OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2813/01

How Far, How Fast?

Friday **11 JANUARY 2002** Afternoon 1 hour

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour

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 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 will be awarded marks for the quality of written communication where this is indicated in the 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	10	
2	8	
3	12	
4	13	
5	8	
6	9	
TOTAL	60	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 **(a)** The formation of compounds is accompanied by enthalpy changes.

(i) Explain the term *standard enthalpy change of formation.*

.....

.....

..... [2]

(ii) State the conditions under which standard enthalpy changes are measured.

.....

..... [2]

(b) Oxidation reactions are normally exothermic.

(i) What do you understand by the term *exothermic*?

..... [1]

(ii) State **one** example of an exothermic oxidation reaction that is important in industry or everyday life.

..... [1]

(c) The oxidation of hydrazine, N_2H_4, by dinitrogen tetroxide, N_2O_4, has been used in rocket propulsion.

$$2N_2H_4(l) + N_2O_4(l) \longrightarrow 3N_2(g) + 4H_2O(g)$$

(i) Use the following standard enthalpy changes of formation to calculate the enthalpy change for this reaction.

compound	$\Delta H_f^{\ominus}$/kJ mol^{-1}
$N_2H_4(l)$	+51
$N_2O_4(l)$	+9
$H_2O(g)$	–242

Answer ..... kJ mol^{-1} [3]

(ii) Suggest what feature, other than the value of ΔH, makes this reaction suitable for propelling a rocket.

..... [1]

[Total : 10]

2 Photosynthesis is an endothermic reaction.

(a) Under what temperature conditions do most endothermic reactions occur?

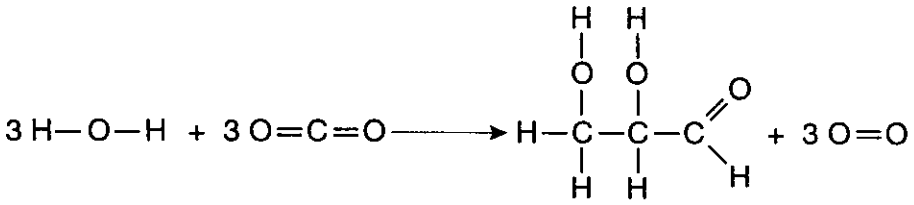
..... [1]

(b) Plants photosynthesise well both in the Tropics and under Arctic conditions.

Why is this?

..... [1]

(c) One of the products of photosynthesis is glyceraldehyde, $C_3H_6O_3$. Equation 2.1 shows the formation of glyceraldehyde.



glyceraldehyde **Equation 2.1**

Table 2.1 lists relevant average bond enthalpies.

Table 2.1

bond	bond enthalpy / kJ mol^{-1}
O=O	+498
O—H	+464
C=O	+750
C—O	+358
C—H	+413
C—C	+347

For Examiner's Use

Use these bond enthalpies to calculate the following quantities:

(i) the total enthalpy of all the bonds on the **left** hand side of Equation 2.1,

[2]

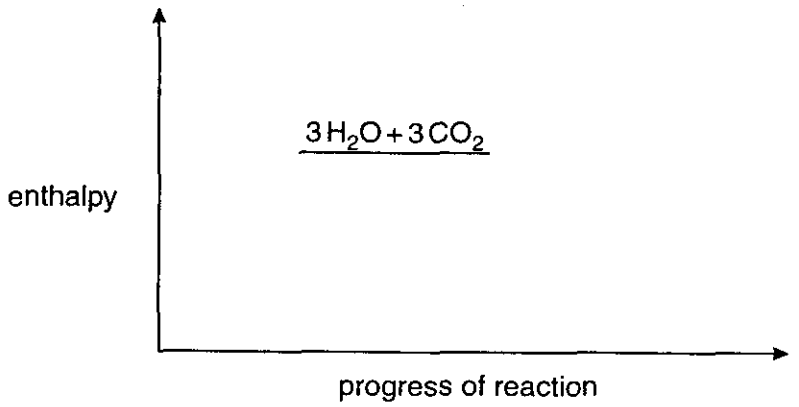
(ii) the total enthalpy of all the bonds on the **right** hand side of Equation 2.1,

[2]

(iii) hence, the enthalpy change for the reaction in Equation 2.1. Include the sign of ΔH in your answer.

ΔH = ... $kJ\,mol^{-1}$ [1]

(d) Complete the following enthalpy profile diagram to show your calculated ΔH for the reaction in Equation 2.1.



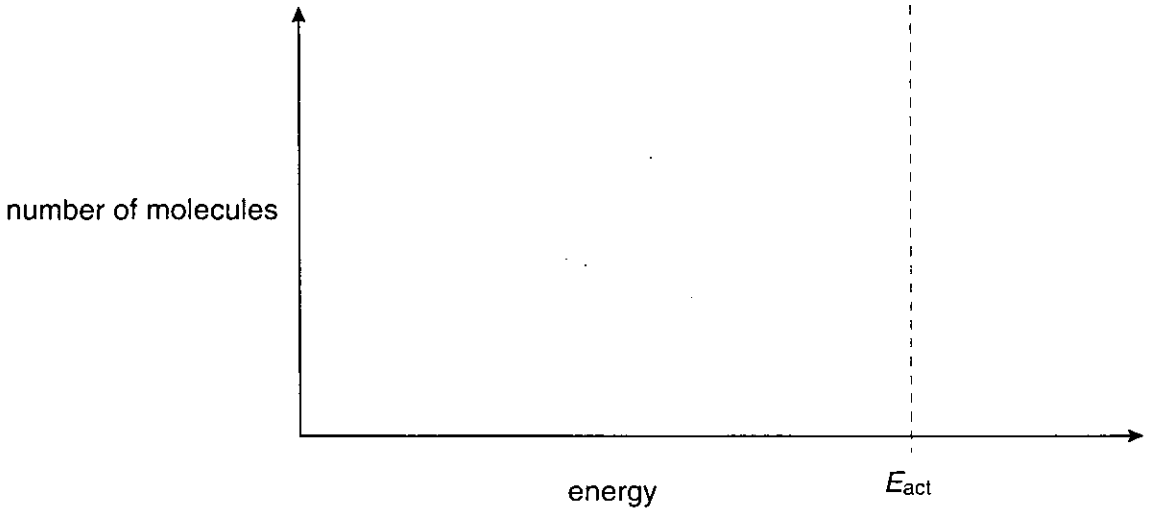
[1]

[Total : 8]

[Turn over

3 **(a)** **(i)** On the following axes, sketch the Boltzmann distribution of molecular energies for a fixed amount of gas at a temperature labelled as T_1.

E_{act} represents the activation energy of the reaction.



[2]

(ii) On the same axes, sketch another distribution for the *same* amount of gas, at a higher temperature, labelled as T_2.

[2]

(b) What do you understand by the term *activation energy*, E_{act}?

.....

..... [1]

(c) Using your answers to **(a)** and **(b)**, explain why the rate of a chemical reaction is affected by changes in temperature.

.....

.....

.....

..... [3]

(d) Table 3.1 lists some average bond enthalpies.

Table 3.1

bond	bond enthalpy /kJ mol^{-1}
C—H	+413
C—Cl	+327
Cl—Cl	+243
Br—Br	+193

(i) Use the values in Table 3.1 to suggest the order of **increasing** E_{act} values for the following four reactions. Write the letters A, B, C and D in the appropriate boxes.

A $CH_4 \longrightarrow CH_3 + H$

B $CH_3 + Cl \longrightarrow CH_3Cl$

C $Br_2 \longrightarrow 2Br$

D $Cl_2 \longrightarrow 2Cl$

☐ < ☐ < ☐ < ☐ [2]

smallest E_{act} largest E_{act}

(ii) Explain your choice of order in **(i)**.

.....

.....

..... [2]

[Total : 12]

4 The equation below shows the first stage in the industrial manufacture of nitric acid from ammonia.

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -907 \text{ kJ mol}^{-1}$ **Reaction 4.1**

This reaction is catalysed by a platinum-rhodium gauze at 800 °C.

(a) State and explain what effect a catalyst has on a reaction.

.....

.....

.....

..... [3]

(b) What *type* of catalyst is the platinum-rhodium gauze?

..... [1]

(c) This reaction is an example of a *dynamic equilibrium*.

State **two** features of a dynamic equilibrium.

.....

.....

..... [2]

(d) **(i)** State le Chatelier's principle.

.....

..... [2]

(ii) Use le Chatelier's principle to describe and explain how the **equilibrium position** of Reaction 4.1 is affected by increasing the pressure and by increasing the temperature.

increasing the pressure

.....

.....

.....

increasing the temperature

.....

.....

..... [4]

(e) Suggest a reason why the reaction is carried out at 800 °C.

.....

..... [1]

[Total : 13]

For Examiner's Use

5 This question is about the reactions of acids.

(a) Sulphuric acid reacts with ammonia to give ammonium sulphate.

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

(i) What property of ammonia is shown in this reaction?

..... [1]

(ii) Calculate the maximum mass of ammonium sulphate that can be obtained from 100 g of ammonia.

[A_r: H, 1.0; N, 14.0; O, 16.0; S, 32.1]

mass = ... g [3]

(iii) State a large scale use of ammonium sulphate.

..... [1]

(b) State what you would observe on adding nitric acid to magnesium carbonate. Write a balanced equation for the reaction.

Observation(s)

.....

.....

Equation

.....

[3]

[Total : 8]

In this question, 1 mark is available for the quality of written communication.

6 Part of the Earth's atmosphere is damaged by the presence of CFCs.
State which component of the atmosphere CFCs affect, and describe in detail how this damage is caused.

[Total : 9]