Names: ______________________ ______________________

______________________ ______________________

Grade	

Astronomical Redshift

Pre-Lab Quiz:

Record you team’s answer as well as your reasonings and explanations.

1.
2.
3.
4.
5.

Part 1: Measuring Rest Wavelengths

1. With the Hydrogen tube in the carousel, record the wavelengths of the emission lines, identify which Balmer line they are, and rank them (1 = strongest, 3 = weakest) based on their strength.

Wavelength λ_{rest} (nm)	Balmer Line	Relative Strength

2. Sketch the spectrum of Hydrogen and label the axes and the emission lines.

Part 2: Measuring Redshifted Wavelengths

As a class, you will each be responsible for a quasar. The Quasar data can be opened in LoggerPro, and is found under LabImage ➔ Spectra ➔ SDSS. Your instructor will assign you a quasar, and show you how to open the data in LoggerPro.

Using this data and Hubble's Law, you will determine the velocity and distance to the quasar, and then calculate a new Hubble's constant and the age of the Universe using a spectrum assigned to you.

1. Sketch the spectrum of the quasar and identify the emission lines. Include a plot title with the name of your quasar and label your axes. **Note**: The wavelengths are in Angstroms (10 Å = 1 nm) and [OIII] lines are present.

2. Identify emission lines Balmer Hα, Hβ, and Hγ, and [OIII] $\lambda\lambda$ 4959, 5007 in your spectrum and record their observed and rest wavelengths in the table below, and then calculate their redshift value *z*. Indicate the wavelength unit.

Emission Line	λ_{rest} (____)	λ_{obs} (____)	$\Delta\lambda = \lambda_{obs} - \lambda_{rest}$ (____)	$z = \Delta\lambda / \lambda_{rest}$

3. What was the point of the exercise in Part 1?

4. Calculate the average redshift value of your quasar. Then find the velocity of the quasar in km / s using the formula $v = c\,z$, where $c = 3\text{x}10^5$ km / s is the speed of light. **Note**: If any of the z-values are significantly different than the others, you probably misidentified an emission line.

5. In Logger Pro, make a plot of Hubble's law, $v = H_0 D$ with the distance (Mpc) on the x-axis and the velocity (km / s) on the y-axis using the quasar distance data from your TA and the quasar velocity data from all of the groups. Find the best-fit line. Sketch your plot here, label your axes, and record your value of the Hubble constant, which is the slope of the best-fit line.

6. Compare your experimental estimate of the Hubble constant with the actual known value, $H_0 = 70$ km / s / Mpc where Mpc = 1 million pc, using the percent error formula.

7. With your value of the Hubble constant H_0, compute the age of the universe (the "Hubble Time", $t = 1 / H_0$). To do this, take the number 1 and divide it by your value of the Hubble constant (find the reciprocal of H_0). Then multiply this new number by 978. This is the age of the Universe in billions of years. (As 1 pc / Myr = 1 km / s, where 1 Myr = 1 million years, 978 is the number of km in a Mpc divided by the number of seconds in a billion years.) What value did you obtain? How does this number compare with the known age of the Universe?