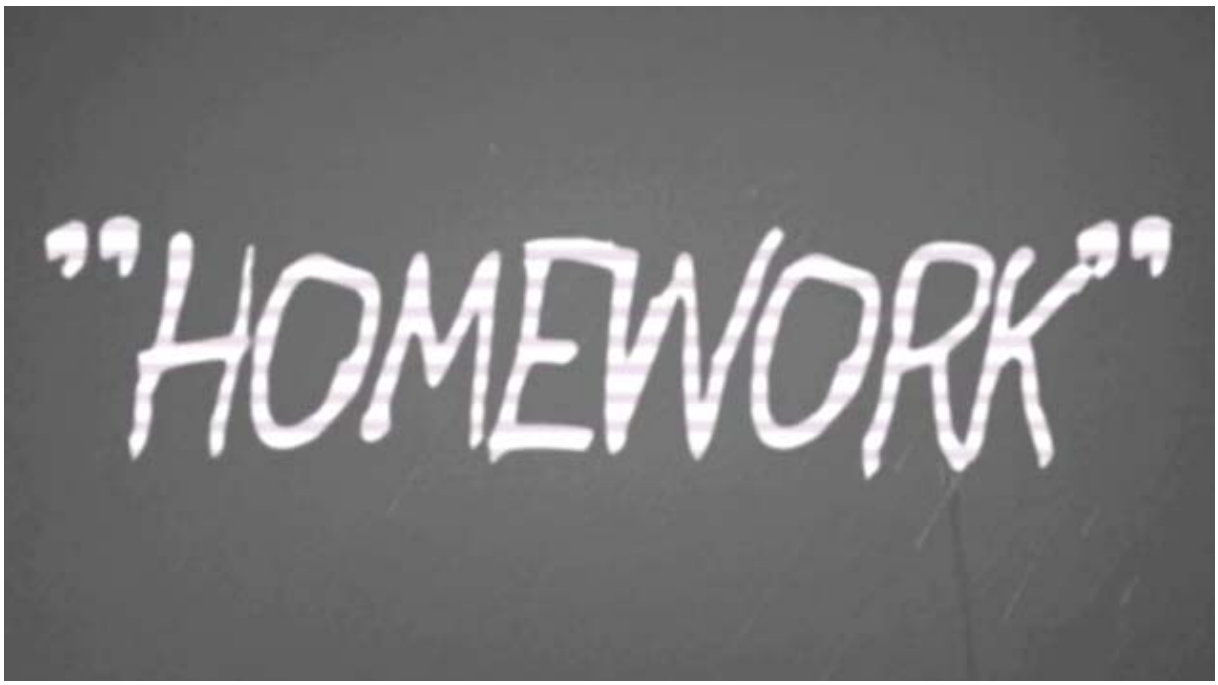
Coltness High School
Technical Department

craft



design

S4 Revision and Assignments 1
Knowledge and Understanding

SAFETY MATTERS

Safety in the school workshop is the responsibility of everyone who uses the workshop. Accidents usually happen when people are fooling about or being careless.

Teachers are responsible for checking that:

- Machines are set up properly
- Safety guards are fitted
- Stop buttons work and are accessible
- Electrical cut-out devices work
- Warning signs are displayed
- The first-aid box is kept topped up
- Fire drill procedures are posted
- Dust extraction units work
- Safety clothing and equipment is available
- Pupils are shown how to use each tool and machine safely
- Workshop safety rules are given, kept to, and understood by all

Pupils are responsible for:

- Following the general safety rules at all times
- Only using tools and machines they have been given permission to use
- Using the machines and tools only in the way that the teacher instructed
- Using tools and machines only for the job they are designed for
- Making use of all machine guards
- Reporting any defects of tools or machines immediately
- Reporting any liquid spillage immediately
- Reporting any accidents, however minor, to the teacher
- Considering the safety of everybody else in the workshop
- Behaving sensibly at all times, especially when the teacher's back is turned
- Using chemicals and smelly adhesives in a ventilated area
- Not leaving hot materials lying around
- Not interfering with other pupils while they are working
- Not throwing anything in a workshop
- Not encouraging others to behave dangerously

For your own safety:

- Wear an apron
- Tie back any long loose hair
- Remove any dangling earrings or bracelets
- Secure loose shirt cuffs or shirt tails.
- Make sure your laces are tied up
- Wear stout shoes
- Do not run in the workshop
- Wear safety clothing when appropriate e.g. goggles, face mask etc.

SAFETY SIGNS

There are three types of safety sign:

Red signs show things that are not allowed

Blue signs show things that must be done

Yellow signs are warnings.

These are **Red** signs.

These are **Blue** signs.

These are **Yellow** signs.

Caution risk of electrical shock | **Caution toxic hazard** | **Caution risk of fire**

AT WORK

In factories there are laws that control Health and Safety. The main law is the -

Health and Safety at Work Act 1974

This law says that employers must take all reasonable care to ensure the safety of their employees and that employees should co-operate with the employer to ensure the safety of all workers.

A Write a list of safety rules for your school workshop, using your own words and in your own style.

MATERIAL PROPERTIES

Choosing Materials

When a product is being designed, one problem is choosing the most suitable materials for the job. A material should not be chosen just because it looks nice. Using royal blue candle wax for making a door handle is not a good choice! A door handle needs to be able to resist the heat from a hand and also the twisting and pulling forces required to operate it. It is therefore important to understand the various properties of materials, so that you can make a sensible choice of which materials to use when you are designing a product.

PHYSICAL PROPERTIES

Physical properties are the basic properties of each material.

Density

is the amount of matter (mass) in a material. A cube made from a high density material will be heavier than the same size cube made from a low density material.

DENSITY	MATERIAL
High	Gold Lead
Medium	Copper Steel
Low	Woods Plastics

Fusibility

is a measure of how easy it is to melt the material. The temperature at which the material normally melts is known as the **melting point**.

MELTING POINT	MATERIAL
High	Tungsten Chromium
Medium	Copper Steel
Low	Zinc Lead

Note: A highly fusible material has a low melting point.

Thermal Conductivity

is a measure of how fast heat can travel through a material. A material is known as an **insulating** material if heat travels through it very slowly.

THERMAL CONDUCTIVITY	MATERIAL
High	Copper Aluminium
Medium	Mild steel Tin
Low	Woods Polystyrene

Electrical Conductivity

is a measure of how fast electricity travels through a material. Generally a good conductor of heat is also a good conductor of electricity. A poor conductor is an **Insulator**.

MELTING POINT	MATERIAL
High	Gold Copper
Medium	Steel Zinc
Low	Woods Nylon

Thermal Expansion

is the amount of expansion that occurs when the material is heated. A high expansion material will become noticeably larger when heated.

THERMAL EXPANSION	MATERIAL
High	Polythene Nylon
Medium	Aluminium Tin
Low	Woods Titanium

Optical Properties

Most materials do not let any light pass through them, these are known as **Opaque** materials. Others like glass can let light pass easily through them, these are known as **transparent** (see-through) materials. There are also materials like some plastics or frosted glass that let some light through, but detail of what is on the other side of the material cannot be seen, these are known as **Translucent** materials.

MECHANICAL PROPERTIES

Mechanical properties are connected with how a material reacts to forces applied to it.

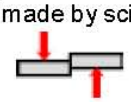
A force will **deform** a material. If the deformation is temporary and the material returns to its original state then it is said to be **elastic**, if it is permanent and the material stays in its new state, it is said to be **plastic**.

Strength

is a measure of how well a material can withstand force without permanently bending or breaking. There are different types of strength measurements.

Tensile strength - resists being crushed e.g. cast iron

Shear strength - resists sliding forces such as those made by scissors



Compressive strength - resists being crushed e.g. cast iron

Torsional strength - resists twisting e.g. tool steel

Bending strength - resists bending - is **rigid**. e.g. woods

Malleability

is a measure of how easily a material can be permanently deformed by compressive forces. e.g. hammering, without cracking

THERMAL EXPANSION	MATERIAL
High	Copper Aluminium
Medium	Mild steel Bronze
Low	Woods Thermoset plastics

Ductility

is a measure of how easily a material can be permanently deformed, without cracking or breaking, by bending, stretching or twisting.

DUCTILITY	MATERIAL
High	Polypropylene Copper
Medium	Mild steel Bronze
Low	Woods Thermoset plastics

Hardness

is a measure of how well a material resists scratching and being worn away by other materials

HARDNESS	MATERIAL
High	Diamond Chromium
Medium	Mild steel Bronze
Low	Woods Thermoplastics

Toughness

is a measure of how well a material can stand up to sudden forces, e.g. a hammer blow, without cracking. A material that is not tough is called **Brittle**

TOUGHNESS	MATERIAL
High	Polycarbonate Copper
Medium	Mild steel Brass
Low	Glass Polyester resin

Durability

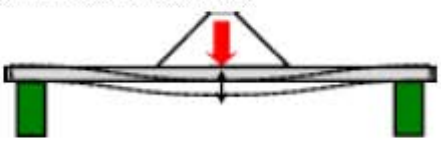
is a measure of how well a material stands up to weathering (the sun, cold, wind, rain, corrosion and rotting)

DURABILITY	MATERIAL
High	Gold Tin
Medium	Ceramics Bronze
Low	Mild steel Soft woods

MATERIALS TESTING

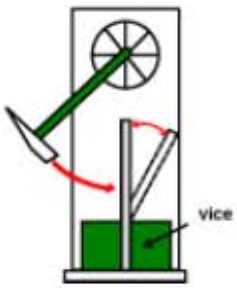
In industry, materials are put through a series of tests to test all of the properties mentioned in this chapter to see if they are suitable for the product being designed. Special machines are used to test tensile strength, brittleness and hardness etc. In school you can still carry out basic tests to check that your choice of materials is suitable.

Bending strength (rigidity)



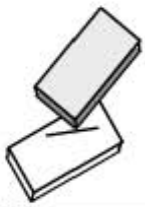
Cut identical lengths (samples) of the materials you wish to test and place each over the same length gap. Place the same weight over the middle and measure the amount the sample has bent from the horizontal. The most rigid will have moved the least.

Toughness



Use identical samples of different materials, place in the vice and lift the suspended hammer to the same height each time. Let it go and then measure the angle that the sample has been bent to. The smaller the angle the tougher the material.

Hardness



Find samples of each material, they do not have to be identical, just have a sharp corner. Then use each sample in turn to try and scratch the other samples. The hardest is the one that all the other samples cannot scratch. Using this method you can put the samples into rank order of hardest to softest.

KEY WORDS Density: Fusibility: Conductivity: Insulating: Malleability: Ductility: Deformation: Toughness

1. Define the term 'density' and give two examples of a dense material.
2. How would you describe a fusible material? Give two examples of easily fused materials.
3. Give two examples of materials that are good heat insulators.
4. If I wish to make switch contacts that will conduct electricity well, which materials might I use?
5. What do you understand by the term 'translucent'?
6. Explain what an elastic material is.
7. With the aid of diagrams, explain the terms 'tensile strength', 'shear strength and 'bending strength'.
8. What property allows a material to be stretched until it becomes a long thin wire or fibre?
9. What is the property that makes a material a malleable material?
10. Explain what is meant by a 'tough' material. Describe the sort of materials that are the opposite of tough.

A Describe, with the aid of diagrams and notes, a test that you could carry out at school to measure heat conductivity in different materials.

B Describe, with the aid of diagrams and notes, a test that you could carry out at school to measure the durability of different materials in water.

C What are the properties required by the materials that are used to make a garden fork. Take each part in turn (handle, shaft and the fork head), state what you think they are made from and then list their properties.

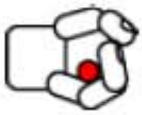
ERGONOMICS

Every well designed product must be easy, comfortable and safe to use. The parts of the product that are touched by humans, e.g. handles, seats, table tops etc. are said to be **ergonomically designed**. Not every part of a product needs to be ergonomically designed, e.g. the parts inside a DVD player are not normally touched by the user so do not need ergonomic design.

Designing Handles Ergonomically

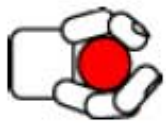
A designer who is working on a handle needs to consider the following:

Is the handle wide enough to be comfortable to use, without being too wide so that it is difficult to grip and could slide out of the hand?



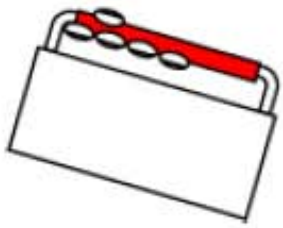
Or is it too narrow, so that it cuts into the fingers and cuts off the blood supply?

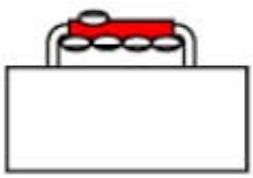
Or is it just right so that the user can get a good firm grip and hold it comfortably and safely?



Is the length of the handle long enough to allow all four fingers to fit into it without squashing them?

Or is it too long so the hand can slide to one end and not hold the object level?





Or is it just right so that the fingers fit without being squashed and the handle ends stop any sliding?

If the handle has to be long, then sliding can be stopped by using a slip resistant material such as soft rubber, or by shaping the handle.

Slip resistant handle shapes

KEY WORDS Ergonomic: Anthropometric: Percentile: Ergonome

ERGONOME

When a designer is working on large products, such as furniture, they often use a stylised scale drawing or 3D model of the human body called an **ergonome.**

This diagram shows an ergonome made from pieces of card. Each of the pieces are loosely pinned to each other so that the body can be placed in various positions. e.g. sitting on a seat.

If the ergonome above is printed on an A4 sheet it will be at a scale of approximately 1:35

ANTHROPOMETRIC DATA

A designer needs to make sure that the sizes chosen for a design are ergonomically correct. To do this the designer will look up **anthropometric data**.

The data is a series of tables showing measurements from all parts of the body, for men, women and children of various ages. A lot of people were measured and their results were pooled together to provide the data.

Most designers of popular products only consider 90% of the population, the smallest 5% and the largest 5% are not normally catered for, and rely upon specialist designs,e.g. shoes larger than size 14 are normally handmade to order and cost a lot of money.

To help tell the difference between the smallest 5% and largest 5%, anthropometric tables use the term **percentiles** instead of percentages and give three columns of information for each measurement.

e.g. For the standing height measurement of adult men **5th percentile** - 5% of the population are 1644mm tall, or smaller

50th percentile - 50% (half) of the population will be 1753mm tall, or smaller.

95th percentile- 95% of the population will be 1861mm tall, or smaller.

Measurement	Subject	5th Percentile	50th Percentile	95th Percentile
standing height in mm	adult male	1644	1753	1861
	adult female	1517	1626	1734
handle diameter in mm	all adults	40	45	52

A Using a school chair, or a dining room chair at home, identify the parts that should be ergonomically designed, (use diagrams and notes). Also, draw a sitting ergonome and show which measurements need to be made to help the designer make the chair comfortable to use by 90% of the population.