

Candidate Name	Centre Number	Candidate Number
		2



**General Certificate of Education  
Advanced Subsidiary/Advanced**

332/01

**CHEMISTRY CH2**

A.M. THURSDAY, 10 January 2008

(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)**.

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-8	
B	9	
	10	
	11	
	12	
TOTAL MARK		

**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.

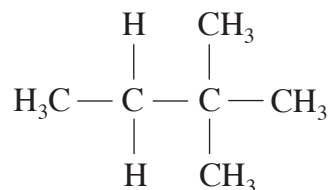
Page 14 may be used for rough work.

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

## SECTION A

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

1. State the systematic name for the compound having the following structure. [1]



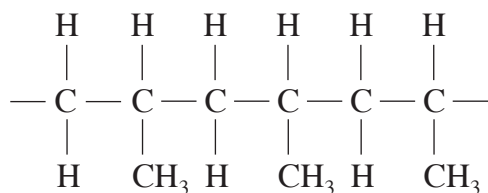
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2. State the reagent(s) and condition(s) necessary for the oxidation of a primary alcohol to a carboxylic acid. [2]

Reagent(s) .....

Condition(s) .....

3. Draw the structure of the alkene monomer used to form the polymer of which the following structure represents part of the chain. [1]



Monomer structure:

4. Explain the terms

(i) *dynamic equilibrium*,

[1]

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.....

(ii) *activation energy*.

[1]

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.....

5. State which **one** of the following can be determined from the tangent to a graph of reactant concentration versus time: [1]

- A the equilibrium constant  $K_c$ ;
- B the temperature change during the reaction;
- C the rate of the reaction;
- D the activation energy of the reaction.

.....

6. State which of the following letters represent formulae of **alkanes**.

[1]

- A  $\text{CH}_4$
- B  $\text{C}_6\text{H}_6$
- C  $\text{C}_{10}\text{H}_{18}$
- D  $\text{C}_{12}\text{H}_{26}$

.....

7. The acid dissociation constants,  $K_a$ , for methanoic acid and ethanoic acid are

methanoic acid  $1.6 \times 10^{-4} \text{ mol dm}^{-3}$

ethanoic acid  $1.7 \times 10^{-5} \text{ mol dm}^{-3}$

State, giving your reasons, which of the two is the stronger acid. [1]

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8. In which **one** of the following is water,  $\text{H}_2\text{O}$ , behaving as a base? [1]



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**Section A Total [10]**

**SECTION B**

*Answer all questions in the spaces provided.*

9. (a) An aqueous solution of sodium hydrogensulphate,  $\text{NaHSO}_4$ , reacts with sodium hydroxide solution according to the following equation.



In one experiment, 3.0 g  $\text{NaHSO}_4$  was dissolved in water to give 50 g of solution which was then mixed with 50 g of sodium hydroxide solution (a slight excess).

- (i) Giving your reason(s), state whether the temperature would rise or fall on mixing the two solutions. [1]

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- (ii) Calculate the number of moles of  $\text{NaHSO}_4$  in 3.0 g. [1]

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- (iii) Using the given value of  $\Delta H^\ominus$ , calculate the energy change when this number of moles of  $\text{NaHSO}_4$  reacts with  $\text{NaOH}$ , giving your answer in joules (J). [1]

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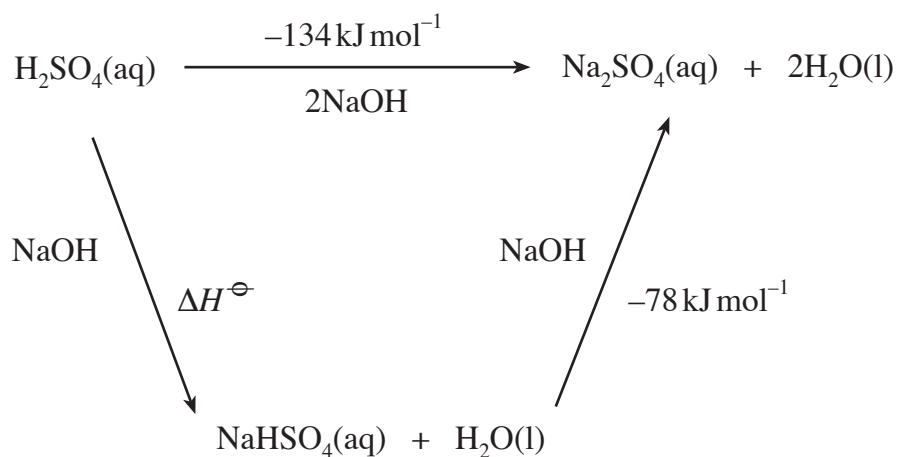
- (iv) Calculate the temperature change,  $\Delta T$ , on reacting the two solutions, given that

$$\text{Energy Change} = \text{Total mass of solution} \times \text{Heat Capacity} \times \Delta T$$

$$\text{and the Heat Capacity} = 4.2 \text{ J K}^{-1} \text{ g}^{-1} \quad [2]$$

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- (b) Sulphuric acid,  $\text{H}_2\text{SO}_4$ , has two acidic hydrogens. The equation in (a) represents neutralisation of the second hydrogen. Use the following cycle to calculate  $\Delta H^\ominus$ , the enthalpy change when the first hydrogen is neutralised.



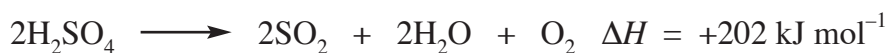
[2]

- (c) The Contact Process for the production of sulphuric acid has three main stages:

- the production of  $\text{SO}_2$ ;
  - the oxidation of  $\text{SO}_2$ ;
  - the absorption of  $\text{SO}_3$ .
- (i)  $\text{SO}_2$  can be produced by burning sulphur in air.



In recent years a process has been developed whereby “spent” (used) sulphuric acid can be recycled to generate  $\text{SO}_2$ .



Give **one** advantage and **one** disadvantage of using spent sulphuric acid to generate  $\text{SO}_2$  compared with burning sulphur in air. [2]

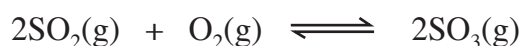
*Advantage* .....

.....

*Disadvantage* .....

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(ii) The oxidation of  $\text{SO}_2$  is a reversible reaction.



I. Write the expression for the equilibrium constant,  $K_p$ , for this reaction.

[1]

II. State the temperature and catalyst used in industry to carry out this oxidation.

[2]

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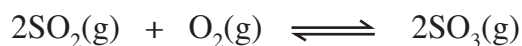
(iii) The Double Contact Process is now used in which the gaseous reactants in (c)(ii) are passed over the catalyst in the reaction vessel twice.

State what effect, if any, increasing the time the gases are in contact with the catalyst has on the position of equilibrium.

[1]

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(iv) By applying Le Chatelier's Principle to the equilibrium below,



explain how removing some of the  $\text{SO}_3$  leads to an increased yield of  $\text{SO}_3$ . [1]

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Total [14]

10. Trichloroethene,  $C_2HCl_3$ , was previously widely used to degrease metal and glass and to extract chemicals from food. In America it is still one of the commonest organic pollutants in groundwater.

(a) (i) Draw the full graphic structure of trichloroethene. [1]

(ii) Giving your reasons, state whether trichloroethene will occur as cis- and trans-isomers. [2]

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(b) One method of manufacturing trichloroethene was to heat 1,1,2,2-tetrachloroethane with a catalyst at  $400\text{ }^\circ\text{C}$ , when hydrogen chloride and trichloroethene were the two products.

(i) Write a balanced equation for this reaction. [1]

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(ii) Classify the type of reaction occurring. [1]

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(c) In groundwater, trichloroethene is slowly hydrolysed to produce compound **A**, which contains a carboxylic acid group,  $-\text{COOH}$ .

(i) Describe a test, including reagent(s) and expected observation(s), which could be used to confirm that compound **A** contains a carboxylic acid functional group. [2]

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- (ii) Compound **A** can be titrated against sodium hydroxide solution in a 1:1 mole ratio. In one experiment, 0.258 g of **A** required 20.00 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> NaOH for complete reaction. Calculate the number of moles of **A** used and hence the relative molecular mass,  $M_r$ , of **A**. [2]

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- (iii) Analysis of compound **A** showed that it contained 18.60% C, 1.57% H, 24.80% O and 55.03% Cl by mass. Calculate the empirical formula of **A**. [2]

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- (iv) Using your answers to part (c), determine the molecular formula of **A** and draw its structural formula. [2]

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Total [13]

11. (a) Petrol is a mixture of alkanes. Short-chain alkanes burn more evenly in a car engine than long-chain alkanes and branched alkanes burn more evenly than straight-chain alkanes.

(i) The proportion of short-chain alkanes can be increased by thermal cracking.

I. Thermal cracking involves the *homolytic fission of a C-C bond*. Explain the meaning of *homolytic fission of a C-C bond*. [2]

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II. A molecule of decane,  $C_{10}H_{22}$ , can be cracked to form two molecules, both of which contain five carbon atoms. Name both the molecules produced. [2]

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(ii) The proportion of branched alkanes can be increased by thermal reforming, in which heating to  $500\text{ }^{\circ}\text{C}$  at a high pressure causes straight-chain alkanes to isomerise. Draw the structures of two isomers of pentane which could be formed by thermal reforming. [2]

(b) Alkenes, unlike alkanes, generally undergo electrophilic addition reactions.

(i) Explain what is meant by *electrophilic addition in alkenes*. [2]

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- (ii) Name the main product formed when hydrogen bromide, HBr, is added to propene. [1]

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- (iii) Give the mechanism of the addition of HBr to propene to give the compound produced in (ii). [3]

- (iv) Explain why only one product can be formed when hydrogen bromide, HBr, is added to but-2-ene. [1]

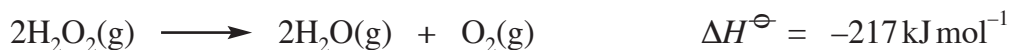
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- (c) Write a balanced equation to show the **hydrogenation** of propene and name the catalyst used for this reaction. [2]

*Equation* .....

*Catalyst* .....

Total [15]

12. (a) Hydrogen peroxide,  $\text{H}_2\text{O}_2$ , can decompose in the gas phase to water and oxygen.



- (i) If the activation energy for the forward reaction is  $112 \text{ kJ mol}^{-1}$ , calculate the activation energy for the reverse reaction. [1]

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- (ii) The structure of hydrogen peroxide contains three single covalent bonds.



Given the bond energies O-H  $464 \text{ kJ mol}^{-1}$  and O=O  $498 \text{ kJ mol}^{-1}$ , use the above equation and  $\Delta H^\ominus$  value to calculate a value for the O-O bond energy in hydrogen peroxide. [3]

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- (b) The same decomposition occurs in aqueous solution.



- (i) Outline a method, including a sketch of the apparatus, which could be used to measure the rate of this reaction. [3]

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(ii) Various metal compounds, such as potassium chromate(VI), catalyse the decomposition of hydrogen peroxide if they are dissolved in the aqueous solution. Using this reaction and the Haber process as examples, discuss the role of catalysts in reactions. Your answer should include

- the reason(s) for using catalysts
- how a catalyst works
- homogeneous and heterogeneous catalysts
- the effect of a catalyst on equilibrium.

[4]

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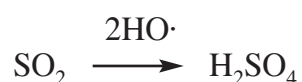
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(c) The hydroxyl radical, HO·, is important in the chemistry of the Earth's atmosphere. The scheme below gives, as a simplified example, one route to the formation of acid rain.



(i) HO· is an example of a *free radical*. Explain the meaning of this term. [1]

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(ii) From the information given, explain why UV light from the sun is necessary for the formation of acid rain by this route. [1]

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(iii) State **one** problem associated with acid rain. [1]

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Total [14]

**Section B Total [56]****Turn over.**

