Cambridge Assessment International Education

Interactive

# Interactive Example Candidate Responses
# Paper 22 (May/June 2016), Question 5

## Cambridge International AS & A Level Chemistry 9701

Version 1.0

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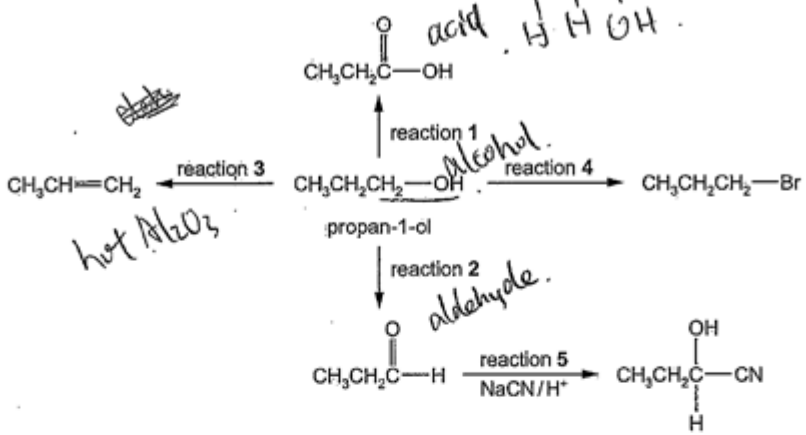
5 A reaction sequence based on propan-1-ol is shown.




(a) Reactions 1 and 2 can both be carried out using the same reagents.

(i) Identify suitable reagents for reactions 1 and 2.

acidified potassium dichromate solution

[1]

(ii) State and explain how the reaction should be carried out to ensure that reaction 2 rather than reaction 1 occurs.

The mixture of reaction reactants are heated gently. And aldehyde is distilled off as it forms. Because further oxidation of aldehyde to carboxylic acid will occur if it is not distilled off immediately.

[2]

(b) Identify the necessary reagents and conditions for each of reactions 3 and 4.

reaction 3 reagents = vapour propan-1-ol

conditions = hot $Al_2O_3$ powders, heated under reflux

reaction 4 reagents = NaBr and conc $H_2SO_4$

conditions = heated under reflux

[2]

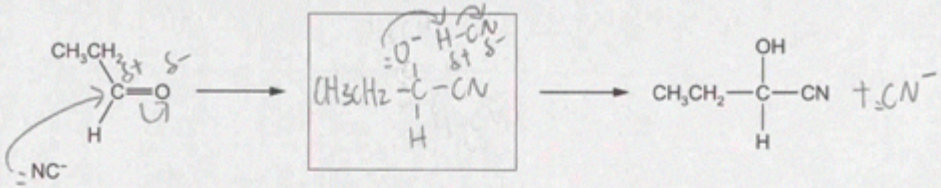
| | Your Mark |
|---|---|
| 5(a)(i) | |
| 5(a)(ii) | |
| 5(b) | |
| 5(c)(i) | |
| 5(c)(ii) | |
| 5(c)(iii) | |

| Q5 | Mark scheme | |
|---|---|---|
| (a)(i) | acidified / $H^+$<br>AND<br>potassium / sodium dichromate | [1] |
| (a)(ii) | distillation (rather than reflux)<br>(ensures aldehyde escapes) to avoid further oxidation / to avoid forming acid / as reflux causes further oxidation | [1]<br>[1]<br>[2] |
| (b) | reaction 3 – (conc) H2SO4 / (conc) H3PO4 or Al 2O3 / pumice / porcelain / porous pot / ceramic<br>AND heat<br>reaction 4 – KBr / NaBr with (conc) H2SO4 or (red)P and Br2 / PBr3<br>AND heat | <br><br>[1]<br>[1]<br>[2] |

EXAMINER COMMENTS

MARK SCHEME

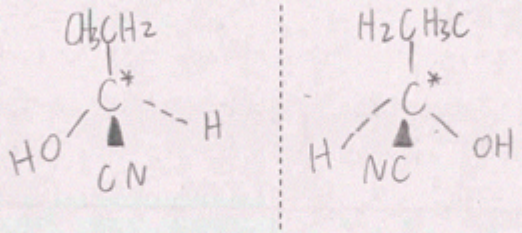
(c) (i) Complete the reaction mechanism for reaction **5**. Include all relevant lone pairs, curly arrows, charges and partial charges.



[4]

The product of reaction **5** exhibits stereoisomerism.

(ii) Draw the two stereoisomers in the conventional way.



[2]

(iii) Suggest why a mixture of the two stereoisomers is formed by reaction **5**.

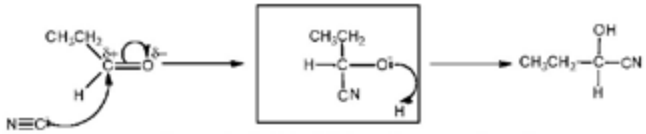
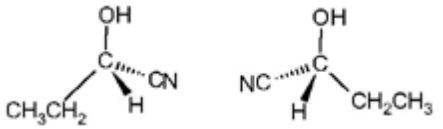
Because planar ~~to~~ carbonyl equal chance chance for ~~the~~ nucleophile attacking for either side. , CN⁻

.....

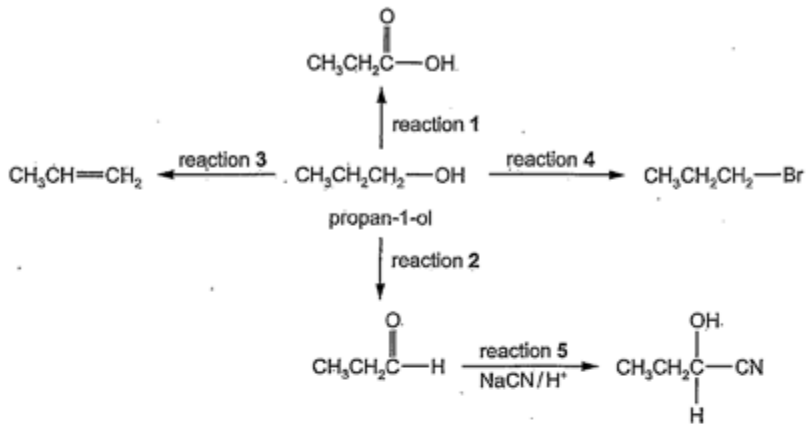
[2]

[Total: 13]

| | Your Mark |
|---|---|
| 5(a)(i) | |
| 5(a)(ii) | |
| 5(b) | |
| 5(c)(i) | |
| 5(c)(ii) | |
| 5(c)(iii) | |

| Q5 | Mark scheme |
|---|---|
| (c)(i) |  <br>M1 = lone pair on C of $CN^-$ AND curly arrow from lone pair to carbonyl carbon [1]<br>M2 = dipole on C=O AND curly arrow to O from = [1]<br>M3 = intermediate with negative charge [1]<br>M4 = lone pair and curly arrow to $H^+$ [1]<br>**[4]** |
| (c)(ii) | [1+1]<br>  <br>**[2]** |
| (c)(iii) | attack / attach from either side / above or below / from two directions because the carbonyl / molecule is [1]<br>planar / trigonal / flat / because of the shape of the molecule [1]<br>OR<br>product is chiral / has a chiral carbon / has a carbon attached to four different groups / has a chiral centre / is asymmetric<br>(equal) chance of forming either (of the two optical isomers) / mechanism doesn't distinguish between the two<br>(optical isomers) / able to form either / chance of forming / able to form 50:50<br>OR<br>because the carbonyl / molecule is planar / trigonal / flat OR<br>because of the shape of the molecule (equal) chance of forming either (of the two optical isomers) / mechanism<br>doesn't distinguish between the two (optical isomers) / able to form either / chance of forming / able to form 50:50<br>**[2]**<br>**[Total: 13]** |

5 A reaction sequence based on propan-1-ol is shown.




**(a)** Reactions **1** and **2** can both be carried out using the same reagents.

**(i)** Identify suitable reagents for reactions **1** and **2**.

Acidified potassium dichromate

[1]

**(ii)** State and explain how the reaction should be carried out to ensure that reaction **2** rather than reaction **1** occurs.

The reactants should be placed in a round bottom flask.

The reactants are heated and distilled so as to prevent complete oxidation to propanal.

[2]

**(b)** Identify the necessary reagents and conditions for each of reactions **3** and **4**.

reaction 3 conc $H_2SO_4$ 200°C

reaction 4 Aqueous HBr Heat

[2]

**Your Mark**

5(a)(i)

5(a)(ii)

5(b)

5(c)(i)

5(c)(ii)

5(c)(iii)

| Q5 | Mark scheme |
|---|---|
| (a)(i) | acidified / $H^+$<br>AND<br>potassium / sodium dichromate **[1]** |
| (a)(ii) | distillation (rather than reflux) [1]<br>(ensures aldehyde escapes) to avoid further oxidation / to avoid forming acid / as reflux causes further oxidation [1]<br>**[2]** |
| (b) | reaction 3 – (conc) H2SO4 / (conc) H3PO4 or Al 2O3 / pumice / porcelain / porous pot / ceramic<br>AND heat<br>reaction 4 – KBr / NaBr with (conc) H2SO4 or (red)P and Br2 / PBr3 [1]<br>AND heat [1]<br>**[2]** |

EXAMINER COMMENTS

MARK SCHEME

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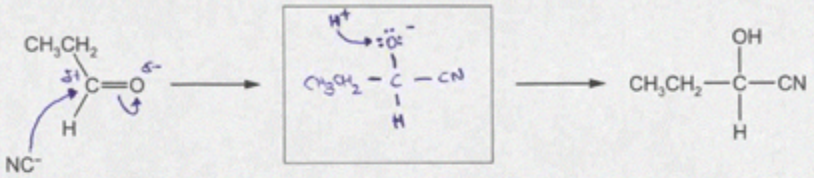
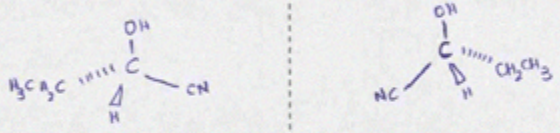
(c) (i) Complete the reaction mechanism for reaction **5**. Include all relevant lone pairs, curly arrows, charges and partial charges.



[4]

The product of reaction **5** exhibits stereoisomerism.

(ii) Draw the two stereoisomers in the conventional way.



[2]

(iii) Suggest why a mixture of the two stereoisomers is formed by reaction **5**.

The $CN^-$ can do both backside or forward attack. This forming a product with retension configuration and another one with inversion configuration ($S_N2$ mechanism) [2]

[Total: 13]

| | Your Mark |
|---|---|
| 5(a)(i) | |
| 5(a)(ii) | |
| 5(b) | |
| 5(c)(i) | |
| 5(c)(ii) | |
| 5(c)(iii) | |

| Q5 | Mark scheme |
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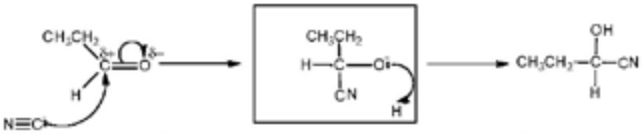
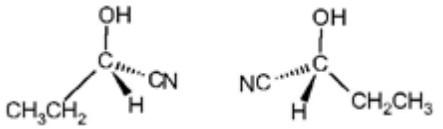
| (c)(i) |  <br>M1 = lone pair on C of $CN^-$ AND curly arrow from lone pair to carbonyl carbon [1]<br>M2 = dipole on C=O AND curly arrow to O from = [1]<br>M3 = intermediate with negative charge [1]<br>M4 = lone pair and curly arrow to $H^+$ [1]<br>**[4]** |
| (c)(ii) | [1+1]<br>  <br>**[2]** |
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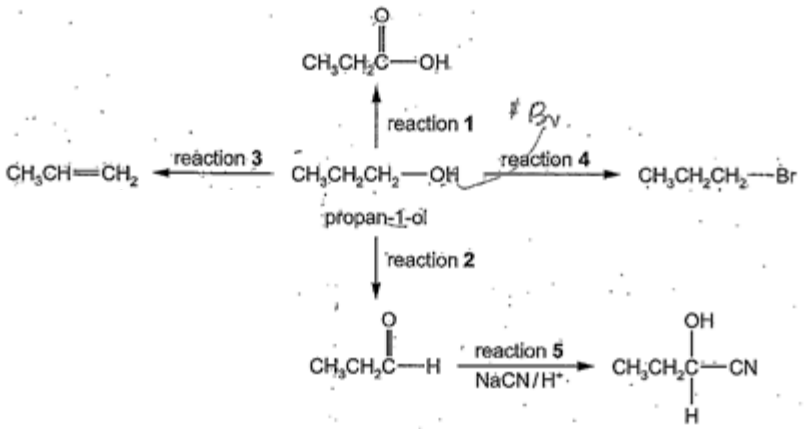



(a) Reactions 1 and 2 can both be carried out using the same reagents.

(i) Identify suitable reagents for reactions 1 and 2.

~~fore for reaction 1 KMnO4 in H2SO4 or~~ ~~cold KMnO4~~ K2Cr2O7 in H2SO4 [1]

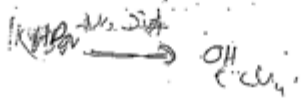
(ii) State and explain how the reaction should be carried out to ensure that reaction 2 rather than reaction 1 occurs.

It can be carried out by using K2CrO7 at rtp with H2SO4 ~~with gas~~ but with reaction ~~are~~ 1 the reaction should be ~~as~~ carried out with heat with reflux in reaction 2 [2]

(b) Identify the necessary reagents and conditions for each of reactions 3 and 4.

reaction 3 H2SO4 170°C temp

reaction 4 HBr at room temprate ~~in~~ in solvent ~~NaOH~~ NaOH / ethanol [2]



| Your Mark | |
|---|---|
| 5(a)(i) | |
| 5(a)(ii) | |
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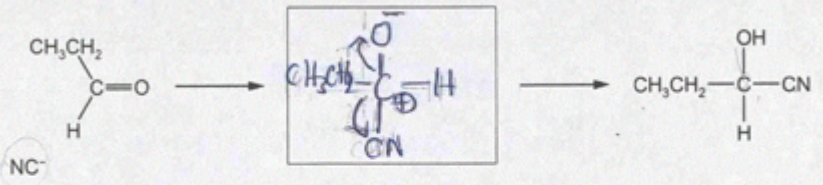
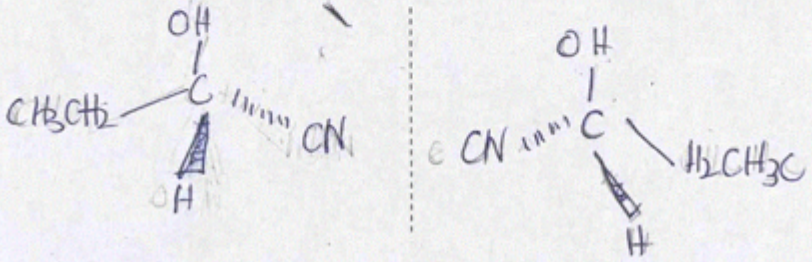


[4]

The product of reaction **5** exhibits stereoisomerism.

(ii) Draw the two stereoisomers in the conventional way.



[2]

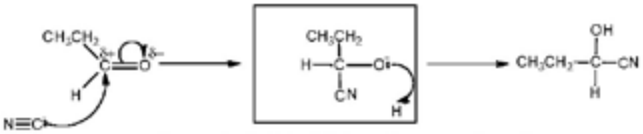
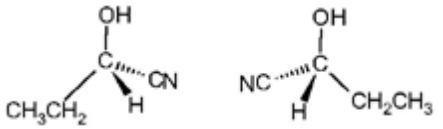
(iii) Suggest why a mixture of the two stereoisomers is formed by reaction **5**.

It is because of the carbo cation formed and the double bond has enough electron so nucleophile addition takes place

[2]

[Total: 13]

| | Your Mark |
|---|---|
| 5(a)(i) | |
| 5(a)(ii) | |
| 5(b) | |
| 5(c)(i) | |
| 5(c)(ii) | |
| 5(c)(iii) | |

| Q5 | Mark scheme |
|---|---|
| (c)(i) |  <br>M1 = lone pair on C of $CN^-$ AND curly arrow from lone pair to carbonyl carbon [1]<br>M2 = dipole on C=O AND curly arrow to O from = [1]<br>M3 = intermediate with negative charge [1]<br>M4 = lone pair and curly arrow to $H^+$ [1]<br>**[4]** |
| (c)(ii) | [1+1]<br>  <br>**[2]** |
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EXAMINER COMMENTS

MARK SCHEME

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