

**City College, Chemistry Department  
Chemistry 10301, sections T and T2, Prof. T. Lazaridis  
Third Midterm exam, Nov 30, 2006**

**Name (last name first):** \_\_\_\_\_

**I.D. Number:** \_\_\_\_\_

**Workshop leader:** \_\_\_\_\_

**Note: There are 10 questions in this exam. Fill in your answer in the blank space provided immediately following each question. 1/2 point will be subtracted every time you report a numerical result with an incorrect number of significant figures.**

**Useful data:**      **Speed of light :  $2.9979 \times 10^8$  m/s**  
                          **Planck's constant :  $6.626 \times 10^{-34}$  Js**  
                           **$E_n = -2.179 \times 10^{-18} \text{ J/n}^2$**

1. (5) A diode laser emits at a wavelength of 987 nm. All of the radiation it emits is absorbed in a detector which measures a total energy of 0.52 J over a period of 32 sec. How many photons per second are being emitted by the laser?

$$\begin{aligned} 0.52 \text{ J} / 32 \text{ sec} &= 0.016 \text{ J/sec} \\ E &= h c / \lambda = 6.626 \times 10^{-34} \text{ Js} \times 2.9979 \times 10^8 \text{ (m/s)} / 987 \times 10^{-9} \text{ m} \\ &= 0.020 \times 10^{-17} \text{ J/photon} \end{aligned}$$

$$\begin{aligned} 0.016 \text{ J/sec} \\ \text{-----} &= 0.8 \times 10^{17} \text{ photons/sec} \\ 0.020 \times 10^{-17} \text{ J/photon} \end{aligned}$$

2. (5) Give the values for the quantum numbers n, l, m<sub>l</sub> for each orbital in the 4d subshell.

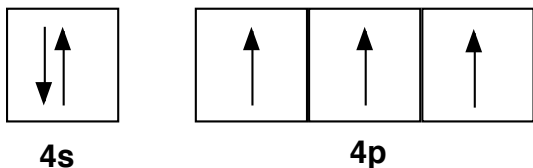
$$\begin{aligned} n &= 4, l = 2 \\ m_l &= -2, -1, 0, +1, +2 \end{aligned}$$

3. (10) Write the noble-gas core abbreviated electron configurations of the following elements:

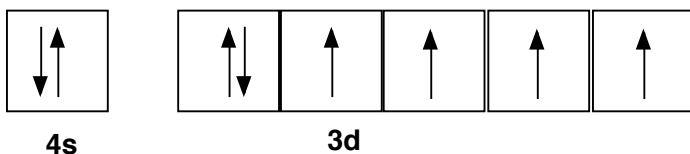


4. (10) Using orbital diagrams, determine the number of unpaired electrons in each of the following atoms:

a) As **3 unpaired electrons**



b) Fe **4 unpaired electrons**



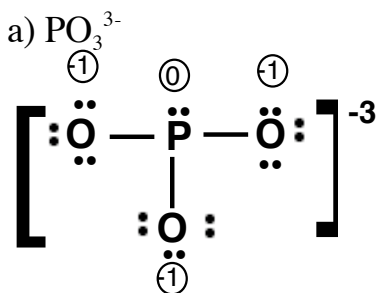
5. (5) Use the periodic table to predict which atom in the following pair has the smaller first ionization energy:

**K** or Ca

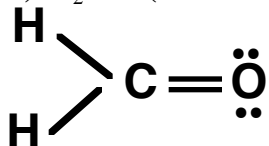
6. (5) Use the periodic table to predict which atom in the following pair has the higher electronegativity:

Si or Cl

7. (20) Draw a Lewis structure that obeys the octet rule for each of the following molecules or ions and indicate the formal charge on each atom:

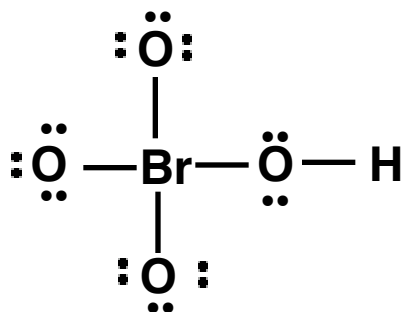


b)  $\text{H}_2\text{CO}$  (both H atoms are bonded to C)

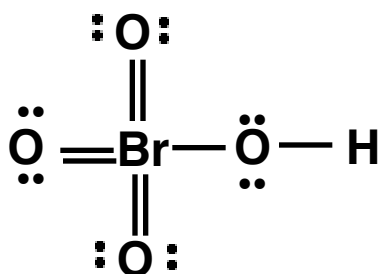


**all formal charges = 0**

8. (10) Draw two Lewis structures for perbromic acid (HBrO<sub>4</sub>), one that satisfies the octet rule and one that has the least formal charge (reminder: for all acids, H is bonded to O).



Satisfies octet rule



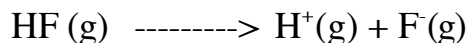
All formal charges zero, expanded octet on Br

9. (15) Draw the possible resonance structures for nitrous acid (HNO<sub>2</sub>) and indicate which one(s) contribute more and why.

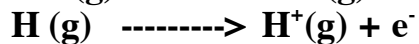
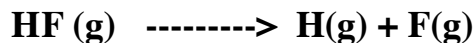


The one on the left contributes more because the formal charges are zero

10. (15) Use data provided (and the ionization energy of hydrogen, which is 1312 kJ/mol) to estimate the enthalpy of the following gas phase reaction:



The above reaction is the sum of:



Sum: +1549 kJ