CHEM105H Test 1 *Please show all formulas and all work to receive any credit.* *Name on back only please*

1. Answer each of the following:
   a. Write complete symbols for the four naturally occurring isotopes of iron whose mass numbers are 54, 56, 57 and 58.

   b. The amount of carbon monoxide, a common air pollutant, in a sample of air is measured at 0.0057 µg/mL air. Express this mass/volume ratio in units of kg/kL.

   c. Determine the number of protons, electrons and neutrons present in atoms or ions with:
      1) Atomic number = 27 and mass number = 59

      2) Z = 69, A = 169, charge = +2

   d. Calculate the density, in units of g/cm^3, of a strontium-90 nucleus. Assume it is spherical in shape and has a radius of 5.51 x 10^{-3} pm; (V_{sphere} =4/3 * π r^3). The isotopic mass of Sr-90 is 89.907738 amu. Compare your answer with the density of strontium which is 2.64 g/cm^3 at room temperature.

2. Today is the 20th day of the month; in celebration of today, please complete the following table showing, in the order that they are filled (beginning with the lowest energy level), the quantum numbers for each of the 20 electrons in a calcium atom that is in the ground electronic state.

Electron number	***n***	***l***	***m_l***	***m_s***
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

3. In March 2011, a 9.0-magnitude earthquake rocked the Fukushima No. 1 nuclear power plant; this earthquake cut off the nuclear plant from the electrical power grid. The engineers who designed this plant brilliantly located the emergency power diesel generators in the basement of the turbine building, a structure that is located directly on the seacoast. The tsunami that followed the earthquake knocked out all emergency power. Without power to cool the cores of its three fueled reactors, hydrogen gas was generated, released, and exploded in the reactor buildings, releasing plumes of radioactivity. An intense plume spread northwest from the stricken plant for more than 50 miles. Because of the radioactive materials deposited by the plume, including cesium-137 and strontium-90, large areas in Fukushima Prefecture will be uninhabitable for generations. The strontium-90 radioactive isotope fission product present in the fallout has a half-life of 28.78 years.

    a. Calculate how long it takes for 99.9% of the deposited strontium-90 to radioactively decay.

    b. Conduct an analysis that clearly demonstrates whether your answer to part a makes sense.

    c. Predict how strontium-90 would be expected to radioactively decay; fully support your answer, and write a balanced equation for this nuclear reaction.

    d. Environmental Sr-90 is hazardous to humans due to accumulation in the skeletal system where it resides for long periods. Use the periodic table to postulate why Sr-90 accumulates.

    e. Calculate the binding energy per nucleon, in units of MeV, for strontium-90. The isotopic mass of Sr-90 is 89.907738 amu.

4. Complete the following table; clearly show all work.

Molecule	BrO_2^-	BH_3	ICl_5	SF_6	CH_3CHO
Number of Valence Electrons					
Lewis Structure (include all nonzero formal charges)					
Electron Arrangement					
Molecular Geometry about Central Atom					
Bond Angle(s)					
Hybridization					
Polar or Nonpolar					
Number of sigma (σ) bonds					
Number of pi (π) bonds					
Bond Order					

5. Compare the second ionization energy of magnesium with the second ionization energy of sodium and fully explain, using fundamental scientific principles, the reason for the difference.

6. Compare the relative sizes of Cl^-, Ar, and P^{3-}. Fully explain, using fundamental scientific principles, the reason for the differences.

7. Astronomers classify stars as being in the Am class by spectral signatures with strong emissions at a wavelength of 424.6 nm for excited Sr^{+2} ions and significantly weaker emissions for Sc^{+2} ions at 421.5 nm. Sr has a lower second ionization energy (11.03 eV) than Sc (12.89 eV), resulting in its greater abundances; hotter stars have both these elements present in the doubly ionized states.

    a. Calculate the energy, in Joules, of a single photon from an Am class star's strontium ion emission line at 424.6 nm.

    b. Describe the specific energy source of the 424.6 nm photons.

8. Using the core shell inert gas format, write the electronic configuration for a:

    a. Vanadium +2 ion

    b. Silver atom

9. Define lattice energy; then compare the lattice energies of LiF and KCl. Fully support your answer by explaining in terms of all the key fundamental scientific principles.

10. Obesity is becoming a serious national and world health problem. The WHO estimates that 38.5 % of Chinese are overweight or obese (BMI>25); approximately 78% of U.S. adults meet the same standard of being overweight or obese. Determine the total energy required for a 100.0 kg faculty member to climb the stairs of Sims to the 3rd floor; a vertical climb of 9.5 m. Assuming that a food Calorie corresponds to 4,184 J and that 3,500 food Calories must be burned for each lost pound of body fat, determine how many trips are required over a one year period for the faculty member to lose ten pounds of body fat.