Chapter – 3 Atoms and Molecules

Multiple Choice Questions

Q1. Which of the following correctly represents 360 g of water?

- **i)** **2 moles of H_2O**
- **ii)** **20 moles of water**
- **iii)** **6.022 × 10^{23} molecules of water**
- **iv)** **1.2044×10^{25} molecules of water**

- **a)** **Only i)**
- **b)** **i) and iv)**
- **c)** **ii) and iii)**
- **d)** **ii) and iv)**

Answer: Option d)

Points i) and iv) correctly represents 360 g of water.

ii) 1 mole of water = molar mass of water = 18 g

So, 20 moles of water = 18 g × 20 = 360 g

v) 6.022 × 10^{23} molecules of water = 1 mole =18 g of water

So, 1.2044×10^{25} molecules of water

$$= \frac{18\ g\ \times 1.2044\ \times\ 10^{25}}{6.022 \times 10^{23}} = 360\ g$$

Q2. Which of the following statements is not true about an atom?

- **a)** **Atoms are not able to exist independently**
- **b)** **Atoms are the basic units from which molecules and ions are formed**
- **c)** **Atoms are always neutral in nature**
- **d)** **Atoms aggregate in large numbers to form the matter that we can see, feel or touch**

Answer: Option d) Atoms aggregate in large numbers to form the matter that we can see, feel or touch

The ions and the molecules combined together to form matter. The individual molecules/ions are visible through naked eyes.

Q3. The chemical symbol for nitrogen gas is

- **a)** Ni

b) N_2
c) N^+
d) N

Answer: Option b) N$_2$

Q4. The chemical symbol for sodium is

a) So
b) Sd
c) NA
d) Na

Answer: Option d) Na

Q5. Which of the following would weigh the highest?

a) **0.2 mole of sucrose** $(C_{12}\ H_{22}\ O_{11})$
b) **2 moles of** CO_2
c) **2 moles of** $CaCO_3$
d) **10 moles of** H_2O

Answer: Option c) 2 moles of CaCO$_3$

a) Mass of 1 mole of sucrose $(C_{12}\ H_{22}\ O_{11}) = (12 \times 12) + (1 \times 22) + (16 \times 11) = 342\ g$
0.2 mole of sucrose $= 342\ \times 0.2 = 68.4\ g$

b) Mass of 1 mole of $CO_2 = 12 + (16 \times 2) = 44\ g$
Mass of 2 moles of $CO_2 = 44\ \times 2 = 88\ g$

c) Mass of 1 mole of $CaCO_3 = 40 + 12 + (16 \times 3) = 100\ g$
Mass of 2 moles of $CaCO_3 = 100 \times 2 = 200\ g$

d) Mass of 1 mole of $H_2O = 2 + 16 = 18\ g$
Mass of 10 moles of $H_2O = 18 \times 10 = 180\ g$

So, mass of 2 moles of $CaCO_3$ is the highest i.e., 200 g.

Q6. Which of the following has maximum number of atoms?

a) **18 g of** H_2O
b) **18 g of** O_2
c) **18 g of** CO_2

d) **18 g of CH_4**

Answer: Option d) 18 g of CH_4

a) Number of atoms in 18 g of H_2O

$$= \frac{18}{18} \times 6.022 \times 10^{23} \times 3$$

$$= 18.066 \times 10^{23} = 1.8066 \times 10^{24}$$

b) Number of atoms in 18 g of O_2

$$= \frac{18}{32} \times 6.022 \times 10^{23} \times 2$$

$$= 3.387 \times 10^{23} \times 2 = 6.774 \times 10^{23}$$

c) Number of atoms in 18 g of CO_2

$$= \frac{18}{44} \times 6.022 \times 10^{23} \times 3 = 7.390 \times 10^{23}$$

d) Number of atoms in 18 g of CH_4

$$= \frac{18}{16} \times 6.022 \times 10^{23} \times 5 = 3.387 \times 10^{24}$$

Thus, 18 g of CH_4 have maximum number of atoms.

Q7. Which of the following contains maximum number of molecules?

a) 1 g CO_2
b) 1 g N_2
c) 1 g H_2
d) 1 g CH_4

Answer: Option c) 1 g H_2

a) Number of molecules in 44 g $CO_2 = 6.022 \times 10^{23}$

Number of molecules in 1 g CO_2

$$= \frac{6.022 \times 10^{23}}{44} = 1.37 \times 10^{22}$$

b) Number of molecules in 28 g $N_2 = 6.022 \times 10^{23}$

Number of molecules in 1 g N_2

$$= \frac{6.022 \times 10^{23}}{28} = 2.15 \times 10^{22}$$

c) Number of molecules in 2 g $H_2 = 6.022 \times 10^{23}$

Number of molecules in 1 g H_2

$$= \frac{6.022 \times 10^{23}}{2} = 3.011 \times 10^{23}$$

d) Number of molecules in 16 g $CH_4 = 6.022 \times 10^{23}$

Number of molecules in 1 g CH_4

$$= \frac{6.022 \times 10^{23}}{16} = 3.76 \times 10^{22}$$

So, 1 g H_2 have maximum number of molecules.

Q8. Mass of one atom of oxygen is

$\boldsymbol{a)\ \frac{16}{6.023 \times 10^{23}}\ g}$

$\boldsymbol{b)\ \frac{32}{6.023 \times 10^{23}}\ g}$

$\boldsymbol{c)\ \frac{1}{6.023 \times 10^{23}}\ g}$

$\boldsymbol{d)\ 8\ u}$

Answer: Option a) $\boldsymbol{\frac{16}{6.023 \times 10^{23}}\ g}$

Mass of 6.023×10^{23} atoms of oxygen = gram atomic mass of oxygen

Mass of 6.023×10^{23} atoms of oxygen = 16 g

So, Mass of 1 atom of oxygen

$$= \frac{16}{6.023 \times 10^{23}}\ g$$

Q9. 3.42 g of sucrose are dissolved in 18 g of water in a beaker. The number of oxygen atoms in the solution are

$\boldsymbol{a)\ 6.68 \times 10^{23}}$

$\boldsymbol{b)\ 6.09 \times 10^{22}}$

$\boldsymbol{c)}\ \mathbf{6.022 \times 10^{23}}$

$\boldsymbol{d)}\ \mathbf{6.022 \times 10^{21}}$

Answer: Option a) $\mathbf{6.68 \times 10^{23}}$

Step – 1: Molar mass of sucrose, $C_{12}\ H_{22}O_{11} = 12 \times 12 + 1 \times 22 + 16 \times 11 = 342\ g$

Or, 342 = 1 mole of sucrose

3.42 g = 0.01 mole of sucrose

1 mole of sucrose ($C_{12}\ H_{22}O_{11}$) have O atoms $= 11 \times 6.022 \times 10^{23}\ atoms$

0.01 mole of sucrose have, O atoms

$$= 0.01 \times 11 \times 6.022 \times 10^{23}\ atoms = 6.6242 \times 10^{22}$$

Step – 2: 18 g of water (H_2O) = 1 mole of water

1 mole of water (H_2O) contains O atoms $= 6.022 \times 10^{23}\ atoms$

Step – 3: adding the number of O atoms present in 3.42 g of sucrose and 18 g of water

$$6.022 \times 10^{23} + 6.6242 \times 10^{22} = 10^{22}\ (60.22 + 6.6242)$$

$$= 66.844 \times 10^{22} = 6.68 \times 10^{23}\ atoms$$

Q10. A change in the physical state can be brought about

- **a) only when energy is given to the system**
- **b) only when energy is taken out from the system**
- **c) when energy is either given to, or taken out from the system**
- **d) without any energy change**

Answer: Option c) when energy is either given to, or taken out from the system

Any change in physical state can be brought when energy is either given or taken from the system, as change in energy help to change the magnitude of attractive forces between the particles, so change the physical states of matter.

Short Answer Type Questions

Q11. Which of the following represents a correct chemical formula? Name it.

a) $CaCl$
b) B_iPO_4
c) $NaSO_4$
d) NaS

Answer: Option b)

The chemical name of $BiPO_4$ is Bismuth phosphate.

Q12. Write the molecular formulae for the following compounds

a) **Copper (II) bromide**
b) **Aluminium (III) nitrate**
c) **Calcium (II) phosphate**
d) **Iron (III) sulphide**
e) **Mercury (II) chloride**
f) **Magnesium (II) acetate**

Answer: Positive ions are written first and then valences are interchanged:

a) Copper (II) bromide:

	Symbol	Valency
Potassium	Cu	$2+$
Chlorine	Br	$1-$

Formula = $CuBr_2$

b) Aluminium (III) nitrate:

	Symbol	Valency
Aluminium	Al	$3+$
Nitrate	NO	$1-$

Formula = $Al(NO_3)_3$

c) Calcium (II) phosphate:

	Symbol	Valences
Calcium	Ca	$2+$
Phosphate	PO	$3-$

Formula = $Ca_3(PO_4)_2$

d) Iron (III) sulphide:

	Symbol	Valences
Iron	Fe	$3-$
Sulphide	S	$2-$

Formula = $\boldsymbol{Fe_2S_3}$

e) Mercury (II) chloride

	Symbol	Valences
Mercury	Hg	$2+$
Chloride	Cl	$1+$

Formula = $\boldsymbol{HgCl_2}$

f) Magnesium (II) acetate:

	Symbol	Valences
Magnesium	Mg	$2+$
Acetate	CH_3COO	$1-$

Formula = $\boldsymbol{(CH_3COO)_2Mg}$

Q13. Write the molecular formulae of all the compounds that can be formed by the combination of following ions.

$$\boldsymbol{Cu^{2+}, Na^{+}, Fe^{3+}, Cl^{-}, SO_4^{2-}, PO_4^{3-}}$$

Answer:

Compound of Cu^{2+}

i) Combination with $Cl^- \rightarrow Cu^{2+}$ $Cl^{1-} = CuCl_2$

ii) Combination with $SO_4^{2-} \rightarrow Cu^{2+}$ $SO_4^{2-} = CuSO_4$

iii) Combination with $PO_4^{3-} \rightarrow Cu^{2+}$ $PO_4^{3-} = Cu_3(PO_4)_2$

Compound of Na^+

i) Combination with $Cl^{-} \rightarrow Na^{1+}$ $Cl^{1-} = NaCl$

ii) Combination with $SO_4^{2-} \rightarrow Na^{1+}$ $SO_4^{2-} = Na_2SO_4$

iii) Combination with $PO_4^{3-} \rightarrow Na^{1+}$ $PO_4^{3-} = Na_3PO_4$

Compound of Fe^{3+}

i) Combination with $Cl^{-} \rightarrow Fe^{3+}$ $Cl^{1-} = FeCl_3$

ii) Combination with $SO_4^{2-} \rightarrow Fe^{3+}$ $SO_4^{2-} = Fe_2(SO_4)_3$

iii) Combination with $PO_4^{3-} \rightarrow Fe^{3+}$ $PO_4^{3-} = FePO_4$

Q14 Write the cations and anions presents (if any) in the following compounds.

a) $\boldsymbol{CH_3COONa}$
b) $\boldsymbol{NaCl}$
c) $\boldsymbol{H_2}$
d) $\boldsymbol{NH_4NO_3}$

Answer:

S/No.	Compounds	Cation	Anion
i)	CH_3COONa	Na^+	CH_3COO^-
ii)	$NaCl$	Na^+	Cl^-
iii)	H_2	$-$	$-$
iv)	NH_4NO_3	NH_4^+	NO_3^-

Q15. Give the formulae of the compounds formed from the following sets of elements.

a) Calcium and fluorine
b) Hydrogen and sulphur
c) Nitrogen and hydrogen
d) Carbon and chlorine
e) Sodium and oxygen
f) Carbon and oxygen

Answer:

S/No.	Set of Elements	Formulae of compounds
i)	Calcium and fluorine	Ca^2 $F^{1-} = CaF_2$
ii)	Hydrogen and sulphur	H^1 $S^{2-} = H_2S$

iii)	Nitrogen and hydrogen	N^{3-} $H^{1} = NH_3$
iv)	Carbon and Chlorine	C^{4+} $C^{1-} = CCl_4$
v)	Sodium and oxygen	Na^{1+} $O^{2-} = Na_2O$
vi)	Carbon and oxygen	C^{4+} $O^{2-} = C_2O_4$ or CO_2

Q16. Which of the following symbols of elements are incorrect? Give their correct symbols.

a) **Cobalt CO**
b) **Carbon C**
c) **Aluminium AL**
d) **Helium He**
e) **Sodium So**

Answer:

a) Co is the correct symbol.
b) C is the correct symbol.
c) Al is the correct symbol.
d) Na is the correct symbol.
e) He is the correct symbol of Helium.

Q17. Give the chemical formulae for the following compounds and compute the ratio by mass of the combining elements in each one of them.

a) **Ammonia**
b) **Carbon monoxide**
c) **Hydrogen chloride**
d) **Aluminium fluoride**
e) **Magnesium sulphide**

Answer:

The chemical formulae of the compounds are ratio by mass of each combining element.

S/No.	Compounds	Chemical formula	Ratio by mass of the combining elements
a)	Ammonia	NH_3	$N:H = 14:3$
b)	Carbon monoxide	CO	$C:O = 12:16 = 3:4$
c)	Hydrogen chloride	HCl	$H:Cl = 1:35.5$
d)	Aluminium fluoride	AlF_3	$Al:F = 27:57 = 9:19$
e)	Magnesium sulphide	MgS	$Mg:S = 24:32 = 3:4$

Q18. State the number of atoms present in each of the following chemical species.

a) CO_3^{2-}
b) PO_4^{3-}
c) P_2O_5
d) CO

Answer:

a) Number of atoms in CO_3^{2-} = number of C atoms + number of O atoms

$$= 1 + 3 = 4$$

b) Number of atoms in PO_4^{3-} = number of P atoms + number of O atoms

$$= 1 + 4 = 5$$

c) Number of atoms in P_2O_5 = number of P atoms + number of O atoms

$$= 2 + 5 = 7$$

d) Number of atoms in CO = number of C atoms + number of O atoms

$$= 1 + 1 = 2$$

Q19. What is the fraction of the mass of water due to neutrons?

Answer:

In water molecules, (H_20)

$$Number\ of\ neutrons = [(number\ of\ neutrons\ in\ H) \times 2 + (number\ of\ neutrons\ in\ O)]$$

$$= 0 \times 2 + 8 = 8$$ (Since number of neutrons in H = O)

$Mass\ of\ 8\ neutrons = 8 \times 1.00893 = 8.07$ (Since mass of 1 neutron = 1.008934)

$$Molar\ mass\ of\ water = 1.008 \times 2 + 16.0 = 18.016\ u$$

$$= \frac{mass\ of\ total\ neutrons\ in\ water}{molar\ mass\ of\ water} \times 100$$

$$= \frac{8.07}{18.016} \times 100$$

$$= 44.8\%$$

Q20. Does the solubility of a substance change with temperature? Explain with the help of an example.

Answer: Yes

Solubility changes with temperature.

Solubility is the maximum amount of a solute dissolved in a 100 g of solvent at a specific temperature.

Effect of temperature on solubility

i) The solubility of solids with liquids, depend on change of the temperature increases and decreases as temperature decreases.
ii) The solubility of gases with liquids decreases as the temperature increases and increases as the temperature decreases.

Example: -

Copper sulphate

copper sulphate soluble in water at different temperatures are:

Temperature	0^oC	10^oC	20^oC	30^oC	40^oC	50^oC	60^oC	70^oC
Solubility of copper sulpahte	$14\ g$	$17\ g$	$21\ g$	$24\ g$	$29\ g$	$34\ g$	$40\ g$	$47\ g$

As temperature increases from 0^oC to 70^oC, the solubility of copper in water increases from 14 g to 47 g.

The solubility of a salt increases as the temperature is increased.

Q21. Classify each of the following on the basis of their atomicity.

a) F_2
b) NO_2
c) N_2O
d) C_2H_6
e) P_4
f) H_2O_2
g) P_4O_4
h) O_3
i) HCl
j) CH_4
k) He
l) Ag

Answer:

The classification is in three categories:

i) Monoatomic: He, Ag
ii) Diatomic: F_2, HCl
iii) Polyatomic: NO_2, N_2O, C_2H_6, P_4, H_2O_2, P_4O_{10}, O_3, CH_4

Q22. You are provided with a fine white coloured powder which is either sugar or salt. How would you identify it without testing?

Answer:

To differentiate sugar and salt without testing:

i) Dissolving sugar and salt separately in alcohol, salt do not dissolve but sugar dissolve in it.
ii) Heating the salt separately, melt the sugar but salt do not melt.
iii) Dissolving, two separately in water. The electricity is conducted by the salt solution due to the presence of Na^+ ion and Cl^- ion, but sugar solution is a non-conductor. So, testing a drop of solution with an ohmmeter, immediate difference is observed.

Q23. Calculate the number of moles of magnesium present in a magnesium ribbon weighing 12 g. Molar atomic mass of magnesium is 24 g mol^{-1}.

Answer:

Molar atomic mass of $Mg = 24\ g\ mol^{-1}$

$$24\ g \text{ of } Mg = 1\ mol$$

$$12\ g\ of\ Mg = \frac{1 \times 12}{24}$$

$$= \frac{1}{2} = 0.5\ mol$$

Long Answer Type Questions

Q24. Verify by calculating that

a) 5 moles of CO_2 and 5 moles of H_2O do not have the same mass.
b) 240 g of calcium and 240 g magnesium elements have a mole ratio of 3:5

Answer:

a) Molar mass of $CO_2 = 12 + 2 \times 16 = 12 + 32 = 44\ g\ mol^{-1}$

1 mole of CO_2 has mass $= 44\ g$
5 moles of CO_2 have mass $= 44\ \times 5 = 200\ g$

the molar mass of $H_2O = 2 \times 1 + 16 = 18\ g\ mol^{-1}$

1 mole of H_2O has mass $= 18\ g$
5 moles of H_2O have mass $= 18 \times 5 = 90\ g$
So, 5 moles of CO_2 and H_2O do not have same mass.

b) Molar mass of calcium $= 40\ g$

$40\ g$ of Ca has number of moles $= 1\ mol$
$240\ g$ of Ca has number of moles $= \frac{1}{40} \times 240 = 6\ mol$

Molar mass of magnesium = $24\ g$

$24\ g$ of Mg has number of moles = $1\ mol$
$240\ g$ of Mg has number of moles = $\frac{1}{24} \times 240 = 10\ mol$

$$\frac{Number\ of\ moles\ of\ Ca}{Number\ of\ moles\ of\ Mg} = \frac{6}{10} = \frac{3}{5} = 3:5$$

So, 240 g of calcium and magnesium elements have a mole ratio of 3:5

Q25. Find the ratio by mass of the combining elements in the following compounds.

- **a)** $\boldsymbol{CaCO_3}$
- **b)** $\boldsymbol{MgCl_2}$
- **c)** $\boldsymbol{H_2SO_4}$
- **d)** $\boldsymbol{C_2H_5OH}$
- **e)** $\boldsymbol{NH_3}$
- **f)** $\boldsymbol{Ca(OH)_2}$

Answer: The ratio by mass of combining elements are -

a) $CaCO_3 \rightarrow Ca: C: O = 40: 12: 48 = 10: 3: 12$

b) $MgCl_2 \rightarrow Mg: Cl = 24: 2 \times 35.5 = 24: 71$

c) $H_2SO_4 \rightarrow H: S: O = 2 \times 1: 32: 4 \times 16 = 2: 32: 64 = 1: 16: 32$

d) $C_2H_5OH \rightarrow C: H: O = 2 \times 12: 6 \times 1: 16 = 24: 6: 16 = 12: 3: 8$

e) $NH_3 \rightarrow N: H = 14: 3 \times 1 = 14: 3$

f) $Ca(OH)_2 \rightarrow Ca: O: H = 40: 2 \times 16: 2 \times 1 = 40: 32: 2 = 20: 16: 1$

Q26. Calcium chloride when dissolved in water dissociates into its ions according to the following equation.

$$\boldsymbol{CaCl_2\ (aq) \rightarrow Ca^{2+}\ (aq) + 2Cl^-\ (aq)}$$

Calculate the number of ions obtained from $\boldsymbol{CaCl_2}$ when 222 g of it is dissolved in water.

Answer:

Molar mass of $CaCl_2 = 40 + 2 \times 35.5$

$= 40 + 71 = 111\ g\ mol^{-1}$

$CaCl_2$ ionizes:

$$CaCl_2\ (aq) \rightarrow\ Ca^{2+}\ (aq) +\ 2Cl^{-1}\ (aq)$$

$111\ g$ of $CaCl_2\ = 3\ mol = 3 \times 6.022 \times 10^{23}\ ions$

$222\ g$ of $CaCl_2$ have,

$$= \frac{3 \times 6.022 \times 10^{23}}{111} \times 222$$

$$= 36.132\ \times 10^{23}$$

$$= 3.6132 \times 10^{24}\ ions$$

Q27. The difference in the ass of 100 moles each of sodium atoms and sodium ion is 5.48002 g. Compute the mass of an electron.

Answer:

$$Na\ \rightarrow\ Na^{+} +\ e^{-}$$

Sodium atom loose an electron to f sodium ion,

100 moles of sodium and sodium ion, the difference is $100e^{-}$. As, the mass of 100 moles of electrons = $5.48002\ g$

Mass of 1 mole of electron,

$$= \frac{5.48002}{100}\ g$$

As, $1\ mole = 6.022 \times 10^{23}\ electrons$

mass of $6.022 \times 10^{23}\ electrons$

$$= \frac{5.48002}{100} g$$

$$Mass\ of\ 1\ electron = \frac{5.48002}{100 \times 6.022 \times 10^{23}}$$

$$= 9.1 \times 10^{-26}\ g$$

So, the mass of an electron = $9.1 \times 10^{-26}\ g$

Q28. Cinnabar (HgS) is a prominent ore of mercury. How many grams of mercury are present in 225 g of pure HgS? Molar mass of Hg and S are 200.6 g mol^{-1} and 32 g mol^{-1} respectively.

Answer:

Molar mass of $Hg = 200.6\ g\ mol^{-1}$

Of $S = 32\ g\ mol^{-1}$

Molar mass of HgS = molar mass of the Hg + molar mass of the S

Molar mass of $HgS = 200.6 + 32 = 232.6\ g$

$232.6\ g$ of HgS contains $Hg = 200.6$

$225\ g\ of\ HgS$ will contain Hg

$$= \frac{200.6 \times 225}{232.6} = 194.05\ g$$

So, $194.05\ g$ of mercury is in $225\ g$ of pure Cinnabar.

Q29. The mass of one steel screw is 4.11 g. Find the mass of one mole of these steel screws. Compare this value with the mass of the earth $(5.98 \times 10^{24}\ kg)$. Which one of the two is heavier and by how many times?

Answer:

Mass of one steel screw $= 4.11\ g$

Mass of earth $= 5.98\ \times\ 10^{24}\ kg$

$$= 5.98\ \times 10^{27}\ g$$

Since, 1 mole $= 6.022 \times 10^{23}\ atoms/molecules/ions$

So, mass of 1 mole of screw $= 6.022 \times 10^{23} \times 4.11\ g$

$$= 2.48 \times 10^{24}\ g$$

$$\frac{Mass\ of\ 1\ mole\ screw}{Mass\ of\ earth} = \frac{2.48 \times 10^{24}\ g}{5.98 \times 10^{27}\ g}$$

$$= \frac{1}{2.41 \times 10^{3}} = \frac{1}{2410}$$

The ratio of screw and mass of earth $= 1:2410$

So, the earth is heavier than screw by 2410 times.

Q30. A sample of vitamin C is known to contain 2.58×10^{24} oxygen atoms. How many moles of oxygen atoms are present in the sample?

Answer:

Number of oxygen atoms in sample $= 2.58 \times 10^{24}$

$$1\ mol = 6.022 \times 10^{23}\ oxygen\ atoms$$

$$2.58 \times 10^{24}\ oxygen\ atoms = \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$$

$$2.58 \times 10^{24}\ oxygen\ atoms = 4.28\ mol$$

So, 4.28 mol of oxygen atoms are present in the sample.

Q31. Raunak took 5 moles of carbon atoms in a container and Krish also took 5 moles of sodium atoms in another container of same weight.

a) Whose container is heavier?
b) Whose container has more number of atoms?

Answer:

a) 1 mole = $molar\ mass\ of\ a\ substance$

1 mole of carbon atoms weigh $= 12\ g$
5 moles of carbon atoms will weigh $= 12 \times 5 = 60\ g$

Container of Raunak has weight $= 60\ g$

1 mole of sodium atoms weigh $= 23\ g$

5 moles of sodium atoms will have weigh $= 23\ \times 5 = 115\ g$
Container of Krish has weight $= 115\ g$

The container of Krish is heavier than Raunak's container.

$$1\ mole = 6.022 \times 10^{23}\ atoms$$

b) Both the containers have 5 moles of each carbon and sodium, so, both the containers have an equal number of atoms, that is,

$5 \times 6.022 \times 10^{23}\ atoms$ or $3.011 \times 10^{24}\ atoms\ in\ each.$

Q32. Fill in the missing data in the following table.

Species property	H_2O	CO_2	$Na - atom$	$MgCl_2$
Number of moles	2	–	–	0.5
Number of particles	–	3.011×10^{23}	–	–
Mass	$36\ g$	–	$115\ g$	–

Answer:

For H_2O (Water): -

number of moles $= 2$

Number of mass $= 36\ g$

Number of particles = number of moles $\times 6.022 \times 10^{23}$

$$= 2 \times 6.022 \times 10^{23}$$

$$= 1.2044 \times 10^{24}$$

CO_2 (Carbon dioxide): -

number of particles = 3.011×10^{23}

$$Number\ of\ moles\ of\ CO_2 = \frac{number\ of\ particles}{6.022 \times 10^{23}}$$

$$= \frac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = 0.5\ mol$$

$Mass\ of\ CO_2$ = moles × molar mass

$= 0.5 \times 44 = 22\ g$ (molar mass of CO_2= 12+2× 16 = 44)

For $Na - atom$

mass = $115\ g$

$$Number\ of\ moles = \frac{mass}{molar\ mass} = \frac{115}{23} = 5\ mol$$

$Number\ of\ particles = 5 \times 6.022 \times 10^{23} = 3.011 \times 10^{24}$

For $MgCl_2$

number of moles = 0.5

number of particles = $0.5 \times 6.022 \times 10^{23} = 3.011 \times 10^{23}$

$$Mass = number\ of\ moles\ \times molar\ mass$$

(molar mass of $MgCl_2 = 24 + 2 \times 35.5 = 24 + 71 = 95$)

$$= 0.5 \times 95$$

$$= 47.5\ g$$

Species property	H_2O	CO_2	$Na - atom$	$MgCl_2$
Number of moles	2	0.5	5.0	0.5
Number of particles	1.2044×10^{24}	3.011×10^{23}	3.011×10^{24}	3.011×10^{23}
Mass	$36\ g$	$22\ g$	$115\ g$	$47.5\ g$

Q33. The visible universe is estimated to contain 10^{22} stars. How many moles of stars are present in the visible universe?

Answer:

$$1 \, moles \, stars = 6.022 \times 10^{23}$$

$$10^{22} = \frac{1 \times 10^{22}}{6.022 \times 10^{23}}$$

$$10^{22} = 1.67 \times 10^{-2} \, mol$$

Q34. What is SI prefix for each of the following multiples and submultiples of a unit?

a) $\mathbf{10^{3}}$
b) $\mathbf{10^{-1}}$
c) $\mathbf{10^{-2}}$
d) $\mathbf{10^{-6}}$
e) $\mathbf{10^{-9}}$
f) $\mathbf{10^{-12}}$

Answer:

S.I prefix of each of the multiples of submultiples of a unit –

S/No.	Prefix	Unit
1.	10^{3}	kg
2.	10^{-1}	deci
3.	10^{-2}	centi
4.	10^{-6}	micro
5.	10^{-9}	nano
6.	10^{-12}	pico

Q35. Express each of the following in kilograms.

a) $\mathbf{5.84 \times 10^{-3} \, mg}$
b) $\mathbf{58.34 \, g}$
c) $\mathbf{0.584 \, g}$
d) $\mathbf{5.873 \times 10^{-21} \, g}$

Answer:

a)

$$10^{6} \, mg = 1 \, kg$$

$$5.84 \times 10^{-3} mg = \frac{1 \times 5.84 \times 10^{-3}}{10^{6}} \, kg$$

$$= 5.84 \times 10^{-9} \, kg$$

b)

$$10^3 g = 1\ kg$$

$$58.34\ g = \frac{1 \times 58.34}{10^3}\ kg$$

$$= 5.834 \times 10^{-3}\ kg$$

c) $0.584\ g$

$$0.584\ g = \frac{1 \times 0.584}{10^3}\ kg$$
$$= 0.584 \times 10^{-3}\ kg$$

$$= 5.84 \times 10^{-4}\ kg$$

d) $5.873 \times 10^{-21}\ g$

$$5.873 \times 10^{-21} = \frac{5.873 \times 10^{-21}}{10^3}\ kg$$

$$= 5.873 \times 10^{-24}\ kg$$

Q36. Compute the difference in masses of 10^3 moles each of magnesium atoms and magnesium ions.

Answer:

$$10^3\ moles\ of\ Mg\ atoms = 10^3 \times 6.022 \times 10^{23}$$

$$= 6.022 \times 10^{26}\ Mg\ atoms$$

So, for ions

$$10^3\ moles\ of\ Mg^{2+}\ atoms = 10^3 \times 6.022 \times 10^{23}$$

$$= 6.022 \times 10^{26}\ Mg^{2+}\ ions$$

Mg^{2+} ion is formed from Mg atom with the loss of 2 electrons;

$$Mg \rightarrow Mg^{2+} + 2e^-$$

The difference in mass of 6.022×10^{26} Mg atoms and Mg^{2+} ions

$$= mass\ of\ 2 \times 6.022 \times 10^{26}\ electrons$$

$$= 2 \times 6.022 \times 10^{26} \times 9.1 \times 10^{-31}\ kg$$

(mass of an electron = $9.1 \times 10^{-31}\ kg$)

$$= 109.6004 \times 10^{-5}\ kg$$

$$= 1.096 \times 10^{-3}\ kg$$

Q37. Which has more number of atoms?

$$\mathbf{100\ g\ of\ N_2\ or\ 100\ g\ of\ NH_3}$$

Answer:

molar mass of

$$N_2 = 2 \times 14 = 28\ g$$

$28\ g\ of\ N_2$ has number of molecules $= 6.022 \times 10^{23}$

$100\ g\ of\ N_2$ has number of molecules,

$$= \frac{6.022 \times 10^{23} \times 100}{28} = 2.1 \times 10^{24}$$

Atoms in $100\ g$ of $N_2 = 2.1 \times 10^{24} \times 2$

$$= 4.2 \times 10^{24}\ atoms$$

Molar mass of $NH_3 = 14 + 3 \times 1 = 17\ g$

$17\ g\ NH_3$ has number of molecules $= 6.022 \times 10^{23}$

$$100\ g\ NH_3\ has\ number\ of\ molecules = \frac{6.022 \times 10^{23} \times 100}{17}$$

$$100\ g\ NH_3\ has\ number\ of\ molecules = 3.54 \times 10^{24}$$

Atoms in $100\ g$ of $NH_3 = 3.54 \times 10^{24} \times 4 = 1.416 \times 10^{25}$

$100\ g\ of\ NH_3$ has greater number of atoms.

Q38. Compute the number of ions present in 5.85 g of sodium chloride.

Answer:

The molar mass of sodium chloride $= 23 + 35.5 = 58.5\ g$

$58.5\ g$ of sodium, $(NaCl)$ has number of ions $= 6.02 \times 10^{23} \times 2$

$$\underset{Sodium\ chloride}{NaCl} \rightarrow \underset{Sodium\ ion}{Na^+} + \underset{Chloride\ ion}{Cl^-}$$

5.85 g of $NaCl$ has number of ions,

$$= \frac{6.022 \times 10^{23} \times 2 \times 5.85}{58.5}$$

$$= 12.044 \times 10^{22}$$

$$= 1.2044 \times 10^{23}$$

Q39. A gold sample contains 90% of gold and the rest copper. How many atoms of gold are present in one gram of this sample of gold?

Answer:

mass of the sample $= 100\ g$

Mass of gold $= 90\ g$

Mass of copper $= (100 - 90) = 10\ g$

$100\ g$ of sample has gold $= 90\ g$

$1\ g$ of this sample has gold,

$$= \frac{90}{100}$$

$$1\ g \text{ of this sample has gold} = 0.9\ g$$

Atomic mass of gold $(Au) = 197\ g$

$197\ g$ of gold have number of atoms $= 6.022 \times 10^{23}$

$0.9\ g$ of gold will have number of atoms,

$$= \frac{6.022 \times 10^{23} \times 0.9}{197}$$

$$0.9\ g \text{ of gold will have number of atoms} = 2.75 \times 10^{21}$$

Q40. What are ionic and molecular compounds? Give examples.

Answer:

Ionic compound are made up of ions. In ionic compounds, the cations or positively charged ions and anions or negatively charged ions are held together by a strong electrostatic force of attraction and are called as electrovalent bond.

Example: Sodium $(NaCl)$, Calcium oxide (CaO) etc.

Molecular compounds are those compounds in which the atoms of elements have covalent bonds.

Example: - Methane (CH_4), Water (H_2O)

Q41. Compute the difference in masses of one mole each of aluminium atoms and one mole of its ions (Mass of an electron is $\mathbf{9.1 \times 10^{-28}}$ $\boldsymbol{g}$). Which one is heavier?

Answer:

The ionization of Al atom is,

$$Al \rightarrow Al^{3+} + 3e^-$$

Al^{3+} ions are formed by loss of 3 electrons of Al atoms

Difference in the mass of 1 mole of Al atoms and Al^{3+} ions

$$= mass\ of\ 3 \times 6.022 \times 10^{-28}\ electrons$$

the mass of electron $= 9.1 \times 10^{-28}\ g$

$$= (3 \times 6.022 \times 10^{23}) \times (9.1 \times 10^{-28} g)$$

$$= 164.4 \times 10^{-5} g$$

$$= 1.644 \times 10^{-3} g$$

1 mole of Al atoms is heavier than 1 mole of Al^{3+} ions.

Q42. A silver ornament of mass 'm' gram is polished with gold equivalent to 1% of the mass of silver. Compute the ratio of the number of atoms of gold and silver in the ornament.

Answer: -

Mass of silver ornament (Ag) $= m. gms$

Mass of gold used for polishing,

$$= \frac{1}{100} \times m\ gms$$

$$= 0.01\ m\ gms$$

Atomic mass of Ag $= 108\ u$

1 mole of Ag $= 108\ gms = 6.022 \times 10^{23}\ atoms$

$108\ gms$ of Ag have atoms $= 6.022 \times 10^{23}$

$m.gms$ of Ag will have atoms,

$$= \frac{6.022 \times 10^{23}}{108} \times m$$

atomic mass of gold $(Au) = 197\ u$

$$1\ mole\ of\ Au = 197\ g$$

$$= 6.022 \times 10^{23}\ atoms$$

$$197\ g \text{ of Au have atoms} = 6.022 \times 10^{23}$$

$0.01\ m\ g$ of Au will have atoms,

$$= \frac{6.022 \times 10^{23} \times 0.01\ m}{197}$$

So, the ratio of the number of atoms of gold and silver,

$$= \frac{6.022 \times 10^{23}}{197} \times 0.01\ m : \frac{6.022 \times 10^{23}}{108}\ m$$

$$= \frac{1}{19700} : \frac{1}{108}$$

$$Ratio\ of\ the\ number\ of\ atoms\ of\ gold\ and\ silver = 108 : 19700$$

Q43. A sample of ethane (C_2H_6) gas has the same mass as 1.5×10^{20} molecules of methane (CH_4). How many C_2H_6 molecules does the sample of gas contain?

Answer:

Molar mass of methane $(CH_4) = 6.022 \times 10^{23}$ molecules of methane

$$= 12 + 4 \times 1 = 16\ g$$

1.5×10^{20} molecules of methane have mass,

$$= \frac{16 \times 15 \times 10^{20}}{6.022 \times 10^{23}}$$

$$= 3.98 \times 10^{-3}\ g$$

Molar mass of ethane $(C_2H_6) = 2 \times 12 + 6 \times 1$

$$= 24 + 6 = 30\ g$$

30 g of ethane has number of molecules $= 6.022 \times 10^{23}$

$3.98 \times 10^{-3}\ g$ of ethane has number of molecules,

$$= \frac{6.022 \times 10^{23} \times 3.98 \times 10^{-3}}{30\ g}\ g$$

$$= 7.99 \times 10^{19}$$

$$3.98 \times 10^{-3}\ gms \text{ of ethane has number of molecules} = 8 \times 10^{19}\ molecules$$

Q44. Fill in the blanks.

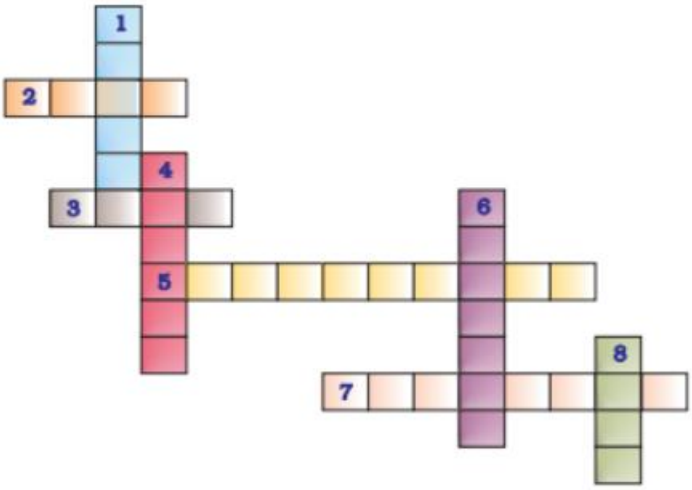
a) **In a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is called ______**
b) **A group of atoms carrying a fixed charge on them is called ______**
c) **The formula unit mass of $Ca_3(PO_4)_2$ is ________**
d) **Formula of sodium carbonate is ________ and that of ammonium sulphate is ________**

Answer:

a) <u>**law of conservation of mass**</u>.
b) <u>**polyatomic ion**</u>.
c) <u>**310 g**</u>.
d) $\underline{\boldsymbol{Na_2CO_3}}$ and $\underline{(\boldsymbol{NH_4})_2\boldsymbol{SO_4}}$.

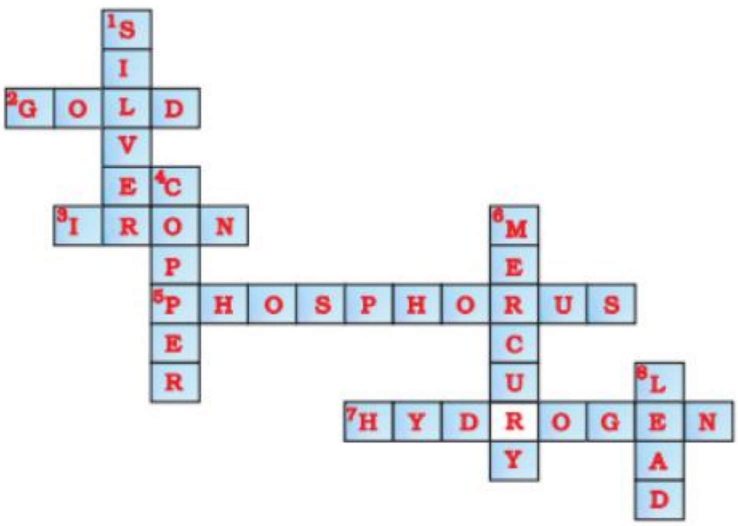
Q45. Complete the following crossword puzzle (Figure) by using the name of the chemical elements. Use the data given in the table following.

Across	Down
2. The element used by Rutherford during his α–scattering experiment	1. A white lustrous metal used for making ornaments and which tends to get tarnished black in the presence of moist air
3. An element which forms rust on exposure to moist air	4. Both brass and bronze are alloys of the element
5. A very reactive non–metal stored under water	6. The metal which exists in the liquid state at room temperature
7. Zinc metal when treated with dilute hydrochloric acid produces a gas of this element which when tested with burning splinter produces a pop sound.	8. An element with symbol Pb



Answer:

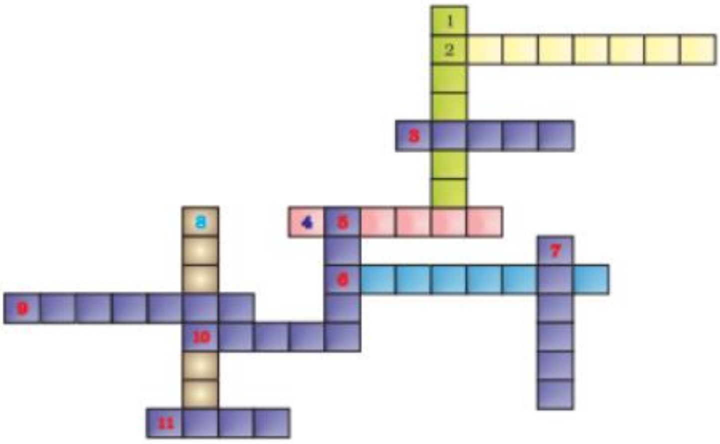
1. Silver
2. Gold
3. Iron
4. Copper
5. Phosphorus
6. Mercury
7. Hydrogen
8. Lead



Q46. a) In this crossword puzzle (Figure), names of 11 elements are hidden. Symbols of these are given below. Complete the puzzle.

1. Cl

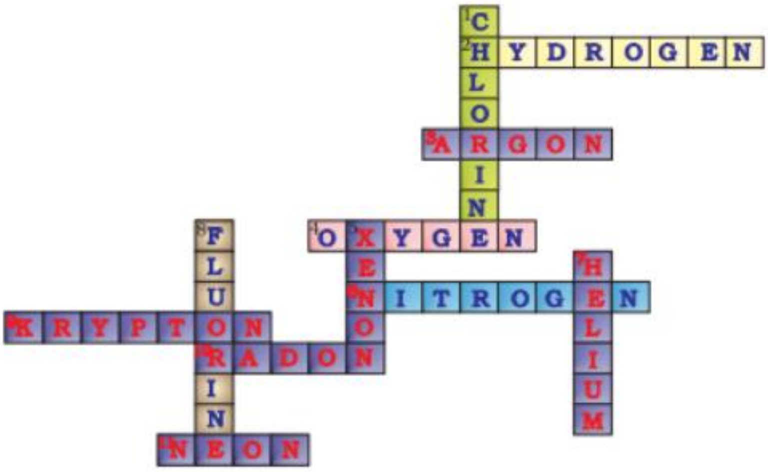
2. H
3. Ar
4. O
5. Xe
6. N
7. He
8. F
9. Kr
10. Rn
11. Ne



Answer:

The names of the elements are –

S/No.	Chemical Symbol of these elements	Name of these elements
1.	Cl	Chlorine
2.	H	Hydrogen
3.	Ar	Argon
4.	O	Oxygen
5.	Xe	Xenon
6.	N	Nitrogen
7.	He	Helium
8.	F	Fluorine
9.	Kr	Krypton
10.	Rn	Radon
11.	Ne	Neon



Q47. Write the formulae for the following and calculate the molecular mass for each one of them.

- **a) Caustic potash.**
- **b) Baking powder.**
- **c) Lime stone.**
- **d) Caustic soda.**
- **e) Ethanol.**
- **f) Common salt.**

Answer:

S/No.	Compound	Formula	Molecular mass
1.	Caustic potash	KOH	$39 + 16 + 1 = 56\ u$
2.	Baking soda	$NaHCO_3$	$23 + 1 + 12 + 3 \times 16 = 84\ u$
3.	Lime stone	$CaCO_3$	$40 + 12 + 3 \times 16 = 100\ u$
4.	Caustic soda	$NaOH$	$23 + 16 + 1 = 40\ u$
5.	Ethanol	C_2H_5OH	$2 \times 12 + 5 \times 1 + 16 + 1 = 46\ u$
6.	Common salt	$NaCl$	$23 + 35.5 = 58.5\ u$

Q48. In photosynthesis, 6 molecules of carbon dioxide combine with an equal number of water molecules through a complex series of reactions to give a molecule of glucose having a molecular formula $C_6H_{12}O_6$. How many grams of water would be required to produce 18 g of glucose? Compute the volume of water so consumed assuming the density of water to be 1 $g\ cm^{-3}$.

Answer:

In the process of photosynthesis, the reactions is –

$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

$$6\,(2 \times 1 + 16)$$

$$= 6 \times 18$$

$$= 108\ g$$

Molecular formula of glucose $(C_6H_{12}O_6) = 6 \times 12 + 12 \times 1 + 6 \times 16$

$$= 72 + 12 + 96$$

$$= 108\ g$$

$180\ g$ of glucose require the amount of water $= 108\ g$

$18\ g$ of glucose will require the amount of water,

$$= \frac{108\ g\ \times 18\ g}{180\ g}$$

$$= 10.8\ g$$

Amount of water consumed $= 10.8\ g$

The density (d) of water $= 1\ g\ cm^{-3}$

the volume of water consumed is ,

$$= \frac{m}{d}\ \left[As\ d = \frac{m}{v}\right]$$

$$= \frac{10.8\ g}{1\ g\ cm^{-3}}$$

$$= 10.8\ cm^3$$

Volume (V) of water consumed $= 10.8\ cm^3$