MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01X Fall Term 2001

PROBLEM SET 8

Handed out: October 26
Due: November 2 at 5 pm in 4-339B.

Please write your name, subject, **recitation number**, and the name of the recitation instructor on the top right corner of the first page of your homework solutions. The solutions should be placed in the appropriate box in room 4-339B.

Problem 1:

a. The Zambesi River in Africa rushes over Victoria Falls at a rate of 25×10^6 gallons per minute. The falls are 108 m high. Determine the power developed by the water in SI units.

b. A 2.3×10^3 kg spacecraft has an ion engine that delivers 150 kW of power via its six thrusters. Assuming it to be far from any massive object, how much time would it take to accelerate from "rest" to 600 mph?

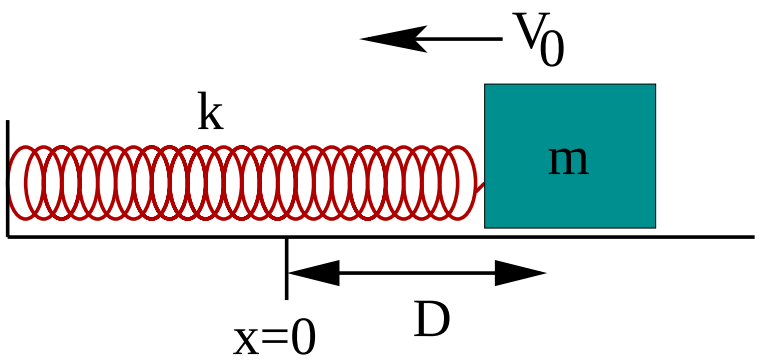
Problem 2:

You are driving down a steep mountain road at 20 m/s. You and your car have mass 1500 kg. The angle of incline of the road is 30°. Suddenly, a deer bounds out into the road and you slam on the brakes. You skid for 30 m and manage to stop just in time.

How much do the tires heat up as a result of the skid? Assume that for each joule of energy absorbed by the tire, it heats up by 4×10^{-5} degrees Celsius, and that 50% of the heat energy generated by the skid is absorbed by the tires.

Problem 3:

A block of mass m is attached to one end of a spring, the other end of which is attached to a wall. The floor is frictionless, and the spring has constant k. Let $x = 0$ denote the block's position when the block is at its equilibrium length. Suppose the block is displaced to $x = D$. Instead of releasing the block from rest, however, someone shoves the block towards $x = 0$ with speed v_0 at time $t = 0$.



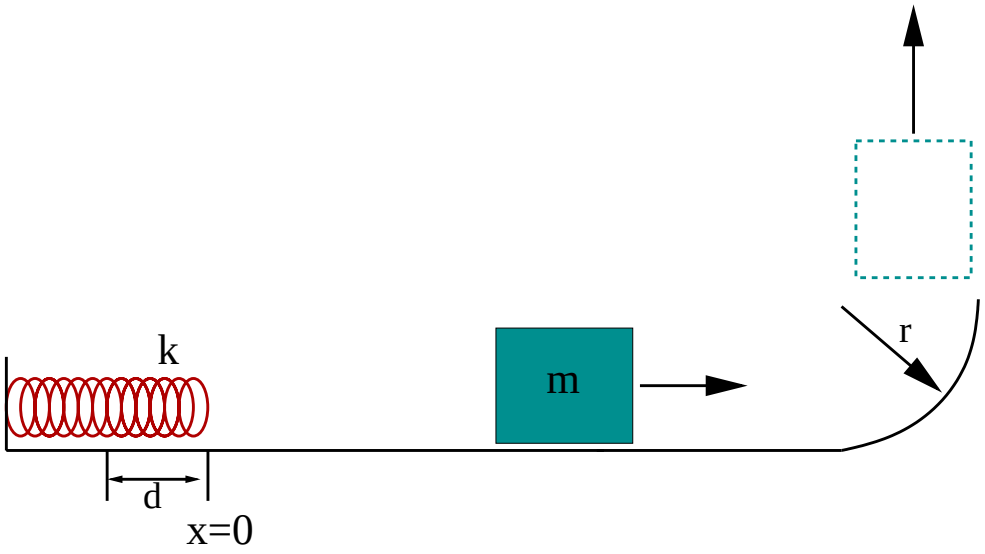
a. What is the block's velocity at an arbitrary later time t?

b. During its oscillations, when the block is instantaneously motionless, what is its acceleration?

c. When the block passes through $x = 0$ what is its speed?

Problem 4:

Consider the spring and block of the previous problem, except that now the spring is not attached to the block. The block and spring are compressed a distance d from equilibrium, then released. The block keeps sliding to the right even after losing contact with the spring. It slides along frictionlessly until reaching a semicircular ramp of radius r. It ascends the ramp and shoots straight up into the air.



Express your answers in terms of k, d, r, m and g.

a. What is the block's speed at point B, the "take-off" point of the circular ramp?

b. What is the maximum height reached by the block?