

Mark schemes

1

- (a) Yes, because it is oxidised to ethanal / CH_3CHO
OR it is oxidised to a compound that contains CH_3CO group
*Ignore 'primary alcohols are oxidised to aldehydes'.
Need 'yes' and an explanation to be awarded the mark.*

1

- (b) $M_r \text{CHI}_3 = 393.7$ (**M1**)
*Allow if clearly shown in a calculation.
Allow 394*

1

Moles $\text{CHI}_3 = 10 / 393.7 = 2.54 \times 10^{-2}$ (**M2**)
*Allow a consequential answer on an incorrect M_r .
 2.54×10^{-2} scores **M1** and **M2**.*

1

Moles $\text{I}_2 = 7.62 \times 10^{-2}$ (**M3**)
Allow $3 \times \text{M2}$.

1

Mass $\text{I}_2 = 7.62 \times 10^{-2} \times 253.8 = 19.34\text{g}$ (**M4**)
*Allow **M3** $\times 253.8$ or **M3** $\times 254$*

1

Scaling $19.34 / 0.832 = 23.2\text{g}$ (**M5**)
*Allow **M4** / 0.832
Lose this mark if the answer is not given to 3 significant figures.
Answer without working scores **M5** only.
Allow any chemically correct alternative method.
Calculations which combine several steps in one expression can
score the marks for all of these individual steps.*

1

- (c) Remove soluble impurities
*Allow 'remove excess sodium hydroxide / iodine'.
Allow 'remove excess sodium methanoate / sodium iodide'.
Allow 'remove excess reagents'.*

1

- (d) Will not dissolve solid / solid is insoluble in water
Allow 'will not react with solid'.

1

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2

(a) Sn / HCl **OR** Fe / HCl not conc H₂SO₄ nor any HNO₃

Ignore subsequent use of NaOH

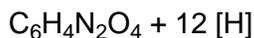
Ignore reference to Sn as a catalyst with the acid

Allow H₂ (Ni / Pt) but penalise wrong metal

But NOT NaBH₄ LiAlH₄ Na / C₂H₅OH

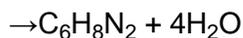
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Equation must use molecular formulae



12[H] and 4H₂O without correct molecular formula scores 1 out of 2

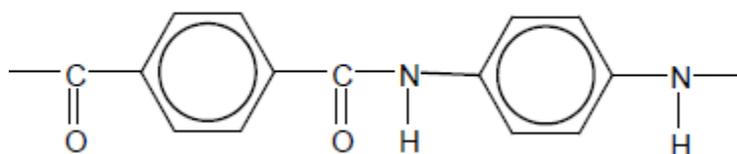
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Allow + 6H₂ if H₂ / Ni used

Allow -CONH- or -COHN- or -C₆H₄-

1



Mark two halves separately: lose 1 each for

- error in diamine part*
- error in diacid part*
- error in peptide link*
- missing trailing bonds at one or both ends*
- either or both of H or OH on ends*

Ignore n

2

(b) H₂ (Ni / Pt) but penalise wrong metal

NOT Sn / HCl, NaBH₄ etc.

1



1

In benzene 120°

1

In cyclohexane 109° 28' or 109½°

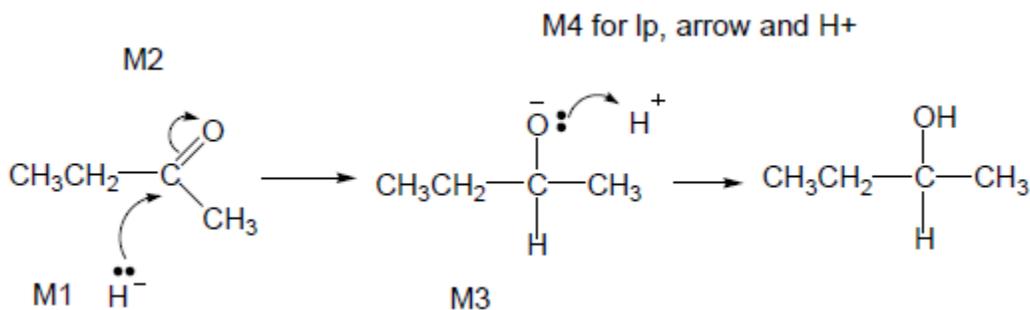
Allow 108° - 110°

If only one angle stated without correct qualification, no mark awarded

1

(c) (i) Nucleophilic addition

1



- M2 not allowed independent of M1, but allow M1 for correct attack on C⁺
- + rather than δ⁺ on C=O loses M2
- M3 is for correct structure including minus sign but lone pair is part of M4
- Allow C₂H₅
- M1 and M4 include lp and curly arrow
- Allow M4 arrow to H in H₂O (ignore further arrows)

4

(ii) M1 Planar C=O (bond / group)
Not just planar molecule

1

M2 Attack (equally likely) from either side
Not just planar bond without reference to carbonyl

1

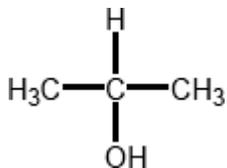
M3 (about product): Racemic mixture formed **OR** 50:50 mixture or each enantiomer equally likely

1

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3

L



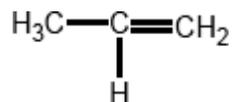
Allow (CH₃)₂CHOH or CH₃CH(OH)CH₃

Allow name propan-2-ol

Penalise contradiction of name and structure

1

M



Allow $\text{CH}_3\text{CH}=\text{CH}_2$

Allow name propene

ignore -1- but penalise other numbers

Penalise contradiction of name and structure

1

Step 1 NaBH_4 or LiAlH_4

Zn/HCl or Sn/HCl

or H_2/Ni or H_2/Pt

Ignore name if formula is correct

ignore solvent

ignore acid (for 2nd step) but penalise acidified NaBH_4

Apply list principle for extra reagents and catalysts.

M1

1

(nucleophilic) addition

Addition (not nucleophilic)

Penalise electrophilic

Ignore reduction

M2

1

Step 2 conc H_2SO_4 or conc H_3PO_4 or Al_2O_3

Apply list principle for extra reagents and catalysts.

M3

1

elimination

Independent from M3

penalise nucleophilic or electrophilic

ignore dehydration

M4

1

Step 3 HBr

Apply list principle for extra reagents and catalysts.

M5

1

electrophilic addition
Independent from M5

M6

1

[8]

4

(a) (i) Green

Ignore shades of green.

1

(ii) Excess acidified potassium dichromate(VI)

1

Reflux (for some time)

1

In the diagram credit should be given for

- a vertical condenser

Lose M3 and M4 for a distillation apparatus.

1

- an apparatus which would clearly work

Do not allow this mark for a flask drawn on its own.

Penalise diagrams where the apparatus is sealed.

1

(iii) Distillation

1

Immediately (the reagents are mixed)

1

(b) Keep away from naked flames

Allow heat with water-bath or heating mantle.

If a list is given ignore eye protection, otherwise lose this mark.

1

(c) (i) Tollens' or Fehling's reagents

*Incorrect reagent(s) loses **both** marks.*

Accept mis-spellings if meaning is clear.

1

Silver mirror / red ppt. formed

Accept 'blue to red' but not 'red' alone.

1

(ii) Sodium carbonate (solution) / Group II metal

Allow indicator solutions with appropriate colours.

Accept any named carbonate or hydrogen carbonate.

1

Effervescence / evolves a gas

Accept 'fizzes'.

1

(d) Propanoic acid

If this mark is lost allow one mark if there is reference to stronger intermolecular forces in the named compound.

Lose M1 and M3.

1

Contains hydrogen bonding

1

Some comparison with other compounds explaining that the intermolecular forces are stronger in propanoic acid

1

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5

(a) (i) $C_6H_6 + CH_3CH_2COCl \rightarrow C_6H_5COCH_2CH_3 + HCl$

OR

$C_6H_6 + CH_3CH_2CO^+ \rightarrow C_6H_5COCH_2CH_3 + H^+$

allow C_2H_5

penalise $C_6H_5-CH_3CH_2CO$

allow + on C or O in equation

1

Phenylpropanone

OR ethylphenylketone **OR** phenylethylketone

Ignore 1 in formula, but penalise other numbers

1

$AlCl_3$

can score in equation

1

$CH_3CH_2COCl + AlCl_3 \rightarrow CH_3CH_2CO^+ + AlCl_4^-$

allow C_2H_5

allow + on C or O in equation

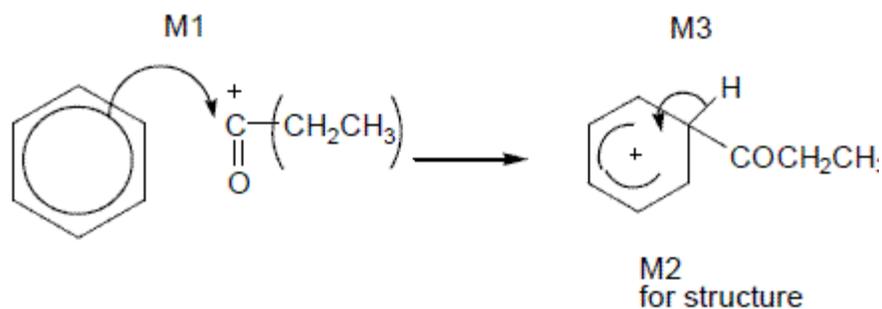
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$AlCl_4^- + H^+ \rightarrow AlCl_3 + HCl$

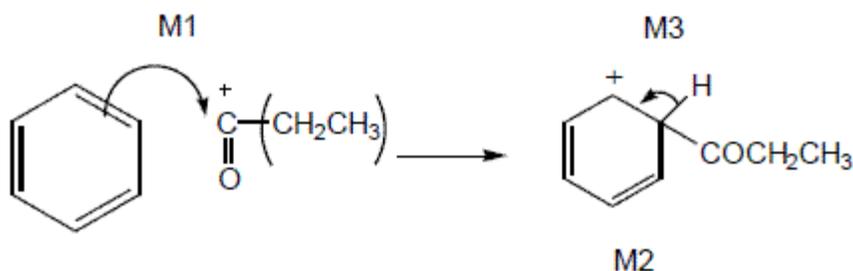
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- (ii) electrophilic substitution
can allow in (a)(i) if no contradiction

1



OR



M1 arrow from circle or within it to C or to + on C
 horseshoe must not extend beyond C2 to C6 but can be smaller
 + not too close to C1
 M2 penalise $C_6H_5-CH_3CH_2CO$ (even if already penalized in (a)(i))
 M3 arrow into hexagon unless Kekule
 allow M3 arrow independent of M2 structure
 ignore base removing H in M3

3

- (b) (i) $CH_3CH_2CHO + HCN \rightarrow CH_3CH_2CH(OH)CN$ OR
 $C_2H_5CH(OH)CN$
aldehyde must be -CHO brackets optional

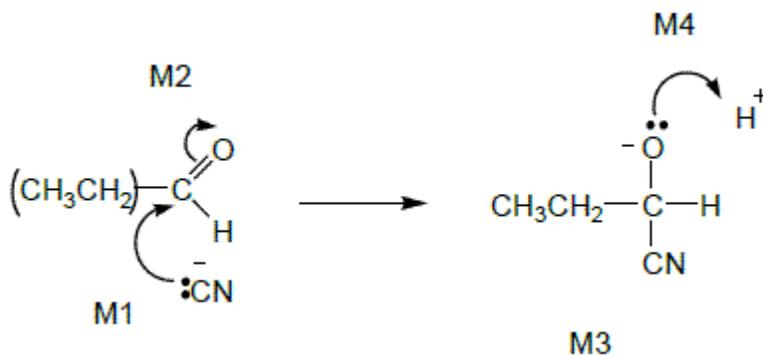
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2-hydroxybutanenitrile OR 2-hydroxybutanenitrile
no others

1

(ii) nucleophilic addition

1



M1 includes lp and arrow to Carbonyl C and minus charge (on either C or N)

Not allow M2 before M1, but allow M1 to C⁺ after non-scoring carbonyl arrow

Ignore δ^+ , δ^- on carbonyl group, but if wrong way round or full + charge on C lose M2

M3 for correct structure including minus sign. Allow C₂H₅

M4 for lp and curly arrow to H⁺

4

(iii) (propanone) slower **OR** propanal faster

1

inductive effects of alkyl groups

OR

C of C=O less δ^+ in propanone

OR

alkyl groups in ketone hinder attack

OR

easier to attack at end of chain

if wrong, no further marks

1

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6(a) nucleophilic addition

1



*Attack by HCN loses M1 and M2
 M2 not allowed independent of M1, but
 allow M1 for correct attack on C+
 +C=O loses M2
 M2 only allowed if correct carbon attacked
 allow minus charge on N i.e. :CN⁻*

4

M3 for completely correct structure not including lp
allow C₃H₇ in M3

M4 for lp and arrow
allow without –

1

2-hydroxy-2-methylpentan(e)nitrile
allow 2-hydroxy-2-methylpentanonitrile

(b) Product from **Q** is a racemic mixture/equal amounts of enantiomers
if no reference to products then no marks;

1

racemic mixture is inactive or inactive explained
*not **Q** is optically active or has a chiral centre etc*

1

Product from **R** is inactive (molecule) or has no chiral centre

1

[9]**7**

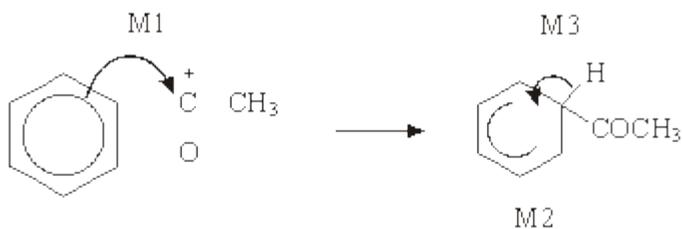
(a) $\text{CH}_3\text{COCl} + \text{AlCl}_3 \rightarrow \text{CH}_3\overset{+}{\text{C}}\text{O} + \text{AlCl}_4^-$
 (1) equation (1)

2

penalise wrong alkyl group once at first error
 position of + on electrophile can be on O or C or outside []
 penalise wrong curly arrow in the equation or lone pair on AlCl₃ else ignore

Electrophilic substitution
NOT F/C acylation

1



*horseshoe must not extend beyond C2 to C6 but can be smaller
 + not too close to C1
 M3 arrow into hexagon unless Kekule
 allow M3 arrow independent of M2 structure*

M1 arrow from within hexagon to C or to + on C

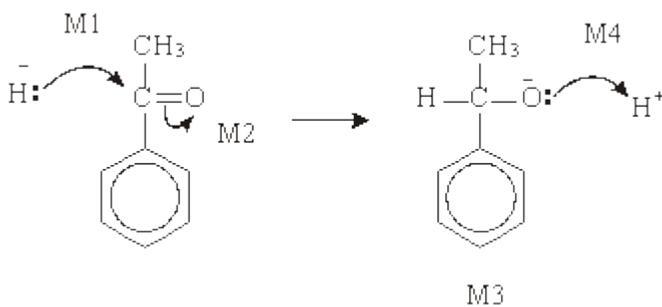
+ must be on C of RCO^+

3

(b) Nucleophilic addition

NOT reduction

1



M2 not allowed independent, but can allow M1 for attack of H- on C+ formed

4

1-phenylethan(-1-)-ol or (1-hydroxyethyl)benzene

1

(c) dehydration or elimination

1

(conc) H_2SO_4 or (conc) H_3PO_4

allow dilute and Al_2O_3

Do not allow iron oxides

1

[14]