

Chemistry 105-Fundamental Chemistry
Exam 3-Tuesday, 2 December 1997

Name _____
Laboratory Section _____
ID Number _____

PLEASE ANSWER IN THE SPACE PROVIDED. SHOW **ALL** WORK WHEREVER POSSIBLE- ESPECIALLY STOICHIOMETRIC FACTORS, FORMULAS, CHEMICAL EQUATIONS, AND UNIT CONVERSIONS. THERE WILL BE ABSOLUTELY NO TALKING DURING THIS EXAM PERIOD. IF YOU HAVE A QUESTION, RAISE YOUR HAND. IF YOU FINISH EARLY, BRING YOUR EXAM TO ME AND LEAVE QUIETLY. DURING THE LAST TEN MINUTES OF THE EXAM PERIOD, DO NOT LEAVE YOUR SEAT AND DO NOT SPEAK TO OTHERS UNTIL ALL PAPERS HAVE BEEN COLLECTED. INITIAL EACH PAGE SO THAT IF THE PAGES BECOME SEPARATED I CAN PIECE YOUR EXAM BACK TOGETHER. USE A PEN. FILL YOUR STUDENT ID NUMBER IN THE SPACE PROVIDED. GOOD LUCK.

$M_1V_1=M_2V_2$, g solute/ g solution x 100= % conc. by mass, $PV = nRT$, $1J = 1 \text{ kg m}^2 \text{ s}^{-2}$, 4 qts = 1 gal, 1.057 qts = 1L, 4.184 J = 1 cal, 2.54 cm = 1 in, 2000 lbs = 1 ton, 5280 ft = 1 mile, 453.6g = 1.00lb, 12 = dozen, 101.325 kps = 1 atm, 1.00 troy oz. = 1.10 avoirdupois [ordinary] oz., 16.0 avoirdupois oz. = 1.00 avoirdupois pound, $R=0.08206\text{L atm/K mol}$, $1\text{atm}=29.92$
 $\text{in}=760\text{torr}=760\text{mm Hg}$, $1J = 1\text{kg m}^2 \text{ s}^{-2}$, $h = 6.6260755 \times 10^{-34} \text{ J s}$, mass of the electron = $9.1093897 \times 10^{-31} \text{ kg}$, $c = 2.99792458 \times 10^8 \text{ m s}^{-1}$

$$C = \frac{q}{T} \quad v = \frac{c}{\lambda} \quad E = h\nu \quad \lambda = \frac{h}{m\nu}$$

Soluble compounds	Insoluble compounds
compounds of Group 1 elements	carbonates, chromates, and phosphates, except those of the Group 1 elements and NH_4^+
ammonium compounds	
chlorides, bromides, and iodides, except those of Ag^+ , Hg_2^{2+} , and Pb^{2+} *	sulfides, except those of the Group 1 and 2 elements and NH_4^+
nitrates, acetates, chlorates, and perchlorates	hydroxides and oxides, except those of the Group 1 and 2 elements**
sulfates, except those of Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+} , Hg_2^{2+} , and Ag^{+***}	

* PbCl_2 is slightly soluble.

** $\text{Ca}(\text{OH})_2$ and $\text{Sr}(\text{OH})_2$ are sparingly (slightly) soluble; $\text{Mg}(\text{OH})_2$ is only very slightly soluble.

*** Ag_2SO_4 is slightly soluble.

Part I. Vocabulary (10pts) Place the most appropriate term in the space provided.

A direct result of the study of light has been an increased understanding of the nature and the structure of the _____. Atomic absorption spectra and atomic _____ spectra are evidence that atoms absorb and emit light at particular frequencies. This in turn led to the idea of _____ energy levels within the atom. Thus, Bohr postulated that the orbit of the _____ did not decay and eventually collide with the nucleus of the atom. Furthermore, our theory of discrete energy levels in both atoms and light led _____ to propose the now famous equation $E = h\nu$. This equation then provides us with our modern understanding of the structure of the atom through careful study of the solutions. The solutions are in the form of four numbers. The first, or _____ quantum number (n) can have integral values from one to infinity. The azimuthal quantum number (l) takes on values of _____ to zero. The magnetic quantum number (m_l) can have values from _____ to zero to _____. And finally the _____ quantum number (m_s) can be $\pm 1/2$.

Part II. Problems In all problems, if you use an equation, show the equation for full credit.

1) (5 pts) Near room temperature, the specific heat capacity of benzene is $1.05 \text{ J} \cdot (\text{°C})^{-1} \cdot \text{g}^{-1}$. Calculate the heat needed to raise the temperature of 50.0g of benzene from 25.3 °C to 37.2 °C.

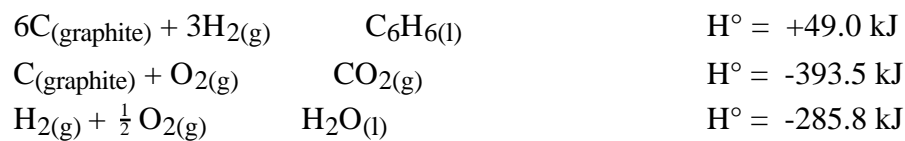
2) (5 pts) An electron is accelerated to the speed of light in a particle accelerator. What would the wavelength of the particle be in nanometers?

3) (6pts) Assume that Professor Czerwinski has a mass of 77.27 kg and is being chased down the hallway by a mob of angry students at 9.12 m/s shortly after the quiz. What would his wavelength in nanometers be?

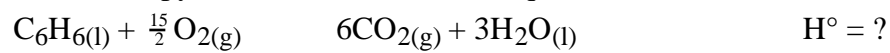
4) (8 pts) The enthalpy of combustion of benzoic acid (C_6H_5COOH) which is often used to calculate the heat capacity of calorimeters is -3227 kJ/mol. If the products of the combustion reaction (reaction with oxygen gas) of benzoic acid are only carbon dioxide and water, what is the reaction enthalpy?

5) (6 pts) For the combustion of benzoic acid (as above), if 1.946g of water were obtained, how much heat would have been produced?

6) (15 pts) Use the following equations:



to calculate the reaction enthalpy for the thermochemical equation:

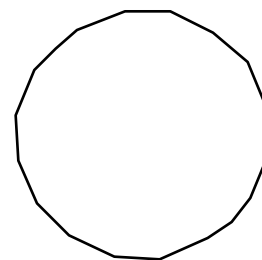
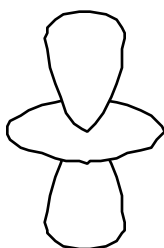
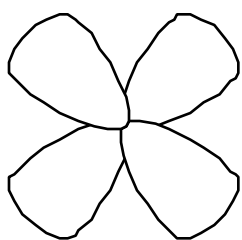


7) (6 pts) Give the complete electron configuration for the selenium (Se) atom.

8) (6 pts) Draw an electron energy level diagram for the selenium atom.

9) (4 pt) Give a valid set of quantum numbers for the sixteenth electron placed into the energy level diagram above.

10) (4 pts) The four diagrams below are representations of 90% probability contour plots for individual orbitals. Indicate the orbital type for each by placing its letter designation on the orbital.



Part III. Laboratory (25pts)

You wish to know the concentration of a particular brand of vinegar so as to check the accuracy and truthfulness of the manufacturer's label. Suppose you pipetted 25.00 mL of this vinegar into a 250.00 mL volumetric flask and diluted it with distilled water to the mark. Furthermore, supposing that you then withdrew 10.00 mL of the solution, placed it into an Erlenmeyer flask and upon titration found it took 8.60 mL of 0.1089M sodium hydroxide solution to reach the endpoint or stoichiometric point, what would be the molarity of the acetic acid in the original bottle? For full credit, write the chemical equation for the titration, and show all calculations. Express the concentration as a percentage by mass. You may assume 1mL = 1 g of the vinegar.