Exam 1
Friday, Sept 23, 2016
100 pts

1. a. Write the formula for the following compounds. (5 pt)

   i. cobaltous phosphide

   ii. lithium hydroxide monohydrate

   iii. nitric acid

   iv. dichlorine heptoxide

   v. lead (IV) sulfate

   b. Write the name for the following compounds or ions. (5 pt)

   i. HCO_3^-

   ii. KO_2

   iii. XeF_2

   iv. H_2CrO_4

   v. $Fe(ClO_4)_3 \bullet 6H_2O$

2. (16 pt total) Justify all parts of the following true statements. Some will be based on the Bohr model or quantum theory. Be sure to state clearly which model you are using. Choose your language and reasoning carefully and support your arguments with diagrams, tables, or calculations! (8 pt each)

   a. The amount of energy that it takes to completely remove an electron from the ground state of a H atom is 1312 kJ/mol.

b. You can put a total of 18 electrons into the 3rd principal quantum level!

3. Using your periodic table and other relevant information from this course, identify the following (3 pt each, 18 pt total):

   a. The symbol for the 2rd period alkali metal

   b. The **name** of a main group element with a common ionic charge of +3

   c. The element that has the electron configuration [Xe] $6s^2$ $5d^{10}$ $4f^{14}$ $6p^6$

   d. The **name** of a chalcogen

   e. The orbital designation for a dumbbell shaped orbital with 4 radial nodes.

   f. The name for the species that gains electrons in a redox reaction

4. (12 pt) Answer the following questions based on chemical reactions:

   a. In Lab 1, you could identify whether Cl^- or SO_4^{2-} was present in your solution by adding a solution of $Ba(NO_3)_2$ to it. Write the net ionic equation for a "positive" test for the ion that would undergo **a precipitation** reaction with this test. (4 pt)

   b. In Lab 3, you added NH_3 to a precipitate of copper (I) iodide and it dissolved to form a very pale blue solution (almost colorless). In this reaction a complexation reaction occurs between the copper (I) and the NH_3, with the resulting complex ion containing a ratio of 1 Cu (I) to 4 NH_3. Write a balanced formula for this reaction including states of matter. (4 pt)

   c. In Lab 1 the addition of NH_3 in one case led to the formation of a hydroxide precipitate with the Fe^{3+} ion. Write a balanced **acid base equation** with states of matter between NH_3 with H_2O that explains where the hydroxide comes from. Clearly identify the acid and base. (4 pt)

5. (15 pt total)
   a. Draw a **general** sketch of a d_{x2-y2} orbital, labeling the axes clearly. (3 pt)

   b. How many angular nodes does this type of orbital have? _____Label those. (3 pt)

   c. What differences would you have between a $3d_{x2-y2}$ and a $5d_{x2-y2}$ orbital? (3 pt)

   d. Draw a radial probability diagram with axes appropriately labeled for the two specific orbitals in part c (put the radial probability diagram for both orbitals on the same set of axes). (6 pt)

6. (9 pt) Circle the correct answer(s) below (3 pt each) (it is possible but not necessary to have more than 1 correct answer!):

   a. Elements that are metals:

      antimony platinum strontium beryllium mercury

   b. Terms for a proton acceptor and an electron pair acceptor, respectively.

   Lewis acid, Base Acid, Lewis Acid Base, Lewis Base Acid, Lewis base Base, Lewis Acid

   c. Compounds that would form extended 3D solids

   CO_2 Na_3PO_4 $(NH_4)_2CO_3$ PF_5 $MgCl_2$

7. (15 pt) The interaction of light with matter is one of the most important methods of studying it. Visible spectroscopy is frequently used to study the electron transitions between energy levels in atoms or molecules because it has the appropriate energy to affect these transitions. If you take visible absorption spectrum of the blood red $Fe(SCN)^{2+}$ complex ion that you made several times in lab, you would find that it absorbs light with a wavelength of 470 nm.
    a. What is the total amount of light energy in kJ that a mole of $Fe(SCN)^{2+}$ ions could absorb in solution? (5 pt)

    b. What would the frequency of this light be in units of MHz? (4 pt)

    c. When the light is absorbed, do the $Fe(SCN)^{2+}$ ions end up in the ground state or an excited state? (2 pt)

    d. Give an example of another part of the electromagnetic spectrum that can be used to study matter and what it can tell us about that matter. Is the example you gave of higher or lower frequency than visible light? (4 pt)

8. (5 pt total)
    a. Write the electron configuration for Gd (2 pt):

    b. Is neutral Gd paramagnetic or diamagnetic? (1 pt)

    c. Write the formula for the compound formed between Gd^{3+} and the sulfate ion (2 pt):

Potentially useful information:

$E = h\nu$

$c = \lambda\nu$

1 J = 1 (kg m^2)/ s^2

h= 6.626 x 10^{-34} J•s

Avogadro's number: 6.022 x 10^{23}

c= 3.00 x 10^8 m/s

$E_n = -2.18 \times 10^{-18}$ J $(1/n^2)$

$\lambda = \frac{hm}{u}$

$\Delta x * m \Delta u \geq \frac{h}{4\pi}$

General Solubility Rule
All nitrates are soluble
All acetates are soluble ($AgC_2H_3O_2$ only moderately)
All chlorides, bromides and iodides are soluble except Ag^+, Pb^+ and Hg_2^{2+}. ($PbCl_2$ is slightly soluble in cold water and moderatel soluble in hot water.)
All sulfates are soluble except those of Ba^{2+}, Pb^{2+}, Ca^{2+} and Sr^{2+}
All carbonates and phosphates are insoluble except those of Na^+, K^+ and NH_4^+. (Many acid phosphates are soluble).
All hydroxides are insoluble except those of Na^+ and K^+. Hydroxides of Ba^{2+} and Ca^{2+} are slightly soluble.
All sulfides are insoluble except those of Na^+, K^+, NH_4^+ and those of the alkaline earths: Mg^{2+}, Ca^{2+}, Sr^{2+} and Ba^{2+}. (Sulfides of Al^{3+} and Cr^{3+} hydrolyze and precipiate as the corresponding hydroxides.
All salts of sodium ion, potassium ion and ammonium ion are soluble except several uncommon ones.