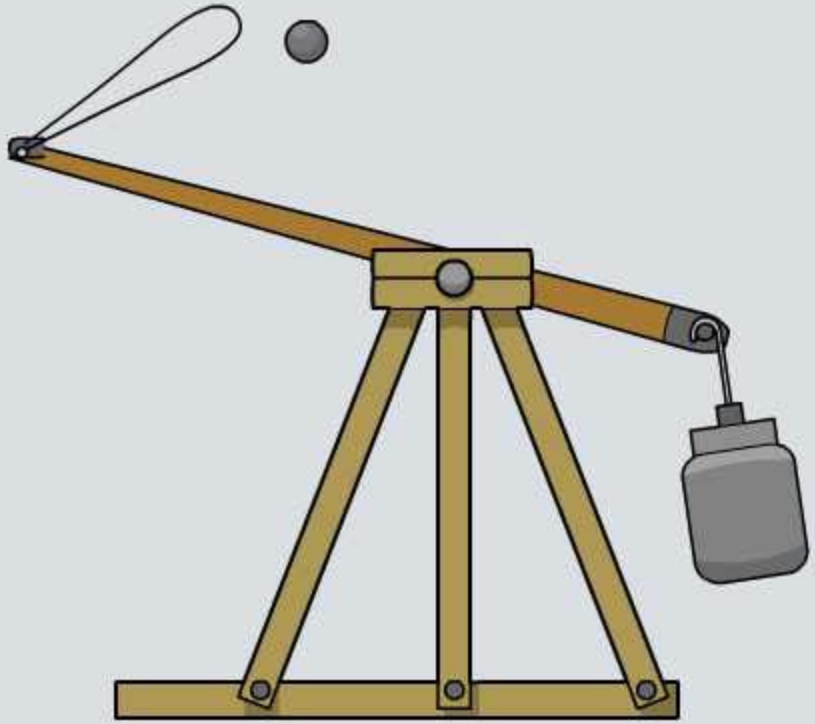
Moment Calculations

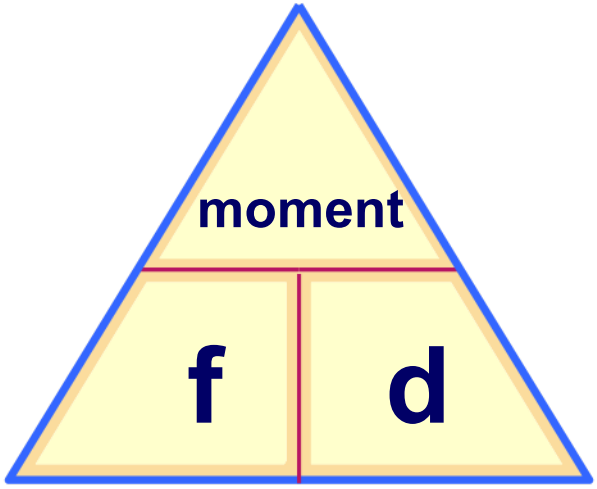


Moment equation

The moment of a force is given by the formula:

moment = force (N) × distance from pivot (cm or m)

This can also be represented in a formula triangle:

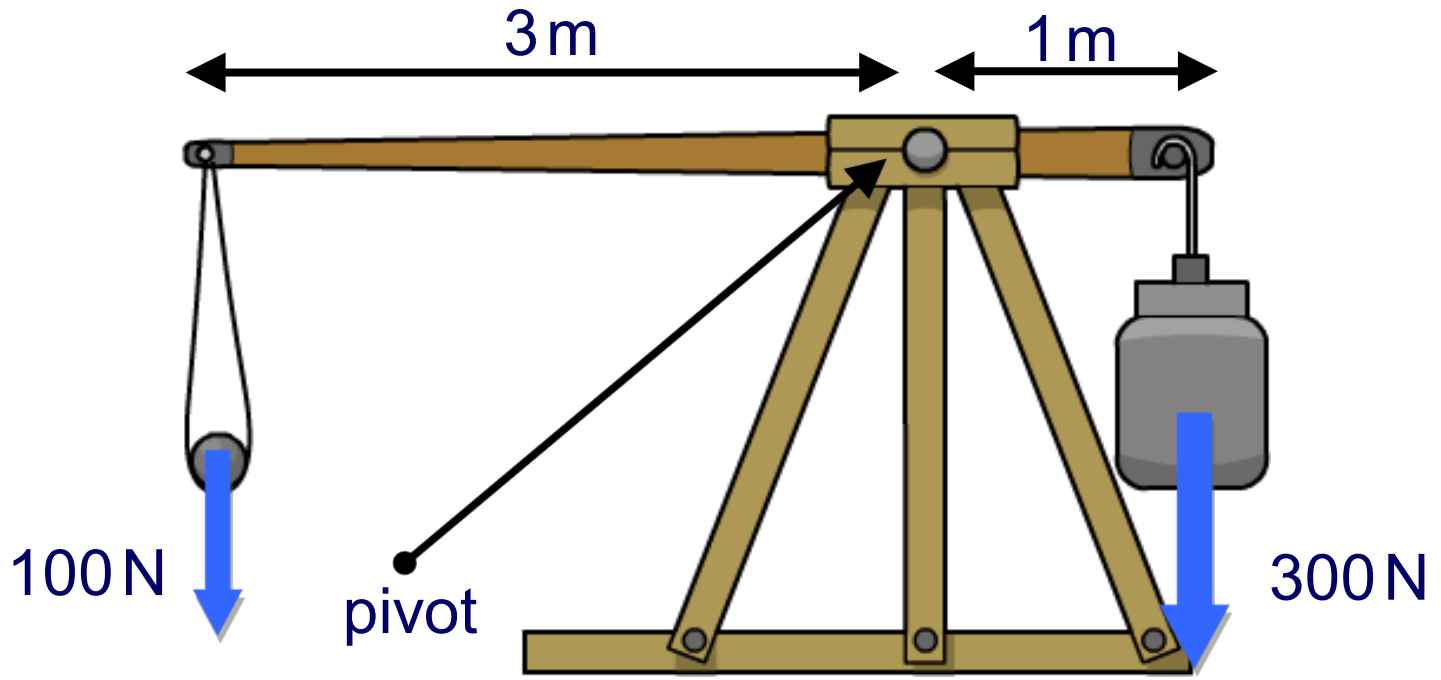


Moments are measured in newton centimeters (Ncm) or newton meters (Nm).

Moment calculation

The counterweight on the trebuchet weighs 300 N and is attached to the short arm. It is 1 m from the pivot. It exerts a clockwise moment. What is the size of this moment?

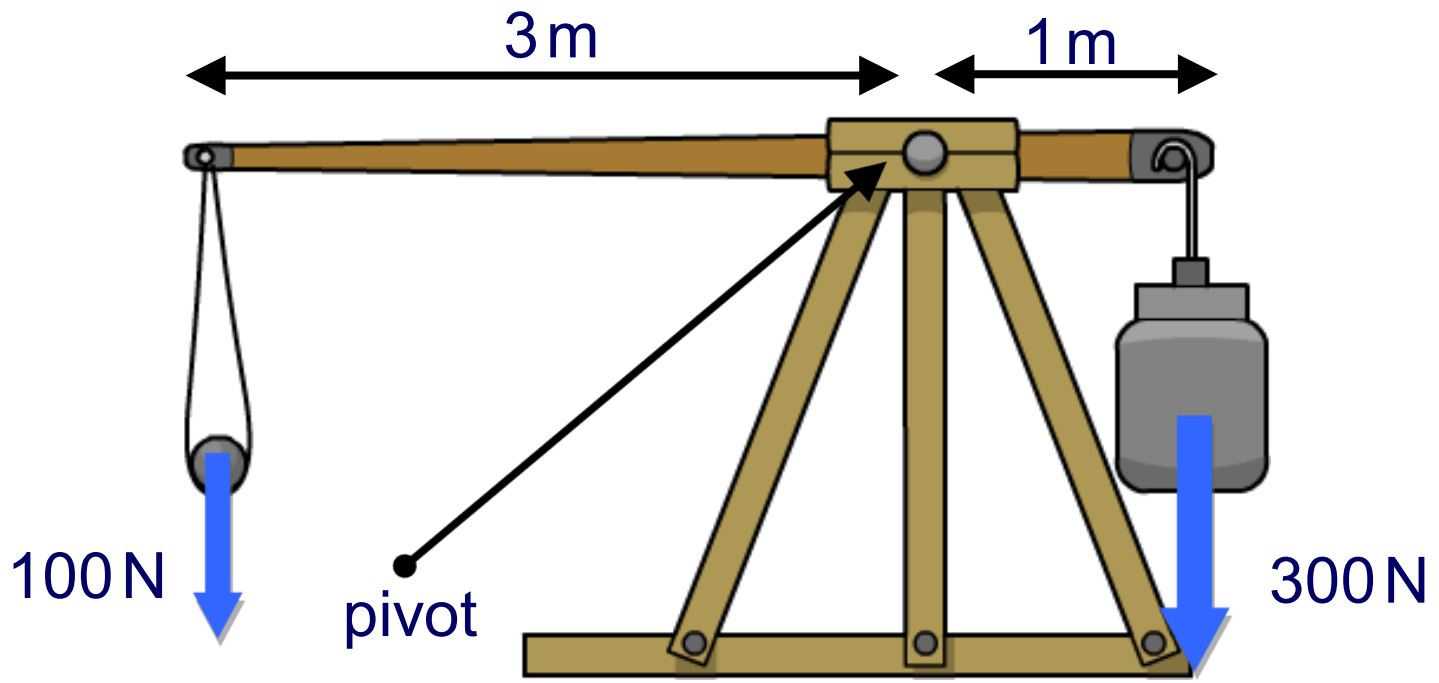
moment = 300 × 1 = 300 Nm



Principle of moments

The lead shot on the trebuchet weighs 100 N and is attached to the long arm. It is 3 m from the pivot. It exerts a clockwise moment. What is the size of this moment?

moment = 100 x 3 = 300 Nm

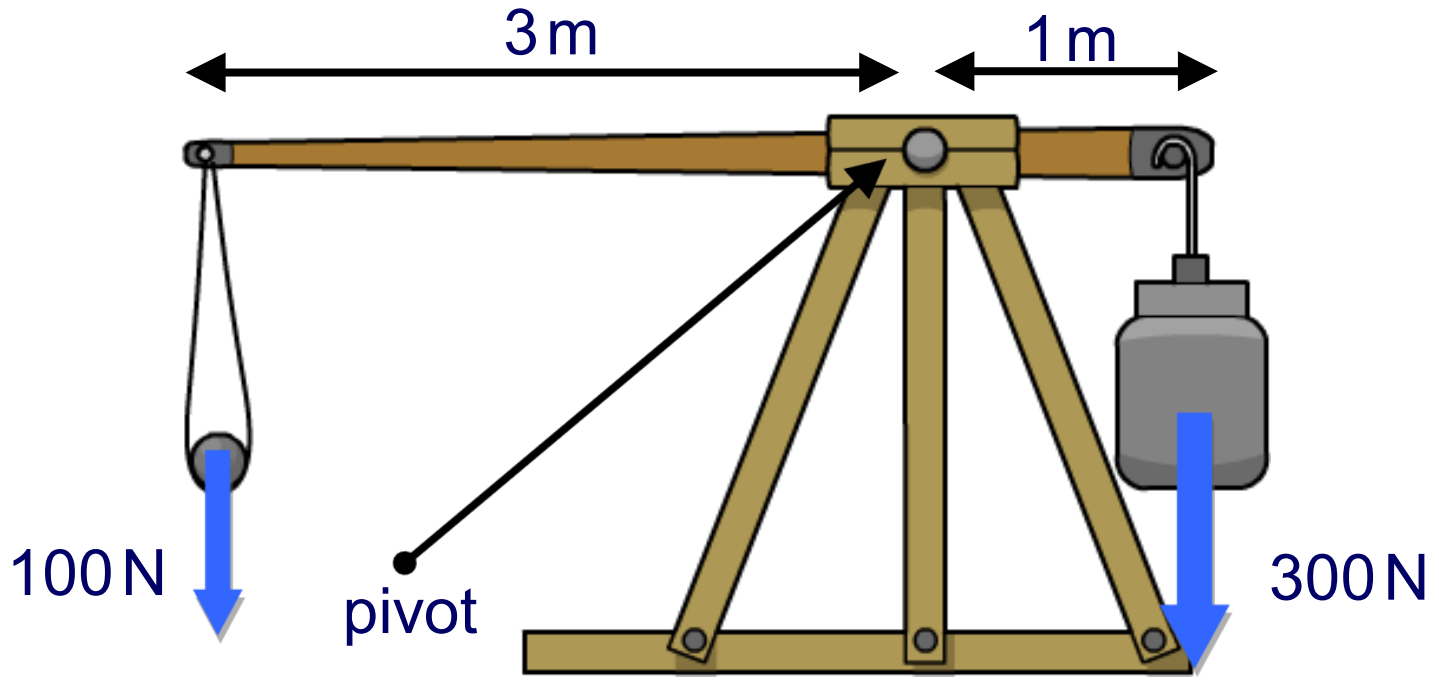


Principle of moments

If the counterclockwise moment and clockwise moment are equal, then the trebuchet is balanced. This is known as the **principle of moments**.

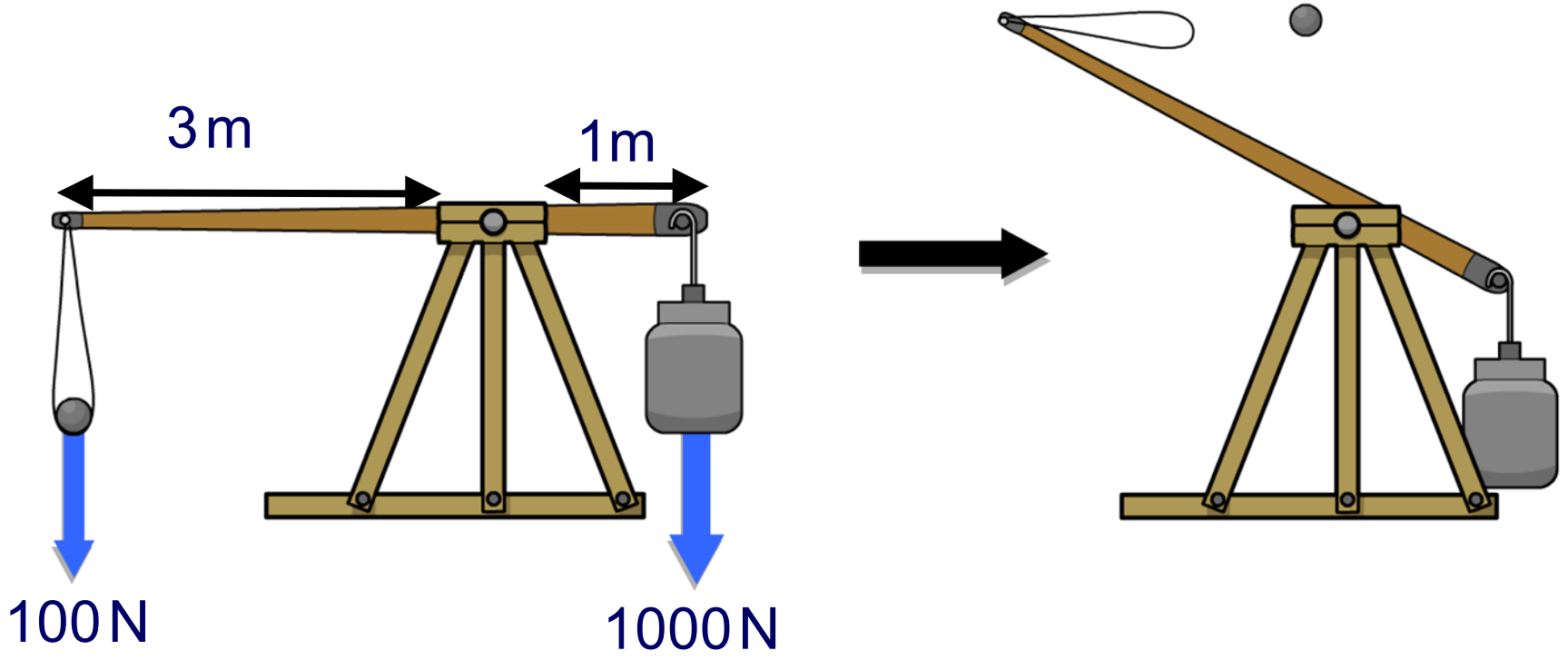
When something is balanced around a pivot:

total clockwise moment = total counterclockwise moment



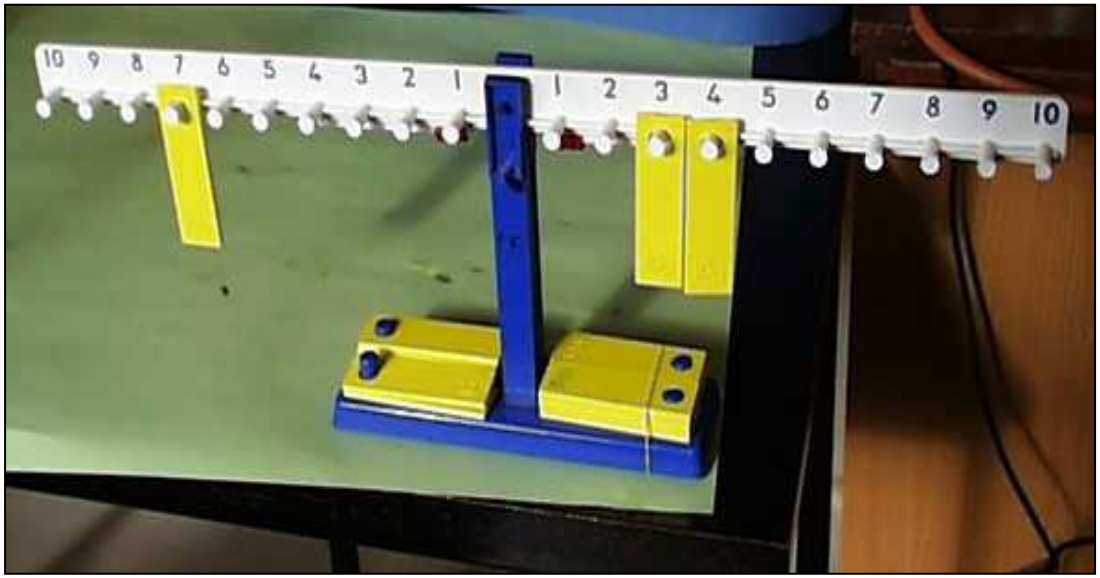
Principle of moments

What happens if the counterweight is increased to 1000 N? The moments will no longer be balanced, so the trebuchet will be able to fire.



Principle of moments

The principle of moments can be investigated using 10 g masses with this balance. 10 g exerts a force of 0.1 N.



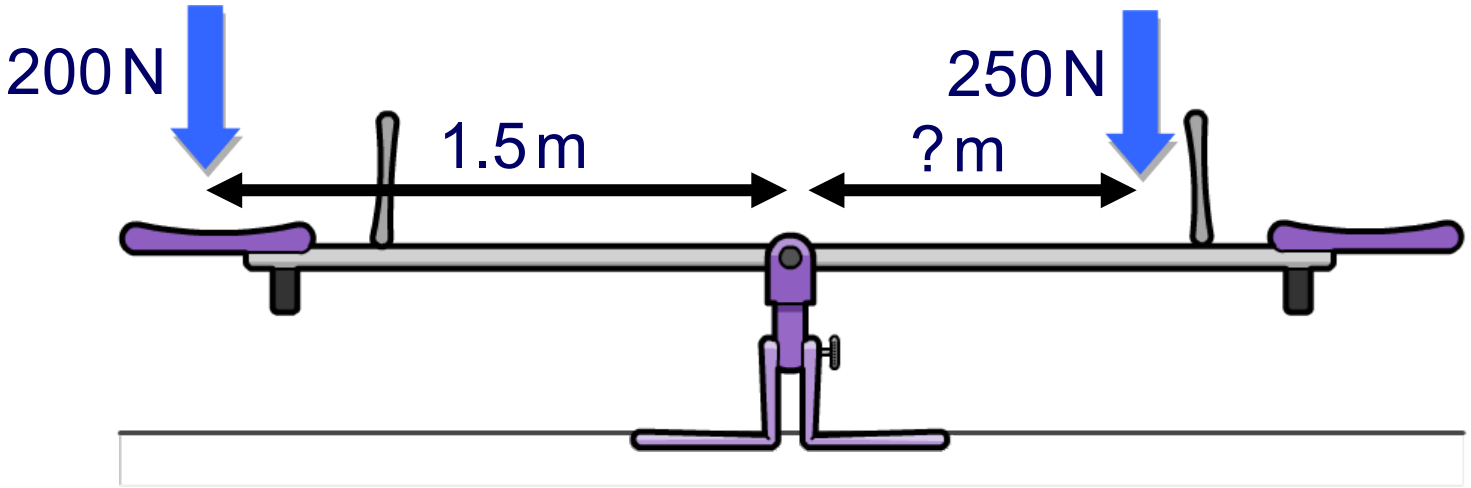
Counterclockwise moment = 0.1 × 7 = 0.7 Ncm

Clockwise moment = (0.1 × 3) + (0.1 × 4) = 0.7 Ncm

Both moments are equal, so the see-saw is balanced.

Principle of moments – calculation

Two girls are sitting on opposite sides of a see-saw. One girl weighs 200 N and is 1.5 m from the pivot. How far from the pivot must her 250 N friend sit if the see-saw is to balance?



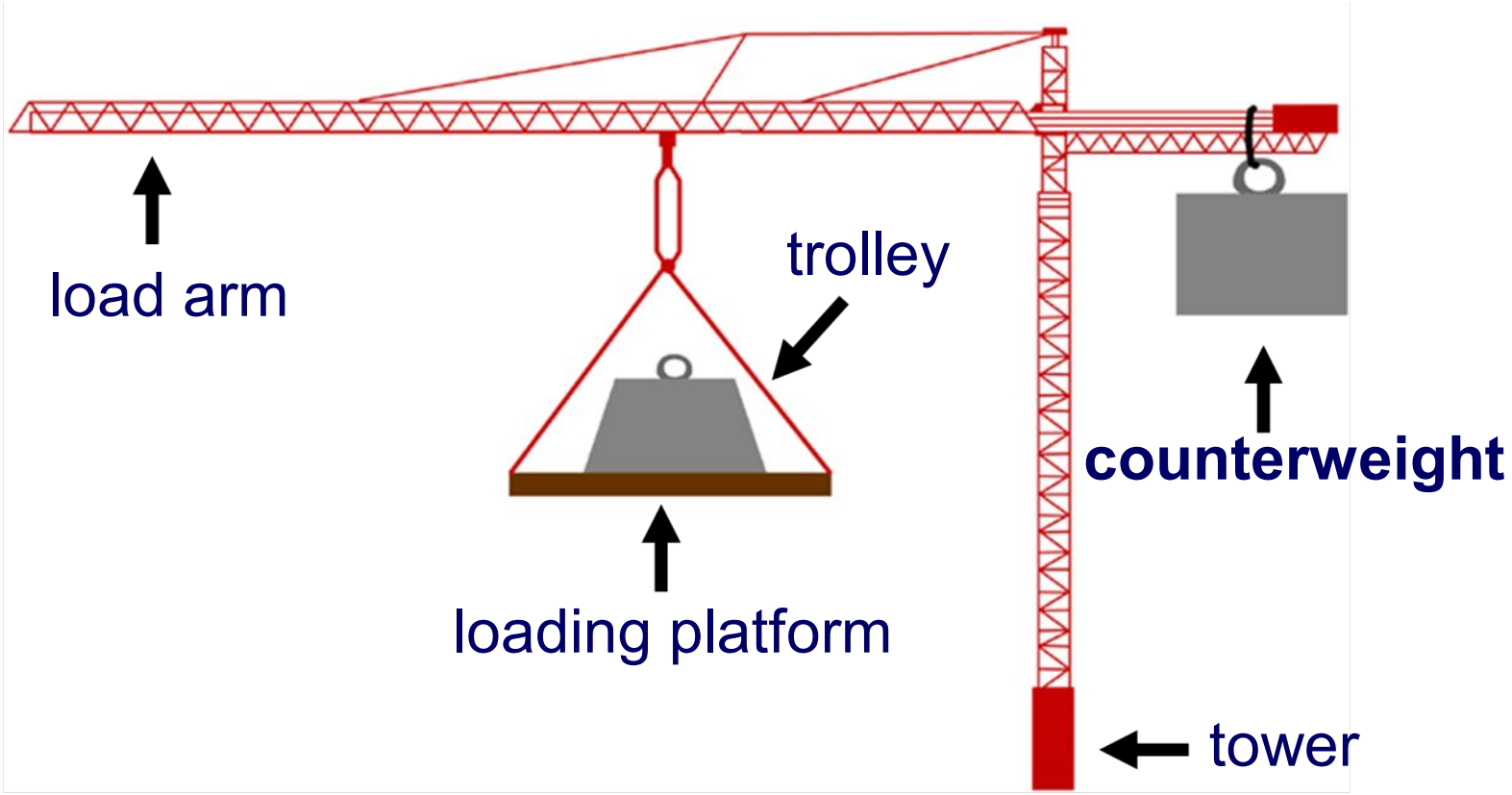
total clockwise moment = total counterclockwise moment

$$200\,\text{N} \times 1.5\,\text{m} = 250\,\text{N} \times \text{distance}$$

$$\frac{200}{250} \times 1.5 = \text{distance} = \mathbf{1.2\,m}$$

How do tower cranes work?

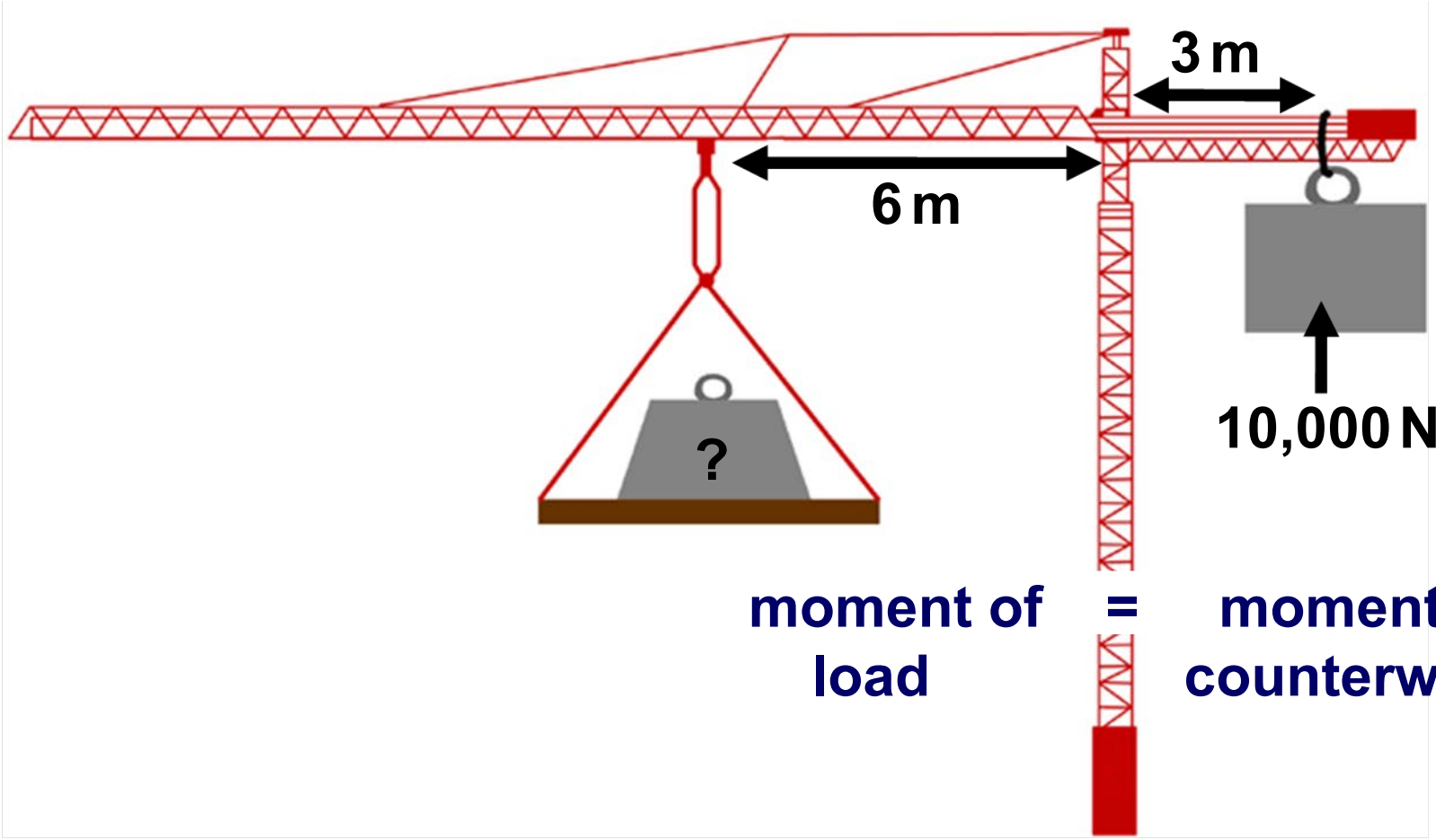
Tower cranes are essential at any major construction site.



Concrete counterweights are fitted to the crane's short arm. Why are these needed for lifting heavy loads?

Moment calculation – crane

If the crane below is balanced, how heavy is the load?



Moment calculation – crane

Moment of load = load × distance from tower

= ? × 6

Counterweight moment = counterweight × distance

= 10,000 × 3

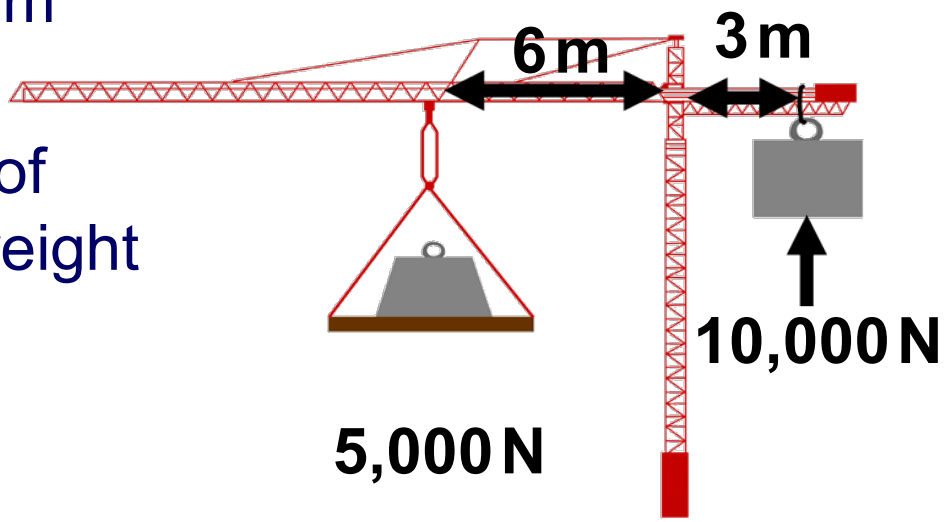
= 30,000 Nm

Moment of load = moment of counterweight

? × 6 = 30,000

$? = \frac{30{,}000}{6}$

? = **5,000 N**



Crane operator activity