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Answers Key:

Case Study Questions

1. (a) 1 mole of N_2 needs 3 moles of H_2 ,
Therefore, 2 moles of N_2 needs 6 moles of H_2 .
But we have only 2 moles of H_2 , so H_2 is limiting reagent.
3 moles of H_2 gives 2 moles of NH_2.
2 moles of H_2 gives $\frac{2}{3} \times 2 = 1.33$ moles of NH_3 .
(b) 18 g of water (1 mole) containing 10 x 6.022 x 10^{23} electrons = 6.022 x 10^{24} electrons.
[∵1 molecule of H_2O = 2 + 8 = 10 e)
(c) 'M is molarity
'd is density of solution
'm' is molality
$m = \frac{M \times 1000}{1000 \times d - M \times \text{Molar mass}}$
$= \frac{1 \times 1000}{1000 \times 1.10 - 1 \times 58.5}$
$= \frac{1000}{1100 - 58.5} = \frac{1000}{1041.5} = m = 0.96 \text{ mol/kg}.$
(d) It is ratio of number of moles of solute (component) to the total number of moles of solute and solvent (all components).
(e) $X_{glucose}$ + x_{H2O} = 1
$\Rightarrow X_{H2O}$ = 1 - 0.1 = 0.9

3 Marks

2. Molality is defined as the moles of solute per kilogram of solvent.
Molality = m = $\frac{Moles\ of\ solute}{Mass\ of\ solvent(in\ kg)}$
Molality of a solution does not depend on temperature.
3. 392 g of sulphuric acid
Molar mass of H_2SO_4 = 2 x 1 + 32 + 4 x 16 = 98 g
98 g of sulphuric acid = 1 mol
392 g of sulphuric acid = 1 mol x $\frac{392\ g}{(98\ g)}$ = 4 mol
4. $(i) 4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$
$(ii) Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$
$(iii) Fe_2(SO_4)_3 + 6NH_3 + 6H_2O \longrightarrow 2Fe(OH)_3 + 3(NH_4)_2SO_4$
$(iv) 3Cl_2 + 6NaOH \xrightarrow{heat} 5NaCl + NaClO_3 + 3H_2O$
5.

Element	Percentage by mass	Relative number of moles	Simplest ratio of moles	Simplest whole number ratio
Na	21.6	0.939	1	1
Cl	33.3	0.938	1	1
O	45.1	2.82	3	3

Hence, the empirical formula in $NaClO_3$.
6. $2KMnO_4 + 3C_2H_4 + 4H_2O \longrightarrow 2MnO_2 + 2KOH + 3(CH_2OH)_2$
7. $2FeSO_4 \xrightarrow{heat} Fe_2O_3 + SO_2 + SO_3$
Ferrous sulphate, on heating gives Fe_2O_3, SO_2 and SO_3 gases.
8. $\underset{100}{CaCO_g} \longrightarrow CaO_{56\ g} + CO_2$
$MgCO_3 \longrightarrow MgO + CO_2$
$24 + 12 + 48 = 84 \quad g24 + 16 = 40\ g$
Let the mass of $CaCO_3$ be 'x', $MgCO_3$ will be 1 - x.
100 g of $CaCO_3$ will gives 56 g of CaO
x g of $CaCO_3$ will gives $\frac{56x}{100}$ g of CaO
84 g of $MgCO_3$ gives 40 g of MgO
$1 - x$ g of $MgCO_3$ gives $= \frac{40(1-x)}{84}$ g of MgO
$\frac{56x}{100} + \frac{40(1-x)}{84} = 0.96$ g
$84 \times 0.56x + 40 \times 1.84 - 40x = 0.96 \times 84 \times 100$
$47.04x - 40x = 80.64 - 73.60$
$7.04x = 7.04 \Rightarrow x = 1$
% of $CaCO_3 = \frac{1}{1.84} \times 100 = 54.35\%$
% of $MgCO_3 = 100 - 54.35 = 45.65\%$