

Spectral Lines

Read from **Lesson 1: Physics in the Early 20th Century** in the **Chemistry Tutorial Section, Chapter 5 of The Physics Classroom:**

Part a: [Emission Spectrum of the Elements](#)

Part b: [The Photon](#)

Part c: [Bohr's Quantized Energy Levels](#)

Here is the line spectrum of helium:



Image Source: [Wikipedia](#)

- Complete the following table using the appropriate equations and constants about the different colored lines found in the line spectrum of helium.

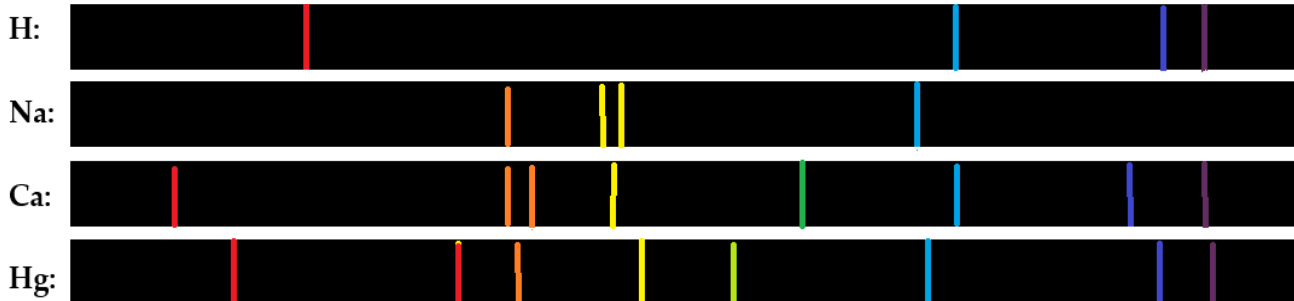
Color	Wavelength, λ	Frequency, f	Energy, E
Red	668 nm		
Yellow		5.10×10^{14} Hz	
Green			3.97×10^{-19} J
	471 nm		
			4.45×10^{-19} J

- An element is heated, and a photon of light is emitted. This particular photon of light has 8.67×10^{-15} J of energy.
 - What is the frequency of the emitted light?
 - What is the wavelength of the emitted light? (give your answer in nanometers and meters)
 - How does the speed of this emitted light compare to the speed of a photon of visible light? Explain your answer.
 - How does the energy of this emitted light compare to the energy of a photon of visible light? Explain your answer.

Early Models of the Atom

3. Answer the following questions about the line spectra of four elements and a line spectrum of a mixture of gases shown below.

Line spectra of known elements:



Mixture of gases line spectrum:



- a. Which of the four elements are present in this mixture of gases? Which are not present? Explain your answers.
- b. Why do larger elements like mercury produce more colored lines in their line spectrum than smaller gases like hydrogen?
- c. Consider the red, green, and violet line shown in the line spectrum of calcium. If these colored lines were produced by the following energy level transitions:
- | | | |
|--------------------|--------------------|--------------------|
| E4 to ground state | Ground state to E3 | E1 to ground state |
| E2 to E1 | E3 to ground state | Ground state to E4 |
- which one could have produced the red line?
- which one could have produced the green line?
- which one could have produced the violet line?