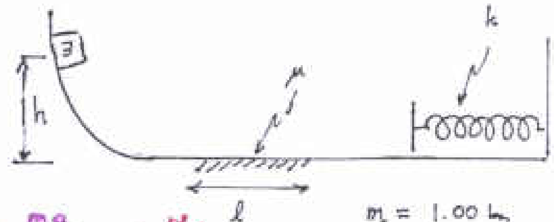
Name________________________________

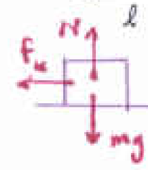
Phys 2110, Section 5
Quiz #3 — Fall 2001

1. A 1.00 kg mass starts at a height of 0.550 m and slides down a frictionless ramp onto a horizontal surface which has one rough spot of length 0.600 m and coefficient of kinetic friction 0.300. After passing over the rough spot it compresses a horizontal spring with force constant 510 N/m.



a) After the mass has passed over the rough spot, what was the work done by friction?

Here, normal force of surface is just the weight, mg. Then the work done by friction is:



$m = 1.00\ kg$
$h = 0.550\ m$
$\mu = 0.300$
$\ell = 0.600\ m$
$k = 510\ N/m$

$$W_{fric} = -f_k \ell = -\mu_k N \ell = -\mu_k m g \ell$$

$$= -(0.300)(1.00\ kg)(9.80\ m/s^2)(0.600\ m) = \boxed{-1.76\ J}$$

b) When the mass has (momentarily) come to rest against the spring, by how much is the spring compressed?

$$\Delta E = \Delta U_{grav} + \Delta U_{spr} + \Delta K$$

$$= -mgh + \tfrac{1}{2}kx^2 + 0 = W_{fric} = -1.76\ J$$

Then $\tfrac{1}{2}kx^2 = -1.76\ J + mgh = -1.76\ J + (1.00\ kg)(9.80\ m/s^2)(0.550\ m)$

$$= 3.63\ J$$

$$x^2 = 2(3.63\ J)/(510\ N/m) = 1.42 \times 10^{-2}\ m^2$$

$$x = \boxed{0.119\ m = 11.9\ cm}$$

c) The spring propels the mass back over the rough spot and back up the ramp to some new (smaller) maximum height h'. What is h' ?

Now the total work by friction for the whole trip is twice the amt found in (a), $W_{fric} = -3.53\ J$

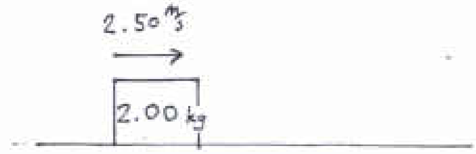
so now

$$\Delta E = \Delta U_{grav} + \Delta U_{spr} + \Delta K = mg(h'-h) + 0 + 0 = W_{fric} = -3.53\ J$$

$$h' - h = \frac{-3.53\ J}{(1.00\ kg)(9.80\ m/s^2)} = -0.360\ m$$

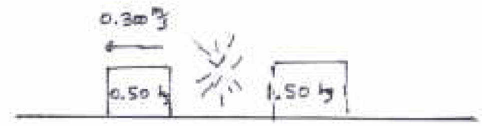
$$h' = h - 0.360\ m = 0.550\ m - 0.360\ m = \boxed{0.190\ m}$$

2. A 2.0 kg mass slides on a frictionless one–dimensional track with a speed of $2.50\frac{\text{m}}{\text{s}}$ Suddenly it explodes so that afterwards a section of mass 0.500 kg is moving in the opposite direction with speed $0.300\frac{\text{m}}{\text{s}}$. The remaining section has mass 1.500 kg.



a) What is the final velocity of the 1.500 kg section?

If the (final) velocity of the 1.500 kg section is V_x then momentum conservation for the system (it is isolated) gives



$$(2.00\text{ kg})(2.50\tfrac{\text{m}}{\text{s}}) = (0.500\text{ kg})(-0.300\tfrac{\text{m}}{\text{s}}) + (1.500\text{ kg})V_x$$

$$(1.500\text{ kg})V_x = 5.15\ \tfrac{\text{kg}\cdot\text{m}}{\text{s}}$$

$$\rightarrow \quad V_x = \boxed{3.43\ \tfrac{\text{m}}{\text{s}}}$$

b) How much energy was released in the explosion?

$$\Delta K = \sum K_f - \sum K_i$$

$$= \tfrac{1}{2}(1.50\text{ kg})(3.43\tfrac{\text{m}}{\text{s}})^2 + \tfrac{1}{2}(0.50\text{ kg})(0.300\tfrac{\text{m}}{\text{s}})^2 - \tfrac{1}{2}(2.00\text{ kg})(2.50\tfrac{\text{m}}{\text{s}})^2$$

$$= 2.61\text{ J}$$

Mechanical energy of the system has increased by $\boxed{2.61\text{ J}}$

(This is amt. of released energy.)

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

$$g = 9.8\,\tfrac{\text{m}}{\text{s}^2} \qquad f_k = \mu_k N \qquad W = Fs\cos\phi$$

$$K = \tfrac{1}{2}mv^2 \qquad U_{\text{grav}} = mgy \qquad U_{\text{spring}} = \tfrac{1}{2}kx^2 \qquad \Delta E = W_{\text{fric}}$$

$$\mathbf{p} = m\mathbf{v} \qquad \mathbf{P} = \sum_i \mathbf{p}_i \qquad \text{Isolated system,} \quad \mathbf{P}_i = \mathbf{P}_f$$