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

a) \( \text{O} \) and \( \text{H}_2\text{C=CH}_2 \)
a constitutional

b) \( \text{O} \) and \( \text{H}_2\text{C=CH}_2 \)
completely different

c) \( \text{CH}_3 \) and \( \text{CH}_3 \)
constitutional

**2. (5) Circle any statement in the box to the right that correctly describes the molecule shown.

**3. (5) Circle any of the following species that would be considered to be a strong Lewis Base?

**4. (12) Show the partial (use \( \delta^+ \) or \( \delta^- \)) or real charges (use + or -) that would be present in each of the following if a bond was formed between the pairs of atoms shown.

a) \( \text{P}^{\delta^+} \), \( \text{F}^{\delta^-} \)  
b) \( \text{N}^- \), \( \text{Li}^+ \)  
c) \( \text{Ca}^+ \), \( \text{S}^- \)  
d) \( \text{O}^{\delta^-} \), \( \text{N}^{\delta^+} \)

**5. (12) Fill in any non-bonding valence electrons (lone pairs) missing from the following structures:

a) 

b) 

c) 

**
**6. (10)** Provide a correct systematic (IUPAC) name for the following molecule. *In addition*, indicate how many primary, secondary and tertiary carbons are present in the molecule.

(CH₃)₂CHCH(CH₃)CH₂CH(CH₂CH₃)CH₂CH(CH₃)CH(CH₂CH₃)CH₂CH₃

5,8-diethyl-2,3,7-trimethyldecane

Seven primary; five secondary; five tertiary carbons

**7. (8)** In the following molecules, state what the hybridization is of the four indicated atoms.

a) b)

sp² sp³ sp²

**8. (3.5)** What is the overall shape of the molecule shown in question 7a above? Choices: tetrahedral; trigonal planar; linear.

**9. (3)** True or False? A molecule that is a constitutional isomer of another molecule could also be a stereoisomer of the other molecule.

**10. (3)** True or False? Hydrogens attached to electronegative atoms are more acidic than those attached to less electronegative elements.

**11. (3)** True or False? In general, the more hydrogen bonding present in a molecule the greater the water solubility.

**12. (4)** Draw the conjugate acid of Li⁺ ´OCH₃.

CH₃OH

**13. (3)** Which of the following isolated elements has 4 valence electrons?

- a) Oxygen, atomic number 8
- b) Fluorine, atomic number 9
- c) Silicon, atomic number 14
- d) Boron, atomic number 5

**14. (13)** Name the following molecules using any acceptable method.

a) b)

5-ethyl-1-methyl-2-propylcyclooctane 5,7-diethyl-6-isopropyl-2,3-dimethylnonane
**15. (3.5) Which side of this equilibrium is favored?

\[ \text{CH}_3\text{OH} + \text{KO}_2\text{CCH}_3 \rightleftharpoons \text{KOCH}_3 + \text{CH}_3\text{CO}_2\text{H} \]

pKa = 16.5  \hspace{1cm} \text{pKa} = 5

(A) left (B) right

**16. (3.5) In question 15 above, CH₃CO₂H is acting as a(n) ?

(A) Acid  (B) Base

**17. (3.5) In question 15 above, KOCH₃ is a ?

(A) Conjugate Acid  (B) Conjugate Base

**18. (8) Circle any statement below that is true about carbon or its compounds.

a) Carbon has low electronegativity  \hspace{1cm} b) Carbon tends to form ionic bonds

c) Carbon is neutral when it is tetravalently bonded  \hspace{1cm} d) Alkanes dissolve well in water

**19. (4) Which of the following is closest to the B-F bond angle in BF₃?

a) 180°  \hspace{1cm} b) 120°  \hspace{1cm} c) 109.5°  \hspace{1cm} d) 90°

**20. (8) In the molecule shown below, for each bond indicated with an arrow (2 examples), state the types of orbital, from each atom, which were used in making the bond.

N \text{ sp}^2 - \text{sp}^3 \text{ O}

H₂\text{C≡N} = \text{N} - \text{OH}

sigma bond only

N⁺ \text{ sp} - \text{sp}^2 \text{ N}
**21. (4.5) Circle the Newmann projection on the right that correctly represents the molecule shown on the left, viewed as indicated from the left.

![Molecules](image)

**22. (4) As the molecule shown in question 21 rotates it experiences what types of strain. Choose one or more from the following: angle; torsional; steric; constitutional.

**23. (7.5) Fill in the missing blanks in the following sentences using one of the suggestions in parentheses:

a) As we move from left to right in a row on the periodic table, electronegativity ________ (decreases, increases, doubles, stays the same).

b) As we move from top to bottom in a group on the periodic table, electronegativity ________ (decreases, increases, doubles, stays the same).

c) In a covalent bond, the greater the difference in electronegativity between the 2 atoms making the bond, the greater the ________ (hybridization, ionization, polarization, conformation).

**24. (3) True or False? In a carbon carbon triple bond, there will always be a sigma bond and two pi bonds.

**25. (7) Draw a reasonable structure for the following formula. Use only stick structures (aka line form).

C₄H₆O₂

e.g. ![Example Structures](image)