

Step 6: Questions

1. Compare the speed of the galaxy with the highest redshift to the speed of light.
 - a. Identify that galaxy and state its recessional velocity.
 - b. What fraction of the speed of light is that galaxy receding from us?
 - c. Comment on your value—that is, in terrestrial terms, is this speed high? How about celestial terms? (Show all calculations.)

2. Why does the best-fit line to your data need to go through the origin of your graph?
 - a. Where does the "origin" lie in the Universe?

3. Quantitatively compare your maximum age for the Universe to the age of the Sun (5 billion years), and to the age of the oldest stars in the Milky Way (approx. 15 billion years).
 - a. Briefly discuss any discrepancies, or comment about your comparisons of these ages.

4. Theoretically, your plot should be a straight line, but it probably isn't. Think carefully about the following sources of error and answer the questions.
 - a. First, write down the formula you used to determine the distances to these galaxies (the last column of your data table) and explain each term. State whether the distance is **proportional to** or **inversely proportional to each of** the individual terms on the right-hand-side of the equation.
 - b. One obvious source of error is the assumption we made that all spiral galaxies have the same **actual** diameter. How would an over-estimate or an under-estimate of the actual diameter (not angular diameter) of a galaxy affect your estimate of the distance to it? Explain.
 - c. You must have noted that for some galaxies you can see at least a vague spiral arm structure, while for others (the more distant?) you could not. What would be the effect on your value for the Hubble constant of your consistently **under-measuring** or **over-measuring** the angular diameter of the galaxies? (Hint: look at the distance formula and the Hubble Law formula, —this is a harder question.)
 - d. A third source of error is in the measurements that you make.
 - i. Quantitatively (give some numbers) how precise do you believe your measurements to be for the wavelengths?
 - ii. For the angular sizes?
 - iii. Give one example of something that might affect your precision in your measurements.

5. Another consideration is the fact that galaxies are found in groups or clusters. The motion of these galaxies through space as they orbit their common center of mass is called *peculiar motion*. That is, some galaxies will be receding more slowly than others in the cluster while others will be receding more quickly. How does this *peculiar motion* affect your velocity measurements?

6. Take a picture of your graph and insert it into the box (here is a [video](#) of how to do this at the link)