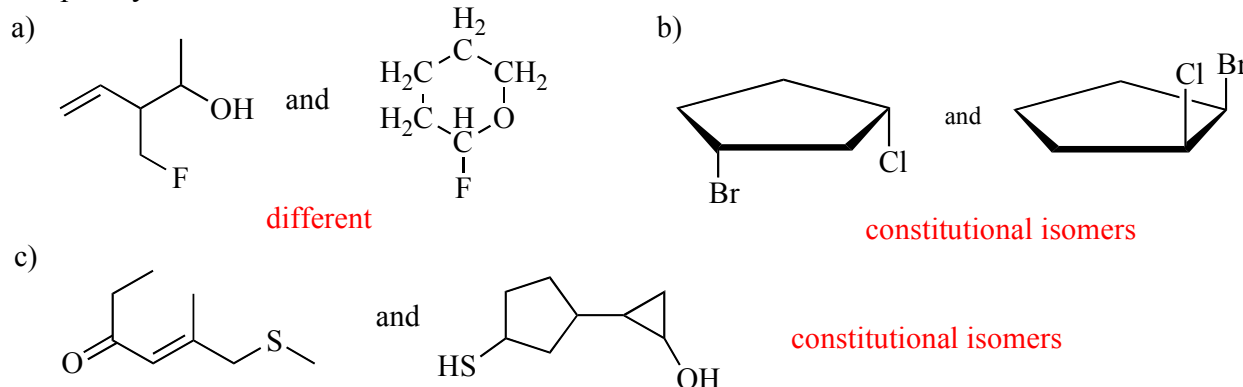


Answer all **29** questions (150 pts).

1. (10.5) State whether *each* of the following pairs are constitutional isomers, stereoisomers or completely different molecules.



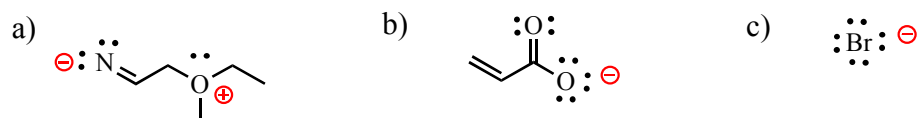
2. (6) In each of the following molecules, fill in any non-bonding, valence electrons that are missing from any atom.



3. (6) State the hybridization of the central carbon atom in each of the following species.



4. (8) Write in any missing charges on any atom in each of the following structures:

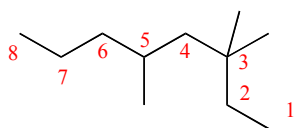


5. (3) Which has the stronger conjugate base, ammonia (pK_a = 35) or methane thiol (pK_a = 9)?
ammonia

6. (3) True or **False**? Lewis Acids must have protons to donate.

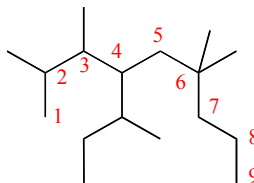
7. (12) Provide correct systematic (IUPAC) names for each of the following molecules.

a)



3,3,5-trimethyloctane

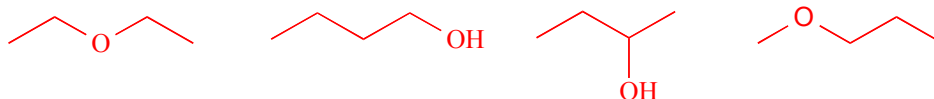
b)



2,3,6,6-tetramethyl-4-(1-methylpropyl)nonane

8. (6) Draw, as line structures, three of the 7 constitutional isomers of formula $C_4H_{10}O$.

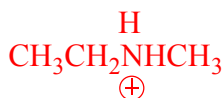
for example:



9. (3) **True** or False? The molecule shown below contains three tertiary carbons.



10. (5) Draw both the conjugate acid and conjugate base of $CH_3CH_2NHCH_3$.



conjugate acid

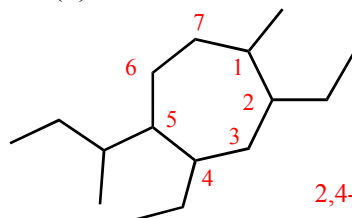


conjugate base

11. (4) The compound, BH_3 , (Boron, atomic number 5) is a strong Lewis acid. Explain, briefly but *clearly*.

B has 3 electrons in its valence shell and, accordingly, when it bonds covalently to 3 things it forms a neutral molecule. However, the resultant molecule does not have an octet of electrons on the B and is therefore a strong electron acceptor - Lewis Acid

12. (6) Name the molecule shown using systematic naming rules.



2,4-diethyl-1-methyl-5-(1-methylpropyl)cycloheptane

13. (4) Write the products of the following acid – base reaction.



14. (4) Which of the following compounds are ionic (at least, in part)? (note: more than one positive answer is possible).

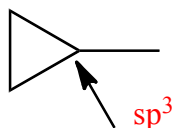
- a) NH_3 b) NH_4Cl c) KBr d) HF

15. (3) Which of the following is closest to the $\text{C}=\text{CH}-\text{CH}$ bond angle in $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{NH}$?

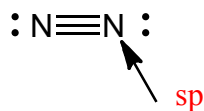
- a) 180° b) 120° c) 109.5° d) 90°

16. (7.5) State the hybridization of the atom indicated in each of the following molecules:

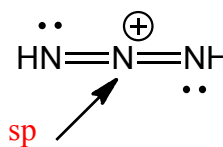
a)



b)



c)

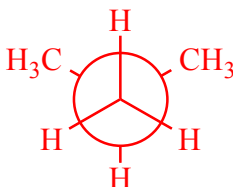
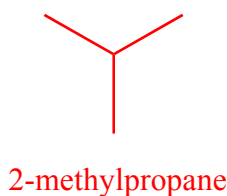


17. (7) Circle the molecule in each of the following pairs, which best fits the given description.

a) $-\text{CH}_3$ $-\text{OH}$ Stronger base

b) H_4N^+ OH_2 Stronger acid

18. (6) Using a Newman projection, draw a staggered conformation for 2-methylpropane, viewed along the $\text{C1} - \text{C2}$ bond.



19. (6) Circle the more electronegative element in each of the following molecules.

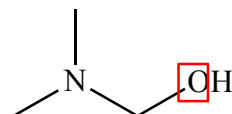
a)



b)



c)



20. (3) **True** or False? For a base, the general trend is: "the more electronegative the atom bearing the electrons to be shared, the poorer the base".

21. (4) Which of the following best explains the relative stabilities of the eclipsed and staggered forms of ethane? The _____ form has the most _____ strain.

- a) eclipsed; steric b) eclipsed; torsional c) staggered; steric d) staggered; torsional

isopropyl ; *tert*-butyl ; 1-methylbutyl ; pentamethyl
 2 1 4 3

$$\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{N}^+-\text{H} \\ | \\ \text{H} \end{array} \quad \text{and} \quad \begin{array}{c} + \\ \text{H}-\text{N} : \\ | \\ \text{H} \end{array}$$

Even though both ions have a positive charge, the ion on the left has an octet of electrons on the N atom whereas the N in the molecule on the right does not. An octet makes the species more stable.

2,2,6-trimethyloctane

a) C_nH_n

b) C_nH_{2n} c) C_nH_{2n+2}

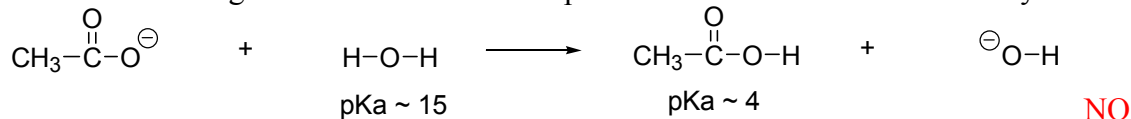
d) C_nH_{2n-2}

a) Carbon, atomic number 6 and / or c) Oxygen, atomic number 8

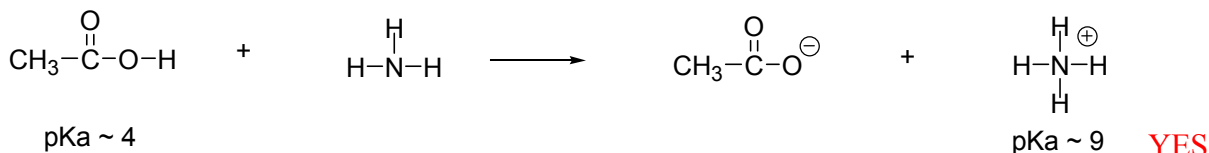
b) Nitrogen, atomic number 7

d) Fluorine, atomic number 9

28. (6) Will the following acid base reactions take place in the direction shown? State yes or no.



NO



YES

29. (3) In a cyclohexane conformation, the two different positions that a substituent can occupy are called: **axial and equatorial**