

5.4.3 Connect amine reactions and complete polymer structures

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS evidence • conditions

Objective

Connect amine reactions and complete polymer structures. All questions and marking guidance are original.

1 Key knowledge and worked examples

Butylamine is both a base and a nucleophile. Water gives a reversible basic solution; acid protonates it. Halogenoalkanes can alkylate it, while ethanoyl chloride acylates it to an amide. Nitrogen can also donate its lone pair as a ligand to copper(II).

■ Worked method

$\text{C}_4\text{H}_9\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_4\text{H}_9\text{NH}_3^+ + \text{OH}^-$. In acylation, $\text{CH}_3\text{COCl} + 2\text{C}_4\text{H}_9\text{NH}_2 \rightarrow \text{CH}_3\text{CONHC}_4\text{H}_9 + \text{C}_4\text{H}_9\text{NH}_3^+\text{Cl}^-$. With a diacid and diamine, repeated amide formation links both skeletons into a polyamide backbone. Retain the two monomer carbon counts when drawing a repeat.

2 Practice

2.1 Write butylamine's equation with water and explain why a basic solution forms. [2]

2.2 Explain two different uses of butylamine's nitrogen lone pair when reacting with HCl and with a copper(II) complex. [2]

2.3 A primary amine reacts with a halogenoalkane. Explain why further alkylation can occur and how excess ammonia affects primary-amine preparation from a halogenoalkane. [2]

3 Exam-style questions

3.1 Draw a complete nylon-6,6 repeat from $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ and $\text{HOOC}(\text{CH}_2)_4\text{COOH}$, with amide links and continuing bonds through brackets. [4]

3.2 Give condensed repeat units for poly(propenamide) and poly(ethenol), including continuing bonds at both ends. Explain the type of polymerisation for the former. [3]

3.3 Phenylamine is converted to a diazonium salt and coupled with phenol. State both conditions and name the link formed. Explain why warm diazonium storage is unsuitable. [4]

3.4 Draw displayed and skeletal formulae for ethanamine, ethanamide and uncharged 2-aminopropanoic acid. [6]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

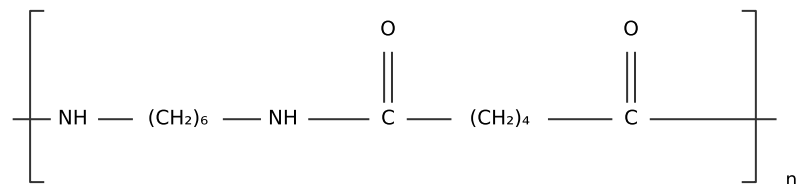
2.1 $\text{C}_4\text{H}_9\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_4\text{H}_9\text{NH}_3^+ + \text{OH}^-$. Nitrogen accepts a proton from water, increasing OH^- .

2.2 It binds H^+ as a base, forming butylammonium; it donates an electron pair to Cu^{2+} as a ligand, forming a coordinate bond.

2.3 The first amine product is also a nucleophile and can react again. Excess ammonia makes its attack more likely relative to amine attack, reducing but not eliminating further substitution.

3.1

Condensation polymer repeat unit



Nylon-6,6: open bonds continue through the brackets; amide links lie in the backbone.

B1 six-carbon diamine skeleton; B1 four- CH_2 diacid skeleton with both carbonyl carbons; B1 correct amide links; B1 open bonds/brackets/n.

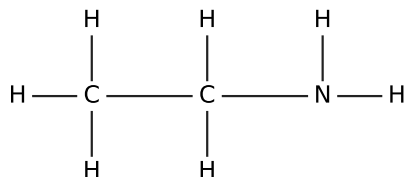
3.2 $[-\text{CH}_2-\text{CH}(\text{CONH}_2)-]$; $[-\text{CH}_2-\text{CH}(\text{OH})-]$. Poly(propenamide) forms by addition across $\text{C}=\text{C}$ without loss of a small molecule.

3.3 Nitrous acid from $\text{NaNO}_2/\text{acid}$ below about 10°C ; alkaline phenol coupling; $-\text{N}=\text{N}-$ azo linkage. Warming increases decomposition of the unstable diazonium salt.

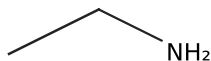
3.4

Ethanamine (ethylamine)

Displayed formula

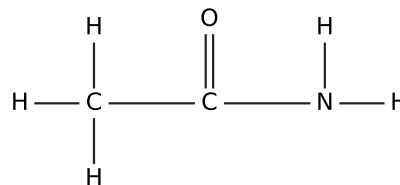


Skeletal formula

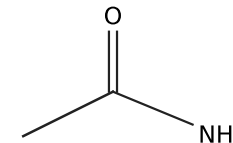


Ethanamide

Displayed formula

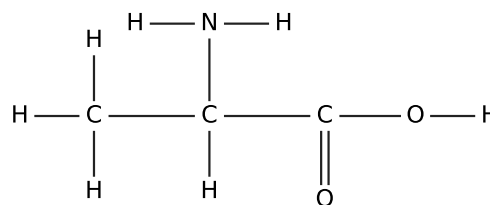


Skeletal formula

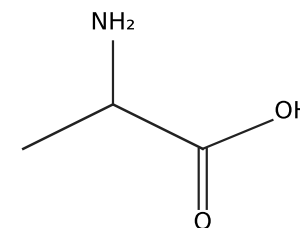


2-aminopropanoic acid (alanine; uncharged form)

Displayed formula



Skeletal formula



B1 each correct displayed formula; B1 each correct skeletal formula (six marks total).