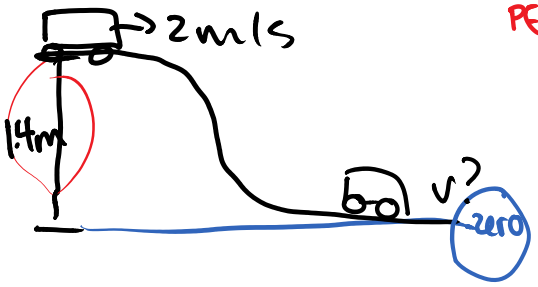
Conservation of Mechanical Energy

Monday, November 4, 2013 7:55 AM

A rollercoaster has a mass of 500 kg. At the top of a 14 m hill, it has a velocity of 2 m/s. Find its velocity at the bottom.

Sketch:



$ME_i = ME_f$

$PE_{gi} + PE_{ei} + KE_i = PE_{gf} + PE_{ef} + KE_f$

PE_{ei}: no springs; PE_{gf}: lower pt; PE_{ef}: no spring

$PE_{gi} + KE_i = KE_f$

$mgh_i + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2$

$500 \cdot 9.8 \cdot 14 + \frac{1}{2}(500)(2^2) = \frac{1}{2} \cdot 500 v_f^2$

$68{,}600 + 1000 = 250 v_f^2$

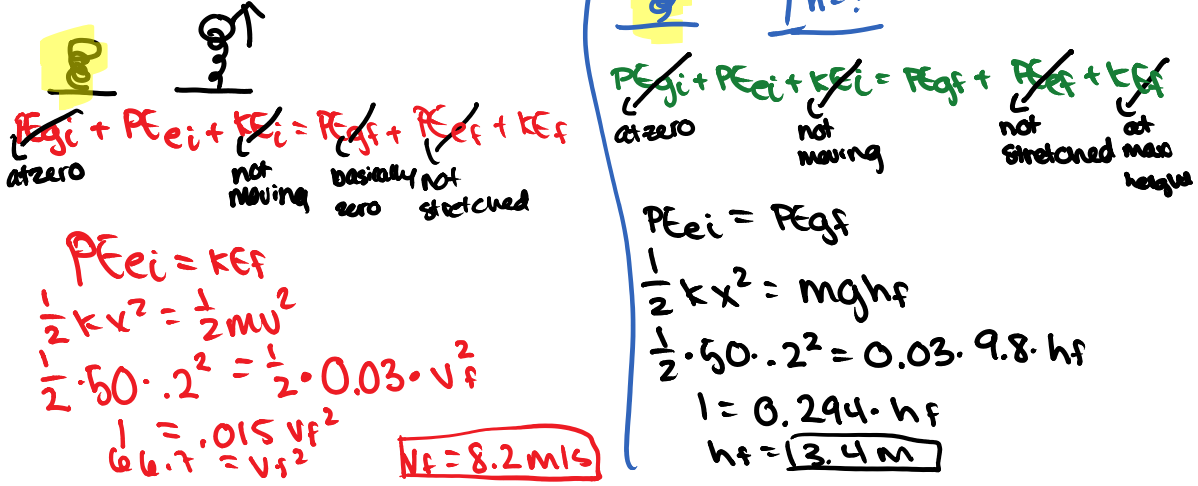
$69{,}600 = 250 v_f^2$

$278.4 = v_f^2$

$v_f = 16.7$ m/s

A spring is pulled back 20 cm. Its spring constant is 50 N/m and its mass is 30 g.

1. How fast is it when you just let it go?
2. How high will it rise?



$PE_{ei} = KE_f$

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

$\frac{1}{2} \cdot 50 \cdot .2^2 = \frac{1}{2} \cdot 0.03 \cdot v_f^2$

$1 = .015 v_f^2$

$66.7 = v_f^2$

$v_f = 8.2$ m/s

$PE_{ei} = PE_{gf}$

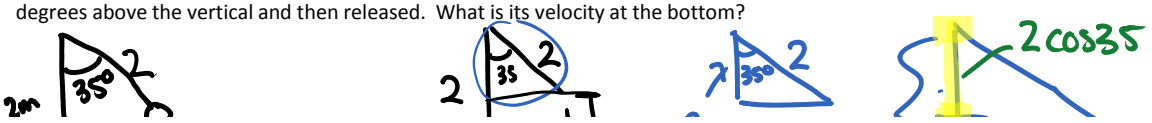
$\frac{1}{2}kx^2 = mgh_f$

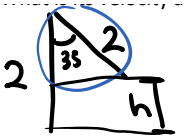
$\frac{1}{2} \cdot 50 \cdot .2^2 = 0.03 \cdot 9.8 \cdot h_f$

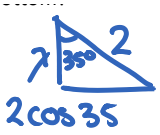
$1 = 0.294 \cdot h_f$

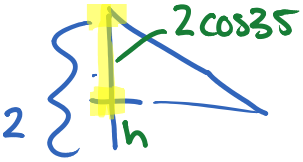
$h_f = 3.4$ m

A ball hangs on a string that is 2 m long. The ball has a mass of 2 kg and is pulled back to an angle of 35 degrees above the vertical and then released. What is its velocity at the bottom?









zero level

$PE_{gi} + PE_{ei} + KE_i = PE_{gf} + PE_{ef} + KE_f$

no springs; not moving; lowest pt; no springs

$2 = 2\cos 35 + h$

$h = 2 - 2\cos 35$

$= 0.36m$

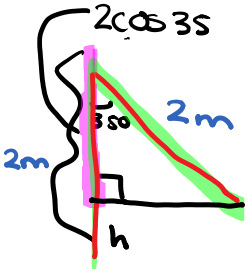
$PE_{gi} = KE_f$

$mgh_i = \frac{1}{2}mv_f^2$

$2 \cdot 9.8 \cdot 0.36 = \frac{1}{2} \cdot 2 \cdot v_f^2$

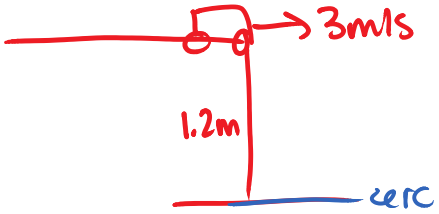
$7.09 = v_f^2$

$v_f = 2.7 m/s$



Hotwheels Problem

A hotwheels car flies off a 1.2 m tall table with a velocity of 3 m/s. What is its final velocity?



$ME_i = ME_f$

$PE_{gi} + PE_{ei} + KE_i = PE_{gf} + PE_{ef} + KE_f$

$0 \quad 0 \quad 0$

$PE_{gi} + KE_i = KE_f$

$mgh_i + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2$

$m(gh_i + \frac{1}{2}v_i^2) = m(\frac{1}{2}v_f^2)$

$gh_i + \frac{1}{2}v_i^2 = \frac{1}{2}v_f^2$

$9.8 \cdot 1.2 + \frac{1}{2} \cdot 3^2 = \frac{1}{2}v_f^2$

$11.76 + 4.5 = \frac{1}{2}v_f^2$

$16.26 = \frac{1}{2}v_f^2$

$32.52 = v_f^2$

$v_f = 5.7 m/s$