Alkanes, Alkenes & Polymers

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Chemistry Lab Skills 1
Sub Topic	Alkanes, Alkenes & Polymers
Booklet	Question Paper

Time Allowed: **46 minutes**

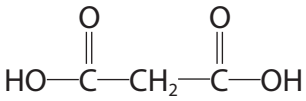
Score: **/38**

Percentage: **/100**

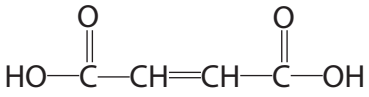
Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 This question is about the following two dicarboxylic acids.
Both acids are solid at room temperature.



Propanedioic acid



Butenedioic acid

(a) (i) Phosphorus(V) chloride is often used to confirm the presence of an —OH group in a compound.

Suggest a practical problem if solid phosphorus(V) chloride is used with these two dicarboxylic acids.

(1)

.....

.....

.....

(ii) Suggest a reagent that could be used to confirm the presence of an **acid** group in either of the two compounds above, and the positive observation that would be made.

(2)

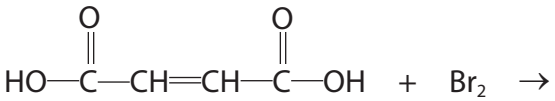
Reagent .....

Observation .....

(b) Bromine dissolved in an organic solvent reacts rapidly with butenedioic acid.

Complete the equation for the reaction of butenedioic acid with bromine.

(1)



(c) Propanedioic acid can be produced by the oxidation of propane-1,3-diol.

(i) Draw the **skeletal** formula of propane-1,3-diol.

(1)

(ii) Identify **one** way in which the infrared spectrum of propanedioic acid would be different from that of the infrared spectrum of propane-1,3-diol.

Wavenumber data are not required.

(1)

.....

.....

.....

(Total for Question 1 = 6 marks)

2 Cyclohexene, C_6H_{10}, can be prepared by dehydrating cyclohexanol, $C_6H_{11}OH$, with phosphoric acid.

$$C_6H_{11}OH \xrightarrow{H_3PO_4} C_6H_{10} + H_2O$$

Procedure

Step 1 12.0 cm^3 of cyclohexanol was put into a small flask. 5 cm^3 of concentrated phosphoric acid, an excess, was added slowly to the cyclohexanol using a dropping pipette. Some anti-bumping granules were added to the mixture and the flask was set up for distillation.

Step 2 The portion of the distillate collected between 80 °C and 90 °C contained only cyclohexene and water.

Step 3 The distillate of cyclohexene and water was transferred to a separating funnel and a saturated solution of sodium chloride was added. Most of the water which was in the distillate went into the saturated sodium chloride layer.

Step 4 The crude cyclohexene was run out of the separating funnel and dried with anhydrous calcium chloride.

Step 5 The calcium chloride was removed by filtration through glass wool, and the liquid was redistilled to collect pure cyclohexene.

Cyclohexene has an unpleasant smell and irritates the eyes, so the entire experiment was carried out in a fume cupboard. In **Step 1**, tubing was connected to carry any uncondensed cyclohexene to a drain.

(a) The chemicals involved in this reaction are all hazardous if they make contact with the eyes, or if swallowed or inhaled.

Other than their effect on the eyes or their toxicity, state **two** different hazards of the chemicals involved in this reaction. Name the chemical associated with each hazard.

(2)

Chemical	Hazard

(b) Calculate the number of moles of cyclohexanol used in this experiment. The density of cyclohexanol is 0.962 g cm^{-3}.

(2)

(c) Draw a labelled diagram showing how to distil the reaction mixture in **Step 1** and collect the distillate boiling between 80 °C and 90 °C.

(4)

(d) Explain the difference between a 'dehydrating agent', such as the phosphoric acid used in **Step 1**, and a 'drying agent', such as the anhydrous calcium chloride used in **Step 4**.

(2)

.....

.....

.....

.....

(e) Suggest **one** advantage of using glass wool, rather than filter paper, when removing the calcium chloride in **Step 5**.

(1)

.....

.....

(f) Calculate the mass of cyclohexanol needed to obtain 10.0 g cyclohexene if the yield is 75%.

(3)

(g) The cyclohexene was tested by mixing it with bromine dissolved in an organic solvent.

(i) What colour change would be observed?

(1)

.....

(ii) Give the **displayed** formula for the organic product of this reaction.

(1)

(Total for Question 2 = 16 marks)

3 Cyclohexene, C_6H_{10}, can be prepared from cyclohexanol, $C_6H_{11}OH$, using the procedure below.

Step 1 Place 0.100 mol of cyclohexanol in a flask and add about 4 cm^3 of concentrated phosphoric(V) acid, drop by drop, while shaking the flask.

Step 2 Assemble the flask for distillation, and collect the liquid which distils over between 70 °C and 90 °C.

Step 3 Add the distillate to an equal volume of a saturated solution of sodium chloride. Shake the mixture, allow the layers to separate, and discard the aqueous (sodium chloride) layer.

Step 4 Transfer the layer containing cyclohexene into a small flask. Add a few pieces of a solid drying agent to the crude cyclohexene, stopper the flask and shake it for a few minutes.

Step 5 Decant the crude liquid alkene and carry out a final purification in order to obtain pure cyclohexene.

(a) (i) Use the formulae of the reactant and product to deduce the role of phosphoric(V) acid in this reaction.

(1)

.....

(ii) Suggest the main hazard when using concentrated phosphoric(V) acid in this preparation.

Give **one** precaution which should be taken when using it, other than the use of safety goggles and a laboratory coat.

(2)

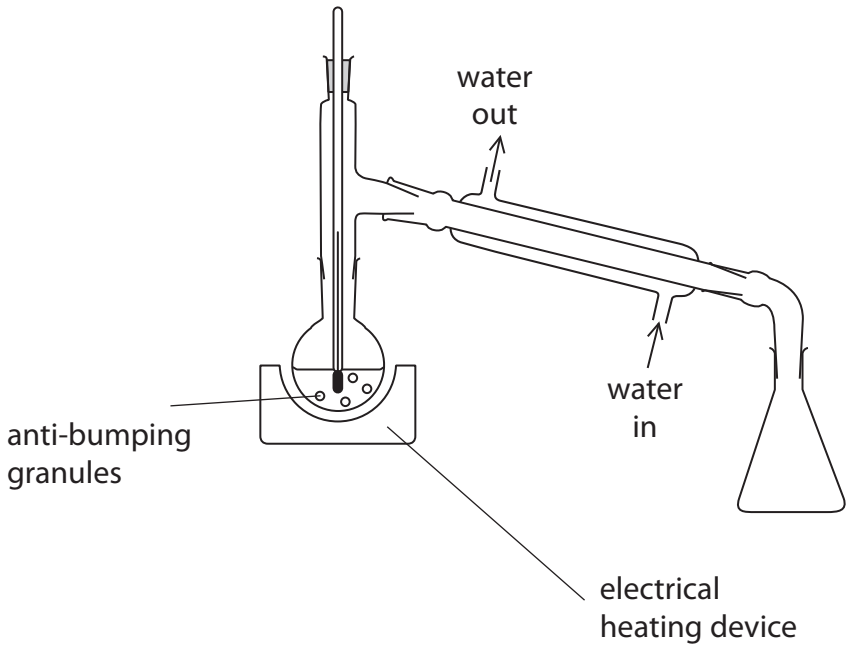
Hazard .....

Precaution .....

(b) A student suggested using the apparatus shown in the diagram below to carry out **Step 2**.

Describe **two** ways in which this apparatus must be modified for safe and efficient use in **Step 2**. Assume the apparatus is suitably clamped.

(2)



1 .....

.....

2 .....

.....

(c) (i) Cyclohexene can be separated from other products in **Step 3** because it is insoluble in aqueous solutions.

Explain this lack of solubility.

(2)

(ii) Draw a diagram of the apparatus which should be used in **Step 3**.

Label the cyclohexene layer.

Data

Substance	Density / g cm^{-3}
Cyclohexene	0.81
Saturated sodium chloride solution	1.20

(2)

(d) (i) Suggest a suitable solid drying agent to use in **Step 4**.

(1)

.....

(ii) What change would you see in the appearance of the organic liquid when it is dried in **Step 4**?

(1)

.....

.....

(e) Suggest a method for the final purification of the crude cyclohexene in **Step 5**.

(1)

.....

(f) (i) Calculate the volume of 0.100 mol of cyclohexanol, $C_6H_{11}OH$.

The density of cyclohexanol is 0.962 g cm^{-3}.

(2)

(ii) After final purification, the yield of cyclohexene was 5.50 g.

Calculate the percentage yield in this reaction. Each mole of cyclohexanol can give a maximum yield of one mole of cyclohexene.

(2)

(Total for Question 3 = 16 marks)