Mark schemes

1 (a) M1 NaOH

Only score M2 if M1 gained, but mark on from hydroxide. Mention of acid loses M1 & M2

1

M2 Aqueous/(warm)

Ignore alcoholic / conc / dil.

1

M3 (Fractional) distillation or described

Not just evaporation; not reflux

Allow chromatography

1

(b) M1 S is $CH_3CH(CN)CH_2CH_3$

Allow without brackets

1

Step 3

M2 KCN (mark on from CN^-)

Not HCN, not KCN with acid

1

M3 <u>Alcoholic</u> / (aqueous)

Allow ethanolic

Can only score M3 if M2 gained

1

Step 4

M4 H_2

$LiAlH_4$

Na

Can only score M5 if M4 gained

1

M5 Ni or Pt or Pd

Ethoxyethane or ether

$LiAlH_4$ with acid loses both M4 and M5

Ignore 'followed by acid'

Na

Ethanol

NOT $NaBH_4$ OR Sn/HCl

Penalise other extras as list

Ignore pressure or temperature

1

[8]

2 (a) Hydrogen <u>bond</u>(ing)

Allow H bonding.

Penalise mention of any other type of bond.

1

(b) (i) Ammonia is a nucleophile

Allow ammonia has a lone pair.

1

Benzene repels nucleophiles

Allow (benzene) attracts / reacts with electrophiles.

***OR** benzene repels electron rich species or lone pairs.*

***OR** C–Cl bond is short / strong / weakly polar.*

1

(ii) H_2 / Ni **OR** H_2 / Pt **OR** Sn / HCl **OR** Fe / HCl

Ignore dil / conc of HCl.

Ignore the term 'catalyst'.

Allow H_2SO_4 with Sn and Fe but not conc.

Ignore NaOH following correct answer.

Not $NaBH_4$ nor $LiAlH_4$.

1

(iii) conc HNO_3

conc H_2SO_4

1

If either or both conc missed can score 1 for both acids.

1

$HNO_3 + 2H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$

OR using two equations

$HNO_3 + H_2SO_4 \longrightarrow H_2NO_3^+ + HSO_4^-$

$H_2NO_3^+ \longrightarrow H_2O + NO_2^+$

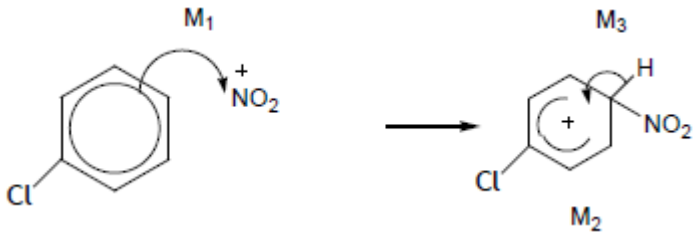
Allow 1:1 equation.

$HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_2O + HSO_4^-$.

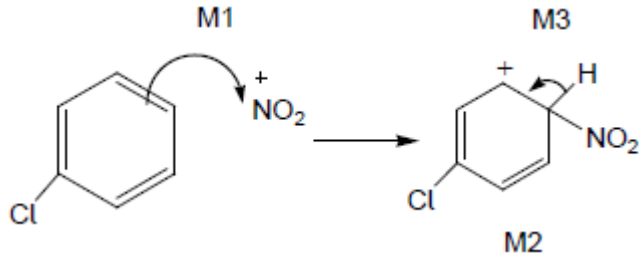
1

(iv) Electrophilic substitution

1



OR



- *Ignore position or absence of Cl in M1 but must be in correct position for M2.*
- *M1 arrow from within hexagon to N or <u>+ on N</u>.*
- *Allow NO_2^+ in mechanism.*
- *Bond to NO_2 must be to N for structure mark M2.*
- *Gap in horseshoe must be centered around correct carbon (C1).*
- *+ in intermediate not too close to C1 (allow on or "below" a line from C2 to C6).*
- *M3 arrow into hexagon unless Kekule.*
- *Allow M3 arrow independent of M2 structure.*
- *Ignore base removing H in M3.*
- *+ on H in intermediate loses M2 not M3.*

3

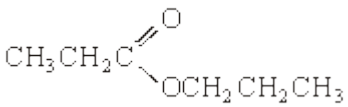
[11]

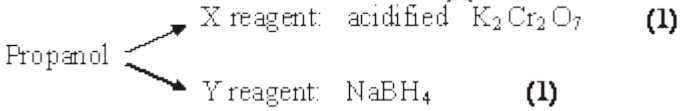
3 (a) X contains > C=O **(1)**

if X and Y reversed lose this mark but allow remaining max 6/7

∴ X is CH_3CH_2COOH **(1)**

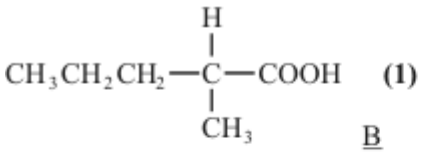
∴ Y is $CH_3CH_2CH_2OH$ **(1)**

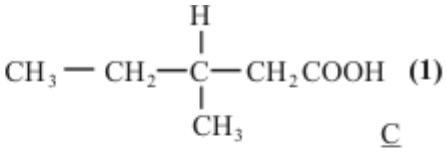
∴ A is  **(1)**

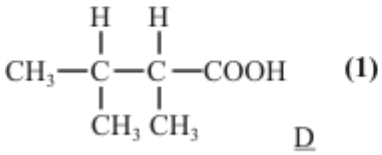


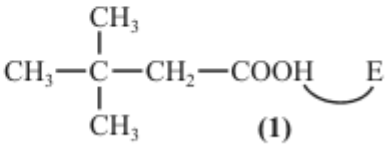
Conc H_2SO_4 : catalyst **(1)**

7

(b)  **(1)** B

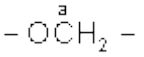
 **(1)** C

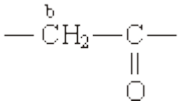
 **(1)** D

 **(1)** E

in any order

4

(c)  3.1 – 3.9 **(1)**

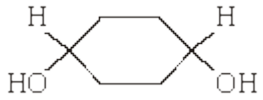
 2.1 – 2.6 **(1)**

a: quartet **(1)** 3 adjacent H **(1)**

b: triplet **(1)** 2 adjacent H **(1)**

6

(d) 3269 cm^{-1} ∴ OH alcohol **(1)**

∴ G is  (1)

2

Notes

(a) first mark for C=O stated or shown in **X**

Ignore wrong names

Y $\underline{CH_3CH_2}CH_2OH$

allow C_3H_7 in **A** if **Y** correct or vice versa

Allow **(1)** for **A** if correct conseq to wrong **X** and **Y**

other oxidising agents: acidified $KMnO_4$; Tollens; Fehlings

other reducing agents: $LiAlH_4$; Na/ethanol; Ni/H_2; Zn or Sn or Fe/HCl

(b) give **(1)** for carboxylic acid stated or COOH shown in <u>each</u> suggestion
(1) for correct **E**
any 2 out of 3 for **B**, **C** or **D**
allow C_3H_7 for either the **B** or **D** shown on the mark scheme
i.e. a correct structure labelled **B**, **C** or **D** or **E** will gain 2.

(c) protons a – *quartet* must be correct to score *3 adjacent H* mark. Same for b

(d) allow **(1)** for any OH (alcohol) shown correctly in any structure – ignore extra functional groups. Structure must be completely correct to gain second mark

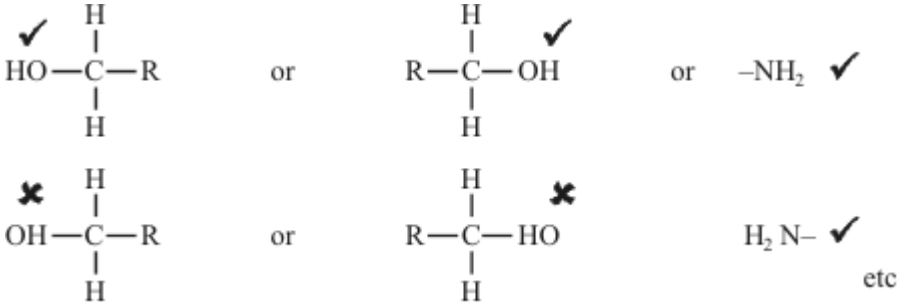
[19]

<u>Organic points</u>

(1) <u>Curly arrows:</u> must show movement of a pair of electrons,
i.e. from bond to atom or from lp to atom / space
e.g.

(2) <u>Structures</u>

penalise sticks (i.e. ) <u>once per paper</u>



<u>Penalise once per paper</u>

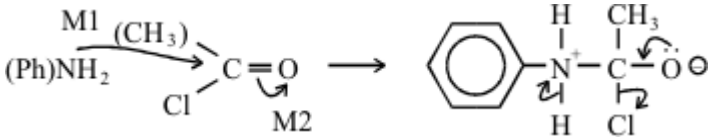
<u>allow</u> CH_3– or –CH_3 or  or CH_3
or H_3C–

4

(a) CH_3COCl or $(CH_3CO)_2O$ **(1)**

$AlCl_3$ or H_2O or CH_2SO_4 loses this mark
CH_3COOH loses reagent and M3, M4 = max 3

nucleophilic addition–elimination **(1)**



M3: structure
M4: 3 correct arrows
Allow M1 for attack on CH3-C⁺=O
Penalise Cl^- removing H^+

6

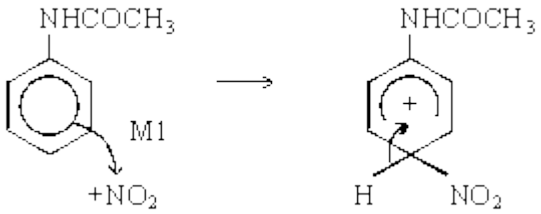
(b) Conc HNO_3 **(1)**
Conc H_2SO_4 **(1)**

$HNO_3 + 2\ H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2\ HSO_4^-$ **(2)**

(or H_2SO_4) **(or H_2O + HSO_4^-)**

HNO_3 / H_2SO_4 scores 1
Any 2

electrophilic substitution **(1)**

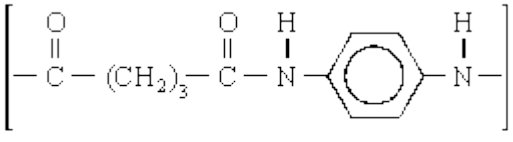


M2 structure
M3 arrow

6

(c) Sn **(or Fe)** / HCl or Ni / H_2 **(1)**

NOT $LiAlH_4$ $NaBH_4$



(1) **(1)**

3

[15]

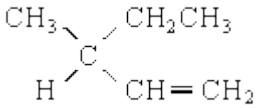
5 D

[1]

6 C

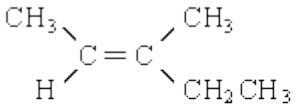
[1]

7 (a) *Structure of* **P**:

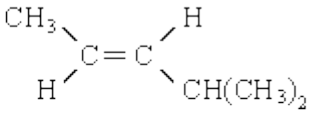


(1)

Structures of **Q** and **R**:



and



NOT C_3H_7

(1) **(1)**

Q and R in any order

3

(b) (i) *Racemic mixture*: <u>equal</u> mixture of optical isomers / enantiomers

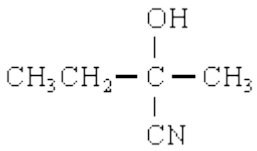
OR in explanation

Explanation: planar (>C=O) **(1)**

attack from either side is equally likely **(1)**

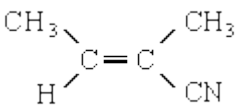
(ii) *Reagent **S***: HCN or (KCN / HCl **or** H_2SO_4) **(1)**

*Compound **T***:



(1)

*Compound **U***:



(1)

6

[9]

8

(a) 1, 4-diaminobutane or butane -1, 4-diamine **(1)**

A: $BrCH_2CH_2Br$ **or** $ClCH_2CH_2Cl$ **(1)**

B: $NC\ CH_2CH_2CN$

Step 1: Br_2 or Cl_2 **(1) (ignore aq)**

Step 2: KCN **(1) (NOT HCN)**

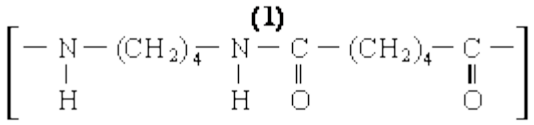
Step 3: H_2 / Ni **or** $LiAlH_4$ **or** Na / C_2H_5OH **(1) (NOT $NaBH_4$)**

Hydrogenation only for H_2 / Ni, **or** nucleophilic addition only for $LiAlH_4$**(1)**

OR reduction or addition

7

(b)



(1)

(1)

QL hydrogen bonding **(1)**

Polarity of H-bonding shown or discussed **(1)**

4

(c) Polyamides / peptide link can be hydrolysed **(1)**

OR polyalkenes cannot be hydrolysed

QL OH^- attacks peptide link or C^{d+} **(1)**

poly(ethene) non-polar **(1)**

3

[14]

9 B **[1]**

10 A **[1]**

11 C **[1]**