OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2813/01**

CHEMISTRY

How Far, How Fast?

THURSDAY 10 JANUARY 2008 Morning

Time: 45 minutes

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

CUP/T41131

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **45**.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max**	**Mark**
1	**6**	
2	**15**	
3	**12**	
4	**12**	
TOTAL	**45**	

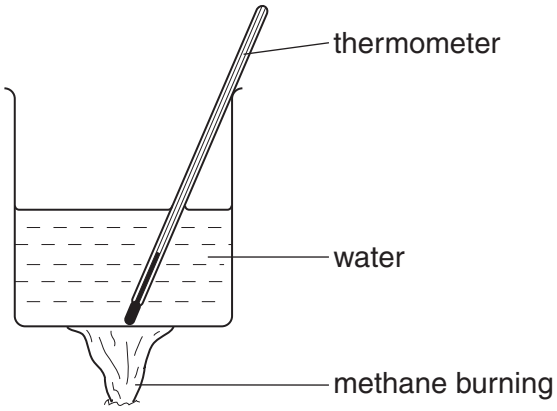
This document consists of **10** printed pages, **2** blank pages and a *Data Sheet for Chemistry*.

[Turn over

Answer **all** the questions.

1 Alkanes, such as methane, can be used as fuels.

In an experiment to determine its enthalpy change of combustion, methane, CH_4, was burnt in air.



In the experiment, 150 g of water were used. The temperature of the water changed from 19.5 °C to 61.5 °C when 0.600 g of methane was burnt.

(a) Write the equation for the complete combustion of methane.

.....[1]

(b) Calculate the energy gained by the water, in kJ.

The specific heat capacity of water is $4.18\,J\,g^{-1}\,K^{-1}$.

energy = ... kJ [2]

(c) How many moles of methane were burnt in the experiment?

answer = ... mol [1]

(d) Calculate the enthalpy change of combustion, in kJ mol^{-1}, of methane.

enthalpy change of combustion = ... kJ mol^{-1} [2]

[Total: 6]

2 The energy needed to propel a rocket away from Earth is produced by burning a fuel in oxygen.

(a) Hydrazine, N_2H_4, is a liquid that has been used as a rocket fuel. It reacts with oxygen as shown below.

$$N_2H_4(l) + O_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

Hess's Law can be used to find the enthalpy change for this reaction using enthalpy changes of formation, ΔH_f.

(i) State Hess's Law.

.....

.....

.....[1]

(ii) Write the equation, including state symbols, for the standard enthalpy change of formation of hydrazine.

.....[1]

(iii) The table below shows some enthalpy changes of formation.

compound	ΔH_f /kJ mol^{-1}
$N_2H_4(l)$	+51
$H_2O(g)$	–241

Calculate the enthalpy change for the combustion of hydrazine.

$$N_2H_4(l) + O_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

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

(iv) Suggest and explain why using hydrazine as a rocket fuel may be 'environmentally friendly'.

.....

.....[1]

(b) A rocket could be sent to Mars. It has been suggested that methane could be made on Mars. The methane could be used to provide the fuel to bring the rocket back to Earth.

The atmosphere of Mars contains carbon dioxide and this can react with hydrogen to produce methane as shown below.

$$CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2O(g) \quad \textbf{equation 2.1}$$

(i) **Equation 2.1** shows a reaction in dynamic equilibrium.

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

1 .....

.....

2 .....

.....[2]

(ii) The table below shows some average bond enthalpies.

bond	average bond enthalpy/kJ mol^{-1}
C═O	805
H—H	436
C—H	413
O—H	464

Calculate the enthalpy change for the forward reaction in **equation 2.1**.

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

(iii) Suggest what conditions of temperature and pressure should be used to give a high equilibrium yield of methane in **equation 2.1**. Give your reasoning.

temperature .....

.....

.....

pressure .....

.....

.....[4]

[Total: 15]

3 This question is concerned with the reactions of acids.

(a) Define an acid.

.....[1]

(b) The table below gives data about some solid compounds of copper and sodium. Use the data to help to answer the questions in **(i)** and **(iii)**.

compound	formula	colour	solubility in water	colour in solution
copper(II) oxide	CuO	black	insoluble	—
copper(II) chloride	$CuCl_2$	yellow	soluble	blue/green
copper(II) carbonate	$CuCO_3$	green	insoluble	—
sodium chloride	$NaCl$	white	soluble	colourless
sodium carbonate	Na_2CO_3	white	soluble	colourless

(i) Write equations, including state symbols, for the following reactions of hydrochloric acid.

copper(II) oxide and hydrochloric acid

.....

sodium carbonate and hydrochloric acid.

.....[3]

(ii) The reaction between copper(II) oxide and hydrochloric acid is very slow at room temperature and is therefore usually heated.

Suggest a reason why this reaction is so slow at room temperature.

.....

.....[1]

(iii) What would you expect to **see** when copper(II) carbonate reacts with hydrochloric acid?

.....

.....

.....[2]

(c) Chloric(VII) acid, $HClO_4$, and hydrochloric acid, HCl, are both strong acids.

(i) Explain the meaning of the term *strong* when applied to acids.

.....

.....[1]

(ii) Write an equation to show the dissociation of chloric(VII) acid.

.....[1]

(iii) Write an **ionic** equation to show the reaction between magnesium and hydrochloric acid.

.....[1]

(iv) Copper(II) carbonate reacts with chloric(VII) acid and with hydrochloric acid.

What difference, if any, would you expect to see in the rate of the reaction?

The concentration and temperature of each acid is the same.

.....

.....

.....[2]

[Total: 12]

TURN OVER FOR QUESTION 4

4 In the 19th century the Swedish chemist Berzelius first gave the name 'catalyst' to a substance that increases the rate of chemical reactions. Nowadays heterogeneous catalysts are important in a variety of industrial processes and in everyday life.

Describe the importance of heterogeneous catalysts in industrial processes or in everyday life. In your answer you should:

- explain, in terms of particles, how a catalyst increases the rate of a reaction;
- draw a labelled enthalpy profile diagram for an uncatalysed reaction and for the same reaction when catalysed;
- name **two** heterogeneous catalysts used in industrial processes or in everyday life – in each case write an equation for the reaction that they catalyse;
- explain how a heterogeneous catalyst works.

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[Total: 12]

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