Physics 1A, Section 2

November 8, 2010

Quiz #3

- was due 3 hours ago.

Crash Course in Collision Problems

- Assume collision happens in an instant.
  - Describe "before" and "after" cases, nearly simultaneous.
  - During collision, ignore relatively weak external forces, compared to strong impulsive forces.
- Momentum is conserved:
  - $\Sigma\, m_j \mathbf{v}_j$ = **constant**
- Kinetic energy:
  - elastic: $\Sigma\, {}^1/_2\, m_j v_j^2$ = constant
  - (partially) inelastic: $\Sigma\, {}^1/_2\, m_j v_j^2$ decreases
  - completely inelastic: objects stick to each other

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Quadratic equation required in general ➔ algebra more challenging.
To simplify: work in frame with one object at rest, or in center of mass frame.

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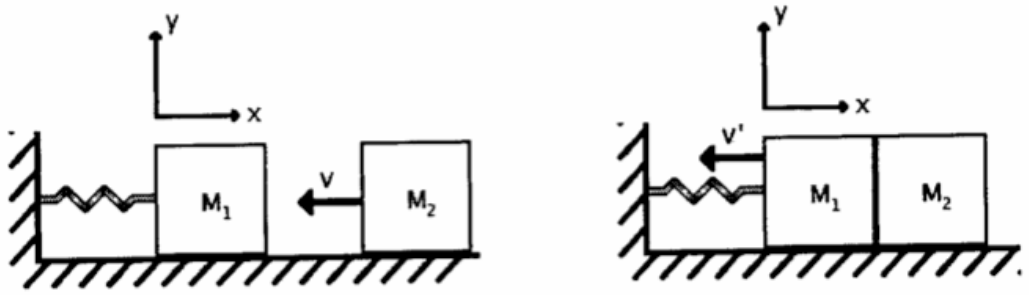
Algebra much simpler, since there is only one "unknown" (velocity of combined object).

Final Problem 19

Problem 1: Stay and Sway

A mass m_1 sits on a frictionless surface and is attached to one end of a spring with spring constant k. The other end of the spring is attached to the wall. The mass and the spring are initially at rest.



A second mass m_2 comes sliding in with velocity $-v\,\hat{x}$, hits the first mass m_1 at time $t = 0$, and sticks to it. This induces oscillations in the spring, which can then be measured. This in turn can be used to determine the mass m_2 of the impinging object.

(3 points) (a) What is the velocity $\vec{v}'$ of the two masses immediately after the collision? Express you answer in terms of v, m_1, and m_2.

(3 points) (b) Find an expression for m_2 in terms of m_1, k, and the angular frequency ω_o of the observed oscillations.

A function which describes the position of the two masses for all time following the collision is $x = A\sin(\omega_o t) + B\cos(\omega_o t)$ where A and B are unknown constants, $t = 0$ is the time of the collision, and $x = 0$ is the equilibrium position of the spring.

(4 points) (c) What are the values of A and B? Express you answer in terms of ω_o, m_1, m_2, and v.

Oscillation Problems

- basic oscillator (no damping or forcing): mass on spring, pendulum:
  - $d^2x/dt^2 + \omega_0^2 x = 0$
  - Trial solution:
    - $x = A \cos(\omega_0 t) + B \sin(\omega_0 t)$
  - A and B are determined by initial conditions, often x(t=0) and dx/dt(t=0).

- For oscillator with damping and/or forcing, see box on p. 330 of Frautschi et al.

Final Problem 19

- Answer:

a) $v' = v\, m_2/(m_1 + m_2)$, in –x direction

b) $m_2 = k/\omega_0^2 - m_1$

c) $A = -m_2 v/\mathrm{sqrt}[k(m_1+m_2)]$, $B = 0$

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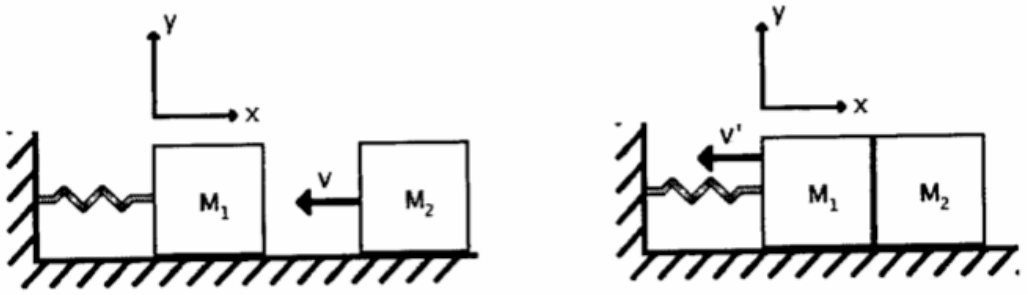

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Thursday, November 11:

- Quiz Problem 53 (oscillation and rotation)
- Quiz Problem 25 (rotational motion)

- *Optional, but helpful, to try these in advance.*