Physics 172 – Recitation 07

Spring 2012

As you work on today's problems remember that every time you use a fundamental principle you must explain clearly what physical system you are applying the principle to and which objects in the system's surroundings are interacting significantly with it.

Problem 1. A spring with a stiffness k_s and relaxed length L stands vertically on a table. You hold a mass M just barely touching the top of the spring.

a) You *very slowly* let the mass down onto the spring a certain distance, and when you let go, the mass doesn't move anymore. How much did the spring compress? How much work did you do as you lowered the mass?

[Checkpoint 1]

b) Now, you again hold the mass just barely touching the top of the spring and then let go. What is the maximum compression of the spring? What approximations and simplifying assumptions did you make?

c) Next you push the mass down on the spring so that the spring is compressed an amount s, then let it go, and the mass starts moving upward and goes quite high. The mass is not attached to the spring.

When the mass is a height $2L$ above the table, what is its speed?

[Checkpoint 2]

Problem 2. A proton (mass 1.6726×10^{-27} kg) and a neutron (mass 1.6749×10^{-27} kg) at rest interact to form a deuterium nucleus (heavy hydrogen). In this process, a gamma ray (high energy photon) is emitted. The energy of this gamma ray is measured to be 2.2 MeV $\equiv 2.2\times10^{6}$ eV.

a) What is the mass of the deuteron? Assume that you can neglect the small kinetic energy of the deuteron acquires after emitting the gamma ray, but keep all five significant figures as you calculate.

b) If we include the emitted gamma ray along with the proton and neutron (now bound in the deuteron) in the final state of the system to which we apply the momentum principle, we conclude that the system's momentum must be conserved. That is, the deuteron must recoil with momentum equal and opposite to the momentum of the emitted gamma ray. Estimate the kinetic energy of the recoiling deuteron and verify that it is indeed small compared to the energy of the gamma ray, as assumed in part a).

[Checkpoint 3]