Conservation of Energy

F 14 -14

By conservation of energy

$$T_1 + V_1 = T_2 + V_2$$

$$\tfrac{1}{2} m v_1^2 + W h_1 = \tfrac{1}{2} m V_2^2 + W h_2^2$$

using point B as our datum

$$\tfrac{1}{2} \cdot 2 \cdot 1^2 + 2(9.81) \cdot 4 = \tfrac{1}{2} \cdot 2 \cdot V^2 + 0$$

$$V = \sqrt{1 + 39.24} = \sqrt{1 + 78.48}$$

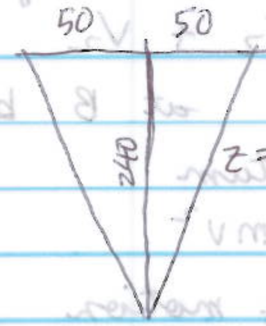
$$\approx \cancel{6.34} \text{ m/s}$$

$$= 8.91 \text{ m/s}$$

$$\text{Normal force} = \frac{v^2}{\rho}$$

$$= \frac{8.91^2}{2}$$

14 – 77



Datum

$z = \sqrt{240^2 + 50^2} = 245.15 \text{ mm}$

Before release all energy is stored in elastic rubber bands.

$$V_1 = \sum \tfrac{1}{2} K S_i^2$$

$$= 2 \cdot \frac{50}{2} (\cancel{0.4}\, 245.15 - 200)^2 = 0.1 \text{ J}$$

Now we want to know what happens the moment the spring energy is dissipated

From conservation of energy

$$T_1 + V_1 = T_2 + V_2$$

$$0 + \cancel{24452}3 = \tfrac{1}{2} m v^2 + 0$$

$$0.1 \cancel{24452} = 0.5 (0.025) V^2$$

$$V = 2.85 \text{ m/s}$$

Note; remember spring forces or ~~non~~conservative forces, so that is why we did not do

$$F_{spring} = \tfrac{1}{2} K (S \cos\theta)^2 \quad \ldots$$

14 − 78

for max height we consider potential energy in conservation of energy equation

$$T_1 + V_1 = T_{@max} + V_{@max}$$

at max height $v = 0$ so kinetic energy $T = 0$.

$$0 + 0.1 = 0 + Wh$$

$$0.1 = 0.025(9.81)h$$

$$h = 0.408 \text{ m}$$

14—97

By conservation of energy
(from release to just above water)

$T_1 + V_1 = T_2 + V_2$

Using water surface as datum

$T_1 = \frac{1}{2}mv^2 = 0.5(75)(1.5^2) = 84.375$

$V_1 = Wh = 75(9.81)(150) = 110362.5$

$T_2 = 0$

$V_2 = Wh_2 + \cancel{\frac{1}{2}ks^2} \cancel{+} \int_0^s F_s ds$

$\int_0^s ks\,ds = \frac{1}{2}ks^2$

So at some unknown point before stretching (z)

$T_z = \frac{1}{2}mv_z^2$

$V_z = Wz$

elastic potential $= 0$.

from 3rd Eqn of motion

$v_z^2 = u^2 + 2gz$

~~or from 1st Eqn of motion~~

$\cancel{v_z = u + at}$

$v_z^2 = 1.5^2 + 2(9.81)(150 - z)$

$= 2.25 + 2943 \quad W + 19.62z$

$= \cancel{2940.75 + 19.62z}$

$= 2945.25 + 19.62z$

$T_z = \frac{1}{2} m (19.62z + 2945.25)$

$V_z = w (19.62z + 2945.25)^{1/2}$

~~Note between z and stoppage point:~~
at stoppage all energy has been stored in spring

$T_1 + V_1 = \frac{1}{2} K S^2$

$84.375 + 110362.5 = \frac{1}{2} (\cancel{4000}\ 3000) S^2$

$S = 8.58 \text{ m}$

so original length of bungee rope

$= 150 - 8.58$

$= 141.42 \text{ m}$

14-78

to get max. height we now analyze conversion of energy to include potential energy at max height

$T_1 + V_1 = T_{max\,h} + V_{max\,h}$

$= 0$

14 - 87

Use the bottom track of rollercoaster as datum
By Conservation of Energy

$$T_A + V_A = T_B + V_B = T_C + V_C$$

between A and B

$$\frac{1}{2}mV_A^2 + wh_A = \frac{1}{2}mV_B^2 + wh_B$$

$$\frac{1}{2}(800)(3)^2 + 800(9.81)h_A = \frac{1}{2}(800)V_B^2 + 800(9.81)(20)$$

$$3600 + 7848h_A = 400V_B^2 + 156960$$

$$7848h_A - 400V_B^2 = 153360 \quad \text{--- (1)}$$

now at bottom of A

$$\frac{1}{2}mV_A^2 + wh_A = \frac{1}{2}mV_{bA}^2$$

$$V_{bA}^2 = \frac{\left(\frac{1}{2}mV_A^2 + wh_A\right)}{0.5m} =$$

No! not needed!

A and C

$$\frac{1}{2}mV_A^2 + wh_A = \frac{1}{2}mV_C^2 + wh_C$$

$$0.5(800)V_A^2 + 800(9.81)h_A = 0.5(800)V_C^2 + 800(9.81)(14)$$

$$3600 + 7848h_A = 400V_C^2 + 109872$$

$$7848h_A - 400V_C^2 = 106272 \quad \text{--- (2)}$$

B and C

$$0.5(800)V_B^2 + 800(9.81)(20) = 0.5(800)V_C^2 + 800(9.81)(14)$$

$$400V_B^2 - 400V_C^2 = -47088 \quad \text{--- (3)}$$

Now solve 3 simultaneous equations