Cloud systems** are commonly known as cloud computing. Instead of a traditional set up where all information is stored locally on the computer and the processor does all the processing, information can be stored on a web based server and users can get access to the information from anywhere in the world.

An example of this is email. If you have a Hotmail or Yahoo account then this is an example of cloud computing. Instead of running an email application on your computer you log into a web email account remotely. The software for the email account is not on your computer; you log into the software and get access to your emails. Another common example of cloud computing is the increasing use of online office suites such as Google Docs or Microsoft Office 365. These are often tied in with your local storage (on your hard drive for example) and copies are synchronised across all your devices.

Cloud systems decrease the hardware and software demands that are placed on computers. The software to run applications, like email, do not need to be stored on your computer, freeing up memory space. If you are logging into an application remotely then some, or all, of the processing used will be done by the remote server, easing the workload for your own processor. Files used by cloud systems are also hosted on the remote server, meaning you do not need a large amount of backing storage on your personal device - especially important on very portable devices such as smartphones and tablet computers.

**Servers** are usually a dedicated computer that responds to a request from a user. A server may be a collection of computers linked together. Servers either provide services to users on a network within an organisation, or via an Internet connection. Companies may have an email server, web server, print server or a file server.



Many organisations use the client/server network structure as it has several advantages. In a client/server network the users log on to their computers, or clients, and request services from the server. Client/server networks allow users to have a centralised

backup, get access to their files from any computer and share resources.

An alternative to setting up a client/server network is to allow each individual machine to set their own access, file sharing and network access up. This is referred to as a '**peer-to-peer**' network as all machines are equal. They will all have to be configured individually for each service they wish to use, but this can avoid the expense of buying and running a server in a small network.

**Quiz: Cloud systems & Server provision**

**Q2:** Give an example of a cloud system.

.....

**Q3:** What is a server?

.....

**Q4:** What are the advantages of using a client/server network?

.....



15 min

**10.3 Public, private & hybrid**

**Learning objective**

By the end of this section you will be able to:

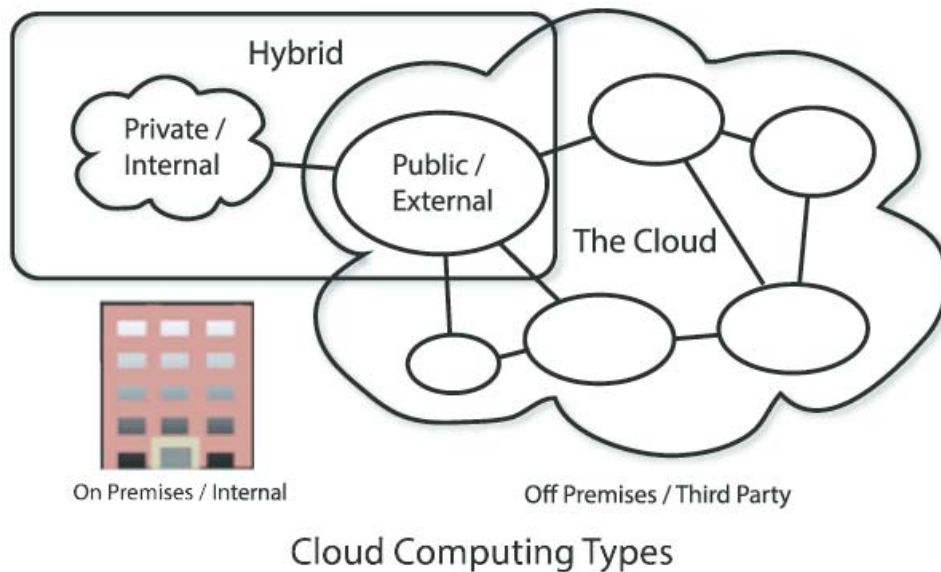
- state the differences between public, private and hybrid cloud systems.

**Public cloud** - applications and information are delivered through the Internet. The Internet is a public network and open to anyone, so anyone can use the cloud system. The main difference to a private system is that there needs to be a security consideration. Users must be able to prove their identity before they are given access to data. Access is usually only permitted through a dedicated Internet connection.

**Private cloud** - a physical server that is within the companies' own network. A private cloud is an infrastructure that is used for only one organisation. A private cloud requires an investment from a company to provide the hardware and software necessary for a cloud system. This investment will need to be refreshed as and when necessary.

**Hybrid cloud** - a combination of public and private cloud systems. Companies may have sensitive data that they wish to keep on a private cloud, where it is more secure, but they may also wish to give employees access to applications where ever they are working from and so need to use a public cloud.

Figure 10.1: A public, private and hybrid cloud



.....



15 min

**Quiz: Public, private & hybrid**

**Q5:** Describe the three types of cloud system.

.....

**Q6:** What do you think are the disadvantages of private clouds?

.....

**Q7:** What do you think are the advantages of public clouds?

.....

**10.4 Cloud-based services**

**Learning objective**

By the end of this section you will be able to:

- explain the services provided by cloud systems.

There are a huge array of cloud-based services on offer, usually accessed via the Internet or a private connection. Generally speaking, cloud services provided by companies fall into three types: the provision of **infrastructure**, the provision of a **platform** or the provision of **software/applications**.

**Infrastructure services**

In this case, the cloud provider will be providing the processing power, RAM and storage

that you can run your own software on. In essence a very powerful, blank virtual computer! This 'computer' will usually be expandable - both in terms of processing and storage - as it will be hosted in a server warehouse. Companies will typically lease the processing and storage required from the cloud company, but will maintain all the software themselves. Examples of infrastructure services include:

- Amazon EC2 - <http://aws.amazon.com/ec2/>
- Google Compute - <http://cloud.google.com/compute/>

### Platform Services

Some cloud providers have opted to go a stage further than providing an infrastructure solution and will lease a complete 'platform' to users: A pre-configured virtual computer with Operating System and required software already installed and ready to go, usually in the form of a virtual machine. This means you can access the VM using a terminal emulator or a thin client and use it to focus on developing cloud-based applications and services. Examples include:

- Redhat Openshift - <http://www.openshift.com>
- Microsoft Azure - <http://azure.microsoft.com>

### Software Services

This is probably the most well-known type of cloud service. In this case, users (often home users nowadays) are paying for an individual application hosted on cloud servers. This may be an email client such as Outlook online, an office suite such as Google Docs for Business or more specific items that will allow remote working such as Customer Relationship Software. Examples of these are:

- Microsoft Office Web - <http://www.office.com>
- Google Mail - <http://mail.google.com>
- Zendesk - <http://www.zendesk.com>

### Advantages of Cloud-based services

- **Remote accessibility** - Users are not restricted to using the one computer in their office. Users can access files from anywhere in the world (as long as they have an Internet connection).
- **Easy expansion** - if more storage space is required then the company simply needs to purchase more storage space. This is done by contacting the provider and asking for extra resources, a request which can be processed within minutes. There is no need to cost and purchase hardware and have it installed, which can take time.
- **Security** - people may be sceptical but there is actually a higher level of security provided through cloud computing. Clouds offer real time backups so there is little chance of any data being lost. They are less prone to hacks and denial of service attacks as no one knows the exact location of data.

- **Environmentally friendly** - companies can reduce their electricity expenses. Server warehouses are usually designed to be power-efficient and many companies have invested heavily in 'green' energy sources and natural cooling systems.

### Disadvantages of Cloud-based services

- **Bandwidth constraints** - Using services and software remotely will usually require a high bandwidth connection. Even basic services such as online office software becomes useless if you don't have Internet access.
- **Security concerns** - while the data is physically more secure and backed up, you are still relying on employees/users keeping their account details safe.
- **Public perception** - there have been several high profile breaches of security (usually, but not always, over-hyped) meaning cloud computing is not always trusted.
- **Data Protection** - one of the terms of the Data Protection Act requires businesses to store personal data within the EU, but with cloud servers spread around the world this may be difficult to guarantee. The customer is no longer in complete control of their data. It can be viewed by security organizations in the country where it is stored, or it can disappear if the cloud provider goes out of business.



20 min

### Practical task: Cloud-based services

Use the Internet to investigate the advantages of cloud computing. Make your own notes.

.....

## 10.5 Web hosting

### Learning objective

By the end of this section you will be able to:

- explain the term web hosting.

A **web hosting** service is one that enables a company, or individuals, to make their website available over the Internet. A web host provides a space on a server that companies can purchase and they provide Internet connectivity. A basic web hosting service would provide space to store the company website and perhaps allow files to be uploaded. Web hosting companies may also provide a **domain name**, or purchase one for the user.

Sometimes your **ISP** (Internet Service Provider; the company that provides your connection to the internet) will provide a web hosting service. This is often fairly basic and provided free with your internet access. Specialist companies sell hosting packages that offer more space and advanced features.



Web hosting - whether for personal or business use - can be expensive and often depends on the services needed. The web host will normally provide an interface that allows the users to edit or amend the contents of their web pages, as well as configure their hosting settings such as domain names, email accounts and storage. More advanced features include access to Server-side scripting software (such as PHP or ASP) and the ability to host databases using MySQL or similar technology. Both of these are required even for basic content management systems or online shopping sites.

There are several types of web hosting available, only a few are discussed in this topic:

- **Free web hosting** - limited service offered by some companies. The website may have to include advertising for other products or companies.
- **Shared web hosting** - website is placed on a web server along with thousands of other websites. They share ram and processor resources and the services may be quite limited.
- **Dedicated hosting** - every user gets its own web server and has full control over it.

It's perfectly possible to set up your own web server and serve web pages yourself. A quick Internet search will throw up several projects like turning a Raspberry Pi computer into a web server or re-using an old desktop for the same purpose (and the software is usually open-source). There are some practical considerations though which make commercial hosting packages more attractive for all but the most basic projects:

- The machine would have to be on 24/7.
- You need a static IP address so that Domain Name Servers on the Internet can route traffic to you.
- You may incur bandwidth charges if you generate a large amount of traffic.

**Quiz: Web hosting**

**Q8:** What is web hosting?

.....

**Q9:** What are the differences between free, shared and dedicated hosting?

.....



10 min

**Practical task: Web hosting**

Use the Internet to investigate the different types of web hosting available. Recommend a hosting package for each of the users below.

- Liz is a student who wishes to publish her PhD results online. She has a number of static HTML pages and some JPG images totalling 30MB in size.
- Bob is the manager of a local museum. He wishes to create a website using the popular WordPress CMS so that other non-technical staff can update the contents.

.....



50 min

## 10.6 Current trends

### Learning objective

By the end of this section you will be able to:

- discuss current trends in networking and connectivity.

Networks have developed as a result of users wishing to share information. As users requirements have changed, so have the networks. We now have peer-to-peer networks and **client/server** networks. Users have gone from storing their data on floppy disks and hard drives to using cloud computing.

### Some examples of current trends in networking and connectivity

#### Internet everywhere

The growth in smartphones and tablet computers have created a desire for Internet connectivity always being available. This is being achieved through mobile broadband services such as 3G / 4G as well as wifi hotspots in popular places and on transport.

#### Increasing bandwidth

As well as a growth in the availability of Internet services through mobile services, the bandwidth available has dramatically increased. Upgrading of older phone lines, installation of new hardware and development of new mobile technologies have all played their part, making new services such as streaming video possible; a far cry from the early days of text-based hypertext pages. There is a complication however; much of this has been driven by commercial interests meaning that some sparsely populated areas of the country have been left behind. There is little commercial sense in replacing miles of old phone lines with fibre optic for a few isolated houses down a highland glen! Some people argue that the improvements should be driven by (and paid for by) government, rather than left to market forces.

#### Move to cloud computing

Both businesses and individuals have recognised the benefits of cloud computing that have been discussed earlier. This has required more reliable, faster connectivity too. Companies can save money by only paying for the computing power they need, and leasing software on an 'as-needed' basis. Home users too can now lease cloud-based software; Microsoft moved to this model in 2013 for Office, which comes with the ability to store your files online and access them across multiple devices.

#### Internet of things

It's not just computers that can be connected to the Internet; all sorts of home appliances can be fitted with network interfaces so they can communicate with each other - and their owners - over the Internet. Devices such as smart heating controllers, security systems and even lights can be controlled from a smartphone via the Internet.



20 min

### Practical task: Current trends

Use the Internet to research recent trends in networking and connectivity and make your own notes.

.....

## 10.7 Learning points

### Summary

You should now know:

- A network is two or more computers connected together.
- Connectivity is the how computers are connected together.
- A cloud system allows information to be stored on servers provided by a company and the information can then be accessed from anywhere.
- Cloud systems reduce the hardware and software demands placed on a company's network.
- Cloud computing is very secure as backups are constantly made.
- A public cloud is open to any user. A private cloud is limited to only one company.
- A hybrid cloud is a combination of a public and private cloud.
- Cloud-based services are provided over an Internet connection and provide remote access, are easy to expand, are secure and are environmentally friendly.
- Cloud based services can provide infrastructure (hardware for processing), platform (hardware and software) or software services.
- Web hosting is where a company provides space on a web server to save web pages so that they can be accessed over the Internet.

## 10.8 End of topic test

### End of topic test



10 min

**Q10:** Which of the following describes a hybrid cloud?

- a) It is owned and accessed by only one company.
- b) It is available to any user.
- c) It is partly private and partly public.
- d) It does not exist.

.....

**Q11:** Which of the following is **not** an advantage of cloud systems?

- a) They are easy to expand.
- b) They are secure.
- c) They are environmentally friendly.
- d) They are hard to use.

.....

**Q12:** Which of the following is true for web hosting?

- A It is always free.
- B It can be provided by an ISP.
- C It stores websites so that they are available over the Internet.
- D It is very complicated to use.

.....

**Q13:** Which of the following are advantages of using a client/server network?

- A Client/server networks allow resources to be shared.
- B Centralised backups.
- C The server is inexpensive to purchase.
- D Access to files from any computer.

.....

**Q14:** The Internet is a public network.

- a) True
- b) False

.....



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# Topic 11

## Security risks

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### Contents

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Viruses, Worms, Trojans;*
- *Hacking;*
- *Spyware, Phishing, Keylogging;*
- *Online fraud, Identity theft;*
- *DOS (Denial of Service) attacks.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *state which law makes hacking illegal;*
  - *state the differences between a virus, a worm and a Trojan;*
  - *describe Spyware;*
  - *describe how criminals phish for information;*
  - *explain the purpose of keylogging;*
  - *describe what is meant by the term online fraud;*
  - *describe a DOS attack;*
  - *describe a DDOS attack.*
-

This topic looks at the security risks that are associated with accessing the internet from your computer. It will look at how you can become a victim of identity theft and how to protect your computer or network from a DOS attack.

## 11.1 Introduction

### Learning objective

By the end of this section you will be able to:

- state which law makes hacking illegal;
- state the differences between a virus, a worm and a Trojan.

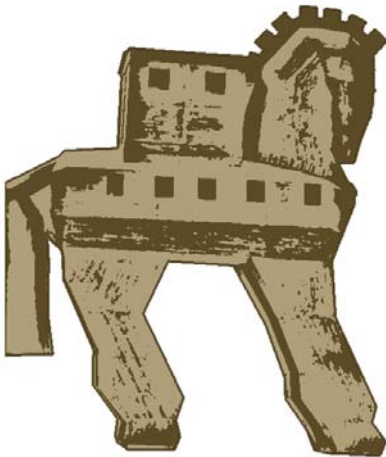
From studying National 5 computing you will know that computers store a lot of information. Information can be a valuable resource and some users try to access this information without permission. This is generally referred to as 'hacking'. Gaining access to a computer system without permission, as well as altering or removing information without permission of the owner is illegal under the Computer Misuse Act. The Act refers to these acts as "unauthorised access" and "unauthorised modification". It also defines a more serious crime if you intend to commit further criminal offences through your access or modification.



A **virus** is a program, that can replicate itself by copying its source code into other programs (called 'executable files'). While many viruses are simply written for a programming challenge, or to cause annoyance, they can also be powerful weapons: a well documented case in 2010 saw U.S. intelligence experts successfully cripple computers at uranium enrichment plants in Iran through the use of malicious software called StuxNet. Many experts believe we will soon spend more on 'cyber warfare' than we do on traditional defence.



A **worm** is a malicious computer program that replicates itself in order to spread to other computer systems. Often spreads through a network and unlike a virus does not need to attach itself to a program. A worm replicates itself through computer networks, executing its code in the receiving computers memory. The actions of a worm may be nothing more than to scan network connections and try to replicate itself onwards, or may be more serious e.g. scanning for and sending user data back across a network.



A **Trojan** is a malicious program but it does not replicate itself. When activated it may steal data or damage the computer system. Trojans can also be used to control a computer remotely without the user's permission. It gets its name from the Greek Trojan Horse. Trojans are often used as a back door to let a user gain access to a system. They can be difficult to detect. A Trojan can be used to gather a user's login and password details, or perhaps bank account details.

**Quiz: Introduction**

**Q1:** Which law makes hacking illegal?

.....

**Q2:** Summarise the differences between a virus, a worm and a Trojan.

.....



10 min

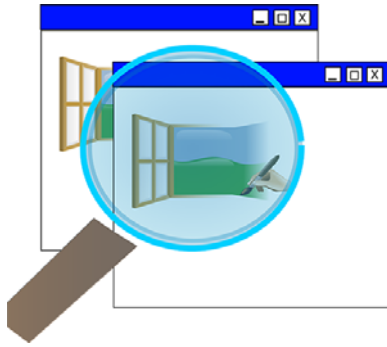
**11.2 Spyware, Phishing & Keylogging**

**Learning objective**

By the end of this section you will be able to:

- describe Spyware;
- describe how criminals phish for information;
- explain the purpose of keylogging.

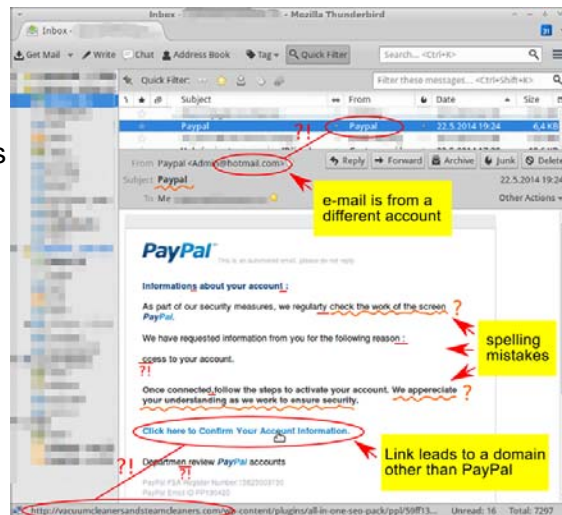
**Spyware** is a piece of software that installs itself on a computer, usually without the user's knowledge. It is used to gather personal or private information from the computer, without the user's knowledge or permission. Spyware can collect any type of data; passwords, usernames, credit card details or internet surfing information.



Spyware can be split into four categories: system monitors, Trojans, adware and tracking **cookies**. Its main purpose is to track a user's movements on the Internet and to target the user with pop ups. Some spyware can be used for useful purposes in business: many programs exist that can monitor activity across a network to see what employees are working on or looking at on the Internet.

**Phishing** is the attempt to acquire information like passwords or credit card details from users by pretending to be someone else, like a bank. Phishing is usually an attempt to gain information that will allow the criminals to make money, or to defraud the user.

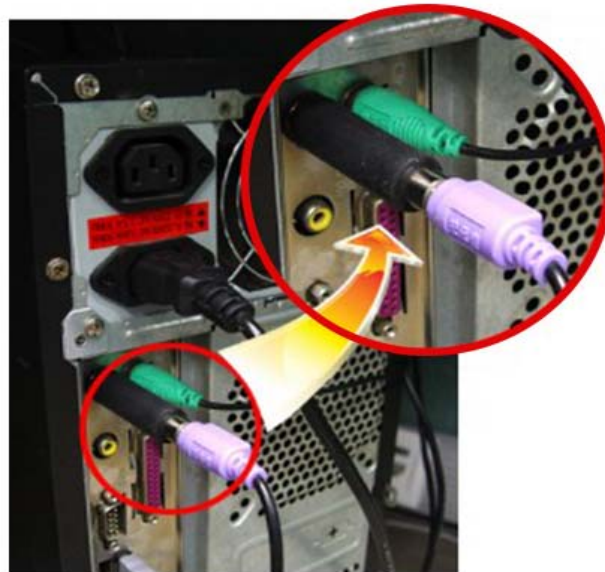
A popular method is to generate emails to users that look like they have come from a reliable source. The email will then ask the user to email sensitive information, such as their bank account details, or to click on a link that will take them to a fake website where they will be asked to enter sensitive information. Phishing emails can be identified by their poor quality, spelling mistakes or strange requests. Financial institutions will never contact customers and ask them to send sensitive information by email.



Emails may be sent to users that state the user has won a prize and all they have to do is send money or their bank details in order to claim the prize. (This is sometimes called 'advanced fee fraud' or 419 scam after the Nigerian legal system code for these offences, where they were first perpetrated on a wide scale). These emails are fakes and they will never turn out to be true. If an offer sounds too good to be true then it usually is. Criminals are often attracted to using phishing because of the very low cost involved in sending emails: no matter how poor the attempt, you can send millions of emails and only need to fool one person to turn a profit!

**Keylogging** is an abbreviation of keystroke logging and it does what the name suggests - it logs the keys that are pressed on a keyboard. Usually a user will not be aware that their keystrokes are being recorded. Keylogging can be achieved by a hardware or software method. Figure 11.1 shows a hardware device that can be fitted to a keyboard cable in order to record the keys being pressed. Software keyloggers can often be deployed through the use of Trojan Horses or viruses.

Figure 11.1: Keylogging device



.....

Keylogging may be used by employers to monitor what employees are accessing on the internet or it could be used by criminals to gather usernames and passwords. It is a technique that has even been used by law enforcement agencies to gather information on criminals.

One way to avoid software keyloggers is to install anti-spyware software, or an anti-keylogger program. You could make use of one time passwords, a technique used by some banks. Two-step authentication, whereby feedback from another communication path is also required to complete an important process is becoming increasingly popular. It is possible on many sites (including e-commerce, e-mail providers and social media sites) to configure your account so that - for example - a code is sent to your mobile phone by text message when you try to log in from a new device.

**Quiz: Spyware, Phishing & Keylogging**

**Q3:** Why do some employers use keyloggers?

.....

**Q4:** How can you identify a possible phishing email?

.....



10 min

**Practical task: Spyware, Phishing & Keylogging**

Use the internet to investigate Spyware, phishing and keylogging. Create a short presentation, report or poster to show your findings.

.....



30 min

### 11.3 Online Fraud & Identity Theft

**Learning objective**

By the end of this section you will be able to:

- describe what is meant by the term online fraud;
- explain how to protect yourself from identity theft.

Online fraud is where criminals use the Internet in order to commit crimes. Many criminals find that it is easier to con people over the Internet as they may be more trusting or because less information is available on the identity of the criminal. There are many different types of online fraud ranging from bank card theft, to holiday scams and fake prizes. It is important to remember that not everyone is honest and that if something sounds too good to be true then it probably is! Online fraud includes using phishing emails to gather information from people and accessing someone else's bank accounts.

The following list of types of online fraud was taken from a police website: <http://www.actionfraud.police.uk/fraud-az-online-fraud>

- Account takeover
- Advance fee frauds
- Bank card and cheque fraud
- Business directory fraud
- Business opportunity fraud
- Charity donation fraud
- Clairvoyant or psychic scams
- Click fraud
- Domain name scams
- Fraud recovery fraud
- Government agency scams
- Health scams
- Holiday fraud
- Identity fraud
- Inheritance fraud
- Internet auction fraud
- Internet dialler scam
- Land banking scams

- Loan scams
- Lottery scams
- Mass marketing fraud
- Miracle health scams
- Money muling
- Online shopping fraud
- Plastic card fraud
- Rental fraud
- Romance scams
- Vehicle matching scams
- West African or 419 scam
- Work from home scams.

**Practical task: Online Fraud**



30 min

Using the internet, pick three or four of the terms above and try to find out how the fraud is carried out. If there are a large number of people in your class, try to cover different terms and share your results.

.....

It is becoming more and more common for people to complain that they have been the victim of **identity theft**. Identity theft is when your personal details are stolen and identity fraud is when those details are used to commit fraud.



Identity fraud can happen when:

- Fraudsters use a false identity or somebody else's identity details to obtain goods or services by deception. This could be ordering goods off the internet and getting them delivered but in someone else's name and using some else's bank card.
- Criminals use genuine but falsely obtained documents, such as other people's passports or national insurance cards, to travel, or to get public sector and welfare services. Information that is put into recycling bins can contain a lot of information that is valuable to criminals, that is why it is important to shred sensitive information. It is sensible to avoid putting details like your correct date of birth and national insurance number on your social networking sites as these can be accessed by criminals.

- Identity information belonging to an individual or organisation is used to open accounts or apply for credit. Criminals can use your personal information to open a credit card in your name, go shopping and spend lots of money and then the bill is sent to you, or you end up with a bad credit rating and cannot use your own credit card.
- A fraudster uses identity details to produce counterfeit documents. Criminals can print their own bank and credit cards if they have your account details. Account information can be collected by 'skimming' machines. This is where your bank card is swiped through a machine and the information copied. It can happen at bank machines or in shops.

If you are a victim of identity theft, it can lead to fraud that can have a direct impact on your personal finances and could also make it difficult for you to obtain loans, credit cards or a mortgage until the matter is resolved. What's more, it costs the government and financial services industry many millions of pounds every year.



25 min

### Quiz: Online Fraud & Identity Theft

**Q5:** Describe the difference between online fraud and identity theft.

.....

**Q6:** Name and describe 5 types of online fraud, you may use the internet to help you.

.....

**Q7:** How do criminals get hold of 'sensitive' information?

.....



20 min

### Practical task: Online Fraud & Identity Theft

Use the internet to find recent stories of online fraud or identity theft that have made the news. Create a presentation, poster or article describing some recent examples that you have found.

.....

## 11.4 Denial of Service (DOS) attacks

### Learning objective

By the end of this section you will be able to:

- describe a DOS attack.

A Denial of Service (DOS) attack is when a website or a network is targeted, with the intention of making it unavailable to users. Often the purpose of a **DOS** attack is to draw attention to a group that are against the network or website(s) hosted by that server. At a basic level, a DOS attack is usually carried out by a group of people who target specific vulnerabilities in the web server software to force it to crash or shut down. This

is the result that the group will be looking for. If users cannot access a website then the website could be losing money or business. Another variation of this is when a group of people bombard a specific website with requests, making the website slow to respond to genuine users or even crash.

Obviously, even a fairly large group of people would not be able to bombard a large-scale web server (like Amazon or Google) with enough data to crash it manually, so the Distributed Denial of Service has been developed. A **distributed denial of service attack (DDOS)** may use your computer to attack another computer. An attacker can take control of your computer and force it to send huge amounts of information or requests to another computer or website. Usually, the process is automated through the use of malicious software. Thousands - or even millions - of users may have downloaded a trojan horse or virus that will 'listen' to a central node for instructions. When the instruction is received, the software will begin sending requests to the targetted website. This system is often referred to as a **'Bot-net'**.

An attacker can use spam email messages to launch a similar attack on your email account. Whether you have an email account supplied by your employer or one available through a free service such as Yahoo or Hotmail, you are assigned a specific quota, which limits the amount of data you can have in your account at any given time. By sending many, or large, email messages to the account, an attacker can consume your quota, preventing you from receiving legitimate messages.

You can try to avoid being a victim of a DOS attack or unwittingly becoming part of a bot-net by following a few simple safety measures. Always use a **firewall** and have your **anti-virus** software up to date. Try to limit who gets access to your email address and never post your email address on a public website or forum (spammers write software to scan for these!). There is no way to completely protect against a DOS attack but these measures may make it less likely.

**Quiz: DOS attacks**

**Q8:** What is a DOS attack?  
 .....

**Q9:** What is a DDOS attack?  
 .....

**Q10:** What steps can you take to protect against a DOS attack?  
 .....



10 min

**Practical task: DOS attacks**

Use the internet to find recent stories of DOS/DDOS attacks that have made the news. Using a real example, design an educational leaflet or poster for your classroom to explain what a DOS/DDOS attack is and how to protect yourself.

.....



20 min

## 11.5 Learning points

### Summary

You should now know:

- Phishing is an attempt to get users to pass on sensitive information to criminals by using fake emails/communications.
- Viruses are malicious programs that can replicate by copying their code into other programs.
- Worms are malicious programs that replicate across network connections.
- Trojan Horse programs appear to do something useful whilst hiding their malicious actions.
- Spyware is used to spy on you whilst you are using the computer. What are you looking at? What passwords do you use? What websites do you visit?
- Keylogging keeps a track of all keys that are pressed on a keyboard.
- Online fraud is where criminals use the internet to commit fraud.
- Identity theft is where criminals steal a user's identity so that they can commit fraud or crimes online.
- A DOS attack aims to bring down a server or a network so that it is not available for use.
- A DDoS attack aims to bring down a website by swamping it with requests. It often needs to use many computer infected with malicious software to accomplish this.



## 11.6 End of topic test

### End of topic test



10 min

**Q11:** Which of the following are examples of online fraud?

- a) Click fraud
- b) Holiday fraud
- c) Shoe fraud
- d) Lottery scams

.....

**Q12:** Which of the following are true for phishing emails?

- a) They will address the customer by name.
- b) They may have spelling mistakes.
- c) They will be very long.
- d) They will **not** address the customer by name.

.....

**Q13:** Which type of hacking-related program is a malicious program which does not replicate itself?

- a) Virus
- b) Trojan
- c) Worm
- d) Malware

.....

**Q14:** What can you do to protect yourself from a DOS (Denial of Service) attack?

- a) Use a firewall.
- b) Make your email address available.
- c) Use anti-virus software.
- d) Limit who gets access to your email address.

.....

**Q15:** Which of the following is a piece of software that installs itself on a computer, and is used to gather personal or private information without the user's knowledge or permission?

- a) Phishing email
- b) Worm
- c) Spyware
- d) DOS attack

.....



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## Topic 12

# Security precautions

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Anti-virus software;*
- *Passwords/Encryption;*
- *Biometrics;*
- *Security Protocols and Firewalls;*
- *use of Security suites.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *state the purpose of anti-virus software;*
  - *explain how a firewall works;*
  - *describe how encryption works;*
  - *state the benefits of encryption;*
  - *describe a digital certificate;*
  - *state the purpose of a digital signature;*
  - *describe what is meant by the term validation;*
-

- *explain the difference between client-side and server-side validation;*
- *explain what is meant by the term biometrics;*
- *give examples of where biometrics can be used.*

This topic looks at the security precautions that can be taken to protect your computer and information from the security risks identified in the Security Risks topic.

## 12.1 Introduction

### Learning objective

By the end of this section you will be able to:

- state the purpose of anti-virus software;
- explain how a firewall works.

There are two basic methods of protecting your computer from security risks: anti-virus software and by using a firewall. Sometimes both types of security software may be built into a larger 'security suite' that may even include other items useful to computer security such as parental controls, 'phishing' monitors and password managers.

Anti-virus software is a program that tries to prevent files on your computer from becoming affected by a piece of malicious software. It is important that you have up to date anti-virus software on your computer at all times as new threats are constantly being created and discovered. When a new threat is discovered the anti-virus software will be updated so that your computer will be protected.

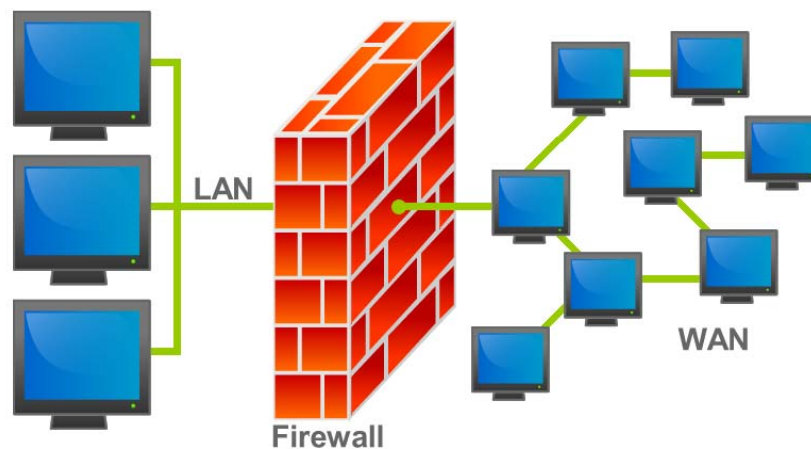
Anti-virus software uses several techniques to spot viruses. Examples include:

- Keeping a database of 'Virus Signatures': snippets of actual virus code that the anti-virus software can reference code against.
- Using 'heuristics' or pattern-matching: anti-virus software will look for suspicious behaviour, e.g. frequent access to executable files or attempts to overwrite reserved areas of memory.
- Calculating 'checksums': When the anti-virus software is first installed it will calculate a unique value based on the code in each executable file.
- When scanning, it will re-calculate these values and compare them to the original, helping to spot if a file has been modified. Often several different techniques will be used by one package.

A firewall is a piece of software that is used to try and maintain the security of a network. It often runs on a computer as a utility in the background, but in commercial settings it is often running on its' own hardware platform, between the internet and the Local Area Network. The aim of a firewall is to monitor and control the data that comes in and out of the network and to identify any data that should not be there, or might be a threat.

Firewalls will typically use a number of techniques. They may limit transmission to/from particular IP addresses, and only on particular 'ports' (the number that identifies the program or client/server function you are trying to access). As a rule of thumb, most communication will be blocked by a firewall, with only essential services enabled (web, email, etc). If you encounter a service that needs access through the firewall configured

- for example a peer-to-peer sharing service - this can be added later.



A firewall ultimately forms a barrier between the internal secure network and any other network, such as the internet (most modern broadband routers contain a built-in firewall). You can imagine it as a wall that will stop data from all but essential requested sources from entering the network.



15 min

### Quiz: Introduction

**Q1:** What is the purpose of anti-virus software?

.....

**Q2:** What is the purpose of a firewall?

.....

## 12.2 Encryption

### Learning objective

By the end of this section you will be able to:

- describe how encryption works;
- state the benefits of encryption.

**Encryption** means that before information is sent or stored electronically, (for example in an email), it is scrambled using a mathematical process which turns it into something that looks like nonsense. This means that if anyone steals the information it will be meaningless to them. It will look like gobbledygook. Encryption is always a trade-off between security and convenience: it takes time and processing power to carry out encryption and decryption, often with specialist software needing to be installed.

When the information needs to be accessed by someone that has permission it is decrypted. The person who has received the encrypted email will have the key to the

code and be able to decrypt the email. This means that it becomes readable again.

Encryption can be used on files that are stored on a computer or a backing storage device. Information that is in long term storage may have encryption applied to it to prevent it being accessed by hackers. Laptops and backing storage devices that contain sensitive information can benefit from being encrypted. There have been several occasions where government officials have lost laptops that have contained information that they do not wish to become publically available. If the information is encrypted, even if the laptop is stolen, the contents should remain private. It is now regarded as best practice for any portable devices containing personal or sensitive data to be encrypted. This is one step an organisation may take to meet their obligations under the **Data Protection Act** (there is more about the Data Protection Act in the next topic).

The military make use of encryption to protect their sensitive files and emails. In fact, one of the world's earliest computers was used to decipher the Enigma codes used during World War 2. Alan Turing used decoders called bombes to test all 17,576 possible Enigma ciphers until the coded messages were cracked.

Encryption does not prevent hacking but it means that when information is intercepted it cannot be read and is therefore worthless.

**What is encryption?**

Since the earliest days, people have invented various ways to send coded information to maintain secrecy. One of the simplest ways of doing this was the Caesar cipher. This is a simple technique - reputed to be invented by Julius Caesar to protect military commandments - whereby you 'shift' the letters of the alphabet by a fixed number. So, for example, if you employ a shift of 2, A becomes C, B becomes D, and so on.

Because of the simplicity of this system it offers little protection in reality, even without the power of a computer most Caesar Ciphers can be worked out with just a little knowledge of language. Picking on an often-used word or letter combination (The, Qu, ing,) will often reveal the offset quickly.

**Activity: Crack the code!**

See if you can work out the hidden message here.

Ciphertext: L DP OHDUQLQJ DOO DERXW HQFUBSWLRQ ZLWK VFKRODU

.....

To get around this problem, you need to scramble data using a more 'randomised' pattern, and one that changes the output in a less predictable way so that the same letter may be encoded into different 'ciphertext' letters. Perhaps the most famous example of trying to achieve this is the aforementioned 'enigma' machine of WWII, which used 3 dials (later 4) which rotated in a set pattern after every keypress. This caused a real problem for those trying to decode the messages, hence the development of early computers: instead of trying to figure out a simple substitution, you have to potentially test every possible scrambling permutation of the machine.

Modern computers now employ a much more sophisticated 'scrambling' system called key-based encryption, to protect against the power of other computers being able to try out millions of combinations every second: a virtual arms race!



5 min

There are two types of key-based encryption: **symmetric key** and **public key**.

When using symmetric key encryption the key for encrypting and decrypting the information is the same. This key must be agreed between both parties before the transfer of information begins. Of course, the big weakness of symmetric encryption comes in trying to transmit the encryption key without it being intercepted! To get around this problem, asymmetric - or 'public key' encryption was developed.

Public key encryption (sometimes called asymmetric encryption) is a complex mathematical process involving the generation of two keys: a public key and a private key. Both keys are mathematically linked using very large prime numbers. Both keys work as a pair:

- The private key can encrypt data that can only be decrypted with the corresponding public key, and - going the other way - can decrypt data that has been encrypted by the corresponding public key.
- The public key can encrypt data that can then only be decrypted with the corresponding private key. The public key can also decrypt data that has been encrypted with the private key. Which way around this happens depends on our purpose.

Here is an example of how SSL - a popular encryption system for secure websites - works:

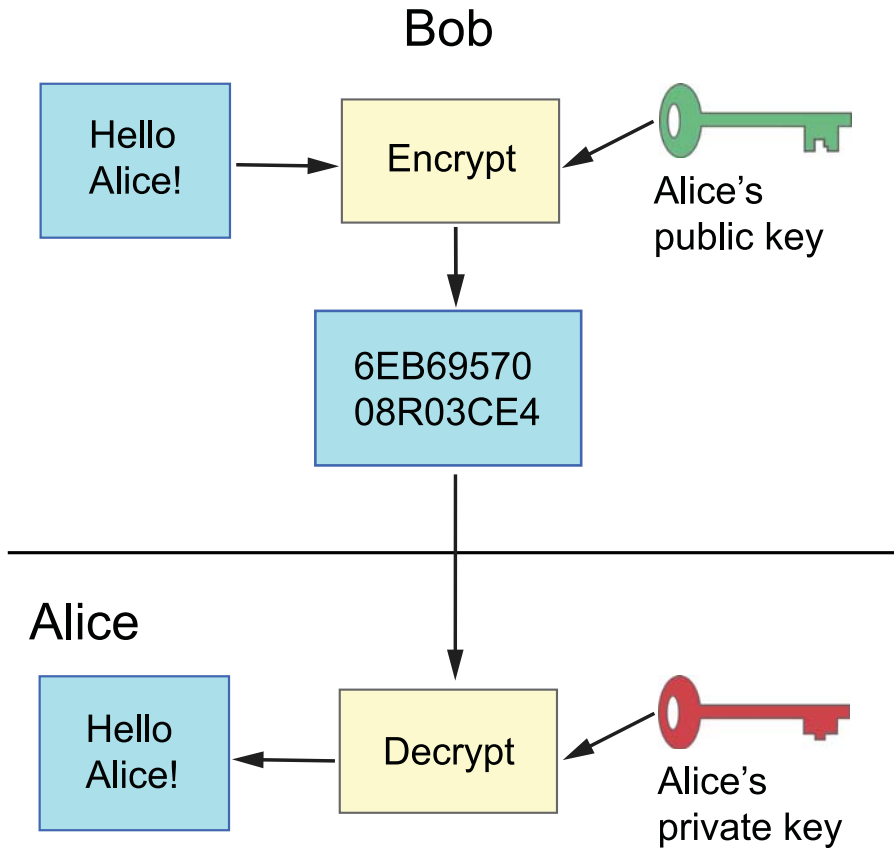
1. Your browser will be sent the website's public key - the private key remains on the server, so is still secure and cannot be intercepted.
2. Your browser uses the public key to encrypt the data you are sending (your credit card number?)
3. The data is sent back to the server - even if someone has intercepted the public key and your message they are still no further forward.
4. Once back at the server, the private key is used to decrypt the message.

In the next section, we will look at digital signatures, which use the two keys the other way around (the private key encrypts the data).

Figure 12.1 Diagram showing the encryption and decryption process



Figure 12.1: The encryption and decryption process



.....

Key based encryption used by a typical secure browser session can use a scrambling key of some  $1.6 \times 10^{77}$  combinations - enough even to keep a supercomputer churning away until the end of time!

There is a good summary of the two types of encryption here: <http://youtu.be/ERp8420ucGs>

**Quiz: Encryption**

**Q3:** Explain what is meant by encryption?

.....

**Q4:** What are the benefits of encryption?

.....

**Q5:** Explain the difference between symmetric and public key encryption.

.....



15 min

## 12.3 Digital certificates & signatures

### Learning objective

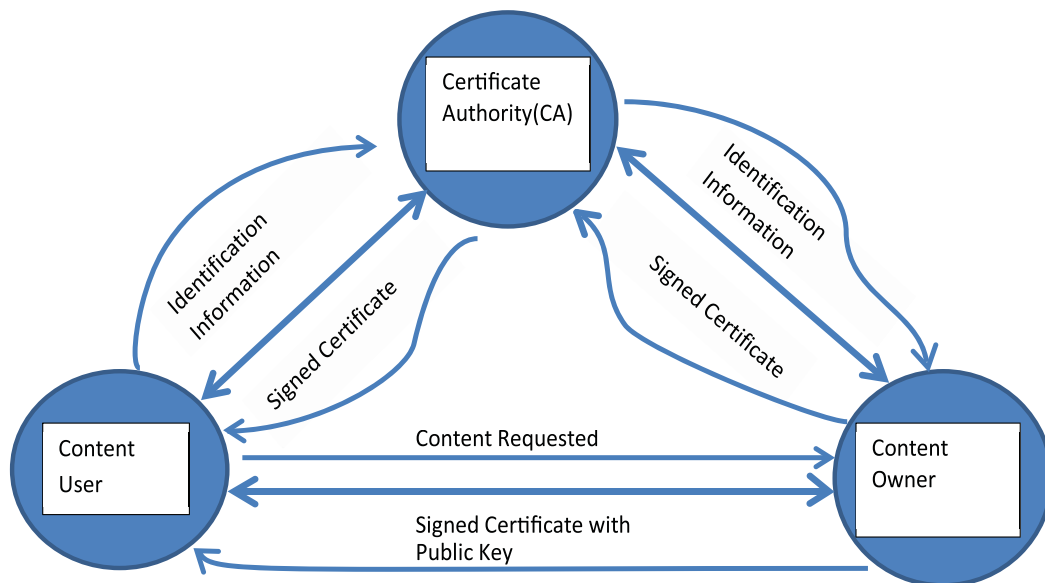
By the end of this section you will be able to:

- describe a digital certificate;
- state the purpose of a digital signature.

A **digital certificate** can be known as a digital key certificate, public key certificate or an identity certificate, but they all refer to the same product. A digital certificate is an electronic document that contains a digital signature, which confirms the name and identity of a person or organisation. The digital certificate uses a public key to bind the digital signature and identity together.

A public key, or **public key infrastructure (PKI)**, is a scheme that allows companies and individuals to state that the identity information and the public key belong together.

Figure 12.2: Digital certificate process



A digital certificate becomes the equivalent of an electronic passport. It allows individuals or companies to feel secure in exchanging information as they each know the identity of the other party. A digital certificate is exceptionally hard to forge and can be trusted as it will have been issued by a trusted agency.

A digital certificate will contain the name of the certificate holder, serial number, expiry dates, public key for encrypting messages and the digital signature of the certificate issuing authority (CA).

A **digital signature** is an electronic signature that can be used to authenticate the identity of the sender of a message or the signer of a document, and to ensure that the original content of the message or document has not been tampered with. Digital signatures are easily transportable, cannot be forged by someone else, and can be

automatically time stamped.

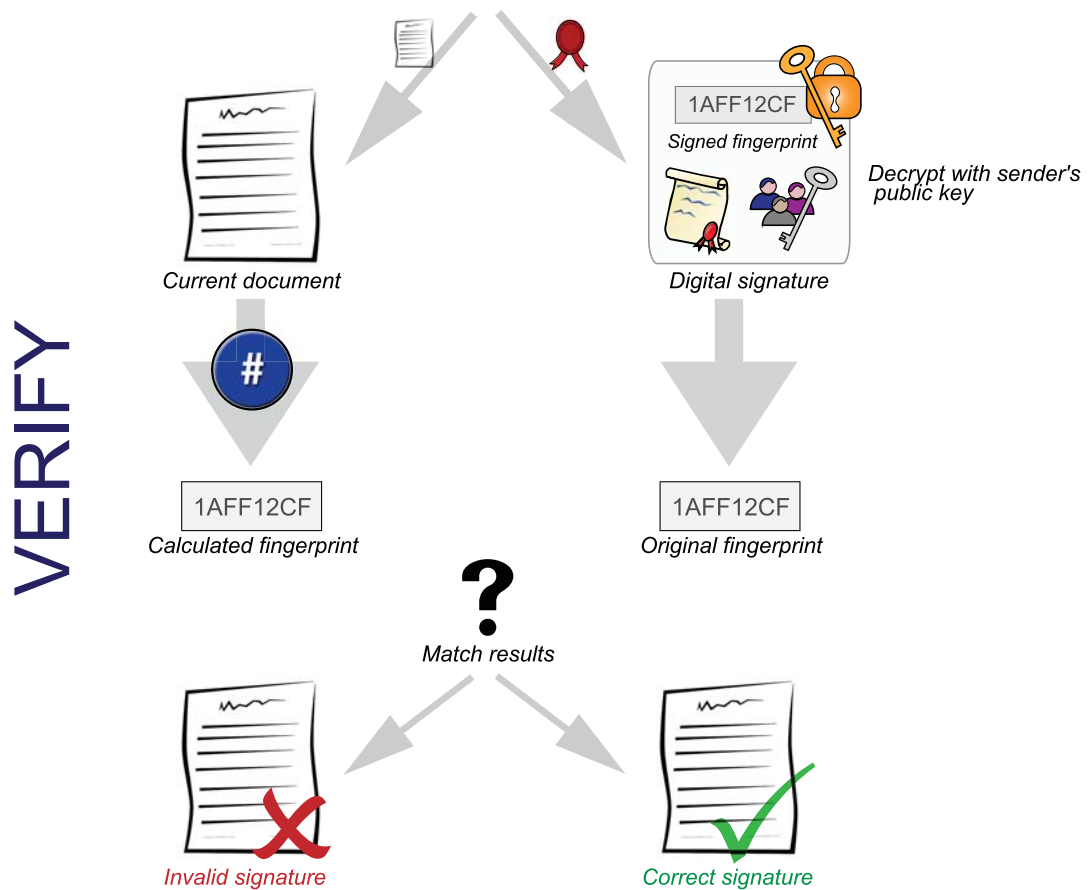
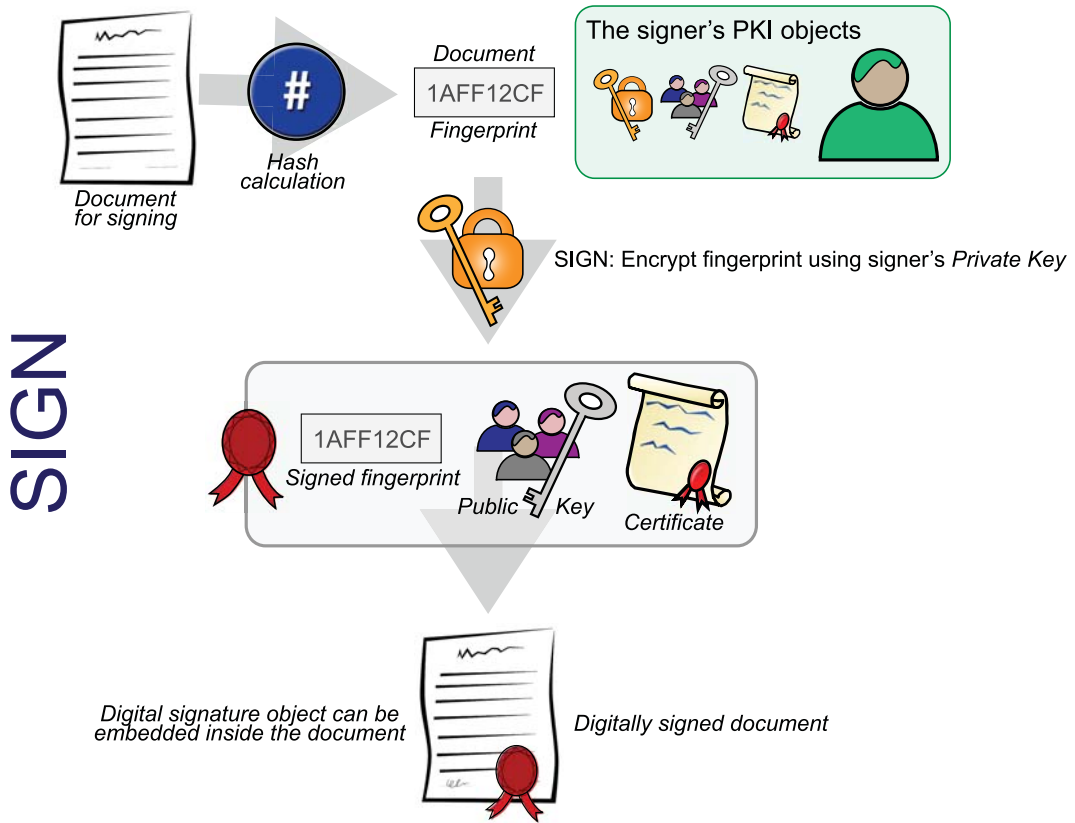
Digital signatures are supported by a wide variety of software packages used by business. This ensures that legally important messages arrive intact, are timestamped and can be trusted to be genuinely from the sender.

For example, assume that you were going to send the draft of a contract to your lawyer in another town. You want to give your lawyer the assurance that it was unchanged from what you sent and that it is really from you.

- You copy-and-paste the contract into an e-mail.
- Using special software, you generate a message hash (mathematical summary) of the contract.
- You then use a private key that you have previously obtained from a public-private key authority (along with your digital certificate and public key) to encrypt the hash.
- The encrypted hash becomes your digital signature of the message. (Note that it will be different each time you send a message as the hash is generated from the message contents directly). This is then attached to the original message and sent to the lawyer.

At the other end, your lawyer receives the message.

- To make sure it's intact and from you, your lawyer's software makes a hash of the received message.
- Your lawyer's software then uses your public key to decrypt the original hash that was calculated before the message was sent.
- If the decrypted hash value matches the hash value that the lawyer has calculated, then it is unchanged from when the document was signed. Note that this process also proves the original sender is the author (you): only you would have access to your private key, so if your - linked - public key can decrypt the hash value, only you could possibly have sent it. (This is an important legal point called repudiation - it basically means you can't later deny you sent the message with those contents).



**Quiz: Digital certificates & signatures**

25 min

**Q6:** What is a digital certificate?

.....

**Q7:** What is the purpose of a digital certificate?

.....

**Q8:** Who can make use of digital certificates?

.....

**Q9:** What is a digital signature?

.....

**Q10:** What is the purpose of a digital signature?

.....

**12.4 Server-side validation****Learning objective**

By the end of this section you will be able to:

- describe what is meant by the term validation;
- explain the difference between client-side and server-side validation.

**Validation** is often required on websites to check the information that the user is entering. This could mean checking that the user has entered their password correctly, or that they have put numbers into a number field and text into a text field. The process of validating the user information can be performed client-side, on the user's computer, or server-side, on the server.

In **client-side** validation the information that the user enters is checked by the user's browser, possibly using a scripting language like JavaScript.

In **server-side** validation all the information is checked and verified by the server, not on the user's computer.

Client-side validation is faster than server-side validation as the processing takes place on the user's computer. This saves time for information which doesn't need to be sent between the client and the server. When information is validated by the server it must be sent from the user's computer to the server, checked and then sent back to the client.

Because a third party could theoretically tamper with data between the user and server, server-side processing is used for sensitive or important data; server-side processing is more secure. It may take longer to process but if it is sensitive information that is being handled, i.e. credit card details, then it would be worthwhile to use server-side validation. For example, users ordering goods online will be asked to pass a series of security 'challenge' questions: what is the number on the rear of the card; what is your postcode; etc. Because this is checked on the server a user (or intermediary) cannot

interfere with this process.

When server-side scripting is used and data is validated on the server it has two advantages: the validation of data cannot be disabled and centrally held data can be updated.



15 min

### Quiz: Server-side validation

**Q11:** What is validation?

.....

**Q12:** What is the difference between client-side and server-side validation?

.....

**Q13:** Compare the advantages of client and server-side validation.

.....

## 12.5 Biometrics

### Learning objective

By the end of this section you will be able to:

- explain what is meant by the term biometrics;
- give examples of where biometrics can be used.

**Biometrics** has always appeared in James Bond films but they are increasingly becoming more wide spread and available in everyday life. Every human being has different and unique biometric information and this can be used to identify them. Biometrics can be used as security measures to prevent a computer from being accessed or preventing information from being accessed.

Everyone has a unique fingerprint and this can easily be scanned into a computer. This can then be used to identify a person and allow them access to a room or to a USB storage device. Some countries trialed scanning a customer's fingerprint when they were paying with a credit or debit card but this was not a popular security method and has since been abandoned. More recently fingerprint technology has started to make a comeback and was introduced in 2013 to Apple's iPhone range of smartphones; users scan a fingerprint to unlock the device. Many people have hailed this as a good step forward in mobile security, and an important safeguard for business users.

*Figure 12.3: Fingerprint scanner*

.....

Scanners that scan the iris of your eye can also be used as a security device, or as a way of identifying that someone is who they say they are. You are most likely to have encountered this technology at airports - many countries now scan your iris and fingerprints upon entry to try to combat illegal immigration. (You can't argue who you are if you are caught!).

*Figure 12.4: Iris scanner*

Why should we consider biometrics?

- It eliminates problems caused by lost IDs or forgotten passwords - you can't lose your fingerprint!
- It prevents unauthorised use of a lost or stolen ID card.
- It reduce fraud as these methods are very hard to forge.

Are there concerns about biometrics?

Yes! Whilst early scare stories of people having fingers chopped off to gain access to stolen devices has remained the stuff of movie plots, many people are concerned that recording and using our biometric data is another invasion of our privacy. Criminals have long since had fingerprints held on the Police National Computer, but what if the security services were able to access other 'banks' of biometric data?

There has also been great developments in facial recognition software that can pick out individuals in a crowded area. Combined with high resolution CCTV cameras, some argue this is a great tool to fight crime and security threats, whilst others argue this is too intrusive in a society already heavily monitored by CCTV.



### Quiz: Biometrics

10 min

**Q14:** Explain what is meant by the term biometrics.

.....

**Q15:** Why are biometrics used in computer security systems?

.....



### Practical task: Biometrics

20 min

Use the internet to find examples of where biometrics is used in security systems. You may wish to consider lifts that can only move if the correct voice is used, or if a fingerprint is scanned, doors that only open when an iris is scanned, face recognition and signature verification.

.....



## 12.6 Learning points

### Summary

You should now know:

- Anti-virus software and firewalls are methods of protecting a computer from security risks.
- Encryption is using a key (rules to scramble the data) to turn the data into seemingly meaningless content before it is sent electronically.
- Decryption is reversing the original encryption process using the key.
- Symmetric key encryption uses the same key for both encryption and decryption. This has to be agreed securely before use.
- Public key encryption means that the encryption key is public and available for anyone to use to encrypt data. Only the private key can decrypt data encrypted by the public key.
- A digital certificate is an electronic document that contains an electronic signature and is used to confirm the identity of a person or organisation.
- A digital signature is an electronic signature that can be used to authenticate the identity of someone sending you information. It also confirms the integrity of the document.
- Validation is used to check information that is being entered into a website.
- Client-side validation performs all the checks on the user's browsers.
- Server-side validation performs all checks on the server.
- Biometrics is the process of using an individual's unique information to prove their identity, or to allow access to information on a computer.

## 12.7 End of topic test



10 min

### End of topic test

**Q16:** Which one of the following forms an internal barrier between a secure network and any other network?

- a) Anti-virus
  - b) Firewall
  - c) Encryption
  - d) Phishing protection
- .....

**Q17:** Which one of the following is an electronic document that is used to confirm the identity of a person or organisation?

- a) Encryption
  - b) Digital Signature
  - c) Digital Certificate
  - d) Validation
- .....

**Q18:** In symmetric encryption both the key for encrypting and decrypting are the same and are agreed before information is transmitted:

- a) True
  - b) False
- .....

**Q19:** Which of the following validation checks are performed in a more secure environment?

- a) Client-side validation
  - b) Server-side validation
- .....

**Q20:** Which one of the following security systems are very hard to forge or fool?

- a) Digital signature
  - b) Digital certificate
  - c) Biometrics
  - d) Client-side validation
- .....

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## Topic 13

# Legal implications

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Computer Misuse Act*
- *Data Protection Act*
- *Copyright, Designs and Patents Act and Plagiarism*
- *Health And Safety Regulations*
- *Communications Act*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *summarise the Data Protection Act;*
  - *explain what is meant by Health and Safety Regulations;*
  - *describe the main points and implications of the Computer Misuse Act;*
  - *give examples of the Computer Misuse Act being broken;*
  - *explain the purpose of the Copyright, Designs and Patents Act;*
  - *explain what activities are illegal under the Communications Act;*
-

- *describe the Electronic Communications Act;*
- *explain what is meant by plagiarism;*
- *describe the Regulation of Investigatory Powers Act.*

This topic looks at the laws that are used to govern and protect users and their information. This topic will look at the legislation that covers common offences committed using computers.

## 13.1 Introduction

### Learning objective

By the end of this section you will be able to:

- summarise the Data Protection Act;
- explain what is meant by Health and Safety Regulations.

**The Data Protection Act** makes it illegal for companies to pass on customer details to third parties. It means that companies have to keep customers details safe, secure and up to date. If the details are no longer required then the company should dispose of them. Before a company can keep customer details they must register their intention to keep such information.



### DATA PROTECTION ACT 1998

You can find more information here:

<http://www.legislation.gov.uk/ukpga/1998/29/contents>

Customers have the right to ask a company to show them what information they have stored about them, and to get it changed if it is not accurate.

**Health and Safety regulations** cover keeping users safe whilst using computer equipment. This includes minimising potential risks such as strains and stiffness, musculoskeletal problems and eye strain.



You can find more information here: <http://www.hse.gov.uk/msd/dse/index.htm>



5 min

### Activity: Introduction

Use the following words to complete the sentences below:

- data controller
- data subject
- data user

A \_\_\_\_\_ is the person who has information stored about them.

A \_\_\_\_\_ is the person who uses the information stored on a computer.

A \_\_\_\_\_ is the person responsible for all the data stored in a company or organisation.

.....



15 min

### Quiz: Introduction

**Q1:** What rights do data subjects have under the Data Protection Act?

.....

**Q2:** What responsibilities do companies have under the Data Protection Act?

.....

**Q3:** What are the two main risks associated with Health and Safety Regulations?

.....

## 13.2 Computer Misuse Act

### Learning objective

By the end of this section you will be able to:

- Describe the main points and implications of the Computer Misuse Act;
- give examples of the Computer Misuse Act being broken.

The Computer Misuse Act was introduced in the UK in 1990 to deal with an increasing number of crimes where people were accessing and modifying computer content without permission, often by by-passing security precautions to do so. The Act made the following activities illegal:

- Unauthorised access to computer systems or material saved on a computer.
- Modifying material stored on a computer without the users permission.
- Deliberate introduction of virus's into a computer system.
- Using Unauthorised Access or modification of computer systems to facilitate further criminal offences.

Gaining access to a computer system without the user's knowledge or permission is known as hacking. Hacking can occur because the hacker has an inclination towards hacking and wants to see if they can do it, or because the company is storing information that is interesting or valuable to the hacker.



## Computer Misuse Act 1990

You can find more information here: <http://www.legislation.gov.uk/ukpga/1990/18/contents>

A hacker may gain access to a computer system and modify the information that is stored. This is often achieved without the owner's knowledge.

Writing and releasing a virus, or deliberately introducing a virus into a computer system can cause a lot of damage to a computer system or network and is made illegal by the Computer Misuse Act.

One of the issues around spreading viruses in particular that is often criticised about the Act is that a crime is only committed if a user deliberately spreads the virus. In many cases, this can be difficult to establish. Technically, it is perfectly legal to write computer viruses, as long as you do not deliberately spread them.

The Computer Misuse Act is a useful tool in the fight against online crime, however with the spread of global networking - especially the internet - it can be increasingly difficult to find hackers in foreign countries and bring them before a court in the UK. Perhaps the most famous case in Scotland that involved hacking was that of Gary McKinnon. In 2002 he gained access to American military computers. Although prosecuted under the UK's Computer Misuse Act, the Americans asked for his extradition so he could also be prosecuted there, thus an 8-year legal battle ensued. Supporters of Mr McKinnon claim that - because he suffered from Asperger's syndrome - he did not fully appreciate the severity of his actions. The American military argued that he caused significant problems leading to several computers being shut down, which compromised security. In the end (in 2012) Mr McKinnon won his fight against extradition.



30 min

### Practical task: Computer Misuse Act

Use the internet to research and investigate the Computer Misuse Act. Find examples or stories of how and when the law has been broken and what the potential punishments are. Put this information into a presentation or poster.

.....



10 min

### Quiz: Computer Misuse Act

**Q4:** What activities are illegal under the Computer Misuse Act?

.....

**Q5:** What are the potential punishments for breaking the law?

.....

## 13.3 Copyright, Designs and Patents Act and Plagiarism

### Learning objective

By the end of this section you will be able to:

- explain the purpose of the Copyright, Designs and Patents Act.

The Copyright, Designs and Patents Act of 1998 gives the creators of written, musical and art work control over how the material is used. This includes computer software and games.

This act means that a book, article, song or photograph cannot be used without the owner's permission if it has been copyrighted. Names of bands for example can be copyrighted and so two bands cannot have the same name. Newspaper articles cannot be scanned into a computer and used, or photocopied without the author's permission.

If you purchase a music CD you are not entitled to make copies of it and sell it on to your friends. If you purchase a computer game it will come with one license and you are not permitted to make copies and pass it on to others.



You can find more information here: <http://www.legislation.gov.uk/ukpga/1988/48/contents>

The Internet has made it much easier for materials to be used without the creator's permission as they are available over the web. If you wish to use an image or a song created by someone else then you can ask their permission, which they may or may not give.



When you are writing an essay for perhaps English or History, it is important that you attribute your quotes to the correct sources; otherwise you are breaking the law. If you download music over the Internet then you must ensure that you are using a legal site that is not sharing information illegally.

Criminals have been known to flout the Copyright, Designs and Patents Act in a bid to make money. In many cases, large-scale, organised production of counterfeit CD's, DVDs and computer software have been shown to help fund other organised crimes and even terrorism.

**Plagiarism**

When discussing Copyright, it is also worthwhile considering the act of Plagiarism. Plagiarism is the act of trying to attribute the works of another person to yourself. This may simply be to claim credit and approval from others, though more commonly it is used to cheat in official exams, academic papers and essays. With the growth of the internet it is now increasingly easy to find content online and try to pass this off as your own work. Some enterprising people have even set up 'buy an essay' services online, ranging from simple downloadable papers on common topics right through to services where people will write the essay for you! Carrying out plagiarism in itself is not necessarily a criminal offence, though it may be a civil offence under the Copyrights, Designs and Patents Act if you do not have permission to reproduce the work. Certainly, all schools, colleges and universities take a dim view of this as an ethical issue: those caught often lose their grade for the course, can be stopped from sitting further courses and even thrown out of their college/university. Companies now market a range of products that scan student papers and try to check for plagiarism.

**Practical task: Copyright, Designs and Patents Act and Plagiarism**

Use the internet to research and investigate the Copyright, Designs and Patents Act. Make your own notes to explain what activities are made illegal by this act, why some criminals break the act and what the potential punishments are.



30 min

.....

**Quiz: Copyright, Designs and Patents Act and Plagiarism**

**Q6:** What is the purpose of the Copyright, Designs and Patents Act?



10 min

.....

**Q7:** Explain why the growth of the internet has led to a massive increase in breaches of the Copyright, Designs and Patents Act.

.....

**Q8:** What are the potential punishments for breaking the law?

.....

## 13.4 Communications Act

### Learning objective

By the end of this section you will be able to:

- explain what activities are illegal under the Communications Act.

The Communications Act 2003 was introduced to cover many types of communication offences. This can include cloning or reprogramming stolen mobile phones, intercepting or interfering with electronic communications and social networking offences.

Under the Communications Act it is illegal for you to access another person's wireless network without their permission. They are paying their Internet Service Provider for a service and if they have put a password onto their network then they do not want unauthorised users to use their network.

### The Communications Act and Social Networking



Social networking is very popular with users of all ages and whilst this is a positive experience for many it can be negative for others. Internet 'trolls' can post offensive or hurtful comments, famous people have been subjected to abuse (Tom Daley) and incorrect information can be published about people. These activities may be illegal under this act. Cyberbullying is made illegal under this act.

The Communications Act covers sending messages or images that are of an obscene nature, also known as sexting. The sharing and storing of pornographic images is also covered under this act.



30 min

### Practical task: Communications Act

Use the internet to research and investigate the Communications Act. Create your own notes, presentation or poster to show what activities are illegal under this act. Give examples of stories that have been in the news and explain the potential punishments.

.....

**Quiz: Communication Act**



10 min

**Q9:** What activities are illegal under the Communications Act?  
 .....

**Q10:** What are the potential punishments for breaking the law?  
 .....

**13.5 Electronic Communications Act**

**Learning objective**

By the end of this section you will be able to:

- describe the Electronic Communications Act.

The Electronic Communications Act 2000 achieved two goals. It regulated the provision of cryptographic services in the UK and confirmed the legal status of electronic signatures. More information on cryptography and electronic signatures can be found in topic 12, Security Precautions.

The act confirms that documents that have been signed electronically are just as legally acceptable as a printed and signed document.

**Quiz: Electronic Communications Act**



5 min

**Q11:** What is covered under the Electronic Communications Act?  
 .....

**13.6 Regulation of Investigatory Powers Act**

**Learning objective**

By the end of this section you will be able to:

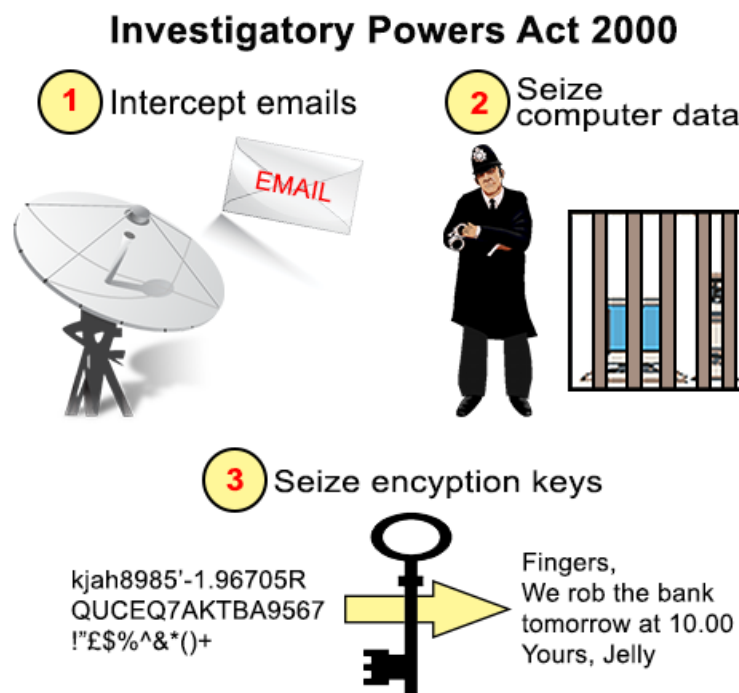
- describe the Regulation of Investigatory Powers Act.

The Regulation of Investigatory Powers Act 2000 gives Police and Security Services the powers to:

- Intercept communications - wire taps and reading post.
- Acquire communications data - information about a communication, but not the content of the communication. For example, billing data.
- Set up intrusive surveillance - bugging residential properties and cars.
- Set up covert surveillance - following people.

- Use covert human intelligence sources - using informers.
- Access encrypted data.

This means that the Police and Security Services can demand that a communications provider intercepts an individual's communications. Normally, a court order (or 'warrant') would have to be granted to allow the police or security services to carry out some of the actions defined by the act. Employers are also allowed by this act to carry out 'reasonable' monitoring of business communications equipment to ensure it is not being misused by employees. This may involve monitoring company email accounts or telephones.



If a person is suspected of a crime, tax evasion, or the matter is in the interests of public safety then a person can be investigated. For example, if a person was suspected of being a terrorist then the police might be allowed to use some of the measures available to them under this act.

As Internet Service Providers have to provide this information to the government if it is requested, it is important that they have the systems in place to intercept and store information. They cannot pass it on if they cannot gather it. Gathering the required information has become increasingly challenging due to the encryption methods that are now available. Users wishing to avoid detection can securely encrypt their data and it may be the case that no one else can decrypt it unless the user can be persuaded to give them the decryption key. Police and security services can obtain a court order demanding you hand over any encryption keys, though it is difficult to argue against a defence of 'I destroyed it, and it was too long to remember...!'

Many people would argue that the RIPA is overly-intrusive and gives the state too many powers over an individual's right to privacy. Several high-profile incidents have highlighted the extent of surveillance that exists. In 2013, Edward Snowden released

several classified documents to the media obtained when he worked for America's CIA: This revealed details of a global surveillance program run by several American and European agencies, including Britain's GCHQ. Some regard Snowden as a hero and whistleblower (he has even been elected Rector of Glasgow University) whilst others claim he has damaged legitimate spying operations and harmed national security.

**Practical task: Regulation of Investigatory Powers Act**

Use the internet to research the Regulation of Investigatory Powers Act and make your own notes. Be sure to include examples of measures that the government can take and the reasons that the measures are justified.



30 min

Alternatively, if you are in a big enough class, carry out some research about this area and organise a debate amongst your classmates. Are these powers necessary and appropriate in the modern world, or are they too intrusive?

.....

**Quiz: Regulation of Investigatory Powers Act**

**Q12:** What reasons must the Police and Security Services have before they can use the Regulation of Investigatory Powers Act?



10 min

.....

**Q13:** What measures does this act allow the Police and Security Services to take?

.....

## 13.7 Learning points

### Summary

You should now know:

- The Data Protection Act was created to protect the rights of individuals who have information stored about them by companies.
- Health and Safety regulations have been introduced to minimise the potential risks of using computer equipment to users.
- The Computer Misuse Act makes hacking, changing materials without permission and the wilful introduction of a virus illegal.
- The Copyright, Designs and Patents Act protects the rights of those who have created material from it being copied, or used without their permission.
- The Communications Act makes it illegal to use someone else's wireless network without their permission and covers offences that are committed on social networking sites.
- The Electronic Communications Act regulates the provision of the use of cryptography and gave electronically signed documents the same status as a paper document.
- The Regulation of Investigatory Powers Act gives governments the right to use special measures to investigate people suspected of serious crimes.

## 13.8 End of topic test

### End of topic test



10 min

**Q14:** Which law makes hacking illegal?

- a) Computer Misuse Act
  - b) Copyright, Designs and Patents Act
  - c) Communication Act
  - d) Regulation of Investigatory Powers Act
- .....

**Q15:** Which law makes cyber bullying illegal?

- a) Computer Misuse Act
  - b) Copyright, Designs and Patents Act
  - c) Communication Act
  - d) Regulation of Investigatory Powers Act
- .....

**Q16:** Which law makes introducing a virus illegal?

- a) Computer Misuse Act
  - b) Copyright, Designs and Patents Act
  - c) Communication Act
  - d) Regulation of Investigatory Powers Act
- .....

**Q17:** Which law makes using someone's photographs illegal?

- a) Computer Misuse Act
  - b) Copyright, Designs and Patents Act
  - c) Communication Act
  - d) Regulation of Investigatory Powers Act
- .....

**Q18:** Which law can the government use when they believe something is a matter of public safety?

- a) Computer Misuse Act
  - b) Copyright, Designs and Patents Act
  - c) Communication Act
  - d) Regulation of Investigatory Powers Act
- .....





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## Topic 14

# Environmental implications

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### **Prerequisite knowledge**

*From your studies at National 5 you should already be familiar with the following terms:*

- *Energy use;*
- *Disposal of IT Equipment;*
- *Carbon Footprint.*

### **Learning objectives**

*By the end of this topic you will be able to:*

- *explain what is meant by the term Energy Use;*
  - *describe how to responsibly dispose of redundant IT equipment;*
  - *explain what a carbon footprint is;*
  - *give examples of how individuals can reduce their carbon footprint;*
  - *explain the environmental benefits of computers and technology.*
-

This topic looks at the environmental implications of creating, using and disposing of electronic equipment, specifically computers and computing devices.

## 14.1 Introduction

### Learning objective

By the end of this section you will be able to:

- explain what is meant by the term Energy Use;
- describe how to responsibly dispose of redundant IT equipment.

From your studies at National 5 you will already know that all electronic devices use electricity, either to run or have their batteries charged, and that we all have a responsibility to dispose of redundant computer equipment responsibly.

For a desktop computer to run, a smartphone to charge, a router to operate and a printer to print, one source of energy is required - electricity. The more electronic gadgets a person uses the more energy they consume. The more energy that is consumed the worse this is for the environment. Despite recent investment in renewable generation technology, the majority of the world's electricity is still produced by burning fossil fuels like coal or gas.



We are increasingly living in a 'throw away' society. This means that if a gadget is broken, or you get a new one then you tend to throw out the old one. This has been made worse by the constant 'upgrade cycle' that people, especially in affluent countries, follow: Much of the 'old' equipment thrown away often works fine, but has been replaced by a newer, more desirable, model. This causes several problems. Throwing away gadgets creates landfill and the world is rapidly running out of places to keep this landfill.

Many components of electronic equipment contain harmful chemicals, which can seep into the ground and cause damage. Not everyone disposes of their equipment correctly and this leads to rubbish being dumped in the countryside. Setting fire to electronic equipment can release harmful chemicals and gases into the atmosphere.

Some equipment can be recycled instead of being thrown away. Printer cartridges can be refilled and reused. Mobile phones can be sold to companies who use them for spare parts.

Another problem with the 'throw away' society is that these machines also cause a lot of pollution and damage getting the raw materials to manufacture them. Rare earth metals such as Yttrium, Europium and Lanthanum take enormous efforts to mine and leave behind toxic and radioactive by-products. These are essential materials for a modern device, and we need them more than ever to keep up with demand.

You can read more about this problem here:

<http://www.cnet.com/uk/news/digging-for-rare-earths-the-mines-where-iphones-are-born/>

**Quiz: Introduction**

**Q1:** Why do more electronic gadgets mean that more energy is being used?

.....

**Q2:** Why is it important to dispose of your unwanted IT in a responsible manner?

.....



10 min

**14.2 Lifetime Carbon Footprint**

**Learning objective**

By the end of this section you will be able to:

- explain what a carbon footprint is;
- give examples of how individuals can reduce their carbon footprint.

Carbon Dioxide, or CO<sub>2</sub>, is a gas found in the atmosphere. Since the industrial revolution, when humans began burning large amounts of 'fossil fuels' (coal, oil and gas) the amount of Carbon Dioxide in the atmosphere has been increasing as CO<sub>2</sub> is a by-product of burning these fuels. Most of the scientific evidence available today shows that this is causing our climate to change (sometimes called 'global warming' or the 'greenhouse effect') because Carbon Dioxide is more efficient than Oxygen or Nitrogen at trapping the sun's heat in the atmosphere.



One of the reasons that the amount of carbon dioxide being released has increased is because the use of technology has significantly increased in the last few decades. Computers have become affordable and consumers have found that gadgets can be fun and save them time. Many modern consumers, from children up, may own several computer-based gadgets in developed countries such as laptops, tablets, smartphones, games consoles, 'smart' TVs, etc.



10 min

### Practical task: Device count

Count up all the computing devices currently in use in your house. Include items used by all your family. Remember to count items such as smartphones and tablets, as well as larger items like laptops or desktops!

Now try to find out how many computing devices were in use in your household when you were born. (You may need to discuss this later with a parent to get an accurate idea).

Find out if your results are similar to your classmates.

.....

Charging portable devices, running computers and networks, using printers and digital cameras all uses electricity. Manufacturing and disposing of these devices also consumes large amounts of electricity. Which - as discussed earlier - often comes from burning fossil fuels in our power stations. This means that as an individual using these devices we are ultimately responsible for releasing more carbon dioxide.

Your carbon footprint is the amount of carbon dioxide that you are responsible for releasing into the atmosphere. Your lifetime carbon footprint is the amount of carbon dioxide that you are responsible for over your lifetime. The lifetime carbon footprint of a product is the amount of carbon dioxide that is released over the product's life span. How much is created when the product is manufactured? How much is created when the product is used? How much is created when the product is destroyed or recycled?

It is not only computers that are responsible for carbon dioxide. Any item that uses electricity to be made, charged, run or disposed of is adding to a carbon footprint. Washing machines, televisions, cars and microwaves all consume energy and are therefore responsible for contributing to this problem.

How to reduce your carbon footprint:

- Turn electrical devices off when not in use.
- Replace old equipment with modern, more energy efficient devices.
- Recycle redundant devices appropriately.
- Offset your carbon footprint by sponsoring charities that plant trees.
- Don't print unless it is necessary.
- Fix items instead of binning and replacing them.
- Use rechargeable batteries instead of disposable.
- Use technology to communicate instead of travelling by car or aeroplane.



Of course, it's not all quite as 'black-and-white' as would first appear: whilst we may own many more gadgets today, they are likely to all be much more power-efficient than ever. For example, a modern laptop, tablet and smartphone may all use less electricity than a single desktop computer only a few years ago. If kept for a long time, this may make up for manufacturing three devices instead of one.

**Practical task: Lifetime Carbon Footprint**

Use the internet to find a carbon footprint calculator and discover your carbon footprint. Write down three steps that you can take to reduce your carbon emissions.



20 min

.....

**Quiz: Lifetime Carbon Footprint**

**Q3:** What is a carbon footprint?

.....

**Q4:** Who has a carbon footprint?

.....

**Q5:** State three ways that an individual can reduce their carbon footprint.

.....



15 min

### 14.3 Environmental benefits

#### Learning objective

By the end of this section you will be able to:

- explain the environmental benefits of computers and technology.

The widespread use of technology and computers can be said to have had a detrimental effect on our lives and environment but it has also had a positive impact.

Companies and organisations no longer have to fly employees round the world to attend business meetings. Thanks to technology these meetings can now take place over the Internet using video conferencing, emails and perhaps Facetime. This is cost effective in saving time and money, and reduces the company's carbon footprint as the employee does not have to travel.

The amount of paper that a company uses should be reduced as members of staff can share files electronically and communicate electronically. This means that fewer documents need to be printed, recycled or physically transported around.



Computers and the ease in which people can communicate means that many employees can choose to work from home, which reduces their carbon footprint as they are not travelling to work in cars and buses.

Computing devices have developed over the years to become more efficient and use less energy.

Consumers are purchasing items online, reducing the carbon footprint that they would create by travelling to the shops.

Computers can help to monitor and manage fuel use in your home. Smart electricity meters show how much electricity you are using and can encourage people to reduce their consumption. Heating can be controlled remotely over the internet; perfect if you are delayed getting home or forget to turn it down as you leave for your holiday!

**Practical task: Environmental benefits**

Use the internet to research and investigate the positive influences that computers have had on our environment. Make your own notes.



20 min

.....

**Quiz: Environmental benefits**

**Q6:** Give three examples of positive impacts that computers have had on the environment.



5 min

.....

## 14.4 Learning points

**Summary**

You should now know:

- A carbon footprint is the amount of carbon dioxide that is released into the atmosphere when doing a task.
- A lifetime carbon footprint is how much carbon dioxide is released over the lifetime of a product, or in an individual's lifetime.
- There are many ways that individuals can reduce their carbon footprints.
- Computers have had both a negative and a beneficial impact on the environment.

## 14.5 End of topic test



10 min

### End of topic test

**Q7:** Which of the following does NOT have a negative effect on your carbon footprint?

- a) Leaving computers on all day.
  - b) Printing all emails.
  - c) Walking up stairs instead of taking the lift.
  - d) Using disposable batteries.
- .....

**Q8:** Which of the following reduces your carbon footprint?

- A Turning computers off when not using them.
  - B Recycling ink cartridges.
  - C Using a wireless network.
  - D Using energy efficient monitors.
- .....

**Q9:** How can you measure your carbon footprint?

.....

**Q10:** Which of the following are benefits of computers on the environment?

- A Less paper is used for printing.
  - B People are warmer.
  - C People are fitter.
  - D Employees can work from home.
- .....



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## Topic 15

# Economics and social impact

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### Learning objectives

By the end of this topic you will be able to:

- discuss how the use of technology and computers has changed in our society;
  - discuss the economic impact that computers and technology have had on our society;
  - discuss the social impact that computers and technology have had on our society;
  - explain what is meant by the term intelligent system;
  - discuss current developments within intelligent systems.
-

This topic will look at the economic and social impact that the growing use of technology and computers has had on our society.

## 15.1 Introduction

### Learning objective

By the end of this section you will be able to:

- discuss how the use of technology and computers has changed in our society.

Personal computers did not become common in private homes until the 1990s. Before then they were too expensive for most families to afford and the limited amount of memory and processor speed did not make them desirable.

The development and availability of the Internet changed this and the number of computers that are in our homes has significantly increased. We have moved from having dial up access to the Internet to having high speed, wireless, broadband access. The majority of young people and adults now own smartphones and 'wearable tech' is becoming more and more common.

The amount of memory available and the increase in speed of processors has made computers much more desirable. Technology has advanced to make devices portable and the cost of products fallen as companies try to be competitive, larger amounts of electronics are made and manufacturing processes become more efficient.



10 min

### Quiz: Introduction

**Q1:** Give two reasons why there are more computing devices available today than twenty years ago.

.....

**Q2:** How has the way that we use computers changed over the years?

.....

## 15.2 Economic impact

### Learning objective

By the end of this section you will be able to:

- discuss how technology can be used to create and maintain competitive advantage;
- consider the economic advantages and disadvantages of the global marketplace;
- discuss business costs for IT systems;
- discuss how businesses ensure IT systems are maintainable and scalable.

As computers have developed and become de-facto in the workplace it has affected the job market. Some jobs no longer exist as they can be done more efficiently using computers. However, other jobs have been created, such as computer programmers, software engineers and computing teachers.

Many of the new jobs created by technology are regarded as highly-skilled, with either high-level vocational or academic qualifications needed. Those working in software development, hardware design and network infrastructure will often be educated to degree level. Technicians who service and maintain machines on a day-to-day basis will almost certainly have spent time at College initially, and will continue to take courses to update their skills as technology advances.

### 15.2.1 Competitive advantage

Computers can save money for a business as one person with a computer can often produce the same volume of work as two or three people who do not have a computer. Technology may be able to save companies money if less paper copies are required, employees can work from home and electronic forms of communication can be used over face to face meetings.

The growth of the Internet has led to the growth of online shopping and websites. Nearly all companies have an online presence, which allows them to advertise to customers - world-wide if appropriate - maintain email contact lists and most importantly - sell products over the Internet. The Internet has given companies access to a much larger customer base, which is available 24/7.

Using computers to perform task better, faster and cheaper in order to make your business stand out is often referred to as "competitive advantage". This is not a new idea, however technology has brought about new ways to develop a competitive advantage and enhance it as new technologies emerge. Consider the case of a large online retailer such as Amazon. Initially, their competitive advantage was simply being online; they used the new technology of the world wide web to offer books for sale online. As other businesses caught up with this idea they had to continue developing: selling products other than books; finding faster and cheaper ways of delivering products; enhancing customer service with online tracking of orders, complaints resolution and refunds. Sometimes they have been left behind by other companies finding a competitive advantage of their own and have had to play 'catch up' themselves!

### 15.2.2 Global marketplace

Some developing countries have benefited from technology, but many of the jobs created (such as recovering recyclable materials from computers) are low-skilled and poorly paid. Furthermore, poor working conditions, lack of health and safety and use of child labour have blighted some developing nations as they try to benefit from our electronic waste in what has become a global marketplace to treat the 'scrap' from developed countries as cheaply as possible. Even in the developed world, not everyone has been a winner. The freedoms granted by technology are leading to increased insecurity in the workplace. Some workers are under threat as companies shift their production lines or call centres overseas to low-wage economies.

There are positives however: many highly-skilled jobs have been created around the world because they are not tied to a geographical area; with modern communication it does not matter if your programmers are in Edinburgh, San Francisco or Delhi. Many people in developing countries have become well educated and entire economies have begun changing for the better as a result of a global demand for these jobs.

The trend towards more tied-in, global marketplaces is part of a larger picture of globalisation. This is a term that is often used to describe the spreading of businesses, information and cultures across national boundaries. This process has been going on for many years (some would argue since the spread of European-based empires) however it is the rapid growth of information technologies that have accelerated this and enabled a truly global marketplace.

The Internet spearheads a global communications revolution whilst large companies (like McDonald's) spread their interests across the globe. Many would say that globalisation was a good thing. For example, increased international trade has made us wealthier and allowed us to lead more diverse lifestyles. Many would disagree however. Environmentalists, anti-poverty campaigners, trade unionists and anti-capitalist groups see the growth of global companies as raising more problems than it solves.

At the heart of globalisation concerns is the fact that huge trans-national companies are becoming more powerful and influential than democratically-elected governments, putting shareholder interests above those of communities and even customers. Even small businesses are afraid that global economies of scale will put them out of work.

Ecological campaigners say corporations are disregarding the environment in the stampede for mega-profits and marketplace supremacy. Human rights groups say corporate power is restricting individual freedom.



### 15.2.3 Business costs

Technology has had a huge impact on the costs of running a business. On the positive side:

- E-commerce has enabled a relatively cheap way of expanding your business to a larger (global) marketplace.
- Increasing data format standards allow you to outsource processing that would require experts with ease, such as payroll functions or customer relationship management apps.
- There is less need for expensive high street shops to be rented, furnished, lit, and heated.
- Delivery no longer needs to go via the retailer.
- Sales facilities can be offered 24/7, potentially increasing custom.
- Social media, 'viral' marketing and web advertising can make it cheap to promote and maintain your brand identity and relationship with customers.

There are also increased costs to be considered though, making it important businesses get best use of the technology:

- Initial set-up costs can be high when purchasing equipment, requiring increased lending for new businesses who need the technology to be competitive. Leasing options have become popular for hardware, software and even web server space and 'cloud computing' services.
- There are running costs to be met: electricity for the hardware, communications bills for internet connections and web hosting, ongoing maintenance, hardware and software updates.

- Staff will have to be sourced with adequate technical skills to work with computerised systems. This will attract a higher wage, particularly for 'expert' roles such as technicians, programmers and media specialists. Ongoing training to update skills will add to these costs.

#### 15.2.4 Maintainability

Maintenance of hardware and software is a constant drain on resources for both individuals and businesses. All IT equipment has a lifespan, meaning parts - and often whole systems - have to be replaced.

One area of concern around modern technology has been in some of the compromises made to miniaturise technology: a typical desktop PC will be relatively easy to take apart and replace, say, a faulty RAM module. The same fault in a smartphone would render it useless however, and (at least) the entire motherboard would need replaced, with the faulty part being discarded along with other functioning parts. Often, such technology is treated by consumers as 'disposable' and they simply buy a whole new device due to the high repair costs.

#### 15.2.5 Scalability

Scalability of IT infrastructure is an important topic when considering economic factors. It is important that businesses are able to respond to demand for their product/service as well as the growth that will hopefully come with this. Some examples of scalability include:

- Computer networks are carefully planned to make expansion and addition of terminals as easy as possible. Modern office buildings will have structured cabling in place that can also be easily added to.
- Companies are making increasing use of thin client technology which allows workers to access a powerful, central server from an inexpensive terminal.
- The servers used are often highly expandable, and often rack-mounted, modular units.
- Web hosting is often leased from large companies with Terabytes of space and very high bandwidth connections. In the early days of the web, companies would often pay for a fixed package to host their website, or even purchase their own web server. With the move to scalable technologies, money can be saved by adjusting the web hosting to meet demand.



30 min

#### Practical task: Economic impact

Use the internet to research an industry where the introduction of computers have had an economic impact - positive, negative or mixed - like those listed above.

Create a set of notes about this area.

.....

**Quiz: Economic impact**



10 min

**Q3:** In your opinion what has been the biggest economic impact that computers and technology have had on society?

.....

**Q4:** Which of the following are positive economic impacts of technology in a business?

- a) You can sell goods 24 hours a day online.
- b) You have to pay for staff training to use new technologies.
- c) Social media can be an inexpensive marketing tool.
- d) You don't need to pay expensive high-street rental prices for a store.

.....

**Q5:** The global marketplace has meant increased job security in specialist roles.

- a) True
- b) False

.....

**Q6:** What is meant by the term 'competitive advantage'?

.....

**15.3 Social impact**

**Learning objective**

By the end of this section you will be able to:

- explain the idea of global citizenship and online communities;
- discuss issues around censorship and freedom of speech;
- discuss the impact of encryption and the relationship with privacy.

In 1990 if you wanted to send a birthday card to a friend you would buy a card, write it and post it a few days before their birthday. Nowadays you may design a card on the Internet and have it sent directly to their house. You may choose to send them a birthday card in an email, text them or wish them happy birthday over your favourite social networking site. The way in which we interact socially with each other has changed dramatically due to the use of computers and technology.



Consider mobile phones. In the 1980s and 1990s individuals did not have their own smartphones. If you wanted to phone someone you used your house phone (which was not cordless). You would have had to type in the number before it would ring. It is much more common now to text someone, send them a picture or video call them. You don't even need to type in their number: your smartphone has a contact list!

Young people spend a lot of time interacting socially via game websites or social networking sites. In previous years the only way that young people would have been able to interact was to meet up at the local youth club or shopping centre. People now go on virtual dates without leaving their house!

Whilst social networking has made it easier to keep in contact with friends and relations that have are spread around the world it has led to some individuals becoming more isolated. It is possible to run your life from behind a computer and some individuals have stopped leaving their homes.

People have become more sedentary as they have no reason to get up and leave the house. They have plenty to entertain them in the form of games and news sites so they stop interacting face to face with 'real' people. This has begun to have an impact on the health and weight of many individuals. If people are constantly sitting in front of a computer then they are not taking as much exercise as they should and are likely to face health issues in later life such as obesity, diabetes and heart disease.

### **15.3.1 Censorship and Freedom of Speech**

Freedom of Speech is regarded as a basic human right by the UN, the EU and most individual countries. In reality however there have always been controls put in place by governments to regulate against activities which may cause 'harm' to other people or the state. This may be libel, copyright breaches, so-called 'hate speech' or the release of classified information from governments. Censorship is the term for banning or removing communications that cause harm or offence. Many people argue that censorship is a necessity to guard against the most extreme types of communication which the vast



majority of people would find unacceptable. Others however feel that censorship can be a dangerous tool, particularly if used to control legitimate questions, arguments and opinions. Throughout history there are numerous examples of governments taking steps to control what their citizens know; perhaps the most extreme modern example is North Korea, where the public only get information from official news sources and are unaware of anything happening in the outside world.

It's easy to see how the Internet can be used for good in this case: a global network that can reach beyond the boundaries of state censorship. Many governments have found it almost impossible to prevent information getting in - or out - of their borders due to this network and the availability of mobile internet technology. China still filters content on a national scale, but easy workarounds exist if you have the knowhow.

The dark side of course is that with no effective censorship, anything goes. You can find information about almost anything on the internet that most would agree to be abhorrent: instructions to build bombs; child pornography; propaganda encouraging violence against other nations or religions; 3D printing plans for gun parts. The list is almost endless.



### **Practical task: Freedom of Speech**

Use the internet to find out the background to a recent issue concerning freedom of speech. Create a short summary in presentation format to present to others in your class. You might want to pick from the following (though there are plenty others!)

- Wikileaks & Julian Assange
  - Paul Chambers & Robin Hood Airport
  - Jyllands-Posten Muhammad cartoons
  - David Miranda
  - Edward Snowden
- .....

### **15.3.2 Privacy and Encryption**

You learned about encryption technology in the Security precautions topic. Whilst much of the focus has been on how encryption enables transactions to be carried out safely online or businesses to secure data, it is important to remember it is also an important tool for individuals to help maintain their privacy.

People have become increasingly concerned about personal privacy with much of our details passing over the internet, concerns about increasingly sophisticated hacking schemes and leaks about data the security services hold about us. Encryption of personal data is seen by many people as an increasingly necessary step to address these concerns.

Some examples of encryption technology being used by individuals include: Ensuring online accounts are always accessed using the HTTPS protocol, which includes encryption; setting up your operating system to encrypt your personal folders; using password manager software to deploy long, complex and unique passwords on websites by encrypting them with one master password on your computer; using encrypted USB Flash Drives.

Encryption is an important step in personal security but has not been without its problems: In 2014 a major flaw was found in the OpenSSL encryption software, used by a large number of web servers. No one really knows whether hackers had found this flaw before the research team who published their findings, or - if so - how long it had been exploited. Some servers were even still found to be running the unpatched software weeks later. This is however a rare occurrence; most security breaches of encrypted data rely on simply not keeping your private key secure enough.

### **15.3.3 Global citizenship**

Globalisation has brought many advantages, not least economic ones as mentioned previously. We now have easy access to a whole host of different cultures, entertainment and writing from all around the world. Previously local companies have become international brands and we have access to up-to-the-minute news from anywhere on earth. Even revolutionary movements (like the 'Arab Spring' of 2011) are attributed in large parts to the ability to communicate rapidly via the internet. The counter-argument

is that more localised cultures are actually under threat due to this increase in globally-available media - often dominated by US and European firms - which exposes people of a new foreign culture at the expense of their own.

Global Citizenship is a term used to encompass the ideals of being able to participate in activities that would previously have been confined by geographical or political boundaries. This may simply involve interacting with people with similar interests around the world, but it is increasingly showing itself through political, cultural and environmental activism on a global scale.

**Practical task: Social impact**

Use the internet to research the social impact that computers and technology have had on society. Make your own notes.



30 min

.....

**Quiz: Social impact**

**Q7:** In your opinion what has been the biggest social impact that computers and technology have had on society?



10 min

.....

**Q8:** Explain what it meant by 'censorship'.

.....

**Q9:** Which of these is a positive example of global citizenship?

- a) Terrorist propaganda videos can be widely circulated.
- b) It is easy for hackers to share information and vulnerabilities.
- c) More attention can be focussed on humanitarian disasters because of online communication.
- d) Local customs and cultures are disappearing.

.....

**15.4 Intelligent systems**

**Learning objective**

By the end of this section you will be able to:

- explain what is meant by the term intelligent system;
- discuss current developments within intelligent systems.

An intelligent system is a machine that has ability to perform tasks that would require intelligence if they were performed by a human.

Examples of intelligence could be displaying one or more of the following attributes:

- Problem solving
- Creativity
- Learning from experience
- Reasoning and the ability to explain
- Vision
- Adapting to new situations
- Memory
- Natural language understanding.

Examples of intelligent systems could include robots that are built to act like humans and to perform human tasks, computer systems that can hold conversations as if they were human (expert systems), and computer systems that can play games and beat human opponents.

Expert systems are an area of intelligent systems that have been very popular. An expert system is a piece of software that attempts to take human knowledge about a subject and represent it using facts, rules and relationships. Answering a series of questions will allow the expert system to work through the rules and relationships to draw a conclusion. Whilst trying to encode facets of human experience and knowledge into a computerised solution can be difficult, the end results can be very accurate.



30 min

### **Practical task: Intelligent systems**

Use the internet to research current developments in intelligent systems. Make your own notes.

.....



5 min

### **Quiz: Intelligent systems**

**Q10:** Explain what is meant by the term intelligent system.

.....

## 15.5 Learning points

### Summary

You should now know:

- The use of computers and technology has increased dramatically over recent years.
- Computers are now more affordable, portable and run faster.
- Computers can be said to have had an economic impact as they have created new jobs and changed the way in which we work.
- The invention of social media has made it easier for friends and family to keep in touch.
- Global citizenship and online communities enable us to take part in activities and campaigns on a world-wide scale.
- Personal privacy can be an issue online. Encryption of personal communications can help with this.
- The internet can be an important tool to enable freedom of speech where this has been curtailed through censorship.
- Lack of censorship can also be abused and expose people to harmful media and ideas.
- The impact of intelligent systems.

## 15.6 End of topic test



10 min

### End of topic test

**Q11:** Why are there are more computing devices available today than twenty years ago?

- a) Devices are cheaper.
  - b) They have more memory.
  - c) They are portable.
  - d) They have faster processors.
- .....

**Q12:** Computers are now available in most homes:

- a) True
  - b) False
- .....

**Q13:** It has been claimed that the use of technology in the workplace has affected the job market:

- a) True
  - b) False
- .....

**Q14:** Which of the following are disadvantages of the social impact of technology?

- a) Individuals could become isolated.
  - b) Social networking has made it easier to keep in contact with friends/family.
  - c) Individuals could become sedentary.
  - d) Easy to text someone, use face time, or have them on speed dial.
- .....

**Q15:** Which of the following are advantages of the social impact of technology?

- a) Restricted media such as religious extremism videos can be accessed easily.
  - b) Freedom of Speech can be exercised online where there are heavy controls by dictatorships.
  - c) It is easy for others to intercept your communications.
  - d) You can communicate easily and cheaply with friends and family abroad.
- .....

**Q16:** What is meant by the term intelligent system?

.....

## **Topic 16**

# **End of Unit 2 Test**

---



## End of unit 2 test

**Q1:** What **two** items are necessary to link two tables together in a database?

- a) Foreign Key
- b) Field
- c) Primary Key
- d) Form

.....

**Q2:** Which of the following are advantages of linking tables in a database? You may choose more than one option.

- a) It can save replication of information.
- b) It looks neater.
- c) Smaller tables are easier to manage.
- d) It is more complicated.

.....

**Q3:** Define metadata.

.....

**Q4:** Which of the following could be found in the metadata? You may choose more than one option.

- a) Primary keys
- b) Data type
- c) Date created
- d) Author

.....

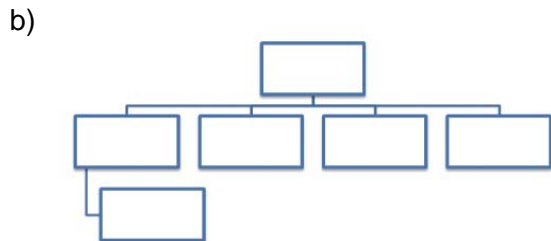
**Q5:** Match the following terms to the correct description below: Table, Query, Form, Report

	It has a graphical user interface that can help novice users enter data into a database, can show one record at a time.
	It is used to enter and edit data in a database, has a basic layout.
	It is used for printing database, can have a graphical format, displays a chosen amount of records.
	It is used to perform a search or a sort on database.



.....

**Q6:** Which image shows a linear structure for an information system?



.....

**Q7:** Name the necessary tags for the structure of a webpage. You may choose more than one option.

- a) <title>
- b) <body>
- c) < head>
- d) <html>

.....

**Q8:** Which section of a web page would you expect to contain metadata?

- a) <nav>
- b) <body>
- c) < head>
- d) <html>

.....

**Q9:** Cascading Style Sheets (CSS) rules consist of a selector and a declaration. The declaration is made up of?

- a) a list of attributes and the associated values
- b) a list of different fonts in order of priority
- c) metadata about the stylesheet

.....

**Q10:** Which method of creating metadata is more accurate?

- a) Manual
- b) Automatic

.....

**Q11:** Match the following terms to the definitions below: Static web page, Dynamic web page

	Web page where information does not change.
	Web page where information changes every time the page is loaded.

.....

**Q12:** Which of the following makes a web page interactive? You may choose more than one option.

- a) Text
- b) Buttons
- c) Videos
- d) Tables

.....

**Q13:** What is the difference between lossy and lossless compression?

- a) Lossy reduces files size and loses information; Lossless reduces file size without removing information.
- b) Lossless reduces files size and loses information; Lossy reduces file size without removing information.

.....

**Q14:** Match the terms to the definitions: Sampling depth, Sampling frequency:

	How many times per second a sound is sampled.
	Number of bits used to store a sound sample.

.....

**Q15:** Define frame rate.

.....

**Q16:** Match the file types to the correct type of media: Graphics, Sound, Text, Video.

	mp3, wav
	avi, mpeg
	bmp, gif, jpeg, png
	txt, rtf

.....

**Q17:** What type of language is used to write macros?

.....

**Q18:** What does HTML stand for?

- a) High Text Markup Language
- b) HyperText Missing Language
- c) HyperText Markup Language
- d) High Tea Markup Language

.....

**Q19:** What is a script?

.....

**Q20:** What does SQL stand for?

- a) Sequel Query Language
- b) Server Query Language
- c) Structured Query Language
- d) Sequenced Query Language

.....

**Q21:** In client-side scripting where are scripts executed?

- a) User's browser
- b) On the Web Server

.....

**Q22:** In server-side scripting where are scripts executed?

- a) User's browser
- b) On the Web Server

.....

**Q23:** Which of the following can be considered as Search Engine Optimisation? You may choose more than one option.

- a) Use back links
- b) Use lots of colour and pictures
- c) Use keywords throughout
- d) Use a crawler

.....

**Q24:** Which techniques will optimise the loading time of a web page? You may choose more than one option.

- a) Reducing the size of html, css and JavaScript files by removing comments, unnecessary code and long variable names
- b) Only using server-side scripting
- c) Compressing media used on the page
- d) Linking to JavaScript files in the <head> section

.....

**Q25:** Who performs beta testing? You may choose more than one option.

- a) The programmer
- b) The project manager
- c) The client
- d) Members of the public

.....

**Q26:** Match the following terms to the definitions below: Efficient, Fit for purpose, Maintainable, Robust

	It does not waste resources disproportionate to its size.
	It can cope with unexpected errors whilst running without failing.
	It solves the task that it was created to solve.
	It is easy to update and correct.

.....

**Q27:** Complete the following sentence.

Raw data has no meaning, \_\_\_\_\_ is data that has been processed and has meaning.

.....

**Q28:** Define target audience.

- a) People watching a show
- b) Who the website is aimed at
- c) Who is designing the website
- d) People who create the web design software

.....

**Q29:** What is the difference between an expert user and a novice user?

- a) A novice has little experience; an expert has some experience.
- b) A novice has lots of experience; an expert has little experience.
- c) A novice has no experience; an expert has lots of experience.

.....

**Q30:** What kind of storage does a digital camera use?

.....

*See further questions on page 277.*

## Glossary

### Alpha testing

testing of software within the development organisation which does not necessarily wait until the product is complete.

### Animation

when images can appear to move.

### Anti-virus

is software used to detect the presence of viruses (and often other malicious software) on a computer system.

### Attributes

a property or characteristic of something.

### Back links

having links within a website that point to the homepage of the website.

### Bandwidth

The rate that data that can be transmitted through a connection, typically measures in bits per second.

### Beta testing

getting members of the public to check a website or program for errors. Website is checked using real world data to try to find as many errors as possible.

### Biometrics

using an individual's unique information to prove their identity.

### Body

second section of a web page that contains all the data that is to be displayed.

### Bot-net

is slang term for the computers that have become infected with malicious software and can then be used to launch a DDoS attack.

### Calculated field

is a field that obtains its value by carrying out calculations or operations on the contents of other fields.

### Cardinality

is the type of relationship between tables in a relational database: 1:1, 1:Many or Many:Many.Many

### Cascading Style Sheet (CSS)

the language used to construct style sheets for websites.

**Client/Server**

The Operating Systems on a network allow you to assign one machine as a 'server' to manage services for the other machines (clients). This may include file storage, user authentication, print queues or web access.

**Client-side**

when an operation is done at the 'client' end of a client/server connection.

**Client-side scripting**

the scripts for a website are executed on the client's computer. This allows the code to be viewed and copied.

**Cloud system**

applications and services that are accessed remotely from a server.

**Colour depth**

the number of colours that have been used to capture an image.

**Compatibility**

whether or not an information system will work on a particular device.

**Compression**

used to reduce the size of files.

**Connectivity**

how computers in a network are connected.

**Cookies**

small text files saved by your browser that can be accessed and read by websites visited. Often used to 'save' personal preferences, but can be used to track users for advertising purposes, which some people dislike.

**Database**

a collection of information stored in a structured format that can be quickly searched or sorted.

**Database-driven website**

a database-driven website is one that collects its content from a connected database.

**Differential backup**

only changes made since the last full backup are saved.

**Digital Certificate**

an electronic document that is used to confirm the identity of an individual or organisation.

**Digital signature**

an electronic signature that is used to authenticate the identity of the sender.

**Disk mirroring**

a constant backup is made every time any changes are made.

**Distributed denial of service attack (DDOS)**

is when a group of computers infected with malicious software bombards a website to force it offline.

**Domain**

the permitted values of an attribute, for example a type of data (text, numeric, boolean) and/or a range of numbers, dates, times.

**Domain name**

A text-based address that is registered with a Domain Name Server (DNS) and ties your web server to your IP address. E.g. 'Scholar.hw.ac.uk'. All URLs include the domain name along with the file path of the resource you wish to retrieve.

**DOS**

Denial of Service attack. When a user or malicious software bombards a web server in order to make it unavailable to genuine users.

**Dynamic web page**

a web page that's contents are subject to change every time it is loaded.

**Encryption**

applying a code to data before it is transmitted electronically. It prevents information from being understood if it is intercepted.

**Entity**

Something that exists as a particular and discrete form.

**Entity set**

a collection of entities of similar form represented in a database as a table.

**Field**

one piece of information in a record.

**Firewall**

is software that monitors network traffic, blocking activity as described by the firewall settings.

**Foreign Key**

the primary key of a separate table that is included in a table.

**Form**

a graphical user interface in a database. Can only display one record at a time.

**Frame rate**

how many still images are played per second to give the impression that they are moving.

**Full backup**

all data is backed up, regardless of when it was last backed up.

**Head**

the top section of a web page that contains the metadata and title tag.

**Hierarchical**

pages can be accessed in a random order.

**Identity theft**

is when your personal details are obtained by others for the purposes of committing fraud.

**Incremental backup**

only the changes made since any form of backup are saved.

**Instances**

an occurrence or example of an entity.

**Interactive web page**

a page that encourages the user to interact with it.

**Interface**

compensates for the differences between computer systems and peripheral devices.

**ISP**

Internet Service Provider. A company providing access to the internet to an individual or business, usually through a phone line or wireless signal (mobile network, satellite).

**Key**

in a database a key is one or more attributes that is selected to identify a record and used when searching and sorting.

**Keylogging**

using hardware or software to record every keystroke made by the user.

**Keyword**

what the user types into a search engine.

**Keyword stuffing**

including a lot of keywords in the meta tags so that the website ranks higher in search engines.

**Linear**

pages are accessed one after another, in order.

**Lossless**

a type of compression that reduces the size of a file but does not remove any information.



**Lossy**

type of compression that reduces the size of a file by removing part of the information.

**Macro**

used to automate a repetitive or complicated process, or to add functionality to a program.

**Metadata**

information about the web page. Who created in, creation date, meta tags, content information.

**Multi-user access**

when data is stored in a manner that allows many users to access it simultaneously. Examples may include distributed databases and some Cloud-based files.

**Networking**

two or more computers connected together.

**Peer-to-peer**

An alternative to Client/Server organisation. Each individual machine is responsible for managing its own services and access across a network. User accounts, shared storage and web access would have to be individually configured on each machine.

**Peer to peer network**

all computers have equal status, user must use the same computer every time to be able to access data.

**Phishing**

is the name given to fraudulently extracting credit card and other financial details from individuals using emails and fake company websites

**Pixelated**

when the quality of an image is reduced so that individual pixels can be seen.

**Platform**

a term used to describe the hardware and Operating System combination that makes up a working computer system.

**Primary Key**

is a key that uniquely identifies each record in a table and is used to access that record.

**Public key (encryption)**

a form of encryption that uses a pair of keys: a public key to encrypt information and a private key to decrypt information. The private key does not need to be known by the person using the public key, and so is very secure.

**Public key infrastructure**

a trusted service that ties identity information to published public keys, showing that a public key comes from the stated company/individual.

**Query**

performing a complex search or sort on a database.

**Record**

a collection of all the information about one object in a database.

**Relational Database**

a database that contains more than one linked table.

**Report**

used to print out databases in a format that is easier to read.

**Reverse engineered**

trying to recreate a program by looking at the finished product and working out how it was programmed.

**Sampling depth**

the number of bits used to store each sample of sound.

**Sampling frequency**

the number of times per second that a sample of sound is taken and stored.

**Scripting language**

can be used to write macros or to add extra functionality to a web page.

**Search Engine Optimisation (SEO)**

manipulating a search engine to rank your website higher so that it has a better chance of being visited.

**Selector**

the name for the CSS rule that determines what the rule will be applied to in the HTML document.

**Server**

a computer used to provide requests to clients.

**Server-side**

when an operation is done at the 'server' end of a client/server connection.

**Server-side scripting**

the code for a website is executed on the server. This does not allow the code to be viewed or copied.

**Source code**

the code that was used to write a program.

**Spyware**

a general term for any piece of software that tracks what you are doing on the computer. Can be used for advertising purposes, gathering data or watching for specific actions or events.

**SQL**

Structured Query Language, used to edit queries in a database.

**Standard file formats**

a way to save files so that they can be displayed correctly on other platforms.

**Static web page**

a web page that does not change every time it is loaded.

**Streaming**

where files are transmitted over the internet and viewed on a computer as they arrive. Large files do not need to be completely downloaded before they can be viewed.

**Style sheet**

a separate file that contains all the formatting information for a web page.

**Symmetric key (encryption)**

a form of encryption (scrambling of data) that uses the same key (scrambling rule) to encrypt and decrypt the data.

**Systems Analyst**

a member of a software development team who specialises in modelling existing systems or finding out about new ones through investigation and helps to develop a possible software-based solution to a problem.

**Tables**

in a relational database, a table organises the information about a single topic into rows and columns.

**Target Audience**

who the intended users of the information system are.

**Title**

the name of the web page and what will appear in the web page title bar.

**Transparency**

part of an image can be made transparent so that objects placed behind can still be viewed.

**Trojan**

A trojan (named after the trojan horse from Greek mythology) is a piece of software which when installed on a user's machine allows someone else to access data on that machine or to take control of it. Trojan software is similar to remote control software in that it opens a port on the internet to allow sending and receiving of control data.

**True colour**

when 24bits is used to store the colours in an image. This is the best quality that humans can recognise.

**URL**

Uniform Resource Locator. The unique address of a web page or other piece of media.

**Usability**

a subjective assessment of how the user finds their experience of using the information system.

**User Interface**

what the user sees and interacts with.

**Validation**

checking that the information that has been entered to a website.

**Virtual machine**

an emulation of a complete computer system running within an operating system which can be used to run alternative operating systems, or several copies of a single operating system.

**Virus**

is a piece of malicious code which has been inserted into a host program in order to cause damage to or gain control over a computer system. Viruses usually have the ability to replicate themselves over a network and some can change their characteristics in order to avoid detection.

**Web hosting**

providing space on a server for web pages so that they can be accessed over the Internet.

**Website optimisation**

techniques involving changing the code, structure and media items to improve the loading performance of your web page(s).

**Worm**

is a malicious program which replicates itself over a network in order to cause damage or to gain control over computer systems. Unlike a virus, a worm does not require a host program in order to function.

## Further questions

**Topic 1: Structures and links (Databases)**

**Topic 2: Structures and links (Web-based)**

**Topic 3: Media types**

**Topic 4: Coding**

**Topic 5: Testing**

**Topic 6: Purpose, features and functionality**

**Topic 7: Technical implementations (Hardware)**

**Topic 8: Technical implementations (Software)**

**Topic 9: Technical implementations (Storage)**

**Topic 10: Technical implementations (Networking/connectivity)**

**Topic 11: Security risks**

**Topic 12: Security precautions**

**Topic 13: Legal implications**

**Topic 14: Environmental implications**

**Topic 15: Economics and social impact**

**Topic 16: End of Unit 2 Test**

**End of unit 2 test (page 264)**

**Q31:** Explain why touchscreen technology can be considered to have improved user friendliness.

.....

**Q32:** Apart from touchscreens, give two examples of input devices you would expect to find built into a smartphone.

.....

**Q33:** How can printers be compared?

.....

**Q34:** Which of the following statements apply to RAM? You may choose more than one option.

- a) Volatile
- b) Non volatile
- c) Stores programs when the computer is turned off
- d) Stores programs whilst they are being used

.....

**Q35:** Can you edit proprietary software?

- a) True
- b) False

.....

**Q36:** Fill in the blanks from the word bank below.

An internal hard drive is not \_\_\_\_\_, but a USB flash drive is. CD-ROMs are not \_\_\_\_\_ but a CD-RW is.

The capacity of backing storage devices varies greatly, a CD is 700 MB, a hard drive could be measured in \_\_\_\_\_.

A \_\_\_\_\_ is a magnetic device, CDs and DVDs are \_\_\_\_\_. USB flash drives are \_\_\_\_\_ devices, as are \_\_\_\_\_.

**Word bank:** hard drive, memory cards, optical, portable, rewritable, solid state storage, terabytes

.....

**Q37:** Is offline storage part of a network?

- a) Yes
- b) No

.....

**Q38:** Is storing data offline cheaper than storing data online?

- a) Yes
- b) No

.....

**Q39:** Why is a backup necessary?

.....

**Q40:** Match the following terms to the correct definitions below: Differential, Disk mirroring, Full back up, Incremental

	Fastest backup, changes since any type of backup are stored.
	A constant backup is made.
	Only data that has changed since last backup is saved.
	Simplest type of backup, all data is backed up.

.....

**Q41:** Put these backing storage devices in order in terms of capacity, smallest first: CD, DVD, Hard Drive, USB Flash Drive

.....

**Q42:** Name the five functions of an interface.

.....

**Q43:** Define a portable backing storage device.

.....

**Q44:** Which of the following are advantages of solid state storage devices? You may choose more than one option.

- a) They use less power
- b) They are robust
- c) They are not portable
- d) They are easy to use

.....

**Q45:** What is a network?

.....

**Q46:** Which of the following are advantages of cloud computing? You may choose more than one option.

- a) Files can be accessed from any computer via internet
- b) They are hard to use
- c) Files are backed up
- d) It is easy to add capacity

.....

**Q47:** What is the purpose of web hosting?

.....

**Q48:** Match the following terms to the correct definition below: Keylogging, Phishing, Spyware

	It can be hardware or software based, logs the keys that are pressed on a keyboard.
	Software that installs itself and gathers private information from the user.
	An attempt to acquire information such as passwords or bank details from a user.

.....

**Q49:** Define a DDOS attack.

.....

**Q50:** What can you do to protect yourself from a DOS (Denial of Service) attack? You may choose more than one option.

- a) Use a firewall
- b) Make your email address available
- c) Use anti-virus software
- d) Limit who gets access to your email address

.....

**Q51:** What is the purpose of encryption?

- a) To prevent your computer from becoming infected with a virus
- b) To monitor data that passes in and out of a network
- c) To avoid someone being able to intercept and read your data
- d) To confirm the identity of a person or organisation

.....

**Q52:** Which of the following are advantages of digital signatures? You may choose more than one option.

- a) They save time and energy.
- b) They are very hard to forge.
- c) They give neater handwriting.
- d) They can be time stamped.

.....

**Q53:** Which of the following are advantages of server-side validation? You may choose more than one option.

- a) It costs less.
- b) The code is available to copy.
- c) The code is hidden.
- d) It has more security.

.....

**Q54:** Fill in the blanks using the following terms: data controller, data subject, data user

A \_\_\_\_\_ is the person who has information stored about them.

A \_\_\_\_\_ is the person who uses the information stored on a computer.

A \_\_\_\_\_ is the person responsible for all the data stored in a company or organisation.

.....

**Q55:** Which law makes spreading a virus illegal?

- a) Computer Misuse Act
- b) Copyright, Designs and Patents Act (Plagiarism)
- c) Communication Act
- d) Regulation of Investigatory Powers Act



.....

**Q56:** Which law protects programmers that have created computer games?

- a) Computer Misuse Act
- b) Copyright, Designs and Patents Act (Plagiarism)
- c) Communication Act
- d) Regulation of Investigatory Powers Act

.....

**Q57:** Which law makes using someone else's Wi-Fi illegal?

- a) Computer Misuse Act
- b) Copyright, Designs and Patents Act (Plagiarism)
- c) Communication Act
- d) Regulation of Investigatory Powers Act

.....

**Q58:** Which law gives the government the right to intercept someone's emails?

- a) Computer Misuse Act
- b) Copyright, Designs and Patents Act (Plagiarism)
- c) Communication Act
- d) Regulation of Investigatory Powers Act

.....

**Q59:** Which of the following are ways to reduce your carbon footprint? You may choose more than one option.

- a) Leave computers on standby
- b) Replace old equipment with modern, more energy efficient devices
- c) Recycle redundant devices appropriately
- d) Print all of your emails

.....

**Q60:** What is an intelligent system?

.....

## Hints for activities

**Topic 12: Security precautions**

**Activity: Crack the code!**

**Hint 1:** there are only 2 words in English with one letter!

## Answers to questions and activities

### 1 Structures and links (Databases)

#### Activity: Database table keywords (page 3)

Q1:

Keyword	Definition
Data Type	If a field is to be an integer, Boolean, image etc.
Field	A single piece of information
Table	All the records together
Record	All the data about one object or person

#### Quiz: Databases (page 5)

**Q2:** A flat database will only contain one table whereas a relational database will contain more than one.

#### Quiz: Primary keys (page 6)

**Q3:** A primary key is a field that holds a piece of data that is unique for every record.

**Q4:** A compound key uses two fields to create a unique field that can be used as a primary key.

#### Quiz: Relationships (page 15)

**Q5:** A primary key is necessary to identify the unique field in each table and the foreign key is a field that appears in both tables, and is the primary key of one table. This allows a relationship to be created between the tables.

**Q6:** It avoids the replication of information and allows the creation of smaller tables, which are easier to manage.

**Q7:** If there is information to be stored that will not be accessed regularly. It would allow two smaller tables to be created so that they could be accessed faster.


**Q8:** A foreign and a primary key.

**Q9:** A one-to-one relationship is where each row is directly related to another row in a different table. In a one-to-many relationship a row can be related to several other rows in a separate table.

**Q10:** A many-to-many relationship is to allow rows to be related to one or more other rows.

**Activity: Attributes and Data Types (page 17)**

Q11:

Attribute	Example	Data type
Surname	Toner	Text
First name	Geraldo	Text
Postcode	TD7 0EG	Text
SQA candidate number	2311447853	Integer
Enrollment fee paid	£27.50	Real
Passport photo		Object
All documents received	Y	Boolean
Enrolment date	23/03/14	Date
Course begins at	19:30	Time

**Activity: Entities (page 18)**

Q12:

<b>BOWMORE SPORTS COMPLEX</b>						
Invoice						
<b>Date:</b> 27 July 2005						
<b>Client:</b> Eastdyke Youth Club				<b>Client No:</b> 16523		
<b>Contact Name:</b> Alasdair Donnelly						
<b>Contact Telephone Number:</b> 0141 912 9562						
<i>Bookings for September 2005</i>						
Date	Time	Facility Code	Facility	Duration (hours)	Charge per 30 mins	Sub-Total
1/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
3/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
7/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
10/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
14/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
15/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
17/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
21/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
24/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
28/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
29/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
<b>Total Due:</b>						£138.00

Q13:

<b>BOWMORE SPORTS COMPLEX</b>						
<b>Invoice</b>						
<b>Date:</b> 27 July 2005						
<b>Client:</b> Eastdyke Youth Club				<b>Client No:</b> 16523		
<b>Contact Name:</b> Alasdair Donnelly						
<b>Contact Telephone Number:</b> 0141 912 9562						
<i>Bookings for September 2005</i>						
Date	Time	Facility Code	Facility	Duration (hours)	Charge per 30 mins	Sub-Total
1/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
3/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
7/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
10/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
14/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
15/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
17/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
21/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
24/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
28/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
29/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
<b>Total Due:</b>						£138.00

Q14:

<b>BOWMORE SPORTS COMPLEX</b>						
<b>Invoice</b>						
<b>Date:</b> 27 July 2005						
<b>Client:</b> Eastdyke Youth Club				<b>Client No:</b> 16523		
<b>Contact Name:</b> Alasdair Donnelly						
<b>Contact Telephone Number:</b> 0141 912 9562						
<i>Bookings for September 2005</i>						
Date	Time	Facility Code	Facility	Duration (hours)	Charge per 30 mins	Sub-Total
1/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
3/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
7/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
10/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
14/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
15/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
17/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
21/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
24/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
28/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
29/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
<b>Total Due:</b>						£138.00

Q15:

<b>BOWMORE SPORTS COMPLEX</b>						
<b>Invoice</b>						
<b>Date:</b> 27 July 2005						
<b>Client:</b> Eastdyke Youth Club				<b>Client No:</b> 16523		
<b>Contact Name:</b> Alasdair Donnelly						
<b>Contact Telephone Number:</b> 0141 912 9562						
<i>Bookings for September 2005</i>						
Date	Time	Facility Code	Facility	Duration (hours)	Charge per 30 mins	Sub-Total
1/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
3/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
7/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
10/9/2005	9:00	SH1	Sports Hall	2	£3.00	£12.00
14/9/2005	18:30	AT1	Astroturf	1	£2.25	£4.50
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24/9/2005	9:00	SH2	Sports Hall	2	£3.00	£12.00
28/9/2005	18:30	AT2	Astroturf	1	£2.25	£4.50
29/9/2005	20:00	SW	Swimming Pool	1.5	£8.00	£24.00
<b>Total Due:</b>						<b>£138.00</b>

Activity: Entity relationships (page 21)

Q16:

Entity 1	Entity 2	Relationship
School	Head Teacher	1-to-1
Teacher	Course	1-to-many
Classroom	Desk	1-to-many
School	Swimming pool	1-to-1
Pupil	Exam	many-to-many

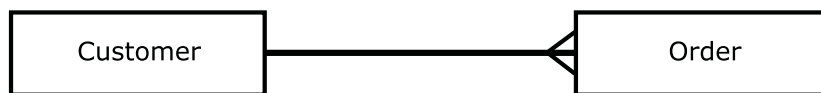
Activity: ERD Exercise (page 21)

Expected answer

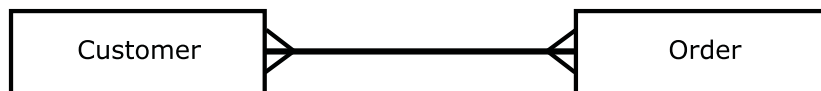
One-to-one (1:1) relationship. **This is incorrect.** This means that the system can only cope with one customer placing a single order.



One-to-many (1:M) relationship. **This is incorrect.** This means that the system can only cope with one customer placing multiple orders.



Many-to-many (M:M) relationship. **This is correct.** This means that the system can cope with multiple customers placing multiple orders.



### Quiz: Databases (page 33)

**Q17:** A table is used for entering and editing data, all the records can be viewed at one time. A form can be used as a front end, to allow records to be added, or searches performed. A form can have many buttons with queries attached to them. Only one record at a time can be viewed on a form. A report is often used for printing and it can incorporate graphics. All the records can be included in a report.

**Q18:** Tables are used for entering or editing data. Forms are used as a front end. Reports are used to print out the database in a format that is easier to read.

**Q19:** A calculated field is a field in a database that is calculated based on the values of other field in the database.

**Q20:** Pupil's own answer.

**End of topic test (page 36)**

**Q21:** c) The unique field within a record.

**Q22:** b) A field that is the primary key of another table.

**Q23:** c) One-to-several

**Q24:** b) A form can be used as a front end.

**Q25:** b) Data duplication is eliminated, reducing the chance of errors.



## 2 Structures and links (Web-based)

### Quiz: Introduction (page 39)

**Q1:** A website is a collection of web pages grouped together. A web page is one page on its own.

**Q2:** A homepage is the first page in a website. It usually has a description of the website and links to all the other pages in the website.

### Quiz: Site structure (page 42)

**Q3:** In a linear structure all the pages must be accessed in the order that they are positioned in, one after another. In a hierarchical structure the pages can be accessed in a random order.

**Q4:** A multi-level structure means that there are several levels in a hierarchical structure which can be navigated between. Often, tools such as searching and backtracking will be required to help manage navigation between pages.

**Q5:** Breadcrumbs are useful as they allow the user to see where the page they are on sits within a multi-level structure, and navigate to a parent page or category easily (even if they haven't visited it previously).

### Quiz: Basic Page structure (page 45)

**Q6:** Metadata, which describes a document and its contents.

**Q7:** It is a compulsory tag within the head section and it contains a title that will appear on the top right (tab) of web pages.

**Q8:** Everything that is to appear on the web page.

### Activity: Web page structure (page 46)

#### Q9:

The **Head** is the first section of an HTML page. It contains the **Title** tag, which is a compulsory tag.

This section can also contain **Metadata**.

The **Body** section contains all the information that is to be displayed on the **Web page**.

### Quiz: Style sheets and CSS (page 54)

**Q10:** CSS allows precise control over the look and layout of the document. CSS can format multiple pages identically from 1 file. Multiple CSS rules and even style sheets can be attached to HTML files for different media (screen, print, mobile, etc).

**Q11:** A selector is the identifier that defines what the part(s) of the HTML page the rule will be applied to.

**Quiz: Metadata (page 58)**

**Q12:** Metadata is data that describes data. On a web page it is used to describe the contents of the web page, state the author and date of creation, link to style sheet, software used etc.

**Q13:** Meta tags are keywords that are picked up by search engines. To have your web page picked up by a search engine and returned in the list of websites then it must have keywords in the meta tags.

**Q14:** In the head section.

**Q15:** When companies add words to the meta tags that are not really relevant to the website but are popular in searches. It is an attempt to get their website top of the list in a search engines returns.

**Q16:** Manually created is much more accurate as it will reflect the true content of the website.

**Q17:** To get their website returned in searches more often so that people will look at their website.

**Quiz: Dynamic web pages and database-driven websites (page 59)**

**Q18:** A dynamic web page has data that can change every time the page is loaded. A static page will remain the same unless the original file is edited.

**Q19:** Airlines for booking seats - to avoid double booking. Bank account information as it will change daily.

**Q20:** Instead of manually altering the web page every time that data changes it is automatically pulled from a database.

**Quiz: Interactive web pages (page 60)**

**Q21:** Where the user has to become involved in the website, clicking on buttons, playing quizzes etc.

**End of topic test (page 62)**

**Q22:** c) A selector followed by attributes with values.

**Q23:** b) The date created. c) Information for search engines. d) The author.

**Q24:** a) True

**Q25:** a) True

**Q26:** b) Hierarchical

**Q27:** a) True

### 3 Media types

#### Practical task: Standard file formats (page 67)

Q1:

Media Types	File type
Sound	Mp3, wav
Video	Avi, mpeg
Graphics	Bmp, gif, jpeg, png
Text	Txt, rtf

#### Quiz: Compression (page 68)

**Q2:** Where the size of a file is reduced by using ways to reduce the amount of information that needs to be stored.

**Q3:** They have large file sizes, may take up too much space on backing storage devices, may take to long to transmit or download.

**Q4:** File quality may be compromised and decompression requires more processing power than handling uncompressed media.

#### Quiz: Lossy vs Lossless (page 71)

**Q5:** Lossy compression reduces file size but also loses information so quality may be affected. Lossless compression reduces file size without removing any information so quality should not be affected.

**Q6:** Smaller file sizes, take up less space on backing storage, quicker to display on websites, faster to transmit or download.

**Q7:** No information is lost so quality is not affected.

#### Quiz: Sound (page 73)

**Q8:** Crop - cut off part of the sound. Reduce the sampling depth or sampling frequency. Apply compression.

**Q9:** A wav has not been compressed but an mp3 has.

#### Quiz: Graphics (page 75)

**Q10:** Gifs can support animation and transparency where a jpeg cannot.

**Q11:** The resolution has been adjusted and now the pixels are showing, giving a very poor quality image.

**Q12:** 24bit colour, the most colours that humans can recognise.

**Q13:** Repeating patterns of colour are identified. One pixel is stored and then it stores how many adjacent pixels are of the same colour.

**Q14:** Parts of the image that humans will not notice are removed.

**Quiz: Video (page 77)**

**Q15:** You can trim the length of the video, reduce the frame rate, reduce the resolution or apply compression.

**Q16:** Key frames are identified and stored as jpegs. Then the changes between the frames are stored.

**End of topic test (page 79)**

**Q17:**

- a) JPEG supports true colour.
- c) JPEG is a popular format for photographic images.
- d) The amount of compression in a JPEG can be varied.

**Q18:** a) Size of the file is reduced and information is lost.

**Q19:** c) Size of the file is reduced and no information is lost.

**Q20:** a) Frame rate. c) Resolution. d) Length of the video.

**Q21:** a) True

**Q22:** b) They have large file sizes. d) They may take up too much space on backing storage devices.

**Q23:** c) 24 bit colour

## 4 Coding

### Quiz: Introduction (page 83)

**Q1:** They are used to add extra features or to make a web page more interactive.

**Q2:** Used to automate a repetitive or complicated process, or to add functionality to a program.

### Quiz: Scripting (page 85)

**Q3:** A language that is used to create web pages.

**Q4:** HyperText Markup Language

**Q5:** A script is extra code that is added to a web page to improve the interactivity.

**Q6:** Scripting languages can add interactive elements such as menus, change page contents, validate form data, and (if server-based) access and query databases.

### Quiz: Client-side scripting (page 86)

**Q7:** On the clients computer.

**Q8:** Running quizzes, displaying videos, date and time.

**Q9:** If the user's computer is slow then they may run slowly. They may not run at all if the browser does not understand the scripting language.

### Quiz: Server-side scripting (page 93)

**Q10:** On the server.

**Q11:** Server-side scripting is more secure as the code is not available for the user to view.

**Q12:** For logging into websites or displaying personal preferences on a website.

### Quiz: SQL (page 99)

**Q13:** Structured Query Language

**Q14:** b) `INSERT INTO cars VALUES ('ford','fiesta','1.4l',23345)`

**Q15:** a) `SELECT player_name, score FROM tournament ORDER BY score;`

### Quiz: Optimisation (page 105)

**Q16:** Trying to ensure that a website is returned by a search engine when a search is made.

**Q17:** In an attempt to have their website ranked higher.

**Q18:** Adding many popular keywords to the meta tags in a website to try to manipulate the search engines results.

**Q19:** They can improve the rating of a website in a search engine as the number of links towards a page is counted.

**Q20:**

- Compressing media files used in the page linking to external scripts at the end of a file.
- Minimising code used in the page. specifying different resolution image files in the CSS file.
- Combining external files (eg JavaScript or CSS) so that only one of each type of file is requested from the server.

**End of topic test (page 107)**

**Q21:** c) HyperText Markup Language

**Q22:** b) Processing for the website is all performed on the server.

**Q23:** c) Structured Query Language

**Q24:** a) On the clients computer.

**Q25:** b) On the server.

**Q26:**

- a) Compressing the background image
- b) Combining two .js files linked to the page
- d) Linking external scripts at the end of the HTML page

## 5 Testing

### Quiz: Beta testing (page 111)

**Q1:** Beta testing is when members of the public, who have no connection to a project, are asked to test the website. This is different to alpha testing as they can use real world data in an effort to find more errors.

**Q2:** Beta testing is performed by any user, members of the public, people who are not connected to the project.

**Q3:** Testers are not biased, more errors may be found as real world data is being used. Errors that can only be found when running a project may be discovered.

**Q4:** It may put people off buying, or using, a product.

### Quiz: Usability (page 115)

**Q5:**

- **Layout** - is it consistent Navigation - can users find their way around the site and do navigation options work as expected?
- **Target Audience** - does it meet with their expectations and abilities.
- **Finding information** - how long does it take to locate information. Is the route obvious?

**Q6:**

- Use bright, appealing colours.
- Use a very simple user interface with large navigation buttons.
- Avoid clutter - use white space.
- Give animated feedback, eg a pulse effect on the button to press next.

**Q7:** Candidate's own experience: Examples may include recent move to tile-based UI in Windows, increasing use of touch interfaces, re-design of a popular website.

### Quiz: Compatibility (page 116)

**Q8:** If it uses too much space in memory then it may not be able to run on the user's device, and may take too long to load if they have limited bandwidth.

**Q9:** Test your website on all different devices and if necessary create different versions for all types of computer.

**Q10:** They make it simple to maintain consistency. They can be used to quickly adjust elements across the product. Alternative style sheets can be used for accessibility reasons or different media types.



**End of topic test (page 118)**

**Q11:** b) Ease of Navigation, Screen Layout, Target Audience, Ease of locating information.

**Q12:** A) Designing separate mobile and desktop versions. B) Using Responsive Web Design methods.

**Q13:** c) Screen Size, RAM, Processor Speed, browser.

**Q14:** a) True

**Q15:** c) Errors that can only be found when running a project may be discovered.

## 6 Purpose, features and functionality

### Activity: Data or Information? (page 121)

Q1:

	Data	Information
<b>Definition</b>	raw facts and figures	processed facts and figures, put in a context
<b>How it can be used</b>	can be coded, structured and stored in a computer system	can be interpreted and understood by a human
<b>Date example</b>	250209	the date 25th Feb 2009
<b>Password example</b>	Xg34Rtz	the password I use to log in to my emails
<b>Graphic example</b>	001011101101011010100111 11001010001100010100100	a bit-mapped image stored on a memory card in my camera

### Quiz: Introduction (page 122)

**Q2:** Data is unprocessed and has no meaning, information has been processed and has meaning.

**Q3:** They have a large amount of information to be stored that they require to be able to search and sort, or to have multi-user access.

**Q4:** An information system is a way of storing and processing information on a computer.

### Quiz: Description of purpose (page 123)

**Q5:** To let the users know what the purpose of the information system is.

**Q6:**

- What information is to be stored
- Why the information is to be stored
- How the information is to be stored
- How the information will be used
- Who will be using the information system.

### Quiz: Interaction of information systems with human users (page 124)

**Q7:** The website is properly pitched at the right level, and is fit for purpose.

**Q8:**

- If the database is too complicated then novice users will not be able to use it.
- If it is too simplistic for expert users then they may not be able to use it for the tasks that they require.

**Quiz: Interaction of information systems with software (page 127)**

**Q9:** They need to be able to interact with other software in order to display properly or be returned by a search engine.

**Q10:**

- A database driven website.
- The database needs to interact with the website in order for the information to be taken from the website and displayed properly.

**End of topic test (page 128)**

**Q11:** c) Unprocessed and has no meaning

**Q12:** a) Processed and has meaning

**Q13:** b) People who the website is aimed at

**Q14:** d) Date it was created

**Q15:** a) 410490 and d) 01121967

## 7 Technical implementations (Hardware)

### Quiz: Introduction (page 131)

**Q1:** b) USB Flash Drive, and d) Motherboard.

**Q2:** A device that forms part of the computer but is not central to its operation like the processor and main memory. A peripheral requires an interface to communicate with the CPU.

### Quiz: Input devices (page 134)

**Q3:** Touchscreens can save on space as they are an input and an output device in one, they are good for novice users and they are robust as they have no moving parts.

**Q4:** Scanning involves scanning a paper document and the digital file is then saved as a graphic. The picture could be edited but text cannot be edited. When OCR is used pattern matching is used to decipher the text and it is saved as a text document, which can then be edited.

**Q5:** Mark sense readers are used to scan in sections that have been completed using a different coloured pen. The information can be sent straight into a database. They can be used for lottery tickets or to grade multiple choice exams.

**Q6:** Barcodes are linked to a database so that they can be used to keep track of stock levels and to get pricing information for products.

### Quiz: Output devices (page 138)

**Q7:** TFT screens are less bulky, which is necessary for portable devices. They consume less power and give a sharper image.

**Q8:** They would almost certainly buy a laser printer. Laser printers give very fast print speeds which will help avoid queues at a shared printer. They give high quality output for a professional look, and have very low running costs when used for high volume printing. They may also have additional features the office may find useful such as multiple paper sources and duplex operation.

### Quiz: Processors (page 140)

**Q9:** Dual core processors have the parts of the processor duplicated on the chip, making two processors available compared to one on a single core. Quad core processors have 4 processors on the chip.

**Q10:** The speed of a processor is the number of clock cycles that can be processed in a second and is measured in megahertz, or gigahertz.

**Quiz: Memory (page 141)**

**Q11:** Main memory is used to store programs and data while they are being used.

**Q12:** Data in RAM is lost when the computer is turned off, data in ROM is not. Data in RAM can be edited whilst data in ROM cannot.

**Q13:** Cache memory is memory that is on or next to the processor. It is fast access due to the physical location. Cache memory uses faster memory as well as being closer.

**Q14:** Cache memory can improve computer performance as it stores recently used information, which is quicker to access in the cache than from the main memory. This can speed up the fetch-execute cycle.

**End of topic test (page 145)**

**Q15:** b) The clock speed. c) The number of cores. d) Whether it is a mobile or desktop processor.

**Q16:** a) RAM is volatile. d) RAM is editable.

**Q17:** b) ROM is random access. c) ROM is permanent.

**Q18:** a) Cache is very large. d) Cache is expensive.

## 8 Technical implementations (Software)

### Quiz: Introduction (page 148)

**Q1:** Software provides the instructions and data needed to get the hardware components to do anything useful.

### Quiz: Operating systems (page 152)

**Q2:** The computer may have a menu driven, graphical or a command-driven interface and this is how the user can give commands.

**Q3:** This is the part of the operating system that is responsible for managing the backing storage devices. When a file is to be saved the file management system will create an entry on the disk to store details of where the file is stored. This would include information such as the date it was saved and address. The file management system organises files into a hierarchical filing system, which allows the creation of folders and sub-folders. This is helpful to users as it allows related files to be kept together. As different files would have different path names it allows for two files to have the same name, if the paths are different. The file management system will ensure that no files are overwritten.

**Q4:** The memory management system controls where programs and data are placed in the computers main memory. The memory management system keeps track of how much space is in main memory and what programs and data are currently in main memory. If the user attempts to open up a program and there is not enough free space in the main memory then an error message would be displayed. Most modern computers allow for more than one program to be in main memory at the same time and the memory management system ensures that they do not interfere with the running of other programs.

**Q5:** The I/O system communicates directly between the peripherals and the processor. The I/O system handles the transfer of data between the peripherals and the processor. It will check to see that devices are ready for data transfer and check that errors have not occurred during data transmission.

**Q6:** If an error occurs during execution then the operating system will display a message to the user.

**Q7:** It is responsible for ensuring that a process has adequate resources to allow it to complete. Resource allocation ensures that all processes are allocated a share of the processors time and resources so that they are all able to function.

**Q8:**

- Advantages: easy for novices to use as they don't need to know commands. Actions can be guessed by the graphical representation on screen.
- Disadvantages: Requires more powerful graphics hardware to display the interface. Expert users may become frustrated having to navigate through several layers of graphical commands to complete a task that would only require 1 typed command.

**Quiz: Licencing (page 154)**

**Q9:** A licence gives permission for a user to run and use a piece of software.

**Q10:** A single user licence is a licence for the software to be on one computer. A site licence allows all the computers within an organisation to have the software installed.

**Q11:** Freeware is free to install but should not be changed, it is often proprietary. Shareware is free to download but after a trial period the user will need to pay to continue to use the software, or pay to get the full functionality.

**Q12:** Shareware is a good way of getting users to try a new program, which they may then pay to use.

**Quiz: Proprietary versus Open Source (page 156)**

**Q13:** Proprietary software does not come with source code and should not be edited, modified or redistributed. Open source code is software that can be edited and redistributed.

**Quiz: Portability (page 157)**

**Q14:** Portability is whether a piece of software can run on a variety of platforms and devices.

**End of topic test (page 160)**

**Q15:** a) It is free. b) Source code is available.

**Q16:** a) File management. d) Error reporting.

**Q17:** c) You will be able to take advantage of the software company's customer service department for troubleshooting and setup purposes.

**Q18:** b) A menu-driven interface.

**Q19:** a) True

## 9 Technical implementations (Storage)

### Practical task: Storage (page 163)

**Q1:** A hard drive is not **portable**. USB flash drive is a portable device. CD-ROMs are not **rewritable** but a CD-RW is. The capacity of backing storage devices varies greatly, a CD is 700 MB, a hard drive could be measured in **terabytes**. A **hard drive** is a magnetic device, CDs and DVDs are **optical**. USB flash drives are **solid state storage devices**, as are **memory cards**.

### Quiz: Introduction (page 163)

**Q2:** The purpose of backing storage is to store programs and data when the computer is turned off.

### Quiz: Distributed and off-line storage (page 165)

**Q3:** Distributed storage is where more than one computer is used to store data - the data is distributed amongst computers. Off-line storage is where data is removed from a network so that it cannot be accessed and can be stored separately from the network.

**Q4:** The advantages of a distributed system are that it gives more storage space and more processing power than just using one computer.

**Q5:** Off-line storage is very secure as it cannot then be accessed digitally as it is not connected to any network.

### Quiz: Backup systems and strategy (page 167)

**Q6:** A backup is a second copy of data that is stored in case the first copy is lost or damaged.

**Q7:** Backups are very important to businesses and organisations as they cannot afford to lose any data as that might cost them customers and thus money.

**Q8:** Backups can be stored separately from a network in hard drives or tapes, or could be stored online using cloud computing.

**Q9:** Backups can be made as often as they are required. Once an hour, once a day or once a week. It is up to the user.

### Q10:

- A full backup is when all the data on a system is copied regardless of whether or not it has changed since it was last backed up. This is the simplest type of backup but it takes a long time.
- Differential backup is where only data that has changed since the last full backup is stored. This saves space and time.
- Incremental backup is where only changes made since the last backup of any kind



are stored. This is the fastest type of backup but will take the longest time to restore data.

**Q11:** Disk mirroring is when a constant backup of a network is made. Every time data on the network changes, or is added, a second copy is made. The second copy 'mirrors' the original copy and so no data should ever be lost through disk failure. Does not cope with user error or virus activity.

**Quiz: Rewritable & Read Only (page 169)**

**Q12:**

- ROM stands for read only memory and it means that you cannot save to the disk. The disk already has data stored on it and you cannot change it. An example of this is if you buy a DVD to watch or a computer game to play. The information is already on the disk and you watch or install it on your own computer. You do not need to change the information.
- R stands for recordable. This means that the disk is blank when it is purchased and the user can then store information onto it, but only once. After it has been saved to the disk it cannot be deleted or amended.
- RW stands for rewritable. This means that the disk is bought blank and can be saved to as many times as the user requires. The information can be edited and deleted as required.

**Quiz: Interface type (page 172)**

**Q13:** Answer may depend on current developments.

**Q14:** USB 3 uses smart charging, has a much higher data transfer rate and a higher charging power than USB 2.

**Q15:** Bluetooth is wireless connection between two devices; USB uses a cable to connect two devices. USB has a shorter range than Bluetooth but a faster transfer rate.

**Quiz: Data transfer speed (page 173)**

**Q16:** Data transfer speed is the rate at which data is transferred from one device to another. It is measured in megabits or megabytes.

**Q17:** Noise, interference, errors during transfer and overheads can all affect data transfer speeds.

**Quiz: Built in & External storage (page 173)**

**Q18:**

- If a backing storage device is built in then it is included inside the computer, for

example, a hard drive. Built in storage devices are not portable as they cannot be moved around to be used with other devices.

- External storage devices are devices that are separate from the computer, for example an external hard drive.
- Portable storage devices are storage devices that can easily be moved around and be used with other computers. For example, USB Flash Drives.

**Q19:**

- Built in - Internal hard drive, Solid state hard drive
- External - external hard drive, USB flash drive, DVD-RW, CD-RW, memory card
- Portable - external hard drive, USB flash drive, DVD-RW, CD-RW, memory card.

**Quiz: Magnetic & Optical storage (page 178)**

**Q20:** Hard drive, magnetic tape, floppy disk

**Q21:** CD-RW, DVD-RW

**Q22:** Magnetic storage uses magnetic charges stored on a magnetisable metal oxide layer on a disk or tape. Optical storage uses the reflection of a laser from a surface made of 'lands' and 'pits' (or dark areas in the case of recordable disks).

**Quiz: Solid State (page 180)**

**Q23:** A device that does not have any moving parts - i.e. It is solid.

**Q24:**

- They are small and so are easy to carry around.
- They are robust (hard to break) because they do not have any moving parts.
- They use less power than hard drives, which means that batteries can last longer in portable devices.
- They are available in a range of capacities to suit all needs and budgets.
- They can be used with security software, passwords or fingerprint scanners.

**Q25:** Answers will depend on current developments.

**Q26:** Answers will depend on current developments.

**End of topic test (page 183)**

**Q27:** c) Incremental backup

**Q28:** a) True

**Q29:** a) Interference. b) Errors during transfer.

**Q30:** b) USB flash drive. c) DVD-RW. d) Memory card.

**Q31:**

- a) They are small and so are easy to carry around.
- b) They are robust (hard to break) because they do not have any moving parts.
- c) They are available in a range of capacities to suit all needs and budgets.
- d) They use less power than hard drives, which means that batteries can last longer in portable devices.

## 10 Technical implementations (Networking/connectivity)

### Quiz: Introduction (page 187)

**Q1:** Networking is two or more computers joined together; connectivity is how the computers are connected.

### Quiz: Cloud systems & Server provision (page 189)

**Q2:** An email provider such as Hotmail or Yahoo. Applications are not downloaded to users computer they are accessed over the Internet.

**Q3:** A server is a computer that provides a service to a user. This could be providing access to files or email or web pages.

**Q4:** Client/server networks allow resources to be shared, centralised backups and access to files from any computer.

### Quiz: Public, private & hybrid (page 190)

#### Q5:

- Public cloud - applications and information are delivered through the Internet. The Internet is a public network and open to anyone, so anyone can use the cloud system.
- Private cloud - a physical server that is within the companies own network. A private cloud is an infrastructure that is used for only one organization.
- Hybrid cloud - a combination of public and private cloud systems.

**Q6:** Hardware and software needs to be provided by the company, which can be expensive and may need updating.

**Q7:** Public clouds are cheaper to implement, very secure and provide remote access.

### Quiz: Web hosting (page 193)

**Q8:** Web hosting is providing space on a server for web pages to be stored so that they can be accessed over the Internet.

#### Q9:

- Free web hosting - limited service offered by some companies. The website may have to include advertising for other products or companies.
- Shared web hosting - website is placed on a web server along with thousands of other websites. They share ram and processor resources and the services may be quite limited.
- Dedicated hosting - every user gets its own web server and has full control over it.

**End of topic test (page 197)**

**Q10:** c) It is partly private and partly public.

**Q11:** d) They are hard to use.

**Q12:**

B) It can be provided by an ISP.

C) It stores websites so that they are available over the Internet.

**Q13:**

A) Client/server networks allow resources to be shared.

B) Centralised backups.

D) Access to files from any computer.

**Q14:** a) True

## 11 Security risks

### Quiz: Introduction (page 201)

**Q1:** The Computer Misuse Act

**Q2:**

- A virus is a self-replicating program that must be attached to a program.
- A worm does not need to be attached to another program and it does not always damage the computer system, it will replicate itself.
- A Trojan does not replicate itself but gathers information without the user's knowledge.

### Quiz: Spyware, Phishing & Keylogging (page 203)

**Q3:** Employers may wish to keep track of what their employees are using the computers for, what are they looking at on the internet, how are they using company resources?

**Q4:** Phishing emails may have spelling or grammar mistakes, request sensitive information or be addressed to dear customer instead of the user's name.

### Quiz: Online Fraud & Identity Theft (page 206)

**Q5:** Online fraud is a fraud that is committed online. Identity theft is when someone else uses or steals your identity, often with the aim of committing online fraud.

**Q6:** Pupils own research.

**Q7:** They might gather it from social networking sites, recycling bins or phishing emails.

### Quiz: DOS attacks (page 207)

**Q8:** A DOS attack is when a web server is targeted by criminals in an attempt to force it offline. It may take advantage of specific vulnerabilities in the server software or rely on flooding the server with traffic.

**Q9:** A DDOS attack is a distributed denial of service attack which targets web sites, attempting to force them offline by sending a huge number of requests generated by a bot-net.

**Q10:** Always use a firewall and anti-virus software, be careful who has access to your email address.

### End of topic test (page 209)

**Q11:** a) Click fraud. b) Holiday fraud. d) Lottery scams.

**Q12:** b) They may have spelling mistakes. d) They will **not** address the customer by name.

**Q13:** b) Trojan

**Q14:**

- a) Use a firewall.
- c) Use anti-virus software.
- d) Limit who gets access to your email address.

**Q15:** c) Spyware

## 12 Security precautions

### Quiz: Introduction (page 214)

**Q1:** The purpose of anti-virus software is to prevent your computer from becoming infected with a virus, or other security risk.

**Q2:** A firewall is either hardware or software based and monitors the data that passes in and out of a network. It forms an internal barrier between a secure network and any other network.

### Activity: Crack the code! (page 215)

#### Expected answer

I am learning all about encryption with scholar

### Quiz: Encryption (page 217)

**Q3:** Encryption applies a code - called a key - to scramble information before it is transmitted in an attempt to protect it. If the data is intercepted it will be meaningless.

**Q4:** If data is intercepted it cannot be understood. A computer's backing storage can also be encrypted so that sensitive information is not vulnerable if the device is stolen.

**Q5:** In symmetric encryption both the key for encrypting and decrypting are the same and are agreed before information is transmitted. In public key encryption the encryption code is public and the decryption key is only available to the person receiving the information.

### Quiz: Digital certificates & signatures (page 221)

**Q6:** A digital certificate is an electronic document that is used to confirm the identity of a person or organisation.

**Q7:** The purpose of a digital certificate is to allow individuals and companies to feel secure in exchanging information as they are able to confirm each other's identity.

**Q8:** Anyone can make use of digital certificates.

**Q9:** A digital signature is an electronic signature that can be used to validate the identity of the person sending a message or document.

**Q10:** The purpose of a digital signature is to confirm and prove a person's identity.

### Quiz: Server-side validation (page 222)

**Q11:** Validation is checking information that has been entered into a website is sensible.

**Q12:** In client-side validation the checking is performed by the users browser, in server-



side validation the checks are performed by the server.

**Q13:** The advantage of client-side validation is that the checks can be performed very quickly. The advantage of server-side validation is that the checks are performed in a more secure environment.

**Quiz: Biometrics (page 224)**

**Q14:** Biometrics is the process of using an individual's unique data to prove their identity or to let them access computers or sensitive information.

**Q15:** Biometrics are used in security systems as they are very hard to forge or fool, users cannot 'forget' the information and it prevents the unauthorized use of lost or stolen identity cards.

**End of topic test (page 226)**

**Q16:** b) Firewall

**Q17:** c) Digital Certificate

**Q18:** a) True

**Q19:** b) Server-side validation

**Q20:** c) Biometrics

### **13 Legal implications**

#### **Quiz: Introduction (page 230)**

**Q1:** Data subjects have the right to see information that companies have stored about them and they have the right to get it changed if it is incorrect.

**Q2:** Companies have a responsibility to register that they are storing information, store only information that they need, keep it secure, keep it up to date, provide access to data subjects and remove information that they no longer need.

**Q3:** Musculoskeletal problems and eye strain.

#### **Quiz: Computer Misuse Act (page 232)**

**Q4:** Hacking, changing information without permission, deliberately introducing viruses.

**Q5:** Pupils own research

#### **Quiz: Copyright, Designs and Patents Act and Plagiarism (page 233)**

**Q6:** To protect the rights of those who have created material from it being copied and used without their permission.

**Q7:** The growth of the internet has made it very easy to locate, copy and distribute material. People distributing materials subject to copyright can be difficult to trace due to the global nature of the internet, and copyright owners can find it almost impossible to notice an infringement in such a large amount of information.

**Q8:** Pupil's own research.

#### **Quiz: Communication Act (page 235)**

**Q9:** Cyber bullying, using someone else's wireless network, intercepting electronic communications.

**Q10:** Pupils own research.

#### **Quiz: Electronic Communications Act (page 235)**

**Q11:** Regulates the use of cryptography and clarifies the legal status of electronically signed documents.

#### **Quiz: Regulation of Investigatory Powers Act (page 237)**

**Q12:** They must think that the person is a criminal or it must be a matter of public safety.

**Q13:** They can follow people, bug houses, intercept communication details, access encrypted data and use informers.

**End of topic test (page 239)**

**Q14:** a) Computer Misuse Act

**Q15:** c) Communication Act

**Q16:** a) Computer Misuse Act

**Q17:** b) Copyright, Designs and Patents Act

**Q18:** d) Regulation of Investigatory Powers Act

## 14 Environmental implications

### Quiz: Introduction (page 243)

**Q1:** An increase in the number of electronic devices being used mean that more energy is used to create the devices, to run the devices and to dispose of the devices.

**Q2:** If IT equipment is disposed of in an irresponsible manner then it can lead to pollution and landfill.

### Quiz: Lifetime Carbon Footprint (page 245)

**Q3:** A carbon footprint is a measure of the amount of carbon dioxide released into the atmosphere when a task is performed.

**Q4:** Everyone has a carbon footprint.

**Q5:**

- Turn it off devices when not in use.
- Replace old equipment with modern, more energy efficient devices.
- Recycle redundant devices appropriately.
- Offset your carbon footprint by sponsoring charities that plant trees.
- Don't print unless it is necessary.
- Fix items instead of binning and replacing them.
- Use rechargeable batteries instead of disposable .
- Use technology to communicate instead of travelling by car or aeroplane.

### Quiz: Environmental benefits (page 247)

**Q6:**

- Can communicate without travelling.
- Communicate electronically.
- Less paper used for printing.
- Working from home.
- Devices are more energy efficient.

### End of topic test (page 248)

**Q7:** c) Walking up stairs instead of taking the lift.

**Q8:**

- A) Turning computers off when not using them.
- B) Recycling ink cartridges.
- D) Using energy efficient monitors.

**Q9:** Use a carbon footprint calculator.

**Q10:** A) Less paper is used for printing. D) Employees can work from home.

**15 Economics and social impact****Quiz: Introduction (page 250)**

**Q1:** Devices are cheaper, they have more memory, they are portable and they have faster processors.

**Q2:** Computers are now available in most homes and people feel that they cannot live without their technology.

**Quiz: Economic impact (page 255)**

**Q3:** Pupils own opinion.

**Q4:**

- a) You can sell goods 24 hours a day online.
- c) Social media can be an inexpensive marketing tool.
- d) You don't need to pay expensive high-street rental prices for a store.

**Q5:** b) False

**Q6:** Trying to ensure your business can offer services or products that are better than your competitors in the market, giving consumers a reason to use your business over others.

**Quiz: Social impact (page 259)**

**Q7:** Pupils own opinion.

**Q8:** Censorship is when organisations or governments restrict an individual's ability to access particular material, or to produce certain materials. This may be for reasons of morality or reasons of control.

**Q9:** c) More attention can be focussed on humanitarian disasters because of online communication.

**Quiz: Intelligent systems (page 260)**

**Q10:** A machine that has ability to perform tasks that would require intelligence if they were performed by a human.

**End of topic test (page 262)****Q11:** All -

- a) Devices are cheaper.
- b) They have more memory.
- c) They are portable.
- d) They have faster processors.

**Q12:** a) True**Q13:** a) True**Q14:** a) Individuals could become isolated. b) Social networking has made it easier to keep in contact with friends/family.**Q15:**

- b) Freedom of Speech can be exercised online where there are heavy controls by dictatorships.
- d) You can communicate easily and cheaply with friends and family abroad.

**Q16:** A machine that has ability to perform tasks that would require intelligence if they were performed by a human.

**16 End of Unit 2 Test****End of unit 2 test (page 264)**

**Q1:** a) Foreign Key and c) Primary Key

**Q2:** a) It can save replication of information and c) Smaller tables are easier to manage

**Q3:** Data that is used to describe other data.

**Q4:** c) Date created and d) Author

**Q5:**

Form	It has a graphical user interface that can help novice users enter data into a database, can show one record at a time.
Table	It is used to enter and edit data in a database, has a basic layout.
Report	It is used for printing database, can have a graphical format, displays a chosen amount of records.
Query	It is used to perform a search or a sort on database.

**Q6:** a)



**Q7:** b) <body> and c) <head>

**Q8:** c) <head>

**Q9:** a) a list of attributes and the associated values

**Q10:** a) Manual

**Q11:**

Static web page	Web page where information does not change.
Dynamic web page	Web page where information changes every time the page is loaded.

**Q12:** b) Buttons and c) Videos

**Q13:** a) Lossy reduces files size and loses information; Lossless reduces file size without removing information.

**Q14:**

Sampling frequency	How many times per second a sound is sampled.
Sampling depth	Number of bits used to store a sound sample.

**Q15:** The number of frames that are displayed per second.



**Q16:**

Sound	mp3, wav
Video	avi, mpeg
Graphics	bmp, gif, jpeg, png
Text	txt, rtf

**Q17:** Scripting language**Q18:** c) HyperText Markup Language**Q19:** A set of instructions for a web page that can change the way it displays.**Q20:** c) Structured Query Language**Q21:** a) User's browser**Q22:** b) On the Web Server**Q23:** a) Use back links and c) Use keywords throughout**Q24:** a) Reducing the size of html, css and JavaScript files by removing comments, unnecessary code and long variable names, and c) Compressing media used on the page.**Q25:** c) The client and d) Members of the public**Q26:**

Efficient	It does not waste resources disproportionate to its size.
Robust	It can cope with unexpected errors whilst running without failing.
Fit for purpose	It solves the task that it was created to solve.
Maintainable	It is easy to update and correct.

**Q27:**Raw data has no meaning, **information** is data that has been processed and has meaning.**Q28:** b) Who the website is aimed at**Q29:** c) A novice has no experience; an expert has lots of experience.**Q30:** Solid state/memory card**Further answers****End of unit 2 test (page 264)****Q31:** The user interface can be directly manipulated on the screen.**Q32:** Any two of: GPS receiver; Tilt-sensor; accelerometer; Digital Cameras / Webcams; light sensor.

**Q33:** Resolution, speed of printing (ppm), , colour or black/white, type of technology (laser/inkjet), cost.

**Q34:** a) Volatile and d) Stores programs whilst they are being used

**Q35:** b) False

**Q36:**

An internal hard drive is not **portable**, but a USB flash drive is. CD-ROMs are not **rewritable** but a CD-RW is.

The capacity of backing storage devices varies greatly, a CD is 700 MB, a hard drive could be measured in **terabytes**.

A **hard drive** is a magnetic device, CDs and DVDs are **optical**. USB flash drives are **solid state storage** devices, as are **memory cards**.

**Q37:** b) No

**Q38:** a) Yes

**Q39:** In case the original is lost or damaged.

**Q40:**

Incremental	Fastest backup, changes since any type of backup are stored.
Disk mirroring	A constant backup is made.
Differential	Only data that has changed since last backup is saved.
Full back up	Simplest type of backup, all data is backed up.

**Q41:** CD, DVD, USB Flash Drive, Hard Drive

**Q42:**

1. Buffering
2. Handling of status signals
3. Protocol conversion
4. Voltage conversion
5. Data format conversion

**Q43:** A device that can be removed and used on another computer.

**Q44:** a) They use less power and b) They are robust

**Q45:** Two or more computers connected together so that they can communicate.

**Q46:** a) Files can be accessed from any computer via internet, c) Files are backed up and d) They are easy to expand

**Q47:** To make web pages / sites available over the internet

**Q48:**

Keylogging	It can be hardware or software based, logs the keys that are pressed on a keyboard.
Spyware	Software that installs itself and gathers private information from the user.
Phishing	An attempt to acquire information such as passwords or bank details from a user.

**Q49:** A website/network is flooded with requests that it cannot process and so crashes.

**Q50:** a) Use a firewall, c) Use anti-virus software, and d) Limit who gets access to your email address

**Q51:** c) To avoid someone being able to intercept and read your data

**Q52:** b) They are very hard to forge and d) They can be time stamped

**Q53:** c) The code is hidden and d) It has more security

**Q54:**

A **data subject** is the person who has information stored about them.

A **data user** is the person who uses the information stored on a computer.

A **data controller** is the person responsible for all the data stored in a company or organisation.

**Q55:** a) Computer Misuse Act

**Q56:** b) Copyright, Designs and Patents Act (Plagiarism)

**Q57:** c) Communication Act

**Q58:** d) Regulation of Investigatory Powers Act

**Q59:** b) Replace old equipment with modern, more energy efficient devices and c) Recycle redundant devices appropriately

**Q60:** A machine that has ability to perform tasks that would require intelligence if they were performed by a human.