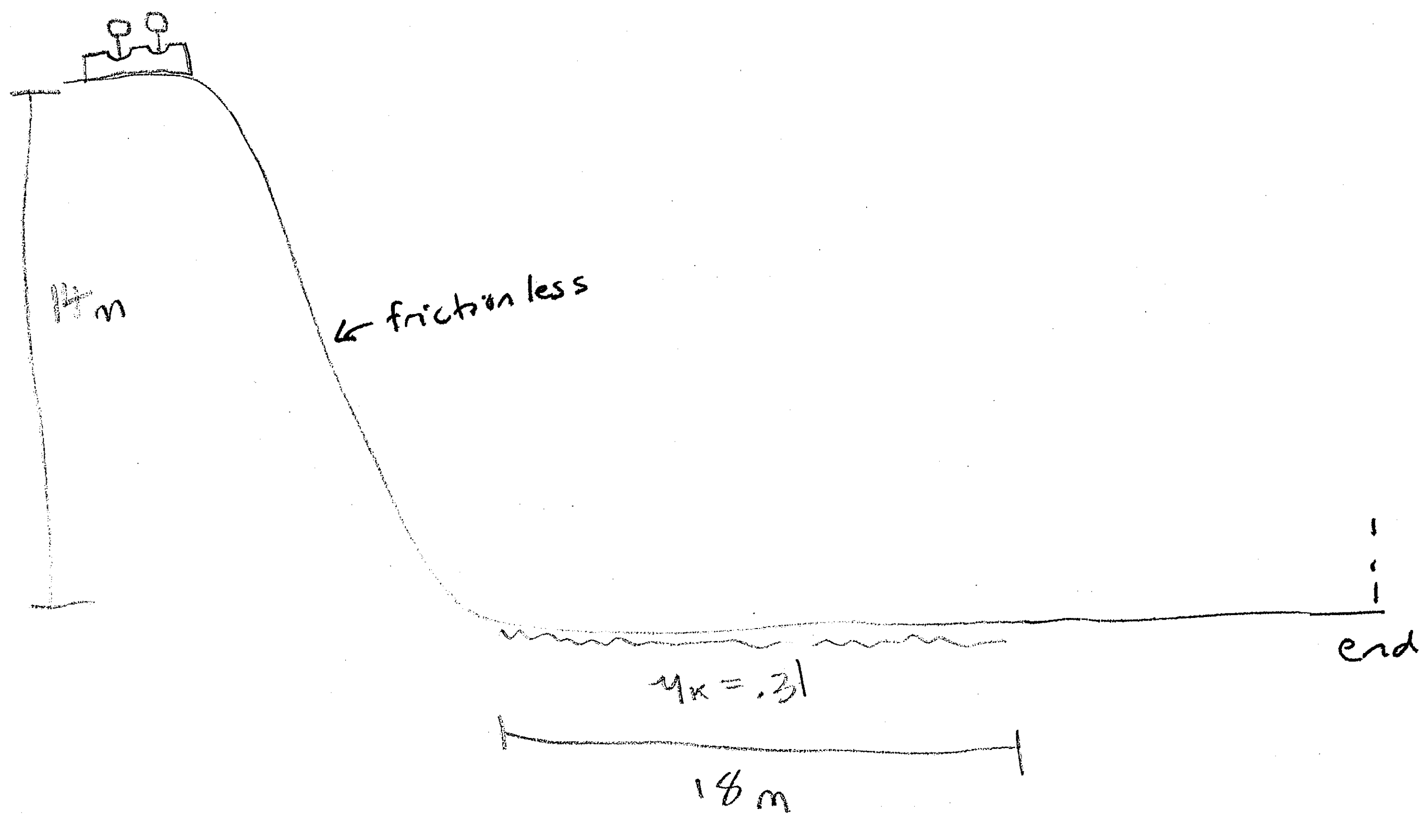
#6: CONSERVATION OF ENERGY

A log flume goes down a slide with a height of 14 m. At the bottom of the slide, there is a flat section that is 18 m long with a μ_K of .31. How fast is the log going at the end of the ride



$$K_i + U_{g_i} + U_{ee_i} = K_f + U_{gf} + U_{ee_f} + \Delta U_{int}$$

$$0 + \cancel{m}gh + 0 = \tfrac{1}{2}\cancel{m}v^2 + 0 + 0 + \mu_K \cancel{m}gd$$

$$gh = \tfrac{1}{2}v^2 + \mu_K gd$$

$$gh - \mu_K gd = \tfrac{1}{2}v^2$$

$$2g(h - \mu_K d) = v^2$$

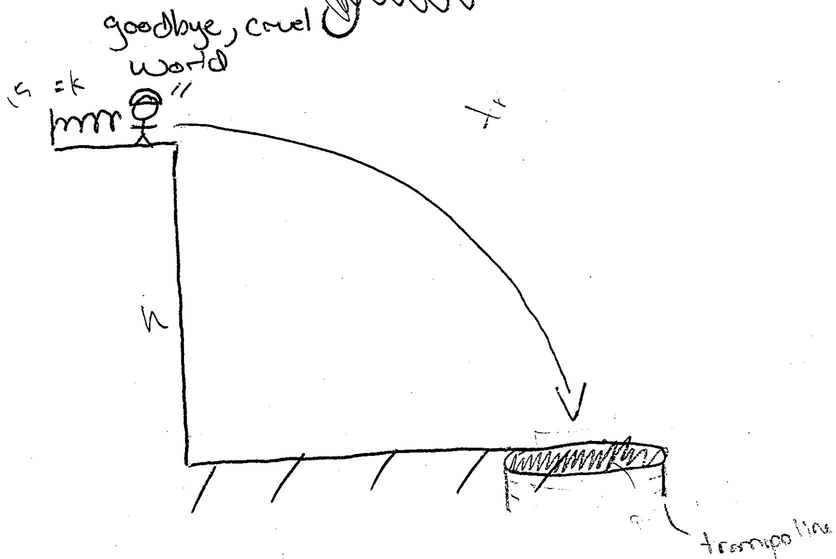
$$2(9.8)(14 - .31(18)) = v^2$$

$$165.032 = v^2$$

$$v = 12.846 \text{ m/s}$$

OK, BUT HOW DO THEY get off the ride???

Wade and his handy, dandy helmet, with a total mass of 80 kg is getting launched off a building by a spring with a spring constant of 15 N/m. If the building height is 450 m and the spring is initially compressed 1 m, how fast is wade going right before he hits the ~~ground~~?



Wade lives because it is a very good trampoline :)

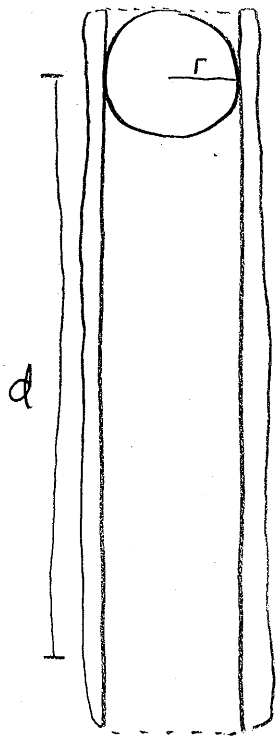
$$\frac{1}{2}kx^2 + mgh = \frac{1}{2}mv^2$$

$$\frac{1}{2}(15)(1) + (80)(9.8)(450) = \frac{1}{2}(80)(v)^2$$

$$7.5 + 352\,800 = 40v^2$$

$$v^2 = 8820.1875$$

$$v = 93.92 \text{ m/s}$$

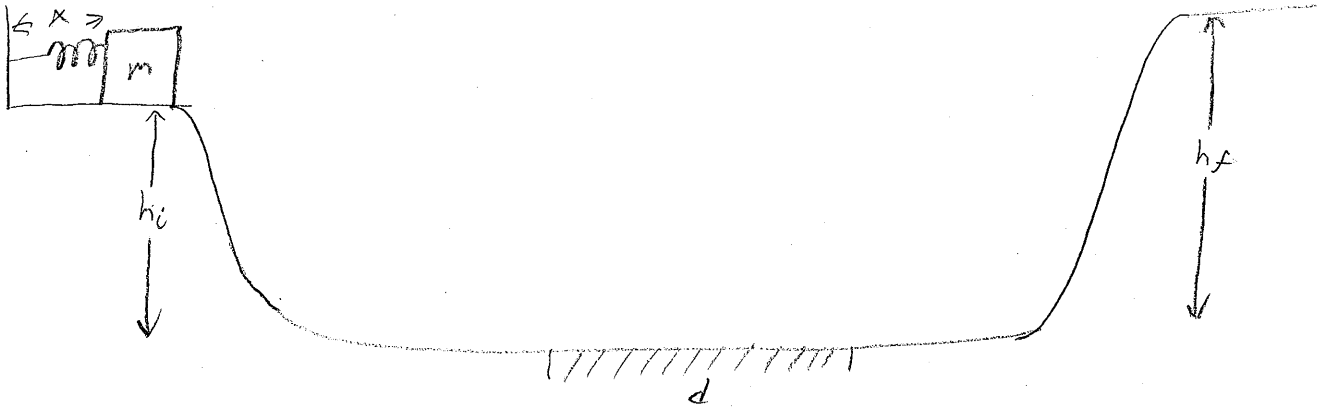


A ball is dropped down a tube with a diameter that is twice the radius of the ball. After falling a distance d, the ball has a velocity v. What is the change in internal energy in terms of m, g, h, and v?

$$mgh = \frac{1}{2}mv^2 + \Delta U_{int}$$

$$\Delta U_{int} = mgh - \frac{1}{2}mv^2$$

$$\Delta U_{int} = m\left(gh - \frac{1}{2}v^2\right)$$



You are given x, m, h_i, d, h_f. The mass is compressed x distance and released from rest at height h_i. It will then travel through a rough patch with a μ_K a distance d. Then continue until it reachs a height h_f and then come to rest. Find k.

$$\frac{1}{2} K x^2 + m g h_i = m g h_f + \mu_K d m g$$

$$\frac{1}{2} K x^2 = m g h_f + \mu_K m g d - m g h_i$$

$$K = \frac{2(m g h_f + \mu_K m g d - m g h_i)}{x^2}$$

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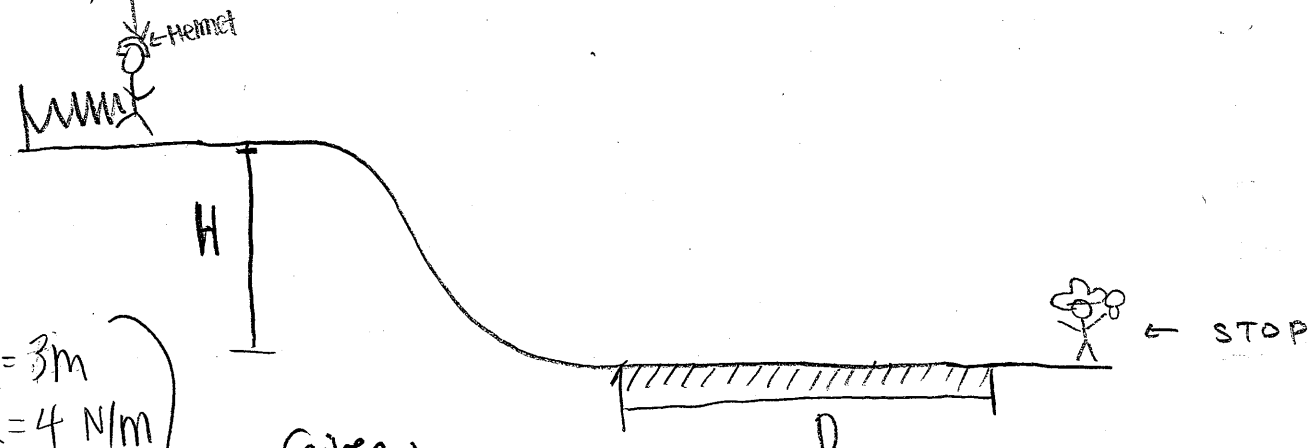


$x = 3m$
$K = 4\ N/m$
$H = 10m$
$D = ?$
$V_0 = 0$
$V = 0$
$\mu_k = .3$
$m = 33kg$

Given

$\Longrightarrow$ Find D

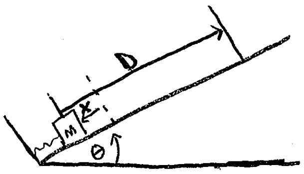
SOLUTION:

$$U_{E_1} + U_{g_1} + K_1 = K_2 + U_{g_2} + W_0$$

$$\frac{1}{2}\left(4\frac{N}{m}\right)(3m)^2 + (33kg)\left(9.81\frac{m}{s^2}\right)(10m) = \mu_k mg \cdot D$$

$$18\ kg\frac{m^2}{s^2} + 3237.3\ kg\frac{m^2}{s^2} = (0.3)(33kg)\left(9.81\frac{m}{s^2}\right)D$$

$$\frac{3255.3\ kg\frac{m^2}{s^2}}{97.119\ \frac{kg\,m}{s^2}} = \boxed{D = 33.52m}$$



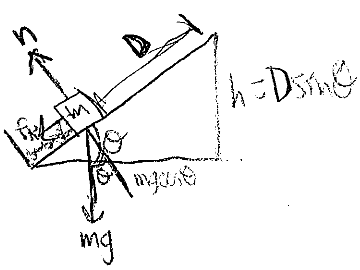
Spring compressed by mass m, ramp has friction of μ_k and angle θ, how far up the ramp does the mass go before stopping?

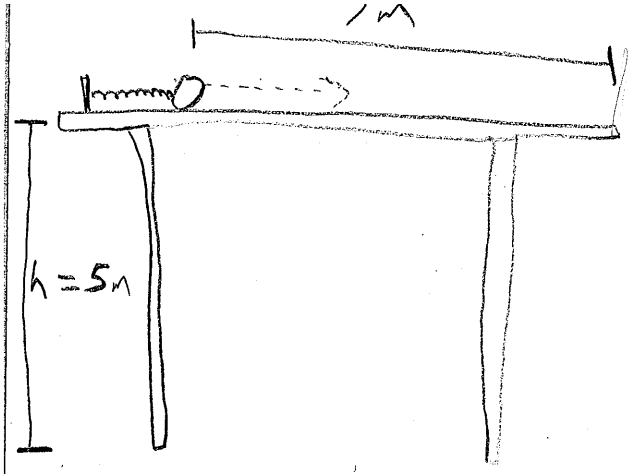
Initial	final
$K_i = 0$	$K_f = 0$
$U_{g_i} = 0$	$U_{g_f} = mgD\sin\theta$
$U_{el_i} = \frac{1}{2}kx^2$	$U_{el_f} = 0$
	$\Delta U_{int} = \mu_k mg\cos\theta D$

$$\frac{1}{2}kx^2 = mgD\sin\theta + \mu_k mg\cos\theta D$$

$$\frac{1}{2}kx^2 = D(mg\sin\theta + \mu_k mg\cos\theta)$$

$$\boxed{D = \frac{kx^2}{2mg(\sin\theta + \mu_k\cos\theta)}}$$





Friction on table, $\mu = 0.6$
mass of ball is 3 kg
Distance from compressed position
to end of table is 7 m
and height of table is 5 m.
Spring is compress .5 m.
and spring has a K value
of 2,500 $\frac{N}{m}$.
Find the speed when
the ball leaves the table.

$$\frac{1}{2}kx^2 = \mu mgd + \frac{1}{2}mv^2$$

$$\frac{1}{2}kx^2 = m(\mu gd + \frac{1}{2}v^2)$$

$$\frac{kx^2}{2m} = \mu gd + \frac{1}{2}v^2$$

$$\frac{kx^2}{2m} - \mu gd = \frac{1}{2}v^2$$

$$\frac{kx^2}{m} - 2\mu gd = v^2$$

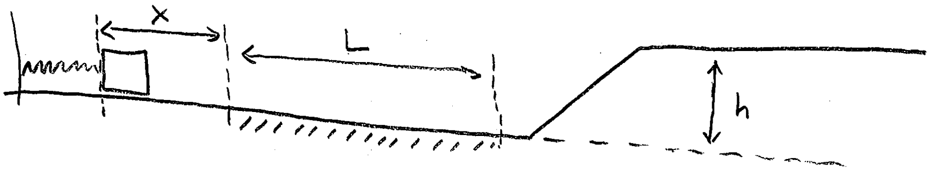
$$V = \sqrt{\frac{kx^2}{m} - 2\mu gd}$$

$$V = \sqrt{\frac{2500N/m \cdot .5^2 m}{3kg} - 2 \cdot .6 \cdot 9.8m/s^2 \cdot 7m}$$

$$V = 11.22556606 m/s$$

$$V = 10 m/s$$

An object of mass 0.67 kg compresses a spring 3.3 m with a spring constant of $k = 4.0$ N/m. If $h = 3.0$ m, $L = 5.0$ m, $\mu_k = 0.37$ does the object reach the top of the hill.



$$U_{el} = \tfrac{1}{2}(4.0)(3.3)^2 = 21.8\text{ J} \Big\} \text{initial energy}$$

$$\underbrace{U_g + \Delta U_{int} = .67(9.8)\,3.0 + (.37)(.67)(9.8)(5.0) = 31.8\text{ J}}_{\text{Final energy needed if made to top}}$$

No, it does not reach the top of the hill because

Final Energy needed > initial energy.