EXPANDING BALLOON UNIVERSE

NAME:
LAB PARTNERS:

(credit: This lab was inspired by the University of Washington lab. Some text was also copied from the lab given at Physics 1040 class at Weber State)

Summary

In this exercise, you will use a two-dimensional, the surface of a balloon, to explore the expansion of the Universe.

Equipment Needed

light colored balloon, ink pen or marker, string, ruler, partner

Background and Theory

The Hubble Law tells us that our Universe is expanding. We observe galaxies, find their distances and their velocities, and find that they are all moving away from us. The more distant the galaxy, the faster it is moving away. The observed relationship between galaxy recession velocity and distance is linear: $v = H\,d$, where v is the velocity a galaxy appears to move away from us, d is its distance away from us, and H is the Hubble constant. From this information, we can estimate the age of our Universe. If we assume that the Universe has always been expanding at the same rate, then we know how long distant galaxies have been traveling in order to get where they are today.

Procedure and data acquisition

1. Blow up the balloon a little bit. DO NOT TIE IT SHUT!
2. Draw nine galaxies on the balloon (away from the valve). Mark one of these galaxies as the reference galaxy, number the remaining galaxies 1 through 8. The reference galaxy is the galaxy that *you* live in and are making your measurements from.
3. Measure the distance between the reference galaxy and each of the numbered galaxies. The easiest way to do this is to use a piece of string. Stretch it between the two points on the balloon, then measure the string. Record these data, including units, in the table.
4. Blow up the balloon, while counting how long it takes. The time does not need to be precise, you can watch the second hand on the wall clock or just count, “one thousand one, one thousand two, one thousand...” etc. You can tie the balloon shut this time if you like. Record the time it took your balloon universe to expand in you data table.
5. Measure the new distance between the reference galaxy and each of the numbered galaxies. Record these data in the table.

Data Analysis

1. To calculate the distance each balloon galaxy traveled while the balloon universe expanded: subtract your first from your second distance measurements. Record this distance difference in your data table. You don't need to show your work.

2. Calculate each galaxy's velocity by dividing the distance traveled by the galaxies by the time it took you to blow up the balloon. You don't need to show your work.

3. Plot the velocity versus the current galaxy distance on the graph provided to get the "Hubble Law for Balloons". Don't forget to label your graph's axes.

4. Fit a straight line to your data. "Eyeballing" it is close enough.

5. Find the slope of your line. (Remember that the slope is "the change in y over the change in x".) This is exactly the way that we find the value of *H* from Hubble's Law. i.e., the slope *is* Hubble's Constant, *H*. Show your work.

Interpretation

1. Find the age of your balloon universe from this slope. The age is one over the slope: $T = 1 / H$. How does it compare to the time it took you to blow the balloon up between measurements? What assumptions are you making by doing this? Are they sensible assumptions?

2. How would your results change if you used a different reference "galaxy" on the balloon?

Data Table and Analysis

Time that your balloon Universe expanded: _____

galaxy number	measurement one	measurement two	difference	velocity