

## 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  $\text{CH}_3\text{CH}(\text{CN})\text{CH}_2\text{CH}_3$   
*Allow without brackets* 1

Step 3

M2 KCN (mark on from  $\text{CN}^-$ )  
*Not HCN, not KCN with acid* 1

M3 Alcoholic / (aqueous)  
*Allow ethanolic*  
*Can only score M3 if M2 gained* 1

Step 4

M4  $\text{H}_2$   
  
 $\text{LiAlH}_4$   
  
Na  
*Can only score M5 if M4 gained* 1

M5 Ni or Pt or Pd  
  
Ethoxyethane or ether  
  
 $\text{LiAlH}_4$  with acid loses both M4 and M5  
  
Ignore 'followed by acid'  
  
Na  
  
Ethanol  
*NOT  $\text{NaBH}_4$  OR  $\text{Sn/HCl}$*   
*Penalise other extras as list*  
*Ignore pressure or temperature* 1

[8]

2

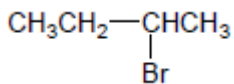
Step 1

HBr

*In any step, if wrong reagent or extra wrong reagent, can only score mechanism mark, but if AlCl<sub>3</sub> 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

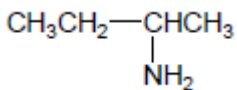
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Step 2

NH<sub>3</sub>

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

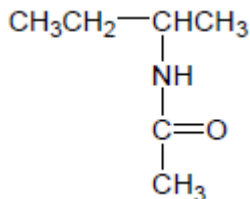
Step 3

CH<sub>3</sub>COCl or (CH<sub>3</sub>CO)<sub>2</sub>O

*Allow C<sub>2</sub>H<sub>5</sub> for CH<sub>3</sub>CH<sub>2</sub>*

M7

1



M8

1

(nucleophilic) addition-elimination

*Not allow (electrophilic) addition-elimination*

M9

1

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3

(a) Hydrogen bond(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<sub>2</sub> / Ni **OR** H<sub>2</sub> / Pt **OR** Sn / HCl **OR** Fe / HCl

*Ignore dil / conc of HCl.*

*Ignore the term 'catalyst'.*

*Allow H<sub>2</sub>SO<sub>4</sub> with Sn and Fe but not conc.*

*Ignore NaOH following correct answer.*

*Not NaBH<sub>4</sub> nor LiAlH<sub>4</sub>.*

1

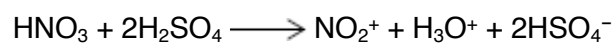
(iii) conc HNO<sub>3</sub>

conc H<sub>2</sub>SO<sub>4</sub>

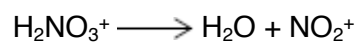
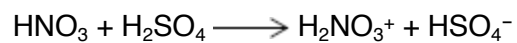
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*If either or both conc missed can score 1 for both acids.*

1



**OR** using two equations



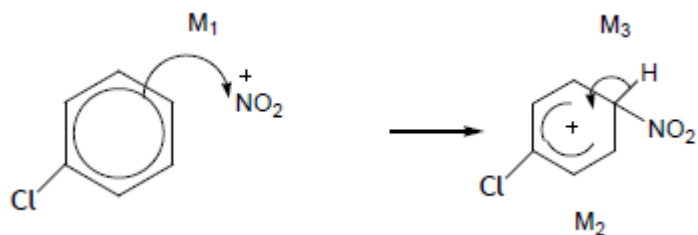
*Allow 1:1 equation.*



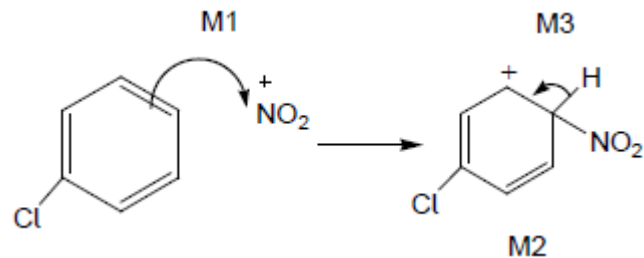
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(iv) Electrophilic substitution

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 + on N.
- Allow  $\text{NO}_2^+$  in mechanism.
- Bond to  $\text{NO}_2$  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]

4

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)

	$K_2Cr_2O_7 / H^+$	$KMnO_4 / H^+$	Lucas test ( $ZnCl_2 / HCl$ )
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1

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

<b>S</b> 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)

	$Na_2CO_3 / NaHCO_3$ named carbonate	metal eg Mg	named indicator
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$PCl_5$   $PCl_3$

$SOCl_2$

*Named alcohol + HCl /  $H_2SO_4$*

1

<b>T</b> ester	no change / no observable reaction	no change / no observable reaction	no effect
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*no change / no observable reaction*

1

<b>U</b> Acid	Effervescence or (CO <sub>2</sub> ) gas formed	Effervescence or (H <sub>2</sub> ) gas formed	acid colour
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*Fumes / (HCl) gas formed*

*Sweet smell*

1

(c)

	Fehling's / Benedict's	Tollens' / [Ag(NH <sub>3</sub> ) <sub>2</sub> ] <sup>+</sup>	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / H <sup>+</sup>
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*I<sub>2</sub> / NaOH*

1

<b>V</b> Ketone	no change / no observable reaction	no change / no observable reaction	no change / no observable reaction
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*Yellow ppt*

1

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

1  
[9]



5

(a) (i) Single reagent

If wrong single reagent, CE = zero

Incomplete single reagent (e.g. carbonate) or wrong formula (e.g. NaCO<sub>3</sub>) 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<sub>5</sub> PCl<sub>3</sub>

SOCl<sub>2</sub>

1

**E ester**

Na<sub>2</sub>CO<sub>3</sub>/NaHCO<sub>3</sub> named carbonate

metal e.g. Mg

no reaction

no reaction

named indicator

no effect

No reaction

1

**F acid**

Na<sub>2</sub>CO<sub>3</sub>/NaHCO<sub>3</sub> named carbonate

Effervescence or CO<sub>2</sub>

metal e.g. Mg

Effervescence or H<sub>2</sub>

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.  $\text{NaCO}_3$ ) 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

$\text{AgNO}_3$

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

AgNO<sub>3</sub>

(white) ppt

Na<sub>2</sub>CO<sub>3</sub>/NaHCO<sub>3</sub> named carbonate

Effervescence or CO<sub>2</sub> 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. NaCO<sub>3</sub>) 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*

5

Singlet or one or no splitting

1

1

1

[15]

6

Acidified potassium dichromate(VI)

Turns green with propan-2-ol and propanal

No reaction with hexene and 1-bromopropane

Tollens with propan-2-ol and propanal

only propanal gives silver mirror

Bromine water

Decolourised by hexane

No reaction with 1-bromopropane

Warm NaOH followed by acidified AgNO<sub>3</sub>

White ppt with 1-bromopropane

1

1

1

1

1

1

1

1

1

1

[10]