THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

**ADVANCED SUBSIDIARY GCE**

# CHEMISTRY

How Far, How Fast?

**2813/01**

Candidates answer on the question paper

**OCR Supplied Materials:**
- *Data Sheet for Chemistry* (Inserted)

**Other Materials Required:**
- Scientific calculator

**Wednesday 3 June 2009**
**Morning**

**Duration:** 45 minutes

*OCE/T57246*

*2813013*

| Candidate Forename | | Candidate Surname | |
|---|---|---|---|

| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**INFORMATION FOR CANDIDATES**

- The number of marks 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.
- This document consists of **12** pages. Any blank pages are indicated.

| FOR EXAMINER'S USE | | |
|---|---|---|
| **Qu.** | **Max** | **Mark** |
| **1** | **16** | |
| **2** | **9** | |
| **3** | **8** | |
| **4** | **4** | |
| **5** | **8** | |
| **TOTAL** | **45** | |

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Answer **all** the questions.

**1** Glucose, $C_6H_{12}O_6$, can be used directly as a source of energy in living species or fermented to produce ethanol, $C_2H_5OH$. The ethanol produced can then be used as a fuel.

**(a)** Energy is released from the oxidation of glucose in living species.

**(i)** What name is given to this process?

..... **[1]**

**(ii)** Write the equation for this oxidation.

..... **[1]**

**(b)** When ethanol is used as a fuel, a combustion reaction takes place. The equation for this process is shown below.

$$C_2H_5OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l) \qquad \Delta H^{\ominus} = -1367 \text{ kJ mol}^{-1}$$

**Table 1.1** shows values for standard enthalpy changes of formation, $\Delta H_f^{\ominus}$.

| compound | $\Delta H_f^{\ominus}$ / kJ mol$^{-1}$ |
|---|---|
| $CO_2(g)$ | –394 |
| $H_2O(l)$ | –286 |

**Table 1.1**

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

.....

.....

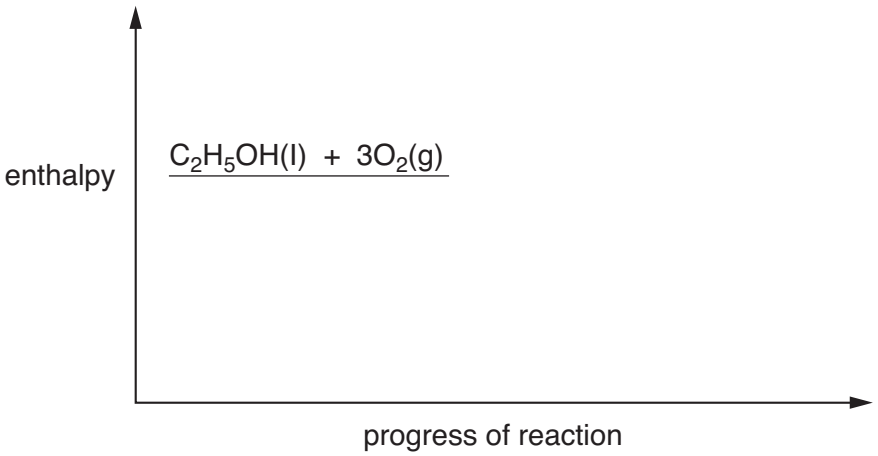
.....

..... **[3]**

**(ii)** Calculate the standard enthalpy change of formation of ethanol.

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

**(iii)** On the axes below draw the enthalpy profile diagram for the combustion of ethanol. Label $E_a$ and $\Delta H^{\ominus}$ on your diagram.




**[3]**

**(c)** Ethanol can be made industrially by reacting ethene with steam using a catalyst.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

At equilibrium the percentage conversion of ethene using excess steam, at various reaction conditions, is shown below.

| pressure / atm | temperature / °C | percentage conversion (%) |
|---|---|---|
| 50 | 200 | 45 |
| 50 | 320 | 30 |
| 80 | 200 | 60 |
| 80 | 320 | 45 |

**(i)** State and explain the effect of increasing the pressure on the percentage conversion.

.....

.....

.....

..... **[2]**

**(ii)** Use the data to deduce the sign of the enthalpy change for the forward reaction. Explain how you reached your conclusion.

.....

.....

.....

..... **[2]**

**(iii)** The equation for the formation of ethanol shows that equal numbers of moles of ethene and steam are required. In industry however excess steam is used.

Suggest why excess steam is used.

.....

..... **[1]**

**[Total: 16]**

**2** Some students were measuring the enthalpy changes for the neutralisation of 1 mol of different acids with different alkalis.

**(a)** In a first experiment, a student investigated the neutralisation of hydrochloric acid, HC*l*(aq), with aqueous potassium hydroxide, KOH(aq).

The student poured 200 $cm^3$ of 2.00 mol $dm^{-3}$ hydrochloric acid into a plastic cup. He added 200 $cm^3$ of 2.00 mol $dm^{-3}$ potassium hydroxide and the temperature increased from 21.3 °C to 34.9 °C.

**(i)** Calculate the energy, in kJ, produced in the reaction.

The specific heat capacity of aqueous solutions is 4.18 J $g^{-1}$ $K^{-1}$.
The density of aqueous solutions is 1.00 g $cm^{-3}$.

energy produced = ..... kJ **[2]**

**(ii)** Calculate the enthalpy change, $\Delta H$, for the neutralisation of 1 mol of hydrochloric acid by aqueous potassium hydroxide.

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

**(b)** The enthalpy change that occurs when 1 mol of water is produced by reacting an aqueous acid with an aqueous alkali is the enthalpy change of neutralisation.

Write the **ionic** equation for the enthalpy change of neutralisation.

..... **[1]**

**(c)** The enthalpy changes for the neutralisation of 1 mol of three acids are given below.

- **experiment 1**
  $HNO_3$(aq) with NaOH(aq) $\Delta H = -57.3\ kJ\,mol^{-1}$
- **experiment 2**
  $HCl$(aq) with NaOH(aq) $\Delta H = -57.3\ kJ\,mol^{-1}$
- **experiment 3**
  $CH_3COOH$(aq) with NaOH(aq) $\Delta H = -55.2\ kJ\,mol^{-1}$

Explain why the enthalpy change is the same for **experiments 1** and **2** but different for **experiment 3**.

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.....

.....

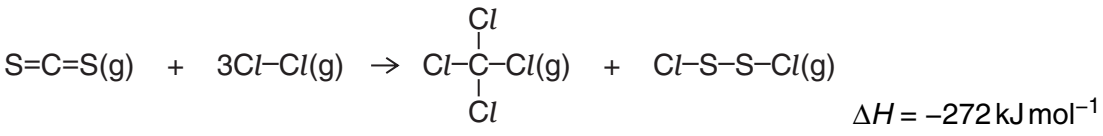
..... **[3]**

**[Total: 9]**

**3** This question is concerned with some halogenoalkanes that were, in the past, widely used industrially and in the home.

**(a)** Tetrachloromethane, $CCl_4$, was used as a dry cleaning solvent and in fire extinguishers.

$CCl_4$ was made by the reaction between chlorine and carbon disulphide, $CS_2$, as shown below.




Some bond enthalpies are given in **Table 3.1**.

| bond | bond enthalpy / kJ mol$^{-1}$ |
|---|---|
| C–Cl | +328 |
| C–F | +485 |
| C=S | +543 |
| S–Cl | +253 |
| S–S | +266 |

**Table 3.1**

Calculate the bond enthalpy for the Cl–Cl bond.

**[3]**

**(b)** Trichlorofluoromethane, $CFCl_3$, was used as a coolant and is still used in some inhalers. Its boiling point is 24 °C at 1 atm pressure.

Write the equation, including state symbols, for the enthalpy change of formation of $CFCl_3$ at 25 °C and 1 atm pressure.

..... **[2]**

**(c)** It is now known that $CFCl_3$ breaks down the ozone layer. For this reason, $CFCl_3$ is no longer manufactured in large quantities.

The first stage in ozone breakdown is the formation of a halogen free radical. This free radical catalyses the breakdown of ozone.

**(i)** Use the data in **Table 3.1** to suggest which free radical is formed from $CFCl_3$. Give a reason for your answer.

.....

.....

..... **[1]**

**(ii)** What type of catalysis is shown by the halogen free radical in the breakdown of ozone? Give a reason for your answer.

type of catalysis .....

reason .....

..... **[2]**

**[Total: 8]**

**4** The rate of many gaseous reactions is approximately doubled by a temperature increase of 10 °C. The number of collisions is only increased a small amount by this temperature rise.

Use a Boltzmann distribution to explain why an increase in temperature has such a significant effect on the rate of a reaction.

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..... **[4]**

**[Total: 4]**

**5** Nitric acid, $HNO_3$, is a strong acid which can react in a similar way to hydrochloric acid.

**(a)** Explain, with the aid of an equation, the meaning of the term *strong* applied to nitric acid.

.....

..... **[2]**

**(b)** **(i)** Write the equation for the reaction that occurs when solid magnesium carbonate, $MgCO_3$, is added to aqueous nitric acid.

..... **[1]**

**(ii)** What is **observed** when solid magnesium carbonate is added to aqueous nitric acid?

.....

..... **[1]**

**(iii)** Write the ionic equation for the reaction between solid magnesium carbonate and aqueous nitric acid.

..... **[1]**

**(c)** Nitric acid reacts with ammonia, $NH_3$, to form ammonium nitrate, $NH_4NO_3$.

$$NH_3(g) + HNO_3(aq) \longrightarrow NH_4NO_3(aq)$$

$NH_4NO_3$ can be used as a fertiliser because it contains a high percentage of nitrogen.

**(i)** Why does ammonia react with nitric acid?

..... **[1]**

**(ii)** Calculate the percentage, by mass, of nitrogen in $NH_4NO_3$.

**[2]**

**[Total: 8]**

**END OF QUESTION PAPER**

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