Amines

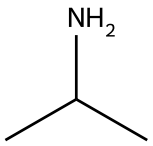
AQA 7405 · A level

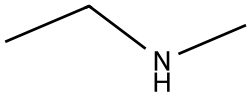
Show your working where needed. Check the worked answers when you finish.

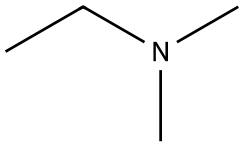
Name _____ Date _____

1. Classify the amines shown

Classify A, B and C as primary, secondary or tertiary amines. State what you counted.

A 

B 

C 

2. Form a salt

Write an equation for propylamine, $CH_3CH_2CH_2NH_2$, reacting with dilute hydrochloric acid. Explain the role of the nitrogen lone pair.

3. Control the products of substitution

Bromoethane reacts with ethanolic ammonia. Draw the first two steps leading to the primary amine. Explain why a large excess of ammonia favours this amine.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-amines

Amines

AQA 7405 · A level

4. A reaction of butanenitrile

Butanenitrile, $CH_3CH_2CH_2C{\equiv}N$, is treated with hydrogen over nickel. Draw the organic product and give a balanced equation using H_2. Track the nitrile carbon in the product.

5. The reduction mixture

Nitrobenzene is heated with tin and concentrated hydrochloric acid. Give an equation using [H] for the overall conversion to the free amine. Explain why adding sodium hydroxide is necessary to obtain it.

6. Compare bases

Put phenylamine, ammonia and ethylamine in order of increasing basicity using the AQA lone-pair model. Explain the order.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-amines

Amines

AQA 7405 · A level

7. Check a functional-group claim

A student calls $CH_3C(=O)NHCH_2CH_3$ a secondary amine. Name the compound, explain your classification using the bond to nitrogen and give two reactants that could make it by acylation.

8. Trimethylamine and iodoethane

Trimethylamine reacts with iodoethane. Draw or write the full salt and explain what happens to the nitrogen lone pair.

9. Extra challenge · Follow successive reactions at nitrogen

During exhaustive alkylation, ethylamine reacts with excess iodomethane. Give the structures of the possible neutral secondary and tertiary amine intermediates and the final salt.

Explain how each neutral intermediate is formed and why the final nitrogen centre cannot react in the same way again.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-amines

Worked answers

Amines · AQA 7405 · A level

1. Classify the amines shown

A, B and C are primary, secondary and tertiary respectively. Count the carbon groups directly bonded to N. The isopropyl group in A counts as one group, and the ethyl group in B and in C counts as one group each.

2. Form a salt

$CH_3CH_2CH_2NH_2 + HCl \rightarrow CH_3CH_2CH_2NH_3^+ Cl^-$. The nitrogen lone pair accepts H^+ to form the propylammonium ion.

3. Control the products of substitution

The ammonia N lone pair attacks the carbon bonded to Br. The C-Br bond electrons go to Br, giving $CH_3CH_2NH_3^+$ and Br^-.

A second NH_3 attacks H on $CH_3CH_2NH_3^+$. The N-H bond electrons return to the bonded N, giving $CH_3CH_2NH_2$ and NH_4^+.

Ethylamine can attack more bromoethane. Excess ammonia favours reaction with NH_3.

4. A reaction of butanenitrile

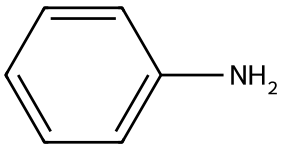
$CH_3CH_2CH_2C{\equiv}N + 2H_2 \rightarrow CH_3CH_2CH_2CH_2NH_2$. The product is butan-1-amine.

The C≡N carbon becomes the CH_2 carbon bonded to NH_2. The product still has four carbons.

5. The reduction mixture

$C_6H_5NO_2 + 6[H] \rightarrow C_6H_5NH_2 + 2H_2O$. The equation gives the overall conversion to free phenylamine.

The amine is protonated to $C_6H_5NH_3^+$ in the acidic mixture. Hydroxide removes its extra proton, forming water and free phenylamine.



Phenylamine

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-amines

Worked answers

Amines · AQA 7405 · A level

6. Compare bases

Phenylamine < ammonia < ethylamine.

The nitrogen lone pair in phenylamine is partly delocalised into the aromatic ring and is less available to accept H^+. An ethyl group donates electron density towards N, making the lone pair in ethylamine more available than in ammonia.

7. Check a functional-group claim

It is a secondary amide, N-ethylethanamide. The nitrogen is bonded directly to the carbonyl carbon.

Ethanoyl chloride supplies CH_3CO- and ethylamine supplies -$NHCH_2CH_3$.

8. Trimethylamine and iodoethane

The salt is $[(CH_3)_3NCH_2CH_3]^+ I^-$.

The nitrogen lone pair forms a bond to the ethyl carbon as the C-I bond electrons move to iodine. The nitrogen then has four covalent bonds and formal charge +1.

9. Extra challenge · Follow successive reactions at nitrogen

The secondary amine is $CH_3CH_2NHCH_3$ and the tertiary amine is $CH_3CH_2N(CH_3)_2$. The final salt is $[CH_3CH_2N(CH_3)_3]^+ I^-$.

An N lone pair bonds to the methyl carbon as the C-I bond breaks. For the first two additions, deprotonation of the resulting ammonium ion gives the neutral amine. The final ion has four groups bonded to N and no N lone pair to donate.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-amines