

**City College, Chemistry Department**  
**Chemistry 10301, sections L and L2, Prof. T. Lazaridis**  
**Third Midterm exam, Nov 30, 2000**

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

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

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

**Note: There are 7 questions in this exam (check both sides of the sheet).  
Fill in your answer in the blank space provided immediately following each  
question. One 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. a. (5) Calculate the energy of a photon required to excite a hydrogen atom from  $n=1$  to  $n=4$

$$\Delta E = -2.179 \times 10^{-18} \text{ J} (1/4^2 - 1/1) = 2.043 \times 10^{-18} \text{ J}$$

- b. (5) What is the wavelength of this photon?

$$\Delta E = h \nu = h c/\lambda \Rightarrow \lambda = 9.724 \times 10^{-8} \text{ m} = 97.24 \text{ nm}$$

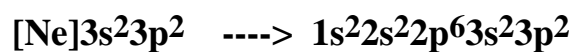
- c. (5) In which part of the electromagnetic spectrum would you find this radiation?

**Ultraviolet**

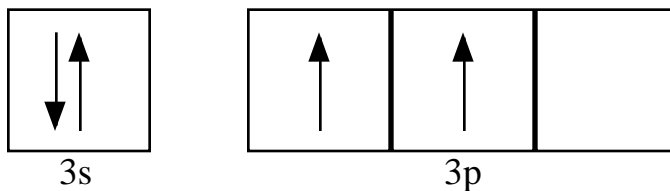
- d. (5) What are the possible values of the magnetic quantum number when the principal quantum number is 2?

$$n=2 \Rightarrow l=0 \text{ or } 1 \Rightarrow m= -1, 0, \text{ or } +1$$

2. a. (5) Write an expanded (not abbreviated) ground state configuration of Si



- b. (5) Draw an orbital diagram for this atom



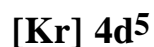
- c. (5) Is Si diamagnetic or paramagnetic?

**It has unpaired electrons ---> paramagnetic**

3. a. (5) Predict the electron configuration of Technetium (Tc) from the periodic table (write using a noble gas core).



- b. (5) What is the electron configuration of  $\text{Tc}^{2+}$  ?



- c. (5) Which one is larger in size, Tc or  $\text{Tc}^{2+}$  ?

**Tc**

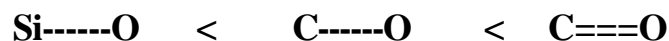
4. a. (5) Write Sc, Sr, and  $\text{Sc}^{3+}$  in order of increasing atomic radius



- b. (5) Write Al, P, and In in order of increasing ionization energy



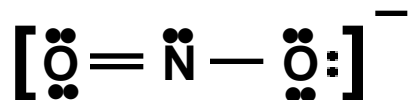
- c. (5) Write the bonds C-----O, C===O, Si-----O in order of increasing bond energy



5. a. (10) Draw a Lewis structure for the nitrite ion ( $\text{NO}_2^-$ )



V.E. :  $12 + 5 + 1 = 18$  Remaining: 14 Needed:  $6+6+4 = 16 \Rightarrow$   
one additional bond



- b. (5) What is the shape of this ion (tetrahedral, linear, trigonal, etc) and the O-N-O bond angle?

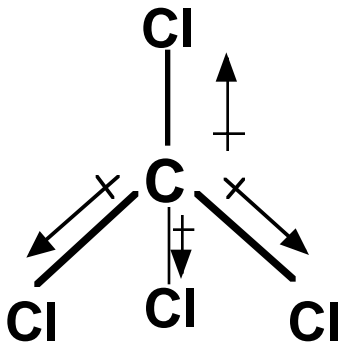
**3 VSEPR pairs, one of them lone  $\Rightarrow$  bent  
angle = 120 degrees**

6. (10) The Pauling electronegativity values for C, and Cl are 2.6, and 3.2, respectively.

- a. (3) What is the shape of the molecule  $\text{CCl}_4$  ?

**4 VSEPR pairs  $\Rightarrow$  tetrahedral**

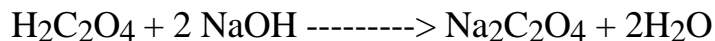
- b. (4) Draw this molecule along with the individual bond dipole moments using the crossed arrow notation.



- c. (3) Is this molecule polar or nonpolar ?

**The bond dipole moment vectors sum up to zero.  
It is nonpolar.**

7. (10) 0.270 g of dry oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) was dissolved in water and titrated with NaOH solution. It took 48.7 ml of NaOH to reach the endpoint. What is the molarity of the NaOH solution?



**Molecular weight:  $2 \times 1.008 + 2 \times 12.01 + 4 \times 16.00 = 90.04 \text{ g/mol}$**

$$\frac{0.270 \text{ g}}{90.04 \text{ g/mol}} * \frac{2 \text{ mol}}{1 \text{ mol}} = 0.006 \text{ mol NaOH}$$

$$\text{molarity} = \frac{0.006 \text{ mol}}{48.7 \cdot 10^{-3} \text{ L}} = 0.122 \text{ M}$$