Academic Year 2021-22

Tutorial #06

PH100: Mechanics and Thermodynamics

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1. A ball drops to the floor and bounces, eventually coming to rest. Collisions between the ball and floor are inelastic; the speed after each collision is *e* times the speed before the collision where $e < 1$, (*e* is called the coefficient of restitution.) If the speed just before the first bounce is v_0, find the time to come to rest.

2. A proton makes a head-on collision with an unknown particle at rest. The proton rebounds straight back with *4/9* of its initial kinetic energy. Find the ratio of the mass of the unknown particle to the mass of the proton, assuming that the collision is elastic.

3. A particle of mass *m* and velocity v_0 collides elastically with a particle of mass *M* initially at rest and is scattered through angle θ in the center of mass system.
   a. Find the final velocity of *m* in the laboratory system.
   b. Find the fractional loss of kinetic energy of *m*.

4. A 0.3-kg mass is attached to a spring and oscillates at 2 Hz with a *Q* of 60. Find the spring constant and damping constant.

5. In an undamped free harmonic oscillator the motion is given by x = A sin (\omega_0)t. The displacement is maximum exactly midway between the zero crossings. In a damped oscillator the motion is no longer sinusoidal, and the maximum is advanced before the midpoint of the zero crossings. Show that the maximum is advanced by a phase angle Φ given approximately by: Φ=1/2Q, where we assume that Q is large.

6. The logarithmic decrement \delta is defined to be the natural logarithm of the ratio of successive maximum displacements (in the same direction) of a free damped oscillator. Show that \delta = \pi /Q. Find the spring constant *k* and damping constant *b* of a damped oscillator having a mass of 5 kg, frequency of oscillation 0.5 Hz, and logarithmic decrement 0.02.