CH 221 Practice Problem Set #4

*This is a **practice problem set** and not the actual graded problem set that you will turn in for credit.*
Answers to each problem can be found at the end of this assignment.

Covering: **Chapter Four** *and* **Chapter Guide Four**
Important Tables and/or Constants: "**Geometry and Polarity Guide**" (summary of molecular geometries and polarities *Handout* in *Companion or here:* https://mhchem.org/geopo*)*

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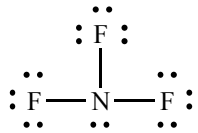
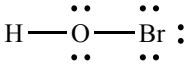
1. Give the periodic group number and number of valence electrons for each of the following atoms.
   a. O b. B c. Na d. Mg e. F f. S
2. Which of the following elements are capable of forming compounds in which the indicated atom has more than four valence electron pairs?
   a. N b. As c. C d. O e. Br f. Be g. S h. Se
3. Draw a Lewis structure for each of the following molecules.
   a. NF_3 b. $CHClF_2$ c. HOBr d. CH_3CN
4. Draw a Lewis structure for each of the following molecules or ions.
   a. BrF_3 b. I_3^{1-} c. XeO_2F_2 d. XeF_3^{1+}
5. Draw a Lewis structure for each of the following molecules or ions. Describe the electron-pair geometry and the molecular geometry around the central atom.
   a. NH_2Cl b. Cl_2O (O is the central atom) c. SCN^{1-} (C is the central atom) d. HOF
6. Draw a Lewis structure for each of the following molecules or ions. Describe the electron-pair geometry and the molecular geometry around the central atom.
   a. ClF_2^{1-} b. ClF_3 c. ClF_4^{1-} d. ClF_5
7. Give approximate values for the indicated bond angles.
   a. O-S-O in SO_2
   b. F-B-F angle in BF_3
   c. Cl-C-Cl angle in Cl_2CO
8. Determine the formal charge on each atom in the following molecules and ions.
   a. NO_2^{+1} b. NO_2^{1-} c. NF_3 d. HNO_3
9. For each of the bonds below, Tell which atom is the more negatively charged using values of electronegativity in your textbook to support your answer..
   a. C-O b. P-Cl c. B-O d. B-F
10. In the following list of compounds, which bond is the most polar? Which compound(s) are nonpolar? Which atom in ClF is more negatively charged?
    a. H_2O b. NH_3 c. CO_2 d. ClF e. CCl_4
11. Three resonance structures are possible for dinitrogen monoxide, N_2O.
    a. Draw the three resonance structures.
    b. Calculate the formal charge on each atom in each resonance structure.
    c. Based on formal charges and electronegativity, predict which resonance structure is the most reasonable.
12. Give the bond order for each bond in the following molecules or ions.
    a. CH_2O b. CO_2 c. NO_2^{1+} d. CH_4

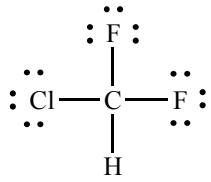
13. Nitric acid, HNO_3, has three resonance structures. One of them, however, contributes much less to the resonance hybrid than the other two. Sketch the three resonance structures and assign a formal charge to each atom. Which one of your structures is the least important?
14. Draw the Lewis structure of ammonium nitrate.

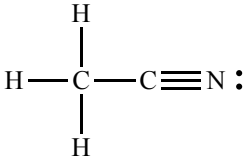
Answers to the Practice Problem Set:

1. *Answers:*
   a. O Group 6A 6 valence electrons
   b. B Group 3A 3 valence electrons
   c. Na Group 1A 1 valence electron
   d. Mg Group 2A 2 valence electrons
   e. F Group 7A 7 valence electrons
   f. S Group 6A 6 valence electrons
2. b. As e. Br g. S h. Se (all third period or lower)
3. *Answers:*

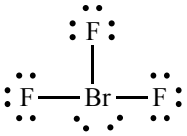
a. 

c. 

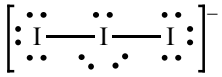
b. 

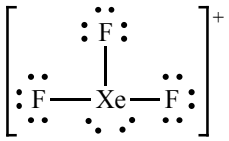
d. 

4. *Answers:*

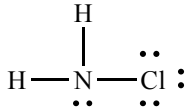
a. 

c.

b. 

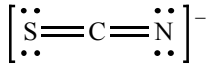
d. 

5. *Answers:*

a. 

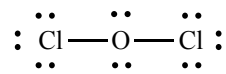
electron pair geometry, tetrahedral

molecular geometry, trigonal pyramidal

c. 

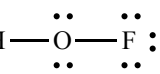
electron pair geometry, linear

molecular geometry, linear

b. 

electron pair geometry, tetrahedral

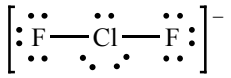
molecular geometry, bent

d. 

electron pair geometry, tetrahedral

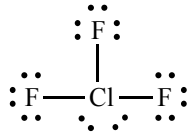
molecular geometry, bent

6. *Answers:*

a. 

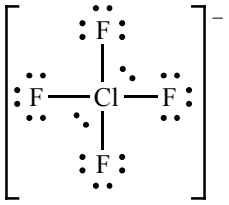
electron-pair geometry, trigonal bipyramid

molecular geometry, linear

b. 

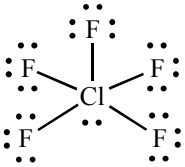
electron-pair geometry = trigonal bipyramid

molecular geometry, T-shaped

c. 

electron-pair geometry, octahedral

molecular geometry, square planar

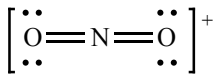
d. 

electron-pair geometry, octahedral

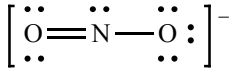
molecular geometry, square pyramidal

7. a. 120° b. 120° c. 120°

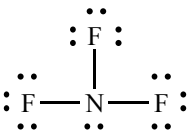
8. *Answers:*

a. 

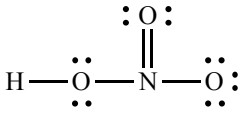
O = 6 – 4 – $^1/_2$(4) = 0
N = 5 – 0 – $^1/_2$(8) = 1

b. 

O = 6 – 4 – $^1/_2$(4) = 0
N = 5 – 2 – $^1/_2$(6) = 0
O = 6 – 6 – $^1/_2$(2) = –1

c. 

F = 7 – 6 – $^1/_2$(2) = 0
N = 5 – 2 – $^1/_2$(6) = 0

d. 

H = 1 – 0 – $^1/_2$(2) = 0
O = 6 – 4 – $^1/_2$(4) = 0
N = 5 – 0 – $^1/_2$(8) = 1
O = 6 – 4 – $^1/_2$(4) = 0
O = 6 – 6 – $^1/_2$(2) = –1

9. *Answers:*

a.	C—O	O	2.5 - 3.5
b.	P—Cl	Cl	2.2 - 3.2
c.	B—O	O	2.9 - 3.5
d.	B—F	F	2.0 - 4.0

10. Answers:

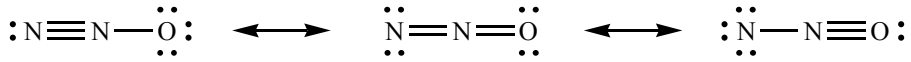
Molecule	$\Delta\chi$ for bond
H_2O	O—H = 3.5 – 2.1 = 1.4
NH_3	N—H = 3.0 – 2.1 = 0.9
CO_2	O—C = 3.5 – 2.5 = 1.0
ClF	F—Cl = 4.0 – 3.0 = 1.0
CCl_4	Cl—C = 3.0 – 2.5 = 0.5

(i) The bonds are most polar in H_2O (biggest $\Delta\chi$)

(ii) CO_2 and CCl_4 are nonpolar molecules.

(iii) The F atom in ClF is more negatively charged.

11. Answers:

a. 

b.

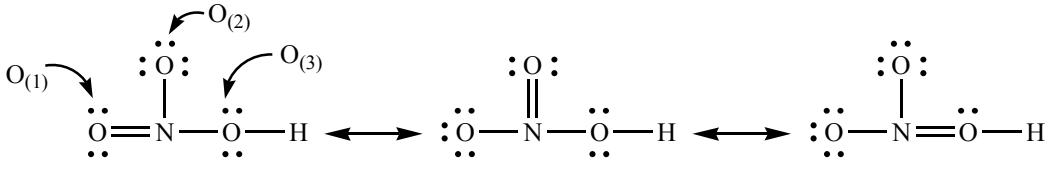
$N = 5 - 2 - {}^1/_2(6) = 0$	$N = 5 - 4 - {}^1/_2(4) = -1$	$N = 5 - 6 - {}^1/_2(2) = -2$
$N = 5 - 0 - {}^1/_2(8) = 1$	$N = 5 - 0 - {}^1/_2(8) = 1$	$N = 5 - 0 - {}^1/_2(8) = 1$
$O = 6 - 6 - {}^1/_2(2) = -1$	$O = 6 - 4 - {}^1/_2(4) = 0$	$O = 6 - 2 - {}^1/_2(6) = 1$

c. The first resonance structure is most reasonable (the most electronegative element, oxygen, has a negative formal charge).

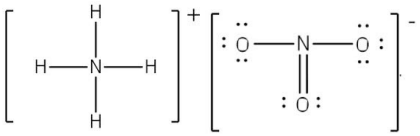
12. Answers:

a.	H_2CO	two carbon-hydrogen single bonds	bond order = 1
		one carbon-oxygen double bond	bond order = 2
b.	CO_2	two carbon-oxygen double bonds	bond order = 2
c.	NO_2^+	two nitrogen-oxygen double bonds	bond order = 2
d.	CH_4	four carbon-hydrogen single bonds	bond order = 1

13. Answers:



$O_{(1)} = 0$	$O_{(1)} = -1$	$O_{(1)} = -1$
$O_{(2)} = -1$	$O_{(2)} = 0$	$O_{(2)} = -1$
$O_{(3)} = 0$	$O_{(3)} = 0$	$O_{(3)} = 1$
H = 0	H = 0	H = 0
N = 1	N = 1	N = 1

The third resonance structure is the least important since it has a positive formal charge on one of the oxygen atoms.

14.