Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

332/01

CHEMISTRY CH2

A.M. WEDNESDAY, 4 June 2008

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
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.

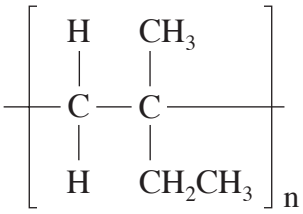
You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 15 may be used for rough work.

SECTION A

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

1. Select, from the list below, the compound that can be polymerised to give



A 2-methylbut-1-ene

B 2-methylbut-2-ene

C pent-1-ene

D pent-2-ene [1]

.....

2. (i) Name a reagent, used in alcoholic solution, to prepare ethene from bromoethane. [1]

.....

(ii) State the type of reaction occurring in (i) above. [1]

.....

3. The molecular formula of the gas cyclobutane is C_4H_8.

(i) Give the name of an **isomer** of cyclobutane that has *cis*- and *trans*- isomers. [1]

.....

(ii) State the minimum number of moles of oxygen gas necessary to completely burn one mole of cyclobutane to produce only carbon dioxide and water. [1]

.....

(iii) Write an equation, giving state symbols, that shows the standard enthalpy of formation of cyclobutane. [1]

.....

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4. Describe how the burning of fossil fuels can produce acid rain. [2]

.....

.....

.....

5. Give the **ionic** equation for the reaction that occurs between aqueous sodium hydroxide and dilute hydrochloric acid. [1]

.....

6. Which **one** of the following is a correct statement about a catalyst?

A It can only be used once.

B It only speeds up the forward reaction.

C It does not affect the position of equilibrium.

D It is always a solid. [1]

.....

Section A Total [10]

SECTION B

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

7. *(a)* Sulphur dichloride dioxide (sulphuryl chloride), SO_2Cl_2, is made by heating together sulphur dioxide and chlorine gases over a solid graphite catalyst.

(i) State the type of catalyst used in this reaction.

Type of catalyst ..... [1]

(ii) Give another catalyst of this type and the reaction for which it is used.

Catalyst .....

Reaction .....

..... [1]

(b) At higher temperatures, sulphuryl chloride dissociates into sulphur dioxide and chlorine.

$$SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g) \qquad \Delta H = +97 \text{ kJ mol}^{-1}$$

(i) Write the expression for the equilibrium constant in terms of partial pressures, K_p, for this reaction. [1]

(ii) A system containing sulphuryl chloride, sulphur dioxide and chlorine gases reaches equilibrium at 250 °C. More sulphur dioxide is added to this mixture. Explain why the temperature of the mixture rises. [2]

.....

.....

.....

(c) Under suitable conditions, sulphuryl chloride will chlorinate an alkane.

$$CH_4 + SO_2Cl_2 \longrightarrow CH_3Cl + SO_2 + HCl$$

(i) A hydrocarbon, C_4H_{10}, reacted with sulphuryl chloride in this way. One of the products was 1,2-dichloro-2-methylpropane.
Write the full graphic formula for this product. [1]

(ii) Describe a chemical test to show the presence of a C-Cl bond in compounds such as 1,2-dichloro-2-methylpropane. [2]

.....

.....

.....

(d) The reactions of an alkane with both sulphuryl chloride and with chlorine are believed to proceed via a chlorine free radical.

Complete the mechanism below to produce chloromethane. [2]

$CH_4 + Cl\bullet \longrightarrow$

(e) One of the side products from the chlorination of methane is a hydrocarbon that has a molar mass of 30 g mol^{-1}.

Identify this hydrocarbon and explain its formation in this reaction. [2]

.....

.....

(f) In a study of fuels, it was found that the complete combustion of 1 g of propane gave an enthalpy change of –50·3 kJ.

Calculate the molar enthalpy change of combustion of propane. [2]

.....

.....

.....

..... kJ mol^{-1}

Total [14]

8. *(a)* Gas oil is a hydrocarbon fraction obtained from petroleum.

(i) State how gas oil and other hydrocarbon fractions are obtained, starting from petroleum. [1]

.....

(ii) State why some of the gas oil fraction is cracked. [1]

.....

.....

(b) Tridecane, $C_{13}H_{28}$, is one of the compounds present in gas oil.
One of the equations used to represent the cracking of tridecane is shown below.

$$C_{13}H_{28} \longrightarrow \text{Compound } \mathbf{Z} + C_4H_6 + H_2$$

(i) Find the molecular formula of compound **Z** by using the equation. [1]

.....

(ii) Write the molecular formula of a compound which is in the same homologous series as compound **Z** but contains **six** carbon atoms per molecule. [1]

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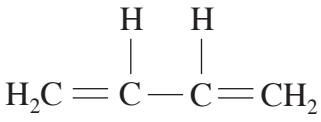
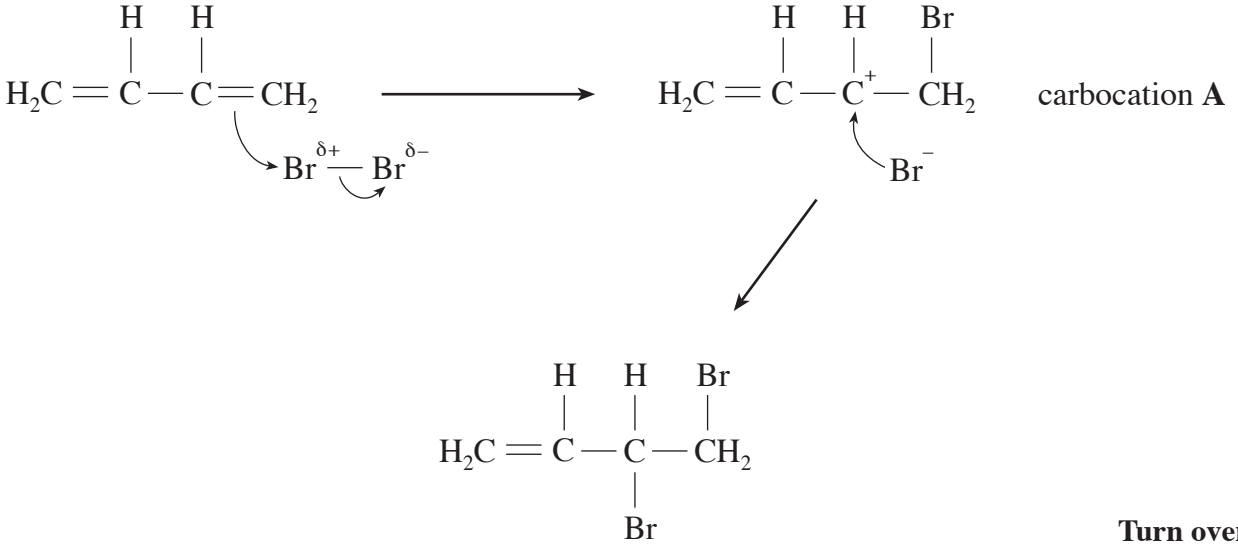
(c) Another of the products made by cracking tridecane is but-1, 3-diene,



which reacts with bromine to give several products.

(i) One of the products is 3, 4-dibromobut-1-ene, $CH_2=CH-CHBr-CH_2Br$.
A possible mechanism for this bromination is shown below.



I. State what is represented by a curly arrow. [1]

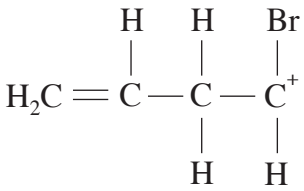
.....

II. State what is represented by the δ+ and δ– symbols on the bromine atoms. [1]

.....

.....

III. The mechanism shows the formation of a carbocation (carbonium ion) **A**.
Explain why, using your knowledge of the mechanism for the reaction of propene and hydrogen bromide, the mechanism is less likely to proceed via carbocation **B**. [1]



carbocation **B**

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.....

(ii) Another product of the bromination of but-1, 3-diene is 1, 4-dibromobut-2-ene.

$$BrCH_2 - CH = CH - CH_2Br$$

This shows geometrical isomerism.

I. Give the graphic formula of the *trans* isomer of this compound. [1]

II. Explain why 1, 4-dibromobut-2-ene shows geometrical isomerism. [1]

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.....

(iii) But-1, 3-diene slowly dimerises when heated above 200 °C as shown in the equation below.

$$2C_4H_6(g) \longrightarrow C_8H_{12}(g)$$

The table shows the initial concentration of but-1, 3-diene and its concentration after 200 seconds.

Concentration of but-1, 3-diene / mol dm^{-3}	*Time* / s
$1{\cdot}66 \times 10^{-2}$	0
$1{\cdot}60 \times 10^{-2}$	200

I. Use the values to calculate the initial rate of the reaction in mol $dm^{-3}s^{-1}$. [1]

.....

.....

..... mol $dm^{-3}s^{-1}$

II. State how the value for the rate of the reaction would change as the reaction proceeds at constant temperature, giving a reason for your answer. [2]

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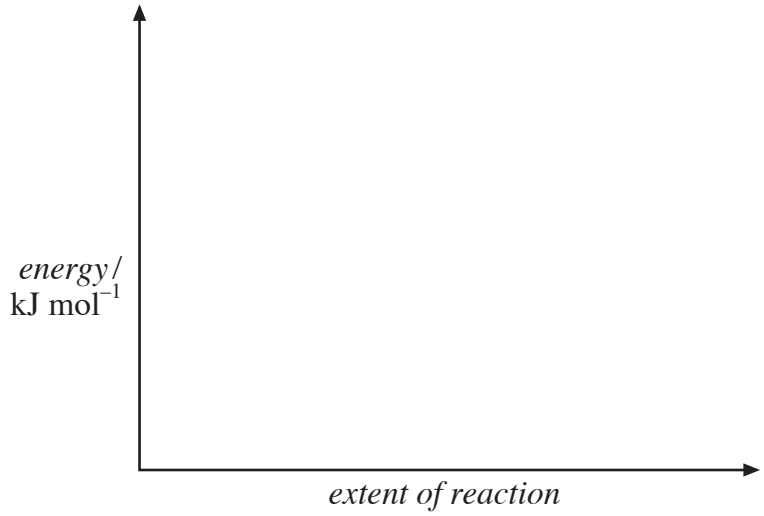
.....

.....

III. The dimerisation of but-1, 3-diene is an endothermic process.
Use the axes below to sketch the reaction profile for this reaction, indicating the activation energy, E_a. [2]



Total [14]

9. *(a)* (i) Name a compound that can be used in the laboratory to oxidise ethanol to ethanoic acid. [1]

.....

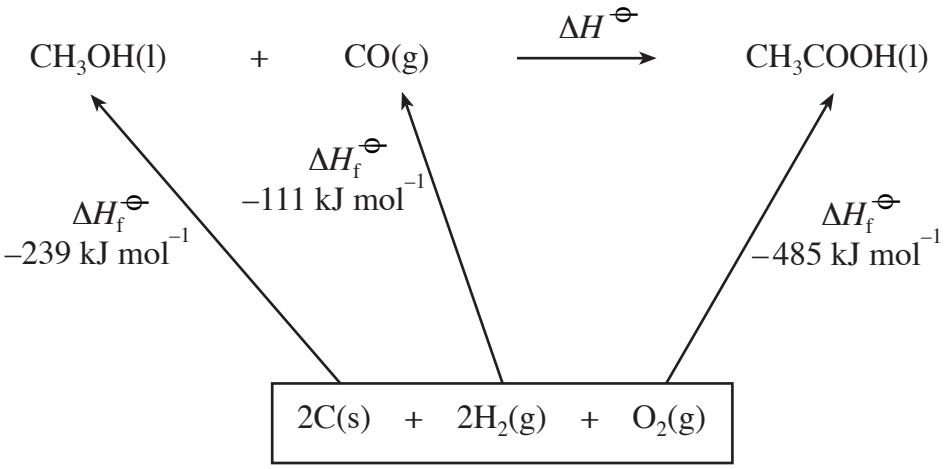
(ii) State the colour change that occurs during the oxidation of ethanol by the compound that you have chosen in (i). [1]

.....

(b) In industry, ethanoic acid is made by reacting methanol with carbon monoxide.

$$CH_3OH(l) + CO(g) \longrightarrow CH_3COOH(l)$$

The enthalpy change that occurs during this reaction can be found using the energy cycle below.



Use the given standard enthalpy of formation values, $\Delta H_f^{\ominus}$, to calculate the standard enthalpy change of reaction, $\Delta H^{\ominus}$, in kJ mol^{-1}. [2]

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.....

.....

.....

..... kJ mol^{-1}

(c) The enthalpy change of neutralisation for ethanoic acid can be calculated from the temperature rise that occurs when aqueous ethanoic acid is neutralised by aqueous sodium hydroxide. In an experiment, 50·0 cm^3 of aqueous ethanoic acid of concentration 1·20 mol dm^{-3} was exactly neutralised by 50·0 cm^3 of a sodium hydroxide solution.
After mixing, the maximum temperature rise (ΔT) was 7·9 °C.

You should assume that the mass of each solution is 50·0 g and that the specific heat capacity, c, of the mixture is 4·2 J g^{-1} $°C^{-1}$.

(i) Calculate the heat evolved, Q, by using the equation

$$Q = mc\Delta T$$

where m is the mass of the solution. [1]

.....

.....

.....

(ii) Use your answer to (i) to calculate the enthalpy change of neutralisation in kJ mol^{-1}. [2]

.....

.....

..... kJ mol^{-1}.

(d) The pH values of aqueous ethanoic and hydrochloric acids are shown in the table.

Acid	*Concentration* / mol dm^{-3}	*pH*
hydrochloric	0·050	1·30
ethanoic	0·080	2·93

Use the values given in the table to distinguish clearly between the **more concentrated** acid and the **stronger** acid, stating the acid to which you are referring and explaining your answer. [2]

More concentrated .....

.....

Stronger .....

.....

(e) The boiling temperature of pentan-1-ol is 138 °C. For the two compounds below, state, giving a reason in each case, whether the boiling temperature is the same as, lower or higher than the value given for pentan-1-ol. [2]

Pentane .....

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Hexan-1-ol .....

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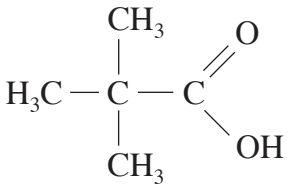
(f) A carboxylic acid **T** has the formula shown below.



(i) Write the graphic formula of the primary alcohol which is oxidised to form acid **T**, stating the name of the alcohol.
The use of CH_3 when drawing a methyl group is acceptable. [2]

Formula

Name .....

(ii) The molecular formula of acid **T** is $C_5H_{10}O_2$.
Explain why the molecular formula does not necessarily mean that the compound is an acid. [1]

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.....

.....

Total [14]

10. (i) Briefly outline the preparation of ammonia by the Haber process.
Your answer should include:

- the raw materials used in the process and their sources;
- an equation for the reaction;
- the conditions used for the process and why these conditions are chosen. [6]

(ii) State **two** economic or technical factors that should be taken into account when considering the siting and operation of a plant that manufactures ammonia. [2]

(iii) A sample of concentrated aqueous ammonia, of volume 5·00 cm^3, was diluted by the addition of water.
This diluted solution needed 35·0 cm^3 of a hydrochloric acid solution of concentration 2·00 mol dm^{-3} for complete neutralisation.

$$NH_3(aq) + HCl(aq) \longrightarrow NH_4Cl(aq)$$

I. Calculate the number of moles of hydrochloric acid used. [1]

II. State the number of moles of ammonia present in the diluted solution and hence the number of moles of ammonia present in 5·00 cm^3 of the concentrated solution. [1]

.....

.....

III. Calculate the concentration of the concentrated ammonia solution in mol dm^{-3}. [1]

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(iv) Ammonia is used to make fertiliser **Z** that contains only nitrogen, hydrogen, carbon and oxygen.

- 1 mole of **Z** contains 28 g of nitrogen
- The relative molecular mass of **Z** is 60
- **Z** contains one atom each of carbon and oxygen per molecule

I. State the number of atoms of nitrogen in each molecule of **Z**. [1]

.....

II. Use your answer to I. to deduce the number of atoms of hydrogen in each molecule of **Z**. [1]

number of hydrogen atoms .....

III. Give the molecular formula of fertiliser **Z**. [1]

.....

Total [14]

Section B Total [56]

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Rough Work