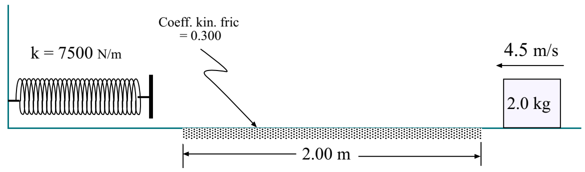
Name____________________________

Oct. 27, 2010

Quiz #3 — Fall 2010

Phys 2110 – Sec 3

1. A 2.00 kg mass has been given a speed of $4.50\frac{\text{m}}{\text{s}}$; it moves toward a spring of force constant $7.50 \times 10^3\ \frac{\text{N}}{\text{m}}$ over a level surface but before contacting it, it travels over a rough stretch of length 2.00 m and coefficient of kinetic friction 0.300.



All the motion is in one dimension.

a) What is the work done by friction on the sliding mass?

The force of friction has magnitude $\mu_k n$ and here the normal force equals the weight of the mass, mg, so $f_k = \mu_k mg$. Then from the definition of work,

$$W_{\text{fric}} = f_k d(-1) = -\mu_k mgd = -(0.300)(2.00\ \text{kg})(9.80\tfrac{\text{m}}{\text{s}^2})(2.00\ \text{m}) = -11.8\ \text{J}$$

b) What is the maximum compression of the spring?

Use $\Delta E = W_{\text{fric}}$ which gives:

$$E_2 - E_1 = -11.8\ \text{J} \qquad \Longrightarrow \qquad E_2 = \tfrac{1}{2}kx^2 = \tfrac{1}{2}mv^2 - 11.8\ \text{J} = \tfrac{1}{2}(2.00\ \text{kg})(4.50\tfrac{\text{m}}{\text{s}})^2 - 11.8\ \text{J} = 8.49\ \text{J}$$

Solve for x:

$$x = \sqrt{\frac{2(8.49\ \text{J})}{k}} = \sqrt{\frac{2(8.49\ \text{J})}{(7500\ \frac{\text{N}}{\text{m}})}} = 4.8 \times 10^{-2}\ \text{m} = 4.8\ \text{cm}$$

2. A potential energy function for a mass moving in one dimension is

$$U(x) = \left(5.00\ \tfrac{\text{J}}{\text{m}^2}\right) x^2 - 4.00\ \text{J}$$

For a particle moving in this potential with total energy 5.0 J, what are the turning points (places where the speed is zero)?

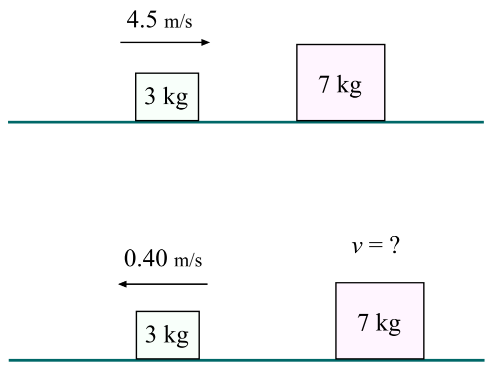
This is where $E = U$ so that

$$5.0\ \text{J} = \left(5.00\ \tfrac{\text{J}}{\text{m}^2}\right) x^2 - 4.00\ \text{J} \qquad \Longrightarrow \qquad \left(5.00\ \tfrac{\text{J}}{\text{m}^2}\right) x^2 = 9.0\ \text{J}$$

This gives

$$x = \pm 1.35\ \text{m}$$

3. On a 1-dimensional frictionless track a 3.00 kg mass moves to the right at a speed of $4.50\frac{\text{m}}{\text{s}}$ toward a 7.00 kg mass which is at rest. After the collision, the 3.00 kg mass moves with a speed of $0.400\frac{\text{m}}{\text{s}}$ *to the left*.



a) Find the velocity of the 7.00 kg mass after the collision.

Momentum is conserved in the collision. This gives:

$$(3.0\text{ kg})(4.5\tfrac{\text{m}}{\text{s}}) + 0 = (3.0\text{ kg})(-0.40\tfrac{\text{m}}{\text{s}}) + (7.0\text{ kg})v_x$$

Solve for v_x. This gives:

$$(7.0\text{ kg})v_x = (3.0\text{ kg})(4.5\tfrac{\text{m}}{\text{s}}) + (3.0\text{ kg})(0.40\tfrac{\text{m}}{\text{s}}) \qquad \Longrightarrow \qquad v_x = 2.1\tfrac{\text{m}}{\text{s}}$$

b) How much kinetic energy was lost in the collision?

Using the result of (a), get:

$$\text{KE}_i = \tfrac{1}{2}(3.0\text{ kg})(4.5\tfrac{\text{m}}{\text{s}})^2 = 30.4\text{ J}$$

$$\text{KE}_f = \tfrac{1}{2}(3.0\text{ kg})(0.40\tfrac{\text{m}}{\text{s}})^2 + \tfrac{1}{2}(7.0\text{ kg})(2.1\tfrac{\text{m}}{\text{s}})^2 = 15.7\text{ J}$$

The loss of KE was

$$\text{KE}_i - \text{KE}_f = 14.7\text{ J}$$

You must show all your work and include the right units with your answers!

$$F_{\text{spr}} = -kx \qquad f_k = \mu_k n \qquad f_s^{\text{Max}} = \mu_s n \qquad a_c = \frac{v^2}{r} \qquad W = Fd\cos\theta \qquad W = \int_{x_1}^{x_2} F_x\,dx$$

$$K = \tfrac{1}{2}mv^2 \qquad U_{\text{grav}} = mgy \qquad U_{\text{spr}} = \tfrac{1}{2}kx^2 \qquad E = K + U \qquad \Delta E = W_{\text{non-cons}}$$

$$F_x = -\frac{dU}{dx} \qquad \mathbf{p} = m\mathbf{v} \qquad \mathbf{F} = \frac{d\mathbf{p}}{dt} \qquad \mathbf{J} = \Delta\mathbf{p} = \int \mathbf{F}\,dt \qquad \frac{d\mathbf{P}}{dt} = \mathbf{F}_{\text{ext, net}}$$