Spectra of Different Light Sources

Goal
To gain an understanding of what a light spectrum is and how it can be measured.

Introduction

Light is colorful. But what makes light have different colors and brightness? How do different light sources generate light? And how can we measure the different features of light? These questions also puzzled scientists centuries ago. In this tutorial, we will make observations of the spectrum of different light sources. Through the experiment and discussions, we will look for clues to resolve those questions.

A. The Instrument of Spectroscopy

A-1. What can we measure with a spectroscope?

A-2. How does a spectroscope work? Discuss with your group all the possibilities that you can think of. When you are finished, consult with the instructor.

A-3. Say you observe a light with a wavelength of 680 nm.

- What is the frequency of this light?

- What is its color?

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B. Pre-experiment Discussion of Different Light Sources

B-1. Before starting the experiment, discuss with your group the features you expect to see for each light source. Be sure to consider the following issues:

- How is the color of the light emitted by each source similar and/or different?

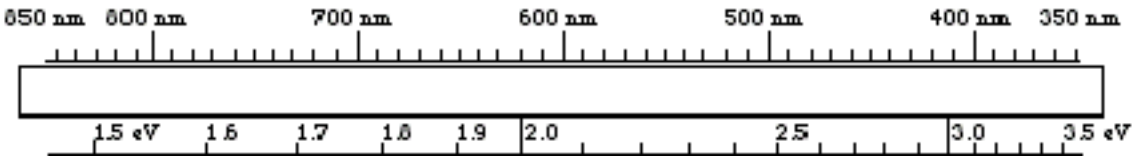
- For each source, does the color or spectrum change with the intensity of the light? Explain your reasoning.

- How are the different colors of the different sources created?

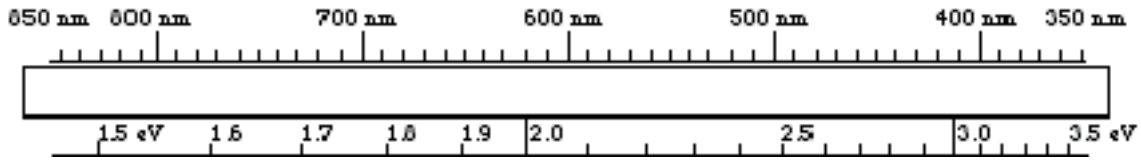
- What are your ideas about how light energy is created from other energy sources?

B-2. Discuss your expectations of how the spectra of the light emitted from each of the different light sources will appear. In the space below, qualitatively sketch how the spectra look for light from each of the following sources. Explain your reasoning.

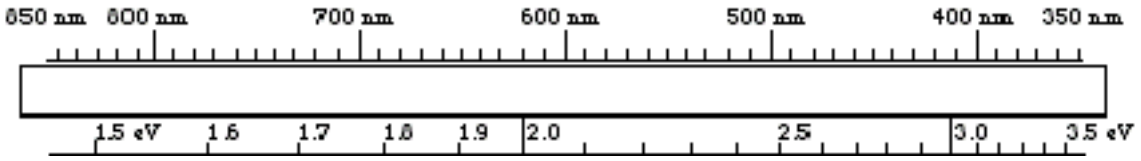
- a light bulb



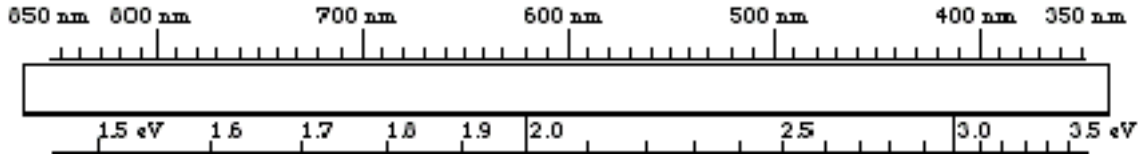
- a red Christmas tree light



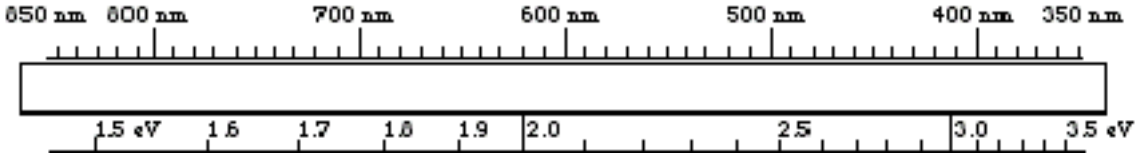
- a neon gas lamp



- an uncoated fluorescent tube



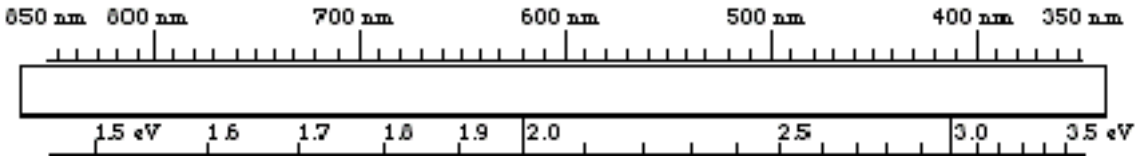
- a fully coated fluorescent tube



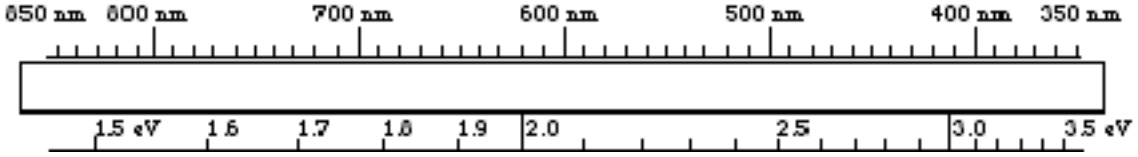
C. Observations of Spectra

C-1. Make observations of spectrum for each of the sources listed below. Then sketch the spectrum. When sketching the observed spectrum, please label clearly any numerical readings.

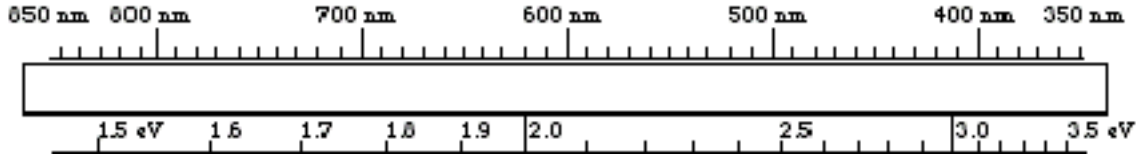
- a light bulb



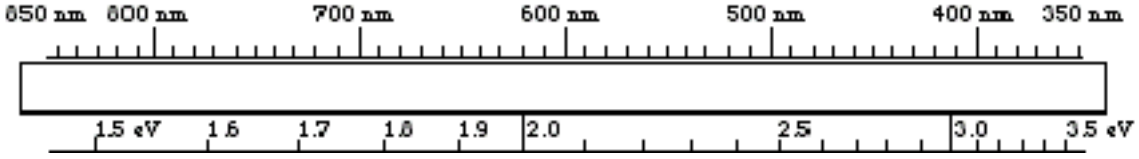
- a hydrogen gas lamp



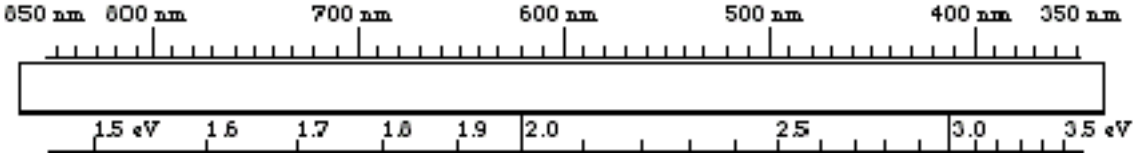
- a neon gas lamp



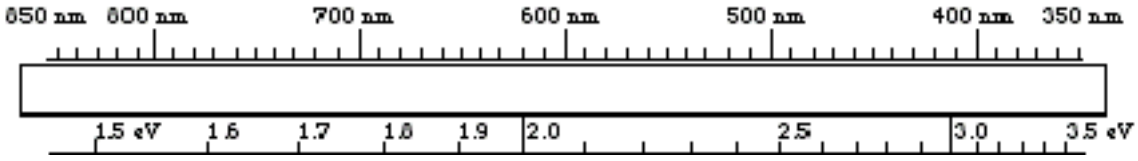
- a mercury light



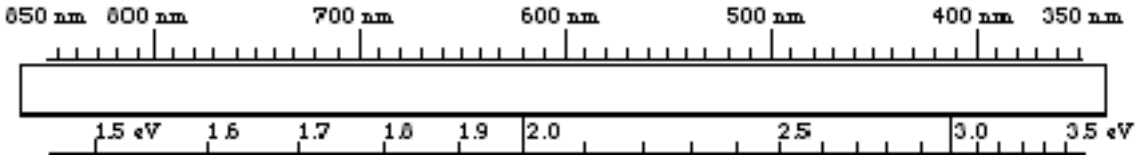
- a red Christmas tree light bulb



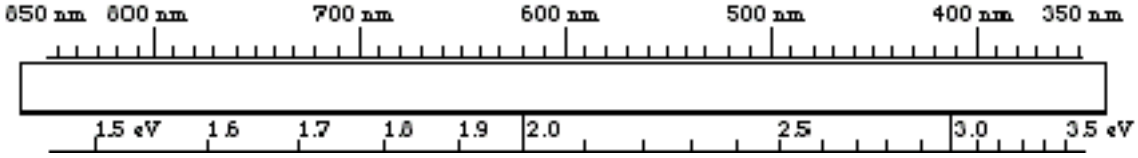
- a red LED



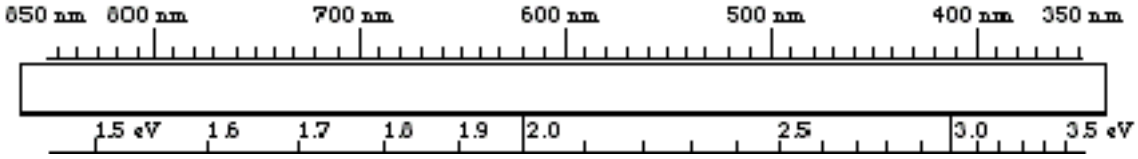
- an uncoated fluorescent tube



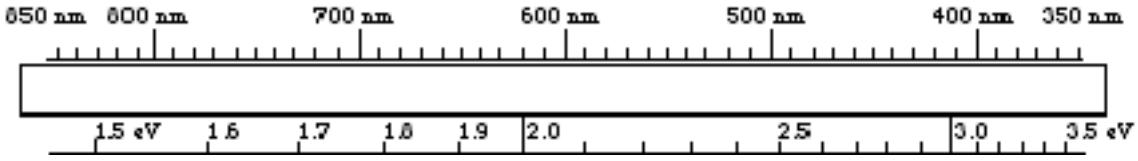
- a half coated tube. What are the differences between spectra of lights from the coated and uncoated parts?



- a fully coated white fluorescent tube



- a red fluorescent tube



C-2. Compare your results of the uncoated tube, half-coated tube and the fully coated tube.

- What conclusions can you draw about how light is created inside the tube?

- What conclusions can you draw about the role of the coating in the light emission process?

C-3. Compare your results of the red Christmas tree light, the red LED, the neon gas lamp and the red fluorescent light. Describe in detail the similarities and differences for the spectra of the different light sources.

C-4. To the best of your knowledge, discuss the similarities and differences in the way light energy is produced by each source.

C-5. How are the spectra of the gas lamps (hydrogen, mercury, neon) similar to or different from the other light sources? Discuss any possible causes that can make these differences.

C-6. For all of the different light sources you have observed, try to identify a few important features of the spectra. Based on these features, create categories of light sources (a source may belong to more than one category).

C-7. In a few paragraphs, summarize your observations and conclusions.

D. Question

This is a challenging question. Discuss it with your group and attempt an answer. We will introduce concepts in later classes which will assist you in forming a complete understanding.

A photocell is a device that converts light energy into electrical energy, so light incident on a photocell can create electric current. A beam of pure colored light is measured to have a wavelength of 560 nm. It is incident on a perfect photocell that converts light to electric power at 100% efficiency. See diagram at right. The photocell has zero internal resistance and the reading of the current meter is 1.0 μA (1.0×10^{-6} Ampere), what is the energy of the photon of this light? How many photons does the photocell receive per second?

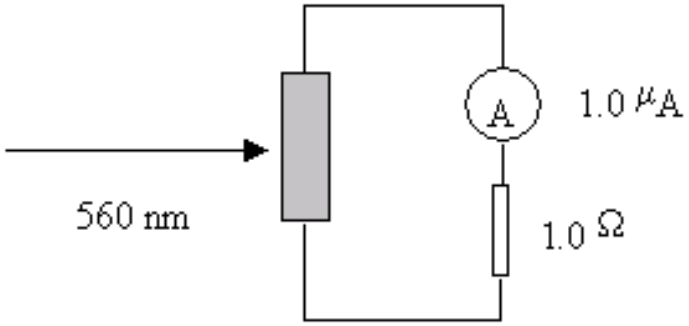


Figure 1: Diagram of a Photocell