Atom Economy and Percentage Yield

1. In a reaction between magnesium and hydrochloric acid, it was calculated that 2.5g of magnesium chloride could be produced. The actual yield of magnesium chloride produced was 1.5g. Calculate the percentage yield of the reaction.

Percentage yield = _____ %

2. Write the balanced symbol equation for the reaction between magnesium and hydrochloric acid.

3. In a reaction between calcium oxide and water, it is calculated that 27g of calcium hydroxide will be produced. The actual yield of calcium hydroxide produced is 13g. Calculate the percentage yield of the reaction.

Percentage yield = _____ %

4. Write the balanced symbol equation for the reaction between calcium oxide (CaO) and water (H_2O) to produce calcium hydroxide ($Ca(OH)_2$).

5. Ammonia can be made in two different ways. Ammonia (NH_3) can be made by reacting calcium oxide (CaO) and ammonium chloride (NH_4Cl) or by reacting hydrogen and nitrogen.

a. Write the balanced symbol equation for the reaction between calcium oxide and ammonium chloride to produce calcium chloride, water and ammonia.

b. Calculate the atom economy for the reaction.

Atom economy = _____ %

c. Write the balanced symbol equation for the reaction between hydrogen and nitrogen to produce ammonia.

d. Calculate the atom economy for the reaction.

Atom economy = _____ %

6. The fermentation of glucose produces ethanol and carbon dioxide. Carbon dioxide is a waste product.

a. Balance the symbol equation for the reaction.

$$\_\_\_\_ C_6H_{12}O_6 \longrightarrow \_\_\_\_ C_2H_5OH + \_\_\_\_ CO_2$$

b. Calculate the atom economy for the reaction.

Atom economy = _____ %

Atom Economy and Percentage Yield Answers

1. In a reaction between magnesium and hydrochloric acid, it was calculated that 2.5g of magnesium chloride could be produced. The actual yield of magnesium chloride produced was 1.5g. Calculate the percentage yield of the reaction.

$$\textbf{percentage yield} = \frac{\textbf{actual mass of product}}{\textbf{theoretical mass of product}} \times 100$$

$$\textbf{percentage yield} = \frac{1.5}{2.5} = 0.6$$

percentage yield = 0.6 × 100 = 60%

2. Write the balanced symbol equation for the reaction between magnesium and hydrochloric acid.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

3. In a reaction between calcium oxide and water, it is calculated that 27g of calcium hydroxide will be produced. The actual yield of calcium hydroxide produced is 13g. Calculate the percentage yield of the reaction.

$$\textbf{percentage yield} = \frac{\textbf{actual mass of product}}{\textbf{theoretical mass of product}} \times 100$$

$$\textbf{percentage yield} = \frac{13}{27} = 0.48$$

percentage yield = 0.48 × 100 = 48%

4. Write the balanced symbol equation for the reaction between calcium oxide (CaO) and water (H_2O) to produce calcium hydroxide ($Ca(OH)_2$).

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

5. Ammonia can be made in two different ways. Ammonia (NH_3) can be made by reacting calcium oxide (CaO) and ammonium chloride (NH_4Cl) or by reacting hydrogen and nitrogen.

a. Write the balanced symbol equation for the reaction between calcium oxide and ammonium chloride to produce calcium chloride, water and ammonia.

$$CaO + 2NH_4Cl \longrightarrow CaCl_2 + H_2O + 2NH_3$$

b. Calculate the atom economy for the reaction.

The desired product in this reaction is ammonia.

M_r of ammonia (NH_3) = 14 + (1 × 3) = 17

M_r of 2 moles of ammonia = 2 × 17 = 34

Reactants	CaO	$2NH_4Cl$
M_r	40 + 16 = 56	2(14 + (1 × 4) + 35.5) = 107

Total M_r of all reactants = 56 + 107 = 163

$$\textbf{percentage yield} = \frac{\textbf{total } M_r \textbf{ of the desired product}}{\textbf{total } M_r \textbf{ of all reactants}} \times 100$$

$$\textbf{percentage yield} = \frac{34}{163} \times 100 = 20.86\%$$

c. Write the balanced symbol equation for the reaction between hydrogen and nitrogen to produce ammonia.

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

d. Calculate the atom economy for the reaction.

M_r of ammonia (NH_3) = 14 + (1 × 3) = 17

M_r of 2 moles of ammonia = 2 × 17 = 34

Reactants	$3H_2$	N_2
M_r	3 × 2 = 6	14 × 2 = 28

Total M_r of all reactants = 6 + 28 = 34

$$\textbf{atom economy} = \frac{\textbf{total } M_r \textbf{ of the desired product}}{\textbf{total } M_r \textbf{ of all reactants}} \times 100$$

$$\textbf{atom economy} = \frac{34}{34} \times 100 = 100\%$$

6. The fermentation of glucose produces ethanol and carbon dioxide. Carbon dioxide is a waste product.

a. Balance the symbol equation for the reaction.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

b. Calculate the atom economy for the reaction.

M_r of ethanol (C_2H_5OH) = (12 × 2) + (1 × 5) + 16 + 1 = 46

M_r of 2 moles of ethanol = 2 × 46 = 92

M_r of glucose ($C_6H_{12}O_6$) = (12 × 6) + (1 × 12) + (16 × 6) = 180

$$\textbf{atom economy} = \frac{\textbf{total } M_r \textbf{ of the desired product}}{\textbf{total } M_r \textbf{ of all reactants}} \times 100$$

$$\textbf{atom economy} = \frac{92}{100} \times 100 = 51.1\%$$