Name:	Index No:	CT Group: 07

PIONEER JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2008

CHEMISTRY **8872/02**
Higher 1

Paper 2 **16 September 2008**

Additional Materials: Data Booklet
Writing papers

1 hour 30 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, CT Group and index number in the spaces at the top of this page.
Write in dark blue or black pen.

Answer **all** questions in Section A and **any two** questions in Section B.
For **Section A**, write your answers in the spaces provided.
For **Section B**, write your answers on the writing papers provided. If there is no answer to the question, a *blank sheet* of paper must still be submitted.

You are advised to show all working in calculations.
You may use a calculator.
The number of marks is given in brackets [ ] at the end of each question or part question.

At the end of the examination, fasten all your work securely together.

FOR EXAMINER'S USE			
Section A		**Section B**	
1	/ 4	1	/ 20
2	/ 5	2	/ 20
3	/ 4	3	/ 20
4	/ 9		
5	/ 8		
6	/ 10	**TOTAL**	

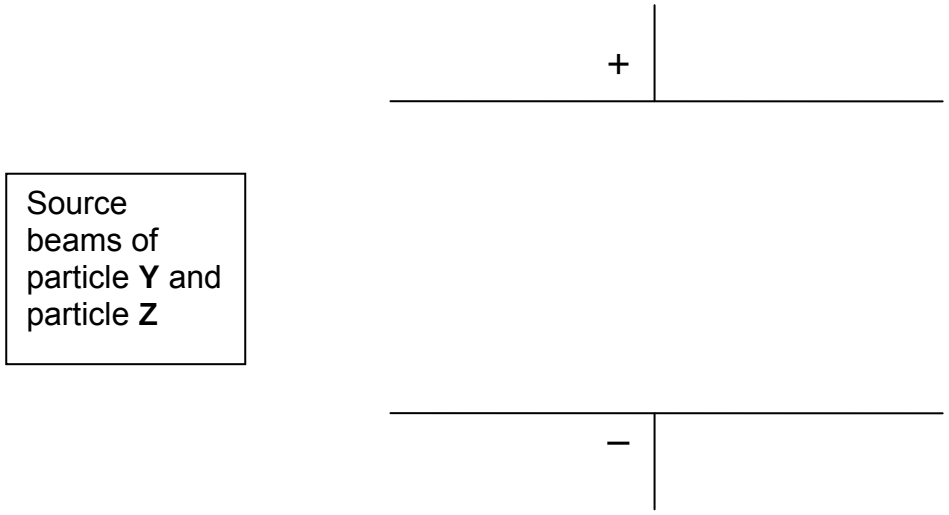
Section A (40 marks)

Answer all questions in the spaces provided.

1 (a) Complete the table below. [2]

Particle	Electric charge	Mass number	Number of		
			Protons	Electrons	Neutrons
X	0		16		16
Y	1-	81		36	
Z		70	31	28	

(b) Sketch on the diagram below how a beam of particle **Y** and a beam of particle **Z** would be affected by the electric field. [2]



[Total: 4]

2 CO_3^{2-} and SO_3^{2-} ions are commonly found in many compounds. Although they have the similar formulae, they have different shapes.

(a) What is the main feature of the electron pair repulsion model for accounting for shapes of molecules or ions? [1]

(b) By means of dot-and-cross diagrams, predict the shapes of the ions. Account for the difference. [4]

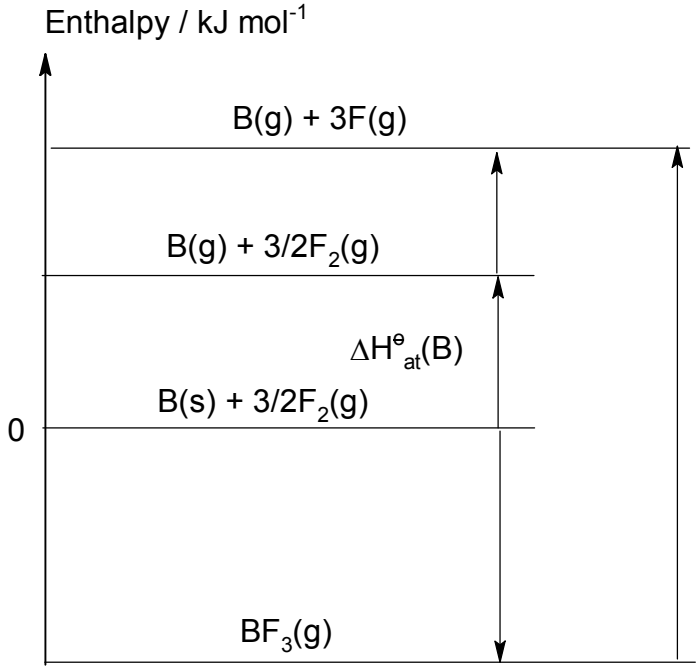
[Total:5]

3 (a) Describe the combustion of magnesium and phosphorus in excess oxygen, writing an equation for each reaction. [3]

(b) It is found that magnesium burns less readily than calcium. Suggest a reason why this is so. [1]

[Total: 4]

4 (a) Reaction of boron hydride with fluorine is a vigorous process and is used as rocket propellant. The reaction yields gaseous born fluoride, BF_3 as one of the products. An energy level diagram involving BF_3 is shown below.



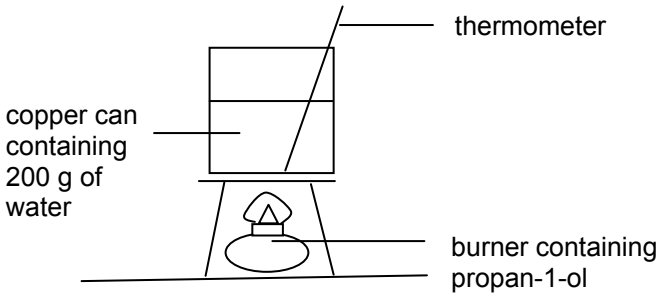
(i) Define the term *standard enthalpy change of formation*. [1]

(ii) Using $\Delta H^{\theta}_{f}(BF_3)$, bond energy (B-F) and bond energy (F-F), label the enthalpy changes of the processes involved on the energy level diagram above. [2]

(iii) Hence, use the information given below and relevant data from the *Data Booklet* to calculate the bond energy of B-F bond. [2]

Standard enthalpy change of formation of boron fluoride, $\Delta H^{\theta}_{f}(BF_3)$ / kJ mol^{-1}	-1137
Standard enthalpy change of atomisation of boron, $\Delta H^{\theta}_{at}(B)$ / kJ mol^{-1}	+573

(b) A student used the apparatus below to determine the enthalpy change of combustion of propan-1-ol. It was found that 0.60 g of propan-1-ol was used to raise the temperature of 200 g of the water. The initial temperature of the water was 21.0°C. The specific heat capacity of water is 4.18 J g^{-1} $K^{-1.}$



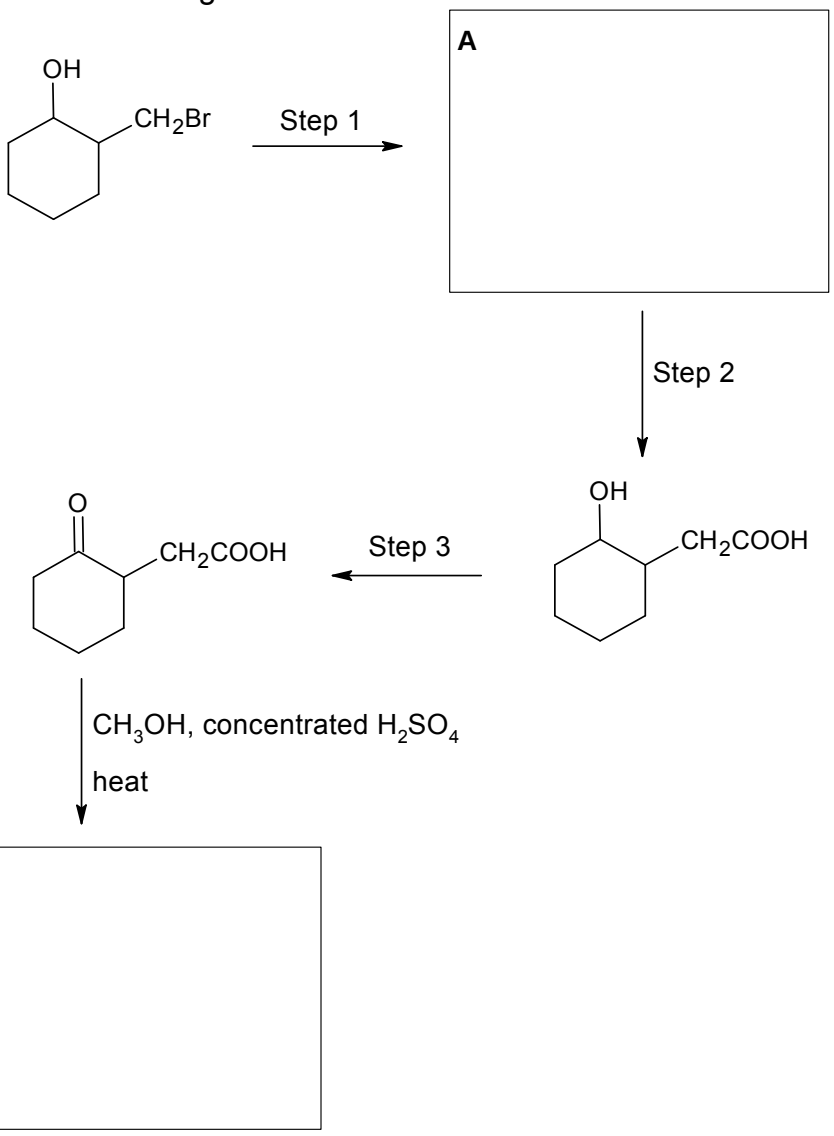
(i) Calculate the number of moles of propan-1-ol burnt. [1]

(ii) Given that the enthalpy of combustion of propan-1-ol is -2021 kJ mol^{-1}, calculate the final temperature of water at the end of the experiment. [2]

(iii) The actual temperature of the water measured at the end of experiment is 38.0°C. Give an explanation for the difference. [1]

[Total: 9]

5 Consider the reaction scheme given below.



(a) Give the structures of **A** and **B** in the boxes provided. [2]

(b) Suggest reagents and conditions for [3]

Step 1: _____

Step 2: _____

Step 3: _____

(c) State the types of reactions occurring in [3]

Step 1: _____

Step 2: _____

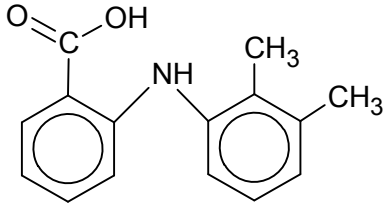
Step 3: _____

[Total: 8]

6 The use of medicine in the treatment of illnesses was revolutionised in the 19th century and beyond due to rapid advancements in chemistry, in terms of research work, laboratory techniques and equipment.

An example of an important drug that has gained world-wide recognition for its medicinal properties is Ponstan. Ponstan capsules contain the active ingredient mefenamic acid, which is a type of medicine called a non-steroidal anti-inflammatory drug (NSAID). NSAIDs are used to relieve pain and inflammation.

The structure and some data of mefenamic acid are given below.



mefenamic acid

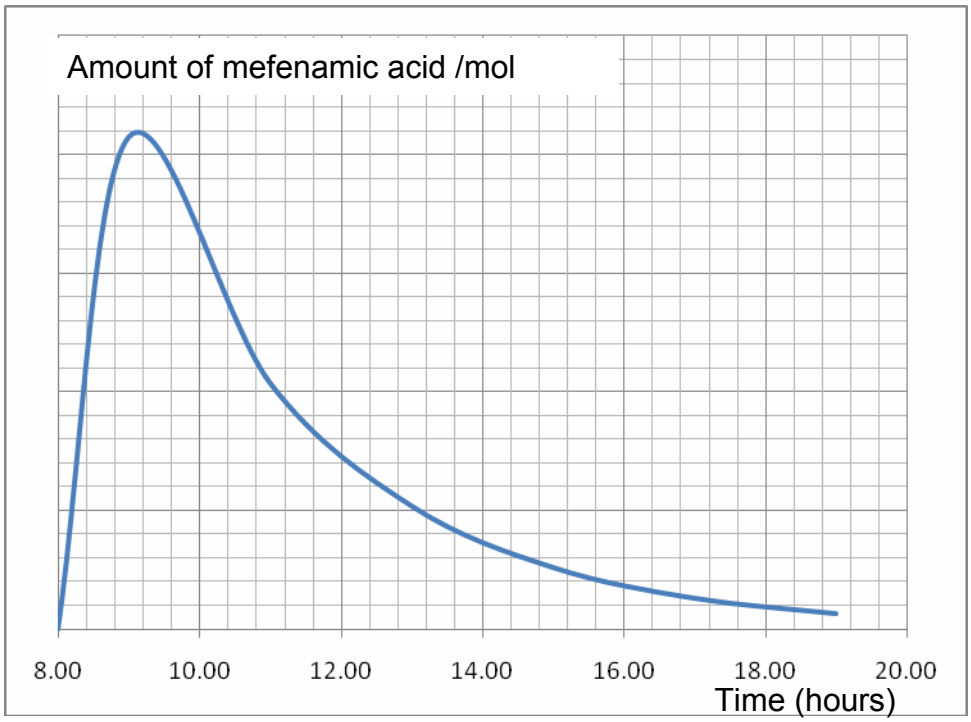
Formula : $C_{15}H_{15}NO_2$
Melting point : 230ºC
Boiling point : 399ºC
Density : 1.203 g cm^{-3}
Protein binding : 90%
Bioavailability : 90%
pK_a : 4.2
Solubility in water : 20 mg dm^{-3}
Enthalpy of vaporisation : 68.5 kJ mol^{-1}
Overdose : 740 mg kg^{-1}
Route of administration : Oral
Excretion : renal and fecal
Adverse effects : drowsiness, dizziness, skin rashes, diarrhoea

(a) To alleviate a case of migraine, a patient was prescribed with a dose of the drug which includes two Ponstan capsules. Calculate the number of moles of mefenamic acid in the dose, given that each capsule contains 50 mg of mefenamic acid. [2]

(b) The patient took a dose of Ponstan at 8 am in the morning. The mefenamic acid took an hour to pass through the alimentary canal before being absorbed into the bloodstream.

The graph below shows the variation in the amount of mefenamic acid in the patient's blood with time.

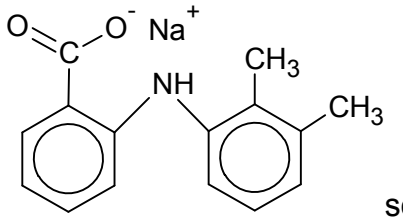
Use the graph to determine the half-life of mefenamic acid in the patient's blood, showing the workings clearly. [2]



(c) **(i)** Calculate the solubility, in mol dm^{-3}, of mefenamic acid. [1]

(ii) Account for the low solubility of mefenamic acid in water. [2]

(iii) To overcome the problem of low solubility, mefenamic acid is converted to sodium mefenamate. Suggest suitable reagent and condition for the conversion. [1]



sodium mefenamate

Reagent and condition: _____

(d) Unlike drugs that are administered through intravenous injections, those that are administered via the oral route will not be totally assimilated and utilised effectively by the body. The *bioavailability* of a medicine is a measure of the extent of the drug that reaches the systemic circulation and is available at the sites of action to release its therapeutic effects.

The term *overdose* describes the ingestion of a drug in quantities greater than are recommended or generally practised, which is considered harmful and dangerous as it results in detrimental impact on health.

For a patient with a mass of 65 kg, calculate the maximum mass of mefenamic acid he can ingest before he gets “overdosed”, taking into consideration its “bioavailability”. [2]

[Total: 10]

Section B (40 marks)

Answer **any two** questions in this section on the writing papers provided.

1 **(a)** The pH of a 0.100 mol dm^{-3} solution of 3-chloropropanoic acid is 2.49.

(i) Calculate concentration of hydrogen ions in the solution. [1]

(ii) Explain, with reasons, whether 3-chloropropanoic acid is a strong or weak acid. [2]

(iii) Write down an expression for the dissociation constant, K_a, for 3-chloropropanoic acid. Hence, use it to calculate the value of K_a for 3-chloropropanoic acid. [2]

(b) In an experiment, 25.0 cm^3 of 0.100 mol dm^{-3} solution of 3-chloropropanoic acid required 22.50 cm^3 of aqueous sodium hydroxide of unknown concentration for complete neutralisation.

(i) Calculate the concentration of sodium hydroxide used for titration. [1]

(ii) Suggest an indicator for the titration. Give **one** reason for your choice and state the end point colour change. [3]

(c) A solution containing 3-chloropropanoic acid and its salt, sodium 3-chloropropanoate acts as a buffer solution.

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

(ii) With the aid of two equations, explain how the solution of 3-chloropropanoic acid and sodium 3-chloropropanoate can control pH of the solution. [2]

(d) How would you expect the acidity of 3-chloropropanoic acid to compare with 2-chloropropanoic acid? Explain your answer. [3]

(e) Propose a reaction scheme (in **not more than 3 steps**) for each of the following conversion. Give the reagents and conditions, as well as the structure of the intermediate compounds formed. [5]

(i) CH_3COCHO from $CH_3CH_2CH_2Cl$

(ii) $C_6H_5CH(NH_2)CH_3$ from $C_6H_5CH_2CH_2OH$

[Total: 20]

2 (a) **A** and **B** are two elements in the third period from sodium to phosphorus.

The chloride of **A** is a crystalline solid with a melting point of 801°C. It dissolves in water, giving solution of pH 7.

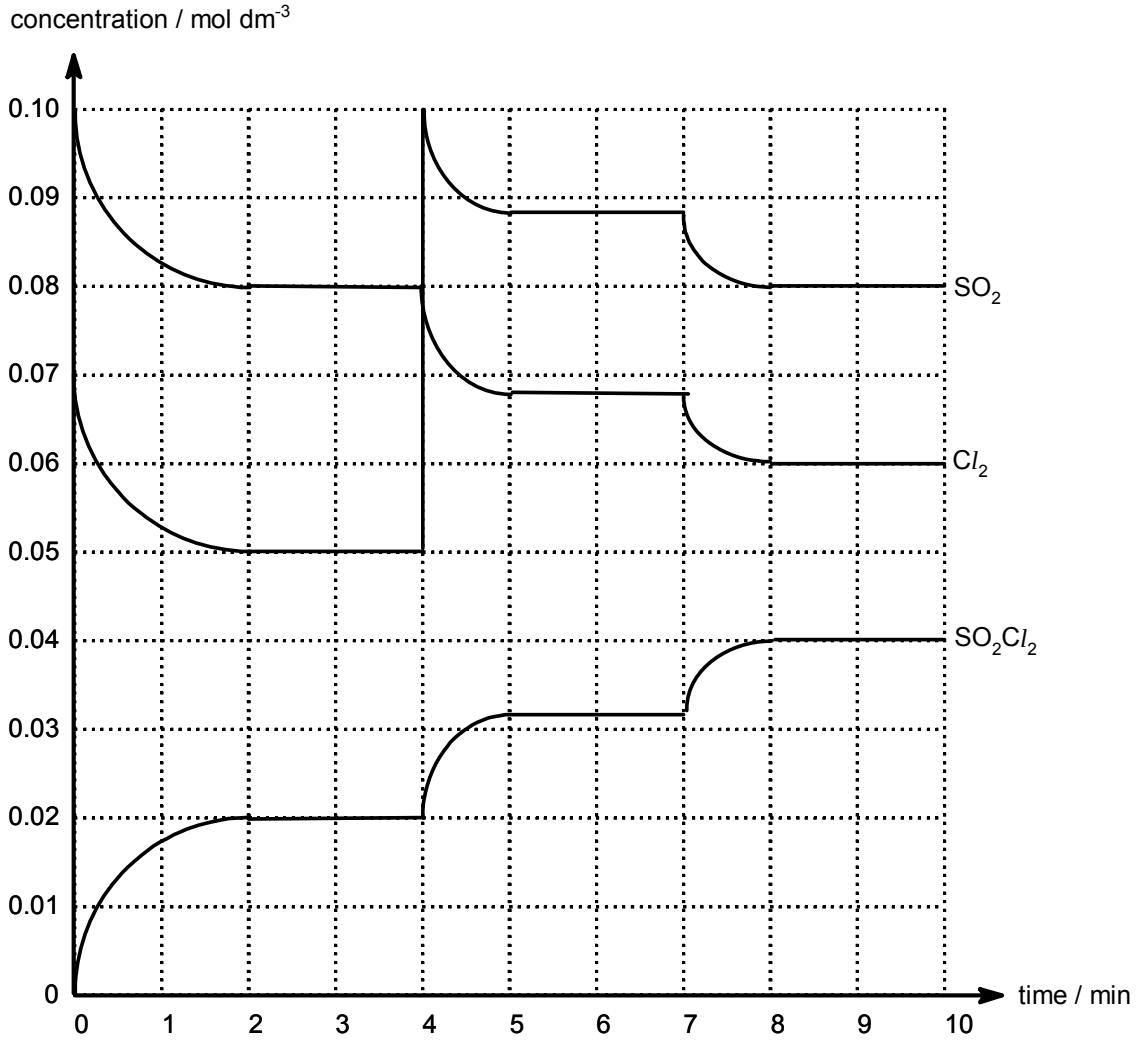
The chloride of **B** melts at about 180ºC. When 2.0 x 10^{-3} mol of the chloride reacts with an excess of aqueous silver nitrate, 1.435 g of AgC*l* are formed.

Identify **A** and **B**. With the aid of relevant equations, explain the observations. [5]

(b) SO_2 was mixed in a closed vessel with Cl_2 and the whole system was allowed to reach equilibrium.

$$SO_2(g) + Cl_2(g) \rightleftharpoons SO_2Cl_2(g)$$

The concentrations of all gases were measured at one-minute interval for 4 minutes, and one of the operating conditions was altered. The effects are shown graphically below.



(i) Calculate the equilibrium constants for the reaction at 3 minutes and at 9 minutes, giving the units. [2]

(ii) Given that the temperature was decreased at 7 minutes, determine whether the forward reaction is exothermic or endothermic? Explain your answer. [2]

(iii) What change to the system must have occurred at the 4th minute? Account for the observed changes in concentration of the gases as a result of this change. [2]

(iv) Explain the effect on the equilibrium position and K_c if the volume of the container is decreased keeping temperature constant. [2]

(c) Compound **C**, $C_6H_{10}O_3$ reacts with 2,4-dinitrophenylhydrazine to form an orange precipitate. Reaction of **C** with hot dilute sulphuric acid yields two products **D** and **E**. Compound **E**, C_3H_8O gives a pale yellow precipitate when warmed with alkaline aqueous iodine. When **D** is warmed with acidified potassium dichromate(VI), compound **F** is obtained. 1 mole of **F** reacts with 1 mole of sodium carbonate to give carbon dioxide gas and compound **G**.

Deduce the structural formulae of compounds **C**, **D**, **E**, **F** and **G**, explaining clearly your reasoning for all reactions described.
[Chemical equations are not required in your answer.] [7]

[Total: 20]

3 (a) Suggest simple test-tube reactions by which the following pairs of compounds can be distinguished. You are to state the reagents and conditions for each test, and describe how each compound in the pair behaves. [4]

(i) $CH_3CH_2COOCH_3$ and $CH_3COOCH_2CH_3$

(ii) $CH_3COCH_2CH_3$ and CH_3CH_2COOH

(b) Describe what you might observe and give the **displayed** formula of the organic product when 3-bromopropene, CH_2=$CHCH_2Br$ reacts with

(i) hot, acidified potassium manganate(VII),

(ii) cold, dilute potassium manganate(VII). [4]

(c) 3-bromopropene can be hydrolysed by NaOH(aq). Results of an investigation into kinetics of this reaction are given below.

Experiment	**[CH_2=$CHCH_2Br$] / mol dm^{-3}**	**[NaOH] / mol dm^{-3}**	**Relative initial rate**
1	0.10	0.20	1.00
2	0.20	0.10	2.00
3	0.30	0.20	3.00
4	0.60	0.40	6.00

(i) Use the data in the table to deduce the order of reaction with respect to CH_2=$CHCH_2Br$ and NaOH. [2]

(ii) Write an overall rate equation for the reaction between CH_2=$CHCH_2Br$ and NaOH. [1]

(iii) Sketch a graph of rate against [CH_2=$CHCH_2Br$]. [1]

(iv) Given that the time taken for 75% of CH_2=$CHCH_2Br$ to be used up is 10 mins, calculate the time taken for 87.5% of CH_2=$CHCH_2Br$ to be used up in the reaction. [2]

(v) Unlike the bromine atom in CH_2=$CHCH_2Br$, the bromine atom in CH_2=CHBr is unreactive. Suggest an explanation for the unreactivity of the bromine atom in CH_2=CHBr. [2]

(d) With the aid of a suitable diagram, explain how a catalyst affects the rate of a chemical reaction. [4]

[Total: 20]

End of Paper