

Interactive Example Candidate Responses

Paper 42 (May/June 2016), Question 3

Cambridge International AS & A Level Chemistry 9701

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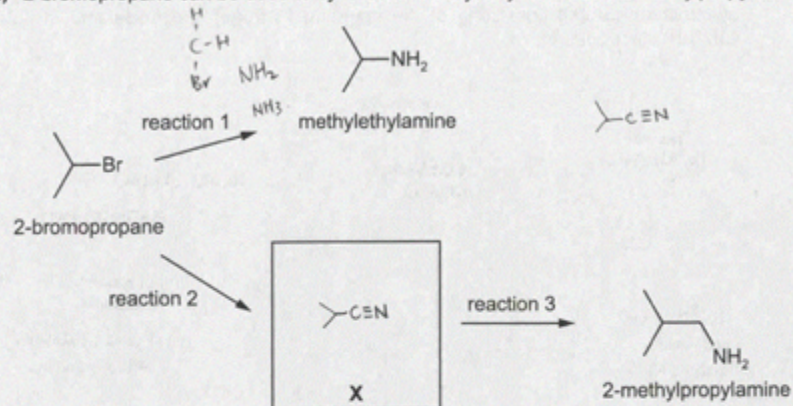
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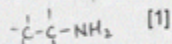
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3 (a) 2-bromopropane can be used to synthesise methylethylamine and 2-methylpropylamine.

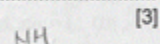


(i) Draw the structure of the intermediate X in the box above.

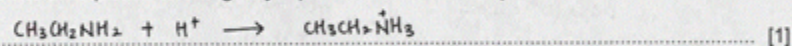


(ii) Suggest reagents and conditions for

- reaction 1, alcoholic NH_3
- reaction 2, alcoholic KCN, reflux
- reaction 3, LiAlH_4



(b) (i) Write an equation showing why aqueous solutions of ethylamine are alkaline.



(ii) Compare the basicities of ethylamine and ammonia. Explain your answer.

Ethylamine is more basic than ammonia. Ethylamine contains ethyl group, which is an electron donating group. Lone pair on N is more readily available to H^+ ion compared to ammonia.

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

3(c)(i)

3(c)(ii)

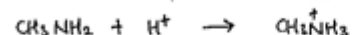
Q3	Mark scheme	
(a)(i)	$(\text{CH}_3)_2\text{CHCN}$	[1]
(a)(ii)	reaction 1: NH_3 (in ethanol) under pressure (+ heat) or heat NH_3 in a sealed tube reaction 2: KCN / NaCN and heat / reflux (in ethanol) reaction 3: H_2 + Ni or LiAlH ₄	[3]
(b)(i)	$\text{CH}_3\text{CH}_2\text{NH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3^+ (+) \text{OH}^-$	[1]
(b)(ii)	ethylamine is more basic than ammonia... because of electron-donating (alkyl / ethyl / R) group (in ethylamine) which makes the <u>lone pair</u> (on N) more available for donation or the <u>lone pair</u> (on N) more available for a proton / H^+	[2]
(c)(i)	A solution which resists / minimises / roughly maintains changes in pH when (small amounts of) H^+ or OH^- are added	[1]
(c)(ii)	$\text{CH}_3\text{NH}_2 + \text{H}^+ \rightarrow \text{CH}_3\text{NH}_3^+$ $\text{CH}_3\text{NH}_3\text{Cl} + \text{OH}^- \rightarrow \text{CH}_3\text{NH}_2 + \text{H}_2\text{O} + \text{Cl}^-$	[2]
		[Total: 10]

(c) Solutions containing mixtures of amines and their salts are buffer solutions.

(i) Explain what is meant by the term *buffer solution*.

A solution consists of positive and negatively charged ions which are ready to take up H^+ ions and OH^- ions to resist small change in pH when a small amount of H^+ ions and OH^- ions are added to the solution. [1]

(ii) Write two equations to show how a solution containing a mixture of CH_3NH_2 and $\text{CH}_3\text{NH}_3\text{Cl}$ acts as a buffer.



[2]

[Total: 10]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

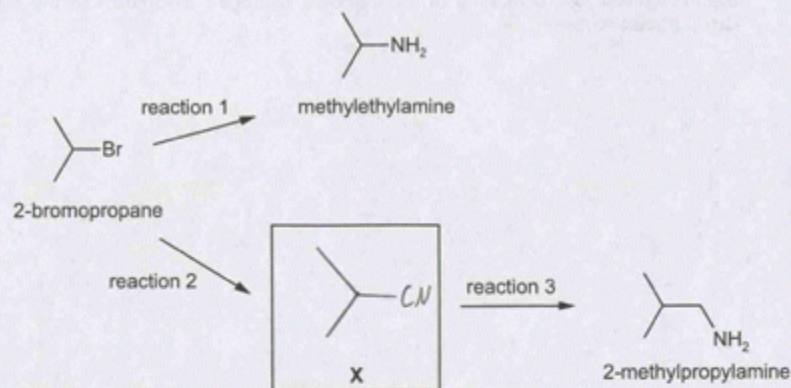
3(b)(ii)

3(c)(i)

3(c)(ii)

Q3	Mark scheme	
(a)(i)	$(\text{CH}_3)_2\text{CHCN}$	[1]
(a)(ii)	reaction 1: NH_3 (in ethanol) under pressure (+ heat) or heat NH_3 in a sealed tube reaction 2: KCN / NaCN and heat / reflux (in ethanol) reaction 3: H_2 + Ni or LiAlH ₄	[3]
(b)(i)	$\text{CH}_3\text{CH}_2\text{NH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3^+ (+) \text{OH}^-$	[1]
(b)(ii)	ethylamine is more basic than ammonia... because of electron-donating (alkyl / ethyl / R) group (in ethylamine) which makes the <u>lone pair</u> (on N) more available for donation or the <u>lone pair</u> (on N) more available for a proton / H^+	[2]
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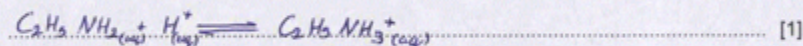
(i) Draw the structure of the intermediate X in the box above. [1]

(ii) Suggest reagents and conditions for

- reaction 1, *heat with ethanolic ammonia (NH₃ in ethanol)*
- reaction 2, *heat with ethanolic KCN*
- reaction 3, *pass over nickel catalyst with hydrogen gas.*

[3]

(b) (i) Write an equation showing why aqueous solutions of ethylamine are alkaline.



[1]

(ii) Compare the basicities of ethylamine and ammonia. Explain your answer.

ethylamine is more basic than ammonia, because ethyl is an electron donating group and increases the ability of nitrogen to form a dative bond with proton, while hydrogen is not as strong of an electron donating group as ethyl

[2]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

3(c)(i)

3(c)(ii)

Q3	Mark scheme	
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		[Total: 10]

(c) Solutions containing mixtures of amines and their salts are buffer solutions.

(i) Explain what is meant by the term *buffer solution*.

A solution that keeps pH constant when small amounts of alkalis and or acid are added. [1]

(ii) Write two equations to show how a solution containing a mixture of CH_3NH_2 and $\text{CH}_3\text{NH}_3\text{Cl}$ acts as a buffer.

$\text{CH}_3\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightleftharpoons \text{CH}_3\text{NH}_3\text{Cl}(\text{aq})$
 $\text{CH}_3\text{NH}_3\text{Cl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{NH}_2(\text{aq}) + \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ [2]

[Total: 10]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

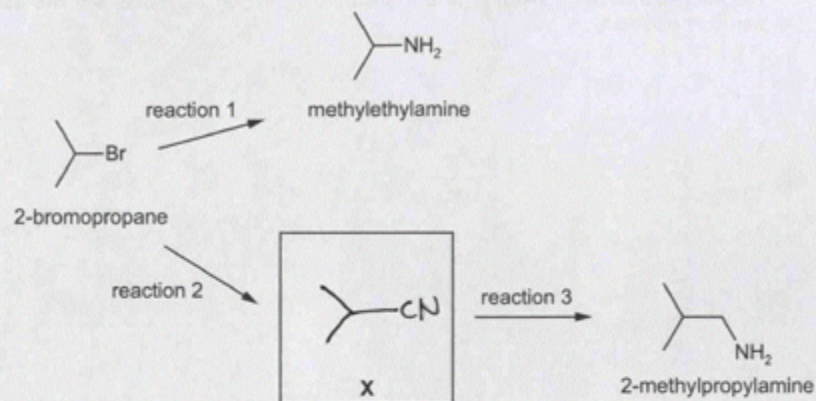
3(b)(ii)

3(c)(i)

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		[Total: 10]

3 (a) 2-bromopropane can be used to synthesise methylethylamine and 2-methylpropylamine.



(i) Draw the structure of the intermediate X in the box above. [1]

(ii) Suggest reagents and conditions for

- reaction 1, Ammonia gas excess, sealed tube
- reaction 2, aqueous NaCN with a trace of alcohol.
- reaction 3, $\text{Sn} + \text{HCl}$

[3]

(b) (i) Write an equation showing why aqueous solutions of ethylamine are alkaline.



[1]

(ii) Compare the basicities of ethylamine and ammonia. Explain your answer.

Ethylamine is more basic as compared to ammonia because the alkyl group is electron releasing which facilitates the removal of a lone pair of electrons.

[2]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

3(c)(i)

3(c)(ii)

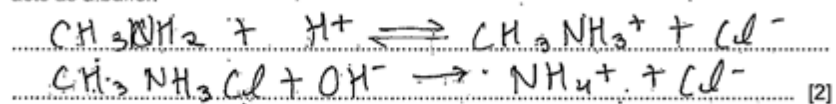
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(i) Explain what is meant by the term *buffer solution*.

A solution which resists changes in pH when small quantities of acid or alkali are added to it. [1]

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[Total: 10]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

3(c)(i)

3(c)(ii)

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