AIM

To verify the law of conservation of mass in a chemical reaction,

MATERIALS AND APPARATUS REQUIRED

Barium chloride ($BaCl_2.2H_2O$), sodium sulphate ($Na_2SO_4.10H_2O$), distilled water, two beakers (100 ml), one beaker (150 ml), physical balance, spring balance (0-500 g), polythene bag, two watch glasses and a glass rod.

THEORY

1. According to the law of conservation of mass, during a physical or chemical change, the total mass of the products remains equal to the total mass of the reactants.
2. It is also referred to as the law of indestructibility of matter, i.e., the matter is neither created nor destroyed in a chemical reaction.
3. For example, when calcium carbonate is heated, calcium oxide and carbon dioxide are formed.

Reactant **Products**

$$\underset{\substack{\text{Calcium carbonate}\\ 100g}}{CaCO_3} \xrightarrow{\text{Heat}} \underset{\substack{\text{Calcium oxide}\\ 56g}}{CaO} + \underset{\substack{\text{Carbon dioxide}\\ 44g}}{CO_2}$$

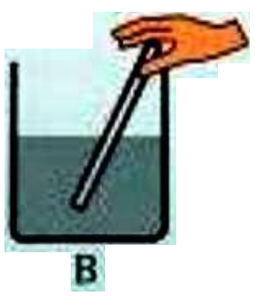
Hence, total mass of reactants is equal to total mass of products.

PROCEDURE

1. Pour 50 ml distilled water into two 100 ml beakers.
2. Using the physical balance, weigh two watch glasses.
3. Weigh 3.6 g of $BaCl_2.2H_2O$ in a watch glass of known mass and dissolve it in a beaker containing 50 ml distilled water and label it 'A' .
4. Similarly, weigh 8.05 g of $Na_2SO_4.10H_2O$ in another watch glass of known mass and dissolve it in the other beaker containing 50 ml distilled water. Label it 'B' .
5. Weigh the 150 ml beaker using spring balance and polythene. Label it 'C' .
6. Mix solutions of beakers 'A' and 'B' together in beaker 'C' . Mix the contents using a glass rod.
7. A white precipitate due to the formation of barium sulphate ($BaSO_4$) appears in beaker 'C' .
8. Weigh the beaker containing the reaction mixture again to find out the mass of products formed.
9. Compare the masses of the contents before and after the reaction.

A

Solution of $BaCl_2$



B

Solution of Na_2SO_4

C

$BaCl2(aq) + Na_2SO_4$

OBSERVATIONS

1. Mass of 50 ml distilled water (assuming density as 1g /cc) = 50.0 g
2. Mass of $BaCl_2.H_2O$ = 3.6 g
3. Mass of $BaCl_2$ solution = 53.6 g
4. Mass of $Na_2SO_4.10H_2O$ = 8.05 g
5. Mass of Na_2SO_4 solution =58.05 g
6. Total mass of reactants (solutions of $BaCl_2$ and Na_2SO_4) = 53.6 + 58.05 = 111.65 g
7. Mass of empty 150 ml beaker, m_1 = ... g
8. Mass of reaction mixture before precipitation, $m_2 = m_1 + 111.65$ g = ... g
9. The final mass of the reaction mixture after precipitation, m_3 = ... g

RESULT

1. On comparing the mass of reactants (m_2) with the mass of products (m_3), we find m_2 equals m_3 (Within reasonable limits).
2. The reaction involved is,

$$\underset{\text{Colourless}}{BaCl_2(aq)} + \underset{\text{Colourless}}{Na_2SO_4(aq)} \longrightarrow \underset{\text{White precipitate}}{BaSO_4(s)} + 2NaCl(aq)$$

The ionic equation is,

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow \underset{\text{White precipitate}}{BaSO_4(s)}$$

According to the law of conservation of mass, Mass of reactants (barium chloride + sodium sulphate) = Mass of products (barium sulphate + sodium chloride).

PRECAUTIONS

1. Accurate measurement of masses should be ensured.
2. The spring balance should be held vertically while taking measurements.
3. Before taking a reading, ensure the pointer of the spring balance is at the zero mark.
4. The reading of spring balance should be noted when its pointer comes to rest.
5. Use a small number of chemicals.
6. Mix solutions of $BaCl_2$ and Na_2SO_4 slowly with constant stirring.

VIVA VOCE

Q1. What is the aim of your experiment?

Ans. To prove the law of conservation of mass.

Q2. What is the law of conservation of mass?

Ans. Law of conservation of mass means that during a chemical reaction, the mass of reactants and products remains the same.

Q3. In this experiment, instead of $BaCl_2$ can you use $CaCl_2$? Why?

Ans. Yes, $CaCl_2$ can also be used, because, on reaction with Na_2SO_4, a white precipitate of $CaSO_4$ will be formed.

Q4. Give the equation involved using $Cacl_2$ and Na_2SO_4.

Ans. $CaCl_2(aq) + Na_2SO_4(aq) \longrightarrow \underset{\text{White precipitate}}{CaSO_4(s)} + 2NaCl(aq)$

Q5. Can any other barium salt be used to carry out the reaction?

Ans. Yes, any other soluble barium salt can be used in the reaction.

Q6. Explain why it is so?

Ans. Basically, this reaction can be represented as:

$Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$

Since the reaction is between Ba^{2+} and SO_4^{2-} ions, therefore, any other soluble barium salt can be used for the reaction.

Q7. What type of a reaction is this?

Ans. It is a double displacement, precipitation reaction.

Q8. 9.80 g of ClO_3 on heating produces 3.84 g of oxygen and the residue KCl left behind weighs 5.92 g. Show that the result illustrates the law of conservation of mass.

Ans. Mass of reactant (m_1) = 9.80 g

Mass of product (m_2) = 3.84+5.92 =9.76 g

Difference m_2 - m_1 = 0.04 g which may be an experimental error

Q9. Can a combination reaction also be used to prove the law of conservation of mass?

Ans. Yes

Q10. Does the law of conservation of mass hold good for nuclear reactions?

Ans. No, it holds good only for chemical reactions.

Q11. Who gave the law of conservation of mass?

Ans. The French chemist Antoine Lavoisier gave the law of conservation of mass.

Q12. In nuclear reactions, why does the law of conservation of mass not hold good?

Ans. Because in nuclear reactions, mass is converted into energy according to the Einstein equation $E = mc^2$.

Q13. What are the other precipitation reactions that can be conveniently studied in the laboratory to verify this law?

Ans. Other precipitation reactions which can prove this law is a reaction between NaCl (aq) and $AgNO_3$ (aq)

as per the following equation:

$$NaCl(aq) + AgNO_3(aq) \longrightarrow \underset{\text{White ppt.}}{AgCl(s)} + NaNO_3(aq)$$

The ionic equation,

$$Ag^+(aq) + Cl^-(aq) \longrightarrow \underset{\text{White ppt.}}{AgCl(s)}$$

Q14. Which of the following reactions best illustrates the law of conservation of mass?

Ans. This option is the most perfect example of the conservation of mass.

Q15. The law of conservation of mass was formulated by:

Ans. Antoine Lavoisier's 1789 discovery that mass is neither created nor destroyed in chemical reactions.