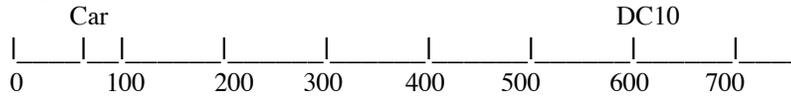


We previously compared the speed of a DC10 jetliner at 608 mph to a car traveling at 60mph and discovered that by making a ratio the DC10 was found to travel about 10 times faster than the car. We could also try to represent the speed of these two vehicles graphically on a number line with increments of 100 mph:



However if we were to try to graph on this same scale two additional things of vastly different speeds such as a beam of light traveling at 670,215,600 mph and a snail traveling at 0.000949 mph (one inch per minute), we would be faced with great difficulty. The snail's speed would be indistinguishable from zero on this scale and the beam of light would require us to extend the scale several rooms away to the right! When comparing numbers of vastly different sizes a logarithmic is more useful. A logarithmic scale is marked off in orders of magnitude, that is, each mark on the scale as you move left to right is 10 times larger than the one preceding it. But first we have to change the speeds of snail, car, DC10 and light beam into scientific notation then graph the order of magnitude of each one (ignoring their seed numbers):

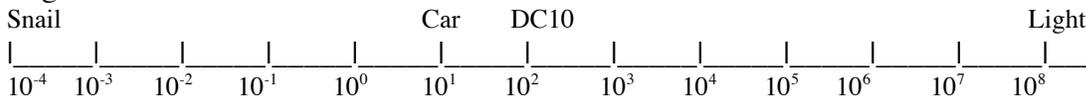
$$\text{Snail} = 0.000949 \text{ mph} = 9.49 \times 10^{-4}$$

$$\text{Car} = 60 \text{ mph} = 6.0 \times 10^1$$

$$\text{DC10} = 608 \text{ mph} = 6.08 \times 10^2$$

$$\text{Light} = 670,215,600 \text{ mph} \approx 6.7 \times 10^8$$

Logarithmic scale:



Using the scale above we can easily make comparisons by counting how many steps to right or left one thing is from the other. One step to the right is 10 times larger or one order of magnitude larger, one step to the left is one step smaller or one-tenth as large or one order of magnitude smaller:

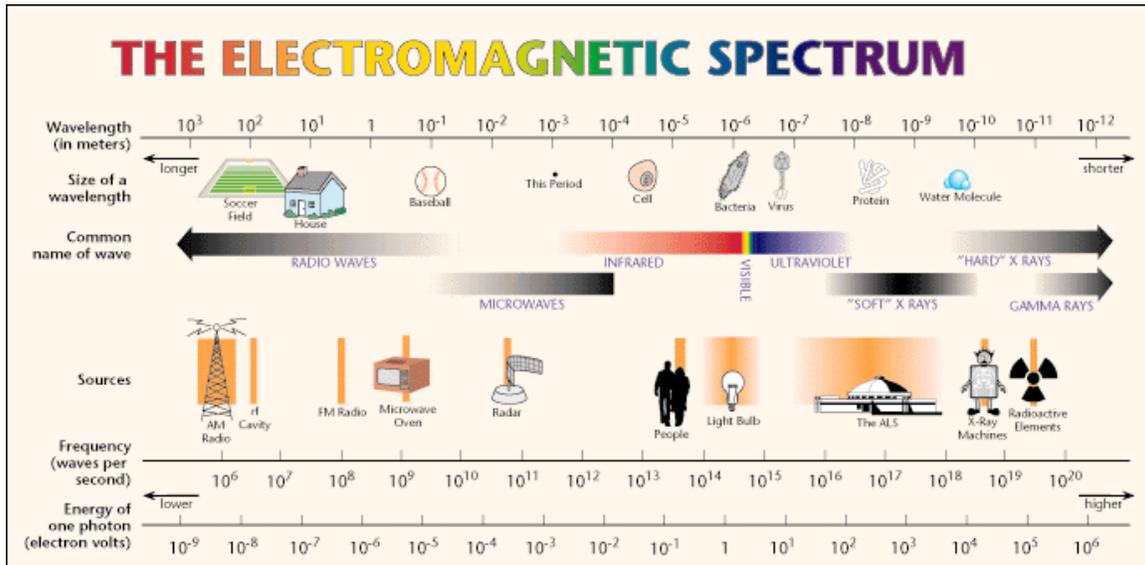
Compare the speed of the car to the speed of the snail: The car is 5 steps to the right of the snail, meaning that the car is 5 orders of magnitude faster or 5 multiples of 10 or 100,000 times as fast as the snail(10^5).

$$\text{Car/Snail} = 10^1/10^{-4} = 10^{1-(-4)} = 10^5/1$$

Compare the speed of the light beam to the speed of the DC10: The light beam is 6 steps to the right of the DC10, meaning that the light beam is 6 orders of magnitude faster or 6 multiples of 10 or 1,000,000 times as fast as the DC10(10^6).

$$\text{Light/DC10} = 10^8/10^2 = 10^{8-2} = 10^6/1$$

Use the logarithmic scale below for electromagnetic waves such things as radio waves, microwaves, light, x-rays:



1. How many times larger is a soccer field than a baseball? How many orders of magnitude?
2. How many times larger is a bacteria than a water molecule? How many orders of magnitude?
3. Use the wavelength scale to determine how many times longer are AM radio waves than Radar waves? How many orders of magnitude?
4. Use the frequency scale to determine how many times longer are AM radio waves than Radar waves? How many orders of magnitude?