Solutions

Each answer shows the steps, then the **result**.

2.1

- the nitrogen lone pair can accept (donate to) an H^+

2.2

- excess ammonia, NH_3, in ethanol; heat under pressure

3.1 C

- Ethylamine — the alkyl group makes the lone pair most available

3.2 A

- $LiAlH_4$ reduces the nitrile to a primary amine, ethylamine

3.3

- the ethyl group pushes electron density onto the nitrogen (positive inductive effect); this makes the lone pair more available to accept an H^+, so ethylamine is a stronger base than ammonia

3.4

- in phenylamine the nitrogen lone pair overlaps with / is delocalised into the benzene ring; so it is less available to accept an H^+; whereas in ethylamine the lone pair is fully available (and the alkyl group pushes electrons onto N), so phenylamine is much weaker

3.5

(a)

- phenylamine < ammonia < ethylamine. A base donates the nitrogen lone pair, so the more available that pair, the stronger the base. In ethylamine the ethyl group **releases** electron density inductively towards the nitrogen, making the lone pair more available; in phenylamine the lone pair is delocalised into the benzene ring, so it is much less available

(b)

- $CH_3CH_2Br + 2NH_3 \rightarrow CH_3CH_2NH_2 + NH_4Br$; the mechanism is **nucleophilic substitution**; an excess of ammonia makes it more likely that ammonia — not the ethylamine already made — attacks the next bromoethane, which limits further substitution to secondary and tertiary amines

(c)

- Tin and concentrated hydrochloric acid, heated under reflux, then made alkaline with sodium hydroxide; $C_6H_5NO_2 + 6[H] \rightarrow C_6H_5NH_2 + 2H_2O$

(d)

- $CH_3CH_2NH_2 + HCl \rightarrow CH_3CH_2NH_3^+Cl^-$; **ethylammonium chloride**