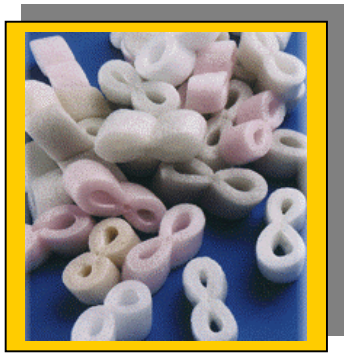
Cosmic Chemistry: Cosmogony

Density and Gravity: The Push and Pull of the Universe

STUDENT ACTIVITY

INSTRUCTIONS

PART 1



1. From the teacher, the team will receive a collection of five or six items including "packing peanuts," one or more partially inflated balloons, some threaded nuts, a few marbles, some cotton balls and some wooden blocks. In addition, the team will receive a box with a lid—perhaps a shoebox.

2. The team's first assignment is to determine the density of each of the items issued by the teacher. You should discuss each type of item and decide how you might determine its density. Also discuss the following questions. Do all items of a given type have the same density? Would it be advisable or necessary to measure the density of each and every object? For which objects might it be best to make several measurements? What assumptions have you made?

3. Select a reporter for your team. Develop a plan for measuring the density of each object. For your plan include the procedure you will use, a list of supplies needed, and answers to the questions in step 2. Once the teacher has approved your plan, you can proceed to step 4.

4. Locate the supplies and instruments that you will need for determining the densities of the objects and proceed to make your density determinations. Record your results on the Data/Recording Sheet.

5. Now the team should place all of the objects in the box, close it with the lid, and proceed to make a theoretical calculation of what the density of the box should be when filled with the items. Record the result of your calculations on the Recording/Data Sheet, showing how you carried out the calculations.

6. Now, the team should measure the density of the box (with the objects remaining in the box). Record the measured density on the Reporting/Data Sheet and describe how you made the measurement.

7. Next, on the Reporting/Data Sheet, the team should compose a short paragraph in which they compare the results of the theoretical calculation to the actual measurement. Note any differences and offer an explanation for them should they exist.

8. Turn your Reporting/Data Sheet in to the teacher.

PART 2

In this part of the activity you will work individually and consider some aspects of gravity. Answer each of the following questions on a piece of paper. You may want to re-read the gravity section of the Student Text, "The Push and Pull of the Universe" as you respond to the questions. When you are through, hand the paper in to your teacher.

1. Name several forces you experience in everyday life.

2. Consider two spherical objects that are attracted to each other gravitationally with a force of 100 Newtons. If the distance between the objects is tripled, what will be the force of gravitational attraction between the objects at the new distance? Explain and show how your answer was determined.

3. Again consider two spherical objects that are gravitationally attracted to each other with a force of 100 Newtons. Now calculate the gravitational attraction if the two objects are replaced with spherical objects each having a mass five times the mass of the original objects. Explain and show how your answer was determined.

4. How would the force of gravitational attraction between the two objects in question 2 change if a sheet of lead were placed between them?

5. Now consider two spherical objects that can change in mass and separation. If the mass of each object were to quadruple, determine how the distance between them would have to change to keep the gravitational force between them the same as it was before the transformation.

6. Why do we call Newton's law a UNIVERSAL Law of Gravitation?

7. The mass of the beautiful planet Saturn is around 5.7×10^{26} kg and its average distance from Earth is about 1.28×10^{9} km. Calculate the gravitational force exerted on you by Saturn, assuming you are at the same distance from Saturn as is Earth.

8. Now calculate the gravitational force that exists between you and your best friend when you are seated 5 meters away form each other. To whom are you more strongly attracted—Saturn or your best friend?

9. Determine the forces for everyday experiences from question 1. How do the forces calculated in questions 7 and 8 compare to the forces that you experience in everyday life?

10. From an appropriate source, look up the mass of the moon, the mass of the Earth, and their separation. Now calculate the force of gravitational attraction between the two bodies. What effects of the moon's gravity do we observe on Earth?