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

$C_4H_9NH_2 + H_2O \rightleftharpoons C_4H_9NH_3^+ + OH^-$. In acylation, $CH_3COCl + 2C_4H_9NH_2 \rightarrow CH_3CONHC_4H_9 + C_4H_9NH_3^+Cl^-$. 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 $H_2N(CH_2)_6NH_2$ and $HOOC(CH_2)_4COOH$, 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

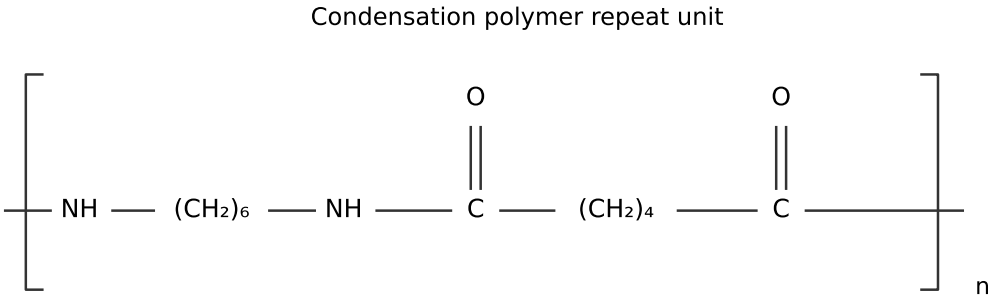
Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $C_4H_9NH_2 + H_2O \rightleftharpoons C_4H_9NH_3^+ + OH^-$. 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



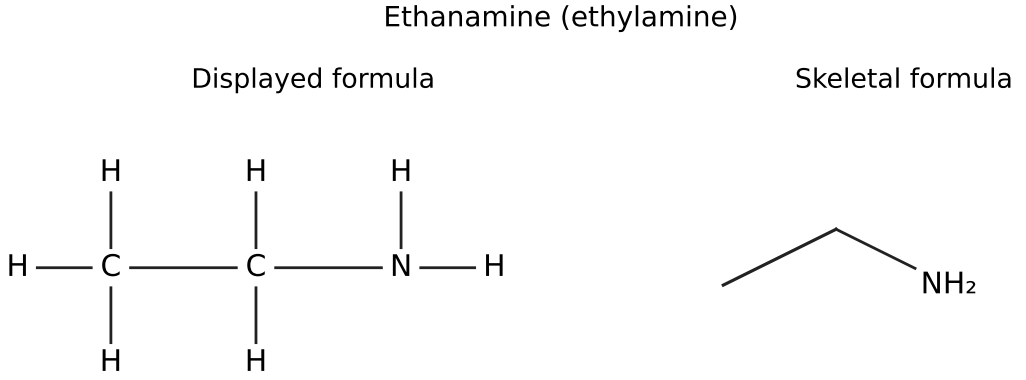
Nylon-6,6: open bonds continue through the brackets; amide links lie in the backbone.

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 [–CH_2–$CH(CONH_2)$–]; [–CH_2–$CH(OH)$–]. Poly(propenamide) forms by addition across C=C without loss of a small molecule.

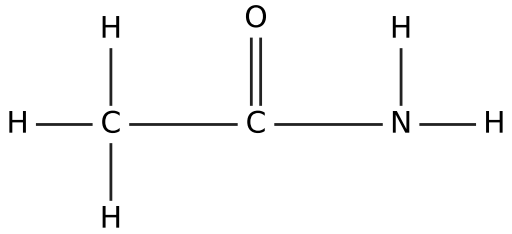
3.3 Nitrous acid from $NaNO_2$/acid below about 10 °C; alkaline phenol coupling; –N=N– azo linkage. Warming increases decomposition of the unstable diazonium salt.

3.4

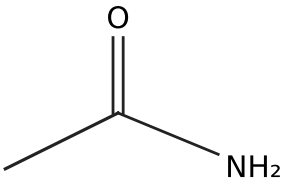


Ethanamide

Displayed formula

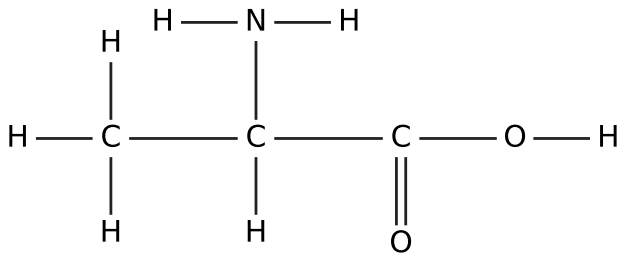


Skeletal formula

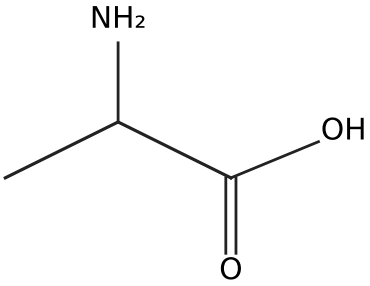


2-aminopropanoic acid (alanine; uncharged form)

Displayed formula



Skeletal formula



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