ORGANIC CHEMISTRY I
MIDTERM TEST

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

This test paper includes 3 pages (both sides) plus a periodic table; some potentially useful information is given on the back of the periodic table. Check that your paper is complete. You can remove the periodic table if you wish. Calculators and model kits are permitted; cell phones and electronic dictionaries are not allowed. You have the whole class (75 minutes) to complete the test. Each page is worth 10 marks. Read through the whole test quickly before starting. **GOOD LUCK!**

LAST NAME: _____ FIRST NAME: _____

STUDENT NUMBER: _____

Mark breakdown:

Page 2.	/ 10
Page 3.	/ 10
Page 4.	/ 10
Page 5.	/ 10
TOTAL:	/ 40
PERCENT:	%
EARNED toward FINAL GRADE:	/ 15

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

T / F Propylamine is expected to have a higher boiling point than trimethylamine.

T / F $(CH_3)_3CBr$ is an example of a secondary alkyl halide.

T / F sp^3-hybridized carbon atoms have an unhybridized p orbital and an overall tetrahedral geometry.

T / F Compounds with closed (full) valence shells are described as electrophiles or Lewis acids.

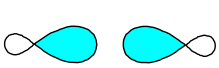
T / F Resonance can only occur in a molecule if p-orbitals on adjacent atoms are able to align parallel.

T / F Alkanes are unreactive under most conditions because they only contain C-C and C-H σ-bonds.

 # 2. (__/ 1 mark) Which of the following species contain(s) an sp^2-hybridized carbon? CHOOSE ONE.

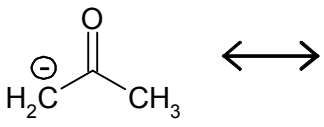
a) $:\overset{\ominus}{C}H_3$ b) $\overset{\cdot}{C}H_3$ c) $\overset{\oplus}{C}H_3$ d) both a & b e) all three

 # 3. (__/ 1 mark) What type of orbital results when orbitals overlap in <u>each</u> of the orientations shown below?

a)  CIRCLE ONE: σ, σ^*, π, π^*

b)  CIRCLE ONE: σ, σ^*, π, π^*

 # 4. (__/ 2 marks) Add lone pairs to the following Lewis structure, and draw another resonance contributor for this species. Identify which of the two structures is more stable, and give the reason why (just a few words).



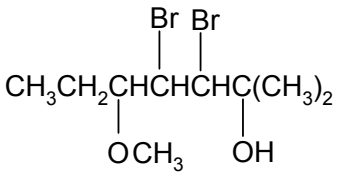
 # 5. (4 Marks) Draw a line structure for each of the following compounds:

a) 3-chloro-2-methylpentane

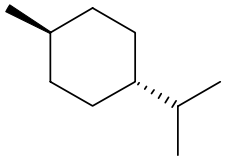
b) *N*-propyl-5-methyl-3-hexanamine

 # 6. (4 Marks) Provide a systematic IUPAC name for each of the following compounds:

a)

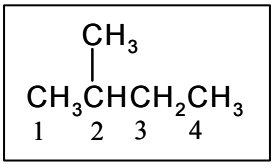


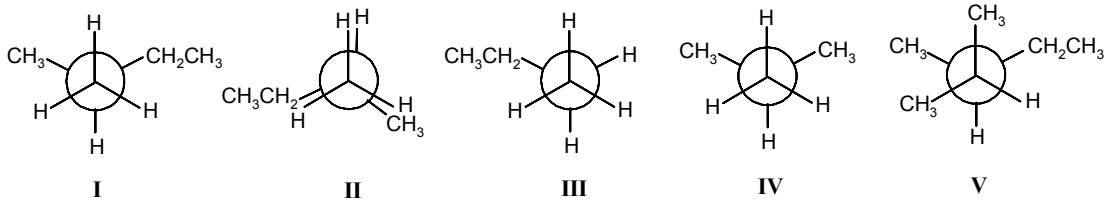
b)



Specify relative stereochemistry only; ignore absolute configurations.

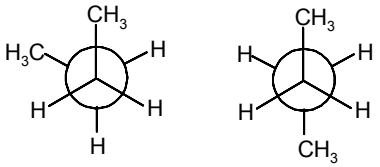
 # 7. (__/ 1 mark) Which diagram (I-V) represents a Newman projection along the C1-C2 bond for a staggered conformation of the compound shown in the box? CIRCLE YOUR CHOICE.





I **II** **III** **IV** **V**

 # 8. (__/ 1 mark) The Newman projections below represent different conformations of butane. Which one of the following statements is true?

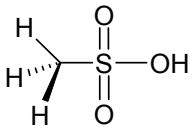


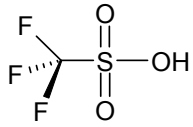
I **II**

a) Both torsional and steric strain are lower in **I** than in **II**.
b) The methyl groups are gauche in conformer **I**.
c) An intramolecular hydrogen bond stabilizes conformer **I**.
d) The C1-C4 dihedral angle in **II** is 60°.
e) More than one of these statements is true.
f) All of these statements are false.

 # 10. (__/ 6 marks) Think about the acid-base properties of the following pairs of compounds.

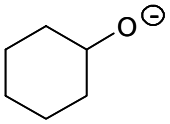
a) **(1 mark)** Which is the stronger acid?

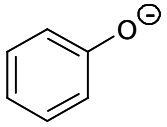




(2 marks) Give a brief explanation:

b) **(1 mark)** Which is the stronger base?





(2 marks) Give a brief explanation:

 # 11. (__/ 4 marks) Imagine you add a small amount of n-hexyl amine ($CH_3(CH_2)_5NH_2$) to a separatory funnel that contains the organic solvent diethyl ether ($CH_3CH_2OCH_2CH_3$) and water at a pH of 4.0.

a) **(1 mark)** Circle the dominant form of the amine present after you mix the phases:

$CH_3(CH_2)_5NH_2$ *or* $CH_3(CH_2)_5NH_3^{\oplus}$

b) **(1 mark)** After the layers separate (water and diethyl ether are immiscible liquids), will the species identified in part (a) be found in the organic phase or in the aqueous phase?

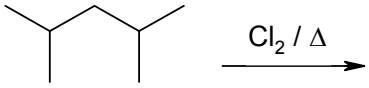
c) **(2 marks)** Briefly <u>explain</u> your choice in part (b) using a discussion of intermolecular forces.

 # 12. (__/ 2 marks) Draw the chair-chair interconversion (ring-flipping equilibrium) for methylcyclohexane. Label the substituent as axial ("ax") or equatorial ("eq") as appropriate. Circle the more stable conformer and identify *(name and sketch)* the steric interactions that cause the difference in stability.

 # 13. (__/ 3 marks) Which of the following compounds has two equatorial alkyl substituents in its most stable conformation? CIRCLE YOUR CHOICE(S).

a) *cis*-1,2-dimethylcyclohexane
b) 1,1-dimethylcyclohexane
c) *cis*-1,4-diethylcyclohexane
d) *cis*-1,3-diethylcyclohexane
e) all of the above

 # 14. (__/ 5 marks) Consider the following reaction:



a) **(1 mark)** How many hydrogen atoms of each type are present in the alkane starting material?
Primary (1°): Secondary (2°): Tertiary (3°):

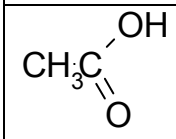
b) **(2 marks)** How many monochlorinated products (ignoring stereochemistry) can form? Draw them.

c) **(2 marks)** Bromination is a more convenient reaction to use in the lab than chlorination. Explain why.

SPACE FOR ROUGH WORK (NOT MARKED)

POTENTIALLY USEFUL INFORMATION

TABLE OF pK_a VALUES

Compound	**pK_a**
$CH_3CH_2CH_2CH_3$	>51
CH_4	51
NH_3	38
HCCH	25
$(CH_3)_3COH$	19
CH_3CH_2OH	17
CH_3OH	15.5
H_2O	15.7
RNH_3^+	9
	4.7
HF	3.2
$CH_3CH_2OH_2$+	-2.4
H_2SO_4	-5.2
HCl	-7
HI	-9