Name: _____ **Section (please circle): A(Rice) — B(McKinney)**

Part I. Short Answer: **4 points each (answer ALL 8 questions).**

1. Match each orbital in the list below with the correct description: 3s, 2p, 4d, 1s

   _____ Has the lowest energy

   _____ Has one planar (or angular) node

   _____ Has 2 total nodes

   _____ Is one of a set of 5 degenerate orbitals

2. Of the following species, _____ has the largest radius.

   a) Rb^{+}
   b) Sr^{2+}
   c) Br-
   d) Kr
   e) Ar

3. Of the following atoms, which has the largest first ionization energy?

   a) K
   b) Rb
   c) Sr
   d) Ca
   e) Ba

4. Which of the following kinds of electromagnetic radiation has the *highest* energy per photon?

   a) visible light
   b) ultraviolet light
   c) infrared light
   d) microwaves
   e) radio waves

5. Which of the following ionic compounds possesses the *smallest* magnitude lattice energy?

   a) NaF
   b) NaCl
   c) NaBr
   d) NaI
   e) CsI

6. Which of the following sets of quantum numbers (n, l, m_l, m_s) describes the highest energy electron of potassium in its ground state?

a) 4, 0, 0, +½
b) 3, 0, 0, +½
c) 3, 2, -2, -½
d) 4, 3, +3, +½
e) 4, 2, -2, -½

7. Which of the following bonds is *most* ionic?

a) H-Cl
b) F-Cl
c) O-Cl
d) Cs-Cl
e) Li-Cl

8. Write the electron configuration of the following species:

Cr: _____

Zr^{3+}: _____

<u>Part II. Problems:</u> answer ALL questions; you must show your work for partial credit

9. For the molecular anion ICl_4^-, **(14 pts)**

a) Draw a plausible Lewis dot structure

b) Identify the electron domain geometry: _____

c) Identify the molecular geometry: _____

d) Identify the hybridization about the central atom: _____

10. A photon strikes the surface of a block of metal and an electron is ejected. **(14 pts)**

a) What is the velocity of this electron if its de Broglie wavelength is 8.7×10^{-11} m?

b) What is the kinetic energy of this photoelectron?

11. What is the bond dissociation enthalpy of an oxygen-to-oxygen double bond if the enthalpy of combustion for one mole of ethane gas (C_2H_6) is approximately -1.911×10^3 kJ? **(12 pts)**

Bond Dissociation Energies (kJ/mol)

C≡O	1072	C—H	413
C=O	799	O—O	146
C—O	358	O—H	463
C—C	348	H—H	436

12. An electron in monatomic hydrogen atom moves from a 1s orbital to a 3d orbital… **(14 pts)**

a) Is this transition more likely to correspond to the absorption or emission of a photon?

b) What is the wavelength of the photon?

c) If this *hydrogen* electron moves from the 3d orbital to a 3p orbital, what is the ΔE?

d) What is the potential energy of the electron when it is no longer associated with the atom?

13. For the nitrate anion (NO_3^-)... **(14 pts)**

a) Draw the three most likely resonance forms as Lewis dot structures

b) How many 'pi' bonds does each structure have?

c) What is the average bond order for the N-O bonds?

d) How many unhybridized p-orbitals remain on the central atom?

$\lambda\nu = c$

$$E_{photon} = h\nu = \frac{hc}{\lambda}$$

$$\lambda = \frac{h}{p} = \frac{h}{m\nu}$$

$$E_K = \tfrac{1}{2}\, m\nu^2$$

$$\Delta p \times \Delta x \geq \frac{h}{4\pi} \quad \text{or} \quad m\Delta\nu \times \Delta x \geq \frac{h}{4\pi}$$

$$E_n = \left(-2.178 \times 10^{-18}\ \text{J}\right)\left(\frac{1}{n^2}\right)$$

$$\Delta E = \left(-2.178 \times 10^{-18}\ \text{J}\right)\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$h = 6.626 \times 10^{-34}$ J•s

$c = 2.9979 \times 10^{8}$ m•s^{-1}

$R = 8.3145$ J•mol^{-1}•K^{-1} = 0.08206 L•atm•mol^{-1}•K^{-1}

$e = 1.60218 \times 10^{-19}$ C

1 Å = 0.1 nm = 10^{-10} m

1 D = 3.336×10^{-30} C•m

1 J = 1 kg•m^2•s^{-2}

Proton mass: $m_p = 1.673 \times 10^{-27}$ kg

Neutron mass: $m_n = 1.675 \times 10^{-27}$ kg

Electron mass: $m_e = 9.10939 \times 10^{-31}$ kg