

# CHE-2C11 : ORGANIC CHEMISTRY

## PRACTICE QUESTIONS / MOCK EXAM

Name: \_\_\_\_\_

There are a total of eight questions in this booklet which have been manipulated from the lecture content.

Each question will have its own relative mark which will be shown where necessary.

Good Luck. James 😊

Question	Your Score	Relative (x 0.125)
1		
2		
3		
4		
5		
6		
7		
8		
TOTAL		

**Question 1**

(a) Consider the following annulenes and predict, with appropriate reasoning, if they are aromatic, anti-aromatic or non-aromatic. Draw an energy level diagram of each annulene to support your answer.

(i) [14]-annulene

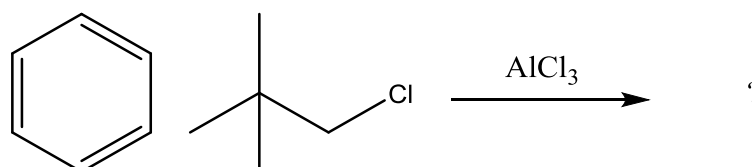
(ii) [16]-annulene

[40%]

(b) Explain why cyclopentadiene is unusually acidic, pKa 16, whereas in contrast the pKa of cycloheptatriene is 36.

[30%]

(c) Show with mechanistic reasoning the product of the following reaction

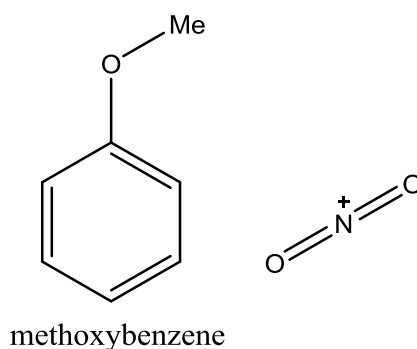


[30%]

**End of Question 1**

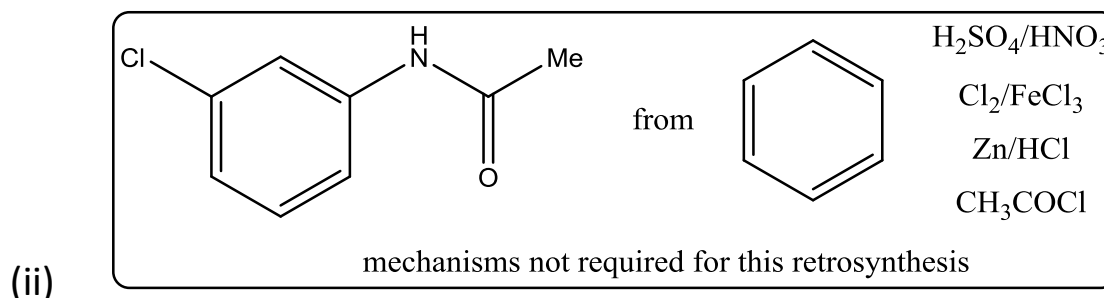
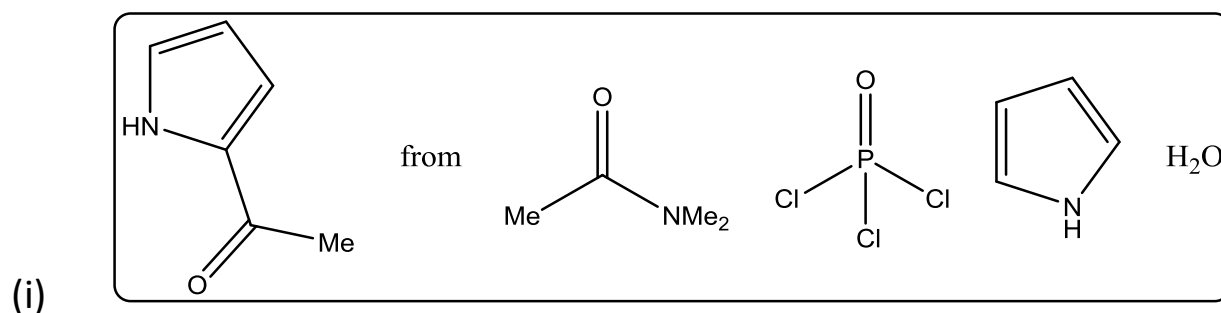
**Question 2**

- (a) Draw the aromatic electrophilic substitution mechanism of  $[\text{NO}_2]^+$  with methoxybenzene in ortho, meta and para positions with any appropriate resonance structures. Highlight which resonance structures are a major contributor to the real structure of the intermediate. Draw structures of all predicted products.



[40%]

- (b) Synthesise, with mechanisms (unless stated otherwise), the following target molecules using the reagents given:

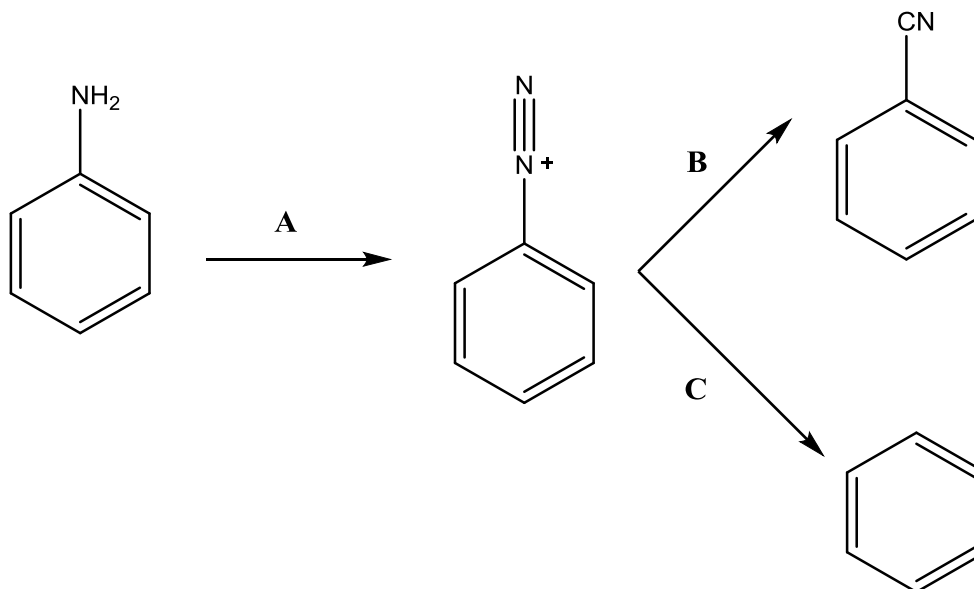


[40%]

**Question 2 continues on next page...**

**...Question 2 continued**

(c) Suggest reagents for the following transformations **A**, **B**, and **C**.

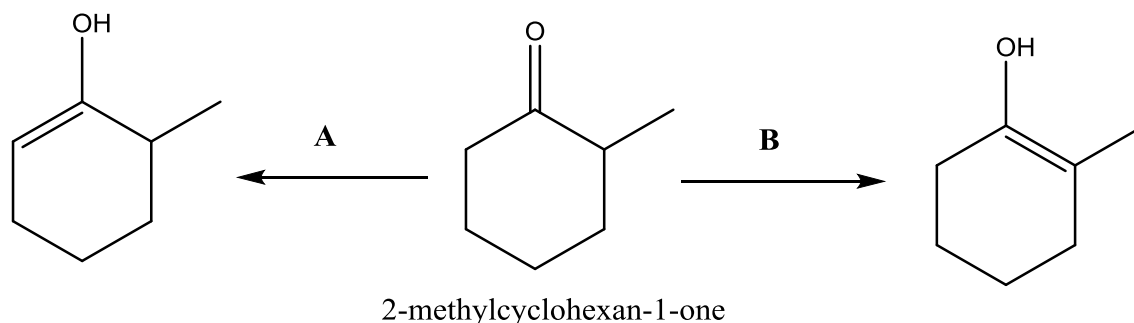


[20%]

**End of Question 2**

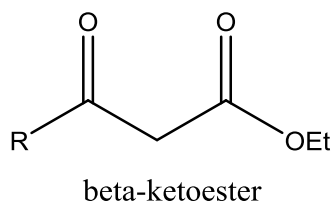
**Question 3**

- (a) Suggest suitable reagents for the following transformations **A** and **B**. What is the driving force for each transformation:



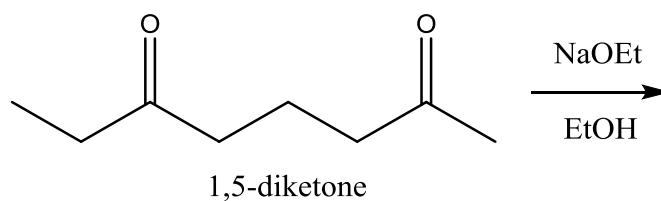
[40%]

- (b) Suggest a mechanism for the decarboxylation of a  $\beta$ -ketoester with suitable reagents where necessary:



[30%]

- (c) Show with mechanistic reasoning the possible product(s) of the following intramolecular aldol reaction:

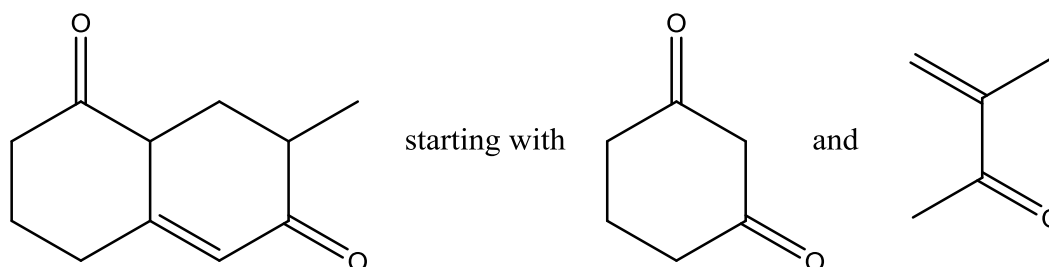
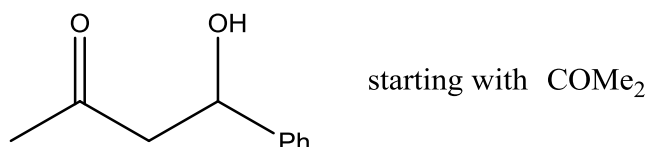


[30%]

**End of Question 3**

**Question 4**

- (a) Perform a retrosynthetic analysis of the following target molecules:



[60%]

- (b) Draw mechanisms of the following three stages of the Wittig Reaction:

- i. Preparation of a phosphonium salt from an alkyl halide
- ii. Deprotonation of the phosphonium salt to form an ylid (choose a suitable base)
- iii. Reaction of the ylid with a carbonyl group

What is the driving force for stage **iii**?

Use the following compounds:

- Triphenylphosphine
- Bromoethane
- Acetone (ethanal)

[40%]

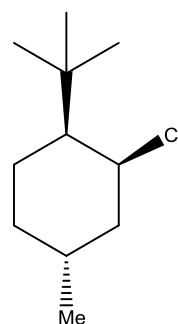
**End of Question 4**

**Question 5**

- (a) Sketch an energy level diagram of n-butane with respect to its dihedral angle. Explain why, if so, there are energy barriers.

[20%]

- (b) A tri-substituted cyclohexane is shown below:
- Draw a newman diagram of the compound
  - Draw a chair conformation of the compound
  - Perform a ring flip of the chair conformation you have drawn to form the second conformation
  - Draw a newman diagram of the second conformation
  - Which conformation exists in a higher energy state? Explain your answer.



2-chloro,4-methyl,1-t-butylcyclohexane

[50%]

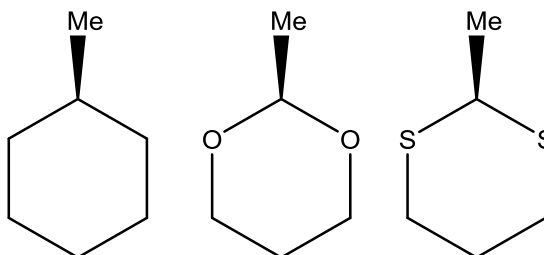
- (c) State the different types of strains that need to be considered in cycloalkanes. Compare the relative stabilities of cyclopropane, cyclobutane and cyclopentane with discussion to these types of strains; draw structures to illustrate your answer.

[30%]

**End of Question 5**

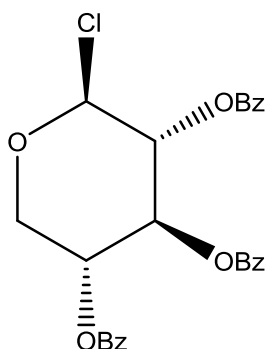
**Question 6**

- (a) Compare, with reasoning, the relative stabilities of the following heterocyclic compounds:



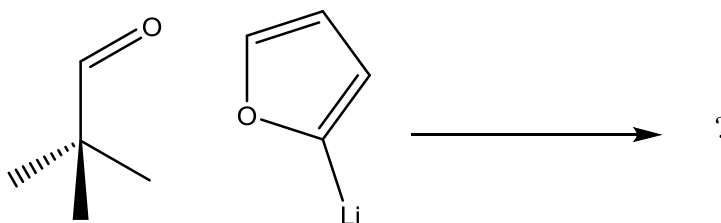
[15%]

- (b) Illustrate the more stable conformation of the following substituted cyclohexane. Give your reasoning:



[15%]

- (c) What product(s) are formed from the following reaction involving an **unsymmetrical** ketone? Label any enantiomers.



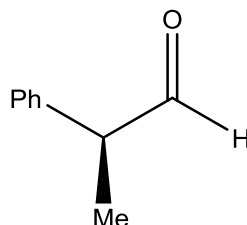
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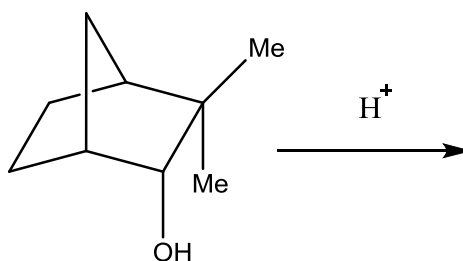
**...Question 6 continued**

- (d) Draw the most reactive conformation, as a newman projection, of the following unsymmetrical ketone. Show on your diagram the angle of attack of a nucleophile,  $\text{Nuc}^-$ , and therefore the predicted structure of the final product.



[30%]

- (e) The following compound reacts with acid. Propose a possible mechanism to a stable product.



[20%]

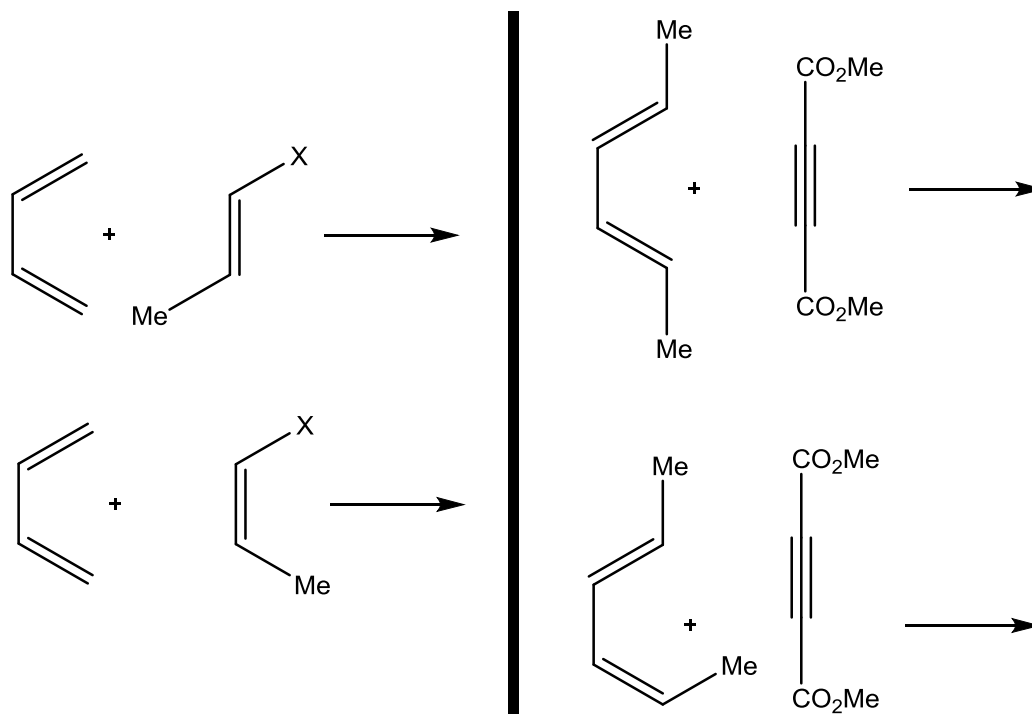
**End of Question 6**

**Question 7**

- (a) Define **concerted**, and therefore define a **pericyclic reaction**.

[10%]

- (b) Show all possible products of the following four reactions:



[40%]

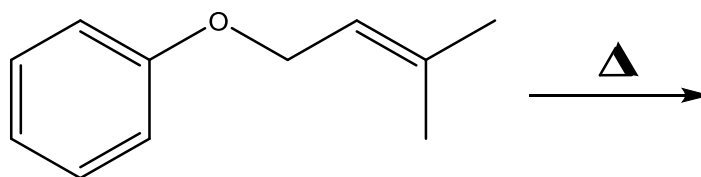
- (c) Explain why butadiene will undergo a Diels-Alder reaction with ethene and not with another butadiene molecule.

[30%]

Question 7 continues on next page...

**...Question 7 continued**

- (d) Show the product of the following reaction of a substituted phenyl allyl ether:

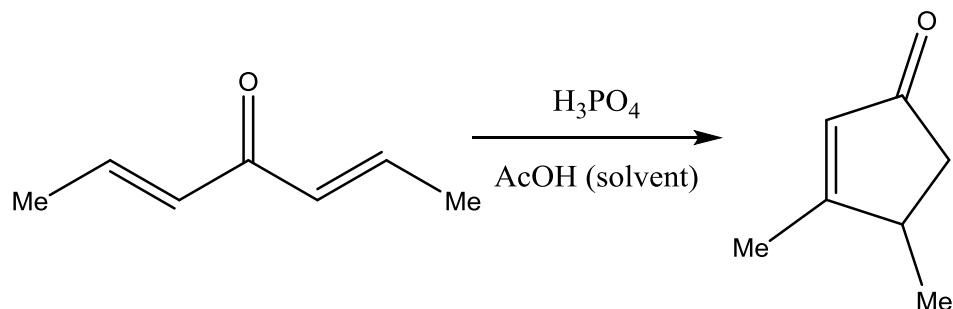


[20%]

**End of Question 7**

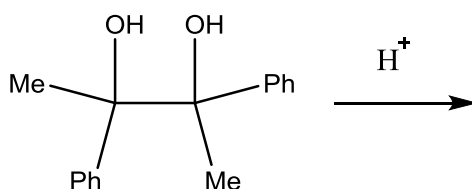
**Question 8**

- (a) Show the mechanism for the following electrocyclic reaction:



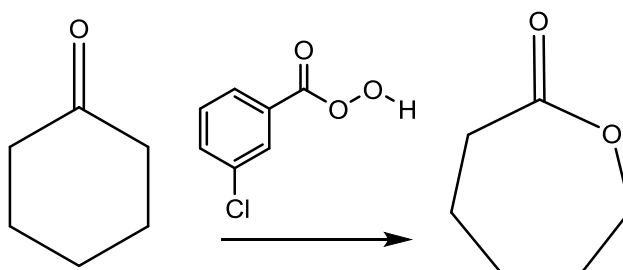
[20%]

- (b) What is the product of the following rearrangement reaction? Show mechanisms to support your answer:



[20%]

- (c) Show the mechanism of the following reaction:



[60%]

**End of Question 8**