**Modelling the Big Bang Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

"Why does it seem like everything moving away from us? Why does it seem like things going faster and faster away the further away they are? Are we at the centre of an explosion or are we just really unpopular?" To try and answer these questions you are going to look at three models of the Big Bang

1. **Paper Clip and Elastic Band Model**: Some paperclips and elastic bands are linked in a line. The paper clips represent galaxies and the elastics represent the space in between.
2. Tape the two ends to a desk or wall so that the model is slightly stretched. Tape the ends securely and wear safety glasses.
3. Label the galaxies A, B, C etc. Have each person in the group select a different galaxy to be their galaxy. Measure the distance from your galaxy to each of the other galaxies. Each person in the group should get a different set of numbers. Record these original distances in the table below.
4. Stretch the model so that it is about two times bigger and repeat your measurements. Record these new distances below.
5. Suppose that it took 10 seconds to stretch the model. Calculate how fast each galaxy moved away from you by subtracting the two distances and dividing by 10 s. Record these speeds below.
6. Graph the original distance on the horizontal axis and the speed on the vertical axis.

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| 2 Paper Clip Names | **Original Distance (cm)** | New Distance (cm) | **Speed (cm/s)** |
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1. Compare your graph with Hubble’s astronomical data.
2. Use this model to explain why galaxies that are farther away from Earth appear to be moving faster
3. Compare your graph with the others in your group. Use this model to explain why everything seems to be moving away from the Earth.
4. **Paper and Transparency Model**: You have a grid of white circles printed on paper and a grid of black circles printed on a transparency. The circles represent the position of galaxies at two different times.
5. Which grid shows the galaxies at an earlier time? Explain.
6. Place the transparency over the paper so that one galaxy is directly on top of another galaxy. If you lived on this galaxy what would you notice about the behaviour of all the other galaxies?
7. You have a friend who feels unhappy that all the galaxies are moving away from the Earth. What’s wrong with the Earth? Does it have galactic body odour? Describe how you could use the model to explain to your friend that the galaxies are not moving away from the Earth in particular.
8. **Balloon Model**: Draw some galaxies on the balloon. Draw some wavy lines representing light. Inflate the balloon but do not tie it.
9. What happens to the galaxies as the balloon gets bigger?
10. The universe expands but the galaxies do not. Gravity holds them together. How could you represent galaxies more correctly on this balloon model?
11. Galaxies don’t stretch, but light waves do and this changes their colour. Suppose you started out with yellow light. What colours - visible and then invisible - would you see as space expanded?
12. **Comparing the models**: You looked at three different models and each is able to capture some, but not all of the details of the Big Bang. Describe which of the models are able to show each of the following;
13. All galaxies appear to move away from all other galaxies.
14. The farther galaxies appear to move faster.
15. The galaxies do not stretch as the universe expands.
16. Light waves stretch as the universe expands.
17. The universe is three-dimensional.
18. There is no centre and no edge to the universe.

1. The name ‘Big Bang’ suggests that it was a huge explosion like a water balloon popping or a firecracker exploding. Explain how these are not good models for how the universe started. Hint: Is matter expanding into existing space?
2. Watch “**The Known Universe**” <http://www.youtube.com/watch?feature=endscreen&v=702kVrhOvL4&NR=1> from the Rubin Museum of Art and the American Museum of Natural History.
3. What are the farthest and oldest things that we can detect?

1. Astronomical research costs money. Astronomy used to be important because it helped people time their crops, find their way at sea and they used to believe in astrology. These aren’t important anymore. Why do people continue to fund astronomical research?