# Mark Scheme - 4.3 Alcohols and Phenols

1. (a) (i) ultraviolet / sunlight [1]

(ii) A species with an unpaired electron. [1]

(b) $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$ (1)
$CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ (1) [2]

(c) (i) Two $CH_3\bullet$ radicals combine (in a termination reaction). [1]

(ii) 24.3 ÷ 12 = 2.025 for C 4.1 ÷ 1.01 = 4.059 H 71.6 ÷ 35.5 = 2.017 Cl (1)
$CH_2Cl$ (1) [2]

(d) (i) Nucleophilic substitution [1]

(ii) Methanol has hydrogen bonding between molecules (1)
Chloromethane has van der Waals forces / dipole-dipole forces between molecules (1)
Hydrogen bonding is stronger than Van der Waals/dipole-dipole (1) [3]

(iii) Acidified potassium dichromate / acidified potassium manganate(VII) (1)
Heat /warm (1) (Need correct reagent to gain heat mark) [2]

(e) Compounds B and C are stable enough to reach the ozone layer OR Compound D would not reach the ozone layer as it would decompose in the lower atmosphere. (1)

(The C-Cl forms) Cl• which will decompose the ozone. (1)

Compound A does not contain chlorine, (so it cannot form Cl•) / Compound A has a lower RODP (1)

[3]

**Total [16]**

2.

(a) (i) $\delta-$ on Br and $\delta+$ on C attached (1)

Arrow from lone pair on $OH^-$ to $\delta+$ on C (1)

Arrow from C-Br bond to Br (1)

Correct alcohol + $Br^-$ (1) [4]

(ii) Nucleophilic substitution [1]

(iii) The bond breaks and both the electrons go to one of the bonded atoms/ the bond breaks and ions are formed. [1]

(b) (i) Sodium hydroxide in ethanol/ alcohol [1]

(ii) Elimination/ dehydrohalogenation [1]

(iii) Structural formulae for but-1-ene (1)

and but-2-ene (1) [2]

(c) A is non-miscible with water/ does not mix with water and B is miscible/ mixes with water/ is soluble in water (1)

A has a longer carbon chain/ is bigger (1)

Hydrogen bonding (1)

Between the OH in alcohol and water (1)

In large alcohols non-polar/ hydrophobic part of molecule is large / OH is less significant part of molecule (1) [5]

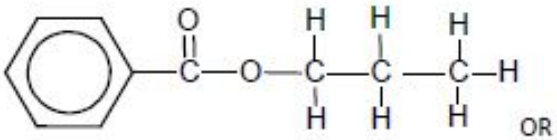
*QWC: organisation of information clearly and coherently; use of specialist vocabulary such as intermolecular force/ hydrogen bond/ hydrophobic/ non-polar/ miscible* [1]

**Total [16]**

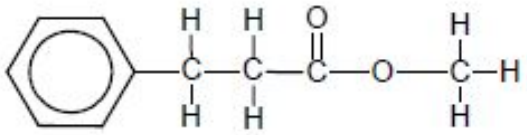
3.

(a) Any valid ester structure with formula $C_{10}H_{12}O_2$ [1]

Examples:

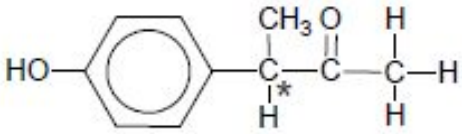


OR



(b) (i) Compound X [1]

(ii) [1]



(iii) Rotate the plane of polarised light in opposite directions [1]

(c)

| *Reagent(s)* | *Observation if the test is positive* | *Compound(s) that would give a positive result* |
|---|---|---|
| $I_2$ / NaOH (aq) | Yellow solid | X |
| $Na_2CO_3$ (aq) | Bubbles of colourless gas / effervescence | W |
| $FeCl_3$ (aq) | Dark purple/blue/green<br>- do not accept 'precipitate' | X, Z |

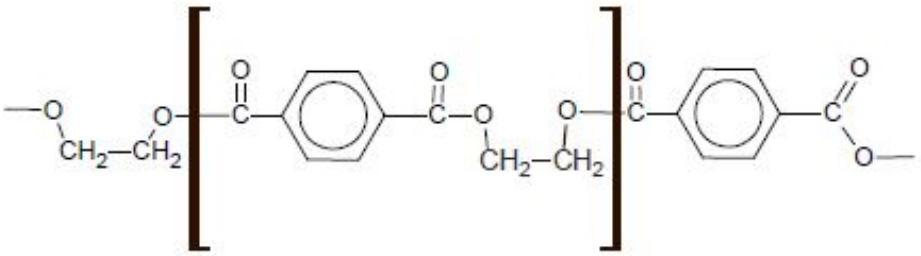
*(1 mark for each box)* [6]

(d) (i) Heat / Alkaline / Potassium manganate(VII) / then acidify
(1 mark for Potassium manganate + 1 other point; 2 marks for all) [2]

(ii) I. Addition polymer – One large molecule formed only / Condensation polymer – one large molecule with small molecules (e.g. water) lost. (1)

Addition polymer – one starting material / Condensation – two starting materials
OR Addition polymer – one functional group in each molecule/ Condensation polymer – two functional groups in each molecule (1) [2]

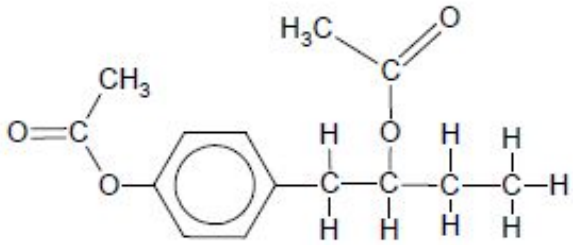
II.



[1]

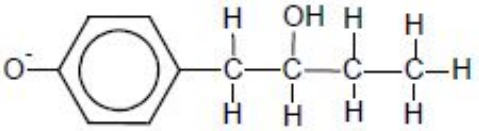
(e) (i) $NaBH_4$ / $LiAlH_4$ or name(1) Reduction (1) [2]
- ignore conditions unless $LiACH_4$ in water
- do not accept 'redox'

(ii)



*Accept structures with only one –OH group reacted.* [1]

(iii) [1]



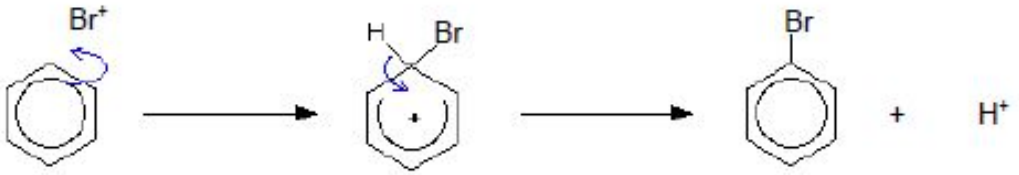
[19 marks]

4.

(a) (i) Electrophilic substitution [1]

(ii)

$Br_2 + FeBr_3 \longrightarrow Br^+ + FeBr_4^-$




Formation of $Br^+$ (1), curly arrows (1), intermediate (1) [3]

(b) (i) The extra stability in the benzene molecule due to electron delocalisation / the difference in energy between the experimental $\Delta H^\theta$ reaction for benzene and the $\Delta H^\theta$ reaction according to the Kekulé structure [1]

(ii) If benzene had 3 double bonds enthalpy change would be $3 \times -120 = -360$ kJ $mol^{-1}$ (1)

Delocalisation energy is difference between $-360$ and $-208 = 152$ kJ $mol^{-1}$ (1) [2]

(c) Benzene is carcinogenic / toxic [1]

5.

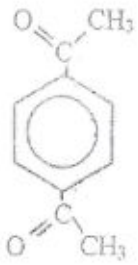
(a) (i) $CH_3CH_2CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CH_2CH_2CH_2Cl + HCl$ [1]

(ii) $CH_3CH_2CH_2\dot{C}HCH_3$ [1]

(b) (Anhydrous) aluminium chloride / iron(III) chloride allow $AlCl_3$ / $FeCl_3$ [1]

(c) (i) orange / red precipitate [1]

(ii)



(1) $-COCH_3$ groups in any positions

It must contain a C=O group but it is not an aldehyde as it does not react with Tollens' reagent (1) [2]

(d) (i) (Alkaline) potassium manganate(VII) (solution) allow $KMnO_4$ / $MnO_4^-$ [1]

(ii) Dilute acid allow HCl / $H^+$ [1]

(iii) Lithium tetrahydridoaluminate(III) / lithium aluminium hydride
allow $LiAlH_4$ [1]

(iv)

(e) Only the infrared spectrum of benzoic acid would have a peak at 1650–1750 $cm^{-1}$ (1)
This is due to the carbonyl group present in the benzoic acid (1) [2]

**Total [12]**

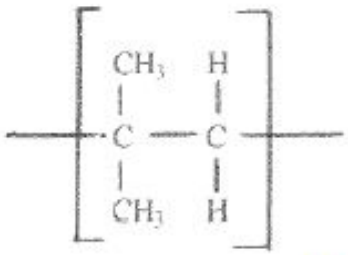
6.

(a) (i) (2-)Methylpropan-2-ol **[1]**

(ii) 30.1 / 30 **[1]**

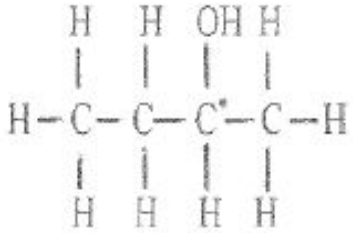
(iii) (Concentrated) sulfuric acid / phosphoric acid / aluminium oxide / pumice **[1]**

(iv)



(with or without n) **[1]**

(v)



(1) for structure, (1) for asterisk **[2]**

(vi) I acidified potassium dichromate / $H^+$, $Cr_2O_7^{2-}$(aq) **[1]**

II ethanal has a C = O bond at 1650-1750 $cm^{-1}$
(metaldehyde does not have this bond) (1)

metaldehyde has a C – O bond at 1000-1300 $cm^{-1}$
(ethanal does not have this bond) (1) **[2]**

(b) (i) **Reagent** 2,4-dinitrophenylhydrazine / 2,4-DNP OR iodine / NaOH or KI / NaOCl (1)

**Observation** yellow / orange / red precipitate OR yellow precipitate (1) **[2]**

(ii) **Reagent** ethanol / sulfuric acid OR $NaHCO_3$ OR $Ag^+/NH_3$ / Tollens' (1)

**Observation** sweet smelling liquid OR effervescence OR silver mirror (1) **[2]**

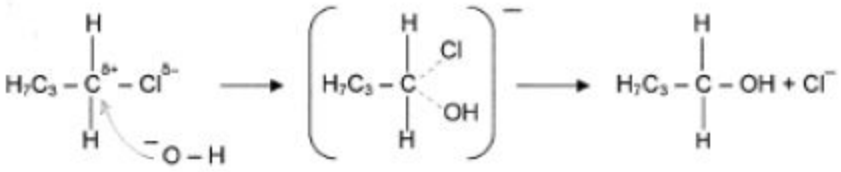
**Total [13]**

7.

(a) e.g. damages liver/ damages pancreas/causes cancer/causes skin disorders/ short-term effects (1)

e.g. more traffic accidents/violent behaviour/criminal behaviour (1) **[2]**

(b) (i) Nucleophilic substitution / hydrolysis (1)



Reactants: Intermediate (1)
Polarisation (1) (accept curly arrow to show
curly arrow (1) C – Cl breaking instead of intermediate) **[4]**
(Incorrect starting material or product maximum 2 marks from 3 for mechanism)

(ii) Peak at 650–800 $cm^{-1}$ due to C – Cl bond will be gone (1)
Peak at 2500–3500 $cm^{-1}$ due to O – H bond /
1000–1300 $cm^{-1}$ due to C – O bond will be present (1) **[2]**

(c) (i)

**[1]**

(ii) Structural / positional / chain **[1]**

(iii) Colour change from orange to green **[1]**

(iv) Concentrated sulfuric acid / aluminium oxide (1)
$CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CHCH_2 + H_2O$ (1) **[2]**

(d) (i) C – F bond stronger than C – Cl bond (1)
C – Cl bond breaks (in stratosphere) forming Cl• which
reacts with ozone (1) **[2]**

(ii) Some CFCs still being used / CFCs take a very long time to reach the ozone layer / other substances deplete the ozone layer **[1]**

**Total [16]**

8.

(a) Orange to green [1]

(b) (i) C–H [1]

(ii) C [1]

(iii) 1650 to 1750 $cm^{-1}$ C = O [1]

9.

(a) (i) **Aqueous** sodium hydroxide (1) Heat [below 110°C] (1) [2]

(ii) Bromobutane cannot form hydrogen bonds (1)
Butan-1-ol can form hydrogen bonds due to its —OH (1)
Hydrogen bonds between butan-1-ol and water molecules allow butan-1-ol to dissolve (1) [3]

(b) (i) Acidified dichromate(VI) / acidified manganate(VII) (1)
Heat (1) [2]

(ii) Butanoic acid can form hydrogen bonds between molecules (1)
Bromobutane has van der Waals' forces between the molecules (1)
Hydrogen bonds are stronger than van der Waals' so require more energy to break these (1)
[3]

(iii) Fractional distillation [1]

**Total [11]**

10. Reagent: acidified potassium dichromate / $Cr_2O_7^{2-}$ and $H^+$
or acidified manganate(VII) / $MnO_4^-$ and $H^+$ (1)

Colour change: from orange to green
or from purple to colourless (1) [2]

11.

(a) diagram completed with at least 1 water molecule and indication of interaction between O on one molecule and H on the other (1)

interaction between $\delta^+$ on H and lone pair on O (1)

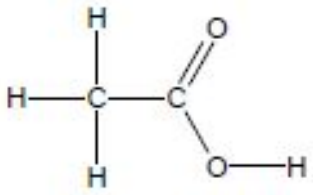
interaction labelled hydrogen bond (1) [3]

(b) (i) reduction/ redox – accept 'oxidation' [1]

(ii) I OH [1]

II OH is also present in water [1]

(c) (i) [1]




(ii) peak at 1650-1750 (1)

due to C=O (1) [2]

Total [9]