THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 01-2006

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

X NASSAU
☐ FREEPORT
☐ EXUMA
☐ ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, April 18, 2006 at 7:00 p.m.
DURATION: 3 HOURS

COURSE NUMBER: Chemistry 230

COURSE TITLE: Organic Chemistry I

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME: Dr. D. Davis

INSTRUCTIONS TO CANDIDATES:

This examination paper consists of 15 questions on 8 pages (excluding this instruction page). Answer ALL questions in the spaces provided on the examination paper.

Only handheld calculators are allowed during this examination. The use of any other electronic device, *e.g.*, cellular phone or PDA, is strictly prohibited for the duration of this examination.

PERIODIC TABLE OF THE ELEMENTS

I	II											III	IV	V	VI	VII	0
1 H hydrogen 1·0																	2 He helium 4·0
3 Li lithium 6·9	4 Be beryllium 9·0											5 B boron 10·8	6 C carbon 12·0	7 N nitrogen 14·0	8 O oxygen 16·0	9 F fluorine 19·0	10 Ne neon 20·2
11 Na sodium 23·0	12 Mg magnesium 24·3											13 Al aluminium 27·0	14 Si silicon 28·1	15 P phosphorus 31·0	16 S sulfur 32·1	17 Cl chlorine 35·5	18 Ar argon 39·9
19 K potassium 39·1	20 Ca calcium 40·1	21 Sc scandium 45·0	22 Ti titanium 47·9	23 V vanadium 50·9	24 Cr chromium 52·0	25 Mn manganese 54·9	26 Fe iron 55·8	27 Co cobalt 58·9	28 Ni nickel 58·7	29 Cu copper 63·5	30 Zn zinc 65·4	31 Ga galium 69·7	32 Ge germanium 72·6	33 As arsenic 74·9	34 Se selenium 79·0	35 Br bromine 79·9	36 Kr krypton 83·8
37 Rb rubidium 85·5	38 Sr srontium 87·6	39 Y yttrium 88·9	40 Zr zirconium 91·2	41 Nb niobium 92·9	42 Mo molybdenum 95·9	43 Tc technetium 98·9	44 Ru ruthenium 101·1	45 Rh rhodium 102·9	46 Pd paladium 106·4	47 Ag silver 107·9	48 Cd cadmium 112·4	49 In indium 114·8	50 Sn tin 118·7	51 Sb antimony 121·8	52 Te tellurium 127·6	53 I iodine 126·9	54 Xe xenon 131·3
55 Cs cesium 132·9	56 Ba barium 137·3	57 La lanthanum 138·9	72 Hf hafnium 178·5	73 Ta tantalum 180·9	74 W tungsten 183·85	75 Re rhenium 186·2	76 Os osmium 190·2	77 Ir iridium 192·2	78 Pt platinum 195·1	79 Au gold 197·0	80 Hg mercury 200·6	81 Tl thallium 204·4	82 Pb lead 207·2	83 Bi bismuth 209·0	84 Po pollonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89 Ac actinium															

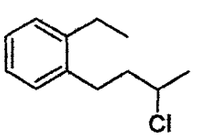
58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 Pm promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium	71 Lu lutetium
90 Th thorium	91 Pa protoactinium	92 U uranium	93 Np neptunium	94 Pu plutonium	95 Am americium	06 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

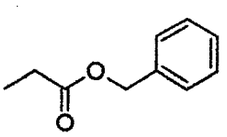
1. Draw the complete Lewis structure for the following molecules. Remember to show all non-bonding electrons.

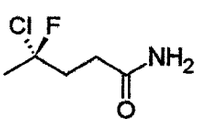
   (a) CH_3OCH_3 (b) BH_3 (c) CH_2N_2

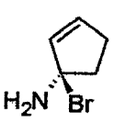
[6 marks]

2. Give systemic names including stereochemical designations (*R, S, cis* or *trans*) when required for the following molecules:

(a) 

(b) 

(c) 

(d) 

[8 marks]

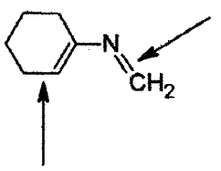
3. Draw the chemical structure showing stereochemical designations (*R, S, cis* or *trans*) where required for the following:

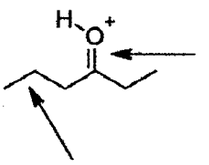
   (a) 3-chloro-5-methylbenzenesulfonic acid (b) (4*R*,5*R*)-4-hexyl-5-nitrocyclohexene

   (c) 4-(1-hydroxypropyl)benzoic acid (d) (3*R*,4*S*)-3-floro-4-aminopentanal

[8 marks]

4. Clearly indicate the type of bond AND the orbitals involved in the formation of the indicated bonds in the following molecules.

(a) 

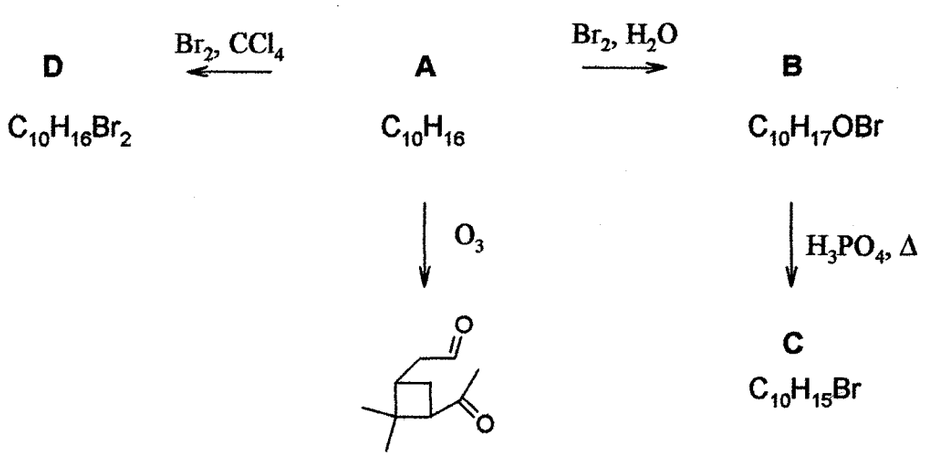
(b) 

[5 marks]

5. The reaction shown below involves a special type of alkyl group shift called a ring expansion. Draw a step by step curved arrow mechanism that accounts for the formation of the products shown in reaction below.

[6 marks]

6. Draw the structures of the molecules (**A-D**) in the scheme below:

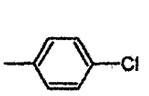
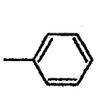


[8 marks]

7. In each case below assign priority numbers to the groups. Let the number **4** represent the group of lowest priority and the number **1** represent the group of highest priority.

(a) -COOH $-CH_2NH_2$ $-CH_2NHCH_3$ $-CH_2$-OH

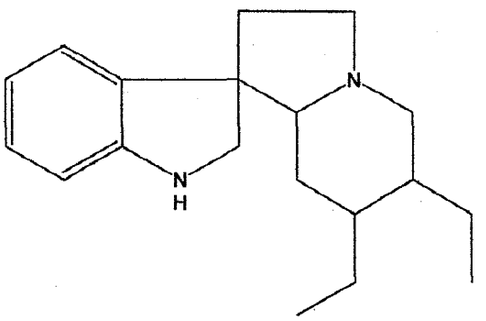
(b) $-Si(CH_3)_3$ $-Si(OCH_3)_3$ $-Si(OH)_3$ -OH

(c)   $-CH=CHCH_3$ $-CH_2$-O-CH_3

(d) -OH $-SO_3H$ -SH -SeH

[8 marks]

8. (a) Mark each stereocenter (chirality center) in the following molecule with an asterisk. Ensure that your asterisks are not ambiguously placed. You will lose 0.25 marks for each incorrectly labeled carbon.



(b) What is the maximum number of stereoisomers for this molecule?

[5 marks]

9. When a sample of (*2S,4R*)-2-chloro-4-methylhexane is hydrolyzed under S_N2 conditions the product is (*2S,4S*)-2-hydroxy-4-methylhexane. When (4*R*)-4-methyl-1-hexene treated with aqueous acid a mixture of 2-hydroxy-4-methylhexane diastereomers is obtained.

(a) Draw the structure (or give the name) of the enantionmer of the product obtained from the hydrolysis of (*2S,4R*)-2-chloro-4-methylhexane.

(b) Draw the structure (or give the name) of one diastereomer of the product obtained from the hydrolysis of (*2S,4R*)-2-chloro-4-methylhexane.

(c) Why was a mixture of diastereomers obtained when (4*R*)-4-methyl-1-hexene was treated with aqueous acid, *i.e.* why wasn't a single isomer isolated as in the other reaction.

[4 marks]

10. The specific rotation of *S*-proline is -85.0°. The observed rotation of a mixture of *S*-proline and its enantiomer was determined to be -65.5°.

    a. What enantiomer is in excess in the sample?

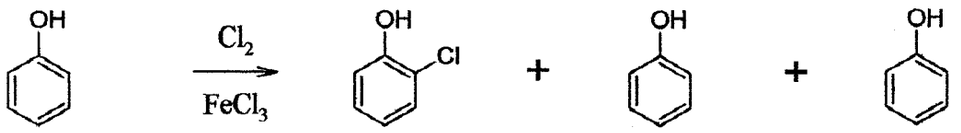
    b. What is the enantiomeric excess (%ee) of the mixture?

    c. What percentage of the mixture is *S*-proline?

    d. What percentage of the mixture is *R*-proline?

[6 marks]

11. The reaction shown below is a typical electrophilic aromatic substation reaction.
    (a) Explain (using curved arrow mechanisms) the formation of the products given below. Ensure that your mechanism accounts for the formation of the electrophile and all of the products.



E **F** **G**

(b) Estimate the percentage of each product formed. Give a reason for your estimations.

[6 marks]

12. The H-N-H bond angle in NH_3 is smaller than the H-N-H bond angle in NH_4^+. Explain the difference in bond angle in these two species.

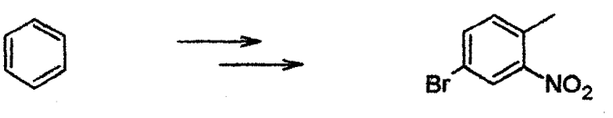
[4 marks]

13. The methyl cation and the methyl anion have similar chemical structures but different shapes. Predict AND explain the shapes of these two molecules.

[4 marks]

14. Provide a reaction scheme to show the preparation of the following compounds starting from benzene. Mechanisms are NOT required.

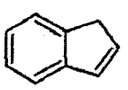
(a) 

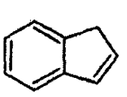
(b) 

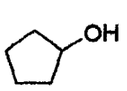
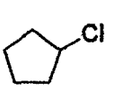
[6 marks]

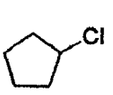
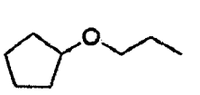
15. Draw structures, showing stereochemistry when relevant, for the reactant(s)/major product to complete the following reactions. Mechanisms of the reactions and names of the structures are NOT required.

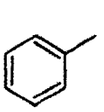
(a)  + HBr ⟶

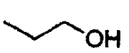
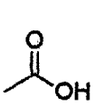
(b)  $\xrightarrow[\text{heat}]{KMnO_4}$

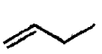
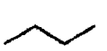
(c)  $\xrightarrow[\text{cold}]{KMnO_4}$

(d)  ⟶ 

(e)  ⟶ 

(f)  $\xrightarrow[\text{hν or heat}]{Cl_2}$

(g)  +  $\xrightarrow{\text{acid}}$

(h)  ⟶ 

[16 marks]

******** End of Examination ********