Pre-workshop Problems

1. Draw a Lewis Dot diagram for each of the following atoms or ions. Which ones obey the octet rule?

   a. Na
      \[
      \text{Na}^+ \quad \text{does not obey octet rule, since} \quad 1s^2 2s^2 2p^6
      \]

   b. Na^+
      \[
      [\text{Na}]^+ \quad \text{obeys octet rule, since} \quad 1s^2 2s^2 2p^6
      \]

   c. P
      \[
      [P:]^3 \quad \text{does not obey octet rule (only 6 valence e\textsuperscript{-})}
      \]

   d. O^2-
      \[
      [O:]^2 \quad \text{obeys octet rule (8 valence e\textsuperscript{-})}
      \]

   e. I
      \[
      [I:] \quad \text{obeys octet rule (8 valence e\textsuperscript{-})}
      \]

   f. F
      \[
      [:F:] \quad \text{does not obey octet rule (only 7 valence e\textsuperscript{-})}
      \]

2. Predict how many bonds each of the following atoms will typically form in stable complexes. Draw a Lewis dot diagram for each.

   a. P
      \[
      \text{P} \quad \text{can make 3 bonds}
      \]

   b. Cl
      \[
      \text{Cl} \quad \text{one more e\textsuperscript{-} (one bond)}
      \]

   c. H
      \[
      \text{H} \quad \text{one more bond}
      \]

   d. Ar
      \[
      \text{Ar} \quad \text{no more e\textsuperscript{-} (already filled)}
      \]
3. Predict formulas for compounds that would form between the following pairs of atoms. Draw Lewis Structures for each molecule you predict.

a. S and H

\[ \begin{array}{c}
\cdot \quad S \\
\downarrow \\
\cdot \quad H
\end{array} \quad \text{or} \quad \begin{array}{c}
\cdot \quad S \\
\downarrow \\
\cdot \quad H \quad H\cdot \cdot \cdot \cdot \cdot H
\end{array} \]

\[ \text{H}_2\text{S} \]

b. P and Cl

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ \text{PCl}_3 \]

c. N and F

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ \text{NF}_3 \]

d. I and H

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \text{I} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ \text{HI} \]

4. Each of the following diatomic molecules is stable. Draw a structure for each that obeys the octet rule and has the proper number of electrons. When you draw a stable Lewis Structure for each molecule, how many bonds are formed between the two atoms?

a. O$_2$

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ O = O \quad 0 = 6 \times 2 = 12e^- \]

b. F$_2$

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ F - F \quad F = 7 \times 2 = 14e^- \]

c. N$_2$

\[ \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \quad \begin{array}{c}
\cdot \\
\downarrow \\
\cdot
\end{array} \]

\[ N = 5 \times 2 = 10e^- \]

Note: This is not the actual structure of O$_2$.  
Cooperative Group Problems

1. Without looking up values for the electronegativity of each element, decide whether the electronegativity difference for each pair of elements is large or small. Explain your reasoning.

   a. H and C
   - Small (they are seen as though they're far from each other, but they're actually similar since they're closer to the left side of the table)

   b. Si and F
   - Large (fluorine is definitely more electronegative than Si, which is towards the left side of the table)

   c. Rb and Cl
   - Largest (they are placed on opposite sides of the periodic table)

   d. O and F
   - Intermediate (they are placed pretty closely to each other but F is definitely more electronegative)

2. For each of the following bonds, predict whether it will be a non-polar covalent bond, a polar bond, or an ionic bond?

   a. H-F
   - Polar bond
   - Covalent

   b. S-F
   - Polar bond
   - Covalent

   c. Mg-Cl
   - Ionic bond

   d. I-I
   - Non-polar bond
   - Covalent
3. Draw a Lewis Structure for each molecule or ion. How many lone pairs of electrons are on each central atom?

a. water

\[ \text{H}_2\text{O} \quad \text{or} \quad \text{H} = \text{O} = \text{H} \]

b. hydrogen fluoride

\[ \text{HF} \]

\[ \text{H} - \text{F} \]

c. phosphine (PH\textsubscript{3})

\[ \text{PH}_3 \]

\[ \text{H} - \text{P} - \text{H} \]

\[ \text{H} \]

d. nitrate

\[ \text{NO}_3^- \]

\[ \text{[O} - \text{N} = \text{O}] \]
e. oxygen difluoride

\[
\text{OF}_2
\]

f. sulfate

\[
\text{SO}_4^{2-}
\]

\[
\begin{align*}
\text{O} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{S} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{O} & \\
\end{align*}
\]

\[
\begin{align*}
\text{O} \\
\text{S} = \cdot \\
\text{O} \\
\end{align*}
\]

g. sulfur trioxide

\[
\text{SO}_3
\]

\[
\begin{align*}
\text{O} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{S} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{O} & \\
\end{align*}
\]

h. formaldehyde (CH₂O with C as the central atom)

\[
\begin{align*}
\text{H} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{C} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{H} & \\
\end{align*}
\]

\[
\text{O}
\]

i. sulfur tetrafluoride

\[
\text{SF}_4
\]

\[
\begin{align*}
\text{F} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{S} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{F} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\text{F} & \quad \quad \quad \quad \quad \quad \quad \quad \\
\end{align*}
\]

The next all have an expanded octet

(Read p313 for exceptions to the octet)

Expanded octet

(more than 8 valence e⁻)
j. sulfur hexafluoride

\[ SF_6 \]

\[ S = 6 \]

\[ F = 7(6) = \frac{42}{48} \]

k. iodine trifluoride

\[ ICl_3 \]

l. xenon difluoride

\[ XeF_2 \]

\[ Xe = 8 \]

\[ F = 7 \times 2 = 14 \]

\[ 22e^- \]

noble gas

(same as form bond!)