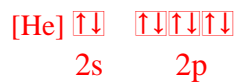
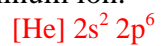


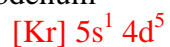
Practice Exam for Exam III

1. Write *electron configurations* and *orbital diagrams* for the following atoms or ions.

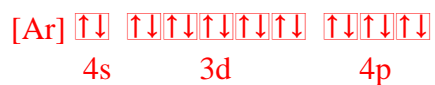
a. Aluminum ion.



b. Molybdenum

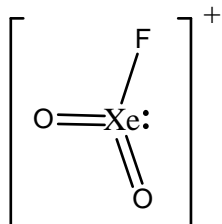


c. Selenide ion



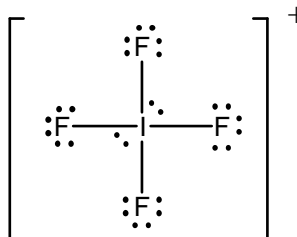
2. For the following compounds draw the *electron dot structure*. For any that are covalently bonded also give:
- the electron pair and molecular geometries*
 - the polarity of the molecule* (polar or not)
 - the hybridization on the central atom*
 - whether or not there is resonance*
 - the number of sigma and pi bonds in the molecule.*

a. XeO_2F^+



EG = Tetrahedral
 MG = Trigonal pyramidal
 Polar
 sp^3
 no resonance
 $3 \sigma, 2 \pi$

b. IF_4^-



EG = Octahedral
 MG = Square planar
 Non-Polar
 sp^3d^2
 no resonance
 $4 \sigma, 0 \pi$

3. The energy required to dissociate the Cl_2 molecule is 239 kJ/mol. If the dissociation of a Cl_2 molecule were accomplished by the absorption of a single photon whose energy was exactly the quantity required, what would be its wavelength (in meters)?

Energy per molecule:

$$? \frac{\text{J}}{\text{molecule}} = \frac{239 \text{ kJ}}{\text{mol}} \times \frac{10^3 \text{ J}}{1 \text{ kJ}} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecule}} = 3.968 \times 10^{-19} \text{ J}$$

Wavelength of photon with above energy:

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{(6.6261 \times 10^{-34} \text{ J s})(2.9979 \times 10^8 \text{ m s}^{-1})}{3.968 \times 10^{-19} \text{ J}} = 5.01 \times 10^{-7} \text{ m}$$

4. Multiple choice. Write the *best answer on the line*.

B i. In molecular orbital theory, a bonding orbital has an energy that is _____ than the energy of the atomic orbitals from which it came.

- a. higher b. lower c. the same d. none of the above

D ii. A molecule that has 5 total groups of electron and 1 group of non-bonding electrons has a central atom that has what hybridization?

- a. sp b. sp² c. sp³ d. sp³d

C iii. A molecule that has linear molecular geometry and trigonal bipyramidal electron geometry has how many lone pairs?

- a. 1 b. 2 c. 3 d. 3.5

A iv. A molecule that has a zero bond order is:

- a. unstable b. very stable c. no way to tell d. none of the above.

C v. When a bond is formed, energy is:

- a. all over b. absorbed c. released d. both a and b

D vi. Which of the following molecular geometries is polar (assume all outer atoms are the same)?

- a. tetrahedral b. trigonal planar c. linear d. square pyramidal

C vii. A molecule with 6 total groups of electron and 5 bonding groups has a molecular geometry that is:

- a. linear b. square planar c. square pyramidal d. trigonal pyramidal

B viii. Period three and higher atoms can form “expanded octets” because they have:

- a. special abilities b. d-orbitals c. p-orbitals d. s-orbitals

B ix. Molecules that have all electrons paired are:

- a. paramagnetic b. diamagnetic c. stupid d. not possible

D x. A molecule’s polarity is determined by:

- a. unpaired electrons b. geometry c. polar bonds d. all of the above

5. Miscellaneous questions.

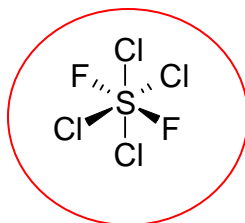
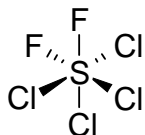
a. Arrange the following atoms in order of *decreasing size*: Cl, Cs, Li, He



b. Arrange the following ions in order of *increasing size*: N^{3-} , O^{2-} , F^- , Cl^-



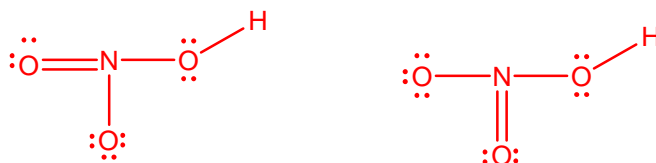
c. Which molecule should be *less polar* (Circle correct answer):



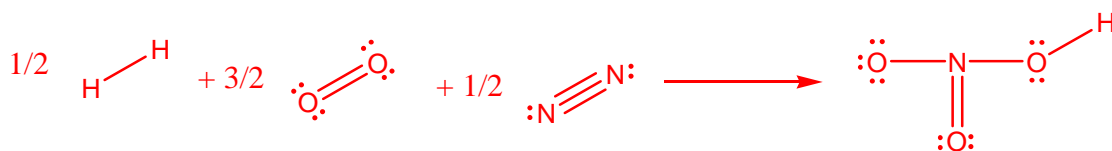
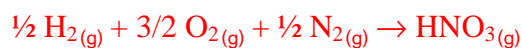
d. Arrange the following in order of *increasing electron affinity energy*: F, Cl, I, Br



6. Draw resonance formulas of the nitric acid molecule, HNO_3 (The hydrogen is attached to one of the oxygens, not the central atom). What is the geometry about the N atom? What is the hybridization on N? Use bond energies and one Lewis formula for HNO_3 to estimate ΔH_f° for $\text{HNO}_{3(g)}$. The actual value of ΔH_f° for $\text{HNO}_{3(g)}$ is -135 kJ/mol, which is lower than the estimated value because of stabilization of HNO_3 by resonance. The *resonance energy* is defined as $\Delta H_f^\circ(\text{estimated}) - \Delta H_f^\circ(\text{actual})$. What is the resonance energy of HNO_3 ?



Geometry = Trigonal planar
Hybridization = sp^2



Broken	Formed
$\frac{1}{2} \text{H-H}$ (432 kJ)	1 O-H (459 kJ)
$\frac{3}{2} \text{O=O}$ (494 kJ)	2 O-N (201 kJ)
$\frac{1}{2} \text{N}\equiv\text{N}$ (942 kJ)	1 O=N (607 kJ)

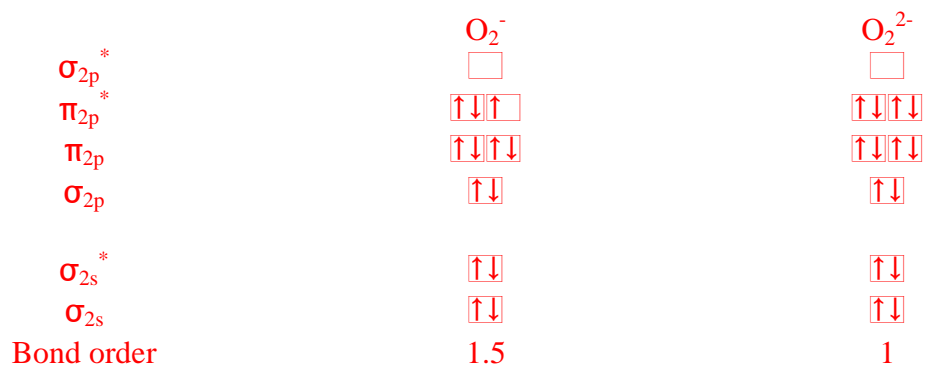
$$\Delta H = BE(\text{broken}) - BE(\text{formed})$$

$$= \left[\left(\frac{1}{2} \right) (432 \text{ kJ}) + \left(\frac{3}{2} \right) (494 \text{ kJ}) + \left(\frac{1}{2} \right) (942 \text{ kJ}) \right] - \left[(1)(459 \text{ kJ}) + (2)(201 \text{ kJ}) + (1)(607 \text{ kJ}) \right]$$

$$= -40 \text{ kJ}$$

$$\text{resonance energy} = \Delta H_f^\circ(\text{estimated}) - \Delta H_f^\circ(\text{actual}) = -40 \text{ kJ} - (-135 \text{ kJ}) = 95 \text{ kJ}$$

7. Draw the *molecular orbital energy level diagram* for O_2^- and O_2^{2-} . Decide *which is more stable* based on bond order.



Higher bond order is more stable. O_2^- should be more stable than O_2^{2-} .