Exercise walk-through

# 17.1 Rates, catalysts and reliable endpoints

International Baccalaureate · IB Diploma · Chemistry · HL

# 17.1 Rates, catalysts and reliable endpoints

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

**KEY WORDS** rate • activation energy

## Objective

Rates, catalysts and reliable endpoints. Original classroom practice for IB HL; not an official IB paper.

## 1 Key knowledge and worked examples

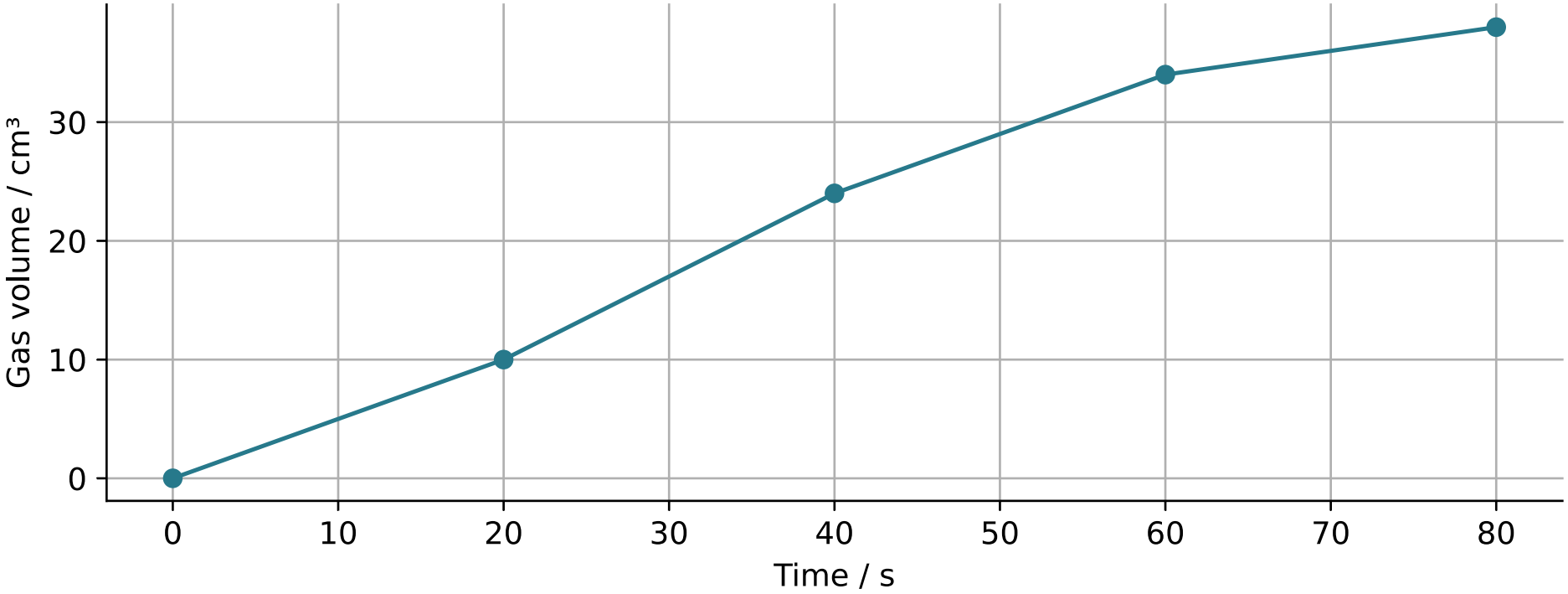
### What would explain this observation?

- A faster reaction finishes sooner, but it need not make more product. **Rate** and final yield answer different questions.

## 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.

**In the lab:** 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.

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## Work from known quantities

- 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.

**Your turn:** A reaction makes 24 cubic centimetres of gas in 40 s. Find average rate.

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## ■ 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.

**Not true:** A faster reaction always produces a larger final amount of product. Rate measures how quickly product forms, not how much finally forms. The final amount is fixed by the limiting reagent; a catalyst or powder changes only the time taken to reach

it.

**Key:**

- Reaction rate describes reactant used or product formed per time.
- A product-time graph has a steeper gradient where rate is larger.
- Watch for: A catalyst does not change the equilibrium constant at a fixed temperature.

## ■ Write from an average rate of 0.40 cubic centimetres per second

- Gas volume rises from 8 to 20 cubic centimetres between 10 s and 40 s.

- Find the average rate. A faster rate does not increase the final amount.

# 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 product must have different molar mass
- **C** The balanced equation must be different [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 product must have different molar mass
- **C** The balanced equation must be different [1]

**2.1 A** The final volume depends on the amounts reacting, not on how fast they react. Two reactions with the same amounts reach the same final volume even if one is much faster; rate is about time, not about the balanced totals.

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**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 $cm^3/s$.

# Exercises 2.3·3.1

**2.3** Decide whether this claim is true and justify: Rate measures how quickly product forms, not how much finally forms. [2]

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

**3.1** Fictional gas volumes at0,20,40 s are0,18,24 $cm^3$. Compare interval rates. Can the0–40 s average be called the instantaneous rate at20 s? [4]

# Exercises 2.3·3.1

**2.3** Decide whether this claim is true and justify: Rate measures how quickly product forms, not how much finally forms. [2]

**2.3** True. True. Rate measures how quickly product forms, not how much finally forms. The final amount is fixed by the limiting reagent; a catalyst or powder changes only the time taken to reach it.

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

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

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**3.1** Fictional gas volumes at0,20,40 s are0,18,24 $cm^3$. Compare interval rates. Can the0–40 s average be called the instantaneous rate at20 s? [4]

**3.1** 0.90 then0.30 $cm^3/s$;overall0.60. A secant does not in general give the tangent at20s. More closely spaced data are needed for the instantaneous estimate.