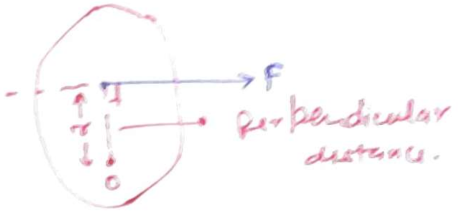
Moment of force.

The parallel forces are having their line of action parallel to each other. For finding the resultant of two parallel forces the parallelogram cannot be drawn. The resultant of such forces can be determined by applying the principle of moments.

Moment of force:

$M = F \times r$. N-m.

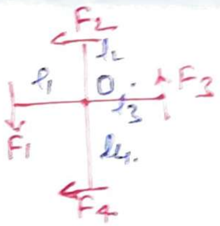


The tendency of this moment is to rotate the body in the clockwise direction about O.

- The moment of force about point (O) is a vector which is directed perpendicular to the plane containing the moment centre and the force.

- The general convention is to take the clockwise moments as positive and anticlockwise moments as negative

Resultant of moment about point O.



$M = -F_1 l_1 + F_2 l_2 - F_3 l_3 + F_4 l_4$.

algebric sum of the forces.

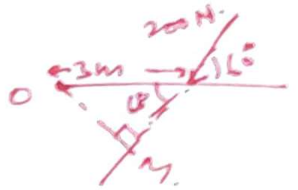
Principle of moments: A body is acted upon by a number of coplaner forces will be in equilibrium, if the algebric sum of moments of all the forces about a point lying in the same plane is zero.

$\Sigma M = 0$

~~Var~~ Varignon's Theorem:- Principle of moments is also called Varignon's Theorem.

Ex. A force of 200N is acting at a point B as shown in the figure. Determine the moment of force about O.

M = Force × perpendicular distance between O & line of action

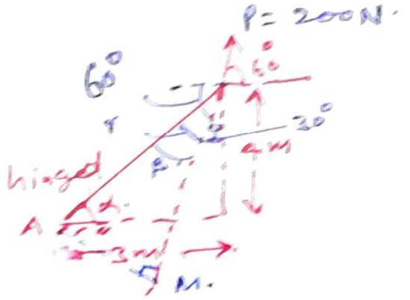


M = 200 × OM.

= 200 × 3 sin60 = 200 × 3 × .866

= 519.6 N m (clockwise)

Ex. A Force of 200N acting at point B of lever AB which is hinged at its lower end as shown in fig. Find the moment of force about the hinged end.



M = P × AM.

$AB = \sqrt{(.4)^2 + (.3)^2} = .5m.$

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

$\alpha = 53.13°$.

$\gamma = 90° - 53.13° = 36.87°$

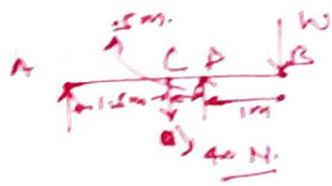
$\beta = 36.87 - 30° = 6.87°$

AM = AB × sin6.87° = .5 × .1196 = 0.0598 m. (Anticlockwise)

or. $P_x = 200\cos60° = 100N$, $P_y = 200\sin60 = 173.2N$

$M_a = 100 \times .4 - 173.2 \times .3 = 11.96$ m (Anticlockwise.

Ex.3 A uniform wooden plank AB of length 3m has a weight of 40N. Its supported at the end A and at a point D which is 1m from the other end B. Determine the max^m weight W that can be placed at end B so that the plank does not topple.



Sol^n. Ra should be zero.

taking moment about point D

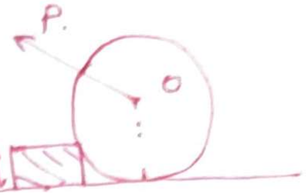
W × 1 = 40 × .5

W = 20 N.

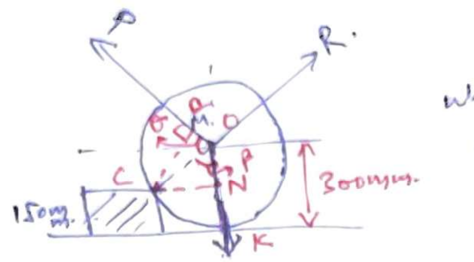
Q. A uniform wheel [redacted] weighing 20 kN and of 600 mm diameter rests against 150 mm thick rigid block as shown in fig. Considering all surfaces to be smooth, determine

a) the least pull through the centre of wheel to just turn the wheel over the corner of the block

b) the reaction of the block.



Soln.



When wheel is about to turn, its contact with the ground will be lost. wheel has to be in eqm under the action of its weight & the force P

$OC = OK = 300\text{mm}$

$ON = OK - NK = 300 - 150 = 150\text{mm}$

$CN = \sqrt{(OC)^2 - (ON)^2} = \sqrt{(300)^2 - (150)^2} = 259.81\text{ mm}$

Moment about C.

$$P \times CM = W \times CN$$

$$P \times OC \sin\theta = W \times 259.81$$

$$P = \frac{20 \times 259.81}{300 \times \sin\theta}$$

P will be minimum when $\sin\theta$ is maxm.

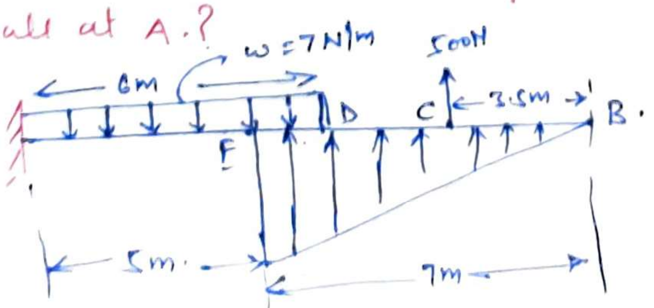
$\sin\theta = 1$, $\theta = 90°$

$$P_{min} = \frac{20 \times 259.81}{300} = 17.32\text{ kN}$$

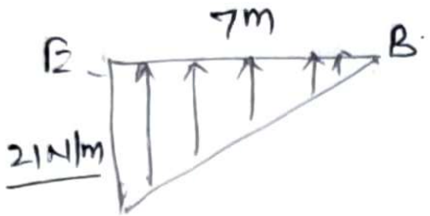
b) $R = W\cos\beta \Rightarrow \cos\beta = \frac{ON}{OC} = \frac{150}{300} = \frac{1}{2}$

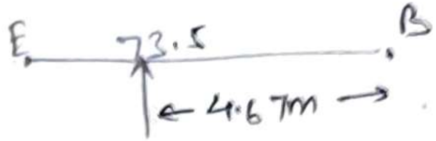
$$\boxed{R = 20 \times \frac{1}{2} = 10\text{ kN}}$$

ex. Compute the simplest resultant force for the loads acting on a cantilever beam as shown in fig. What force and moment is transmitted by this force to the support the wall at A.?



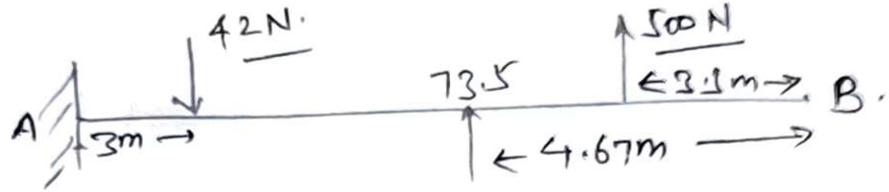
sol^n load and position.





load $= \frac{1}{2} \times 7 \times 21 = 73.5N$

Position $- \frac{2}{3} \times 7 = 4.67m$ from the apex (B).



Resultant force $= 42 - 73.5 - 500 = -531 \cdot N$ (upward)

Moment acting at wall -

$$MA = 42 \times 3 - 500(12 - 3.5) - 73.5(12 - 4.67)$$

$$= 4662.75N \text{ (Anticlock wise)}$$