Solutions

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

2.1

- tin (Sn) and concentrated hydrochloric acid; then NaOH(aq)

2.2

- below 10 °C (kept cold in an ice bath)

2.3

- Tin and concentrated hydrochloric acid; then an excess of sodium hydroxide; heat under reflux

2.4

- Above about 10 °C the diazonium ion is unstable and decomposes to phenol and nitrogen gas, so the yield is lost

2.5

- In phenylamine the nitrogen's lone pair is delocalised into the benzene ring, so it is less available to accept a proton; in ethylamine the alkyl group releases electron density towards the nitrogen, making the lone pair more available

3.1 A

- $NaNO_2$ + dilute acid below 10 °C makes the diazonium salt

3.2 C

- The –N=N– azo group is responsible for the colour

3.3

- nitrate benzene with conc. HNO_3 + conc. H_2SO_4 to give nitrobenzene; reduce with Sn and conc. HCl; then add NaOH(aq) to free the phenylamine

3.4

(a)

- an azo compound / azo dye

(b)

- used as a dye (colouring)

3.5

(a)

- Concentrated nitric acid and concentrated sulfuric acid at about 55 °C; electrophilic substitution

(b)

- Tin and concentrated hydrochloric acid; the product of the reduction is the phenylammonium salt, not the free amine, so excess sodium hydroxide is added to liberate phenylamine from it

(c)

- Sodium nitrite with dilute hydrochloric acid, below 10 °C; $C_6H_5N_2^+Cl^-$

(d)

- Two benzene rings joined by $-N=N-$, with the $-OH$ group para to the azo link on the phenol ring

(e)

- The azo group $-N=N-$ joins the two rings into one extended delocalised system; a larger delocalised system has a smaller gap between the energy levels; the gap now corresponds to visible light, which is absorbed, and the complementary colour is seen