Loughborough University

Structure and Reactivity 2

(22CMB106)

Semester 2 22/23 Online Long-window Exam paper

This is an online long-window examination, meaning you have **23 hours** in which to complete and submit this paper. How you manage your time within the 23-hour window is up to you, but we expect you should only need to spend approximately **2 hours** working on it. If you have extra time or rest breaks as part of a Reasonable Adjustment, you will need to add this to the amount of time you are expected to spend on the paper.

It is your responsibility to submit your work by the deadline for this examination. You must make sure you leave yourself enough time to do so.

It is also your responsibility to check that you have submitted the correct file.

Exam Help

If you are experiencing difficulties in accessing or uploading files during the exam period, you should contact the Exam Helpline. For urgent queries please call **01509 222900**.

For other queries email examhelp@lboro.ac.uk

Answer **ALL** questions

You may handwrite and/or word process your answers.

You may use a calculator and molecular model kits for this exam.

Where a question involves drawing molecular reaction schemes or mechanisms, you should include commentary explaining each step of the transformation. Diagrams *must* be hand drawn. When photographing your answers for upload, please check that all parts of your answer are clearly visible and legible in the recorded version.

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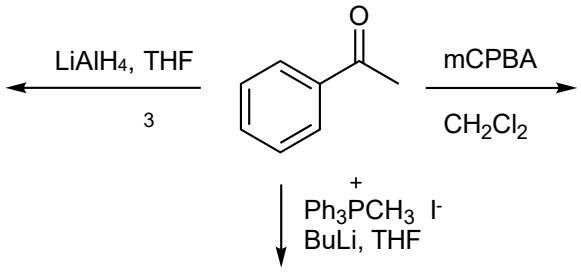
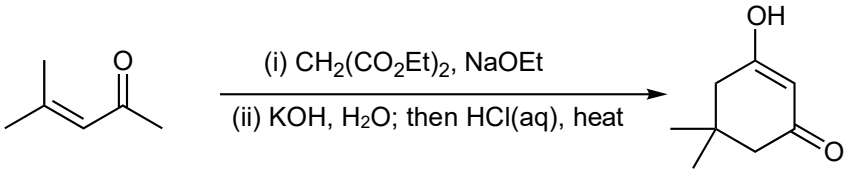
1. Answer **ALL** parts

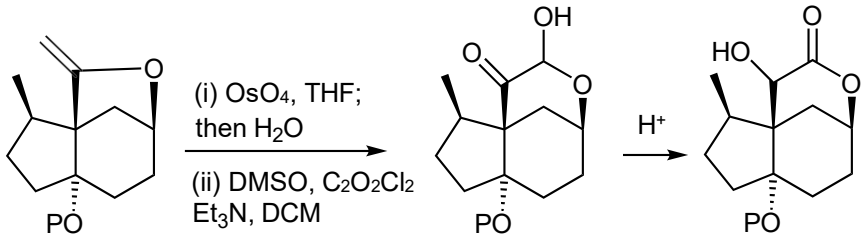
a) Give the product and mechanism for *each* of the following transformations of acetophenone. [3 x 4 marks]



b) Provide a mechanism for the reaction below. Comment on the key steps in the mechanism. [8 marks]



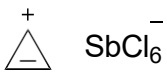
c) In a synthesis of a natural product, the enol ether **A** shown below, was converted into lactol **B** using the conditions listed. Explain the transformation of **A** into **B** (steps i and ii), and rationalise the subsequent acid catalysed conversion of **B** into lactone **C**. Give mechanisms for all steps. [10 marks]



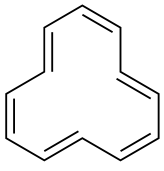
A **B** **C**

2. Answer **ALL** parts

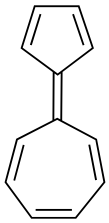
a) Discuss the bonding in each of the following molecules, and state whether you consider them to be aromatic. You should include relevant resonance structures in your answer, and refer to Hückel's rule in each case.



[3 marks]



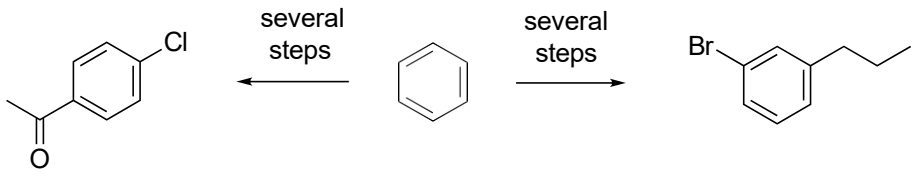
[3 marks]



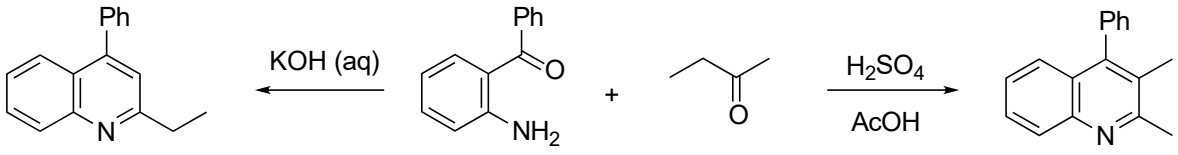
[4 marks]

continued...

b) Outline possible synthetic routes to each of the disubstituted arenes shown below, starting from benzene. Several steps may be needed, and you should discuss the directing effects of substituents and functional group interconversions which may be required to introduce the desired substitution pattern. Suggest reagents, and the order of the steps needed in each case, but reaction mechanisms are *not* required. [10 marks]

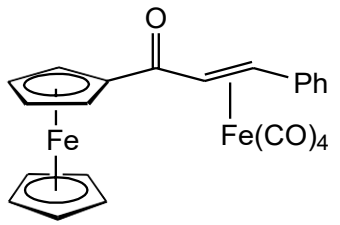


c) The amino ketone shown below can react with butanone to form quinoline derivatives. When the reaction is conducted under acidic conditions, the 2,3-dimethyl substituted product is formed. Under alkaline conditions however, the 2-ethyl substituted quinoline is formed. Draw a plausible reaction mechanism for each transformation, and account for the difference in selectivity between the acid and base catalysed reactions. [10 marks]

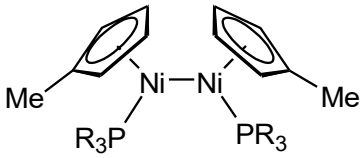


3. Answer **ALL** parts

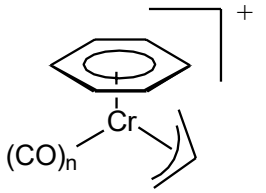
a) Give electron counts for the following organometallic compounds **1** and **2**. Show clearly how you deduce your answer in each case. [4 marks]



1



2



3

b) Calculate the number (n) of terminal CO ligands at the Cr metal centre in **3** to satisfy an eighteen electron count. [2 marks]

continued…

c) Explain the meaning of the term **half sandwich compound** using **3** as a suitable example. [1 mark]

d) Compare the ϖ_{CO} ligand stretching frequencies, with that of the carbonyl functional group also present, in compound **1**. [2 marks]

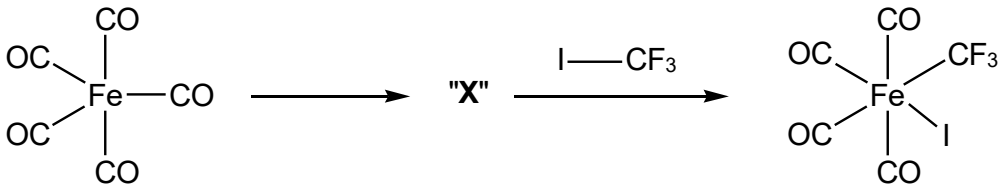
e) State reagents you would use to prepare a sample of the PR_3 ligand (shown in compound **2**, chose an alkyl R group of your preference). Discuss briefly any important experimental reaction conditions, including stoichiometry, that apply to this reaction. [4 marks]

f) To what class of phosphorus compound do PR_3 belong? [1 mark]

g) Describe, with suitable orbital diagrams, the bonding of an alkene to a metal such as that observed in compound **1**. [6 marks]

h) What difference, if any, would be expected in the C=C bond length in **1** and the free, unbound, alkene? Discuss a technique that can be used to probe this. [3 marks]

i) For the following reaction scheme:



4

(i) Identify the type of reaction leading to compound **4**. [1 mark]

(ii) Propose a structure for the intermediate **X**. Why is it necessary to proceed through this species? [2 marks]

(iii) Give reasons to support the type of reaction you have stated in part (i). [4 marks]

G.J. Pritchard, M.B. Smith, G.W. Weaver