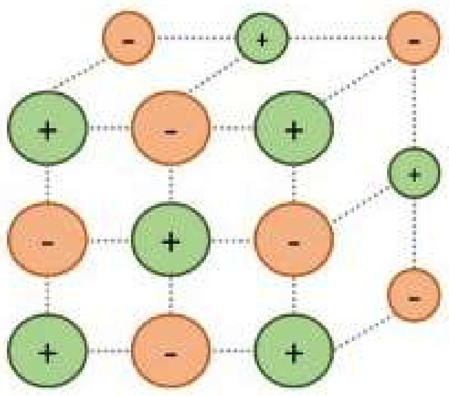
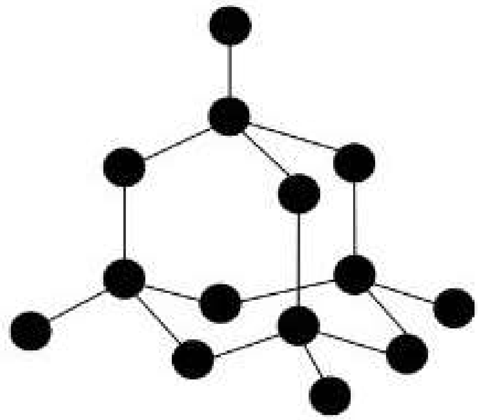
Master

Kirkcaldy High School





N4/5 Chemistry

Unit 1 - part 3

Bonding

Name: ______________________

Class: ______________________

Teacher: ______________________

Assessment Page

End of topic questions

Topic title	Date	Mark/Total Mark
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Homework

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Check tests

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Teacher comments

Date: ________________

Elements and Compounds

Learning Intentions
- To learn about elements and compounds

Success Criteria

- ☐ I can state the definition of element and compound.
- ☐ I can name compounds with -ide/ate/ite.
- ☐ I can state the elements in a compound given its name.

Introduction

An **element** is a substance that consists of only **one** type of **atom** and cannot be **broken** down into simpler substances by **chemical** means.
- Examples include hydrogen, oxygen, and gold.

A **compound** is a substance formed when **two** or more **elements** chemically **combine**.
- Compounds have properties that are **different** from those of the individual elements that make them up.
  - For instance, water is a compound made up of hydrogen and oxygen atoms (H_2O); it has unique properties that are **distinct** from both hydrogen and oxygen.

In the following table, identify whether the substance is an element or compound.

Name (Formula)	Element or Compound?
Hydrogen (H)	
Water (H_2O)	
Sodium Chloride (NaCl)	
Oxygen (O)	
Methane (CH_4)	
Gold (Au)	
Carbon Dioxide (CO_2)	
Sulfur (S)	
Ammonia (NH_3)	
Iron (Fe)	
Calcium Carbonate ($CaCO_3$)	

Naming compounds

Compounds containing two elements have names ending in –**ide**.

- For example, when sodium (Na) combines with chlorine (Cl), the compound is named sodium chlor**ide** (NaCl).

Compounds containing **more** than two elements, one of which is **oxygen**, have names ending in –**ate** or –**ite**.

- The "-ate" suffix is used for the ion with more oxygen atoms, while "-ite" is used for the ion with fewer oxygen atoms. For example, sulfate (SO_4^{2-}) has more oxygen atoms than sulfite (SO_3^{2-}). Both of these ions are related to the element sulfur, but they have different numbers of oxygen atoms and thus different names.
- You can find other group ions on page 8 of your data booklet.

Using the rules given to you, name the following compounds given the elements.

Elements Involved	Compound Name
Sodium and Chlorine	
Carbon and Oxygen	
Sodium and Oxygen	
Calcium and Chlorine	
Calcium and Carbon and Oxygen	
Phosphorus and Oxygen	
Aluminum and Chlorine	
Zinc and Sulfur	
Sodium and Carbon and Oxygen	
Potassium and Nitrogen and Oxygen	
Iron and Oxygen	
Magnesium and Phosphorus and Oxygen	

Now write the name of the elements involved given the compound name.

Compound Name	Elements Involved
Sodium Chloride	
Carbon oxide	
Sodium Carbonate	
Calcium Chloride	
Sulfur oxide	
Hydrogen Sulfide	
Calcium Carbonate	
Phosphorus oxide	
Iron Oxide	
Potassium Iodide	
Calcium Sulfate	
Sodium Oxide	
Potassium Nitrate	
Magnesium Phosphite	

Some compounds have common names that do not have the names of the elements in the compound name, e.g. water

Search which elements are found the following compounds.

Compound Name	Elements Involved
Methane	
Ammonia	
Ethanol	
Acetic acid	
glucose	

Elements and Compounds Experiment (page 15 lab booklet)

Aim: ____

____

Method:

Results:

Conclusion: ____

____

____

Evaluation: ____

____

____

Date: _______________

Bonding – Valency/formula

Learning Intentions

- To learn about valency, charge, and formula.

Success Criteria

☐ I can state the definition of valency and the valency of each group 1 – 8/0

☐ I can relate valency to the charge of the elements most common ion.

☐ I can use bonding arm diagrams to find the formula of a compound.

Introduction to valency

Valency refers to the **combining power** of elements, indicating how many atoms **bond together** to form **stable** molecules or ionic compounds. Essentially, it tells us **how many bonds** an element can make in a compound.

Valency is directly tied to the **number** of **outer** electrons an atom has. Remember, to become stable an atom must either **gain** or **lose** electrons to have an **electron arrangement** the **same** as their **nearest noble gas** (e.g. 2 or 2,8 or 2,8,8 etc).

Metals tend to **lose** electrons to become stable, **non-metal** atoms tend to **gain** electrons to become stable. The **valency** is the **number of electrons** that are **gained** or **lost to become stable**.

Fill out the valency for each group on the periodic table (ignore transition metals)

☐	☐	☐	☐	☐	☐	☐	☐
Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
1 Hydrogen H 1							2 Helium He 2
3 Lithium Li 2,1	4 Beryllium Be 2,2	5 Boron B 2,3	6 Carbon C 2,4	7 Nitrogen N 2,5	8 Oxygen O 2,6	9 Fluorine F 2,7	10 Neon Ne 2,8
11 Sodium Na 2,8,1	12 Magnesium Mg 2,8,2	13 Aluminium Al 2,8,3	14 Silicon Si 2,8,4	15 Phosphorus P 2,8,5	16 Sulfur S 2,8,6	17 Chlorine Cl 2,8,7	18 Argon Ar 2,8,8
19 Potassium K 2,8,8,1	20 Calcium Ca 2,8,8,2	31 Gallium Ga 2,8,18,3	32 Germanium Ge 2,8,18,4	33 Arsenic As 2,8,18,5	34 Selenium Se 2,8,18,6	35 Bromine Br 2,8,18,7	36 Krypton Kr 2,8,18,8
37 Rubidium Rb 2,8,18,8,1	38 Strontium Sr 2,8,18,8,2	49 Indium In 2,8,18,18,3	50 Tin Sn 2,8,18,18,4	51 Antimony Sb 2,8,18,18,5	52 Tellurium Te 2,8,18,18,6	53 Iodine I 2,8,18,18,7	54 Xenon Xe 2,8,18,18,8
55 Caesium Cs 2,8,18,18,8,1	56 Barium Ba 2,8,18,18,8,2	81 Thallium Tl 2,8,18,32,18,3	82 Lead Pb 2,8,18,32,18,4	83 Bismuth Bi 2,8,18,32,18,5	84 Polonium Po 2,8,18,32,18,6	85 Astatine At 2,8,18,32,18,7	86 Radon Rn 2,8,18,32,18,8

This periodic table can be found in page 6 of your data booklet

Complete the table to identify the group, electron arrangement and valency of the following elements.

Element (Symbol)	Electron Arrangement	Group Number	Valency?
Hydrogen (H)			
Oxygen (O)			
Sodium (Na)			
Chlorine (Cl)			
Carbon (C)			
Magnesium (Mg)			
Nitrogen (N)			
Aluminum (Al)			
Sulfur (S)			
Phosphorus (P)			
Silicon (Si)			
Calcium (Ca)			
Fluorine (F)			

Do you see a relationship between the electron arrangement and the valency of an element? Explain your answer with examples from the table.

Valency relating to the charge of ions

Valency and charge are closely related. For ions, the valency of an element often the same as the charge of the ion it forms.

- For example, sodium has a valency of 1 and loses one electron to form a Na^{+} ion with a 1- charge.
- Similarly, chlorine has a valency of 1 but gains one electron to form a Cl^{-} ion with a 1- charge.
- Oxygen has a valency of 2 but gains 2 electrons to form a O^{2-} ion with a charge of 2-

Remember, losing an electron results in the ion becoming positive, gaining an electron causes the ion to become negative.

In general, metal ions are positive and non-metal ions are negative.

Fill in the following table.

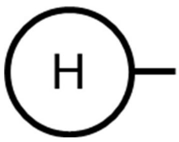
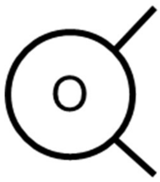
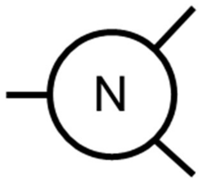
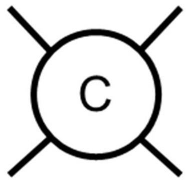
(Symbol)	Electron Arrangement of atom?	Valency?	Charge of Ion? (4+ to 4-)	Electron Arrangement of Ion?
Hydrogen (H)				
Oxygen (O)				
Sodium (Na)				
Chlorine (Cl)				
Carbon (C)				
Magnesium (Mg)				
Nitrogen (N)				
Aluminum (Al)				
Sulfur (S)				
Phosphorus (P)				

Valency and formula

Think of **valency** as the number of **arms** the **atom** has and **how many** different **atoms** it can **hold onto**. Valency helps use find out how many atoms we have in a compound of each element.

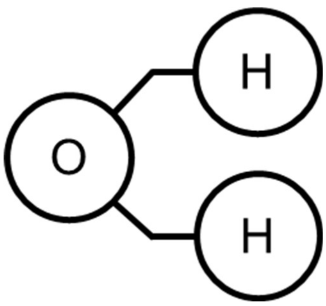
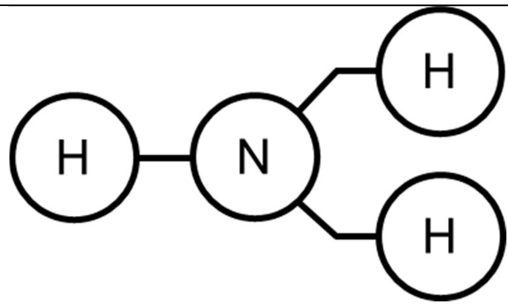
When we write how many atoms of each element are in a compound, like H_2O, we are saying there are 2 atoms of hydrogen and 1 atom of oxygen. This is called the compounds **formula**.

Below shows how each valency is shown using a bonding arm diagram.

Valency	**1**	**2**	**3**	**4**
Bonding arm diagram				

These can be combined to find the formula of different compounds.

Examples

Elements in the compound	Hydrogen and oxygen	Nitrogen and hydrogen
Bonding arm diagram		
Formula	H_2O	NH_3

Questions

Draw the bonding arms diagrams to find the formula for each of these compounds. Use the previous pages to find the valency of each element first. You may want to use a show-me-board before finalising your answers.

Elements in the compound	Sodium and Chlorine	Magnesium and Fluorine	Magnesium and Oxygen
Bonding arm diagram			
Formula			

Elements in the compound	Nitrogen and chlorine	Magnesium and Fluorine	Aluminium and Oxygen
Bonding arm diagram			
Formula			

Date: ________________

Bonding - General

Learning Intentions

- To learn how determine what type of bonding an element or compound has

Success Criteria

☐ I can state the different types of bonding.

☐ I can determine what type of bonding an element or compound has.

Introduction to the Bonding

Bonding is the process by which atoms **join together** to form more **stable structures** such as molecules* or extended networks*. The type of bonding depends on the nature of the atoms involved, and it plays a crucial role in determining the **properties** of the resulting substance.

- The properties of a substance are its melting point, boiling point, density, and solubility, or chemical properties like reactivity, flammability.

There are three types of bonding: **metallic**, **ionic** and **covalent**.

Which type of bonding

Metallic bonding usually occurs between **metal** atoms. e.g. Copper (Cu)

Ionic bonding usually takes place between **metal** and **non-metal** atoms. e.g. Sodium Chloride (NaCl)

Covalent bonding usually happens between **non-metal** atoms. e.g. H_2O

Monatomic elements, such as noble gases, exist as individual atoms and **do not** readily **form bonds** due to their **stable** electron configurations.

- So, all group 0/8 (e.g. Helium) will be monatomic.

*we come back to these words in the section titled 'bonding – covalent'

To determine which type of bonding a compound has you can use the element/compounds name and formula.

Example:

Potassium oxide is compound that contains **potassium** and **oxygen**. Potassium is a **metal**, oxygen is a **non-metal** (remember to look at the step on page 4). The combination of metal and non-metal makes it have **ionic** bonding.

Complete the table below to determine if the element/compound has ionic, metallic, covalent bonding or is a monatomic element.

Element or Compound Name	Type of Bonding?
Iron (Fe)	
Sodium Chloride (NaCl)	
Methane (CH_4)	
Oxygen (O)	
Calcium (Ca)	
Carbon Dioxide (CO_2)	
Argon (Ar)	
Water (H_2O)	
Copper (Cu)	
Hydrogen Sulfide (H_2S)	
Zinc (Zn)	
Ammonia (NH_3)	
Gold (Au)	
Calcium Carbonate ($CaCO_3$)	
Nitrogen (N)	
Helium (He)	
Neon (Ne)	
Potassium Iodide (KI)	

Date: _______________

Bonding - Covalent

Learning Intentions

- To learn about covalent bonding and covalent structures

Success Criteria

- ☐ I can state the definition of a covalent bonding.
- ☐ I can draw out electron diagrams.
- ☐ I can remember the diatomic elements.
- ☐ I can state the shape of a covalent molecule.
- ☐ I can state the type of bonding between molecules.
- ☐ I can describe the properties of covalent molecules and networks.
- ☐ I can explain the exceptional properties of graphite.

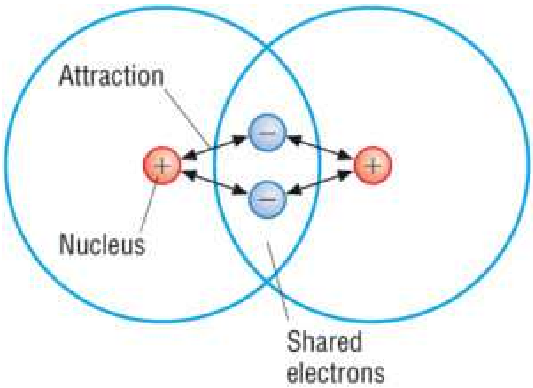
Introduction to atomic number

Covalent substances are made when **atoms share electrons** to form **molecules or networks**. This usually occurs between **non-metals**.

A **molecule** is a **group** of **two** or **more atoms** that are bonded together by **sharing electrons**.

A **covalent bond** forms when two **positive nuclei** are held together by their **common attraction** for a **shared pair** of **electrons**.

Covalent bond



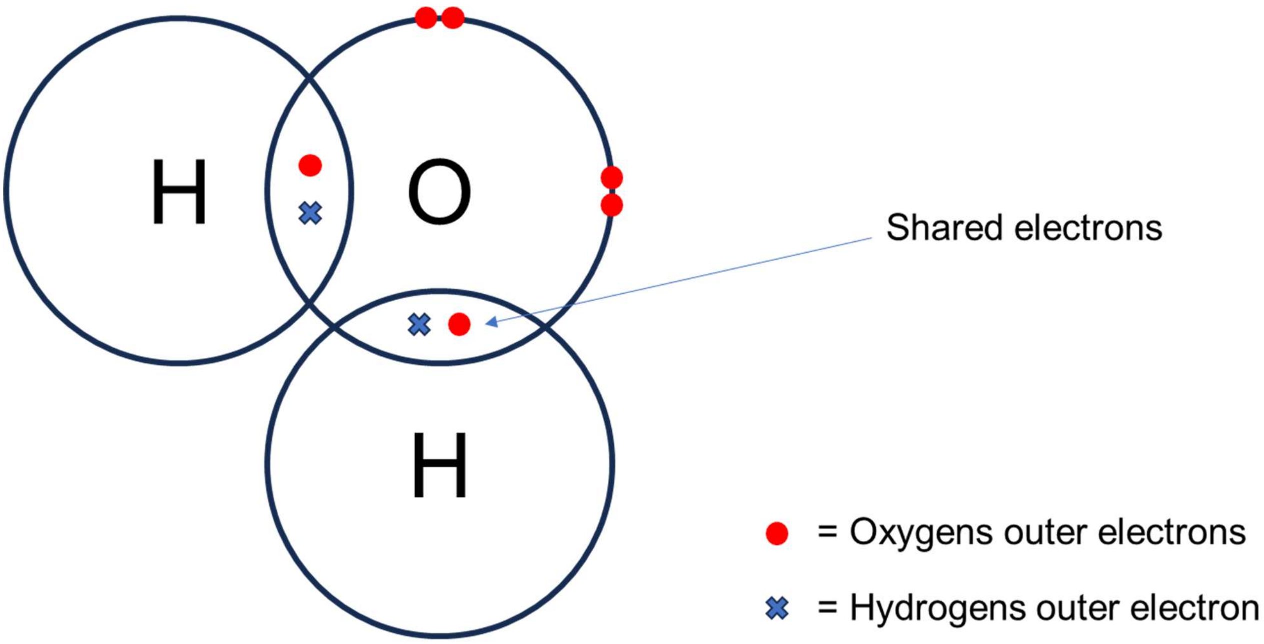
This sharing helps each atom have a full outer shell of electrons, making them more stable.

Outer electron bonding diagrams

Outer electron bonding diagrams are a way to show how atoms in a **molecule share electrons** to form bonds. These diagrams focus on the outermost electrons, also known as **valence** electrons, because these are the electrons **involved** in **bonding**.

For example, in a water molecule (H_2O), two hydrogen atoms share electrons with one oxygen atom. Each hydrogen gets closer to filling its outer shell, and the oxygen atom also gets a full outer shell. The result is a stable water molecule.

To represent this we show only the outer electrons and how they overlap:



Using this diagram we can see that for every 1 oxygen there are 2 hydrogens. That is why we identify water as H_2O. H_2O is the **formula** for water, we will come back to formula later.

Your teacher will now demonstrate how to draw outer electron diagrams.

Hydrogen: H_2

Water: H_2O

Ammonia: NH_3

Methane: CH_4

Diatomic Elements

Diatomic elements are elements that naturally exist as molecules made up of **two atoms** of the **same** type. In other words, these elements are **never** found **alone**; they always pair up with another atom of the same kind to form a diatomic molecule.

The diatomic elements are **Hydrogen (H), Oxygen (O), Nitrogen (N), Chlorine (Cl), Bromine (Br), Iodine (I), and Fluorine (F).**

For example, oxygen in its natural state is not found as a single O atom but as a molecule made up of two oxygen atoms, represented as O_2. Similarly, hydrogen exists as H_2, nitrogen as N_2, and so on.

Colour in the diatomic elements.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
1 Hydrogen H							2 Helium He
3 Lithium Li	4 Beryllium Be	5 Boron B	6 Carbon C	7 Nitrogen N	8 Oxygen O	9 Fluorine F	10 Neon Ne
11 Sodium Na	12 Magnesium Mg	13 Aluminium Al	14 Silicon Si	15 Phosphorus P	16 Sulfur S	17 Chlorine Cl	18 Argon Ar
19 Potassium K	20 Calcium Ca	31 Gallium Ga	32 Germanium Ge	33 Arsenic As	34 Selenium Se	35 Bromine Br	36 Krypton Kr
37 Rubidium Rb	38 Strontium Sr	49 Indium In	50 Tin Sn	51 Antimony Sb	52 Tellurium Te	53 Iodine I	54 Xenon Xe
55 Caesium Cs	56 Barium Ba	81 Thallium Tl	82 Lead Pb	83 Bismuth Bi	84 Polonium Po	85 Astatine At	86 Radon Rn
87 Francium Fr	88 Radium Ra						

Key: ☐ diatomic elements

Single, double and triple bonds in diatomic elements

Each shared pair of electrons results in one bond. It is possible for two atoms to share **2 or 3** pairs of electrons, resulting in a **double or triple bond.**

This can be shown in a bonding diagram:

Single bond: H – H

Double bond: O = O

Triple bond : N ≡ N

Hydrogen (H_2) and halogens like Fluorine (F_2), Chlorine (Cl_2), Bromine (Br_2), and Iodine (I_2) form **single** bonds. Oxygen (O_2) forms a **double** bond between its two atoms. Nitrogen (N_2) has a **triple** bond, making it one of the **strongest** diatomic molecules.

Using this information fill out the following table:

Element	Bonding diagram
Hydrogen	H – H
Fluorine	
Chlorine	
Bromine	
Iodine	
Oxygen	
Nitrogen	

Drawing out electron diagrams with double and triple bonds

Your teacher will now demonstrate how to draw outer electron diagrams with double and triple bonds.

Oxygen: O_2

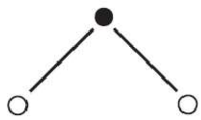
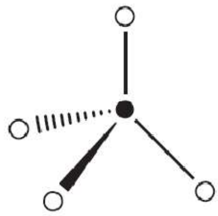
Nitrogen: N_2

Carbon Dioxide: CO_2

Shapes of Molecules

Since covalent bonds are **directional** (they bond at specific **angles**) there are different **shapes** that they can form which are shown below. You can use outer electron bonding diagrams to help you predict these structures. They usually **correspond** to the **number** of **atoms** in the substance.

In the examples, sketch the shapes of the molecules given. Notice that there is usually a central atom that can bond to more than one atom.

Drawing of the molecules shape				
Name of Shape	**Linear**	**Angular**	**Trigonal pyramidal**	**Tetrahedral**
Examples	**The diatomic elements:** **H – H** **F – F, etc.** **Diatomic compounds** **H – F, etc.** **and** **carbon dioxide** **O = C = O**	**Water** **H_2O** **H_2S** **SCl_2**	**Ammonia** **NH_3** **PH_3** **PCl_3**	**Methane** **CH_4** **$SiCl_4$**
Number of atoms involved in the bonding	**Usually 2**	**Usually 3**	**Usually 4**	**Usually 5**

Questions

Predict and sketch the shape of the following elements/compounds.

Compound/Element	Predicted Shape (Linear, Angular, Trigonal Pyramidal, Tetrahedral)	Sketch the molecule
CH_4		
H_2O		
NH_3		
CO_2		
BF_3		
H_2S		
SO_2		

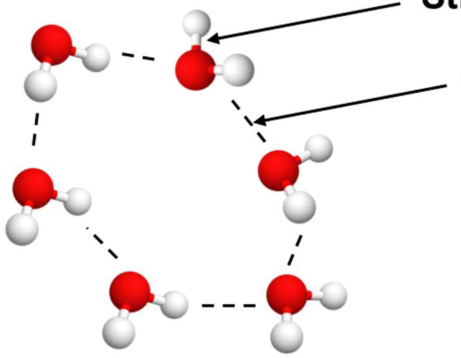
HF		
O_2		
N_2		
Cl_2		
CCl_4		
PCl_3		
SiO_2		

Extension

Go back to your outer electron diagram questions in the previous section and write the name given to that shape.

Intermolecular Forces

Intermolecular bonds are the forces that **hold molecules together** in a substance. These forces are **weaker** than the **strong covalent** bonds **within** the molecules themselves, but they are crucial for determining many properties of a substance.



Strong covalent bonds **within** the molecule

Weak intermolecular bonds **between** the molecules

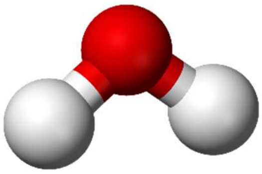
Weak intermolecular forces **hold** the **molecules** together, **breaking** these bonds causes the substance to **melt** and **boil** (think about the solid, liquid, gas state diagrams and how far apart the particles/molecules are).

The **stronger** these **intermolecular bonds** are, the **higher** their **melting** point and **boiling** point.

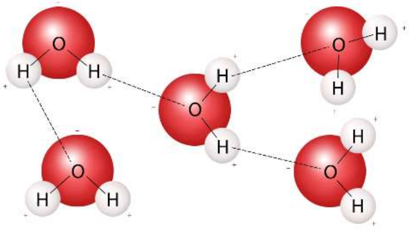
However, because these bonds are generally weak, **covalent molecules** tend to have **low** to **very low melting** and **boiling** points.

Structure and Properties of Covalent Molecular Substances

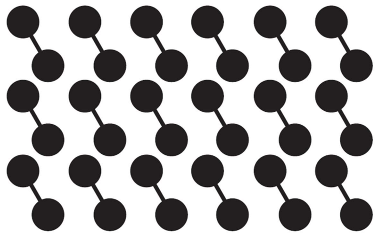
Covalent molecules are groups of atoms bonded together by **sharing** electrons. They are held together by **weak intermolecular forces.**



Covalent molecule (one molecule)

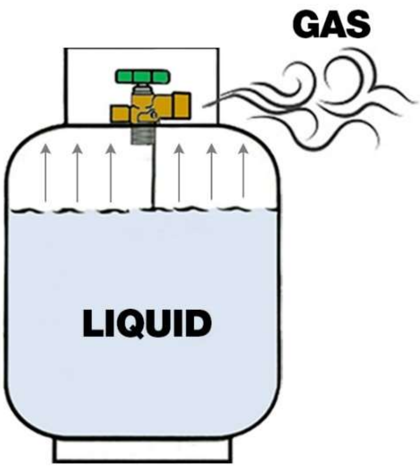


Covalent Molecules (multiple molecules – with intermolecular forces)



Covalent molecules (SQA version)

When we look at these substances with our own eyes, at our human size (or "macro scale")



Summarise the properties of covalent molecular substances below:

Melting and Boiling Points	Generally low
Electrical Conductivity	Do not conduct electricity
Solubility	Can be either soluble or insoluble in water
Physical State	Can exist as solids, liquids, or gases at room temperature
Elements Involved	Usually formed between non-metallic elements
Intermolecular Forces	Generally weak – leading to low melting and boiling point

Covalent Networks

Covalent networks are made of atoms connected by **strong covalent bonds** that go on and on, like a never-ending web. Unlike single molecules, they don't have a set size; they just keep going. This makes them very **strong** and **hard** to **melt**.

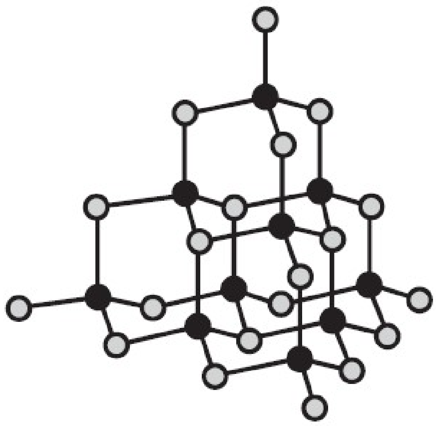
Examples include **carbon (diamond)** and **carbon(graphite)** and **Silicon Dioxide (SiO_2).**

Diamond and Silicon Dioxide

Diamond is a form of **carbon** that is a three-dimensional covalent network. It is an extremely **strong** structure and has a **high melting point**. Diamonds are used in **jewellery** and in **cutting tools** due to its **hardness**.

Silicon dioxide (SiO2) is another very hard material and is used to make **glass**. It is the main component of many types of **sand**. It is also used in construction to make concrete.

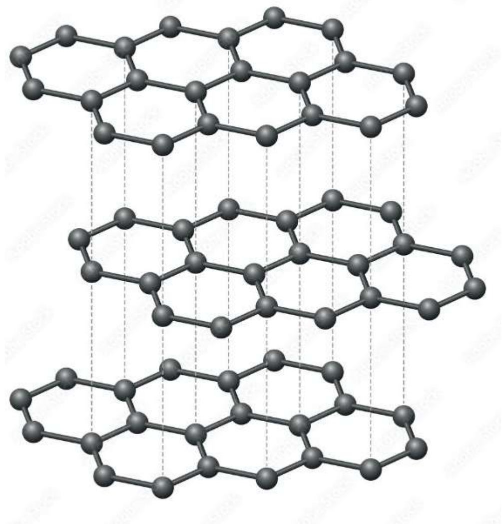
Both diamond and silicon dioxides structure is shown below.



Covalent network – Diamond and Silicon dioxide (SQA version)

Graphite (a form of carbon)

Graphite is another form of **carbon**, like diamond, but with a very different structure and set of properties. In graphite, each carbon atom is bonded to **three** other carbon atoms, forming flat, two-dimensional **layers**. These layers can **slide** over each other easily, which is why graphite is slippery and used as a lubricant.



Carbon(graphite)

The interesting part is that each carbon atom has one electron that is not used in bonding. These "**free**" **electrons** are **delocalised**, meaning they can **move freely** throughout the structure.

These **delocalised electrons** allow **graphite** to **conduct electricity**, unlike most other covalent structures.

Summarise the properties of covalent molecular substances below:

Melting/Boiling Point	High
Electrical Conductivity	No (Except Graphite)
Hardness	Generally Hard (Soft in Graphite between layers)
Solubility in Water	Insoluble
Directionality of Bonds	Three-dimensional (Two-dimensional layers in Graphite)
Examples	Diamond, Graphite, silicon dioxide.

Questions

1. **Identify** the type of covalent structure found in diamond and graphite.

2. **Explain** why graphite can conduct electricity but diamond cannot.

3. **Describe** the bonding in a water molecule using the concept of outer electron bonding diagrams.

4. **Compare** the properties of covalent networks and simple covalent molecules in terms of melting points and electrical conductivity.

5. **List** three uses of silicon dioxide and explain how its properties make it suitable for these uses.

6. **Summarize** how the structure of graphite makes it different from other covalent networks.

7. **Predict** the shape of methane (CH_4) and water (H_2O) molecules.

8. **Determine** the type of bonding in sulfur hexafluoride (SF_6) and state whether it is a simple covalent molecule or part of a covalent network.

Date: ________________

Bonding - Ionic

Learning Intentions

- To learn about ionic bonding and structure.

Success Criteria

☐ I can state how ionic bonds are formed.

☐ I can explain the formation of ions to make stable ionic bonding.

☐ I can explain the properties of ionic substances and how they arise.

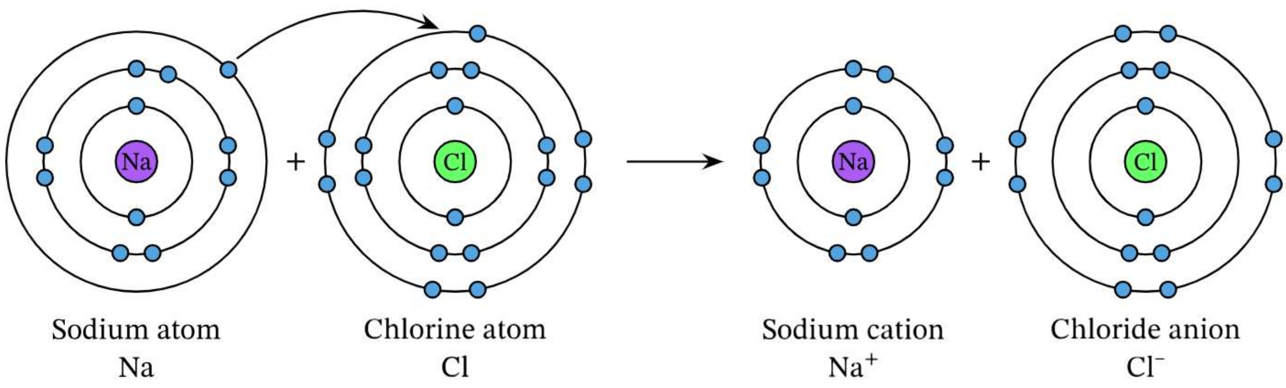
Introduction to ionic bonding

Ionic bonding occurs when atoms **transfer electrons** to achieve a **stable** electron configuration.

- This type of bonding occurs between **metal** and **non-metal** atoms.

In this process, one atom loses electrons and becomes a **positively** charged ion (cation), while another atom gains those electrons and becomes a **negatively** charged ion (anion).

- The resulting ions are held together by the **electrostatic** attraction between their **opposite** charges.

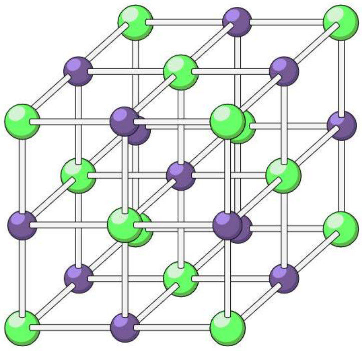


Using sodium and chlorine as an example

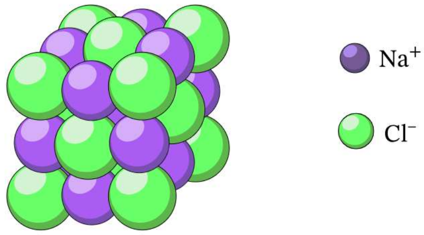
1. Sodium (2, 8, 1) gives its 1 outer electron to chlorine (2, 8, 7).
2. Sodium becomes a positive ion (Na^+) with a full outer shell of 8 (2, 8).
3. Chlorine becomes a negative ion (Cl^-) with a full outer shell of 8 (2, 8, 8).
4. Na^+ and Cl^- stick together to make sodium chloride (NaCl) because opposite charges attract.

Structure and Properties of Ionic Substances

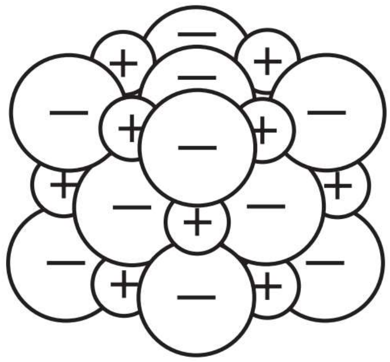
Ionic substances form a **<u>lattice</u>** as shown below. These are shown at the atomic scale (the micro scale).



Ionic lattice
(showing bonds)



Ionic lattice
(not showing bonds)



Ionic lattice
(SQA version)

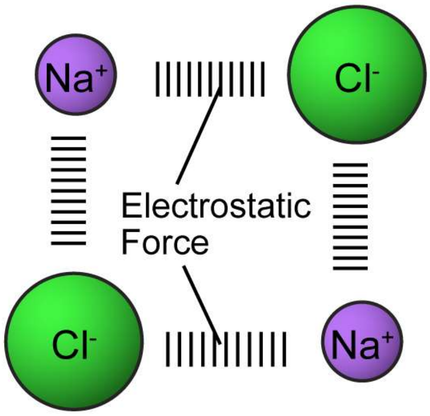
when we look at these substances with our own eyes, at our human size (or "macro scale")

Summarise the properties of ionic compounds below:

State at Room Temperature	**Usually solid**
Melting and Boiling Points	**Generally high**
Electrical Conductivity	**Conductive when molten or dissolved in water**
Solubility in Water	**Generally soluble**
Hardness	**Usually hard but brittle**
Type of Elements Involved	**Metal and non-metal**
Type of Structure	**lattice**

Why do ionic substances have high melting/boiling points?

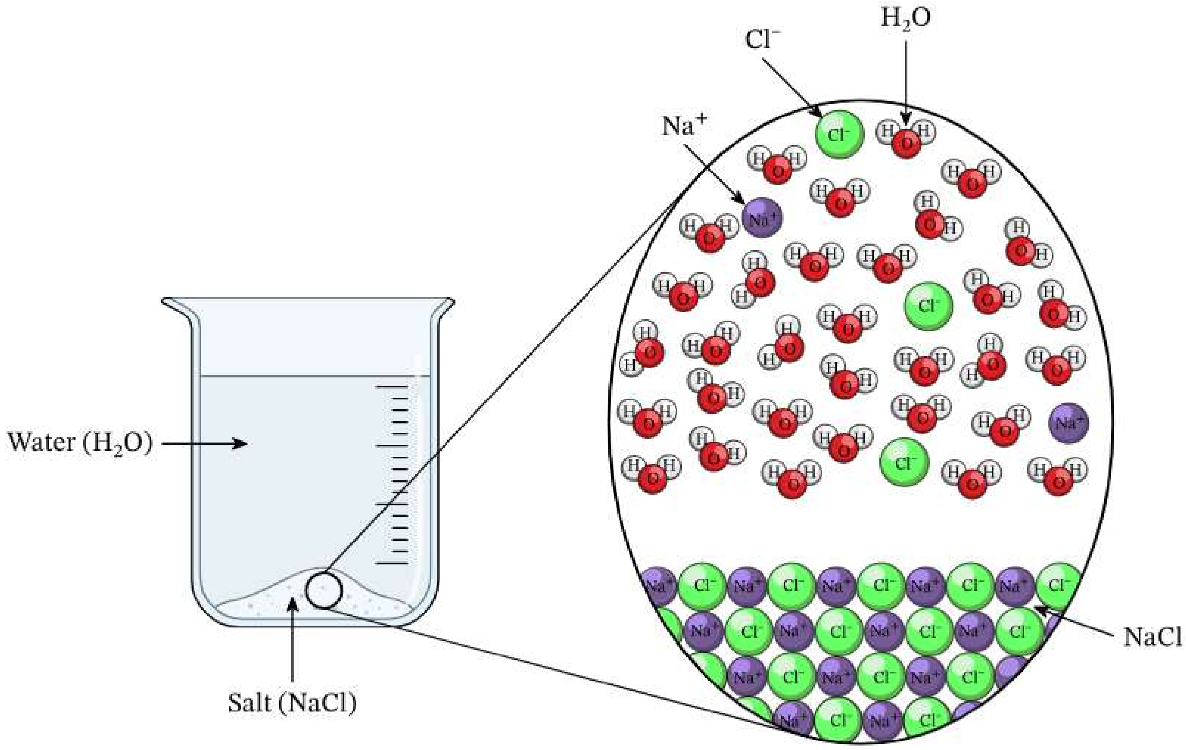
Ionic substances have high melting points because the **strong electrostatic force** of **attraction** between **positive** and **negative** ions holds them tightly together. A lot of **heat** is needed to break these **strong** bonds, so they melt at **high** temperatures.



Why do Ionic compounds conduct when molten/dissolved in water?

In solid form, the ions in an ionic substance are held tightly in a **lattice** structure and **can't move freely**, so they don't conduct electricity. However, when the ionic substance is **melted or dissolved in water**, the **ions** become **free to move**.

Electrical conductivity can only occur when **charged particles** can move **freely**.



Questions

1. **Identify** the types of elements that typically form ionic bonds.

2. **Explain** how an atom becomes an ion in the context of ionic bonding.

3. **Describe** why ionic compounds usually have high melting and boiling points.

4. **Sketch** the lattice structure of an ionic compound, such as sodium chloride (NaCl), to demonstrate how the ions are arranged in a solid state.

5. **Illustrate** how the electron configuration changes when sodium forms an ionic bond with chlorine.

6. **Evaluate** whether ionic compounds can conduct electricity in their solid state, providing reasons for your answer.

Electrolysis of Copper Chloride Solution (page 18 lab booklet)

Aim: ____

____

Method:

Results:

Conclusion: ____

____

____

Evaluation: ____

____

____

Date: ________________

Bonding – Metallic

Learning Intentions

- To learn about metallic bonding.

Success Criteria

☐ I can describe the bonding and structure in a metal element/compound.

☐ I can explain the properties of metallic bonding and how they arise.

Introduction to metallic bonding

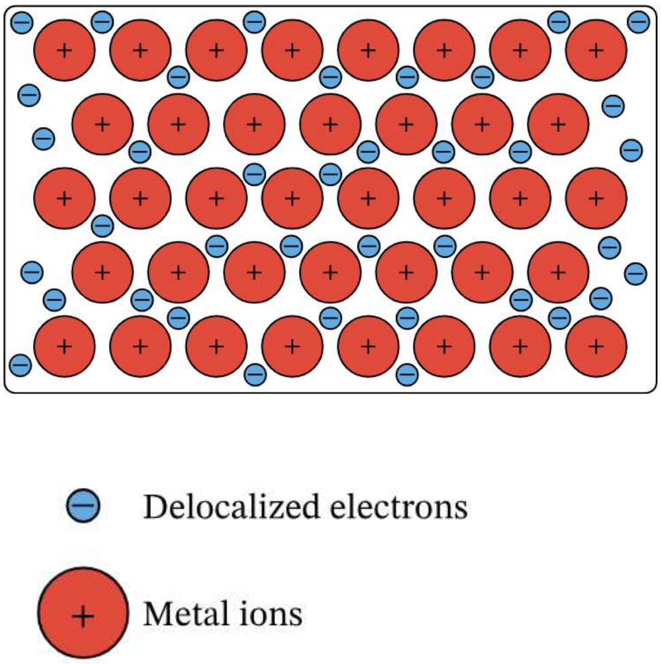
Metallic bonding is the type of bonding that occurs between **metal** atoms.

In this structure, **positive metal ions** are closely packed together in a **lattice**, but their **outer** electrons are **free to move** throughout the structure.

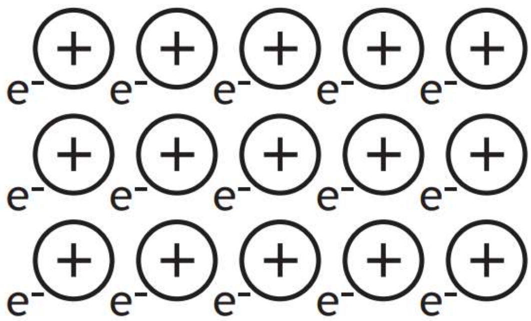
These free to move electrons are known as **delocalised electrons**.

These **delocalised electrons**, often referred to as a "sea of electrons," are **shared** among **all the atoms.** This allows metals to **conduct** electricity, be **malleable**, and have other characteristic properties.

Metallic lattice



Metallic lattice (SQA version)



When we look at these substances with our own eyes, at our human size (or "macro scale")

Summarise the properties of metallic compounds below:

State at Room Temperature	Usually solid (except for mercury)
Melting and Boiling Points	Generally high
Electrical Conductivity	Good conductors of electricity
Thermal Conductivity	Good conductors of heat
Malleability	Can be hammered into thin sheets
Ductility	Can be drawn into wires
Luster	Shiny and reflective
Hardness	Varies; some are hard, some are soft
Type of Elements Involved	Metals
Type of Structure	Lattice with free-moving electron (delocalised)

Questions

1. **Identify** the primary type of elements that participate in metallic bonding.

2. **Explain** why metals are generally good conductors of electricity.

3. **Describe** the "sea of electrons" model in metallic bonding.

4. **Sketch** the lattice structure of a metallic substance, such as iron or copper, to demonstrate how the atoms and free electrons are arranged

5. **Compare** the electrical conductivity of metals with that of ionic and covalent compounds.

6. **Suggest** why most metals have high melting and boiling points.

7. **Illustrate** how the properties of metals are influenced by metallic bonding.

Date: ________________

Bonding - Summary

Summarise the bonding topic. You may make a flow chart, mind-map, bullet-points, outlines, or brief statements.

You are draw a table to show the difference in properties in each type of substance. Include general melting/boiling points, and electrical conductivity.

Questions

State the type of bonding for each, metallic, ionic, or covalent.

Substance	Type of Bonding
Sodium Chloride ($NaCl$)	
Carbon Dioxide (CO_2)	
Magnesium Oxide (MgO)	
Copper (Cu)	
Water (H_2O)	
Methane (CH_4)	
Calcium Carbonate ($CaCO_3$)	
Iron (Fe)	
Silicon Dioxide (SiO_2)	
Sulfur Hexafluoride (SF_6)	
Potassium Bromide (KBr)	
Silver (Ag)	
Hydrogen Sulfide (H_2S)	
Ammonia (NH_3)	
Aluminum Oxide (Al_2O_3)	
Zinc (Zn)	
Phosphorus Pentachloride (PCl_5)	
Carbon Monoxide (CO)	
Calcium Phosphate ($Ca_3(PO_4)_2$)	
Platinum (Pt)	
Sodium Sulfate (Na_2SO_4)	
Silicon Carbide (SiC)	

State the type of bonding for each based on the properties of the substance.

1. A substance melts at a high temperature and is soluble in water, but it doesn't conduct electricity when solid. What type of bonding does this substance likely have?

2. This substance has a low melting and boiling point and is a poor conductor of electricity in all states. Can you identify the type of bonding present?

3. A material has a high melting point, can conduct electricity when molten or in solution but not in its solid state, and is hard and brittle. What type of bonding does this indicate?

4. A substance is a good conductor of electricity in the solid state and is malleable and ductile. What type of bonding does this suggest?

5. This substance is a gas at room temperature and is a poor conductor of electricity. What type of bonding is likely present?

6. A compound is soluble in water and has a high boiling point. It conducts electricity when dissolved in water. What type of bonding does this suggest?

7. This substance has a very high melting point, is insoluble in water, and is hard and brittle. It doesn't conduct electricity in any state. What type of bonding is likely present?

8. A substance is a good conductor of heat and electricity in the solid state and has a high melting and boiling point. What type of bonding does this substance likely have?

9. A compound is a poor conductor of electricity, is soluble in organic solvents but not in water, and has a relatively low melting and boiling point. What type of bonding does this suggest?

10. This substance is a good conductor of electricity in the solid and liquid state, has a high melting point and is malleable. What type of bonding does this indicate?

Extension questions:
Chemcord purple books (N5): page 23 – 39
SCHOLAR

Topic	2015	2016	2017	2018	2019
Bonding	MC – 5,7 S2 – 4(a),9(b)ii, 14(a)ii	MC – 4,5,6 S2 – 1(c)i, 11(c),	MC – S2 – 3	MC – 3,4,6 S2 – 10(b)	MC – 5,6 S2 – 3(a)

MC = multiple choice section, S2 = section 2, the written section.