Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

WJEC
CBAC

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch Gyfrannol/Uwch

332/01

CHEMISTRY CH2

A.M. WEDNESDAY, 11 January 2006

(1 hour 30 minutes)

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 14 may be used for rough work.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

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

1. *(a)* State the systematic name of Compound **Y**, whose structure is
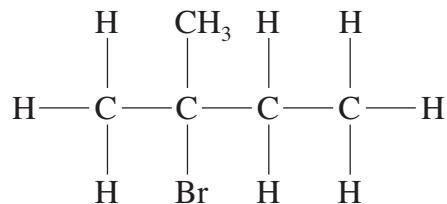
.... [1]

(b) Compound **Y** reacts to form Compound **Z**, whose structure is
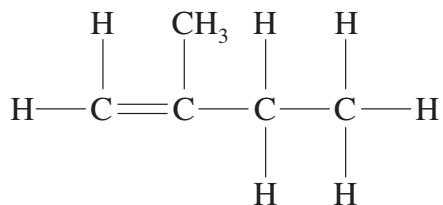
State which **one** of the following is the type of reaction that occurs when Compound **Z** is made from Compound **Y**.

 A Substitution

 B Addition

 C Elimination

 D Hydrolysis

.... [1]

2. The diagram below shows the reaction profile for an endothermic process. Indicate on the diagram

   (i)   the activation energy, E_f, for the forward reaction and

   (ii) the overall enthalpy change, ΔH, for the reaction. [2]

enthalpy / kJ mol^{-1}

reaction path (extent of reaction)
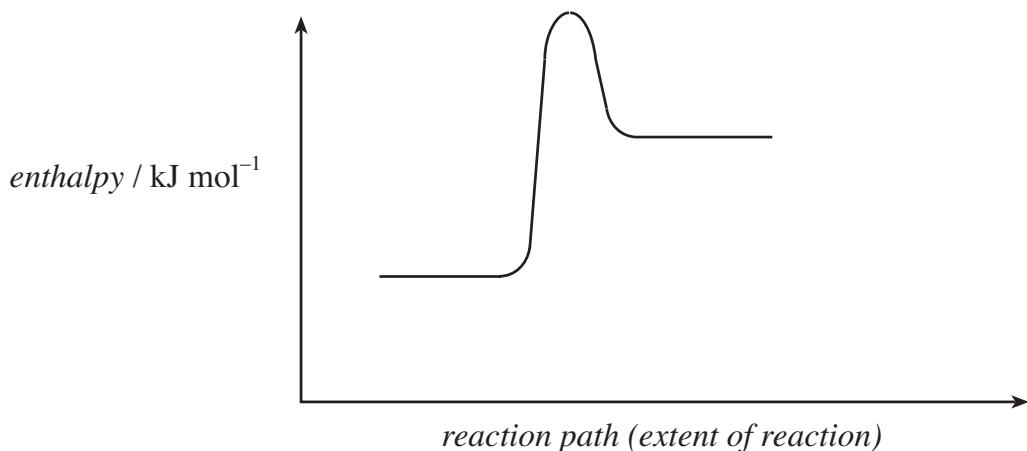
3. Aqueous methanoic acid, HCOOH, reacts with limescale (calcium carbonate) in kettles. State what you would see in this reaction and how you would confirm the identity of one of the products. [3]

Observation ....

Identification ....

....

Turn over.

4. Bronze is an alloy consisting largely of copper. In Ancient History, the Bronze Age occurred before the Iron Age. Use the information in the table below, which shows the standard enthalpy of formation of two oxides, to suggest a reason for this. [1]

compound	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$CuO(s)$	-155
$Fe_2O_3(s)$	-822

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5. State which **one** of the following is the **most** soluble in water.

    A   Hexan-1-ol

    B   2-Methylbutane

    C   Propene

    D   Propanoic acid   .... [1]

6. Silver metal is produced when silver bromide is exposed to light during photography. State **one** way, other than by changing the temperature, in which this decomposition can be made faster. [1]

....

Section A Total [10]

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SECTION B

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

7. *(a)* Read the short account written below and then answer the questions that follow.

One method of producing a halogenoalkane is by the direct halogenation of an alkane. An example of this method is the reaction of methane with chlorine in the presence of ultraviolet light, giving chloromethane as one of the products.
This reaction is an example of free radical substitution.

(i) Write the equation for the reaction between methane and chlorine that gives chloromethane as one of the products. [1]

....

(ii) State what is meant by the term **free radical**. [1]

....

(iii) Write an equation that shows the initiation stage of this free radical substitution. [1]

....

(iv) Explain, in terms of the reaction mechanism, how the reaction can proceed further to give dichloromethane as another product. [1]

....

....

(v) Chlorine reacts with ethane in a similar way to its reaction with methane. Explain how butane, $CH_3CH_2CH_2CH_3$, occurs as one of the products in the reaction of ethane with chlorine. [2]

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(b)   The cracking of alkane hydrocarbons can also proceed by a free radical mechanism.

   (i)   Complete the equation below by giving the graphic (full structural) formula of the other product that is obtained by cracking a molecule of nonane, C_9H_{20}. [1]

C_9H_{20} $\longrightarrow$ +
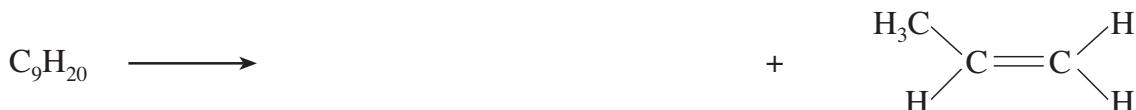
   (ii)   Name this other product .... [1]

(c)   Propene reacts with hydrogen bromide to give 2-bromopropane as the major product.

   (i)   Using the reaction scheme below, show the mechanism of the reaction using curly arrows and negative and positive charges as appropriate.   [2]
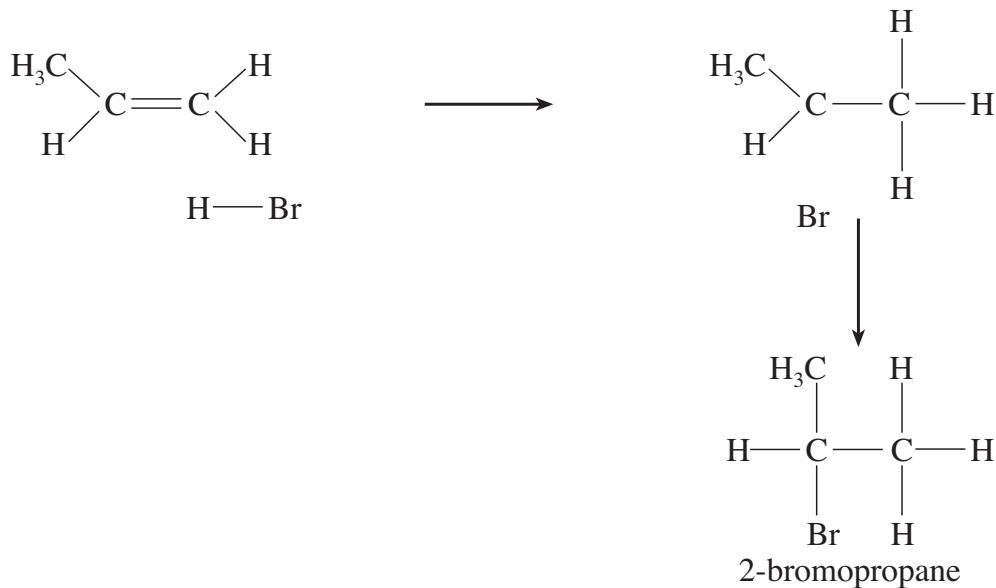
2-bromopropane

   (ii)   State briefly, why 2-bromopropane, rather than 1-bromopropane, is the main product of this reaction.   [1]

....

(d)   Describe, giving necessary reactants and observations, how you would detect the presence of a bromine atom in 2-bromopropane.   [2]

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Total [13]

Turn over.

8. *(a)* Ethanoic acid, CH_3COOH, is made by reacting methanol with carbon monoxide in the presence of a homogeneous catalyst.

$$CH_3OH \quad + \quad CO \quad \rightleftharpoons \quad CH_3COOH$$

(i) Explain what is meant by the term **homogeneous**. [1]

....

(ii) Write the expression for the equilibrium constant in terms of concentrations, K_c, for this reaction. [1]

(iii) This process is run at a pressure of 50 atmospheres. State how the value of K_c would change, if at all, if this reaction were run at a pressure of 70 atmospheres. [1]

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(iv) The process, which is exothermic in the forward direction, is maintained at 300 °C. State and explain the effect on the equilibrium yield of ethanoic acid if the reaction temperature were increased to 400 °C. [2]

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(b) Vinegar, an aqueous solution of ethanoic acid, is formed by the slow oxidation of aqueous ethanol in the presence of a suitable micro-organism.

$$CH_3CH_2OH \quad + \quad O_2 \quad \longrightarrow \quad CH_3COOH \quad + \quad H_2O$$

(i) Explain, in terms of the collision theory, why this reaction is fastest at the start of the process. [2]

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(ii) Suggest a method by which the concentration of ethanoic acid in the vinegar could be determined at different stages **during** the process. [1]

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(iii) A traditional method for finding the concentration of ethanoic acid in the final vinegar product is to react it with solid sodium carbonate.

$$2CH_3COOH \quad + \quad Na_2CO_3 \quad \longrightarrow \quad 2CH_3COONa \quad + \quad CO_2 \quad + \quad H_2O$$

In an experiment, 0·0120 mole of sodium carbonate reacted exactly with the ethanoic acid in a sample of vinegar of volume 25·0 cm^3.

Giving your answers to three significant figures,

I. state the number of moles of ethanoic acid present, [1]

....

II. calculate the concentration of ethanoic acid in mol dm^{-3}. [1]

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III. The concentration of vinegar is usually given as a percentage (i.e. the number of grams of ethanoic acid in 100 cm^3 of solution).
Use the value obtained in II. to find the concentration of ethanoic acid (M_r 60) in g dm^{-3} and then as a percentage. [2]

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(c) Aqueous ethanoic acid and hydrochloric acid both react with magnesium to form hydrogen. Explain why, when the acids have the same concentration and are added separately to similar samples of magnesium, hydrogen is given off more slowly from the ethanoic acid. [2]

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Total [14]

Turn over.

9. *(a)* The smell of some rotting vegetables is due to small quantitites of carbon disulphide, CS_2. Carbon disulphide is a colourless liquid that is dangerously flammable, burning to give carbon dioxide and sulphur dioxide gases.

(i) Outline one environmental problem caused by each of these gases and state one step that can be taken to counteract the problem.

Carbon dioxide ....

....

.... [2]

Sulphur dioxide ....

....

.... [2]

(ii) Use the values given in the enthalpy cycle below to calculate the enthalpy of combustion of carbon disulphide, ΔH_c, in kJ mol^{-1}. [2]

$$\underset{}{CS_2} \quad + \quad 3O_2 \quad \xrightarrow{\Delta H_c} \quad CO_2 \quad + \quad 2SO_2$$

+90 kJ mol^{-1} −394 kJ mol^{-1} 2(−297) kJ mol^{-1}

Elements in their standard states

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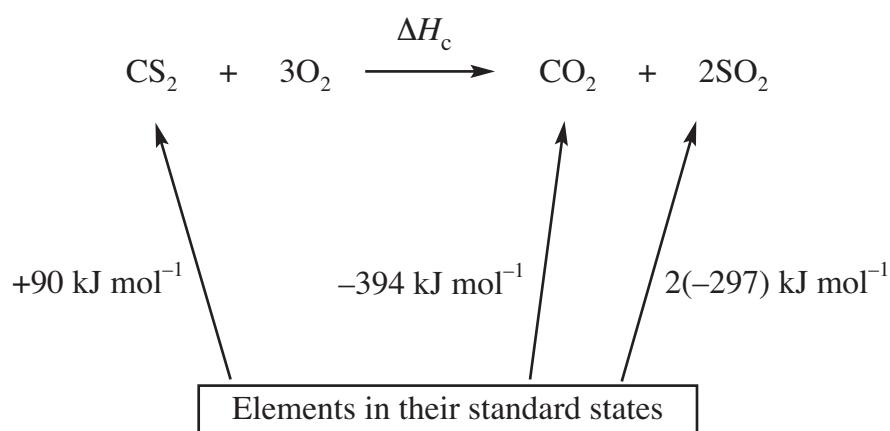
(b) Ethene gas, produced by a banana plant, accelerates the ripening of bananas.

(i) State the reagent used to test for ethene and the expected observation. [2]

Reagent ....

Observation ....

....

(ii) Ethene reacts with steam in the presence of a catalyst under suitable conditions of pressure and temperature.

I. State the type of reaction that occurs. .... [1]

II. Give the graphic (full structural) formula of the compound produced. [1]

(c) A **branched** alkene, **T**, contains four carbon atoms per molecule.

(i) State the empirical formula of the alkene, **T**. ....[1]

(ii) State the molecular formula of the alkene, **T**. ....[1]

(iii) Use the information given to deduce the graphic (full structural) formula of alkene **T**. [1]

(iv) State, giving a reason, whether the alkene, **T**, can exist as cis-trans isomers. [2]

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Total [15]

Turn over.

10. *(a)* Chlorine(I) oxide, Cl_2O, used to bleach wood pulp, readily decomposes into chlorine and oxygen gases.

$$2 \; Cl \diagdown \diagup Cl(g) \longrightarrow 2 \; Cl - Cl(g) \quad + \quad O = O(g) \qquad \Delta H = -160 \text{ kJ mol}^{-1}$$
$$\qquad\quad O$$
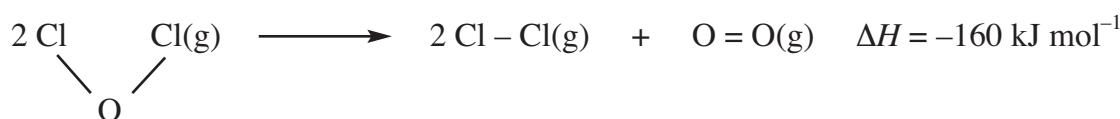
Use the enthalpy change for the reaction and the bond enthalpy values given in the table below to calculate the average bond enthalpy for the $Cl - O$ bond to three significant figures. [3]

Bond	*Average bond enthalpy*/kJ mol^{-1}
$Cl - Cl$	242
$O = O$	498

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(b) At a certain temperature, chlorate(I) ions, used in domestic bleaches, decompose into chloride ions, Cl^-, and chlorate(V) ions, ClO_3^-.

$$3 \; ClO^-(aq) \longrightarrow 2 \; Cl^-(aq) \quad + \quad ClO_3^-(aq)$$

The initial rate of formation of the chloride ion is $2\cdot4$ mol dm^{-3}min^{-1}.
Use the equation to calculate the initial rate of decomposition of the chlorate(I) ions in mol dm^{-3}min^{-1}. [1]

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(c) (i) Describe **briefly** how ethene is obtained from petroleum (crude oil) and then describe how ethene is used to produce low density poly(ethene).
Your answer should include

- the names of the methods used to obtain ethene from petroleum and the reasons why these methods are used,

- the conditions necessary to obtain low density poly(ethene) from ethene,

- an equation for the polymerisation process. [8]

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(ii) State **one** advantage and **one** disadvantage of the use of poly(ethene) in society.

Advantage ....

.... [1]

Disadvantage ....

.... [1]

Total [14]

Section B Total [56]

Turn over.

Rough Work