Autumn Examinations 2012 / 2013

Exam Code(s)  2BS, 2BY, 2EV, 2BPC, 2EV, 1OS
Exam(s)  2nd Science (denominated and undenominated), occasional science

Module Code(s)  CH202
Module(s)  Organic Chemistry

Paper No.

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Instructions:  Answer Four questions: one question must be attempted from each section (A, B, C and D)
Use separate Answer Books for Section A, Section B, Section C and Section D.
All questions carry 25 marks distributed as shown.

Leave the front page of the Answer Book blank and clearly list on it the numbers of the questions attempted.

Duration  2 hrs
No. of Pages  7
Discipline(s)  Chemistry

Requirements  None
Section A

1. Answer each of the following:

(i) Four acid derivatives are shown above (A-D).
   (a) All of these are polar molecules. In your choice of two show the partial charges on the atoms of the molecules. [3 Marks]
   (b) Which is the most readily hydrolysed with aqueous base? Explain your answer. [4 Marks]

(ii) Compounds A-C can be converted to D by reaction with methylamine under the correct conditions. Show by means of the curly arrow mechanism how A is converted to D. [7 Marks]

(iii) Compound C when reacted with methylamine can give two different amides D and one other.
   (a) Draw the other possible amide [3 Marks]
   (b) Draw an anhydride which could be used instead of C which would give only one amide product D. Explain your answer. [3 Marks]

(iv) Give reagents conditions and products of 2 other reactions of the compound B [5 Marks]
2. Answer each of the following:

(i) The schemes above show two reactions of an alkene.
   (a) Identify the two main products of the reactions E and F. [4 Marks]
   (b) The reaction to give E can also produce a second product. What is the side product and explain by showing the mechanism of the reaction how it is formed? [5 Marks]
   (c) What is the mechanism of the reaction to give product F? [4 Marks]

(ii) The schemes above show two reactions of alkynes.
   (a) Name the two products G and H. [3 Marks]
   (b) What are the reagents and conditions which should be used to produce G and H in their respective reactions? [5 Marks]
   (c) What is the mechanism of the reaction leading to H? [4 Marks]
Section B

3. Answer each of the following:

(i) Outline any three methods by which the alcohol 2-butanol could be synthesized. Provide a simple mechanism for the reaction involved in any one of the methods you suggest.

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{OH} \\
\text{2-butanol} & \\
\end{align*}
\]

[8 marks]

(ii) Using 2-butanol as one of the reactants, give an example of each of the following types of reaction: (a) an elimination reaction; (b) a nucleophilic addition reaction involving ethanoic (acetic) acid; (c) an oxidation reaction; (d) a nucleophilic substitution reaction. Draw simple mechanisms for any two of the examples you provide.

[9 Marks]

(iii) Draw the structures of the products formed in the reactions of the molecules shown below with the Grignard reagent \( \text{H}_3\text{CMgBr} \), followed by the addition of dilute acid \( (\text{H}^+) \). Provide a simple mechanism for any one of the reactions. What would happen if water was present as an impurity in the substance which is to be reacted with the Grignard reagent?

Reaction in this case involves 2 moles of \( \text{H}_3\text{CMgBr} \) for every mole of ester

[8 Marks]
4. **Answer each of the following:**

(i) Draw the structures of the products that result when (a) 2-pentanone, and (b) pentanal react with ethylamine. Indicate which of these carbonyl containing molecules will be the more reactive in this reaction and explain your answer.

![2-pentanone, pentanal, ethylamine structures](image)

(ii) The ion that forms when acetophenone (structure given below) reacts with a base such as NaOH can exist in two forms. Draw the structures of both forms, explain how they are related to each other, and indicate the type (name) of ion involved in each case.

![Acetophenone structure](image)

(iii) (a) Which of the molecules (A), (B) and (C), cannot form a carbanion/enolate? Explain your answer.

![Molecules A, B, C, D](image)

(b) Which of the other two molecules could be used to make (D)? Indicate what other molecules and reagents would be required and draw a simple mechanism for the formation of (D).
**Section C**

5. **Answer each of the following:**

An enantiomerically pure compound A undergoes an SN1 reaction in the presence of ethanol to give products.

\[
\begin{align*}
\text{CH}_2\text{CH}_3 & \quad \text{EtOH} \\
\text{CH}_3 & \quad \text{Products}
\end{align*}
\]

\(A\)

(i) Write the mechanism for the SN1 reaction and give structures for the products formed from A. Discuss the stereochemical outcome of this reaction. **[9 marks]**

(ii) Four alkenes are formed from the E1 reaction of 3-chloro-2,3-dimethylhexane. Give the structures of the alkenes, and rank them according to the relative amounts that may be expected to be formed. Explain the selectivity you propose. **[9 marks]**

(iii) Which of the alkyl halides (D or E) is more reactive in an E2 reaction? Give the mechanism for an E2 reaction and explain your answer. **[7 marks]**

6. **Answer each of the following:**

(i) Draw the structure of (S)-2-hexanol. Suggest the structure for an alkyl halide that could be used to prepare (S)-2-hexanol. **[6 Marks]**

(ii) Write the mechanism for an SN1 reaction of your choice **[3 marks]**

(iii) Arrange the following alkyl bromides in order of decreasing reactivity in an SN1 reaction and explain your answer:

- 2-bromobutane
- 1-bromobutane
- 2-bromo-2-methylbutane **[8 marks]**

Question continues overleaf....
(iv) Propose a mechanism, using curly arrows, for the formation of \( \text{G} \) from \( \text{F} \)

\[
\begin{align*}
\text{F} & \quad \overset{\text{H}_3\text{O}^+}{\rightarrow} \quad \text{G} \\
\end{align*}
\]

Section D

7. Answer each of the following:

Answer each of the following:

(i) Which of the following compounds or ions is aromatic? State the number of \( \pi \)-electrons, and draw resonance structures with curly arrows for aromatics.

(ii) Draw a reaction scheme with reagents for the chlorination of benzene.

(iii) Name the latter product.

(iv) Draw a curly arrow mechanism for the chlorination of benzene, include the formation of intermediates in your answer.

8. Answer each of the following:

(i) Draw any primary, secondary and tertiary aliphatic amine.

(ii) Name each amine in part (i).

(iii) Give schemes and reagents for the formation of aniline from benzene.

(iv) Aniline is a weaker base than primary aliphatic amines. Rationalize this statement and include resonance structures in your answer.