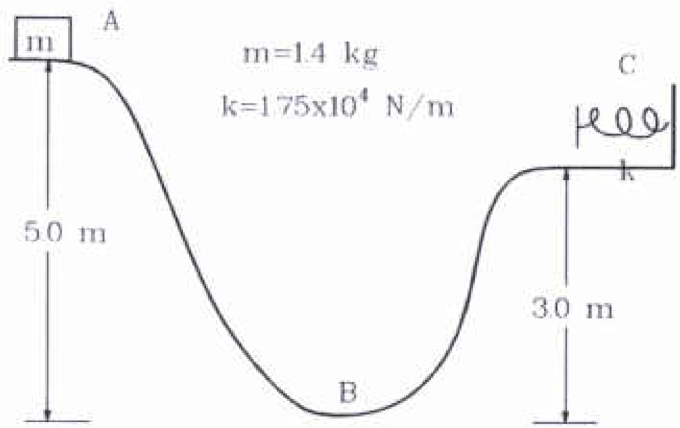
Name ______________________________

Physics 121, Section 1 ....Quiz #3

1. In the highly improbable device pictured here, a 1.4 kg mass starts at rest on a flat surface at point A, then slides down a slope (the lowest point is B) and back up to another flat surface where it compresses a horizontal spring and momentarily comes to rest at point C. The heights above the lowest point are as indicated in the figure, and the force constant of the spring is $k = 1.75 \times 10^4$ N/m.
Assume that there is no friction.



a) What is the speed of the mass when it gets to point B?

Mechanical energy is conserved. Measuring height from the lowest level (B),

$E_A = E_B \quad \rightarrow \quad mgy_A = \frac{1}{2} m v_B^2$

$\rightarrow \quad v_B^2 = 2gy_A = 2(9.8\,\frac{m}{s^2})(5.0\,m) = 98\,\frac{m^2}{s^2}$

$\boxed{v_B = 9.9\,\frac{m}{s}}$

b) What will be the speed of the mass just before it hits the spring?

Just before hitting the spring on the second level,

$E_A = E_{\substack{sec.\\level}} \quad \rightarrow \quad mgy_A = mgy_{\substack{sec\\lev}} + \frac{1}{2} m v_{\substack{sec\\lev}}^2$

$mg(y_A - y_{\substack{sec\\lev}}) = \frac{1}{2} m v_{\substack{sec\\lev}}^2$

$v_{sec\text{-}lev}^2 = 2g(y_A - y_{sec.}) = 2(9.8\,\frac{m}{s^2})(2.0\,m) = 39.2\,\frac{m^2}{s^2}$

$\boxed{v_{sec} = 6.3\,\frac{m}{s}}$

c) By what length x will the spring be squished when the mass is at C?

Use: $E_A = E_C$

$$\Rightarrow \quad mgy_A = mgy_C + \tfrac{1}{2}kx^2$$

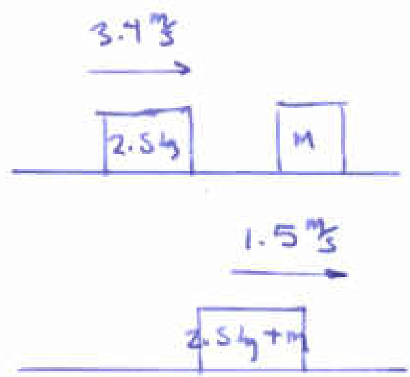
$$x^2 = \frac{2mg(y_A - y_C)}{k} = \frac{2(1.4\ \text{kg})(9.8\ \frac{\text{m}}{\text{s}^2})(2.0\ \text{m})}{1.75\times10^4\ \frac{\text{N}}{\text{m}}} = 3.13\times10^{-3}\ \text{m}^2$$

$$x = 5.6\times10^{-2}\ \text{m} = \boxed{5.6\ \text{cm}}$$

2. In a one-dimensional collision (on a smooth surface!) a 2.5 kg mass moving at 3.4 $\frac{m}{s}$ strikes and sticks to a second mass; the two move off together with a speed of 1.5 $\frac{m}{s}$.

What was the value of the second mass?

Total momentum is conserved:



$$(2.5\ \text{kg})(3.4\ \tfrac{\text{m}}{\text{s}}) = (2.5\ \text{kg} + m)(1.5\ \tfrac{\text{m}}{\text{s}})$$

$$2.5\ \text{kg} + m = \frac{(2.5\ \text{kg})(3.4\ \frac{\text{m}}{\text{s}})}{(1.5\ \frac{\text{m}}{\text{s}})} = 5.67\ \text{kg}$$

$$\boxed{m = 3.2\ \text{kg}}$$

$F_{x,\text{ spring}} = -kx$ KE $= \frac{1}{2}mv^2$ PE: mgh $\frac{1}{2}kx^2$ $W = Fd\sin\theta$

Change in mechanical energy is the work done by the "miscellaneous" forces.

$\mathbf{p} = m\mathbf{v}$ In collisions, total momentum is conserved.

REMEMBER TO <u>SHOW YOUR WORK</u>!