Homework #7-2: Bohr’s Theory of the Hydrogen Atom, EM Spectroscopy, Fluorescence Problems pg. 298 #23, 26, 28, 30, 43, 47 and additional Spectroscopy Questions

23 Briefly describe Bohr’s theory of the hydrogen atom and how it explains the appearance of an emission spectrum. How does Bohr’s theory differ from concepts of classical physics?

26 Some copper compounds emit green light when they are heated in a flame. How would you determine whether the light is of one wavelength or a mixture of two or more wavelengths?

28 Explain how astronomers are able to tell which elements are present in distant stars by analyzing the electromagnetic radiation emitted by the stars.

30 The first line of the Balmer series occurs at a wavelength of 656.3 nm. What is the energy difference between the two energy levels involved in the emission that results in this spectral line?

A. How would the wavelength and energy of light absorbed when an electron is excited from the n = 2 to the n = 3 energy level compare to the wavelength and energy emitted in problem 30 above?

43 What are the inadequacies of Bohr’s theory? What questions could it not answer?

47 What is an atomic orbital? How does an atomic orbital differ from an orbit?
B. What kind of information (Molecular Rotation, Bond Vibration, or Electronic Transitions) is obtained by spectroscopy involving absorption of light in the UV/visible region of the EM spectrum.

C. How does the color of light transmitted by a clear colored solution or reflected by a colored substance relate to the color of light absorbed by the substance?

D. (i) What is Beer’s (Beer-Lambert) Law, and how is it used in chemical analyses?

(ii) Below is the absorption spectrum for CoCl₂ (left) and the Beer’s Law plot for CoCl₂ at 560 nm. Explain why 560 nm is an appropriate wavelength for the Beer’s Law analysis, then determine the concentration of a solution with absorbance = 0.32.

E. What is the basic process by which fluorescence and phosphorescence work? Why is higher-energy UV light necessary? How are the two processes different?

F. At right is the IR transmission spectrum of diethylamine. What kind of information (Molecular Rotation, Bond Vibration, or Electronic Transitions) can be obtained from this region of the EM spectrum?

G. Microwave radiation spectroscopy (λ is actually in the mm range) can be used to investigate rotational motion of small molecules such as water. Rank the relative energies of UV-Vis, Infrared, and Microwave spectroscopies, from lowest to highest.