Rings, Polymers and Analysis <u>Carbonyl Compounds</u>

1. (a) (i) silver mirror ✓ ALLOW Ag(s) OR Ag mirror OR precipitate OR ppt OR solid ALLOW brown OR black OR grey 1 HOCH₂COOH ✓ (ii) **ALLOW** CH₂OHCOOH **OR** CH₂OHCO₂H **OR** HOCH₂CO₂H **OR** displayed **OR** skeletal formula **OR** HOCH₂COO **DO NOT ALLOW** C₂H₄O **OR** 2-hydroxyethanoic acid 1 $HOCH_2CHO + 3[O] \longrightarrow HOOCCOOH + H_2O$ (b) both products reagents **ALLOW** displayed/skeletal formula/COOHCOOH ✓✓ if molecular formula used $C_2H_4O_2 + 3[O] \longrightarrow C_2H_2O_4 + H_2O$ max = 1Any correctly balanced equation for partial oxidation can score 1 mark ✓ $HOCH_2CHO + [O] \longrightarrow HOCH_2COOH$ OR $HOCH_2CHO + 2[O] \longrightarrow OHCCOOH + H_2O$ OR $HOCH_2CHO + [O] \longrightarrow OHCCHO + H_2O$ OR $HOCH_2CHO + 2[O] \longrightarrow HOOCCHO + H_2O$ 2

ALLOW $HO(CH_2)_2OH$ **OR** $(CH_2OH)_2$ **OR** skeletal formula **OR**

DO NOT ALLOW molecular formula $(C_2H_6O_2)$

1

(c)

(i)

HOCH₂CH₂OH ✓

displayed formula

(ii) curly arrow from H⁻ to C^{δ^+} \checkmark dipoles <u>and</u> curly arrow from C=O bond to O \checkmark

ALLOW curly arrow to C even if dipole missing or incorrect intermediate ✓

curly arrow from intermediate to H $^{\delta^+}$ in H₂O/ H⁺ and if H₂O is used it must show the curly arrow from the O–H bond to the O \checkmark lone pairs are not essential

ALLOW maximum of 3 marks if incorrect starting material is used

Alternative 1

Alternative 2

$$HOH_{2}C \xrightarrow{\delta^{-}} H$$

$$HOH_{2}C \xrightarrow{H} HOH_{2}C \xrightarrow{H} HOH_{2}C$$

products are not required

Alternative 3

Alternative 3 scores all 4 marks even though the intermediate is not shown

[9]

2. (i)

$$h^{\delta +}$$
 $h^{\delta +}$
 $h^{\delta +}$

1 mark for each curly arrow (1)(1)

2

(ii)

(iii) electron pair donor (1)

1

3

3

1

(iv) electron pair on H⁻ attracted to δ+ carbon forming a dative covalent bond (1) the double/π electron pair breaks (1) electron pair now on O⁻ (1)

[7]

3. (a) (i) Tollens' reagent / ammoniacal silver nitrate (1) silver mirror / precipitate (1)

butanoate / butanoic acid / unambiguous formula or structure (1)

(ii) Any of:

 $Br_2-decolourises-(electrophilic)\ addition$

Na – fizzes – redox

SOCl₂ /PCl₅ /acid chloride – white fumes –

substitution/chlorination

 $\begin{array}{c} carboxylic\ acid + conc\ H_2SO_4\ /acid\ chloride - sweet\ smell - \\ esterification/\ condensation \end{array}$

test (1) - observation (1) - type of reaction (1)

3

NOT

2-4DNPH to give no precipitate

(b) recrystallise /purify (the precipitate) (1)measure melting point (1)compare with known values (1)

[9]

4. (a) (i) heat with:
Tollens' reagent / ammoniacal silver nitrate (1)
to give: silver mirror / precipitate (1)

2

3

(ii) aldehydes can be oxidised to a carboxylic acid **ora** / aldehydes can reduce Ag⁺ to Ag (1)

1

(b) (i) CH₃CH=CHCH₂OH (1) (either stereoisomer)

1

(ii) reduction / redox / addition (1) (NOT hydrogenation)

1

1

(c) $C_4H_6O + 5O_2 \rightarrow 4CO_2 + 3H_2O$ (1)

[6]

5. (a)

curly arrow from O of OH to C (1)

dipole on C=O and curly arrow breaking C=O (1)

structure of the intermediate (1)

curly arrow from O (of the correct intermediate)

... to H of H₂O (1) (allow O to H⁺ ion here)

curly arrow breaking the H–O bond in H₂O (1)

5

(b) one mark for the correct answer to each step below with ecf throughout steps may come in any order

one week's supply = $21 \times dose$ (1)

5.25 g / 0.0317mol

mass of trichloroethanal =

4.68 g (223mg if done first)

 $0.891 \times \text{mass of chloral hydrate (1)}$

60% yield = mass/moles x 100/60 (1)

7.8(0 g)

3

common errors for two marks are: 9.82 g (mass ratio upside down) 8.75 g (mass ratio not done)

2.60 g (3× not done), 1.11 g (7× not done), 0.371g (21× not done)

7798 g (mg to g not done) etc.

[8]

[1]

6. $CCl_3CH(OH)_2 + [O] \rightarrow CCl_3COOH + H_2O$ (1)

7. (i) OH H

1

1

1

(ii) $C_{14}H_{10}O_2 + 4[H] \rightarrow C_{14}H_{14}O_2$ (1) allow ecf from (i)

[2]

8. (i)

a correct skeletal aldehyde is shown on C1 (1)

rest of the skeletal structure (C_2 - C_{10})correct (1)

2

2

(ii) $C_9H_{15}CH_2OH + [O] \rightarrow C_9H_{15}CHO$ (1) + H_2O (1) **NOT** COH, allow $C_{10}H_{16}O$

[4]

9. (i) aldehyde / C=O / carbonyl (1)

1

allow $C_9H_{10}O$ [2] 10. method silver nitrate (1) ammonia / ammoniacal (1) warm / heat (1) silver (mirror) / brown ppt forms (1) explanation silver ions reduced / $Ag^+ + e^- \rightarrow Ag$ (1) aldehyde oxidised to a carboxylic acid (1) correct structure – eg C₆H₅CHCHCOO⁻/COOH (1) quality of written communication mark for correct spelling, punctuation and grammar in at least two sentences (1) 8 [8]

(ii) $C_6H_5CHCHCHO + 2[H] \rightarrow C_6H_5CHCHCH_2OH$ (1)

1