**A2 Chemistry November Exam A\* = 60-66 A = 54-59 B = 46-53 C = 40-45 D = 33-39 E = 27-32 U = under 27**

**Name: Time: 50 minutes Score = /66**

1. (a) Ketone K has the molecular formula C4H8O.

i. The mass spectrum of compound K contains a major peak at m/z = 43. Deduce the structure of the fragment ion responsible for this peak and write an equation showing its formation from the molecular ion of K.

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ii. Less intense, but significant peaks appear at m/z = 57 and m/z = 59. Deduce the structures of the fragment ions that are responsible for these two peaks.

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iii. Give the structural formula and name of ketone K.

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(b) Aldehyde A also has the molecular formula C4H8O. Unlike the 13C NMR spectrum of ketone K which has four peaks, the 13C NMR spectrum of aldehyde A has only 3 peaks.

i. Explain why aldehyde A does not have four peaks.

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ii. Give the structural formula and name of aldehyde A.

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(c) Aldehyde A and ketone K can be distinguished by using a simple chemical test.

i. Name the reagent you would use for this test and describe what you would observe.

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ii. Give the structural formula of the organic reaction product.

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(d) Using RCHO to represent aldehyde A:

i. Write an equation for the reaction between the aldehyde and sodium borohydride (NaBH4). You may use [H] to represent the sodium borohydride.

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ii. Name the type of reaction occurring

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iii. Name and draw the mechanism for this reaction.

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[Total: 17]

2. The local anaesthetic benzocaine (S) can be made by the following sequence:



 (a) In step 1, methylbenzene is treated with a mixture of two reagents.

i. Identify the two reagents and write an equation showing the formation of the reactive species involved.

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ii. State the type of reaction taking place.

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iii. Name and draw the mechanism.

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(b) The product obtained from step 1 is a liquid and contains compound P, contaminated with other isomers. When pure, compound P is a crystalline solid, with melting point 51oC.

i. Describe briefly how chromatography could be used to obtain a pure sample of crystalline P from 5g of the impure liquid mixture.

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 (c) Name the type of reaction occurring in step 2.

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(d) Name the type of reaction taking place in step 3 and give a suitable reagent or mixture of reagents for this conversion.

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 (e) Write an equation to represent the reaction between R and hydrochloric acid.

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 (f) i. Name the type of reaction occurring in step 4.

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 ii. Identify the reagents needed for the conversion.

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 ii. Give the systematic name of compound S.

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[Total: 21]

3. (a) Write an equation to illustrate how the primary amine RNH2 functions as a BrØnsted-Lowry base.

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 (b) Explain why ethylamine is a stronger base than ammonia whereas phenylamine is less basic than ammonia.

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 (c) Amines such as propylamine can be made from halogenalkanes.

 i. Name the type of reaction involved.

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ii. Name the reagents used for the conversion of 1-bromopropane into propylamine.

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 iii. Write an equation for the reaction and draw the mechanism.

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iv. When there is an excess of the halogenoalkane, further substitution may occur. Use displayed formulae to show how this occurs.

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(d) i. Give the structure and name the type of compound formed when R2NH is heated with a large excess of chloromethane.

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ii. Give one use of the product obtained when R is a very long alkyl group.

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[Total: 15]

4. A mixture of two organic liquids could not be separated efficiently using fractional distillation. Use of a different laboratory technique permitted the isolation of compound X (boiling point = 202oC) and compound Y (boiling point = 205oC).

 The mass spectrum of compound X has the molecular ion peak at m/z = 120 together with two major peaks at m/z = 77 and m/z = 105. A dominant peak appears in the infra-red spectrum of X at 1690cm-1. One peak in the 1H NMR spectrum of X is a three-proton singlet at δ 2.60 ppm and one of the peaks present in the 13C NMR spectrum has a strong signal at δ 198 ppm. Compound X remains unchanged when heated with acidified potassium dichromate(VI) solution.

 The mass spectrum of compound Y has the molecular ion peak at m/z = 108 and a major peak at m/z = 77. An intense peak appears in the infra-red spectrum of Y at 3352cm-1. One peak in the 1H NMR spectrum of Y is a two-proton singlet at δ 4.50 ppm. Compound Y is oxidised to benzenecarboxylic acid when heated with acidified potassium dichromate (VI) solution.

 (a) Suggest which technique was used to separate compounds X and Y.

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(b) What conclusions can be drawn from the fact that both X and Y have a fragment ion at m/z = 77 in their mass spectra?

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(c) By reference to the various m/z values provided, deduce the structure of the fragment ion appearing at m/z = 105 in the mass spectrum of compound X.

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 (d) For compound X, identify the groups associated with the following peaks:

 i. 1690cm-1 in the infra-red spectrum

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ii. δ 2.60 ppm in the 1H NMR spectrum

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iii. δ 198 ppm in the 13C NMR spectrum

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 (e) Deduce the structure of compound X.

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 (f) For compound Y, identify the groups associated with the following peaks:

 i. 3352cm-1 in the infra-red spectrum

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ii. δ 4.50 ppm in the 1H NMR spectrum

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 (g) Deduce the structure of compound Y.

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(h) Explain how the behaviour of compounds X and Y towards acidified potassium dichromate (VI) solution relates to the structures of these compounds.

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[Total: 13]