# 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:- $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

The loss of baking soda is due to release of $CO_2$ and $H_2O$.

$NaHCO_3 \rightarrow 23 + 1 + 12 + 3(16) = 84$ gms.

$2NaHCO_3 \rightarrow 2 \times 84 = 168$ gms.

2 moles of $NaHCO_3$ it looses 1 mole of $CO_2$ & $H_2O$

$CO_2 = 12 + 32 = 44$ gms.

$H_2O = 2 + 16 = 18$ gms.

For 2 moles of $NaHCO_3$ it looses 62gms.

| weight | loss |
|---|---|
| 168 | 62 |
| x | 3.1 |

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

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

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 :-

$2Mg + O_2 \rightarrow 2MgO$

$2 \times 24 = 48$  32 gms.

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

For Mg = 1 gm.

| Mg | $O_2$ |
|---|---|
| 48 | 32 |
| 1 | x |

$x = \frac{32}{48} = 0.666$ 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 $O_2$

| Mg | $O_2$ |
|---|---|
| 48 | 32 |
| x | 0.5 |

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

$= 0.75$ gms of Mg.

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

Remaining Mg = 1 − 0.75

= 0.25 gms of Mg.

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

Solution: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

For 1 mole of $H_2SO_4$, 2 moles of NaOH required.

$H_2SO_4 = 2(1)+32+4(16) = 98$ gms.

$NaOH = 23+16+1 = 40$ gms.

2 moles of NaOH = 80 gms.

Given, NaOH = 60g.

| $H_2SO_4$ | NaOH |
|---|---|
| 98 | 80 |
| x | 60 |

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

Pure $H_2SO_4$ is 73.5 gms mixed with 60 gms NaOH.

But they are telling 80% pure $H_2SO_4$. So add impure $H_2SO_4$ to get 80% pure $H_2SO_4$.

80% → 73.5

100% → x

$\therefore 80x = 73.5 \times 100$

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

$= 91.875$ gms

**Answer:1**

4. 60 gms of limestone on heating produced 22g of $CO_2$. The percentage of $CaCO_3$ 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 (Fe=56)

1) 1.2g 2) 1.8g 3) 2.4g 4) 3.2g

**Answer:2**

Q4) Ans: 3.

Solution: $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

$CaCO_3 = 40 + 12 + 48 = 100$ gms

$CO_2 = 12 + 2(16) = 44$ gms

| $CaCO_3$ | $CO_2$ |
|---|---|
| 100 | 44 |
| x | 22 |

$x = \frac{22 \times 100}{44} = 50$ gms.

To produce 22 gms of $CO_2$, 50 gms $CaCO_3$ required.

But they are giving 60 gms.

| | |
|---|---|
| 100% | 60 |
| x | 50 |

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

83.33% of $CaCO_3$ is used produce 22 gms of $CO_2$.

Q5) Ans: 2

Solution: $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

4 moles of Fe required for 3 moles of $O_2$

$4Fe \rightarrow 4 \times 56$, $3O_2 = 3 \times 32 = 96$ gms

| Fe | $O_2$ |
|---|---|
| 224 | 96 |
| 4.2 | x |

$x = \frac{96 \times 4.2}{224} = 1.8$ gms.



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: $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$.

On heating baking soda it loses $CO_2$ & $H_2O$

$2NaHCO_3 \rightarrow 2[23+1+12+48] = 2 \times 84 = 168$ gms

$Na_2CO_3 \rightarrow 46+12+48 = 106$ gms.

$NaHCO_3$    $Na_2CO_3$.

168    106

4.2    x

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

On strong heating of 4.2gms of NaOH, 2.65gms of $Na_2CO_3$ is remained.

7. The number of moles of KI required to produce 0.1 mole of $K_2$ Hg $I_4$ is

1) 1.6    2) 0.8    3) 3.2    4) 0.4

**Answer:4**

Solution: $4KI + Hg \rightarrow K_2HgI_4 + 2K^+$

Moles of KI needed: 0.1×4=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**



Solution: $CaCO_3 \rightarrow CaO + CO_2$

For 1 mole $CaCO_3$ ,1 mole of Cao produced

1 mole $CaCO_3$ molecular weight=40+12+3(16)=100gms

1 mole of CaO molecular weight=40+16=56gms

Given CaO=28,No.of moles=28/56=0.5moles

So $CaCO_3$ is also 0.5 moles

0.5 mole $CaCO_3$ molecular weight=0.5(100)=50

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

$2Ca_3(PO_4)_2 + 6SiO_2 + 10C \longrightarrow 6CaSiO_3 + 10CO + P_4$ Determine.

i) The amount of phosphorus formed for each mole of $Ca_3(PO_4)_2$ used.

ii) The amount of phosphorus formed for each gram of $Ca_3(PO_4)_2$ used.

iii) The amount of phosphorus in tons formed for each ton of $Ca_3(PO_4)_2$ used.

| | *i* | *ii* | *iii* |
|---|---|---|---|
| 1) | 62g | 0.2g | 0.2g |
| 2) | 72g | 2g | 0.4g |
| 3) | 52g | 3g | 0.2g |
| 4) | 42g | 0.2g | 4g |

**Answer:1**

$$2Ca_3(PO_4)_2 + 6SiO_2 + 10C \rightarrow 6CaSiO_3 + 10CO + P_4$$

Sol

i) Phosphorus per mole of $Ca_3(PO_4)_2$:

- 2 moles of $Ca_3(PO_4)_2 \rightarrow$ 1 mole of $P_4$ (124 g).
- 1 mole $\rightarrow$ 62 g of $P_4$.

ii) Phosphorus per gram of $Ca_3(PO_4)_2$:

- Molar mass of $Ca_3(PO_4)_2 = 310\ g/mol$.
- 1 g $\rightarrow \frac{62}{2\times310} = 0.1$ g of $P_4$.

iii) Phosphorus per ton of $Ca_3(PO_4)_2$:

- 1 ton $\rightarrow$ 0.2 ton of $P_4$.

10. What volume of $H_2$ at NTP is required to convert 2.8g of $N_2$ in to $NH_3$?

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

**Answer:3**

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

Moles of $N_2$: $\frac{2.8}{28} = 0.1 mol$

$H_2$ 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 $CO_2$ liberated at STP, when 2.12gms of sodium carbonate (MW=106) is treated with excess dilute HC*l*?

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

**Answer:2**

Solution: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

Moles of $Na_2CO_3$: $\frac{2.12}{106} = 0.02 mol$

CO2 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 $SO_2$. In this reacton, 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: $S + O_2 \rightarrow SO_2$

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

$O_2$ 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 in to sulphurdioxide

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

**Answer:3**

Solution: $S + O_2 \rightarrow SO_2$

1 mole S ,1 mole of oxygen required

number of moles of oxygen=1.5moles

Volume=1.5(22.4)=33.6litres

14. 'X' litres of carbonmonoxide is present at STP. It is completely oxidised to $CO_2$. The volume of $CO_2$ 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: $2CO + O_2 \rightarrow 2CO_2$

Moles of $CO_2$: 11.2/22.4=0.5moles

CO Also same moles ,CO occupies 11.2litres

15. 0.01 mole of iodoform($CHI_3$) 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: $CHI_3 + 3Ag \rightarrow AgI + CH_3I$

Moles of $CHI_3$: 0.01 mol.

Gas ($CH_3I$) produced: 0.01 mol.Volume at NTP: 0.01×22.4=0.224 L=224 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:Solution: $S + O_2 \rightarrow SO_2$

1 mole S ,1 mole of oxygen required

number of moles of oxygen=1.5moles

Volume=1.5(22.4)=33.6litres

17. The number of moles of $Fe_2O_3$ formed when 5.6 lit of $O_2$ reacts with 5.6g of Fe?

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

**Answer:3**

Solution: $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

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

Moles of $O_2$: $\frac{5.6}{22.4} = 0.25 moles$

$Fe_2O_3$ formed: 0.05 mol.

18. 20 ml of nitric oxide combines with 10 ml of oxygen at STP to give $NO_2$. The final volume will be

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

**Answer:2**

Solution: $2NO + O_2 \rightarrow 2NO_2$

20 mL NO + 10 mL $O_2$:NO is limiting (uses 10 mL $O_2$, produces 20 mL NO2).

Final volume: 20 mL.

19. When 10ml of $H_2$ and 12.5 ml of $Cl_2$ 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 $Cl_2$ 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 Cl2 (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 H2).

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

$$4\ Ag + 8\ KCN + O_2 + 2H_2O \longrightarrow 4\ K[Ag\ (CN)_2] + 4\ KOH$$

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 mol Ag = 1 mol $O_2$.

For 0.926 mol Ag:

$$O_2 = 0.926 \times \frac{1}{4} = 0.2315 \text{ mol} \approx 7.40 \text{ g} \quad (\text{Molar mass } O_2 = 32 \text{ g/mol}).$$

Volume at STP:0.2315×22.4=5.20 L (not grams).

Statements:

2 (0.742 g O2): Incorrect.

3 (7.40 g O2): Correct.

4 (5.20 grams O2): 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: $NaNO_3 + NH_4Cl \rightarrow N_2 + 2H_2O + 2NaCl$

Given:

0.5 mol $NaNO_2$ (limiting reactant).

1 mol $NH_4Cl$ (excess).

Gas Produced ($N_2$):

Stoichiometry: 1 mol $NaNO_2$ = 1 mol $N_2$.

0.5 mol $NaNO_2$ $\rightarrow$0.5 mol $N_2$.

At STP:0.5×22.4=11.2 L.

Mass of $N_2$: 0.5×28=14 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=0.1moles

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 =0.1×2=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

$$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$$

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 $O_2 = \frac{5}{2} \times 70 = 175ml$

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**

$$O_3 + NO \rightarrow NO_2 + O_2$$

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 $O_3$=48g/mol

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

Molar mass of NO=30g/mol

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

Determine the limiting reactant

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

$O_3$ requires 0.0154molof NO, but we have 0.0223mol 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 ($O_3$)=0.0154mol

Convert moles of $NO_2$ to grams

Molar mass of $NO_2$ =46g/mol

Mass of $NO_2$ =0.0154(46)=0.7084g

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=0.0223mol

Moles of NO consumed=0.0154mol

Excess NO=0.0223-0.0154=0.0069mol˜0.007mol

**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

$4Al + 3O_2 \rightarrow 2Al_2O_3$

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

3mol $O_2$ reacts with 4mol Al

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

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

10. The mass of zinc (Zn=65) required to produce 224 ml of $H_2$ at STP on treatement 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.

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

1mol Zn produces 1mol $H_2$

Moles of Zn required=0.01mol

Mass of Zn=0.01x65=0.65g



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 $C_3H_8$=(3×12)+(8×1)=44g/mol

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

1mol $C_3H_8$ requires 5mol $O_2$

0.05mol $C_3H_8$ requires 0.05×5=0.25mol $O_2$

Volume of $O_2$ =0.25×22.4=5.6L

**INTEGER TYPE**

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

**Answer:12**

Solution: $H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

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

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

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

1mol $H_3PO_4$ requires 3mol NaOH

Moles of NaOH=0.1×3=0.3mol

Molar mass of NaOH=23+16+1=40g/mol

Mass of NaOH=0.3×40=12g

13. $Zn + \underset{(excess)}{H_2SO_4} \rightarrow ZnSO_4 + H_2$ If 44.8L of $H_2$ gas at STP was produced , then find the no. of moles of Zn taken initially is ______

**Answer:2**

Solution: $Zn + \underset{(excess)}{H_2SO_4} \rightarrow ZnSO_4 + H_2$

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

At STP, 1 mole of gas occupies 22.4 L.

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

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**

Solution: $CaCO_3 \rightarrow CaO + CO_2$

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

Given volume of $CO_2$ = 448 mL.

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

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

Moles of pure $CaCO_3$=0.02mol

Molar mass of $CaCO_3$=40+12+48=100g/mol

Mass of pure $CaCO_3$=0.02mol×100g/mol=2g

Total mass of impure sample = 10 g

Mass of pure $CaCO_3$ = 2 g

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

Given that purity is 10x%, we have:10x=20-->x=2

**MATRIX MATCHING TYPE**

15. **Column I** — **Column II**

| Column I | Column II |
|---|---|
| **1)** $\underset{(2\text{moles})}{A} + \underset{(6\text{ moles})}{2B} \rightarrow 3C+4D$ | **(P)** Limiting Reagent is A |
| **2)** $\underset{(16\text{moles})}{2A} + \underset{(24\text{ moles})}{4B} \rightarrow C+\frac{4}{3}D$ | **(Q)** Moles of C formed is 6 moles. |
| **3)** $\underset{(26\text{moles})}{3A} + \underset{(16\text{ moles})}{2B} \rightarrow 2C+D$ | **(R)** Limiting Reagent is B |
| **4)** $\underset{(12\text{moles})}{4A} + \underset{(17\text{ moles})}{5B} \rightarrow 2C+3D$ | **(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**

Solution:**1)** $\underset{(2\text{moles})}{A} + \underset{(6\text{ moles})}{2B} \rightarrow 3C+4D$

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 × moles of A = 3 × 2 = 6 moles

Moles of D = 4 × moles of A = 4 × 2 = 8 moles

Excess reagent left:

B required = 2 × moles of A = 4 moles

B left = 6 - 4 = 2 moles

**2)**
$$\underset{(16\,moles)}{2A} + \underset{(24\,moles)}{4B} \rightarrow C + \frac{4}{3}D$$

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 = $\frac{1}{4}$ × moles of B = $\frac{1}{4}$ × 24 = 6 moles

Moles of D = $\frac{4}{3\times4}$ × moles of B = $\frac{1}{3}\times24 = 8\,moles$

Excess reagent left:

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

A left = 16 - 12 = 4 moles

**3)**
$$\underset{(26\,moles)}{3A} + \underset{(16\,moles)}{2B} \rightarrow 2C + D$$

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):

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

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

Excess reagent left:

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

A left = 26 - 24 = 2 moles

**4)** $\underset{(12\text{moles})}{4A} + \underset{(17\text{ moles})}{5B} \rightarrow 2C + 3D$

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):

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

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

Excess reagent left:

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

B left = 17 - 15 = 2 moles

16. **List –I** | **List –II (At STP)**

| List –I | List –II (At STP) |
|---|---|
| A) 10g. $CaCO_3 \xrightarrow{\Delta}$ | i) 0.224 lit . $CO_2$ |
| B) 1.06 g . $Na_2CO_3 \xrightarrow{excess HCl}$ | ii) 4.48 lit. $CO_2$ |
| C) 2.4 g.C $\xrightarrow{excess\ O_2}$ | iii) 0.448 lit. $CO_2$ |
| D) 0.56 g. CO $\xrightarrow{excess\ O_2}$ | iv) 2.24 lit. $CO_2$ |
| | v) 22.4 lit. $CO_2$ |

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

Solution:

A) 10g. $CaCO_3 \xrightarrow{\Delta}$

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Molar mass of $CaCO_3$= 40 (Ca) + 12 (C) + 3×16 (O) = 100 g/mol

Moles of $CaCO_3$ = $\frac{10g}{100g/mol} = 0.1mol$

From the equation, 1 mole of CaCO3 produces 1 mole of CO2.
Moles of $CO_2$ = 0.1 mol
At STP, 1 mole of gas occupies 22.4 L.
Volume of $CO_2$ = 0.1 mol × 22.4 L/mol = 2.24 L
B) 1.06 g . $Na_2CO_3 \xrightarrow{excessHCl}$

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

Molar mass of $Na_2CO_3$ = 2×23 (Na) + 12 (C) + 3×16 (O) = 106 g/mol

Moles of $Na_2CO_3$= $\frac{1.06g}{106g/mol} = 0.01mol$

From the equation, 1 mole of$Na_2CO_3$ produces 1 mole of $CO_2$.
Moles of $CO_2$ = 0.01 mol
Volume of $CO_2$ = 0.01 mol × 22.4 L/mol = 0.224 L



C) 2.4 g.C $\xrightarrow{excess\ O_2}$

$C + O_2 \rightarrow CO_2$

Molar mass of C = 12 g/mol

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

From the equation, 1 mole of C produces 1 mole of $CO_2$.
Moles of $CO_2$ = 0.2 mol
Volume of $CO_2$ = 0.2 mol × 22.4 L/mol = 4.48 L

D) 0.56 g. CO $\xrightarrow{excess\ O_2}$

$2CO + O_2 \rightarrow 2CO_2$

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

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

From the equation, 2 moles of CO produce 2 moles of $CO_2$ (1:1 ratio).

Moles of $CO_2$ = 0.02 mol

Volume of $CO_2$ = 0.02 mol × 22.4 L/mol = 0.448 L

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**LEARNERS TASK**

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

1. The mass of $CO_2$ obtained when 2g of pure limestone is calcined is

   1) 44g  2) 0.22g  3) 0.88g  4) 8.8g

**Answer:3**

Solution: $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Molar mass of $CaCO_3$= 100 g/mol

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

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

Moles of $CO_2$=0.02mol

Molar mass of $CO_2$ = 44 g/mol

Mass=0.02mol×44g/mol=0.88g

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: $Ag_2CO_3 \xrightarrow{\Delta} 2Ag + CO_2 + \frac{1}{2}O_2$

Molar mass of $Ag_2CO_3$ = 276 g/mol

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

1 mole of $Ag_2CO_3$ produces 2 moles of Ag.

Moles of Ag=0.02mol

Molar mass of Ag = 108 g/mol

Mass of Ag=0.02mol×108g/mol=2.16g

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

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

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

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

Molar mass of O2 = 32 g/mol

Mass=0.75mol×32g/mol=24g

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**

Solution: $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

Molar mass of $MgSO_4$ = 120 g/mol

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

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

Moles of $MgCO_3$=0.1mol

Molar mass of MgCO3 = 84 g/mol

Mass=0.1mol×84g/mol=8.4g

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**

Solution: $S + O_2 \rightarrow SO_2$

At NTP, 22.4 L = 1 mole.

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

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

Molar mass of S = 32 g/mol

Mass=0.01mol×32g/mol=0.32g



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**

Solution: $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

At STP, 22.4 L = 1 mole.

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

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

Molar mass of $CaCO_3$ = 100 g/mol

Mass=0.25mol×100g/mol=25g

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 $Cl_2$ reacts with 1 volume of $H_2S$.

Volume of $Cl_2$=10L

10. How much volume of $CO_2$ at S.T.P is liberated by the combustion of 100 cm³ of propane ($C_3H_8$)?

1) $100cm^3$ 2) $200cm^3$ 3) $300cm^3$ 4) $400cm^3$

**Answer:3**

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

1 volume of $C_3H_8$ produces 3 volumes of $CO_2$.

volumes of $CO_2$=3x100 cm³=300 cm³

## 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: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

For 1 mole Mg,1 mole $H_2$ produced

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

Number of moles of Hydrogen =0.25 moles

Mass of Hydrogen=0.25(2)=0.5g

12. In the formation of $Al_2O_3$ from Al and $O_2$, 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: $4Al + 3O_2 \rightarrow 2Al_2O_3$

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

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

Molar mass of Al = 27 g/mol

Mass of Al=2mol×27g/mol=54g

13. 6.5g of Zn is dissolved in excess of $H_2SO_4$. The weight of $ZnSO_4$ formed is

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

**Answer:2**

Solution: $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

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

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

Moles of $ZnSO_4$ =0.1mol

Molar mass of $ZnSO_4$ =65+32+64=161g/mol

Mass of $ZnSO_4$=0.1mol×161g/mol=16.1g

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

$4HCl (aq) + MnO_2(s) \rightarrow 2H_2O(l) + MnCl_2(aq) + Cl_2(g)$

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 $MnO_2$

Molar mass of $MnO_2$=55+32=87

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

HCl moles=4(0.0574)=0.229moles

Molar mass of HCl =01+35.5=36.5

Mass of HC=0.229(36.5)=8.394=8.4g

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**

Solution: $Fe + H_2O \rightarrow FeO + H_2$

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

Mass of $H_2O$ = 18 g

Molar mass of $H_2O$ = 2 + 16 = 18 g/mol

Moles=18/18=1 mole

1mol $H_2O$=1mol Fe

Molar mass of Fe = 56 g/mol

Mass of Fe=1×56g/mol=56g

16. The volume of $CO_2$ formed when 1 litre of $O_2$ reacted with 2 lit of CO under the same condition is

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

**Answer:2**

Solution: $2CO + O_2 \rightarrow 2CO_2$

2 volumes of CO react with 1 volume of $O_2$ to produce 2 volumes of $CO_2$.

2 L of CO produces 2 L of $CO_2$.

1 L of O2 produces 2 L of $CO_2$.

Since the reaction uses all reactants completely, the total volume of $CO_2$ formed is 2 L.

17. The mass of 80% pure calcium carbonate required to prepare 11.2 L of $CO_2$ at STP is

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

**Answer:2**

Solution: $CaCO_3 \rightarrow CaO + CO_2$

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

1 mole of any gas occupies 22.4 L.

Given volume of $CO_2$ = 11.2 L.

Moles of $CO_2$ =11.2/22.4=0.5moles

Moles of $CaCO_3$=0.5mol



Molar mass of CaCO3 = 40 (Ca) + 12 (C) + 3×16 (O) = 100 g/mol

Mass of pure $CaCO_3$ =0.5mol×100g/mol=50g

The sample is 80% pure, meaning only 80% of its mass is $CaCO_3$.

Total mass required= $\frac{MassOfPureCaCO_3}{Purity} = \frac{50g}{0.8} = 62.5g$

18. If 5 ml of methane is completely burnt the volume of oxygen required and the volume of $CO_2$ 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: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

1 volume of $CH_4$ reacts with 2 volumes of $O_2$

1 volume of $CH_4$ produces 1 volume of $CO_2$

CH4 = 5 mL

Then from the equation: $O_2$ needed = 5×2=10 mL

$CO_2$ formed = 5×1=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 × 12) + (6 × 1) = 78 g/mol

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

From the balanced equation:2mol $C_6H_6$=15mol $O_2$

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

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

Volume of $O_2$=3.75mol×22.4L/mol=84L

20. $KClO_3$ decomposes to KC*l* 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 $O_2$ = $\frac{1.12}{22.4} = 0.05 moles$

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

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

Mass of KCl=0.0333mol×74.5g/mol˜2.48g

## ADVANCED LEVEL QUESTIONS

**MULTIPLE CORRECT ANSWER TYPE**

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

$2H_2 + O_2 \rightarrow 2H_2O$

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: $2H_2 + O_2 \rightarrow 2H_2O$

2 moles of $H_2$ react with 1 mole of $O_2$ to produce 2 moles of $H_2O$.

Molar mass of $H_2$ = 2 g/mol

Moles of $H_2$=4/2=2moles

Molar mass of $O_2$ = 32 g/mol

Moles of $O_2$=4/32=0.125moles

2 mol H2 requires 1 mol O2.

Given: 2 mol $H_2$ and 0.125 mol $O_2$.

$O_2$ is the limiting reagent because:Required $O_2$ for 2 mol $H_2$ =1mol (but only 0.125 mol is available)

Since $O_2$ is limiting (0.125 mol):

Moles of $H_2O$ produced = 2 × moles of O2 = 2 × 0.125 = 0.25 mol.

Mass of $H_2O$ = 0.25 mol × 18 g/mol = 4.5 g.

Excess $H_2$ left:

Moles of $H_2$ consumed = 2 × moles of $O_2$ = 2 × 0.125 = 0.25 mol.

Moles of $H_2$ remaining = 2 - 0.25 = 1.75 mol.

Mass of excess $H_2$ = 1.75 mol × 2 g/mol = 3.5 g.



2. $3BaCl_2 + 2Na_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6NaCl$

If 0.2 moles of $Na_3PO_4$ is mixed with 0.4 moles of $BaCl_2$ then which of the following statements are correct?

1) $Na_3PO_4$ is limiting reagent
2) 0.1 moles of $Ba_3(PO_4)_2$ is formed
3) 0.6 moles of NaCl is formed
4) 0.1 moles of $BaCl_2$ is left back

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

Solution:Moles of $Na_3PO_4$=0.2

Moles of $BaCl_2$=0.4

3 moles of $BaCl_2$ react with 2 moles of $Na_3PO_4$

Ratio required: $\frac{BaCl_2}{Na_3PO_4} = \frac{3}{2} = 1.5$

Given quantities: $\frac{BaCl_2}{Na_3PO_4} = \frac{0.4}{0.2} = 2$

Since 2 > 1.5, $Na_3PO_4$ is the limiting reagent.
2 moles of $Na_3PO_4$ produce 1 mole of $Ba_3(PO_4)_2$
Moles of $Ba_3(PO_4)_2$ =0.2/2=0.1moles

2 moles of $Na_3PO_4$ produce 6 moles of NaCl

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

2 moles of $Na_3PO_4$ react with 3 moles of $BaCl_2$

Moles of $BaCl_2$ used=$\frac{3}{2}\times 0.2 = 0.3 moles$

Excess

$BaCl_2$ left:0.4 (initial)-0.3 (used)=0.1 moles.

**STATEMENT TYPE**

3. A: The moles ratio of $H_2$, $Cl_2$ and $HC\ell$ in the reaction $H_{2(g)} + Cl_{2(g)} \rightarrow HCl_{(g)}$ is 1 : 1 : 2

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

**Answer:3**

Solution: $H_{2(g)} + Cl_{2(g)} \rightarrow HCl_{(g)}$

Mole ratio ($H_2$:$Cl_2$: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 $CH_4$ 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 $CH_4$ (Molar mass = 16 g/mol): $\frac{8g}{16g/mol} = 0.5 moles$

Moles of $N_2$ (Molar mass = 28 g/mol): $\frac{14g}{28g/mol} = 0.5 moles$

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 $HC\ell$ 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 mol $NH_3$=$\frac{5}{4} \times 0.8molO_2 = 1molO_2$

Molar mass of $O_2$ = 32 g/mol

Mass of $O_2$=1 mol×32 g/mol=32 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 mol $NH_3$=$\frac{6}{4} \times 0.8molH_2O = 1.2molH_2O$

**Comprehension-2**

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

8. 26c.c of $CO_2$ 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: $CO_2 + C(coke) \rightarrow 2CO$

1 volume $CO_2$ produces 2 volumes CO

Volume of $CO_2$ = 26 c.c

Volume of CO=2×26 c.c=52 c.c

9. If 2 litres of butane is completely burnt the volume of $CO_2$ obtained under the same conditions would be

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

**Answer:4**

Solution: $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

2 volumes $C_4H_{10}$ produce 8 volumes $CO_2$.

Simplified ratio: 1 volume $C_4H_{10}$ ---> 4 volumes $CO_2$.

Volume of butane = 2 litres

Volume of $CO_2$=4×2 L=8 L



10. The volume of $O_2$ 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) 2lit

**Answer:3**

Solution: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

1 volume $CH_4$ requires 2 volumes $O_2$.

Given: Volume of methane = 10 litres

Volume of $O_2$=2×10 L=20 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: $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

1 mole $CaCO_3$ (100 g) $\rightarrow$ 1 mole CaO (56 g) + $CO_2$.

Residue (CaO) = 28 g.

Moles of CaO=28/56=0.5mol

Moles of $CaCO_3$=0.5 mol

Calculate Mass of $CaCO_3$ (S)=0.5 mol×100 g/mol=50 g

S=0.5 mol×100 g/mol=50 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=0.5×2=1 mole of B

13. What is the volume of oxygen required for complete combustion of 2 ml of ethene $(C_2H_4)$?

**Answer:6**

Solution: $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

1 volume $C_2H_4$ requires 3 volumes O2.

Volume of ethene ($C_2H_4$) = 2 mL.

Volume of $O_2$=3×2 mL=6 mL



**MATRIX MATCHING TYPE**

14.

| List - I | List - II (at STP) |
|---|---|
| A) $CH_3OH$ | 1) 0.224L $CO_2$ |
| B) $1.06\,g\,Na_2CO_3 \xrightarrow{Excess\,HCl}$ | 2) 4.48 L $CO_2$ |
| C) $2.4\,g\,C \xrightarrow[combustion]{Excess\,O_2}$ | 3) 0.448 L $CO_2$ |
| D) $0.56\,g\,CO \xrightarrow[combustion]{Excess\,O_2}$ | 4) 2.24 L $CO_2$ |
| | 5) 44.8L $CO_2$ |

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

Solution:A) $CH_3OH$

$$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$$

2 moles CH3OH (64 g) → 2 moles CO2 (44.8 L at STP).

B) $1.06\,g\,Na_2CO_3 \xrightarrow{\text{Excess HCl}}$

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

1 mole $Na_2CO_3$ (106 g) → 1 mole $CO_2$ (22.4 L at STP).
Given mass: 1.06 g $Na_2CO_3$ → Moles=1.06/106=0.01moles
$CO_2$ produced: 0.01 mol × 22.4 L/mol = 0.224 L.

C) $2.4\,g\,C \xrightarrow[\text{combustion}]{\text{Excess } O_2}$

$$C + O_2 \rightarrow CO_2$$

1 mole C (12 g) → 1 mole $CO_2$ (22.4 L at STP).
Given mass: 2.4 g C → Moles=2.4/12=0.2mol
$CO_2$ produced: 0.2 mol × 22.4 L/mol = 4.48 L.

D) $0.56\,g\,CO \xrightarrow[\text{combustion}]{\text{Excess } O_2}$

$$2CO + O_2 \rightarrow 2CO_2$$

2 moles CO (56 g) → 2 moles $CO_2$ (44.8 L at STP).
Given mass: 0.56 g CO → Moles =0.56/28=0.02mol
$CO_2$ produced: 0.02 mol CO → 0.02 mol $CO_2$ = 0.02 × 22.4 L = 0.448 L.



15.

| | **Column I** | | **Column II** |
|---|---|---|---|
| **1)** | $\underset{2\text{moles}}{A} + \underset{6\text{moles}}{3B} \rightarrow 2C + 4D$ | **(P)** | Limiting reagent is A |
| **2)** | $\underset{(16\text{moles})}{A} + \underset{10\text{moles}}{2B} \rightarrow \frac{4}{5}C + 5D$ | **(Q)** | Moles of C formed is 4 |
| **3)** | $\underset{10\text{moles}}{3A} + \underset{20\text{moles}}{B} \rightarrow C + \frac{2}{5}D$ | **(R)** | Moles of D formed is 8 |
| **4)** | $\underset{15\text{moles}}{4A} + \underset{25\text{moles}}{5B} \rightarrow 2C + 3D$ | **(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**

Solution: $\underset{2\text{moles}}{A} + \underset{6\text{moles}}{3B} \rightarrow 2C + 4D$

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

**2)** $\underset{(16moles)}{A} + \underset{10moles}{2B} \rightarrow \frac{4}{5}C + 5D$

1 mole of A react with 2 moles of B and produces 4/5molesof C and 5 moles of D

Given 16 moles of A,it requires 32 moles of B butgiven 10 moles only soB is limiting reagent.

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

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

**3)** $\underset{10moles}{3A} + \underset{20moles}{B} \rightarrow C + \frac{2}{5}D$

3 mole s of A react with 1 molesof B and produces 1 moleof C and 2/5 moles of D

Given 20 moles of B,it requires 60 moles of A butgiven 10 moles only soA is limiting reagent.

10 moles of Aproduces 10/3 moles of C

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

10 moles of A uses3.33 mles of B

Excess amount=6.666g of B



4) $\underset{15moles}{4A} + \underset{25moles}{5B} \rightarrow 2C + 3D$

4 mole s of A react with 5 molesof B and produces 2 moleof C and 3 moles of D

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

Excess reagent B=25-18.75=6.25g

15 molesof A produces 7.5 moles of C

15 molesof A  prouces 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 | | | | |