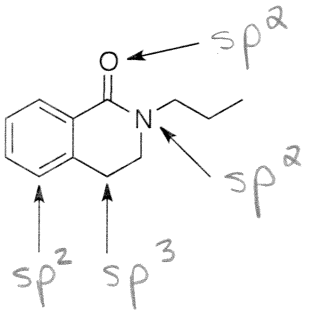
CHM 1321 B
Midterm 1
February 9, 2012

Note: The points are given as a guide and are subject to minor changes.

Surname: _____ First name: _____

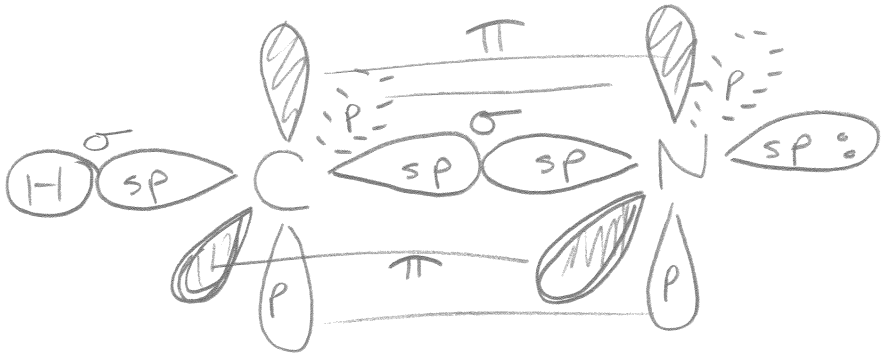
Student Number: _____ Seat number: _____

1. Identify the hybridization of the indicated atoms: **(4 points)**



1 point each.

2.
   a. Draw HCN using the LCAO method, including any lone pairs. **(4 points)**
   b. Label all atomic and molecular orbitals. **(6 points)**



a) linear geometry: 1
π geometry: 1
lone pair is sp orb: 1
H in s orbital: 1

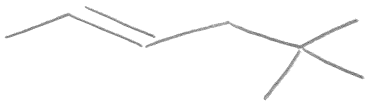
b) σ x 2 → 2 pts
π x 2 → 2 pts
sp orbitals → 1 pt (labels)
p labels → 1 pt

3. Draw the line structure for the following molecules: **(4 points)**

a. $CH_3CHCHCH_2C(CH_3)_3$

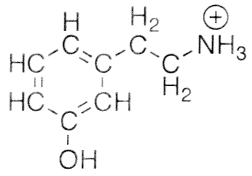
/2

-1 per error



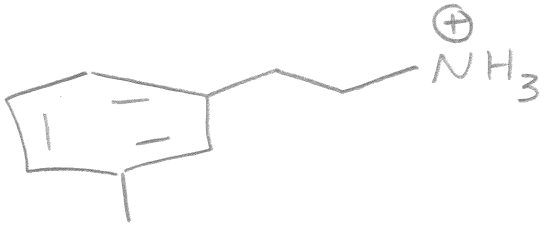
or

b.



/2

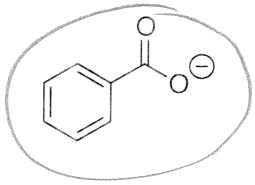
-1 per error



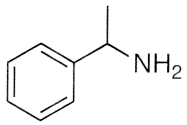
OH

4. Circle the compound in each pair that would: **(4 points)**

a. Be most soluble in water.

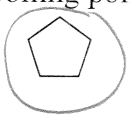


vs



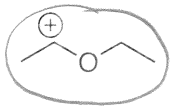
b. Have the highest boiling point.

vs

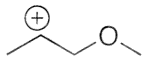


1 pt each.

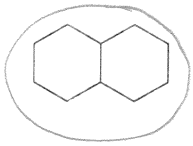
c. Be most stable.



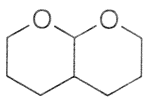
vs



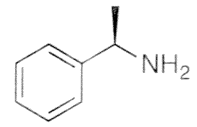
d. Have the lowest melting point.



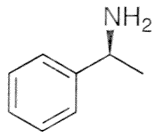
vs



5. Identify the isomeric relationship between each of the pairs of molecules, being as specific as possible. **(3 points)**

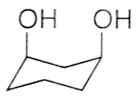


and

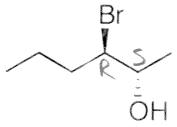


enantiomers (1)

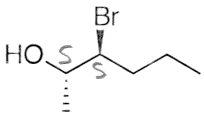
and



same molecules (1)
or meso cmpds
or conformers

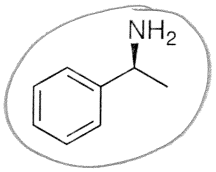


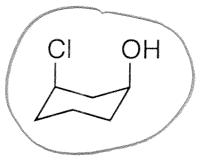
and

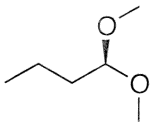


diastereomers (1)

6. Circle all of the chiral molecules from among the following choices. **(4 points)**



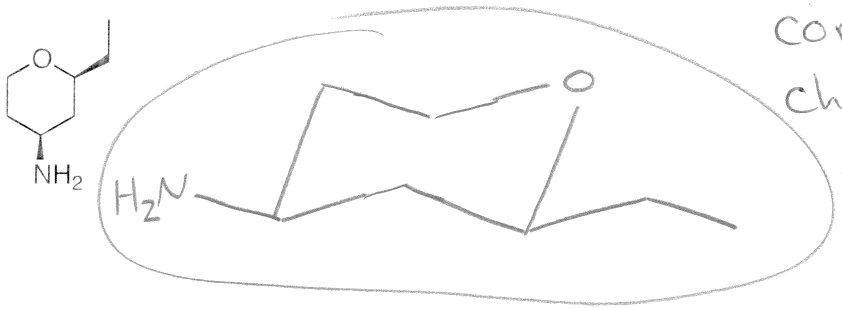




1 pt each

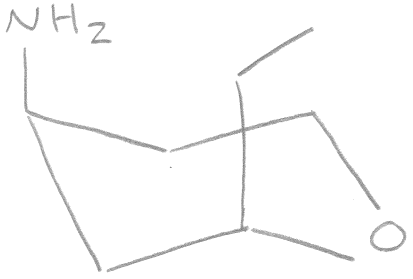
7.

a. Draw the molecule shown below in a chair conformation. **(4 points)**



correct Σ: 1
chair well-drawn: 1
substituents well-drawn: 2 (1 pt each)

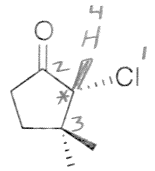
b. Draw the other chair conformation of the molecule. **(2 points)**



correct conformer: 1
chair + substituents well-drawn: 1

c. Circle the most stable conformation **(1 point)**

8. For the following molecule **(9 points)**
   a. Identify the stereocentre(s) with a star (*). 2 pts < * on CHCl / no * on $C(CH_3)_2$
   b. Determine the priorities on the stereocentre(s). 2 pts; (-1 per error)
   c. Assign the configuration of the stereocentre(s). 1 pt (R) → based on priorities determined
   d. Name the molecule using IUPAC nomenclature or accepted common names. 4 pts

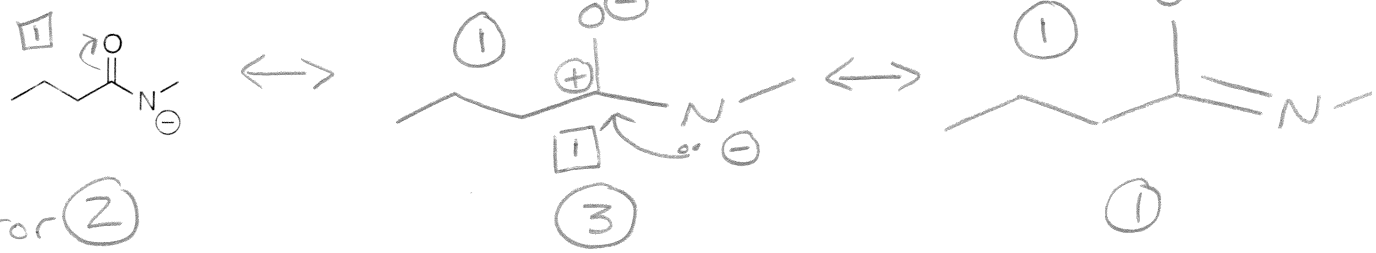


R

(R)-2-chloro-3,3-dimethylcyclopentanone

(1) (1) (1) (1)

9.
   a. Draw all the resonance structures for the following compound, including arrows to show the movement of electrons. **(5 points)** O → structure, □ → arrow(s)
   b. Rank the resonance structures (with #1 being the most important resonance contributor). **(2 points)**
   c. Justify your choice in part b. **(3 points)**



a) 1 3 1

b) /2 : -1 per error (2)

c) full octets — $C^{\oplus}$ lacks octet (1) — full octets (1)

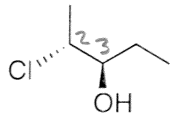
⊖ not on most elecneg atom

⊖ on most elecneg atom (1)

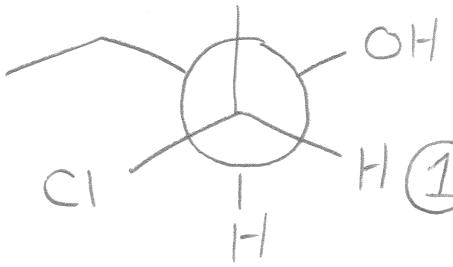
10. Draw a mechanism to explain the following reaction. **(2 points)**

(1) (1)

11. Consider the Newman projection of the following molecule down the C2-C3 bond.



a. Draw a Newman projection of the molecule in any staggered conformation. **(3 points)**

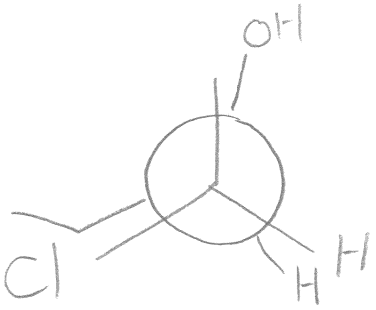


correct ~~molecule~~ : (1)
constitutional isome
with
correct stereoisomer

(1) Newman well-drawn

staggered : (1)

b. Draw a Newman projection of the molecule in any eclipsed conformation. **(3 points)**

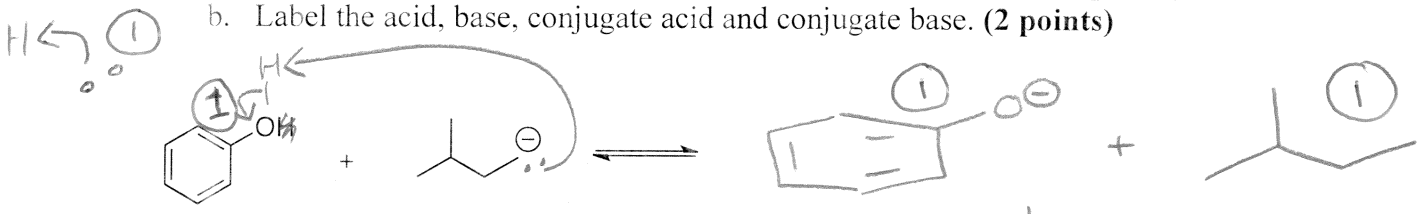


Newman well-drawn
(1)

eclipsed (1)

12.

a. Draw a mechanism and product(s) for the following reaction: **(5 points)**
b. Label the acid, base, conjugate acid and conjugate base. **(2 points)**



b) Acid (1) Base

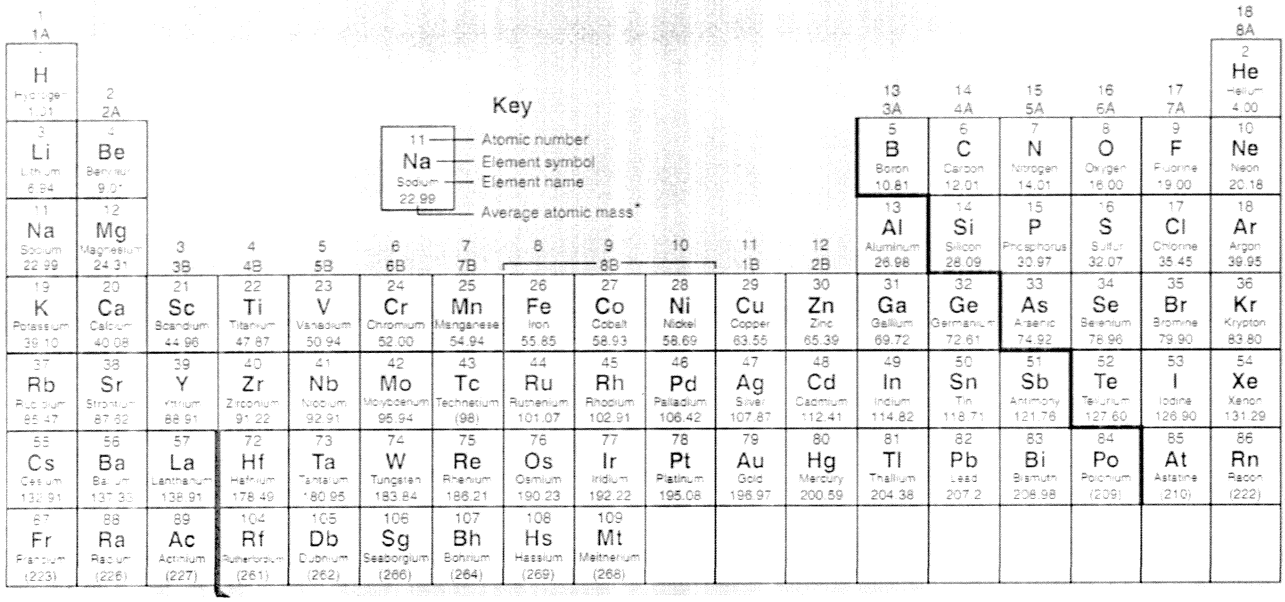
conjugate base (1) conjugate acid

c. Will the reaction favour the starting materials or products? **(1 point)**

d. Justify your answer in part c. **(3 points)**

Acid has $pK_a \approx 10$ (1)

c.a. " $pK_a \approx 50$ (1) weaker acid (1)



Acid	Approximate pK_a
$HSbF_6$	−12
HI	−10
H_2SO_4	−9
HBr	−9
HCl	−7
$C_6H_5SO_3H$	−6.5
$(CH_3)_2\overset{+}{O}H$	−3.8
$(CH_3)_2C{=}\overset{+}{O}H$	−2.9
$CH_3\overset{+}{O}H_2$	−2.5
H_3O^+	−1.74
HNO_3	−1.4
CF_3CO_2H	0.18
HF	3.2
$C_6H_5CO_2H$	4.21
$C_6H_5\overset{+}{N}H_3$	4.63
CH_3CO_2H	4.75
H_2CO_3	6.35
$CH_3COCH_2\overset{-}{C}OCH_3$	9.0
NH_4^+	9.2
C_6H_5OH	9.9
HCO_3^-	10.2
$CH_3\overset{+}{N}H_3$	10.6
H_2O	15.7
CH_3CH_2OH	16
$(CH_3)_3COH$	18
CH_3COCH_3	19.2
$HC{\equiv}CH$	25
H_2	35
NH_3	38
$CH_2{=}CH_2$	44
CH_3CH_3	50