EXAM-STYLE QUESTIONS – A2 Organic Reaction Mechanisms

1. Bromobenzene can be prepared from benzene, through reaction with Br₂ and an FeBr₃ catalyst.
   - Draw and name the mechanism for this reaction.
   - Use Br⁺ as the electrophile. Include any intermediate(s) and the product(s).

   ![Mechanism Diagram]

   Name of mechanism: ………………………………………………………………………………… (5 marks)

2. Acetoacetic acid, shown below, is an organic compound used in the synthesis of some dyes.

   ![Acetoacetic Acid Structure]

   (a) Explain briefly why acetoacetic acid is soluble in water.

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   …………………………………………………………………………………………………………………… (1 mark)

   (b) Name the functional groups present in acetoacetic acid.

   …………………………………………………………………………………………………………………… (2 marks)

   (c) Acetoacetic acid can be reduced using sodium borohydride, NaBH₄, to form CH₃CH(OH)CH₂COOH.

   Draw a mechanism for this reaction, using curly arrows and showing relevant dipoles. Use :H⁻ as the nucleophile.

   …………………………………………………………………………………………………………………… (4 marks)

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3 Nitrobenzene is formed from the reaction of benzene with concentrated nitric acid and concentrated sulfuric acid.

(a) Outline the mechanism for this reaction. Your answer should also include a balanced equation showing how the electrophile is formed.

(b) 1,3,5-trimethylbenzene is used as the starting material instead of benzene in the synthesis of some azo dyes. How many different structural isomers could be formed from the mononitration of 1,3,5-

4 Ethanal reacts with :CN⁻ ions, formed from HCN in the presence of KCN.

(a) Draw and name the mechanism for this reaction. The structure of ethanal is given below.

Name of mechanism:
(b) The product of this reaction contains a **chiral** centre. Identify this centre by marking the chiral carbon in your answer to (a) with an asterisk (*).

(1 mark)

(c) Would you expect the reaction to produce a racemic mixture of products? Explain your answer. (Note: A ‘racemic mixture’ is a solution in which both optical isomers are present in equal amounts.)

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(2 marks)

5 Amides can be produced by reacting amines with acyl chlorides.

This reaction proceeds via a nucleophilic addition-elimination mechanism.

Using your knowledge of reaction mechanisms, draw appropriate curly arrows to complete the mechanism for the reaction of CH₃COCl with CH₃NH₂, showing all relevant dipoles. Draw the products of the reaction.

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\[
\begin{align*}
\text{CH}_3\text{COCl} & \quad \text{step 1} \quad \text{H}_3\text{C}\text{N}^-\text{NH}_2 \\
\text{H}_3\text{C}---\text{NH}_2 & \quad \text{step 2} \quad \text{H}_3\text{C} \quad \text{Cl}^- \\
\text{products} & \quad \text{step 3} \quad \text{H}_3\text{C} \quad \text{N} \quad \text{H} \quad \text{H}
\end{align*}
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(5 marks)
EXTENSION QUESTION

6  Isocyanates are organic compounds used in the production of polymers and pesticides. The general structure of an isocyanate is shown below, with the ‘R’ representing any generic alkyl group.

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\begin{align*}
R & \quad \text{isocyanate} \\
\text{O} & \quad \text{C} \quad \text{N} \quad \text{C} \quad \text{O}
\end{align*}
\]

Some of the steps in the formation of an isocyanate compound are shown below.

\[
\begin{align*}
\text{H}_2\text{C} & \quad \text{C} \quad \text{NBr} & \quad \overset{\text{NaOH, step 1}}{\longrightarrow} & \quad \text{H}_2\text{C} & \quad \text{C} \quad \text{N} \quad \text{Br} & \quad \overset{\text{step 2}}{\longrightarrow} & \quad \text{H}_3\text{C} \quad \text{N} \quad \text{C} \quad \text{O} & + \text{Br} \\
\text{compound D} & & & & & & & \text{compound E}
\end{align*}
\]

(i) What type of reaction occurs in step 1?

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(1 mark)

(ii) Draw curly arrows on compound D to suggest a mechanism for step 2.

(3 marks)

TOTAL MARKS: 35