OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY

How Far, How Fast?

2813/01

Wednesday **7 JUNE 2006** Morning 45 minutes

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

Candidate Name

Centre Number 2

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 blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for diagrams and graphs **only**.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

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	7	
2	17	
3	9	
	12	
	45	

This question paper consists of 8 printed pages

Answer **all** the questions.

1 Many chemical reactions occur in the atmosphere.

(a) Car engines produce carbon monoxide and nitrogen monoxide near to the Earth's surface.

Explain how carbon monoxide and nitrogen monoxide are formed in the car engine.

carbon monoxide .....

.....

nitrogen monoxide .....

.....[2]

(b) In the upper atmosphere, reactions occur involving chlorine free radicals, C*l*.

Equations for two such processes are given below.

$Cl + O_3 \rightarrow ClO + O_2$ **equation 1**

$ClO +$ ..... $\rightarrow Cl + O_2$ **equation 2**

(i) Complete **equation 2**. [1]

(ii) Write the overall equation for the two processes shown in **equations 1** and **2**.

.....[1]

(iii) Describe how the chlorine free radicals, C*l*, are formed in the upper atmosphere.

.....

.....

.....[2]

(iv) State **one** undesirable result of ozone depletion in the upper atmosphere for life on Earth.

.....[1]

[Total: 7]

2 **(a)** Energy changes during reactions can be considered using several *different* enthalpy changes. These include average bond enthalpies and enthalpy changes of combustion.

Table 2.1 shows the values of some average bond enthalpies.

Table 2.1

bond	average bond enthalpy / kJ mol^{-1}
C—H	+ 410
O—H	+ 465
O=O	+ 500
C=O	+ 805
C—O	+ 336

(i) Why do bond enthalpies have positive values?

.....

.....[1]

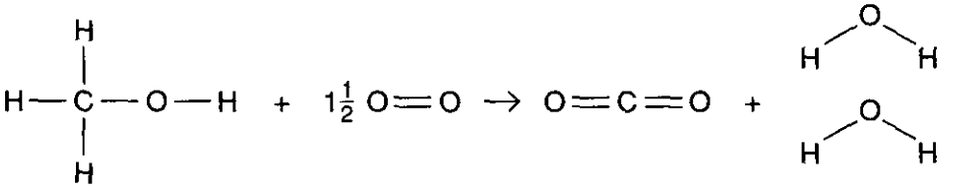
(ii) Define the term *bond enthalpy*.

.....

.....

.....[2]

(iii) The equation below shows the combustion of methanol, CH_3OH, in the gaseous state.



Use the average bond enthalpies from Table 2.1 to calculate the enthalpy change of combustion of gaseous methanol, ΔH_c.

ΔH_c = ... kJ mol^{-1} [3]

(iv) Suggest **two** reasons why the **standard** enthalpy change of combustion of methanol will be different from that calculated in part **(iii)**.

reason 1 .....

.....

reason 2 .....

.....[2]

(b) Methanol can be used as a fuel or as the feedstock for a variety of organic compounds. It is manufactured from carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH\ (g) \qquad \Delta H = -129\,kJ\,mol^{-1}$$

(i) Describe and explain how the composition of the equilibrium mixture is affected by

increasing the temperature

.....

.....

.....

increasing the pressure in the reaction.

.....

.....

.....[4]

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

.....

.....

.....[2]

(iii) The reaction is carried out by passing gaseous reactants over a transition metal catalyst.

Name this type of catalysis.

.....[1]

(iv) Suggest and explain the effect of a catalyst on the equilibrium position.

.....

.....

.....[2]

[Total: 17]

3 **(a)** A group of students were considering the factors that affect the rate of a chemical reaction. One of the students wrote the following.

> The rate of a chemical reaction increases as the temperature is increased because there are more collisions.

Discuss to what extent this statement is true and describe any other factors that should be considered when looking at the effect of temperature on rate of reaction.

.....

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.....

.....

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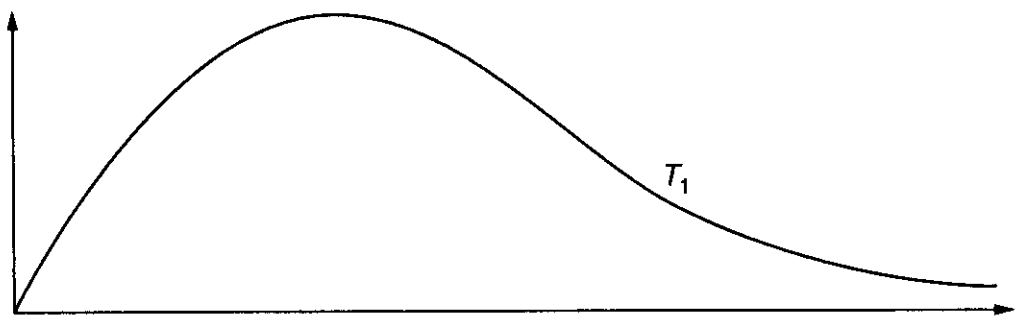
.....

.....

.....[5]

(b) The students drew a Boltzmann distribution for a gas at temperature T_1.

(i) Label the axes on the students' diagram below.



[2]

(ii) Sketch, on the diagram, the distribution that would be obtained at a **lower** temperature, T_2. Label this line T_2. [2]

[Total: 9]

4 **(a)** The changes in energy during reactions are often considered using enthalpy changes of reaction. One such enthalpy change is the standard enthalpy change of formation.

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

.....

.....

.....

.....[3]

(ii) Write the equation for the reaction corresponding to the standard enthalpy change of formation of magnesium nitrate, $Mg(NO_3)_2$. Include state symbols.

[2]

(iii) When magnesium nitrate is heated, it decomposes to give magnesium oxide, nitrogen dioxide and oxygen.

Use the standard enthalpy changes of formation to find the enthalpy change of reaction for this decomposition.

substance	standard enthalpy change of formation / kJ mol^{-1}
$Mg(NO_3)_2$	−791
MgO	−602
NO_2	−33

The equation for this reaction is shown below.

$$Mg(NO_3)_2(s) \longrightarrow MgO(s) + 2NO_2(g) + \tfrac{1}{2}O_2(g)$$

enthalpy change = ...kJ mol^{-1} [3]

(b) A small amount of solid magnesium oxide, MgO, was reacted with excess dilute hydrochloric acid.

(i) Define an acid.

.....[1]

(ii) Describe what would be seen as the reaction occurs.

.....

.....[1]

(iii) Write a balanced equation for this reaction.

.....[1]

(iv) Write an **ionic** equation for this reaction.

.....[1]

[Total: 12]

END OF QUESTION PAPER