I. Choose the correct answer

a. Which of the following names represents silver?

i. Kalium

ii. Ferrum

iii. Argentum ✓

iv. Aurum

b. An element with mass number 24 has 12 protons. What is the name of the element?

i. Fluorine

ii. Magnesium ✓

iii. Sodium

iv. Potassium

c. Which of the following elements has a variable valency?

i. Calcium

ii. Silver

iii. Chlorine

iv. Copper ✓

d. What is the molecular formula of nitric acid?

i. HCl

ii. H_2SO_4

iii. HNO_3 ✓

iv. NaOH

e. Which of the following is the most reactive non-metal?

i. Fluorine ✓

ii. Chlorine

iii. Bromine

iv. Iodine

f. What is the valency of iron in $FeSO_4$?

i. 1

ii. 2 ✓

iii. 3

iv. 4

g. What is the molecular weight of $CaCO_3$?

i. 44

ii. 98 ✓

iii. 100

iv. 50

II. Answer these questions in brief

a. What are elements?

Elements are pure substances made up of only one kind of atom. They cannot be broken down into simpler substances by chemical means. Example: Oxygen (O), Iron (Fe).

b. How many elements have been discovered so far?
About **118 elements** have been discovered, out of which some are naturally occurring and others are artificially synthesized.

c. Write down the postulates of Niels Bohr's model of an atom.

- Electrons revolve around the nucleus in fixed circular paths called **orbits or shells**.
- Each orbit has a fixed energy level.
- Electrons in an orbit do not radiate energy.
- Energy is absorbed or emitted only when an electron jumps from one orbit to another.

d. Define duplet and octet rule with examples.

Duplet Rule: Atoms tend to achieve **2 electrons** in their outer shell (like Helium). Example: Hydrogen (H_2), Helium (He).

Octet Rule: Atoms tend to have **8 electrons** in their outer shell to become stable (like noble gases). Example: Sodium chloride (NaCl), Water (H_2O).

e. What is a molecule?
A molecule is the smallest unit of a substance that can exist independently and retains all the properties of that substance. Example: O_2, H_2O, CO_2.

f. Which is a molecule of hydrogen H_2 or 2H?
H_2 is a molecule of hydrogen (two atoms bonded).
2H means two separate hydrogen atoms, not a molecule.

g. What is valence shell? How does valence electron affect the valency of an element?
The **outermost shell** of an atom is called the valence shell.
The number of electrons in this shell is called **valence electrons**. They determine the **valency** of an element, i.e., its combining capacity.

h. What are radicals? Explain electropositive and electronegative radicals with examples.
Radicals are **atoms or groups of atoms** that carry a charge and behave as a single unit during a chemical reaction.

Electropositive radicals (cations): Positively charged. Example: Na^+, Ca^{2+}, NH_4^+.

Electronegative radicals (anions): Negatively charged. Example: Cl^-, SO_4^{2-}, NO_3^-.

i. What is electrovalent bond? Write down the characteristics of electrovalent compounds.

An **electrovalent bond (ionic bond)** is formed when one atom transfers electrons to another atom.

Characteristics:

1. Hard and crystalline solids.
2. High melting and boiling points.
3. Soluble in water.
4. Conduct electricity in molten or aqueous state.

j. What is covalent bond? Write down the properties of covalent compounds.

A **covalent bond** is formed when two atoms share electrons.

Properties:

- Usually liquids or gases, some are soft solids.
- Low melting and boiling points.
- Generally insoluble in water.
- Do not conduct electricity.

k. Describe the formation of ammonia, water and carbon dioxide.

Formation of ammonia(NH3)

The atomic number of nitrogen is 7. Its electronic configuration is 2, 5, which means nitrogen has **five valence electrons** in its outermost shell. To complete its octet, nitrogen needs **three more electrons**.

Each hydrogen atom has one valence electron and requires one more electron to complete its duplet. Therefore, nitrogen shares **one electron with each of three hydrogen atoms**, and each hydrogen atom shares its single electron with nitrogen.

In this way, nitrogen completes its octet (8 electrons in the valence shell), and each hydrogen atom completes its duplet (2 electrons in the valence shell).

Thus, **ammonia (NH_3) is formed by three covalent bonds** between nitrogen and hydrogen atoms.

Formation of H20

The atomic number of oxygen is 8. Its electronic configuration is 2, 6, which means oxygen has **six valence electrons** in its outermost shell. To complete its octet, oxygen requires **two more electrons**.

Each hydrogen atom has one valence electron and needs one more electron to complete its duplet. Oxygen therefore shares **one electron with each of the two hydrogen atoms**, and each hydrogen atom shares its single electron with oxygen.

As a result, oxygen attains a stable octet (8 electrons), and both hydrogen atoms attain stable duplets (2 electrons).

Thus, **water (H_2O) is formed by two covalent bonds** between oxygen and hydrogen atoms.

Formation on Carbon Dioxide

The atomic number of carbon is 6. Its electronic configuration is 2, 4, which means carbon has **four valence electrons** in its outermost shell. To complete its octet, carbon requires **four more electrons**.

Each oxygen atom has the atomic number 8 and electronic configuration 2, 6. This means each oxygen atom has **six valence electrons** and needs **two more electrons** to complete its octet.

Carbon shares **two pairs of electrons with each oxygen atom**, and each oxygen atom shares two electrons with carbon. This results in the formation of **two double covalent bonds** between carbon and the two oxygen atoms.

In this way, the carbon atom attains an octet, and each oxygen atom also attains an octet.

Thus, **carbon dioxide (CO_2) is formed by two double covalent bonds**.

I. Describe the formation of aluminium chloride, sodium chloride and calcium oxide.

Aluminium chloride ($AlCl_3$):
One aluminium atom loses 3 electrons to form Al^{3+}. Each chlorine atom gains 1 electron to form Cl^-. Three chloride ions combine with one aluminium ion to form ionic $AlCl_3$.

Sodium chloride (NaCl):
Sodium atom loses 1 electron to form Na^+. Chlorine atom gains that electron to form Cl^-. Strong electrostatic force between Na^+ and Cl^- forms ionic NaCl.

Calcium oxide (CaO):
Calcium atom loses 2 electrons to form Ca^{2+}. Oxygen atom gains 2 electrons to form O^{2-}. These oppositely charged ions bond to give ionic CaO.

III. Differentiate between

a. Elements and Compounds

Elements	Compounds
Pure substances made of only one kind of atom.	Substances formed by the chemical combination of two or more elements.
Cannot be broken into simpler substances.	Can be broken down into simpler substances (elements).
Example: O_2, Na, Fe	Example: H_2O, NaCl, CO_2

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b. Electrovalent and Covalent bond

Electrovalent Bond (Ionic)	Covalent Bond
Formed by transfer of electrons.	Formed by sharing of electrons.
Usually between metal and non-metal.	Usually between non-metals.
Compounds are crystalline solids.	Compounds are gases, liquids or soft solids.
Conduct electricity in molten/solution state.	Do not conduct electricity.

C. Symbol and molecular formula

Symbol	Molecular Formula
Short notation of a single element.	Representation of a compound showing number of atoms.
Example: H (hydrogen), Na (sodium), O (oxygen).	Example: H_2O (water), CO_2 (carbon dioxide), NH_3 (ammonia).
Refers only to one type of atom/element.	Refers to an actual molecule made of different atoms.

D. atom and ion

Atom	Ion
Electrically neutral particle (protons = electrons).	Charged particle formed when atom gains or loses electrons.
Example: Na (sodium atom), Cl (chlorine atom).	Example: Na^+ (sodium ion, lost 1 electron), Cl^- (chloride ion, gained 1 electron).
Stable in neutral state.	Stable in charged state (cation or anion).

Give reasons

a. **Magnesium chloride is an electrovalent (ionic) compound.**
Because Mg (a metal) transfers electrons to Cl (a nonmetal) forming Mg^{2+} and Cl^- ions; they are held together by electrostatic attraction.

b. **Carbon dioxide is a covalent compound.**
Because C and O are nonmetals that share electrons to form covalent bonds, producing discrete CO_2 molecules.

c. **Helium has a duplet state.**
Helium has two electrons . The outer shell holds 2 electrons which is a stable duplet configuration.

d. **The valency of argon is 0.**
Argon is a noble gas with a full outer shell (stable electronic configuration), so it does not usually form bonds — effective valency 0.

e. **The valency of sodium is 1.**
Sodium (Na) has one electron in its outermost shell, so it tends to lose one electron to achieve a noble gas configuration → valency 1.

f. **An atom is electrically neutral.**
Because the number of protons (positive charge) equals the number of electrons (negative charge), so net charge = 0.

Write the molecular formula (by criss-cross / standard formulas)

a. Ammonia – **NH_3**
b. Marble – **$CaCO_3$** (marble = calcium carbonate)
c. Water – **H_2O**
d. Methane – **CH_4**
e. Silver nitrate – **$AgNO_3$**
f. Calcium chloride – **$CaCl_2$**
g. Magnesium hydroxide – **$Mg(OH)_2$**
h. Limestone – **$CaCO_3$** (same as marble)
i. Potassium oxide – **K_2O**
j. Potassium chloride – **KCl**
k. Sodium chloride – **NaCl**
l. Sulphur trioxide – **SO_3**
m. Nitric acid – **HNO_3**
n. Nitrous acid – **HNO_2**
o. Sulphuric acid – **H_2SO_4**
p. Sulphur dioxide – **SO_2**
q. Auric chloride (gold(III) chloride) – **$AuCl_3$**
r. Hydrogen peroxide – **H_2O_2**
s. Sodium peroxide – **Na_2O_2**
t. Slaked lime – **$Ca(OH)_2$** (calcium hydroxide)
u. Magnesium cyanide – **$Mg(CN)_2$**
v. Phosphoric acid – **H_3PO_4**
w. Ferric chloride (iron(III) chloride) – **$FeCl_3$**
x. Mercuric oxide (mercury(II) oxide) – **HgO**
y. Potassium bicarbonate – **$KHCO_3$**
z. Silver chloride – **AgCl**
za. Ammonium sulphate – **$(NH_4)_2SO_4$**
zb. Calcium phosphate – **$Ca_3(PO_4)_2$**
zc. Ammonium nitrate – **NH_4NO_3**
zd. Washing soda – **$Na_2CO_3 \cdot 10H_2O$** (sodium carbonate decahydrate; anhydrous is Na_2CO_3)

Calculate the molecular weight

a. **Sodium chloride (NaCl)**
Na (23) + Cl (35) = **58.**

b. **Calcium carbonate ($CaCO_3$)**
Ca (40) + C (12) + 3×O (3×16 = 48) = **100**

c. **Magnesium sulphate ($MgSO_4$)**
Mg (24) + S (32) + 4×O (64) = **120**

Write down the names of the following compounds

a. **$Ca(OH)_2$** – Calcium hydroxide (slaked lime)
b. **H_2SO_4** – Sulphuric acid
c. **CH_4** – Methane
d. **$MgCO_3$** – Magnesium carbonate
e. **$Ca(HCO_3)_2$** – Calcium hydrogen carbonate (calcium bicarbonate)
f. **$Ca_3(PO_4)_2$** – Calcium phosphate
g. **HNO_3** – Nitric acid
h. **$KClO_3$** – Potassium chlorate
i. **KCN** – Potassium cyanide
j. **Na_2O** – Sodium oxide
k. **HgO** – Mercuric oxide / mercury(II) oxide
l. **$CuSO_4$** – Copper(II) sulphate (blue vitriol)
m. **HCl** – Hydrochloric acid
n. **$(NH_4)_2SO_4$** – Ammonium sulphate