TOPIC : MOLE CONCEPT
EXERCISE # 1

SECTION (A)

1. 1 Torr = 1 mm.

2. This is the required relation in Centigrade and Fahrenheit scales.

4. Atoms of an element are alike.

8. The mass of one mole of a substance will remain unchanged.

SECTION (B)

1. $\text{mole} = \frac{\text{mass}}{\text{at. wt.}} = \frac{46}{23} = 2$ mole.

3. We know that, 1 amu = $\frac{1}{12}$ × weight of one ^{12}C atom
or weight of one ^{12}C atom = 12 amu (at. wt. of C = 12 amu).
Similarly, as the atomic weight of He is 4 amu, weight of one He atom = 4 amu.
Thus, the number of atoms in 100 amu of He = $\frac{100}{4} = 25$.

4. In 18 g, no. of molecules = N_A
so in 0.09 g no. of molecules = $\frac{N_A}{18} \times 0.09 = \frac{N_A}{2 \times 100} = 3.01 \times 10^{21}$.

5. mole = $\frac{w}{m} = \frac{1}{m}$ for largest no. of molecule m should be lowest.

8. molecule of $H_2SO_4 = \frac{196}{98} = 2$.
Hence : H = 4 atoms, S = 2 atoms, O = 8 atoms.

10. 17 g $NH_3 = N_A$ molecules

11. 1 mole P_4 = N molecules of P_4 = 4 N atoms of P_4.

12. 560g of Fe No. of moles = $\frac{560\,g}{56\,g}$ = 10 mole
70 g of N
14g = 1 mole atom of N
70g = 5 moles of N
20g H = 20 moles of H-atoms.

13. (1) moles of C = 24/12 = 2, So no. of atoms = $2N_A$
(2) moles of Fe = 56/56 = 1, So no. of atoms = N_A
(3) moles of Al = 27/27 = 1, So no. of atoms = N_A
(4) moles of Fe = 108/108 = 1, So no. of atoms = N_A

14. 12 g $_6C^{12}$ contains $6N_A$ electrons and 6 N_A neutrons.

15. 4 g He = N_A atoms

16. Mole of Aluminium = $\frac{54}{27}$ = 2 mole.
Al and Mg have same number of atoms (given). Hence same moles also.
∴ Mass of magnesium = 2 × 24 = 48 g.

17. 558.5 g Fe = $\frac{558.5}{55.85}$ mole Fe = 10 mole Fe = 2×5 mole C = 2× $\frac{60}{12}$ mole C

18. $\frac{1}{2} \times 6.023 \times 10^{23} = 3.0125 \times 10^{23}$

20. 9.108×10^{-31} kg is the wt. of 1 e^- = moles of e^-

So 1 kg is the wt. of 1 e^- = $\frac{1}{9.108\times10^{-31}}\times\frac{1}{N_A} = \frac{1}{9.108\times10^{-31}\times6.023\times10^{23}} = \frac{10^8}{9.108\times6.023}$.

21. Statement of avogadro's hypothesis.

25. Mol. wt. of gas is $= \frac{16\times22.4}{5.6}$ = 64 g

$32 + 16x = 64$
$x = 2$

SECTION (C)

3. Number of electrons = $\frac{1.8\times10}{18} \times N_A$

SECTION (E)

2. $2\text{ Al} + \frac{3}{2}\text{ O}_2 \longrightarrow \text{Al}_2\text{O}_3$ $\Rightarrow$ weight of Al required = 2 × 27 = 54 g

3. $\text{KClO}_3 \quad \text{KCl} + \frac{3}{2}\text{ O}_2$

$\frac{3}{2}$ mole or 33.6 litre O_2 from 1 mole $KClO_3$

11.2 litre of O_2 formed by $\frac{1}{3}$ mole $KClO_3$

SECTION (F)

2. By applying POAC for C atoms
moles of ethylene × 2 = mole of polythene × n × 2

$\frac{100g}{28} \times 2 = \frac{\text{wt. of polethene}}{28\times n} \times n \times 2$ wt. of polyethene = 100 g

3. $CaCl_2 + NaCl = 10$ g
Let weight of $CaCl_2$ = x g
$CaCl \rightarrow CaCO_3 \rightarrow CaO$
1 mol 1 mol 1 mol
$\frac{x}{111}\text{mol}\ \frac{x}{111}\text{mol}\ \frac{x}{111}\text{mol} \Rightarrow$ Mole of CaO = $\frac{1.62}{56}$ $\therefore \frac{x}{111} = \frac{1.62}{56}$
x = 3.21 g

% of $CaCl_2$ = $\frac{3.21}{10}$ ×100 = 32.1 %

SECTION (G)

6. $\text{Zn} + \text{Fe} + 2\text{S} \longrightarrow \text{Zn (FeS}_2)$

	Zn	Fe	2S	Zn (FeS$_2$)
initial mole	2	3	5	0
final mole	0	3–2 = 1	5 –4 =1	2

SECTION (H)

1. Molarity $= \frac{6.02\times10^{22}}{6.02\times10^{23}} \times \frac{1}{1/2}$ = 0.2

3. Mole = M × V
$100 \times 10^{-3} = 0.8 \times V$
V = 0.125

SECTION (I)

1. $M_1V_1 + M_2V_2 = M_R [V_1 + V_2]$
$1 \times 500 + 3 \times 500 = M_R [500 + 500]$
$M_R = 1$

5. Weight of NaOH = 20 gram
Weight of solvent = 80 g

$$M = \frac{20 \times 1000}{40 \times 80} = 6.25 \text{ m}$$

7. $M = \frac{10 \times 1.14 \times 20}{98}$

M = 2.32

8. $M = \frac{\%\ \text{by weight} \times 10 \times d}{Mw_2} = \frac{36.5 \times 10 \times 1.2}{36.5} = 12\text{ M}$

$m = \frac{36.5 \times 1000}{36.5 \times (100 - 36.5)} = \frac{1000}{63.5} = 15.7\text{ m}$

9. 1000 mL solution contain 2 mole of ethanol or 1000 × 1.025 g solution contain 2 mole of ethanol
wt. of solvent = 1000 × 1.025 – 2 × 46

$m = \frac{2}{1000 \times 1.025 - 2 \times 46} \times 1000$

$m = \frac{2}{933} \times 1000 = 2.143$

10. Molarity of HCl = $\frac{\text{Total moles of HCl}}{\text{Total volume}} = \frac{5 \times 2}{2 + 3} = 2\text{ M}$

SECTION (J)

1. $2(+1) + 2\ x = 0 \quad \therefore \quad x = -1$

2. $2(+2) + 2x + 7(-2) = 0 \quad \therefore \quad x = +5$

3. $SO_3^{2-} \Rightarrow 1(x) + 3(-2) = -2 \therefore x = +4$
$S_2O_4^{2-} \Rightarrow 2(x) + 4(-2) = -2 \therefore x = +3$
$S_2O_6^{2-} \Rightarrow 2(x) + 6(-2) = -2 \therefore x = +5$

4. $NaN_3 \Rightarrow 1(+1) + 3(x) = 0 \therefore x = -1/3$
$N_2H_2 \Rightarrow 2(x) + 2(+1) = 0 \therefore x = -1$
$NO \Rightarrow 1(x) + 1(-2) = 0 \therefore x = +2$
$N_2O_5 \Rightarrow 2(x) + 5(-2) = 0 \therefore x = +5$

5. $x + 4(+1) = +1$
$x = -3$

SECTION (K)

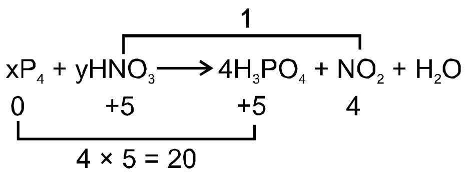
1. Valency factor ratio is inversely related to molar ratio.
(V.f.)HI : (V.f.)HNO_3 = 1 : 3 = 2 : 6 ∴ Molar ratio = 6 : 2

2.✍ $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

V.f. = 5 V.f. = 2

∴ Balanced equation : $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

3.



$xP_4 + yHNO_3 \longrightarrow 4H_3PO_4 + NO_2 + H_2O$

∴ (V.f.)P_4 : (V.f.) HNO_3 = 20 : 1

∴ x = 1; y = 20

4.✍ Br_2 undergoes disproportionation, i.e. it undergoes both oxidation & reduction.

EXERCISE # 2

2. $\frac{F-32}{9} = \frac{C}{5}$

Let temperature be t, same on two scale $\therefore$ $t - 32 = \frac{9t}{5}$ or $t = -40$

4. No. of atoms = mole × N_a

$1 = \frac{x}{238} \times N_a$ (x is wt. of uranium)

$x = \frac{238}{6} \times 10^{-23}$

$x = 3.95 \times 10^{-22}$

5. Let mole % of ^{26}Mg be x $\therefore$ $\frac{(21-x)\ \ 25+x\ \ (26)+79\ \ (24)}{100} = 24.31$ $\Rightarrow$ x = 10%

11. 10 mole NH_3 have mole of 'H' atom = 10 × 3

5 mole of H_2SO_4 have mole of 'H' atom = 10

Total mole of 'H' atom = 40

mole of H_2 = 20

Hence : number of H_2 molecules = $20N_A$

12.

	A	B
Atomic mass	40	80
given weight	x gram	2x gram
No. of mole	$\frac{x}{40}$	$\frac{2x}{80}$
No. of Atom	$\frac{x}{40} \times N_A$	$\frac{x}{40} \times N_A$

But according to question $= \frac{x}{40} \times N_A = y$

13.

	H_2	:	He	:	O_2	:	O_3
Ratio of total no. of molecules =	1	:	1	:	1	:	1
So ratio of total no. of atoms =	2	:	1	:	2	:	3

17. 1 litre Hg metal

volume = 1000

$d = \frac{m}{v}$ mass = d × V = 13.6 × 1000

No of mole of Hg metal $= \frac{13.6 \times 1000}{200}$ = 68 mole

20.

	C	H	O
mass	24	8	32
moles	$\frac{24}{12}$	$\frac{8}{1}$	$\frac{32}{16}$
ratio	2	8	2
Simple integer ratio	1	4	1

Hence empirical formula is CH_4O

27. $2KClO_3 \longrightarrow 2KCl + 3O_2$

$n_{KClO3} = \frac{36.75}{122.5} = 0.3$ $\Rightarrow$ By mole-mole analysis $\frac{n_{KClO_3}}{2} = \frac{n_{O_2}}{3}$

or $n_{O2} = \frac{3}{2} \times 0.3 = 0.45$ or volume of O_2 = 0.45 × 22.4 = 10.08 lit. = 10.08 dm^3

31.

	I_2	+	$2Cl_2$	$\longrightarrow$	ICl	+	ICl_3
Given mass	25.4 gram		14.2 gram		0		0
initial mole	0.1 mole		0.2 mole		0		0
final mole	0		0		0.1		0.1

34.

	$2\,SO_2$	+	O_2	$\longrightarrow$	$2\,SO_3$
Initial mole	10		15		0
Final mole	(10 – 2x)		(15 – x)		2x

$\because$ Given $2x = 8$

$\therefore$ $x = 4$

$\therefore$ Mole of SO_2 left = $10 - 2 \times 4 = 2$

Mole of O_2 left = $15 - 4 = 11$

35.

	H_2SO_4	+	$Ca(OH)_2$	$\longrightarrow$	$CaSO_4$	+	$2H_2O$
Initial mole	0.5		0.2		0		0
finally mole	0.5 – 0.2		0		0.2		0.4

41. $X = \frac{20}{M_1 \times 50}$

$Y = \frac{15}{70 \times M_2}$

$X = Y$

$\frac{20}{M_1 \times 50} = \frac{15}{70 \times M_2}$

$\frac{28}{15} = \frac{M_1}{M_2}$

42. 500 gm toothpaste contains 0.4 g fluoride

$\therefore$ 10^6 g toothpaste will contain $\frac{0.4}{500} \times 10^6 = 800$ g fluoride $\therefore$ ppm of fluoride = 800

43. $M_{final} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2 + V_{water}}$; $0.25 = \frac{0.6 \times 250 + 0.2 \times 750}{250 + 750 + V_{water}}$; So $V_{water} = 200$ ml.

45. Moles of HNO_3 required = $\frac{0.784}{108} = 0.0072 \times \frac{4}{3} = 0.00968$.

Vol. of HNO_3 = $\frac{0.00963}{1.15} \times 1000 = 8.41$ ml.

46. Molarity = $\frac{10 \times 1.8 \times 98}{98} = 18$ M

48.✍ $N_2H_4 \xrightarrow{-10e^-} 2N^{x+}$

(– 2)

$\therefore$ $2x - 2(-2) = 10$ $\therefore$ $2x = 6$ $\therefore$ $x = +3$.

49. Fe_3O_4 can be written as $FeO.Fe_2O_3$.

In FeO , Fe has oxidation state + 2 , in Fe_2O_3 has oxidation state + 3.

resultant oxidation number = $\frac{1 \times 2 + 2 \times 3}{3} = \frac{8}{3}$.

50. For a completely balanced equation, net charge on reactant side & product side must be equal.

$-1 + 4 + x(-1) = 0$

$x = +3$

51.✍ $X^- + XO_3^- + H^+ \longrightarrow X_2 + H_2O$

V.f. = 1   V.f. = 5 $\therefore$ Molar ratio = 5 : 1

EXERCISE # 3

PART - I

20. For XY_2 $n = \frac{w}{M}$

$0.1 = \frac{10}{X+2Y}$

$X + 2Y = 100$ ....(1) For X_3Y_2 $n = \frac{w}{M}$

$0.05 = \frac{9}{3X+2Y}$

$3X + 2Y = 180$ ....(2) Form (1) and (2)

$2X = 80$

$X = 40$ and $2Y = 100 - 40 = 60 = Y = 30$

21. Molarity has volume term in its expression and volume is temperature dependent.

22. (i) 10^{-3} mole water = 6.02×10^{20} molecule H_2O

(ii) 18 ml H_2O = 18 gram = 1 mole

= 6.02×10^{23} molecule

(iii) At 1 atm & 273 K

No. of mole of H_2O = $\frac{0.00224}{22.4} = \frac{22.4\times10^{-4}}{22.4}$ = 10^{-4} mole= 6.02×10^{19} molecule.

(iv) 0.18 gram H_2O = 0.1 mole = 6.02×10^{22} molecule.

23. $HCOOH + H_2C_2O_4$

2.3 gram 4.5 gram

$HCOOH + H_2SO_4\,(Conc.) \longrightarrow CO_{(g)} + H_2O_{(\ell)}$

2.3 / 46

1/20 mole 1/20 mole

Mass of CO = 1/20 x 28 = 1.4 gram

$H_2C_2O_4 + H_2SO_4\,(Conc.) \longrightarrow CO_{(g)} + H_2O_{(\ell)} + CO_2$ (gas)

4.5 / 90

1/20 mole 1/20 mole 1/20 mole

Mass of CO = 1/20 x 28 = 1.4 gram

KOH absorb CO_2 so remaing gas is only CO so total mass of remaing gas is (1.4 + 1.4) = 2.8 garm.

24. Formation of ammonia

$N_2 + 3H_2 \longrightarrow 2NH_3$

2 mole of NH_3 is formed by 3 mole of H_2

20 mole of NH_3 is formed by 30 mole of H_2

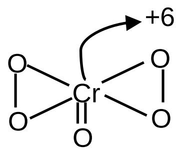
25. Disproportionation reaction : The reaction in which same element/ compound get oxidized and reduced simultaneously.

(a) $2Cu^{+} \rightleftharpoons Cu^{2+} + Cu^{0}$

(b) $3MnO_4^{2-}\ 4H^{+} \rightleftharpoons 2MnO_4^{-} + MnO_2 + 2H_2O$

(d) option belongs to comproportionation reaction

26.



27. molality = $\dfrac{\text{Molarity}}{\text{density} - \dfrac{\text{molarity} \times \text{molar mass}}{1000}}$

Molarity (M) = 2

Density = 1.2 g/cm^3 $\Rightarrow$ m = $\dfrac{2}{1.2 - \dfrac{2 \times 40}{1000}}$ = 1.67

PART - II

12. $CaCl_2 + CO_3^{2-} \longrightarrow CaCO_3 + 2Cl^-$

111 g 100g

$CaCO_3 \longrightarrow CaO + CO_2$

100g 56 g

$\therefore$ 56 g CaO is obtained by the decomposition of $CaCO_3$ = 100 g

$\therefore$ 0.959 g CaO will be obtained by the decomposition of $CaCO_3 = \dfrac{100 \times 0.959}{56}$=1.71g

Further, 100 g $CaCO_3$ = 111 g $CaCO_2$

171 g $CaCO_3 = \dfrac{111 \times 171}{100}$ = 189 g $CaCl_2$

Percentage of $CaCl_2$ in the mixture $= \dfrac{189}{4.22} \times 100 = 44.78 = 45\%$

14. $A + 2HCl \longrightarrow ACl_2 + H_2$

mole = $\dfrac{x}{15}$ $\dfrac{x}{15}$

$B + 2\,HCl \longrightarrow BCl_2 + H_2$

mole = $\dfrac{2-x}{30}$ $\dfrac{2-x}{30}$

Mole of $H_2 = \dfrac{x}{15} + \dfrac{2-x}{30} = \dfrac{2.24}{22.4} = \dfrac{1}{10} \Rightarrow \dfrac{x}{15} - \dfrac{x}{30} = \dfrac{1}{10} - \dfrac{1}{15}$

x = 1 gm

PART - III

1. In the reaction.

$$\underset{+1\;\,-1}{2H\,I} + \underset{+1\;\;+6\;\;-2}{H_2\,S\,O_4} \rightarrow \underset{0}{I_2} + \underset{+4}{SO_2} + \underset{+1\;\;-2}{2H_2\,O}$$

Ist half reaction : $\underset{-1}{2HI} \rightarrow \underset{0}{I_2}$

In this reaction oxidation number of I increases by one, thus this is an oxidation reaction and HI behaves as a reducing agent.

IInd half reaction : $\underset{+6}{H_2SO_4} \rightarrow \underset{+4}{SO_2}$

On the other hand, in this reaction, oxidation number of S decreases by two, thus this is a reduction reaction and H_2SO_4 behaves as oxidizing agent.

2. 8 moles of O-atom are contained by 1 mole $Mg_3(PO_4)_2$.

Hence, 0.25 moles of O-atom = × 0.25 = 3.125 × 10^{-2} mole $Mg_3(PO_4)_2$.

3. molality (m) = $\dfrac{M}{1000d - MM_1} \times 1000$

M = Molarity
M_1 = Molecular mass of solute

d = density = $\frac{2.05}{(1000 \times 1.02) \; - \; (2.05 \; \times \; 60)} \times 1000$ = 2.28 mol kg^{-1}

4. $2Al(s) + 6HCl(aq) \longrightarrow 2Al^{3+}(aq) + 6Cl^{-}(aq) + 3H_2(g)$
3 mole H_2 from 6 mole HCl consumed.
$\therefore$ 1 mole H_2 from 2 mole HCl consumed.
1/2 mole(11.2 Lit) H_2 from 1 mole HCl consumed.

5. 3.6 M solution means 3.6 mole of H_2SO_4 is present in 1000 ml of solution
$\therefore$ Mass of 3.6 moles of H_2SO_4 is = 3.6 × 98 g = 352.8 g
$\therefore$ Mass of H_2SO_4 in 1000 ml of solution = 352.8 g
Given, 29g of H_2 SO_4 is present in 100 g of solution
$\therefore$ 352.8 g of H_2SO_4 is present in $\frac{100}{29} \times 352.8 = 1216$ g of solution

Now density = $\frac{\text{Mass}}{\text{Volume}} = \frac{1216}{1000}$ = 1.216 g/mL = 1.22 g/mL

6. $X_{\text{ethyl alcohol}} = \frac{5.2}{5.2 + \frac{1000}{18}} = 0.086$

7. Molality = $\frac{0.01/60}{0.3} = \frac{0.01}{60 \times 0.3}$; d = 1 g/ml = 5.55×10^{-4} m.

8. Molarity = $\frac{\text{mols of solute}}{\text{volume of sol. } (\ell)} = \frac{120 \times 1.15}{60 \times 1120} \times 1000$ = 2.05 M

9. $M_f = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$

$$= \frac{0.5 \times \frac{3}{4} + 2 \times \frac{1}{4}}{1} = 0.875 \text{ M}$$

10. MnO_4^{-} + $C_2O_4^{2-} + H^{+} \longrightarrow Mn^{2} + CO_2 + H_2O$
vf = 1(7 –2) vf = 2(3–2)
= 5 = 2
Balanced Equation :
$2MnO_4^{-} + 5C_2O_4^{2-} + 16\,H^{+} \longrightarrow 2Mn^{2+} + 10\,CO_2 + 8H_2O$
So, x = 2, y = 5 & z = 16.

11. $$\frac{n_{O_2}}{n_{N_2}} = \frac{\frac{(m_{O_2})}{(M_{O_2})}}{\frac{(m_{N_2})}{(M_{N_2})}} = \left(\frac{m_{O_2}}{m_{N_2}}\right)\frac{28}{32} = \frac{1}{4} \times \frac{28}{32} = \frac{7}{32}$$

12. 1 g of $C_8H_7SO_3Na = \frac{1}{206}$ mole

$$2C_8H_7SO_3Na \; + \; Ca^{2+} \longrightarrow (C_8H_7SO_3)_2Ca \; + \; 2Na^{+}$$

$\frac{1}{206}$ mole $\frac{1}{412}$ mole

13. 75 kg person contain 10% hydrogen i.e. 7.5 kg Hydrogen.

If all H atom are replaced by ^2H, the weight of Hydrogen become twice i.e. it increases by 7.5 kg.

14. $M_2CO_3 + 2HCl \longrightarrow MCl_2 + H_2O + CO_2$

$\frac{1}{M_0}$Mole   0.01186 mol.

M_0 = Molar mass of M_2CO_3

$\frac{1}{M_0} = 0.01186$

$M_0 = 84.3\ g/mol$

15. 1, 2, 3 are non redox. In 4, O_2F_2 is oxidising agent & XeF_4 is reducing agent.

16.

Element	C	:	H		
Mass ratio	6	:	1		
Mole Ratio	6/12	:	1	⇒	= 1 : 2

So C_XH_Y have empirical formula : CH_2 for Burning a CH_2 unit ; oxygen required is $\frac{3}{2}$ mol

$CH_2 + \frac{3}{2}O_2 \longrightarrow CO_2 + H_2O$

Empirical formula is 2 × $(CH_2O_{3/2}) \Rightarrow C_2H_4O_3$ **Ans. (2)**

17. $2C_{57}H_{110}O_6(s) + 163O_2(g) \longrightarrow 114CO_2(g) + 110H_2O\ (\ell)$

445 g = $\frac{1}{2}$ mole ⇒ $\frac{110}{2} \times \frac{1}{2}$ mole = $\frac{110 \times 18}{4}$g = 495 g.

18. m = $\frac{92}{23} = 4$

19. Moles of sucrose required = 2 × 0.1 = 0.2 wt. = 0.2 × 342 g = 68.4 g

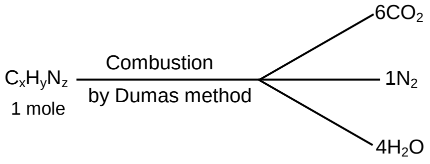
20.

$Ca(OH)_2$	+	Na_2SO_4	→	$CaSO_4$	+	2 OH^-
100 mmol		$\frac{2000}{142}$ = 13.986 ≈ 14 milimol		14 mmol		28 mmol

mass of $CaSO_4$= $\frac{14 \times 136}{1000}$ = 1.9 g

$[OH^-] = \frac{28}{100}$ = 0.28 M

21.



on applying POAC we get the formula $C_6H_8N_2$

22. $2NaHCO_3 + H_2C_2O_4 \rightarrow Na_2C_2O_4 + 2CO_2 + 2H_2O$

Let mass of $NaHCO_3$ be x mg

n = $\frac{0.25}{25000} = 10^{-5}$ ⇒ w = 84×10^{-5} g ⇒ $\% = \frac{84 \times 10^{-5}}{10^{-2}} \times 100$ = 8.4%

23. $n_1 = \frac{8}{40} = 0.2$

$n_2 = \frac{18}{18} = 1$ ⇒ mole fraction of NaOH = $\frac{0.2}{1.2} = 0.167$ ⇒ molality = $\frac{8}{40} \times \frac{1000}{18} = 11.11$