

Mark schemes

1

X is CH₃CN or ethanenitrile or ethanonitrile or methyl cyanide or cyanomethane or ethyl nitrile or methanecarbonitrile

Not ethanitrile

but contradiction of name and structure lose marks

1

Y is CH₃CH₂NH₂ or ethylamine or aminoethane or ethanamine

1

Step 1: reagent KCN not HCN/HCl
condition (aq)/alcohol - only allow condition if reagent correct or incomplete

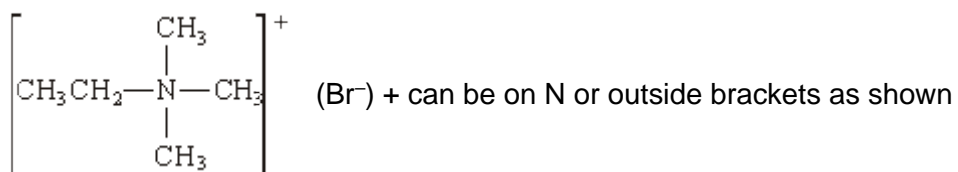
2

Step 2: reagent H₂ LiAlH₄ Na Zn/Fe/Sn Not NaBH₄
condition Ni/Pt/Pd ether ethanol HCl

2

Z is an amine or aminoalkane or named amine even if incorrect name for **Z** secondary (only award if amine correct)

1



1

nucleophilic substitution

1

[9]

2

[1]

3

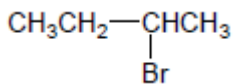
Step 1

HBr

In any step, if wrong reagent or extra wrong reagent, can only score mechanism mark, but if AlCl₃ added in Step 3, lose M7 but can score M8 & M9

M1

1



M2

1

electrophilic addition

If 1-bromobutane structure given for M2 then 1-aminobutane structure for M5, penalise M2 and M5 but mark M8 consequentially

M3

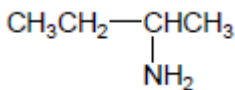
1

Step 2

NH₃

M4

1



If 1-bromobutane structure given for M2 then 2-aminobutane structure for M5, penalise M2, M5 and M8

M5

1

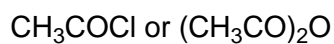
nucleophilic substitution

If 2-bromobutane structure given for M2 then 1-aminobutane structure, penalise M5 and M8

M6

1

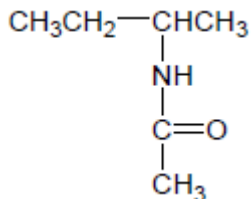
Step 3



Allow C₂H₅ for CH₃CH₂

M7

1



M8

1

(nucleophilic) addition-elimination

Not allow (electrophilic) addition-elimination

M9

1

[9]

D
4

[1]

B
5

[1]

6

(a) (i)

Reagent	Tollens	Fehlings or Benedicts	K ₂ Cr ₂ O ₇ /H ⁺ or acidified	KMnO ₄ /H ⁺	I ₂ /NaOH
Propanal	silver (mirror)	red ppt or goes red (<i>not red solution</i>)	goes green	goes colourless	No reaction
Propanone	no reaction	no reaction	no reaction	no reaction	Yellow (ppt)

(penalise incomplete reagent e.g. K₂Cr₂O₇ or Cr₂O₇²⁻/H⁺ then mark on)

3

(ii) propanal 3 peaks

ignore splitting even if wrong

1

propanone 1 peak

1

(b) X is CH₃CH₂COOH or propanoic acid if both name and formula given,
both must be correct, but

1

Y is CH₃CH(OH)CH₃ or propan-2-ol allow propanol with correct formula

1

Mark the type of reaction and reagent/condition independently.
The reagent must be correct or close to score condition

Step 1 Oxidation

K₂Cr₂O₇/H⁺ or other oxidation methods as above

allow Cr₂O₇²⁻H⁺ if penalised above (ecf)

reflux (not Tollens/Fehlings) or heat or warm

1

Step 2

reduction or nucleophilic addition	reduction or nucleophilic addition	reduction or hydrogenation
NaBH ₄	LiAlH ₄	H ₂
in (m)ethanol or water or ether or dry	ether or dry	Ni / Pt etc

1

1

1

Step 3 esterification or (nucleophilic) addition-elimination or condensation

1

(conc) H₂SO₄ or HCl

1

warm (allow without acid reagent if X and Y given as reagents)

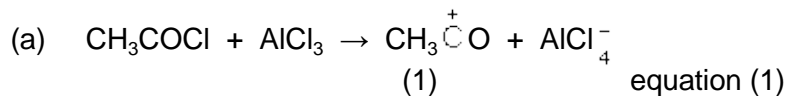
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or reflux or heat

1

[15]

7



2

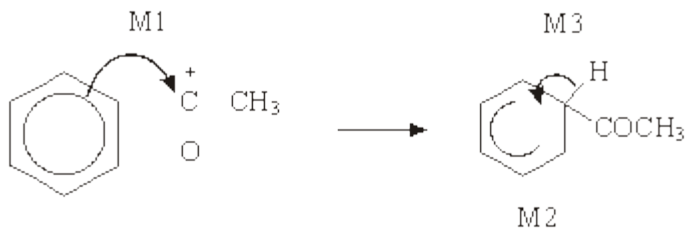
penalise wrong alkyl group once at first error

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

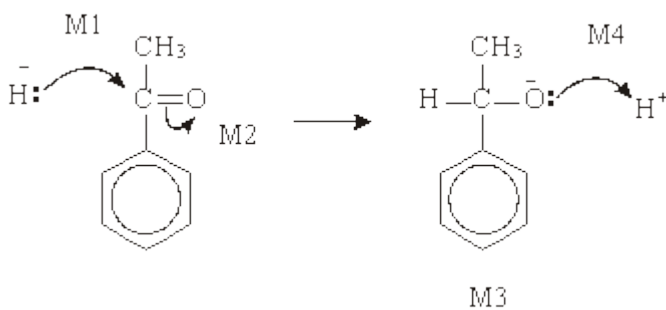
+ must be on C of RCO^+

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]

8

In each section

- If wrong or no reagent given, no marks for any observations;
- Penalise incomplete reagent or incorrect formula – but mark observations
- Mark each observation independently
- Allow *no reaction* for no change / no observable reaction in all three parts, but not *none* or *nothing*
- Q says **one test**. If two tests are given, score zero

(a)

	$\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$	$\text{KMnO}_4 / \text{H}^+$	Lucas test ($\text{ZnCl}_2 / \text{HCl}$)
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1

R Primary alcohol	(Orange) goes green Penalise wrong starting colour	(purple) goes colourless / decolourises allow goes brown	No cloudiness
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1

S Tertiary alcohol	no change / no observable reaction	no change / no observable reaction	Rapid cloudiness
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1

Allow acidified potassium manganate and acidified potassium dichromate without oxidation numbers

(b)

	$\text{Na}_2\text{CO}_3 / \text{NaHCO}_3$ named carbonate	metal eg Mg	named indicator
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Named alcohol + HCl / H_2SO_4

T ester	no change / no observable reaction	no change / no observable reaction	no effect
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no change / no observable reaction

U Acid	Effervescence or (CO_2) gas formed	Effervescence or (H_2) gas formed	acid colour
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Fumes / (HCl) gas formed

Sweet smell

(c)

	Fehling's / Benedict's	Tollens' / [$\text{Ag}(\text{NH}_3)_2$] ⁺	$\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$
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I_2 / NaOH

V Ketone	no change / no observable reaction	no change / no observable reaction	no change / no observable reaction
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Yellow ppt

W aldehyde	Red ppt	Silver mirror	(Orange) goes green Penalise wrong starting colour
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no change / no observable reaction

9

1

1

1

1

1

1
[9]

[1]

10

(a) (i) Single reagent

If wrong single reagent, CE = zero

Incomplete single reagent (e.g. carbonate) or wrong formula (e.g. NaCO_3) loses reagent mark, but mark on

For “no reaction” allow “nothing”

Different reagents

If different tests on E and F; both reagents and any follow on chemistry must be correct for first (reagent) mark.

Reagent must react: i.e. not allow Tollens on G (ketone) – no reaction.

Second and third marks are for correct observations.

i.e. for different tests on E and F, if one reagent is correct and one wrong, can score max 1 for correct observation with correct reagent.

PCl_5 PCl_3

SOCl_2

1

E ester

$\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ named carbonate

metal e.g. Mg

no reaction

no reaction

named indicator

no effect

No reaction

1

F acid

$\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ named carbonate

Effervescence or CO_2

metal e.g. Mg

Effervescence or H_2

named indicator

acid colour

fumes

1

(ii) Single reagent

If wrong single reagent, CE = zero

Incomplete single reagent (e.g. carbonate) or wrong formula (e.g. NaCO_3) loses reagent mark, but mark on

For “no reaction” allow “nothing”

Different reagents

If different tests on E and F; **both** reagents and any follow on chemistry must be correct for first (reagent) mark.

Reagent must react: i.e. not allow Tollens on

G (ketone) – no reaction.

Second and third marks are for correct observations.

1

i.e. for different tests on E and F, if one reagent is correct and one wrong, can score max 1 for correct observation with correct reagent.

G ketone

AgNO_3

no reaction

$\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ named carbonate

water

no reaction

named indicator

no effect

Named alcohol

no reaction

Named amine or ammonia

no reaction

1

H Acyl chloride

AgNO₃

(white) ppt

Na₂CO₃/NaHCO₃ named carbonate

Effervescence or CO₂ or fumes or exothermic

water

fumes

named indicator

acid colour

Named alcohol

Smell or fumes

Named amine or ammonia

fumes

1

Allow iodoform test or Brady's reagent (2,4,dnph) test (both positive for G)

(iii) Single reagent

If wrong single reagent, CE = zero

Incomplete single reagent (e.g. carbonate) or wrong formula (e.g. NaCO₃) loses reagent mark, but mark on

For "no reaction" allow "nothing"

Different reagents

If different tests on E and F; **both** reagents and any follow on chemistry must be correct for first (reagent) mark.

Reagent must react: i.e. not allow Tollens on G (ketone) – no reaction.

Second and third marks are for correct observations.

i.e. for different tests on E and F, if one reagent is correct and one wrong, can score max 1 for correct observation with correct reagent.

1

J Primary alcohol

$K_2Cr_2O_7 / H^+$

goes green

$KMnO_4 / H^+$

decolourised / goes brown

Lucas test ($ZnCl_2/HCl$)

Penalise missing H^+ but mark on

1

K Tertiary alcohol

$K_2Cr_2O_7 / H^+$

No reaction

$KMnO_4 / H^+$

no reaction

Lucas test ($ZnCl_2/HCl$)

Rapid cloudiness

1

If uses subsequent tests e.g. Tollens/Fehlings, test must be on product of oxidation

(b) (i) 3,3-dimethylbutan-1-ol

Allow 3,3-dimethyl-1-butanol

1

4

1

Triplet on three

1

(ii) 2-methylpentan-2-ol
Allow 2-methyl-2-pentanol

1

5

1

Singlet or one or no splitting

1

[15]

11

Acidified potassium dichromate(VI)

1

Turns green with propan-2-ol and propanal

1

No reaction with hexene and 1-bromopropane

1

Tollens with propan-2-ol and propanal

1

only propanal gives silver mirror

1

Bromine water

1

Decolourised by hexane

1

No reaction with 1-bromopropane

1

Warm NaOH followed by acidified AgNO₃

1

White ppt with 1-bromopropane

1

[10]

