CCHE 4272 FIRST PUBLIC EXAMINATION

Preliminary Examination in Chemistry

SUBJECT 2: ORGANIC CHEMISTRY

Trinity Term 2010

Tuesday, 8 June 2010, 9.30 a.m.-12.30 p.m.

Time allowed **3 hours**

CANDIDATES SHOULD ANSWER FIVE QUESTIONS, AT LEAST ONE OF WHICH MUST BE CHOSEN FROM SECTION B

The numbers in square brackets **[x]** indicate marks that the examiners normally expect to assign to each part of the question.

Use a separate booklet for each question.

The following abbreviations may be used:
Me = CH_3; Et = C_2H_5; Pr = C_3H_7; *i*-Pr = Me_2CH; Bu = $CH_3CH_2CH_2CH_2$; *t*-Bu = Me_3C; Ph = C_6H_5; Ts = *p*-$MeC_6H_4SO_2$; eq. = equivalent(s); cat. = catalytic; ∿∿∿ = mixture of stereisomers; aq. = aqueous.

Assume reactions are carried out at ambient temperature and are worked up with a proton source unless otherwise indicated.

In section A, all formulae depicting chiral molecules refer to racemic mixtures unless a single enantiomer is explicitly specified.

In section B, all formulae depicting chiral molecules refer to a single enantiomer unless otherwise stated.

DO NOT TURN OVER THE FIRST PAGE UNTIL INSTRUCTED TO DO SO.

SECTION A

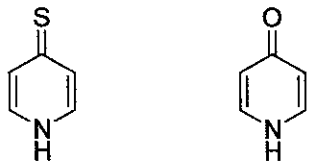
1. Answer Parts I, II and III.

Part I.

For ***three*** of the following pairs *explain* which member is more acidic. **[3 × 3]**

a) 

b) 

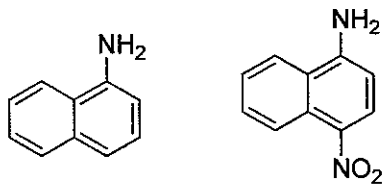
c) 

d) 

Part II.

For ***three*** of the following pairs *explain* which member is more basic. **[3 × 3]**

a) 

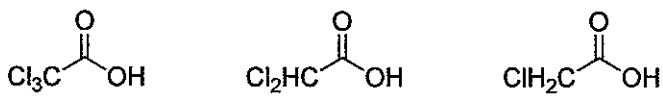
b) 

c) 

d) $EtNH_2$ MeCN

Part III.

Rationalise the difference between the pK_a values (in water) of the three chloroacetic acids shown below. **[2]**

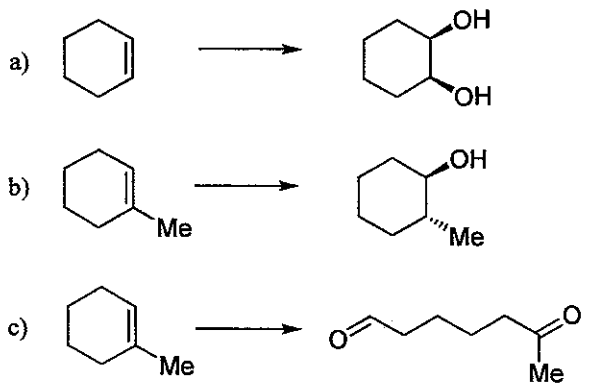


CCHE 4272

2. Answer Parts I, II and III.

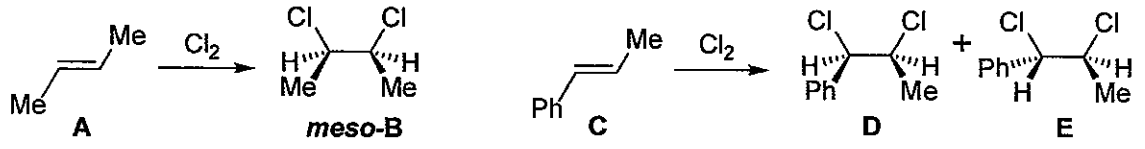
Part I.

Suggest reagents and provide mechanisms for **TWO** of the following transformations. **[6]**



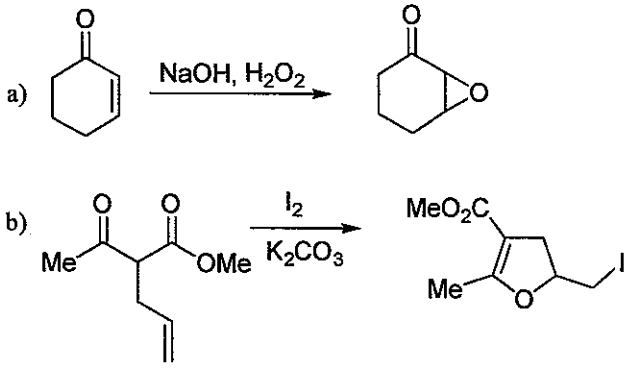
Part II.

Explain why reaction of compound **A** with chlorine only gives a single product **B**, which is *meso*-, and yet compound **C** gives a mixture of **D** and **E** as products. Illustrate your answers using three dimensional drawings. **[6]**



Part III.

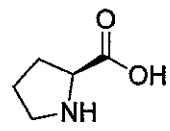
Provide mechanisms for ***both*** of the following reactions. **[2 × 4]**

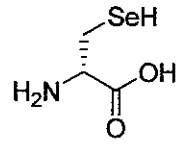


3. Answer Parts I, II and III.

Part I.

Using the Cahn-Ingold-Prelog system, assign absolute stereochemical descriptors to ***both*** of the following compounds. **[5]**

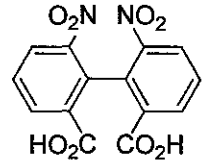
a) 

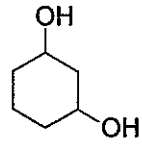
b) 

Part II.

Draw all stereoisomers for ***all*** of the following compounds and indicate what type of stereoisomerism is involved. **[11]**

a) Cl–CH=C=CH–Cl

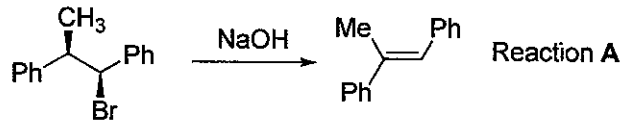
b) 

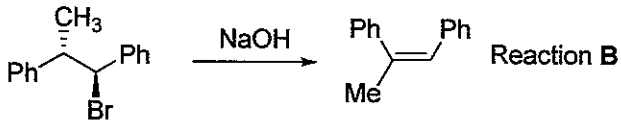
c) 

d) Me–CH=CH–Me

Part III.

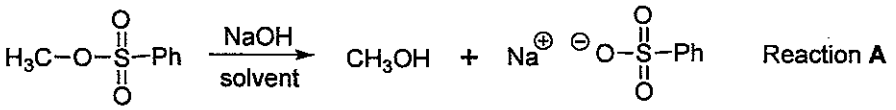
Explain why reaction **A** proceeds more rapidly than reaction **B**. **[4]**

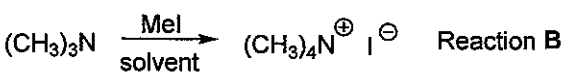




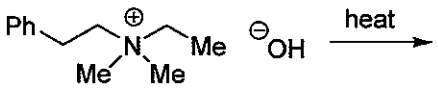
4. Answer FIVE Parts of this question. **[5 × 4]**

a) Explain why an increase in solvent polarity causes a decrease in the rate of reaction **A** but the opposite effect is observed for the rate of reaction **B**.

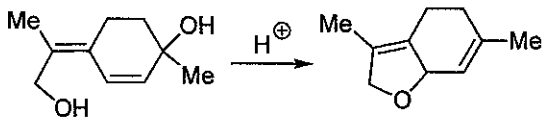




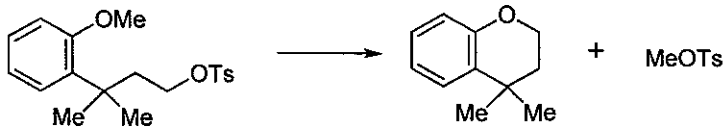
b) Predict, and rationalize mechanistically, the outcome of the following reaction.



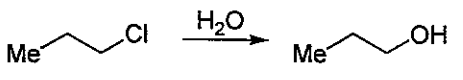
c) Give a mechanism for the following reaction.



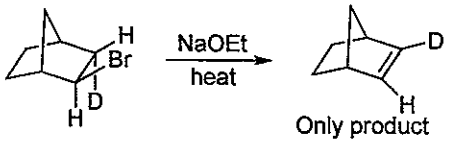
d) Suggest a mechanism for the following reaction.



e) Explain the difference in nucleophilic substitution rates for the following reaction under different conditions (with and without sodium iodide).

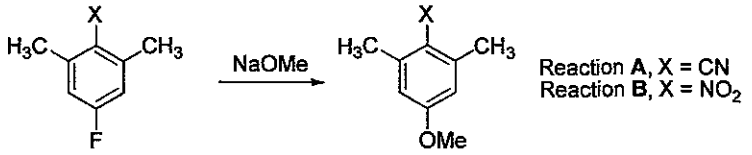


f) Give a mechanistic explanation for the following reaction.

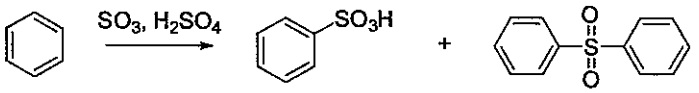


5. Answer FIVE Parts of this question. **[5 × 4]**

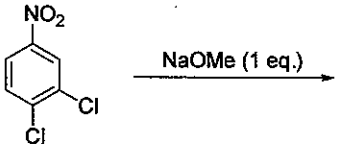
a) Explain why reaction **A** proceeds more rapidly than reaction **B**.



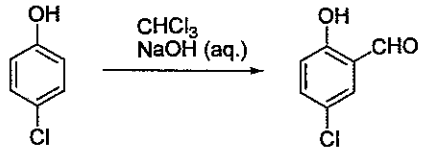
b) Use a mechanistic rationale to explain the formation of ***both*** products in the reaction below.



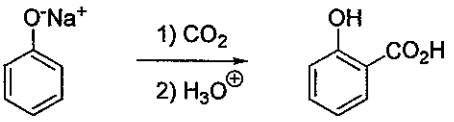
c) Predict mechanistically the outcome of the following reaction.



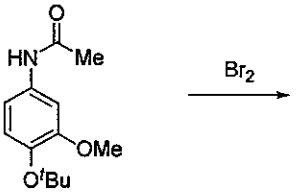
d) Give a mechanism for the reaction below.



e) Give a mechanism for the reaction below.

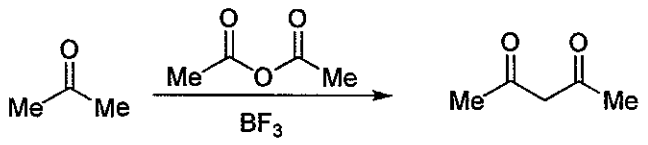


f) Give a mechanism for the reaction below and hence predict the structure of the major product.

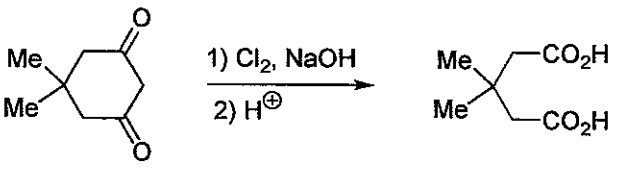


6. Suggest mechanisms for **FIVE** of the reactions shown below. **[5 × 4]**

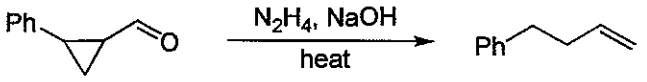
a)



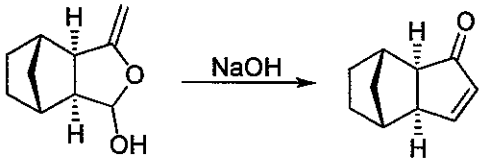
b)



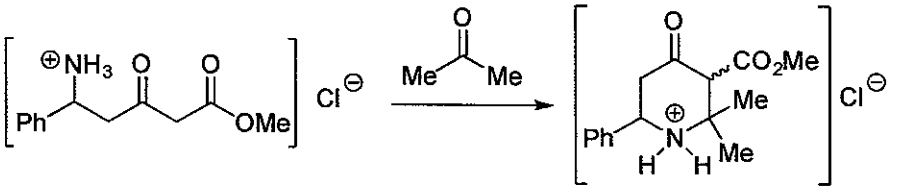
c)



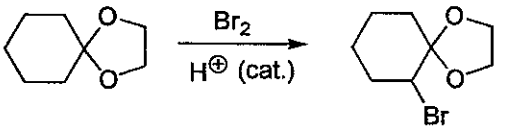
d)



e)

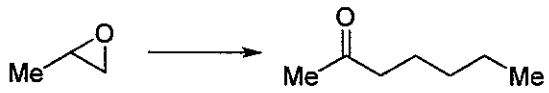


f)

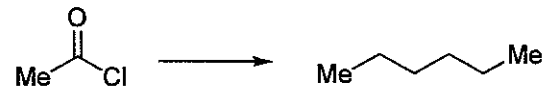


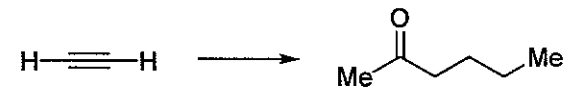
7. Suggest possible conditions and reagents for **FIVE** of the following transformations. More than one step may be necessary for each transformation and mechanisms are **not** required. **[5 x 4]**

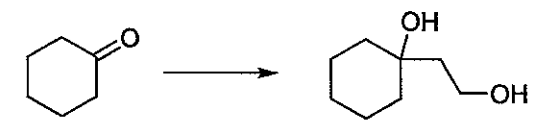
a) 

b) 

c) 

d) 

e) 

f) 

END OF SECTION A

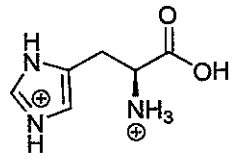
SECTION B

8. Answer all Parts of this question.

Part I.

a) Assign the following p*Ka* values to the functional groups in histidine and provide justifications for your assignments. **[6]**

p*Ka* values: 1.8; 6.0; 9.2 (in water)

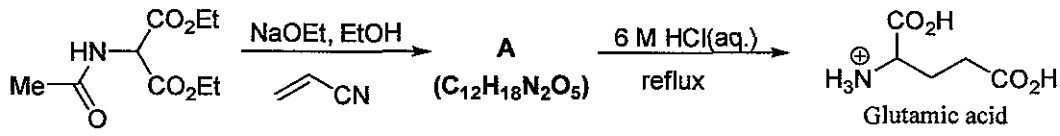


Histidine

b) Calculate the isoelectric point of histidine. **[2]**

Part II.

Answer ***ALL*** of the following questions relating to the synthesis of glutamic acid, shown below.

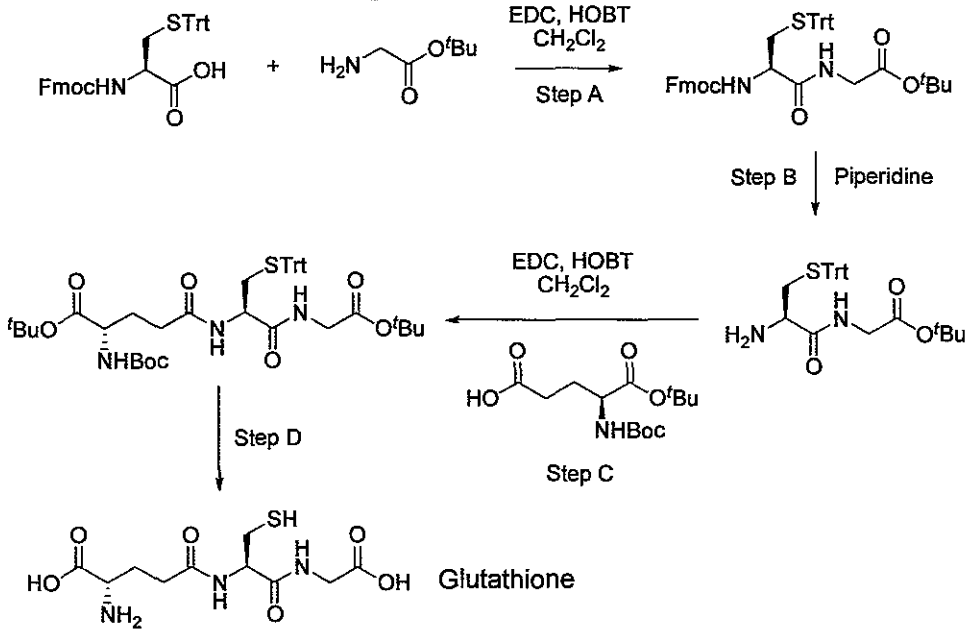


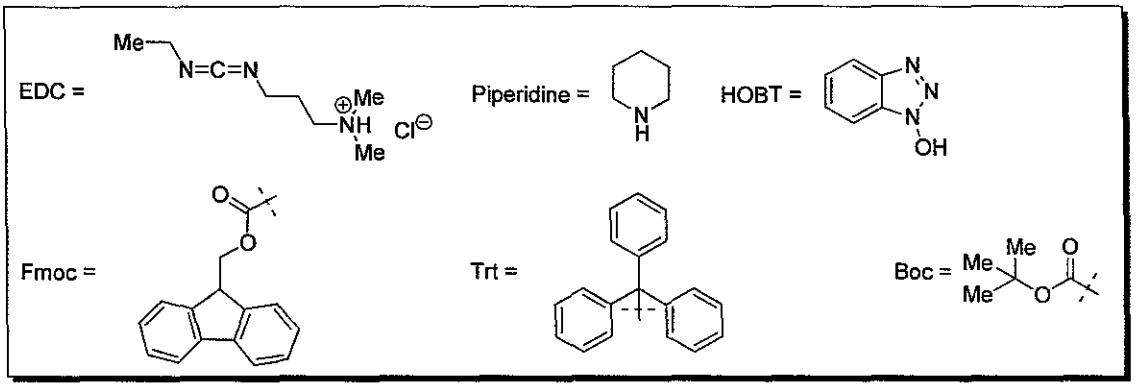
Glutamic acid

a) Give the structure of compound **A** and provide a mechanism for its formation. **[4]**

b) Provide mechanisms for all the steps in the conversion of compound **A** to glutamic acid. **[8]**

9. Answer All Parts of this question.





A synthesis of the naturally occurring peptide glutathione is shown above.

a) Give a mechanism for Step A. **[6]**

b) Give a mechanism for Step B and explain why the Fmoc and ^{t}Bu is a suitable protecting group combination for this situation. **[5]**

c) Suggest reagents for Step D and give a mechanism for the removal of one protecting group (either Trt, Boc or ^{t}Bu). **[4]**

d) Explain, briefly, why the inclusion of HOBT is important in amide bond formation for peptide syntheses such as the one shown above. **[2]**

e) With reference to the functional groups in glutathione, suggest possible biological actions for this molecule. **[3]**

Last Page