AST101: Our Corner of the Universe
Lab 9: Spectra II Prelab

Name:

Student number (SUID):

Lab section:

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1 Introduction

Last week in class, you saw that atoms emit and absorb photons with particular energies, corresponding to particular wavelengths and colors, based on their energy levels. In this week's lab, you will experiment with devices that let you directly observe the colors emitted by different types of atom (different chemical elements), and study the properties of spectra.

2 Reference

The following table will be helpful for the rest of the lab. (Note that the visible spectrum is a continuous band of color, so a photon with energy of 2.0 eV would be seen as reddish-orange; there are no "hard stops" between the different colors.)

Color	Photon energy (eV)	Wavelength (nm)
Infrared	<1.6	>750
Red	1.6-2.0	620-750
Orange	2.0-2.1	590-620
Yellow	2.1-2.2	570-590
Green	2.2-2.5	490-590
Blue	2.5-2.7	450-490
Violet	2.7-3.2	380-450
Ultraviolet	>3.2	<380

3 Energy Levels and Atoms

As we discussed in class, electrons in an atom are restricted in what energies they can have. For example, suppose an atom has the following set of energy levels: (0 eV, 2 eV, 3.5 eV, 4.5 eV). An electron in this atom can have any of these energies, but no others.

An electron in this atom can jump up to a higher level if it absorbs a photon whose energy is equal to the difference in energy, and can fall down to a lower level by emitting a photon whose energy is equal to the difference in energy.

Suppose that I run an electric current through a lot of these atoms. Their electrons will be excited up to higher levels, and will emit light as they fall back down. As they do, there are six possible transitions that will emit six different energies, and thus colors, of light. Fill out the following table:

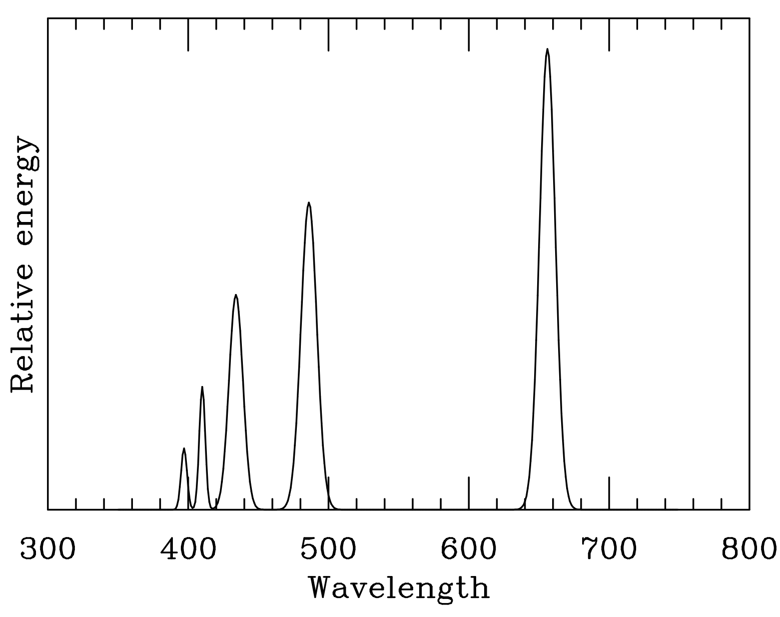
First energy level	Second energy level	Photon energy (eV)	Color of light emitted

4 Representing Spectra

You will see spectra in two different forms in this lab (and in the rest of the course, and in life):

- As a graph of amplitude vs. wavelength, generated by a computer spectrometer that collects and analyzes light
- As a series of colored lines, produced by an optical spectrometer that separates light by color

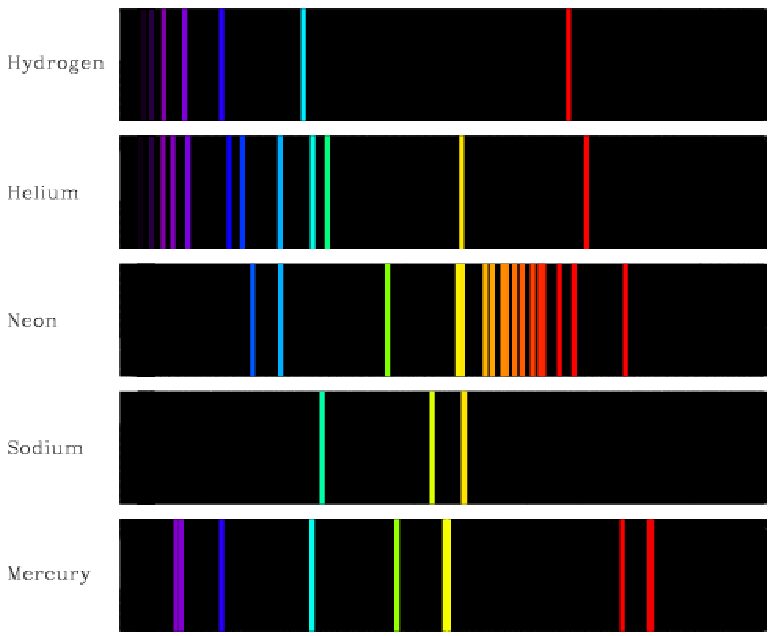
Here's a spectrum in the first format of an unknown gas:



Answer the following:

1. What would this spectrum look like if you looked at it with a spectrometer (which spreads light out based on its wavelength for you to see with your eyes) instead of a computer that made a graph? (You may want to refer back to the table above to figure out which wavelengths go which with colors.)

2. Here is a set of emission spectra for some common elements:



Which of these spectra is the unknown gas above, and how do you know?

3. Suppose you have two different kinds of light bulbs.

   - An incandescent bulb: a thin wire that is heated to around 3000 K by an electric current. (It doesn't matter what the wire is made of.)
   - A fluorescent bulb: a tube containing a diffuse mercury gas, with electric current running through it that excites the electrons in the mercury atoms, raising them to higher energy levels so they can fall back down and emit light

   You can't tell the difference with your eyes; both of them appear to glow a soft white, and both of them are covered in frosted glass so you can't see what's inside. How could you tell which one was which if you had a spectrometer?