OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY 2813/01

How Far, How Fast?

Thursday **10 JUNE 2004** Morning 45 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Scientific calculator

Candidate Name	Centre Number	Candidate Number

TIME 45 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	13	
2	10	
3	9	
4	5	
5	8	
TOTAL	45	

This question paper consists of 8 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 This question is about the relationship between bond enthalpies and enthalpy changes of combustion.

(a) Define the term *bond enthalpy.*

.....

.....

.....[2]

(b) Methane burns in air according to the following equation.

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$$

(i) Use the average bond enthalpies given in the table below to calculate a value for the enthalpy change of combustion of methane, ΔH_c.

bond	average bond enthalpy / kJ mol^{-1}
C–H	+410
O–H	+465
O=O	+500
C=O	+805

ΔH_c = ... kJ mol^{-1} [3]

(ii) The standard enthalpy change of combustion of methane is –890 kJ mol^{-1}

Suggest why your calculated value differs from this value.

.....

.....[1]

(c) Table 1.1 gives values for the standard enthalpy changes of combustion for the first three alkanes.

Table 1.1

alkane	formula	$\Delta H_c^{\ominus}$/kJ mol^{-1}
methane	CH_4	−890
ethane	C_2H_6	−1560
propane	C_3H_8	−2220

(i) Write a balanced equation, including state symbols, illustrating the standard enthalpy change of combustion of propane gas.

.....[2]

(ii) As the chain length in the alkanes increases, the value of $\Delta H_c^{\ominus}$ becomes more negative. Use your understanding of bond breaking and bond making to explain this trend.

.....

.....

.....

.....[2]

(iii) Propane can be cracked to form ethene and methane.

$$C_3H_8(g) \longrightarrow C_2H_4(g) + CH_4(g)$$

The standard enthalpy change of combustion of ethene, $\Delta H_c^{\ominus} = -1410\ \text{kJ mol}^{-1}$.

Use this value together with relevant values in Table 1.1 to calculate the enthalpy change of this reaction.

$\Delta H^{\ominus}$ = ... kJ mol^{-1} [3]

[Total: 13]

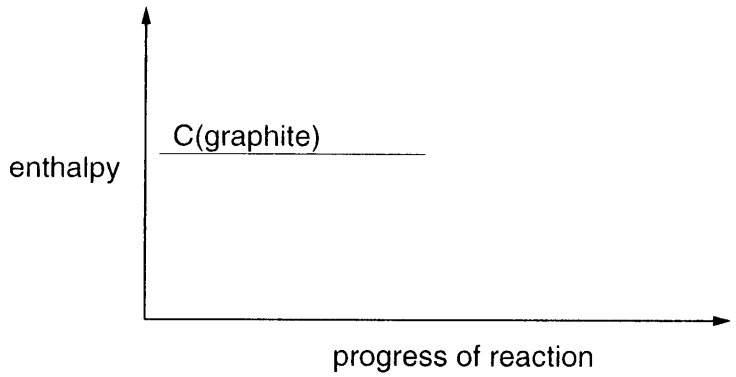
2 Diamond and graphite are two allotropes of carbon. Allotropes are different forms of the same element. Diamonds are made industrially from the much cheaper graphite.

Under high pressure the following equilibrium exists.

$$\text{C(graphite)} \rightleftharpoons \text{C(diamond)} \qquad \Delta H^{\ominus} = +1.8\,\text{kJ mol}^{-1}$$

substance	density / g cm^{-3}
graphite	2.25
diamond	3.51

(a) Complete the following enthalpy profile diagram for the conversion of graphite into diamond, labelling $\Delta H^{\ominus}$.



[2]

(b) Suggest which allotrope of carbon is thermodynamically more stable. Give a reason for your choice.

.....

.....[1]

(c) In which allotrope do the carbon atoms take up less space? Give a reason for your choice.

.....

.....[1]

(d) State Le Chatelier's principle.

.....

.....

.....[2]

(e) Use Le Chatelier's principle and the information given at the start of the question to deduce the likely conditions of pressure and temperature needed to turn graphite into diamond. Explain your answer.

pressure .....

.....

.....[2]

temperature .....

.....

.....[2]

[Total: 10]

[Turn over

3 There are two types of catalysis, homogeneous and heterogeneous.

(a) CFCs form chlorine free radicals, Cl, in the atmosphere. Chlorine free radicals are one of the factors responsible for depleting the ozone layer in the stratosphere. This is an example of homogeneous catalysis.

(i) Equations 3.1 and 3.2 represent two possible steps that occur during this process. Complete these equations and construct an overall equation for the reaction.

$Cl + O_3 \longrightarrow ClO +$ ..... equation 3.1

..... $+ O \longrightarrow Cl + O_2$ equation 3.2

..... + ... $\longrightarrow$ ..... overall equation

[3]

(ii) Use the equations above to identify a catalyst in the reaction scheme.

Explain your answer.

.....

.....

.....[2]

(b) A catalytic converter contains a heterogeneous catalyst. One of the reactions catalysed is shown below.

$$2NO(g) + 2CO(g) \longrightarrow N_2(g) + 2CO_2(g)$$

State what is meant by a *heterogeneous* catalyst and outline the way that this type of catalyst works in a catalytic converter.

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 9]

4 **(a)** Hydrochloric acid is a strong acid.

(i) What is meant by the term *acid*?

.....

.....[1]

(ii) Explain the meaning of the term *strong* acid.

.....

.....[1]

(b) Hydrochloric acid reacts with a solution of sodium carbonate.

(i) Write appropriate state symbols in the equation for this reaction shown below.

$2HCl$ ..... + Na_2CO_3 ..... $\longrightarrow$ $2NaCl$ ..... + CO_2 ..... + H_2O ..... [1]

(ii) State what you would see to indicate that the reaction was taking place.

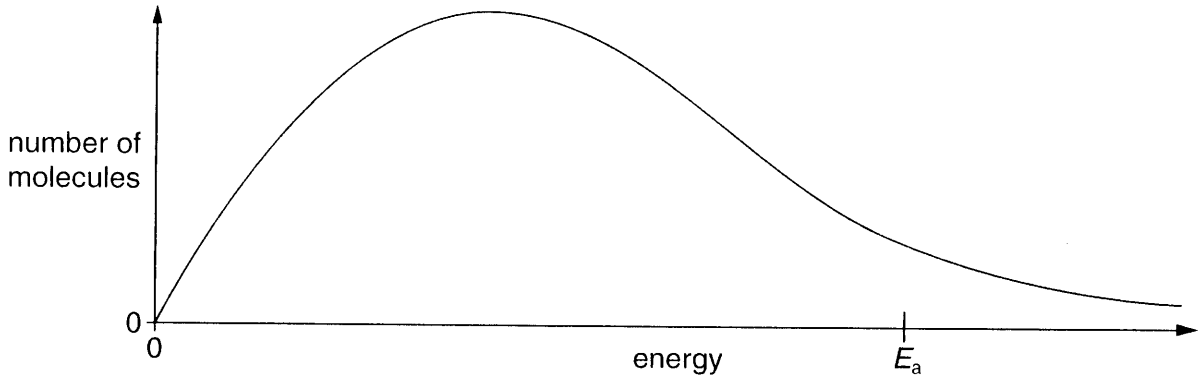
.....[1]

(iii) Construct an ionic equation for this reaction.

.....[1]

[Total: 5]

5 **(a)** The diagram below shows the energy distribution of reactant molecules at a particular temperature. E_a represents the activation energy of the reaction.



(i) On the diagram, draw a second curve to represent the energy distribution of the same number of molecules at a higher temperature. [2]

(ii) Use your completed diagram to explain how an increase in temperature can cause an increase in the rate of a reaction.

.....

.....

.....

.....[2]

(b) The rate of the reaction between hydrogen and oxygen depends on the pressure as well as the temperature.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g) \qquad \Delta H = -286\,kJ\,mol^{-1}$$

(i) Describe and explain the effect of increasing the pressure on the **rate** of this reaction.

.....

.....

.....[2]

(ii) A sudden rapid increase in the rate of a reaction causes an explosion to occur.

Suggest why highly exothermic reactions such as this one are more likely to explode than other reactions.

.....

.....

.....[2]

[Total: 8]

END OF QUESTION PAPER