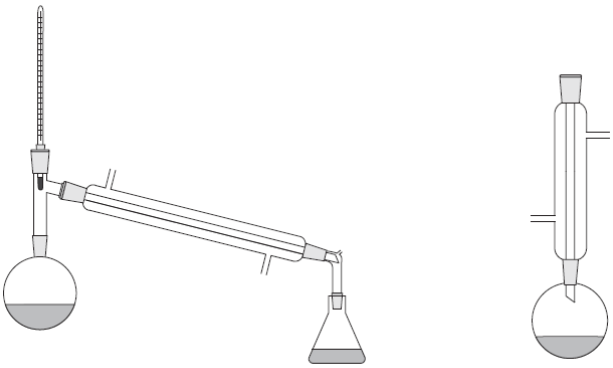
91391 Demonstrate understanding of the properties of organic compounds

Collated Organic Technique Questions

(2021:1)

(c) Pentan-1-ol can react when heated with MnO_4^- / H^+ to form either pentanal or pentanoic acid depending on the apparatus (equipment) used. Two apparatuses are pictured below.



1

2

(i) Name the process carried out by each apparatus.

(ii) Explain why apparatus 1 is used to produce pentanal from pentan-1-ol, whereas apparatus 2 is used to produce pentanoic acid from pentan-1-ol. In both reactions, pentan-1-ol is heated with MnO_4^- / H^+. Your answer should include:

- identification of the type of reaction occurring in both reactions
- an explanation of how the process carried out by each apparatus works to produce the desired organic product.

(2020:3)

(c) (iii) Outline the advantages of heating under reflux when hydrolysing a triglyceride. (Part Q)

(2019:1)

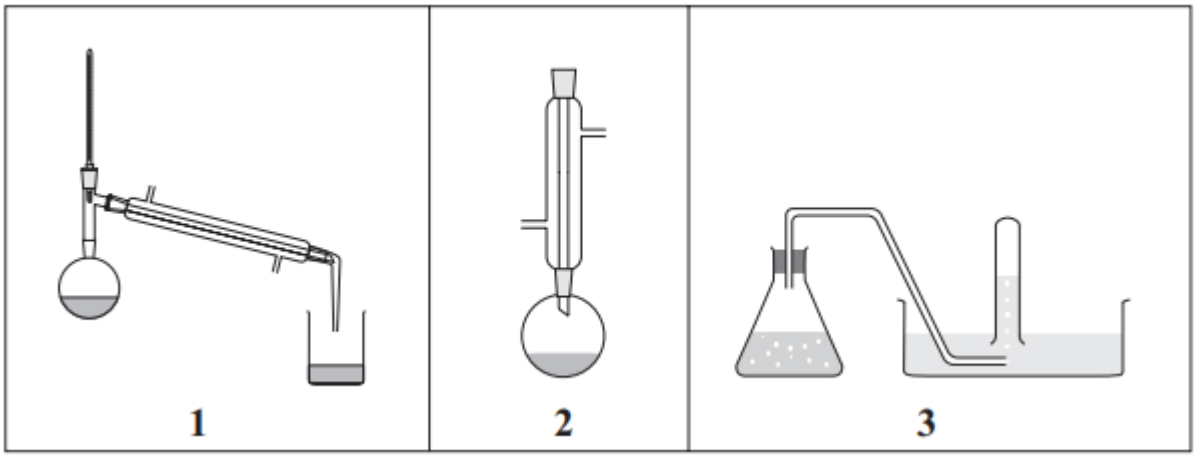
(a) (ii) Propanal, $CH_3–CH_2–CHO$, can be formed from the oxidation of a primary alcohol. Draw the structural formula of the primary alcohol, and explain why distillation is required to obtain the aldehyde product during the oxidation process.

(2018:3)

(b) Many organic synthesis reactions are heated under reflux.

(i) Draw the structural formula and name the ester formed from heating ethanol and butanoic acid under reflux in the presence of concentrated sulfuric acid.

(ii) From the diagrams below, give the number of the apparatus used for heating under reflux.



(iii) Outline the advantages of heating under reflux in the preparation of the ester in part (i).

(iv) From the diagrams above, give the number of the apparatus and explain the process that could be used to purify (separate) the ester in part (i) from the reaction mixture.

(2017:2)

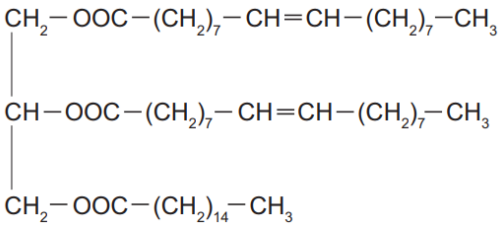
(b) (i) Adding an acidified potassium dichromate solution to propan-1-ol can produce either propanal or propanoic acid.
Explain the laboratory procedure used to convert propan-1-ol to propanal.
In your answer, you should:

- outline the procedure for the conversion, and describe any colour changes linked to the species involved
- state the type of reaction occurring
- explain how the procedure ensures only propanal is collected.

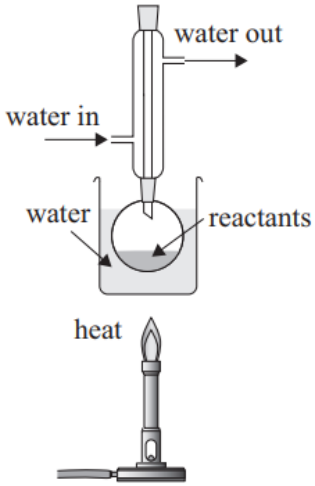
(2016)

No question asked

(2015:3) - modified



(a) (iv) Explain <u>why the equipment below is used for hydrolysis of the triglyceride</u> (shown opposite), using aqueous sodium hydroxide.



(2014:2)

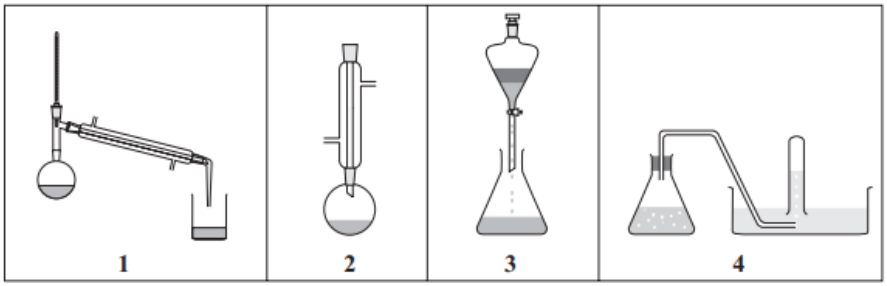
(b) Instructions for the preparation of 2-chloro-2-methylpropane are given below.
Read the instructions carefully and answer the questions that follow.

1. Shake 10 mL of 2-methylpropan-2-ol with 30 mL of concentrated hydrochloric acid in a separating funnel for 10 minutes.
2. Run off the bottom acid layer and discard it. Add saturated sodium hydrogen carbonate to the organic product. Shake, releasing the tap every few seconds to relieve the pressure.
3. Run off the bottom aqueous layer and discard it. Transfer into a conical flask and add some anhydrous sodium sulfate, and stir thoroughly.
4. Transfer the organic product into a round-bottom flask, and collect the fraction boiling within 2°C of the boiling point of 2-chloro-2-methylpropane.

(i) Explain why the solution of sodium hydrogen carbonate is added in instruction 2. Name the gas produced in this step.

(ii) Explain why anhydrous sodium sulfate is added in instruction 3.

(iii) Name the process used in instruction 4 to purify the organic product. Write the number of the equipment that a student would use to perform this process from the diagrams below.



(iv) Discuss the process carried out in instruction 4 Include in your answer: the purpose of this process, and an explanation of how it works.

Answers

(2021:1)

(c) (ii) When oxidising pentan-1-ol by heating it with acidified permanganate (MnO_4^-/H^+), distillation is used to produce pentanal. Distillation separates organic molecules by evaporating and condensing molecules based on boiling points. Pentanal is an aldehyde with a lower boiling point than pentan-1-ol so it vaporises when heated and is then condensed and collected before it is further oxidised to a carboxylic acid. The reflux process is used because it ensures that volatile molecules are contained when the reaction is heated so that pentan-1-ol is fully oxidised to pentanoic acid. As the pentan-1-ol is heated with acidified permanganate, it produces pentanal, which vaporises. As, it travels upwards, the vapour is condensed in the condenser, and drops back into the reaction mixture to be further oxidised to pentanoic acid.

(2020:3)

(c) (iii) Heating under reflux is an advantage as it condenses volatile organic molecules that have turned into gases back into liquids. This allows the reaction to go to completion and ensures none of the reactants / products escape, thus increasing the yield of the product. This also means the reaction can be heated without the risk of losing reactant / product, so the rate of the reaction increases.

2019:1

(a) (ii) $CH_3CH_2CH_2OH$

The aldehyde can be oxidised to the carboxylic acid so it needs to be removed from the reaction mixture before this happens. Distillation separates liquids with different boiling points so removes the aldehyde before it oxidises to a carboxylic acid as it has a lower boiling point than the alcohol.

2018:3

(b) (i) ethyl butanoate $CH_3CH_2CH_2COOCH_2CH_3$

(ii) Heat under reflux: Diagram 2.

(iii) Increases rate because it is able to be heated No loss of products / reactants because they are condensed back into the mixture Increases the amount of products / yield because reactants / products are prevented from escaping.

(iv) Distillation could be used to purify the ester (diagram 1). The reaction mixture is heated to the boiling point of the ester which is different from both the alcohol and carboxylic acid reactants. The ester will evaporate from the mixture and enter the condenser where it is cooled back to the liquid to be collected. The ester has therefore been separated from the reaction mixture.

2017:2

(b) (i) Aldehyde (propanal) is obtained by distillation of propan-1-ol with acidified (potassium) dichromate ($Cr_2O_7^{2-}$ / H^+). The orange colour of the $Cr_2O_7^{2-}$ / H^+ changes to (blue) green (Cr^{3+} ions). The reaction is an oxidation reaction. Distillation is a way to separate the aldehyde (propanal) from the reactant alcohol (propan-1-ol) which has a higher boiling point. The aldehyde (propanal) can react further to form a carboxylic acid (propanoic acid). This reaction is prevented if the aldehyde is removed as it is formed – distillation achieves this by evaporating the aldehyde and then allowing it to condense for collection.

2015:3

(a) (iv) Increases the rate of reaction;

(Condensing) prevents volatile chemicals from being lost to the environment,

(The mixture refluxed to increase reaction rate without loss of product through evaporation)

2014:2

(b) (i) Gas = Carbon dioxide / CO_2 NaHCO3 is used to remove any remaining acid mixed with the liquid product.

(ii) Na_2SO_4 is added to remove any remaining water mixed with the liquid product.

(iii) Fractional Distillation. Equipment 1.

(iv) The purpose of the process is to purify the chemical / remove impurities / separate product

- This is achieved by separating liquids according to their boiling points.
- Chemicals are boiled then condensed / liquid-gas then gas-liquid.
- The fraction at the desired boiling point is kept / other fractions are discarded.