Exam 1
Monday, February 26, 2018
100 pts

1. (18 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! (9 pt each)

   a. If you completely remove electrons from H-atoms (go from the ground state to n = ∞) it takes 1312 kJ/mol. To do this with light requires absorption of light with a wavelength of 91 nm.

   b. There are no such things as a 1p orbital, but there are three p orbitals in both the 2nd principal quantum level and the 8th principal quantum level.

2. Using your periodic table and other relevant information from this course, identify the following (3 pt each, 21 pt total):

   a. The **name** and **formula** of a weak acid

   b. The name of the alkaline earth metal in period 6

   c. The symbol for aqueous iron (III)

   d. The electron configuration for germanium

   e. The designation for an orbital with n=5 and ℓ=0

   f. The symbol for the element with the electron configuration $[Xe]6s^25d^{10}4f^{14}$

   g. The number of angular nodes in a 5f orbital

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

      i. cobaltous phosphide

      ii. lithium hydroxide monohydrate

      iii. oxalic acid

      iv. dichlorine heptoxide

      v. lead (IV) sulfate

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

      i. HCO_3^-

      ii. Li_2O_2

      iii. XeF_4

      iv. H_2CrO_4

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

4. (10 pt) a. (6 pt total) What are the symbol and name for the quantum numbers that describe an atomic orbital in quantum theory, what are the rules for each and what do each of them tell you about the orbital?

   b. (4 pt) Sketch a generic p_z orbital. Which quantum numbers would you need to determine that an orbital was a p_z?

5. (16 pt)
   a. In lab 3, you reacted aqueous H^+ with both copper (II) carbonate and copper (II) hydroxide and the solids dissolved. Write balanced reactions for both of those processes, indicating states of matter. (6 pt)

   b. Later in the same lab you reacted aqueous copper (II) with iodide to produce copper (I) iodide solid and iodine (I_2). Write an unbalanced version of this reaction and indicate what type of reaction it is. (4 pt)

   c. Still later in the lab, you reacted aqueous Cu^+ with 4 molecules of NH_3 to produce the resulting aqueous complex ion. Write and balanced reaction and clearly label states of matter. Label the Lewis acid in the reaction. (6 pt)

6. (16 pt) Circle the correct answer(s) below.

a. Elements that are diamagnetic

arsenic   tellurium   argon   potassium   nickel

b. Strong electrolytes

Li_2CO_3 H_2SO_4 $BaSO_4$ $Ag(NO_3)_2$ HNO_2

c. Valid atomic orbitals

$4p_{xy}$ $4d_{x^2-y^2}$ $6d_{xz}$ $6p_x$ $7d_{z^2}$

d. Compounds that form extended solids

SO_2 $NaNO_3$ $CuCl_2$ $(NH_4)_2CO_3$ IF_3

7. (9 pt) In the most recent issue of *Chemical and Engineering News*, it was reported that a team from Zhejiang University had created a porous fabric that mimics the hair of a polar bear and is invisible to night vision goggles that sense body heat which emits in the infrared part of the electromagnetic spectrum.

a. How does the infrared part of the electromagnetic spectrum relate to the visible part in terms of (circle the appropriate answer for each) (3 pt)
    i. Energy   higher   lower
    ii. Wavelength   higher   lower
    iii. Frequency   higher   lower

b. If infrared light of a wavelength of 23 μm is used to detect the heat coming off the bunny, what is the frequency of that light in Hz?   (6 pt)
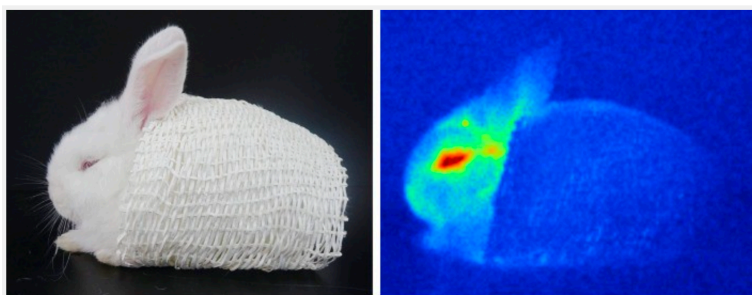
A lab rabbit wearing a cloak with fibers that mimic polar bear hair (left) is invisible to a thermal imaging camera (right).

Potentially useful information:

$E = h\nu$

$c = \lambda\nu$

$1 \text{ J} = 1 \text{ (kg m}^2\text{)/ s}^2$

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

Avogadro's number: 6.022×10^{23}

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

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

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

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

Solubility rules

- Salts of Group IA cations and the ammonium ion are soluble.
- Nitrate, perchlorate, acetate salts are soluble.
- Halides are soluble except salts of silver (I), mercury (I), and lead (II).
- Sulfates are soluble except salts of strontium, barium, mercury (I) and lead (II).

- Carbonates are insoluble except Group IA and ammonium.
- Sulfides are insoluble except Group IA, ammonium, calcium, barium and strontium salts.
- Hydroxides are insoluble except Group IA, ammonium, calcium, barium and strontium salts.
- Phosphates are insoluble except Group IA and ammonium.