Unit: Redshift and the Universe Expansion
Activity 1: How Fast Do Galaxies Move?

Name _____
Date _____
Period _____

Objectives: Students will……

- *Interpret an emission spectrum for redshift.*
- *Use the percent change of redshift to calculate the speed of a galaxy.*

Directions: Go to the "How Fast Do Galaxies Move?" interactive lab website at www.cfa.harvard.edu/seuforum/galSpeed. Follow the guide below as you work through the different sections, recording your data and answering questions in the spaces provided.

[this tool likely works best in Firefox and not Chrome, as it requires Java.]

Student Interactive Lab Guide:

Read "Frozen In Time" and "Welcome to Virtual Spectroscope Lab" information.

Step 1: Getting a Feel For The Spectroscope

*Read information
*Click on Virtual Spectroscope
*Select "Sun" on pull down menu

Q1. Name the colors of the visible spectrum from longest wavelength to shortest.	
Q2. What type of EMR has a wavelength longer than 700 nm?	
Q3. Can humans "see" this wavelength? If so, how can it be done?	

Step 2: What Do The Patterns Tell Us?

*Read this section
*Click back on Virtual Spectroscope and choose fluorescent lamp from the pull down menu.

Q4. The top image is a bright line emission graph. Describe the emission lines by wavelength and type of EMR. They should also appear in the middle graph.	

Step 3: "Fingerprinting" an Element.

*Read this section

*Click back on Virtual Spectroscope and choose hydrogen from the pull down menue.

*Click on the center graph to create a vertical line you can move to align with different points. Notice the wavelength reading in the upper right that changes with movement. We'll use this tool in the next steps.

Q 5. If hydrogen's red line represents a wavelength of 656 nm, what is the wavelength for the blue line?	

Step 4: Exploring the Doppler Effect.

*Read this section

*Choose your speed and click "emit waves"

Q 6. Your Prediction – If the source of the waves moves towards you, will the wavelength of the waves appear shorter, longer, or the same as when the source is stationary?	
Q 7. How about for a source that's moving away from you?	
Q 8. Describe how the Doppler effect would be recognized with sound waves.	

Step 5: Understanding "REDSHIFT"

*Read this section

*Click back on Virtual Spectroscope and choose Galaxy 1 from the pull down menu.

Q 9. In the original hydrogen emission spectrum the red line represented a wavelength of 656 nm. What is its wavelength in Galaxy 1?	

Q 10. Would you conclude Galaxy 1 is moving away from Earth or towards Earth? Why?	

Step 6: "Clocking" a Galaxy

*Read this section

*Click on Virtual Spectroscope and choose Galaxy 3 from the pull down menu.

Q 11. Compare the hydrogen redshift of Galaxy 3 to Galaxy 1. Based on your above investigation with Doppler effect, which galaxy is moving away faster?	
If the amount of redshift is proportional to the speed of the galaxy…then… **% change of redshift = % of speed of light**	Galaxy 1 redshifted 13 nm from the original 656 nm. $\frac{13\text{ nm}}{656\text{ nm}} \times 100$ = 1.98% change in hydrogen redshift $.198\ (3.0 \times 10^8\text{ m/sec}) = 5.94 \times 10^6\text{ m/sec}$ speed of light or 5,940 km/sec
Q 12. Calculate the speed of Galaxy 3. Show work. Did you support your Q 11. answer?	

CONGRATULATIONS!

It's one thing to measure the speed of a car or baseball pitch (v=d/t)….but you've just measured the speed of a galaxy from millions of trillions of kilometers away from Earth!