PRAYAS

FOR JEE 2023

MOLE CONCEPT

Lec-2

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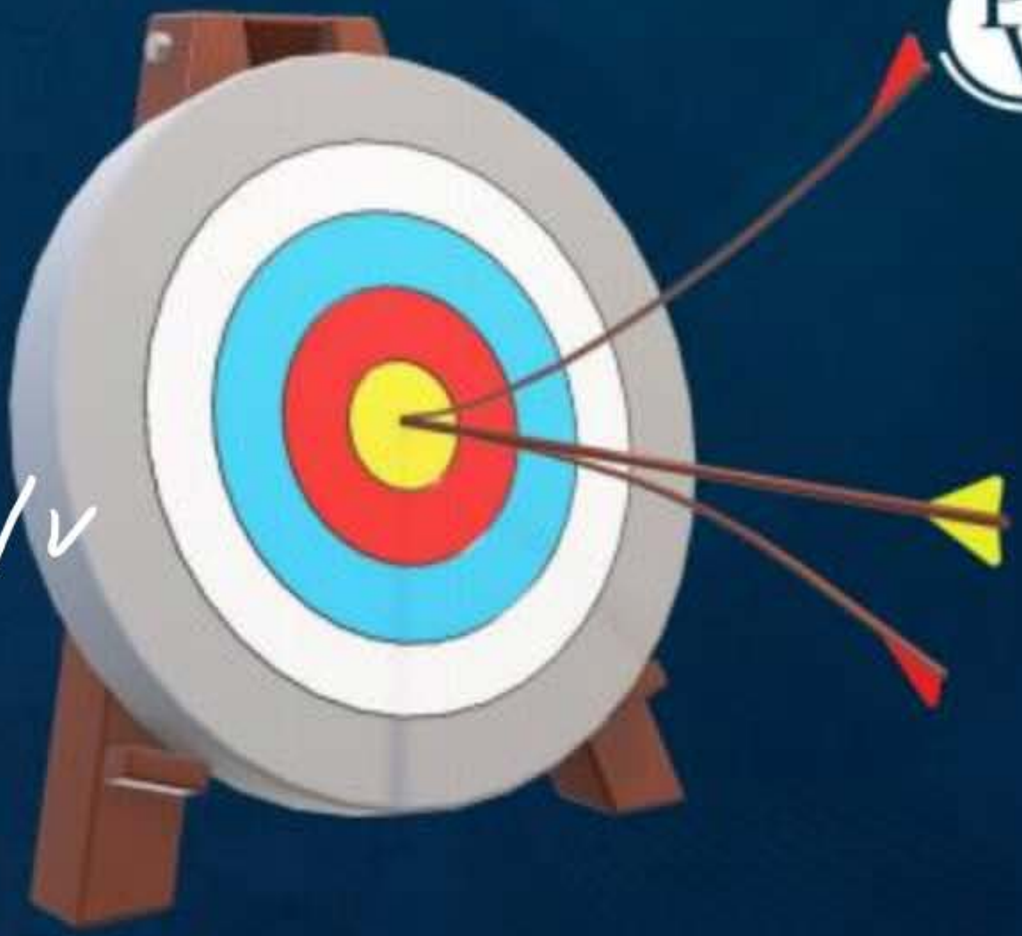
TOPICS TO BE COVERED



1. No. of moles calculation
2. % composition % w/w, % w/v, % V/V
3. Mole Fraction
4. Chemical equation & Stoichiometric Coefficient
5. Limiting and Excess reagent
6. Concentration Terms (M, m, N)

(g ⟶) (g ⟵) (g × 8)

90

64 g
CH_4

Total n° = 24 N_A

Total p^+ = 40 N_A

Total e^- = 40 N_A

@ STP = 22.4 × 4
= 89.6 lit

H-atoms = 16 N_A

Moles = $\frac{64}{16}$ = 4

Molecules = 4 N_A

Atoms = 20 N_A

C-atoms = 4 N_A

% Composition

(gm/gm)

$$\boxed{\%\ w/w = \frac{\text{wt of A}}{\text{Total wt}} \times 100}$$

$$\boxed{\%\ w/w\ B = \frac{\text{wt of B}}{\text{Total wt}} \times 100}$$

Calculate % of Ca in pure sample of lime stone.

$\boxed{CaCO_3} \Rightarrow 1\text{mol}$

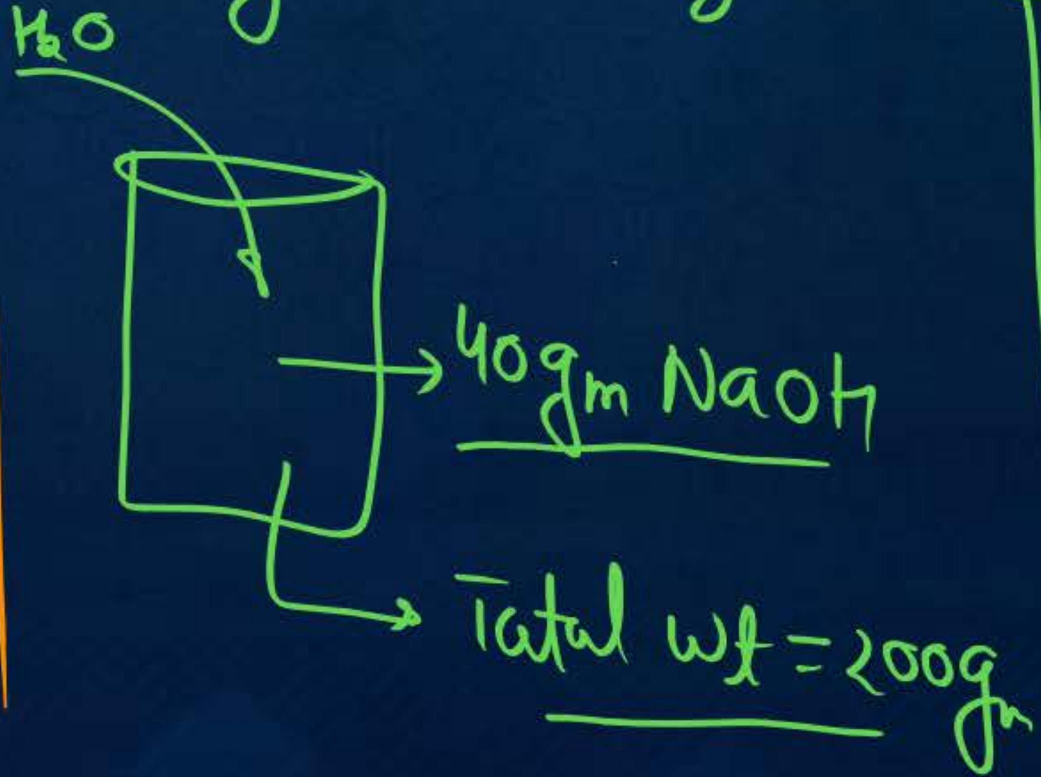
$\Rightarrow 40 + 12 + 3(16)$

$= 40 + 12 + 48 = 100\text{ g}$

1mol $\underset{100g}{CaCO_3} \Rightarrow \underset{40g}{1\text{ mol Ca}}$

$\%\ Ca = \frac{40}{100} \times 100 = 40\%$

40 gm NaOH is mixed with Water to give 200 g solution. % w/w H_2O



$w_T\ NaOH + w_T\ H_2O$

$40 + w_{T\,H_2O} = 200$

$w_t\ H_2O = 200 - 40$

$= 160g$

$wt\% = \frac{160}{200} \times 100$

$= 80\%$

% v/v ⇒ Liquids only $\left(\frac{lit}{lit}\right)$ $\left(\frac{ml}{ml}\right)$

$$\boxed{\% \, v/v \; A = \frac{\text{volume of A}}{\text{Total volume}} \times 100}$$

Ideal soln of liq A & B.

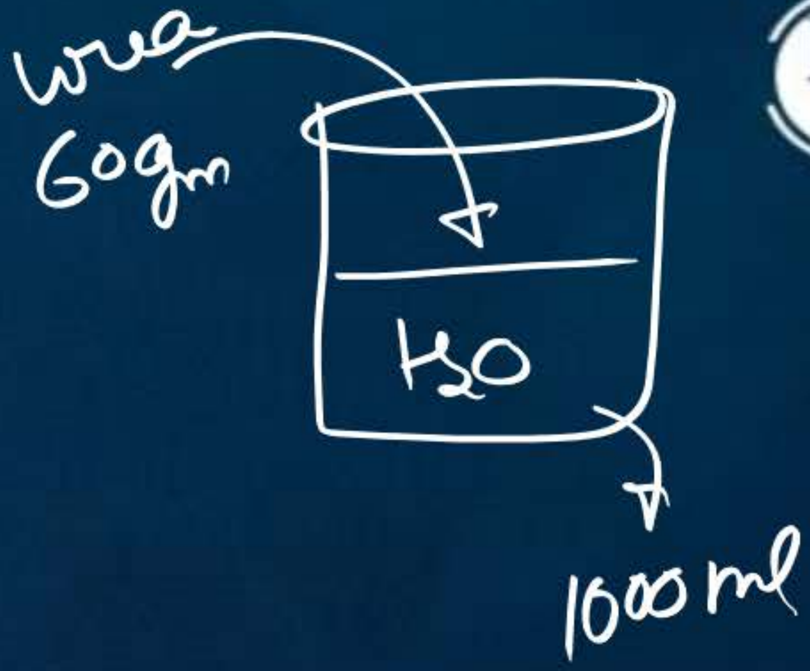
300 ml A &
200 ml B

$$\% \, v/v \; A = \frac{300}{300+200} \times 100$$

$$= \frac{3}{5} \times 100$$

$$= 60\%$$

$\% \, w/v \Rightarrow$ $\frac{gm}{ml}$



$$\% \, w/v \, A = \frac{Wt \text{ of } A}{\text{volume of sol}^n} \times 100$$

$$\% \, w/v \text{ Urea} = \frac{60}{10\cancel{00}} \times 1\cancel{00}$$

$$= 6\%$$

The percentage composition of Nitrogen by mass in urea is

(A) 47% (B) 30%

(C) 63% (D) 70%

$$NH_2-\overset{\overset{\large O}{\|}}{C}-NH_2$$

$$\frac{14+2}{16}+12+16+\frac{14+2}{16}$$

$$48+12=60\ g$$

Molar mass urea = 60 g

2 mol of N = 28

$$\%\ w/w\ N=\frac{Wt\ N}{Wt\ Total}\times 100$$

$$=\frac{28}{60}\times 100$$

$$=46.7\approx \underline{47\%}$$

The percentage composition of carbon by mole in methane is

[2019 Main, 8 April II]

(A) 75% ~~(B)~~ 20%

(C) 25% (D) 80%

$CH_4 \Rightarrow \% C \ w/w = ?$

$CH_4 \Rightarrow 12 + 4(1) = 16 \text{ gm}$

$\% \ w/w \ C = \frac{\cancel{12}\ 3}{\cancel{16}\ 4} \times 100$

$= 75\%$

$\text{Mole} \% = \frac{\text{moles of C}}{\text{Total moles}} \times 100$

1 mol

$CH_4 \rightarrow$ C mol

$\rightarrow$ 4 mol H

Total = 5 mol

$\% C = \frac{1}{5} \times 100$

$= 20\%$

A compound possesses 8% sulphur by mass. The least molecular mass is

[AIIMS 2002]

(a) 200 (b) 400

(c) 155 (d) 355

least molar Mass
$\Rightarrow MS_1$

$\boxed{MS_1}$

Molar Mass (MS)

1 mol S = 32 gm

$\because$ 8% of compound = 1 mol S = 32 gm

$\therefore$ 1% = $\frac{32}{8}$

1% = $\frac{32}{8}$

100% = $\frac{\cancel{32}^{4}}{\cancel{8}} \times 100$

= 400 gm

100 ml of liquid A (d = 0.8 gm/ml) is mixed with 1000 ml of liquid B (d = 0.9 g/ml), calculate %w/w, %w/v, %v/v pf A. (No change in volume during mixing)

100 ml A

1000 ml B

$$\% \, v/v \, A = \left(\frac{100}{1000+100}\right) \times 100$$

$$= \frac{100}{1100} \times 100$$

$$= \frac{100}{11} \approx 9\%$$

$$d_A = \frac{m_A}{V_A} \qquad d_B = \frac{m_B}{V_B}$$

$$0.8 = \frac{m_A}{100} \qquad 0.9 = \frac{m_B}{1000}$$

$$m_A = 80 \, g \qquad m_B = 900 \, g$$

$$\% \, w/w \, A = \left(\frac{80}{890}\right) \times 100$$

$\% \, w/v$ (A)

$$= \frac{80}{1100} \times 100$$

Mole Fraction

$$\boxed{x_A = \frac{n_A}{n_T}} \qquad \boxed{x_B = \frac{n_B}{n_T}}$$

$$\boxed{\begin{aligned} H_2 &= 4g \\ N_2 &= 56g \\ O_2 &= 32g \end{aligned}}$$

X_{O_2}

X_{H_2}

X_{N_2}

$$X_{O_2} = \frac{1}{5} = 0.2$$

$$X_{H_2} = \frac{2}{5} = 0.4$$

$$X_{N_2} = \frac{2}{5} = 0.4$$

$$n_{H_2} = 4/2 = 2\text{ mol}$$

$$n_{N_2} = \frac{56}{28} = 2\text{ mol}$$

$$n_{O_2} = 32/32 = 1\text{ mol}$$

$$\overline{} \qquad \frac{}{5}$$

$$AMM = \left(\frac{m_A(\%A) + m_B(\%B)}{100}\right)$$

X_A = mole fraction A

$$\boxed{X_A \cdot 100 = \%\ \text{mole}}$$

$$\boxed{X_A = \frac{\%\ \text{mole}}{100}}$$

$$\boxed{\begin{matrix} A + B \\ +C \end{matrix}} \quad \boxed{\begin{matrix} X_A + X_B \\ +X_C \end{matrix}} = 1$$

$$\boxed{\text{Average Molar mass} = (M_A \cdot X_A) + (M_B \cdot X_B)}$$

In any solution $X_A = 0.2$

→ Out of Total 1 mole sample 0.2 mole belong 'A'.

In an aq. solⁿ of NaOH. $X_{NaOH} = 0.2$

$$\text{Total moles} = 1\ \text{mole} \begin{cases} \nearrow 0.2\ \text{mol NaOH} \\ \searrow 0.8\ \text{mole}\ H_2O \end{cases}$$

In a mixture I_2 & Br_2, $X_{Br_2} = 0.7$, calculate no. of moles of I_2, if Total 10 moles are present.

$X_{I_2} + X_{Br_2} = 1$

$X_{I_2} + 0.7 = 1$

$X_{I_2} = 0.3$

$X_{I_2} = \dfrac{n_{I_2}}{n_T}$

$0.3 = \dfrac{n_{I_2}}{10}$

$n_{I_2} = 10 \times 0.3$

$= 3$ moles

The mole fraction of glucose ($C_6H_{12}O_6$) in an aqueous binary solution is 0.1. The mass percentage of water in it, to the nearest integer, is 47%. *(September)*

Assume

1 mole of solution

$\rightarrow$ 0.1 mole $C_6H_{12}O_6 \Rightarrow 180 \times 0.1 = 18$ gm

$\rightarrow$ 0.9 mole $H_2O \Rightarrow 18 \times 0.9 = 16.2$ gm

fraction means out of total 1 mole

$$\% \, w/w \; H_2O = \frac{16.2}{18 + 16.2} \times 100 = \frac{16.2}{34.2} \times 100$$

$= 47.3\%$

$\doteq 48\%$

58.5 g of NaCl are dissolved in 72 g of water. The mole fraction of NaCl is:

a) 0.1 b) 0.01 c) 0.2 d) 0.0196

$$n_{NaCl} = \frac{58.5}{(23+35.5)} = \frac{58.5}{58.5} = 1\ mol$$

$$n_{H_2O} = \frac{72}{18} = 4\ mol$$

$$X_{NaCl} = \frac{n_{NaCl}}{n_{NaCl} + n_{H_2O}}$$

$$= \frac{1}{1+4} = \frac{1}{5}$$

$$\boxed{X_{NaCl} = 0.2}$$

The ratio mass of oxygen and nitrogen of a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is (Jee-Main 2014)

(A) 1 : 4

(B) 7 : 32

(C) 1 : 8

(D) 3 : 16

$$\frac{m_O}{n_N} = \frac{1}{4} \Rightarrow \frac{n_O}{n_N} = \frac{1/32}{4/28} = \frac{1/32}{1/7} = 7:32$$

Assume

O_2 mass = 1 gm

N_2 mass = 4 gm

Chemical equation & Stoichiometric Coefficient

$$1\,N_2(g) + 3H_2(g) \underset{550^\circ C,\ 200\,atm}{\overset{}{\underset{Fe,\,Mo}{\rightleftharpoons}}} 2NH_3(g)$$

1 mole   3 moles   2 moles NH_3 ⇒ 1 : 3 : 2

1. What are the reactants & Products
2. Physical states of reactants & Products
3. Types of reaction ($\longrightarrow$) or ($\rightleftharpoons$)
4. Conditions of reaction (Temp., Pre., pH, catalyst etc)
5. Combining ratio of reactants & Products (Stiochiometric coefficient)

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

	N_2	$3H_2$	$2NH_3$
t = 0 sec	1 mol	3 mol	0 mole
t = complete	0	0	2 moles

N_2	H_2	NH_3
1	3	2
2	6	4

Q. 2 mole

$n_{H_2} = 6$ moles

H_2 mass = 12 gm

4 moles

mass $NH_3 = 17 \times 4 = 68$ gm

@ STP $V_{NH_3} = 22.4 \times 4 = 89.6$ lit

% yield ⇒ % completion

We can not change Stoichiometric coefficient of any reaction

$$1F + 2W \longrightarrow 1B$$

	F	W	B
	1	2	1
	100	200	0
Tea Break $\xrightarrow{\text{yield = 25\%}}$	100−25 = 75	200−50 = 150	25
Lunch $\xrightarrow{50\%}$	100−50 = 50	200−100 = 200	50
Tea Bre $\xrightarrow{75\%}$	100−75 = 25	200−150 = 50	75
leave $\xrightarrow{100\%}$	100−100 = 0	200−200 = 0	100

no. of moles of B @ 25% yield = 25

@ 50%

@ 75%

GOD $\longrightarrow$ 

$$1B + 2H \longrightarrow 1P$$

		$1B$	$2H$	$1P$
day ① $\longrightarrow$		100	200	0
	50%	$100-50$ $=50$	$200-100$ $=100$	50
day ② $\longrightarrow$		500	1000	0
	25%	$500-\underline{125}$ $=375$	$1000-250$ $=750$	125

$1B + 2H \longrightarrow 1P$

1000   200   100

ER   LR

ER

LR

$1B + 2H \longrightarrow 1P$

10   100   0

100−20

$\boxed{0}$ $\boxed{80}$ $\boxed{10}$

LR

ER $\rightarrow$ 1B 1000 $\longrightarrow$ 1P 1000

LR $\rightarrow$ 2H 200 $\longrightarrow$ 1P 100

$1B = 2H = 1P$

$10B = 20h = 10P$

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$$

8 mole   2 mole   0

$8/2 = 4$ $2/1 = 2$

ER   LR

$8-4=4$ $2-2=0$ 4

$$\frac{\text{Given conc.}}{\text{Stiochiometric coefficient}}$$

smallest ratio belongs to LR

$1O_2 = 2H_2O$

$2O_2 = 4H_2O$

$3A + 7B + 17C \rightarrow P$

8   19   15

A, B, C   smallest

$8/3$ $\frac{19}{7}$ $\frac{15}{17}$

LR

$1O_2 = 2H_2$

$2O_2 = 4H_2$

$$1B + 2H \longrightarrow 1P$$

	1 B	2 H	1 P
$\boxed{\text{Yield}}$ (LR)	100	400	0
25% (LR)	100−25 = 75	400−50 = 350	25
50% (LR)	100−50 = 50	400−100 = 300	50
75% (LR)	100−75 = 25	400−150 = 250	75
100% (LR)	100−100 = 0	400−200 = 200	100

$\boxed{400 \quad 80}$

$\frac{100}{1}$ $\frac{400}{2} = 200$

LR   E.R

Calculation

18 g

H_2O

How many moles of methane are required to produce 22 g CO_2 (g) after combustion ?

What mass of zinc is required to produce hydrogen by reaction with HCl which is enough to produce 4 mol of ammonia according to the reactions ? (molar mass of Zn = 65 g)

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

$$3H_2 + N_2 \rightarrow 2NH_3$$

A sample of $NaClO_3$ is converted by heat to NaCl with a loss of 0.16 g of oxygen. The residue is dissolved in water and precipitated as AgCl. The mass of AgCl (in g) obtained will be

(Given : Molar mass of AgCl = 143.5 g mol^{-1})

(a) 0.54

(b) 0.35

(c) 0.48

(d) 0.41

(Online 2019)

7. Suppose the elements X and Y combine to form two compounds XY_2 and X_3Y_2. When 0.1 mole of XY_2 weighs 10 g and 0.05 mole of X_3Y_2 weighs 9 g, the atomic weights of X and Y are

(a) 40, 30
(b) 60, 40
(c) 20, 30
(d) 30, 20

Weight of oxygen in one mole each of Fe_2O_3 and FeO is in the simple ratio of:

a) 3 : 2 b) 1 : 2 c) 2 : 1 d) 3 : 1

2.76 g of silver carbonate on being strongly heated yields a residue weighing

[1979, 1M]

(A) 2.16 g

(B) 2.48 g

(C) 2.32 g

(D) 2.64 g

112 g of N_2 (g) and 12.0 g of H_2 (g) are mixed to produce NH_3(g). Calculate the NH_3 (g) formed. Identify the limiting reagent in this situation.

$$N_2(g) \quad + \quad 3H_2(g) \quad \rightarrow \quad 2NH_3(g)$$

If 0.50 mole of $BaCl_2$ is mixed with 0.20 mole of Na_3PO_4, the maximum number of moles of $Ba_3(PO_4)_2$ that can be formed is [1981, 1M]

(A) 0.70

(B) 0.50

(C) 0.20

(D) 0.10

For a reaction, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, identify dihydrogen ($H_2$) as a limiting reagent in the following reaction mixtures.

(A) 56 g of N_2 + 8 g of H_2

(B) 28 g of N_2 + 8 g of H_2

(C) 14 g of N_2 + 10 g of H_2

(D) 28 g of N_2 + 16 g of H_2

In the following reaction, $MnO_2 + 4HCl \rightarrow MNCl_2 + 2H_2O + Cl_2$

2 moles of MnO_2 react with 4 moles of HCl to form 11.2 L Cl_2 at STP. Thus, percent yield of Cl_2 is:

(A) 25%

(B) 50%

(C) 100%

(D) 75%

NH_3 is formed in the following steps:

I. $Ca + 2C \rightarrow CaC_2$ 50% yield

II. $CaC_2 + N_2 \rightarrow CaCN_2 + C$ 100% yield

III. $CaCN_2 + 3H_2O \rightarrow 2NH_3 + CaCO_3$ 50% yield

To obtain 2 moles NH_3, calcium required is:

(A) 1 mol (B) 2 mol

(C) 3 mol (D) 4 mol

$K_2Cr_2O_7$ is obtained in the following steps:

$$2FeCrO_4 + 2Na_2CO_3 + \tfrac{1}{2} O_2 \rightarrow Fe_2O_3 + 2Na_2CrO_4 + 2CO_2$$

$$2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + H_2O + Na_2SO_4$$

$$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$$

To get 0.25 mol of $K_2Cr_2O_7$, mol of 50% pure $FeCrO_4$ required

(A) 1 mol

(B) 0.50 mol

(C) 0.25 mol

(D) 0.125 mol

Al and $KClO_3$ react together to form Al_2O_3 according to:

$2KClO_3 \rightarrow 2KCl + 3O_2$

$4Al + 3O_2 \rightarrow 2Al_2O_3$

4 moles of $KClO_3$ (50% pure) on reaction with excess of Al form Al_2O_3:

(A) 2 mol
(B) 4 mol
(C) 6 mol
(D) 8 mol

In the reaction,

$$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}{}_{(aq)} + 6Cl^{-}{}_{(aq)} + 3H_{2(g)}$$

(a) 11.2 L $H_{2(g)}$ at STP is produced for every mole $HCl_{(aq)}$ consumed

(b) 6 L $HCl_{(aq)}$ is consumed for every 3 L $H_{2(g)}$ produced

(c) 33.6 L $H_{2(g)}$ is produced regardless of temperature and pressure for every mole Al that reacts

(d) 67.2 L $H_{2(g)}$ at STP is produced for every mole Al that reacts. **(2007)**

90 Th THORIUM	7 N NITROGEN	19 K POTASSIUM
39 Y YTTRIUM	8 O OXYGEN	92 U URANIUM