Chem 1A - Review Problems for the Final Exam – Part 3

1. Calculate the wavelength and energy (J/electron and kJ/mole e^-) of an electron traveling at 1.0×10^6 m/sec.
2. Calculate the wavelength and energy of a photon (J/photon and kJ/mole photons) with a frequency of 2.15×10^{15} Hz. What region of the electromagnetic spectrum does this correspond to?
3. Calculate the root-mean-square speed of CO_2 at 100.°C. How would this compare to the root-mean-square speed of O_2 at the same temperature? How would it compare to the rms speed of CO_2 at room temperature?
4. Write the full electron configuration, noble gas notation, and the arrow diagram for the valence electrons for the following species. State whether each one is paramagnetic or diamagnetic. Which would be attracted to a strong magnetic field and which would be repelled?
   a. Fe
   b. Fe^{3+}
   c. Mo
   d. S^{2-}
5. Rank the following atoms or ions in order of decreasing radius (and be able to explain the order):
   a. Ca, P, Sr
   b. H, Si, Te
   c. P^{3-}, Cl^-, Ca^{2+}, Ba^{2+}
   d. Na, Na^+
   e. S, S^{2-}
6. How does ionization energy relate to atomic radius? Why?
7. Explain the differences in the first, second, and third ionization energies of Mg. (738 kJ, 1451 kJ, and 7733 kJ, respectively.)
8. The ionization energy of N is 1402 kJ, while the IE for O is 1314 kJ. Explain this exception to the normal trend.
9. The fermentation of sugar to produce ethanol occurs by the following reaction:
   $C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$
   If this reaction normally has a 76.8% yield, what mass of sugar is needed to produce 1.50 kg of ethanol?
10. At a temperature of 65 °F and 52 % relative humidity, what is the dew point?
11. Why does hydrogen emit different wavelengths of light than mercury? Why do they each emit only certain wavelengths?
12. Do 3f orbitals exist? Do 7f orbitals exist? Explain. How many electrons can occupy a set of f orbitals? How many different orientations will a set of f orbitals have?
13. Glycerol is the common name for 1,2,3-propanetriol. This molecule contains three carbon atoms and has an OH group on each carbon. Draw its structure, and explain why it is so viscous.
14. What is the boiling point of water at an altitude of 13,000 feet, where the atmospheric pressure is about 465 mmHg?
15. a. For dilute aqueous solutions, the molarity (M) and the molality (m) are approximately equal. Why?
    b. Why isn't this true if the solvent is not water?
    c. Why isn't this true if the solution is concentrated?

16. a. Write the balanced equation for the reaction of aqueous hydrobromic acid with solid aluminum.
b. If 11.2 cubic inches (in^3) of aluminum is combined with 10.0 L of 6.00 M hydrobromic acid, what volume of gas will be produced at 744 torr and 22°C? (The density of aluminum is 2.70 g/ cm^3.)
c. How many molecules of gas will be produced from the reaction of 50.0 mL of 2.50 M hydrobromic acid with excess aluminum?

Some Answers:

1a. $\lambda = 7.3 \times 10^{-10}$ m
1b. $E = 4.6 \times 10^{-19}$ J/photon
1c. E = 270 kJ/mol
2. 140. nm, 858 kJ/mol, UV
3. 460. m/sec
O_2 at 100°C – faster
CO_2 at 25°C – slower
9. 3.82 kg sugar
10. 46°F
14. approx. 87°C
16b. 681 L
16c. 3.76×10^{22} molecules