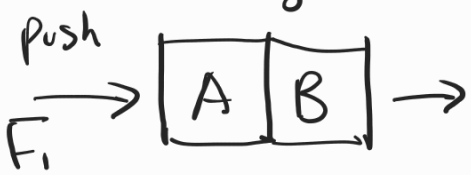
Physics 2.3 - More about Force

System of objects

We have more than one object, connected together

2 objects



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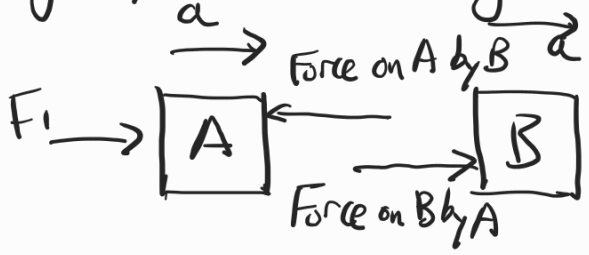
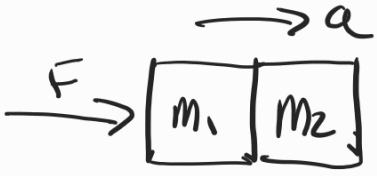
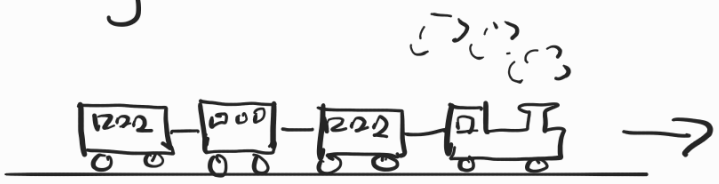


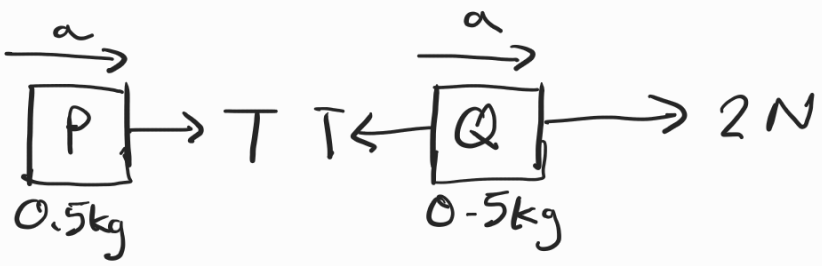


$\Rightarrow F_{net} = ma = (m_1 + m_2) \times a$

Pulling a chain of blocks



e.g.



$F_{net} = ma$

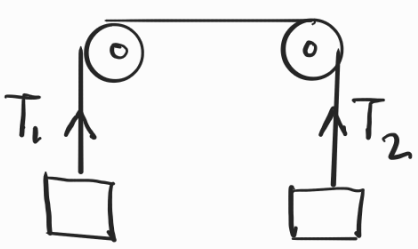
$T = 0.5a$ $\quad 2 - T = 0.5a$

$T + (2 - T) = 0.5a + 0.5a$

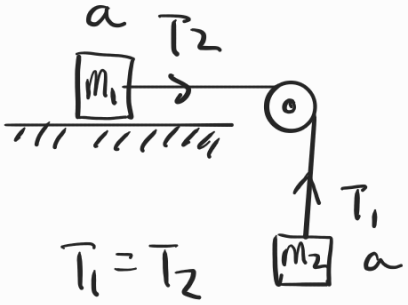
$a = 2 ms^{-2}$ //

Just **ADD** the 2 equations together

Pulley

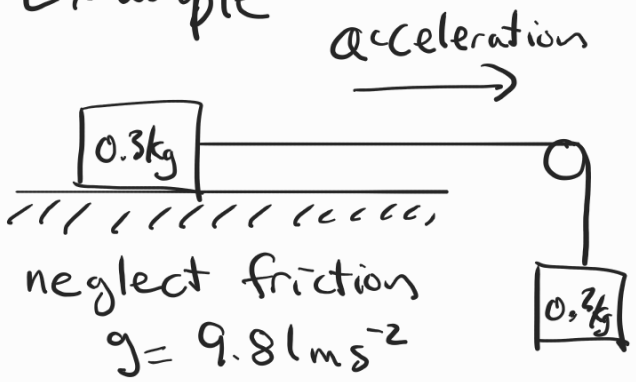


$T_1 = T_2$



$T_1 = T_2$

Example



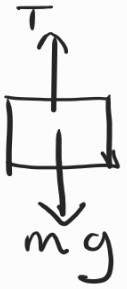
neglect friction

$g = 9.81 ms^{-2}$

Find a and T

Free Body Diagram

$T = 0.3a$



$(mg - T) = 0.2a$

Add the 2 equations :

$T + (mg - T) = 0.3a + 0.2a$

$0.2 \times 9.81 = 0.5a$

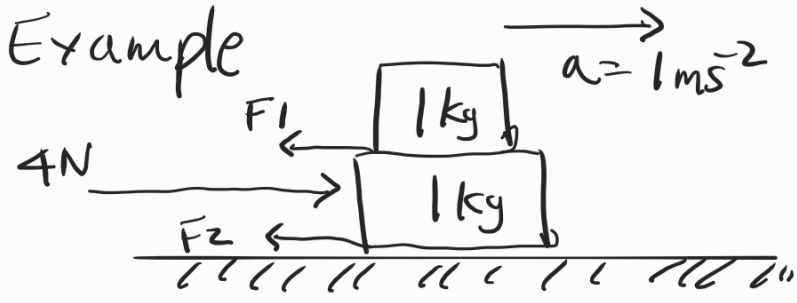
$a = 3.9 ms^{-2}$ //

$T = 0.3a = 3.9 \times 0.3 = 1.18N$ //

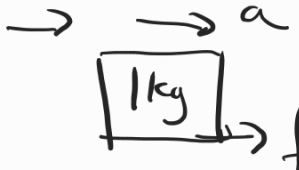
Stack of boxes

Hint : Treat the boxes as a system

Example



Find the friction $F_1 + F_2$



$f = ma$

$= 1 \times 1 = 1$ //

Alternatively

$F_{net} = ma$

$4 - f = (1+1)1$

$f = 2N$

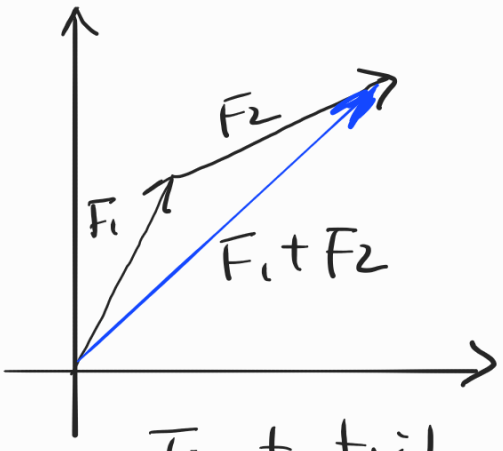
f' and f action and reaction

$4 - f' - f'' = 1 \times 1$

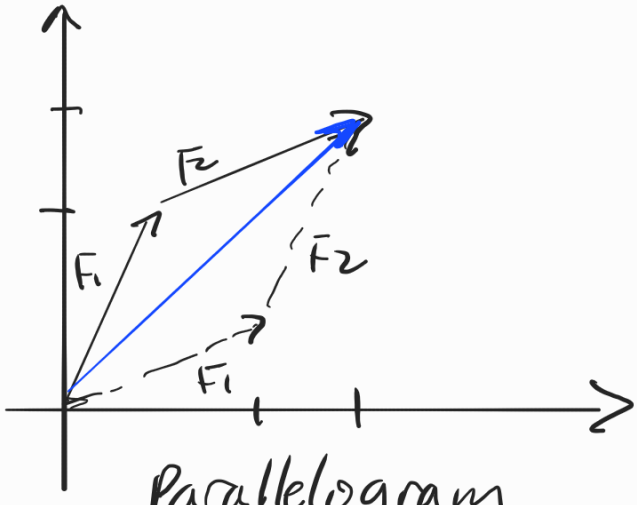
$4 - 1 - f'' = 1$

$f'' = 2N$

How to add force graphically



Tip to tail method

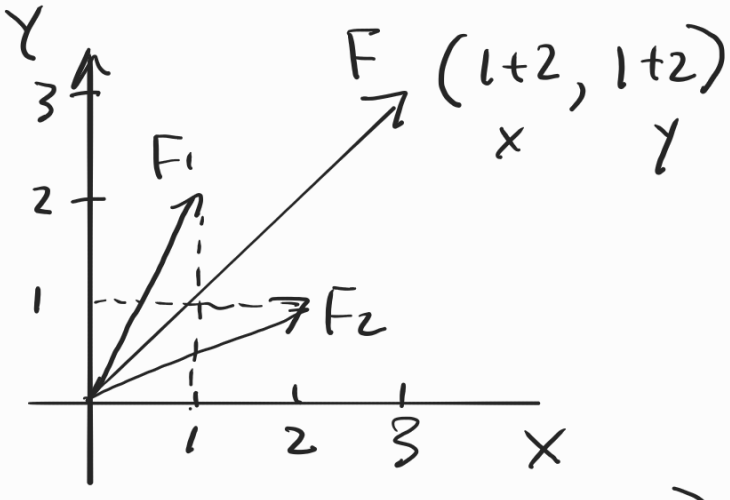


Parallelogram method

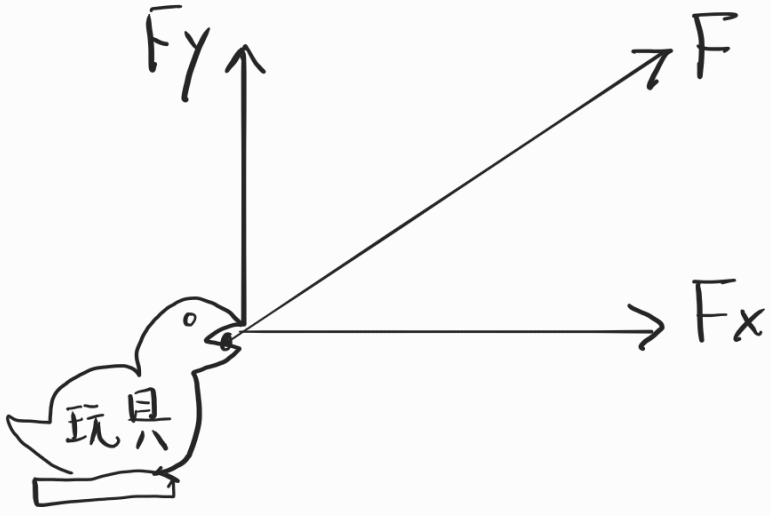
BestMethod

Resolve into x, and Y and process them individually

$$F_{xy} = \left[(F_{1x} + F_{2x}), (F_{1y} + F_{2y}) \right]$$



Resoluing Forces (Simplify 2D forces into X, Y 1D)



$$F_x = F\cos\theta$$

$$F_y = F\sin\theta$$

$$F = \sqrt{F_x^2 + F_y^2}$$

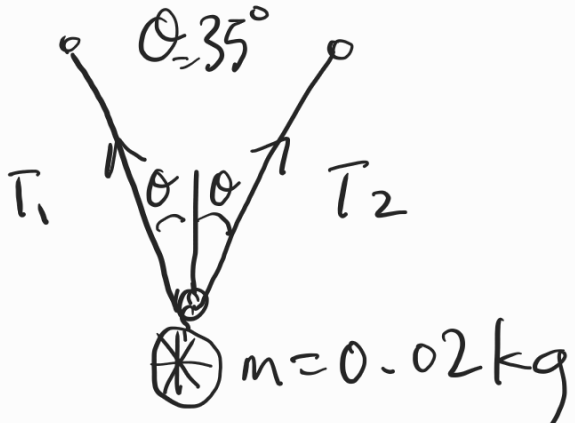
Objects at rest or in uniform motion

i.e. constant velocity

The F_{net} (in 2D) $= 0$

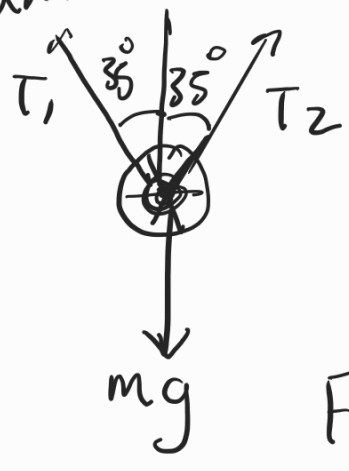
i.e. F_{net} in x direction $= 0$
F_{net} in y direction $= 0$
} $F_{net\ x,y} = 0$

Example 吊金束



Find T_1, T_2

Free body diagram



Since it is at rest

$F_{net\ x,y} = 0$

$F_{net\ x}$ $T_1 \sin 35^\circ = T_2 \sin 35^\circ$

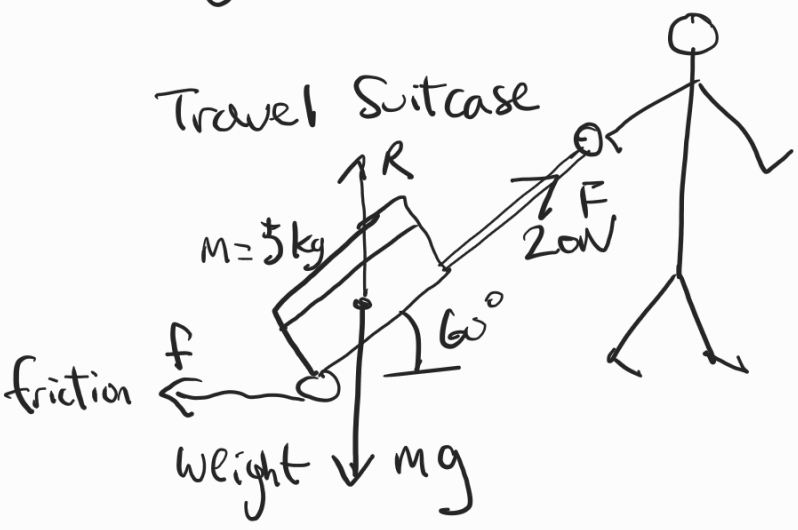
$T_1 = T_2 = T$

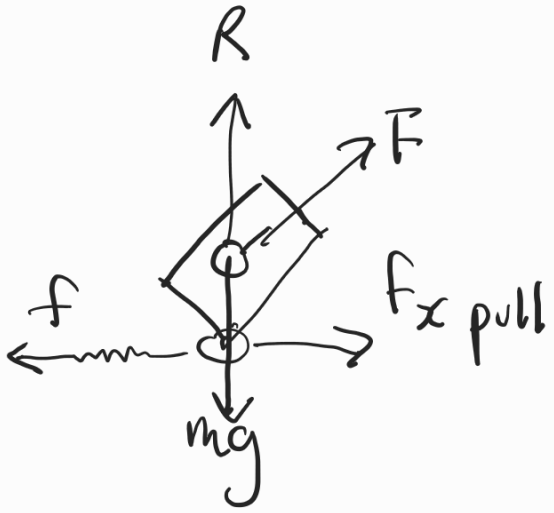
$F_{net\ y}$ $T \cos 35^\circ + T \cos 35^\circ = mg$

$2T \cos 35^\circ = 0.02 \times 9.81$

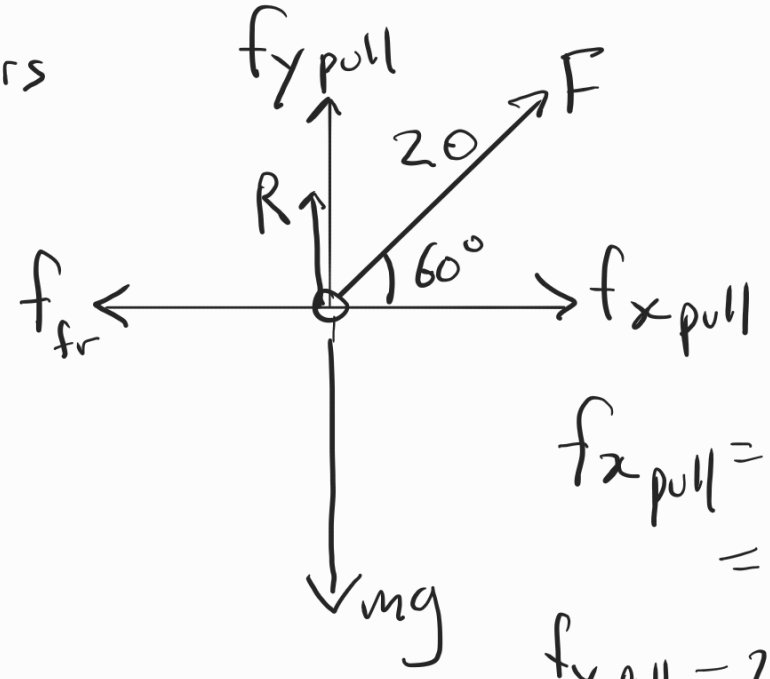
$T = 0.12\ N$ // $= T_1 = T_2$

Angle of inclination





Adding the vectors



$R = mg$

$f_{x\,pull} = 20\cos 60^\circ$

$= 10\ N$

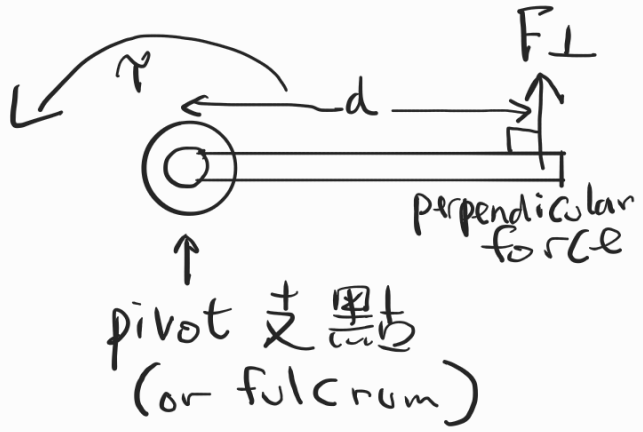
$f_{y\,pull} = 20\sin 60^\circ$

$R + f_{y\,pull} = mg \quad R + 20\sin 60^\circ = 5 \times 9.81$

$R = 31.7\ N \quad f_{fr} = f_{x\,pull} = 10\ N$

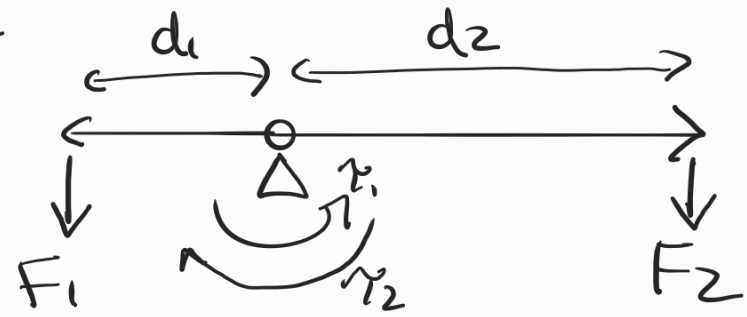
Turning Moment (τ)

(轉動) (力矩)



equation $\tau = F_\perp \times d$

Example



γ_1: anti clockwise moment

γ_2: clockwise moment

The structured will be balanced if $\gamma_1 = \gamma_2$

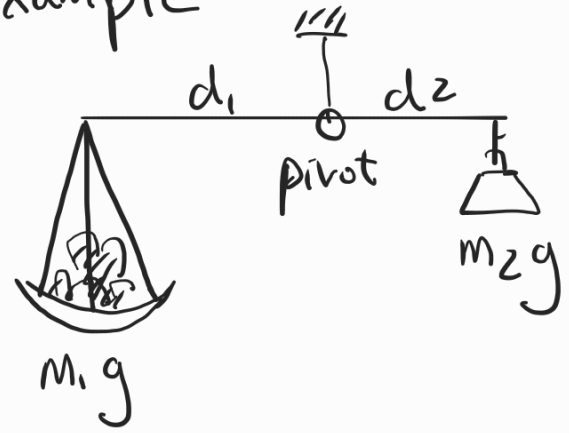
and $F_1 d_1 = F_2 d_2$

i.e. if $d_1 = 1\,m$ and $d_2 = 2m$ $\quad F_1 = \frac{1}{2} F_2$

For objects that does not rotate :

sum of CW moments (clockwise) = sum of CCW moments (counter clockwise)

Example

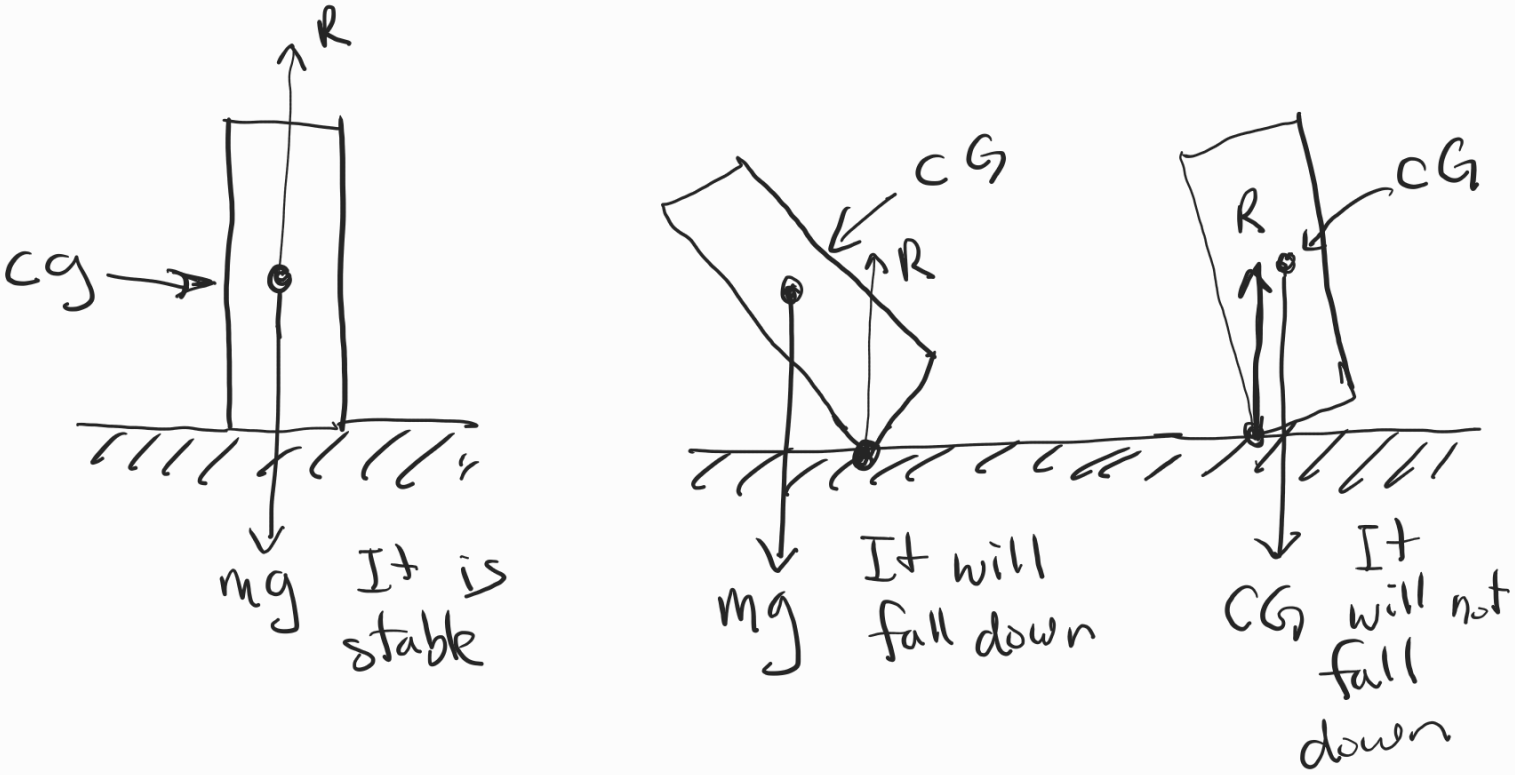


$m_1 g \times d_1 = m_2 g \times d_2$

$m_1 d_1 = m_2 d_2$

Centre of gravity (CG) 重心

The CG of a body is the point at which its <u>entire weight</u> may be considered to act



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