

Name: KEY

Chemistry 121
Fall 2008
Test 3, Form A

Instructions: You have 75 minutes to complete this 100-point exam. You may use a scientific calculator.

I. Multiple Choice (10 pts, 2 points each) Carefully and clearly circle the best answer. If you circle two answers, *one of which is correct*, you will receive 1 point.

1. Which of the following atoms has the smallest *electronegativity?*
B a. S b. P c. N d. O e. F

2. Which of the following terms is not used to describe light?
C a. wavelength
b. frequency
c. delocalized
d. intensity
e. None of the above.

3. The equation, $E = h\nu$, can be used to calculate the energy of _____.
D a. An atom
b. A cation
c. An anion
d. A photon
e. None of the above

4. Which of the following energy level diagrams correctly depicts the 3d electrons in Cr?
B a. $\uparrow\downarrow \uparrow \uparrow \uparrow \uparrow$
b. $\uparrow \uparrow \uparrow \uparrow \uparrow$
c. $\uparrow \uparrow\downarrow \uparrow \uparrow \uparrow$
d. $\uparrow\downarrow \uparrow\downarrow \uparrow _ _$
e. None of the above

5. Which of the following elements has the largest atomic radii?
A a. Al b. F c. P d. O e. Si

II. Short Answer and Calculations: Clearly indicate your answer in the space provided and show all work. Partial credit will be given for correct work. If I cannot read the work, it will not be graded.

1. (10 pts) Write all sets of possible quantum numbers for $n = 5$.

n	l	m_l	m_s
5	4	-4, -3, -2, -1, 0, 1, 2, 3, 4	$\pm 1/2$
	3	-3, -2, -1, 0, 1, 2, 3	$\pm 1/2$
	2	-2, -1, 0, 1, 2	$\pm 1/2$
	1	-1, 0, 1	$\pm 1/2$
	0	0	$\pm 1/2$

2. (15 pts) Write the **full or Noble gas** electron configuration (as indicated) for the following atoms and ions, indicate the number of valence electrons (VE) and determine if they are paramagnetic (P) or diamagnetic (D).

			VE	Circle
a.	Full	Ga	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$	3 (P or D)
b.	Full	Se ²⁻	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	8 (P or D)
c.	Noble	Sn	$[Kr] 5s^2 4d^{10} 5p^2$	4 (P or D)
d.	Full	Zr ²⁺	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^2$	10 (P or D)
e.	Noble	Cs	$[Xe] 6s^1$	1 (P or D)

3. (10 pts) When I give talks on my environmental research at conferences, I typically use a green laser pointer that has a wavelength of 532 nm.

a. Calculate the frequency (in MHz) of the laser pointer. (1 MHz = 10⁶ Hz)

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{m}{s}}{532 \text{ nm}} \times \frac{10^9 \text{ nm}}{1 \text{ m}} \times \frac{1 \text{ MHz}}{10^6 \text{ Hz}}$$

$$= 5.63 \times 10^8 \text{ MHz}$$

b. Calculate the energy of a mole of photons of this light.

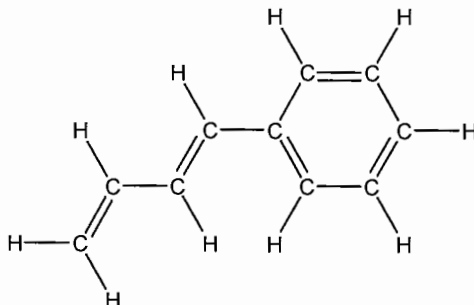
$$E_{\text{mol}} = N h \nu = N h \frac{c}{\lambda}$$

$$E_{\text{mol}} = \frac{(6.02 \times 10^{23}) (6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (3.00 \times 10^8 \frac{m}{s})}{532 \text{ nm} \cdot \frac{1 \text{ m}}{10^9 \text{ nm}}} = 2.25 \times 10^5 \text{ J/mol}$$

4. (5 pts) Fill-in the blank:

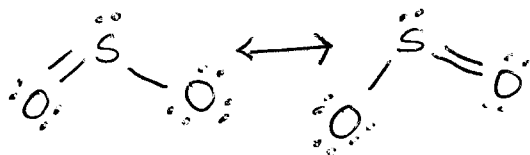
a. If F, Ge and Al were ranked from **smallest to largest** ^{ionization} ~~energy~~, the atoms would be written in the following order: Ge < Al < F.

b. The molecule below has 20 sigma bonds and 5 pi bonds



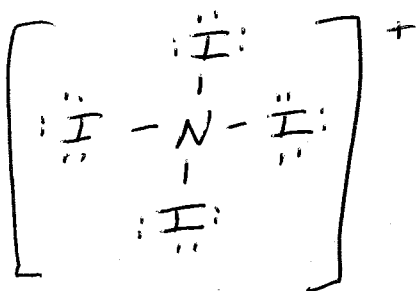
5. (40 pts) For each of the following molecules or ions: draw the correct Lewis Dot Structure, determine the molecular geometry, give the hybridization of the central atom and determine if the molecule is polar or nonpolar. **Include all resonance structures.**

$$\text{SO}_2 \quad 6 + (2 \cdot 6) = 18$$



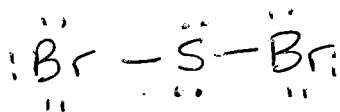
Molecular Geometry: bent
 Hybridization: sp²
 Polarity: polar

$$\text{NI}_4^+ \quad 5 + (4 \cdot 7) - 1 = 32$$



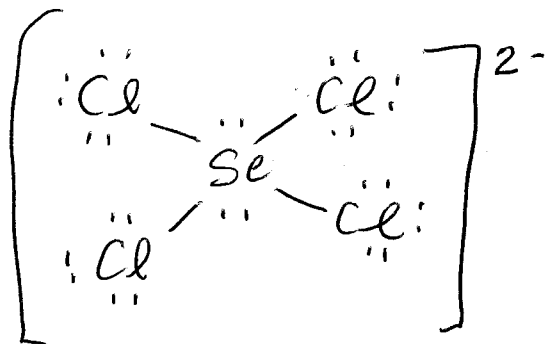
Molecular Geometry: tetrahedral
 Hybridization: sp³
 Polarity: nonpolar

$$\text{SBr}_2 \quad 6 + (2 \cdot 7) = 20$$



Molecular Geometry: bent
 Hybridization: sp³
 Polarity: polar

$$\text{SeCl}_4^{2-} \quad 6 + (4 \cdot 7) + 2 = 36$$



Molecular Geometry: square planar
 Hybridization: sp³d²
 Polarity: nonpolar

Name: _____

6. (10 pts) Indicate whether or not the following quantum numbers or orbitals can exist using Y for yes and N for no. For those that **cannot exist, explain why.**

Circle

If no, then explain why.

a. 3p

Y or N

b. $n = 3, l = 1, m_l = 2, m_s = -\frac{1}{2}$

Y or N

$m_l \neq l$

c. $n = 2, l = 1, m_l = 0, m_s = \frac{1}{2}$

Y or N

d. 9s

Y or N

e. 3f

Y or N

$n = 3, l = 3 \quad n \neq l$

III. Essay: (10 pts) In 4 – 6 grammatically correct sentences, answer **ONE** of the following:

- Explain/discuss the necessity of hybrid orbitals and how hybrid orbitals are formed from atomic orbitals.
- Explain the trend of ionization energy in relation to the periodic table and describe how the trend is caused by effective nuclear charge.

see lecture notes