AP chemistry - Unit 6 Bonding Review

1. Use the principles of bonding and molecular structure to explain the following statements.
    a. Molecules of noble gases in the liquid phase are held together by London dispersion forces, which are weak interactions brought about by instantaneous polarities in nonpolar atoms and molecules. Atoms with more electrons are more easily polarized and experience stronger London dispersion forces. Argon has more electrons than neon, so it experiences stronger London dispersion forces and boils at a higher temperature.

    b. Sodium and potassium are held together by metallic bonds and positively charged ions in a delocalized sea of electrons. Potassium is larger than sodium, so the electrostatic attractions that hold the atoms together act at a greater distance, reducing the attractive force and resulting in its lower melting point.

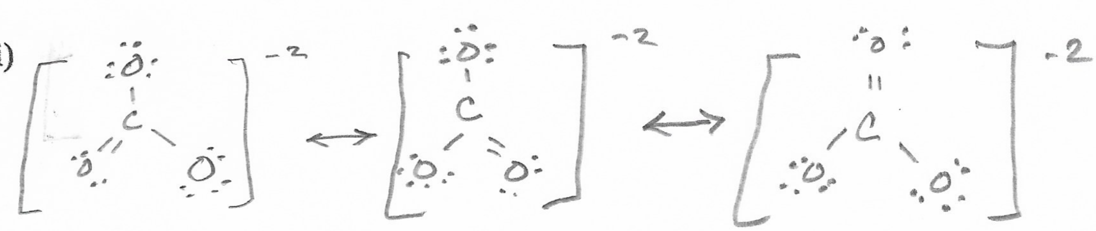
    c. Both $CaO_{(s)}$ and $KF_{(s)}$ are held together by ionic bonds in crystal lattices. Ionic bonds are held together by an electrostatic force, which can be determined by using Coulomb's law.

       CaO is more highly charged, with Ca^{+2} bonded to O^{-2} . So for CaO, Q, and Q, are +2and -2. KF is not as highly charged, with K^{+1} bonded to F^{-}. so for KF, Q, and Q, are +1 and -1. CaO is held together by stronger forces and is more difficult to break apart.

    d. KF is composed of K^{+} and F^{-} ions. In the liquid (molten) state, these ions are free to move and can thus conduct electricity. In the solid state, the K^{+} and F^{-} ions are fixed in a crystal lattice and their electrons are localized around them, so there is no charge that is free to move and thus no conduction of electricity.

2. (a)

(i)



(i)

(b) The central carbon atom forms three sigma bonds with oxygen atoms and has no free electron pairs, so its hybridization must be sp^2.

(c)

(i) All three bonds will be the same length because no particular resonance form is preferred over the others. The actual structure is an average of the resonance structures.

(ii) The C-O bonds in the carbonate ion have resonance forms between single and double bonds, while the C-O bonds in carbon dioxide are both double bonds. The bonds in the carbonate ion will be shorter than single bonds and longer than double bonds, so the carbonate bonds will be longer than the carbon dioxide bonds.

3. (a)

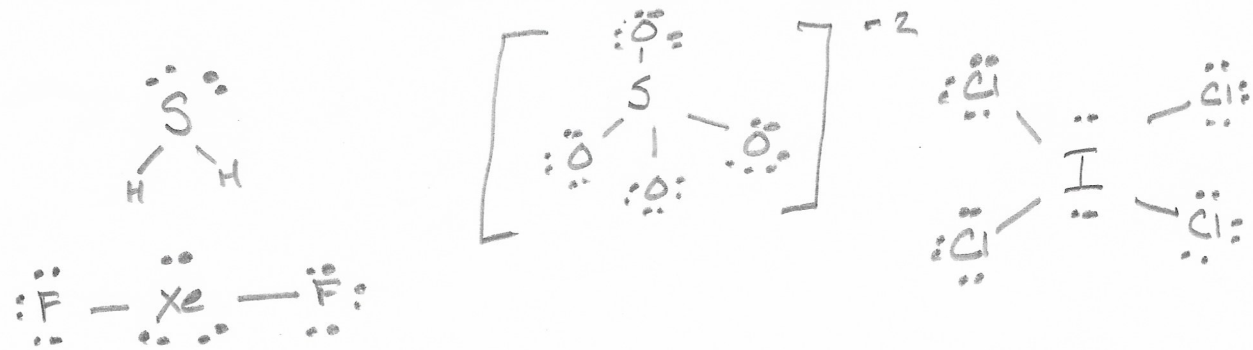
(i) The bond strength of N_2, is larger than the bond strength of O_2, because N_2, molecules have triple bonds and O_2, molecules have double bonds. Triple bonds are stronger and shorter than double bonds.

(ii) The bond length of H_2 is smaller than the bond length of Cl_2 because hydrogen is a smaller atom than chlorine, allowing the hydrogen nuclei to be closer together.

(iii) Liquid oxygen and liquid chlorine are both nonpolar substances that experience only London dispersion forces of attraction. These forces are greater for Cl_2 because it has more electrons (which makes it more polarizable), so Cl_2 has a higher boiling point than O_2.

(b) H_2 and O_2 are both nonpolar molecules that experience only London dispersion forces, which are too weak to form the bonds required for a substance to be liquid at room temperature. H_2O is a polar substance whose molecules form hydrogen bonds with each other.

4. (a)



(b) H_2S has two bonds and two free electron pairs on the central S atom. The greatest distance between the electron pairs is achieved by tetrahedral arrangement. The electron pairs at two of the four corners will cause the molecule to have a bent shape, like water. SO_4^{-2} has four bonds around the central S atom and no free electron pairs. The four bonded pairs will be farthest apart when they are arranged in a tetrahedral shape, so the molecule is tetrahedral. XeF_2, has two bonds and three free electron pairs on the central Xe atom. The greatest distance between the electron pairs can be achieved by a trigonal bipyramidal arrangement. The three free electron pairs will occupy the equatorial positions, which are 120 degrees apart, to minimize repulsion. The two F atoms are at the poles, so the molecule is linear. ICL_4^- has four bonds and two free electron pairs on the central I atom. The greatest distance between the electron pairs can be achieved by an octahedral arrangement. The two free electron pairs will be opposite each other to minimize repulsion. The four Cl atoms are in the equatorial positions, so the molecule is square planar.

5. (a) BF_3 has three bonds on the central B atom and no free electron pairs, so the structure of BF_3 is trigonal planar, with each of the bonds 120° degrees apart. NF_3 has three bonds and one free electron pair on the central N atom. The four electron pairs are pointed toward the corners of a tetrahedron, 109.5° degrees apart. The added repulsion from the free electron pair causes the N-F bonds to be even closer together, and the angle between them is more like 107°.

(b) Polar solvents are best at dissolving polar solutes. Nonpolar solvents are best at dissolving nonpolar solutes.

$I_{2(s)}$ is nonpolar, so it dissolves better in carbon tetrachloride, CCl_4, which is nonpolar, than in water, H_2O, which is polar.

(c) The carbon atoms in diamond are bonded together in a tetrahedral network, with each carbon atom bonded to three other carbon atoms. The tetrahedral structure of the network bonds does not leave any seams along which the diamond can be broken, so a diamond behaves as one big molecule with no weaknesses.

(d) HBr and HCl are polar molecules. In liquid form, both substances are held together by dipole dipole interactions. These interactions are stronger for molecules with more electrons, so HBr has stronger intermolecular bonds and a higher boiling point.

HF has a higher boiling point than HCl because HF undergoes hydrogen bonding, while HCl does not; this causes HF to remain liquid at higher temperatures than HCI, although HF is a polar molecule with fewer electrons than HCl.