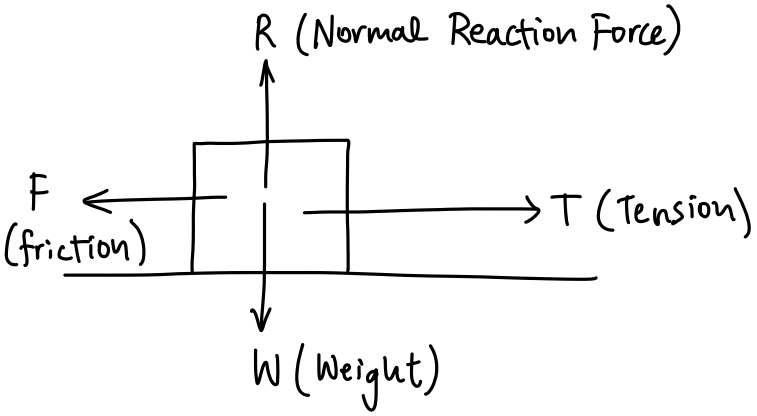
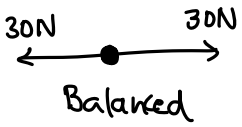
Force Diagrams

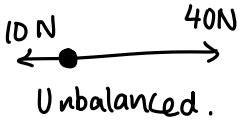


Newton's Laws

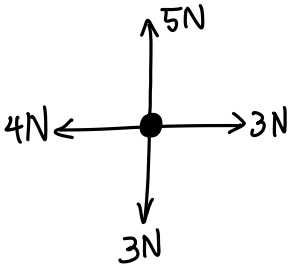
N1L: An object at rest will stay at rest and an object moving at a constant velocity will stay at that velocity unless there is an unbalanced force acting on the object.



Balanced



Unbalanced.



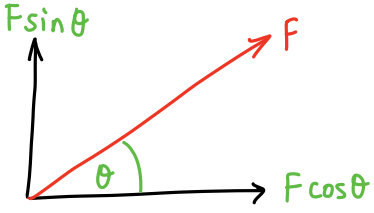
$R(\uparrow) = 5 - 3 = 2N$

$R(\rightarrow) = 3 - 4 = -1N$

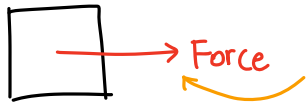
} Resultant force in up/right directions.

Since forces are vectors, we can write forces like this : $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$

Resolving Components



velocity ← 1 arrow outside of object



acceleration ← 2 arrows outside of object

Ex 10B

1. a) $-i+3j+4i-j=(3i+2j)N$

d) $\begin{pmatrix}-1\\4\end{pmatrix}+\begin{pmatrix}6\\0\end{pmatrix}+\begin{pmatrix}-2\\-7\end{pmatrix}=\begin{pmatrix}3\\-3\end{pmatrix}N$

2. a) $\begin{pmatrix}2\\7\end{pmatrix}+\begin{pmatrix}-3\\1\end{pmatrix}+\begin{pmatrix}x\\y\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}$

$\begin{pmatrix}x\\y\end{pmatrix}=\begin{pmatrix}1\\-8\end{pmatrix}$

b) $\begin{pmatrix}3\\-4\end{pmatrix}+\begin{pmatrix}2\\3\end{pmatrix}+\begin{pmatrix}x\\y\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}$

$\begin{pmatrix}x\\y\end{pmatrix}=\begin{pmatrix}-5\\1\end{pmatrix}$

6. $\begin{pmatrix}a\\-b\end{pmatrix}+\begin{pmatrix}b\\a\end{pmatrix}+\begin{pmatrix}-4\\-2\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}$

$a+b=4$ — ①

$a-b=2$ — ②

① + ②: $2a=6 \rightarrow a=3$

$b=1$

8. a) $\begin{pmatrix}-3\\7\end{pmatrix}+\begin{pmatrix}1\\-1\end{pmatrix}+\begin{pmatrix}p\\q\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}$

$\begin{pmatrix}p\\q\end{pmatrix}=\begin{pmatrix}2\\-6\end{pmatrix} \rightarrow p=2,\ q=-6$

b) $R=\begin{pmatrix}-3\\7\end{pmatrix}+\begin{pmatrix}1\\-1\end{pmatrix}=\begin{pmatrix}-2\\6\end{pmatrix}N$

$|R|=\sqrt{2^2+6^2}=2\sqrt{10}\ N$

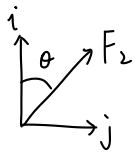
c)

$\tan\phi=\frac{6}{2}$

$\phi=\tan^{-1}(3)=72°$

$\therefore \theta=180°-\phi=108°$

9. a)



$\tan\theta=\frac{2}{1}$

$\theta=\tan^{-1}2=63.4°$

b) $F_1+F_2=\begin{pmatrix}3\\-2\end{pmatrix}+\begin{pmatrix}a\\2a\end{pmatrix}=\begin{pmatrix}a+3\\2a-2\end{pmatrix}=R \parallel \begin{pmatrix}13\\10\end{pmatrix}$

$\lambda\begin{pmatrix}a+3\\2a-2\end{pmatrix}=\begin{pmatrix}13\\10\end{pmatrix}$

$\lambda a+3\lambda=13$ — ①

$2\lambda a-2\lambda=10$ — ②

① ×2: $2\lambda a+6\lambda=26$ — ①′

①′ − ②: $8\lambda=16$

$\lambda=2$

①: $2a+6=13$

$a=7/2$

Ex 10C

1. $F = ma$

$a = F/m = 120/400 = 0.3\ ms^{-2}$

2. $W = mg = 4 \times 9.8 = 39.2\ N$

3. $F = ma$

$m = F/a = 30/1.2 = 25\ kg$

4. $W = mg$ (earth)

$m = W/g = 735/9.8 = 75\ kg$

$W = mg$ (moon)

$g = W/m = 120/75 = 1.5\ ms^{-2}$

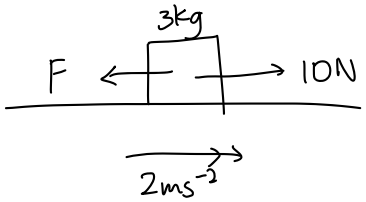
7. a) $F_{net} = 2g - 8 = ma = 2a$

$a = (g - 4)\ ms^{-2}$

b) $F_{net} = 100 - 8g = ma = 8a$

$a = (12.5 - g)\ ms^{-2}$

8.

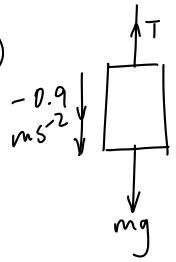


$F_{net} = ma = 3 \times 2 = 6\ N$

$F = F_{net} - 10N = -4N$

9. a) $v^2 = u^2 + 2as$ $\quad a = \frac{v^2 - u^2}{2s} = \frac{3^2 - 0}{2 \times 5} = 0.9\ ms^{-2}$

b)

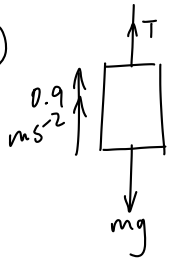


$mg = (500 + 300)(9.8) = -7840N$

$F_{net} = ma = (500 + 300)(-0.9) = -720\ N$

$T = F_{net} - mg = -720 + 7840 = 7120\ N$ upwards

c)



$F_{net} = ma = (500 + 300)(0.9) = 720N$

$T = F_{net} - mg = 720 + 7840 = 8560N$ upwards

Movement in 2 Dimensions

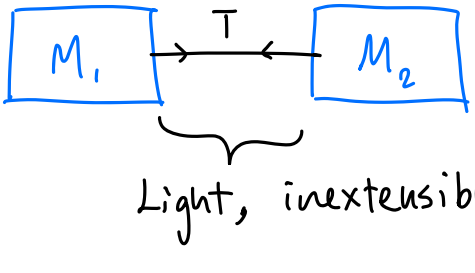
$F = ma$

There really is nothing much to talk about here.

Vector = scalar × vector

$$\begin{pmatrix} F_x \\ F_y \end{pmatrix} = m \times \begin{pmatrix} a_x \\ a_y \end{pmatrix}$$

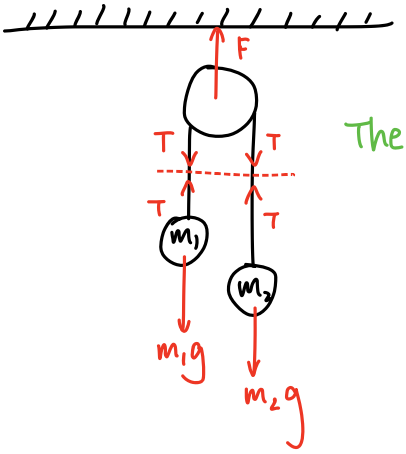
Connected Particles



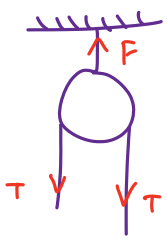
Light, inextensible string

T acts on both M_1 and M_2, in opposite directions

Pulleys



The tension throughout the string is constant.



If at rest,

$F = 2T$