

## Chemistry 123 : Exam 3A

The 76 pts exam consists of 6 questions and students have the whole class period to complete the exam. Answers must be written in the box provided or else no credit is provided. Use the empty space provided to do your work. A periodic table is provided at the end. Fill in your name along with your student ID number.

**Problem 1 : Photoelectric Effect** When light shines on a metal, electrons can be ejected from the surface of the metal in a phenomenon known as the photoelectric effect. You perform an experiment to eject electrons from aluminum (Al) metal. It is known that a wavelength of 302 nm is the minimum energy to eject an electron from Al. (16 pts)

- (a) Determine the work function ( $\Phi$ ), or the minimum energy in J to eject an electron, of the Al metal.

- (b) How much energy in kJ is required to eject a mole of electrons from Al metal? (Hint : One photon with enough energy ejects 1 electron.)

- (c) Suppose a laser emits photons with an energy of 8.44 eV. Is this energy sufficient to eject an electron from Al metal? (Hint :  $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$ )

- (d) What is the velocity of the electron if a photon with a frequency  $1.5 \times 10^{15} \text{ Hz}$  hits the surface of Al metal and ejects an electron? The mass of an electron is  $9.109 \times 10^{-31} \text{ kg}$ .

**Problem 2 : Bohr's Model** The Bohr's model was first developed to explain the emission and absorption of the hydrogen atom. (6 pts)

- (a) What is the initial energy level of the electron if it absorbs a wavelength of 1,093 nm to a final energy state of 6?

- (b) True/False. The Bohr model can accurately predict the emission and absorption of multi-electron atoms.

**Problem 3 : Classical and Quantum Pictures of Energy** Describe the difference between the classical and quantum pictures of energy. Which theory describes that energy is quantized or discrete steps? You may include illustrations to support your answer. (6 pts)

**Problem 4 : Electron Configurations** Write the electron configuration of the following atoms or ions. Your answer may be in the long or short forms. (12 pts)

(a) Pb

(b) Ag

(c)  $\text{I}^-$

(d) Mo

(e) K

(f)  $\text{Ga}^+$

**Problem 5 : Periodic Trends** Rank the following periodic trends. (8 pts)

(a) Electronegativity (Strongest to Weakest) : Ra, P, N, F, I

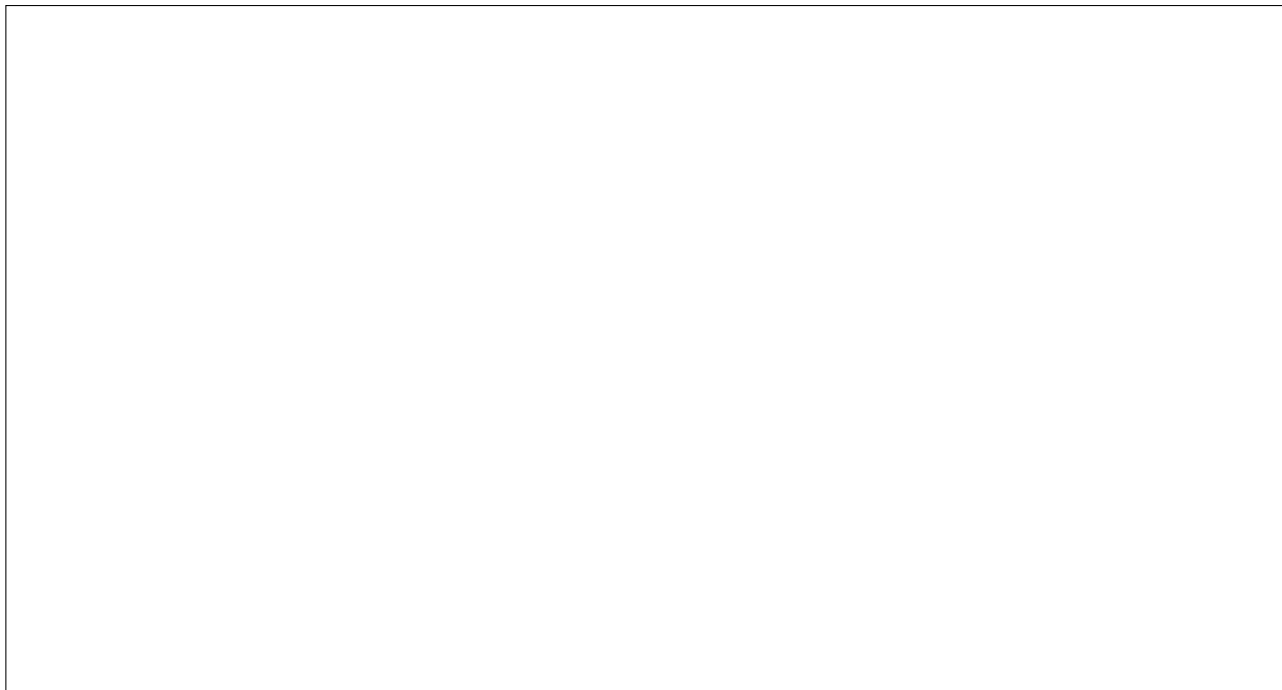
(b) Atomic Radius (Largest to Smallest) : O, Na, Ca, Cl, Cs

(c) First ionization energy (Highest to Lowest) : Li, Cl, Ar, He, Be

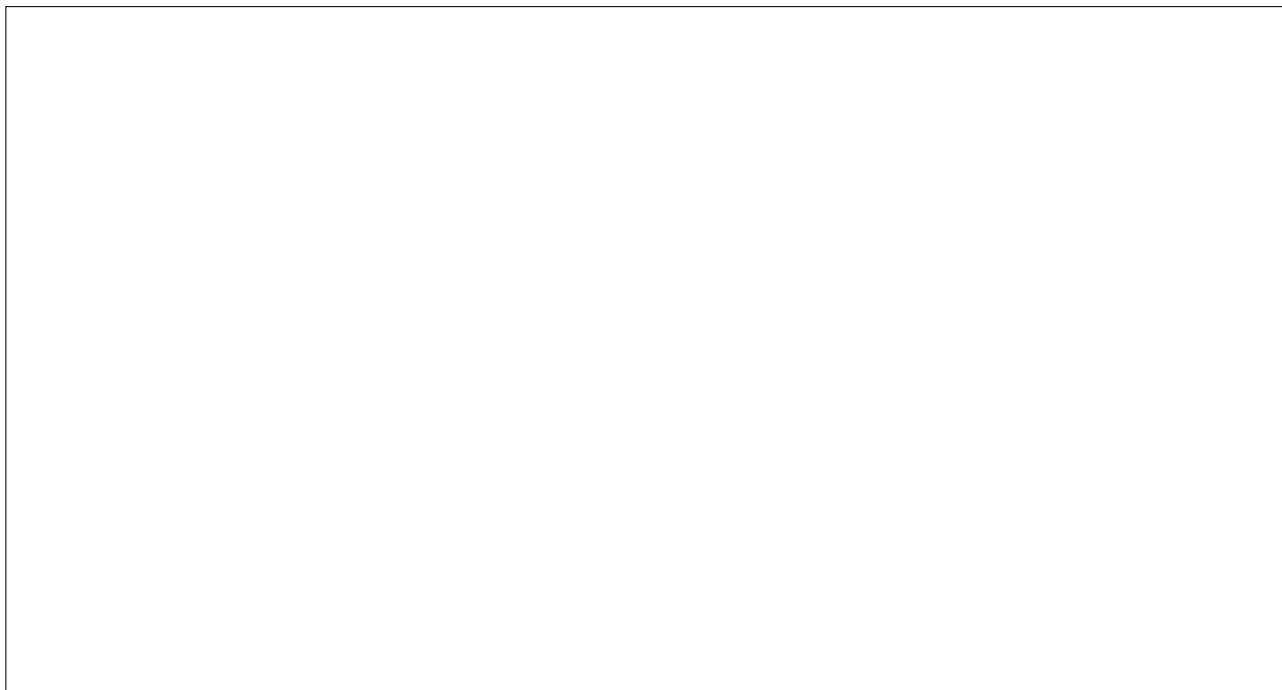
(d) Electron affinity (Highest to Lowest) : F, Cl, Br, I, At

**Problem 6 : Lewis Structures and VSEPR Model** For the following compounds, draw the Lewis structure and include resonance structures if they exist. Determine the electronic arrangement and molecular geometry for the underlined atom. Determine whether the molecule is polar or nonpolar. (24 pts)

(a)  $\underline{\text{P}}\text{F}_6^-$



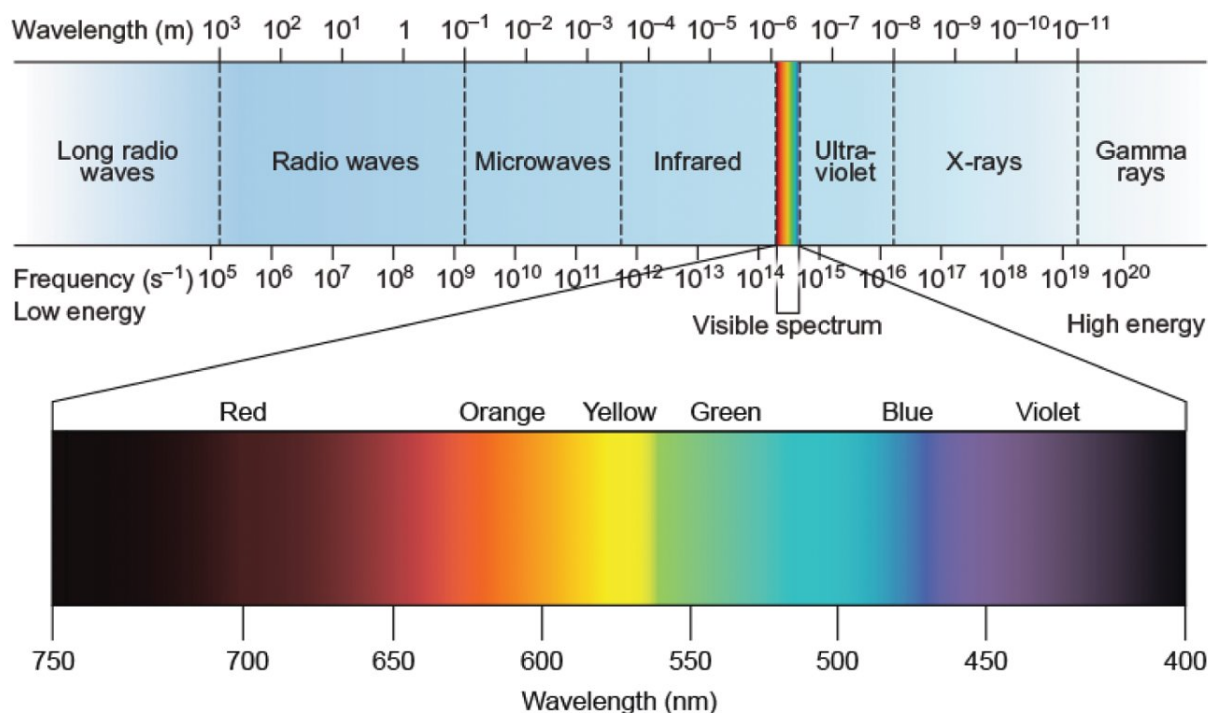
(b)  $\text{CF}_3\text{CH}_2\underline{\text{C}}\text{OOH}$



(c)  $\text{HC}\underline{\text{C}}\text{H}$

(d)  $\underline{\text{P}}\text{O}_4^{3-}$

# Chemistry 123 : Apppendix 2 - Formulas and Constants



$$c = \lambda\nu$$

$$E = h\nu = \frac{hc}{\lambda}$$

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$KE = h\nu - \Phi$$

$$KE = \frac{1}{2}mv^2$$

$$\frac{1}{\lambda} = R_H \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$R_H = 1.097 \times 10^7 \text{ m}^{-1}$$

$$m_{\text{electron}} = 9.109 \times 10^{-31} \text{ kg}$$

$$N_A = 6.022 \times 10^{23} \text{ particles/mol}$$

1 H Hydrogen 1.008																		2 He Helium 4.003																			
3 Li Lithium 6.94		4 Be Beryllium 9.012																		9 F Fluorine 18.998	10 Ne Neon 20.180																
11 Na Sodium 22.990		12 Mg Magnesium 24.305																		17 Cl Chlorine 35.45	18 Ar Argon 39.948																
19 K Potassium 39.098		20 Ca Calcium 40.078		21 Sc Scandium 44.956		22 Ti Titanium 47.867		23 V Vanadium 50.942		24 Cr Chromium 51.996		25 Mn Manganese 54.938		26 Fe Iron 55.845		27 Co Cobalt 58.933		28 Ni Nickel 58.693		29 Cu Copper 63.546		30 Zn Zinc 65.38		31 Ga Gallium 69.723		32 Ge Germanium 72.630		33 As Arsenic 74.922		34 Se Selenium 78.97		35 Br Bromine 79.904		36 Kr Krypton 83.798			
37 Rb Rubidium 85.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906		40 Zr Zirconium 91.224		41 Nb Niobium 92.906		42 Mo Molybdenum 95.95		43 Tc Technetium [97]		44 Ru Ruthenium 101.07		45 Rh Rhodium 102.906		46 Pd Palladium 106.42		47 Ag Silver 107.868		48 Cd Cadmium 112.414		49 In Indium 114.818		50 Sn Tin 118.710		51 Sb Antimony 121.760		53 Te Tellurium 127.60		53 I Iodine 126.904		54 Xe Xenon 131.293			
55 Cs Cesium 132.905		56 Ba Barium 137.327		57 - 70 *		71 Lu Lutetium 174.967		72 Hf Hafnium 178.49		73 Ta Tantalum 180.948		74 W Tungsten 183.84		75 Re Rhenium 186.207		76 Os Osmium 190.23		77 Ir Iridium 192.217		78 Pt Platinum 195.084		79 Au Gold 196.997		80 Hg Mercury 200.592		81 Tl Thallium 204.38		82 Pb Lead 207.2		83 Bi Bismuth 208.980		84 Po Polonium [209]		85 At Astatine [210]		86 Rn Radon [222]	
87 Fr Francium [223]		88 Ra Radium [226]		89 - 102 **		103 Lr Lawrencium [262]		104 Rf Rutherfordium [267]		105 Db Dubnium [270]		106 Sg Seaborgium [269]		107 Bh Bohrium [270]		108 Hs Hassium [270]		109 Mt Meitnerium [278]		110 Ds Darmstadtium [281]		111 Rg Roentgenium [281]		112 Cn Copernicium [285]		113 Nh Nihonium [286]		114 Fl Flerovium [289]		115 Mc Moscovium [289]		116 Lv Livermorium [293]		117 Ts Tennessine [293]		118 Og Oganesson [294]	
				Lanthanide series																																	
57 La Lanthanum 138.905		58 Ce Cerium 140.116		59 Pr Praseodymium 140.908		60 Nd Neodymium 144.242		61 Pm Promethium [145]		62 Sm Samarium 150.36		63 Eu Europium 151.964		64 Gd Gadolinium 157.25		65 Tb Terbium 158.925		66 Dy Dysprosium 162.500		67 Ho Holmium 164.930		68 Er Erbium 167.259		69 Tm Thulium 168.934		70 Yb Ytterbium 173.045											
				Actinide series																																	
89 Ac Actinium [227]		90 Th Thorium 232.038		91 Pa Protactinium 231.036		92 U Uranium 238.029		93 Np Neptunium [237]		94 Pu Plutonium [244]		95 Am Americium [243]		96 Cm Curium [247]		97 Bk Berkelium [247]		98 Cf Californium [251]		99 Es Einsteinium [252]		100 Fm Fermium [257]		101 Md Mendelevium [258]		102 No Nobelium [259]											