Final Test Prep, Part 1

1) What is the electronegativity trend of the periodic table?

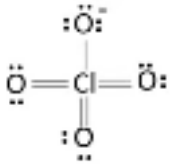
Fluorine is the most electronegative element and electronegativity decreases down the table and to the left of Fluorine.

2) When bonds are formed, what determines if it will be a covalent bond or an ionic bond?

The difference in electronegativity and the exchange of electrons (which is caused by the difference in electronegativity). A large difference will result in an ionic bond (the more electronegative element will take the two electrons in that bond). A small difference will result in a covalent bond where they share the electrons (because neither element is entirely capable of taking those electrons for themselves).

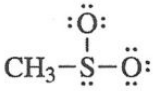
3) Draw the ClO_4^- ion, and assign formal charges to all of the elements.

Formal charge: valence e^- - # of bonds - # of nonbonding e^-



Cl: 7 valence - 7 bonds = 0
Top O: 6 valence - 1 bond - 6 nonbonding = -1
Bottom, Right and Left O: 6 valence - 2 bonds - 4 nonbonding = 0

4) What is the formal charge on the S and O atoms in the following structure?

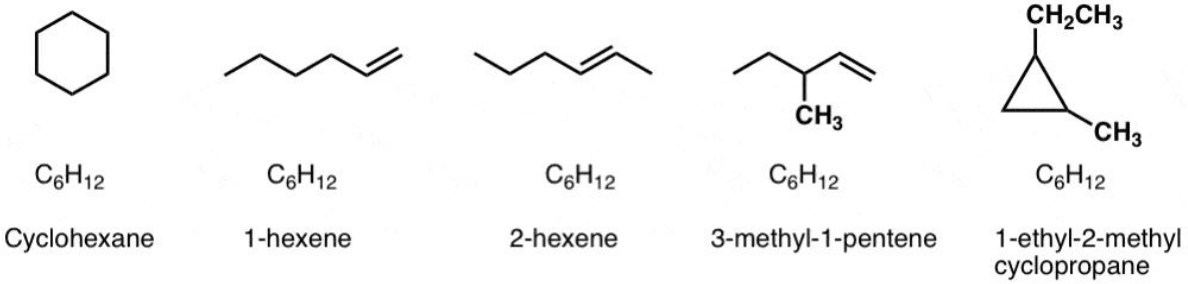


S: 6 valence - 3 bonds - 2 nonbonding = +1
Both O: 6 valence - 1 bond - 6 nonbonding = -1

5) What are constitutional isomers?

They are compounds with the same structural formula (C_XH_Y), but different connectivity.

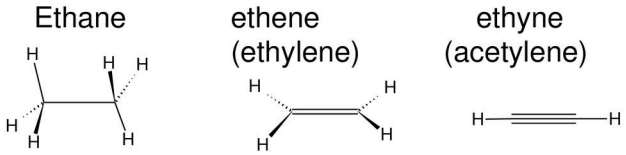
6) Cyclohexane has the molecular formula of C_6H_{12}. Draw it and four more constitutional isomers of C_6H_{12}. Then, name the isomers.



7) What type of bonds are the shortest bonds? Which are the weakest bonds?

The triple bond is shortest and strongest, and the single bond is the longest and weakest bond.

8) What is the s and p hybridization of the C atoms in the following compounds?



sp^3 sp^2 sp

9) What is the difference between saying something is sp^3 hybridized and that it has a tetrahedral structure?

Sp^3 hybridized refers to the electron domain geometry. Tetrahedral can refer to molecular geometry (4 bonds) or the hybridization (4 electron domains).

10) What constitutes a polar bond?

A large difference in electronegativities, while still being a covalent bond. One element of the bond (the one with higher electronegativity) will be slightly more possessive over the electrons of that bond.

11) What is a zero dipole moment?

A zero dipole moment is present when a compound has polar bonds, but they are equal and opposite in magnitude, so they essentially cancel each other out.

12) What are the three rules of electron configuration?

Pauli Exclusion Principle: Only 2 electrons fit in an orbital and they must have opposing spins.

Hund's Rule: Each orbital must have one electron before they double up.

Aufbau Principle: You fill the lowest energy orbitals first.

13) What is resonance?

Resonance is the ability to shift double or triple bonds. It increases stability of the compound, and actually allows the bond length to resemble something in between a single and double bond.

14) What is a conjugate acid-base pair?

It is either an acid or a base and its conjugate. A conjugate base will have one less H than its acid pair. A conjugate acid will have one more H than its base pair.

15) Define Bronsted-Lowry and Lewis acids and bases.

B-L acid = H+ donor
B-L base = H+ acceptor

Lewis acid = e- pair acceptor
Lewis base = e- pair donor

B-L acid-base reactions involve a transfer of protons, and Lewis acid-base reactions involve a transfer of electron pairs.

16) Explain how you might identify the above acids and bases.

Since a B-L acid donates a proton, it would need to have an H in its chemical formula. A B-L base might have a negative charge, which would make it willing to accept a proton. A Lewis acid might have a positive charge and be willing to accept an electron pair. A Lewis base has electron pairs to donate, and it might even have a negative charge.

17) There is an acid and conjugate base pair and a base and conjugate acid pair in the following reaction. What are they?

HCl is the acid on the reactants side, and its conjugate base is Cl^-.
NH_3 is the base on the reactants side, and its conjugate acid is NH_4^+

Acids: HCl and NH_4^+ Bases: NH_3 and Cl^-

18) What is the difference between a nucleophile and an electrophile?

A nucleophile is electron-rich (has a negative or partial negative) and seeks a positive center (will attack an electrophile). An electrophile is electron-deficient (has a positive or partial positive) and will be attacked by an electrophile.

19) Will a strong acid have a high or low pK_a?

Since pK_a is similar to pH, the lowest number will mean that you have a strong acid. Remember that regular alkanes have a pK_a of around 50, which means that they are very weak acids.

20) What is the relationship between the strength of an acid and the strength of its base?

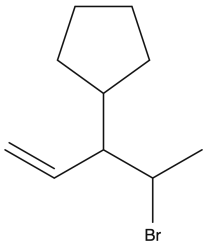
A strong acid will have a weak conjugate base and weak acid will have a strong conjugate base. The same is true for bases and their conjugate acids.

21) What is the Gibbs Free Energy equation?

$\Delta G = \Delta H - T\Delta S$

22) Name the following compounds.

a)

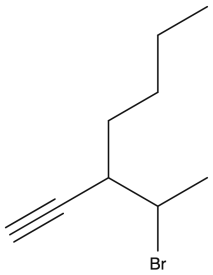


1-pentene, 3-cyclopentyl, 4-bromo

4-bromo-3-cyclopentyl-1-pentene

Or 4-bromo-3-cyclopentylpent-1-ene

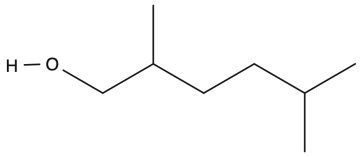
b)



1-pentyne (or pent-1-yne), 3-butyl, 4-bromo

4-bromo-3-butyl-1-pentyne

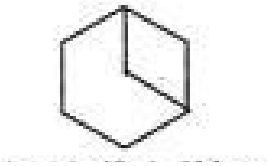
c)



1-hexanol, 2,5-dimethyl

2,5-dimethyl-1-hexanol (or 2,5-dimethylhexan-1-ol)

d)

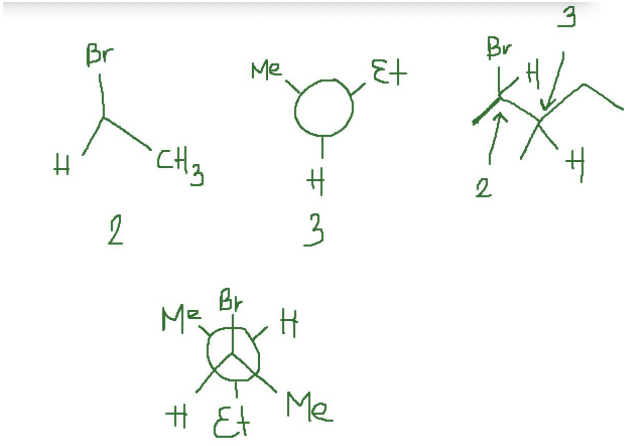


bicyclo[X.Y.Z]parent X = left, Y = right, Z = middle

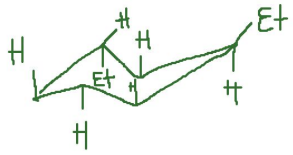
X = 3, Y = 1, Z = 1

Bicyclo[3.1.1]heptane

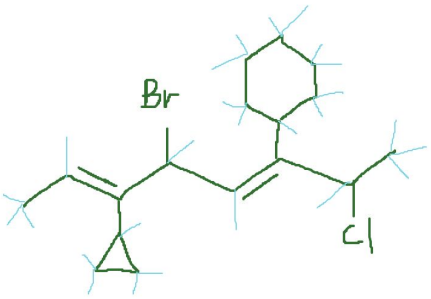
23) Draw the most stable conformation of 2-bromo-3-methylpentane, viewed through the C2-C3 bond (C-2 in the front, C-3 in the back).



24) Draw the most stable form of trans-1,3-diethylcyclohexane.



25) Calculate the index of hydrogen deficiency of
4-bromo-7-chloro-6-cyclohexyl-3-cyclopropyl-2,5-octa-diene.



$$\frac{2C+2+N-H-X}{2}$$

$$\frac{34+2+0-26-2}{2} = 4$$