Paper 3

Questions are applicable for both core and extended candidates

1 Alkenes are a homologous series of hydrocarbons which are made by cracking larger alkane molecules.

(e) Poly(ethene) is produced by the polymerisation of ethene. The reaction is exothermic.

(i) State the meaning of the term exothermic.

..... [1]

(ii) Fig. 4.2 shows the reaction pathway diagram for this reaction.

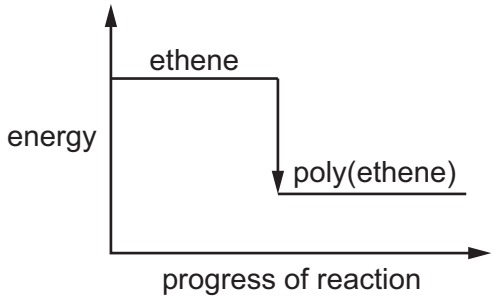


Fig. 4.2

Explain how this reaction pathway diagram shows that the reaction is exothermic.

.....

..... [1]

2 This question is about metals and compounds of metals.

(c) Magnesium chloride is produced when magnesium burns in chlorine.

$$Mg + Cl_2 \rightarrow MgCl_2$$

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

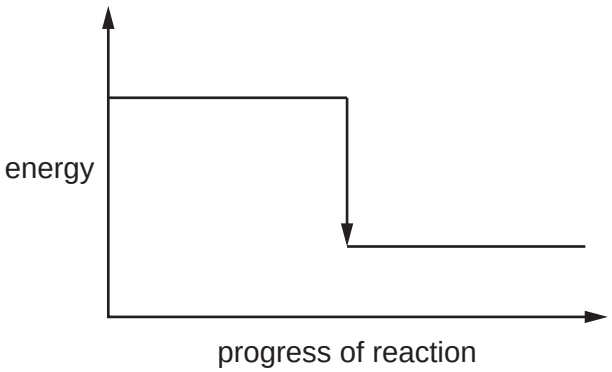


Fig. 4.1

(i) Complete Fig. 4.1 by writing these formulae on the diagram:

- $Mg + Cl_2$
- $MgCl_2$.

[1]

(ii) Explain how Fig. 4.1 shows that the reaction is exothermic.

.....

..... [1]

3 This question is about sulfur and compounds of sulfur.

(c) Sulfur burns in oxygen to produce sulfur dioxide.

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

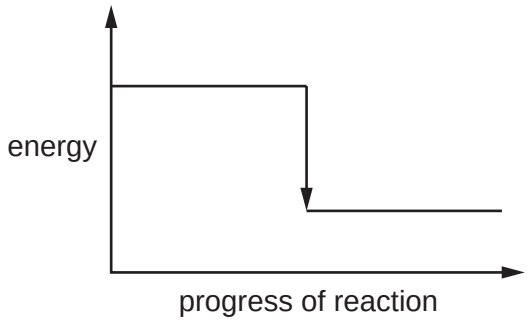


Fig. 4.1

(i) Complete Fig. 4.1 by writing these formulae on the diagram:

- $S + O_2$
- SO_2. [1]

(ii) Explain how Fig. 4.1 shows that the reaction is exothermic.

.....

..... [1]

(iii) Complete this sentence about an exothermic reaction using a word from the list.

products **reactants** **sulfur** **surroundings**

An exothermic reaction transfers thermal energy to the ..... . [1]

4 This question is about chlorine and compounds of chlorine.

(c) Chlorine reacts with phosphorus to produce phosphorus(V) chloride.

(i) Balance the equation for this reaction.

$$.....P + ...Cl_2 \rightarrow 2PCl_5$$ [2]

(ii) This reaction is exothermic.

State the meaning of the term *exothermic*.

..... [1]

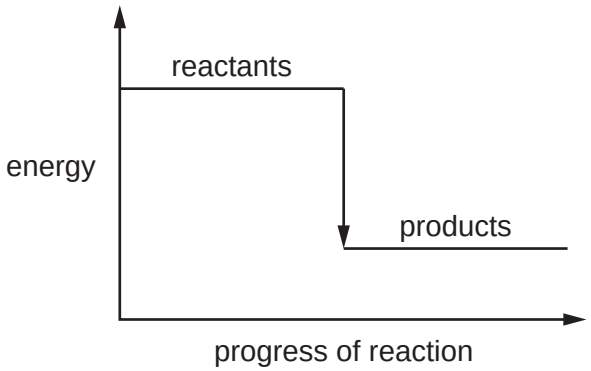
5 This question is about acids and bases.

(d) The reaction of hydrochloric acid with calcium oxide is exothermic.

(i) State the meaning of the term *exothermic*.

..... [1]

(ii) The energy level diagram for the reaction of hydrochloric acid with calcium oxide is shown.



Explain how the energy level diagram shows that this reaction is exothermic.

.....

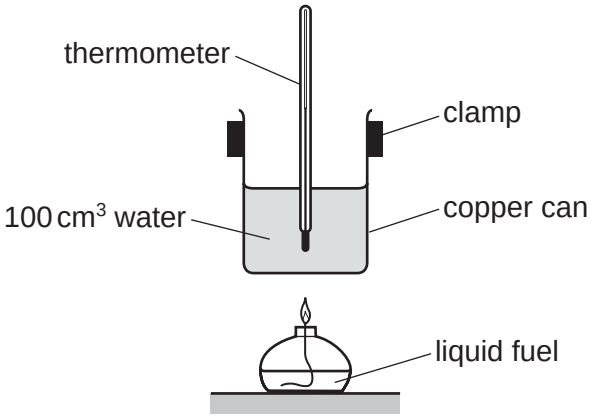
..... [1]

6 This question is about fuels and energy production.

(a) Name a fuel that is a solid at room temperature.

..... [1]

(b) The diagram shows the apparatus used to compare the energy released when 100 cm^3 of water is heated by burning different liquid fuels, **J**, **K**, **L** and **M**.



All conditions are kept the same, apart from the type of fuel and mass of fuel burned.

The results are shown.

fuel	mass of fuel burned / g	increase in temperature / °C
J	1	5
K	2	9
L	1	6
M	3	12

Deduce which fuel, **J**, **K**, **L** or **M**, releases the most energy per gram.

..... [1]

(c) Name the type of chemical reaction that releases heat energy.

..... [1]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

7 The Haber process is used to manufacture ammonia.

(b) The equation for the Haber process is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ/mol$$

The reaction is reversible. The forward reaction is exothermic.

(i) State what is meant by the symbol ΔH. **(extended only)**

..... [1]

(ii) ΔH for the forward reaction is –92 kJ / mol.

State why this value shows that the forward reaction is exothermic. **(extended only)**

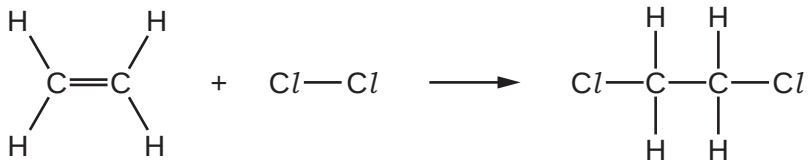
..... [1]

8 This question is about alkanes and alkenes.

(c) Ethene reacts with chlorine at room temperature to form dichloroethane, $C_2H_4Cl_2$.

$$C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$$

(ii) The chemical equation for this reaction can be represented as shown.



The energy change for the reaction is –180 kJ / mol.

Use the bond energies in the table to calculate the bond energy of a C–Cl bond, in kJ / mol.

bond	C–H	C=C	Cl–Cl	C–C
bond energy in kJ / mol	410	610	240	350

Use the following steps. **(extended only)**

step 1 Calculate the energy needed to break bonds.

energy needed to break bonds = ... kJ

step 2 Use your answer in **step 1** and the energy change for the reaction to determine the energy released when bonds are formed.

energy released when bonds form = ... kJ

step 3 Use your answer in **step 2** and bond energy values to determine the energy of a C–Cl bond.

bond energy of a C–Cl bond = ... kJ / mol

[4]

9 The Periodic Table can be used to classify elements.

(e) Bromine monochloride, BrC*l*, is made by the reaction between bromine and chlorine. The chemical equation is shown.

$$Br_2(g) + Cl_2(g) \rightarrow 2BrCl(g)$$

bond	bond energy in kJ/mol
Br–Br	190
C*l*–C*l*	242
Br–C*l*	218

Calculate the overall energy change for the reaction using bond energies.

Use the following steps. **(extended only)**

- Calculate the total amount of energy required to break the bonds in 1 mole of $Br_2(g)$ and 1 mole of $Cl_2(g)$.

..... kJ

- Calculate the total amount of energy released when the bonds in 2 moles of BrC*l*(g) are formed.

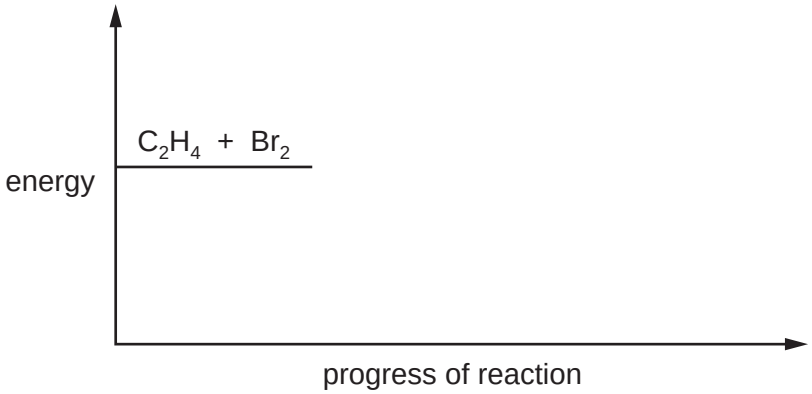
..... kJ

- Calculate the overall energy change for the reaction.

..... kJ/mol
[3]

10 Ethene is an alkene which reacts with bromine as shown in the equation.

(d) Part of the energy profile diagram of this reaction is shown.



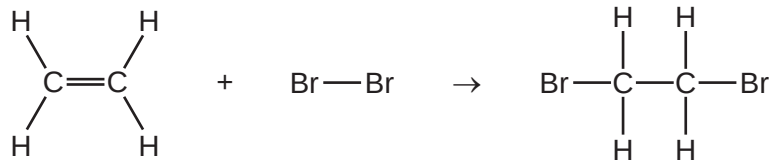
(i) The reaction is exothermic.

Complete the energy profile diagram for this reaction. **(extended only)**
Include:

- the position of the products
- an arrow to show the activation energy, labelled as A
- an arrow to show the energy change for the reaction.

[3]

(ii) The chemical equation for the reaction can be represented as shown.



Some bond energies are given.

bond	bond energy / kJ mol
C–H	410
C=C	610
Br–Br	190
C–C	350
C–Br	290

Use the bond energies in the table to calculate the energy change in this reaction.

Use the following steps. **(extended only)**

- Calculate the energy needed to break bonds.

energy = ... kJ

- Calculate the energy released in making bonds.

energy = ... kJ

- Determine the energy change in this reaction.

energy change in this reaction = ... kJ / mol
[3]