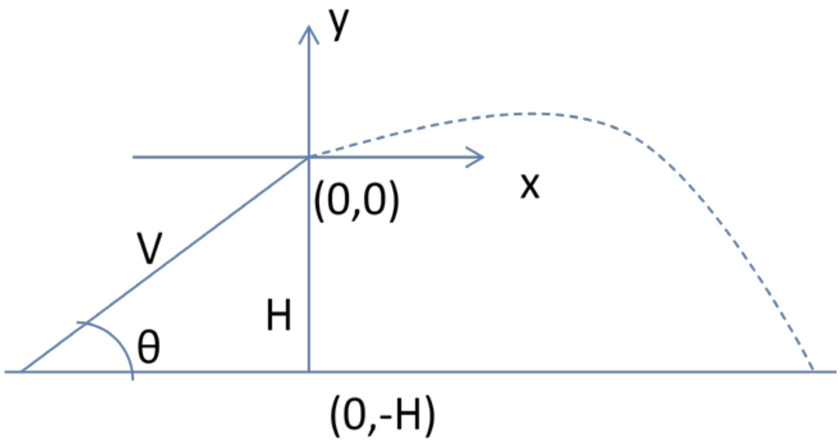
Calculations for Bike Movement



V_o: initial velocity of bike, in ft/sec

V_{ox}: component in x of V_o , in ft/sec

V_{oy}: component in y of V_o , in ft/sec

V_f: final velocity of bike when on ground, in ft/sec

V_{fx}: component in x of V_f , in ft/sec

V_{fy}: component in y of V_f , in ft/sec

$$V_{ox} = V_o \cos(\theta)$$
$$V_{oy} = V_o \sin(\theta)$$

$$V_{fx} = V_{ox}$$
$$\overline{V}_{fy} = \overline{V}_{oy} + \overline{a}_y t$$
$$\overline{d}_y t = V_{oy} t + \frac{1}{2} \overline{d}_y t^2$$
$$d_x = V_{ox} t$$

g: acceleration due to gravity, -32.2 ft/sec^2

Conservation of Energy: total energy at the end equal total energy at the beginning.

E_p: potential energy

E_k: kinetic energy

$$E_p = mgh$$
$$E_k = \frac{1}{2} m v^2$$
$$E_{pf+} E_{kf} = E_{po+} E_{ko}$$
$$mgh_f + \frac{1}{2} m v_f^{\ 2} = mgh_o + \frac{1}{2} m v_o^{\ 2}$$

Using vertical motion only, total energy at the top is equal total energy at the bottom.

$$E_{ptop+} E_{ktop} = E_{pbotom+} E_{kbottom}$$
$$mgH + \frac{1}{2} m v_{oy}^{\ 2} = mg(0) + \frac{1}{2} m v_{fy}^{\ 2}$$
$$rearranging:$$
$$2gH + v_{oy}^{\ 2} = v_{fy}^{\ 2}$$
$$\pm\sqrt{2gH + v_{oy}^{\ 2}} = v_{fy}$$

Which means bike falls down with velocity:

$$-\sqrt{2gH + v_{oy}^{\ 2}} = v_{fy}$$

The ultimate final condition is when bike hits the ground with $V_{fy}=0$; the final horizontal velocity of the bike is the same as the horizontal component of the velocity as it left the top of the ramp.

To find the force needed to stop the rider depends on two factors, which are the mass of the rider and the time it takes for rider to stop. The rider's leg provide an impulse which cause the momentum of the rider to change to zero in the vertical direction.

Impulse is defined as change in momentum. Below it is shown that the impulse is directed up in the positive direction.

$$\text{Im}\,pulse = m\Delta v$$
$$\text{Im}\,pulse = m(V_{fy} - V_{fo})$$
$$\text{Im}\,pulse = m(0 - (-\sqrt{2gH + v_{oy}^{2}}))$$
$$\text{Im}\,pulse = m\sqrt{2gH + v_{oy}^{2}}$$

