Class Assignment 1 (Chapter 2)_Chemical Bonding
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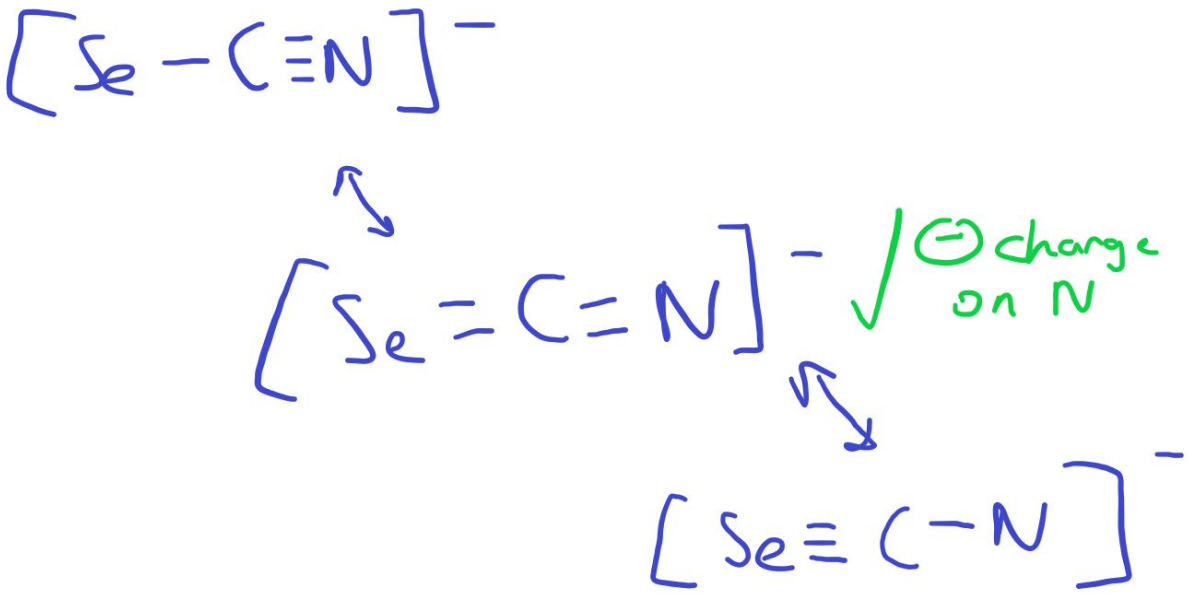
Questions (20 pts):

Q1. Draw each possible resonance structure for the following molecule and select the resonance structure likely to provide the best description of the ion.

Selenocyante ion, SeCN



Q2. Give Lewis dot structures and sketch the shapes of the following. Write the name of the geometry.

(a) $SeCl_4$

Se forms four sigma bonds with four Cl atoms and is left with one lone pair. It forms a geometric see saw shape.

(b) I_3^-

The central I has 7 valence electrons because of the negative charge. The geometric shape is linear.

(c) $PSCl_3$ (P is central)

The central P atom has four sigma bonds and no lone pairs. It is a tetrahedral shape.

(d) IF_4^-

The central I has four sigma bonds and 2 lone pairs. The shape is square planar.

(e) PH_2^-

The P has two sigma bonds and has two lone pairs. The ion is nonlinear.

(f) TeF_4^{2-}

Te atom has four sigma bonds and 2 lone pairs. The shape is square planar.

(g) N_3^-

The central N atom has 2 sigma bonds and no lone pairs. The geometric shape is linear.

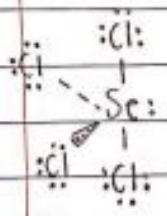
h) $SeOCl_4$ (Se is central)

Se has 5 sigma bonds and no lone pairs. The geometric shape is trigonal bipyramidal.

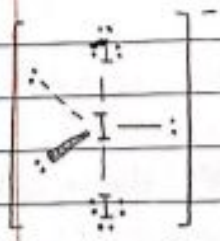
(i) PH_4^+

The P atom has four sigma bonds and no lone pairs. The geometric shape is tetrahedral.

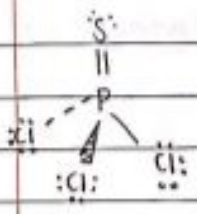
a.)



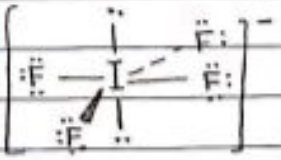
b.)



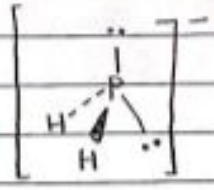
c.)



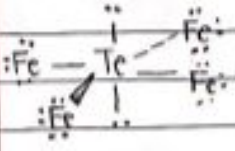
d.)



e.)

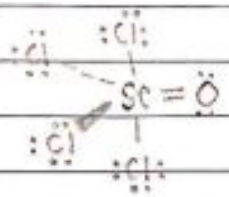


f.)

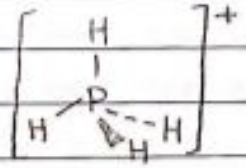


g.) $[\ddot{N}=N=\ddot{N}]^-$

h.)



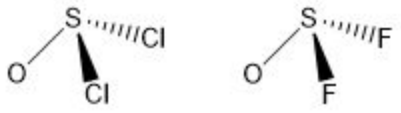
i.)



Q3. Select from each set the molecule or ion having the smallest bond angle, and briefly explain your choices.

(a) NH_3, PH_3, AsH_3

AsH_3 would be the molecule with the smallest bond angle. Since the central atoms are changing, the atom with the lowest electronegativity will give the smallest bond angle due to less repulsion with less electrons closer to the central atom.

(b) 

(halogen-sulfur-halogen angle)

OSF_2 will have the smaller bond angle because Cl is less electronegative than F, which means the electrons are shared closer to the central atom, causing the bond angle to increase due to repulsion in $OSCl_2$. Therefore, the bond angle in OSF_2 is smaller.

(c) NO_2^- or O_3

NO_2^- has the smallest bond angle. This is because we are swapping the central atom from N in NO_2^- to O in O_3 , since N is less electronegative than O, the bond will be smaller in NO_2^- due to less repulsion.

(d) ClO_3^- or BrO_3^-

BrO_3^- will have the smallest bond angle. SImilarly to (a), here since the central atoms are changing, the atom with the lowest electronegativity will give the smallest bond angle due to less repulsion, being Br.

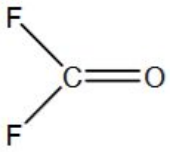
Q4. Explain PCl_5 is a stable molecule, but NCl_5 is not.

PCl_5 has d-orbitals to expand its octet. NCl_5 does not have any d-orbitals since nitrogen is only in the second energy level. There is nowhere for any extra electrons to bond to the central nitrogen atom to expand the octet to become a hypervalent atom.

Q5. Which has longer axial P-F distance, $PF_2(CH_3)_2$ or $PF_2(CF_3)_2$? Explain briefly.

$PF_2(CH_3)_2$ has a longer axial P-F distance because $PF_2(CF_3)_2$ has more electronegative atoms (more Fluorine atoms) in its structure. The CF_3 groups pull more electrons from the central P atom, which in turn pulls in the F atoms due to having a greater partial positive charge. Therefore, $PF_2(CF_3)_2$ has a shorter distance, and $PF_2(CH_3)_2$ is longer.

Q6. The F-C-F angle in F_2CO, shown here, is 109.5^0; the C-F distance is 131.7 pm, and the F….F distance is 215 pm. On the basis of the LCP model, predict the C-F distance in the CF_3^+ ion.

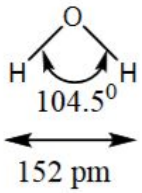


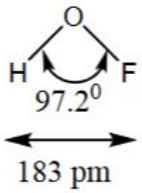
The F-C-F bond angle would be 120° because the molecule is trigonal planar.

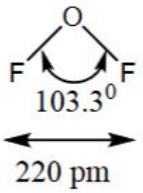
sin (120°/2) = ½*(215 pm) / x

X = 107.5/sin(60°) = 124 pm

Q7. Provide a rationale for HOF having the smallest bond angle in the following set. H radius is 76 pm (half of H…..H bond distance) and F radius is 110 pm (half of F…..F) bond distance.







H_2O has repulsion, both Hydrogen atoms would be attracted to the Oxygen atom and away from each other. Both Hydrogen atoms would have the same radius and would cover the same area.

HOF has attraction because the Hydrogen atom would be attracted to the Oxygen atom, but the Fluorine atom would be repelled from the Oxygen atom because Fluorine is more electronegative than Oxygen and would not be attracted to it.

F_2O has repulsion because both Fluorine atoms would be repelled by the central Oxygen atom because of how electronegative each atom is.