

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 reasoning. Additional correct chemical evidence is acceptable when it addresses the stated alternatives.

2.1 $2\text{C}_3\text{H}_7\text{OH} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 8\text{H}_2\text{O}$. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{PCl}_5 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{POCl}_3 + \text{HCl}$. Water or a carboxylic acid can also produce HCl with PCl_5 , so fumes alone do not uniquely establish an alcohol.

2.2 A butanal, B butanoic acid, C butanone. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + [\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{H}_2\text{O}$; $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{H}_2\text{O}$. Dichromate changes orange to green. A gives a brick-red precipitate with warm Fehling's/Benedict's solution; B gives effervescence of CO_2 with sodium carbonate. Ketone C does not give the ordinary positive aldehyde test.

2.3 The stated organic product is the upper layer because $0.87 < 1.00 \text{ g cm}^{-3}$; do not generalise to every organic liquid. Layer separation removes the bulk aqueous phase, whereas an anhydrous salt removes residual water. Decant/filter the salt before distilling to leave the dried liquid product. Reflux returns condensate to the reaction vessel; distillation collects a volatile fraction separately. Place the bulb in the vapour path at the condenser entrance and compare at the same pressure. A narrow range supports purity, but another substance or mixture may have a similar range, so further identity evidence is needed.

3.1 $M_r = 3(12) + 6(1) + 16 = 58$ for both isomers. C_2H_5^+ : $2(12) + 5 = 29$; CHO^+ : $12 + 1 + 16 = 29$. Positive Fehling's evidence supports propanal, $\text{CH}_3\text{CH}_2\text{CHO}$, over propanone. A fragment mass permits different ionic formulae/pathways and does not uniquely locate the carbonyl; use the combined evidence.

3.2 Original marking guidance by structure:

- $\text{CH}_2=\text{CHCH}_2\text{NH}_2$: alkene C–H 3000–3100 and alkane C–H 2850–3000; C=C 1620–1680; N–H 3300–3500.
- $\text{CH}_3\text{CH}_2\text{Cl}$: alkane C–H 2850–3000; C–Cl 500–800.
- HOCH_2CHO : alkane C–H 2850–3000 and aldehyde C–H 2700–2900; broad alcohol O–H 3200–3600; C=O 1680–1750.
- CH_3COOH : alkane C–H 2850–3000; very broad acid O–H 2500–3300; C=O 1680–1750.

The supplied regions overlap; intensities, shapes and other evidence matter. The alcohol and acid answers must distinguish their OH environments rather than merely state “OH present”.

3.3 A ammonium sulfate; B sodium sulfate; C propanal; D propanone. $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$; $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4(\text{s})$. Fresh aliquots prevent reagent carry-over from introducing ions or altering later test conditions. Both isomers contain C=O and have M_r 58, so those shared results cannot distinguish them; the aldehyde's reducing test does. This closed candidate list supports these assignments; it does not make the tests unique among all possible chemicals.