MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2012/2013

SECOND YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE) WITH INFORMATION TECHNOLOGY (MAIN CAMPUS)

SCH 206: ORGANIC CHEMISTRY II

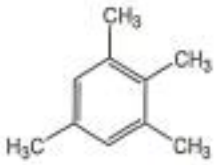
Date: 16th July, 2013 *Time: 2.30 – 4.30 p.m.*

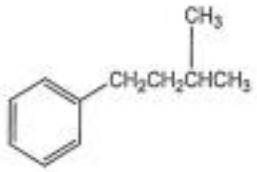
INSTRUCTIONS

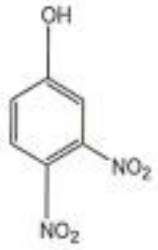
Attempt ANY FIVE questions.

Question 1 [14 marks]

(a) Provide IUPAC names for each of the following compounds:

(i) 

(ii) 

(iii) 

[3 marks]

(b) Draw structures corresponding to the names given below:

(i) 3,5-Dimethylbenzoic acid

(ii) 1-Methyl-2,4-benzenediamine

(iii) 1-Phenyl-3-methylpentane

[3 marks]

C. Use the information in the table below to answer the following questions:

Average Bond enthalpies (kJ/mol)

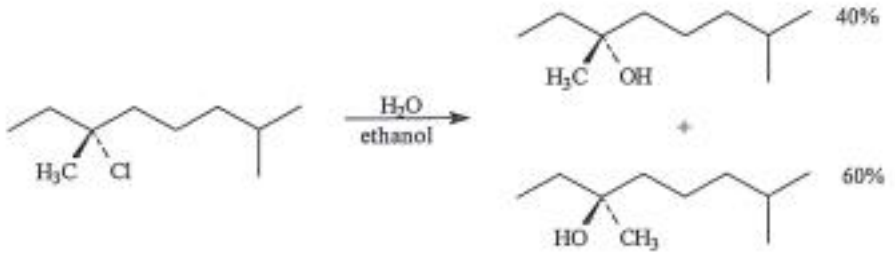
Single Bonds	Energies
C-H	414
C-C	347
O-H	464
N-H	389
N-N	159
H-H	436
Multiple bonds	
N≡N	946
O=O	498
C=O	804

Estimate the enthalpies of formation of:

(i) Hydrazine N_2H_4 from N_2 and H_2
(ii)Ethene (C_2H_4) given $\Delta H_{comb} = -1323$ kJ/mol [8 marks]

Question 2 (14 marks)

(a) Consider the reaction below to answer the following questions.



(i) Write the complete stepwise mechanism for this reaction. Clearly show the formation of both products. Show all electron flow with arrows and draw all intermediate structures.
[4 marks]

(ii) Write the rate law equation that reaction obeys. [1 mark]

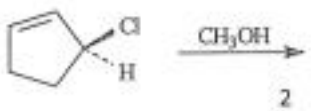
(b) Consider the S_N1 reaction of tert-butyl chloride with iodide ion:

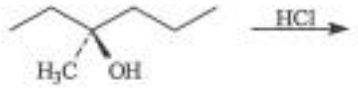
$$(CH_3)_3C\text{-}Cl + I^- \longrightarrow (CH_3)_3C\,I + Cl^-$$

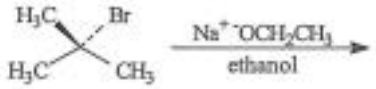
What would be the predicted effect in the formation of tert-butyl iodide if the concentration of iodide ion is doubled?
[3 marks]

(c) Draw the structure of the major organic products(s) for each of the following reactions. Indicate the stereochemistry for each reaction when appropriate.

(i) 

(ii) 

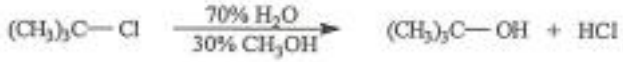
(iii) 

(iv) 

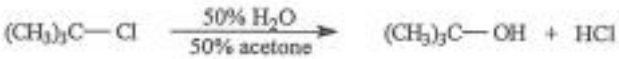
(6 marks)

QUESTION 3 (14 marks)

(a) Consider the pair of reactions below to answer the following questions.

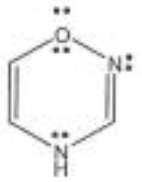
A. 

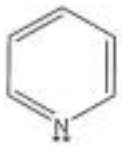
or

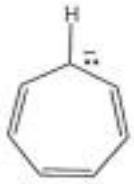
B. 

(i) Which reaction above is faster? [1 mark]
(ii) Explain your answer to the question above [3 marks]
(iii) State the mechanism and kinetics of these reactions are: [2 marks]

(b) Classify each molecule or ion as aromatic, antiaromatic or nonaromatic. Give the number of pi electrons in each case:

(i) 

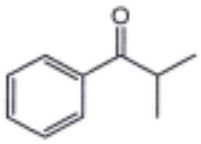
(ii) 

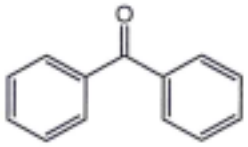
(iii) 

[3 marks]

(c) Draw the orbital picture of the molecule in C (ii) above. [2 marks]

(d) (i) Draw the carboxylic acid chloride that might be used in a Friedel-Crafts reaction to prepare each of the following acylbenzenes:

I 

II 

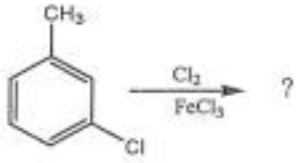
[2 marks]

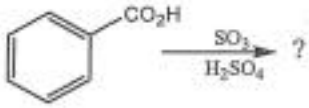
(ii) Expain why Friedel-Crafts alkylations often give polysubstitution but Friedel-Crafts acylations do not.

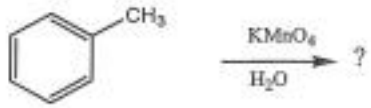
[1 marks]

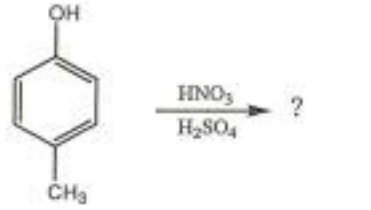
QUESTION 4 (14 marks)

(a) Compete the following reactions by drawing the structure(s) of the major products:

(i) 

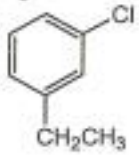
(ii) 

(iii) 

(iv) 

[5 marks]

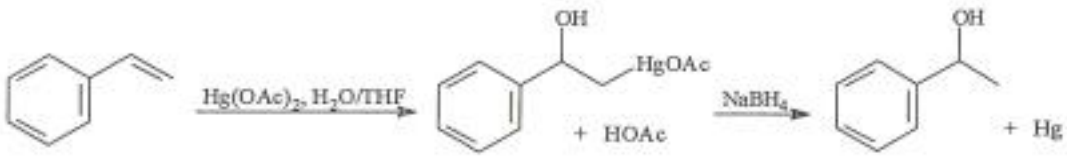
(b) Propose how you would synthesize *m*-chloroethylbenzene from benzene.



m-Chloroethylbenzene

[4 marks]

(c) Consider the reaction sequence below to answer the following questions:



(i) Write the complete reaction mechanism for the first step of this reaction sequence. Show all electron flow with arrows and show all intermediate structures. [3 marks]

(ii) Name the intermediate in the first step of this reaction sequence. [1 mark]

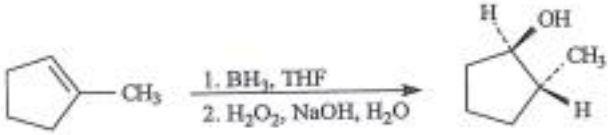
(iii) In the second step of this reaction sequence, the organomercury compound is treated with sodium borohydride, $NaBH_4$, to yield the alcohol product. This replacement of a carbon-mercury bond with a carbon-hydrogen bond is termed.

[1 mark]

Question 5 [14 marks]

(a) Consider the reaction below to answer the following questions:

Alkenes may be hydrated by the hydroboration/oxidation procedure shown.



(i) Draw structure of the intermediate formed in the first step of this reaction. [1 mark]

(ii) Name the type of reaction that hydroboration of alkenes represent

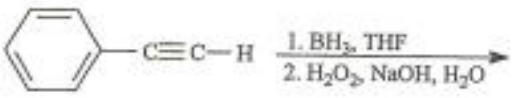
[1 mark]

(iii) What stereochemistry does the hydroboration/oxidation of alkenes occur with? [1 mark]

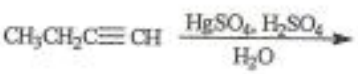
(iv) What type of regiochemistry does hydroboration/oxidation of alkenes represent? [1 mark]

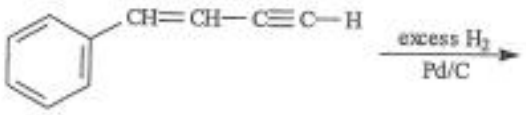
(b) Predict the product of each reaction below. Be sure to indicate stereochemistry when appropriate.

(i). $CH_3CH_2-C\equiv C-CH_3 \xrightarrow[\text{Lindlar catalyst}]{D_2}$

(ii) 

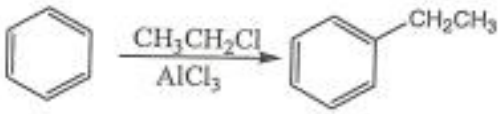
(iii) 

(iv) 

(v) 

[5 marks]

(c) Consider the Friedel-Crafts alkylation reaction below to answer the following questions:



(i) Draw the structure of the electrophilic intermediate in this reaction. [1 mark]

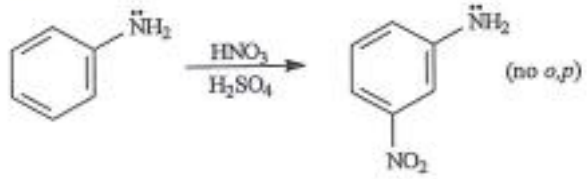
(ii) What is the role of the $AlCl_3$ in the reaction? [1 mark]

(iii) Write the stepwise mechanism for this reaction. Show all electron flow using curly arrows and include all intermediates. [3 marks]

Question 6 [14 marks]

(a) Consider the data below to answer the following questions:

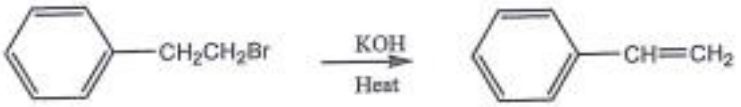
The -NH_2 group is considered as a strong *ortho, para*-directing activator in electrophilic aromatic substitution reactions. However, when aniline is subjected to standard nitration conditions, poor yields of *m*-nitroaniline result.



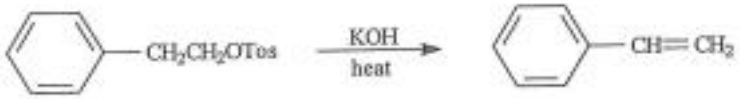
Draw all the resonance forms of aniline showing the electron-donating effect of the –NH_2 substituent.

[4 marks]

(b) Consider the pair of reactions below to answer the following questions:

A. 

or

B. 

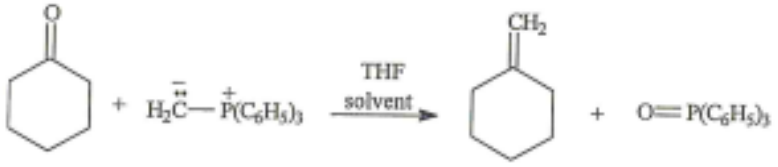
(i) Which reaction above is faster [1 mark]

(ii) Explain your answer to question 6b (i) above. [2 marks]

(iii) Suppose the concentration of potassium hydroxide is doubled what would happen the reactions. [2 marks]

(c)

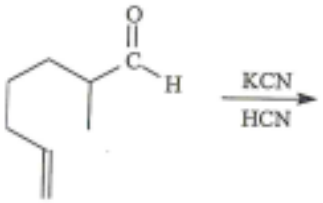
(i) In the Wittig reaction, a phosphorus ylide adds to a ketone or aldehyde to yield an alkene. Write the complete stepwise mechanism for the Wittig reaction shown below. Show all intermediate structures and all electron flow with arrows.



[3 marks]

(ii). Give the major organic product(s) for each of the following reactions or sequences of reactions. Show all relevant stereochemistry.

I



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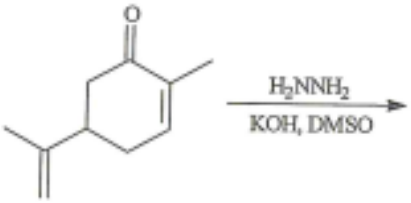

[2 marks]