**Hubble’s Law and the Big Bang Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. Astronomy measures really big objects at large distances and they often measure distance in light-years. Watch **Minute Physics: How far is a second?** <http://www.youtube.com/watch?v=Wp20Sc8qPeo> Describe how far is it from your home to school using units like bus-minutes.
2. A hundred years ago Edwin Hubble and other scientists looked at galaxies and measured how far away they were and how fast they were moving. Some modern sample data is shown below.

|  |  |  |
| --- | --- | --- |
| Name of galactic cluster | Distance in billions of light-years | Speed in millions of metres per second |
| Virgo | 0.78 | 12 |
| Ursa Major | 1.0 | 15 |
| Corona Borealis | 1.4 | 22 |
| Bootes | 2.5 | 39 |
| Hydra | 3.96 | 61 |

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1. Make a large, neatly labelled graph of the data with velocity on the vertical axis

**v (106m/s)**

**60**

**50**

**40**

**30**

**20**

**10**

**0**

**0 1 2 3 4 d (109 light-year)**

1. There is a very clear pattern here. Describe how speed and distance are related.
2. A galaxy is moving at 30 million m/s. How far away is it? Label this on the graph
3. A galaxy is moving at 70 million m/s. How far away is it? Label this on the graph.
4. A galaxy is 2 billion light-years away. How fast is it moving? Label this on the graph.
5. A galaxy is 5 billion light-years away. How fast is it moving? Label this on the graph.
6. The space between the galaxies is growing larger and larger. This suggests that at one time they were all together in one place and then moved apart in a ‘**Big Bang’**. You will calculate how long ago this occurred was by using the data for one of the galaxies above.

The name of my assigned galaxy is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

a) How far away is your galaxy in metres? Hint: A light-year is how far light travels in one year and that is 9,500,000,000,000,000 m or 9.5 x 1015 m. A billion is 1,000,000,000 or 109.

b) How long ago was the Big Bang? The time can be calculated by dividing the distance in metres by the velocity in metres per second, t = d/v. Hint: A million is 1,000,000 or 106.

c) How old is the universe in years? Hint: There are about 32,000,000 or 3.2 x 107s in a year.

1. Go to **Alice & Bob in Wonderland:** “**Is that star really there?”** <http://www.q2cfestival.com/play.php?lecture_id=8245&talk=alice\> Explain why looking far away in space is like looking back in time.
2. **Watch Minute Physics:** **The Oldest Light in the Universe**
<http://www.youtube.com/watch?NR=1&feature=endscreen&v=_mZQ-5-KYHw>

What is the cosmic background radiation and what does it have to do with the big bang?