Name:________________________________ Date:______________________________

LIGHT AND SPECTRA PRE-LAB

Using your lecture textbook and/or any other acceptable source of information, answer each question in complete sentences. Be sure to define any relevant terms.

1. Identify the three types of spectra and explain how each is generated. Sketch the appearance of each type of spectrum.

2. Explain how spectral lines can be used to detect the presence of certain elements.

3. A spectral line of sodium is normally has a wavelength of 5890 Angstroms. The same line measure in the spectrum of a star is at a wavelength of 5625 Angstroms. What speed is the star traveling? Is the star moving towards us or away from us?

Name:____________________________ Partners: ______________________________

Date:______________________________ ______________________________

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LIGHT AND SPECTRA LAB ONLINE

PART 1: SPECTRA AND SPECTRAL LINES

Go to the GSU Perimeter College ASTR 1020 Lab website (http://sites.gsu.edu/astr1020lab) and click on the "Light & Spectra Lab" link on the left menu. There are images of the powered spectral tubes of six labeled ionized gases with their corresponding emission spectra as you would see them through the hand-held spectroscope that students use on campus. The spectra images are just the thumbnails you need to click on to bring up the full spectra (do NOT draw the thumbnails!)

For each of the six elements, record the name of the element, the color of the gas tube *(if you have difficulties identifying the colors, you may use the table of gas tubes and spectra of elements posted in the respective content module for this lab in iCollege or provided by your instructor)*, and draw one set of lines. Draw the lines proportionally in number, color, and location into the rectangular templates below. Label the color of the lines (violet, blue, green, yellow, orange, red) or use colored pencils, and give an approximate wavelength if possible. Notice the differences between the spectra.

1. a. Element:____________________

   Tube Color:__________________

   b. Element: ____________________

   Tube Color:__________________

   c. Element:____________________

   Tube Color:__________________

   d. Element: ____________________

   Tube Color:__________________

e. Element:____________________ f. Element: ____________________

Tube Color:__________________ Tube Color:__________________

IDENTIFYING AN UNKNOWN SPECTRUM

Scroll down on the Astronomy Labs website and click on the thumbnail of the UNKNOWN 1 spectrum. With a cm-ruler held up to the screen, you will measure the location of the brightest lines from the left edge of the spectrum. Note the wavelength value of the left edge. It is NOT zero. You will need to add this left edge wavelength to each spectral line after you have converted the cm reading into the unit of Angstrom (by multiplying your cm readings with the scale factor we will develop right now)

2. For the scale factor, record the number of Angstrom (Å) in the double arrow directly underneath the spectrum

number of Angstroms: ______________________ Å

Measure and record the length in cm of the double arrow:

length: ___________________________________ cm

Calculate the scale factor by dividing number of Å by the number of cm:

Scale: ________________________________ Å /cm

Now, record the color and corresponding wavelength of the spectral lines below starting at the left. Use the following to find the wavelength of each spectral line:

Wavelength (Å) = Wavelength of left edge + (cm-location) x (scale factor)

color						
cm-location						
Wavelength (Å)						

3. We can identify the element based on its spectral lines. Compare your measurements to the lines listed in Table 1. You may not have seen all the lines that are listed for

your element. Note that lines which are very close together may seem blended into one line.

Name of Element ____________________ Have your instructor verify your conclusion.

Table 1
Wavelengths of spectral lines (in Angstroms)

argon	hydrogen	Helium	mercury	neon	sodium
4100	4101	4471	4047	4540	5890
4200	4340	4713	4358	4580	5896
4265	4861	4921	5461	4690	
4330	6563	5016	5790	4700	
4510		5876	6150	4790	
4686		6678	6907	5330	
				5360	
				5400	
				5850	
				5880	
				6400	
				6940	

4. Scientists determine their measurements' accuracy by calculating a percent error. Percent error measures how close an experimental number is to an accepted value. Record your wavelengths of the spectral lines from the unknown element in Column A. Write the known value for the spectral lines from Table 1 in Column B. Take the difference between the experimental and the known values (Column C), divide by the known value (Column D) and multiply by 100 (Column E).

A experimental value	B known value	C $\lvert$difference$\rvert$	D C/B	E D × 100 (percent error)
___________	_________	___________	_______	_____________
___________	_________	___________	_______	_____________
___________	_________	___________	_______	_____________
___________	_________	___________	_______	_____________
___________	_________	___________	_______	_____________
___________	_________	___________	_______	_____________

All of the values in Column E should be less than 15%. If they are not, check your calculations and your measurements.

DOPPLER SHIFT

All stars are moving. When they move, the wavelengths of their spectral lines are affected. The lines shift from the wavelengths observed in a stationary lab to other wavelengths by an amount proportional to the speed of the star. This property is called <u>Doppler Shift</u>. If the star is moving toward the Earth, the lines will have shorter wavelengths and the spectrum is said to be <u>blueshifted</u>. If the star is moving away from the Earth, the lines will have longer wavelengths and the spectrum is said to be <u>redshifted</u>. By measuring the amount of the shift, we can determine the speed of the star. We use the following formula:

$$\Delta\lambda / \lambda_o = v / c$$

where:

$\Delta\lambda$ is the shift in wavelength away from the normal wavelength taken from the spectrum of a stationary gas.
λ_o is the wavelength of the line in the spectrum of a stationary gas.
c is the speed of light. Its value is 3×10^5 km/s
v is the speed of the star.

In order to determine the speed of a star, we must compare the spectrum of a star which is moving to the spectrum found in a stationary laboratory. Stars contain many elements and the spectrum of a star contains lines from all of those elements. To simplify things, we will consider only the hydrogen spectrum of a star.

First, we need a **comparison spectrum**. Figure 1 shows the spectrum of the element Hydrogen. This would be taken in a lab, so it is **stationary**, neither red nor blueshifted.

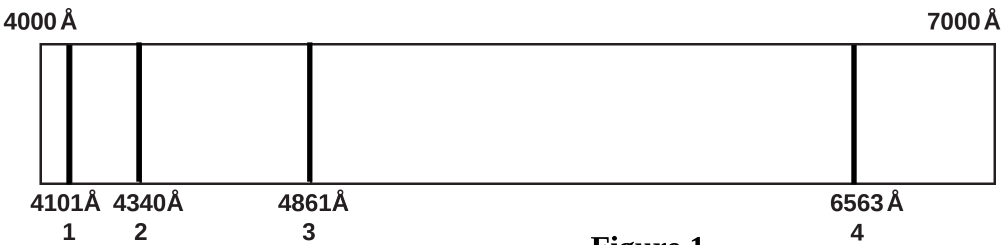
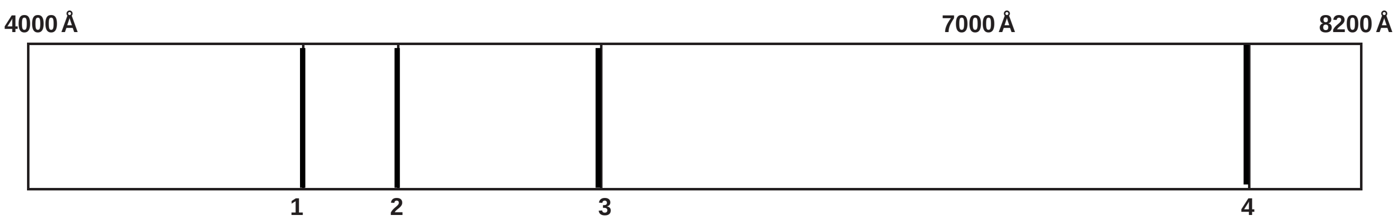


Figure 1

Let us examine the hydrogen spectrum from a **moving** star, Star A, shown below. By comparing this to stationary spectrum, we can find the amount of the shift and, therefore, determine the speed of the star. Both the stationary spectrum and the spectrum of the star have the same scale and start at 4000Å at the left edge. Note how the location of the lines differs between the stationary spectrum and the spectrum of the moving star.



STAR A

5. Is the spectrum redshifted or blueshifted? Explain your reasoning.

6. Now we want to determine the amount of shift that has occurred. We can measure the shift on the page in centimeters. We will, however, need to change this to Angstroms. We will need a scale factor to relate a change in location on the page to a change in wavelength. Measure with a ruler in cm the length of the box in Figure 1. (Since the boxes are drawn to the same scale, we can determine the scale for both from one box). Also, calculate the number of Angstroms represented in the box.

Centimeters =______________________ Angstroms = ______________________

Calculate the scale factor by dividing the number of Angstroms by the length of the box.

Scale =______________ Å/cm

7. Measure (in cm) the distance *from the left edge* to each of the spectral lines in the comparison spectrum in Figure 1. Record these distances in column A. Similarly, measure the position of the lines (in cm) in the spectrum of Star A. Record these in column B. Calculate the difference between the corresponding lines in column C. To convert the shift from cm to Angstroms, multiply the values of column C by the scale you found in Question 6. Record these values in column D. Using Figure 1, record the original wavelengths for each line in column E. Complete the remainder of the table as indicated. Use the value of 3 x 10^5 km/s for the speed of light.

	A	**B**	**C**	**D**	**E**	**F**	**G**
line #	**comp. line position (cm)**	**Star A line position (cm)**	**Shift (cm) (A-B)**	**Shift (in Å)**	**Original λ (in Å)**	**D/E**	**F × speed of light**
1							
2							
3							
4							

8. The speed you get should all be nearly the same. Calculate the average of your four (4) speeds. This is the speed of the star.