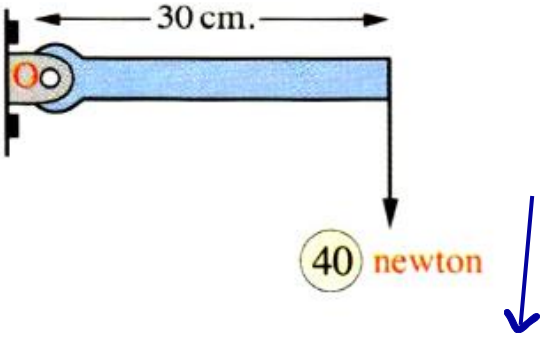
Exercise 2

The moment of a force about a point in 2D-coordinate system

Second : Moment by using perpendicular length

① Find the algebraic measure of the moment of the force about the point O of each of the following figures :

1

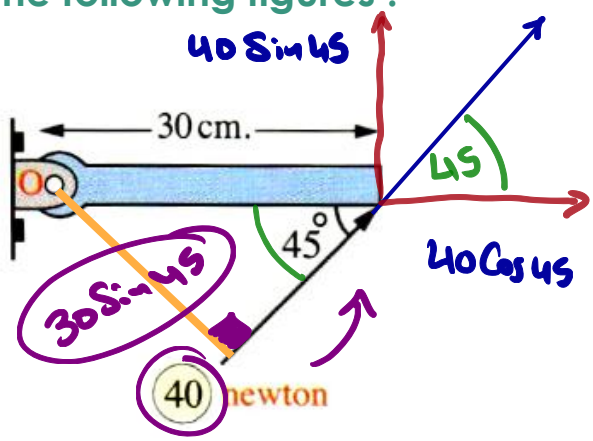


$M_O = -40 \times 30$

$= -1200$ N.m.

1 Find the algebraic measure of the moment of the force about the point O of each of the following figures :

2



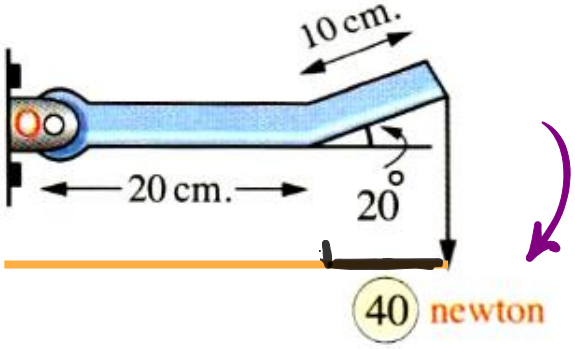
$M_O = 40 \sin 45 \times 30$

$= 1200 \frac{\sqrt{2}}{2}$

$= 600\sqrt{2}$ N.m

(1) Find the algebraic measure of the moment of the force about the point O of each of the following figures :

3



$M_o = -40 \times (20 + 10\cos 20)$

$= -1213.46$ N. m.

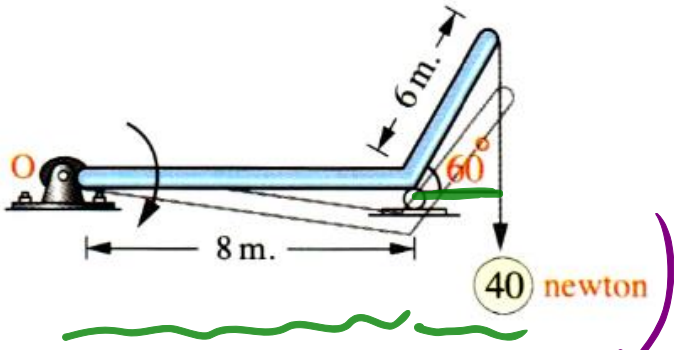
$(20 + 10\cos 20)$

1 Find the algebraic measure of the moment of the force about the point O of each of the following figures :

4

$M_{o.} = -40 \times 11$

$= -440$ N.m

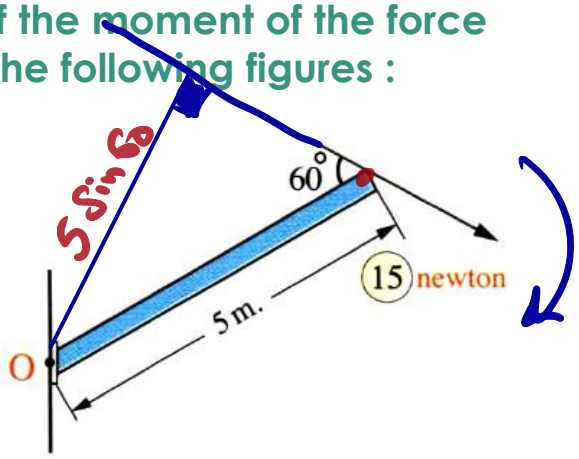


$8 + 6\cos 60$

$(8 + 3)$

1 Find the algebraic measure of the moment of the force about the point O of each of the following figures :

5



$$M_o = -15 \times \frac{5\sqrt{3}}{2}$$

$$= -\frac{75\sqrt{3}}{2}$$

1 Find the algebraic measure of the moment of the force about the point O of each of the following figures :

6

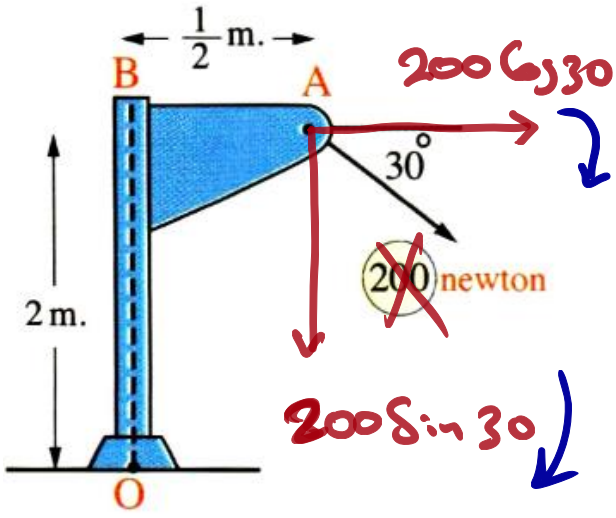
$-50 - 200\sqrt{3}$

$M_{o} = -200 \sin 30 \times \frac{1}{2}$

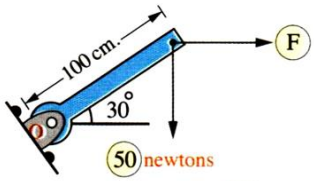
$\frac{\sqrt{3}}{2}$

$-200 \cos 30 \times 2$

$\simeq -396.4 \ N.m$



(2) If the moment of the horizontal force F about point O is equal to the moment of the vertical force 50 newton about point O , find the value of F

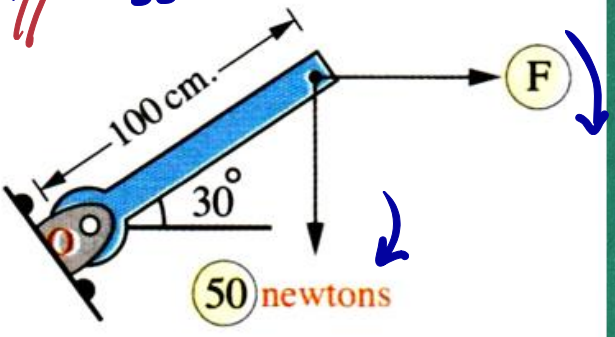


« $50\sqrt{3}$ N. »

$+F \times 100 \sin 30 = +50 \times 100 \cos 30$

$\frac{1}{2} F \cdot 25\sqrt{3}$

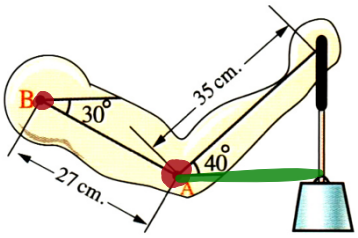
$F \cdot 50\sqrt{3}$ N



(3) **In the opposite figure :**

Person carry load by his hand , if norm of moment of this load about the point A equals 80 N.m.

Find norm of moment of this load about B

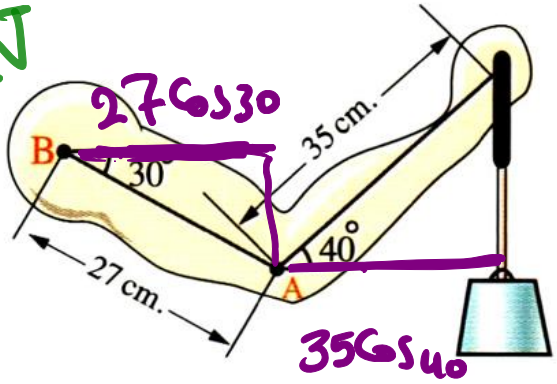


« 149.77 N.m. »

$M_A = W \times L$

$80 = W \times 35 \cos 40$

$W = \frac{80}{35 \cos 40} \simeq 2.98 N$

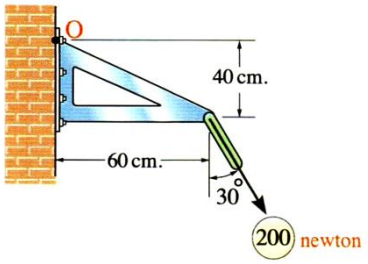


$M_B = 2.98 [35 \cos 40 + 27 \cos 30]$

$= 149.77 N.m$

4 **In the opposite figure :**

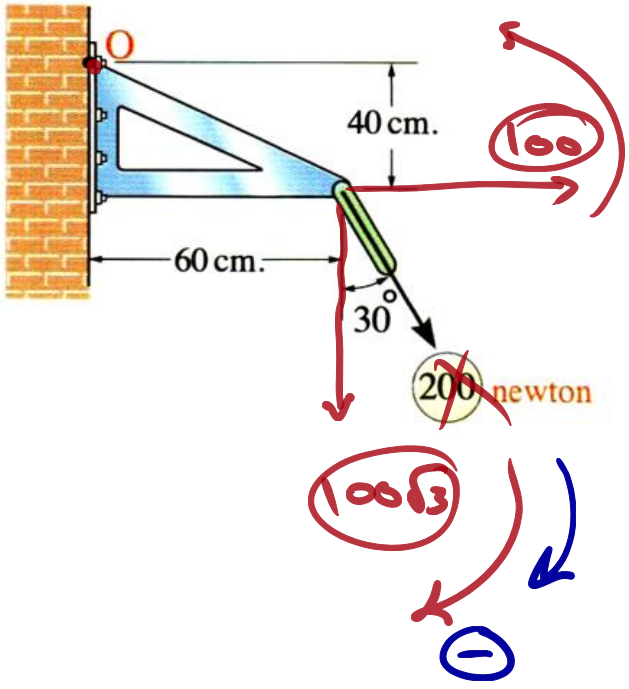
Find the algebraic measure of the moment of the force of magnitude 200 N. about the point O



« – 6392.3 N.cm. »

$M_o = 100 \times 40 - 100\sqrt{3} \times 60$

$= -6392.3$ N.cm



Choose the correct answer

📖 A force of a magnitude 50 newtons and is 8 cm. away from point A , then the norm of the moment of the force about point A equals ..... newtons.cm.

(a) 40 (b) zero (c) 200 (d) 400

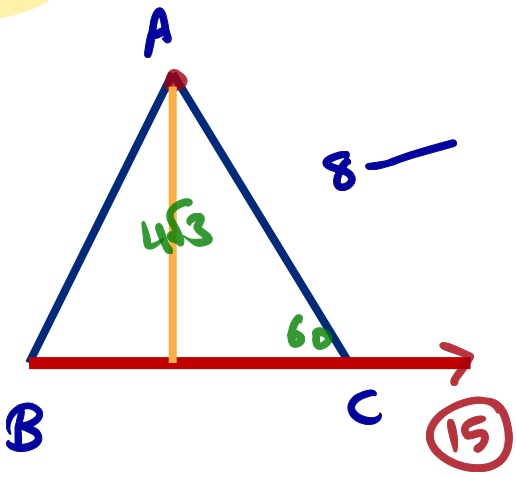
$M_A = 50 \times 8 = 400$ N.cm

ABC is an equilateral triangle , length of its side is 8 cm. , a force of magnitude 15 N. acts along $\overrightarrow{BC}$, then the magnitude of moment of this force about A is .....

(a) $40\sqrt{3}$ (b) 60 (c) $60\sqrt{3}$ (d) 120

$|\overrightarrow{M}|_A = 15 \times 4\sqrt{3}$

$= 60\sqrt{3}$

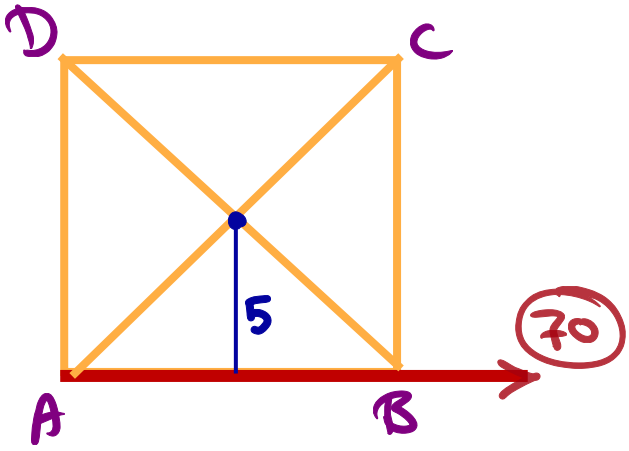


A force of magnitude 70 N. , acts along $\overrightarrow{AB}$ where ABCD is square with side length 10 cm. , then the norm of the moment of this force about centre of the square is ..... newtons.cm.

(a) $175\sqrt{2}$ (b) 350 (c) $350\sqrt{2}$ (d) 700

$\|\overrightarrow{M}\| = 70 \times 5$

$= 350$ N.cm



The moment of force $\vec{F}$ about point A equals M_1. If the force has moved parallel to itself towards A its moment about A becomes M_2 , then .....

(a) $M_2 > M_1$

(b) $M_2 < M_1$

(c) $M_2 = M_1$

(d) $M_2 + M_1 = \text{zero}$

$M_1 > M_2$

$M_2 < M_1$

In the opposite figure :

The least perpendicular force to unscrew the nut should act at point .....

(a) A (b) B

(c) C (d) D

In the opposite figure :

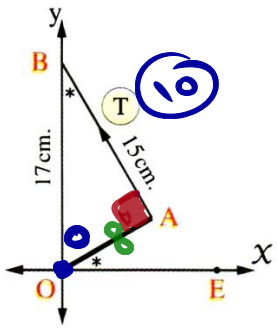
If AB = 15 cm. , OB = 17 cm.

, m (∠ ABO) = m (∠ AOE)

The tension in the string $\overline{AB}$ equals 10 newtons

, then the magnitude of the moment of the tension

about O equals ..... N.cm.



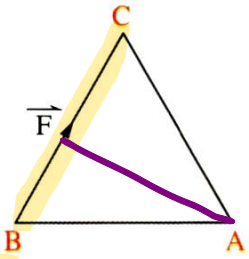
(a) 50 (b) 80 OA =

(c) 150 (d) 170

$\|\vec{M}\| = 10 \times 8 = 80$ N.cm

In the opposite figure :

If the force $\vec{F}$ is represented by $\overrightarrow{BC}$ where the length unit represents a force unit then $\| \vec{M}_A \| =$ .....



(a) $\| \overrightarrow{AC} \| \times \| \vec{F} \|$

(b) $\| \overrightarrow{AB} \| \times \| \vec{F} \|$

(c) $\frac{1}{2}$ the area of Δ ABC

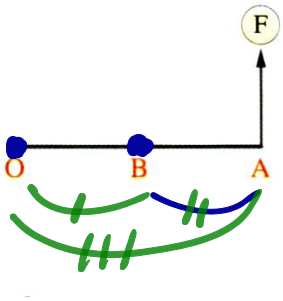
(d) 2 the area of Δ ABC

$\| \vec{M} \| = \| \vec{F} \| \times L$

$\| \overrightarrow{BC} \| \times h$

base $\times h = 2$ a. Δ ABC

If the magnitude of the moment of $\vec{F}$ about O equals 60 and the magnitude of the moment of $\vec{F}$ about (B) equals 40 , then .....



(a) AB = BO

(b) AB = $\frac{1}{2}$ BO

(c) AB = 2 BO

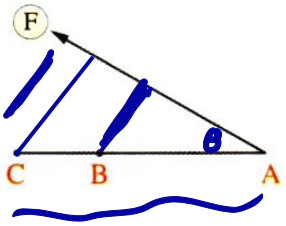
(d) AB = $\frac{2}{3}$ BO

$M_O = F \times AO = 60$

$M_B = F \times AB = 40$ $\Rightarrow \frac{F \times AO}{F \times AB} = \frac{3}{2}$

In the opposite figure :

If the magnitude of the moment of $\vec{F}$ about B equals M_B and the magnitude of moment of $\vec{F}$ about C equals M_C , then .....



(a) $M_B = M_C$

(b) $M_B + M_C$ = zero

(c) $\frac{M_B}{M_C} = \frac{AB}{AC}$

(d) $\frac{M_B}{M_C} = \frac{AB}{BC}$

$$\frac{M_B = F \times AB \sin\theta}{M_C = F \times AC \sin\theta} \Rightarrow \frac{M_B}{M_C} = \frac{AB}{AC}$$

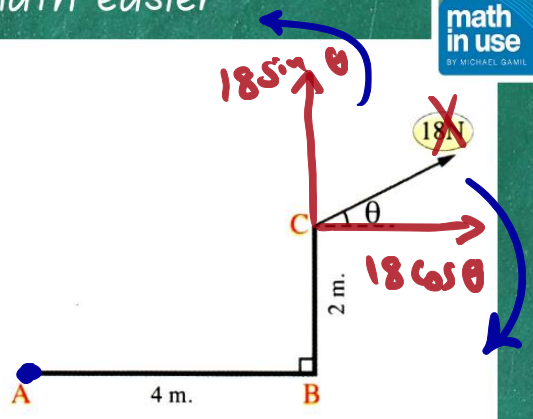
In the opposite figure :

If the moment of the force 18 N.

about A equals zero , then tan θ = ...

(a) $\frac{3}{4}$ (b) $\frac{2}{3}$

(c) $\frac{1}{2}$ (d) $\frac{1}{3}$



$M_A = 18 \sin\theta \times 4 - 18 \cos\theta \times 2 = 0$

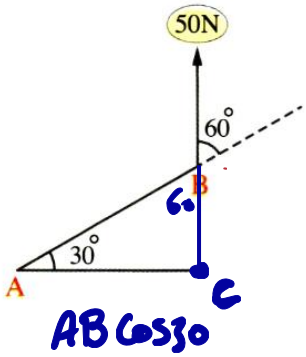
$18 \sin\theta \times 4 = 18 \cos\theta \times 2$

$2 \sin\theta = 1 \cos\theta$

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

In the opposite figure :

If the moment of the force 50 N.
about the point A equals $100\sqrt{3}$ N.cm.
, then AB = ... cm.



(a) 2 (b) 3

(c) 4 (d) 5

$M_A = 50 \times AB \cos 30 = 100\sqrt{3}$

$25\sqrt{3}\ AB = 100\sqrt{3}$

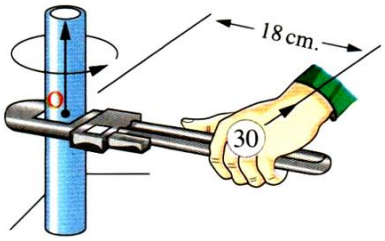
$AB = 4$

In the opposite figure :

The norm of the moment of the force about the origin point (O) equals ..... moment unit.

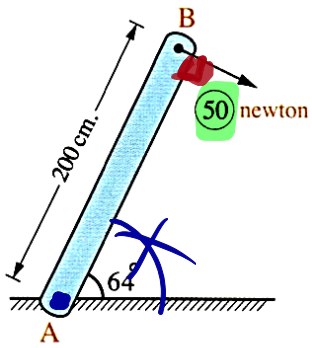
(a) – 540 (b) 270

(c) – 270 (d) 540



$30 \times 18 = 540$

In the opposite figure :



A rod fixed by a hinge at A

If a force of a magnitude 50 newton acts on the end B in direction perpendicular to the rod , then the norm of the moment about A is equal to ..... newton.metre.

(a) 10^4

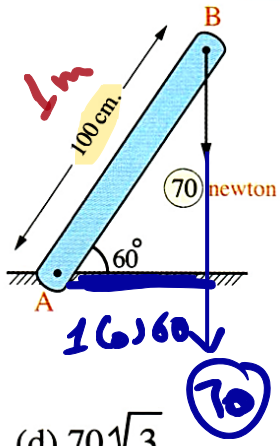
(b) 10^2

(c) $10000 \sin 64°$

(d) $100 \cos 64°$

$M_A = 50 \times 2 = 100\ N.m = 10^2$

In the opposite figure :



A rod fixed by a hinge at A

If a vertical force of a magnitude 70 newton acts on the end B downward , then the norm of the moment of the force about A is equal to ..... newtons. metre.

(a) 35 (b) $35\sqrt{3}$ (c) 70 (d) $70\sqrt{3}$

$M_A = 70 \times \cos 60 = 35\sqrt{3}$ N.m

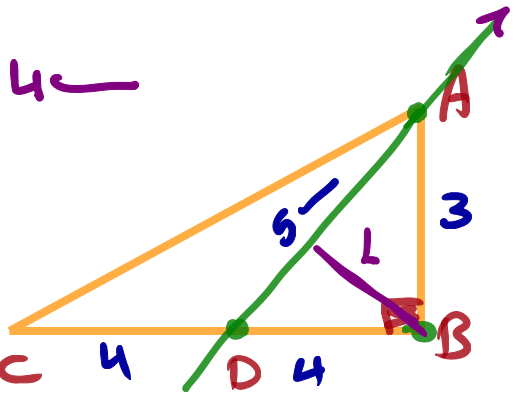
ABC is a right-angled triangle at B , AB = 3 cm. , BC = 8 cm. Force $\vec{F}$ acts in the same plane as triangle ABC and M_A = zero , $M_B = -M_C = 60$ N.cm.

, then $\|\vec{F}\|$ = ... N.

$M_B = 60$ $M_C = -60$

(a) 25 (b) 30 (c) 40 (d) 60

$L = \frac{3 \times 4}{5} = \frac{12}{5} = 2.4$



$M_B = 60$

$F \times 2.4 = 60$

$F = \frac{60}{2.4} = 25$ N

(Trial 2021) **In the opposite figure :**

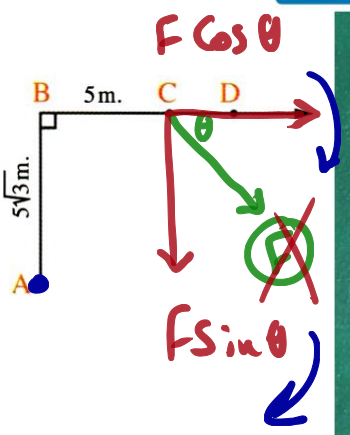
$\overline{AB} \perp \overline{BD}$, AB = $5\sqrt{3}$ m. , BC = 5 cm.

Force $\vec{F}$ acts at point C and acts in direction

inclined to $\overrightarrow{CD}$ at an angle θ downward.

If the moment of the force $\vec{F}$ vanished about the point

A , then measure of angle θ = ...°



→ $M_A = 0$

(a) 30 (b) 60 (c) 120 (d) 150

$-F\cos\theta \times 5\sqrt{3} - F\sin\theta \times 5 = 0$

$-\sqrt{3}\cos\theta - \sin\theta = 0$

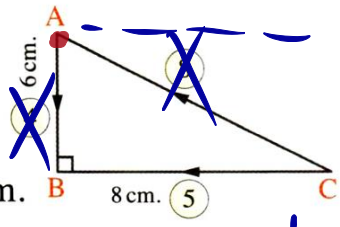
$-\sqrt{3}\cos\theta = \sin\theta$

$\frac{-\sqrt{3}\cos\theta}{\cos\theta} = \frac{\sin\theta}{\cos\theta}$

$\tan\theta = -\sqrt{3} \Rightarrow \theta = 120$

In the opposite figure :

Δ ABC is right-angled at B , forces of magnitudes 8 , 4 and 5 N. , act along $\overrightarrow{CA}$, $\overrightarrow{AB}$ and $\overrightarrow{CB}$, then sum of moments of the forces about A = ... N.cm.



(a) 30 (b) – 30 (c) 20 (d) 38.4

$M_A = -5 \times 6 = -30$ N.cm

In the opposite figure :

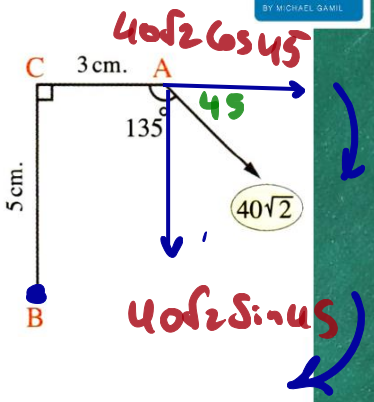
Norm of moment of the force F = $40\sqrt{2}$ newtons about the point B equals .....

(a) 320

(b) $200\sqrt{2}$

(c) $120\sqrt{2}$

(d) $80\sqrt{17}$



$-40\sqrt{2}\cos 45 \times 5 - 40\sqrt{2}\sin 45 \times 3$

$= 320$

In the opposite figure :

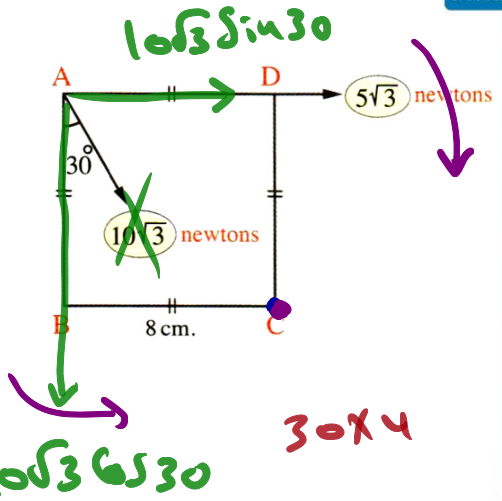
Sum of moments of the forces about the point C = ...

(a) $40\sqrt{3}$

(b) $120 - 80\sqrt{3}$

(c) $80\sqrt{3}$

(d) $120\sqrt{3}$



$10\sqrt{3}\sin 30$

$10\sqrt{3}\cos 30$

30×4

$\frac{\sqrt{3}}{2}$

$-5\sqrt{3} \times 8 - 10\sqrt{3}\sin 30 \times 8 + 10\sqrt{3}\cos 30 \times 8$

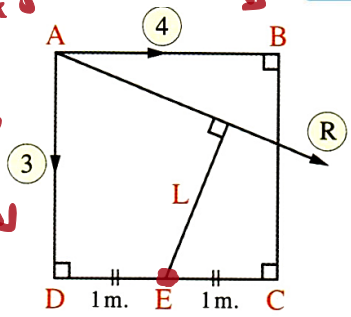
$-40\sqrt{3} - 40\sqrt{3} + 120 = 120 - 80\sqrt{3}$

$= -18.56$

(First session 2019) : **In the opposite figure :**

ABCD is a square of side length 2 m. , two forces 4 , 3 kg.wt. acts along , $\overrightarrow{AB}$, $\overrightarrow{AD}$ respectively

If their resultant $\vec{R}$, ℓ is the length of the perpendicular from E to the line of action of $\vec{R}$, then .....



(a) R = 5 kg.wt. , ℓ = 1.5 m.

(b) R = 5 kg.wt. , ℓ = 1 m.

(c) R = 5 kg.wt. , $\ell = \sqrt{2}$ m.

(d) R = 5 kg.wt. , ℓ = 1.2 m.

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

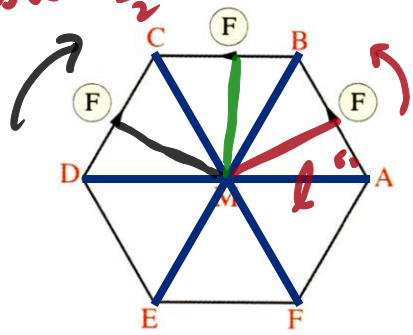
$L = \frac{\|M_E\|}{\|R\|}$

$M_E = -4 \times 2 + 3 \times 1 = -5$

$L = \frac{\|M_E\|}{\|R\|} = \frac{5}{5} = 1$

(Second session 2018) : **In the opposite figure :**

ABCDEF is a regular hexagon , its side length is (ℓ)
Three equal forces each of magnitude (F) act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ respectively , then the sum of moments of these forces about (M) (the centre of the hexagon) equals ..... moment unit.



$\ell \cos 60 = \frac{\sqrt{3}}{2}\ell$

(a) $\frac{3\sqrt{3}}{2}$ F ℓ

(b) $\frac{\sqrt{3}}{3}$ F ℓ

(c) $\frac{\sqrt{3}}{2}$ F ℓ

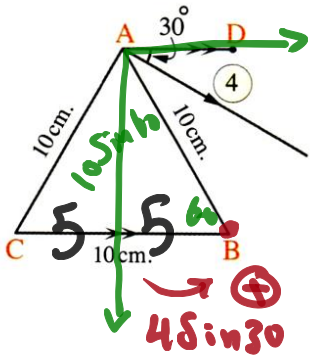
(d) $\frac{-\sqrt{3}}{2}$ F ℓ

$F \times \frac{\sqrt{3}}{2}\ell + F \times \frac{\sqrt{3}}{2}\ell - F \times \frac{\sqrt{3}}{2}\ell$

$\frac{\sqrt{3}}{2}$ F ℓ

(First session 2021) : **In the opposite figure :**

ABC is an equilateral triangle of side length 10 cm. , a force of magnitude 4 newton acts at the point A in direction makes an angle of measure 30° with $\overline{AD}$ where $\overline{AD}$ // $\overline{BC}$, then the algebraic measure of the moment of the force about B = ... newton.cm.



(a) 20 (b) – 20 (c) 40 (d) – 40

$-4\cos 30 \times 10\sin 60 + 4\sin 30 \times 5$

$= -20$.

(2nd Session 2021) **In the opposite figure :**

A force $\vec{F}$ of magnitude 25 newton acts at the point D such that $\vec{F} \perp \overline{DB}$, if DC = 3 cm. , BC = 4 cm. , AB = 2 cm. , then the algebraic measure of the moment of the force $\vec{F}$ about the point A equals ..... newton.cm.

(a) 125

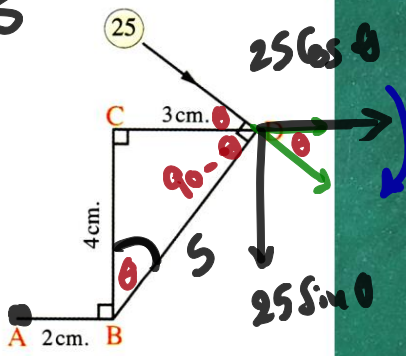
(b) 155

(c) – 155

(c) – 125

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

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



$M_A = -25\cos\theta \times 4 - 25\sin\theta\,(3+2)$

$= -25 \times \frac{4}{5} \times 4 - 25 \times \frac{3}{5} \times 5$

$= -155$ N.m