Solutions

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

2.1

- concentrated HNO_3 and concentrated H_2SO_4; warm, 25–60 °C

2.2

- $LiAlH_4$ (or H_2/Ni)

2.3

- chloromethane (CH_3Cl) with an $AlCl_3$ catalyst

2.4

- acidified potassium dichromate(VI), heated under reflux

3.1 B

- KCN adds a –CN group, lengthening the chain by one carbon

3.2 B

- Work backwards from the target molecule

3.3

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

3.4

(a)

- KCN (in ethanol) to give propanenitrile; then $LiAlH_4$ (or H_2/Ni) to reduce it to propylamine

(b)

- the direct halogenoalkane + ammonia route also makes secondary/tertiary amines (over-substitution), lowering the yield of the primary amine

3.5

- step 1: HCN with a little KCN
- the intermediate is 2-hydroxypropanenitrile, $CH_3CH(OH)CN$
- step 2: heat under reflux with dilute acid (such as HCl), hydrolysing the nitrile to the acid

3.6

(a)

- $0.80 \times 0.70 \times 0.60 = 0.336$, so the overall yield is **33.6**%

(b)

- fewer steps lose less product overall, and need less time, reagents and separation