4) Moments

4.1) Moments

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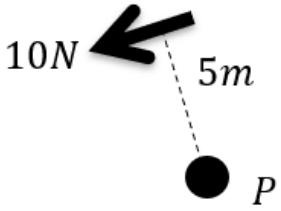
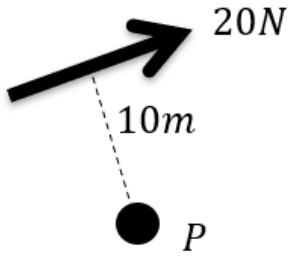
Worked example

Calculate the moment of the force about the point P



Your turn

Calculate the moment of the force about the point P

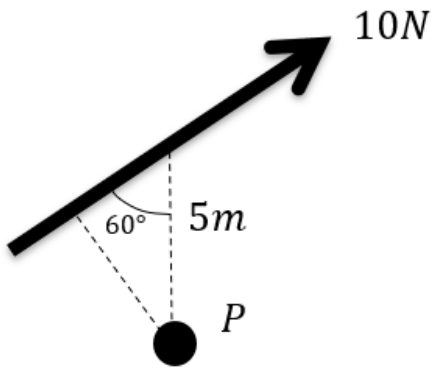


$200\ Nm$ clockwise

$0\ Nm$

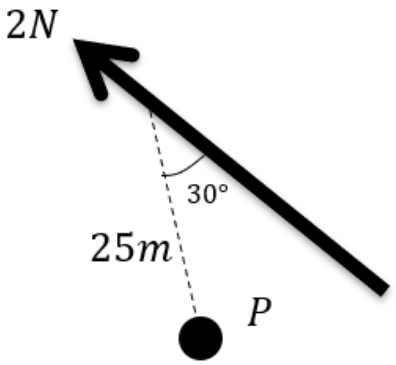
Worked example

Calculate the moment of the force about the point P



Your turn

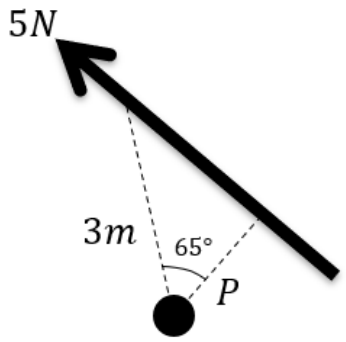
Calculate the moment of the force about the point P



$50 \sin 30° \, Nm = 25 \, Nm$

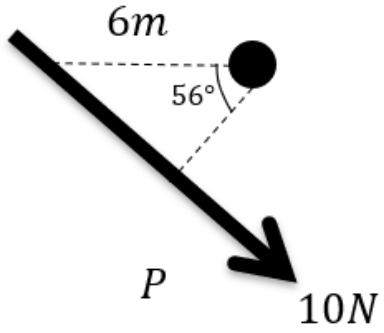
Worked example

Calculate the moment of the force about the point P



Your turn

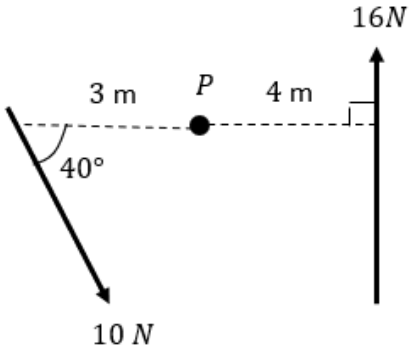
Calculate the moment of the force about the point P



$33.6\ Nm$ (3 sf) clockwise

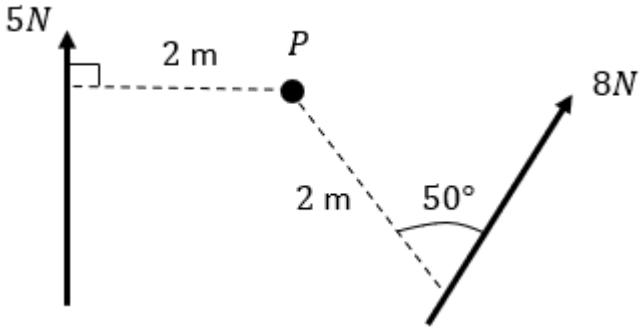
Worked example

Two forces act on a lamina. Find the moment of each of the forces about the point P.



Your turn

Two forces act on a lamina. Find the moment of each of the forces about the point P.



Moment of 5N force $= 10$ Nm clockwise

Moment of 8N force

$= 12.3$ Nm anticlockwise (3 sf)

4.2) Resultant moments

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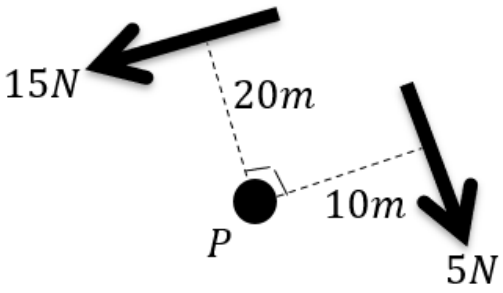
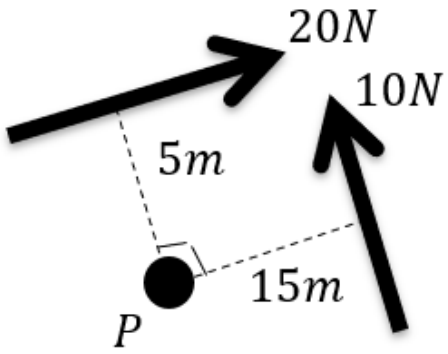
Worked example

Calculate the resultant moment acting about P



Your turn

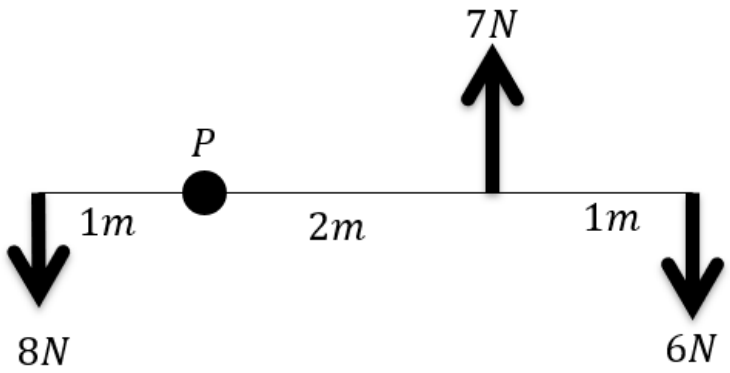
Calculate the resultant moment acting about P



50 Nm anticlockwise

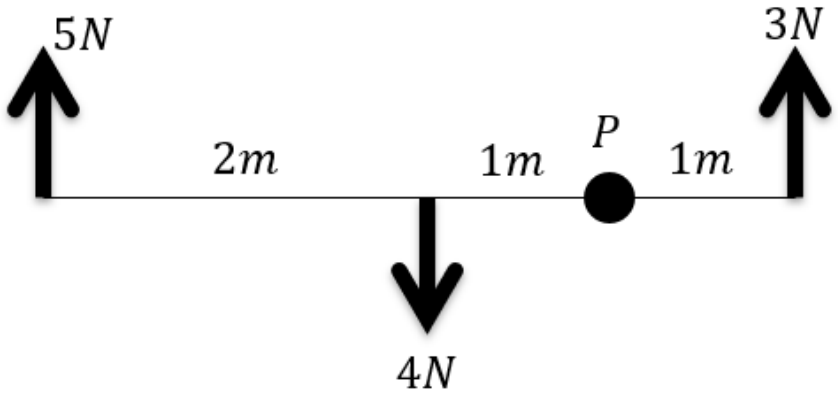
Worked example

The rod is light. Calculate the resultant moment acting about P.



Your turn

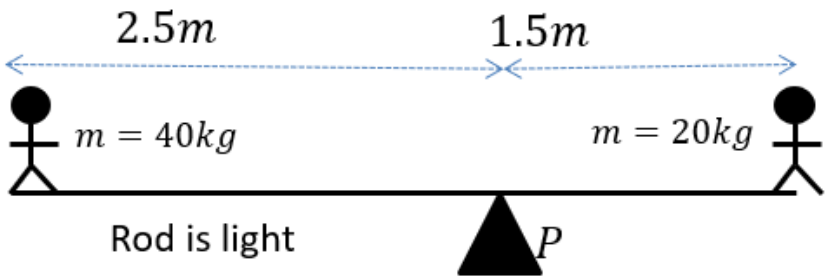
The rod is light. Calculate the resultant moment acting about P.



$8\ Nm$ clockwise

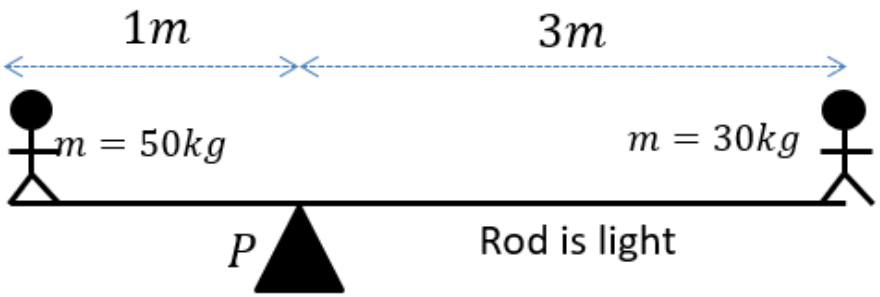
Worked example

Find the resultant moment acting about P



Your turn

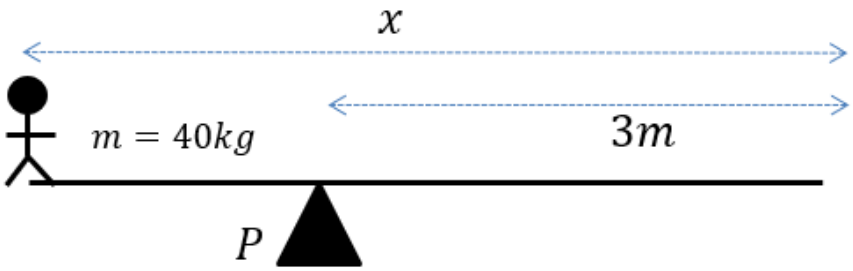
Find the resultant moment acting about P



$40g\ Nm = 392\ Nm$ clockwise

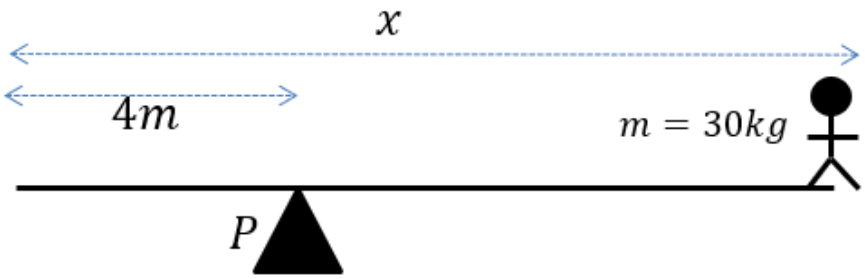
Worked example

The rod is light. Calculate the resultant moment acting about P.



Your turn

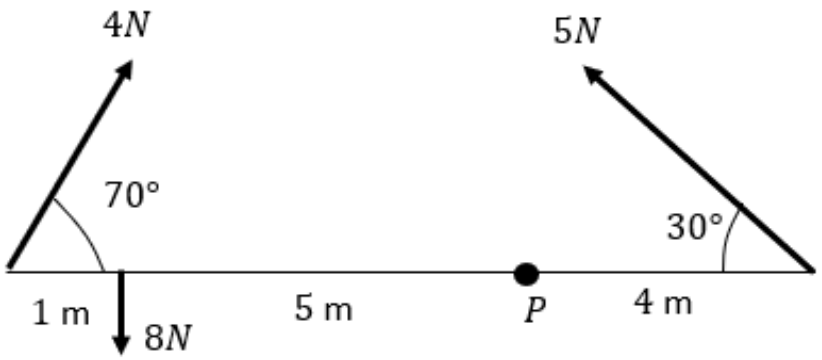
The rod is light. Calculate the resultant moment acting about P.



$30g(x - 4)\ Nm$ clockwise

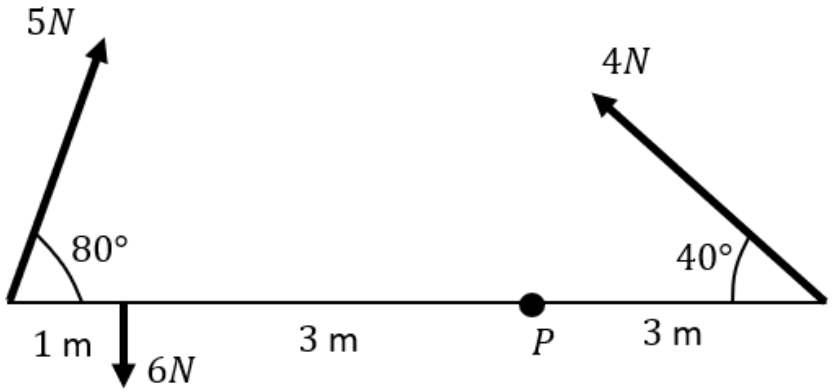
Worked example

The rod is light. Calculate the resultant moment acting about P.



Your turn

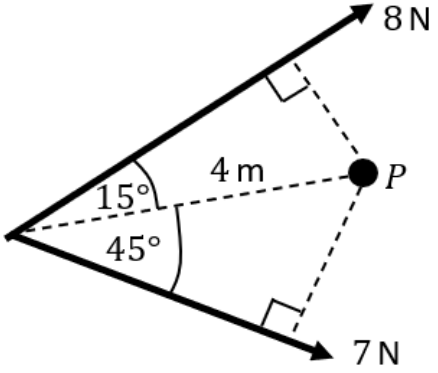
The rod is light. Calculate the resultant moment acting about P.



$6.02\ Nm$ anticlockwise (3 sf)

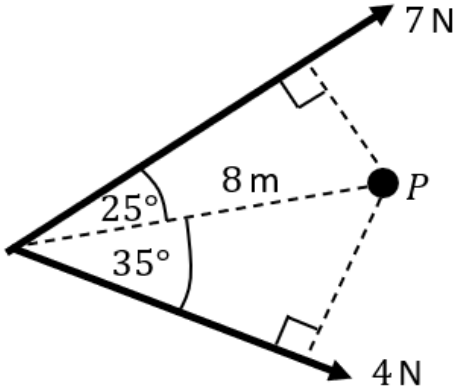
Worked example

The rod is light. Calculate the resultant moment acting about P



Your turn

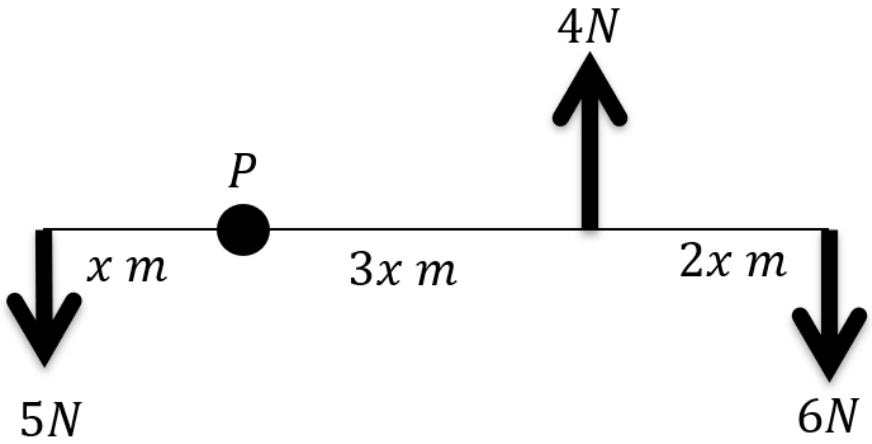
Two forces act on a lamina. Calculate the resultant moment about the point P.



5.31 Nm clockwise (3 sf)

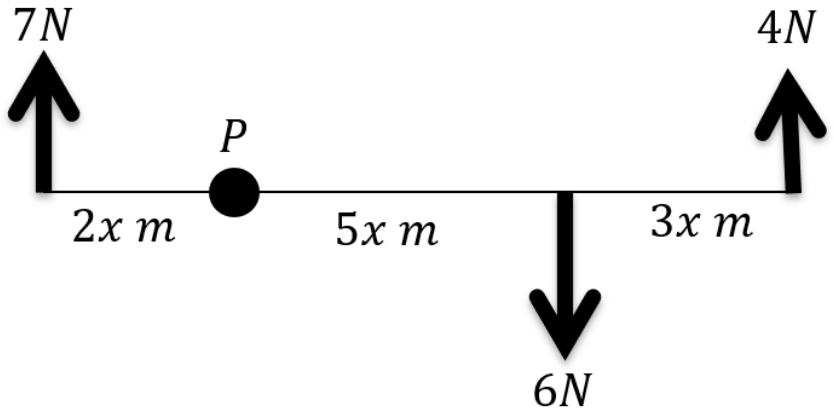
Worked example

A set of forces act on a light rod.
The resultant moment of P is $26\ Nm$ clockwise. Find the value of x



Your turn

A set of forces act on a light rod.
The resultant moment of P is $48\ Nm$ clockwise. Find the value of x



$x = 4$

4.3) Equilibrium

Chapter CONTENTS

Worked example

Person A and Person B are on opposite ends of a uniform seesaw of mass 30kg.
A weighs 60kg and is 5m from the pivot.
B is 4m from the pivot.
The seesaw remains horizontal. Determine:

a) The reaction force at the pivot of the seesaw
b) The mass of B

Your turn

Person A and Person B are on opposite ends of a uniform seesaw of mass 20kg.
A weighs 70kg and is 10m from the pivot.
B is 8m from the pivot.
The seesaw remains horizontal. Determine:

a) The reaction force at the pivot of the seesaw
b) The mass of B

a) $1764\ N$
b) $90\ kg$

Worked example

A uniform beam AB, of mass 20 kg and length 10m, rests horizontally on supports at C and D, where $AC = DB = 2$ m.
When a man of mass 60kg stands on the beam at E the magnitude of the reaction at D is three times the magnitude of the reaction at C.
By modelling the beam as a rod and the man as a particle, find the distance AE.

Your turn

A uniform beam AB, of mass 40 kg and length 5m, rests horizontally on supports at C and D, where $AC = DB = 1$ m.
When a man of mass 80kg stands on the beam at E the magnitude of the reaction at D is twice the magnitude of the reaction at C.
By modelling the beam as a rod and the man as a particle, find the distance AE.

$3.25\ m$

Worked example

A uniform rod AB has length $5\ m$ and mass $20\ kg$. The rod is in equilibrium in a horizontal position, resting on two smooth supports at C and D, where $AC = 0.4$ metres and $DB = x$ metres.
Given that the magnitude of the reaction on the rod at D is three times the magnitude of the reaction on the rod at C, find the value of x

Your turn

A uniform rod AB has length $2\ m$ and mass $50\ kg$. The rod is in equilibrium in a horizontal position, resting on two smooth supports at C and D, where $AC = 0.2$ metres and $DB = x$ metres.
Given that the magnitude of the reaction on the rod at D is twice the magnitude of the reaction on the rod at C, find the value of x

$x = 0.6$

Worked example

A uniform ladder, AB, is leaning against a smooth vertical wall on rough horizontal ground at an angle of $50°$ to the horizontal. The ladder has length $6\ m$ and is held in equilibrium by a frictional force of magnitude $40\ N$ acting horizontally at B which is the end of the ladder on the ground.
Find the mass of the ladder.

Your turn

A uniform ladder, AB, is leaning against a smooth vertical wall on rough horizontal ground at an angle of $60°$ to the horizontal. The ladder has length $5\ m$ and is held in equilibrium by a frictional force of magnitude $80\ N$ acting horizontally at B which is the end of the ladder on the ground.
Find the mass of the ladder.

$28.3\ kg$ (3 sf)

4.4) Centres of mass

Chapter CONTENTS

Worked example

Sam and Tamsin are sitting on a non-uniform plan AB of mass 45kg and length 2m.
The plank is pivoted at M, the midpoint of AB.
The centre of mass of AB is at C where AC is 0.8.
Sam has mass 70 kg.
Tamsin has mass 50 kg and sits at A.
Where must Sam sit for the plank to be horizontal?

Your turn

Sam and Tamsin are sitting on a non-uniform plan AB of mass 25kg 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 1.8 m.
Sam has mass 35 kg.
Tamsin has mass 25 kg and sits at A.
Where must Sam sit for the plank to be horizontal?

3.57 m from end A

Worked example

A non-uniform rod AB is $6\ m$ long and has weight $40\ N$.
It is in a horizontal position resting on supports at points C and D, where $AC = 0.5\ m$ and $AD = 5\ m$.
The magnitude of the reaction at C is four times the magnitude of the reaction at D.
Find the distance of the centre of mass of the rod from A

Your turn

A non-uniform rod AB is $3\ m$ long and has weight $20\ N$. It is in a horizontal position resting on supports at points C and D, where $AC = 1\ m$ and $AD = 2.5\ m$.
The magnitude of the reaction at C is three times the magnitude of the reaction at D.
Find the distance of the centre of mass of the rod from A

$1.38\ m$ (3 sf)

4.5) Tilting

Chapter CONTENTS

Worked example

A uniform beam beam AB, of mass 54kg and length 8m, rests horizontally on supports C and D where $AC = 2$ m and $CD = 7$ m.
When an object is placed at A, the beam is on the point of tilting about C.
Determine the mass of the object.

Your turn

A uniform beam beam AB, of mass 45kg and length 16m, rests horizontally on supports C and D where $AC = 5$ m and $CD = 9$ m.
When an object is placed at A, the beam is on the point of tilting about C.
Determine the mass of the object.

$27\ kg$

Worked example

A non-uniform rod AB, of length 5 m and weight 80 N, is suspended from a pair of light cables attached to C and D where $AC = 2$ m and $BD = 1$ m.
When a weight of 50 N is hung from A the rod is on the point of rotating.
Find the distance of the centre of mass of the rod from A.

Your turn

A non-uniform rod AB, of length 10 m and weight 40 N, is suspended from a pair of light cables attached to C and D where $AC = 3$ m and $BD = 2$ m.
When a weight of 25 N is hung from A the rod is on the point of rotating.
Find the distance of the centre of mass of the rod from A.

$4.875\ m$

Worked example

A beam AB has length $25\ m$. The beam rests horizontally in equilibrium on two smooth supports at the points P and Q, where $AP = 4\ m$ and $QB = 5\ m$.
When an adult of mass $60\ kg$ stands on the beam at A, the beam remains in equilibrium and is on the point of tilting about P.
When the same child stands on the beam at B, the beam remains in equilibrium and is on the point of tilting about Q.
The child is modelled as a particle and the beam is modelled as a non-uniform rod.

a) Find the mass of the beam
b) Find the distance of the centre of mass of the beam from A

Your turn

A beam AB has length $15\ m$. The beam rests horizontally in equilibrium on two smooth supports at the points P and Q, where $AP = 2\ m$ and $QB = 3\ m$.
When a child of mass $50\ kg$ stands on the beam at A, the beam remains in equilibrium and is on the point of tilting about P.
When the same child stands on the beam at B, the beam remains in equilibrium and is on the point of tilting about Q.
The child is modelled as a particle and the beam is modelled as a non-uniform rod.

a) Find the mass of the beam
b) Find the distance of the centre of mass of the beam from A

a) $25\ kg$
b) $6\ m$