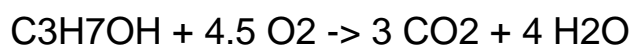# 2025 Ch H2 Q4

Section: Nature's Chemistry

Topic: Alcohols and Carboxylic Acids

Question Summary:

This question covers combustion of alcohols, oxidation reactions, titration calculations, and analysis of ethanoic acid including impurity effects.

Worked Solution

(a)(i) Balanced combustion equation

$C_3H_7OH + 4.5 O_2 \rightarrow 3 CO_2 + 4 H_2O$

(a)(ii) Enthalpy of combustion

Temperature rise = 35.1 - 21.2 = 13.9 C

Mass of water = 150 g

$E_h = cm\Delta T = 4.18 \times 150 \times 13.9 = 8712.9$ J = 8.7129 kJ

Mass burned = 0.498 g, molar mass = 60 g

Scaling to 1 mol: (8.7129 kJ × 60) / 0.498 = 1050.04 kJ mol-1

(a)(iii) Essential equipment

Alcohol burner, copper can/beaker, thermometer, measuring cylinder, clamp stand.

(a)(iv) Reason for lower experimental value

Heat losses to surroundings, incomplete combustion, or evaporation of alcohol.

(b)(i) Oxygen to hydrogen ratio for ethane-1,2-diol

Formula: $C_2H_6O_2 \rightarrow$ O:H ratio = 2:6 = 1:3

(b)(ii)(A) Suitable oxidising agent

Acidified potassium dichromate or hot copper(II) oxide.

(b)(ii)(B) Structural formula for Z (turns UI red)

Product is a carboxylic acid: $CH_3CH_2CH_2COOH$

(b)(ii)(C) Product from oxidation of the secondary isomer

Butanone (butan-2-one).

(c)(i) Glassware for making up 250 cm3 solution

Volumetric flask.

(c)(ii)(A) Improvement to burette rinsing

Rinse the burette with sodium hydroxide solution before filling.

(c)(ii)(B) Average volume

Use concordant titres: 20.5, 20.0, 20.3 cm3

Average = (20.5 + 20.0 + 20.3)/3 = 20.27 cm3 ≈ 20.3 cm3

(c)(ii)(C) Concentration of ethanoic acid

$n(NaOH) = 0.105 \times 0.0198 = 2.079 \times 10^{-3}$ mol

1:1 reaction, so mol ethanoic acid = mol NaOH

Concentration = 2.079×10^{-3} / 0.0250 = 0.08316 mol l-1

(c)(iii)(A) Ionic formula for potassium ethanoate

CH_3COO^- K^+

(c)(iii)(B) Mass of ethanoic acid

n = cV = 0.45 × 0.200 = 0.090 mol

Mass = n × GFM = 0.090 × 60 = 5.4 g

Revision Tips

- Heat loss is the main reason calorimetry results differ from data booklet values.
- Concordant titres differ by no more than 0.2 cm3.
- Oxidation level increases with higher O:H ratio.
- Know the structures of butanoic acid and butanone.