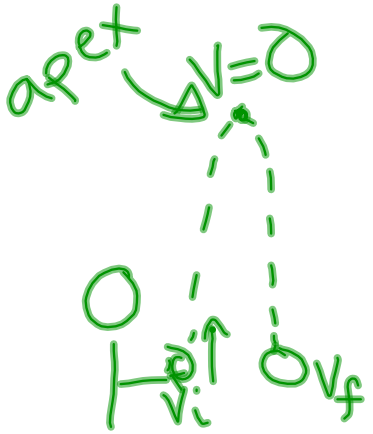
Free Fall

something falling

↳ Gravity is the only force

↳ Physicstopia has no air so we ignore air resistance

in free fall acceleration is always negative!



v_i is pos

v_f is neg

Constant Acceleration Equations

$$V_f = V_0 + at$$

$a = a$ $\quad a = x''$

$$V = at + V_0$$

$$X = \frac{1}{2}at^2 + V_0 t + X_0$$

$$X_f - X_0 = \frac{1}{2}at^2 + V_0 t$$

$$\Delta X = V_0 t + \frac{1}{2}at^2$$ ← no V_f

$$V_f = V_0 + at$$ ← no ΔX

Variables we care about:

Velocity: V_0, V_f

position/displacement: Δx

acceleration: a

time: t

Eq w/ no time

$$\Delta x = v_0 t + \frac{1}{2}at^2$$

$$v_f = v_0 + at$$

$$v_f - v_0 = at \qquad t = \frac{v_f - v_0}{a}$$

$$\Delta x = v_0\left(\frac{v_f - v_0}{a}\right) + \frac{1}{2}a\left(\frac{v_f - v_0}{a}\right)^2$$

$$\Delta x = (v_f - v_0)\left(\frac{v_0}{a} + \frac{1}{2}\frac{(v_f - v_0)}{a}\right)$$

$$\Delta x = (v_f - v_0)\left(\frac{1}{2}\frac{v_0}{a} + \frac{1}{2}\frac{v_f}{a}\right)2$$

$$2\Delta x = (v_f - v_0)\left(\frac{v_0}{a} + \frac{v_f}{a}\right)\cdot a$$

$$2a\Delta x = (v_f - v_0)(v_0 + v_f)$$

$$2a\Delta x = v_f^2 - v_0^2$$

$$\boxed{v_f^2 = v_0^2 + 2a\Delta x}$$

$$v_f = \pm\sqrt{v_0^2 + 2a\Delta x}$$

Equation w/ no acceleration

$$\Delta x = v_0 t + \frac{1}{2} a t^2$$

$$v_f = v_0 + at \longrightarrow a = \frac{v_f - v_0}{t}$$

$$v_f^2 = v_0^2 + 2a\Delta x$$

$$\Delta x = v_0 t + \frac{1}{2}\left(\frac{v_f - v_0}{t}\right) t^2$$

$$\Delta x = v_0 t + \frac{1}{2} v_f t - \frac{1}{2} v_0 t$$

$$\Delta x = \frac{1}{2} v_0 t + \frac{1}{2} v_f t$$

$$\boxed{\Delta x = \frac{t}{2}\left(v_0 + v_f\right)}$$

4 constant acceleration Equations

$$V_f = V_0 + at$$

$$\Delta x = V_0 t + \frac{1}{2} a t^2$$

$$V_f^2 = V_0^2 + 2a\Delta x$$

$$\Delta x = \frac{t}{2}(V_f + V_0)$$