Exam 1 Review Problems

Disclaimer: *This review sheet is not complete! This is a sample of some of the types of problems that may be on Exam 1. For a more complete review, also consult the, homeworks and lecture notes.*

We will be holding two review sessions/office hours for the Exam:

Friday, September 21, 2001	3-5 pm	Room: Wean 5403
Monday, September 24, 2001	7-9 pm	Room: Baker 235A

Please come to the review sessions with questions! We will answer any reasonable question, but we will not prepare any additional review materials.

Some helpful information for the exam:

Relationships you should know (i.e. will not appear on exam)

$E_{photon} = h\nu$ $\nu\lambda = c$ (for photon) $\lambda_{particle} = h/(mv)$ $E_n = -(Z^2/n^2)$ R_h (Bohr atom)
definition of cm, mm, μm, nm, and Angstrom

Data that will be on the exam

$r_n = (n^2/Z)\, a_o$ $a_o = 0.529$Angstroms
$E_n = h\, n^2/(8\, m\, L^2)$ (for particle in a box)
$R_h = 2.18 \times 10^{-18}$ J
All unit conversions etc. that are on the inside cover of the text

Units, balancing equations, and stoichiometry

1. a) Balance the following equation:

$$Fe_2O_3 + CO \rightarrow Fe + CO_2$$

   b) [4 points] How much Fe will be produced from 152.6 g of carbon monoxide (CO) and an excess of iron oxide (Fe_2O_3)?

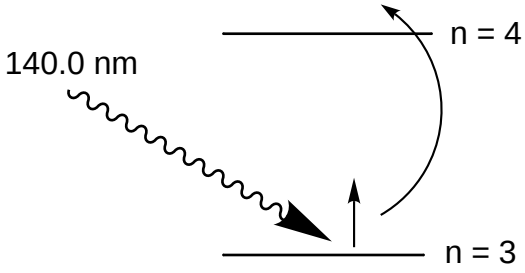
2. A sample of dry-cleaning solvent is found to have 10.08% C, 1.36% H and 47.84% Cl. What is the empirical formula for this compound?

3. For an upcoming experiment, I need to make a buffer solution that is 0.500 M in $NaHCO_3$ and 0.500 M in Na_2CO_3. If I want to make up 750.0 mL of this solution, how many grams of $NaHCO_3$ and Na_2CO_3 should I weigh out? I can only find K_2CO_3 in the lab, how much of that should I use instead of Na_2CO_3?

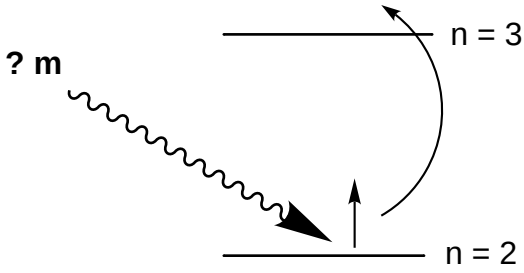
4. Aluminum carbide (Al_4C_3) reacts with water (H_2O) to produce methane (CH_4) and aluminum oxide (Al_2O_3).
   a) Write a balanced equation describing this process.
   b) Calculate the mass of CH_4 produced from 63.2 g Al_4C_3 and 27.89 g of H_2O.

Light, energy, and the description of electrons and atoms

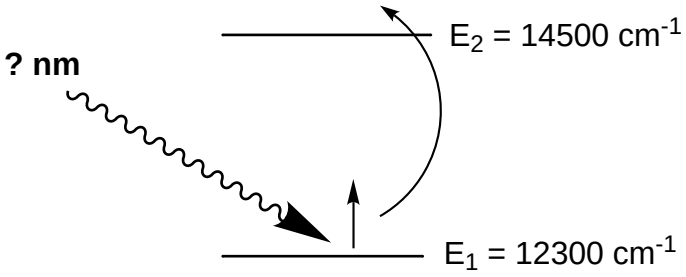
5. Complete the following diagrams for missing information.



ΔE = ?
Z_{eff} = ?



for a Li atom (assume a one-electron system)



6. A molecule has energy levels that are given by the following formula:

$$E_n = (7.2 \times 10^{-19} J)\ (n+1/2)$$

The ground state has n=0 and the excited states have n=1,2,3….

a) A molecule starts in the excited state with n=2 and emits a photon while dropping to the ground state. What is the wavelength of the emitted photon? (i.e. what is the wavelength of the photon associated with an n=2→0 transition of this molecule)?

7. Using the Bohr model, calculate the energy of an electron in the n = 7 state of Fe^{25+}. Will this electron be more difficult or less difficult to remove than an electron from the n = 6 level?

8. Light whose wavelength is 250 nm falls upon the surface of a piece of metal in an evacuated tube. If the work function, Φ, is 7.21×10^{-19} J, what is the maximum kinetic energy of the emitted photoelectrons? The velocity of those electrons?

9. The average length of a C = O double bond is 1.20 Å. For an electron confined in CO_2 (O = C = O), what is the wavelength of light absorbed by an electron that jumps from n=2 to n=4?

Multi-electron atoms and the Periodic Table

10. For the n = 3 level, what are the allowed values of ℓ?

11. Is the following set of quantum numbers a legitimate set?

$$n = 5,\ \ell = 4,\ m_\ell = -3,\ m_s = 1$$

12. Give the electron configuration for Arsenic, As (Z=33). How many valence electrons are there? How many unpaired electrons are there?

13. Place the following elements in order of increasing size (smallest → largest):

V, Ge, Co, Ca.

14. Circle the choice that best satisfies the statement:

Higher Electronegativity	S	Cl
Higher Electron Affinity	F	N
Higher Ionization Energy	C	B
Larger Atomic Radius	Cl^+	Cl^-
More Polar Bond	S - H	C - H
Higher Electron Affinity	N	C
Lower Ionization Energy	K	Cs
Lower Electron Affinity	Cl	F

15. The Electron Affinity for C is 122 kJ mol^{-1}, whereas for N, one element to the right, the Electron Affinity is actually -7 kJ mol^{-1}, which goes against the general periodic trend. Explain why this occurs. [10 points]

16. Draw the Lewis Dot structure for nitrogen, N.

17. Draw complete Lewis structures for the following molecules. Indicate formal charges and resonance structures where applicable.

NO_2, PBr_3, ClO_4^-