2.5.2 Alcohol pathways, purification and spectra

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS distillation

Objective

Choose oxidation conditions and combine chemical tests with mass and IR evidence. All questions and marking guidance are original.

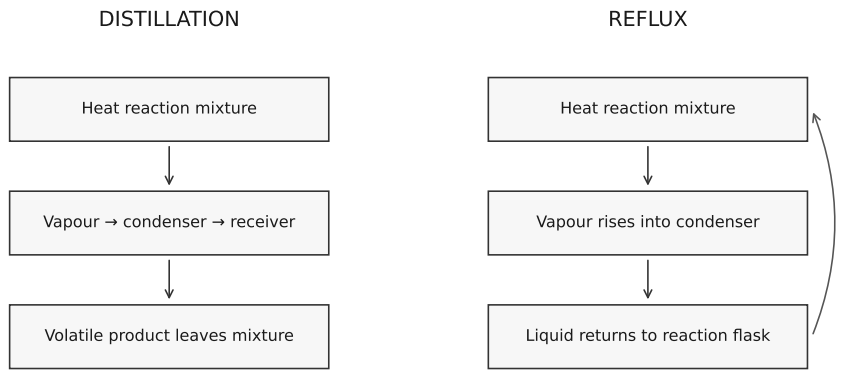
1 Key knowledge and worked examples

Primary alcohol + acidified dichromate gives an aldehyde if distilled as formed, or a carboxylic acid under reflux with excess oxidant. Secondary alcohol gives a ketone. Tertiary alcohol resists these conditions. Reflux returns condensed vapour; distillation removes volatile material.

■ Worked identification

An unknown has formula C_3H_6O, a C=O IR absorption and a positive warm Fehling's test. Propanal, CH_3CH_2CHO, fits all three. Propanone fits the formula and C=O but not the reducing test. A molecular-ion peak gives mass for a singly charged ion; the base peak need not be the molecular ion.

Extract with an immiscible solvent, separate layers using evidence of their identities, dry with a suitable anhydrous salt and remove the drying agent before distilling. A narrow boiling range supports purity but does not alone prove identity.



Process comparison only; use the approved apparatus and risk assessment.

2 Practice

2.1 Name the products of controlled oxidation of propan-1-ol by immediate distillation, propan-1-ol by reflux with excess oxidant, and propan-2-ol. [3]

2.2 Write the equation using [O] for propan-2-ol oxidation and state the oxidant colour change. [3]

2.3 State the reagent/condition for ethanol dehydration and the organic product. Classify the reaction. [3]

3 Exam-style questions

3.1 An unknown has molecular-ion m/z 60, a C=O absorption and very broad acid O–H absorption. It releases CO_2 with Na_2CO_3. Given C = 12, H = 1, O = 16, assess CH_3COOH and $CH_3CH_2CH_2OH$ as proposals. Explain why one strong IR peak alone is insufficient. [5]

3.2 Explain why reflux is appropriate when making propanoic acid but distillation is useful when making propanal. State two distinct purification actions after a liquid-organic preparation. [4]

3.3 State the reagents used to convert an alcohol to a chloroalkane, bromoalkane and iodoalkane. For 2-methylpropan-2-ol with concentrated HCl, name the organic product and explain why layer identification and drying are separate steps. [5]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 Propanal; propanoic acid; propanone. Acidified potassium dichromate(VI) is the stated oxidant.

2.2 $CH_3CH(OH)CH_3 + [O] \rightarrow CH_3COCH_3 + H_2O$. Orange to green.

2.3 Concentrated phosphoric acid with heat, ethene, elimination.

3.1 Ethanoic acid has Mr 60, contains both carbonyl and acid OH, and reacts with carbonate. Propan-1-ol also has Mr 60 but lacks carbonyl and does not give the acid carbonate test. A carbonyl alone also fits aldehydes/ketones, so combine independent evidence.

3.2 Reflux returns vapour and allows further oxidation to acid; distillation removes aldehyde before further oxidation. Any two explained actions: solvent extraction/separation, drying removes residual water, final distillation separates volatile product from less volatile impurities.

3.3 PCl_5 gives a chloroalkane; KBr with 50% concentrated sulfuric acid supplies HBr for a bromoalkane; red phosphorus and iodine provide reagent for an iodoalkane. The tertiary alcohol gives 2-chloro-2-methylpropane. Layer identification separates bulk aqueous/organic phases; drying removes water remaining in the organic layer.