| Candidate Name | Centre Number | Candidate Number |
|---|---|---|
| | | 2 |

# GCE AS/A level

332/01

# CHEMISTRY CH2

P.M. FRIDAY, 9 January 2009

1½ hours

| FOR EXAMINER'S USE ONLY | | |
|---|---|---|
| Section | Question | Mark |
| A | 1-5 | |
| B | 6 | |
| | 7 | |
| | 8 | |
| | 9 | |
| TOTAL MARK | | |

## ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- copy of the **Periodic Table** supplied by WJEC.
  Refer to it for any **relative atomic masses** you require.

## INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

**Section A** Answer **all** questions in the spaces provided.
**Section B** Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (56 marks)**.

## INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 66.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 15 may be used for rough work.

## SECTION A

*Answer* **all** *the questions in the spaces provided.*

**1.** Draw the full structural (graphic) formula of 2-chloropropene. [1]

**2.** *(a)* Write the balanced equation for the thermal cracking of decane, $C_{10}H_{22}$, to form an alkane and ethene as the only products. [1]

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*(b)* Give **one** reason why cracking is an important industrial process. [1]

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**3.** *(a)* Complete the table, which refers to the effect that a change in conditions has on the position of equilibrium shown below. [2]

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

| *Change* | *Effect, if any, on position of equilibrium* | *Effect, if any, on value of* $K_P$ |
|---|---|---|
| Addition of reactant at constant temperature | | No effect |
| Drop in temperature | Shift to the right | |

*(b)* State the catalyst **and** the optimum pressure in the manufacture of ammonia in the Haber process. [2]

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**4.** State why ammonia is classified as a ***nucleophilic reagent***. [1]

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**5.** Name **one** type of commercial compound that accelerates the decomposition of ozone in the upper atmosphere and give **one** way in which this effect has been reduced in recent years. [2]

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**Section A Total [10]**

## SECTION B

*Answer* **all** *the questions in the spaces provided.*

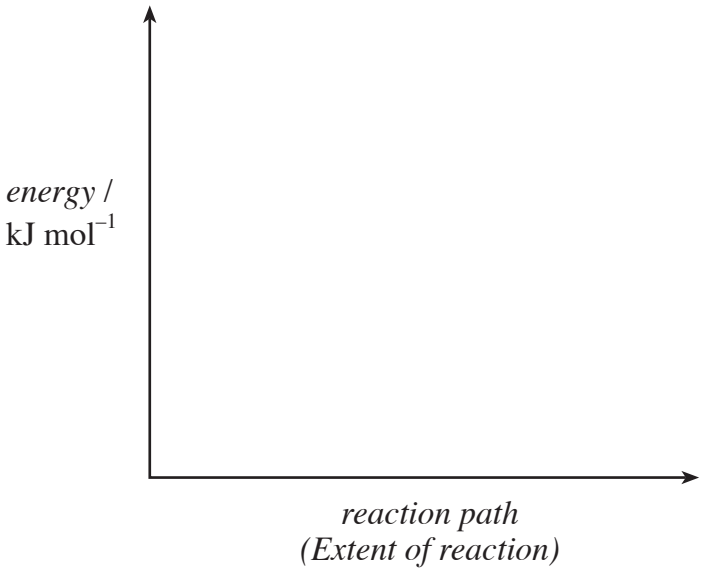
**6.** *(a)* The decomposition of gaseous hydrogen iodide, HI, is shown in the following equation.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = -53 \text{ kJ mol}^{-1}$$

Sketch and label on the axes below:

(i) the energy profile for the above decomposition; [1]

(ii) the energy profile for the same reaction if it were catalysed. [1]




(iii) I. Write an expression for the equilibrium constant, $K_P$, in terms of partial pressure, for the forward reaction. [1]

II. If the pressures are measured in atmospheres, state the units, if any, of $K_P$. [1]

.....

(iv) Use Le Chatelier's principle to explain what happens to the equilibrium yield of hydrogen iodide on increasing the pressure at constant temperature. [2]

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*(b)* State how the collision theory explains the effect of changes in temperature on the rate of a reaction. [3]

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*(c)* Washing soda, which is hydrated sodium carbonate, has been used for generations as a means of cleaning clothes and softening water.

Standard hydrochloric acid solution can be used to determine the percentage of sodium carbonate in washing soda.

4·75 g of washing soda are contained in 250 $cm^3$ of solution. A 25·0 $cm^3$ portion of the aqueous solution required 33·2 $cm^3$ of 0·100 mol $dm^{-3}$ aqueous hydrochloric acid solution for neutralisation.

(i) Calculate the number of moles of hydrochloric acid used. [1]

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(ii) Sodium carbonate reacts with aqueous hydrochloric acid according to the equation below.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

Use the equation to deduce the number of moles of sodium carbonate in the 25·0 $cm^3$ portion of the washing soda solution neutralised by the hydrochloric acid. [1]

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(iii) Use your answer to part (ii) to calculate the number of moles of sodium carbonate in the original 250 $cm^3$ solution. [1]

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(iv) Calculate the mass, in grams, of sodium carbonate in the original washing soda solution. [1]

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(v) Calculate the percentage by mass of sodium carbonate in the washing soda. [1]

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Total [14]

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**7.** *(a)* (i) State what is meant by the term ***standard molar enthalphy change of formation***. [2]

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(ii) The enthalpy change of formation values for nitrogen dioxide, $NO_2$, and nitrogen monoxide, NO, are given below.

| *Compound* | $\Delta H_f^{\ominus}$ /kJ mol$^{-1}$ |
|---|---|
| $NO_2(g)$ | +33·2 |
| NO(g) | +90·3 |

State, giving a reason, which of these two oxides is more stable. [1]

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(iii) Using the data in the table above, calculate the enthalpy change for the following reaction, in kilojoules per mole. [2]

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

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(iv) Write a balanced equation for the reaction of $NO_2$ with water and oxygen to form nitric acid, $HNO_3$, as the only product. [1]

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*(b)* Acids can be classified as strong or weak. Dilute aqueous nitric acid is a strong acid, while dilute aqueous ethanoic acid is a weak acid, which dissociates according to the following equation.

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

(i) Write an expression for the acid dissociation constant, $K_a$, of ethanoic acid and give the units. [2]

Units .....

(ii) Explain the meaning of the terms ***strong*** and ***dilute*** as applied to acid solutions. [2]

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(iii) Use Le Chatelier's principle to explain what happens to the position of equilibrium if a small amount of dilute aqueous sodium hydroxide is added to the solution. [2]

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*(c)* Give one chemical test which could be used to confirm the presence of a carboxylic acid group, –COOH, in ethanoic acid. Your answer should include all reagents and observations. [2]

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Total [14]

**8.** *(a)* Ethene can be used as a starting material for the manufacture of a wide range of chemicals.

(i) Complete the following table which refers to reactions of ethene. [5]

| *Type of Reaction* | *Name of reagent(s)* | *Condition(s)* | *Structural formula of organic product* |
|---|---|---|---|
| Polymerisation | Not required | Not required | |
| Catalytic hydrogenation | Hydrogen | | |
| | Bromine | Not required | |

(ii) Ethene can be prepared under certain conditions from bromoethane.

Name the reagent and condition(s) necessary to convert bromoethane to ethene and classify the type of reaction. [2]

*Reagent and condition(s)* .....

*Reaction type* .....

(iii) Briefly describe the structure of and bonding in ethene. [3]

A diagram may be used in support of your answer.

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*(b)* Ethene is the simplest alkene. Explain why it has a lower boiling temperature than but-1-ene, $C_4H_8$. [2]

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*(c)* But-1-ene is one of the isomers for the alkene $C_4H_8$.

Draw the structures for two **other** isomers of $C_4H_8$. [2]

Isomer 1 Isomer 2

Total [14]

**9.** *(a)* Petroleum (crude oil) is one of the major raw materials of the organic chemical industry. It is a mixture of compounds, mainly from the homologous series of alkanes.

Name the process by which alkanes are extracted from petroleum. [1]

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*(b)* Methane can react with chlorine in the presence of ultraviolet light to form chloromethane, $CH_3Cl$.

By means of relevant equations, show the mechanism of this reaction. [3]

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*(c)* Propane is a constituent of liquefied petroleum gas (LPG). Propane burns in air to form carbon dioxide and water. The equation for the reaction is given below.

Calculate the enthalpy change, in kJ $mol^{-1}$, for the above reaction by using the average bond enthalpy values given in the table below. [3]

| *Bond* | *Average bond enthalpy*/kJ $mol^{-1}$ |
|---|---|
| C – C | 348 |
| C – H | 412 |
| O – H | 463 |
| O = O | 496 |
| C = O | 743 |

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*(d)* In the inorganic chemical industry a greater mass of sulphuric acid is produced than any other compound.

Write an account of the Contact process for the manufacture of sulphuric acid.

Your account should cover

- the raw materials used in the process;
- the operating conditions and the chemical principles underlying the choice of these conditions;
- the method for obtaining the final product;
- any relevant equations. [7]

Total [14]

**Section B Total [56]**

Examiner only

## Rough Work