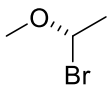
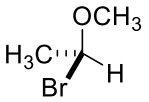
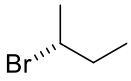
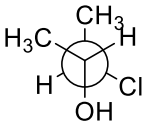
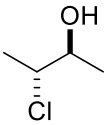
CHM 1321 A
Mid Term 1 Version A Answers

1) Identify the stereochemical relationship between the following pairs of molecules (enantiomers, diastereomers, same molecule, meso compound) (**3 Points**)

a)  and  relationship same

b)  and (S)-2-bromobutane relationship enantiomers

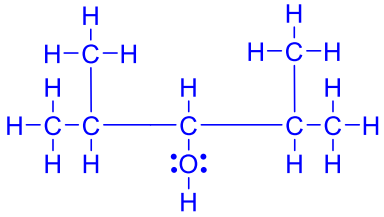
c)  and  relationship diastereomers

2) Draw 2,4-dimethylpentan-3-ol as: (**6 points**)

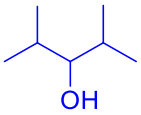
a) A condensed formula

$(CH_3)_2CHCH(OH)CH(CH_3)_2$ parentheses optional for OH

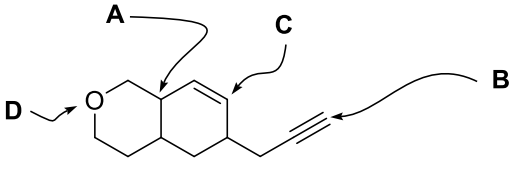
b) A Lewis structure



c) A line structure



3) For the following compound:



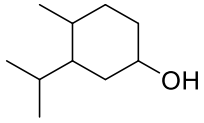
a) What is the hybridization of the indicated atoms? (**4 points**)

Atom A = ___sp^3_____
Atom B = ___ sp_____
Atom C = ___ sp^2_____
Atom D = ___ sp^3_____

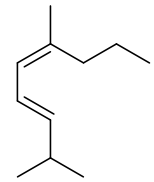
b) What type of molecular orbitals connect the following atoms to other atoms? (**6 points**)

Atom A = _σ_____
Atom B = _ σ + π_____
Atom C = _ σ + π _____
Atom D = _ σ _____

4) Give IUPAC names for the following: (**4 points**)

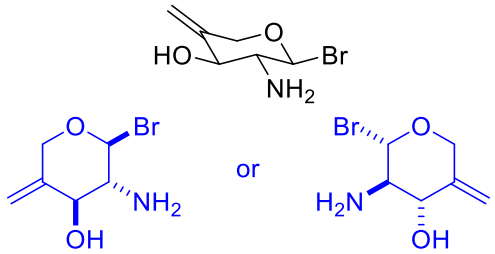
a) 

3-(1-methylethyl)-4-methylcyclohexanol
or
1-(1-methylethyl)-2-methyl-5-hydroxycyclohexanol
or
2-(1-methylethyl)-1-methyl-4-hydroxycyclohexane
isopropyl is acceptable in place of 1-methylethyl

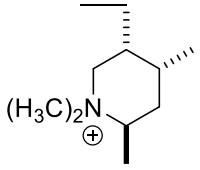
b) 

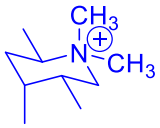
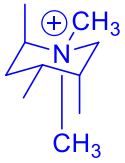
2,6-dimethylnona-3,5-diene

5) For the following:
a) Draw the "hexagon" line structure of the following (be sure to indicate stereochemistry). (**3 points**)

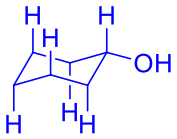
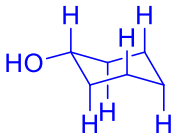


b) Draw one chair conformation of the following compound. (**4 Points**)



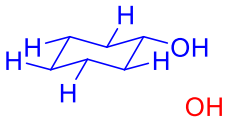
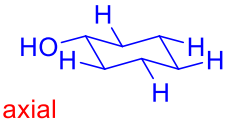



c) Draw <u>one</u> chair conformation of cyclohexanol showing ALL OF THE AXIAL HYDROGENS. (**3 Points**)


or


OH can also be axial

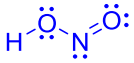
d) Draw <u>the same</u> chair conformation of cyclohexanol showing ALL OF THE EQUATORIAL HYDROGENS. (**3 Points**)

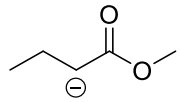
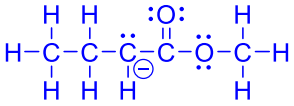

or


OH can also be axial

6) Draw the following molecules as Lewis structures. (**6 points**)

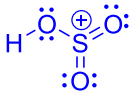
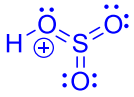
a) HNO_2


(for inorganic acids, leading H is attached to O)

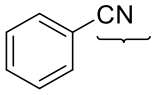
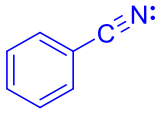
b)



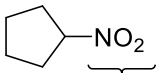
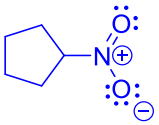
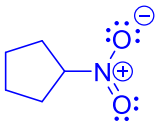
c) $HSO_3^{\oplus}$

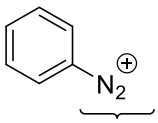
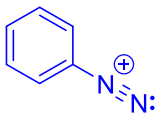
(for inorganic acids, leading H is attached to O)


or


7) Re-draw the following molecules showing the full Lewis structure at the indicated location. (**6 Points**)

a)



b)


or


c)


or

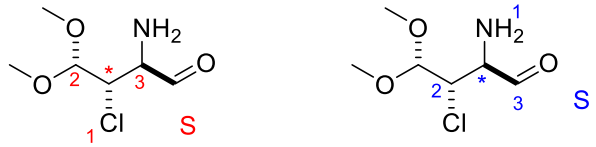

8) For the following compounds

a) show the stereogenic centre(s) by labeling them with a star (*)(**4 points**)

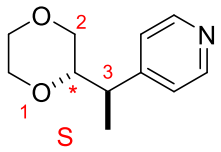
b) determine the priorities of the substituents on each stereogenic centre. For compounds with more than one centre, make sure you clearly indicate which priorities refer to which centre. (re-drawing the structure helps) (**8 points**)

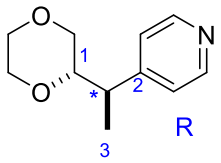
c) Determine the configuration of each stereocentre (**4 points**)

(i)



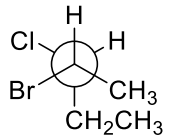
(ii)

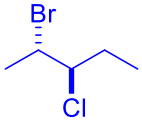




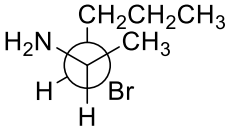
9) For each compound shown below, convert the structure to zig-zag (line) notation (include stereochemistry). (**4 points**)

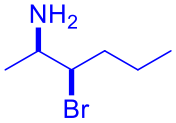
(a)





(b)





10) A solution of 2.0 mg of (l)-glucose was dissolved in 2 mL of water and placed in a 100 mm cell. Using the sodium D line, a rotation of 0.017° was found at 27°C. Determine the specific rotation of the sample. (**6 Points**)

c must be in units of g/100 mL (or g/dL)

$$c = \frac{2.0\ \text{mg}}{2\ \text{mL}} \times \frac{\text{g}}{1000\ \text{mg}} \times \frac{100\ \text{mL}}{(100\ \text{mL})}$$

$$= 0.10\ \text{g/100 mL}$$

$$[\alpha]_D^{27} = \frac{100\,\alpha}{d\,l}$$

$$= \frac{(100)(0.017)}{(1)(0.10)}$$

$$= 17.0$$

11) The specific rotation of the pure (S) form of Naproxen is -20.0°. Canadian Border Services examines a batch of Naproxen that is being imported, and discovers that the specific rotation is +10°.

a) What is the enantiomeric excess of the sample? (**3 points**)

$$\text{ee} = \text{optical purity} = \frac{[\alpha]_{\text{sample}}}{[\alpha]_{\text{pure}}} \times 100\%$$

$$50\% = \frac{10}{20} \times 100\%$$

b) Which isomer is in excess and why? (**2 points**)

the rotation of the sample is positive so the R isomer is in excess (S isomer has a negative rotation)

c) What is the composition of the mixture (how much R form and how much S form)? (**3 points**)

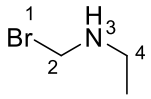
ee = optical purity = $\frac{|d - l|}{d + l} \times 100\%$ $\quad d + l = 100$

$50\% = \frac{|100-2l|}{100} \times 100\%$

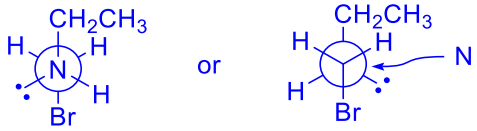
$l = 25$

Mixture is 75 % R isomer and 25 % S isomer

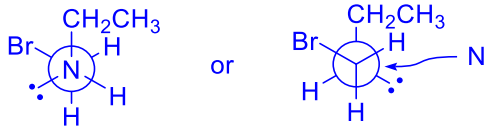
12) For the following compound, draw the appropriate Newman projection along the C2-N3 bond of the following:



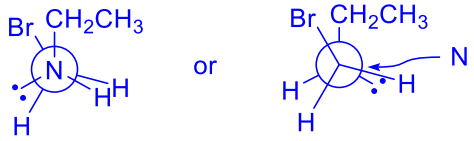
a) The <u>most</u> stable conformer and name the conformer. (**4 Points)**

anti-staggered 

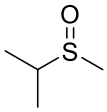
b) The <u>second most</u> stable conformer and name the conformer. (**4 Points)**

gauche 

c) The <u>least</u> stable conformer and name the conformer. (**4 Points)**

totally eclipsed 

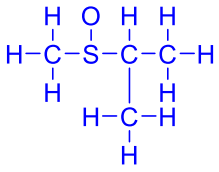
BONUS! The following molecule is chiral. Provide a brief explanation of why this is possible (it may be helpful to draw a Lewis structure of the molecule). (**2 Points**)



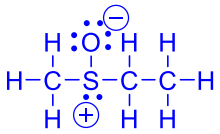
4 X carbon = 4 X 4 = 16
1 X oxygen = 6 X 1 = 6
1 X sulfur = 6 X 1 = 6
10 X hydrogen = 8 X 1 = 10

38 valence electrons

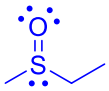
connect with single bonds



15 bonds accounts for 30 electrons



remaining electrons are distributed and formal charges calculated



Final structure has a sulfur with 4 different substituents
it is a chirality center and therefore the molecule is chiral