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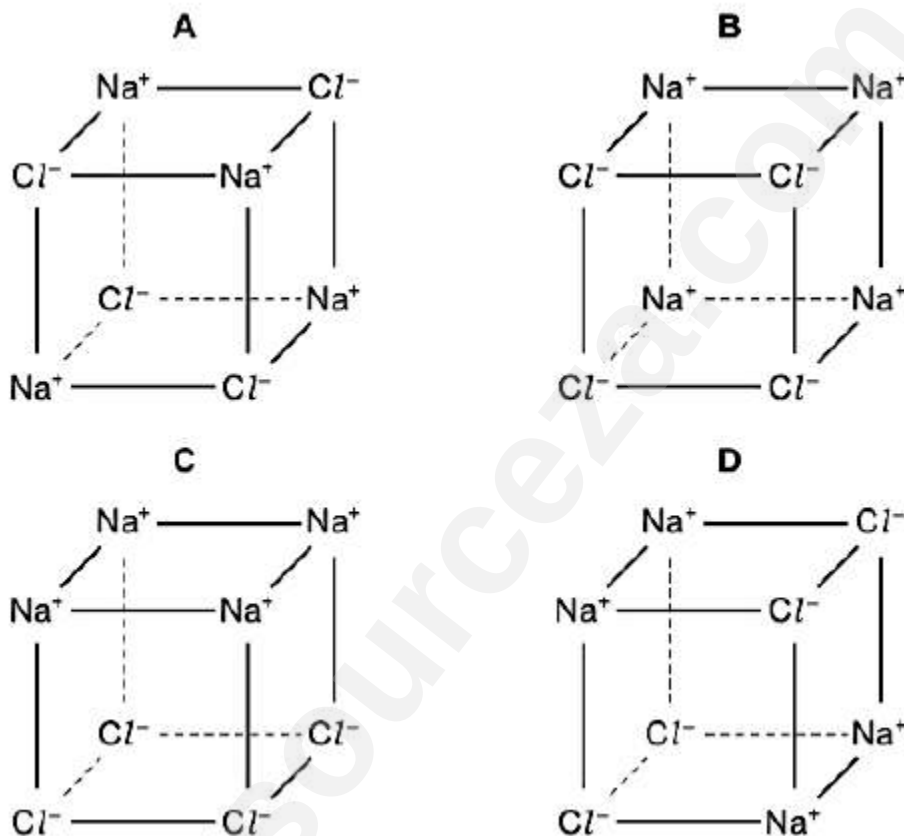
DE LA SALLE HOLY CROSS COLLEGE**Grade 12****Date: 28 September 2020****Physical Science PII: Chemistry****Total: 200 marks****Preliminary Examination****Time: 3 hours****Examiner: A. Kamedza****Moderator: I. Krynauw****INSTRUCTIONS AND INFORMATION**

1. This question paper consists of 13 pages and 2 formula sheets are attached.
2. This question paper consists of EIGHT questions. Answer ALL the questions on folio paper. Write neatly and legibly.
3. Number the answers correctly according to the numbering system used in the question paper.
4. Leave ONE line open between two subsections, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places or THREE SIGNIFICANT FIGURES.

Question 1 Multiple Choice

Choose the correct answer and write the appropriate letter (A-D) next to the question number on your answer sheet, e.g. 1.1 E

1.1 Which diagram correctly shows the arrangement of ions in sodium chloride?



1.2 In which of the following substances is London forces present?

- A CH₄
- B H₂O
- C NaCl
- D HCl

1.3 The decomposition of water can be represented by the following equation:



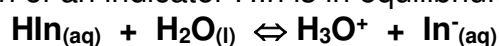
Use the chemical equation to deduce the magnitude and nature of the heat of the reaction that produces two moles of water.

- A $\Delta H = -571,8 \text{ kJ}$
- B $\Delta H = 571,8 \text{ kJ}$
- C $\Delta H = 1143,6 \text{ kJ}$
- D $\Delta H = -1143,6 \text{ kJ}$

- 1.4 Which ONE of the following substances will show the greatest conductivity when in solution at the same concentration?

- A HCl
- B CH_3COOH
- C $\text{Mg}(\text{OH})_2$
- D H_2CO_3

- 1.5 An aqueous solution of an indicator HIn is in equilibrium:

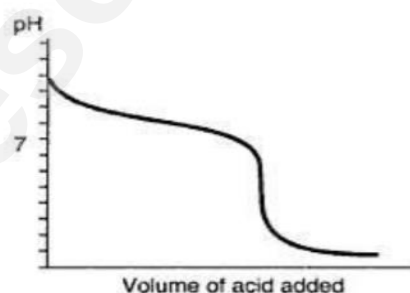


A few drops of this indicator are added to a dilute HCl solution. The table below gives the colours of the species involved.

Species	Colour
$\text{HIn}_{(\text{aq})}$	Yellow
$\text{In}^-_{(\text{aq})}$	Red
$\text{HCl}_{(\text{aq})}$	Colourless
Indicator and end point	Orange

What is the colour of the HCl solution after the indicator has been added?

- A Red
 - B Yellow
 - C Orange
 - D Colourless
- 1.6 The titration curve below represents the equivalence point attained during a titration between a ...

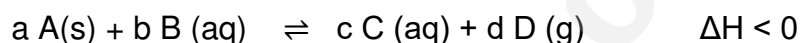


- A strong acid and weak base.
- B strong acid and strong base.
- C strong base and weak acid.
- D weak acid and weak base.

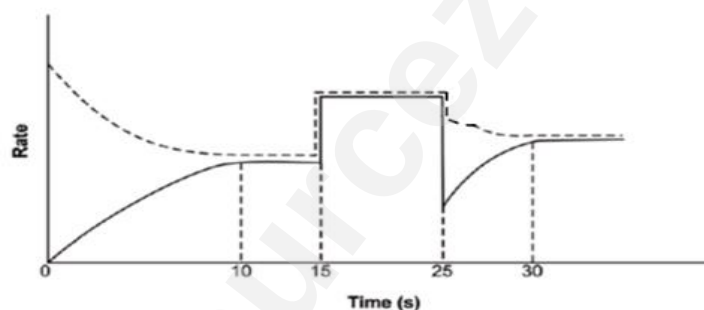
- 1.7 A system is at equilibrium. If the system is cooled, which of the following will change?
- I The rates of the forward and reverse reaction.
 - II Equilibrium constant, K_c
 - III Equilibrium position

- A I only
- B I and II only
- C I and III only
- D I, II and III

- 1.8 A hypothetical chemical reaction in a closed container is represented by the following chemical equation.



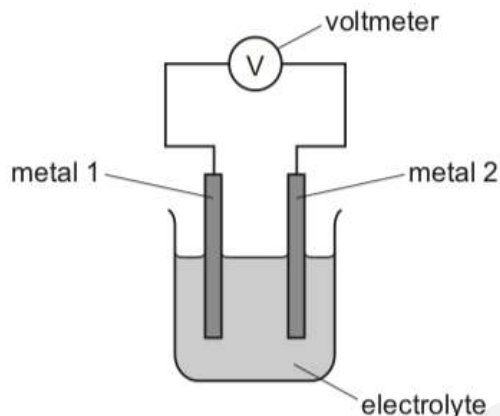
The graph below represents the rates of the forward and reverse reactions plotted as a function of time:



Which one of the following statements correctly describes the factors that caused the change in reaction rate?

	Disturbance at 15 s	Disturbance at 25 s
A	Surface area of A was increased	The pressure of the system was increased.
B	A catalyst was added.	The temperature was decreased.
C	The temperature was increased.	The surface area of A was decreased.
D	The pressure was decreased.	The temperature was increased.

1.9 Pairs of metals are connected together to make a simple cell as shown below:



The table below shows the resulting reading on the voltmeter when different metals are used. If metal 2 is more reactive than metal 1, the voltmeter reading is positive.

		metal 2			
		beryllium	cerium	cobalt	manganese
metal 1	beryllium	0.00 V	+0.64 V	-1.57 V	-0.67 V
	cerium		0.00 V	-2.21 V	-1.30 V
	cobalt			0.00 V	+0.90 V
	manganese				0.00 V

What is the order of reactivity?

	Most reactive → least reactive			
A	cerium	beryllium	cobalt	manganese
B	cerium	beryllium	manganese	cobalt
C	cobalt	manganese	beryllium	cerium
D	cobalt	manganese	cerium	beryllium

1.10 Which row has the **correct** catalyst for the named reaction?

	Reaction	Catalyst
A	Hydrogenation	steam and concentrated H_2SO_4
B	hydrohalogenation	steam and H_3PO_4
C	Hydrolysis	non-polar solvent with Ni catalyst
D	Free-radical Halogenation	UV light

[10 x 2 = 20 marks]

Question 2 Chemical Bonding

2.1 Iodine is a solid, whereas water is a liquid at room temperature. Both compounds have the same **intramolecular forces** but different **intermolecular forces**.

2.1.1 Name the *intramolecular forces* in iodine and water. (1)

2.1.2 Define the term *intermolecular force*. (2)

2.1.3 Explain the difference in the phases of iodine (solid) and water (liquid), with reference to the intermolecular forces present in each substance. (5)

2.2 KI is very soluble in H_2O , but not very soluble in C_6H_{12} .

2.2.1 Define the term *solvent*. (2)

2.2.2 Name the solvent in a solution of KI in H_2O . (1)

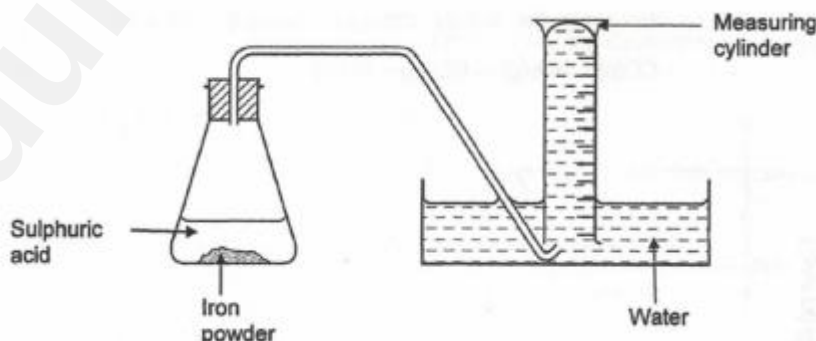
2.2.3 Identify the predominant intermolecular force that occurs between particles of KI and the particles of H_2O in an aqueous solution of KI. (2)

2.2.4 In order for KI to dissolve in C_6H_{12} , the solvent particles just surround the solute particles and are able to dissociate the solute particles. Explain briefly why C_6H_{12} is unable to do this, and hence why KI is insoluble in C_6H_{12} . (3)

[16 marks]

Question 3 Energy Change and Rates of Reactions

A student uses the apparatus below to investigate the rate of reaction between iron and sulphuric acid.



The balanced equation for the reaction is:



3.1 Define the term *rate of reaction*. (2)

- 3.2 Describe how the apparatus in the diagram can be used to investigate the rate of the reaction. (3)

The student repeats the experiment with different concentrations of sulphuric acid. All other variables are kept constant.

The results obtained are shown in the table below:

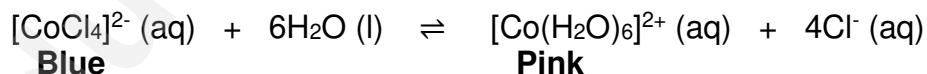
Concentration of sulphuric acid (mol.dm ⁻³)	Rate of reaction (cm ³ .s ⁻¹)
0,4	4,2
0,8	8,5
1,6	17,0

- 3.3 Write down the investigative question for this investigation. (2)
- 3.4 State **three** variables that have to be controlled in this experiment. (3)
- 3.5 What conclusion can be drawn from the results above? (2)
- 3.6 Using the Collision Theory, explain the effect of increasing temperature on the rate of the reaction. (4)
- 3.7 What is the effect on the rate of reaction of using lumps of iron instead of powder? (2)
- 3.8 Draw an energy profile graph to show the effect of a catalyst on the reaction between iron and sulphuric acid. (3)

[21 marks]

Question 4 Chemical Equilibrium

- 4.1 A small quantity of cobalt chloride powder is dissolved in ethanol resulting in a blue solution. When a few drops of water are carefully added to the blue solution, the colour changes to light pink. The following equilibrium has been established:



To investigate some of the factors which affect this equilibrium, the following experiments are performed:

Experiment 1: A small quantity of concentrated HCl is added to the solution.

Observation: The solution turns deep blue.

Experiment 2: The beaker with the solution is cooled by immersing it in ice water.

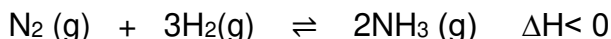
Observation: The colour of the solution changes to pink.

- 4.1.1 State *Le Chatelier's principle*. (2)
- 4.1.2 How was the equilibrium affected in experiment 1? (1)

4.1.3 Explain your answer in 4.1.2 in terms of Le Chatelier's principle. (4)

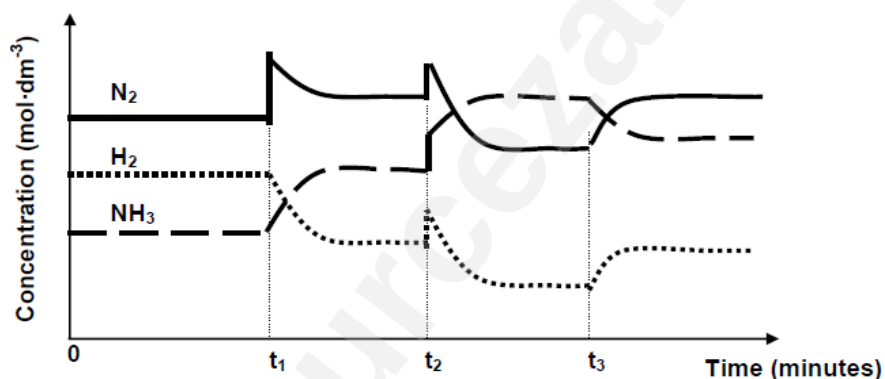
4.1.4 From the results of experiment 2, determine the sign of ΔH for this reaction. (2)

4.2 A fertilizer company produces ammonia on a large scale at a temperature of 450°C . The balanced equation for the reaction that takes place in a sealed container is:



To meet an increased demand for fertilizer, the management of the company instructs their engineer to make the necessary adjustments to increase the yield of ammonia.

In a trial run on a small scale in the laboratory, the engineer makes adjustments to the temperature, pressure and concentration of the equilibrium mixture. The graph below represents the results obtained:



4.2.1 Identify the changes made to the equilibrium mixture at the following times:

- a) t_1 (2)
- b) t_2 (2)
- c) t_3 (2)

4.2.2 At which of the above time(s) did the change made to the reaction mixture lead to a higher yield of ammonia?

Write down only t_1 and/or t_2 and/or t_3 . (2)

The engineer now injects 5 mol of N_2 and 5 mol of H_2 into a 5 dm^3 sealed empty container. Equilibrium is reached at 450°C . Upon analysis of the equilibrium mixture, he finds that the mass of NH_3 is 20,4 g.

4.2.3 Determine the number of moles of NH_3 at equilibrium. (2)

4.2.4 Write down the equilibrium expression for the reaction. (2)

4.2.5 Hence, calculate the equilibrium constant (K_c) at 450°C . (5)

[26 marks]

Question 5 Acids and Bases

A learner is asked to prepare a standard solution of the weak acid, oxalic acid $(\text{COOH})_2 \cdot 2\text{H}_2\text{O}$ for use in a titration. The volume of the standard solution must be 500 cm^3 and the concentration $0,2 \text{ mol} \cdot \text{dm}^{-3}$.

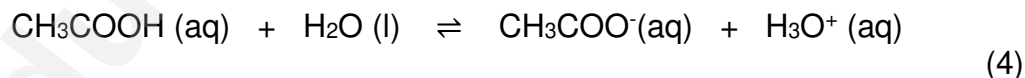
- 5.1 Define the following terms:
5.1.1 standard solution
5.1.2 weak acid
5.1.3 Bronsted-Lowry acid. (3)
- 5.2 What is represented by the ' $2\text{H}_2\text{O}$ ' in the acid formula? (1)
- 5.3 Calculate the mass of oxalic acid which the learner has to dissolve to make up the required standard solution. (4)

The learner titrates the $0,2 \text{ mol} \cdot \text{dm}^{-3}$ oxalic acid solution against a solution of sodium hydroxide. He finds that 40 cm^3 of the oxalic acid exactly neutralizes 35 cm^3 of the sodium hydroxide solution.

- 5.4 Write down the balanced equation for this reaction. (3)
- 5.5 Calculate the concentration of the sodium hydroxide solution. (4)
- 5.6 Explain which of the indicators given below would be a suitable indicator for the above titration. (5)

Indicator	pH range
Methyl orange	3,2 – 4,4
Bromothymol blue	6,0 – 7,6
Phenolphthalein	8,2 – 10,0

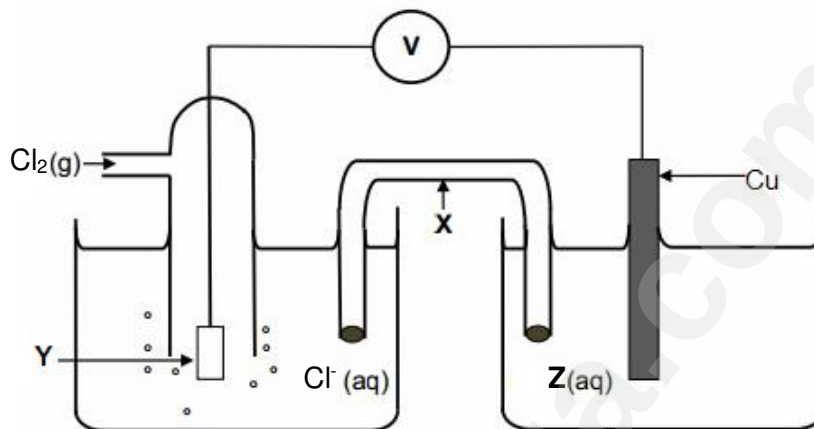
- 5.7 Another example of a weak acid is ethanoic acid. Identify the acid-base conjugate pairs for the reaction below:



[24 marks]

Question 6 Galvanic Cells

A standard galvanic cell is set up as shown in the diagram below. It is made up by connecting a chlorine gas half-cell and a copper half-cell together under standard conditions.

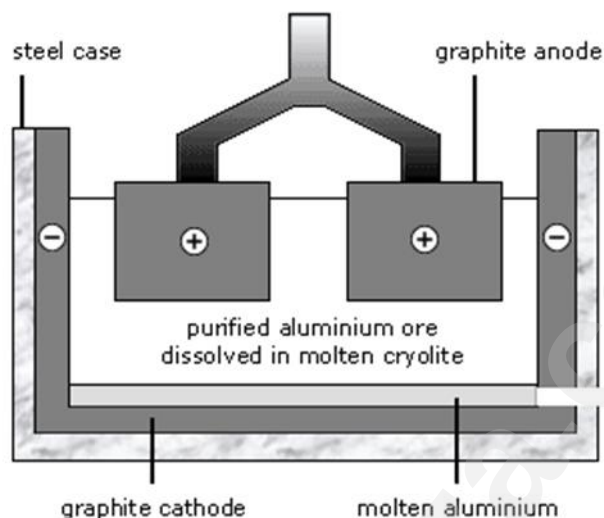


- 6.1 State two main differences between a galvanic/voltaic cell and an electrolytic cell. (2)
- 6.2 Identify the material used in the part labeled **Y** and give its function. (2)
- 6.3 Write down the possible formula of **Z**. (2)
- 6.4 State **two** functions of **X**. (2)
- 6.5 Write down the complete cell notation for the galvanic cell. Standard conditions must be included. (4)
- 6.6 Write down for the reaction taking place in this cell, the balanced:
 - 6.6.1 anode half-reaction (2)
 - 6.6.2 cathode half-reaction (2)
 - 6.6.3 overall ionic reaction (2)
- 6.7 Calculate the emf of this cell. (4)
- 6.8 Identify the reducing agent in the redox reaction taking place in this cell. (2)
- 6.9 As time passes, the reading on the voltmeter drops even though a suitable solution in the salt bridge is used. Explain the reasons for this change. (3)

[27 marks]

Question 7 Application of Electrochemistry

The diagram below shows the cell used in the extraction of aluminium.



http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/chemicals/extractionmetalsrev3.shtml

- 7.1 State the energy conversion that takes place in this cell. (2)
- 7.2 Write down the function of the cryolite with which the aluminium oxide is mixed and state why this is an advantage for the process. (3)
- 7.3 Write down the balanced chemical equation for:
- 7.3.1 half-reaction occurring at the anode. (2)
- 7.3.2 half-reaction occurring at the cathode. (2)
- 7.3.3 net cell reaction. (2)
- 7.4 The graphite anodes in these cells need to be replaced regularly. Explain why the anode needs to be replaced regularly using equations to support your explanation. (4)
- 7.5 The cell is designed such that the anode is easily removable. Explain what benefits this will have to the manufacturing process. (3)
- 7.6 State **two** environmental concerns associated with the extraction of aluminium. (2)

[20 marks]

Question 8 Organic Chemistry

8.1 Define the term *functional group*. (2)

8.2 Name the functional groups of the following compounds:

8.2.1 $\text{C}_2\text{H}_5\text{OH}$ (1)

8.2.2 $\text{CH}_3\text{CH}=\text{CHCH}_3$ (1)

8.3 Define the term *homologous series*. (2)

8.4 Name the homologous series to which each of the following compounds belongs and name the compounds:

8.4.1 $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$ (2)

8.4.2 $\text{CH}_3\text{CHFCl}=\text{C}(\text{CH}_3)\text{CH}_3$ (2)

8.5 Information about several hydrocarbons is given in the table below:

Name	Molecular formula	Melting Point ($^{\circ}\text{C}$)	Boiling Point ($^{\circ}\text{C}$)
ethane	C_2H_6	-183	-89
hexane	C_6H_{14}	-95	69
ethene	C_2H_4	-169	-104
2-methylpentane	C_6H_{14}	-154	60
2,3-dimethylbutane	C_6H_{14}	-129	58

8.5.1 State the phases of the following substances at room temperature:

i) ethane

ii) hexane (2)

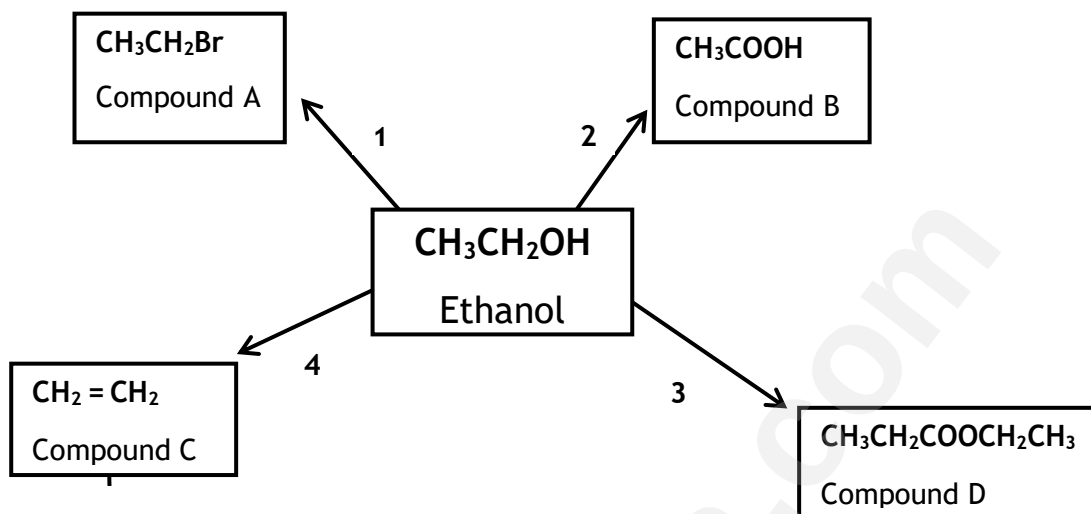
8.5.2 Compare the boiling points of ethane and hexane. Explain the marked difference in their boiling points. (4)

8.5.3 There are three substances on the table whose molecular formula is C_6H_{14} . Give the **specific term** used to refer to those substances. (2)

8.5.4 Account for the difference in the melting points of ethane and ethene. (2)

8.6 Draw the full structural formula for **2-bromo-4-methylhexan-2,4-diol**. (3)

8.7 Consider the flow chart given below:



- 8.7.1 Name the **specific type** of reaction represented by the processes **1** and **4**. (4)
- 8.7.2 Which one would you expect to have a higher boiling point, compound **B** or compound **C**? Explain your answer. (5)
- 8.7.3 Describe a chemical test that could be used to distinguish between compound **C** and ethane. Support your answer using relevant equations. (4)
- 8.7.4 Draw the structural formula of compound **D**. (3)
- 8.7.5 Name the two organic compounds that react to produce compound **D**. (2)
- 8.7.6 Name process **3** and give the catalyst required for the process. (2)
- 8.7.7 Give the name and structural formula of a functional isomer of compound **D**. (3)

[46 marks]

Total: 200 marks