

Core Formula: The mean rate of reaction is calculated using the formula:

$$\text{Rate} = \frac{\text{Quantity of reactant used or product formed}}{\text{Time}}$$

This formula can be rearranged to find other variables:

$$\text{Quantity} = \text{Rate} \times \text{Time} \quad \text{and} \quad \text{Time} = \frac{\text{Quantity}}{\text{Rate}}$$

Units:

- **Rate:** g/s, cm³/s, or mol/s
- **Quantity:** g (grams), cm³ (cubic centimetres), or mol (moles)
- **Time:** s (seconds)

Section A: Understanding the Formula & Units

1. Complete the table below with the correct SI unit and common units used for each variable in rate calculations.

Variable	Common Units
Rate	_____
Quantity	_____
Time	_____

2. Write down the two rearranged forms of the mean rate of reaction formula:

- a) Quantity of reactant used or product formed = _____
- b) Time = _____

3. Perform the following unit conversions:

- a) 3.5 minutes = _____ seconds
- b) 250 cm³ = _____ dm³
- c) The relative formula mass (M_r) of calcium carbonate (CaCO₃) (M_r Ca=40.1, C=12.0, O=16.0) = _____
- d) How many moles are in 22 g of carbon dioxide (CO₂)? (M_r CO₂=44.0) = _____ mol
- e) What is the mass of 0.15 mol of magnesium oxide (MgO)? (M_r MgO=40.3) = _____ g

Section B: Practice Calculations

1. A reaction produces 45.0 g of a solid product in 150 seconds. Calculate the mean rate of reaction in g/s.

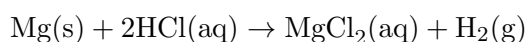
2. During a decomposition reaction, 360 cm³ of gas is collected over a period of 2 minutes. Calculate the mean rate of reaction in cm³/s.

3. A chemical process has a mean rate of 0.25 mol/s. How many moles of product would be formed after 5 minutes?

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4. A student wants to produce 1200 cm^3 of hydrogen gas. If the reaction proceeds at a mean rate of $4.0 \text{ cm}^3/\text{s}$, how long will it take to produce the required volume of gas? Give your answer in seconds and minutes.
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Section C: Challenge Context

1. Magnesium reacts with hydrochloric acid to produce hydrogen gas:



In an experiment, 0.24 g of magnesium ribbon completely reacted in 80 seconds. Calculate the mean rate of hydrogen gas production in mol/s. (Relative atomic mass: $\text{Mg} = 24.3$)

2. A student investigates the rate of reaction between calcium carbonate chips and dilute hydrochloric acid by measuring the mass loss over time. The reaction produces carbon dioxide gas, which escapes through cotton wool placed in the neck of the flask (see Figure 1).

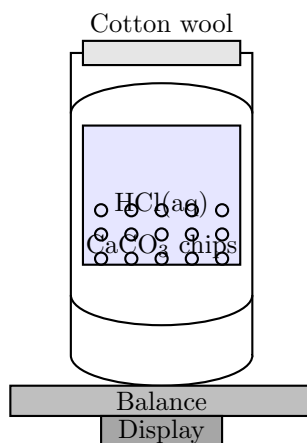


Figure 1: Setup for measuring mass loss during a reaction.

The initial mass of the flask and its contents was 185.50 g. After 3 minutes, the mass had decreased to 183.94 g. Calculate the mean rate of carbon dioxide (CO_2) production in:

- a) g/s
b) mol/s ($M_r \text{ CO}_2 = 44.0$)
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