S1. Ans. (d)

(1) 4 u of He = $\frac{4\,u}{4\,u}$ = 1 He atom

(2) 4 g of Helium = $\frac{4\,g}{4\,g}$ mole = 1 mole = N_A He atom

(3) 2.2710982 of He at STP = $\frac{2.271}{22.710982}$ mole

= 0.1 mole

= 0.1 N_A He atom

(4) 4 mol of He = 4 N_A He atoms

S2. Ans. (a)

$M = \frac{W \times 1000}{M_2 \times V\,(\text{in mL})}$

$W = \frac{M \times M_2 \times V\,(\text{in mL})}{1000} = \frac{0.75 \times 36.5 \times 25}{1000}$

= 0.684 g (Mass of HCl)

$\underset{36.5g}{HCl} + \underset{40g}{NaOH} \longrightarrow HCl + NaOH$

36.5 g HCl reacts with NaOH = 40 g

0.684 g HCl reacts with NaOH

$= \frac{40}{36.5} \times 0.684 = 0.750$ g

Amount of NaOH left = 1 g – 0.750 g

= 0.250 g = 250 mg

S3. Ans. (a)

Element	Mass (%)	No. of moles	No. of moles / Smallest number	Simplest whole number
A	32%	$\frac{32}{64} = \frac{1}{2}$	$\frac{1}{2} \times 2$	= 1
B	20%	$\frac{20}{40} = \frac{1}{2}$	$\frac{1}{2} \times 2$	= 1
C	48%	$\frac{48}{32} = \frac{3}{2}$	$\frac{3}{2} \times 2$	= 3

So, empirical formula of X = A : B : C
1 : 1 : 3

∴ The correct empirical formula of compound X is ABC_3

S4. Ans.(d)

$m = \frac{1000 \times M}{1000 \times d - MM_w}$

$m = \frac{1000 \times 1}{1000 \times 1.25 - 1 \times 85}$

$m = \frac{1000}{1165} = 0.858$

S5. Ans.(a)

Weight of impure limestone = 20 g

Weight of pure limestone ($CaCO_3$) = 20% of 20 g

$= \frac{20}{100} \times 20$

= 4 g

$n_{CaCO_3} = \frac{4}{100} = 0.04$

$n_{CO_2} = 0.04$

$W_{CO_2} = 0.04 \times 44$

= 1.76 g

S6. Ans.(c)

Mass = Volume × Density

= 2.5 × 2.15

= 5.375 g

Since 2.5 has two significant figures, so the mas of solution is correct significant figures will be 5.4 g.

S7. Ans.(b)

$Fe_{0.96}O$

Let Fe(II) present in $Fe_{0.96}O$ = x

Fe(III) present = (0.96 – x)

Total charge on Fe = 2x + (0.96 – x)3

Total charge on O = −2

2x + (0.96 – x)3 = 2

2x + 2.88 – 3x = 2

−x = −0.88

x = 0.88

Fe^{2+} = 0.88, Fe^{3+} = 0.08

Fraction of $Fe^{3+} = \frac{0.08}{0.96} = 1/12$

S8. Ans.(b)

Molality is the moles of solute dissolved per kg of solvent therefore 500 g, 1 molal solution contains 0.5 of solute, as

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

$1 = \frac{0.5}{\text{Mass of solvent (in kg)}}$

∴ Mass of solvent (in kg) = 0.5

= 500 g

S9. Ans.(b)

Let m gram mass of $CaCO_3$ is required

Pure $CaCO_3$ in m gram = $\frac{95}{100} \times m$

Moles of $CaCO_3$ = $\frac{95}{100} \times \frac{m}{100}$

Moles of HCl required = 2 × moles of $CaCO_3$

$= 2 \times \frac{95}{100} \times \frac{m}{100}$

$2 \times \frac{95}{100} \times \frac{m}{100} = \frac{50}{1000} \times 0.5$

m = 1.315 g ≈ 1.32 g

S10. Ans.(b)

Element	%	At Weight	% / At weight	Simplest Ratio
C	78	12	6.5	1
H	22	1	22	3

Empirical formula of this compound is CH_3.

S11. Ans.(c)

(a) Number of Mg atoms = $\frac{1}{24} \times N_A$

$= \frac{1}{24} \times 6.022 \times 10^{23}$ atoms

(b) Number of O atoms = $\frac{1}{32} \times N_A$

$= \frac{1}{32} \times 2 \times 6.022 \times 10^{23}$ atoms

(c) Number of Li atoms = $\frac{1}{7} \times N_A$

$= \frac{1}{7} \times 6.022 \times 10^{23}$ atoms

(d) Number of Ag atoms = $\frac{1}{108} \times N_A$

$= \frac{1}{108} \times 6.022 \times 10^{23}$ atoms

Hence, 1 g lithium has the largest number of atoms.

S12. Ans.(c)

No of atom in 12 g carbon

$= 12 \div (1.9926 \times 10^{-23})$

Thus Number of atoms in 1 mole carbon

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

S13. Ans.(c)

Haber's process

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

20 moles need to be produced

2 moles of $NH_3 \rightarrow 3\, moles\, of\, H_2$

Hence 20 moles of $NH_3 \rightarrow \frac{3\times20}{2}$ = 30 moles of H_2

S14. Ans.(d)

$HCOOH \xrightarrow{Conc.H_2SO_4} CO(g) + H_2O(l)$

2.3g or $\left(\frac{1}{20} mol\right)$ $\frac{1}{20} mol$

$COOH \xrightarrow{Conc.H_2SO_4} CO(g) + CO_2(g) + H_2O(l)$

|

$COOH$ $\frac{1}{20} mol$ $\frac{1}{20} mol$

$4.5\ or \left[\frac{1}{20} mol\right]$

Gaseous mixture formed is CO and CO_2. When it is passed through KOH, only CO_2 is absorbed. So the remaining gas is CO. KOH pellets absorbs all CO_2, H_2O is absorbed by H_2SO_4 thus CO is remaining product.

So, weight of remaining gaseous product CO is $\frac{2}{20} \times 28 = 2.8g$

So, the correct option is (d)

S15. Ans.(a)

(a) Mass of water = 18 × 1 = 18 g
Molecules of water = $mole \times N_A = \frac{18}{18} N_A = 1\, N_A$

(b) Molecules of water $mole \times N_A = \frac{0.18}{18} N_A = 10^{-2} N_A$

(c) Molecules of water $mole \times N_A = 10^{-3}\, N_A$

(d) Moles of water $= mole \times N_A = 10^{-4}\, N_A$

S16. Ans.(c)

	%	Moles	Relative moles
C	85.7	$\frac{85.7}{12} = 7.14$	1
H	14.3	$\frac{14.3}{1} = 14.3$	2

Hence, empirical formula = CH_2.

empirical weight = 14

$\frac{3.01\times10^{20}}{6.022\times10^{23}} = No.of\ moles = \frac{42\times10^{-3}}{M}$

$\frac{1}{2}\times10^{-3} = \frac{42\times10^{-3}}{M}$

M = 84

∴ Atomicity $= \frac{84}{14} = 6$

Molecular formula = C_6H_{12}.

S17. Ans.(c)

For XY_2, let atomic weight of X = A_x and of Y = A_y

So, $n_{xy_2} = 0.1 = \frac{10}{A_x+2A_y}$

$A_x + 2A_y = 100$ ...(i)

Similarly for X_3Y_2,

$3A_x + 2A_y = 180$ ...(ii)

On solving (i) and (ii)

$A_x = 40$ and $A_y = 30$

S18. Ans.(a)

(a) 18 mols of water will contain = 18 × 6.022 × 10^{23} molecules of H_2O

(b) 18 molecules

(c) $\frac{1.8}{18} = 0.1$ mole will contain = 0.1 × 5.022 × 10^{23} molecules of H_2O

(d) $\frac{18}{18}g$ = 1 mole = 1 × 6.022 × 10^{23} molecules of H_2O

So, maximum number of molecules is present in 18 moles of H_2O.

S19. Ans.(c)

Avogadro's number 6.022 × 10^{23} is ideally the mass of number of atoms present in 1 mole that is 12 grams of C. If we change the Avogadro's number it will directly change the mass of 1 mole that is 12 g of C.

S20. Ans.(b)

Molecular weight of $AgNO_3$ = 170

Molecular weight of NaCl = 58.5

1. 16.9% solution of $AgNO_3$ means 16.9 g of $AgNO_3$ in 100 mL of solution So, 8.45 g of $AgNO_3$ in 50 mL of solution.
2. 5.8% solution of NaCl means 5.8 g of NaCl is in 100 mL solution. So, in 50 mL = 2.9 g NaCl

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$$

Initial Mole : $\frac{8.45}{170}$ $\frac{2.9}{58.5}$ 0 0

= 0.049 = 0.049 0 0

Final mole : 0 0 0.049 0.049

Mass of AgCl precipitated = 0.049 mole = 0.049 × 143.3

= 7.02 gm ≃ 7 gm

S21. Ans.(c)

$$MgCO_3 \rightarrow MgO + CO_2(g)$$

↓ ↓

Mg→ 84 g 40 g

According to question

84 g $MgCO_3$ gives = 40 g MgO

1 g $MgCO_3$ gives $= \frac{40}{84}$

20 g $MgCO_3$ gives $= \frac{40}{84}\times 20$

= 9.52 g of MgO

But according to question yield of MgO is = 8 g

% of purity $= \frac{8}{9.52}\times 100 = 84\%$

S22. Ans.(d)

1 mole = 22.4 litres at S.T.P.

$n_{H_2} = \frac{22.4}{22.4} = 1\ mole$; $n_{Cl_2} = \frac{11.2}{22.4} = 0.5\ mol$

Reaction is as,

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Initial 1 mol 0.5 mol 0

Final (1– 0.5) (0.5 – 0.5) (2 × 0.5)

= 0.5 mol = 0 mol 1 mol

Here, Cl_2 is limiting reagent. So, 1 mole of HCl (g) is formed.

S23. Ans.(d)

$n_{Mg} = \frac{1}{24} = 0.0416\ moles$

$n_{O_2} = \frac{0.56}{32} = 0.0175\ moles$

The balanced chemical equation :

$$Mg + \frac{1}{2}O_2 \rightarrow MgO$$

Initial moles	0.0416	0.0175 moles	0
Final	(0.0416–2×0.0175)	0	2×0.0175

= 0.0066 moles (O_2 is limiting reagent)

∴ Mass of Mg left in excess

= 0.0066 × 24 = 0.16 g

S24. Ans.(c)

According to Avogadro's principle, ratio of volume of gases will be equal to the ratio of their number of moles

mole = $\frac{w}{M_w}$

$n_{H_2} : n_{O_2} : n_{CH_4}$

$\frac{w}{2} : \frac{w}{32} : \frac{w}{16} \Rightarrow 16 : 1 : 2$

S25. Ans.(b)

6.02×10^{23} number of molecules

= 1 mole

6.02×10^{20} = 0.001 mole

Concentration= $\frac{mole}{V(mL)} \times 1000$

$= \frac{0.001}{100} \times 1000 \Rightarrow 0.01$ M

S26. Ans.(a)

Molarity of solution of dichlorotetra-aquachromium (III) chloride = 0.01 M.

Volume of solution of dichlorotetra-aquachromium (III) chloride = 100 ml.

The formula of dichlorotetra-aquachromium (III) chloride is $[Cr(H_2O)Cl_2]Cl$.

On ionisation,

$[Cr(H_2O)Cl_2]Cl \rightarrow [Cr(H_2O)Cl_2]^+ + Cl^-$

Initial	100 × 0.01	0	0
Final	0	1 mol	1 mol

So, 1 mol of Cl^- ions will react with 1 mol of $AgNO_3$ mole of $[Cr(H_2O)Cl_2]Cl$ 0.1 M 100 ml solution is,

No. of moles = Molarity × Volume

= 0.01 × 0.1 = 0.001 mol

Hence, 0.001 mol of Cl^- ions will react with 0.001 mole of $AgNO_3$.

So, number of moles of AgCl formed is 0.001 mol.