



NUI Galway
OÉ Gaillimh

Autumn Examinations 2010 / 2011

Exam Code(s) 2BS, 2EV, 2EH, 2BY, 2BPC, 1OA1, 2BPP
Exam(s) 2nd Science

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

External Examiner(s) Professor Richard J. K. Taylor
Internal Examiner(s) Professor P.V. Murphy
Dr. F. Aldabbagh
Dr. N. Geraghty
*Dr. P. O’Leary

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.

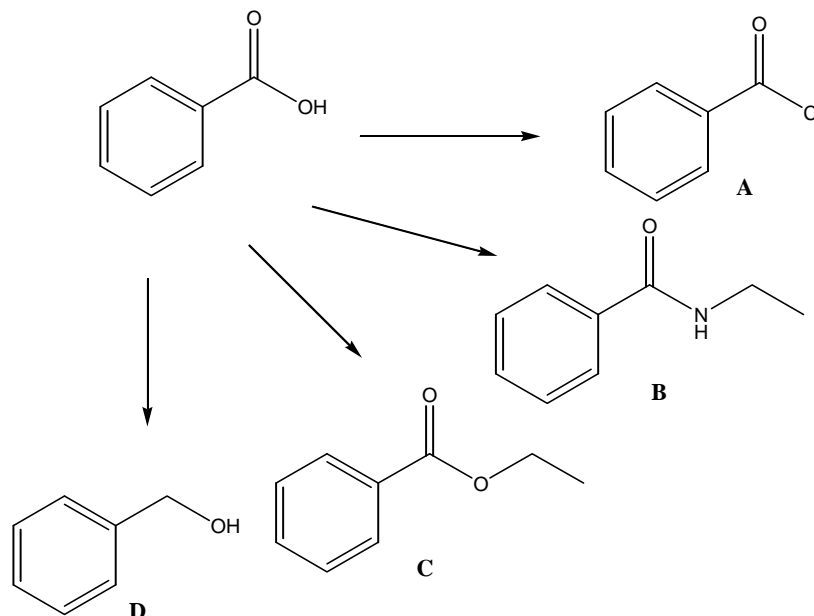
Duration 2hrs
No. of Pages 6 (including this front page)
School(s) Chemistry

Requirements None

Section A

1. Answer each of the following:

- (i) In each case below indicate the reagents and conditions required to carry out the transformation shown.



[12 marks]

- (ii) What is the mechanism of the reaction leading to product **C**? **[7 Marks]**

- (iii) Compound **A** could be used as a starting material for the preparation of **B**. How might this be carried out and describe the mechanism of the reaction?

[6 marks]

2. Answer each of the following:

- (i) Discuss alkenes under the following headings

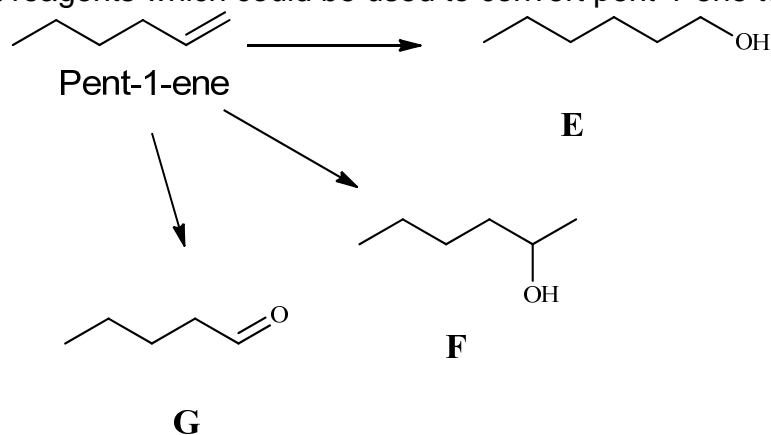
- (a) Bonding and hybridisation
- (b) E and Z isomers
- (c) Reaction to give diols
- (d) Reaction with Br₂

[4 x 3 Marks]

- (ii) Draw the structures of both (E)-2-methyloct-3-ene and (Z)-3-ethylcyclohexene. In the second case the (Z) designator may be omitted from the name. Why is this the case? **[7 Marks]**

Question continues overleaf.....

- (iii) Suggest reagents which could be used to convert pent-1-ene to **E-G**.

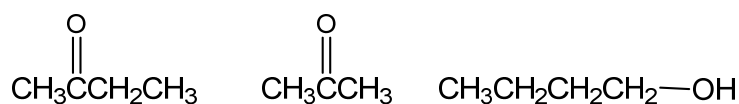


[6 Marks]

Section B

3. Answer each of the following:

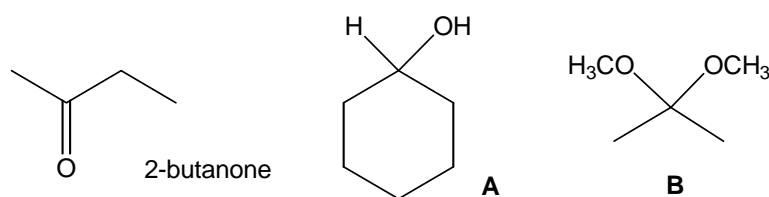
- (i) Outline the factors affecting (a) the boiling point and (b) the water solubility of simple ketones and aldehydes. Explaining your answer, rank the following molecules in order of increasing boiling point:



[8 marks]

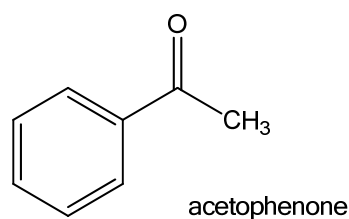
- (ii) Using a simple mechanism, explain why the reduction of 2-butanone using lithium aluminium hydride can be considered to be a nucleophilic addition reaction.

The molecules **A** and **B** can be prepared using nucleophilic addition reactions: outline the starting ketone/aldehyde and other reagents that would be required to make **A** and **B**.



[9 marks]

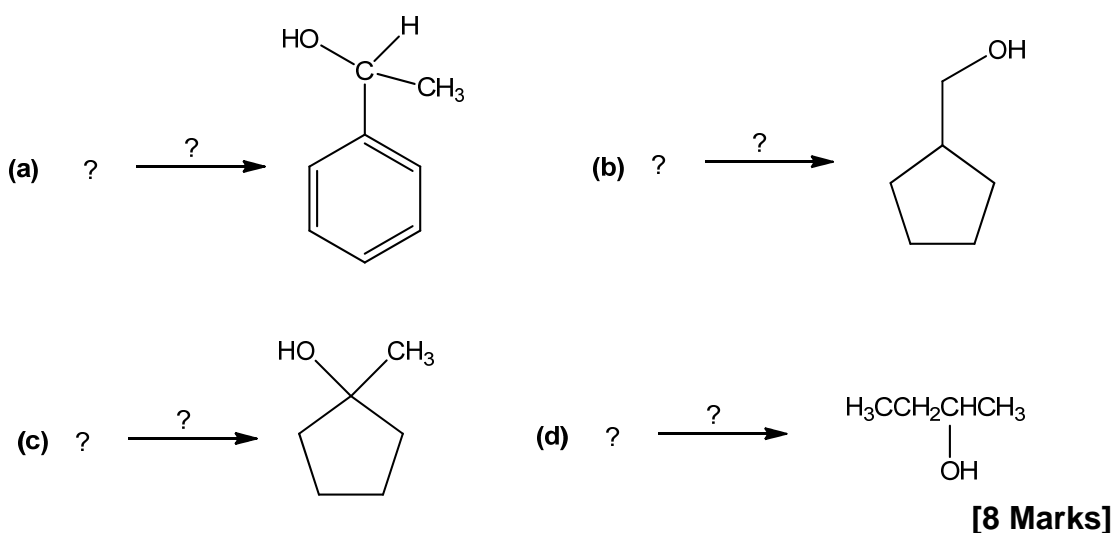
- (iii) Using acetophenone as an example, explain what is meant by the terms enol and enolate. Using curly arrows give a simple mechanism to show how an enolate is involved in the base promoted bromination of acetophenone.



[8 Marks]

4. Answer each of the following:

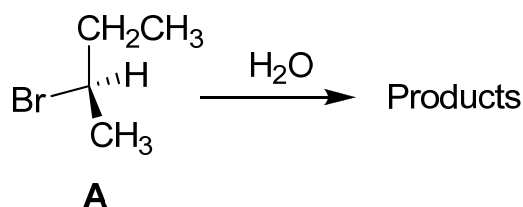
- (i) Explain what is meant by **bioethanol** and outline the methods by which it can be produced. Discuss its use as a fuel. **[8 marks]**
- (ii) Outline the basic factor responsible for the reactivity of a Grignard reagent such as ethylmagnesium bromide ($\text{CH}_3\text{CH}_2\text{-MgI}$) and explain why such a reagent is important in synthesis. In your answer provide at least two specific reactions involving $\text{CH}_3\text{CH}_2\text{-MgI}$, and outline a simple mechanism for either one of them **[9 Marks]**
- (iii) Suggest starting materials and reagents (single step processes) which could be used to prepare the following alcohols:



Section C

5. Answer each of the following:

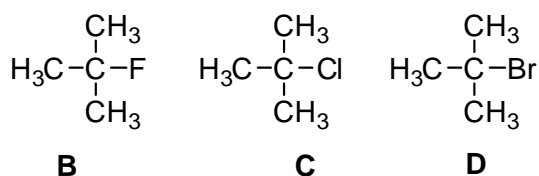
An enantiomerically pure compound **A** undergoes competitive $\text{S}_{\text{N}}1$ and $\text{E}1$ reactions at $45\text{ }^\circ\text{C}$ in the presence of water to give products.



- (i) Write mechanisms for both $\text{S}_{\text{N}}1$ and $\text{E}1$ reactions and give structures for all of the possible products formed from **A**. State any relevant stereoselectivity and regioselectivity that would be expected. **[15 marks]**

Question continues overleaf...

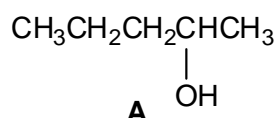
- (ii) Would the relative proportion of products obtained from **A** be expected to change if the reaction was carried out at 100 °C? Explain in detail your answer. **[5 marks]**
- (iii) List the following compounds **B-D** in order of increasing reactivity in an E1 reaction. Explain your answer.



[5 marks]

6. Answer each of the following:

- (i) Draw the *R*-enantiomer of the alcohol **A**. Justify your answer.

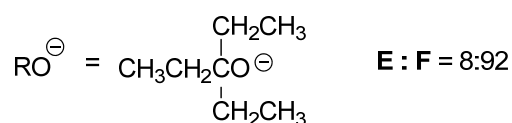
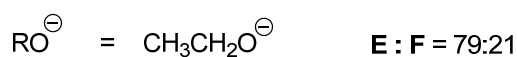
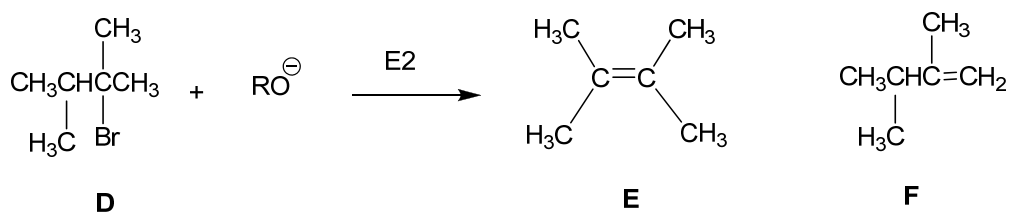


[5 Marks]

- (ii) Suggest a synthesis of the pure *R*-enantiomer of the alcohol **A** from a suitable alkyl halide precursor **B**. In your answer give the structure of **B** and describe in detail a mechanism for the formation of **A** and consider how the pure enantiomer of **A** would be obtained.

[10 marks]

- (iii) Give an explanation for product distribution that arises from using the two different bases in the reaction of **D** below. Give the mechanism of the E2 reaction as part of your answer.

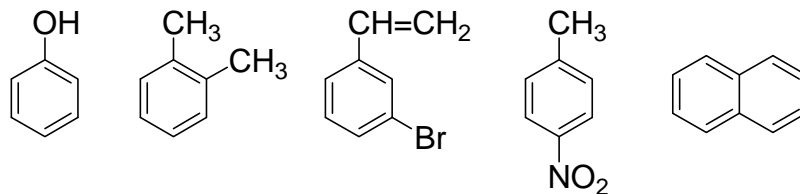


[10 marks]

Section D

7. Answer each of the following

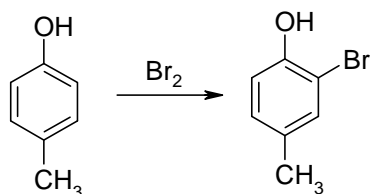
(i) Name the following molecules:



[5 marks]

(ii) State Hückel's rule for aromaticity, and draw aromatic structures each with 2π and 14π electrons. **[5 marks]**

(iii) Rationalize the substitution pattern for the bromination in Scheme 1 using a curly arrow mechanism. How does it compare with the bromination of benzene in terms of conditions and rate?



Scheme 1

[10 marks]

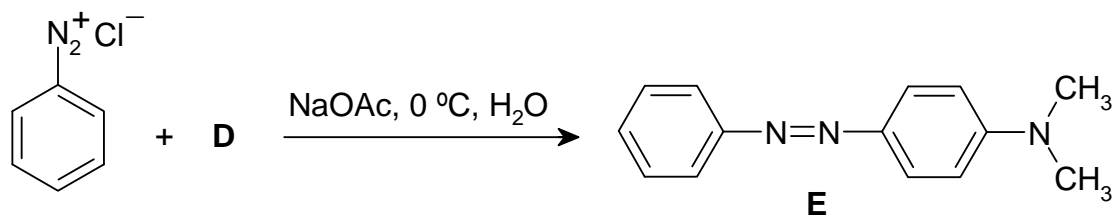
8. Answer each of the following:

(i) Draw the structure of a primary, a secondary and a tertiary aliphatic amine, and name all three amines. **[6 marks]**

(ii) Give a mechanism for the reaction of triethylamine with HCl. **[5 marks]**

(iii) Explain the origin of amine basicity and outline how the basicity of aniline compares with that of a primary aliphatic amine. Draw resonance structures to explain your answer. **[5 marks]**

(iv) Draw the chemical structure of **D**, and give a full reaction mechanism for the formation of yellow azo-compound **E**.



[9 marks]