Energy

1) A 400 g ball is dropped from a height of 8m. It lands on a spring, compressing it 25cm. A) What is the spring constant? B) How fast is the ball moving when the spring is compressed half of the maximum compression above?

A) $mgh_0 = \frac{1}{2}kx^2$

$.4(10)(8) = \frac{1}{2}(k)(.25)^2$

$32 = 0.03125k$

$k = 1024\ N/m$

B) $E_{g_0} = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 + mgh_f$

$32 = \frac{1}{2}(1024)(.125)^2 + \frac{1}{2}(.4)(v)^2 + .4(10)(.125)$

$32 = 8 + 0.2v^2 + 0.05$

$23.95 = .2v^2$

$v = 10.94\ m/s$

2) A cart is at the top of a 40m tall hill. A) How fast is it moving at the bottom of the hill? B) How fast is it moving when it gets to the top of the next hill that is 20m tall? C) The cart hits a spring that has a spring constant of 5000 N/m, what is the maximum displacement of the spring if the cart has a mass of 300 kg?

A) $mgh = \frac{1}{2}mv^2$

$10(40) = \frac{1}{2}v^2$

$v = 28.28\ m/s$

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

$400 = \frac{1}{2}v^2 + 10(20)$

$400 = \frac{1}{2}v^2 + 200$

$200 = \frac{1}{2}v^2$

$v = 20\ m/s$

C) $mgh = mgh_f + \frac{1}{2}kx^2$

$300(10)(40) = 300(10)(20) + \frac{1}{2}(5000)x^2$

$120{,}000 = 60{,}000 + 2500x^2$

$60{,}000 = 2500x^2$

$x^2 = 4.9m$

3) A spring compressed 0.3m launches a 2.0kg box horizontally on a surface. After it leaves the spring it travels 16m as it slides up a hill. What is the spring constant if the box experiences an average frictional force of 15 N & it ends on the hill at a height of 8m?

$\frac{1}{2}kx^2 - W_f = mgh$ $\quad W_f = F_f d$

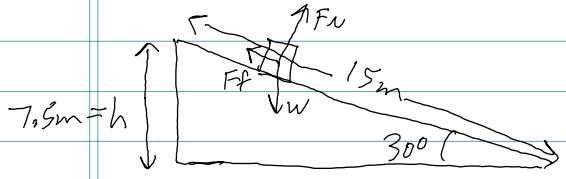
$\frac{1}{2}k(.3)^2 - 15(16) = 2(10)(8)$

$0.045k - 240 = 160$

$.045k = 400$

$\boxed{k = 8,888.89\ N/m}$

4) A 5kg box slides down a 15m long slope that has a coefficient of friction of 0.09. If the hill is at a 30° above the horizontal, how fast is it moving at the bottom?



$F_f = \mu F_N$

$F_f = .09(43.3)$

$F_f = 3.897\ N$

$\sin 30° = \frac{\text{height}}{15}$

$\text{height} = 7.5m$

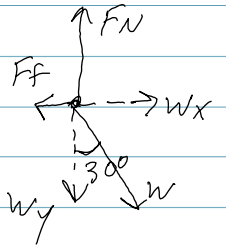
$E_g - W_f = E_K$

$mgh_o - F_f(d) = \frac{1}{2}mv^2$

$5(10)(7.5) - 3.897(15) = \frac{1}{2}(5)v^2$

$375 - 58.455 = 2.5v^2$

$\boxed{v = 11.25 m/s}$



$\cos 30° \quad \frac{W_y}{W} = \frac{W_y}{50} \quad W_y = 43.3N$

$\Sigma F_y = 0 = W_y + F_N$

$0 = -43.3 + F_N$

$F_N = 43.3N$