



Atom Economy and Percentage Yield

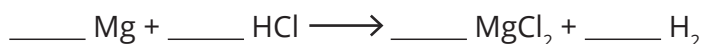
Percentage Yield

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

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. Balance the 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 = _____ %

Atom Economy

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

Worked example

Hydrogen is produced when methane and water react together.



Calculate the atom economy of the reaction.

Step 1 – Calculate the M_r of the desired product. In this case the desired product is hydrogen. From the balanced symbol equation, we know that 3 moles of hydrogen are produced.

$$M_r \text{ of hydrogen (H}_2\text{)} = 1 \times 2 = 2$$

$$M_r \text{ of 3 moles of hydrogen} = 3 \times 2 = 6$$

Step 2 – Calculate the M_r of all the reactants.

Reactants	CH_4	H_2O
M_r	$12 + (1 \times 4) = 16$	$(1 \times 2) + 16 = 18$

$$\text{Total } M_r \text{ of all reactants} = 16 + 18 = 34$$

Step 3 – Using the equation, calculate the percentage atom economy for the reaction.

$$\text{Atom economy} = \frac{6}{34} = 0.176$$

$$0.176 \times 100 = 17.6 \%$$

Using the worked example to help you answer the questions below.

4. Ammonia can be made in two different ways. Ammonia can be made by reacting calcium oxide and ammonium chloride or by reacting hydrogen and nitrogen.
- a. Balance the 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.

Step 1 – Calculate the M_r of the desired product.

Step 2 – Calculate the M_r of all the reactants.

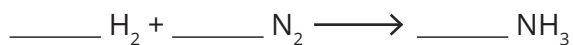
Reactants	CaO	$\text{___ NH}_4\text{Cl}$
M_r		

$$\text{Total } M_r \text{ of all reactants} = \text{_____}$$

**Step 3 – Using the equation, calculate the percentage atom economy for the reaction.**

Atom economy = _____ %

- c. Balance the symbol equation for the reaction between hydrogen and nitrogen to produce ammonia.



- d. Calculate the atom economy for the reaction.

Step 1 – Calculate the M_r of the desired product.

Step 2 – Calculate the M_r of all the reactants.

Reactants	_____ H ₂	N ₂
M_r		

Total M_r of all reactants = _____**Step 3 – Using the equation, calculate the percentage atom economy for the reaction.**

Atom economy = _____ %



Atom Economy and Percentage Yield Answers

Percentage Yield

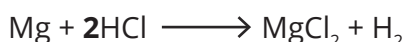
1. In a reaction between magnesium and hydrochloric acid, it was calculated that 2.5g of magnesium chloride could be produced. The actual yield of magnesium chloride produced was 1.5g. Calculate the percentage yield of the reaction.

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

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

$$\text{percentage yield} = 0.6 \times 100 = 60\%$$

2. Balance the 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.

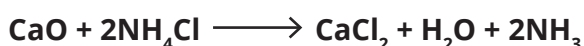
$$\text{percentage yield} = \frac{\text{actual mass of product}}{\text{theoretical mass of product}} \times 100$$

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

$$\text{percentage yield} = 0.48 \times 100 = 48\%$$

Atom Economy

4. Ammonia can be made in two different ways. Ammonia can be made by reacting calcium oxide and ammonium chloride or by reacting hydrogen and nitrogen.
- a. Balance the 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.

Step 1 – Calculate the M_r of the desired product.

$$M_r \text{ of ammonia (NH}_3\text{)} = 14 + (1 \times 3) = 17$$

$$M_r \text{ of 2 moles of ammonia} = 2 \times 17 = 34$$

Step 2 – Calculate the M_r of all the reactants.

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

$$\text{Total } M_r \text{ of all reactants} = 56 + 107 = 163$$

Step 3 - Using the equation, calculate the percentage atom economy for the reaction.

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

$$\text{atom economy} = \frac{34}{163} \times 100 = 20.86\%$$

- c. Balance the symbol equation for the reaction between hydrogen and nitrogen to produce ammonia.



- d. Calculate the atom economy for the reaction.

Step 1 - Calculate the M_r of the desired product.

$$M_r \text{ of ammonia (NH}_3\text{)} = 14 + (1 \times 3) = 17$$

$$M_r \text{ of 2 moles of ammonia} = 2 \times 17 = 34$$

Step 2 - Calculate the M_r of all the reactants.

Reactants	3H_2	N_2
M_r	$3 \times 2 = 6$	$14 \times 2 = 28$

$$\text{Total } M_r \text{ of all reactants} = 6 + 28 = 34$$

Step 3 - Using the equation, calculate the percentage atom economy for the reaction.

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

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