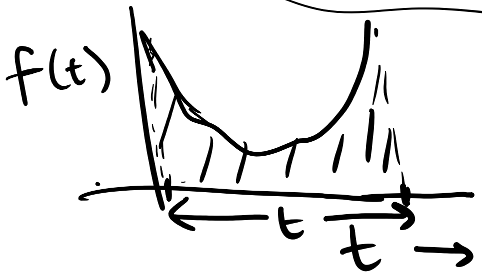
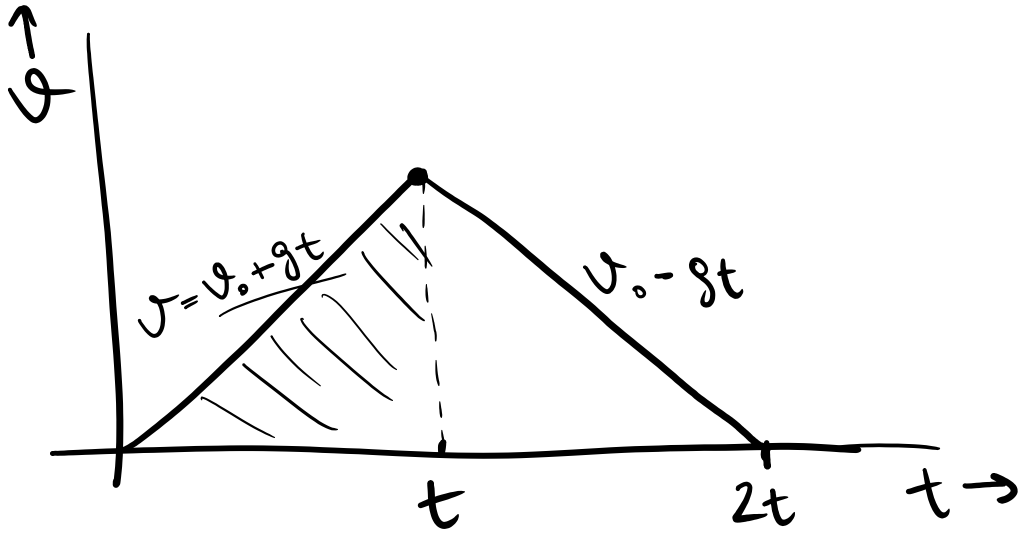
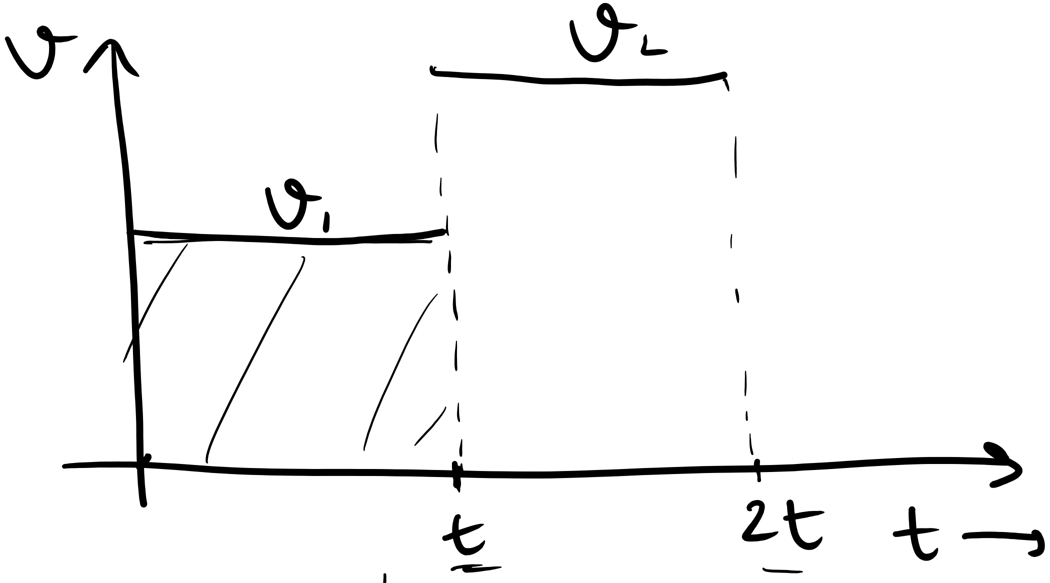
$$\text{Average Velocity} = \frac{\int v \cdot dt}{\int dt} = \frac{\int v\,dt}{t}$$

$$\text{Average} = \frac{\int f(t) \cdot dt}{\int dt} = \frac{\int f(t)\,dt}{t}$$



$$f(t) = t^2 + 2t + 5$$





$$\frac{\int_0^t (v_0 + gt)\cdot dt}{\int_0^t dt} + \frac{\int_t^{2t} (v_0 - gt)\cdot dt}{\int_t^{2t} dt}$$

$$v_{av} = \frac{\int v\,dt}{\int dt}$$

$$= \frac{\int \underline{v_1}\,dt + \int v_2\,dt}{t\Big]_0^{2t}}$$

$$= \frac{v_1 t\Big]_0^t + v_2 t\Big]_t^{2t}}{2t - 0}$$

$$= (v_1 + v_2)/2$$

$$v = 4t^3 - 2t$$

$$\frac{dv}{dt} = \underline{12t^2 - 2} = a = 12(2) - 2$$

$$= 22\ m/s^2$$

$$\int v\,dt = \int 4t^3\,dt - \int 2t\,dt$$

$$S\Big|_0^x = t^4 - t^2$$

$$2 = t^4 - t^2 = \underline{t^2(t^2-1) = 2}$$

let $t^2 = y$

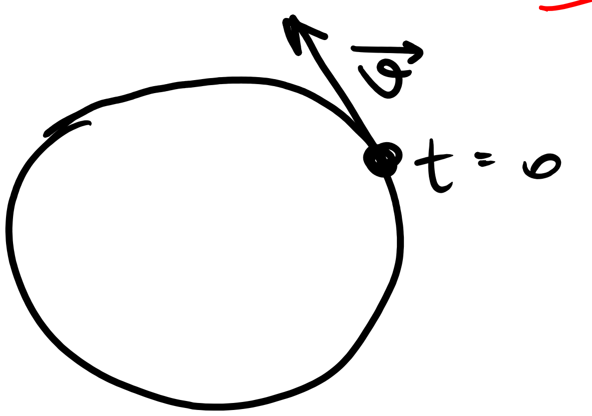
$$y(y-1) = 2$$

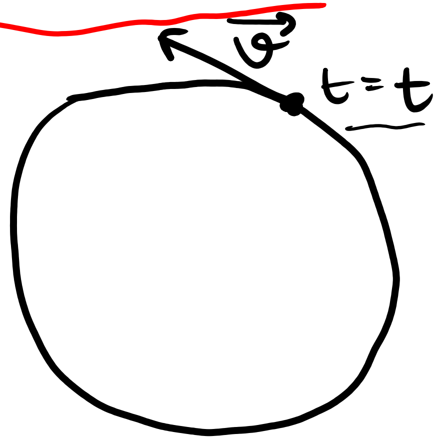
$$\underline{y = 2}$$

$$t^2 = 2$$

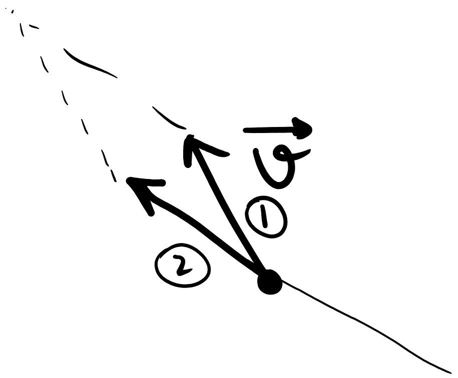
$$t = \sqrt{2}$$

Circular Motion

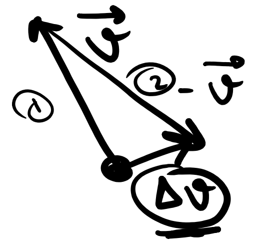




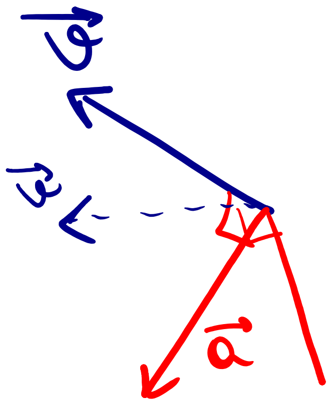
$|\vec{v}| =$ Same



$$\frac{dv}{dt} = a = \underbrace{v^2/r}\ (\perp)$$ Centripetal acceleration



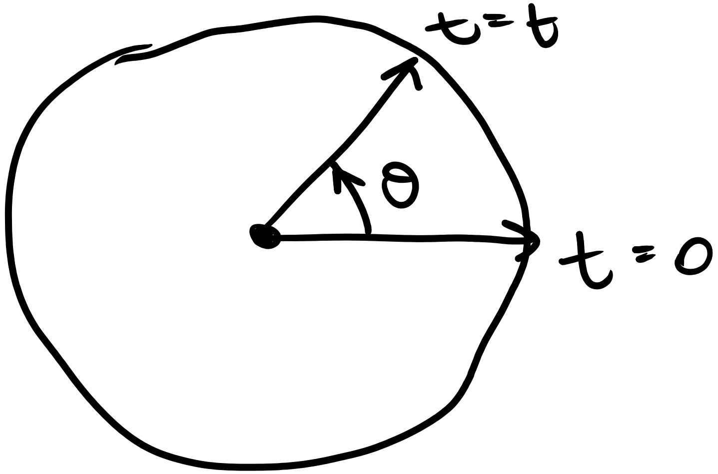
Changing direction



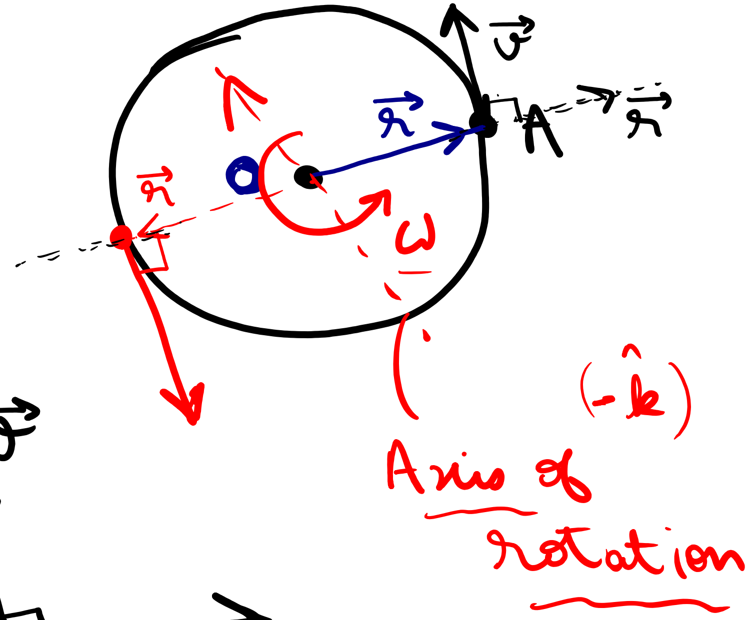
$$v = r\omega$$

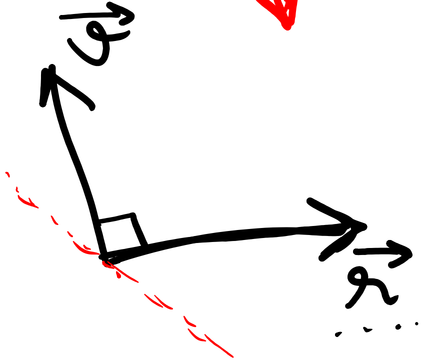
$$\boxed{\omega = v/r}$$

Angular velocity



$$\vec{v} = \vec{r} \times \vec{\omega}$$





Linear

s

v

a

$v^2 - u^2 = 2as$

Circular

θ

ω

α

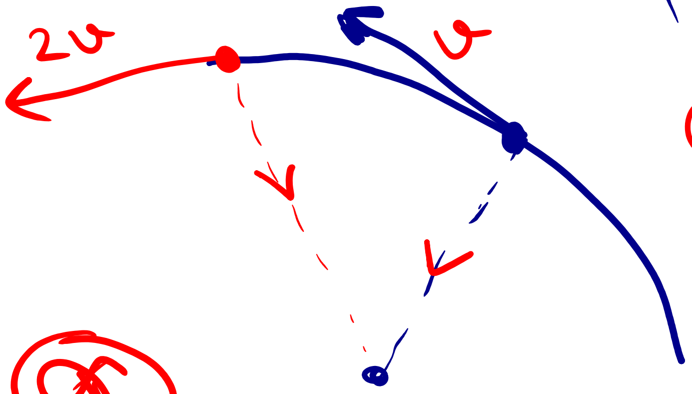
$$\boxed{\omega_f^2 - \omega_i^2 = 2\alpha\theta}$$

$$\boxed{l = r\theta}$$

$$\frac{dl}{dt} = r\frac{d\theta}{dt}$$

$$v = r\omega$$

$$a = r\alpha$$



$$a_c = v^2/r = \omega^2 r$$

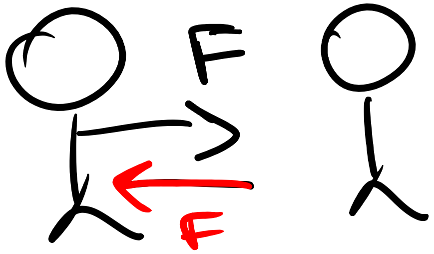
α $\perp$ to v

$$\boxed{\omega_f - \omega_i = \alpha t}$$

Newton's Laws

$$\sum \vec{F}_{ext} = m\vec{a}_{net}$$

III)

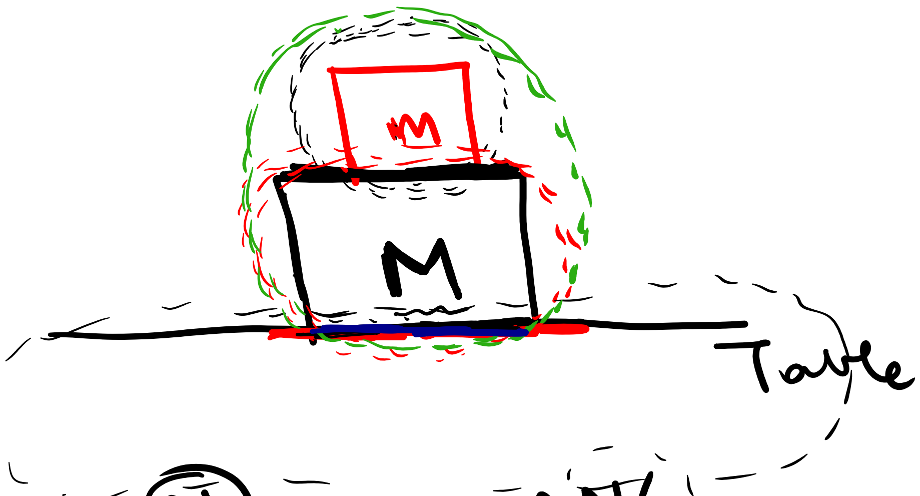


Action - reaction pairs always ACT ON DIFFERENT BODIES

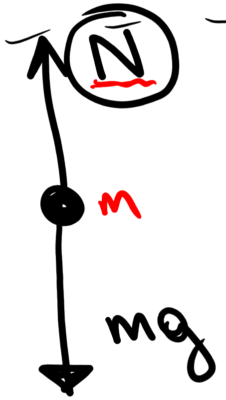
FBD

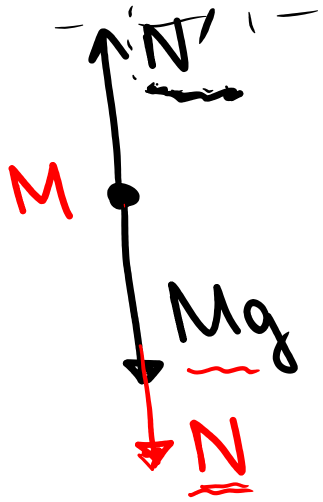
1) Define your frame of reference, Define your system

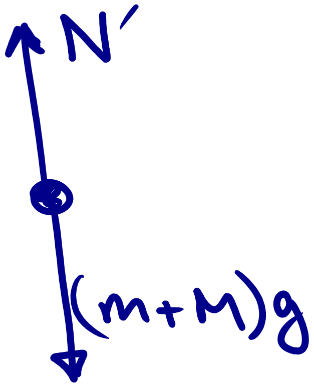
i) m
ii) M
iii) (m + M)



Earth







$$\sum F_{ext} = 0$$

$$N - mg = 0$$

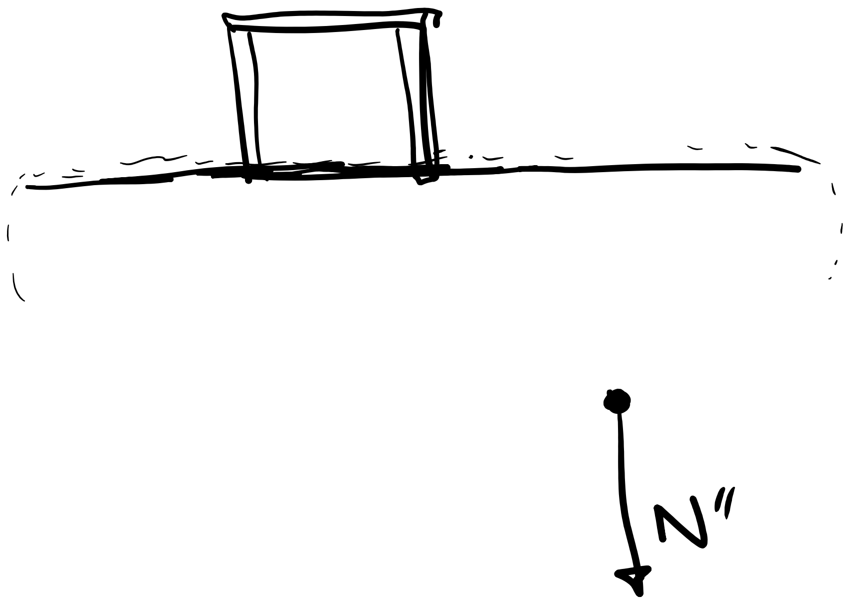
$$N = mg$$

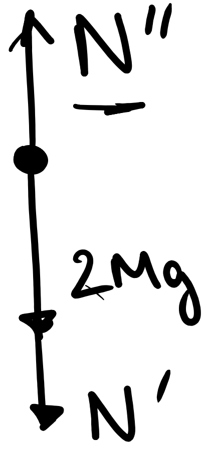
$$N + Mg - N' = 0$$

$$mg + Mg = N'$$

$$N' = (m+M)g$$

FBD of the Table





2M

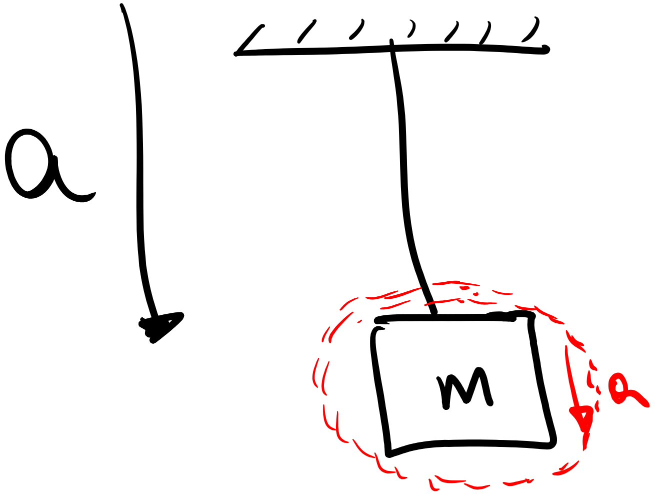
$$N'' = 2mg + N'$$
$$= 2mg + mg + Mg$$

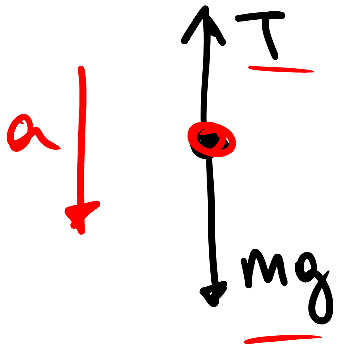
NORMAL $\perp$ to surface

PUSH FORCE

Tention force

PULLING FORCE



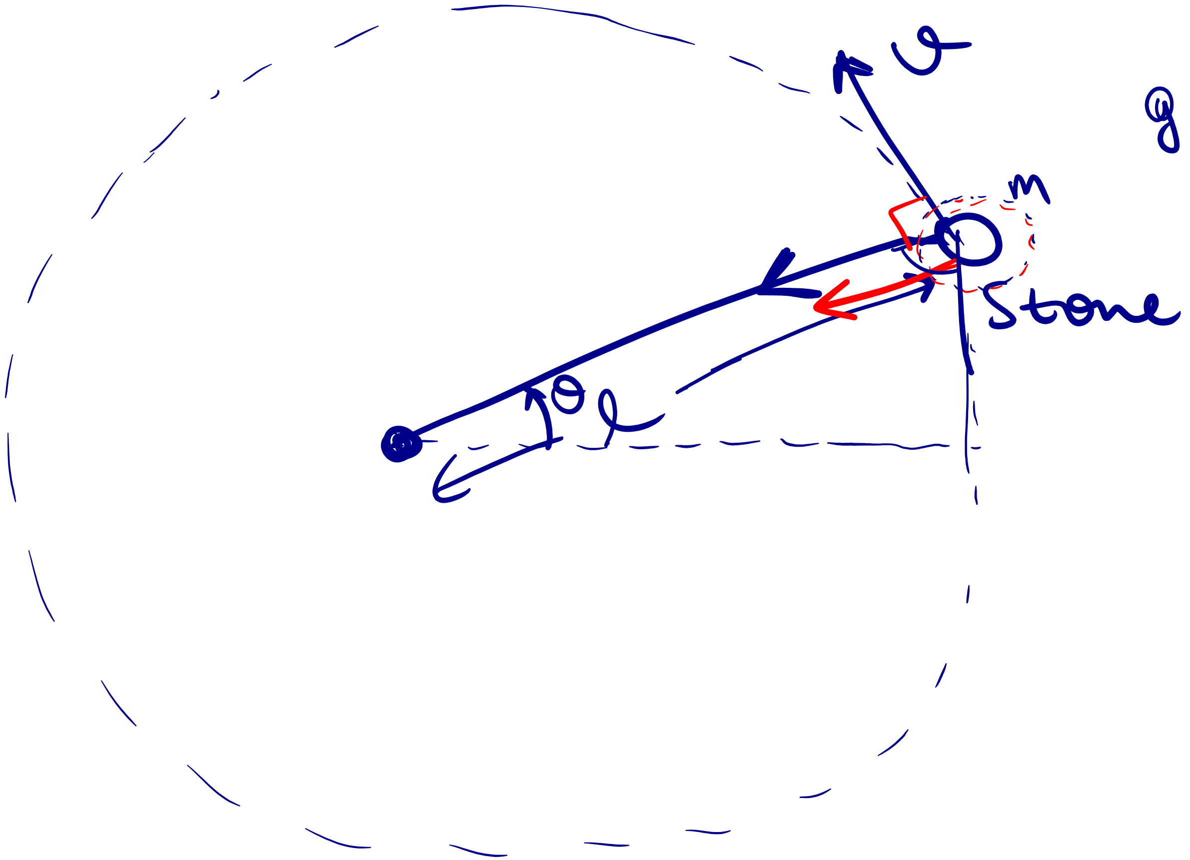


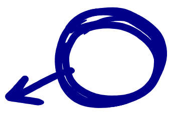
$$\sum F_{net} = m a_{net}$$

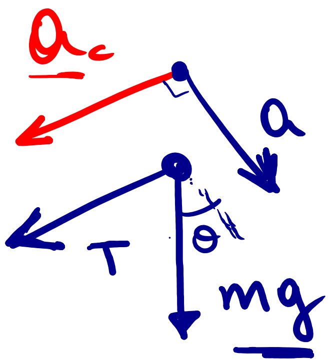
$$mg - T = ma$$

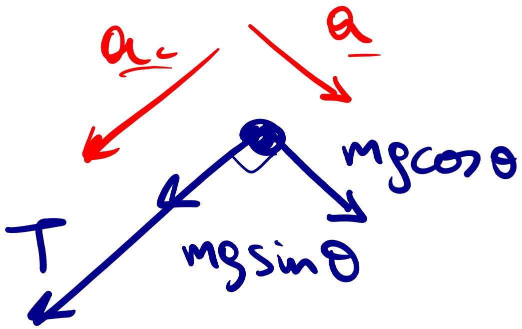
$a_c = \frac{v^2}{r}$

$g = 10$



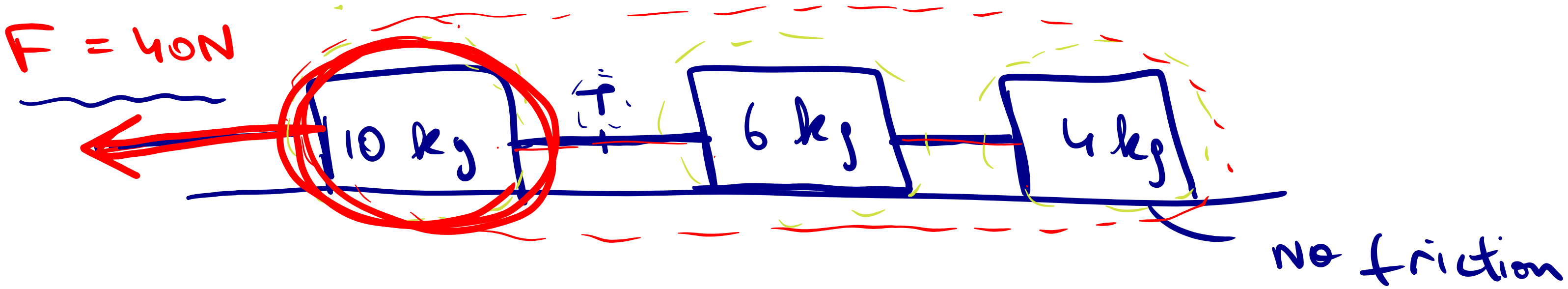


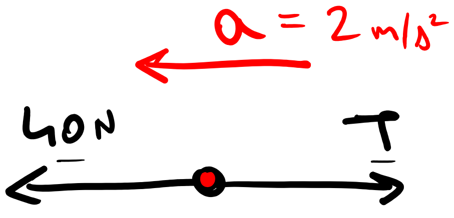


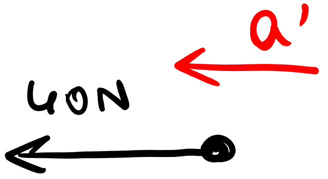


$T + mg\sin\theta = mv^2/r$

$mg\cos\theta = ma$





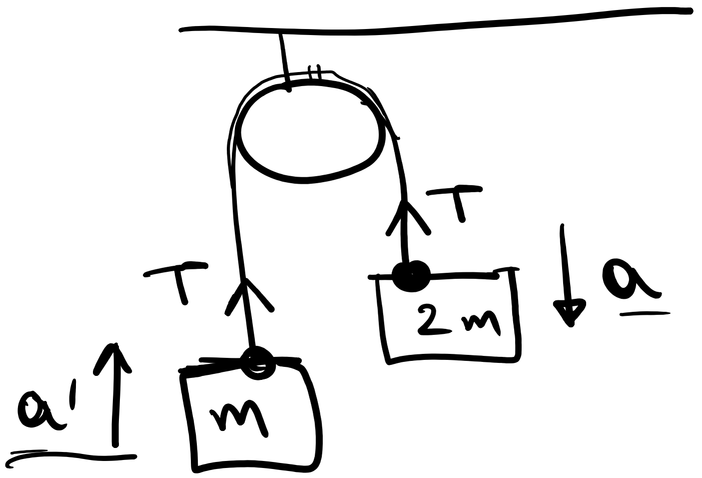


$$40 = (20)a'$$

$$a' = 2 \, m/s^2$$

$$40 - T = 20$$

$$\boxed{T = 20}$$



$$\vec{T}\cdot\vec{a}' + \vec{T}\cdot\vec{a} = 0$$

$$Ta' - Ta = 0$$

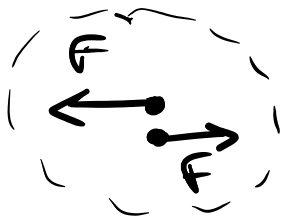
$$\boxed{a = a'}$$

$m = 0$

$$\Sigma F = 0$$

$$T = T$$

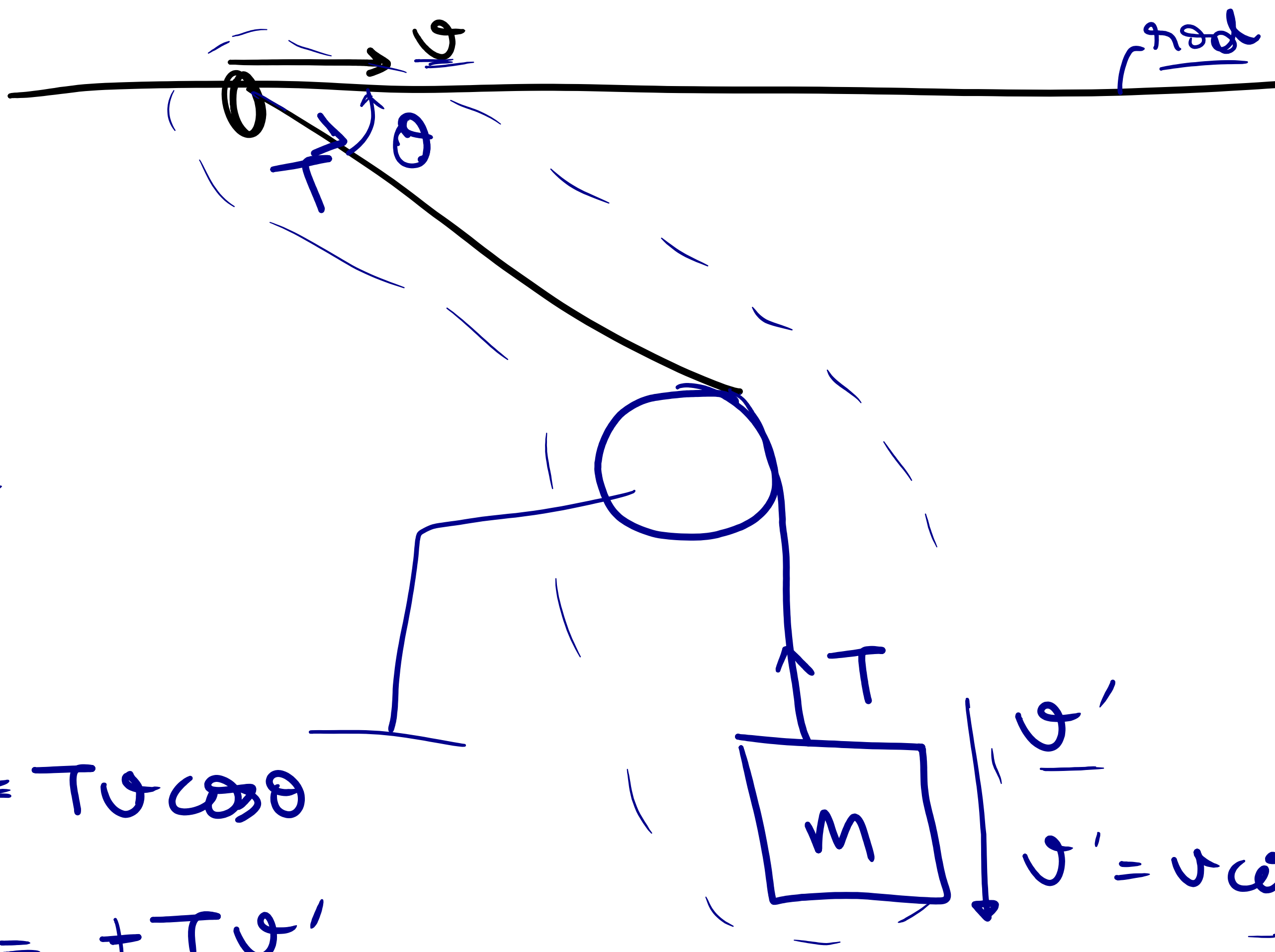
$$\underline{\Sigma T\cdot a} = \underline{0}$$ ✓



$$\frac{d\,\Sigma T\cdot x = 0}{}$$

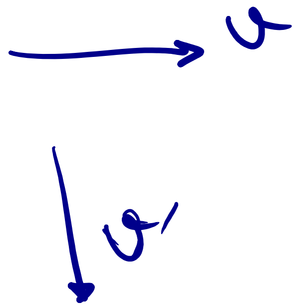
$$d\,T\cdot v = 0$$

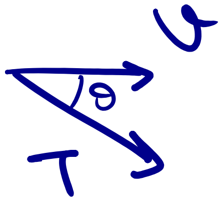
$$T\cdot a = 0$$



Relationship?

$\underline{v'}$ & $\underline{v}$





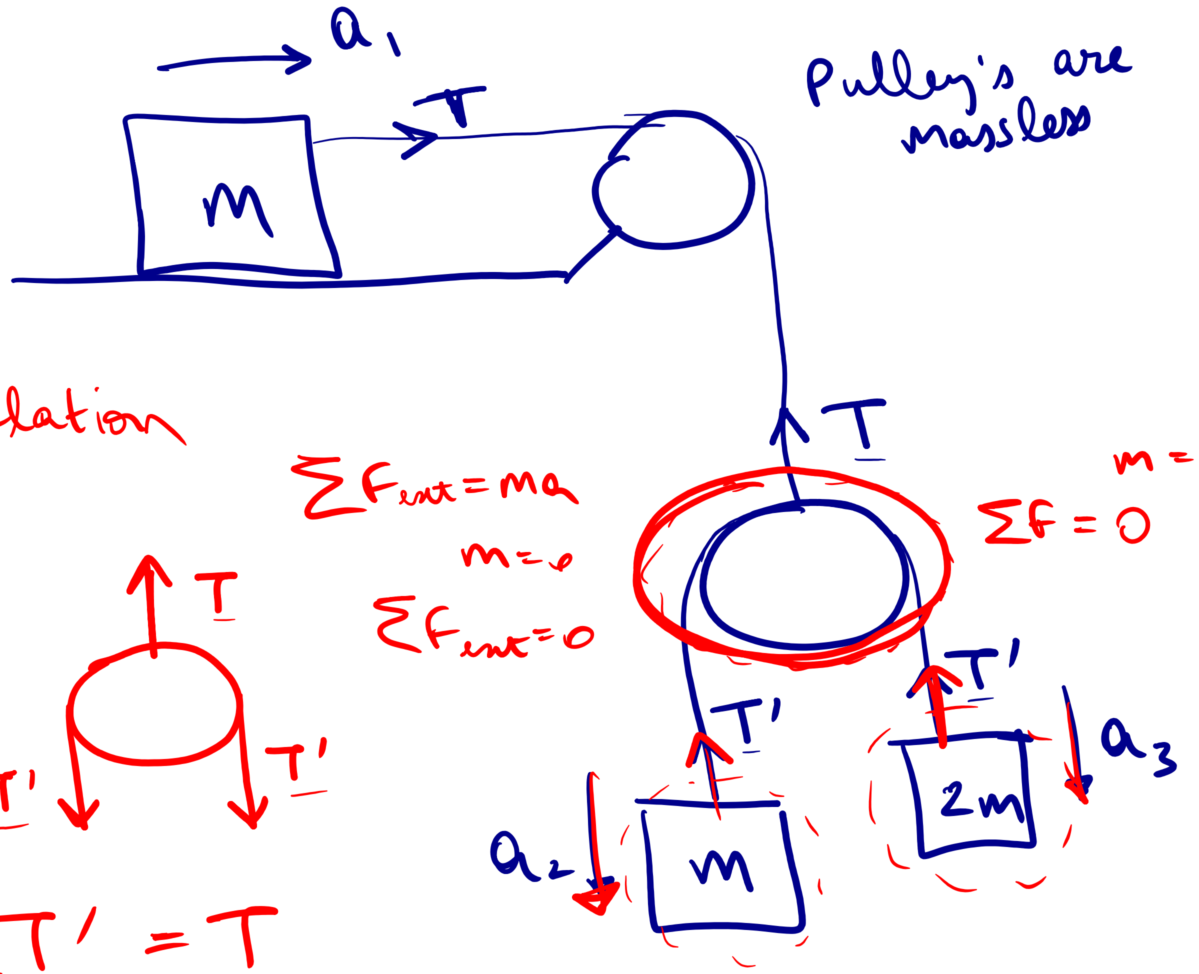
$v' = v\cos\theta$

$$\underline{T}\cdot\underline{v} = Tv\cos\theta$$

$$T\cdot v' = +Tv'$$

$$Tv\cos\theta + Tv' = 0$$

$$-v\cos\theta = v'$$



Pulley's are massless

$\sum F = 0$ $\quad m = 0$

$\sum F_{ext} = ma$

$m = 0$

$\sum F_{ext} = 0$

Relation

T
T'
T'

$2T' = T$

a_1, a_2, a_3

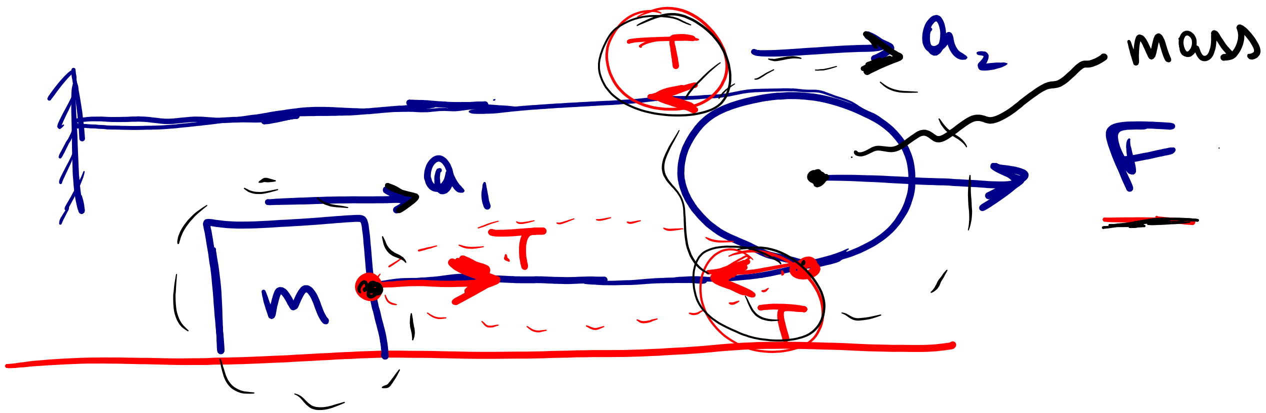
$$\sum \vec{T} \cdot \vec{a} = 0$$

$$T \cdot a_1 + T' \cdot a_2 + T' \cdot a_3 = 0$$

$$2T' a_1 + -T' a_2 - T' a_3 = 0$$

$$\boxed{2a_1 = a_2 + a_3}$$

$$2mg - T' = 2ma_3$$



$m = 0$

$\sum F = 0$

T T

IMPORTANT POINTS

i) Same string → Tention is the same

ii) Tention is always pulling

$\sum \underline{T} \cdot \vec{a} = 0$

$-2Ta_2 + Ta_1 = 0$

$\boxed{a_1 = 2a_2}$