

Solutions

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

2.1 Carbon moles = $1.760/44 = 0.0400$; carbon mass = 0.480 g. Hydrogen atoms = $2(0.900/18) = 0.100$ mol; mass = 0.100 g. Oxygen mass = $0.740 - 0.480 - 0.100 = 0.160$ g, oxygen = 0.0100 mol. Ratio 4:10:1, $C_4H_{10}O$.

2.2 Empirical mass 74, multiplier one, $C_4H_{10}O$. Different atom connectivities can share that formula.

2.3 Propanal, three distinct carbon environments/signals.

3.1 More product remains dissolved in the larger mother-liquor volume; warm wash dissolves more product than a little cold solvent, both lowering recovery.

3.2 Reflux heats without losing volatile reactants. Simple distillation collects a sufficiently separable volatile component. Steam distillation carries a suitable water-insoluble volatile compound at reduced operating temperature. Keep a heated reflux/distillation system open to pressure relief, not sealed.

3.3 The data suggest impurity/retained solvent, not proof of pure intended product. Recrystallise as appropriate and dry to constant mass, then remeasure melting range/mass and combine with independent identification evidence.

3.4 The amine accepts H^+ to form an ammonium salt with HCl. Controlled primary-alcohol oxidation gives an aldehyde when distilled before further oxidation. Use an appropriate non-flame heat source/keep ignition sources away from the flammable solvent; wear eye protection/use suitable handling controls for corrosive acid. The task treats separate functional-group reactions; actual selectivity must follow the supplied procedure.

3.5 In 100 g, amounts are C $58.82/12 = 4.902$, H 9.80, O $31.38/16 = 1.961$ mol. Ratio approximately 2.5:5:1, doubled to $C_5H_{10}O_2$; mass 102 matches the molecular ion. Methyl butanoate, $CH_3CH_2CH_2COOCH_3$, fits the five carbon environments and four proton sets. Ethyl propanoate needs an OCH_2 quartet, not an OCH_3 singlet. m/z 31 is consistent with CH_3O^+ and supports the methoxy assignment but is not unique structure proof.