CHM 1321 B
Midterm 1
February 10, 2011
ANSWERS

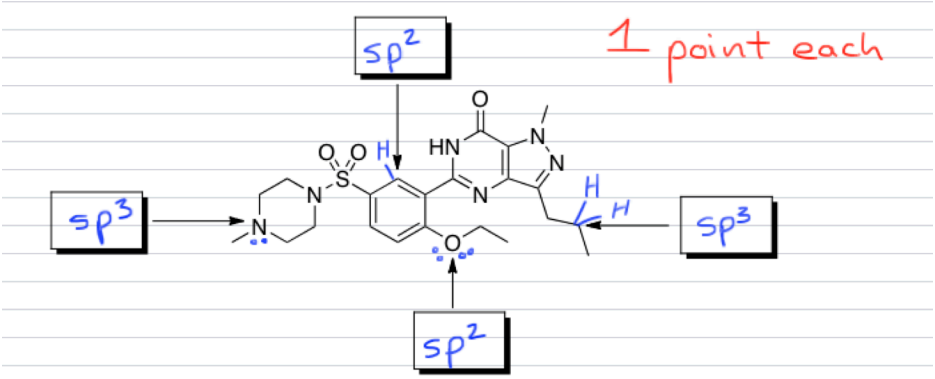
Note: The points are given as a guide and are subject to minor changes.

Last name: _____ First name: _____

Student Number: _____

Seat Number: _____

1. Give the hybridization of each of the indicated atoms in Viagra, shown below, which is a drug used to treat erectile dysfunction. **(4 points)**



2. For the molecule shown below:

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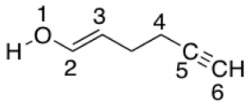
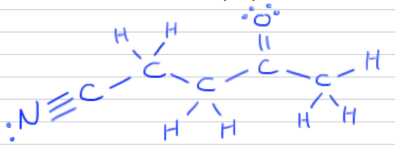


a. What is the geometry of each of the indicated atoms? **(4 points)**.
   (1) i. O1: trigonal planar (bent)
   (1) ii. C2: trig planar
   (1) iii. C4: tetrahedral
   (1) iv. C5: linear

b. Which molecular orbitals join the following atoms together? **(3 points)**.
   (1) i. H and O1: σ
   (1) ii. C2 and C3: σ + π
   (1) iii. C5 and C6: σ + π + π

3. Draw the complete Lewis structure for the following molecule: **(3 points)**

$NCCH_2CH_2C(O)CH_3$



(1) correct connectivity

(1) all correct atoms

(1) all lone pairs included

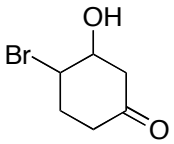
4. Draw the following compound as a line structure in 2D. Be sure to include the appropriate stereochemistry. **(3 points)**

(1) correct constitutional isomer

(1) correct stereochem

(1) techically correct (OH not HO, tBu not iPr, etc)

5. Name the following molecule using IUPAC nomenclature: **(4 points)**



4-bromo-3-hydroxycyclohexan-1-one

(1) "bromo", "hydroxy", "one"

(1) numbering (3,4 not 4,5 or other)

(1) cyclohexane

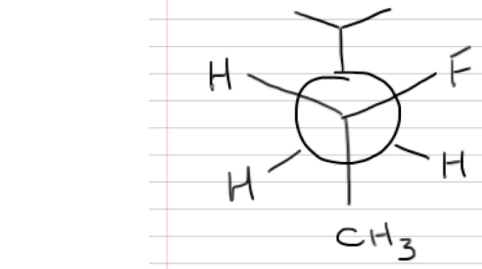
(1) technical (dashes + no spaces)

6. Why is cyclohexane **not** a strained ring? **(2 points)**

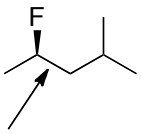
(1) → all bonds are ~109° (ideal for sp^3-hybridized atoms)

(1) → all bonds are staggered (no bonds are eclipsed)

7. Draw and name the Newman projection of the most stable conformation of the following molecule about the indicated bond. **(6 points)**

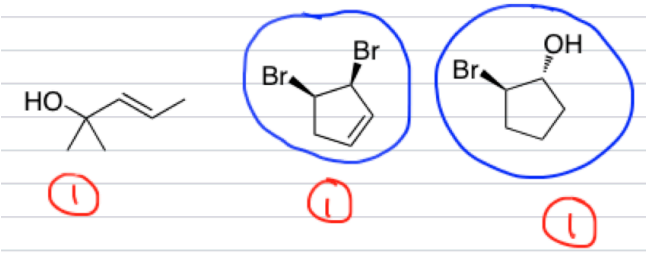


(1) correct molecule
(1) correct stereochem
(1) technically drawn correctly
(1) most stable (iPr + Me anti)



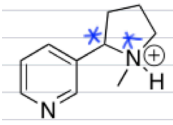
Anti - staggered
(1) (1)

8. Circle the chiral molecule(s) from among the choices below. **(3 points)**



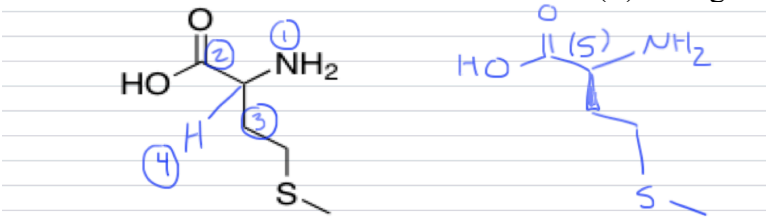
(1) (1) (1)

9. Label all of the chiral centres with a star (*) in the protonated molecule of nicotine, a highly addictive substance, shown below: **(2 points)**



(1) point each
(-1) per additional label
(min score 0)

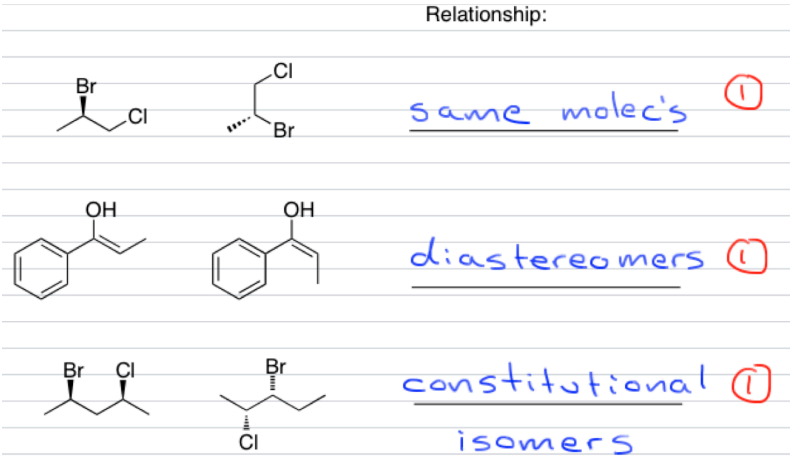
10. For methionine, the essential amino acid shown below: **(3 points)**
    a. Determine the priorities of the substituents around the stereocentre.
    b. Draw methionine in the natural (S) configuration.



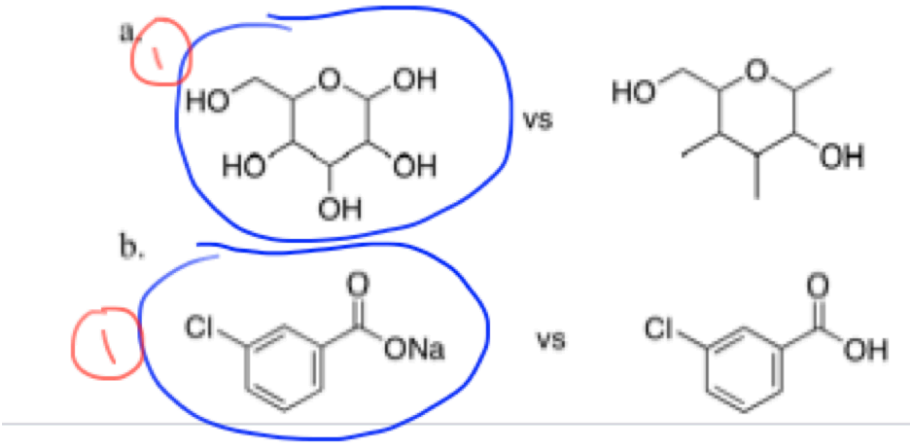
(2) Priorities
-1 per error (min 0/2)

(1) (S) config'n correctly drawn
(based on priorities)

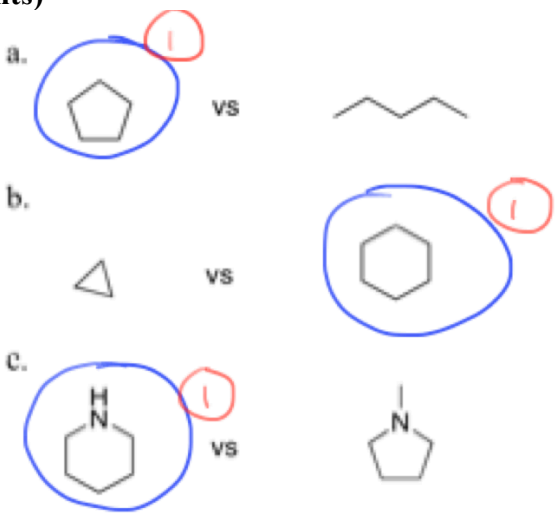
11. Give the isomeric relationship (enantiomer, same molecule, etc...) between each of the following pairs. Be as specific as possible. **(3 points)**



12. Circle the compound that would have the highest solubility in water between each of the following pairs: **(2 points)**

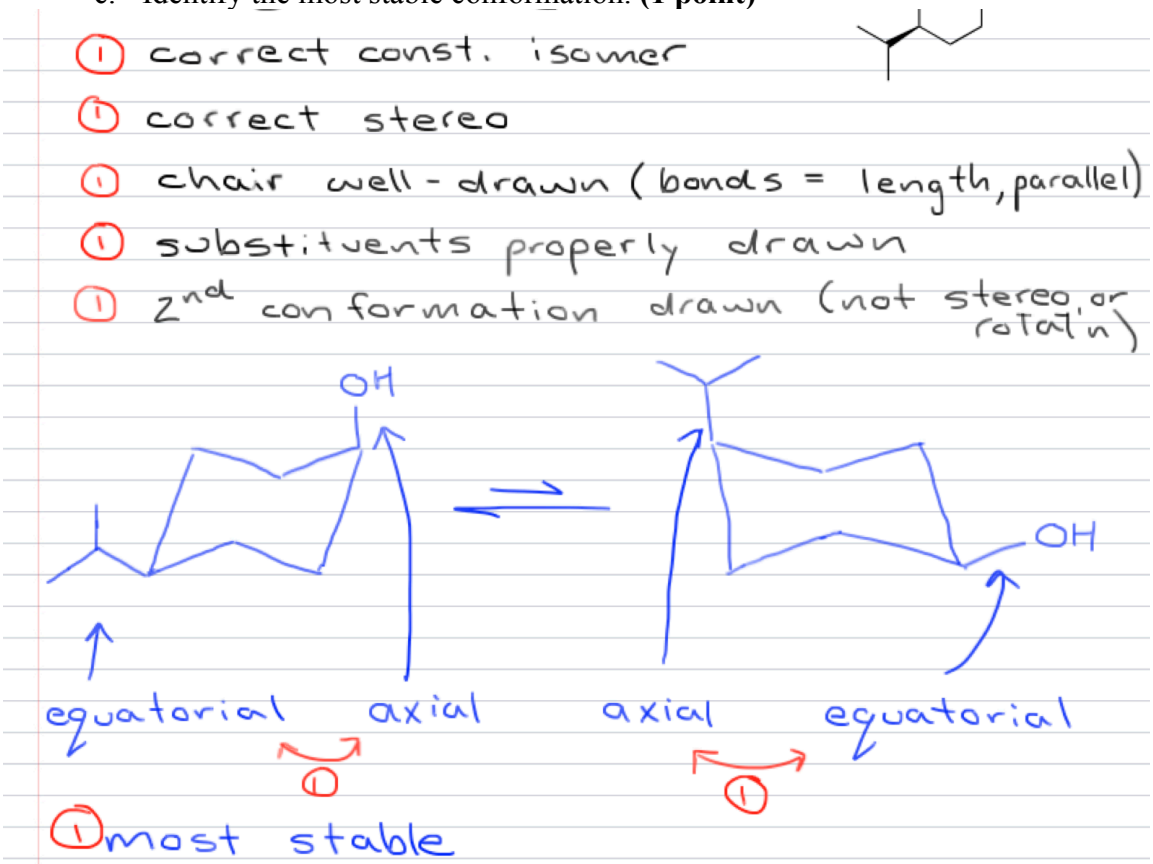


13. Circle the compound with the highest boiling point in each of the following pairs: **(3 points)**



14.

a. Draw the two chair conformations of the molecule below. Note: you do not have to draw the H's. **(5 points)**
b. For each structure, label the substituents as being axial or equatorial. **(2 points)**
c. Identify the most stable conformation. **(1 point)**



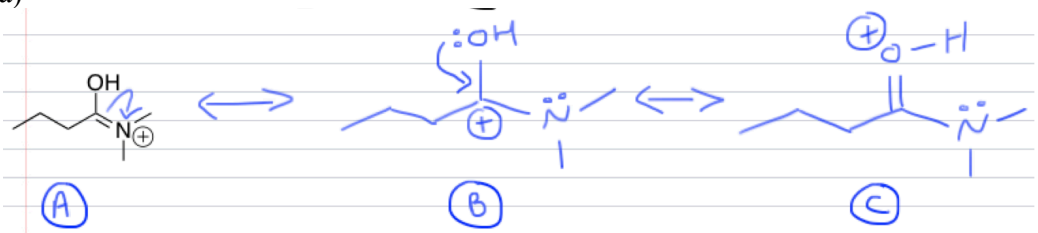
15. For the molecule shown below:

a. Draw all of the resonance structures for the compound, using curved arrows to show the movement of electrons **(5 points)**

b. Rank the resonance structures based on their degree of contribution to the resonance hybrid structure **(2 points)**

c. Draw the resonance hybrid structure **(3 points)**

a)



① ↔ arrows

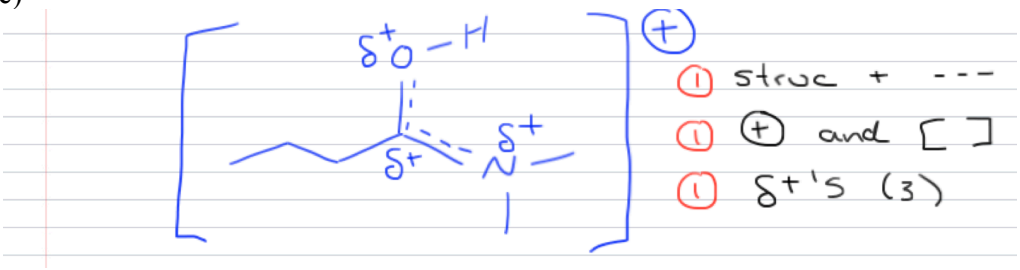
② each ⇝ starts at e⁻s and points to an atom (1 pt each)

① structure (B), including charge

① structure (C), including charge

b)

c)



① struc + ---

① ⊕ and [ ]

① δ+'s (3)

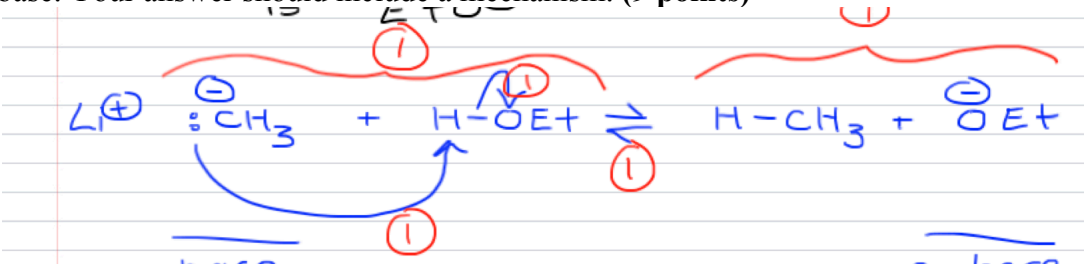
16. For the following reaction:
    a. Draw a mechanism and the products of the reaction. **(4 points)**
    b. Determine the direction of the equilibrium. **(1 point)**
    c. Justify your answer in part b. **(4 points)**

a) (1) ⤳ arrows
(1) ⇌
(1) thiol (RSH)
(1) enolate ($RO^{\ominus}$)

b) ⟵ (1)

c) (1) Compare bases, $RS^{\ominus}$ vs $RO^{\ominus}$
(1) S is larger than O
(1) S can better disperse the ⊖
(1) $RS^{\ominus}$ more stable than $RO^{\ominus}$

17. The strongest base that can exist in ethanol (as a solvent) is ethoxide ($^{-}$OEt). Explain that statement using methyl lithium ($LiCH_3$) as an example of a strong base. Your answer should include a mechanism. **(9 points)**



Compare bases:

(1) → O more elecneg than C

(1) → $^{\ominus}$OEt more stable than $^{\ominus}CH_3$

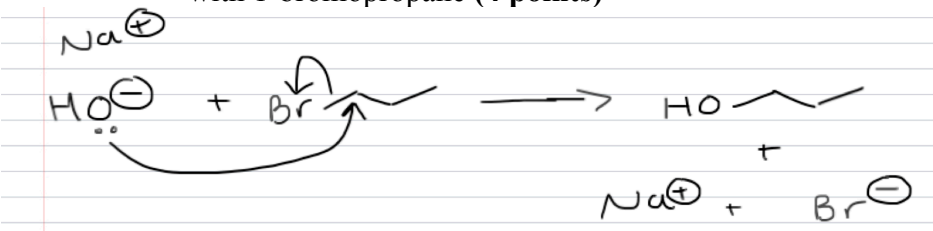
(1) → Equilibrium favours the products

(1) ∴ Any base stronger than $^{\ominus}$OEt will react with EtOH to give $^{\ominus}$OEt

Note: could also compare pK_as of acids (must state relevant pK_a values)

18.

a. Draw the mechanism and products for the reaction of sodium hydroxide with 1-bromopropane **(4 points)**



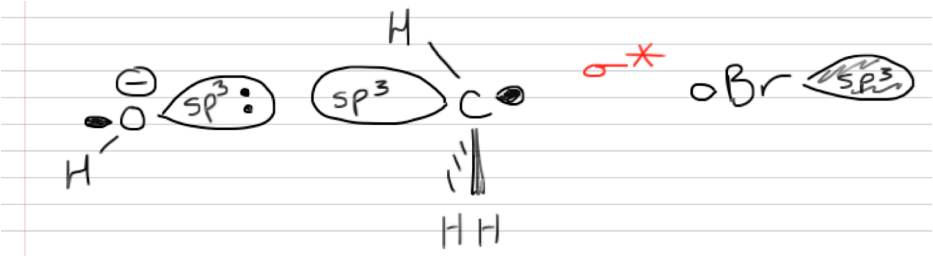
① ⋱C

① Br

① HOR

① Br⊖

b. Draw and label the key orbitals involved between the hydroxide and the α-carbon of 1-bromopropane. **(4 points)**



① sp^3 on O

① orbital on C

① σ* molecular orbital labeled

① σ* phasing

BONUS!

Draw the form of L-serine, an amino acid, that would be observed in a solution of pH 7. **(2 points)**