

Instructions: You have 75 minutes to complete this 100-point exam. You may use a simple scientific calculator. No programmable calculators allowed.

I. Electromagnetic Radiation

1. (10 pts) UV - C radiation is especially harmful to humans. Most of the UV-C radiation is filtered as sunlight passes through the ozone layer. What is the wavelength (in nm) of UV - C radiation having a frequency of  $1.13 \times 10^{15} \text{ s}^{-1}$ ?

$$\lambda \nu = c$$

$$= \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{\text{m}}{\text{s}}}{1.13 \times 10^{15} \text{ s}^{-1}} \times \frac{10^9 \text{ nm}}{1 \text{ m}} = 265 \text{ nm}$$

2. (10 pts) What is the energy of a mole of photons of the above UV-C radiation?

$$E = h\nu = (6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (1.13 \times 10^{15} \text{ s}^{-1})$$

$$= 7.49 \times 10^{-19} \text{ J/photon} \left( \frac{6.02 \times 10^{23} \text{ photons}}{1 \text{ mol}} \right)$$

$$= 4.51 \times 10^5 \text{ J/mol}$$

II. Quantum Numbers and Electron Configurations

1. (10 pts) Write a complete set of 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) Indicate whether the following orbitals/quantum numbers exist. If it does not exist, explain why.

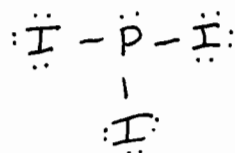
	Y or N	If not, why?
a. 8p	Y	
b. $n = 3, l = 3, m_l = 2, m_s = 1/2$	N	$l \neq n$
c. $n = 5, l = 3, m_l = -1, m_s = -1/2$	Y	
d. 2d	N	$l = 2$ and $n = 2, l \neq n$
e. $n = 4, l = 3, m_l = -1, m_s = -1$	N	$m_s$ must be $+1/2$ or $-1/2$

3. (15 pts) Write the NOBLE GAS electron configuration for the following atoms and ions, indicate the number of valence electrons (VE) and determine if they are paramagnetic (P) or diamagnetic (D).

Atom/Ion	Configuration	#VE	P or D
a. P	$[\text{Ne}] 3s^2 3p^3$	5	P
b. $\text{Ga}^{1+}$	$[\text{Ar}] 4s^2 3d^{10}$	2	D
c. Cu	$[\text{Ar}] 4s^1 3d^{10}$	1	P
d. $\text{S}^{2-}$	$[\text{Ne}] 3s^2 3p^6$	8	D
e. I	$[\text{Kr}] 5s^2 4d^{10} 5p^5$	7	P

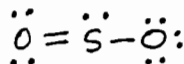
III. Molecular Geometry: (30 pts) For each of the following molecules: (i) Draw the correct Lewis Dot Structure, (ii) Give the AXE notation, (iii) Determine the molecular geometry, (iv) Give hybridization of the central atom, and (v) Indicate if it is polar or nonpolar.

1.  $\text{PI}_3$   $5 + 3(7) = 26$



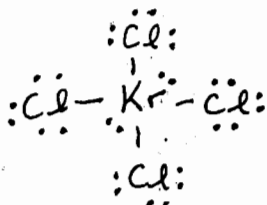
$\text{AX}_3\text{E}$   
trigonal pyramidal  
 $\text{sp}^3$   
polar

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



$\text{AX}_2\text{E}$   
bent  
 $\text{sp}^2$   
polar

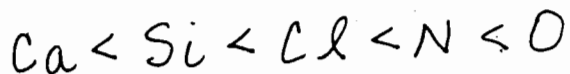
3.  $\text{KrCl}_4$   $8 + 4(7) = 36$



$\text{AX}_4\text{E}_2$   
square planar  
 $\text{sp}^3\text{d}^2$   
nonpolar

IV. Trends, Bonding and Electron Configuration Rules

1. (5 pts) Rank the following atoms in order of increasing ionization energy: Si, O, Cl, Ca and N.



2. (5 pts) In the following groups, circle the species with the largest radii.

a. P or Cl

b. F or  $\text{F}^{1-}$

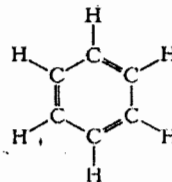
c. Ca or  $\text{Ca}^{2+}$

d. As or Si

e. Ge or Br

3. (10 pts) Fill in the blank

a. There are 12 sigma bonds and 3 pi bonds in the molecule at the right.



b. When placing electrons in orbitals around atoms, you must follow:

i. Pauli Exclusion Principle (Hint: two words)

ii. Aufbau Principle (Hint: one word)

iii. Hund's Rule (Hint: one word)