AQA Chemistry A-Level

Organic Practical Skills Questions

Q1. Propane-1,2-diol has the structure $CH_2(OH)CH(OH)CH_3$. It is used to make polyesters and is one of the main substances in electronic cigarettes (E-cigarettes).

A sample of propane-1,2-diol was refluxed with a large excess of potassium dichromate(VI) and sulfuric acid.

(a) Draw the skeletal formula of propane-1,2-diol.

(1)

(b) Write an equation for this oxidation reaction of propane-1,2-diol under reflux, using [O] to represent the oxidizing agent.

Show the displayed formula of the organic product.

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(2)

(c) Draw a labelled diagram to show how you would set up apparatus for refluxing.

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(d) Anti-bumping granules are placed in the flask when refluxing.
Suggest why these granules prevent bumping.

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(1)

(e) Draw the structure of a different organic product formed when the acidified potassium dichromate(VI) is not in excess.

(1)
(Total 7 marks)

Q2. The following instructions are from an experimental procedure for the preparation of cyclohexene from cyclohexanol and concentrated phosphoric acid.
Read these instructions and answer the questions that follow.

1 Place 25 cm^3 of cyclohexanol into a round-bottomed flask with some porous pot to act as anti-bumping granules. Add 10 cm^3 of concentrated phosphoric acid carefully while shaking the flask. Cool the flask under the tap if it gets too hot.
Make sure the reagents are thoroughly mixed.

2 Set up an apparatus for simple distillation using this flask.

3 Warm the flask, gently at first, for about 15 minutes. Then increase the heating so that cyclohexene begins to distil over. Collect the fraction that distils below 95 °C.

(a) State the purpose of the anti-bumping granules.

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(1)

(b) Name the part of the distillation apparatus where cyclohexene vapour is changed back into a liquid.
Draw a simple diagram of this part of the apparatus.

Name .....

Diagram

(2)
(Total 3 marks)

Q3. N-phenylethanamide is used as an inhibitor in hydrogen peroxide decomposition and also in the production of dyes.

N-phenylethanamide can be produced in a laboratory by the reaction between phenylammonium sulfate and an excess of ethanoic anhydride:

(a) A student carried out this preparation using 1.15 g of phenylammonium sulfate (M_r = 284.1) and excess ethanoic anhydride.

$$(C_6H_5NH_3)_2SO_4 + 2(CH_3CO)_2O \rightarrow 2C_6H_5NHCOCH_3 + 2CH_3COOH + H_2SO_4$$

(i) Calculate the maximum theoretical yield of N−phenylethanamide that could be produced in the reaction. Record your answer to an appropriate precision.

Show your working.

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(3)

(ii) In the preparation, the student produced 0.89 g of N−phenylethanamide.

Calculate the percentage yield for the reaction.

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(1)

(b) The student purified the crude solid product, N−phenylethanamide, by recrystallisation.

(i) Outline the method that the student should use for this recrystallisation.

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(ii) Outline how you would carry out a simple laboratory process to show that the recrystallised product is a pure sample of N−phenylethanamide.

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(3)

(iii) Assume that the reaction goes to completion.

Suggest **two** practical reasons why the percentage yield for this reaction may **not** be 100%.

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(2)

(c) The reaction to form N−phenylethanamide would happen much more quickly if the student used ethanoyl chloride instead of ethanoic anhydride.

Explain why the student might prefer to use ethanoic anhydride, even though it has a slower rate of reaction.

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(2)
(Total 15 marks)

Q4.(a) During the preparation of aspirin, it is necessary to filter the crude product under reduced pressure.

Draw a diagram to show the apparatus you would use to filter the crude product under reduced pressure. (Do **not** include the vacuum pump.)

(2)

(b) You are provided with a small sample of pure aspirin in a melting point tube. Describe briefly how you would determine an accurate value for the melting point of aspirin.

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(2)
(Total 4 marks)

Q5. A student prepared a sample of aspirin (melting point 135 °C) in the laboratory and attempted to purify it by recrystallisation. To check the purity of the aspirin the student determined its melting point.

(a) State **two** observations, during this melting point determination, that would indicate that the sample is **not** pure.

Observation 1 .....

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Observation 2 .....

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(2)

(b) Suggest why a pure sample of aspirin may sometimes appear to melt at a temperature different from 135 °C.

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(1)

(Total 3 marks)

Q6. Salicylic acid can be used to make aspirin. Before using a sample of salicylic acid to make aspirin, a student purified the acid by recrystallisation. The method for recrystallisation is outlined below.

Step 1: The sample is dissolved in a minimum volume of hot water.
Step 2: The solution is filtered hot.
Step 3: The filtrate is cooled in ice to form crystals.
Step 4: The crystals are collected by filtration, washed with cold water and left to dry.

Explain the purpose of each underlined point.

Minimum volume .....

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Hot water .....

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Filtered hot .....

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Cooled in ice .....

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Washed with cold water .....

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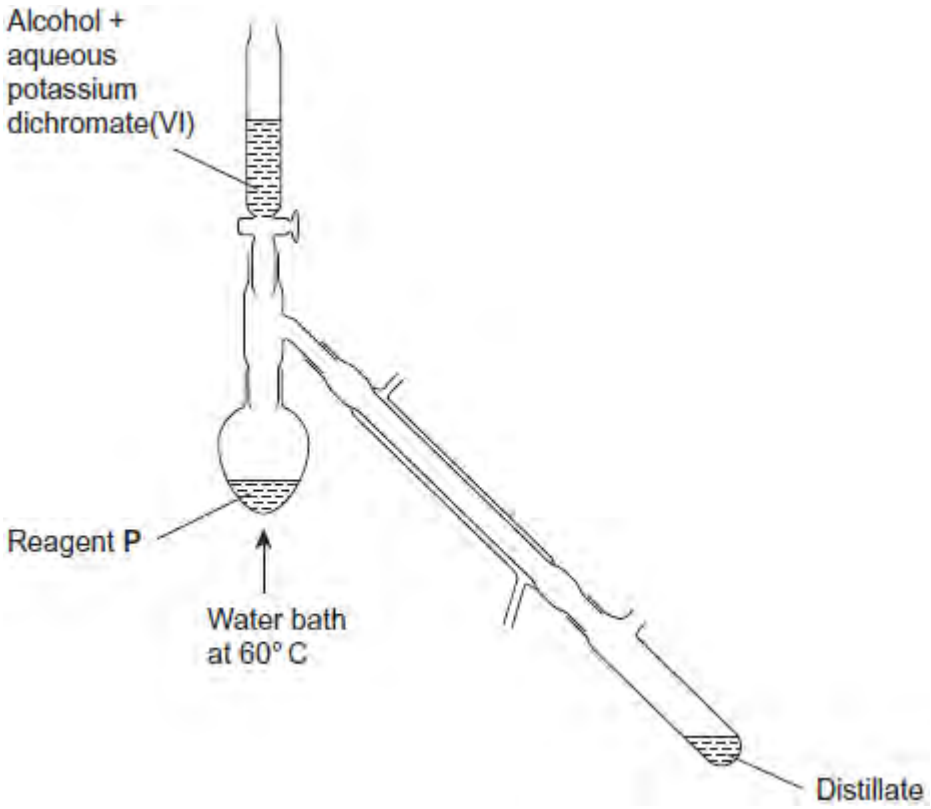
(Total 5 marks)

Q7. This question concerns the oxidation of a primary alcohol.

The experiment was carried out using the distillation apparatus shown in the diagram.
The oxidation product was distilled off as soon as it was formed.



(a) Suggest the identity of reagent **P**.

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(1)

(b) State the chemical change that causes the solution in the flask to appear green at the end of the reaction.

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(1)

(c) Give **one** reason why using a water bath is better than direct heating with a Bunsen burner.

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(1)

(d) Suggest a reagent that could be used to confirm the presence of an aldehyde in the distillate.
State the observation you would expect to make if an aldehyde were present.

Reagent .....

Observation .....

(2)
(Total 5 marks)

Q8. A peptide is hydrolysed to form a solution containing a mixture of amino acids. This mixture is then analysed by silica gel thin-layer chromatography (TLC) using a toxic solvent. The individual amino acids are identified from their R_f values.

Part of the practical procedure is given below.

1. **Wearing plastic gloves to hold a TLC plate**, draw a pencil line 1.5 cm from the bottom of the plate.
2. Use a capillary tube to apply a very small drop of the solution of amino acids to the mid-point of the pencil line.
3. Allow the spot to dry completely.
4. In the developing tank, add the developing solvent to **a depth of not more than 1 cm**.
5. Place your TLC plate in the developing tank.
6. Allow the developing solvent to rise up the plate **to the top**.
7. Remove the plate and quickly mark the position of the solvent front with a pencil.
8. Allow the plate to dry **in a fume cupboard**.

(a) Parts of the procedure are in bold text.

For each of these parts, consider whether it is essential and justify your answer.

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(b) Outline the steps needed to locate the positions of the amino acids on the TLC plate and to determine their R_f values.

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(c) Explain why different amino acids have different R_f values.

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(2)
(Total 10 marks)

Q9. Ethanol can be oxidised by acidified potassium dichromate(VI) to ethanoic acid in a two-step process.

ethanol ⟶ ethanal ⟶ ethanoic acid

(a) In order to ensure that the oxidation to ethanoic acid is complete, the reaction is carried out under reflux.

Describe what happens when a reaction mixture is refluxed and why it is necessary, in this case, for complete oxidation to ethanoic acid.

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(3)

(b) Write a half-equation for the overall oxidation of ethanol into ethanoic acid.

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(1)

(c) The boiling points of the organic compounds in a reaction mixture are shown in the following table.

Compound	ethanol	ethanal	ethanoic acid
Boiling point / °C	78	21	118

Use these data to describe how you would obtain a sample of ethanal from a mixture of these three compounds. Include in your answer a description of the apparatus you would use and how you would minimise the loss of ethanal. Your description of the apparatus can be either a description in words or a labelled sketch.

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(d) Use your knowledge of structure and bonding to explain why it is possible to separate ethanal in this way.

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(2)

(e) A student obtained a sample of a liquid using the apparatus in part **(c)**.

Describe how the student could use chemical tests to confirm that the liquid contained ethanal and did **not** contain ethanoic acid.

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(5)
(Total 16 marks)