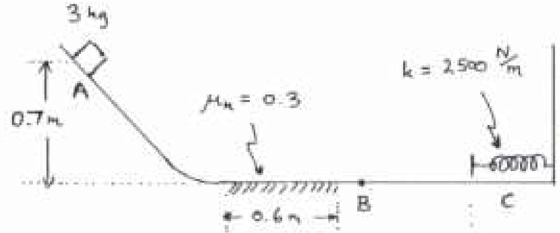
Name Lyle I. K. Rugg

Phys 221 (Section 6)

Quiz #3

1. A 3.0-kg block is released from point A on the track ABC shown here, which is frictionless except for a section of length 0.6 m which has coefficient of kinetic friction $\mu_k = 0.3$ on the level part of it. Its initial vertical height is 0.7 m. At the end of this track is a spring of force constant $k = 2500\frac{\text{N}}{\text{m}}$.



a) What is the speed of the mass when it gets to point B (just past the rough section)?

When the mass is at A the energy of the system is

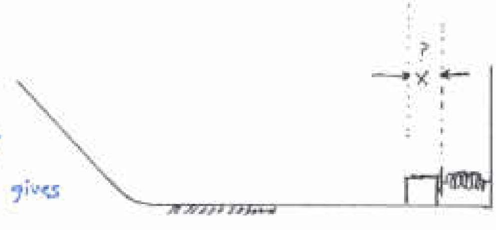
$E_A = mgh = (3.0\,\text{kg})(9.8\,\frac{\text{m}}{\text{s}^2})(0.7\,\text{m}) = 20.6\,\text{J}$

The change in energy in passing to B comes from friction,

$\Delta E = W_{fric} = -\mu mg\,d = -(0.3)(3.0\,\text{kg})(9.8\,\frac{\text{m}}{\text{s}^2})(0.6\,\text{m}) = -5.29\,\text{J}$

So $E_B = E_A + \Delta E = 15.29\,\text{J}$. But $E_B = \frac{1}{2}mv_B^2$. Solving for v_B gives

$v_B = 3.19\,\frac{\text{m}}{\text{s}}$

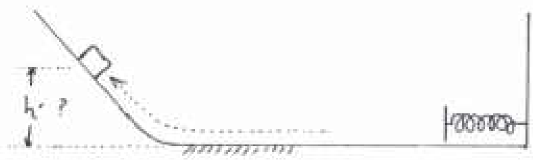


b) When the mass comes to rest *momentarily* as it compresses the spring, by what length x is the spring compressed?

No energy is lost (or gained) as the mass goes on to compress the spring. The energy there is all potential energy (mass has v = 0 there) so

$E = 15.29\,\text{J} = \frac{1}{2}kx^2$

Solving for x gives $x = \sqrt{\frac{2(15.29\,\text{J})}{(2500\,\text{N/m})}} = 0.11\,\text{m} = 11\,\text{cm}$

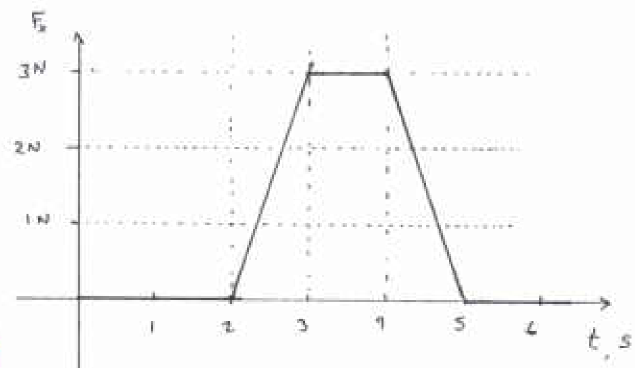


c) Under the action of the spring, the mass is then projected back over the rough surface and up the slope. What is the maximum height attained by the mass on its return?

As the mass slides over the rough part the energy of the system changes again; $\Delta E = -5.29\,\text{J}$ as before. This gives

$E_{final} = 15.29\,\text{J} - 5.29\,\text{J} = 10.0\,\text{J}$. At the position of maximum height, the energy is all potential energy so

$10.0\,\text{J} = mgh'$ Solving for h', $h' = 0.34\,\text{m} = 34\,\text{cm}$



2. A mass moving in one dimension is acted on by the force F_x plotted here versus time. What is the change in momentum of the mass between $t = 1$ s and $t = 6$ s? What is the average force for that time interval?

$\Delta p_x = \int_{t_i}^{t_f} F_x\,dt = (1.5 + 3.0 + 1.5)\,\frac{\text{kg}\cdot\text{m}}{\text{s}} = +6.0\,\frac{\text{kg}\cdot\text{m}}{\text{s}}$

Average force for the given time interval is ($\Delta t = 6\,\text{s} - 1\,\text{s} = 5\,\text{s}$)

$\overline{F_x} = \frac{\Delta p_x}{\Delta t} = \frac{+6.0\,\frac{\text{kg}\cdot\text{m}}{\text{s}}}{5.0\,\text{s}} = +1.2\,\text{N}$

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

$$\mathbf{p} = m\mathbf{v} \qquad \mathbf{F} = \frac{d\mathbf{p}}{dt}$$