

**Preparation for Group Activity (Pre-Activity Assignment):
The Line Spectrum of the Hydrogen Atom and Bohr Theory**

PURPOSE: The purpose of this assignment is to familiarize you with the quantifiable properties of light (electromagnetic radiation). Understanding these properties is important because of their use in *spectroscopy*, the branch of science studying how light interacts with matter. The emission and absorption of light by matter provides most of the information we have about the electronic structure of atoms and molecules. Spectroscopy is the most important tool in chemistry for following the course of chemical reactions and for identifying compounds, which you will see in an upcoming CHEM 1501 lab. It is used routinely in research, quality control, forensic crime, and medical labs (currently, fluorescence spectroscopy is used in some COVID-19 detection and antibody tests). Learning about spectroscopy of one type or another will be part of every course in the chemistry curriculum.

In addition to strengthening your knowledge of these light properties, this assignment will help you develop the skills of interpreting symbolic equations (many of which you will encounter throughout the duration of the general chemistry series). You will also develop the ability to perform and document calculations in the format expected on quizzes or exams for this course. You will be able to practice and demonstrate these skills during the hydrogen atom group activity.

TASKS:

1. Read sections 2.3 and 2.4 in your Zumdahl textbook. After reading, state in words the precise meaning of the equations below. **Be specific.** Don't just say "frequency"—state the frequency of what object. Observe the example in a. to see how to properly interpret symbolic equations.

Example:

a. $v = \frac{c}{\lambda}$ The frequency of a wave is equal to the speed of light divided by the wave's wavelength.

b. $E_{\text{photon}} = hv = \frac{hc}{\lambda}$

c. $E_n = -2.18 \times 10^{-18} \left(\frac{Z^2}{n^2} \right) \text{ J}$

d. $E_{\text{photon}} = \Delta E_{\text{electron}} = E_{\text{final}} - E_{\text{initial}}$

- Record the wavelengths of each of the visible lines in the spectrum for hydrogen from Figure 2-7b in your Zumdahl textbook, then calculate the frequency of each line. Carefully observe *Interactive Example 2-1* in your textbook to see how to properly perform and document your calculations: show the symbolic equation (re-arrange it if necessary), perform relevant conversions, insert values and units into the equation, and provide the final answer with appropriate units.

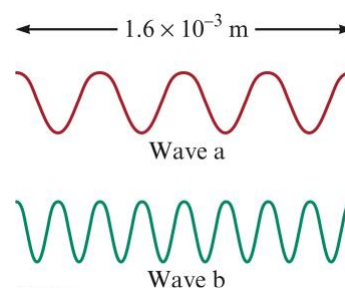
- Complete the following problems (these are EoCs **2.46** and **2.45** from Zumdahl). Make sure to properly perform and document your calculations as described above.

2.46 One type of electromagnetic (EM) radiation has a frequency of 107.1 MHz, another type has a wavelength of 2.12×10^{-10} m, and another type of EM radiation has photons with energy equal to 3.97×10^{-19} J/photon. Identify each type of EM radiation and place them in order of increasing photon energy and increasing frequency. *Note:* $1 \text{ Hz} = 1 \text{ s}^{-1}$; M = mega = 10^6

Hint: For easy comparison, choose one property of light and convert each type of EM radiation to that chosen property.

2.45 Consider waves **a** and **b**, representing electromagnetic radiation:

- i. Calculate the wavelength of both waves. *Hint*: Note the distance scale at the top of the figure to help with your calculations—how many waves “occur” for that distance?



Wave a:

Wave b:

- ii. Which wave has the longer wavelength?

Circle one: Wave a / Wave b

- iii. Which wave has the higher frequency (ν) and larger photon energy (E_{photon})? Calculate the frequency and the energy for both of these values for each wave.

- iv. Which wave has the greater velocity? *Hint*: Velocity (m/s) is synonymous with speed.

- v. What type of electromagnetic radiation does each wave represent?

Wave a:

Wave b:

CRITERIA: Your grade for this assignment will be partially based on completeness (every question attempted, equations clearly interpreted, documentation of calculations demonstrated) and partially based on accuracy (correct answers).

Hydrogen Atom Pre-Activity			
Criteria	Ratings		Pts
Clearly interpreted equations (Task 1)	1 pts Full Marks	0 pts No Marks	1 pts
Full documentation of calculations (Tasks 2-3)	1 pts Full Marks	0 pts No Marks	1 pts
Accurate & correct answers (Tasks 2-3)	2 pts Full Marks	0 pts No Marks	2 pts
All tasks & questions attempted	1 pts Full Marks	0 pts No Marks	1 pts
			Total Points: 5