CHEM 222 - ORGANIC CHEMISTRY II
MIDTERM EXAMINATION

INSTRUCTIONS: ***PLEASE READ THIS PAGE WHILE WAITING TO START YOUR EXAM.***

This test paper includes 4 pages (both sides) including a periodic table with electronegativities and a page of potentially useful information. Check that your paper is complete. You can remove the last page if you wish. Model kits and calculators are permitted; cell phones and electronic dictionaries are not allowed. You have 70 minutes to complete the test. Read through the whole test quickly before starting. **GOOD LUCK.**

LAST NAME: _____ FIRST NAME: _____

STUDENT NUMBER: _____

Mark breakdown:

Page 2.	/ 13
Page 3.	/ 12
Page 4.	/ 6
Page 5.	/ 10
TOTAL:	/ 40 (maximum grade $^{41}/_{40}$)
PERCENT:	%
EARNED toward FINAL GRADE:	/ 15

1. **(6 marks) TRUE or FALSE? Circle T *or* F to describe the following statements.**

T / F If a substance appears green, it likely absorbs in the orange region of the spectrum.

T / F If a carbonyl absorption band appears in a substance's IR spectrum at <1700 cm^{-1}, it suggests that the C=O bond in the substance is somewhat stronger than the C=O in a typical ketone.

T / F Thiols are more acidic than alcohols because sulfur atoms are larger than oxygen atoms.

T / F Mass spectrometry allows us to determine the molecular weight and the mass of some fragments of a compound.

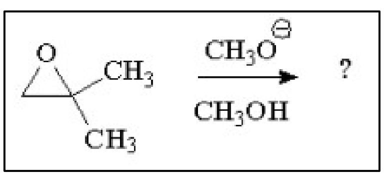
T / F The stronger the NMR spectrometer's magnet, the lower the energy of radio waves needed to cause protons to "flip" their spins.

T / F Grignard reagents are best prepared using a protic solvent such as ethanol.

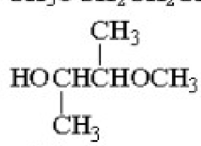
2. **(2 marks)** Which of the following reagents would be best to convert ethanol to chloroethane in one step?

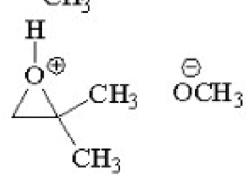
a) PCC
b) NaCl
c) TsCl
d) $SOCl_2$
e) Cl_2 / $h\nu$

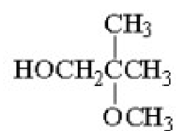
3. **(2 marks)** What is the product of the following reaction?

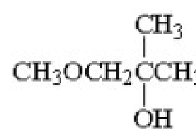


I. $CH_3OCH_2CH_2CH_2CH_2OH$

II. 

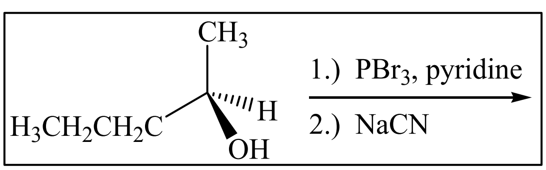
III. 

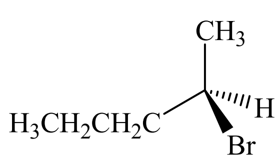
IV. 

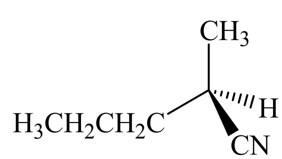
V. 

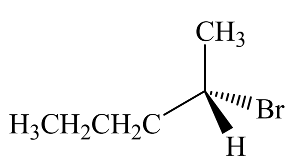
a) I
b) II
c) III
d) IV
e) V

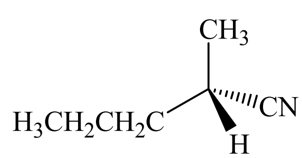
4. **(3 marks)** What is (are) the major product(s) from the following reaction sequence?



I. 

III. 

II. 

IV. 

a) I
b) II
c) III
d) IV
e) I and II
f) III and IV

 # 5. (2 marks) Which of the following is/are true about the mass spectrum of 1-bromobutane?

a) Peaks of approximately equal intensity are observed at m/z 136 and 138.
b) The major fragmentation occurs by cleavage of the C-Br bond.
c) The most intense peak occurs at m/z 43.
d) both a and b
e) both a and c
f) all of the above (a, b and c)

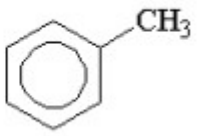
 # 6. (2 marks) What compound results when cyclopentanol undergoes oxidation with chromic acid?

a) cyclopentanone
b) cyclopentanal
c) cyclopentanoic acid
d) cyclopentene
e) 1,2-cyclopentanediol

 # 7. (2 marks) Which of the following methyl groups would be most deshielded in a ^{1}H NMR experiment?

a) I
b) II
c) III
d) IV
e) V

I. CH_3NH_2 IV. $CH_3CH_2CH_3$

II. CH_3OH V. 

III. CH_3CCH_3 (O)

 # 8. (2 marks) Which of the following compounds absorbs the longest wavelengths in the UV/Vis region?

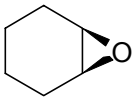
a) I
b) II
c) III
d) IV
f) V

I.  IV. 

II.  V. 

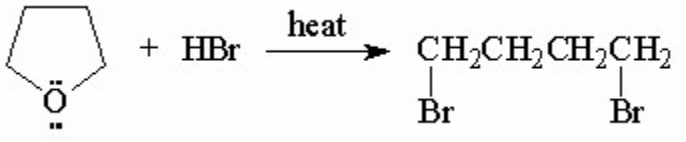
III. 

 # 9. (4 marks) Which of the following sequences of reactions would work best to convert cyclohexene oxide (shown at right) into propylcyclohexane?



a) (1) $CH_3C{\equiv}CNa$ (2) H_3O^+
b) (1) $CH_3CH_2CH_2MgBr$ (2) H_2SO_4, Δ (3) H_2, Pt
c) (1) H_3O^+ (2) $CH_3C{\equiv}CNa$
d) (1) $CH_3CH_2CH_2Li$ (2) HBr
e) (1) H_3PO_4, Δ (2) $CH_3CH_2CH_2MgBr$ (3) H_3O^+

 # 10. (6 Marks) Provide a step-by-step mechanism to explain how THF undergoes the following reaction in the presence of excess hydrogen bromide:



 # 11. (10 marks) Deduce the identity of the compound from the following experimental data. In the tables below, provide a point-form summary of the information you learned from each type of experimental data.

The compound has molecular formula $C_8H_{13}Br$, and it is one of the following five compounds:

a) $CH_3CHBrCCC(CH_3)_3$
b) $HCCCH_2C(CH_3)_2CH_2CH_2Br$
c) 3-bromo-1,2-dimethylcyclohexene
d) 4-bromo-1,2,4-trimethylcyclopentene
e) $BrCH_2CH_2CCC(CH_3)_3$

Data: IR (selected peak positions in cm^{-1}): 2950, 2150
^1H NMR (δ, multiplicity, integral): 3.5 (t, 2H), 1.8 (t, 2H), 0.9 (s, 9H)
^{13}C NMR: 6 signals

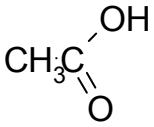
Formula	IR data	^{13}C NMR data

^1H NMR data

EXTRA SPACE FOR ROUGH WORK

POTENTIALLY USEFUL INFORMATION

TABLE OF pK_a VALUES

Compound	pK_a
$CH_3CH_2CH_2CH_3$	>51
CH_4	51
$H_2C{=}CH_2$	44
CH_3NH_2	40
NH_3	38
$HC{\equiv}CH$	25
$(CH_3)_3COH$	19
CH_3CH_2OH	17
CH_3OH	15.5
H_2O	15.7
RNH_3^+	9
H_2CO_3	6.4
	4.7
HF	3.2
$CH_3CH_2OH_2^+$	-2.4
H_2SO_4	-5.2
HCl	-7
HI	-9

SELECTED SPECTROSCOPIC DATA

Type of bond	Wavenumber (cm^{-1})
C≡N	2260–2220
C≡C	2260–2100
C=C	1680–1600
C=N	1650–1550
	~1600 and ~1500–1430
C=O	1780–1650
C—O	1250–1050
C—N	1230–1020
O—H (alcohol)	3650–3200
O—H (carboxylic acid)	3300–2500
N—H	3500–3300
C—H	3300–2700