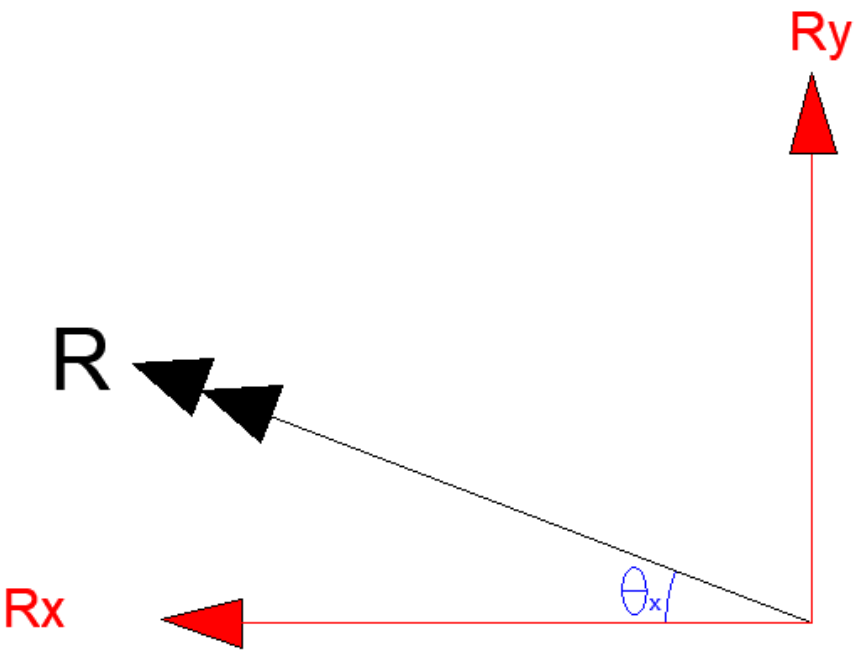
المحصلـــــة The resultant

$Rx = \Sigma Fx$ مجموع المركبات بالاتجاه الافقي

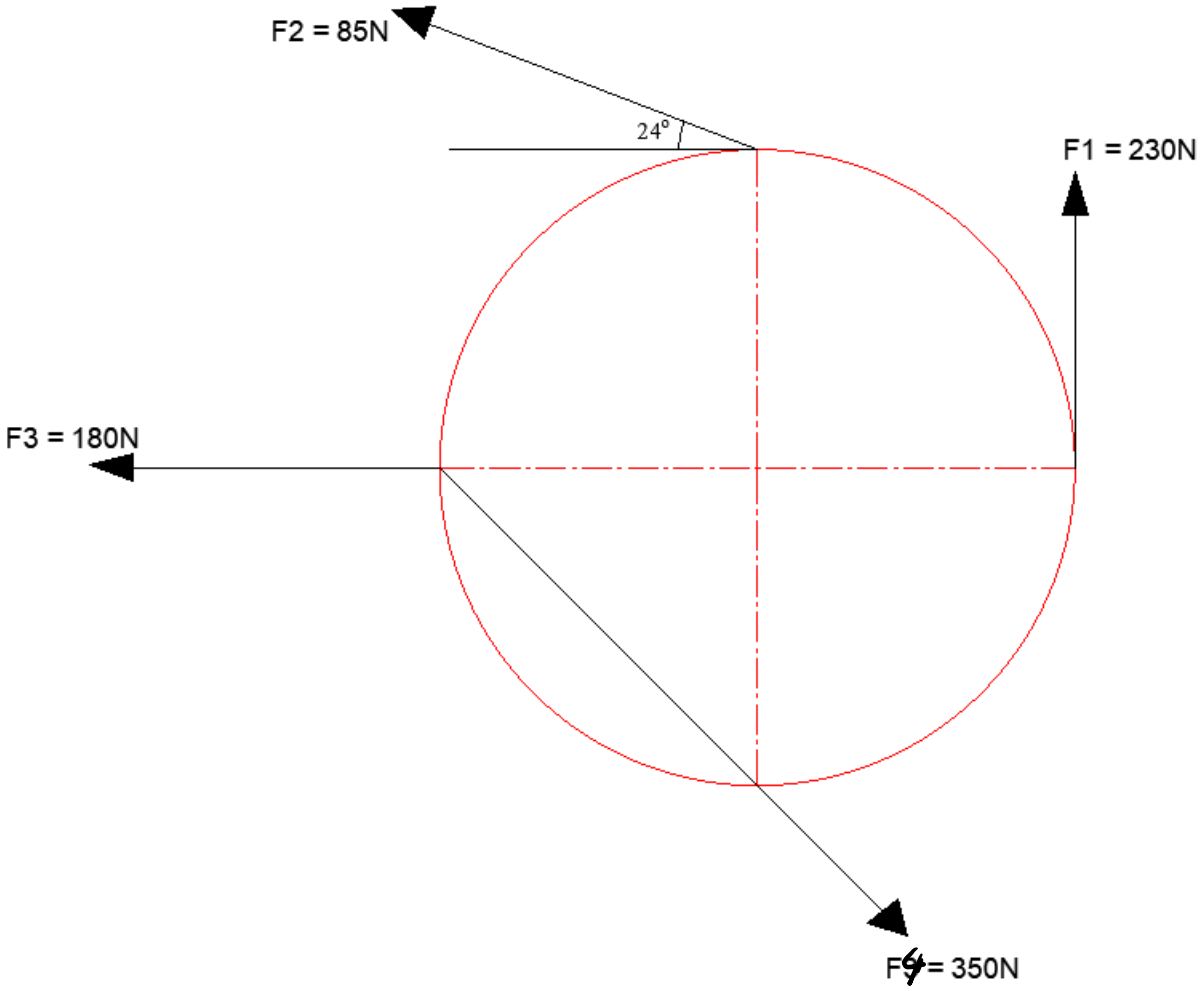
$Ry = \Sigma Fy$ مجموع المركبات بالاتجاه العمودي

$$R = \sqrt{Rx^2 + Ry^2}$$

$$\theta_x = tan^{-1} \frac{Ry}{Rx}$$



Example: Determine the resultant of the forces shown in the figure below?



Solution:

- عند ايجاد محصلة القوى ، يجب اولاً تحليل جميع القوى المائلة الى مركباتها الافقية والعمودية .
- اذا كانت هنالك قوى افقية او عمودية ، فلا نحتاج الى تحليلها .
- مراعاة الاشارة الموجبة او السالبة وحسب الاتجاه .

For F1:

$$Fx = 0$$

$$Fy = +230N$$

For F2:

$$Fx = 85 \cdot \cos 24 = -77.65$$

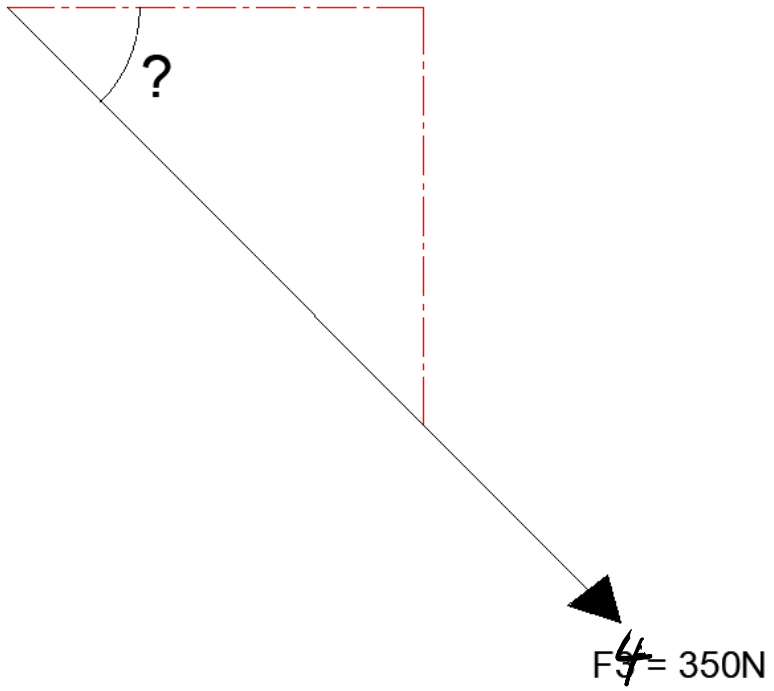
$$Fy = 85 \cdot \sin 24 = +34.57N$$

For F3:

$$Fx = -180N$$

$$Fy = 0$$

For F4:



في المثلث متساوي الساقين ، الزاوية تكون 45

$$Fx = 350 \cdot \cos 45 = +247.49N$$

$$Fy = 85 \cdot \sin 45 = -247.49N \text{ ER4}$$

$$Rx = \Sigma Fx$$

$$= 0 + (-77.65) + (-180) + 247.49$$

$$= -10.16N \quad \text{or} \quad 10.16N \leftarrow$$

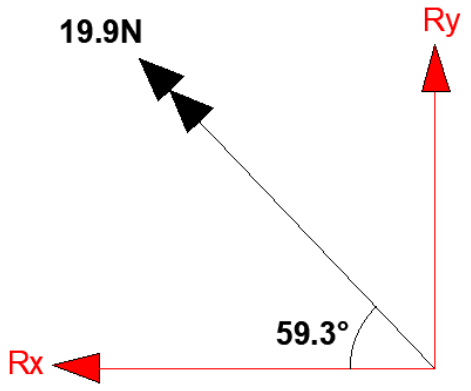
$$Ry = \Sigma Fy$$

$$= 230 + 34.57 + 0 + (-247.49)$$

$$= 17.1N \quad \text{or} \quad 17.1 \uparrow$$

$$R = \sqrt{(-10.16)^2 + (17.1)^2}$$

$$= 19.9\text{N}$$

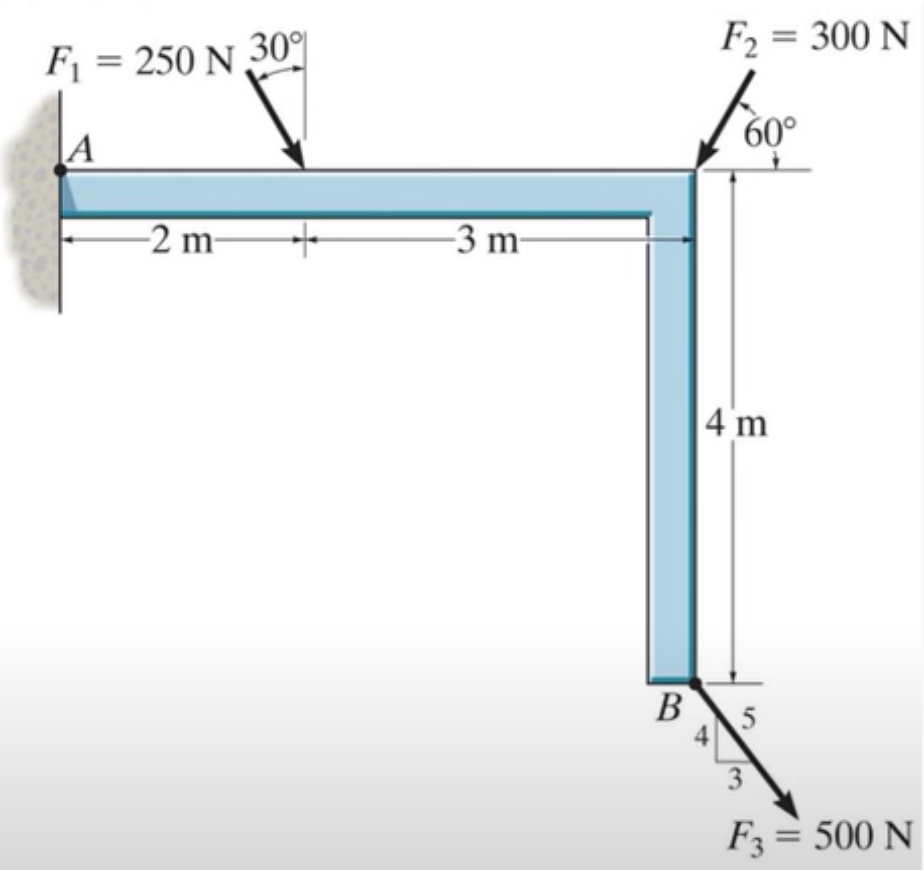


$$\theta_x = tan^{-1} \frac{Ry}{Rx}$$

$$\theta_x = tan^{-1} \frac{17.1}{10.16}$$

$$\theta_x = 59.3^{\circ}$$

Example: Determine the resultant of the forces shown in the figure below?



Solution:

From the last lecture:

$$Fx1 = 250 \,.\sin 30 = +125N$$

$$Fy1 = 250 \,.\cos 30 = -216.5N$$

$$Fx2 = 250 \,.\cos 60 = -125N$$

$$Fy2 = 250 \,.\sin 60 = -216.5N$$

$$Fx3 = 500 \times \frac{3}{5} = +300N$$

$$Fy3 = 500 \times \frac{4}{5} = -400N$$

$$Rx = \Sigma Fx$$

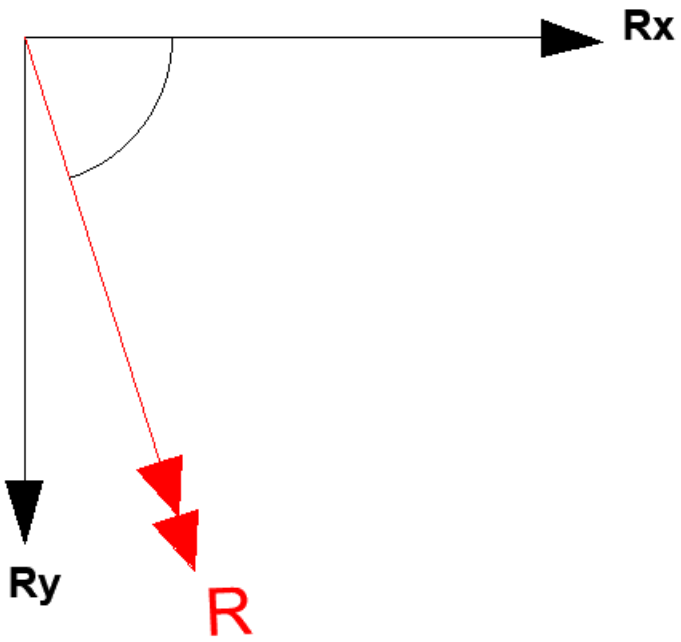
$$= 125 - 125 + 300$$

$$= 300\text{N} \longrightarrow$$

$$Ry = \Sigma Fy$$

$$= -216.5 - 216.5 - 400$$

$$= -833N \downarrow$$



$$R = \sqrt{Rx^2 + Ry^2}$$

$$= \sqrt{(300)^2 + (833)^2}$$

$$R = 885.4N$$

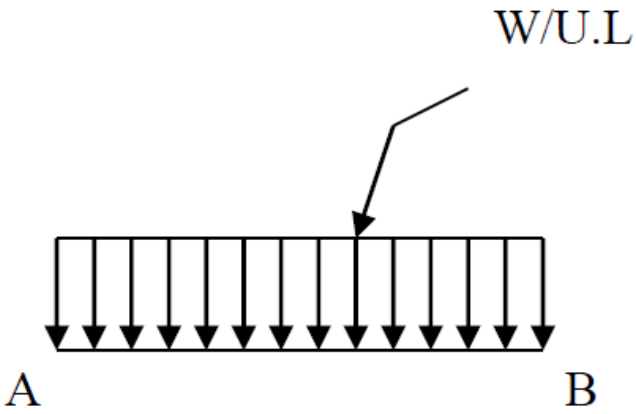
$$\theta_x = \tan^{-1}\frac{Ry}{Rx}$$

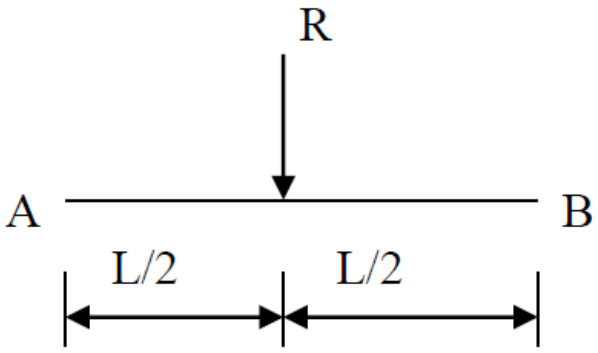
$$= \tan^{-1}\frac{833}{300}$$

$$\theta_x = 70.2^{\circ}$$

Distributed Loads:

1: Uniformly Distributed Loads or rectangular loads U. D. L





$$R = \frac{W}{UL} \times L$$

where:

R: Resultant of the total weight of construction.

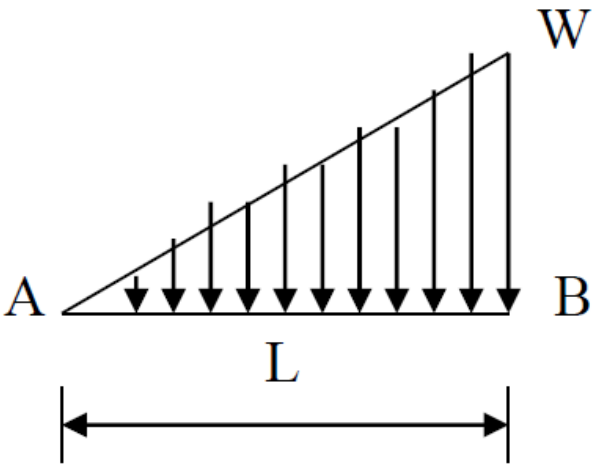
$\frac{W}{UL}$: Weight for unit length.

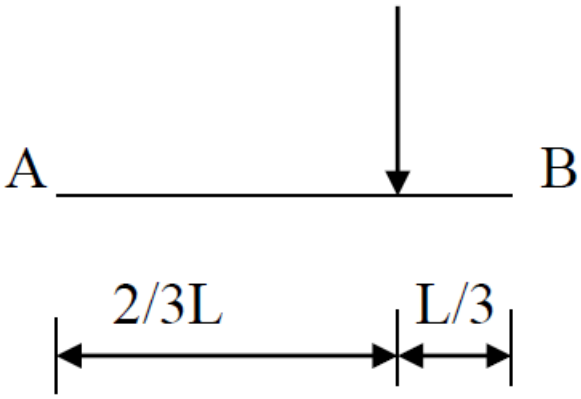
L: Length of the construction.

NOTE: *The location of* **(R)** *is* ***in the middle***

i.e. L/2 from A and B

2: Varying Loads or triangular loads





$$\boldsymbol{R = \frac{1}{2} \times W \times L}$$

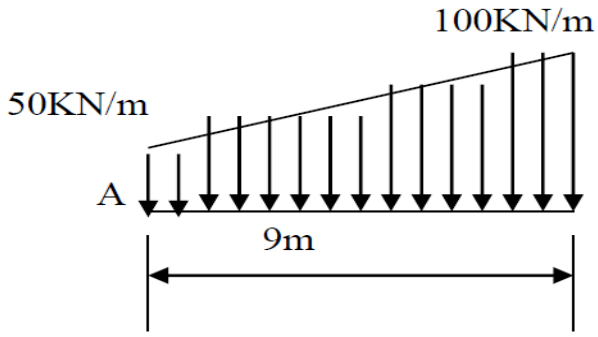
NOTE: *The location of* **(R)** *is:*

L /3 from point B

and

2L /3 from point A

Example: Determine the resultant of the distributed loads shown in figure below and indicate its location from point (A).



Solution:

$$R_1 = 50 \times 9 = 450\text{N}$$

$$R_2 = \frac{1}{2} \times 50 \times 9 = 225\text{N}$$

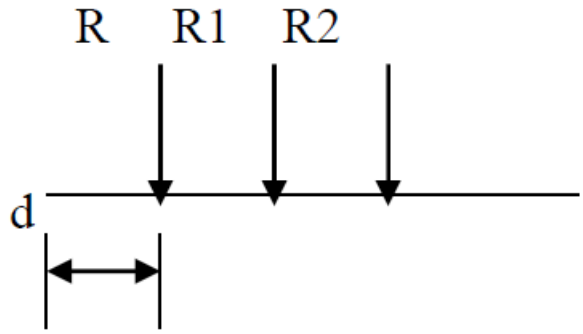
$$\mathbf{R} = R_1 + R_2 = 675\text{N}$$

$$\mathbf{R \times d = M@A}$$

$$675 \times \text{d} = -450 \times 4.5 - 225 \times 6$$

$$675 \times \text{d} = -3375$$

$$\therefore \text{d} = \frac{3375}{675} = 5\text{m}$$



Moments (العزوم)

العزم : وهو قيمة متجهة لقياس مدى قدرة قوة على تدوير المجسّم حول محور ما .

العزم = القوة × ذراعها

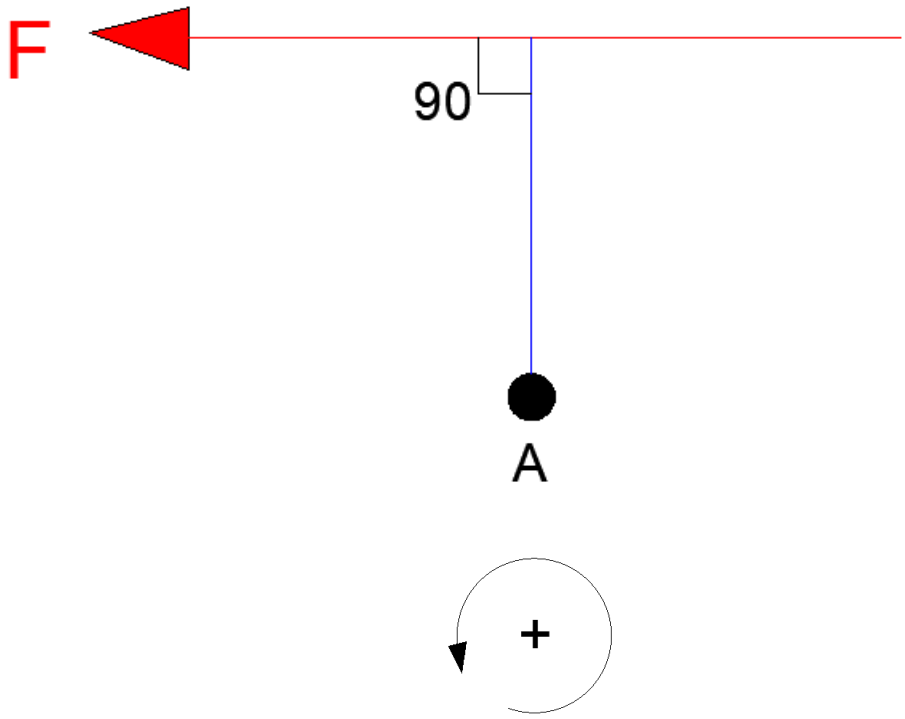
$$M@_{Point} = F \cdot d$$

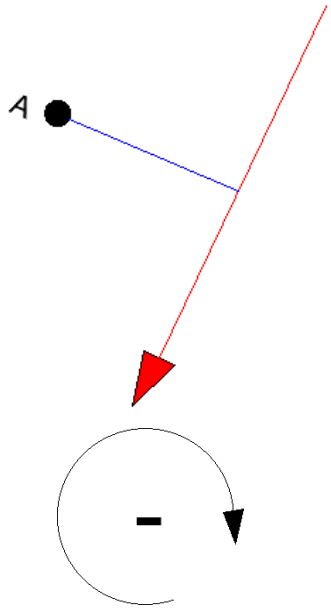
where:

M: The moment about the point (N. mm).

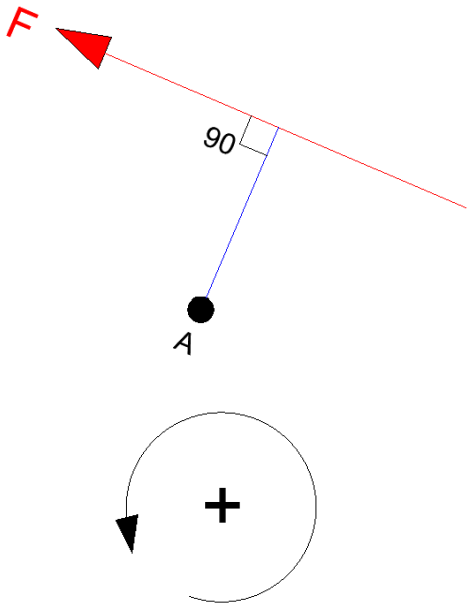
F : Force (N).

d: Perpendicular distance (Moment arm) between the force and the point (mm)

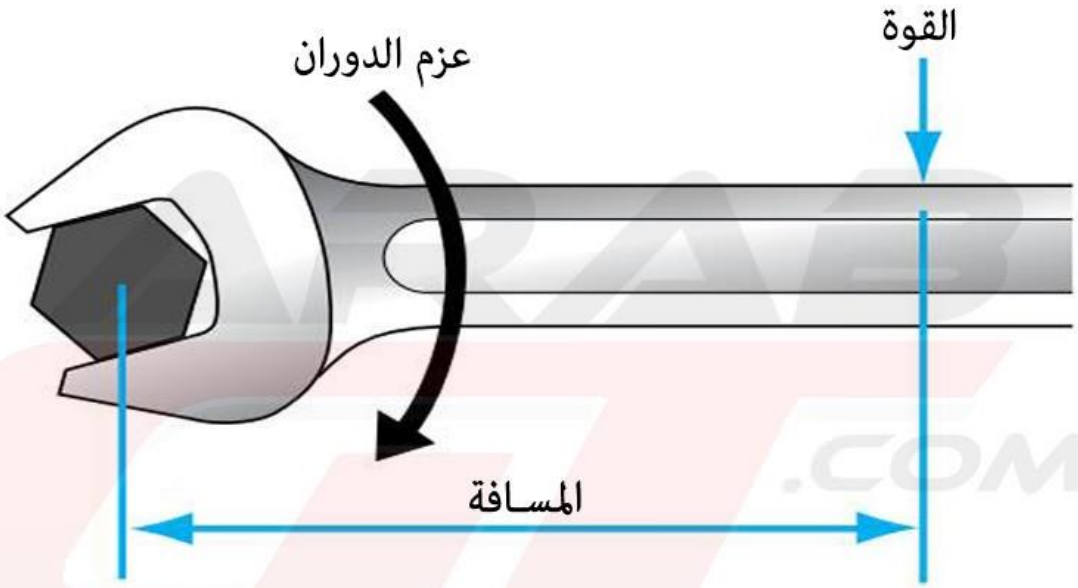




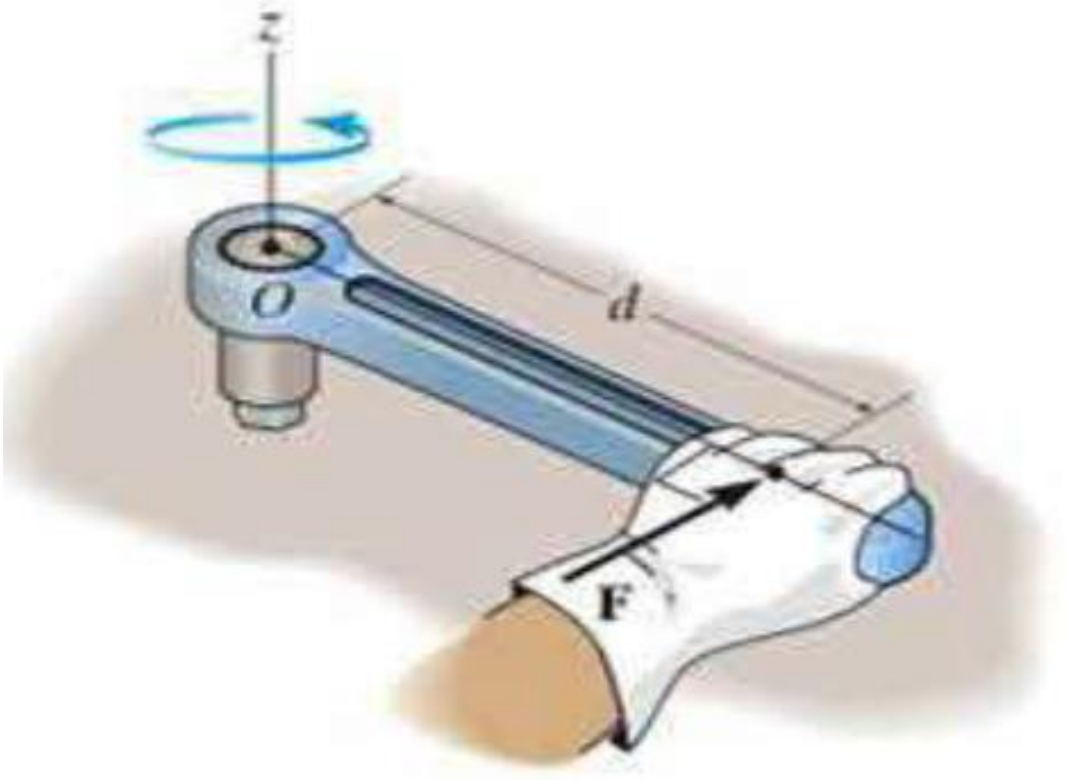
Clockwise



Counterclockwise



عزم الدوران = القوة x المسافة



Steps of the solution:

First: *Check if the force is perpendicular to the point or not.*

Second: ***If the force is perpendicular to the point****, then:*

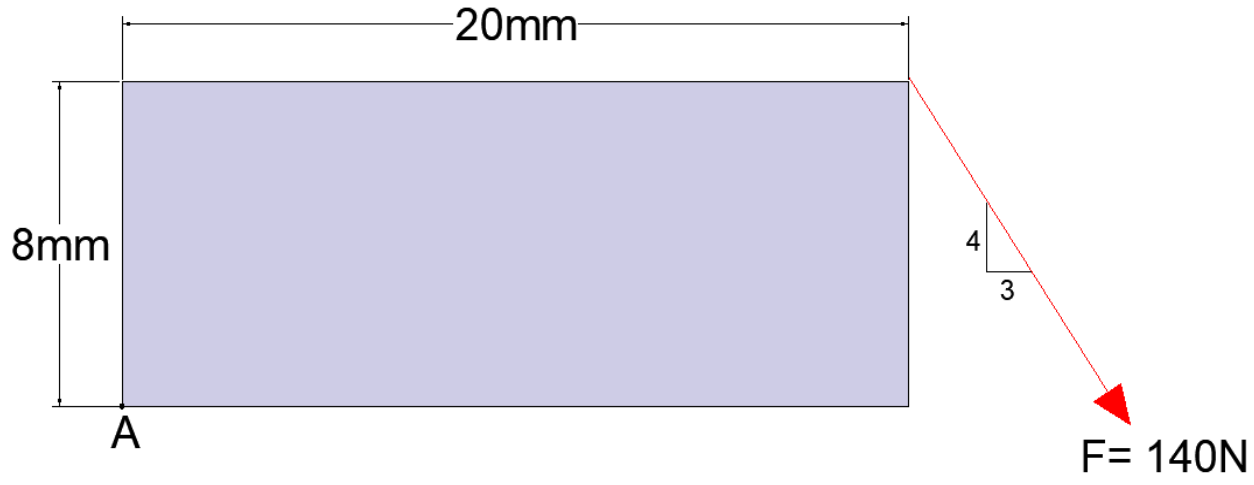
$$M@_{Point} = F \cdot d$$

Third: ***If the force is not perpendicular to the point****, then analyze the force into its components.*

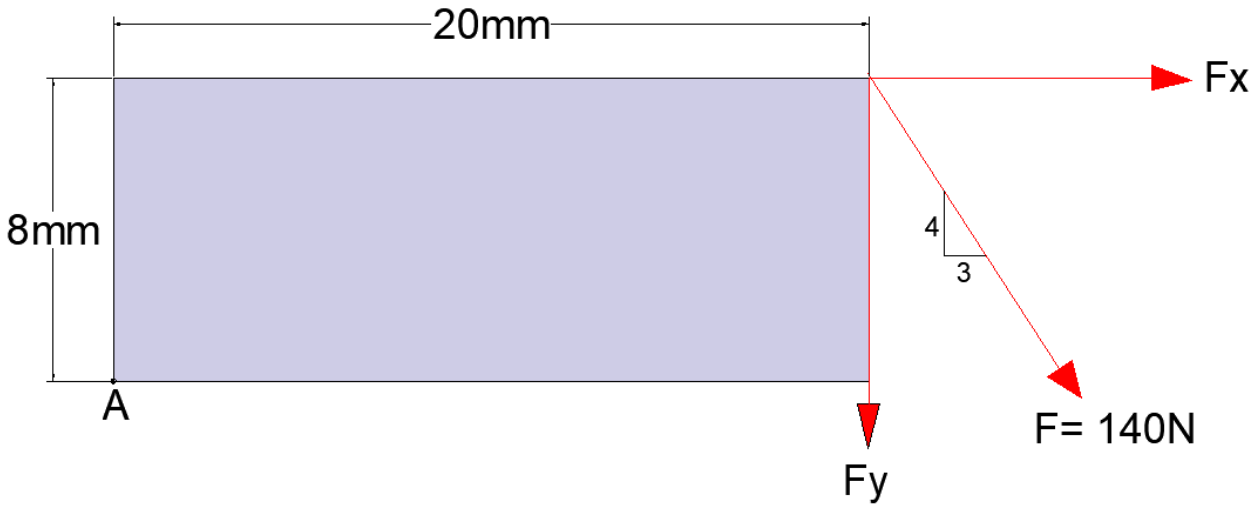
Note: If any force is on the line of the point, then the moment = zero

Example: Determine the moment of the force

F = 140 N with respect to point A?



For this example, the force is not perpendicular to the point, that is means we must analyze the force into its components.



Solution :

$$z = \sqrt{x^2 + y^2}$$

$$Z = \sqrt{3^2 + 4^2} = 5$$

$$Fx = 140 \times \frac{3}{5} = 84\ N$$

$$Fy = 140 \times \frac{4}{5} = 112\ N$$

$$\Sigma Fd = (84 \times 8) + (-112 \times 20)$$

$$\Sigma M@_A = -1568\ \text{N.mm}$$

$$= 1568\ \text{N.mm}$$

+

Example: Determine the resultant moment of the forces shown in (Figure 1) about point A?

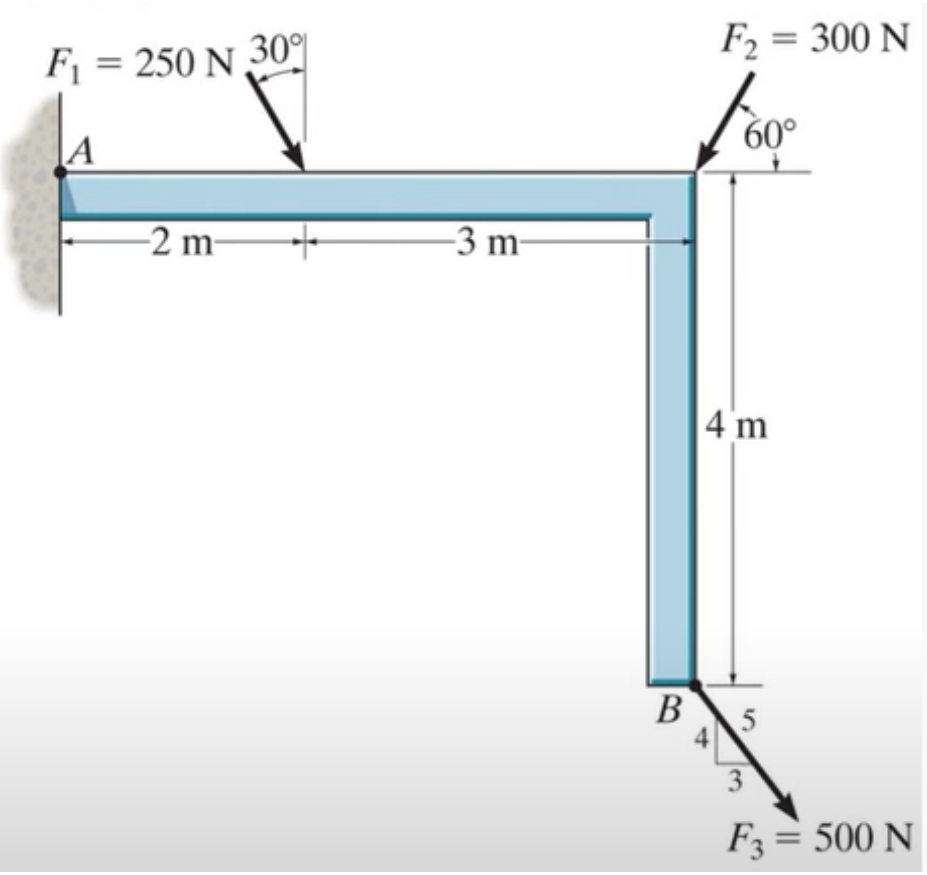


Figure 1

Solution :

For F_1:

$Fx = 250 \,.\sin 30 = +125N$

$Fy = 250 \,.\cos 30 = -216.5N$

For F_2:

$$Fx = 250 \,.\cos 60 = -125N$$

$$Fy = 250 \,.\sin 60 = -216.5N$$

For F_3:

$$Fx = 500 \times \frac{3}{5} = +300N$$

$$Fy = 500 \times \frac{4}{5} = -400N$$

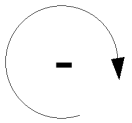
$$\boldsymbol{\Sigma M@_A = \Sigma F\, d}$$

$$= (\mathbf{125 \times 0}) + (\mathbf{-216.5 \times 2}) + (\mathbf{-125 \times 0}) + (\mathbf{-216 \times 5})$$

$$-(\mathbf{300 \times 4}) + (\mathbf{-400 \times 5})$$

$$= \mathbf{-4713}$$

$$= \mathbf{4713} \quad \text{-}$$



Mechanics :

Is a branch of physical science which study the motion of bodies .

Engineering mechanics

Is that science which deals with affection of forces system acting on rigid body.

Engineering mechanics have two parts :

1- Static السكون

2- Dynamic الحركة

وتهتم بدراسة حركة الاجسام بتعجيل

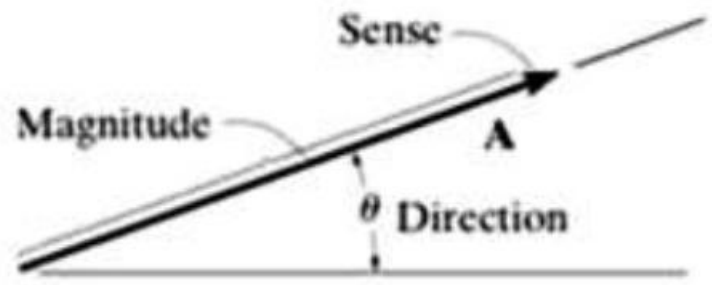
PHYSICAL QUANTITIES
المقادير الفيزيائية

1- Scalar quantity:

which have magnitude only like time, volume area.

2- Vector quantity:

which have magnitude and direction . EX: force , velocity , moment …etc.



FORCE (القوة)

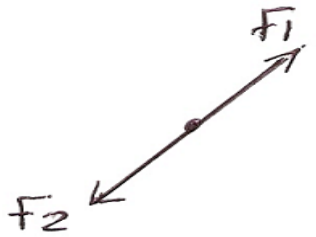
It is the action of one body on another which change or tend to change the motion of the body acted on.

Force system (منظومة القوة)

ويمكن ان تصنف الى :

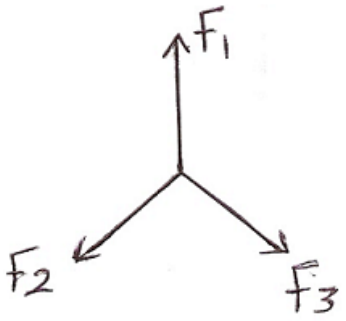
1- Collinear system

القوى الواقعة على خط فعل واحد (متلاقية)



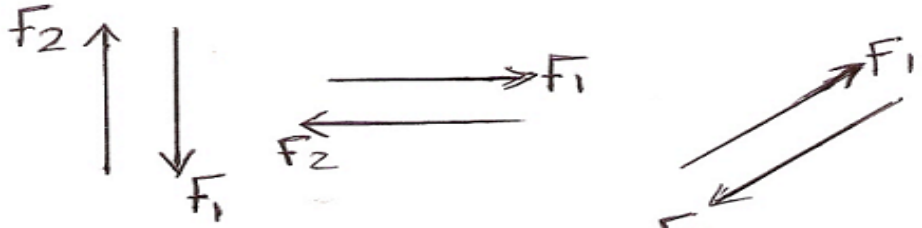
2- Concurrent coplanar system

القوى المتلاقية والواقعة في مستوي واحد



3- Parallel coplanar system:

القوى المتوازية والواقعة في مستوي واحد



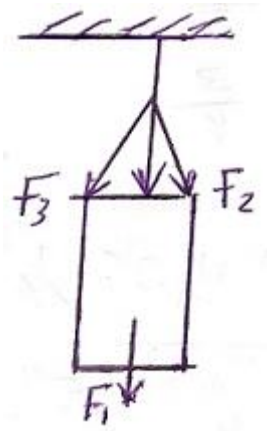
4- Non concurrent non parallel coplanar system :

قوى غير متوازية وغير متلاقية واقعة في نفس المستوى

5- Concurrent non coplanar system :

قوى متلاقية لكن غير واقعة

في نفس المستوي



TRIANGLE FORCE LOW

ويستعمل هذا القانون في حالة تحليل القوى

الى مركبين متعامدين فقط أي الزاوية المحصورة بينهما =90

الطريقة الاولى (بالاعتماد على قوانين المثلثات):

$$\sin \propto = \frac{BC}{AC} \quad , \quad BC = AC \cdot \sin \propto$$

$$\cos \propto = \frac{AB}{AC} \quad , \quad AB = AC \cdot \cos \propto$$

$$\tan \propto = \frac{BC}{AB}$$

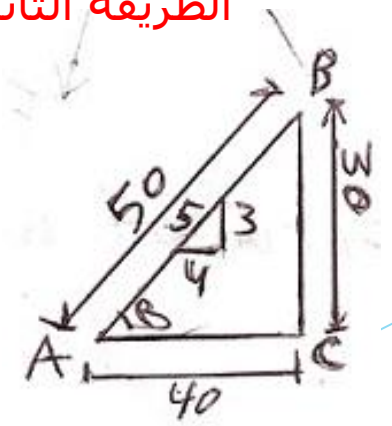
الطريقة الثانية (من معرفة نسبة الاضلاع):

$$L = \sqrt{(30)^2+(40)^2} = 50$$

$$\sin \beta = \frac{3}{5}$$

$$\cos \beta = \frac{4}{5}$$

$$\tan \beta = \frac{3}{4}$$



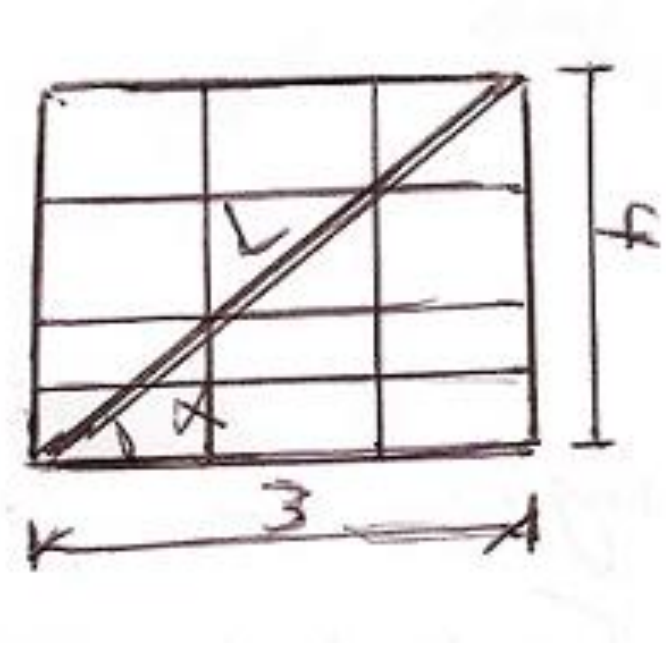
الطريقة الثالثـــة (الطريقة البيانية) :

$$L = \sqrt{(4)^2 + (3)^2} = 5$$

$$\sin\alpha = \frac{4}{5}$$

$$\cos\alpha = \frac{3}{5}$$

$$\tan\alpha = \frac{4}{3}$$



PARALLELOGRAM LOW

قانون متوازي الاضلاع

A) Cosine law

When $\boldsymbol{\beta + \alpha \neq 90^{\circ}}$

$$\boldsymbol{\alpha + \beta + \theta = 180^{\circ}}$$

$$\therefore \quad \boldsymbol{R = \sqrt{P^2 + Q^2 - 2P\cos\theta}}$$

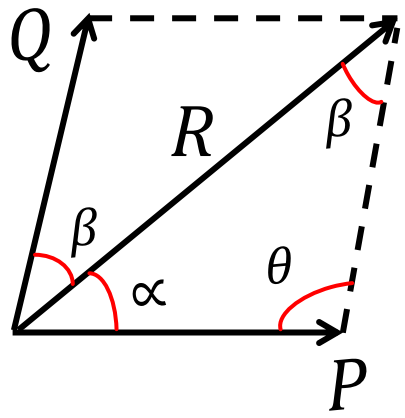
When $\boldsymbol{\beta + \alpha = 90^{\circ}}$

$$\boldsymbol{\theta = 90^{\circ}}$$

$$\therefore \quad \boldsymbol{R = \sqrt{P^2 + Q^2 - 2P\cos\theta}}$$

But $\boldsymbol{\cos\theta = 0}$

$$\therefore \quad \boldsymbol{R = \sqrt{P^2 + Q^2}}$$



B) Sine law:

ويستخدم هذا القانون في الحالين أي عندما تكون الزاوية المحصورة بين القوتين تساوي او لا تساوي 90

1- $\theta \neq 90^{\circ}$

$$\frac{R}{\sin\theta} = \frac{Q}{\sin\beta} = \frac{P}{\sin\alpha}$$

2- $\theta = 90^{\circ}$

$$\frac{R}{\sin\theta} = \frac{Q}{\sin\beta} = \frac{P}{\sin\alpha}$$

But $\sin 90 = 1$

$\therefore$ $R = \frac{Q}{\sin\beta}$ *OR* $R = \frac{P}{\sin\alpha}$