

(c) Reaction **A** occurs faster in the presence of an enzyme. This is reaction **B**.

(i) The activation energy for reaction **B** is $+29 \text{ kJ mol}^{-1}$.

Predict a value for the activation energy of reaction **A**.

..... [1]

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(ii) Explain, in terms of activation energy, E_a , and the collision of particles, how an increase in temperature affects the rate of a chemical reaction.

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.....
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..... [2]

[Total: 14]

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[Turn over

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(iv) H_2SO_4 acts as a homogeneous catalyst in reaction 3.

Explain why H_2SO_4 is described as *homogeneous*.

.....
..... [1]

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- (f) Magnesium, Mg, burns in oxygen, O₂.
The activation energy, E_a , for this reaction is +148 kJ mol⁻¹.

- (i) State **one** observation when magnesium burns in oxygen.
Do **not** refer to temperature changes in your answer.

..... [1]

- (ii) On Fig. 1.1:

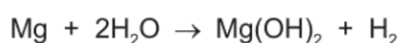
- sketch a reaction pathway diagram for the reaction that occurs when Mg burns in O₂
- label the diagram to show the enthalpy change, ΔH , and the activation energy, E_a , for the reaction.



Fig. 1.1

[3]

- (g) Cold water reacts slowly with a piece of Mg to produce bubbles of H₂(g).
Cold water reacts rapidly with burning Mg to produce H₂(g) in an explosive mixture.



Explain why the rate of reaction of cold water with burning magnesium is greater.

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..... [2]

[Total: 17]

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(a) Complete the reaction pathway diagram in Fig. 2.1 for reaction 2.

Label the diagram to show the enthalpy change, ΔH_2 , and the activation energy, E_A .

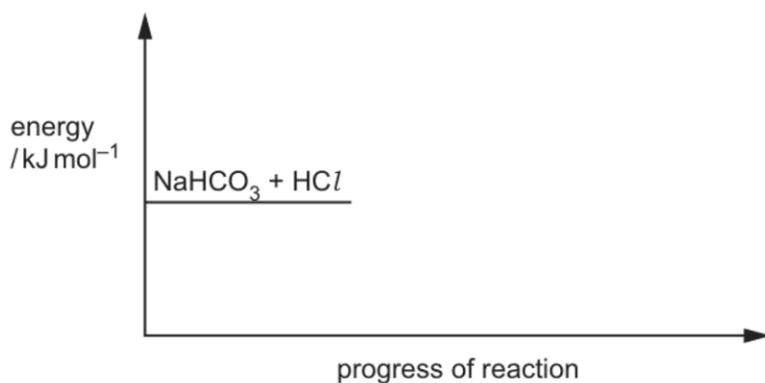


Fig. 2.1

[2]

(b) The value for ΔH_1 is determined by experiment using the following method.

- 50.0 cm³ of 2.00 mol dm⁻³ HCl(aq) is added to a polystyrene cup.
- The initial temperature of the acid is recorded as 19.6 °C.
- 0.0400 mol of Na₂CO₃ is added and the mixture is stirred.
- All the solid Na₂CO₃ disappears and a colourless solution is produced.

The maximum temperature recorded during the reaction is 26.2 °C.

(i) Describe **one** other observation that shows the reaction is complete.

..... [1]

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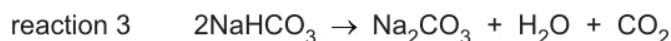
- (ii) Calculate the value of ΔH_1 in kJ mol^{-1} .

Assume the specific heat capacity of the reaction mixture is the same as for water and no heat is lost to the surroundings.

Show your working.

$$\Delta H_1 = \dots\dots\dots \text{kJ mol}^{-1} \quad [3]$$

- (iii) Thermal decomposition occurs when NaHCO_3 is heated.



Calculate the enthalpy change for reaction 3, ΔH_r , using the data in Table 2.1 and the value of ΔH_1 calculated in (b)(ii).

(If you were unable to calculate a value for ΔH_1 in (b)(ii), assume the enthalpy change is $-38.4 \text{ kJ mol}^{-1}$. This is **not** the correct value.)

$$\Delta H_r = \dots\dots\dots \text{kJ mol}^{-1} \quad [2]$$

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- (ii) Explain why increasing the temperature increases the rate of reaction 1.

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.....
..... [2]

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- (d) Hydrocarbon **Y** reacts with $\text{H}_2(\text{g})$.

Fig. 3.3 shows the distribution of energies of $\text{H}_2(\text{g})$ at temperature T .

Area **A** represents the number of molecules with energy greater than or equal to the activation energy, E_A , at temperature T .

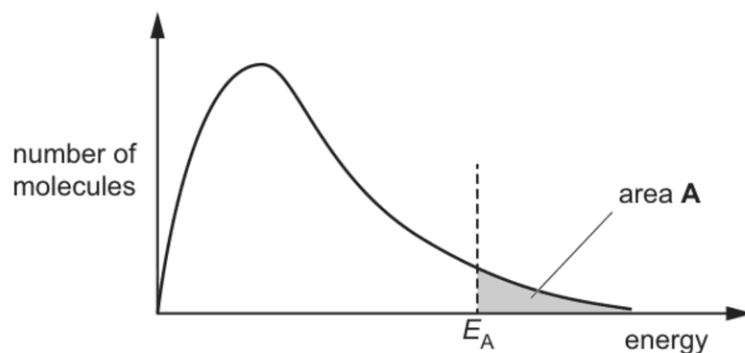


Fig. 3.3

- (i) Annotate Fig. 3.3 to show the effect of adding nickel to **Y** and $\text{H}_2(\text{g})$ at temperature T . [1]
- (ii) Area **B** (not labelled on Fig. 3.3) represents the number of molecules with energy greater than or equal to the activation energy when nickel is added at temperature T .

State the difference, if any, between areas **A** and **B**. Explain the significance of your answer on the rate of hydrogenation of **Y**. Give your answer in terms of collisions.

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.....

..... [2]

(iii) Explain why the rate of reaction changes with time.

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..... [1]

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(v) Explain why the rate of reaction **cannot** be monitored accurately by measuring the volume of $\text{SO}_2(\text{g})$ produced in this reaction.

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..... [1]

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