Alcohols & Halogenoalkanes

Question Paper 1

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

Time Allowed: **66 minutes**

Score: **/55**

Percentage: **/100**

Grade Boundaries:

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

1 **P**, **Q** and **R** are different halogenoalkanes with the general formula C_3H_7X.

(a) 2 cm^3 of ethanol is added to three test tubes in a water bath at 50 °C.

Three drops of **P** are added to the first test tube, three drops of **Q** to the second and three drops of **R** to the third.

2 cm^3 portions of aqueous silver nitrate solution are added to each test tube.

Explain why ethanol is added to each test tube.

(1)

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(b) Cream coloured precipitates form in the test tubes containing **P** and **Q**. These precipitates are **soluble** in concentrated ammonia solution.

A yellow coloured precipitate forms in the test tube which contains **R**. This precipitate is **insoluble** in concentrated ammonia solution.

Deduce the identity of the halogen present in each halogenoalkane.

(2)

P and **Q** .....

R .....

(c) The mass spectrum of **P** includes a peak at $m/e = 29$ but neither **Q** nor **R** has a peak at this value.

(i) Suggest the identity of the positive ion responsible for this peak at $m/e = 29$.

(1)

.....

(ii) Deduce the structural formulae of the three halogenoalkanes.

(3)

P

Q

R

(Total for Question 1 = 7 marks)

2 A student investigates the oxidation of the alcohol, propan-1-ol.

(a) To oxidise propan-1-ol to form propanal, the following procedure is used.

- Place about 20 cm^3 of dilute sulfuric acid in a boiling tube.
- Add about 3 g of sodium dichromate(VI) and 2–3 anti-bumping granules.
- Shake the contents of the boiling tube until the solid is fully dissolved.
- Place about 1 cm^3 of propan-1-ol in a pear-shaped flask.
- Keep the pear-shaped flask cool and slowly add the contents of the boiling tube.
- Add the apparatus needed for immediate distillation of the product.
- Gently distil the product directly from the reaction mixture.

(i) Sodium dichromate(VI) is a carcinogen.

It is often supplied as a fine powder.

Suggest the particular hazard associated with the compound being a fine powder.

Give a suitable safety precaution.

(2)

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(ii) Explain why anti-bumping granules are added and how they work.

(2)

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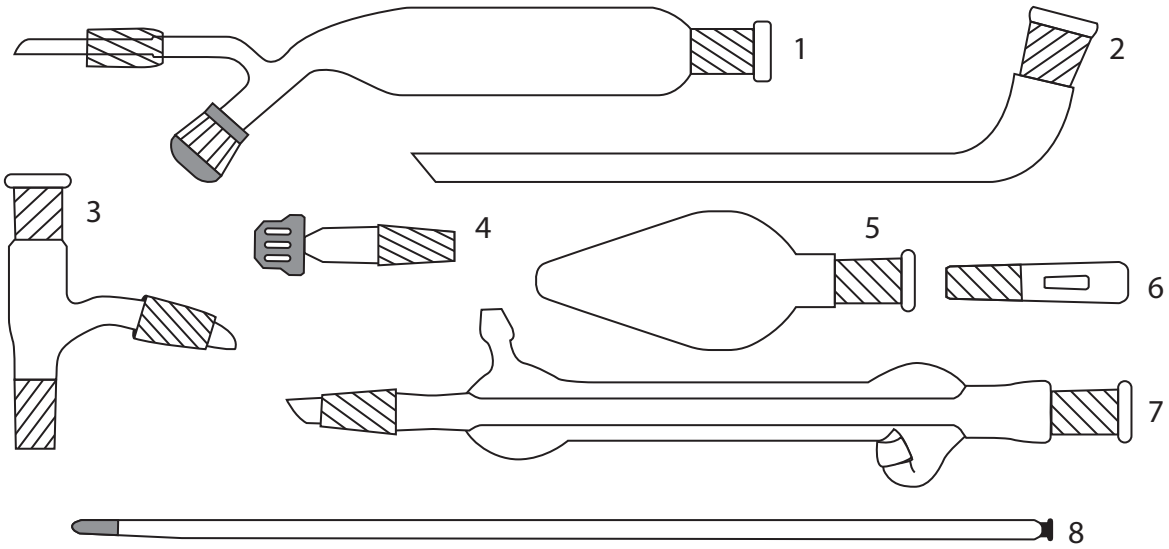
(iii) Select from the apparatus below, the apparatus you would use for distillation.



You should identify each piece of apparatus by number or name and state how you would connect them together for the preparation of propanal.

You should also name a suitable collecting vessel not shown above.

You should **not** draw a diagram.

(3)

(b) The oxidation of propan-1-ol to form propanoic acid is a reaction which involves two steps. These are heating under reflux and distillation.

Differences in the quantities and concentrations of the reactants are also involved, compared to the preparation of propanal.

(i) Give these differences in the quantities and concentrations of reactants. Precise amounts and concentrations are not required.

Justify your answer.

(2)

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(ii) When carrying out the heating under reflux step, a Liebig condenser is used in the top of a pear-shaped flask.

State the direction of water flow in the reflux condenser and what will happen if the water flows in the wrong direction.

(1)

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(iii) Explain why the condenser is needed in the reflux process and how it works.

(2)

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(c) (i) Describe the appearance of propanal and of propanoic acid.

(1)

Propanal .....

Propanoic acid .....

(ii) Suggest a chemical test that would positively identify the functional group of each product after purification. Give the result of each test.

(4)

Test for propanal

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Test for propanoic acid

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(Total for Question 2 = 17 marks)

3 A method for the preparation of iodoethane is given in outline below.

Procedure

Step 1 Suitable quantities of red phosphorus and iodine are placed in a round-bottom flask. The flask is fitted with a reflux condenser and immersed in cold water.

Step 2 Using a dropping pipette, a suitable volume of ethanol is added, in 1 cm^3 portions, down the condenser.

Step 3 After the addition of the ethanol is complete, and a further 15 minutes have passed, the cold water bath is removed and the mixture in the flask is heated under reflux for 45 minutes.

Step 4 The apparatus is allowed to cool and the condenser is rearranged for distillation.

Step 5 The crude iodoethane is distilled off.

Step 6 The distillate is washed with dilute sodium carbonate solution.

Step 7 The washed iodoethane is separated from the aqueous solution.

Step 8 Anhydrous calcium chloride is added to the washed iodoethane.

The equations for the reactions are

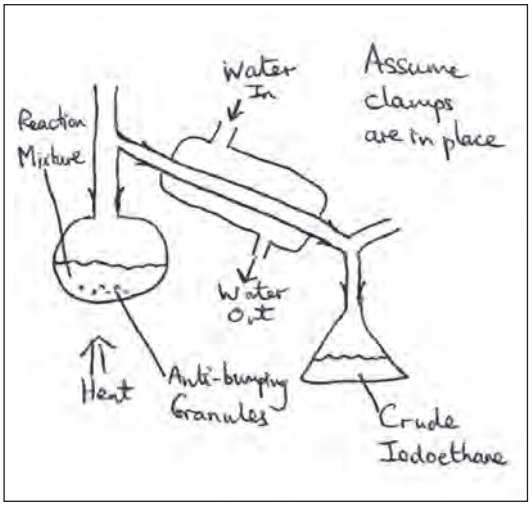
$$2P + 3I_2 \rightarrow 2PI_3$$

$$3CH_3CH_2OH + PI_3 \rightarrow 3CH_3CH_2I + H_3PO_3$$

(a) What does the way in which ethanol is added in **step 2** suggest about the nature of the reaction?

(1)

(b) A student drew a diagram of the apparatus used in **step 5**. There are a number of errors in the diagram.



(i) One of the errors is that the flow of water in the condenser is the wrong way round. Explain the effect of this error.

(1)

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(ii) Identify the most significant error in the diagram and explain the effect of this.

(1)

Error .....

Effect .....

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(c) Suggest why, in **step 6**, the crude iodoethane is washed with dilute sodium carbonate solution.

(1)

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(d) Draw a diagram of the apparatus that would be used in **step 7** to separate the iodoethane. Name the apparatus and label its contents.

The density of iodoethane is 1.5 g cm^{-3} and the density of the aqueous solution is about 1.0 g cm^{-3}.

(3)

Name of apparatus.....

Diagram

(e) How will the appearance of the iodoethane be changed by the addition of anhydrous calcium chloride in **step 8**?

(1)

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(f) How would the iodoethane be separated from the calcium chloride after **step 8**?

(1)

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(g) To obtain pure iodoethane, one further step in the preparation is needed. What is this step?

(1)

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(h) It is not possible to effectively produce iodoethane by reacting ethanol with a mixture of sodium iodide and 50% sulfuric acid. This is because the sulfur in the sulfuric acid can be reduced to form substances such as hydrogen sulfide and sulfur.

State what happens to the iodide ions in the sodium iodide when this occurs.

(1)

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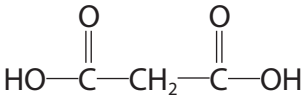
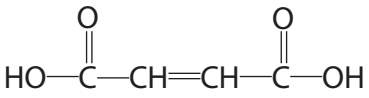
(Total for Question 3 = 11 marks)

4 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)

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(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)

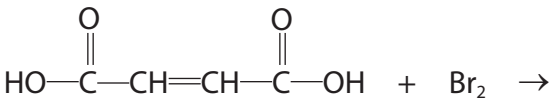
Reagent .....

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)

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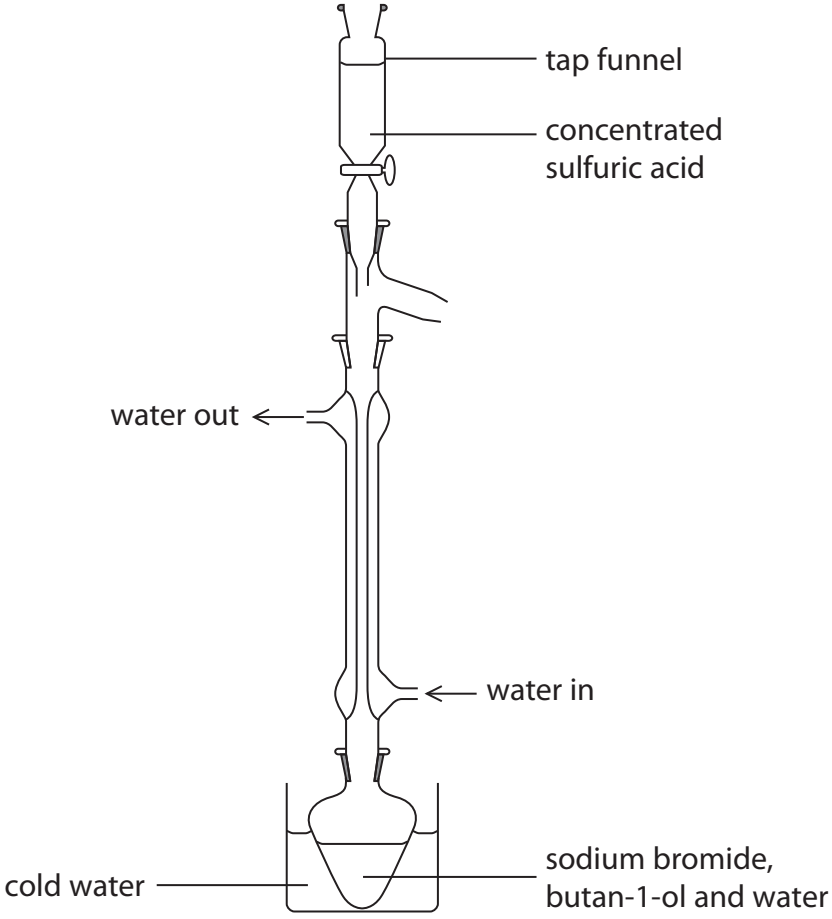
(Total for Question 4 = 6 marks)

5 One method of preparing 1-bromobutane from butan-1-ol is given below.

Procedure

Step 1 10 g of sodium bromide, 10 cm^3 of water and 7.5 cm^3 of butan-1-ol are placed in a flask. The flask is partially immersed in a large beaker of cold water. A condenser is fitted vertically in the neck of the flask as shown in the diagram.



Step 2 10 cm^3 of concentrated sulfuric acid is dripped slowly from the tap funnel into the reaction mixture. The flask is shaken gently.

Step 3 The tap funnel is removed from the top of the condenser and the flask is taken out of the cold water bath. The flask is then heated gently for about 45 minutes.

Step 4 The apparatus is then rearranged for distillation. The 1-bromobutane and water are distilled into a small beaker where they form two layers.

Step 5 The 1-bromobutane layer is separated from the water.

Step 6 The 1-bromobutane layer is washed with concentrated hydrochloric acid to remove unreacted butan-1-ol.

Step 7 The 1-bromobutane is then washed with dilute sodium carbonate solution.

You will need the following data to answer the questions.

Butan-1-ol, $CH_3CH_2CH_2CH_2OH$ $M_r = 74$

1-bromobutane, $CH_3CH_2CH_2CH_2Br$ $M_r = 137$

Liquid	Density / g cm^{-3}
butan-1-ol	0.81
water	1.0
concentrated hydrochloric acid	1.2
1-bromobutane	1.3

(a) The use of the beaker of cold water in **Step 1**, and the slow addition of concentrated sulfuric acid in **Step 2**, both prevent a reaction which gives unwanted **inorganic** products.

Identify **one** of these unwanted products. State the type of reaction occurring when these products form.

(2)

Product .....

Type of reaction .....

.....

(b) (i) Explain why the condenser is set up so that the water flows from bottom to top, as shown in the diagram.

(1)

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(ii) Without the reflux condenser, the procedure in **Step 2** would become more hazardous. Explain why.

(1)

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(c) To achieve the best possible yield of 1-bromobutane, the purification stages should involve the minimum number of transfers of the organic product from one piece of apparatus to another.

(i) How could the water layer be removed from the small beaker in **Step 5** without transferring the organic product?

(1)

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(ii) Name the apparatus you would use to carry out the washing of the crude 1-bromobutane in **Step 6**.

Describe how you would obtain the organic layer from this mixture.

(2)

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(d) What is the purpose of **Step 7**?

(1)

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(e) After **Step 7**, the crude 1-bromobutane is washed with pure water and separated again. Two further steps are needed to obtain a pure sample of 1-bromobutane.

State what these steps are. Detailed experimental procedures are not required, but you should name any reagents which are needed.

(3)

Step 8 .....

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.....

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Step 9 .....

.....

(f) (i) Calculate the mass of butan-1-ol used in **Step 1**.

(1)

(ii) In this experiment, a student obtained 7.5 g of 1-bromobutane.

Calculate the percentage yield of 1-bromobutane. Assume that each mole of butan-1-ol can produce a maximum of one mole of 1-bromobutane.

Give your answer to **two** significant figures.

(3)

(Total for Question 5 = 15 marks)

6 Tests were carried out on compounds **P** and **Q**. Complete the tables below.

(a) Compound **P** is a white inorganic solid which contains one cation and one anion.

	Test	Observation	Inference (Name or formula)	
(i)	Warm **P** with dilute aqueous sodium hydroxide	A gas is given off which turns damp red litmus paper blue	The gas is	**(1)**
(ii)	Add dilute nitric acid followed by aqueous silver nitrate to an aqueous solution of **P**	A cream coloured precipitate forms	**P** contains the ..... ion	**(1)**
(iii)	Add dilute aqueous ammonia to the cream coloured precipitate	....	This confirms the inference in (a)(ii)	**(1)**

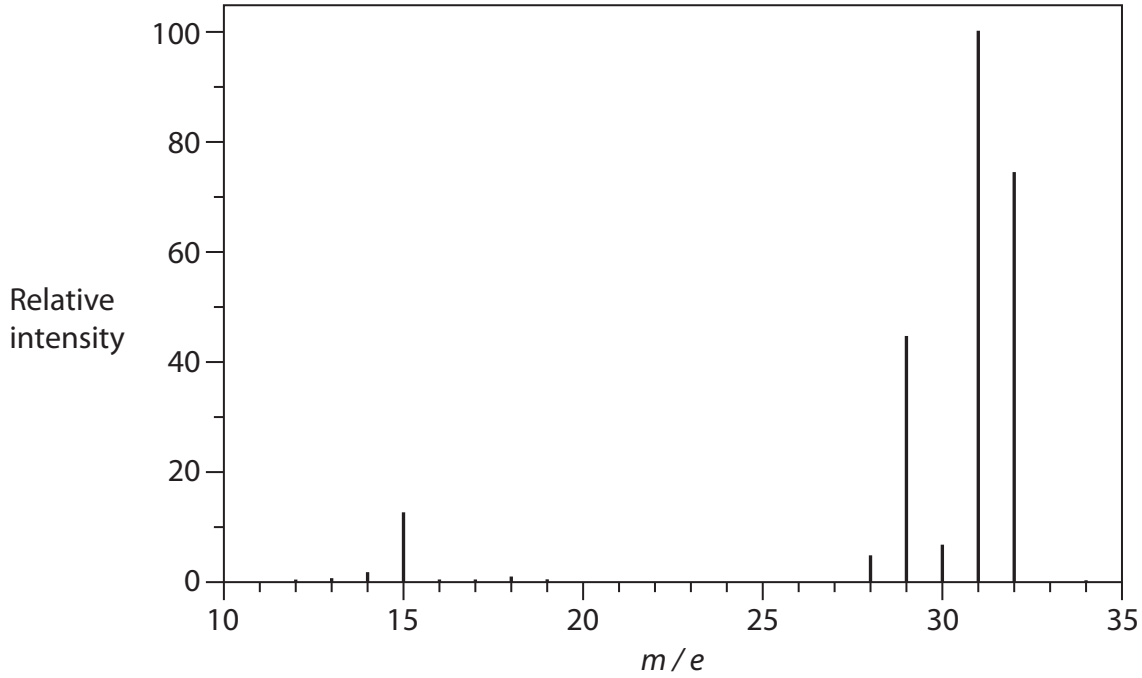
(iv) The **formula** of **P** is .....

(1)

(b) **Q** is an organic liquid which has only one functional group. **Q** dissolves in water forming a **neutral** solution.

	Test	Observation	Inference	
(i)	Add bromine water to **Q**	The bromine is not decolorised	....	**(1)**
(ii)	Add phosphorus(V) chloride to **Q**	Misty fumes which react with ammonia to form a white smoke	The misty fumes are .... The **formula** of the functional group in **Q** is	**(2)**
(iii)	Add a small piece of sodium to **Q**	....	This confirms the inference made in (b)(ii)	**(1)**

(iv) The mass spectrum of **Q** is shown below.



Identify **Q** by name or formula. Use information from the spectrum to justify your answer.

(2)

Identity of **Q** .....

Justification .....

.....

.....

(Total for Question 6 = 10 marks)