Mark schemes

Q1.

(a) filter / decant

1

dissolve in minimum vol

allow *small volume*

allow *to make saturated solution*

not *warm*

Ignore *hot filtration*

1

of hot solvent

1

cool / leave (to crystallise) **AND** filter (under reduced pressure)

1

Wash with cold solvent/water, and dry (with method)

1

(b) **M1** toxic / poisonous

allow *can produce toxic fumes/gas / corrosive*

1

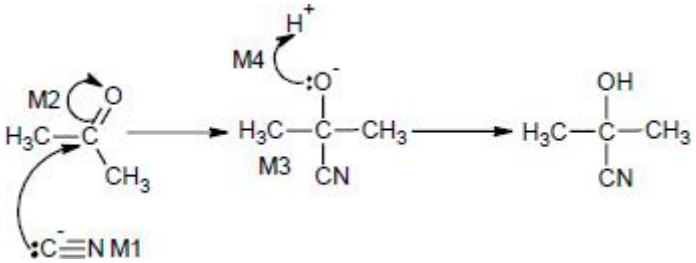
M2 HCN weak / [CN^-] too low **ORA**

allow *KCN dissociates to provide CN^-/nucleophile*

allow *KCN dissociates better/more than HCN*

1

(c)



M1 cyanide ion with lone pair on C and negative charge and curly arrow from lone pair to C of C=O

not *if K−CN bond shown breaking*

1

M2 Curly arrow from = to O

not *if dipole incorrect*

1

M3 intermediate anion

new bond must be to C of CN

1

M4 curly arrow from lone pair on O to H^+

allow *curly arrow to H of HCN*

1

[11]

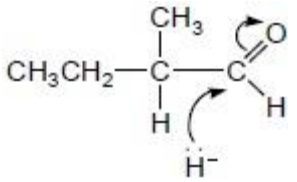
Q2.

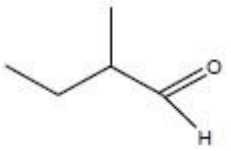
(a) **M1** for structure of 2-methylbutanal

Allow C_2H_5 for CH_3CH_2

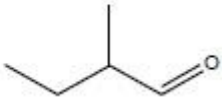
1

M2 for **2** curly arrows and lp on hydride, i.e.





OR



1

Explanation:

*Penalise **M2** for wrong partial charges on C=O*

Ignore product

M3 H^- ion / nucleophile is attracted to δ+ C

1

M4 electron rich C=C

1

M5 H^- ion / nucleophile is repelled by C=C

OR

C=C only attacked by/reacts with electrophiles

1

(b) Tollens' (reagent) OR ammoniacal silver nitrate OR description of making Tollens'

1

Silver mirror/ppt OR black solid / precipitate / deposit

1

NOT dichromate

For Tollens' reagent:

*for **M1** ignore either $AgNO_3$ or $[Ag(NH_3)_2^+]$ or "the silver mirror test" on their own, or "Tolling's reagent", but mark on*

OR Fehling's/ Benedict's (solutions)

red solid / precipitate (allow orange or brown)

For Fehling's/Benedict's solution:

*for **M1** Ignore $Cu^{2+}(aq)$ or $CuSO_4$ or "Fellings" on their*

own, but mark on

[7]

Q3.

(a) nucleophilic addition

both words needed

NOT any additional names

1

(b) **M1** racemic (mixture) / racemate

1

M2 planar (around) carbonyl / C=O

***M2** NOT molecule is planar*

Allow flat for planar

1

M3 (equal chance of) attack from each side (by CN^-)

1

M4 a correct structure of 2-hydroxypropanenitrile

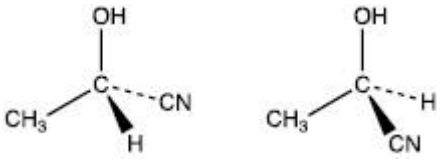
***M4** any correct 2D or 3D structure*

1

M5 correct 3D representations of both isomers, e.g.

***M5** must show at least one wedge bond and one dash bond in each structure and any bonds in the plane cannot be at 180º to each other*

*second structure could be drawn as mirror image of first **or** with same orientation with two groups swapped round, e.g.*



Allow ECF for second structure from incorrect first structure, providing molecule is chiral

1

(c) **M1** conc H_2SO_4 or conc H_3PO_4

***M1** Allow conc to come from conditions line*

1

M2 heat / 170°C

M2** depends on attempt at correct reagent in **M1

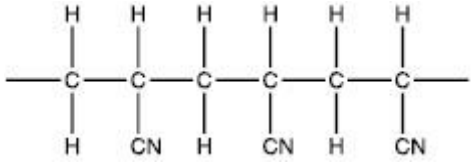
Allow high temperature / hot / 100-300°C / 373 – 573 K /

reflux
Ignore references to pressure
Ignore warm
NOT ethanolic / alcoholic

1

Alternative answer
M1 *Al_2O_3*
M2 *pass vapour over hot Al_2O_3*

(d)



MUST show trailing bonds
Ignore any brackets or n
NOT C–N or C=N if CN group displayed
Allow structures with CN on either C in each of the three units
Allow –CH_2–CH(CN)–CH_2–CH(CN)–CH_2–CH(CN)–

1

[9]

Q4.

(a) **M1** Acylation

Allow electrophilic substitution
Allow ethanoic anhydride for M2

1

M2 CH_3COCl OR Ethanoyl chloride

M3 dependent on M2

1

M3 $AlCl_3$ OR Aluminium chloride (mark could be awarded in space for M2)

Allow Dry/anhydrous for M3
Apply list principle to extra incorrect conditions

1

(b) **M1** Nucleophilic addition

1

M2 $NaBH_4$

Allow $LiAlH_4$ for M2

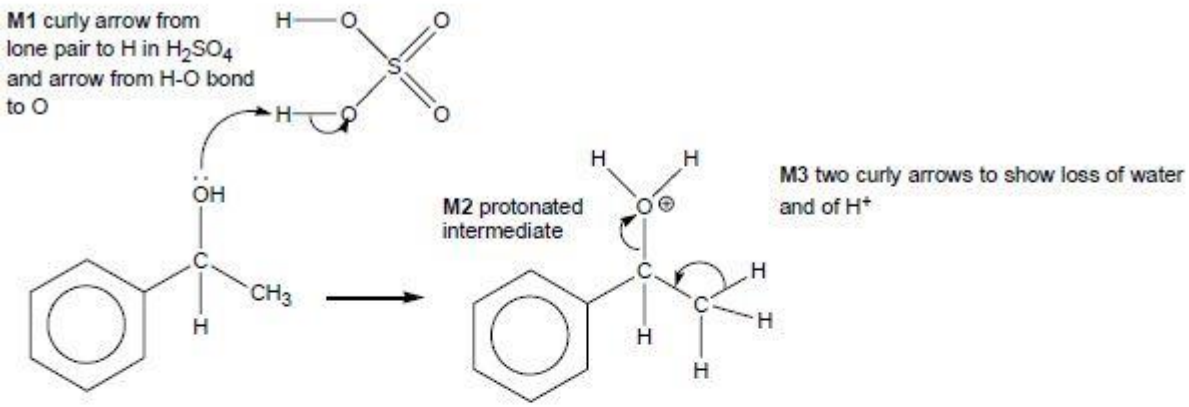
1

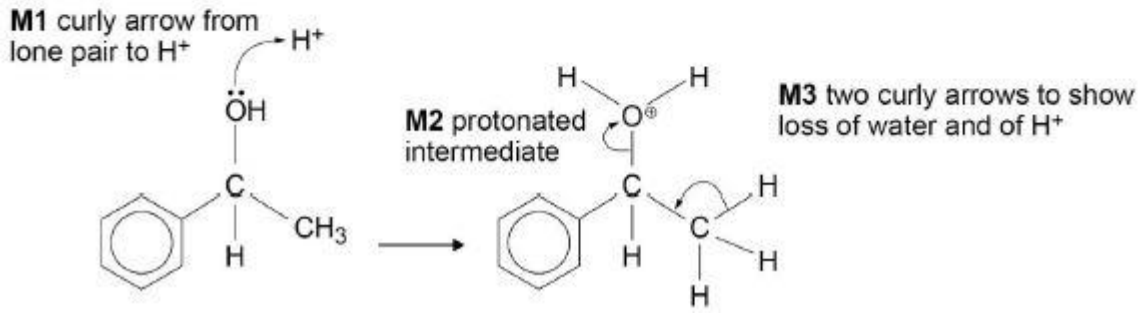
M3 1-phenyl ethan(-1-)ol

If H_2/Ni stated allow M2 and M3 but to score a matching M1 it would have to be Catalytic addition

1

(c)

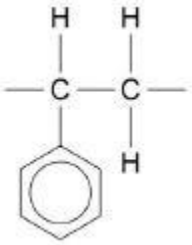




*Penalise **M1** for mistakes on structure of H_2SO_4*
*Allow H^+ attacked in **M1***
*Allow **M3** as two steps*
Allow displayed formulae

3

(d)



Must show trailing bonds
Ignore brackets and any use of n
Allow C_6H_5 for phenyl group

1

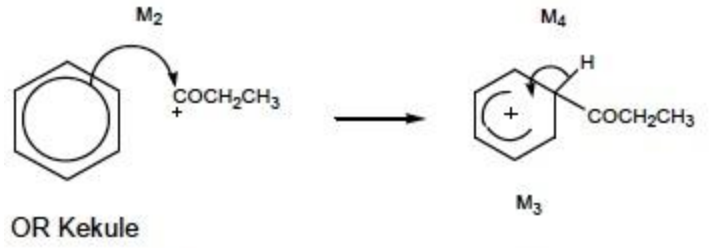
[10]

Q5.

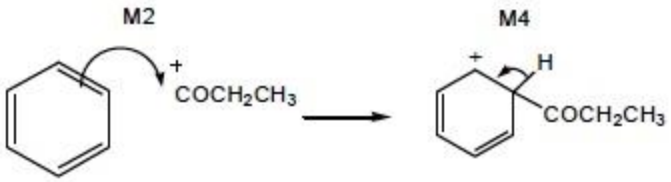
(a) $AlCl_3 + CH_3CH_2COCl \longrightarrow CH_3CH_2-\overset{+}{C}=O + AlCl_4^-$

Allow + on C or O in equation –
But must be on C in mechanism

M1



OR Kekule



M2 Arrow from inside hexagon to C or + on C

1

M3 Structure of intermediate
• horseshoe centred on C1 and must not extend beyond C2 and
C6, but can be smaller
• + in intermediate not too close to C1 (allow on or "below" a line
from C2 to C6)

1

M4 Arrow from bond into hexagon (Unless Kekule)
• Can allow M4 arrow independent of wrong M3 structure
• + on H in intermediate loses M3 not M4
• Ignore Cl^- and $AlCl_4^-$
- used in M4

1

(b) Either...

1-phenylpropan-1-ol

1

$NaBH_4$ / $LiAlH_4$

1

Nucleophilic addition

1

Or...

1-phenylpropan-1-ol

1

H_2 with Ni/Pd/Pt

1

Addition/hydrogenation

1

Both numbers needed for names

Ignore solvents

(c) Misty fumes / steamy fumes

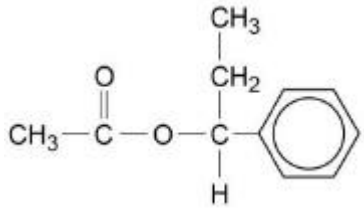
Allow sweet/fruity smell / white fumes

Not smoke

1

(Nucleophilic) addition-elimination

1



1

[10]

Q6.

B

[1]

Q7.

(a) 2-hydroxyhexanenitrile

1

(b) (Plane) polarised light

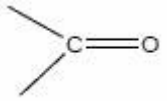
1

Enantiomers would <u>rotate</u> light in opposite directions

not different alone

1

(c) <u>planar</u> carbonyl group or

<u>planar</u> 

Not planar molecule,

not planar bond, not planar C=O

1

Attack from either side

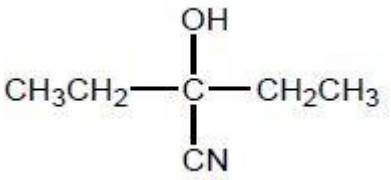
1

With <u>equal</u> probability

OR produces <u>equal</u> amounts (of the two isomers/enantiomers)

1

(d)



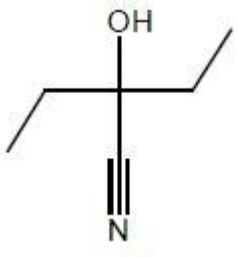
Does not contain a chiral centre

OR does not contain C attached to 4 different groups

OR contains two identical/ethyl groups

OR symmetrical (product)

Allow C_2H_5 or skeletal



M2 dependent on correct M1 (No structure = 0)

If pentan-3-one drawn then allow symmetrical ketone for M2

[8]

Q8.

B

[1]

Q9.

B

[1]

Q10.

(a) $CH_3CH_2COCH_3 + 2[H] \longrightarrow CH_3CH_2CH(OH)CH_3$

1

(b) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 then stage 3.

Level 3
5 – 6 marks

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows progression from stage 1 to stage 3.

Level 2
3 – 4 marks

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes isolated statements but these are not presented in a logical order or show confused reasoning.

Level 1
1 – 2 marks

Insufficient correct chemistry to gain a mark.

Level 0
0 marks

Indicative Chemistry content

Stage 1: Formation of product
- Nucleophilic attack
- Planar carbonyl group
- H^- attacks from either side (stated or drawn)

Stage 2: Nature of product
- Product of step 1 shown
- This exists in two chiral forms (stated or drawn)
- Equal amounts of each enantiomer / racemic mixture formed

Stage 3: Optical activity
- Optical isomers / enantiomers rotate the plane of polarised light equally in
- With a racemic / equal mixture the effects cancel

6

[7]

Q11.

(a) A mixture of liquids is heated to boiling point for a prolonged time

1

Vapour is formed which escapes from the liquid mixture, is changed back into liquid and returned to the liquid mixture

1

Any ethanal and ethanol that initially evaporates can then be oxidised

1

(b) $CH_3CH_2OH + H_2O \longrightarrow CH_3COOH + 4H^+ + 4e^-$

1

(c) Mixture heated in a suitable flask / container

A labelled sketch illustrating these points scores the marks

1

With still head containing a thermometer

1

Water cooled condenser connected to the still head and suitable cooled collecting vessel

1

Collect sample at the boiling point of ethanal

1

Cooled collection vessel necessary to reduce evaporation of ethanal

1

(d) Hydrogen bonding in ethanol and ethanoic acid or no hydrogen bonding in ethanal

1

Intermolecular forces / dipole-dipole are weaker than hydrogen bonding

1

(e) Reagent to confirm the presence of ethanal:

Add Tollens' reagent / ammoniacal silver nitrate / aqueous silver nitrate followed by 1 drop of aqueous sodium hydroxide, then enough aqueous ammonia to dissolve the precipitate formed

OR

Add Fehling's solution

1

Warm

M2 and M3 can only be awarded if M1 is given correctly

1

Result with Tollen's reagent:

Silver mirror / black precipitate

OR

Result with Fehling's solution:

Red precipitate / orange-red precipitate

1

Reagent to confirm the absence of ethanoic acid

Add sodium hydrogencarbonate or sodium carbonate

1

Result; no effervescence observed; hence no acid present

1

M5 can only be awarded if M4 is given correctly

OR

Reagent; add ethanol and concentrated sulfuric acid and warm

Result; no sweet smell / no oily drops on the surface of the liquid,

hence no acid present

[16]

Q12.

B

[1]