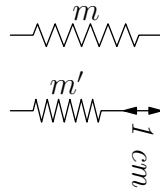


## Homework 5

### Chapter 9

**Problem 1.** By what fraction does the mass of a  $m = 10 \text{ g}$ ,  $k = 500 \text{ N/m}$  spring increase when it is compressed by  $1 \text{ cm}$ ?



**Problem 2.** Returning to Earth in his rocket ship at  $0.6c$ , Jack calls Jill (who is on Earth) to let her know he's almost home. He sets up his radio transmitter to broadcast at  $500 \text{ MHz}$ . (a) In Jill's frame, how much time passes between two successive maxima of the voltage across Jack's antenna? (b) What is the frequency of the signal as it reaches Jill?

**Problem 3.** (a) How long (in Earth time) does it take for a plane to circle the Earth at low altitude (average radius  $6,370 \text{ km}$ ) going  $600 \text{ mph}$ ? (b) How much less time passes according to a clock on the plane? For the purpose of this problem, you may assume the Earth is stationary and not rotating.

**Problem 4.** You are working in the radiology department at a veterinary hospital. The cat you are trying to X-ray refuses to hold still so you volunteer to stand at the table and hold the cat down during the exposure. If X-rays of wavelength  $\lambda = 24 \text{ pm}$  enter the cat from above, what is the wavelength of the photons that enter your head after scattering through a  $135^\circ$  angle?

**Problem 5.** The resolving power of a microscope depends on the wavelength of light used. If you want to "see" an atom, you must resolve features on the order of  $0.1 \text{ \AA}$ . (a) If you use electrons (in an electron microscope), what minimum kinetic energy would they require? (b) If you used photons (in a light microscope), what minimum kinetic energy would they require?

**Problem 6.** (a) How fast would you have to be driving a  $20 \text{ ft}$  long limo to fit into  $15 \text{ ft}$  deep garage? (b) How deep would the garage appear to the driver of the limo? Is the limo ever really entirely in the garage? Explain any apparent paradoxes. Both of the lengths given are proper lengths.