HUBBLE'S LAW LAB

I. A BALLOON UNIVERSE

1. If the dots represent galaxies, do they get larger as the balloon expands? Why do think this is or is not the case?
   Individual galaxies do not get larger. Only the space in between them does. On small scales, gravity is stronger than the expansion of the universe.

2. Given this example, do you think the Milky Way is expanding with the universe?
   No, the Milky Way is not expanding. It is a sticker in our example.

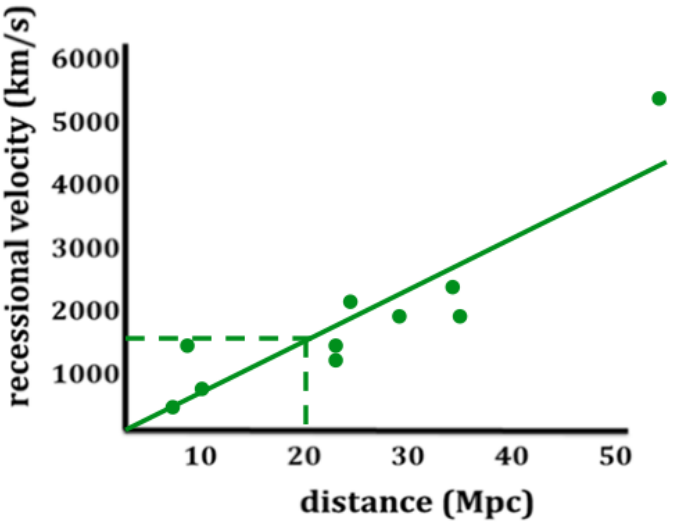
II. STANDARD RULERS AND REDSHIFT

3. Which of the two galaxies above is closer to us? How do you know?
   B is closer because it looks bigger.

TABLE 1: GALACTIC DISTANCES AND RECESSIONAL VELOCITIES

Galaxy	Apparent Size (a) kpc	Distance (d) Mpc	Measured Wavelength ($\lambda_{measured}$) Å	Redshift (z)	Recessional Velocity (v) km/s
NGC 1357	8.7×10^{-4}	***25.3***	6609.0	***0.0070***	***2100***
NGC 1832	7.4×10^{-4}	***29.7***	6605.9	***0.0066***	***1980***
NGC 2775	9.8×10^{-4}	***22.4***	6591.2	***0.0043***	***1290***
NGC 3034	2.7×10^{-3}	***8.1***	6564.1	***0.0002***	***60***
NGC 3227	9.9×10^{-4}	***22.2***	6587.3	***0.0037***	***1110***
NGC 3623	2.6×10^{-3}	***8.5***	6599.7	***0.0056***	***1680***
NGC 3627	2.3×10^{-3}	***9.6***	6578.0	***0.0023***	***690***
NGC 4775	6.0×10^{-4}	***36.7***	6595.1	***0.0049***	***1470***
NGC 5548	3.8×10^{-4}	***57.9***	6674.1	***0.0170***	***5100***
NGC 6764	6.1×10^{-4}	***36.1***	6609.8	***0.0071***	***2130***

GRAPH 1: RELATIONSHIP BETWEEN GALACTIC DISTANCES AND RECESSIONAL VELOCITIES



III. INTERPRETING THE DATA

4. What happens to the recessional velocity of a galaxy as you go out to farther distances away from the Milky Way?
   More distant galaxies have higher recessional velocities, so they're moving away from us faster.

5. Why did you best-fit line have to go through the origin (0,0)? What's at the origin?
   We're at the origin (the Milky Way)!

6. Now we're going to calculate what the Hubble constant H_0 is. Show your work below for your calculation of the slope.
   I got 80. Should be between 40-110.

7. What are the units of your slope?
   km/s/Mpc

8. The currently accepted value for H_0 is about 68 km/s/Mpc. How close were you?
   Answers will vary

IV. THE AGE OF THE UNIVERSE

9. What is the inverse of H_0? *(Use the accepted value)*
   0.0147

10. Multiply the inverse ($1/H_0$) by 3.09×10^{19} to cancel the distance units (the kilometer and mega-parsec portions of the units). This will give you the age of the universe in seconds:
    4.5×10^{17} seconds

11. Convert age in seconds to age in years:
    14.4 billion years