



SUBJECT and GRADE	PHYSICAL SCIENCES GRADE 10	
TERM 1	WEEK 7	
TOPIC	CHEMICAL BONDING	
AIMS OF LESSON	To reiterate the concept of Chemical Bonding and the different types completed last week To introduce the concept of Metallic Bonding	
RESOURCES	Paper based resources	Digital resources
	Refer to your textbook, find the relevant sections of the work, work through the notes and examples and complete the activities listed at the end of each section.	Use the links to watch the following videos: What are metallic bonds/Properties of matter/Chemistry/Fuse School - https://www.youtube.com/watch?v=S08qdOTd0w0 Chemical Bonding - https://www.youtube.com/watch?v=1DWZFkipYtE How to calculate Molar Mass Practice problems - https://www.youtube.com/watch?v=Qflq48Foh2w
INTRODUCTION	From your previous lesson, you have learnt the following: Covalent bond – sharing of electrons between two non-metal atoms to form a molecule Ionic bond - the transfer of electrons from a metal atom to a non-metal atom to form cations (positive ions) and anions (negative ions) that attract each other to form a formula-unit. Lewis diagram - a structural formula in which valence electrons are represented by dots or crosses. It is also known as an electron dot formula, a Lewis formula, or an electron diagram.	

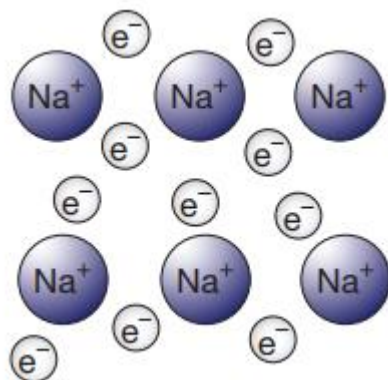
CONCEPTS AND SKILLS

PART 1: CHEMICAL BONDING CONTINUED ...

METALLIC BONDING:

- occurs as the bond between positive ions and delocalised valence electrons in a metal.
- Valence electrons or outer electrons are the electrons in the highest energy level of an atom in which there are electrons.

Example 1: Metallic bonding in Sodium (Na)



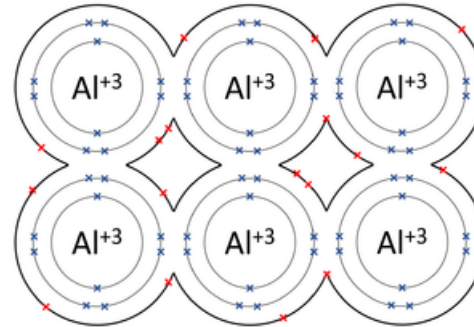
CAN YOU?

- Identify the type of bonding between atoms by identifying the atoms in each molecule/crystal lattice?
- Explain metallic bonding?
- Explain metallic bonding by using diagrams?
- Compare metals with their properties?
- Differentiate between molecules and crystal lattices?
- Calculate the M_r of molecular and ionic substances?

CAN YOU?

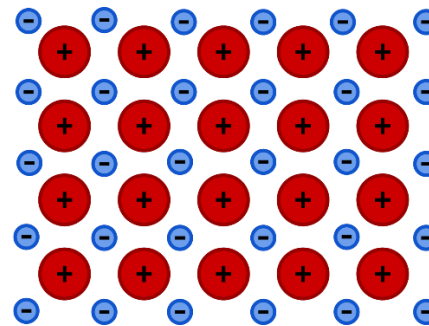
- Identify the different types of charges (in terms of electrostatics)?
- Explain the concept of tribo-electric charging?
- Predict, using the tribo-electric series which substance will lose electrons during contact and rubbing together?
- Predict, using the tribo-electric series which substance will receive electrons during contact and rubbing together?

Example 2: Metallic bonding in Aluminium (Al)



How does it occur?

- Atoms of the same metal form metallic bonds
- The atoms are 'packed' closely together in a metal (solid structure)
- As a result, their outer orbitals overlap (refer to Example 2 above)
- The valence electrons become delocalised (this means that the valence electrons of the metal atoms do not belong to a specific atom but moves freely amongst the atoms (refer to Example 1
- The atoms now become positive ions (indicated by the positive circles below) surrounded by a 'sea' of delocalised electrons.
- The electrons and the positive ions of the metal are held together by strong electrostatic, attractive force between them.



- Metals form very big structures of many metal atoms because it can be held together in this way.

Metallic bonds are used to explain the properties of metals:

Properties:

- Conduction of heat and electricity: The free-moving valence electrons act as carriers of heat and electricity.
- Malleability and ductility: If you hit a piece of metal with a hammer, the positive ions shift over each other, but the delocalised valence electrons move between them and prevent the positive ions from getting too close and then repelling each other. This stops the metal from breaking.
- High density: Metal ions can be packed very close together because electrons are very small.
- Metallic lustre: Valence electrons are free and do not belong to one specific atom. These free electrons can absorb and give back light of any frequency. Metals thus gleam in any light.

PART 2

CALCULATING RELATIVE MOLECULAR MASS (of molecules)

Remember that during covalent bonding, **molecules** are formed. Did you know that the atoms combine in fixed ratios, for example H₂O is the formula for water and it combines in the ratio 2:1 (2 Hydrogen atoms: 1 oxygen atom)?

To calculate the molecular mass (M_r) for molecules:

1. Multiply the atomic mass of each atom by the number of those atoms in the molecule
2. Add all the masses together

Worked example 1: Calculating the M_r of CO₂.

Solution: $M_r(\text{CO}_2) = 12 + [16 \times 2] = 44\text{g}$

Worked example 2: Calculating the M_r of H₂O.

Solution: $M_r(\text{H}_2\text{O}) = [1 \times 2] + 16 = 18\text{g}$

Worked example 3: Calculating the M_r of SO₃.

Solution: $M_r(\text{SO}_3) = 32 + [16 \times 3] = 80\text{g}$

CALCULATING RELATIVE FORMULA MASS (of ionic crystal lattices)

Remember during ionic bonding, **crystal lattices** are formed. The formulae of the crystal lattices indicate the simplest ratio in which the ions combine.

It is calculated in the same manner as the Molecular mass explained above.

Worked example 4: Calculating the M_r of NaCl.

Solution: $M_r(\text{NaCl}) = 23 + 35,5 = 58,5\text{g}$

Worked example 5: Calculating the M_r of CaF_2 .

Solution: $M_r(\text{CaF}_2) = 40 + [19 \times 2] = 78\text{g}$

Worked example 6: Calculating the M_r of NaHCO_3 .

Solution: $M_r(\text{NaHCO}_3) = 23 + 1 + 12 + [16 \times 3] = 84\text{g}$

PART 3: ELECTROSTATICS

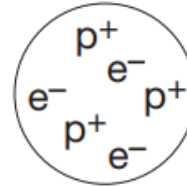
Electrostatics (or static electricity) has to do with the interactions of **charges** that are mainly stationary (NOT MOVING).

All materials consist of very small particles called atoms.

- At the centre of each atom is a nucleus that consists of **neutrons** that have **no charge** and **protons** that carry a **positive charge**.
- Outside the nucleus are much smaller particles called **electrons**. They carry a **negative charge** that is the same size as the positive charge of the protons.

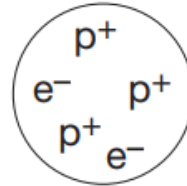
- An object that has an **equal number** of electrons and protons is **neutral**, therefore the **net** charge of the object is zero.

This example contains 3 protons and 3 electrons.



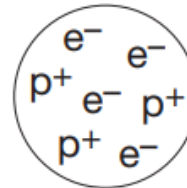
- A **positively charged** object has fewer electrons than protons. It is electron deficient.

This example contains 3 protons and 2 electrons.



- If it is **negatively charged**, an object has more electrons than protons. It has an excess of electrons.

This example contains 3 protons and 4 electrons.



WHAT IS TRIBO-ELECTRIC CHARGING?

- Certain materials are more attracted to electrons than others.
- So, when you bring two different materials into contact with one another, some electrons will transfer from the one to the other.
- The transfer of the electrons from one material to another is also increased by rubbing the materials together.

Table 1: The Tribo-electric series

Substances higher in the table tend to become positively charged.

POSITIVE END OF SERIES
Human hand
Glass
Human hair
Nylon (e.g. stockings)
Wool
Silk
Paper
Cotton
Steel
Wood
Rubber balloon
Copper, brass
Sulfur
Acetate
Polyester
Polyethylene (e.g. plastic bags)
Polypropylene (e.g. plastic chairs)
Polyvinylchloride (PVC) (e.g. insulation for electrical cables)
Teflon
NEGATIVE END OF SERIES

Example:

A piece of paper rubbed on glass becomes **negatively charged** but if the paper is rubbed on a rubber balloon, the paper becomes **positively charged**. Refer to the table above.

The substance that loses electrons becomes positive and the other one substance becomes negative.

ACTIVITIES/ASSESSMENT

ACTIVITY 1:

1. Identify the types of chemical bonding in each of the following below.
Hint – determine the type of elements, and therefore atoms, first.

1.1 NaCl

1.2 H₂O

1.3 MgO

1.4 Fe

1.5 CO₂

2. Fill in the missing word/s to complete the statements.

2.1 Ionic bonds are formed when the electron is transferred from a ... atom to a ... atom.

2.2 Metallic solids are made up of one ... element.

2.3 The combination of atoms formed during covalent bonding is a ...

2.4 When an atom loses an electron, or receives an electron, it becomes an ...

2.5 Metals have high density because the metal ... are packed

3. Calculate the M_r of:

3.1 N₂O₄

3.2 NH₃

3.3 CCl₄

3.4 H₂SO₄

3.5 KMnO₄

	<p><u>ACTIVITY 2:</u></p> <p>1. Write the definitions for the following:</p> <p>1.1 electrically neutral 1.2 net charge 1.3 like charges 1.4 tribo-electric charging</p> <p>2. When you rub plastic and wool together, ...</p> <p>2.1 which particles are transferred from one substance to another? 2.2 which substance will lose electrons and become positively charged? 2.3 which substance will receive electrons and become negatively charged?</p>
<p>CONSOLIDATION</p>	<ul style="list-style-type: none"> • Ensure that you understand, are able to identify and describe the different types of chemical bonding • Link the properties of metals to how metallic bonds are formed • Remember how to calculate the molecular/formula mass of molecules/crystal lattices • Understand the two types of charges and what electrostatics is about • Predict the charges on substances when they are in contact, and then rubbed together • Refer to your textbook, find these sections of work and complete the activities listed • Good luck with the lesson and do not forget to ask your teacher for support if you need it!
<p>VALUES</p>	<p>ATTENTIVENESS INDEPENDENCE</p>