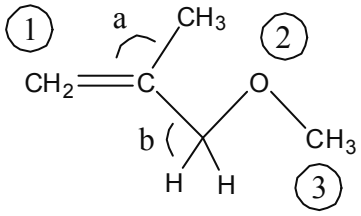
Answers to Questions for Review

Chem 1C Exam #1, Spring 09, Lingwood

1. Draw the Lewis structure of the krypton trifluoride ion, KrF_3^+. (28 electrons total, 2 lone pairs on Kr)
   a. What is the geometry of this ion? T-shaped
   b. What is the hybridization of the krypton atom? dsp^3
   c. What is the hybridization of the fluorine atoms? sp^3
   d. What are the formal charges of all atoms? Kr = +1 F = 0

2. Consider the molecule shown at right.



   a. How many π bonds are in this molecule? 1
   b. How many σ bonds are in this molecule? 15
   c. What is the geometry and hybridization of carbon 1?
      i. Trigonal planar, sp^2
   d. What is the geometry and hybridization of oxygen 2?
      i. Bent, sp^3
   e. What is the geometry and hybridization of carbon 3?
      i. Tetrahedral, sp^3
   f. What is the angle of "a"?
      i. 120 degrees
   g. What is the angle of "b"?
      i. 109.5 degrees

3. Draw the molecular orbital diagram for CN. (assume the orbitals are in the same order as N_2) σ_{2s}^2 σ_{2s}^{*2} π_{2p}^4 σ_{2p}^1
   a. What is the bond order of this molecule? 2.5
   b. Is this molecule paramagnetic? yes
   c. What do you have to do to change the bond order to 3?
      i. Add an electron to make the cyanide ion, CN^-
   d. Is your answer to part c) paramagnetic? no

4. Consider the three substances CO_2, CHF_3 and CH_3OH.
   a. List the dominant intermolecular forces for each molecule.
      i. CO_2: dispersion CHF_3: diploe-dipole CH_3OH: h-bonding
   b. Which molecule has the highest boiling point? CH_3OH
   c. Which molecule has the lowest melting point? CO_2

5. Consider the four molecules $CH_3CH_2CH_3$, CH_3COCH_3, CH_3CH_2OH and $HOCH_2OH$.
   a. Which has the highest boiling point? Highest IMF = $HOCH_2OH$
   b. Which has the lowest viscosity? Lowest IMF = $CH_3CH_2CH_3$
   c. Which has the highest ΔH_{vap}? Highest IMF = $HOCH_2OH$
   d. Which has the highest surface tension? Highest IMF = $HOCH_2OH$
   e. Which has the lowest vapor pressure? Highest IMF = $HOCH_2OH$

6. What type of solid does each substance form?
   a. $CH_3CH_2CH_3$ molecular
   b. $C_{diamond}$ atomic (covalent)
   c. Fe atomic (metallic)
   d. Ne atomic (non-bonding)
   e. $NaNO_3$ ionic

7. The normal boiling point of benzene is 80°C. What is the boiling point at a pressure of 350 torr? The ΔH_{vap} for benzene is 33.9 kJ/mol.

   You Have: P_1 = 1atm = 760 torr; T_1 = 80degC = 353.2K
   P_2 = 350 torr; T_2 = ?
   ΔH_{vap} = 33.9 kJ/mol; R = 8.3145 J / (mol K)

$$\ln\left(\frac{P_{vap}^{T1}}{P_{vap}^{T2}}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{760}{350}\right) = \frac{33900J}{8.3145Jmol^{-1}K^{-1}}\left(\frac{1}{T_2} - \frac{1}{353.2\,K}\right)$$

$$0.7754\frac{8.3145Jmol^{-1}K^{-1}}{33900J} = \frac{1}{T_2} - \frac{1}{353.2\,K}$$

$$1.902 \times 10^{-4} + \frac{1}{353.2\,K} = \frac{1}{T_2}$$

T_2 = 331K or 57.8°C

8. Consider the phase diagram of CO_2 at right.
    a. What happens to solid CO_2 at 1atm as you increase the temperature? sublimes
    b. Starting at the ●, what happens when you
        i. Increase the temperature
            1. Turns to gas
        ii. Decrease the temperature
            1. Turns to solid
        iii. Increase the pressure
            1. Turns to solid
        iv. Decrease the pressure
            1. Turns to gas