

EXAM
DRILL

Atoms and Molecules

ANSWERS

1. Aurum

2. MSO_4 3(i) BaCl_2 3(ii) A compound made up of two elements is called a binary compound, e.g., water (H_2O).

3(iii) Magnesium bromide

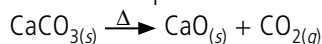
3(iv) CO_3^{2-} 4(i) CaCl_2

4(ii) Valency of Na : 1, Valency of sulphide : 2

4(iii) (b)

4(iv) (a)

5. (c) : According to law of conservation of mass, mass of reactants is equal to the mass of products.

Mass of reactant (CaCO_3) = 10 gMass of products ($\text{CaO} + \text{CO}_2$) = $(5.6 + x)$ g

$$10 \text{ g} = (5.6 + x) \text{ g}$$

$$x = 4.4 \text{ g}$$

OR

(a) : One gram atom of magnesium = 24 g

 $\therefore$ 24 g of magnesium = 1 g atom

$$\therefore 360 \text{ g of magnesium} = \frac{1}{24} \times 360 = 15 \text{ g atom}$$

6. (c)

7. (b) : In flask X :

1 molecule of oxygen (O_2) = 2 atoms of oxygen1 mole of oxygen gas = 6.022×10^{23} moleculesOr 1 mole of $\text{O}_2 = 2 \times 6.022 \times 10^{23}$ atoms

$$\therefore 0.5 \text{ mole of } \text{O}_2 = 2 \times 6.022 \times 10^{23} \times 0.5 \\ = 6.022 \times 10^{23} \text{ atoms}$$

In flask Y :

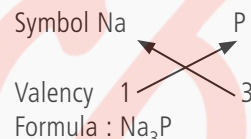
1 molecule of ozone (O_3) = 3 atoms of oxygen1 mole of ozone gas = 6.022×10^{23} moleculesOr 1 mole of $\text{O}_3 = 3 \times 6.022 \times 10^{23}$ atoms

$$\therefore 0.4 \text{ mole of ozone gas} = 3 \times 6.022 \times 10^{23} \times 0.4 \text{ atoms} \\ = 7.23 \times 10^{23} \text{ atoms}$$

$\therefore$ Flask Y has greater number of oxygen atoms as compared to flask X.

8. (b) : Valency of sodium = 1

Valency of phosphorus = 3



OR

(c) : Mass of 6.023×10^{23} Mg^{2+} ions = 24 g

$$\therefore \text{Mass of } 3.01 \times 10^{23} \text{ } \text{Mg}^{2+} \text{ ions} \\ = \frac{24}{6.023 \times 10^{23}} \times 3.01 \times 10^{23} = 12 \text{ g}$$

Similarly, mass of 6.023×10^{23} CO_3^{2-} ions

$$= (12 + 3 \times 16) = 60 \text{ g}$$

Mass of 3.01×10^{23} CO_3^{2-} ions

$$= \frac{60}{6.023 \times 10^{23}} \times 3.01 \times 10^{23} = 30 \text{ g}$$

Hence, mass of MgCO_3 sample = $12 + 30 = 42 \text{ g} = 0.042 \text{ kg}$

9. (d)

10. (c)

11. (a) : Symbol of tin is Sn.

$$12. (a) : \frac{\text{Atomic mass of O}}{\text{Atomic mass of C}} = \frac{16}{12} = \frac{4}{3}$$

OR

(a) : Volume of 1 mole of water = mass/density

$$= 18 \text{ g/1g/mL} = 18 \text{ mL}$$

$$13. (a) : \% \text{ of carbon in the compound} = \frac{12}{106} \times 100 \\ = 11.32\%$$

14. (a) : For universally accepted atomic mass unit in 1961, C-12 was selected as standard. However, the new symbol used is 'u' (unified mass) in place of amu.

$$15. \text{Molecular mass of } \text{CaSO}_4 = 1 (\text{Ca}) + 1 (\text{S}) + 4 (\text{O}) \\ = 1 (40) + 1 (32) + 4 (16) \\ = 40 + 32 + 64 = 136 \text{ u}$$

Also mass of sulphur in $\text{CaSO}_4 = 1 \times (32) = 32 \text{ u}$

$$\therefore \text{Mass percentage of sulphur in } \text{CaSO}_4 \\ = \frac{32}{136} \times 100 = 23.53\%$$

OR

Gram molecular mass (6.022×10^{23} molecules) of $\text{CO}_2 = 44 \text{ g}$

$$\text{Mass of } 10^{21} \text{ molecules of } \text{CO}_2 = \frac{44}{6.022 \times 10^{23}} \times 10^{21} = 0.073 \text{ g}$$

$$\text{Mass of } \text{CO}_2 \text{ left} = (0.2 - 0.073) = 0.127 \text{ g}$$

$$\text{Moles of } \text{CO}_2 \text{ left} = \frac{0.127 \text{ g}}{44 \text{ g}} = 2.88 \times 10^{-3}$$

16. (a) K_2SO_4 (b) Molecular mass of $\text{S}_8 = 32 \times 8 = 256 \text{ g}$ 256 g of S_8 contain 6.022×10^{23} molecules

$$\begin{aligned} 64 \text{ g of } \text{S}_8 \text{ contains} &= \frac{6.022 \times 10^{23} \times 64}{256} \\ &= 1.505 \times 10^{23} \text{ molecules} \end{aligned}$$

17. Gram atomic mass of sulphur = 32 g

$$\text{Mass of one sulphur atom} = \frac{\text{Gram atomic mass}}{6.022 \times 10^{23}}$$

$$= \frac{32}{6.022 \times 10^{23}} = 5.31 \times 10^{-23} \text{ g}$$

$$\text{Molecular mass of } \text{CO}_2 = 12 + 2 \times 16 = 44$$

$$\text{Gram molecular mass of } \text{CO}_2 = 44 \text{ g}$$

$$\begin{aligned} \text{Mass of one molecule of } \text{CO}_2 &= \frac{\text{Gram molecular mass}}{6.022 \times 10^{23}} \\ &= \frac{44}{6.022 \times 10^{23}} = 7.306 \times 10^{-23} \text{ g} \end{aligned}$$

$$18. \text{ Moles of } \text{KClO}_3 = \frac{\text{Given mass}}{\text{Molar mass}} = \frac{122.5 \text{ g}}{122.5 \text{ g}} = 1$$

(Molar mass of $\text{KClO}_3 = 122.5$)

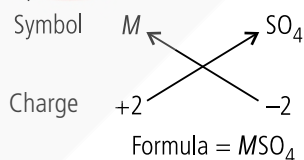
From the formula KClO_3 , we know that 1 mole of KClO_3 contains 1 mole of K atoms, 1 mole of Cl atoms and 3 moles of O atoms.

$$\therefore \text{ Number of atoms of K} = 1 \times 6.022 \times 10^{23}$$

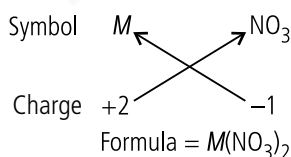
$$\text{Number of atoms of Cl} = 1 \times 6.022 \times 10^{23}$$

$$\text{Number of atoms of O} = 3 \times 6.022 \times 10^{23} = 1.80 \times 10^{24}$$

OR

(a) The formula MO shows that the valency (charge) of $\text{M} = +2$ $\therefore$ Formula of its sulphate

Formula of its nitrate



$$\begin{aligned} \text{(b) (i) In } \text{MgCO}_3, \text{ Mg : C : O} &= 24 : 12 : 3 \times 16 \\ &= 24 : 12 : 48 = 2 : 1 : 4 \end{aligned}$$

$$\begin{aligned} \text{(ii) In } \text{HNO}_3, \text{ H : N : O} &= 1 : 14 : 3 \times 16 \\ &= 1 : 14 : 48 \end{aligned}$$

$$\begin{aligned} \text{(iii) In } \text{C}_2\text{H}_5\text{OH or } \text{C}_2\text{H}_6\text{O, C : H : O} &= 2 \times 12 : 1 \times 6 : 16 = 24 : 6 : 16 = 12 : 3 : 8 \end{aligned}$$

$$\begin{aligned} 19. \text{ (a) Molecular mass of } \text{HNO}_3 &= (1 \times 1) + (14 \times 1) + (16 \times 3) \\ &= 1 + 14 + 48 = 63 \text{ u} \end{aligned}$$

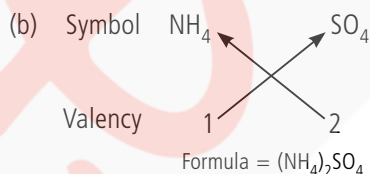
$$\begin{aligned} \text{(b) Number of moles of Al} &= \frac{\text{Given mass}}{\text{Molar mass}} \\ &= \frac{270 \text{ g}}{27 \text{ g}} = 10 \end{aligned}$$

(molar mass of Al = 27 g)

$$\begin{aligned} \text{(c) Mass} &= \text{Number of moles} \times \text{Molar mass} \\ &= 0.5 \times 4 = 2 \text{ g} \end{aligned}$$

20. (a) (i) Atoms cannot exist independently whereas molecules can exist independently.

(ii) Molecular mass is the sum of masses of the atoms in the molecule whereas formula mass is the sum of atomic masses of all the atoms in a formula unit of an ionic compound.

21. (a) It is the mass unit exactly equal to one-twelfth ($1/12^{\text{th}}$) the mass of one atom of carbon-12.

(b) The molecular mass of a substance is the sum of the atomic masses of all atoms in a molecule whereas the mass of 1 mole of any substance is called its molar mass. Molecular mass is measured by amu or u whereas molar mass by g/mol.

(c) Diatomic molecules of a compound : HCl , CO , NO
Triatomic molecules of a compound : CO_2 , H_2O , SO_2

22. The exact number of atoms present in 12 g of carbon-12 is called Avogadro's constant.

$$\text{(b) No. of moles (Ne)} = \frac{m}{M} = \frac{\text{Given mass}}{\text{Molar mass}} = \frac{56}{20} = 2.8$$

OR

$$\text{(i) \% composition of B} = \frac{0.096 \times 100}{0.24} = 40\%$$

$$\% \text{ composition of O} = \frac{0.144}{0.24} \times 100 = 60\%$$

$$\begin{aligned} \text{(ii) Number of moles of } \text{O}_2 &= \frac{0.144}{32} = 0.0045 \text{ mole} \\ &= 4.5 \times 10^{-3} \end{aligned}$$

$$23. \text{ P}_4 \text{ unit mass} = 31 \times 4 = 124 \text{ g}$$

Molar mass contains Avogadro's number of molecules, 124 g contains 6.022×10^{23} molecules

248 g contains = $2 \times 6.022 \times 10^{23}$ molecules
 = 12.044×10^{23} molecules

24. (a) Cation : Mg^{2+} , Anion : CH_3COO^-

(b) The volume occupied by one mole of a gas under standard conditions of temperature and pressure (0°C and 1 atm. pressure) is called molar volume. Its value is 22.4 L at STP.

25. 0.9% mass by mass means 0.9 g NaCl in 100 g of solution

$\therefore$ Given mass = 0.9 g

Molar mass of NaCl = 58.5 g mol^{-1}

(i) Number of moles = $\frac{m}{M} = \frac{0.9}{58.5} = 0.015$

(ii) Number of molecules = $n \times N_0$
 = $0.015 \times 6.022 \times 10^{23}$
 = 0.09×10^{23} or 9.033×10^{21}

OR

(i) (a) Two atoms of oxygen - 2 O
 (b) Diatomic oxygen - O_2 molecule
 (c) Triatomic oxygen - O_3 molecule
 (d) Two atoms of hydrogen and one atom of oxygen forming one molecule of water (H_2O).

(ii) (a) K_2CO_3 - Potassium carbonate

(b) CaCl_2 - Calcium chloride

(iii) $\text{Al}_2(\text{SO}_4)_3 = 2 \times 27 + 3(32 + 4 \times 16)$
 = $54 \text{ u} + 3(96)$
 = $54 + 288 = 342 \text{ u}$

$\therefore$ Formula unit mass = 342 u.

26. (a) Molecular mass of $\text{CO}_2 = 44 \text{ u}$

1 mole of $\text{CO}_2 = 44 \text{ g}$

5 mole of $\text{CO}_2 = 5 \times 44 = 220 \text{ g}$

Molecular mass of $\text{H}_2\text{S} = 34 \text{ u}$

1 mole of $\text{H}_2\text{S} = 34 \text{ g}$

5 mole of $\text{H}_2\text{S} = 5 \times 34 = 170 \text{ g}$

Hence, both do not have same mass.

(b) 40 g of Ca = 1 mole

240 g of Ca = $\frac{1}{40} \times 240 = 6 \text{ mole}$

24 g of Mg = 1 mole

240 g of Mg = $\frac{1}{24} \times 240 = 10 \text{ mole}$

$\therefore$ Molar ratio is 6 : 10 i.e., 3 : 5

27. (i) Atomicity - Number of atoms constituting a molecule,

(ii) Polyatomic element - sulphur (S_8)

Polyatomic ion - NH_4^+ , OH^- , SO_4^{2-}

(iii) CaCl_2 - atomicity - 3

SO_4^{2-} - atomicity - 5

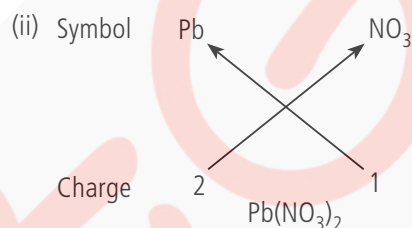
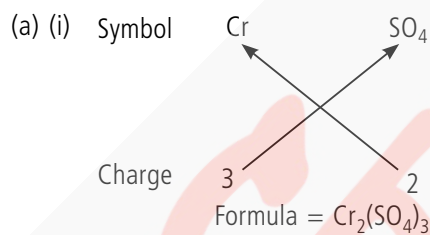
(iv) (a) Na_2CO_3 - Sodium carbonate

(b) NH_4Cl - Ammonium chloride

(c) ZnO - Zinc oxide

(d) $\text{Al}(\text{OH})_3$ - Aluminium hydroxide

28. (a) (i) Symbol



(b) Significance of mole :

(i) It is SI unit of measurement for amount of substance.

(ii) Mole corresponds to the mass of a substance that contains 6.022×10^{23} particles (atom, molecules, ions) of the substance.

(c) For sodium

$m = 100 \text{ g}$

$M = 23 \text{ g}$

$n = \frac{m}{M} = \frac{100}{23}$

$N = n \times N_0$

= $\frac{100}{23} \times 6.022 \times 10^{23} = \frac{100}{56} \times 6.022 \times 10^{23}$

= $4.35 \times 6.022 \times 10^{23} = 1.78 \times 6.022 \times 10^{23}$

Hence, 100 g sodium has more number of atoms.

OR

(i) Mole : One mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.

(ii) 1 mole = 6.022×10^{23} in number

No. of moles = $\frac{\text{Mass of substance (g)}}{\text{Relative molecular mass}}$

(iii) $\therefore$ 1 mole of oxygen contains 6.022×10^{23} molecules

$\therefore$ 0.25 mole of oxygen will contain $6.022 \times 10^{23} \times 0.25$
 = 1.505×10^{23} molecules.

29. (a) A group of atoms carrying a charge is known as polyatomic ion.

e.g., PO_4^{3-} , SO_4^{2-} , NH_4^+

(b) Mass of 10 moles of Na_2SO_3
 $= 10(23 \times 2 + 32 + 16 \times 3) = 1260 \text{ g}$

(c) (i) Molar mass of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
 $= 2 \times (14 + 4 \times 1) + 2 \times 52 + 7 \times 16 = 252 \text{ g}$
 Number of moles of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 = \frac{\text{given mass}}{\text{molar mass}} = \frac{100}{252}$
 $= 0.397 \text{ mol}$

1 mole of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ contains 2 moles of N atoms, 8 moles of H atoms, 2 moles of Cr atoms and 7 moles of O atoms.

Number of moles N atoms $= 2 \times 0.397 = 0.794 \text{ mol}$

Number of moles H atoms $= 8 \times 0.397 = 3.18 \text{ mol}$

Number of moles Cr atoms $= 2 \times 0.397 = 0.794 \text{ mol}$

Number of moles O atoms $= 7 \times 0.397 = 2.78 \text{ mol}$

(ii) $m = 22 \text{ g}$, $M = 44$, $n = ?$

$n = \frac{m}{M} = \frac{22}{44} = \frac{1}{2} = 0.5 \text{ mole}$

30. (a) Mass of pure gold in the sample $= \frac{1 \text{ g} \times 90}{100} = 0.9 \text{ g}$

Number of atoms of gold = Number of moles of gold $\times$ Avogadro's number

$= \frac{0.9 \text{ g} \times 6.022 \times 10^{23} \text{ mol}^{-1}}{197 \text{ g/mol}} = 2.75 \times 10^{21}$

(b) Difference of mass per atom and ion

$= \text{Mass of 2 electrons} = 2 \times 9.1 \times 10^{-31} \text{ kg}$

So, difference in the masses of 10^3 moles of Mg atoms and ions

$= 10^3 \text{ mol} \times 2 \times 9.1 \times 10^{-31} \text{ kg}$

$= 10^3 \times 6.022 \times 10^{23} \times 2 \times 9.1 \times 10^{-31} \text{ kg}$

$= 1.1 \times 10^{-3} \text{ kg}$

OR

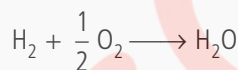
(a) 1 hydrogen gas molecule contains 2 atoms of hydrogen

$\therefore$ 1 dozen of $\text{H}_2 = 24$ atoms of H

6.022×10^{23} molecules of $\text{H}_2 = 1 \text{ mole}$

$\therefore$ 12 molecules of $\text{H}_2 = \frac{12}{6.022 \times 10^{23}} \text{ mole of H}_2$
 $= 1.99 \times 10^{-23}$

(b) Hydrogen : Oxygen (by mass)



$\therefore$ 1 mole of H_2 combines with $\frac{1}{2}$ mole of oxygen,

$\therefore \frac{12}{6.022 \times 10^{23}} \text{ mole of H}_2 \text{ combines} = \frac{1}{2} \times \frac{12}{6.022 \times 10^{23}} \text{ moles of oxygen.}$

So, required $\text{O}_2 = 0.99 \times 10^{-23}$ moles.



