Please solve these before our class meeting on Monday, and come prepared to talk about them.

1. A 1.00 kg block is attached to a horizontal spring with spring constant 2500 N/m. The block is at rest on a frictionless surface. A 10 g bullet is fired into the block through the face opposite the spring and sticks in the block. What was the speed of the bullet if the subsequent oscillations have an amplitude of 10.0 cm?

2. A spring with spring constant 35 N/m is attached to the ceiling, and a 5.0 cm diameter, 1.0 kg metal cylinder is attached to its lower end. The cylinder is held so that the spring is neither stretched nor compressed, then a tank of water is placed underneath with the surface of the water just touching the bottom of the cylinder. When released, the cylinder will oscillate a few times but, damped by the water, quickly reach an equilibrium position. When in equilibrium, what length of the cylinder is submerged?

3. The cylinder in the figure on the right has a moveable piston attached to a spring. The cylinder’s cross sectional area is 10 cm², it contains 0.0040 mol of gas, and the spring constant is 1500 N/m. At 20°C the spring is neither compressed nor stretched. How far is the spring compressed if the gas temperature is raised to 100°C?

4. A nuclear power plant generates 2000 MW (i.e., million J/s) of heat energy from nuclear reactions in the core of the reactor. This energy is used to boil water and produce high pressure steam at 300°C. The steam spins a turbine, which produces 700 MW of electric power, then the steam is condensed and the water is cooled to 30°C before starting the cycle again.

   (a) What is the maximum possible thermal efficiency of this power plant?
   (b) What is the actual efficiency of this power plant?
   (c) The condensation of the steam and cooling of water to 30°C are done by passing it through a device known as a condenser. In essence, water from a nearby large reservoir is cycled through the condenser, and it draws the heat out of the steam and the condensed water. Suppose such cooling water from a nearby river flows through the condenser at the rate of $1.0 \times 10^8$ L/hr (note this is a huge amount, about 30 million gallons per hour; also recall that 1 L = $10^{-3}$ m³). If the river water enters the condenser at 18°C, at what temperature does it exit the condenser? Note: Despite all the fancy words, this is just a calorimetry problem!

5. The two strings in the figure are of equal length and are being driven at equal frequencies. The linear density of the left string is 2.0 g/m. What is the linear density of the right string?