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

   a) \( \text{F} - \text{O} \) and \( \text{O} - \text{F} \)
   
   b) \( \text{P-N} \) and \( \text{N-P} \)
   
   c) \( \text{H} - \text{Br} \) and \( \text{Br} - \text{H} \)

2. (8.5) Complete the electron dot structure of caffeine by clearly filling in any non-bonding, valence electrons that are missing from any atom. Also, identify the hybridization of the 3 indicated atoms.

   ![Caffeine structure]

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

   a) \( \text{H-N} \text{H} \)
   
   b) \( \text{H-N} \text{H} \)
   
   c) \( \text{C} \equiv \text{C} \text{H} \)

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

   a) \( \text{H-N} \text{H} \)
   
   b) \( \text{H-C} \equiv \text{N} \text{O} \)
   
   c) \( \text{H-C} \equiv \text{N} \text{O} \)

5. (3) Which has the stronger conjugate base, methyl amine (pKa = 35) or methanol (pKa = 16)?

6. (5) Explain, briefly but clearly, why BH\(_3\) is a strong Lewis Acid. Also, would it be a nucleophile or an electrophile?
7. (12) Provide correct systematic (IUPAC) names for each of the following molecules.

a) 

b) 

8. (7.5) Draw, as line structures, three of the constitutional isomers of formula C₄H₇N.

9. (5) Draw both the conjugate acid and conjugate base of the molecule shown.

OH

10. (6) Provide a correct, systematic (IUPAC) name for the following molecule.

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

\[
\text{CH}_3\text{CH}_2\text{SH} \quad + \quad \text{LiNH}_2
\]
12. (7.5) Which of the following compounds are ionic (at least, in part)? (note: more than one positive answer is possible).
   a)  LiBF₄   b)  HCl   c)  CH₃CH₂NHK   d)  H₂S   e)  CH₃CH₂OH

13. (6) Circle the molecule in each of the following pairs, which best fits the given description.
   a)  CH₄       F⁻       Stronger base
   b)  HCl       HBr       Stronger acid

14. (6) Using a Newman projection, draw a staggered conformation for 2-methylbutane, viewed along the C2 – C3 bond.

15. (3) True or False? The C atom in CH₃⁺ is sp³ hybridized.

16. (6) In each pair, circle the molecule, which would be more stable.
   a)  BF₃       ⊖BH₄       b)  ⊖NH₂       ⊖NH₄

17. (6) Circle any of the following that are not alkanes?
   a)  C₈H₁₂   b)  C₆H₁₄   c)  C₇H₁₄   d)  C₆H₆

18. (3) Which of the following isolated elements has seven electrons in its valence shell?
   a)  Boron, atomic number 5   c)  Oxygen, atomic number 8
   b)  Nitrogen, atomic number 7   d)  Fluorine, atomic number 9

19. (4) How many secondary (2°) carbons are in the molecule 2,3,4-trimethylpentane? ______

20. (3) Will the following acid base reaction take place in the direction shown? State yes or no.
   CaC₂ + H-O-H → H-C≡C-H + ⊖O-H
   pKa ~ 15         pKa ~ 25

21. (3) True or False? The cyclohexane conformation shown is more stable than its “ring flip” conformation.
22. (5) Indicate for each of the following whether they are cis or trans.

a)
\[
\begin{array}{c}
\text{H} \\
\text{Br} \\
\text{H} \\
\text{Br} \\
\text{H} \\
\text{H} \\
\text{CH}_3 \\
\end{array}
\]
b)
\[
\begin{array}{c}
\text{H} \\
\text{Cl} \\
\text{H} \\
\text{H} \\
\text{CH}_3 \\
\end{array}
\]

23. (5) Name the type of reaction (addition, elimination, substitution or rearrangement) involved in each of the following.

a)
\[
\begin{array}{cccc}
\text{H} & = & \text{H} & + \text{H}_2 & \text{Pd} & \rightarrow & \text{CH}_3\text{CH}_3
\end{array}
\]
b)
\[
\begin{array}{cccc}
\text{H} & \text{C} & \text{C} & : & \Theta & + & \text{CH}_3\text{Br} & \rightarrow & \text{H} & \text{C} & \text{C} & \text{CH}_3 & + & \text{Br} \Theta
\end{array}
\]

24. (4) Use arrows to show the reaction between the following nucleophile & electrophile.

\[
\begin{array}{c}
\text{(CH}_3\text{)}_3\text{N} : + \text{H}_2\text{O}^\Theta \\
\end{array}
\]

25. (5) Name the orbitals (s,p, sp3 etc) from each atom that make up the bonds indicated.

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\text{C} \equiv \text{C} \\
\text{H}_2\text{N} \\
\end{array}
\]

26. (3) What compound (a-d) is represented by the Newman projection shown?

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{H} \\
\text{H} \\
\text{CH}_2\text{CH}_3 \\
\end{array}
\]
a) \text{CH}_3\text{CH}_2\text{CH}_3
b) \text{(CH}_3\text{)}_2\text{CHCH}_2\text{CH}_3
c) \text{CH}_3\text{CH}\text{(CH}_3\text{)}_2
d) \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}\text{(CH}_3\text{)}_2