

# HUBBLE'S LAW

## *History of the Universe*

Name \_\_\_\_\_

**Hubble's Law** Hubble determined that the universe is expanding by making a graph of the speed at which a galaxy is moving versus its distance. The result is a straight line, which can be expressed as a simple equation,  $v = Hd$ , where  $v$  is the speed at which a galaxy is moving away measured in kilometers per second;  $d$  is the distance to the galaxy measured in megaparsecs (Mpc), where  $1 \text{ Mpc} = 1 \times 10^6 \text{ pc}$ ; and  $H$  is a number called the **Hubble constant**, that is measured in kilometers per second per megaparsec.  $H$  represents the slope of the line. You will plot Hubble's law in the *Problem-Solving Lab* on this page.

To measure  $H$  requires finding distances and speeds for many galaxies, out to the largest possible distance, and constructing a graph to find the slope. This is a difficult task, because it is hard to measure accurate distances to the most remote galaxies. Hubble himself could obtain only a crude value for  $H$ . Measuring an accurate value for  $H$  was one of the key goals of astronomers who designed the *Hubble Space Telescope*. It took nearly ten years after the *Hubble Space Telescope's* launch to gather enough data to pinpoint the value of  $H$  to the satisfaction of most astronomers. Currently, the best measurements indicate a value of approximately 70 kilometers per second per megaparsec.

Once the value of  $H$  is known, it can be used to find distances to far away galaxies. By measuring the speed at which a galaxy is moving, astronomers can locate that speed on the graph and can then determine the corresponding distance of the galaxy on the graph. This method works for the most remote galaxies that can be observed, and it allows astronomers to measure distances to the edge of the observable universe.

NOTE: A parsec = 3.26 ly, or  $3.086 \times 10^{12} \text{ km}$

## DIRECTIONS

Analyze Hubble data using the chart and graph on the back, then think critically to answer the following questions.

1. What does the slope represent?
2. A) How accurate do you think your value of  $H$  is?  
  
B) Explain.
3. How would an astronomer improve this measurement of  $H$ ?

**The Hubble constant** The table lists distances and speeds for a number of galaxies.

**Analysis**

1. Use the data to construct a graph. Plot the distance on the x-axis and the speed on the y-axis.
2. Use a ruler to draw a straight line through the center of the band of points on the graph, so that about as many points lie above the line as below it. Make sure your line starts at the origin.
3. Measure the slope by choosing a point on the line and dividing the speed at that point by the distance.

Galaxy Data			
Distance (Mpc)	Speed (km/s)	Distance (Mpc)	Speed (km/s)
3.0	210	26.5	2087
8.3	450	33.7	2813
10.9	972	36.8	2697
16.2	1383	38.7	3177
17.0	1202	43.9	3835
20.4	1685	45.1	3470
21.9	1594	47.6	3784

