Alcohols & Halogenoalkanes

Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Chemistry Lab Skills 1
Sub Topic	Alcohols & Halogenoalkanes
Booklet	Question Paper 2

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

Grade Boundaries:

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

1 This question concerns the analysis of an organic compound.

(a) (i) How can the relative molecular mass of a compound be found from its mass spectrum?

(1)

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(ii) The general formula of an alcohol can be written ROH, where R is an alkyl group.

The relative molecular mass of an alcohol **Q** is 88. The formula of the alkyl group may be represented as C_xH_y.

State the values of x and y.

(1)

x ..... y .....

(b) When **Q** was warmed with a mixture of sulfuric acid and aqueous potassium dichromate(VI), there was no colour change.

Deduce the displayed formula of alcohol **Q**.

(1)

(c) When a sample of **Q** was reacted with phosphorus(V) chloride, PCl_5, steamy fumes were seen.

(i) Identify these steamy fumes by name or formula.

(1)

.....

(ii) The steamy fumes were tested by reacting them with ammonia gas. A white smoke was seen.

Write an equation, including state symbols, for the reaction in which the white smoke was formed.

(2)

(d) One of the isomers of the alcohol **Q** is an ether. Ethers contain two alkyl groups linked by an oxygen atom and can be represented as R-O-R.

Explain how the information in an **infrared** spectrum would be used to decide whether the spectrum is produced by an alcohol or an ether. Wavenumber data are not required.

(1)

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(Total for Question 1 = 7 marks)

2 Butanone, $CH_3COCH_2CH_3$, can be prepared from butan-2-ol, $CH_3CH(OH)CH_2CH_3$, using the procedure below.

An organic solvent suitable for this procedure has a low boiling temperature and is extremely flammable, so adequate safety precautions must be taken.

Procedure

1. Place about 10 g of sodium dichromate(VI) and 20 cm^3 of distilled water in a conical flask. Shake the flask to dissolve the solid. Then slowly add about 8 cm^3 of concentrated sulfuric acid.

2. Dissolve 5.00 g of butan-2-ol in the organic solvent in a round-bottom flask. Stand the flask in a large beaker containing ice and water. Slowly add the acidified sodium dichromate(VI) solution through a funnel to the butan-2-ol solution in the flask.

3. When the addition is finished, leave the mixture to cool and separate the organic layer, which contains the butanone, from the aqueous layer.

4. Wash the organic layer with sodium hydrogencarbonate solution, and then with water. Discard the aqueous layer.

5. Add some sodium sulfate, Na_2SO_4, to the organic layer and wait until this solution is clear.

6. Decant the solution into a flask, and add a few anti-bumping granules. Use distillation to remove the solvent, which has a **lower** boiling temperature than butanone. The solvent boils between 32°C and 36°C.

(a) What colour change will be seen when the acidified sodium dichromate(VI) reacts with the butan-2-ol?

(1)

From ..... to .....

(b) The reaction is exothermic. Other than the risk of explosion, why is it important to cool the flask in a beaker of ice and water in **step 2**?

(1)

(c) State the purpose of washing the crude butanone in **step 4** with sodium hydrogencarbonate solution. Describe the method used to carry out this process, naming the piece of apparatus used.

(3)

Purpose .....

Method .....

(d) What is the purpose of adding sodium sulfate in **step 5**?

(1)

(e) Draw a labelled diagram of the apparatus used in **step 6** to distil off the solvent from the organic layer. The diagram should show at least one precaution which must be taken when distilling an extremely flammable liquid.

(4)

(f) (i) Calculate the volume, in cm^3, of 5.00 g of butan-2-ol.

The density of butan-2-ol is 0.805 g cm^{-3}.

(1)

(ii) Each mole of butan-2-ol can produce a maximum yield of one mole of butanone.

Calculate the mass of butan-2-ol that would be required to make 3.00 g of butanone if the yield is 64%.

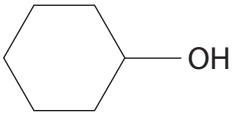
Relative molecular masses:

butan-2-ol	74.1
butanone	72.1

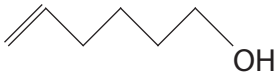
(3)

(Total for Question 2 = 14 marks)

3 The skeletal formulae of two compounds with molecular formula $C_6H_{12}O$ are shown below.



cyclohexanol



hex-5-en-1-ol

(a) Each of the compounds reacts when warmed with a mixture of potassium dichromate(VI) and sulfuric acid.

(i) What colour change is seen during this reaction?

(1)

From ..... to .....

(ii) One of the compounds forms a carboxylic acid when it is heated under reflux with a mixture of potassium dichromate(VI) and sulfuric acid.

Give the **structural** formula of this carboxylic acid.

(1)

(b) Under suitable conditions, each of the compounds reacts slowly with a small piece of sodium to form a sodium salt and one other product. Give **two** observations you would make when this reaction occurs.

(2)

Observation 1 .....

.....

Observation 2 .....

.....

(c) Hex-5-en-1-ol can be distinguished from cyclohexanol by its reaction with aqueous bromine.

(i) What colour change would be seen in this reaction when hex-5-en-1-ol is used?

(1)

From ..... to .....

(ii) Complete the skeletal formula below to show the product of this reaction.

(1)

(d) Hex-5-en-1-ol reacts with acidified potassium manganate(VII) at room temperature.

(i) What colour change would be seen in this reaction?

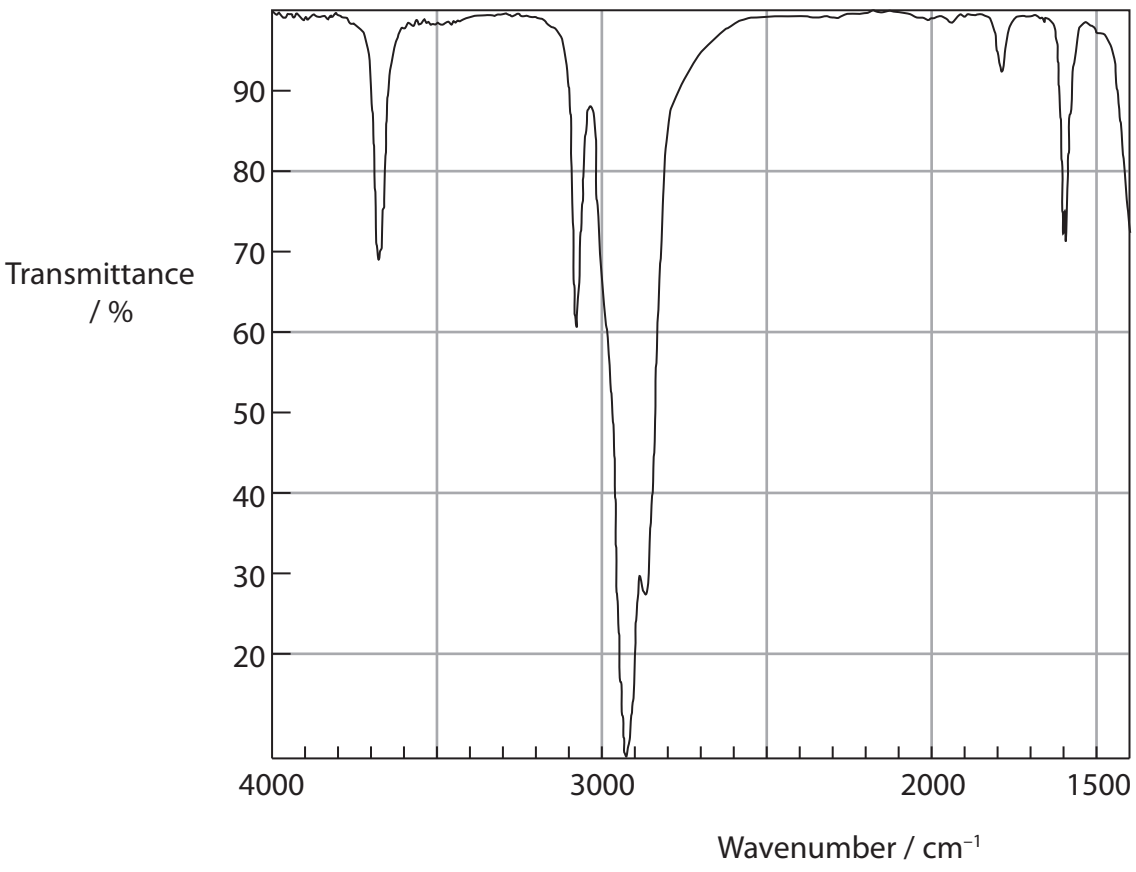
(1)

From ..... to .....

(ii) Complete the skeletal formula below to show the product of this reaction.

(1)

(e) The infrared spectrum below is for either cyclohexanol or hex-5-en-1-ol.



For which of the two compounds is this the infrared spectrum? Use **two** pieces of data from the table below to justify your answer.

Bond	Wavenumber / cm^{-1}
C—H stretch, alkane	2962–2853
C—H stretch, alkene	3100–3010
C=C stretch, alkene	1669–1600
O—H stretch, alcohols	3750–3200

(2)

Spectrum is for .....

Justification:.....

.....

.....

(Total for Question 3 = 10 marks)

4 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)

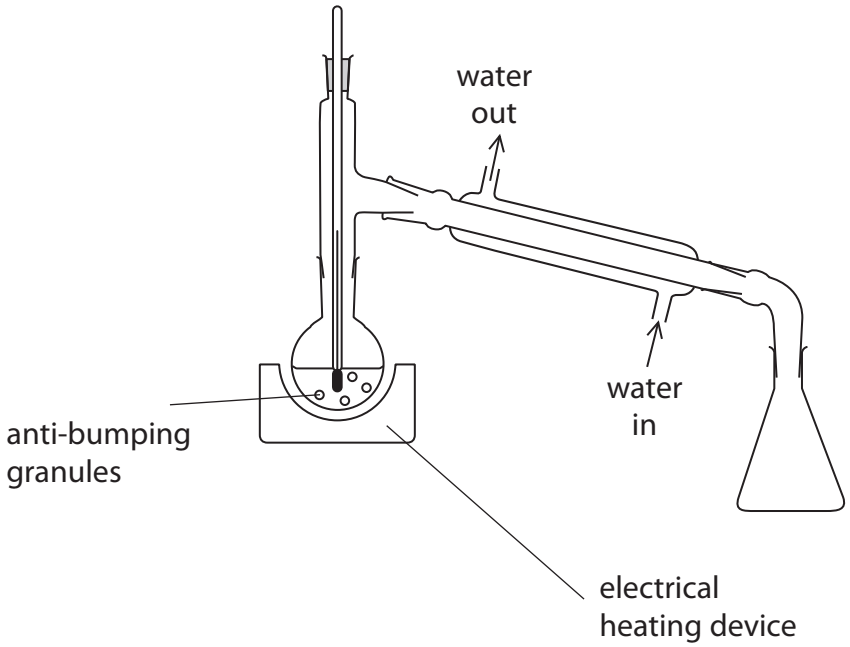
Hazard .....

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 4 = 16 marks)