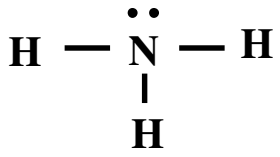
Unit 1, Lesson 08: Answers to Homework on Variations of Covalent Bonding by the Octet Rule

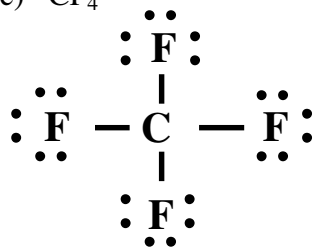
1. Read pages 173 to 177.
2. Questions on page 177, questions 9 – 13. For questions 9 and 12, you do not need the "system".

Page 177, Question 9:

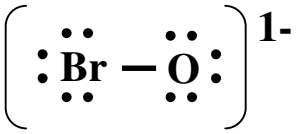
a) NH_3



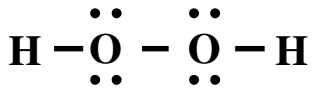
c) CF_4



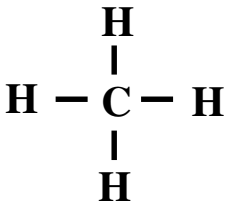
e) BrO^-



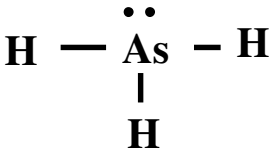
g) H_2O_2



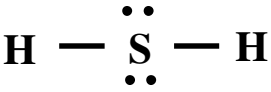
b) CH_4



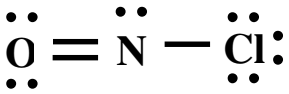
d) AsH_3



f) H_2S



h) $C\ell NO$



(because N has the lowest EN, it is the central atom)

Page 177, Question 10

a) CO_3^{2-} The central atom is carbon

1. **We *have*:**
   - 1 x 4 valence electrons for carbon = 4
   - 3 x 6 valence electrons for oxygen = 18
   - charge of 2- on the ion = 2

   } we ***have*** 24 valence electrons

2. **We *need*:**
   - 1 x 8 valence electrons for carbon = 8
   - 3 x 8 valence electrons for oxygen = 24

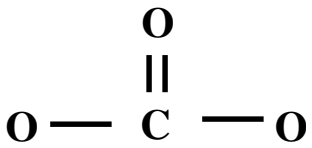
   } we ***need*** 32 valence electrons

3. The **number of electrons in bonds:**
   - we ***need*** 32 valence electrons
   - we ***have*** 24 valence electrons

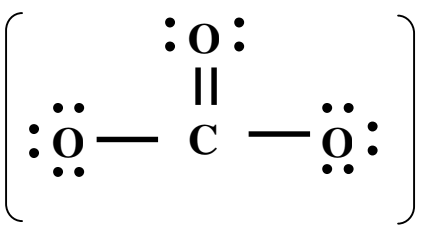
   } (32 – 24) = 8 electrons must be shared in bonds

4. **The number of bonds is:** 8 electrons in bonds)2 electrons per bond = 4 bonds

5. **Skeleton structure:** (four bonds)



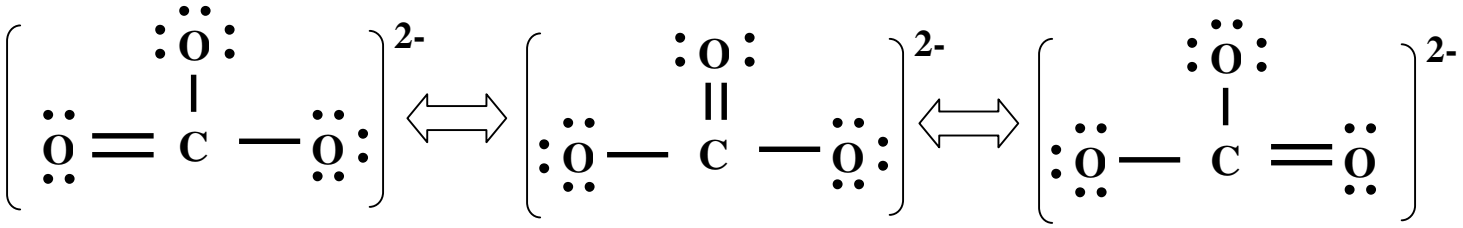
6. **Draw in the lone pairs**
   - we ***have*** 24 valence electrons but 8 of these are bonded
   - there are (24 – 8) = 16 electrons to be added as lone pairs



7. **Complete the Lewis structure:**
   - add the lone pairs to complete stable octets for all atoms
   - for ions, draw brackets and include the charge on the ion

Structure of CO_3^{2-} (continued)

- because there is one double bond and two single bonds between C and O, this molecule will form resonance structures:



Page 177, Question 10:

b) NO^{1+}

1. **We *have*:** 1 x 5 valence electrons for nitrogen = 5
   1 x 6 valence electrons for oxygen = 6
   charge of 1+ on the ion = -1
   } we ***have*** 10 valence electrons

2. **We *need*:** 1 x 8 valence electrons for nitrogen = 8
   1 x 8 valence electrons for oxygen = 8
   } we ***need*** 16 valence electrons

3. The **number of electrons in bonds:** we ***need*** 16 valence electrons
   we ***have*** 10 valence electrons
   } (16 – 10) = 6 electrons must be shared in bonds

4. **The number of bonds is:** 6 electrons in bonds)2 electrons per bond = 3 bonds

5. **Skeleton structure:** (three bonds) 

6. Draw **in the lone pairs**
   - we ***have*** 10 valence electrons but 6 of these are bonded
   - there are (10 – 6) = 4 electrons to be added as lone pairs

7. **Complete the Lewis structure:**
   - add the lone pairs to complete stable octets for all atoms
   - for ions, draw brackets and include the charge on the ion

- because there is one only one triple bond, there are no resonance structures

c) $\mathbf{C\ell O_3^{1-}}$ chlorine is the central atom

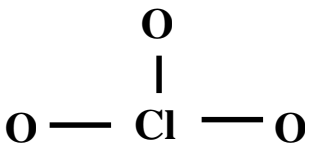
1. **We *have*:** 1 x 7 valence electrons for chlorine = 7
   3 x 6 valence electrons for oxygen = 18
   charge of 1- on the ion = 1
   } we ***have*** 26 valence electrons

2. **We *need*:** 1 x 8 valence electrons for chlorine = 8
   3 x 8 valence electrons for oxygen = 24
   } we ***need*** 32 valence electrons

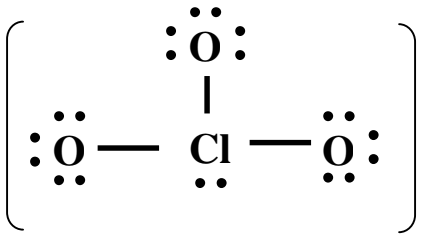
3. The **number of electrons in bonds:** we ***need*** 32 valence electrons
   we ***have*** 26 valence electrons
   } (32 – 26) = 6 electrons must be shared in bonds

4. **The number of bonds is:** 6 electrons in bonds)2 electrons per bond = 3 bonds

5. **Skeleton structure:**
   (three bonds)



6. Draw **in the lone pairs**
- we ***have*** 26 valence electrons but 6 of these are bonded
- there are (26 – 6) = 20 electrons to be added as lone pairs



7. **Complete the Lewis structure:**
- add the lone pairs to complete stable octets for all atoms
- for ions, draw brackets and include the charge on the ion

- because there are only single bonds, there are no resonance structures

d) SO_3^{2-} The central atom is sulfur

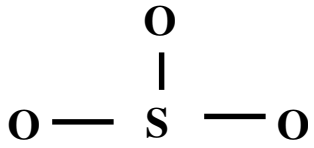
1. **We *have*:** 1 x 6 valence electrons for sulfur = 6
   3 x 6 valence electrons for oxygen = 18
   charge of 2- on the ion = 2
   } we ***have*** 26 valence electrons

2. **We *need*:** 1 x 8 valence electrons for sulfur = 8
   3 x 8 valence electrons for oxygen = 24
   } we ***need*** 32 valence electrons

3. The **number of electrons in bonds:** we ***need*** 32 valence electrons
   we ***have*** 26 valence electrons
   } (32 – 26) = 6 electrons must be shared in bonds

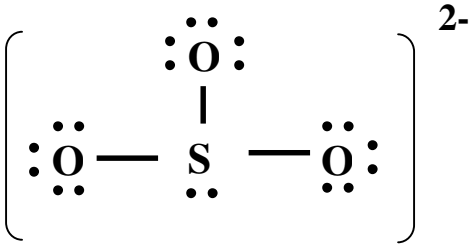
4. **The number of bonds is:** 6 electrons in bonds)2 electrons per bond = 3 bonds

5. **Skeleton structure:** (three bonds)

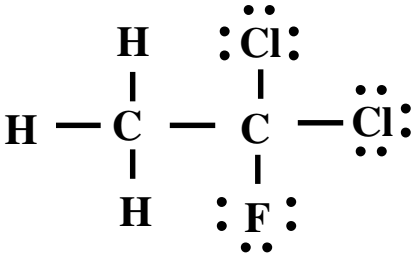


6. **Draw in the lone pairs**
- we ***have*** 26 valence electrons but 6 of these are bonded
- there are (26 – 6) = 20 electrons to be added as lone pairs

7. **Complete the Lewis structure:**
- add the lone pairs to complete stable octets for all atoms
- for ions, draw brackets and include the charge on the ion
- because there are only single bonds, there are no resonance structures



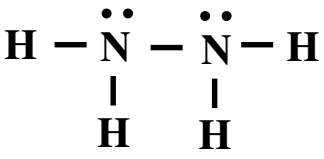
Page 177, Question 11
CH_3CFCl_2



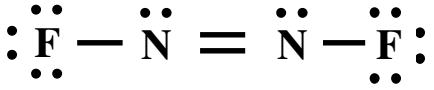
the order of the F and Cℓ on the second atom does not matter

Page 177, Question 12:

a) N_2H_4

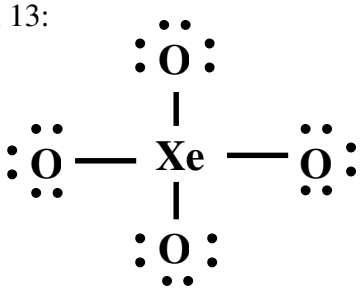


b) N_2F_2



Page 177, Question 13:

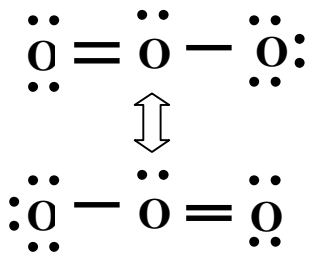
XeO_4



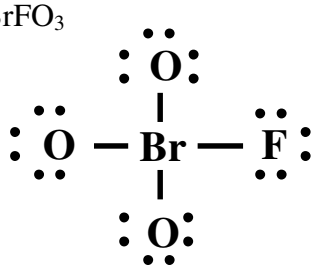
all four bonds in the XeO_4 molecule must be coordinate covalent bonds

3. Draw Lewis structures for ozone (O_3), $BrFO_3$, NH_4^{1+}, NO_3^{1-}, NO_2^{1-}, CO, $C\ell F_2^{1+}$, SeO_3^{2-}. Include any resonance structures.

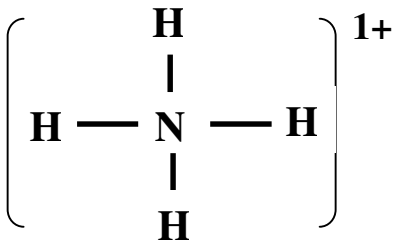
Ozone (O_3)



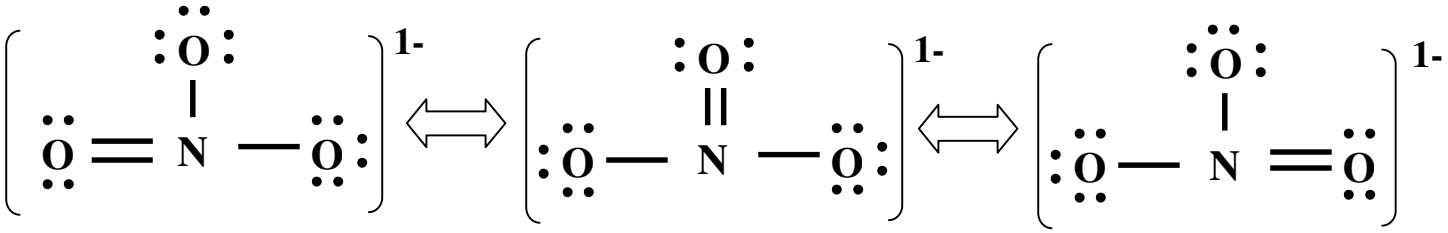
$BrFO_3$



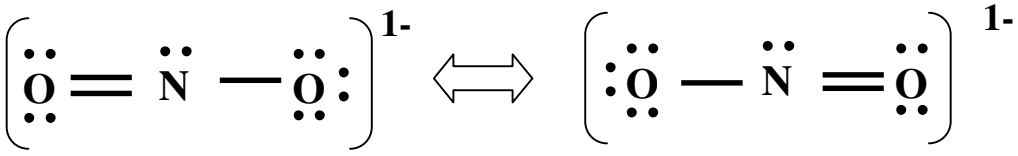
NH_4^{1+}



NO_3^{1-} (because of the double bond and two single bonds, there are three resonance structures)

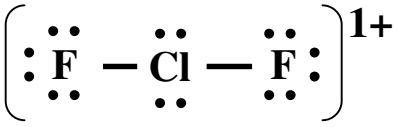


NO_2^{1-} (because of the double bond and one single bond, there are two resonance structures)



CO

$C\ell F_2^{1+}$



SeO_3^{2-}