

**INS Chemistry Take-home exam:
Fall 2007.**

This exam is due by **9:00 AM on Wednesday, November 28 at Jim's office**. This exam should be your individual work. Allowable reference sources include your program textbooks, any program handouts (labs, workshops, and the like) and your lecture notes. NON-allowable references are any on-line site, other books or written material, or consultation with others. Please be sure to indicate any assumptions you make in any problem and the route you use in any calculations. If you have any uncertainties about a question contact Jim by email.

Before turning in your exam please sign below to indicate your agreement to follow these guidelines.

Name: (print).

I agree to follow the guidelines and have only used the allowable sources in preparing this exam. All work included is my own without the assistance of others.

Signature:

Date:

There are three total pages

Total questions on exam: 9

1. An approximate theoretical formula for the radius of an atomic nucleus is $r = (1.3 \times 10^{-15})A^{1/3}$ m, where A is the mass number of the nucleus, m is meters.
 - a. From this equation, calculate the atomic radius for ^{12}C and ^{226}Ra .
 - b. If the atomic radius of a carbon atom is 77 pm and that of a radium atom is 220 pm, what is the ratio of atomic diameter to nuclear diameter for these two examples?
2. The average speed of an oxygen molecule at room temperature is about 4.4×10^2 m/sec.
 - a. Under these conditions estimate the average kinetic energy of a single oxygen molecule.
 - b. What is the kinetic energy of a mole of oxygen molecules?
3. Balance the following chemical equations:
 - a. Solid barium reacts with nitric acid to form hydrogen gas and barium nitrate.
 - b. Propane gas (C_3H_8) burns to form carbon dioxide and water.
 - c. Hydrobromic acid is neutralized by calcium hydroxide.
 - d. Phosphoric acid is added to a solution of zinc chloride producing a precipitate.
4. An attractant molecule for silkworm males has a formula weight of 238 g/mole. If 4.10 micrograms of this material are released into $4.10 \times 10^3 \text{ m}^3$ of air, how many molecules are present in 1.00 cm^3 of air?
5. You have isolated a new compound from plants. Elemental analysis indicates that it is 70.57 % C and 5.92 % H by mass; no other element is present other than oxygen.
 - a. Estimate the empirical formula for this compound.
 - b. You discover that the compound produces an acidic solution in water. You dissolve 0.500 g of this acid in 50 ml of water and add phenolphthalein. You add 36.4 ml of 0.101 M NaOH until the pink end point color is reached. From this data, estimate the molecular weight of this compound.
 - c. Combining the information from parts a and b, what is the best estimate of the molecular formula for this molecule?
6. You have been given a sample of pure metallic element and have been asked to place it in the correct location on the oxidation-reduction activity table. Describe how you would experimentally determine where to locate this element. What would you do and what observations would you make?

7. You are given a waste solution containing calcium nitrate, cesium chloride, and chromium (III) acetate. All of the anions are safe to go down the drain, as are calcium and cesium ion. However, the waste disposal plant does not want any chromium ions to reach the environment. Design a procedure that would selectively remove the chromium ions from this solution in an easy to isolate form. You do not want to produce a large mass of material, so your procedure should only remove the chromium from solution. Provide the chemical equations needed to explain your separation process.
8. Mercury and bromine react to form mercury (II) bromide.
- If 1.00 ml of mercury (density 13.6 g/cm^3) and 1.00 ml of bromine (density 3.12 g/cm^3) react, what is the maximum mass of mercury(II) bromide that could be produced?
 - What would the enthalpy change be for the production of this product? Is this an endothermic or exothermic reaction?
9. Design a simple experiment that would allow you to identify which member of the following pairs of compound was present. In each case, what would you do, and how would the results identify the compound. Provide the chemical equations for the test you provide.
- Aqueous hydrochloric acid and a sodium chloride solution.
 - A solution of calcium nitrate and a solution of silver nitrate.
 - A potassium hydroxide solution and a potassium carbonate solution.
 - A solution of magnesium chloride and a solution of gold (III) chloride.