

These three problems are designed to review some of the important concepts of last semester.

Due Wednesday, 9 January, 2008.

1 Spring, Block, and Free Fall

A block of mass m is pushed against a spring of spring constant k , which is fixed to a frictionless table of height h . Upon reaching a displacement x from equilibrium, the block is released. It launches off the edge of the table and impacts a distance R from the edge of the table. Neglecting air resistance, express R in terms of m , k , x , h , and g , where g is the local acceleration of gravity.

2 Colliding Particles

An accelerator imparts 3 GeV (approximately 500 pJ) of energy to a proton which is then slammed into a block of metal. After the collision (which may be assumed to be elastic) detectors pick up the proton leaving the sample with 80% of its original kinetic energy, and a single atom of sample kicked off by the proton. If the speed of the sample atom is measured at $0.22c$, where c is the speed of light in vacuum, what material is the sample?

3 Moment of Inertia

Beginning with the textbook definition

$$I = \int r^2 dm, \tag{1}$$

where dm is a mass element of a body and r is that element's distance from the axis of rotation, derive the moment of inertia about its axis for a hollow cylinder of inner radius a and outer radius b .