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S3 New Curriculum chemistry

Theme: Structures and bonds

Chapter 2 – Structures and bonds

Definitions

An element is a substance which cannot be split or divided up into simpler substances by chemical means. Common elements are oxygen, nitrogen, sulphur and others.

A **compound** is a substance composed of **two or more elements chemically bonded** together.

An atom is the smallest indivisible particle of an element that can take part in a chemical reaction.

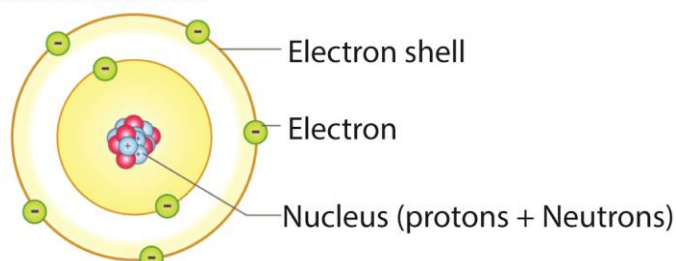
A **molecule** is the smallest particle of an element or compound that can exist in a free and separate state.

Trial 1

Give three examples of each of the following

- (a) Elements
- (b) Compounds
- (c) mixtures

Atomic structure



An atom is composed of three basic subatomic particles, namely the electron, the proton and the neutron; the characteristics of which are given in a table below:

Table: The three main subatomic particles.

Particle	Symbols	Charge	Mass
Electron	e	-1	1/1837
Proton	p	+1	1
Neutron	n	No charge	1

All atoms of the same element contain the **same** number of protons (usually equal to the number of electrons).

Atomic number (Z) is the number of protons in an atom. it is characteristic of an element.

The atomic mass (A) is the sum of the number of protons and neutrons in an atom of an element. **Isotopes** are atoms with the same atomic number but different atomic masses (due to the difference in the number of neutrons in an atom).

Relative atomic mass (Ar) is the **weighted average mass** of an atom of an element compared to **1/12th the mass of a carbon-12 atom**.

Name and chemical symbols of elements

- The chemical symbol(s) is /are a letter or letters that represent an atom of an element.
- If the chemical symbol has one letter then, that letter is a capital letter.
- If the chemical symbol has two letters then, the first letter is capital and the second letter is a small letter and they are written such that they touch each other.

Standard representation of atoms of an element

The element X with atomic mass, A, and atomic number Z is represented as



Trial 1

Write the standard representation of atoms of the following elements:

- Hydrogen
- Oxygen
- nitrogen

A list of the first 20 elements in the periodic table and their chemical symbols

Poem	Name of the element.	Symbol	Atomic numbers (Z)	Atomic mass (A)
Hallo	Hydrogen	H	1	1
Hellene	Helium	He	2	4
Literature	Lithium	Li	3	5
Becomes	Beryllium	Be	4	9
Bore	Boron	B	5	10
Can	Carbon	C	6	12
Not	Nitrogen	N	7	14
Offer	Oxygen	O	8	16
Favourable	Fluorine	F	9	19
Neon	Neon	Ne	10	20
Naye	Sodium	Na	11	23
Mega	Magnesium	Mg	12	25
All	Aluminium	Al	13	26
Sinks	Silicon	Si	14	28
Plus	Phosphorus	P	15	31
Source pans	Sulphur	S	16	32
Clean	Chlorine	Cl	17	35.5
Are	Argon	Ar	18	40
Kept	Potassium	K	19	39
Carefully	Calcium	Ca	20	40

Trial 2

Write electron configurations of the following element

Na, Cl, Ca, O, K and N

Combination of atoms

Atoms combine to form molecules and compound through chemical bonding.

A chemical bond is the force of attraction that binds the atoms within a molecule.

Valence is the combining power of an element or a radical. OR the number of electrons an element loses or acquires to be stable or the number of bonds an atom can form with other atom(s).

Table of the valences of the first twenty elements of the periodic table

Group	1	2	3	4	5	6	7	8
valence	1	2	3	4	3	2	1	0
Elements	H							He
	Li	Be	B	C	N	O	F	Ne
	Na	Mg	A	Si	P	S	Cl	Ar
	K	Ca						

Types of chemical bonds

A chemical bond may be;

- i) Ionic bond
- ii) Covalent bond
- iii) Metallic bond
- iv) Coordinate/Dative bond
- v) Van de Waal

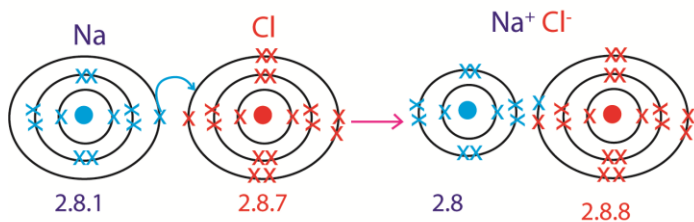
Noble gases have a full outermost energy level/ shell e.g helium (2), argon (2:8:8), neon (2:8). They are stable and therefore, they do not react with other elements. Elements attain this noble gas configuration by combining with other elements to form a molecule or a compound. They do this in two main ways:

1. Ionic or electrovalent bonding
2. Covalent bonding

Ionic or electrovalent bonding:

An **ionic bond** is a bond formed when one atom donates electron(s) to form a positively charged ion or a **cation** and another accepts electron(s) to become a negatively charged ion or an **anion**. The electrostatic attraction between positive and negative ions constitutes an **ionic bond**. The compound formed is called **ionic compound**.

Reaction of sodium with chlorine to form ionic bond



Ionic bond is the attractive force between positive and negative ions

Properties of ionic compound

- i. **Conduct electricity** when molten or in aqueous solution. This is because ionic compounds consists of positively charged ions which, when in molten state or aqueous state, become mobile and conducts electricity.
- ii. Usually they **have high melting and boiling points**. This is because great energy is needed to break the strong electrostatic force holding the ions together in a regular lattice.
- iii. Usually they are **crystalline solids**.
- iv. Usually they **dissolve in polar solvents such as water**. This is because water molecules are able to bond with both the positive and negative ions. They break up the lattice and keeps the ions apart. If they do not dissolve in polar solvent, it is often because very high energy is required to break up the lattice

Trial 3

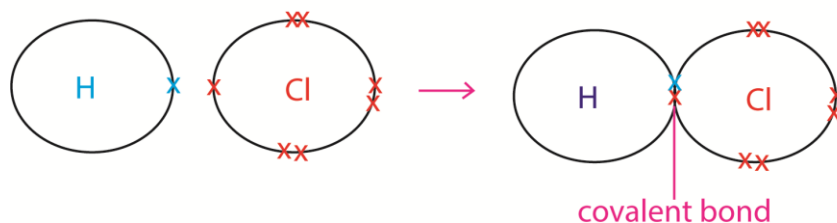
- (a) Electron configurations of calcium and oxygen atoms.
- (b) Draw structural diagrams to show the reaction of calcium and oxygen to form calcium oxide.
- (c) Write electron configuration of calcium and oxygen ions.
- (d) Name the type of bond formed between calcium and oxygen.

Covalent bonding

A covalent bond is a bond formed by mutual sharing of one or more electron pairs between atoms of non-metallic elements. For example,

- (i) two hydrogen atoms combine to form a hydrogen molecule,

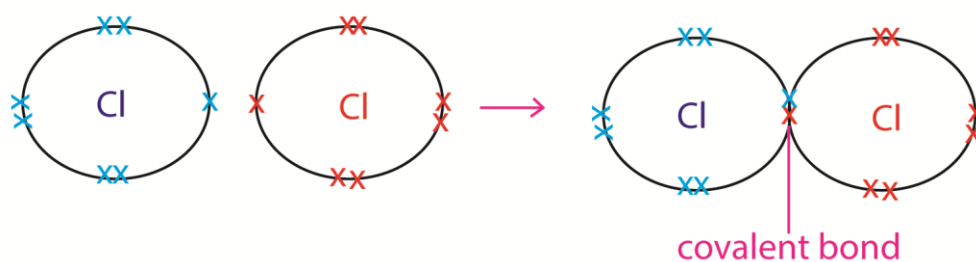
Reaction of hydrogen and chlorine atoms to form a covalent bond



The shared pair of electrons constitute a covalent bond

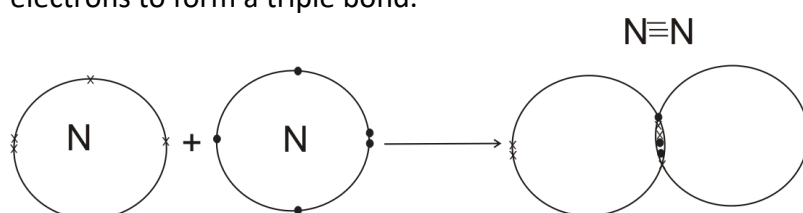
- (ii) chlorine atom combines with a hydrogen atom to form a hydrogen chloride molecule.

Reaction of two chlorine atoms to form a covalent bond

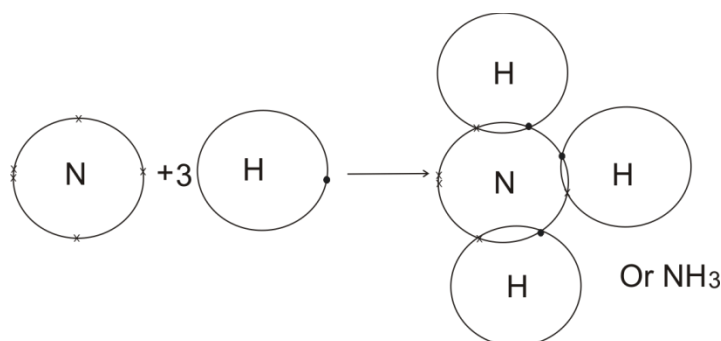


The shared pair of electrons constitute a covalent bond

- (iii) In a covalent bond between two nitrogen atoms involve sharing three pairs of electrons to form a triple bond.



- (iv) In formation of ammonia, Nitrogen uses its unpaired electrons to bond with three hydrogen atoms



Properties of covalent compounds

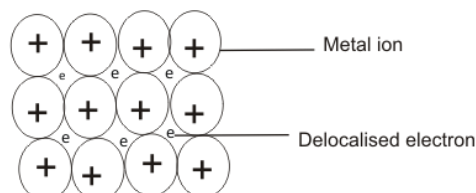
- (i) **Covalent compounds are non-electrolytes.** This is because they consist of molecules with no ions. Non- electrolyte is a solution or a molten compound which does not conduct electricity.
- (ii) They are usually gases, liquids or solids with **low melting points and boiling points** because of the weak inter molecular forces (van der waal forces) of the attraction which exist between simple molecules. Giant molecular substances have higher melting point because the whole structure is held together by strong covalent bonds within the giant molecule as in case of silicon(IV) oxide.
- (iii) They usually **dissolve in non-polar solvents.** Examples of non-polar solvents are tri chloromethane, tetra chloromethane and carbon disulphide. These liquid are covalent compounds and dissolve a great number of covalent compounds. For example tri chloromethane dissolves iodine, carbon disulphide dissolve sulphate. Generally, they do not dissolve in water.

Trial 4

Draw the structure to show the formation of O_2 , CCl_4 , CO_2

Metallic bond

A **metallic bond** is the type of chemical bonding that holds **metal atoms** together in a solid structure. It occurs due to the **delocalization of valence electrons**, meaning that electrons are not bound to a specific atom but instead move freely throughout the metallic structure.



Properties of metals

- (i) Due to the presence of delocalised electrons, metals are good conductor of heat and electricity. When the voltage is applied across the metal, the delocalised electrons are able to move freely through the structured conducting an electric current.
- (ii) Metals generally have high densities because the ions are closely packed in the lattice.
- (iii) They usually have high melting and boiling points due to the strong attraction between the positive metals ions and the delocalised electrons. Most non-metals have low melting points and boiling points.
- (iv) They are malleable and ductile. That is, the metals can be pulled out into thin wires.
- (v) Malleable: means that metals can be harmed into different shapes

Trial 5

- (a) Differentiate between an ionic bond and covalent and ionic bond.
- (b) (i) State the type of bonds in ammonia and methane
 - (i) Use diagrams to show how a hydrogen atom combines with a chlorine atom to form hydrogen chloride.
- (c) What type of bond is formed when hydrogen combines with chlorine to form hydrogen chloride? Explain your answer.

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Thanks

Dr. Bbosa Science