Ch 7: Electromagnetic Radiation

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Quantum Chemistry

1) What is the Schrödinger cat thought experiment? How should electrons be viewed? What are the atomic orbital describing?

2) Why is the energy gaps between subsequent principle energy levels n become smaller e.g. $n = 1$ to $n = 2$, $n = 2$ to $n = 3$, etc.

Electromagnetic Radiation

3) Which transition in the hydrogen atom results in emitted light with the longest wavelength? Explain. Sketch the relative energy levels in the hydrogen atom.

a) $n = 4 \rightarrow n = 3$

b) $n = 2 \rightarrow n = 1$

c) $n = 3 \rightarrow n = 2$

4) An electron in a hydrogen atom is excited with electrical energy to an excited state with n = 2. The atom then emits a photon. What is the value of n for the electron following the emission?

5) Calculate the frequency and energy of each wavelength of electromagnetic radiation. For each, what is the energy for 1 mole of photon? ($N_A = 6.022 \times 10^{23}$)

a) 632.8 nm (wavelength of red light from helium–neon laser)

b) 503 nm (wavelength of maximum solar radiation)

c) 0.052 nm (wavelength contained in medical X-rays)

Electron Configurations and Periodic Trends

6) Write the electron configuration for each ion: O^{2-}, Br^{-}, Sr^{2+}, Co^{3+}. Cu^{2+}, Cl^{-}, P^{3-}, K^{-}, Mo^{3+}, and V^{3+}

4) Consider these elements: N, Mg, O, F, Al.

a) Write the electron configuration for each element.

b) Arrange the elements in order of decreasing atomic radius.

c) Arrange the elements in order of increasing ionization energy.

d) Use the electron configurations in part a to explain the differences between your answers to parts b and c.

7) Explain why atomic radius decreases as we move to the right across a period for main-group elements but not for transition elements.

Taking it Further: Particle in a Box

8) An electron confined to a one-dimensional box has energy levels given by the equation

$$E_n = \frac{n^2 h^2}{8mL^2} \tag{1}$$

where n is a quantum number with possible values of 1, 2, 3,$\cdots$, m is the mass of the electron (9.109×10^{-31}), and L is the length of the box.

a) Calculate the energies of the $n = 1$, $n = 2$, and $n = 3$ levels for an electron in a box with a length of 155 pm.

b) Calculate the wavelength of light required to make a transition from $n = 1 \rightarrow n = 2$ and from $n = 2 \rightarrow n = 3$. In what region of the electromagnetic radiation do these wavelength lie?