PHY6938 Mechanics Spring 97 July 7, 2000

1. A meteoroid of mass M happens to be falling directly towards the Earth, and eventually hits Lake Ella in Tallahassee, Florida. Assume that the initial velocity of the meteoroid is negligible (when it is very far from the Earth) and ignore the air friction.

a) What is the kinetic energy of the meteoroid upon impact? (The radius of the Earth is $R_{\rm Earth} \simeq 6.4 \times 10^3$ km.)

b) What is the minimum mass of the meteoroid necessary to completely vaporize the water from Lake Ella? Assume that the total volume of water in Lake Ella is $V = 10^5$ m^3, and that the ambient temperature is $T_{\rm air} = 20^\circ$ C. (The specific heat of water is $C = 1$ cal/g·K; 1 cal = 4.186 Joules; the heat of vaporization is $Q_{\rm vapor} = 539$ cal/g.)

c) If the typical density of meteoritic material is $\rho \simeq 5 \times 10^3$ kg/m^3, estimate the diameter of the meteoroid.

2. Water enters a house through a pipe with an inside diameter of 2.0 cm, at an absolute pressure of 4×10^5 Pa (about 4 atm). The pipe leading to a second floor bathroom faucet 5 m above has an inside diameter of 1 cm. When the flow velocity at the inlet pipe is 4 m/sec find:

a) The flow velocity at the open bathroom's faucet.

b) The pressure in the bathroom pipe.

c) The pressure in the bathroom's pipe when the faucet is turned off.

3a) Is the force $\mathbf{F} = (-6xyz,\ z(z^2 - 3x^2),\ 3y(z^2 - x^2))$ conservative?

b) What is the potential energy associated with this force?

4 A uniform rod of mass M and length $2b$ is pivoted at a point O, a distance s above the center of mass. The rod is struck with a rapid impulsive force perpendicular to the rod at a point A, a distance a below the center of mass. The magnitude of the impulse is $P = F\Delta t$. Find the value of a such that there is no reaction at the pivot during the impact. (The moment of inertia of a uniform rod about an axis through its center perpendicular to its length is $I = ML^2/12$.