# THE COLLEGE OF THE BAHAMAS

## EXAMINATION

SEMESTER 04-2001

## FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

**DATE AND TIME OF EXAMINATION**: Wednesday, December 5, 2001 at 12 noon
**DURATION:** 3 HOURS

COURSE NUMBER: CHEM 230

COURSE TITLE: ORGANIC CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME:

**INSTRUCTIONS TO CANDIDATES**: This paper has 12 pages and 30 questions. Please follow the instructions given.

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NASSAU: [X] FREEPORT:

*DEPARTMENT OF CHEMISTRY*
*FINAL EXAMINATION FOR SEMESTER 042001, 2001*
*COURSE NUMBER: 230*
*COURSE TITLE: ORGANIC CHEMISTRY*

DATE AND TIME: DURATION: 3 HOURS

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*INSTRUCTIONS TO CANDIDATES*: The exam paper consists of 12 pages **exclusive** of this introductory page. Section A consists of TWENTY-FIVE Multiple Choice Questions. These questions are to be answered on the Multiple-Choice answer sheet provided. Section B consists of FIVE short answer questions. These questions are to be answered in the spaces provided on this question paper.

YOU MUST RETURN THE EXAMINATION PAPER AND YOUR MULTIPLE CHOICE ANSWER SHEET AT THE END OF THE EXAMINATION .

**LECTURER'S NAME:** .....

**STUDENT NAME:** .....

**STUDENT NUMBER:** .....

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CHEMISTRY DEPARTMENT
C230FIN prepared by NN:
LaTeX2e typeset by GLH:

## *SECTION A: MULTIPLE CHOICE QUESTIONS*

Answer *all* questions in this section. Five possible answers **A, B, C, D, E** are given for each of the twenty-five questions in this section. Choose the one you consider to be correct, then shade the letter corresponding to this answer on the multiple choice answer sheet provided. Each question in this section is worth one mark, for a total of 25 marks.

***QUESTIONS 1-6*** refer to the following types of reaction:

**A** Electrophilic addition
**B** Nucleophilic addition
**C** Electrophilic substitution
**D** Nucleophilic substitution
**E** Free radical substitution

Select from **A** to **E** the type of reaction which takes place when

**1** toluene is chlorinated to p-chlorotoulene

**2** toluene is chlorinated to (chloromethyl)toluene

**3** propene is chlorinated to 1,2-dichloropropane

**4** propane is chlorinated to 2-chloropropane

**5** propanal reacts with hydrogen cyanide to form 2-hydroxypropanenitrile

**6** iodoethane reacts with sodium ethoxide to form ethoxyethane.

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***QUESTIONS 7-12*** refer to the following types of reaction:

**A** Redox
**B** Elimination
**C** Hydration
**D** Condensation
**E** Decarboxylation

Select from **A** to **E** the best classification for the formation of

**7** cyclohexene from cyclohexanol

**8** cyclohexanol from cyclohexene

**9** benzoic acid from toulene

**10** ethyl propanoate from ethanol and propanoic acid

**11** propane-1,2-diol from propene

**12** propanone from 2-propanol

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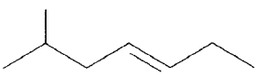
13 The correct IUPAC name for the compound



is

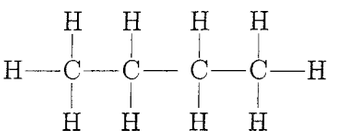
**A** 2-methylheptane
**B** 6-methylheptane
**C** 3-octene
**D** 2-methyl-4-heptene
**E** 6-methyl-3-heptene

14 An alkene produced a compound X of molecular formula $C_2H_4O$ as the only organic product of ozonolysis. Which is X?

**A** $CH_2{=}CH_2$
**B** $CH_3CH_2CH{=}CH_2$
**C** $CH_3CH{=}CHCH_3$
**D** $(CH_3)_2C{=}CH_2$
**E** $CH_3CH{=}CHCH_2CH_3$

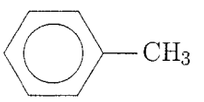
15 Which molecule contains at least one **sp** hybridized carbon atom?

**A**

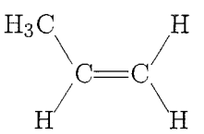


**B**

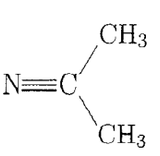
**C**



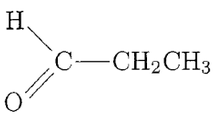
**D**

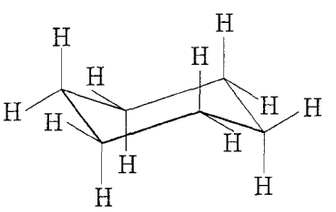


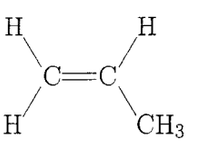
**E**

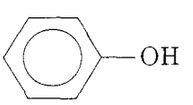


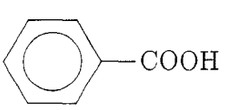
16 Which molecule has *all* of its atoms $sp^3$ hybridized?

A 

B 

C 

D 

E 

17 Which group, when attached to the benzene ring, deactivates the ring towards electrophiles and directs incoming electrophiles to the ortho- and para- positions?

A — OH
B — COOH
C — $NO_2$
D — Cl
E — $CH_3$

18 Which reagent reacts by addition with the $> C = O$ group in aldehydes and ketones and also with the $> C = C <$ group in alkenes?

A bromine
B hydrogen
C hydrogen bromide
D concentrated sulphuric acid
E water

**19** Which pair of compounds is given in order of *decreasing* boiling point

**A** $CH_3OCH_3 > CH_3CH_2OH$
**B** $CH_3COOCH_3 > CH_3CH_2COOH$
**C** $CH_3CH_2CH_3 > CH_3CH_2CH_2Cl$
**D** $CH_3CH_2CH_2CH_2CH_3 > (CH_3)_4C$
**E** $CH_3CH_2OH > CH_2(OH)CH_2(OH)$

**20** Which set of compounds is given in order of *decreasing* acid strength

**A** $CCl_3COOH > CHCl_2COOH > CH_2ClCOOH$
**B** $CH_3COOH > CH_2ClCOOH > CHCl_2COOH$
**C** $CH_3CH_2OH > CH_3CHO > CH_3COOH$
**D** $CH_3COCH_3 > CH_3CHO > CH_3CH_2OH$
**E** $CH_3COOH > CH_2FCOOH > CH_2ClCOOH$

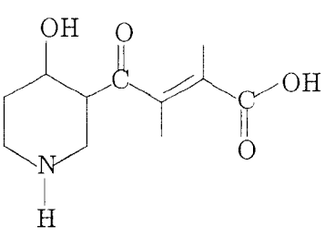
**21** Which substance undergoes hydrolysis most readily?

**A** $CH_3COOCH_3$
**B** $CH_3COOCOCH_3$
**C** $CH_3COCl$
**D** $CH_3CONH_2$
**E** $CH_3CONHCH_3$

**22** Which reagent will *not* convert ethanol to chloroethane?

**A** $PCl_5$
**B** $PCl_3$
**C** $SOCl_2$
**D** HCl
**E** $Cl_2$

**23** Which functional group is *not* present in the compound

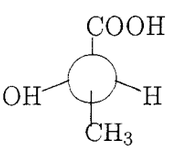



**A** alkene
**B** ketone
**C** alcohol
**D** amide
**E** carboxylic acid

24 With which reagent will propanal and propanone react in a similar fashion?

A Tollen's reagent
B 2,4-dinitrophenylhydrazine
C Fehling's solution
D Benedict's solution
E acidified potassium permanganate

25 The relationship between

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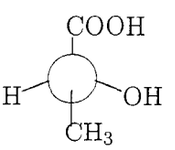



is

A functional group isomers
B geometric isomers
C enantiomers
D positional isomers
E tautomers

## *SECTION B: SHORT ANSWER QUESTIONS*

Answer ***ALL OF THE FOLLOWING FIVE QUESTIONS*** in the space provided on your question paper.

1 When toluene ($C_6H_5CH_3$) reacts with chlorine in the presence of ultra-violet light it does so in a similar fashion to methane. Write an equation for the production of the monochloroderivative of toluene and give the mechanism for the reaction. (5 MARKS)

**2** The following is a list of carbonyl compounds, each of which is indicated by a capital letter.

**A** $CH_3CH_2CHO$
**B** $CH_3COCH_3$
**C** $C_2H_5COC_2H_5$
**D** $C_6H_5CHO$
**E** $C_6H_5COCH_3$

(a) Which two compounds are structural isomers? (2 MARKS)

(b) Which compound has all of its carbon atoms $\mathbf{sp^2}$ hybridized? (1 MARK)

(c) Which compound is planar? (1 MARK)

(d) Give the structural formulae and IUPAC names of *two* ketones which isomeric with **C**. (2 MARKS)

(e) Give the structural formulae of *four* aldehydes which are isomeric with **E**. (4 MARKS)

(f) i. Write an equation for the conversion of benzene to **E**. (2 MARKS)

ii. Discuss the mechanism of the reaction. (4 MARKS)

(g) Give one chemical test to distinguish between each pair of compounds. State the expected results in each case. (4 MARKS)

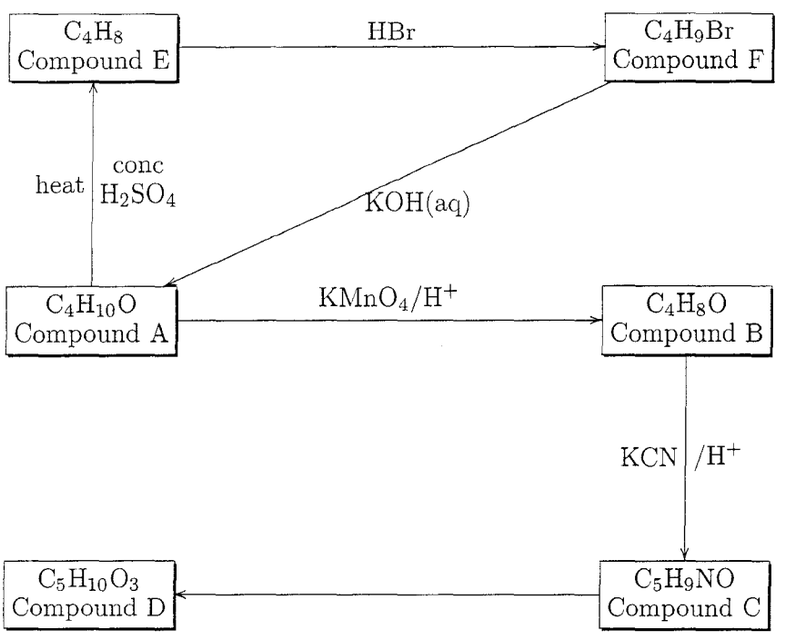
i. **A** and **B**

ii. **B** and **C**

(h) **D** undergoes a *disproportionation* reaction with sodium hydroxide. Write an equation for the reaction and explain the meaning of the term *"disproportionation"* as applied to this reaction. (2 MARKS)

(i) Outline a reaction scheme for the conversion of 2-chloropropane to **B**. (2 MARKS)

**3** Consider the following reaction scheme.




(a) i. Compound **A** is an alcohol. Give the structural formulae and IUPAC names of *four* alcohols with molecular formula $C_4H_{10}O$. (4 MARKS)

ii. Which of these isomers is optically active? (1 MARK)

iii. Compound **A** is a secondary alcohol. What is the structural formula of **A**? (1 MARK)

iv. Which isomer of **A** will *not* decolourize acidified potassium permanganate? (1 MARK)

(b) Deduce the structural formula of the compounds **B** to **F**. Where there is a possiblity of two or more structural isomers formed in any step, give the structural formula of the **major** product. (5 MARKS)

**B**

**C**

**D**

**E**

**F**

(c) Write the structural formula of two isomers of **A** which are not alcohols. (2 MARKS)

(d) Assuming that the conversion of **A** to **E** occurs by a second order, bimolecular reaction propose a mechanism for the reaction. (4 MARKS)

(e) i. Assuming the conversion of **F** to **A** occurs by a first order, unimolecular reaction propose a mechanism for the reaction. (4 MARKS)

ii. By reference to the intermediate formed in the rate determining step, explain why this first order reaction results in the formation of a racemic mixture of **A**. (2 MARKS)

**4** Give an explanation for **three** of the following observations.

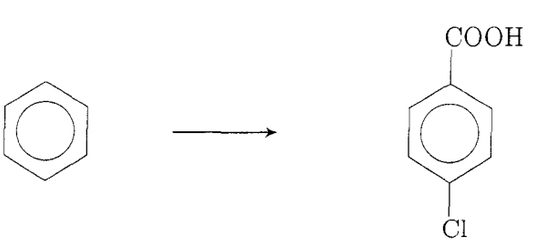
(a) Benzoic acid is a stronger acid than phenol which is a stronger acid than cyclohexanol. (4 MARKS)

(b) The major product of bromination of nitrobenzene is m-bromonitrobenzene rather than p-bromonitrobenzene. (4 MARKS)

(c) In the addition of hydrogen iodide to 1-butene, the major product is 2-iodobutane rather than 1-iodobutane.(4 MARKS)

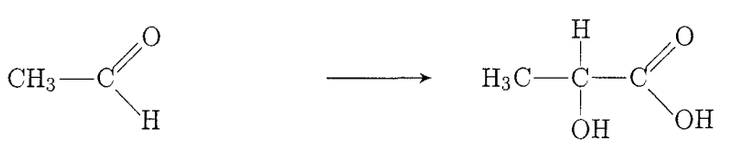
(d) Ethylamine is a stronger base than ammonia, but ethanamide is a weaker base than ammonia. (4 MARKS)

**5** Give the reaction scheme for **three** of the following conversions.(6 MARKS)

(a) 

(b) 


(c) $CH_3CH_2CH_2{-}OH \longrightarrow CH_3CH_2{-}NH_2$

(d) 


(e)