

### 3. STOICHIOMETRIC CALCULATIONS

#### SOLUTIONS

#### TEACHING TASK

#### JEE MAIN LEVEL QUESTIONS

1. When a sample of baking soda is strongly ignited in a crucible, it suffered a loss in weight of 3.1g. The mass of baking soda is

- 1) 16.8 g                      2) 8.4g                      3) 11.6g                      4) 4.2g

**Answer:2**

Solution:-  $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$

The loss of baking soda is due to release of  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .



2 moles of  $\text{NaHCO}_3$  it loses 1 mole of  $\text{CO}_2$  &  $\text{H}_2\text{O}$



For 2 moles of  $\text{NaHCO}_3$  it loses 62gms.

weight                      loss.

$$\begin{array}{ccc} 168 & \xrightarrow{\quad} & 62 \\ x & \xrightarrow{\quad} & 3.1 \end{array}$$

$$x = \frac{168 \times 3.1}{62} = \frac{520.8}{62} = 8.4 \text{ gms.}$$

The mass of baking soda for 3.1gms of loss is 8.4gms.

2. 1g of Mg is burnt in a vessel containing 0.5g of oxygen. The reactant remaining unreacted is

- 1) 0.25g of Mg    2) 0.1g of Mg    3) 0.1g of  $O_2$     4) 0.75g of Mg

**Answer: 1**

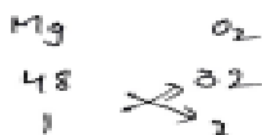
Solution:-



$$2 \times 24 = 48 \quad 32 \text{ gms.}$$

For 48 gms of Mg, 32 gms of  $O_2$  is required.

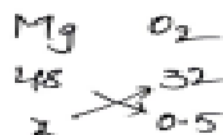
For Mg = 1 gm.



$$2 = \frac{32}{48} = 0.666 \text{ gms.}$$

For 1 gm Mg, 0.66 gms of  $O_2$  required.

So, Mg is excess here because they are giving only 0.5 gms of  $O_2$



$$2 = \frac{48 \times 0.5}{32}$$

$$= 0.75 \text{ gms of Mg.}$$

We have 1 gm of Mg but 0.75 gms of Mg is used.

$$\begin{aligned} \text{Remaining Mg} &= 1 - 0.75 \\ &= 0.25 \text{ gms of Mg.} \end{aligned}$$

3. The mass of 80% pure  $H_2SO_4$  required to completely neutralise 60g of NaOH is

1) 92g

2) 58.8g

3) 73.5g

4) 98g



For 1 mole of  $\text{H}_2\text{SO}_4$ , 2 moles of  $\text{NaOH}$  required.

$$\text{H}_2\text{SO}_4 = 2(1) + 32 + 4(16) = 98 \text{ gms.}$$

$$\text{NaOH} = 23 + 16 + 1 = 40 \text{ gms.}$$

$$2 \text{ moles of NaOH} = 80 \text{ gms.}$$

Given,  
 $\text{NaOH} = 60 \text{g.}$

$\text{H}_2\text{SO}_4$	$\text{NaOH}$
98	80
$x$	60

$$x = \frac{60 \times 98}{80} = \frac{588}{8} = 73.5 \text{ gms.}$$

Pure  $\text{H}_2\text{SO}_4$  is 73.5 gms mixed with 60 gms  $\text{NaOH}$ .

But they are telling 80% pure  $\text{H}_2\text{SO}_4$ . So  
add impure  $\text{H}_2\text{SO}_4$  to get 80% pure  $\text{H}_2\text{SO}_4$ .

**Answer: 1**

$$\begin{array}{l} 80\% \rightarrow 73.5 \\ 100\% \rightarrow x \end{array}$$

$$\therefore 80x = 73.5 \times 100$$

$$x = \frac{73.5 \times 100}{80}$$

$$= 91.875 \text{ gms}$$

4. 60 gms of limestone on heating produced 22g of  $\text{CO}_2$ . The percentage of  $\text{CaCO}_3$  in limestone is

1) 80%

2) 60%

3) 83.3%

4) 87.66%

**Answer: 3**

5. The mass of oxygen required for the rusting of 4.2g of iron is ( $\text{Fe}=56$ )

1) 1.2g

2) 1.8g

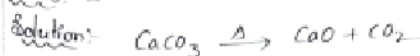
3) 2.4g

4) 3.2g

**Answer: 2**

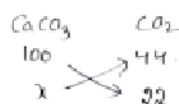
Q4)

Ans: 3.



$$\text{CaCO}_3 = 40 + 12 + 48 = 100 \text{ gm}$$

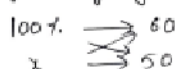
$$\text{CO}_2 = 12 + 2(16) = 44 \text{ gm}$$



$$x = \frac{22 \times 100}{44} = 50 \text{ gm}$$

To produce 22 gm of  $\text{CO}_2$ , 50 gm  $\text{CaCO}_3$  required.

But they are giving 60 gm.

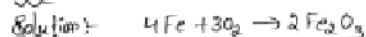


$$x = \frac{100 \times 50}{60} = \frac{500}{6} = 83.33\%$$

83.33% of  $\text{CaCO}_3$  is used produce 22 gm of  $\text{CO}_2$ .

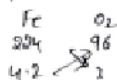
Q5)

Ans: 2



4 moles of Fe required for 3 moles of  $\text{O}_2$

$$4\text{Fe} \rightarrow 4 \times 56, \quad 3\text{O}_2 = 3 \times 32 = 96 \text{ gm}$$



$$x = \frac{96 \times 4.2}{224} = 1.8 \text{ gm}$$

Educational Operating System

6. 4.2g of baking soda on strong ignition in an open container leaves a residue of mass

1) 2.65g

2) 3.1g

3) 2.1g

4) 3.35g

**Answer: 1**

Solution:-  $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$ .

On heating baking soda it loses  $\text{CO}_2$  &  $\text{H}_2\text{O}$ .



$$x = \frac{106 \times 4.2}{168} = \frac{445.2}{168} = 2.65 \text{ gms}$$

On strong heating of 4.2gms of  $\text{NaHCO}_3$ ,

2.65gms of  $\text{Na}_2\text{CO}_3$  is remained.

7. The number of moles of KI required to produce 0.1 mole of  $\text{K}_2\text{HgI}_4$  is

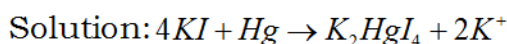
1) 1.6

2) 0.8

3) 3.2

4) 0.4

**Answer:4**



Moles of KI needed:  $0.1 \times 4 = 0.4$  mol

8. 'x' grams of calcium carbonate was completely burnt in air. The weight of the solid residue formed is 28g. What is the value of 'x' (in grams) ?

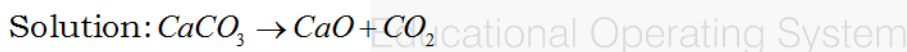
1) 44

2) 200

3) 150

4) 50

**Answer:4**



For 1 mole  $\text{CaCO}_3$ , 1 mole of  $\text{CaO}$  produced

1 mole  $\text{CaCO}_3$  molecular weight =  $40 + 12 + 3(16) = 100$ gms

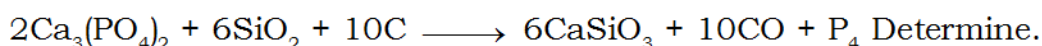
1 mole of  $\text{CaO}$  molecular weight =  $40 + 16 = 56$ gms

Given  $\text{CaO} = 28$ , No. of moles =  $28/56 = 0.5$  moles

So  $\text{CaCO}_3$  is also 0.5 moles

0.5 mole  $\text{CaCO}_3$  molecular weight =  $0.5(100) = 50$

9. The equation for the preparation of phosphorus in an electric furnace is



- The amount of phosphorus formed for each mole of  $\text{Ca}_3(\text{PO}_4)_2$  used.
- The amount of phosphorus formed for each gram of  $\text{Ca}_3(\text{PO}_4)_2$  used.
- The amount of phosphorus in tons formed for each ton of  $\text{Ca}_3(\text{PO}_4)_2$  used.

<i>i</i>	<i>ii</i>	<i>iii</i>
1) 62g	0.2g	0.2g
2) 72g	2g	0.4g
3) 52g	3g	0.2g
4) 42g	0.2g	4g

**Answer:1**



i) Phosphorus per mole of  $\text{Ca}_3(\text{PO}_4)_2$ :

- 2 moles of  $\text{Ca}_3(\text{PO}_4)_2 \rightarrow 1$  mole of  $\text{P}_4$  (124 g).
- 1 mole  $\rightarrow 62$  g of  $\text{P}_4$ .

ii) Phosphorus per gram of  $\text{Ca}_3(\text{PO}_4)_2$ :

- Sol
- Molar mass of  $\text{Ca}_3(\text{PO}_4)_2 = 310$  g/mol.
  - 1 g  $\rightarrow \frac{62}{2 \times 310} = 0.1$  g of  $\text{P}_4$ .

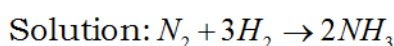
iii) Phosphorus per ton of  $\text{Ca}_3(\text{PO}_4)_2$ :

- 1 ton  $\rightarrow 0.2$  ton of  $\text{P}_4$ .

10. What volume of  $\text{H}_2$  at NTP is required to convert 2.8g of  $\text{N}_2$  in to  $\text{NH}_3$ ?

- 1) 2240 ml      2) 22400 ml      3) 6.72 lit      4) 224 lit

**Answer:3**



Moles of  $\text{N}_2$ :  $\frac{2.8}{28} = 0.1 \text{ mol}$

$\text{H}_2$  required:

$0.1 \times 3 = 0.3$  mol.

Volume at NTP:  $0.3 \times 22.4 = 6.72$  L.

11. What is the volume (in litres) of  $\text{CO}_2$  liberated at STP, when 2.12gms of sodium carbonate (MW=106) is treated with excess dilute HCl?

- 1) 2.28                      2) 0.448                      3) 44.8                      4) 22.4

**Answer:2**

Solution:  $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

Moles of  $\text{Na}_2\text{CO}_3$ :  $\frac{2.12}{106} = 0.02 \text{ mol}$

$\text{CO}_2$  produced: 0.02 mol.

Volume at STP:  $0.02 \times 22.4 = 0.448$  L.

12. Two grams of sulphur is completely burnt in oxygen to form  $\text{SO}_2$ . In this reaction, what is the volume (in litres) of oxygen consumed at STP? (At.wts. of sulphur and oxygen are 32 and 16 respectively)

- 1) 16/22.414              2) 22.414/16              3) 22.414/32              4) 32/22.414

**Answer:2**

Solution:  $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$

Moles of S:  $\frac{2}{16} = 0.0625 \text{ mol}$

$\text{O}_2$  required: 0.0625 mol.

Volume at STP:  $0.0625 \times 22.4 = 1.4$  L. (22.414/16 (Closest to 1.4 L))

13. What is the volume (lit) of oxygen required at STP to completely convert 1.5 moles of sulphur into sulphur dioxide

- 1) 11.2                      2) 22.4                      3) 33.6                      4) 44.8

**Answer:3**

Solution:  $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$

1 mole S, 1 mole of oxygen required

number of moles of oxygen = 1.5 moles

Volume =  $1.5(22.4) = 33.6$  litres

14. 'X' litres of carbon monoxide is present at STP. It is completely oxidised to  $\text{CO}_2$ . The volume of  $\text{CO}_2$  formed is 11.207 litres at STP. What is the value of 'X' in litres?

- 1) 22.414                      2) 11.207                      3) 5.6035                      4) 44.828

**Answer:2**

Solution:  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$

Moles of  $\text{CO}_2$ :  $11.2/22.4 = 0.5$  moles

CO Also same moles, CO occupies 11.2 litres

15. 0.01 mole of iodoform( $\text{CHI}_3$ ) reacts with Ag powder to produce a gas whose volume at NTP is

- 1) 224 ml                      2) 112 ml                      3) 336 ml                      4) None

**Answer:1**

Solution:  $\text{CHI}_3 + 3\text{Ag} \rightarrow \text{AgI} + \text{CH}_3\text{I}$

Moles of  $\text{CHI}_3$ : 0.01 mol.

Gas ( $\text{CH}_3\text{I}$ ) produced: 0.01 mol. Volume at NTP:  $0.01 \times 22.4 = 0.224 \text{ L} = 224 \text{ mL}$ .

16. What is the volume (lit) of oxygen required at STP to completely convert 1.5 moles of sulphur into sulphurdioxide

- 1) 11.2                      2) 22.4                      3) 33.6                      4) 44.8

**Answer:3**

Solution:  $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$

1 mole S , 1 mole of oxygen required

number of moles of oxygen = 1.5 moles

Volume =  $1.5(22.4) = 33.6 \text{ litres}$

17. The number of moles of  $\text{Fe}_2\text{O}_3$  formed when 5.6 lit of  $\text{O}_2$  reacts with 5.6g of Fe?

- 1) 0.125                      2) 0.01                      3) 0.05                      4) 0.10

**Answer:3**

Solution:  $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$

Moles of Fe:  $\frac{5.6}{56} = 0.1 \text{ moles}$

Moles of  $\text{O}_2$ :  $\frac{5.6}{22.4} = 0.25 \text{ moles}$

$\text{Fe}_2\text{O}_3$  formed: 0.05 mol.

18. 20 ml of nitric oxide combines with 10 ml of oxygen at STP to give  $\text{NO}_2$ . The final volume will be

- 1) 30 ml                      2) 20 ml                      3) 10 ml                      4) 40 ml

**Answer:2**

Solution:  $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$

20 mL NO + 10 mL  $\text{O}_2$ : NO is limiting (uses 10 mL  $\text{O}_2$ , produces 20 mL  $\text{NO}_2$ ).

Final volume: 20 mL.

19. When 10ml of  $\text{H}_2$  and 12.5 ml of  $\text{Cl}_2$  are allowed to react, the final mixture contains under the same conditions

- 1) 22.5 ml of HCl                      2) 12.5 ml of HCl  
3) 20 ml of HCl and 2.5ml of  $\text{Cl}_2$                       4) 20 ml of HCl only

**Answer:3**

Solution:  $H_2 + Cl_2 \rightarrow 2HCl$

Given:

10 mL  $H_2$

12.5 mL  $Cl_2$

Determine the Limiting Reactant:

The reaction requires 1:1 mole ratio of  $H_2$  and  $Cl_2$ .

$H_2$  is limiting (10 mL) because it is less than  $Cl_2$  (12.5 mL).

Calculate Volume of HCl Produced:

1 mL  $H_2 \rightarrow 2$  mL HCl (from stoichiometry).

10 mL  $H_2 \rightarrow 20$  mL HCl.

Excess  $Cl_2$  Remaining:

$Cl_2$  consumed = 10 mL (equal to  $H_2$ ).

Excess  $Cl_2$  = 12.5 mL - 10 mL = 2.5 mL.

Final Mixture Composition:

20 mL HCl (from reaction)

2.5 mL  $Cl_2$  (unreacted excess).

**ADVANCED LEVEL QUESTIONS****MULTIPLE CORRECT ANSWER TYPE**

1. Silver metal in ore is dissolved by potassium cyanide solution in the presence of air by the reaction



- 1) The amount of KCN required to dissolve 100 g of pure Ag is 120 g.
- 2) The amount of oxygen used in this process is 0.742 g
- 3) The amount of oxygen used in this process is 7.40 g
- 4) The volume of oxygen used at STP is 5.20 grams.

**Answer:1,3**

Solution: Reaction:  $4Ag + 8KCN + O_2 + 2H_2O \rightarrow 4K[Ag(CN)_2] + 4KOH$

Given:

100 g Ag (Molar mass = 108 g/mol  $\longrightarrow$  100/108=0.926 mol.

i) KCN Required:

Stoichiometry: 4 mol Ag = 8 mol KCN.

For 0.926 mol Ag:

KCN = 0.926 x {8/4} = 1.852mol=120g(Molar mass KCN= 65g/mol)

Statement 1 is correct (120 g KCN).

Oxygen Used:

Stoichiometry:  $4 \text{ mol Ag} = 1 \text{ mol O}_2$ .

For 0.926 mol Ag:

$$\text{O}_2 = 0.926 \times \frac{1}{4} = 0.2315 \text{ mol} \approx 7.40 \text{ g} \quad (\text{Molar mass O}_2 = 32 \text{ g/mol}).$$

Volume at STP:  $0.2315 \times 22.4 = 5.20 \text{ L}$  (not grams).

Statements:

2 (0.742 g O<sub>2</sub>): Incorrect.

3 (7.40 g O<sub>2</sub>): Correct.

4 (5.20 grams O<sub>2</sub>): Incorrect (should be litres)

2. 0.5 mole of sodium nitrite and 1 mole of ammonium chloride are mixed in aqueous solution. The solution is heated and the evolved gas is collected. Then which is/are correct about the gas/

(A) 22.4 L gas at STP

(B) 11.2 L of gas at STP

(C) 0.5 mole of gas

(D) 14 g of gas

**Answer: B, C, D**

Solution:  $\text{NaNO}_2 + \text{NH}_4\text{Cl} \rightarrow \text{N}_2 + 2\text{H}_2\text{O} + 2\text{NaCl}$

Given:

0.5 mol NaNO<sub>2</sub> (limiting reactant).

1 mol NH<sub>4</sub>Cl (excess).

Gas Produced (N<sub>2</sub>):

Stoichiometry:  $1 \text{ mol NaNO}_2 = 1 \text{ mol N}_2$ .

$0.5 \text{ mol NaNO}_2 \rightarrow 0.5 \text{ mol N}_2$ .

At STP:  $0.5 \times 22.4 = 11.2 \text{ L}$ .

Mass of N<sub>2</sub>:  $0.5 \times 28 = 14 \text{ g}$ .

Statements:

(A) 22.4 L: Incorrect.

(B) 11.2 L: Correct.

(C) 0.5 mol: Correct.

(D) 14 g: Correct.

**STATEMENT TYPE**

3. **Assertion:** Mass of hydrogen required to reduce 7.95 grams of cupric oxide to give metal is 0.2 gm

**Reason :** It requires a balanced chemical equation for calculation

**Answer: 1**

Solution: The balanced chemical equation for the reduction of cupric oxide (CuO) by hydrogen ( $H_2$ ) is:  $CuO + H_2 \rightarrow Cu + H_2O$

Molar mass of CuO = 63.5 (Cu) + 16 (O) = 79.5 g/mol

Moles of CuO in 7.95 g =  $7.95/79.5 = 0.1$  moles

From the equation, 1 mole of CuO requires 1 mole of  $H_2$ .

So, 0.1 mole of CuO requires 0.1 mole of  $H_2$ .

Molar mass of  $H_2$  = 2 g/mol

Mass of  $H_2$  required =  $0.1 \times 2 = 0.2$  g

4. Assertion: In Haber's process,  $N_2$  and  $H_2$  combine in 1 : 3 volume ratio

Reason: Gases combine in simple volume ratio

**Answer:2**

Solution: The Haber process reaction is:  $N_2 + 3H_2 \rightarrow 2NH_3$

So, 1 volume of  $N_2$  reacts with 3 volumes of  $H_2$ , which matches the assertion.

The reason states that gases combine in simple volume ratios, which is Gay-Lussac's Law of Combining Volumes. While this is true, it is a general principle and not the specific explanation for the 1:3 ratio in Haber's process.

Assertion is correct (1:3 ratio in Haber's process).

Reason is correct (gases combine in simple ratios).

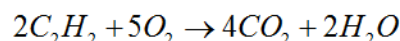
But the reason does not directly explain the assertion.

5. Assertion: The volume of  $O_2$  at STP required to burn completely 70ml of acetylene is 175 ml

Reason: One mole of any gas occupies 22400 ml at STP

**Answer:2**

Solution: The combustion reaction of acetylene ( $C_2H_2$ ) is



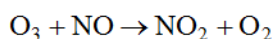
From the equation, 2 volumes of  $C_2H_2$  react with 5 volumes of  $O_2$ .

So, 70 ml of  $C_2H_2$  will require: Volume of  $O_2 = \frac{5}{2} \times 70 = 175$  ml

The reason states that 1 mole of any gas occupies 22400 ml at STP, which is true (Avogadro's Law), but it is not directly used in this calculation. The key here is the volume ratio from the balanced equation, not the molar volume.

## COMPREHENSION TYPE

### Comprehension-1



6. If 0.740 g of  $O_3$  reacts with 0.670 g of NO, how many gram of  $NO_2$  will be produced ?

1) 0.71 g

2) 0.74 g

3) 0.68 g

4) 0.81 g

**Answer:1**

Solution: Write the balanced equation  $O_3 + NO \rightarrow NO_2 + O_2$

Calculate moles of  $O_3$  And NO

Molar mass of  $O_3 = 48 \text{ g/mol}$

$$\text{Moles of } O_3 = \frac{0.740}{48} = 0.0154 \text{ mol}$$

Molar mass of NO = 30 g/mol

$$\text{Moles of NO} = \frac{0.670}{30} = 0.0223 \text{ mol}$$

Determine the limiting reactant

From the balanced equation, 1 mole of  $O_3$  reacts with 1 mole of NO.

$O_3$  requires 0.0154 mol of NO, but we have 0.0223 mol of NO.

Thus,  $O_3$  is the limiting reactant (it will run out first).

Calculate moles of  $NO_2$  produced

Since the reaction is 1:1:

Moles of  $NO_2$  = Moles of limiting reactant ( $O_3$ ) = 0.0154 mol

Convert moles of  $NO_2$  to grams

Molar mass of  $NO_2 = 46 \text{ g/mol}$

Mass of  $NO_2 = 0.0154(46) = 0.7084 \text{ g}$

7. Which compound is the limiting reagent ?

1) NO

2)  $O_3$

3) Both are in equimolar ratio 4) Both are in stoichiometric ratio

**Answer:2**

Solution:  $O_3$  is the limiting reactant because it is completely consumed first.

8. Number of moles of the excess reactant remaining at the end of the reaction is :

1) 0.007 mol  $O_3$  2) 0.014 mol  $O_3$  3) 0.007 mol NO 4) 0.014 mol NO

**Answer:3**

Solution: Number of moles of the excess reactant remaining at the end of the reaction is:

Step 1: Initial moles of excess reactant (NO)

Moles of NO = 0.0223 mol

Moles of NO consumed = 0.0154 mol

Excess NO = 0.0223 - 0.0154 = 0.0069 mol  $\sim$  0.007 mol

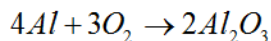
**Comprehension-2**

9. What weight of Al will be completely oxidised by 44.8 lit of oxygen at STP?

- 1) 18g                      2) 37.8g                      3) 50.4g                      4) 72g

**Answer:4**

Solution: Write the balanced equation for the oxidation of Al



$$\text{Moles of } O_2 = \frac{44.8}{22.4} = 2 \text{ mol}$$

3mol  $O_2$  reacts with 4mol Al

$$2 \text{ mol } O_2 \text{ will react with } \frac{4}{3} \times 2 = \frac{8}{3} \text{ mol Al}$$

$$\text{Mass of Al} = \frac{8}{3} \times 27 = 72 \text{ g}$$

10. The mass of zinc (Zn=65) required to produce 224 ml of  $H_2$  at STP on treatment with dilute  $H_2SO_4$  is

- 1) 6.5g                      2) 0.65g                      3) 3.25g                      4) 0.065g

**Answer:2**

Solution: Write the balanced equation  $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

At STP, 22400 mL = 1 mole of gas.

$$\text{Moles of } H_2 = \frac{224}{22400} = 0.01 \text{ mol}$$

1mol Zn produces 1mol  $H_2$

Moles of Zn required = 0.01mol

$$\text{Mass of Zn} = 0.01 \times 65 = 0.65 \text{ g}$$

11. The volume of oxygen required at STP for the complete combustion of 2.2 g of propane is

- 1) 56 L                      2) 5.6 L                      3) 11.2 L                      4) 22.4 L

**Answer:2**

Solution:  $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Molar mass of  $C_3H_8 = (3 \times 12) + (8 \times 1) = 44 \text{ g/mol}$

$$\text{Moles of } C_3H_8 = \frac{2.2}{44} = 0.05 \text{ mol}$$

1mol  $C_3H_8$  requires 5mol  $O_2$

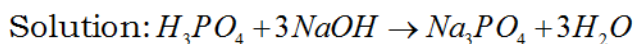
0.05mol  $C_3H_8$  requires  $0.05 \times 5 = 0.25 \text{ mol } O_2$

$$\text{Volume of } O_2 = 0.25 \times 22.4 = 5.6 \text{ L}$$

**INTEGER TYPE**

12. The number of grams of NaOH that completely neutralises 9.8g of phosphoric acid is \_\_\_\_\_

**Answer:12**



(1 mole of  $H_3PO_4$  reacts with 3 moles of NaOH)

Molar mass of  $H_3PO_4 = 3(1) + 31 + 4(16) = 98\text{g/mol}$

$$\text{Moles of } H_3PO_4 = \frac{9.8}{98} = 0.1\text{mol}$$

1mol  $H_3PO_4$  requires 3mol NaOH

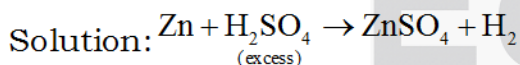
Moles of NaOH =  $0.1 \times 3 = 0.3\text{mol}$

Molar mass of NaOH =  $23 + 16 + 1 = 40\text{g/mol}$

Mass of NaOH =  $0.3 \times 40 = 12\text{g}$

13.  $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$  If 44.8L of  $H_2$  gas at STP was produced, then find the no. of moles of Zn taken initially is \_\_\_\_\_

**Answer:2**



(1 mole of Zn produces 1 mole of  $H_2$ )

At STP, 1 mole of gas occupies 22.4 L.

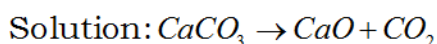
$$\text{Moles of } H_2 = \frac{44.8}{22.4} = 2\text{mol}$$

1mol Zn produces 1mol  $H_2$

Moles of Zn taken = 2mol

14. 10 g of  $CaCO_3$  on thermal decomposition produces 448 ml of  $CO_2$  gas at STP. The purity of  $CaCO_3$  sample is 10x%. Find the value of x.

**Answer:2**



1 mole of any gas occupies 22.4 L (22400 mL).

Given volume of  $CO_2 = 448\text{ mL}$ .

$$\text{Moles of } CO_2 = \frac{448\text{ml}}{22400\text{ml}} = 0.02\text{mol}$$

1mol  $CO_2$  is produced by 1mol  $CaCO_3$

Moles of pure  $\text{CaCO}_3 = 0.02 \text{ mol}$

Molar mass of  $\text{CaCO}_3 = 40 + 12 + 48 = 100 \text{ g/mol}$

Mass of pure  $\text{CaCO}_3 = 0.02 \text{ mol} \times 100 \text{ g/mol} = 2 \text{ g}$

Total mass of impure sample = 10 g

Mass of pure  $\text{CaCO}_3 = 2 \text{ g}$

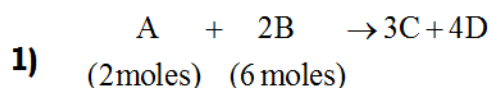
Purity (%) =  $\frac{2}{10} \times 100 = 20\%$

Given that purity is 10x%, we have:  $10x = 20 \rightarrow x = 2$

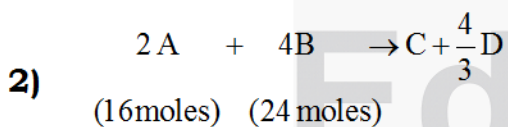
### MATRIX MATCHING TYPE

#### 15. Column I

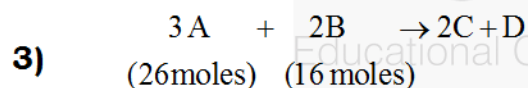
#### Column II



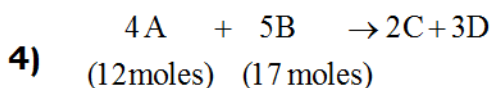
(P) Limiting Reagent is A



(Q) Moles of C formed is 6 moles.



(R) Limiting Reagent is B

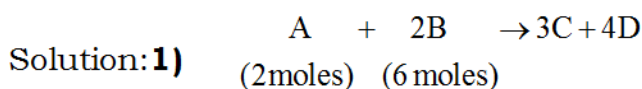


(S) Moles of D formed is 8 moles

(T) Excess of Reagent left is 2

moles.

**Answer: 1 - P, Q, S, T, 2 - R, Q, S, 3 - R, S, T, 4 - P, Q, T**



Given quantities: (2 moles A, 6 moles B)

Stoichiometric ratio check:

For A:B = 1:2

Given A:B = 2:6 = 1:3

B is in excess, A is limiting.

Products formed (based on limiting reagent A):

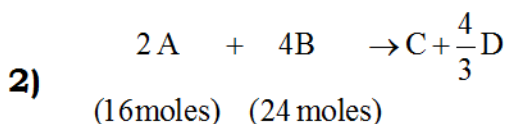
Moles of C =  $3 \times \text{moles of A} = 3 \times 2 = 6$  moles

Moles of D =  $4 \times \text{moles of A} = 4 \times 2 = 8$  moles

Excess reagent left:

B required =  $2 \times \text{moles of A} = 4$  moles

B left =  $6 - 4 = 2$  moles



Given quantities: (16 moles A, 24 moles B)

Stoichiometric ratio check:

For A:B =  $2:4 = 1:2$

Given A:B =  $16:24 = 2:3$

A is in excess, B is limiting.

Products formed (based on limiting reagent B):

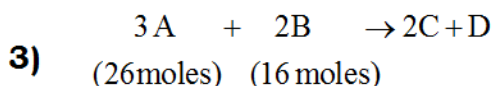
Moles of C =  $\frac{1}{4} \times \text{moles of B} = \frac{1}{4} \times 24 = 6$  moles

Moles of D =  $\frac{4}{3 \times 4} \times \text{moles of B} = \frac{1}{3} \times 24 = 8$  moles

Excess reagent left:

A required =  $\frac{2}{4} \times \text{moles of B} = 12$  moles

A left =  $16 - 12 = 4$  moles



Given quantities: (26 moles A, 16 moles B)

Stoichiometric ratio check:

For A:B =  $3:2$

Given A:B =  $26:16 = 13:8$

B is limiting (since  $\frac{26}{3} > \frac{16}{2}$ )

Products formed (based on limiting reagent B):

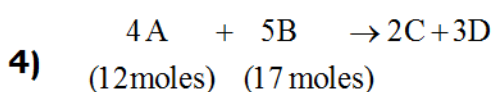
$$\text{Moles of C} = \frac{2}{2} \times \text{moles of B} = 16 \text{ moles}$$

$$\text{Moles of D} = \frac{1}{2} \times \text{moles of B} = 8 \text{ moles}$$

Excess reagent left:

$$\text{A required} = \frac{3}{2} \times \text{moles of B} = 24 \text{ moles}$$

$$\text{A left} = 26 - 24 = 2 \text{ moles}$$



Given quantities: (12 moles A, 17 moles B)

Stoichiometric ratio check:

For A:B = 4:5

Given A:B = 12:17

A is limiting (since  $\frac{12}{4} = 3 < \frac{17}{5} = 3.4$ )

Products formed (based on limiting reagent A):

$$\text{Moles of C} = \frac{2}{4} \times \text{moles of A} = 6 \text{ moles}$$

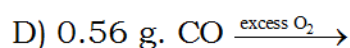
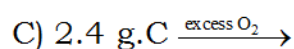
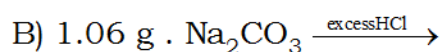
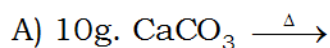
$$\text{Moles of D} = \frac{3}{4} \times \text{moles of A} = 9 \text{ moles}$$

Excess reagent left:

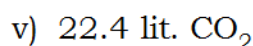
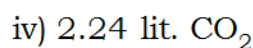
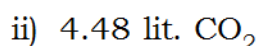
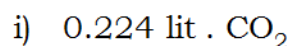
$$\text{B required} = \frac{5}{4} \times \text{moles of A} = 15 \text{ moles}$$

$$\text{B left} = 17 - 15 = 2 \text{ moles}$$

#### 16. List -I

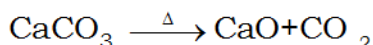
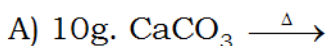


#### List -II (At STP)



**Answer: A - iv, B-i, C-ii, D-iii**

Solution:

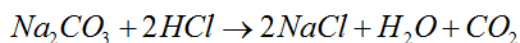
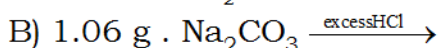
Molar mass of  $\text{CaCO}_3 = 40 (\text{Ca}) + 12 (\text{C}) + 3 \times 16 (\text{O}) = 100 \text{ g/mol}$ 

$$\text{Moles of CaCO}_3 = \frac{10\text{g}}{100\text{g/mol}} = 0.1\text{mol}$$

From the equation, 1 mole of  $\text{CaCO}_3$  produces 1 mole of  $\text{CO}_2$ .Moles of  $\text{CO}_2 = 0.1 \text{ mol}$ 

At STP, 1 mole of gas occupies 22.4 L.

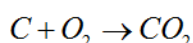
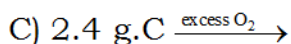
$$\text{Volume of CO}_2 = 0.1 \text{ mol} \times 22.4 \text{ L/mol} = 2.24 \text{ L}$$

Molar mass of  $\text{Na}_2\text{CO}_3 = 2 \times 23 (\text{Na}) + 12 (\text{C}) + 3 \times 16 (\text{O}) = 106 \text{ g/mol}$ 

$$\text{Moles of Na}_2\text{CO}_3 = \frac{1.06\text{g}}{106\text{g/mol}} = 0.01\text{mol}$$

From the equation, 1 mole of  $\text{Na}_2\text{CO}_3$  produces 1 mole of  $\text{CO}_2$ .Moles of  $\text{CO}_2 = 0.01 \text{ mol}$ 

$$\text{Volume of CO}_2 = 0.01 \text{ mol} \times 22.4 \text{ L/mol} = 0.224 \text{ L}$$

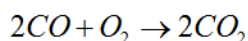
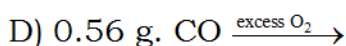


Molar mass of C = 12 g/mol

$$\text{Moles of C} = \frac{2.4\text{g}}{12\text{g/mol}} = 0.2\text{mol}$$

From the equation, 1 mole of C produces 1 mole of  $\text{CO}_2$ .Moles of  $\text{CO}_2 = 0.2 \text{ mol}$ 

$$\text{Volume of CO}_2 = 0.2 \text{ mol} \times 22.4 \text{ L/mol} = 4.48 \text{ L}$$



Molar mass of CO = 12 (C) + 16 (O) = 28 g/mol

$$\text{Moles of CO} = \frac{0.56\text{g}}{28\text{g/mol}} = 0.02\text{mol}$$

From the equation, 2 moles of CO produce 2 moles of  $\text{CO}_2$  (1:1 ratio).

Moles of  $\text{CO}_2 = 0.02 \text{ mol}$

Volume of  $\text{CO}_2 = 0.02 \text{ mol} \times 22.4 \text{ L/mol} = 0.448 \text{ L}$

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### LEARNERS TASK

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#### CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. The mass of  $\text{CO}_2$  obtained when 2g of pure limestone is calcined is  
1) 44g                      2) 0.22g                      3) 0.88g                      4) 8.8g

**Answer:3**

Solution:  $\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$

Molar mass of  $\text{CaCO}_3 = 100 \text{ g/mol}$

$$\text{Moles} = \frac{2\text{g}}{100\text{g/mol}} = 0.02\text{mol}$$

1 mole of  $\text{CaCO}_3$  produces 1 mole of  $\text{CO}_2$ .

Moles of  $\text{CO}_2 = 0.02\text{mol}$

Molar mass of  $\text{CO}_2 = 44 \text{ g/mol}$

Mass =  $0.02\text{mol} \times 44\text{g/mol} = 0.88\text{g}$

2. 2.76g of silver carbonate on strong ignition leaves a residue weighing  
1) 2.48g                      2) 2.16g                      3) 2.32g                      4) 2.84g

**Answer:2**

Solution:  $\text{Ag}_2\text{CO}_3 \xrightarrow{\Delta} 2\text{Ag} + \text{CO}_2 + \frac{1}{2}\text{O}_2$

Molar mass of  $\text{Ag}_2\text{CO}_3 = 276 \text{ g/mol}$

$$\text{Moles} = \frac{2.76\text{g}}{276\text{g/mol}} = 0.01\text{mol}$$

1 mole of  $\text{Ag}_2\text{CO}_3$  produces 2 moles of Ag.

Moles of Ag =  $0.02\text{mol}$

Molar mass of Ag =  $108 \text{ g/mol}$

Mass of Ag =  $0.02\text{mol} \times 108\text{g/mol} = 2.16\text{g}$

3. The weight of oxygen required to completely react with 27g of Al is  
1) 8g                      2) 16g                      3) 32g                      4) 24g

**Answer:4**

Solution:  $4Al + 3O_2 \rightarrow 2Al_2O_3$

Molar mass of Al = 27 g/mol

$$\text{Moles} = \frac{27\text{ g}}{27\text{ g/mol}} = 1\text{ mol}$$

4 moles of Al react with 3 moles of  $O_2$ .

$$\text{Moles of } O_2 = \frac{3}{4} \times 1 = 0.75\text{ mol}$$

Molar mass of  $O_2$  = 32 g/mol

$$\text{Mass} = 0.75\text{ mol} \times 32\text{ g/mol} = 24\text{ g}$$

4. 1 mole of  $Ba(OH)_2$  will exactly neutralise:

1) 2 moles HCl    2) 1 mole of  $H_2SO_4$     3) 1 mole of  $H_3PO_3$     4) 2 mole of  $H_3PO_2$

**Answer: 1,2,3,4**

Solution: 1)  $Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$

1 mole of  $Ba(OH)_2$  will exactly neutralise by 2 moles HCl

2)  $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$

1 mole of  $Ba(OH)_2$  will exactly neutralise by 1 mole of  $H_2SO_4$

3)  $Ba(OH)_2 + H_3PO_3 \rightarrow BaHPO_3 + 2H_2O$

1 mole of  $Ba(OH)_2$  will exactly neutralise by 1 mole of  $H_3PO_3$

4)  $Ba(OH)_2 + 2H_3PO_2 \rightarrow Ba(H_2PO_2)_2 + 2H_2O$

1 mole of  $Ba(OH)_2$  will exactly neutralise by 2 mole of  $H_3PO_2$

5. When three moles of ozone completely reacts with  $SO_2$ , the number of moles of oxygen formed is

1) 3                      2) 2                      3) zero                      4) 1

**Answer: 1**

Solution:  $O_3 + SO_2 \rightarrow SO_3 + O_2$

1 mole of  $O_3$  produces 1 mole of  $O_2$ .

3 moles of  $O_3$  produces 3 moles of  $O_2$ .

6. The weight of  $MgCO_3$  required for the preparation of 12g of  $MgSO_4$  is

1) 8.4g                      2) 4.2g                      3) 16.8g                      4) 12.6g

**Answer:1**

Molar mass of  $MgSO_4 = 120 \text{ g/mol}$

$$\text{Moles} = \frac{12 \text{ g}}{120 \text{ g/mol}} = 0.1 \text{ mol}$$

1 mole of  $MgCO_3$  produces 1 mole of  $MgSO_4$ .

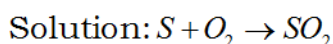
Moles of  $MgCO_3 = 0.1 \text{ mol}$

Molar mass of  $MgCO_3 = 84 \text{ g/mol}$

$$\text{Mass} = 0.1 \text{ mol} \times 84 \text{ g/mol} = 8.4 \text{ g}$$

7. How much sulphur is to be burnt to produce 0.224 lit of  $SO_2$  at NTP?

- 1) 0.03g                      2) 0.32g                      3) 3.2 g                      4) 32g

**Answer:2**

At NTP, 22.4 L = 1 mole.

$$\text{Moles} = \frac{0.224 \text{ L}}{22.4 \text{ L/mol}} = 0.01 \text{ mol}$$

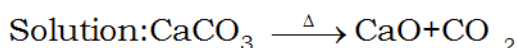
1 mole of S produces 1 mole of  $SO_2$ .

Molar mass of S = 32 g/mol

$$\text{Mass} = 0.01 \text{ mol} \times 32 \text{ g/mol} = 0.32 \text{ g}$$

8. To get 5.6 lit of  $CO_2$  at STP weight of  $CaCO_3$  to be decomposed is

- 1) 100g                      2) 50g                      3) 25g                      4) 75g

**Answer:3**

At STP, 22.4 L = 1 mole.

$$\text{Moles} = \frac{5.6 \text{ L}}{22.4 \text{ L/mol}} = 0.25 \text{ mol}$$

1 mole of  $CaCO_3$  produces 1 mole of  $CO_2$ .

Molar mass of  $CaCO_3 = 100 \text{ g/mol}$

$$\text{Mass} = 0.25 \text{ mol} \times 100 \text{ g/mol} = 25 \text{ g}$$

9. The volume of chlorine required for the complete reaction of 10 litres of  $H_2S$  at STP is  $[Cl_2 + H_2S \longrightarrow 2HCl + S]$

- 1) 22.4 L                      2) 5 lit                      3) 10 lit                      4) 2.5 lit

**Answer:3**

Solution: 1 volume of  $\text{Cl}_2$  reacts with 1 volume of  $\text{H}_2\text{S}$ .

Volume of  $\text{Cl}_2 = 10\text{L}$

10. How much volume of  $\text{CO}_2$  at S.T.P is liberated by the combustion of  $100\text{ cm}^3$  of propane ( $\text{C}_3\text{H}_8$ )?

- 1)  $100\text{ cm}^3$       2)  $200\text{ cm}^3$       3)  $300\text{ cm}^3$       4)  $400\text{ cm}^3$

**Answer:3**

Solution:  $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$

1 volume of  $\text{C}_3\text{H}_8$  produces 3 volumes of  $\text{CO}_2$ .

volumes of  $\text{CO}_2 = 3 \times 100\text{ cm}^3 = 300\text{ cm}^3$

**JEE MAIN LEVEL QUESTIONS**

11. 6g of Mg reacts with excess of an acid. The amount of hydrogen produced would be

- 1) 0.5g      2) 1g      3) 2g      4) 4g

**Answer:1**

Solution:  $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$

For 1 mole Mg, 1 mole  $\text{H}_2$  produced

Mg moles =  $\frac{6}{24} = 0.25\text{ moles}$

Number of moles of Hydrogen = 0.25 moles

Mass of Hydrogen =  $0.25(2) = 0.5\text{g}$

12. In the formation of  $\text{Al}_2\text{O}_3$  from Al and  $\text{O}_2$ , if 1.5 mole of oxygen is used up, the mass of Aluminium that reacted is

- 1) 27g      2) 54g      3) 108g      4) 81g

**Answer:2**

Solution:  $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$

4 moles of Al react with 3 moles of  $\text{O}_2$ .

1.5 moles of oxygen =  $\frac{4}{3} \times 1.5\text{ mol Al} = 2\text{ mol Al}$

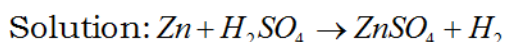
Molar mass of Al = 27 g/mol

Mass of Al =  $2\text{ mol} \times 27\text{ g/mol} = 54\text{g}$

13. 6.5g of Zn is dissolved in excess of  $\text{H}_2\text{SO}_4$ . The weight of  $\text{ZnSO}_4$  formed is

- 1) 161g      2) 16.1g,      3) 16.1g      4) 16.1g

**Answer:2**



1 mole of Zn produces 1 mole of  $ZnSO_4$ .

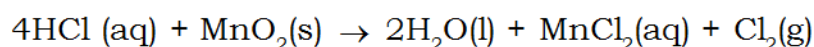
$$\text{Moles of Zn} = \frac{6.5}{65} = 0.1 \text{ moles}$$

$$\text{Moles of } ZnSO_4 = 0.1 \text{ mol}$$

$$\text{Molar mass of } ZnSO_4 = 65 + 32 + 64 = 161 \text{ g/mol}$$

$$\text{Mass of } ZnSO_4 = 0.1 \text{ mol} \times 161 \text{ g/mol} = 16.1 \text{ g}$$

14. Chlorine is prepared in the laboratory by treating manganese dioxide ( $MnO_2$ ) with aqueous hydrochloric acid according to the reaction



The grams of HCl react with 5.0 g of manganese dioxide will be [at.mass of Mn = 55]

- 1) 84 g                      2) 0.84 g                      3) 8.4g                      4) 4.2 g

**Answer:3**

Solution: 4 moles of HCl react with 1 mole of  $MnO_2$

$$\text{Molar mass of } MnO_2 = 55 + 32 = 87$$

$$\text{No. of moles} = \frac{5}{87} = 0.0574 \text{ moles}$$

$$\text{HCl moles} = 4(0.0574) = 0.229 \text{ moles}$$

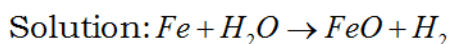
$$\text{Molar mass of HCl} = 01 + 35.5 = 36.5$$

$$\text{Mass of HCl} = 0.229(36.5) = 8.394 = 8.4 \text{ g}$$

15. Calculate the weight of iron which will be converted into its oxide by the action of 18g of steam on it.

- 1) 37.3 gm                      2) 3.73 gm                      3) 56 gm                      4) 5.6 gm

**Answer:3**



1 moles of Fe react with 1 moles of  $H_2O$ .

$$\text{Mass of } H_2O = 18 \text{ g}$$

$$\text{Molar mass of } H_2O = 2 + 16 = 18 \text{ g/mol}$$

$$\text{Moles} = 18/18 = 1 \text{ mole}$$

$$1 \text{ mol } H_2O = 1 \text{ mol Fe}$$

$$\text{Molar mass of Fe} = 56 \text{ g/mol}$$

$$\text{Mass of Fe} = 1 \times 56 \text{ g/mol} = 56 \text{ g}$$

16. The volume of  $\text{CO}_2$  formed when 1 litre of  $\text{O}_2$  reacted with 2 lit of CO under the same condition is

- 1) 1L                      2) 2L                      3) 3L                      4) 1.5L

**Answer:2**

Solution:  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$

2 volumes of CO react with 1 volume of  $\text{O}_2$  to produce 2 volumes of  $\text{CO}_2$ .

2 L of CO produces 2 L of  $\text{CO}_2$ .

1 L of  $\text{O}_2$  produces 2 L of  $\text{CO}_2$ .

Since the reaction uses all reactants completely, the total volume of  $\text{CO}_2$  formed is 2 L.

17. The mass of 80% pure calcium carbonate required to prepare 11.2 L of  $\text{CO}_2$  at STP is

- 1) 50g                      2) 62.5g                      3) 40g                      4) 75g

**Answer:2**

Solution:  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

1 mole of  $\text{CaCO}_3$  produces 1 mole of  $\text{CO}_2$ .

1 mole of any gas occupies 22.4 L.

Given volume of  $\text{CO}_2$  = 11.2 L.

Moles of  $\text{CO}_2$  =  $11.2/22.4 = 0.5$  moles

Moles of  $\text{CaCO}_3$  = 0.5 mol

Molar mass of  $\text{CaCO}_3$  = 40 (Ca) + 12 (C) +  $3 \times 16$  (O) = 100 g/mol

Mass of pure  $\text{CaCO}_3$  =  $0.5 \text{ mol} \times 100 \text{ g/mol} = 50 \text{ g}$

The sample is 80% pure, meaning only 80% of its mass is  $\text{CaCO}_3$ .

Total mass required =  $\frac{\text{Mass of Pure CaCO}_3}{\text{Purity}} = \frac{50 \text{ g}}{0.8} = 62.5 \text{ g}$

18. If 5 ml of methane is completely burnt the volume of oxygen required and the volume of  $\text{CO}_2$  formed under the same conditions are

- 1) 5 ml, 10 ml              2) 10 ml, 5 ml              3) 5 ml, 15 ml              4) 10 ml, 10 ml

**Answer:2**

Solution:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

1 volume of  $\text{CH}_4$  reacts with 2 volumes of  $\text{O}_2$

1 volume of  $\text{CH}_4$  produces 1 volume of  $\text{CO}_2$

$\text{CH}_4$  = 5 mL

Then from the equation:  $\text{O}_2$  needed =  $5 \times 2 = 10$  mL

$\text{CO}_2$  formed =  $5 \times 1 = 5$  mL

19. How many litres of oxygen at STP. are required for complete combustion of 39 gms of liquid Benzene ( $C_6H_6$ )? (Atomic weights C = 12, H = 1, O = 16)

- 1) 84                      2) 22.4                      3) 42                      4) 11.2

**Answer:1**

Solution:  $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

2 moles of  $C_6H_6$  react with 15 moles of  $O_2$ .

Given mass of benzene = 39 g

Molar mass of  $C_6H_6$  =  $(6 \times 12) + (6 \times 1) = 78$  g/mol

Moles of  $C_6H_6$  =  $39/78 = 0.5$  moles

From the balanced equation:  $2\text{mol } C_6H_6 = 15\text{mol } O_2$

$0.5$  moles of  $C_6H_6 = \frac{15}{2} \times 0.5 \text{ moles of } O_2 = 3.75 \text{ moles of } O_2$

At STP, 1 mole of any gas occupies 22.4 L.

Volume of  $O_2$  =  $3.75\text{mol} \times 22.4\text{L/mol} = 84\text{L}$

20.  $KClO_3$  decomposes to  $KCl$  and  $O_2$ . If the volume of  $O_2$  obtained in this reaction is 1.12 lit at STP, weight of  $KCl$  formed in the reaction is

- 1) 7.45 g                      2) 2.48 g                      3) 4.96 g                      4) 1.24 g

**Answer:2**

Solution:  $2KClO_3 \rightarrow 2KCl + 3O_2$

2 moles of  $KClO_3$  produce 2 moles of  $KCl$  and 3 moles of  $O_2$ .

At STP, 1 mole of any gas occupies 22.4 L.

Given volume of  $O_2$  = 1.12 L.

Moles of  $O_2$  =  $\frac{1.12}{22.4} = 0.05 \text{ moles}$

$0.05\text{mol } O_2 = \frac{2}{3} \times 0.05\text{mol } KCl \approx 0.0333\text{mol } KCl$

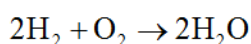
Molar mass of  $KCl$  =  $39$  (K) +  $35.5$  (Cl) =  $74.5$  g/mol

Mass of  $KCl$  =  $0.0333\text{mol} \times 74.5\text{g/mol} \approx 2.48\text{g}$

### ADVANCED LEVEL QUESTIONS

#### MULTIPLE CORRECT ANSWER TYPE

1. 4g of hydrogen is ignited with 4 g oxygen. Following reaction takes place



Select the correct statement(s).

- 1) Oxygen is limiting reactant                      2) Hydrogen is limiting reactant  
 3) 4g of hydrogen reacts with 2g oxygen 4) 4.5 g of water will be formed

**Answer: 1,4**

Solution:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

2 moles of  $\text{H}_2$  react with 1 mole of  $\text{O}_2$  to produce 2 moles of  $\text{H}_2\text{O}$ .

Molar mass of  $\text{H}_2 = 2 \text{ g/mol}$

Moles of  $\text{H}_2 = 4/2 = 2 \text{ moles}$

Molar mass of  $\text{O}_2 = 32 \text{ g/mol}$

Moles of  $\text{O}_2 = 4/32 = 0.125 \text{ moles}$

2 mol  $\text{H}_2$  requires 1 mol  $\text{O}_2$ .

Given: 2 mol  $\text{H}_2$  and 0.125 mol  $\text{O}_2$ .

$\text{O}_2$  is the limiting reagent because: Required  $\text{O}_2$  for 2 mol  $\text{H}_2 = 1 \text{ mol}$  (but only 0.125 mol is available)

Since  $\text{O}_2$  is limiting (0.125 mol):

Moles of  $\text{H}_2\text{O}$  produced =  $2 \times \text{moles of } \text{O}_2 = 2 \times 0.125 = 0.25 \text{ mol}$ .

Mass of  $\text{H}_2\text{O} = 0.25 \text{ mol} \times 18 \text{ g/mol} = 4.5 \text{ g}$ .

Excess  $\text{H}_2$  left:

Moles of  $\text{H}_2$  consumed =  $2 \times \text{moles of } \text{O}_2 = 2 \times 0.125 = 0.25 \text{ mol}$ .

Moles of  $\text{H}_2$  remaining =  $2 - 0.25 = 1.75 \text{ mol}$ .

Mass of excess  $\text{H}_2 = 1.75 \text{ mol} \times 2 \text{ g/mol} = 3.5 \text{ g}$ .

2.  $3\text{BaCl}_2 + 2\text{Na}_3\text{PO}_4 \rightarrow \text{Ba}_3(\text{PO}_4)_2 + 6\text{NaCl}$

If 0.2 moles of  $\text{Na}_3\text{PO}_4$  is mixed with 0.4 moles of  $\text{BaCl}_2$  then which of the following statements are correct?

- 1)  $\text{Na}_3\text{PO}_4$  is limiting reagent                      2) 0.1 moles of  $\text{Ba}_3(\text{PO}_4)_2$  is formed  
 3) 0.6 moles of  $\text{NaCl}$  is formed                      4) 0.1 moles of  $\text{BaCl}_2$  is left back

**Answer: 1,2,3,4**

Solution: Moles of  $\text{Na}_3\text{PO}_4 = 0.2$

Moles of  $\text{BaCl}_2 = 0.4$

3 moles of  $\text{BaCl}_2$  react with 2 moles of  $\text{Na}_3\text{PO}_4$

Ratio required:  $\frac{\text{BaCl}_2}{\text{Na}_3\text{PO}_4} = \frac{3}{2} = 1.5$

Given quantities:  $\frac{\text{BaCl}_2}{\text{Na}_3\text{PO}_4} = \frac{0.4}{0.2} = 2$

Since  $2 > 1.5$ ,  $\text{Na}_3\text{PO}_4$  is the limiting reagent.

2 moles of  $\text{Na}_3\text{PO}_4$  produce 1 mole of  $\text{Ba}_3(\text{PO}_4)_2$

Moles of  $\text{Ba}_3(\text{PO}_4)_2 = 0.2/2 = 0.1$  moles

2 moles of  $\text{Na}_3\text{PO}_4$  produce 6 moles of  $\text{NaCl}$

Moles of  $\text{NaCl} = \frac{6}{2} \times 0.2 = 0.6$  moles

2 moles of  $\text{Na}_3\text{PO}_4$  react with 3 moles of  $\text{BaCl}_2$

Moles of  $\text{BaCl}_2$  used  $= \frac{3}{2} \times 0.2 = 0.3$  moles

Excess

$\text{BaCl}_2$  left:  $0.4$  (initial)  $- 0.3$  (used)  $= 0.1$  moles.

### STATEMENT TYPE

3. A: The moles ratio of  $\text{H}_2$ ,  $\text{Cl}_2$  and  $\text{HCl}$  in the reaction  $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightarrow \text{HCl}_{(g)}$  is  $1 : 1 : 2$

R: Substances always react in such a way that their mole ratio is simple whole number.

### Answer:3

Solution:  $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightarrow \text{HCl}_{(g)}$

Mole ratio ( $\text{H}_2 : \text{Cl}_2 : \text{HCl}$ ) =  $1 : 1 : 2$  (A is true).

While mole ratios in balanced equations are simple whole numbers, this is due to stoichiometry, not a universal law.

R is not always true (e.g., fractional coefficients exist in some reactions).

4. Assertion: 8 g  $\text{CH}_4$  and 14 gr. nitrogen together occupy 11.2 lt. of volume at STP.

Reason: Equal volumes of all gases under the same conditions contain equal number of molecules.

### Answer:4

Solution: Moles of  $\text{CH}_4$  (Molar mass = 16 g/mol):  $\frac{8\text{g}}{16\text{g/mol}} = 0.5$  moles

Moles of  $\text{N}_2$  (Molar mass = 28 g/mol):  $\frac{14\text{g}}{28\text{g/mol}} = 0.5$  moles

Total moles =  $0.5 + 0.5 = 1$  mol.

At STP, 1 mol gas = 22.4 L, but A claims 11.2 L (incorrect).

Reason (R):

Avogadro's Law is correct, but it doesn't explain A (which is false).

5. Assertion: The volume ratio of  $H_2$ ,  $Cl_2$  and  $HCl$  in the reaction  $H_{2(g)} + Cl_{2(g)} \rightarrow HCl_{(g)}$  is 1 : 1 : 2

Reason: Substances always react in such a way that their volume ratio is simple whole number

**Answer:1**

Solution: Volume ratio ( $H_2:Cl_2:HCl$ ) = 1:1:2 (A is true).

Volume ratios follow stoichiometry (Gay-Lussac's Law) and are simple whole numbers for gases.

R is true and explains A for gas-phase reactions.

### COMPREHENSION TYPE

**Ammonia gas combines with oxygen gas over platinum catalyst to produce nitric oxide & water. If 13.6 g of Ammonia gas is taken initially,**

#### Comprehension-1

6. The mass of oxygen required is

1) 16 gm

2) 32 gm

3) 48 gm

4) 8 gm

**Answer:2**

Solution:  $4NH_3 + 5O_2 \xrightarrow{pt} 4NO + 6H_2O$

Molar mass of  $NH_3$  = 14 (N) + 3 (H) = 17 g/mol

Given mass of  $NH_3$  = 13.6 g

Moles of  $NH_3 = \frac{13.6g}{17g/mol} = 0.8mol$

4 mol  $NH_3 = 5$  mol  $O_2$

$0.8 \text{ mol } NH_3 = \frac{5}{4} \times 0.8mol O_2 = 1mol O_2$

Molar mass of  $O_2$  = 32 g/mol

Mass of  $O_2 = 1 \text{ mol} \times 32 \text{ g/mol} = 32 \text{ g}$

7. The number of moles of water molecules formed in the reaction is

1) 2 moles

2) 4 moles

3) 6 moles

4) 8 moles

**Answer:1**

Solution: 4 mol  $NH_3 = 6$  mol  $H_2O$

$0.8 \text{ mol } NH_3 = \frac{6}{4} \times 0.8mol H_2O = 1.2mol H_2O$

**Comprehension-2**

Gay-Lussac's Law states when gases react, the volume of the reacting gases and the volumes of any gaseous products are in the ratio of small whole numbers provided the volumes are measured at the same temperature and pressure.

8. 26 c.c of  $\text{CO}_2$  is passed over red hot coke. The volume of CO evolved is (under the same condition)

- 1) 15 c.c                      2) 10 c.c                      3) 32 c.c                      4) 52 c.c

**Answer:4**

Solution:  $\text{CO}_2 + \text{C}(\text{coke}) \rightarrow 2\text{CO}$

1 volume  $\text{CO}_2$  produces 2 volumes CO

Volume of  $\text{CO}_2 = 26 \text{ c.c}$

Volume of CO =  $2 \times 26 \text{ c.c} = 52 \text{ c.c}$

9. If 2 litres of butane is completely burnt the volume of  $\text{CO}_2$  obtained under the same conditions would be

- 1) 2 lit                      2) 4 lit                      3) 6 lit                      4) 8 lit

**Answer:4**

Solution:  $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$

2 volumes  $\text{C}_4\text{H}_{10}$  produce 8 volumes  $\text{CO}_2$ .

Simplified ratio: 1 volume  $\text{C}_4\text{H}_{10} \rightarrow 4 \text{ volumes } \text{CO}_2$ .

Volume of butane = 2 litres

Volume of  $\text{CO}_2 = 4 \times 2 \text{ L} = 8 \text{ L}$

10. The volume of  $\text{O}_2$  required for the combustion of 10 lit of methane under the same condition is

- 1) 10 lit                      2) 22.4 lit                      3) 20 lit                      4) 2 lit

**Answer:3**

Solution:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

1 volume  $\text{CH}_4$  requires 2 volumes  $\text{O}_2$ .

Given: Volume of methane = 10 litres

Volume of  $\text{O}_2 = 2 \times 10 \text{ L} = 20 \text{ L}$

**INTEGER TYPE**

11. 'S' grams of calcium carbonate was completely burnt in air. The weight of the solid residue formed is 28 g. What is the value of 'S' (in grams) ?

**Answer:50**

Solution:  $\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$

1 mole  $\text{CaCO}_3$  (100 g)  $\rightarrow$  1 mole CaO (56 g) +  $\text{CO}_2$ .

Residue (CaO) = 28 g.

Moles of CaO =  $28/56 = 0.5 \text{ mol}$

Moles of  $\text{CaCO}_3 = 0.5 \text{ mol}$

Calculate Mass of  $\text{CaCO}_3$  (S) =  $0.5 \text{ mol} \times 100 \text{ g/mol} = 50 \text{ g}$

S =  $0.5 \text{ mol} \times 100 \text{ g/mol} = 50 \text{ g}$

12. A hypothetical reaction  $3A \rightarrow 2B + 4C$  is considered. What is the number of moles of B produced if 2 moles of C is produced after the end of reaction?

**Answer:1**

Solution: 4 moles of C = 2 moles of B

2 moles of C =  $0.5 \times 2 = 1$  mole of B

13. What is the volume of oxygen required for complete combustion of 2 ml of ethene ( $\text{C}_2\text{H}_4$ )?

**Answer:6**

Solution:  $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$

1 volume  $\text{C}_2\text{H}_4$  requires 3 volumes  $\text{O}_2$ .

Volume of ethene ( $\text{C}_2\text{H}_4$ ) = 2 mL.

Volume of  $\text{O}_2 = 3 \times 2 \text{ mL} = 6 \text{ mL}$

#### MATRIX MATCHING TYPE

14. **List - I**

A)  $\text{CH}_3\text{OH}$

B)  $1.06 \text{ g Na}_2\text{CO}_3 \xrightarrow{\text{Excess HCl}}$

C)  $2.4 \text{ g C} \xrightarrow[\text{combustion}]{\text{Excess O}_2}$

D)  $0.56 \text{ g CO} \xrightarrow[\text{combustion}]{\text{Excess O}_2}$

**List - II**

**(at STP)**

1)  $0.224 \text{ L CO}_2$

2)  $4.48 \text{ L CO}_2$

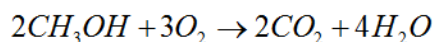
3)  $0.448 \text{ L CO}_2$

4)  $2.24 \text{ L CO}_2$

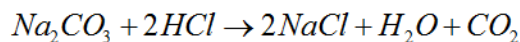
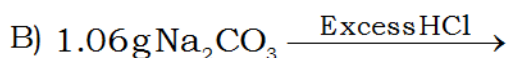
5)  $44.8 \text{ L CO}_2$

**Answer:A-5,B-1,C-2,D-3**

Solution:A)  $\text{CH}_3\text{OH}$



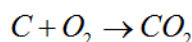
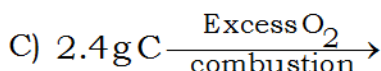
2 moles  $\text{CH}_3\text{OH}$  (64 g)  $\rightarrow$  2 moles  $\text{CO}_2$  (44.8 L at STP).



1 mole  $\text{Na}_2\text{CO}_3$  (106 g)  $\rightarrow$  1 mole  $\text{CO}_2$  (22.4 L at STP).

Given mass: 1.06 g  $\text{Na}_2\text{CO}_3 \rightarrow$  Moles =  $1.06/106 = 0.01$  moles

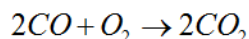
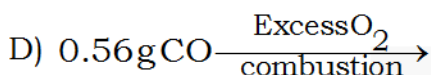
$\text{CO}_2$  produced:  $0.01 \text{ mol} \times 22.4 \text{ L/mol} = 0.224 \text{ L}$ .



1 mole C (12 g)  $\rightarrow$  1 mole  $\text{CO}_2$  (22.4 L at STP).

Given mass: 2.4 g C  $\rightarrow$  Moles =  $2.4/12 = 0.2$  mol

$\text{CO}_2$  produced:  $0.2 \text{ mol} \times 22.4 \text{ L/mol} = 4.48 \text{ L}$ .



2 moles CO (56 g)  $\rightarrow$  2 moles  $\text{CO}_2$  (44.8 L at STP).

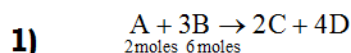
Given mass: 0.56 g CO  $\rightarrow$  Moles =  $0.56/28 = 0.02$  mol

$\text{CO}_2$  produced:  $0.02 \text{ mol CO} \rightarrow 0.02 \text{ mol CO}_2 = 0.02 \times 22.4 \text{ L} = 0.448 \text{ L}$ .

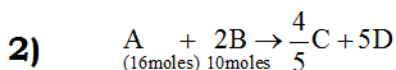
15.

### Column I

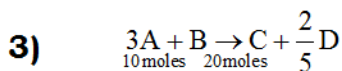
### Column II



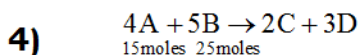
(P) Limiting reagent is A



(Q) Moles of C formed is 4



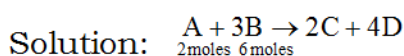
(R) Moles of D formed is 8



(S) Limiting reagent is B

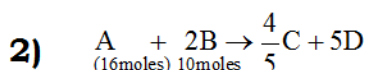
(T) Excess of reagent left is 6.25 moles

**Answer: 1-Q,R, 2-Q,S, 3-P, 4-P,T**



1mole of A combined with 3 moles of B to produce 2 moles of C and 4 moles of D

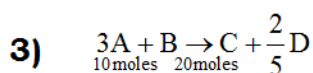
2moles of A combined with 6 moles of B to produce 4 moles of C and 8 moles of D



1 mole of A react with 2 moles of B and produces 4/5moles of C and 5 moles of D  
Given 16 moles of A, it requires 32 moles of B but given 10 moles only so B is limiting reagent.

10 moles of B produces  $\frac{4}{5} \times \frac{10}{2} = 4 \text{ moles of C}$

10 moles of B produces  $\frac{5 \times 10}{2} = 25 \text{ moles of D}$



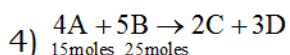
3 moles of A react with 1 mole of B and produces 1 mole of C and 2/5 moles of D  
Given 20 moles of B, it requires 60 moles of A but given 10 moles only so A is limiting reagent.

10 moles of A produces 10/3 moles of C

10 moles of A produces  $\frac{2 \times 10}{5 \times 3} = \frac{4}{3} \text{ moles of D}$

10 moles of A uses 3.33 moles of B

Excess amount = 6.666g of B



4 moles of A react with 5 moles of B and produces 2 moles of C and 3 moles of D

15 moles of A react with 18.75g of B. So A is limiting reagent

Excess reagent B = 25 - 18.75 = 6.25g

15 moles of A produces 7.5 moles of C

15 moles of A produces 11.2 moles of D

## KEY

					TEACHING TASK					
					JEE MAIN LEVEL QUESTIONS					
1	2	3	4	5	6	7	8	9	10	
2	1	1	3	2	1	4	4	1	3	
11	12	13	14	15	16	17	18	19		
2	2	3	2	1	3	3	2	3		
					ADVANCED LEVEL QUESTIONS					
1	2	3	4	5	6	7	8	9	10	
1,3	B,C,D	1	2	2	1	2	3	4	2	
11	12	13	14	15				16		
2	12	2	2	1 - P, Q, S, T, 2- R, Q, S, 3 - R, S, T, 4 - P, Q, T					A - iv, B-i, C-ii, D-iii	
					LEARNERS TASK					
					CUQ'S					
1	2	3	4	5	6	7	8	9	10	
3	2	4	1,2,3,4	1	1	2	3	3	3	
					JEE MAIN LEVEL QUESTIONS					
11	12	13	14	15	16	17	18	19	20	
1,	2	2	3	3	2	2	2	1	2	
					ADVANCED LEVEL QUESTIONS					
1	2	3	4	5	6	7	8	9	10	
1,4	1,2,3,4	3	4	1	2	1	4	4	3	
11	12	13	14		15					
50	1	6	A-5, B-1, C-2, D-3		1-Q, R, 2-Q, S, 3-P, 4-P, T					

