1.7 Scaling:
Say you have two lengths of the same kind of rope, length A is 10 times as long as length B. What is the ratio of their masses?:

$m_A = \underline{\ ?\ } m_B$

You likely recognize the answer is 10, because the mass of a rope (the amount of rope material) scales *linearly* with length.

It turns out that an elephant is about 10 times as long as a raccoon. Would we also expect an elephant to have 10 times the mass of a raccoon? They are both made of the same substance, so they have the same density (about that of water: 1 kg/liter). However, the volume of the animal is proportional to the *width x length x height,* all of which are about 10 times as big for an elephant as a raccoon. We expect an elephant to have about 1000 times the mass of a raccoon. While the mass of a raccoon is about 5 kg, the mass of an elephant is about 5000 kg. Mass scales *linearly* with volume, but volume scales *cubically* with size for objects with the same shape.

We've seen for example that kinetic energy scales *linearly* with mass and *quadratically* with speed. $E_K=½mv^2$

<u>Exercise 1</u>: If cart A has twice the mass and three times the speed of cart B, what is the ratio of their kinetic energies?:

$E_{KA} = \underline{\ ?\ } E_{KB}$

Is the answer "18" or is it "9"? Essentially, do we also multiply by the "½" to find the ratio? Why or why not?

<u>Exercise 2</u>: Two cylindrical glasses have juice filled up to the same height, but glass A has twice the diameter as glass B. What is the ratio of the amount of juice?:

$m_A = \underline{\ ?\ } m_B$