

## 2.4.1 Rates: gradients, energy distributions and catalysts

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 15 marks

**KEY WORDS** activation energy

### Objective

Choose the correct rate measure and explain collision and catalyst evidence. All questions and marking guidance are original.

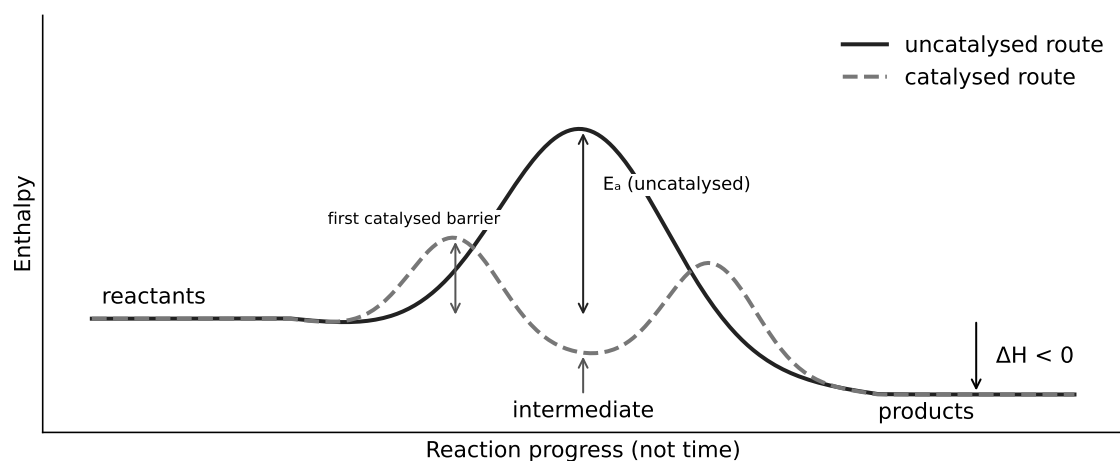
### 1 Key knowledge and worked examples

Successful collisions need enough energy and suitable orientation. Concentration, gas pressure and exposed surface affect collision frequency. Higher temperature increases the fraction above activation energy.

#### ■ Worked method

A tangent to a gas-volume curve passes through (10 s, 12 cm<sup>3</sup>) and (50 s, 36 cm<sup>3</sup>).  
 $\text{rate} = \Delta V / \Delta t = (36 - 12) / (50 - 10) = 0.60 \text{ cm}^3 \text{ s}^{-1}$ . The points must lie on the tangent, not just the curve.

For a fixed endpoint,  $1/t$  is a comparative rate in s<sup>-1</sup>. A catalyst lowers the pathway barrier; it does not change the energy distribution at fixed temperature, the net enthalpy or the equilibrium composition. A catalysed pathway can pass through an intermediate.



## 2 Practice

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**2.1** Two trials reach the same visible endpoint in 40 s and 25 s. Calculate their comparative rates and their rate ratio, second/first. [3]

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**2.2** Explain why powdered calcium carbonate reacts faster than equal mass of large chips with the same excess acid. [2]

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**2.3** State two changes in a Maxwell–Boltzmann curve on raising temperature for the same number of molecules, and identify the area relevant to successful collisions. [3]

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## 3 Exam-style questions

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**3.1** A gas-volume tangent passes through (20 s, 18 cm<sup>3</sup>) and (80 s, 42 cm<sup>3</sup>). Calculate instantaneous rate. Explain why (final volume)/(total time) answers a different question. [3]

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**3.2** A catalyst gives a two-step exothermic route. Draw the uncatalysed and two-step catalysed profiles on the same labelled axes, including the intermediate, and explain two different possible industrial benefits without saying a catalyst always raises atom economy. [4]