CHE1031 Module 6 examples: Electronic structure & periodic props.

These are the problems I'll have you work during lecture. While the problems are presented on lecture slides you may find it useful to print them in this format and bring them to class. The problem number is shown in a green circle in the upper right of slides.

- *Problems identified by **letters** (a) are in optional "sidebar" sections of lecture. We won't cover them in any depth in lecture but they enhance the material that will be the focus of lecture.*
- Problems identified by **number (1)** relate to the focus of this lecture and will be on exams.

6.1: Electromagnetic energy

a. *A sodium streetlight gives off yellow light with a λ of 589 nm.*
What is the frequency of the light?

b. A common US cell phone frequency is 850 MHz.
What is the wavelength of these radio waves?

c. *Neon lights are created by exciting Ne atoms with electricity.*
If the wavelength of neon light is 640 nm, what is the energy of the photon being emitted by the light?

d. *Microwaves have a wavelength that heats water molecules in food, but not materials with low water contents. Microwave frequency is about 3 E9 Hz.*
What is the energy of a microwave photon?

e. *Read these statements of the photoelectric effect.*
(a) Identify those that are false.
(b) Then, change them to make them true.

(1) Increasing the brightness of incoming light increases the kinetic energy of ejected electrons.
(2) Increasing the wavelength of incoming light increases the kinetic energy of ejected electrons.
(3) Increasing the brightness of incoming light increases the number of ejected electrons.
(4) Increasing the frequency of incoming light can increase the number of ejected electrons.

f. *Calculate the threshold energy (kJ/mol) of electrons in Al if the lowest frequency for the photoelectric effect is 9.87 E14 Hz.*

6.2: The Bohr model

g. *What is the energy (J) and the wavelength (m) of the line in the spectrum of H that represents the movement of an e- from a Bohr orbit of n = 4 to the orbit of n = 6?*
Where do we see this in the electromagnetic spectrum?

h. *What is the energy (J) and the wavelength (m) of the photon produced when an electron falls from the n = 5 to the n = 3 level in a He^{+1} ion (Z = 2)?*

i. *What is the radius, in angstroms, of the orbital of an electron with n = 4 in a hydrogen atom?*

6.3: Development of quantum theory

j. *Use de Broglie's equation to calculate the wavelength of an electron traveling at 1.000 E7 m/s if it has a mass of 9.109 E-28 g.*

k. *Calculate the wavelength of a softball with a mass of 100 g traveling at a velocity of 35 m/s, assuming that it acts as a particle. So, use de Broglie's equation.*

l. *We measure an electron's position and find the uncertainty of position (Δx) is 1 pm, about 1% of the diameter of a H atom. What's the uncertainty of the electron's momentum?*

1. Consider the n = 4 principle energy level (or shell) of an atom.

(a) How many subshells?

(b) How many orbitals in each subshell?

(c) Orbital l values?

(d) Orbital m_l values?

m. *Use these quantum numbers to identify subshells.*

(a) n = 3, l = 1
(b) n = 5, l = 3
(c) n = 2, l = 0

2. What is the maximum number of electrons that can occupy these valence shells. (Ignore core electrons.)

(a) n = 2
(b) n = 5 (through f)

n. *Complete this table:*

orbital	n	l	m_l degeneracy	radial nodes (#)
4f				
	4	1		
	7		7	3
5d				

6.4: Electronic structure of atoms (electron configuration)

3. Write the abbreviated electron configurations of:

(a) Ca

(b) O

(c) Si

(d) P

4. Draw the box-arrow diagram of the electron configuration of phosphorus.

5. Identify the atom from its electron configuration:

(a) $[Ar]4s^2 3d^6$

(b) $[Kr]\ 5s^2 4d^{10} 5p^6$

6. Write the atomic & ionic electron configurations of these elements:

(a) Na

(b) P

(c) Al

(d) Fe (+2)

7. Which ion with a charge of +2 has an electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 4d^5$?

8. Which ion with a charge of +3 has an electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 4d^5$?

6.5: Periodic variations in element properties

o. *Arrange these atoms in order of increasing covalent radius by looking at the periodic table:*
Ge, Fl, Br, Kr.

p. *Name an atom whose size is smaller than fluorine.*

9. List five ions or atoms that are isoelectronic 'with' nitrogen ion.

10. List four ions or atoms that are isoelectronic 'with' phosphorus ion.

q. *Rank the energy required for these ionizations:*

Al IE1
Tl IE1
Na IE2
Al IE3

r. *Which has the lowest IE2 value?*

O
Po
Pb
Ba