Walking Speed of an Animal

There is a very generic idea in biology called **allometry**, which states that many properties of animals scale as mass to some power, more or less "universally" for all animals. For example, in 1997 a beautiful paper showed why the lifetime of an organism should scale as

$$t_{\rm life} \sim M^{1/4}$$

where M is the mass of an organism.

In this problem, we will estimate the walking speed of an animal using a very simple toy model, and try to understand how walking speed scales with mass M.

- (a) How should the length, height and width of an animal scale with mass M? In addition to guessing the exponent, what do you think the coefficient should be?
- (b) Now, suppose we model the leg of an organism as a simple pendulum. If the amplitude of pendulum oscillations is a, and the frequency of pendulum oscillations is ω, then the walking speed is given by v = aω. Show that we expect v ~ M^{1/6}, and estimate the coefficient of proportionality.
- (c) Now, determine if your proportionality constant is reasonable, by estimating *your* walking speed. How close do you get (think in terms of multiplicative factors, not additive factors!)?