II. Short Answer Type Questions

Question 1. Define molality. How does molality depend on temperature?

Answer: Molality is defined as the moles of solute per kilogram of solvent.

$$\text{Molality} = m = \frac{\text{Moles of solute}}{\text{Mass of solvent (in kg)}}$$

Molality of a solution does not depend on temperature.

Question 2. Convert 2.6 minutes in seconds.

Answer:

We know that, 1 min = 60 s

Conversion factor = 60 s/(1min)

2.6 min = 2.6 min x conversion factor = 2.6 x 60s/1min= 156 s.

Question 3. Express the following up to four significant figures.

(i) 6.5089 *(ii) 32.3928* *(iii) 8.721×10^4* *(iv) 2000*

Answer:

(i) 6.509 (ii) 32.39 (iii) 8.721×10^4 (iv) 2.000×10^3

Question 4. Calculate the number of moles in each of the following.

Answer:

(i) 392 g of sulphuric acid
(ii) 44.8 litres of sulphur dioxide at N.T.P.
(iii) 6.022×10^{22} molecules of oxygen
(iv) 8g of calcium

(i) 392 g of sulphuric acid

Molar mass of $H_2SO_4 = 2 \times 1 + 32 + 4 \times 16 = 98$ g

98 g of sulphuric acid = 1 mol

$$392 \text{ g of sulphuric acid} = 1 \text{ mol} \times \frac{392 \text{ g}}{(98 \text{ g})} = \mathbf{4 \text{ mol}}$$

(ii) 44.8 litres of sulphur dioxide at N.T.P.

22.4 litres of sulphur dioxide at N.T.P. = 1 mol

$$44.8 \text{ litres of sulphur dioxide at N.T.P.} = \frac{1 \text{ mol}}{(22.4\text{L})} \times (44.8 \text{ L}) = \mathbf{2.0 \text{ mol}}$$

(iii) 6.022×10^{22} molecules of oxygen

6.022×10^{23} molecules of oxygen = 1 mol

$$6.022 \times 10^{22} \text{ molecules of oxygen} = 1 \text{ mol} \times \frac{6.022 \times 10^{22}}{6.022 \times 10^{23}} = \mathbf{0.1 \text{ mol}}$$

(iv) 8g of calcium

Gram atomic mass of Ca = 40 g

40 g of calcium = 1 mol

$$8.0 \text{ g of calcium} = 1 \text{ mol} \times \frac{(8.0 \text{ g})}{(40 \text{ g})} = \mathbf{0.2 \text{ mol.}}$$

Question 5. A compound on analysis was found to contain C = 34.6%, H = 3.85% and O = 61.55%. Calculate the empirical formula.

Answer: Step I. Calculation of simplest whole number ratios of the elements.

Element	Percentage	Atomic Mass	Gram atoms (Moles)	Atomic ratio (Molar ratio)	Simplest whole no. ratio
C	34.6	12	$\frac{34.6}{12} = 2.88$	$\frac{2.88}{2.88} = 1$	3
H	3.85	1	$\frac{3.85}{1} = 3.85$	$\frac{3.85}{2.88} = 1.337$ or $\frac{4}{3}$	4
O	61.55	16	$\frac{61.55}{16} = 3.85$	$\frac{3.85}{2.88} = 1.337$ or $\frac{4}{3}$	4

The simplest whole number ratios of the different elements are:
C:H:O::3:4:4
Step II. Writing the empirical formula of the compound.
The empirical formula of the compound = $C_3H_4O_4$.

Question 6. Calculate:
(a) Mass of 2.5 gram atoms of magnesium,
(b) Gram atom in 1.4 grams of nitrogen (Atomic mass Mg = 24, N = 14)
Answer:
(a) 1 gram atom of Mg = 24g
2.5 gram atoms of Mg = 24 x 2.5 = 60g
(b) 1 gram atom of N = 14g;
14g of N = 1 gram atom 1
1.4g of N = 1/14 x 1.4 = 0.1 gram atom.

Question 7. The density of water at room temperature is 1.0 g/mL. How many molecules are there in a drop of water if its volume is 0.05 mL?
Answer:
Volume of a drop of water = 0.05 mL
Mass of a drop of water = Volume × density
$= (0.05\ mL) \times (1.0\ g/mL) = 0.05\ g$
Gram molecular mass of water (H_2O) = $2 \times 1 + 16 = 18\ g$
18 g of water = 1 mol

$$0.05\ g \text{ of water} = \frac{1\ mol}{(18\ g)} \times (0.05\ g) = 0.0028\ mol$$

No. of molecules present
1 mole of water contain molecules = 6.022×10^{23}
0.0028 mole of water contain molecules = $6.022 \times 10^{23} \times 0.0028 = \mathbf{1.68 \times 10^{21}}$ **molecules.**

Question 8. What is the molecular mass of a substance each molecule of which contains 9 atoms of carbon, 13 atoms of hydrogen and 2.33×10^{-23} g other component?

Answer:
Mass of 9 atoms of carbon = 9 × 12 amu = 108 u.
Mass of 13 atoms of hydrogen = 13 × 1 amu = 13 u

$$\text{Mass of } 2.33 \times 10^{-23} g \text{ of other component} = (1u) \times \frac{(2.33 \times 10^{-23} g)}{(1.66 \times 10^{-24} g)} = 14.04\ u$$

Molecular mass of the substance = (108 + 13 + 14.04) u = **135.04 u.**

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