F324: Rings, Polymers and Analysis
4.1.2 Carbonyl Compounds /56

1. (a) (i) silver mirror ✓

ALLOW *Ag(s)* ***OR*** *Ag mirror* ***OR*** *precipitate* ***OR*** *ppt* ***OR*** *solid*
ALLOW *brown* ***OR*** *black* ***OR*** *grey*

1

(ii) $HOCH_2COOH$ ✓

ALLOW *$CH_2OHCOOH$* ***OR*** *CH_2OHCO_2H* ***OR*** *$HOCH_2CO_2H$*
OR *displayed* ***OR*** *skeletal formula* ***OR*** *$HOCH_2COO^-$*
DO NOT ALLOW *C_2H_4O* ***OR*** *2-hydroxyethanoic acid*

1

(b) $HOCH_2CHO + 3[O] \longrightarrow HOOCCOOH + H_2O$
reagents ✓ both products ✓

ALLOW *displayed/skeletal formula/COOHCOOH* ✓✓

if molecular formula used $C_2H_4O_2 + 3[O] \longrightarrow C_2H_2O_4 + H_2O$
max = 1 ✓

Any 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

(c) (i) $HOCH_2CH_2OH$ ✓

ALLOW *$HO(CH_2)_2OH$* ***OR*** *$(CH_2OH)_2$* ***OR*** *skeletal formula* ***OR*** *displayed formula*
DO NOT ALLOW *molecular formula ($C_2H_6O_2$)*

1

(ii) curly arrow from H^- to $C^{\delta+}$ ✓
dipoles and curly arrow from C=O bond to O ✓

ALLOW curly arrow to C even if dipole missing or incorrect

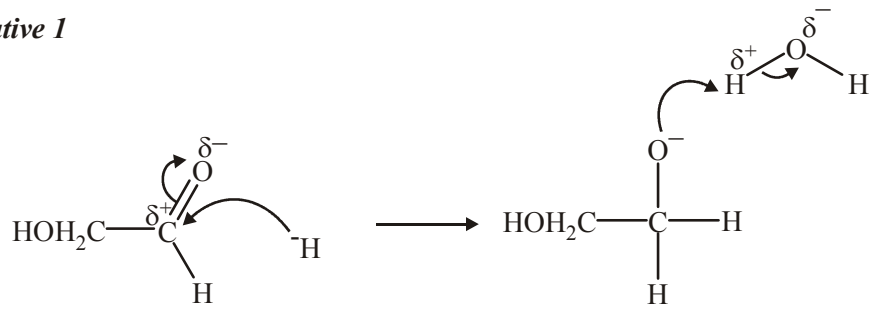
intermediate ✓

curly arrow from intermediate to $H^{\delta+}$ in H_2O/ H^+ and if H_2O is used it must show the curly arrow from the O–H bond to the O ✓

lone pairs are not essential

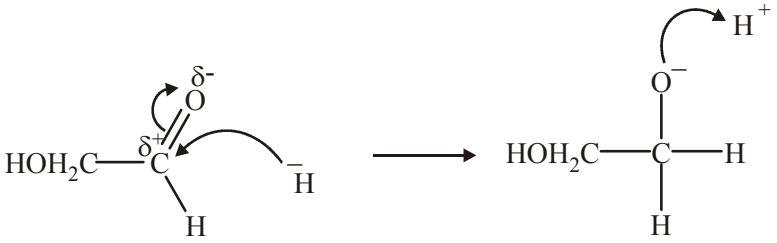
ALLOW maximum of 3 marks if incorrect starting material is used

Alternative 1

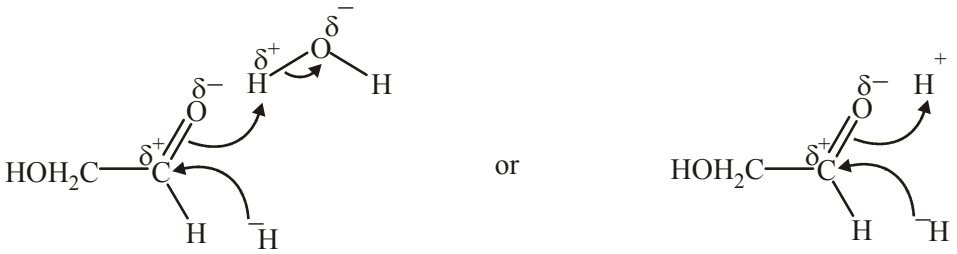


Alternative 2

products are not required



Alternative 3

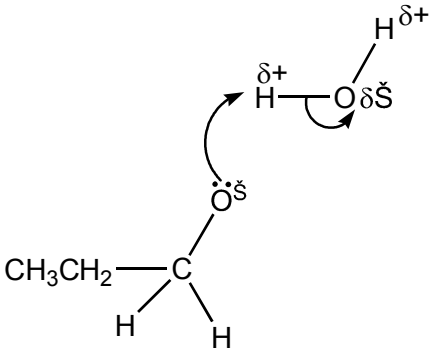


Alternative 3 *scores all 4 marks even though the intermediate is not shown*

4

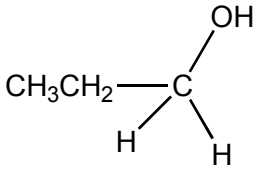
[9]

2. (i)



1 mark for each curly arrow **(1)(1)** 2

(ii)



(1) 1

(iii) electron pair donor **(1)** 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)** 3

[7]

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

silver mirror / precipitate **(1)**

butanoate / butanoic acid / unambiguous formula or structure **(1)** 3

(ii) **Any of:**

Br_2 – decolourises – (electrophilic) addition
Na – fizzes – redox
$SOCl_2$ /PCl_5 /acid chloride – white fumes – substitution/chlorination
carboxylic acid + conc H_2SO_4 /acid chloride – sweet smell – esterification/ condensation

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)** 3

[9]

4. (a) (i) heat with:
Tollens' reagent / ammoniacal silver nitrate **(1)**

to give: silver mirror / precipitate **(1)** 2

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

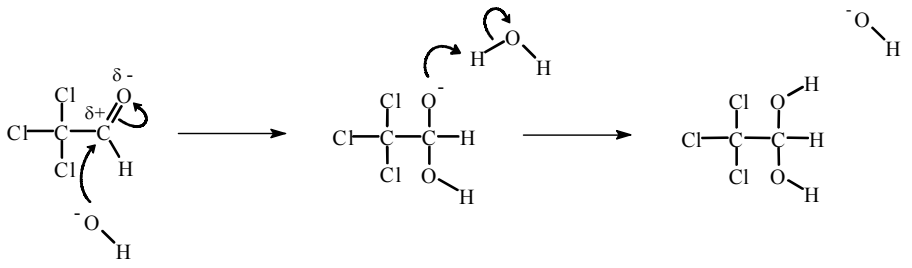
(b) (i) $CH_3CH=CHCH_2OH$ **(1)**
(either stereoisomer) 1

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

(c) $C_4H_6O + \mathbf{5}O_2 \rightarrow \mathbf{4}CO_2 + \mathbf{3}H_2O$ **(1)** 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 H_2O **(1)** (allow O to H^+ ion here)

curly arrow breaking the H–O bond in H_2O **(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× dose **(1)**	5.25 g / 0.0317mol	
mass of trichloroethanal = 0.891 × mass of chloral hydrate **(1)**	4.68 g (223mg if done first)	
60% yield = mass/moles x 100/60 **(1)**	7.8(0 g)	3

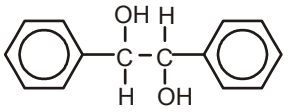
common errors for two marks are: 9.82 g (mass ratio upside down)
8.75 g (mass ratio not done)
2.60 g (3× not done), 1.11 g (7× not done), 0.371g (21× not done)
7798 g (mg to g not done) *etc.*

[8]

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

[1]

7. (i)

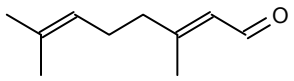


(1) 1

(ii) $C_{14}H_{10}O_2 + 4[H] \rightarrow C_{14}H_{14}O_2$ **(1)** 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

(ii) $C_9H_{15}CH_2OH + [O] \rightarrow C_9H_{15}CHO$ **(1)** + H_2O **(1)** 2
***NOT** COH,*
allow $C_{10}H_{16}O$

[4]

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

(ii) $C_6H_5CHCHCHO + \mathbf{2}[H] \rightarrow C_6H_5CHCHCH_2OH$ **(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 $C_6H_5CHCHCOO^-$/COOH **(1)**

quality of written communication

mark for correct spelling, punctuation and grammar in at least two sentences **(1)** 8

[8]