

Exercise walk-through

16.1

Rates, catalysts and reliable endpoints

International Baccalaureate · IB Diploma · Chemistry · SL

16.1 Rates, catalysts and reliable endpoints

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS rate • activation energy

Objective

Rates, catalysts and reliable endpoints. Supported SL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

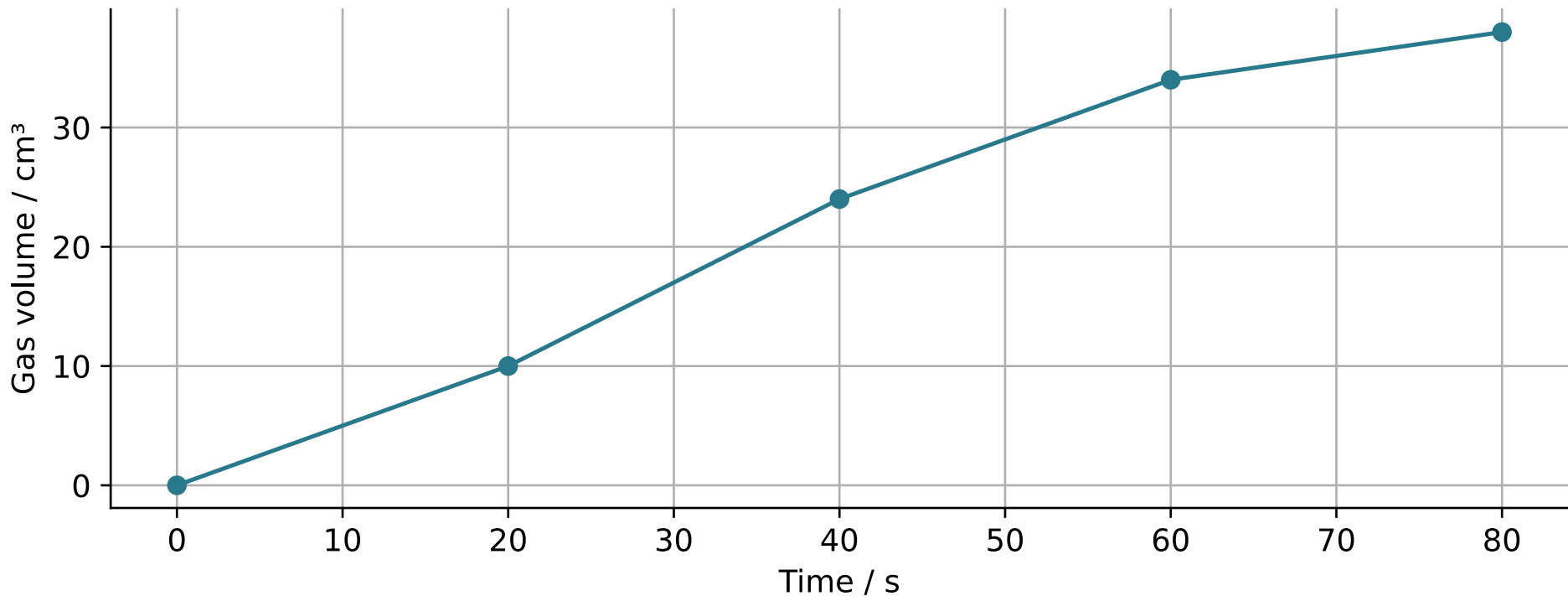
■ What would explain this observation?

- A faster reaction finishes sooner, but it need not make more product. **Rate** and final yield answer different questions.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Reaction rate describes reactant used or product formed per time. Higher temperature increases the fraction of collisions with enough energy. A catalyst provides an alternative pathway with lower **activation energy** .

- activation energy: The energy barrier for a reaction pathway; rate: Change in a measured quantity per unit time.



■ **Choose evidence that can test it**

- A product-time graph has a steeper gradient where rate is larger. A tangent estimates instantaneous rate; a secant gives average rate over an interval. The final plateau reflects the total collected product under the stated conditions.
- For gas production, check apparatus for leaks, start timing consistently and record volume at regular intervals. Keep concentration, reactant amount and surface area controlled when changing temperature.

■ **Work from known quantities**

- State the known values and their units. Choose the relation because its assumptions

fit this case, then rearrange before substitution.

- Known: gas volume increases from 10 to 34 cubic centimetres between 20 and 60 s. Average rate = change in volume/change in time. Rate = $(34 - 10)/(60 - 20) = 0.60$ cubic centimetres per second. This is not necessarily the instantaneous rate at 40 s.

Example:

A reaction makes 24 cubic centimetres of gas in 40 s. Find average rate. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- A catalyst does not change the equilibrium constant at a fixed temperature. A mass-

loss method cannot detect all reactions, and losing gas through a leak biases a collection experiment.

- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A faster reaction always produces a larger final amount of product. This claim is false: A catalyst does not change the equilibrium constant at a fixed temperature. A mass-loss method cannot detect all reactions, and losing gas through a leak biases a collection experiment.

Key:

Rates, catalysts and reliable endpoints: A product-time graph has a steeper gradient where rate is larger. A tangent estimates instantaneous rate; a secant gives average rate

over an interval. The final plateau reflects the total collected product under the stated conditions.

Exercises 2.1·2.2

2.1 Two reactions reach the same final gas volume. Which can still differ? Choose one answer.

- **A** Their rates
- **B** The balanced equation must be different
- **C** The product must have different molar mass

[1]

2.2 A reaction makes 24 cubic centimetres of gas in 40 s. Find average rate. Show the relation, substitution and units.

[2]

Exercises 2.1·2.2

2.1 Two reactions reach the same final gas volume. Which can still differ? Choose one answer.

- **A** Their rates
- **B** The balanced equation must be different
- **C** The product must have different molar mass

[1]

2.1 A A product-time graph has a steeper gradient where rate is larger. A tangent estimates instantaneous rate; a secant gives average rate over an interval. The final plateau reflects the total collected product under the stated conditions.

2.2 A reaction makes 24 cubic centimetres of gas in 40 s. Find average rate. Show the relation, substitution and units.

[2]

2.2 average rate=volume/time= $24/40=0.60 \text{ cm}^3/\text{s}$.

Exercises 2.3-3.1

2.3 Decide whether this claim is true and justify: A faster reaction always produces a larger final amount of product. [2]

2.4 The energy barrier for a reaction pathway: write the technical term. [1]

3 Exam-style questions

3.1 Fictional gas volumes at 0, 20, 40 s are 0, 18, 24 cm³. Compare interval rates. Can the 0–40 s average be called the instantaneous rate at 20 s? [4]

Exercises 2.3-3.1

2.3 Decide whether this claim is true and justify: A faster reaction always produces a larger final amount of product. [2]

2.3 False. A catalyst does not change the equilibrium constant at a fixed temperature. A mass-loss method cannot detect all reactions, and losing gas through a leak biases a collection experiment.

2.4 The energy barrier for a reaction pathway: write the technical term. [1]

3 Exam-style questions

2.4 activation energy. activation energy means The energy barrier for a reaction pathway.

3.1 Fictional gas volumes at 0, 20, 40 s are 0, 18, 24 cm³. Compare interval rates. Can the 0–40 s average be called the instantaneous rate at 20 s? [4]

3.1 0.90 then 0.30 cm³/s; overall 0.60. A secant does not in general give the tangent at 20 s. More closely spaced data are needed for the instantaneous estimate.