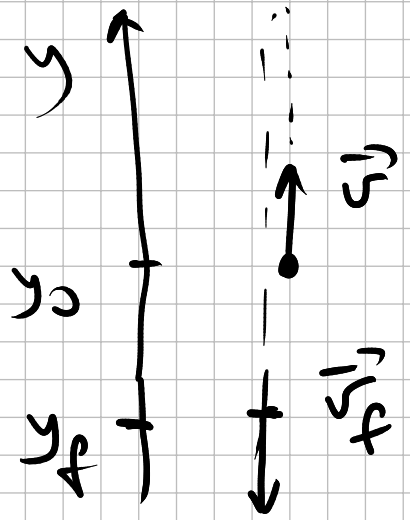
$$\vec{r}(t) = \vec{r}_0 + \vec{v}_0 \cdot t + \frac{\vec{a}t^2}{2} \; ; \; \vec{v}(t) = \vec{v}_0 + \vec{a}t$$

vertical components :

$$\begin{cases} y(t) = y_0 + v_{0y} t + \dfrac{a_y t^2}{2} \\ v_y(t) = v_{0y} + a_y t \end{cases}$$



$v_{0y}, v_{fy} \longleftrightarrow y_0, y_f$

$$v_{fy} = v_{0y} + a_y t_f$$

$$t_f = \frac{v_{fy} - v_{0y}}{a_y}$$

$$y(t) \Rightarrow y(t_f) = y_f = y_0 + v_{0y} t + a_y \frac{t^2}{2}$$

$$y_f = y_0 + v_{0y}\frac{v_{fy} - v_{0y}}{a_y} + \frac{a_y}{2}\left(\frac{(v_{fy} - v_{0y})}{a_y}\right)^2$$

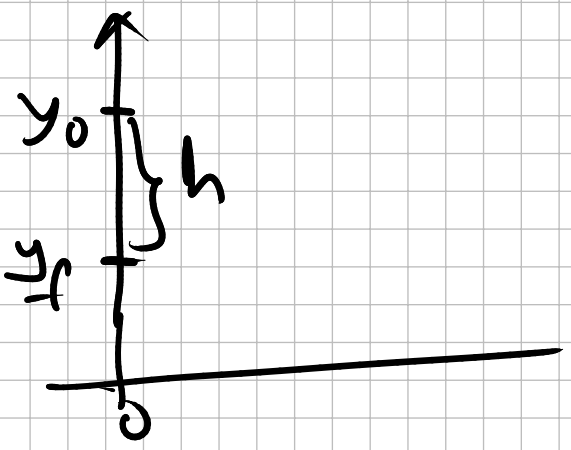
$$y_f - y_0 = \frac{v_{fy}^2 - v_{0y}^2}{2a_y}$$

if $y_f = y_0$

$|v_f| = |v_{0y}|$

$$y_f - y_0 = -h = \frac{v_{fy}^2 - v_{0y}^2}{-2g}$$

$$v_{fy}^2 = 2gh + v_{0y}^2$$



Forces and Newton's laws

1st Newton's law:

In inertial reference frame(s) if the total / net force is zero then an object will maintain its velocity.

2nd Newton's law:

$$m\vec{a} = \vec{F}_{\text{net}}$$

m is not weight!

m units [kg]

Force units [Newtons] = [N]

$$[N] = \left[kg \cdot \frac{m}{s^2} \right]$$

3rd Newton's law:

action equals reaction.

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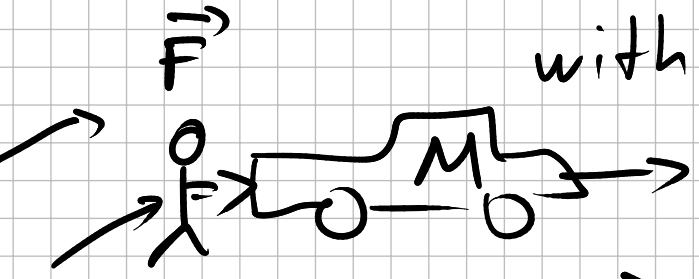
examples

$F = mg$

gravitational pull



with mass $M = 1000\,g$

$v = 25\ mi/h$

$= 11\ m/s$

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

$$\Rightarrow \quad v_f = 0 + \frac{mg}{M} \cdot t$$

$$t = \frac{v_f}{mg} M = \frac{11 \frac{m}{s} \cdot 1000 kg}{100 kg \cdot 10 m/s^2} = 11.0 s$$

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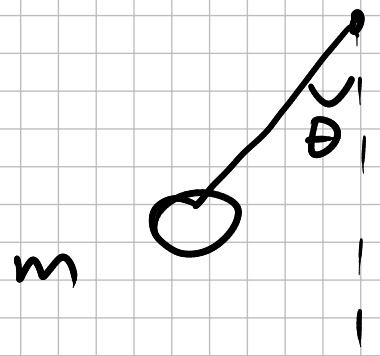
ex 2



Q: what is acceleration of the object