**Student Book Unit 5** Test 2 Mark scheme (Chapters 2.3 to 2.5)

1. **a** Delocalised bonding in benzene (1)
   Benzene does not have three (localised) C—C bonds (1)
   Benzene ring has high stability (1)
   Less susceptible to addition (1)
   _max 2_

   **b** (i) Concentrated acids (1); lower than 60°C (1)
   (ii) \[ \text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightleftharpoons \text{NO}_2 + 2\text{HSO}_3^- + \text{H}_3\text{O}^+ \] (1)  
   or \[ \text{HNO}_3 + \text{H}_2\text{SO}_4 \rightleftharpoons \text{H}_2\text{NO}_3^+ + \text{HSO}_4^- \] (1)  
   or \[ \text{HNO}_3 + \text{H}_2\text{SO}_4 \rightleftharpoons \text{NO}_2^+ + \text{HSO}_4^- + \text{H}_2\text{O} \] (1)
   Sulfuric acid donates H⁺ to nitric acid (1)
   (iii) allow this mark also for H⁺ at end (1)
   (iv) Addition destroys delocalisation substitution does not (1)
   _Total 9 marks_

2. **a** Fume cupboard (1); gloves (1)
   _safety requirements must be specific to question_
   (2)

   **b** \[ \text{C}_6\text{H}_5\text{NH} + \text{HCl} \rightarrow \text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^- \] (1)
   _must have correct charges_
   _ignore Cl⁻ if H⁺ on left-hand side_
   (1)

   **c** (i) Too slow lower than 0°C (1); product decomposes at higher than 5°C (1)
   (ii) Exothermic (1); have to keep temperature below 5°C (1)
   _Total 9 marks_

3. **a** (i) Chlorine (1); sunlight / u.v. light (1); \[ \text{C}_6\text{H}_5\text{CH}_3 + \text{Cl}_2 \rightarrow \text{C}_6\text{H}_5\text{CH}_2\text{Cl} + \text{HCl} \] (1)
   _the first condition mark can be awarded if u.v. light / sunlight is mentioned in part (ii) condition dependent on reagent_
   _allow C₇H₈ + Cl₂ etc._
   (ii) Fractional distillation (1); distil off methylbenzene and distil a sample of benzyl chloride / (chloromethyl) benzene at 179°C (1)
   _Total 9 marks_

   **b** HCl (1); room temperature (1)
   \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{HCl} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_3^+\text{Cl}^- \] (1)
   _Total 8 marks_
Student Book Unit 5 Test 2 Mark scheme (cont.)

4  a  (i)
\[
\begin{align*}
\text{H} & \quad \text{CH}_3 \\
\text{Cl} & \quad \text{C} & \quad \text{NH}_2 \\
\text{H} & \quad \text{C} & \quad \text{N} & \quad \text{H}_3[\text{Cl}^-] \\
\text{O} & \quad \text{C} & \quad \text{O} & \quad \text{COCH}_3
\end{align*}
\]

(1)

(ii) if two structures are given each one should have one of the groups acylated (2)
if just the ring acylated then (1) – position does not matter
if the ring and one group acylated (2)

(iv)
\[
\text{COOH}
\]

allow the sodium salt – charges not necessary
allow the anion

(v)
\[
\text{H} & \quad \text{C} & \quad \text{CH}_3 \\
\text{C} & \quad \text{NH}_3^+ & \quad [\text{HSO}_4^-]
\]

structure must be unambiguous
allow the free amine
not an ether or substitution of SO_3H

b  (i) Fume cupboard / open window (1); gloves (1)

(ii) Dissolve in minimum volume trichloromethane (1); boiling/hot solvent (1); hot filter (1)
cool (1); filter and dry crystals (1)
if give cool and filter (0) if nothing sensible given before

(iii) Melting temperature (1); sharp or compare with known value (1) (9)

(Total 15 marks)

5  a  (i) Na in EtOH / LiAlH_4 / hydrogen (1); not sodium borohydride
Correct condition for reagent used (1); i.e. room temp or warm for Na in EtOH / dry ether for LiAlH_4 / Pt or Ni catalyst for hydrogen
\[
\text{C}_2\text{H}_5\text{CN} + \text{H}_2 \rightarrow \text{C}_2\text{H}_5\text{CH}_2\text{NH}_2
\]
(1)

(ii) Reagent: CH_3COCl (1); at room temperature (1);
\[
\text{C}_2\text{H}_5\text{CH}_2\text{NH}_2 + \text{CH}_3\text{COCl} \rightarrow \text{C}_2\text{H}_5\text{CH}_2\text{NHCOCH}_3 + \text{HCl}
\]
(3)

b  The reaction is used in the synthesis of paracetamol (1) (1)

(Total 7 marks)