6.LAW OF CHEMICAL EQUATIONS

SOLUTIONS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1.In the reaction between 120 g of magnesium chloride and 110 g of silver nitrate, 180 g of silver chloride is produced along with ___ g of magnesium nitrate.

A) 50 g B) 60 g C) 70 g D) 80 g

Solution: $MgCl_2 + 2AgNO_3 \rightarrow 2AgCl + Mg(NO_3)_2$

1mole 2moles 2moles 1mole

Molecular Mass

$MgCl_2$=24+71=95

$AgNO_3$=108+14+3(16)=170

AgCl=108+35.5=143.5

$Mg(NO_3)_2$=24+2(14+3(16))=148

For 1mole $MgCl_2$=95 gms require 2 moles $AgNO_3$=340gms.But they gave 110gms of $AgNO_3$ .So $AgNO_3$ is limiting reagent.

For **2moles of** $AgNO_3$ **=340gms ,1mole of** $Mg(NO_3)_2$=148gms produced.

$AgNO_3$ $Mg(NO_3)_2$

340 gms $\rightarrow$ 148

110gms $\rightarrow$ x

$$x = \frac{110 \times 148}{340} \approx 47.8850$$

Answer:A

2.Zinc reacts with hydrochloric acid to form zinc chloride and hydrogen gas. When 65 g of zinc reacts with 73 g of HCl, but only 120 g of products are collected, the discrepancy is best explained by:

A) Incomplete reaction B) Hydrogen gas escaping

C) Impurities in reactants D) Instrument error

Answer:Balanced Reaction:

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Theoretical Mass Calculations:

Molar Masses:

Zn: 65 g/mol

HCl: 36.5 g/mol

ZnCl2: 136 g/mol

H2: 2 g/mol

Moles of Reactants:

Zn: 65g/65g/mol = 1 mole

HCl: 73g/36g/mol = 2 moles

Products Expected (100% Yield):

$ZnCl_2$: 1 mole × 136 g/mol = 136 g
H_2: 1 mole × 2 g/mol = 2 g
Total Mass of Products: (136 + 2 = 138 g)
Observed vs. Theoretical:
Collected Products: 120 g (18 g less than expected).
Reason: Hydrogen gas (H_2) is light and escapes easily, especially if not properly contained.

Answer:B

3.The reaction between 170 g of silver nitrate and 58.5 g of sodium chloride produces 143.5 g of silver chloride. What is the mass of sodium nitrate formed?
A) 85 g B) 95 g C) 105 g D) 115 g
Solution:1. Write the Balanced Chemical Equation:
$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
2. Calculate Moles of Reactants:
Molar Masses:
$AgNO_3$: (170 ,g/mol) (given in the problem as 170 g corresponds to 1 mole)
NaCl: (58.5g/mol)
AgCl: (143.5 g/mol)
$NaNO_3$: (85 g/mol)

Moles of $AgNO_3$: Moles= $\frac{170g}{170g/mol} = 1mole$

Moles of NaCl: Moles = $\frac{58.5g}{58.5g/mol} = 1mole$

3. Determine the Limiting Reactant:
The reaction has a 1:1 mole ratio, and both reactants are present in 1 mole each, so neither is limiting.
4. Calculate Moles of Products:
From the balanced equation:
1 mole of $AgNO_3$ and 1 mole of NaCl produce 1 mole of AgCl and 1 mole of $NaNO_3$.

Given that 143.5 g of AgCl is produced: Moles of AgCl= $\frac{143.5g}{143.5g/mol} = 1mole$

This confirms the reaction proceeds 100% as expected.

Mass of $NaNO_3$ formed: Mass} = 1 mole x 85 g/mol= 85 g

Answer:A

4.Heating 12.3 g of potassium chlorate produces 7.45 g of potassium chloride. What mass of oxygen gas is released?
A) 4.85 g B) 5.23 g C) 6.12 g D) 7.45 g
Solution: $2KClO_3 \rightarrow 2KCl + 3O_2\uparrow$
Molar Masses:
$KClO_3$: (39.1 + 35.5 + 3 (16) = 122.6 g/mol)
KCl: (39.1 + 35.5 = 74.6 g/mol)

O_2: (2 (16) = 32 g/mol)
For 2 moles $KClO_3$=245.2gms ,it requires 1 mole KCl=74.6gms
But given,$KClO_3$=12.3gms ,KCl=7.45
$KClO_3$ is less inquantity.So $KClO_3$ is called limiting re agent.
2 moles of $KClO_3$ produce 3 moles of O_2.

$KClO_3$ O_2
245.2gms $\rightarrow$ 96gms
12.3gms $\rightarrow x$

$$x = \frac{96 \times 12.3}{245.2} \quad 4.815$$

Answer:A

5.When 7 g of nitrogen reacts completely with 16 g of oxygen to form nitrogen dioxide, what is the total product mass?
A) 23 g B) 25 g C) 30 g D) 32 g

Solution: $N_2 + 2O_2 \rightarrow 2NO_2$

28g 64g 92g

Moles of N_2: Moles of N_2 $= \frac{7}{28}$ $0.25 moles$

Moles of O_2: Moles of $O_2 = \frac{16}{32}$ $0.5 moles$

3. Determine the Limiting Reactant:
The reaction requires 1 mole of N_2 and 2 moles of O2 to produce 2 moles of NO_2.
Here, the mole ratio is 0.25 N_2 : 0.5 O_2, which matches the stoichiometric ratio (1:2).
Neither reactant is limiting; both are fully consumed.
4. Calculate Moles of NO_2 Produced:
From the balanced equation:
Moles of NO_2 = 2 Moles of N_2 = 2 x 0.25 = 0.5 moles
5. Calculate Mass of NO2:
Mass of NO_2 = 0.5x 46 = 23 , g
Answer:A.

Law of Definite Proportions:

6.Which statement correctly describes the law of definite proportions?

A) Elements can combine in any ratio to form different compounds

B) A pure compound always contains elements in a fixed mass ratio

C) The total mass of products equals reactants in a chemical reaction

D) Atoms rearrange but are never created or destroyed

Solution:The law of definite proportions (Proust's law) states that:

A pure chemical compound is always composed of the same elements in a fixed and constant proportion by mass, regardless of its source or method of preparation.

Answer:B

7.In sulfur dioxide (SO_2), sulfur and oxygen always combine in a mass ratio of 32:32. If you have 64 g of sulfur, how much oxygen is required to form SO_2?

A) 32 g B) 64 g C) 96 g D) 128 g

Solution:The mass ratio of sulfur to oxygen in SO_2 is 32:32 (or simplified, 1:1).

This means 32 g of sulfur reacts with 32 g of oxygen to form 64 g of SO_2.

To form SO_2 with 64 g of sulfur, you need 64 g of oxygen

Answer:B

8.Pure methane (CH_4) contains 75% carbon and 25% hydrogen by mass. If you have 80 g of methane, what mass of hydrogen does it contain?

A) 20 g B) 40 g C) 60 g D) 80 g

Solution:Methane (CH4) is 75% carbon and 25% hydrogen by mass.

This means in 100 g of methane, there are 75 g of carbon and 25 g of hydrogen.

Methane		Hydrogen
100g	$\rightarrow$	25g
80g	$\rightarrow$	x

$x = \frac{25 \times 80}{100} = 20$ g of oxygen

Answer:A

9.Which pair demonstrates the law of definite proportions?

A) Two samples of NH_3 (ammonia) synthesized via different methods

B) Samples of NO and NO_2 (nitrogen oxides)

C) Mixtures of iron and sulfur powder

D) Oxygen gas and ozone (O_3)

Solution:The law of definite proportions states that a pure chemical compound always contains the same elements in a fixed mass ratio, regardless of its source or method of preparation.

Analysis of Options:

A) NH3 (Ammonia):

All samples of NH3 will always have a fixed mass ratio of nitrogen (N) to hydrogen (H) = 14:3 (or 82.4% N and 17.6% H by mass).

This holds true whether NH3 is made in a lab, extracted from nature, or synthesized via different reactions.

B) NO and NO2 (Nitrogen Oxides):

These are different compounds with different mass ratios (NO = 14:16, NO2 = 14:32). The law applies to a single compound, not comparisons between compounds.
C) Mixtures of Iron and Sulfur Powder:
A mixture (not a compound) has variable mass ratios (e.g., Fe + S can mix in any proportion).
D) O2 (Oxygen Gas) and O3 (Ozone):
These are allotropes (different forms of the same element), not compounds. The law applies to compounds only.
Only option A demonstrates the law because it involves one compound (NH3) with an invariable mass ratio of its elements.

Answer:A

10.Analysis shows that copper oxide (CuO) contains 79.9% copper and 20.1% oxygen by mass. If a sample contains 39.95 g of copper, what mass of oxygen is present?
A) 10.05 g B) 20.10 g C) 39.95 g D) 79.90 g
Solution:Copper oxide (CuO) composition by mass:
Copper (Cu): 79.9%
Oxygen (O): 20.1%
Mass of copper in the sample: 39.95 g
The mass ratio of Cu to O in CuO is: [Cu :O= 79.9 : 20.1]
This means that for every 79.9 g of copper, there are 20.1 g of oxygen.
Given 39.95 g of copper, we can find the corresponding mass of oxygen using the proportion

Mass of Oxygen= $39.95\,g \times \frac{20.1}{79.9} = 10.05\,g$

Answer:A

Law of Multiple Proportions:

11.Which statement best illustrates the law of multiple proportions?
A) Nitrogen and oxygen can form both NO and NO_2 with different mass ratios
B) Water always contains hydrogen and oxygen in a 1:8 mass ratio
C) Sodium chloride has identical composition regardless of source
D) Atoms of the same element have identical properties
Solution:The law of multiple proportions (Dalton's law) states that:
When two elements form more than one compound, the mass ratios of one element (relative to a fixed mass of the other) can be expressed as small whole numbers.
Example (Option A):
Nitrogen (N) and oxygen (O) form:
Nitric oxide (NO):
Mass ratio of N:O = 14:16 (simplifies to 7:8).
Nitrogen dioxide (NO_2):
Mass ratio of N:O = 14:32 (simplifies to 7:16).
The oxygen ratios for a fixed mass of nitrogen (7 g) are 8:16 (or 1:2), a simple whole-number ratio.
B) Illustrates the law of definite proportions (fixed ratio in one compound, H2O).
C) Demonstrates the law of definite proportions (pure NaCl has fixed composition).
D) Reflects Dalton's atomic theory, not multiple proportions.
Key Point:

The law of multiple proportions compounds (e.g., NO vs. NO2), not single compounds or elements.

Answer: A

12.Phosphorus forms two chlorides: PCl_3 and PCl_5. For the same mass of phosphorus, PCl_3 contains 106.5 g chlorine while PCl_5 contains 177.5 g chlorine. What is the ratio of chlorine masses?

A) 2:3 B) 3:5 C) 1:2 D) 2:5

Solution:To determine the ratio of chlorine masses in PCl_3 and PCl_5 for the same mass of phosphorus, follow these steps:

Given:

PCl_3 contains 106.5 g chlorine per fixed mass of phosphorus.

PCl_5 contains 177.5 g chlorine per the same fixed mass of phosphorus.

Step 1: Identify the Chlorine Mass Ratio

The ratio of chlorine masses in PCl_3 to PCl_5 is:

$$\text{Ratio} = \frac{Mass\,Of\,in\,PCl_3}{Mass\,Of\,Cl\,in\,PCl_5} = \frac{106.5g}{177.5}$$

Simplify the ratio by dividing both numbers by 35.5 (the atomic mass of chlorine):

$$\frac{106.5}{177.5} = \frac{106.5 \div 35.5}{177.5 \div 35.5} = \frac{3}{5}$$

Step 2: Verify Using Chemical Formulas

PCl_3 has 3 chlorine atoms per phosphorus atom.

PCl_5 has 5 chlorine atoms per phosphorus atom.

For the same mass of phosphorus, the ratio of chlorine masses should be 3:5.

Conclusion:The ratio of chlorine masses in PCl_3 to PCl_5 is 3:5, demonstrating the law of multiple proportions.

Answer:B

13.Copper forms two oxides:

$Cu_2O \rightarrow$ 127 g Cu + 16 g O

$CuO \rightarrow$ 63.5 g Cu + 16 g O

When copper mass changes from 63.5 g to 127 g in Cu_2O, how does oxygen mass compare to CuO?

A) Remains 16 g B) Doubles to 32 g C) Halves to 8 g D) Becomes 64 g

Solution:CuO (Copper(II) oxide):

63.5 g Cu combines with 16 g O.

Cu_2O (Copper(I) oxide):

127 g Cu combines with 16 g O.

Step 1: Observe the Copper-to-Oxygen Ratios

In CuO, the Cu:O mass ratio is 63.5:16 (or ~4:1).

In Cu_2O, the Cu:O mass ratio is 127:16 (or ~8:1).

Step 2: Compare Oxygen Mass for a Fixed Copper Mass

If we scale the copper mass in CuO from 63.5 g ? 127 g (i.e., double it), the oxygen mass would logically double to maintain the same Cu:O ratio (4:1).

Expected oxygen mass: (16 X 2 = 32 g).

However, in Cu_2O, 127 g Cu still combines with 16 g O (not 32 g).

Step 3: Key Insight (Law of Multiple Proportions)

The oxygen mass is halved relative to the expected doubling of copper mass.
Reason: Cu2O has 1 oxygen per 2 copper atoms, while CuO has 1 oxygen per 1 copper atom.
Thus, for the same mass of oxygen (16 g), Cu2O requires twice the copper mass compared to CuO.
Conclusion:When copper mass increases from 63.5 g (CuO) $\rightarrow$ 127 g (Cu2O), the oxygen mass remains 16 g (it does not double).

Answer:A

14.Iron combines with sulfur to form FeS and Fe_2S_3. For the same mass of iron, sulfur masses are 32 g and 48 g respectively. What is the simplest mass ratio?
A) 1:2 B) 2:3 C) 3:4 D) 1:3
Solution:To determine the simplest mass ratio of sulfur in FeS and Fe2S3 for the same mass of iron, follow these steps:
Given Data:FeS (Iron(II) sulfide):
For a fixed mass of iron, 32 g of sulfur combines.
Fe_2S_3 (Iron(III) sulfide):
For the same mass of iron, 48 g of sulfur combines.
Step 1: Calculate the Sulfur Mass Ratio
The ratio of sulfur masses in FeS to Fe_2S_3 is:

$$\text{Ratio} = \frac{Mass\,of\,Sin\,FeSg}{Mass\,Of\,Sin\,Fe_2S_3g} = \frac{32}{48} =$$

Step 2: Simplify the Ratio
Divide both numbers by 16 (the greatest common divisor of 32 and 48):

$$\frac{32 \div 16}{48 \div 16} =$$

Step 3: Verify Using Chemical Formulas
In FeS, the Fe:S molar ratio is 1:1.
In Fe2S3, the Fe:S molar ratio is 2:3 (or 1:1.5 per iron atom).
For the same mass of iron, the sulfur mass ratio should match the molar ratio per iron atom:

$$\frac{1}{1.5} =$$

Conclusion:The simplest mass ratio of sulfur in FeS to Fe2S3 is 2:3, demonstrating the law of multiple proportions.

Answer:B

15.Which pair exemplifies the law of multiple proportions?
A) CO and CO_2 B) HCl and H_2SO_4 C) NH_3 and CH_4 D) Na_2O and NaOH
Solution:The law of multiple proportions states that when two elements form more than one compound, the masses of one element that combine with a fixed mass of the other are in a simple whole-number ratio.
Example (Option A): CO and CO_2
Carbon Monoxide (CO):

Mass ratio of C:O = 12:16 (simplifies to 3:4).
Carbon Dioxide (CO_2):
Mass ratio of C:O = 12:32 (simplifies to 3:8).
Ratio of Oxygen Masses (for fixed carbon mass = 12 g):
In CO: 16 g O
In CO2: 32 g O
Ratio = 16:32 = 1:2 (a simple whole-number ratio).
Answer:A
Law of Reciprocal Proportions:
16. Which of the following best defines the Law of Reciprocal Proportions?
A) Elements that combine with a common element do so in ratios that are simple when they combine with each other.
B) Elements always react in whole-number volume ratios.
C) The total mass of reactants equals the total mass of products.
D) The mass ratio in a compound is always different
Solution:The Law of Reciprocal Proportions helps predict how two elements will combine based on their interactions with a common third element.
Answer:A
17. Nitrogen combines with hydrogen to form NH3, and with chlorine to form NCl3. Hydrogen and chlorine also form HCl. According to the law, the mass ratio in HCl is related to:
A) How nitrogen combines with hydrogen and chlorine.
B) The atomic mass of chlorine only.
C) The bond strength of HCl.
D) The volume of gases involved.
Solution: The Law of Reciprocal Proportions, which states:
"If element A combines separately with elements B and C, the ratio in which B and C combine with each other is either the same or a simple multiple of the ratio in which they combine with A."
In this case:
Nitrogen (N) combines with hydrogen (H) to form NH_3.
Nitrogen (N) also combines with chlorine (Cl) to form NCl_3.
Hydrogen (H) and chlorine (Cl) combine to form HCl.
According to the Law of Reciprocal Proportions, the mass ratio of H:Cl in HCl is related to how both H and Cl combine with nitrogen, hence option A is correct.
Answer:A
18. Given: 3g N + 1g H $\rightarrow$ NH_3 3g N + 106.5g Cl $\rightarrow$ NCl_3 What mass ratio will hydrogen and chlorine combine in, according to the law?
A) 1 : 106.5 B) 1 : 35.5 C) 1 : 3 D) 35.5 : 1
Solution:Given:
3g N + 1g H $\rightarrow$ NH_3
3g N + 106.5g Cl $\rightarrow$ NCl_3
Now, both hydrogen and chlorine combine with the same mass of nitrogen (3g).
According to the Law of Reciprocal Proportions, the masses of H and Cl that combine with the same mass of nitrogen (here, 3g) will also combine with each other in the same ratio or a simple multiple.
So we look at:

1g of H
106.5g of Cl
Therefore, the mass ratio in which hydrogen and chlorine will combine with each other (i.e., in HCl) is:
H : Cl = 1 : 106.5
Answer:A
19.. Magnesium reacts with chlorine to form $MgCl_2$ and with oxygen to form MgO. Chlorine and oxygen also form Cl_2O_7. According to the Law of Reciprocal Proportions, the ratio of chlorine to oxygen in Cl_2O_7 is related to:
A) How magnesium reacts with chlorine and oxygen.
B) How chlorine reacts with hydrogen.
C) Their molar volumes.
D) The melting points of the compounds.
Solution:This law states that when two elements (e.g., chlorine and oxygen) combine with a common third element (e.g., magnesium), the ratio in which they combine with each other (in Cl2O7) will be a simple whole-number multiple of the ratios in which they combined with the common element.
Step-by-Step Application:
Magnesium + Chlorine →MgCl2
Mass ratio of Mg:Cl = 24:71 (since 1 Mg [24 g] combines with 2 Cl [2 × 35.5 = 71 g]).
Magnesium + Oxygen → MgO
Mass ratio of Mg:O = 24:16 (since 1 Mg [24 g] combines with 1 O [16 g]).
Ratio of Cl:O when combined with Mg:
For fixed mass of Mg (24 g):
Cl mass = 71 g, O mass = 16 g.
Thus, Cl:O ratio = 71:16 (when combined separately with Mg).
Reciprocal Proportion in Cl_2O_7:
In Cl_2O_7, the mass ratio of Cl:O = (2 × 35.5):(7 × 16) = 71:112 = 71:112 (simplifies to 71:112 or ~1:1.58).
This ratio is a simple multiple (1:1.58 ˜ 71:112) of the individual ratios with magnesium (71:16).
Answer:A
20. Given: 4g Mg + 2g O □ MgO 4g Mg + 71g Cl ?□$MgCl_2$ What mass ratio will oxygen and chlorine combine in?
A) 1 : 71 B) 2 : 71 C) 71 : 2 D) 1 : 35.5
Solution:The masses of oxygen and chlorine that combine with the same amount of magnesium (4g) will also combine with each other in the same ratio or a simple multiple.
So we take:
Oxygen = 2g
Chlorine = 71g
O : Cl= 2 : 71
Answer:B
Mixed Complex Questions:
21. Which set of laws explains:
Water always contains H:O in 1:8 mass ratio
Nitrogen forms both NO (1:1.14) and NO2 (1:2.28) with oxygen

These ratios show simple whole-number relationships?
A) Only conservation of mass B) Definite and multiple proportions
C) Only reciprocal proportions D) Avogadro's law
Solution:"Water always contains H:O in 1:8 mass ratio" →This illustrates the Law of Definite Proportions
A given compound always contains the same elements in a fixed mass ratio.
"Nitrogen forms both NO (1:1.14) and NO2 (1:2.28)" → This illustrates the Law of Multiple Proportions
When one element combines with another in more than one way, the masses of one element that combine with a fixed mass of the other are in simple whole-number ratios. (Here, 2.28 / 1.14 = 2 → a simple whole number)
Answer:B
22.Analysis shows:
• Iron oxide A: 70g Fe + 30g O
• Iron oxide B: 56g Fe + 48g O
When iron mass is fixed at 56g in both, the oxygen masses become 24g and 48g.
Which law explains this 1:2 ratio?
A) Conservation of mass B) Definite proportions
C) Multiple proportions D) Gay-Lussac's law
Solution: Law of Multiple Proportions:
When one element (iron) combines with another (oxygen) in more than one way, the masses of the second element (oxygen) that combine with a fixed mass of the first are in a simple whole-number ratio (here, 1:2).
Answer:C
23.Consider:
Carbon forms CH_4 (75% C) and C_2H_6 (80% C)
For fixed carbon mass, hydrogen ratios are 4:3
These obey both definite and multiple proportions
Which statement is correct?
A) Only statement 1 demonstrates definite proportions
B) Statements 1 and 2 together prove multiple proportions
C) Statement 3 is false as these are different laws
D) All statements correctly interrelate the laws
Solution:Statement 1:
CH_4 is 75% C, C_2H_6 is 80% C ? Each compound has a fixed mass ratio of carbon to hydrogen. →This illustrates the Law of Definite Proportions:
A given compound always contains the same elements in the same mass ratio.
Statement 2:
For fixed carbon mass, H ratio is 4:3 → CH_4 and C_2H_6, when adjusted to the same carbon mass, show that hydrogen combines in a simple ratio (4:3). →This illustrates the Law of Multiple Proportions:
When the same two elements form more than one compound, the masses of one element that combine with a fixed mass of the other are in a simple whole-number ratio.
Statement 3:
These obey both definite and multiple proportions → True — each individual compound obeys definite proportions, and the comparison between them obeys

multiple proportions.
Answer: D

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

24. In a closed container, which of the following follow the law of conservation of mass?
A) Iron reacts with sulfur to form iron sulfide with no change in total mass.
B) Magnesium burns in air, and total mass of system including products equals the reactants.
C) Zinc reacts with hydrochloric acid and hydrogen gas escapes, leading to loss in measured mass.
D) Copper sulfate solution reacts with barium chloride to form a precipitate, but total mass remains unchanged.
Solution:A) Iron + Sulfur $\rightarrow$ Iron Sulfide (FeS)
Closed system: No mass is lost or gained.
Mass conservation: The total mass of iron and sulfur equals the mass of iron sulfide formed.
B) Magnesium Burns in Air (Forms MgO)
Closed system (including air):
The mass of magnesium + oxygen consumed = mass of magnesium oxide formed.
Total mass remains constant if the container is sealed.
D) Copper Sulfate + Barium Chloride $\rightarrow$ Precipitate (BaSO4)
Closed system:
The reaction forms a solid precipitate (BaSO4) and dissolved CuCl2.
Total mass is conserved because no matter escapes.
Why Not C?
C) Zinc + HCl $\rightarrow$Hydrogen Gas Escapes:
Open system: If the container is not sealed, H2 gas escapes, leading to a measured mass loss.
Mass is conserved only in a closed system (where gas cannot escape).
Answer:A,B,D

25.Which of the following support the law of definite proportions?
A) Pure carbon dioxide from respiration and combustion always has a carbon-to-oxygen mass ratio of 12:32.
B) Ammonia from a lab synthesis and from decay both contain nitrogen and hydrogen in the same ratio by mass.
C) Different samples of iron oxide have varying Fe:O mass ratios.
D) Sulfur dioxide and sulfur trioxide show different sulfur-to-oxygen ratios.
Solution:The correct answers are A) and B), as they both support the law of definite proportions, which states that a pure chemical compound always contains the same elements in a fixed mass ratio, regardless of its source or method of preparation.
Explanation:
A) Carbon Dioxide (CO2) from Respiration vs. Combustion
CO2 always has a fixed mass ratio of C:O = 12:32 (or 3:8).
Whether from burning carbon or human respiration, the ratio remains constant.
Supports the law.

B) Ammonia (NH_3) from Lab Synthesis vs. Decay
NH3 always has a fixed mass ratio of N:H = 14:3.
Whether synthesized in a lab or produced by organic decay, the ratio is identical.
Supports the law.
Answer:A,B
26.Which findings are in agreement with the law of multiple proportions?
A) 28 g of nitrogen reacts with 32 g of oxygen to form NO.
B) 28 g of nitrogen reacts with 64 g of oxygen to form NO_2.
C) The mass of oxygen combining with a fixed mass of nitrogen doubles between NO and NO_2.
D) Nitrogen triiodide and ammonia both show different nitrogen-to-halogen ratios, but not in simple ratios.
Solution:This law applies: When two elements form more than one compound, masses of one element that combine with fixed mass of the other are in simple whole-number ratios.
A) 28 N + 32 O $\rightarrow$ NO
B) 28 N + 64 O $\rightarrow$ NO_2
Oxygen doubled for same N
C) The O mass doubles from NO to NO_2 $\rightarrow$ ratio = 1:2
Answer:A,B,C
27. In which cases do the results reflect the law of multiple proportions? (Advanced, subtle twist) (Select all that apply)
A) Tin forms SnO and SnO_2, with oxygen combining in a simple 1:2 mass ratio for the same mass of tin.
B) Phosphorus forms PCl_3 and PCl_5, showing a simple mass ratio of chlorine for the same mass of phosphorus.
C) Hydrogen forms HCl and HBr with different halogens, showing different ratios not involving the same second element.
D) Calcium combines with fluorine in CaF_2 and with oxygen in CaO, showing different element combinations with no common second element.
Solution:A) Tin forms SnO and SnO2, with oxygen combining in a simple 1:2 mass ratio for the same mass of tin. $\rightarrow$Correct
Tin is the same element in both compounds.
Oxygen mass varies in a 1:2 ratio $\rightarrow$ this is a textbook case of the law of multiple proportions.
B) Phosphorus forms PCl3 and PCl5, showing a simple mass ratio of chlorine for the same mass of phosphorus. $\rightarrow$Correct
Phosphorus is fixed, and chlorine varies (3 atoms vs 5 atoms).
Masses of chlorine are in a simple whole-number ratio (3:5).
Another clear example of multiple proportions.
C) Hydrogen forms HCl and HBr with different halogens, showing different ratios not involving the same second element. $\rightarrow$ Incorrect
HCl and HBr involve different second elements (Cl and Br).
The law of multiple proportions requires the same two elements forming multiple compounds.
This case falls outside the scope of the law.

D) Calcium combines with fluorine in CaF2 and with oxygen in CaO, showing different element combinations with no common second element. → Incorrect

Answer:A,B

Assertion and Reason Type:

28. Assertion: According to the law of reciprocal proportions, carbon and sulfur, which both combine with oxygen, should combine with each other in a mass ratio related to their separate combinations with oxygen.

Reason: The law of reciprocal proportions states that if two elements combine separately with a fixed mass of a third element, their ratio in the compound formed between them should be the same or a simple multiple.

Solution:Law of Reciprocal Proportions law states:

If two elements (A and B) combine separately with a fixed mass of a third element (C), the ratio in which A and B combine with each other will be the same or a simple multiple of the ratios in which they combined with C.

2. Application to Carbon (C) and Sulfur (S) Combining with Oxygen (O)

Carbon + Oxygen → CO_2

Mass ratio: C:O = 12:32 = 3:8.

Sulfur + Oxygen → SO2

Mass ratio: S:O = 32:32 = 1:1.

3. Predicting the C:S Ratio in Carbon Disulfide (CS_2)

For a fixed mass of oxygen (32 g):

Carbon combines as 12 g C : 32 g O (CO_2).

Sulfur combines as 32 g S : 32 g O (SO_2).

Thus, the C:S ratio when they combine directly (CS2) should be a simple multiple of their individual ratios with oxygen.

Observed in CS_2:

Mass ratio C:S = 12:64 = 3:16.

This is consistent with the reciprocal proportion of their oxygen reactions (3:8 vs. 1:1).

The Reason correctly describes the law, and the Assertion applies it to C and S combining via their O reactions.

The C:S ratio in CS2 (3:16) is derived from their individual O ratios (3:8 and 1:1), fulfilling the law.

Answer:A

29.Assertion: According to the law of reciprocal proportions, nitrogen and chlorine, which both combine with hydrogen (in NH3 and HCl), should combine with each other in a mass ratio related to their separate combinations with hydrogen.

Reason: The law of reciprocal proportions fails when one of the elements (like nitrogen) forms multiple compounds with the third element (hydrogen).

Solution:Assertion:

"According to the law of reciprocal proportions, nitrogen and chlorine, which both combine with hydrogen (in NH3 and HCl), should combine with each other in a mass ratio related to their separate combinations with hydrogen." → True — This is a correct interpretation of the Law of Reciprocal Proportions.

When two elements (N and Cl) separately combine with a third element (H), then the mass ratio in which they combine with each other (to form NCl_3, for example) is

related to the mass ratios in which they each combine with the third (H).
Reason:
"The law of reciprocal proportions fails when one of the elements (like nitrogen) forms multiple compounds with the third element (hydrogen)." ? False — The law still holds. Even if nitrogen forms multiple compounds with hydrogen (e.g., NH_3, N_2H_4, etc.), the law applies as long as fixed, known compounds are used for comparison.
It doesn't fail — it just means you must use a specific compound (like NH_3) in your mass ratio comparison.
Answer:C
Comprehension Type:
30. According to the law of conservation of mass, what happens to the total mass during a chemical reaction?
A) The total mass increases. B) The total mass decreases.
C) The total mass remains the same.
D) The total mass may increase or decrease depending on the reaction.
Solution:The law of conservation of mass (Lavoisier's law) states that:
In a closed system (where no matter enters or escapes), the total mass of reactants equals the total mass of products.
Answer:C
31.In a closed chemical reaction, if 10 g of hydrogen reacts with 64 g of oxygen to form water, what will be the total mass of the products formed?
A) 54 g B) 64 g C) 74 g D) 10 g
Solution: Law of Conservation of Mass, which states:
"Mass can neither be created nor destroyed in a chemical reaction." The total mass of the products equals the total mass of the reactants.

Given:
Hydrogen = 10 g
Oxygen = 64 g
Total mass of reactants = 10 g + 64 g = 74 g
Therefore, total mass of products (water) = 74 g
Answer:C
Integer Type:
32.Molecular weight of Sodium Chloride (NaCl) is _____.
Solution:Sodium (Na): 23 g/mol
Chlorine (Cl): 35.5 g/mol
Molecular weight of NaCl=23+35.5=58.5
Answer:58.5
33.Molecular weight of Ferric Sulfate $[Fe_2(SO_4)_3]$ is _____.
Solution:Fe=56g/mol,S=32g/mol,O=16g/mol
Molecular weight of $[Fe_2(SO_4)_3]$=2(56)+3(32+4(16))=400
Answer:400
Matrix Matching Type:
34. (A) Law of Conservation of Mass (i) CO (12:16) and CO2 (12:32) show oxygen in a 1:2 ratio.

(B) Law of Definite Proportion (ii) In H2O, hydrogen and oxygen always combine in a 1:8 mass ratio.

(C) Law of Multiple Proportions (iii) Burning 10g of methane produces 10g of CO2 + H2O (mass conserved).

(D) Law of Reciprocal Proportion (iv) H2O (H:O=1:8) and CH4 (C:H=3:1) follow cross-combination rules.

Solution:Law of Conservation of Mass (A $\rightarrow$ iii)

Total mass remains constant in a closed system.

Example: Burning methane (CH4) produces CO2 + H2O, but the total mass of reactants = total mass of products (if no gas escapes).

Law of Definite Proportions (B $\rightarrow$ ii)

A pure compound has a fixed mass ratio of its elements.

Example: Water (H_2O) always has a 1:8 mass ratio of H:O, regardless of its source.

Law of Multiple Proportions (C $\rightarrow$ i)

When two elements form multiple compounds, the mass ratios are simple whole numbers.

Example: CO (12:16) and CO_2 (12:32) show oxygen in a 1:2 ratio for the same mass of carbon.

Law of Reciprocal Proportions (D $\rightarrow$ iv)

If two elements (H and C) combine separately with a third element (O), their direct combination ratio (CH_4) relates to their oxygen ratios (H_2O).

Example:

H_2O (H:O = 1:8)

CO_2 (C:O = 3:8)

Thus, CH_4 (C:H = 3:1) follows a simple reciprocal proportion.

Answer:A $\rightarrow$ (iii),B $\rightarrow$ (ii),C $\rightarrow$ (i),D $\rightarrow$ (iv)

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1.What is the molecular mass of SO_2 (S = 32, O = 16)?

A) 48 amu B) 64 amu C) 80 amu D) 96 amu

Solution:Molecular mass of SO_2=32+2(16)=64amu

Answer:B

2.Why must chemical equations be balanced?

A) To satisfy the Law of Multiple Proportions

B) To obey the Law of Conservation of Mass

C) To change the products formed

D) To increase reaction speed

Solution:Chemical equations must be balanced to ensure that the number of atoms of each element is the same on both sides (reactants and products). This is a direct application of the Law of Conservation of Mass, which states:

Mass cannot be created or destroyed in a chemical reaction

Answer:B

3.What is the molecular mass of $C_6H_{12}O_6$ (glucose)? (C = 12, H = 1, O = 16)

A) 168 amu B) 180 amu C) 192 amu D) 204 amu

Solution:Molecular mass of $C_6H_{12}O_6$ =6(12)+12(1)+6(16)=180amu

Answer:B

4.When balancing Fe + $O_2 \rightarrow Fe_2O_3$, which element is balanced first?

A) Iron (Fe) B) Oxygen (O_2) C) Both simultaneously D) The heavier element

Solution:Balance the most complex element first (usually the one in a polyatomic ion or molecule, like O_2).

Answer:B

5.How many hydrogen (H) atoms are present after balancing: $H_2 + O_2 \rightarrow H_2O$?

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

Solution: $2H_2 + O_2 \rightarrow 2H_2O$

Total H atoms on either side: 4

Answer:B

6.What is the molecular mass of $Al_2(SO_4)_3$ (Al = 27, S = 32, O = 16)?

A) 242 amu B) 278 amu C) 342 amu D) 400 amu

Solution:The molecular mass of $Al_2(SO_4)_3$ =2(27)+3(32+4(16))=342

Answer:C

7.In $2Mg + O_2 \rightarrow 2MgO$, which is a reactant?

A) Only Mg B) Only O_2 C) Both Mg and O_2 D) Only MgO

Solution:Reactants are the substances before the arrow ($\rightarrow$). Here:

Magnesium (Mg),Oxygen gas (O_2)

Product is the substance after the arrow:Magnesium oxide (MgO)

Answer:C

8.How many oxygen atoms are present after balancing: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$?

A) 5 B) 10 C) 15 D) 20

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

Oxygen Atoms After Balancing:

Reactants: 5(2) = 10 $\rightarrow$O atoms.

Products:3(2)+4=10 $\rightarrow$O atoms.

Answer:B

9.The molecular mass of $CaCO_3$ (Ca = 40, C = 12, O = 16) is:

A) 68 amu B) 84 amu C) 100 amu D) 116 amu

Solution:The molecular mass of $CaCO_3$=40+12+3(16)=100amu

Answer:C

10.What is the coefficient of O_2 when $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$ is balanced?

A) 3 B) 5 C) 7 D) 9

Solution:Balanced Equation, $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

The coefficient of $O_2$is 7.

Answer:C

JEE MAINS LEVEL QUESTIONS

Single Answer Type:

11. Sulfur burns in oxygen to form sulfur dioxide (SO_2). If 16 g of sulfur reacts with 16 g of oxygen, what is the mass of SO_2 produced?

A) 16 g B) 32 g C) 48 g D) 64 g

Solution: Law of Conservation of Mass, which states:

The total mass of the reactants equals the total mass of the products.

Given:Sulfur (S) = 16 g ,Oxygen (O2) = 16 g

Total mass of reactants:16+16=32g

the mass of SO2 produced must also be 32g

Answer:B

12.Aluminum reacts with oxygen to form aluminum oxide (Al_2O_3). If 27 g of Al reacts with 24 g of O_2, what is the mass of Al_2O_3 formed? (Al = 27, O = 16)

A) 51 g B) 75 g C) 102 g D) 150 g

Solution:Mass of reactants = Mass of products

Given:Aluminum (Al) = 27 g ,Oxygen (O2) = 24 g

Total mass of reactants:27+24=51g

Mass of aluminum oxide (Al_2O_3) formed is also 51g.

Answer:A

13.Sodium carbonate reacts with hydrochloric acid to produce sodium chloride, water, and CO_2 gas. If 53 g of Na_2CO_3 reacts completely and 22 g of CO_2 escapes, what is the mass of the remaining products?

A) 31 g B) 53 g C) 75 g D) 97 g

Solution:

Law of Conservation of Mass:Total mass of products = Total mass of reactants

Given:

Mass of sodium carbonate (Na_2CO_3) = 53 g

Mass of CO_2 gas that escapes = 22 g

We are asked to find the mass of the remaining products (i.e., NaCl + H2O).

Step 1: Total mass of products = mass of reactants

Total products = 53g

Step 2: Remaining products = Total products - CO2

Remaining products = 53g- 22g = 31g

Answer: A

14.Ethane (C_2H_6) burns in oxygen to form CO_2 and H_2O. If 30 g of ethane reacts with 112 g of O_2, what is the total mass of products formed? (C = 12, H = 1, O = 16)

A) 142 g B) 158 g C) 172 g D) 186 g

Solution: Law of Conservation of Mass question:Mass of reactants = Mass of products

Given:Ethane (C_2H_6) = 30 g , Oxygen (O_2) = 112 g

Total mass of reactants:30g + 112g= 142g

Since no mass is lost during the reaction (only converted into CO2 and H2O), the total mass of products is:142g.

Answer:A

15. Iron reacts with copper sulfate ($CuSO_4$) to form iron sulfate ($FeSO_4$) and copper. If 56 g of Fe reacts with 160 g of $CuSO_4$, but only 152 g of $FeSO_4$ is collected, what

explains the missing mass?
A) Some $CuSO_4$ was unreacted. B) Copper metal was not weighed.
C) $FeSO_4$ decomposed. D) Mass conservation was violated
Solution:$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
Masses:Iron (Fe) = 56 g
Copper sulfate ($CuSO_4$) = 160 g
Iron(II) sulfate ($FeSO_4$) collected = 152 g
Total mass of reactants = 56 g + 160 g = 216 g
Total recorded mass of products = only 152 g ($FeSO_4$)
So, missing mass = 216 g - 152 g = 64 g
What else is formed in the reaction? ? Copper metal (Cu)
This 64 g is the mass of copper that was formed but not included in the weighed products.
Answer: B

Law of Definite Proportions:
16. Carbon dioxide (CO_2) always contains carbon and oxygen in a 3:8 mass ratio. If a sample contains 6 g of carbon, how much oxygen is present?
A) 10 g B) 12 g C) 16 g D) 24 g
Solution:The mass ratio of carbon to oxygen in CO_2 is 3:8.
The sample contains 6 g of carbon.
The ratio 3:8 means:
For every 3 grams of carbon, there are 8 grams of oxygen in CO_2.
We can set up a proportion to find the amount of oxygen ((x)) when 6 g of carbon is present: $\frac{3gC}{8gO} = \frac{6gC}{xgO}$

Solve for (x)
Cross-multiply and solve:
[3x = 8 x 6]
[3x = 48]
x = 48/3 = 16 g O
Step 4: Verify the Answer
If 3 g C corresponds to 8 g O, then doubling the carbon (6 g C) should double the oxygen (16 g O), which matches our calculation.
Answer:C
17. Two samples of methane (CH_4) are analyzed:
Sample 1: 12 g carbon + 4 g hydrogen.
Sample 2: 24 g carbon + 8 g hydrogen.
This confirms the:
A) Law of Multiple Proportions B) Law of Definite Proportions
C) Law of Conservation of Mass D) Avogadro's Law
Solution:Sample 1:Carbon = 12 g,Hydrogen = 4 g $\rightarrow$ Mass ratio of C:H = 12:4 = 3:1
Sample 2:Carbon = 24 g , Hydrogen = 8 g $\rightarrow$ Mass ratio of C:H = 24:8 = 3:1
Both samples have the same ratio of carbon to hydrogen, regardless of the amount.
This is the essence of the:

Law of Definite Proportions A chemical compound always contains the same elements in the same fixed proportion by mass.

Answer:B

18. Glucose ($C_6H_{12}O_6$) has a fixed composition of 40% carbon, 6.7% hydrogen, and 53.3% oxygen by mass. How much hydrogen is present in 180 g of glucose?

A) 6.7 g B) 12 g C) 72 g D) 96 g

Solution:Carbon (C): 40%,Hydrogen (H): 6.7%,Oxygen (O): 53.3%

Step 1: Calculate the mass of hydrogen

Since glucose is 6.7% hydrogen by mass, the amount of hydrogen in 180 g of glucose is:

Mass of hydrogen= 6.7% x 180 g

Mass of hydrogen = 0.067 x 180 g

Mass of hydrogen = 12.06 g

Step 2: Match with the options

Answer:B

19. When 100 g of magnesium carbonate ($MgCO_3$) decomposes, it produces 40 g of magnesium oxide (MgO) and X g of CO_2. The mass of CO_2 released confirms that $MgCO_3$ always decomposes in a fixed ratio, illustrating the:

A) Law of Definite Proportions B) Law of Multiple Proportions

C) Gay-Lussac's Law D) Dalton's Law

Solution:The decomposition reaction is:

$MgCO_3 \rightarrow MgO + CO_2$

Given:Mass of $MgCO_3$ = 100 g , Mass of MgO = 40 g

Mass of CO_2 = X

From Law of Conservation of Mass:

X = 100g- 40g = 60g

Concept:

This decomposition always results in the same fixed mass ratio between MgO and CO_2, regardless of how much $MgCO_3$ is used. That fixed composition supports the: Law of Definite Proportions A compound always contains the same elements in the same proportion by mass.

Answer:A

20. A geologist analyzes two samples of hematite (Fe_2O_3):

Sample 1: 70 g iron + 30 g oxygen.

Sample 2: 140 g iron + 60 g oxygen.

This data supports the:

A) Law of Definite Proportions B) Law of Reciprocal Proportions

C) Pauli's Exclusion Principle D) Le Chatelier's Principle

Solution:Both samples of Fe2O3 have the same fixed mass ratio of iron to oxygen. This is a direct illustration of the:

Law of Definite Proportions A compound always contains the same elements in the same proportion by mass.

Answer:A

Law of Multiple Proportions:

21. Carbon forms two oxides:

CO (12g C + 16g O)
CO_2 (12g C + 32g O)
The ratio of oxygen masses combining with 12g carbon is:
A) 1:1 B) 1:2 C) 2:3 D) 3:4
Solution:CO:12 g Carbon + 16 g Oxygen
CO_2: 12 g Carbon + 32 g Oxygen
Oxygen mass ratio (for same amount of carbon):
CO : CO_2 = 16 : 32 = 1 : 2
Answer:B
22. Which pair of compounds demonstrates the Law of Multiple Proportions?
A) H_2O (2g H + 16g O) and D_2O (4g D + 16g O)
B) SO_2 (32g S + 32g O) and SO3 (32g S + 48g O)
C) NH_3 (14g N + 3g H) and PH_3 (31g P + 3g H)
D) CH_4 (12g C + 4g H) and C_2H_6 (24g C + 6g H)
Solution:A) H2O vs D2O
These differ by isotopes (Hydrogen vs Deuterium), not elements or ratios.
Not applicable. $\rightarrow$ Reject
B) SO2 (32g S + 32g O)
SO3 (32g S + 48g O)
Fixed sulfur mass: 32 g
Oxygen masses: 32 g and 48 g $\rightarrow$Ratio: 32:48 = 2:3 (simple whole number ratio)
$\rightarrow$Correct – Demonstrates the Law of Multiple Proportions
C) NH_3 vs PH_3
Different elements (N vs P). Not the same two elements combining in multiple ways.
$\rightarrow$Reject
D) CH_4 vs C_2H_6
Not same mass of carbon: 12 g vs 24 g
Also not showing mass of one element combining with fixed mass of the other. $\rightarrow$ Reject
Answer:B
23. Sulfur forms two chlorides:
SCl_2 (32g S + 71g Cl)
SCl_4 (32g S + 142g Cl)
The ratio of chlorine masses per 32g sulfur is:
A) 1:1.5 B) 1:2 C) 2:3 D) 3:4
Solution:You are given the mass of chlorine that combines with 32 g of sulfur in two compounds:
SCl_2: 32 g S + 71 g Cl
SCl_4: 32 g S + 142 g Cl
Now calculate the ratio of chlorine masses:
Ratio of Cl in SCl_2 to Cl in SCl_4=71:142=1:2
Answer:B
24. A chemist analyzes two iron oxides:
FeO (56g Fe + 16g O)
Fe_2O_3 (112g Fe + 48g O)
For the same mass of iron (56g), the oxygen mass ratio is:
A) 1:1 B) 1:1.5 C) 1:2 D) 2:3

Solution:We are comparing two iron oxides and determining how much oxygen combines with the same mass of iron (56 g).
FeO: 56 g Fe + 16 g O
Fe2O3: 112 g Fe + 48 g O $\rightarrow$So,for 56 g Fe (half of 112 g), oxygen would be:
48/2 = 24 g O
Now compare oxygen masses:
FeO: 16 g O
Fe2O3 (scaled to 56 g Fe): 24 g O
Ratio = 16 : 24 = 2:3 = 1 : 1.5
Answer: B,D
25. Phosphorus forms two oxides:
P_4O_6 (124g P + 96g O)
P_4O_{10} (124g P + 160g O)
The ratio of oxygen masses per 124g phosphorus is:
A) 2:3 B) 3:5 C) 4:7 D) 5:8
Solution:P_4O_6:124 g phosphorus (P), 96 g oxygen (O)
P_4O_{10}:124 g phosphorus (P),160 g oxygen (O)
The ratio of oxygen masses per 124 g of phosphorus, which is directly given:
For P_4O_6, oxygen mass = 96 g
For P_4O_{10}, oxygen mass = 160 g
Ratio=96:160=3:5
Answer:B

Law of Reciprocal Proportions:
26. Nitrogen combines with hydrogen (NH_3) and with chlorine (NCl_3). According to the law of reciprocal proportions, chlorine and hydrogen will combine in a mass ratio related to:
A) How they combine with nitrogen B) Their atomic numbers
C) Their boiling points D) Their densities
Solution:Nitrogen (A) combines with:
Hydrogen (B) $\rightarrow$ forms NH_3
Chlorine (C) $\rightarrow$ forms NCl_3
Therefore, hydrogen and chlorine (B and C) will combine in a mass ratio that relates to how each combines with nitrogen.
This is the essence of the Law of Reciprocal Proportions.
Answer:A
27. Given:
1 g of nitrogen combines with 3 g of hydrogen (NH3)
1 g of nitrogen combines with 35.5 g of chlorine (NCl3)
What is the mass ratio in which hydrogen and chlorine will combine according to the law of reciprocal proportions?
A) 3:35.5 B) 1:1 C) 35.5:3 D) 2:1
Solution:1 g of nitrogen combines with:3 g of hydrogen (in NH_3),35.5 g of chlorine (in NCl_3)

Hydrogen : Chlorine= 3 : 35.5

Answer:A

28. Magnesium forms compounds with oxygen (MgO) and chlorine ($MgCl_2$). According to the law of reciprocal proportions, oxygen and chlorine will combine:

A) In a mass ratio linked to how they bond with magnesium

B) Based on their electronegativities C) In equal moles only D) Independently of their combination with magnesium

Solution:Magnesium forms:

MgO (with oxygen)

$MgCl_2$ (with chlorine)

According to the law of Reciprocal Proportions, the ratio in which oxygen and chlorine combine (such as in a compound like Cl_2O_7) will relate to how each of them combines with magnesium.

Answer:A

29. Given:

1 g of magnesium reacts with 0.66 g of oxygen (MgO)

1 g of magnesium reacts with 2.37 g of chlorine ($MgCl_2$)

Using the law of reciprocal proportions, what is the expected ratio of oxygen to chlorine by mass when they combine?

A) 0.66:2.37 B) 1:1 C) 2.37:0.66 D) 1:3.5

Solution:1 g of Mg reacts with:

0.66 g of oxygen (MgO)

2.37 g of chlorine ($MgCl_2$)

According to the law, oxygen and chlorine will combine in the mass ratio:

Oxygen : Chlorine = 0.66 : 2.37

This is the expected ratio in which O and Cl would combine with each other (e.g., in compounds like Cl_2O_7), reflecting the law.

Answer:A

30.Calcium forms compounds with fluorine (CaF_2) and with bromine ($CaBr_2$). Bromine and fluorine also form BrF3. According to the law of reciprocal proportions, what is true about the mass ratio in which fluorine and bromine combine?

A) It relates to how calcium combines with fluorine and bromine

B) It is fixed by the periodic table

C) It changes with temperature only

D) It is independent of other reactions

Solution:The Law of Reciprocal Proportions states that when two elements (fluorine and bromine in this case) combine with a third element (calcium) separately, the ratio in which they combine with each other (in BrF3) will be related to their combining ratios with calcium.

In CaF_2, calcium combines with fluorine in a fixed mass ratio

In $CaBr_2$, calcium combines with bromine in a fixed mass ratio

Therefore, when F and Br combine (in BrF3), their mass ratio should relate to these calcium compound ratios

This demonstrates that the F:Br combining ratio in BrF3 is determined by their individual combinations with calcium, not by periodic table positions (B), temperature (C), or being independent (D). The law specifically connects these ratios through

their common combination with calcium.

Answer:A

Mixed Challenge Questions:

31. When 9 g of aluminum (Al) reacts completely with 8 g of oxygen (O_2) to form aluminum oxide (Al_2O_3), what is the mass of the product formed?

A) 17 g B) 25 g C) 34 g D) 42 g

Solution:Mass of aluminum (Al) = 9 g

Mass of oxygen (O2) = 8 g

Total mass of reactants = 9 g + 8 g = 17 g

So, the mass of aluminum oxide (Al_2O_3) formed = 17 g

Answer:A

32. Copper forms two chlorides:

CuCl (63.5g Cu + 35.5g Cl)

$CuCl_2$ (63.5g Cu + 71g Cl)

The ratio of chlorine masses combining with 63.5g copper is:

A) 1:1 B) 1:2 C) 2:3 D) 3:4

Solution:We are given two compounds of copper and chlorine:

CuCl: 63.5 g Cu + 35.5 g Cl

$CuCl_2$: 63.5 g Cu + 71 g Cl

Let's compare the masses of chlorine that combine with the same mass of copper (63.5 g):

Ratio of chlorine} = 35.5 : 71 = 1 : 2

Answer:B

33.When 100 g of calcium carbonate ($CaCO_3$) decomposes into 56 g of calcium oxide (CaO) and 44 g of CO_2, this illustrates the:

A) Law of Definite Proportions B) Law of Multiple Proportions

C) Law of Reciprocal Proportions D) Avogadro's Law

Solution:When calcium carbonate ($CaCO_3$) decomposes, it always produces calcium oxide (CaO) and carbon dioxide (CO_2) in the same fixed mass ratio.

Given:

100 g CaCO3 decomposes into

56 g CaO + 44 g CO2

This fixed composition illustrates the Law of Definite Proportions, which states:

A chemical compound always contains the same elements in the same fixed proportion by mass.

Answer:A

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

34. Which experimental observations support the Law of Conservation of Mass?

A) Dissolving common salt (NaCl) in water does not change the total mass.

B) Heating calcium carbonate ($CaCO_3$) to form calcium oxide (CaO) and CO_2 shows mass is conserved if gases are not allowed to escape.

C) Electrolysis of water shows mass of hydrogen and oxygen collected equals the

mass of water decomposed.
D) Evaporation of alcohol increases the mass of the container.
Solution:Law of Conservation of Mass states: Mass is neither created nor destroyed in a chemical reaction.
A) Dissolving NaCl in water does not change total mass → Mass stays the same before and after dissolving, so this supports conservation of mass.
B) Heating $CaCO_3$ to CaO and CO_2 shows mass is conserved if gases do not escape → If CO_2 gas is contained, total mass remains constant, illustrating the law.
C) Electrolysis of water shows mass of H_2 and O_2 collected equals mass of water decomposed → The total mass of products equals the reactants, confirming conservation.
D) Evaporation of alcohol increases the mass of the container (wrong) → Evaporation usually causes mass loss, not an increase. This contradicts conservation if not considering the system boundaries properly.
Answer:A,B,C
35. Which statements correctly represent the significance of the Law of Definite Proportions?
A) The compound H_2O always contains hydrogen and oxygen in a 1:8 mass ratio, regardless of its source.
B) The compound $CuSO_4$ always contains copper, sulfur, and oxygen in the same ratio by mass.
C) The ratio of nitrogen to oxygen in NO_2 and N_2O_5 is always the same.
D) Pure sodium chloride (NaCl) from different sources always has sodium and chlorine in the same mass ratio
Solution:A) H_2O always contains hydrogen and oxygen in 1:8 mass ratio → This perfectly illustrates the law.
B) $CuSO_4$ always contains copper, sulfur, and oxygen in the same mass ratio → True, as the composition of a pure compound is fixed.
C) The ratio of nitrogen to oxygen in NO_2 and N_2O_5 is always the same →This is false because NO_2 and N_2O_5 are different compounds with different nitrogen:oxygen ratios — this relates more to the Law of Multiple Proportions, not definite proportions.
D) Pure NaCl from different sources has the same sodium-to-chlorine mass ratio → Yes, composition is fixed regardless of source
Answer:A,B,D
36. Which of the following pairs of compounds illustrate the Law of Multiple Proportions?
A) CH_4 and C_2H_6 (methane and ethane)
B) FeO and Fe_2O_3 (iron(II) oxide and iron(III) oxide)
C) H_2O and H_2O_2 (water and hydrogen peroxide)
D) $CaCl_2$ and $CaCO_3$ (calcium chloride and calcium carbonate)
Solution:A) CH_4 and C_2H_6: Same elements (C & H) in different whole-number ratios.
B) FeO and Fe_2O_3: Same elements (Fe & O) in different whole-number ratios.
C) H_2O and H_2O_2: Same elements (H & O) in 1:8 and 1:16 O:H ratios → fits Multiple Proportions.

D) $CaCl_2$ and $CaCO_3$: Not same set of elements (one has Cl, the other has C and O) $\rightarrow$ not applicable.

Answer: A,B ,C

Assertion and Reason Type:

37.Assertion (A): Carbon, which combines with both hydrogen and oxygen, can help predict the ratio in which hydrogen and oxygen combine to form water (H_2O).

Reason (R): The Law of Reciprocal Proportions applies to elements that form compounds with a common third element, regardless of their metallic or nonmetallic nature.

Solution:Assertion (A): Carbon forms compounds with hydrogen (e.g., CH4) and with oxygen (e.g., CO_2). According to the Law of Reciprocal Proportions, hydrogen and oxygen will combine with each other (in H2O) in a ratio that reflects how each combines with carbon. $\rightarrow$ So, true.

Reason (R): The Law of Reciprocal Proportions states: If element A combines with B and also with C, then B and C will combine in a mass ratio that is either the same or a simple multiple of the ratio in which they combine with A. This law applies regardless of whether the elements are metals or nonmetals. So, true and directly explains the assertion.

Answer:A

Comprehension Type:

38.In a chemical equation, the substances written on the left-hand side of the arrow are:

A) Products B) Reactants C) Catalysts D) By-products

Solution:In a chemical equation, the substances written on the left-hand side of the arrow are called Reactants

Answer:B

39.What does the arrow ($\longrightarrow$) in a chemical equation represent?

A) Separation of mixtures B) Equality of mass

C) Direction of the chemical reaction D) Balance between reactants and products

Solution:The arrow ($\longrightarrow$) in a chemical equation represent , Direction of the chemical reaction

Answer:C

Integer Type:

40. Na_2CO_3 + _? _HNO_3 $\longrightarrow$ $2NaNO_3 + H_2O + CO_2$

Find the coefficient (integer) of HNO_3 required to balance the chemical equation.

Solution:Balanced Equation: $Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$

$x = 2$

Answer:2

41.Matrix Matching Type:

41.

Column A (Laws)	Column B (Descriptions)
A) Law of Conservation of Mass	1)Nitrogen forms NO (14:16 mass ratio) and NO_2 (14:32 mass ratio), showing a 1:2 oxygen ratio for fixed nitrogen mass.
B) Law of Definite Proportions	2)When 2g hydrogen reacts with 16g oxygen, exactly 18g water is formed.
C) Law of Multiple Proportions	3)In H_2O, hydrogen and oxygen always combine in a 1:8 mass ratio, whether from rain or a lab.
D) Law of Reciprocal Proportions	4)Carbon's ratios with oxygen (CO_2 = 12:32) and hydrogen (CH_4 = 12:4) predict H_2O's 1:8 ratio when H and O combine.

A) A-2, B-3, C-1, D-4 B) A-1, B-2, C-3, D-4
C) A-3, B-1, C-4, D-2 D) A-4, B-3, C-2, D-1

Solution:

A)Law of Conservation of mass---->2)When 2g of hydrogen reacts wih 16g of oxygen,exactly 18g of water formed
B)Law of definite proportion------->3)In H_2O,hydrogen and oxygen combined in the ratio of 1:8,wether from rain or lab
C)Law ofmultiple proportions----> 1)nitrogen forms NO (14:16) and NO2(14:32), showing a 1:2 oygen ratio for nitrogen mass
D)Law of reciprocal proportion--->4)Carbon ratio with oxygen(CO2=12:32)and hydrogen(CH4=12:4) predict H2O's 1:8 ratio when H and O combines

Answer:A

KEY

					TEACHING TASK				
1	2	3	4	5	6	7	8	9	10
A	B	A	A	A	B	B	A	A	A
11	12	13	14	15	16	17	18	19	20
A	B	A	B	A	A	A	A	A	B
21	22	23	24	25	26	27	28	29	30
B	C	D	A,B,D	A,B	A,B,C	A,B	A	C	C
31	32	33	34						
C	58.5	400	A-iii,B-ii,C-I,D-iv						
					LEARNERS TASK				
1	2	3	4	5	6	7	8	9	10
B	B	B	B	B	C	C	B	C	C
11	12	13	14	15	16	17	18	19	20
B	A	A	A	B	C	B	B	A	A
21	22	23	24	25	26	27	28	29	30
B	B	B	B	B,D	A	A	A	A	A
31	32	33	34	35	36	37	38	39	40
A	B	A	A,B,C	A,B,D	A,B,C	A	B	C	2
41									
A									