OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2813/1

How Far, How Fast?

Wednesday **24 JANUARY 2001** Morning 1 hour

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

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 are advised to show all the steps in any calculations.
- You may use a Data Sheet for Chemistry.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	15	
2	10	
3	14	
4	14	
5	7	
TOTAL	60	

This question paper consists of 10 printed pages, 1 lined page and 1 blank page.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Oxides of nitrogen such as NO and NO_2 are gases that pollute the atmosphere. They are produced during the combustion of petrol in car engines.

(a) Table 1.1 lists the enthalpy changes of formation of NO and NO_2.

Table 1.1

compound	$\Delta H^{\ominus}_f$/kJ mol^{-1}
NO	+90
NO_2	+33

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

.....

.....

.....[2]

(ii) Write an equation, including state symbols, to represent the standard enthalpy change of formation of $NO_2(g)$.

.....[2]

(iii) Use the data in Table 1.1 to calculate the enthalpy change for the following reaction.

$$2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$$

[3]

(b) Oxides of nitrogen only form under high energy conditions such as during lightning strikes or in internal combustion engines.

Suggest why this is so.

.....

.....[1]

(c) Modern cars have 'catalytic converters' in their exhausts to convert nitrogen oxides into less harmful substances. One reaction that occurs is as follows.

$$\_\_CO(g) + \_\_NO_2(g) \longrightarrow \_\_CO_2(g) + \_\_N_2(g)$$

(i) Balance this equation by writing the appropriate numbers in the spaces. [1]

(ii) What **type** of catalysis occurs in the catalytic converter? Explain your answer.

.....

.....

.....[2]

(iii) Explain how this type of catalyst provides a different pathway for the reaction with a lower activation energy.

.....

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.....[2]

(iv) Suggest why a catalytic converter is designed to have a large surface area?

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.....

.....[2]

[Total : 15]

[Turn over

2 *Arcton 133* is a CFC with the molecular formula $C_2H_2ClF_3$.

(a) When *Arcton 133* is released into the atmosphere, its molecules can absorb energy. The C-Cl bond breaks forming free radicals.

$$C_2H_2ClF_3 \longrightarrow C_2H_2F_3^{\bullet} + Cl^{\bullet}$$

(i) What source of energy is required for this reaction to take place?

.....[1]

(ii) Chlorine free radicals catalyse the breakdown of ozone, O_3.

Write **two** equations to show how this happens.

.....

.....[2]

(iii) Write an equation for the overall reaction in **(a) (ii)**.

.....[1]

(iv) What **type** of catalysis is shown here? Explain your answer.

.....

.....

.....[2]

(b) In some applications, CFCs are being replaced by hydrocarbons such as alkanes.

(i) What is the M_r of *Arcton 133*, $C_2H_2ClF_3$?

[1]

(ii) The formulae of some alkanes are shown below.

C_5H_{12} C_6H_{14} C_7H_{16} C_8H_{18} C_9H_{20}

Draw a circle around the molecular formula of the alkane whose M_r is most similar to that of *Arcton 133*. [1]

(iii) Suggest why hydrocarbons are replacing CFCs.

.....

.....[1]

(iv) Apart from cost, suggest **one** possible **disadvantage** of using a hydrocarbon instead of a CFC.

.....[1]

[Total : 10]

3 This question refers to the hydrogen halides HF and HCl. Table 3.1 below lists some bond enthalpies which are required in different parts of this question.

Table 3.1

bond	bond enthalpy/kJ mol^{-1}
F—F	+158
H—H	+436
H—F	+568
H—Cl	+432

(a) Explain the term *bond enthalpy.*

.....

.....

.....[2]

(b) The hydrogen halides HCl and HF can be made from their elements. The formation of HCl is exothermic.

$$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g) \qquad \Delta H = -184\ kJ\ mol^{-1}$$

(i) Calculate the bond enthalpy of the Cl—Cl bond.

[2]

(ii) Calculate the enthalpy change for the formation of HF from its elements:

$$\tfrac{1}{2}H_2(g) + \tfrac{1}{2}F_2(g) \longrightarrow HF(g)$$

[2]

(c) When dissolved in water, HF acts as a weak acid whereas HC*l* acts as a strong acid.

(i) What is the difference between a weak acid and a strong acid?

.....

.....

.....[2]

(ii) Use the data in Table 3.1 to suggest why HF(aq) is a weaker acid than HC*l*(aq).

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.....[2]

(iii) Write a balanced equation for the reaction between HC*l*(aq) and magnesium oxide, MgO(s).

.....[1]

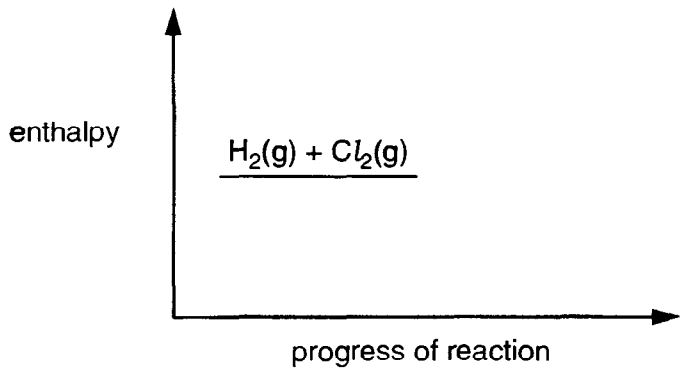
(d) The reaction between hydrogen and chlorine to form hydrogen chloride is exothermic. However, no reaction takes place unless the reactants are sparked or heated or exposed to light.

(i) Explain why this is so.

.....

.....[1]

(ii) Complete and label the enthalpy profile diagram below to support your answer in **(d) (i)**.



[2]

[Total : 14]

4 Ammonia, NH_3, is made industrially from its elements by the Haber process. This is an exothermic equilibrium reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

(a) State **three** reaction conditions that are used in the Haber process.

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.....

.....[3]

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

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.....[2]

(c) Describe and explain how the **equilibrium position** of this reaction is affected by

(i) increasing the temperature,

.....

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.....[2]

(ii) increasing the pressure.

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.....[2]

(d) Why is the temperature used described as a compromise?

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.....[2]

(e) Some of the ammonia from the Haber process reacts with carbon dioxide to make the fertiliser urea.

$$\_\_NH_3(g) + \_\_CO_2(g) \longrightarrow \underset{\text{urea}}{\_\_NH_2CONH_2(s)} + \_\_H_2O(l)$$

(ii) Balance the above equation. [1]

(ii) Calculate the maximum mass of urea that could be obtained from 1.00 kg of ammonia.

[2]

[Total : 14]

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

5 Describe, with the aid of a diagram, how the Boltzmann distribution can help to explain the effect of temperature rises and the presence of catalysts on the rates of chemical reactions.

[Total : 7]