

Chemistry 105-Fundamental Chemistry
Exam 3-Tuesday, 1 December 1998

Name _____
Laboratory Section _____
ID Number _____

PLEASE ANSWER IN THE SPACE PROVIDED. SHOW **ALL** WORK WHEREVER POSSIBLE- ESPECIALLY STOICHIOMETRIC FACTORS, CHEMICAL EQUATIONS, AND UNIT CONVERSIONS. THERE WILL BE ABSOLUTELY NO TALKING DURING THIS QUIZ 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 QUIZ 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 QUIZ BACK TOGETHER. USE A PEN. FILL YOUR STUDENT ID NUMBER IN THE SPACE PROVIDED. GOOD LUCK.

Selected equations, constants, and information:

$M_1 V_1 = M_2 V_2$, $1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2}$, 4 qts = 1 gal, 1.057 qts = 1L, $4.184 \text{ J} = 1 \text{ cal}$, 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, $R = 0.08206 \text{ L atm/K mol}$, $1 \text{ atm} = 29.92 \text{ in} = 760 \text{ torr} = 760 \text{ mm Hg}$, $C = q / T$, $-q = q$, sp heat for water = $4.184 \text{ J/g} \cdot \text{K}$

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.

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

An _____ reaction is a chemical reaction that releases heat. An _____ reaction absorbs heat. One way to measure the amount of heat absorbed or released is to carry out the reaction in a _____. The version of this instrument which we used in lab consisted of: two styrofoam _____, which insulated the reaction, a _____, to minimize the loss of heat, and a _____ to measure the change in _____. With this device and the data it provided, we were able use the number of moles of reactants to calculate the _____, which is defined as the amount of heat released or absorbed at constant pressure by a chemical reaction. When this value is representing heat that is absorbed by the reaction, it will have a _____ value and when representing heat that is given off it will have a _____ value.

II. Problems

1. (5 pts) How much heat in kilojoules is required to raise the temperature of 20.0 g of water from 20.0 °C to 96.0 °C?

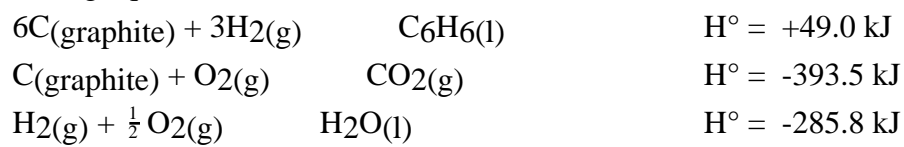
2. (10 pts) A piece of stainless steel (sp. heat = $0.50 \text{ J/g} \cdot ^\circ\text{C}$) is taken from an oven at 178 °C and quickly immersed in 225 mL of water at 25.9 °C. The water temperature rises to 42.4 °C. What is the mass of the piece of steel? You may assume complete heat transfer from the steel to the water.

3. (10 pts) A 500.0-mL sample of 0.500 M NaOH at 20.00 °C is mixed with an equal volume of 0.500 M HCl at the same temperature in a Styrofoam-cup calorimeter. The reaction:

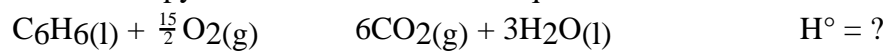


takes place and the temperature rises to 23.21 °C. Calculate the enthalpy change for the reaction.

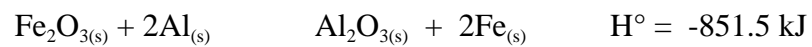
4. (15 pts) Use the following equations:



to calculate the reaction enthalpy for the thermochemical equation:



5. (10 pts) How much heat can be produced from a reaction mixture of 50.0 g of iron (III) oxide and 25.0 g of aluminum metal according to the reaction shown below?

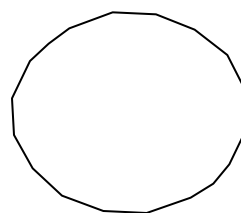
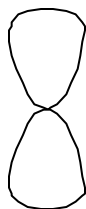
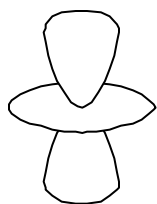
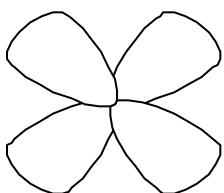


6. (7 pts) Give the complete electron configuration for the iron (Fe) atom.

7. (5 pts) Draw an electron energy level diagram for the iron atom.

8. (4 pt) Give a valid set of quantum numbers for the sixteenth electron placed into the energy level diagram above.

9. (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 (20pts)

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 balanced chemical equation for the titration, and show all calculations.