TURNING EFFECT OF FORCES

Specification

TURNING EFFECT

know and use the relationship:

moment = force × perpendicular distance from the pivot

know that the weight of a body acts through its centre of gravity

know and use the principle of moments for a simple system of parallel forces acting in one plane

understand that the upward forces on a light beam, supported at its ends, vary with the position of a heavy object placed on the beam

The moment of a force

Also known as the **turning effect** of a force.

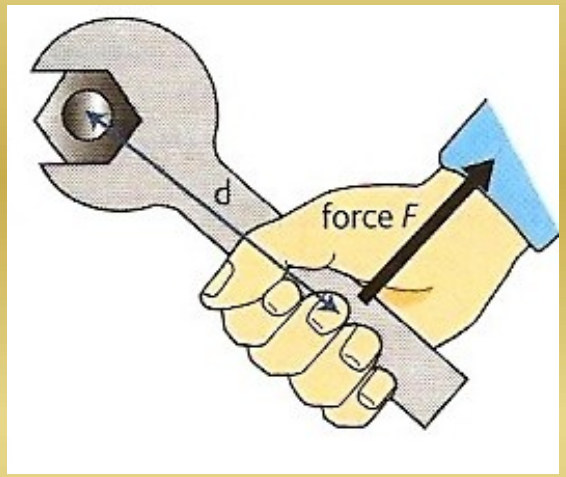
The **moment of a force** about any point is defined as:

moment = force x perpendicular distance from the pivot

$$moment = F \times d$$

Unit: **newton-metre (Nm)**

Moments can be either **CLOCKWISE** or **ANTICLOCKWISE**



Force F exerting an ANTICLOCKWISE moment through the spanner on the nut

Question

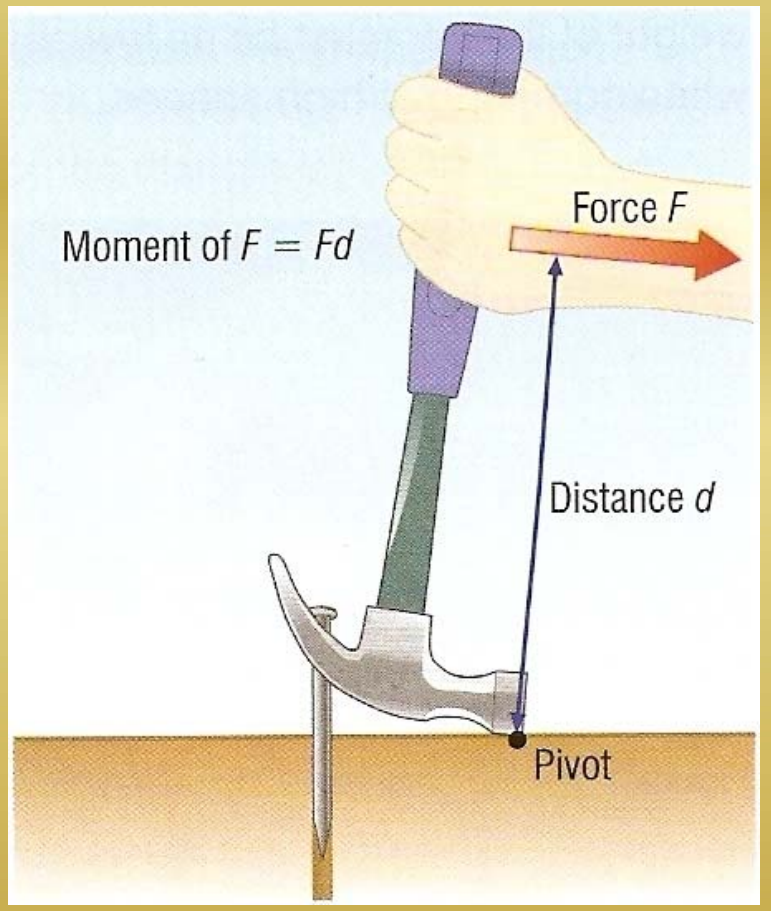
Calculate the moment exerted with the claw hammer if the person exerts a force of 80N and distance d equals 25cm.

moment = F x d

= 80N x 25cm

= 80N x 0.25m

= 20 Nm CLOCKWISE



Complete:

Answers

Force (N)	Distance	Moment (Nm)
40	3 m	
200		1000
	4 m	200
3000	20 cm	

Complete:

Answers

Force (N)	Distance	Moment (Nm)
40	3 m	120
200	5 m	1000
50	4 m	200
3000	20 cm	600

Question

Choose appropriate words to fill in the gaps below:

The ‘moment of a force’ is another name for the ‘_____ effect of force’.

The moment of a force is equal to the _____ multiplied by the perpendicular _____ between the line of _____ of the force and the turning point.

Turning effect is measured in _____ metres.

_____ can be either clockwise or anticlockwise.

WORD SELECTION:

moments force distance newton turning action

Question

Choose appropriate words to fill in the gaps below:

The ‘moment of a force’ is another name for the ‘ turning effect of force’.

The moment of a force is equal to the force multiplied by the perpendicular distance between the line of action of the force and the turning point.

Turning effect is measured in newton metres.

moments can be either clockwise or anticlockwise.

WORD SELECTION:

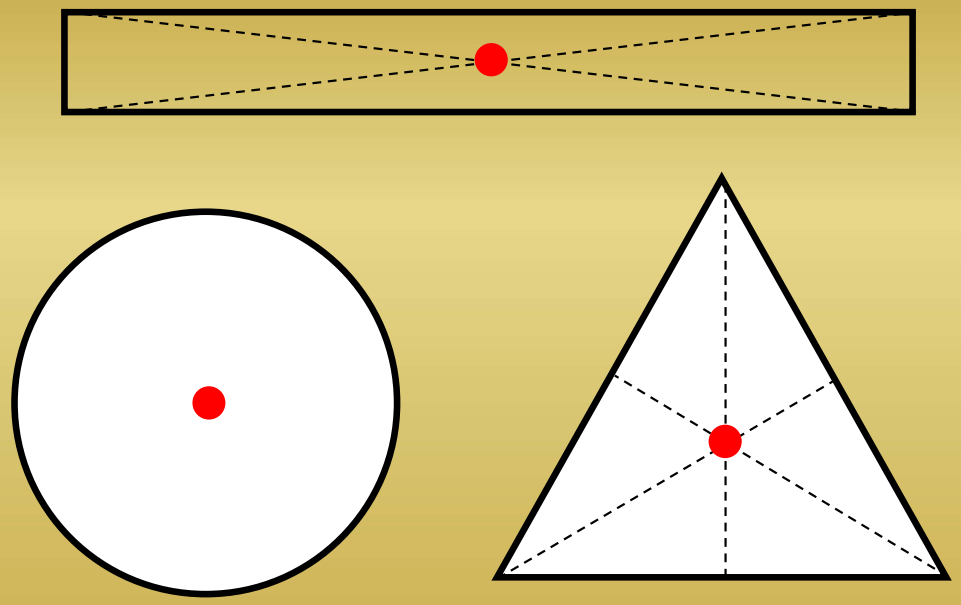
moments force distance newton turning action

Centre of gravity

The centre of gravity of a body is that point at which the weight of the body acts.

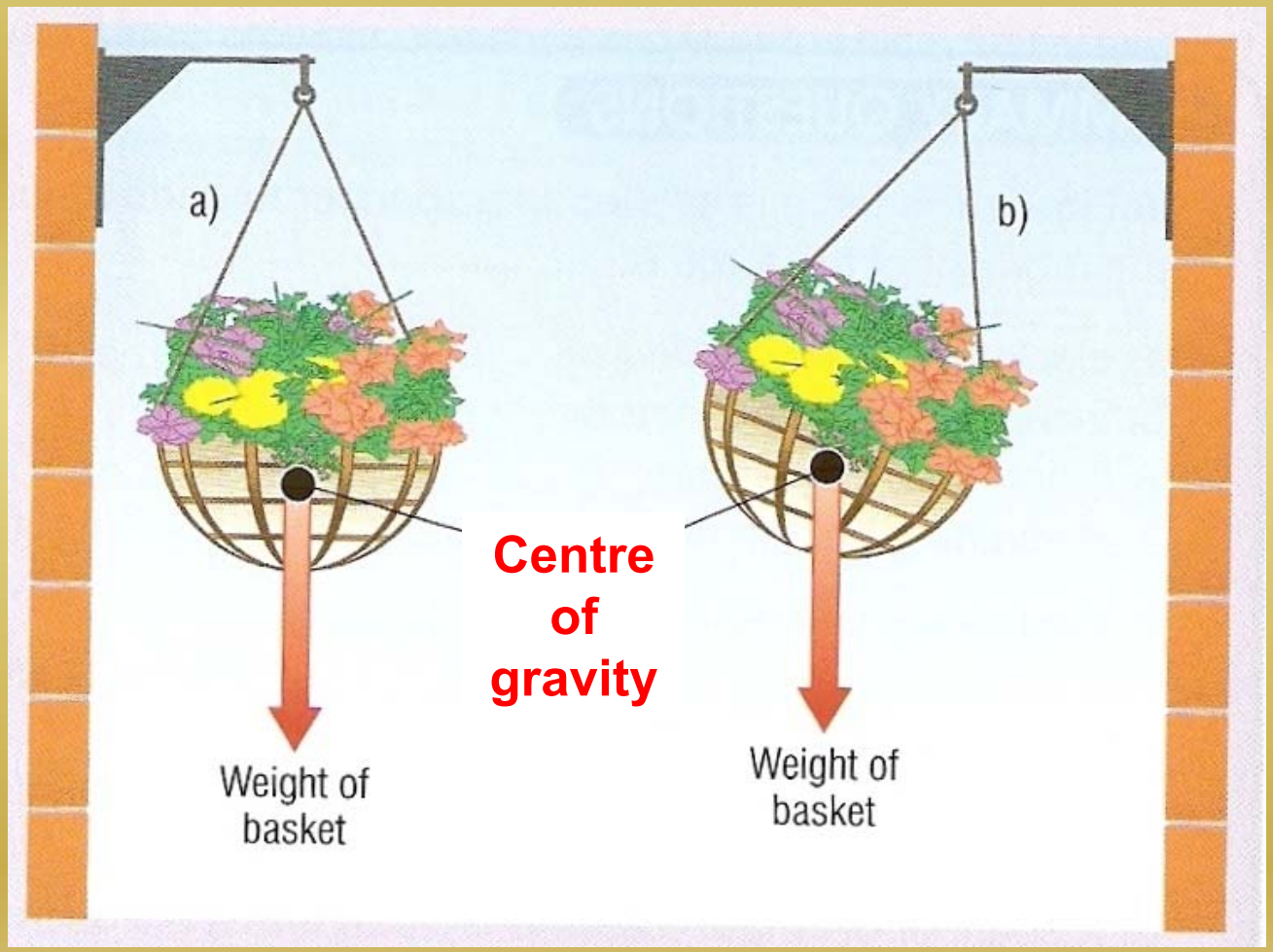
The **centre of gravity** of a symmetrical body is along the axis of symmetry.

Centre of gravity is also sometimes called **centre of mass**.

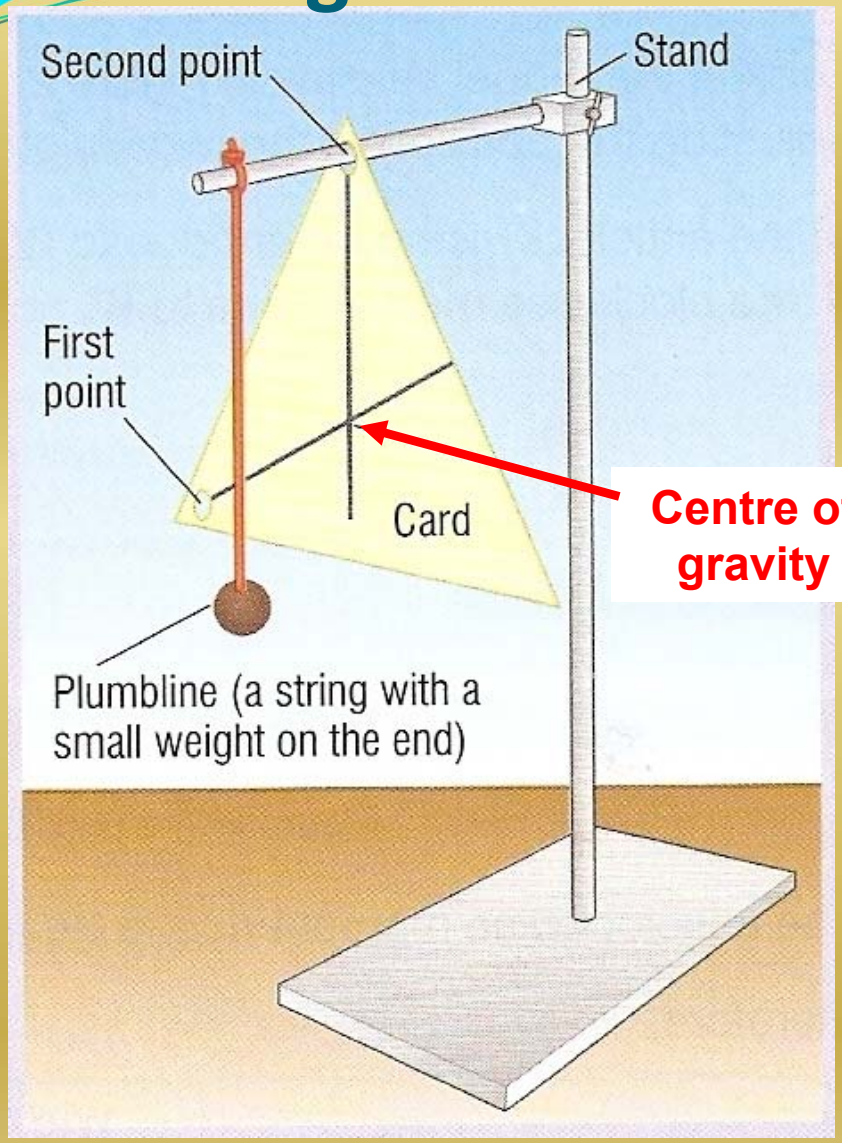


centres of gravity of regular shapes

If suspended, a body will come to rest with its centre of gravity directly below the point of suspension.



Finding the centre of gravity of a card



Pierce the card in at least two places.

Suspend the card from one of these holes.

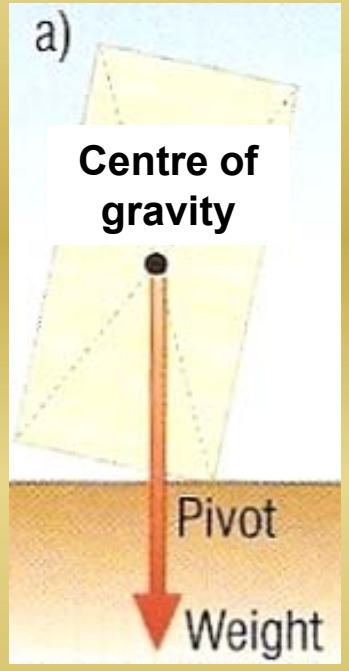
Hang a plumbline from the point of suspension.

Using the plumbline as a reference draw a vertical line on the card.

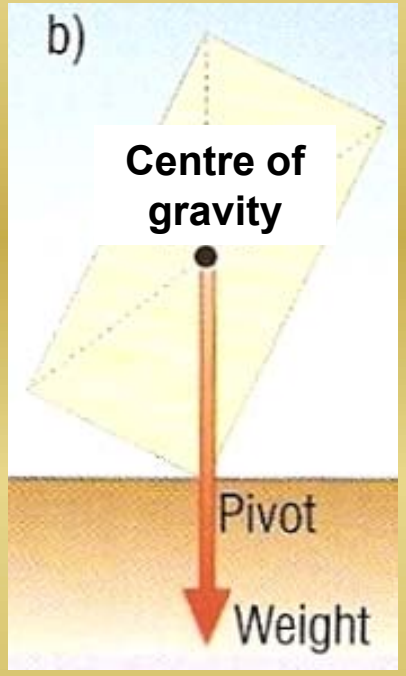
Repeat for the other hole(s).

The **centre of gravity** is where the lines cross on the card.

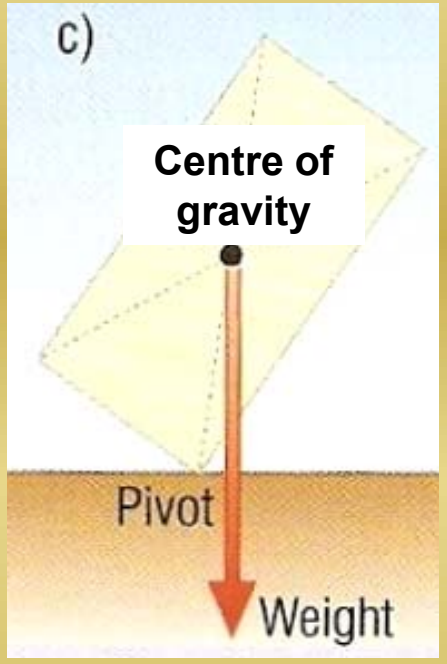
Stability



stable



balanced



unstable - toppling

A body is stable as long as its centre of gravity remains vertically above its base.

If this is not the case, the body will topple.

Question

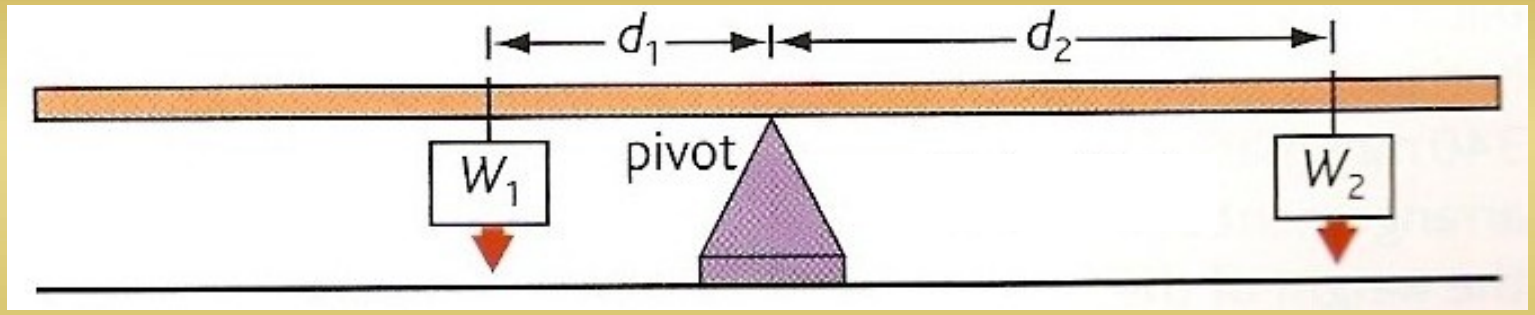
What factors make a modern racing car as stable as possible?

1. A wide wheel base.
2. A low centre of gravity.

The principle of moments

When an object is not turning (e.g. balanced):

The total clockwise moment equals the total anticlockwise moment



If the ruler above is balanced:

clockwise moment = anticlockwise moment

$$W_2 \times d_2 = W_1 \times d_1$$

Question 1

On a see-saw Mary, weight 600N balances John, weight 200N when she sits 1.5m away from the pivot. How far from the pivot is John?

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On a see-saw Mary, weight 600N balances John, weight 200N when she sits 1.5m away from the pivot. How far from the pivot is John?

Applying the principle of moments:

Mary's weight x distance = John's weight x distance

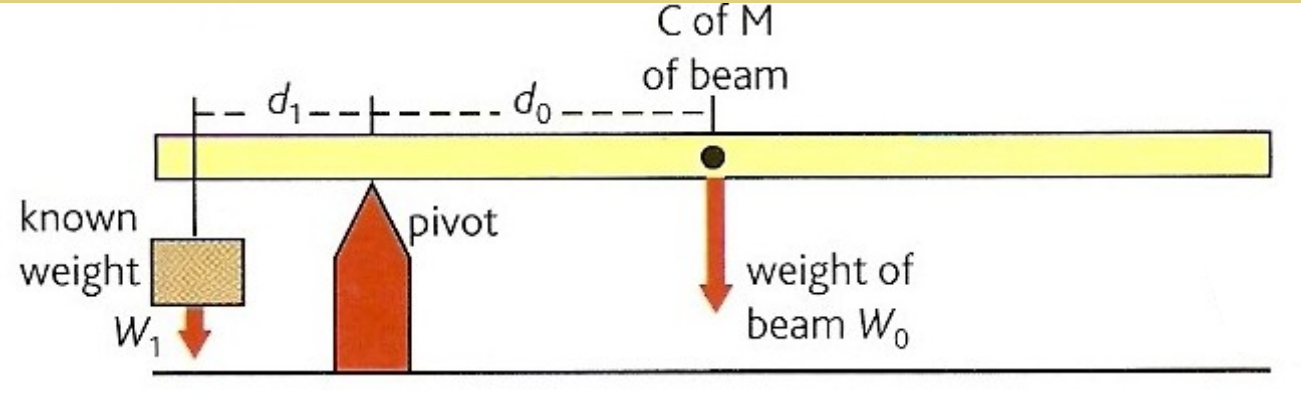
600N x 1.5m = 200N x ***distance***

900 = 200 x ***distance***

900 ÷ 200 = ***distance***

John is 4.5m from the pivot

Question 2



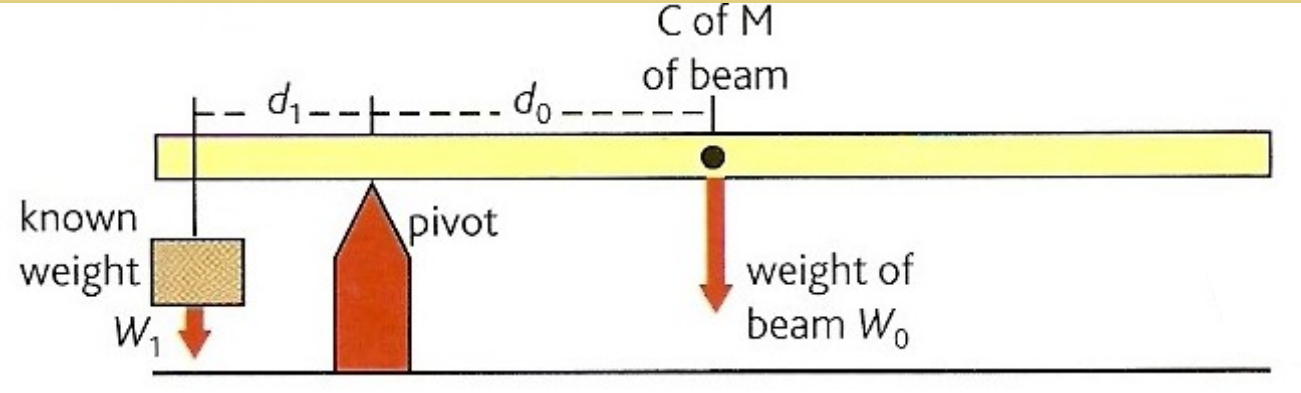
Calculate the weight of the beam, W_o *if it is balanced when:*

$W_1 = 6N$;

$d_1 = 12\ cm$;

$d_o = 36\ cm$.

Question 2



Calculate the weight of the beam, W_o *if it is balanced when:*

$W_1 = 6N$;

$d_1 = 12\ cm$;

$d_o = 36\ cm$.

Applying the principle of moments:

$W_1 \times d_1 = W_0 \times d_0$

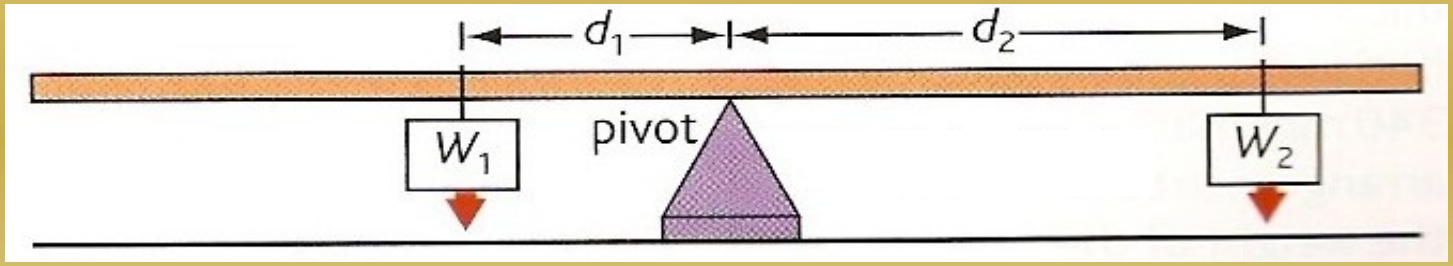
6N x 12 cm = W_0 x 36 cm

W_0 = 72 / 36

W_0 the weight of the beam = 2N

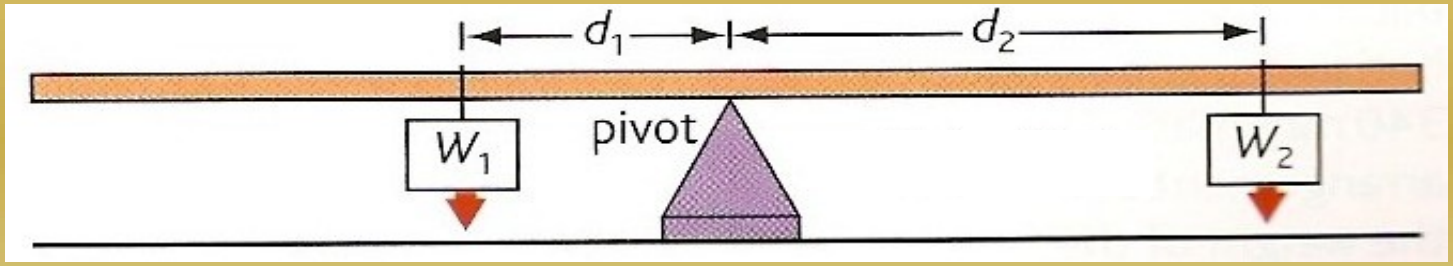
Complete for a balanced ruler:

W_1	d_1	W_2	d_2
5 N	20 cm	10 N	
4 N	15 cm		10 cm
6 N		2 N	36 cm
	25 cm	2 N	100 cm



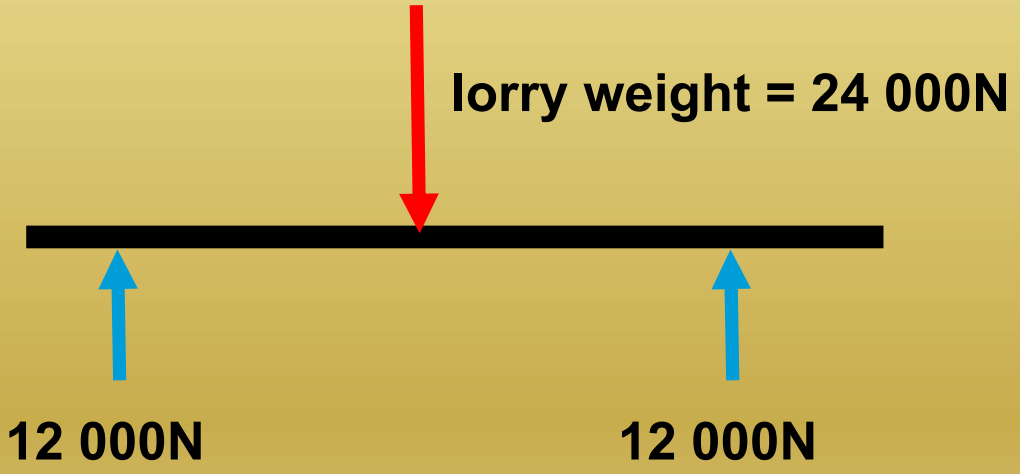
Complete for a balanced ruler:

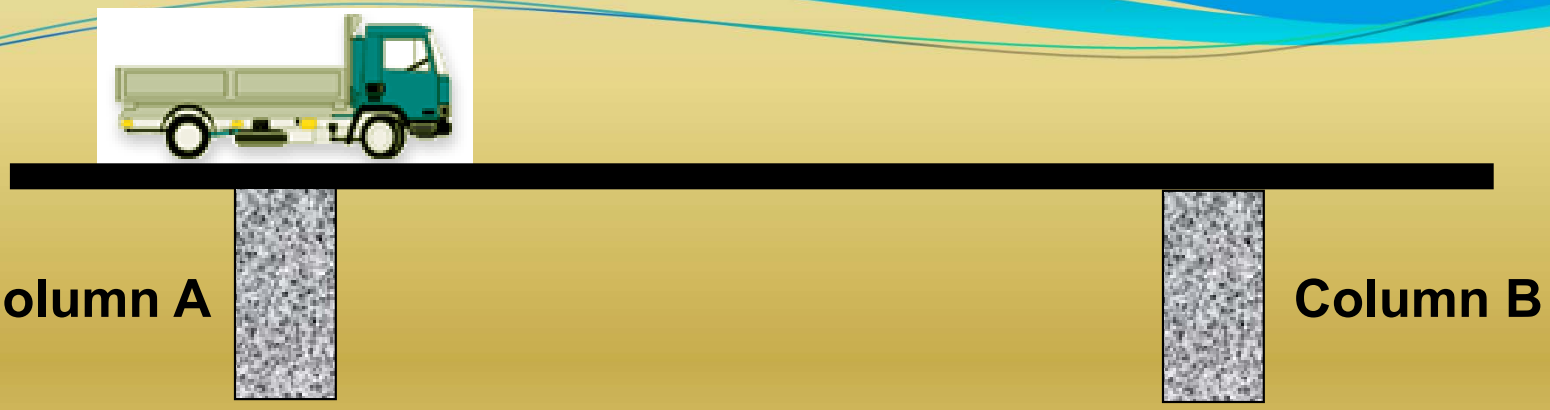
W_1	d_1	W_2	d_2
5 N	20 cm	10 N	10 cm
4 N	15 cm	6 N	10 cm
6 N	12 cm	2 N	36 cm
8 N	25 cm	2 N	100 cm



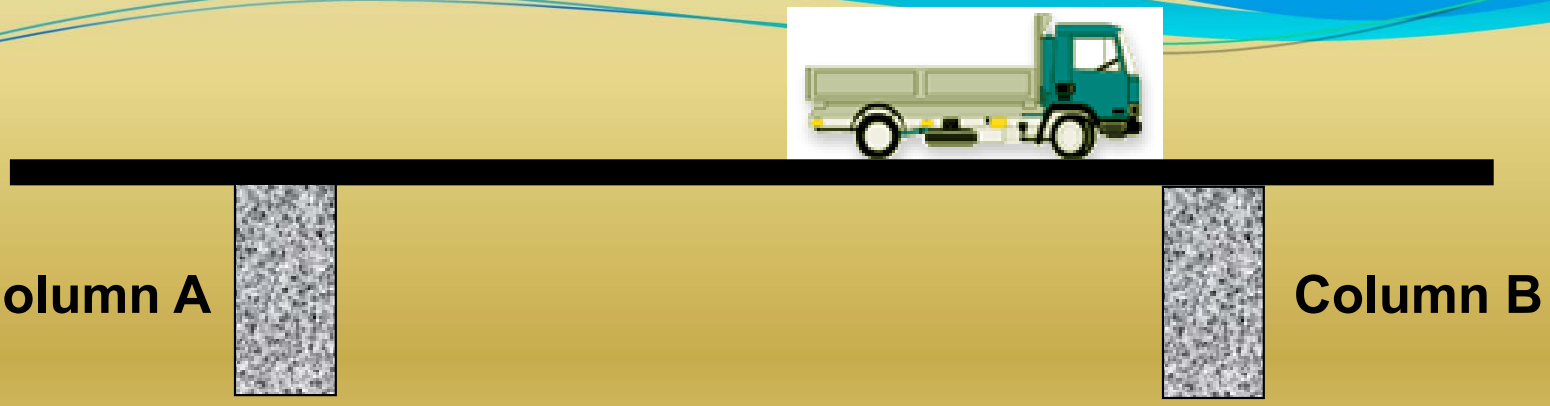
Forces on a beam or bridge

When the lorry is at the centre of the bridge its weight will be supported equally by the two columns A and B.

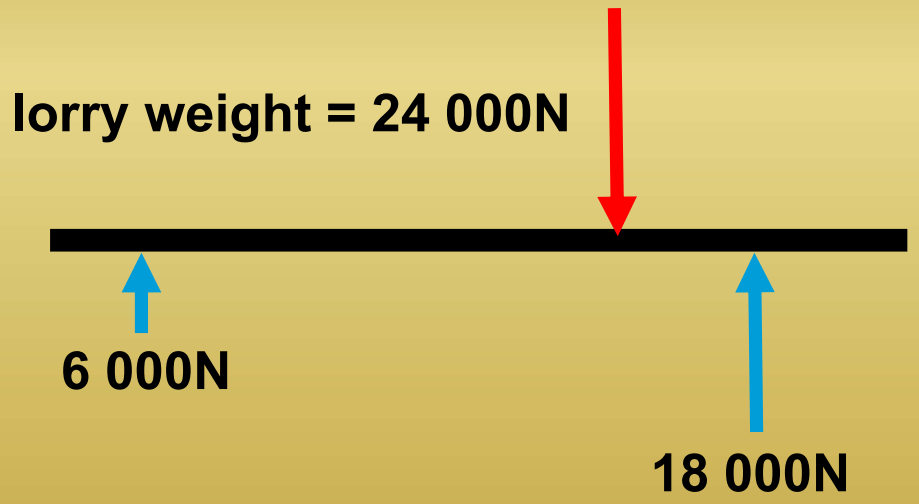




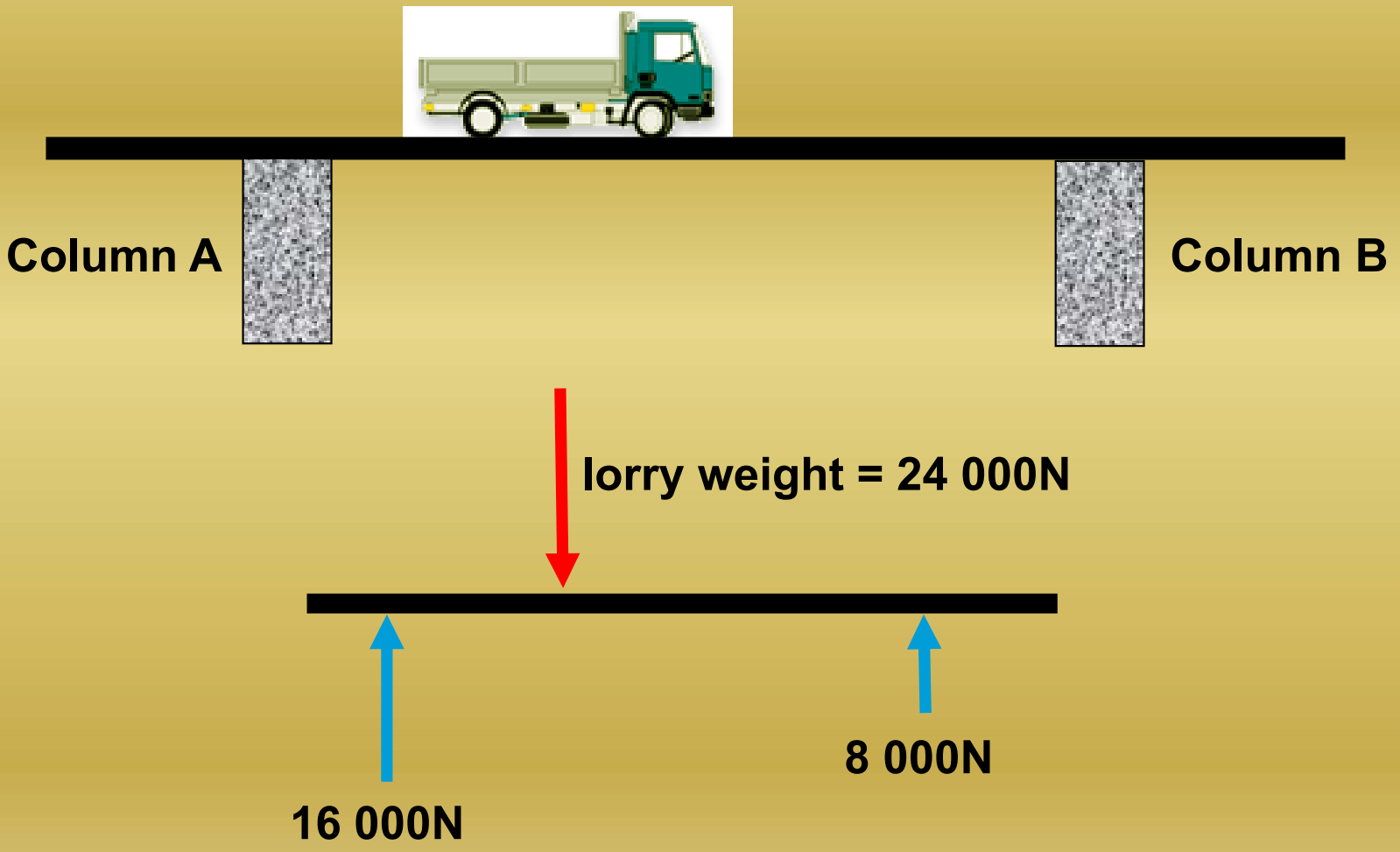
When the lorry was over columns A all of its weight would have been supported by this column



When the lorry is ¾ the way across the bridge column B will bear ¾ of its weight. Column A bears the remaining ¼.



What are the column forces when the lorry is one third the way across the bridge?



Question

Choose appropriate words to fill in the gaps below:

The turning effect of a _____ is also called the _____ of a force. Moment is measured in _____ metres.

If a body is balanced the total clockwise moment is _____ to the total _____ moment.

A body will be _____ if its centre of gravity lies vertically above the _____ of the body. A tractor has a large wheel base to reduce the possibility of it _____.

WORD SELECTION:

toppling anticlockwise newton moment

equal stable force base

Question

Choose appropriate words to fill in the gaps below:

The turning effect of a **force** is also called the **moment** of a force. Moment is measured in **newton** metres.

If a body is balanced the total clockwise moment is **equal** to the total **anticlockwise** moment.

A body will be **stable** if its centre of gravity lies vertically above the **base** of the body. A tractor has a large wheel base to reduce the possibility of it **toppling**.

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