Chapter 4 - Moments

Personal notes:

4.1 - Intro to Moments

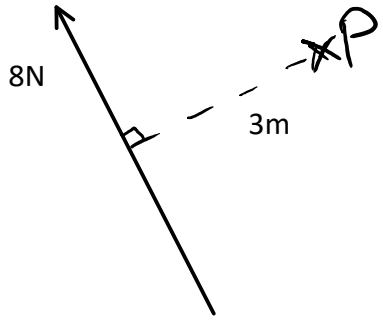
Notes

- Moment of a force is the _____ of a force.
- The _____ the magnitude of the force and the _____ away from the pivot, the _____ the moment.

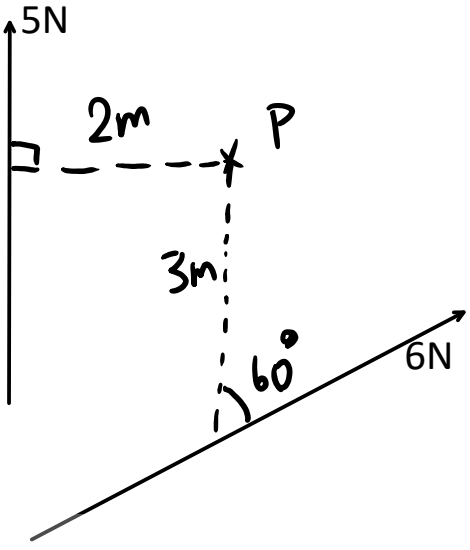
- Moment =

- Classic example - Opening the door: Imagine opening the door right on the hinge (pivot), it is very hard to open.

Example
Find the moment of the force on *P*.



Example
Find the moments of each force on *P*.



Tips:

- Think of the perpendicular distance as a door to work out direction (cw/acw)
- When drawing a perpendicular distance, start from the PIVOT!

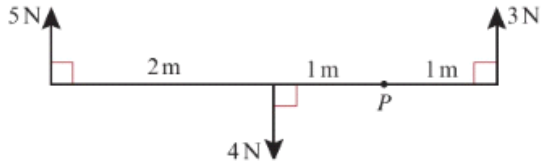
4.2 - Resultant Moment

Notes

Resultant moment (or sum of moments) =

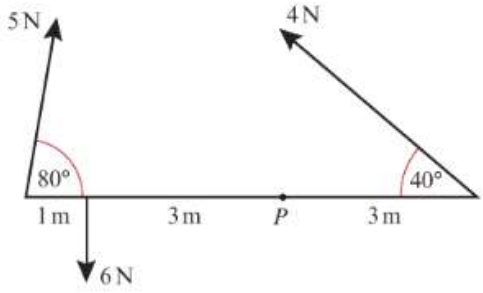
Example

Find the sum of moments about the point P.



Example

Find the resultant moment about P.



4.3 - Equilibrium

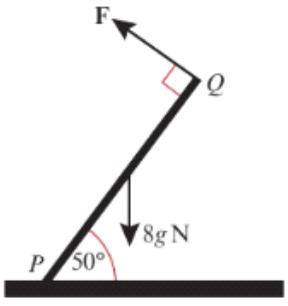
Example 1

The diagram shows a uniform rod AB, of length 3 m and weight 20 N, resting horizontally on supports at A and C, where $AC = 2$ m.

Calculate the magnitude of the reaction at each of the supports.

Example 2

A uniform rod PQ is hinged at the point P, and is held in equilibrium at an angle of 50° to the horizontal by a force of magnitude **F** acting perpendicular to the rod at Q. Given that the rod has a length of 3 m and a mass of 8 kg, find the value of **F**.



4.3 - Equilibrium

Little Summary of Moments

Not Equilibrium	Equilibrium
1. Label Direction of each force on Diagram 2. Find Moment of Each Force 3. Resultant Moment = CW Moments – ACW Moments	1. Set up Equation (if rod is horizontal) Total Forces pointing up = Total Forces pointing down 2. Take moments at a point (choose wisely) Work out the moment of each force about chosen pivot point 3. Sum of CW Moments = Sum of ACW Moments

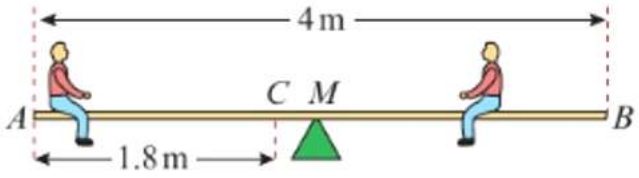
4.4 - Centre of mass

Notes

- If a rod is *non-uniform*, the centre of mass/weight of rod is *not positioned in the middle*.

Example

Tom and Jerry are sitting on a non-uniform plank *AB* of mass 25 kg and length 4m. The plank is pivoted at *M*, the midpoint of *AB*. The centre of mass of *AB* is at *C* where *AC* is 1.8m. Sam has mass 35 kg. Jerry has mass 25 kg and sits at *A*. Where must Tom sit for the plank to be horizontal?

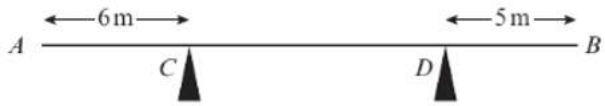


4.4 - Centre of Mass

Example

A non-uniform rod *AB*, of length 25m and weight 80 N, rests horizontally in equilibrium on supports *C* and *D* as shown in the diagram. The centre of mass of the rod is 10m from *A*. A particle of weight *W* newtons is attached to the rod at a point *E*, where *E* is x metres from *A*. The rod remains in equilibrium and the magnitude of the reaction at *C* is five times the magnitude of the reaction at *D*.

Show that $W = \frac{400}{25-3x}$. **(5 marks)**



4.5 - Tilting

Notes

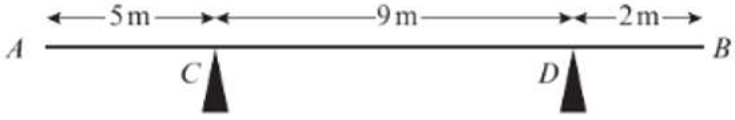
- When a rigid body is on the point of tilting about a pivot,

Balanced, equilibrium

Tilted about bottle B, but plank is not falling yet, so still equilibrium

Example

A uniform beam *AB*, of mass 45 kg and length 16 m, rests horizontally on supports *C* and *D* where $AC = 5$ m and $CD = 9$ m. When a child stands at *A*, the beam is on the point of tilting about *C*. Find the mass of the child.



4.5 - Tilting

Example

A uniform plank *AB* of length 2 m and weight 20 N rests on two supports *C* and *D*, C is 40 cm from *A* and *D* is 60 cm from *B*.

a) Find the reaction force at each support.

A cat of mass 40 N starts from the centre of the plank and walks towards *A*.

b) How far from *A* is the cat when the plank tips?