8. Reaction kinetics

8.3 Catalysts

Paper 2

Question Paper

1 Potassium chlorate, $KClO_3$, is widely used as an oxidising agent and to make $O_2(g)$.

(b) $KClO_3(s)$ decomposes when heated.

$MnO_2(s)$ catalyses the exothermic decomposition reaction.

Complete and label the diagram in Fig. 3.1 to show the effect of $MnO_2(s)$ on the decomposition of $KClO_3(s)$.

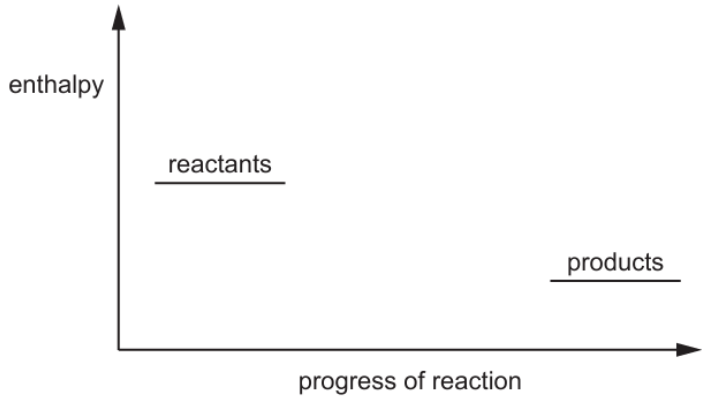
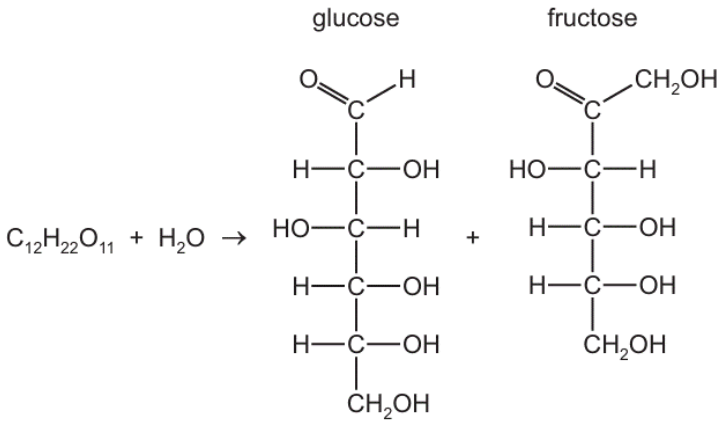


Fig. 3.1

[2]

2 Sucrose, $C_{12}H_{22}O_{11}$, reacts with water to form glucose and fructose in reaction **A**.



reaction **A**

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

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

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

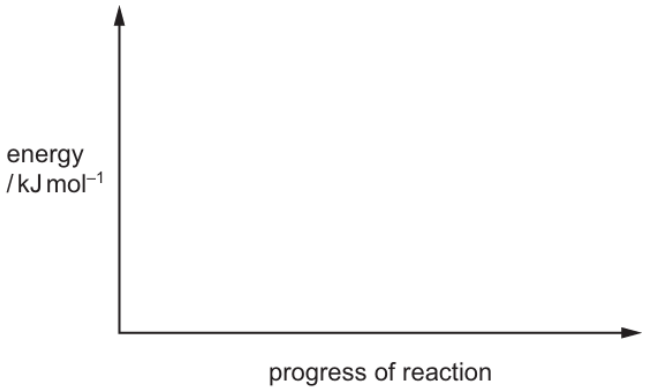
..... [1]

(ii) The enthalpy change for reaction **A** is –14 kJ mol^{-1}.

Predict a value for the enthalpy change for reaction **B**.

..... [1]

(iii) Sketch a labelled energy level diagram for reaction **B**. Use relevant values from **(c)(i)** and **(c)(ii)**.



[2]

3 Sulfuric acid is manufactured by the Contact process.

One stage in this process is the conversion of sulfur dioxide into sulfur trioxide in the presence of a heterogeneous catalyst of vanadium(V) oxide, V_2O_5.

$$2\,O{=}S{=}O(g) + O{=}O(g) \rightleftharpoons 2\,O{=}\overset{\overset{O}{\|}}{S}{=}O(g) \qquad \Delta H = -196\,kJ\,mol^{-1}$$

(a) (i) State the effect of a catalyst on a reaction.
Explain how a catalyst causes this effect.

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.....

..... [2]

(ii) State the meaning of the term *heterogeneous* as applied to catalysts.

.....

.....

..... [1]

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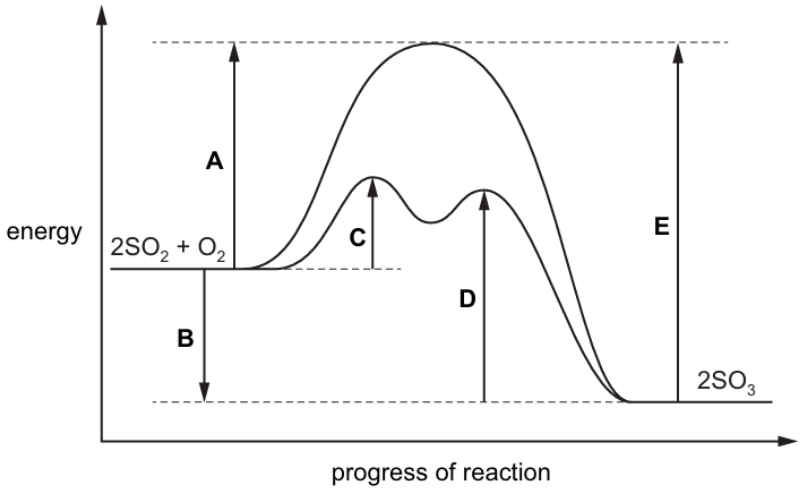
The Contact process is usually carried out at a temperature of about 400 °C and a pressure just above atmospheric pressure. Using a higher or lower temperature and pressure would affect both the rate of production of sulfur trioxide and the yield of sulfur trioxide.

(c) A reaction pathway diagram for both the catalysed and uncatalysed reactions between SO_2 and O_2 is shown.



The letters **A**–**E** represent energy changes.

Complete the table by stating which letter, **A**–**E**, represents the energy change described.

energy change	letter
the energy change for the production of SO_3	
the activation energy for the production of SO_3 in the absence of a catalyst	
the activation energy for the first step in the **decomposition** of SO_3 in the presence of a catalyst	

[3]