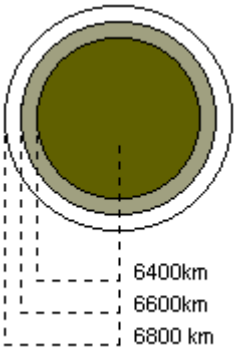
Modeling Collision Probability

NAME_____

Most manned spacecraft orbit at about 100 to 200 miles (or 160 to 320 kilometers) above Earth. How likely is it that such an orbiting vehicle will encounter a particle of orbital debris? We can use a geometrical model to estimate collision probabilities.

Consider this cross section of Earth. Earth's radius is about 6400 kilometers. Even though the figure is not constructed to scale, it should be apparent that the region in which spacecraft orbit is very close to Earth as astronomical distances go.

Next, envision a series of spherical "shells" surrounding Earth. The first includes the atmosphere and is below the surrounding sphere of orbital flight. As a first approximation, made to simplify the calculations, we can let each shell be 200 kilometers in thickness. Thus we are interested in the shell that lies between the two spheres of radius 6600 kilometers and 6800 kilometers.



1. What is the volume of that shell described in the previous paragraph?

2. Suppose that the 4 million pounds of orbital debris described in the earlier lesson are randomly distributed within this shell. If that debris has the density of aluminum (2.7 grams per cubic centimeter), how much debris would you expect to encounter in each cubic kilometer of space?

3. Use the models that you developed earlier to study how the probability of encountering space debris changes as the total amount of debris escalates.

4. If you remove our simplifying assumption and let the "shell of orbital flight" be from 160 to 320 kilometers, as stated in the opening paragraph, will your conclusions change appreciably? In other words, are we justified in making the simplifying assumptions?

5. Prepare a written or oral report of your findings.