Ratios

How much faster is an airplane than a car? The cruising speed of a DC10 airplane is 608 miles per hour. Assume that the car is traveling at the speed of 60 miles per hour. How would you compare these two speeds? Subtracting the speeds gives a result of 548 mph. However, because the scales of the numbers are quite different, this doesn't really give a good comparison of the numbers. A better method is to take the ratio of the two numbers (divide the larger number by the smaller number). This gives a result that is about 10. In other words the airplane is 10 times faster than a car.

Exercises
1.   Use ratios to determine how many times larger one number is than the other.
       a) How much larger is the world population than the population of the U.S.? As of July 1, 2003 the world population was 6,302,486,693 and the U.S. population was 290,810,000.

       b) How many times larger is the diameter of the sun to that of the Earth? The diameter of the sun is 827,716 miles whereas the diameter of the Earth is 7,768 miles.

       c) How much faster is the speed of light than the speed of sound? Note that the speed of light is 670,215,600 miles per hour and the speed of sound is 741 miles per hour.

Orders of Magnitude

Note that in the last example, the speed of light was many times more than the speed of sound. When one number is many times larger than another, it is often more convenient to talk about how many *orders of magnitude* larger it is. This concept simply refers to the number of powers of ten larger it is.

In other words if a number is 10 times larger than another, then we say that it is 1 order of magnitude larger. If a number is 100 times larger then we say it is 2 orders of magnitude larger. If a number is 10,000 times larger then we say it is 4 orders of magnitude larger.

Exercises
2.   Which number is larger and how many orders of magnitude larger is it?
       a) 250 million and 25 billion

b) 10^{12} and 10^{-9}

c) 9,300,000 and 0.093

d) 1 thousand and 1 thousandth

3.   How many orders of magnitude faster is the speed of light than the speed of sound? Recall that the speed of light is 670,215,600 miles per hour and the speed of sound is 741 miles per hour.

4.   The distance from the sun to the Earth is 93 million miles and from the sun to Pluto is 3.5 billion miles. The distance from the sun to the next nearest star (*Proxima Centauri*) is 24.7 trillion miles.
   a) How many orders of magnitude further is it from the sun to Pluto than to the Earth?

   b) How many orders of magnitude further is it from the sun to *Proxima Centauri* than to Pluto?

5.   The Sun is 1 gigameter in radius. The radius of a living cell is about 10 microns. How many orders of magnitude larger in radius is the Sun than a living cell?