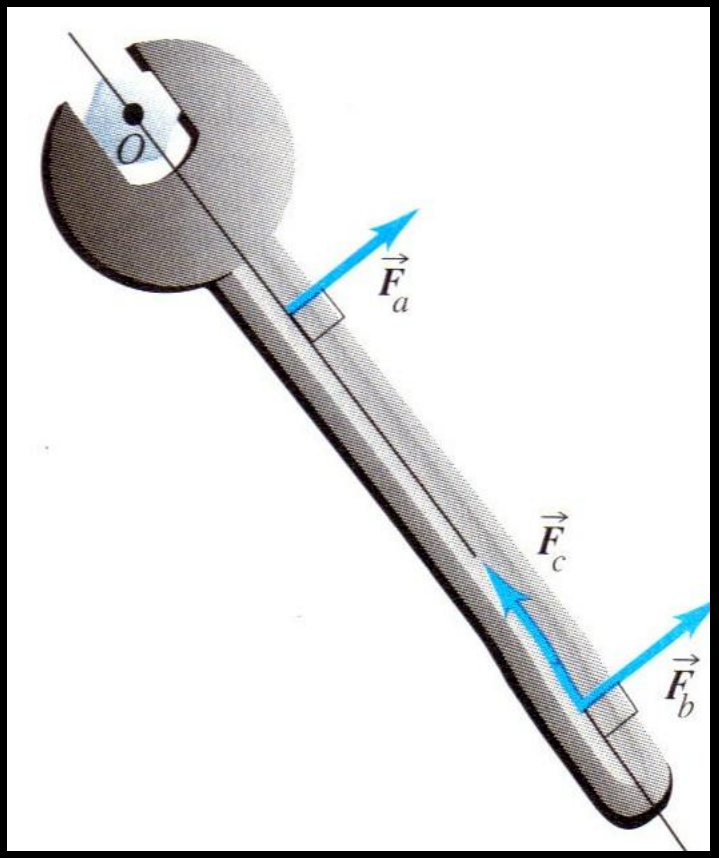
Torque and Moment

At the end of this lecture you should

- Understand what is meant by a *torque (moment of a force)*
- Be able to perform calculations to demonstrate your understanding

Torque (moment of a force)



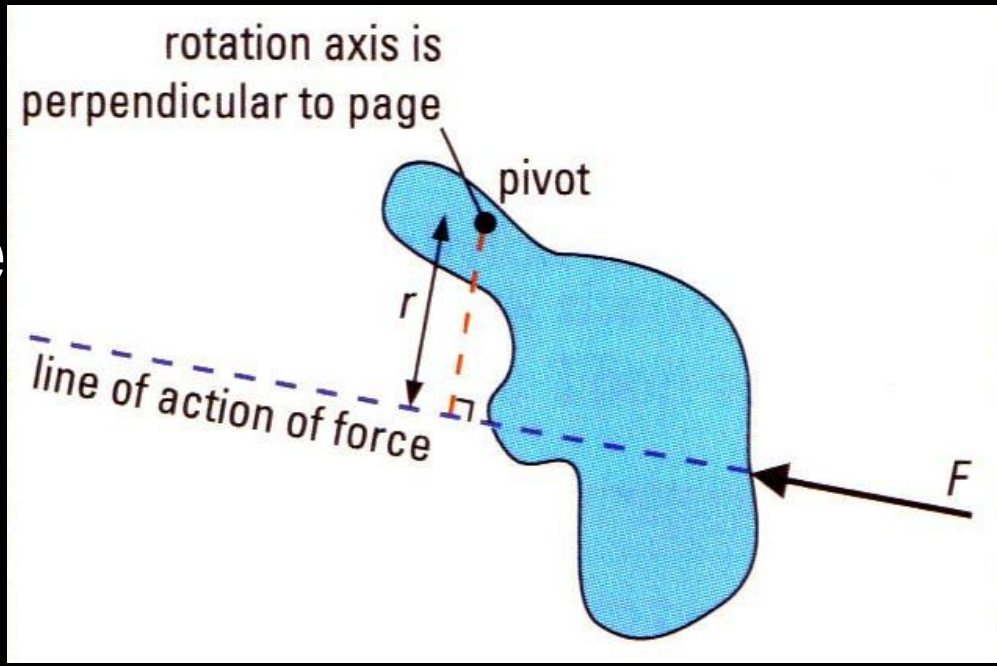
Which of these three forces is most likely to loosen the tight bolt?

Why?

Torque (moment of a force)

The turning effect of a force F about a given axis is called its torque. A torque (also called ‘moment’ of a force) is a ‘turning force’. It gives a measure of how much ‘turning effect’ a force has about a given axis.

Torque = force x perpendicular distance from line of action of force to the pivot

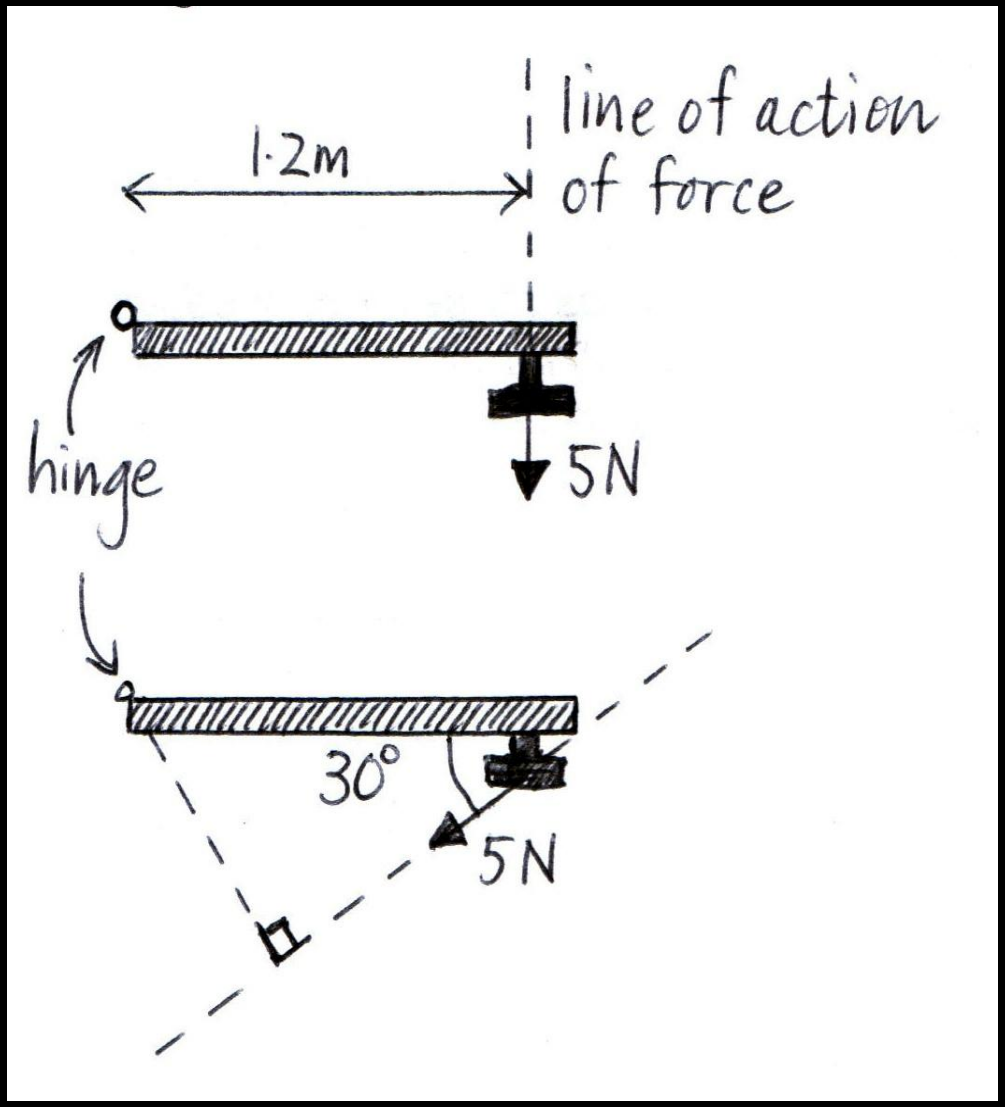


Example 1. ‘Opening doors’

A boy pulls on a door handle.

A) Calculate the torque about the hinge.

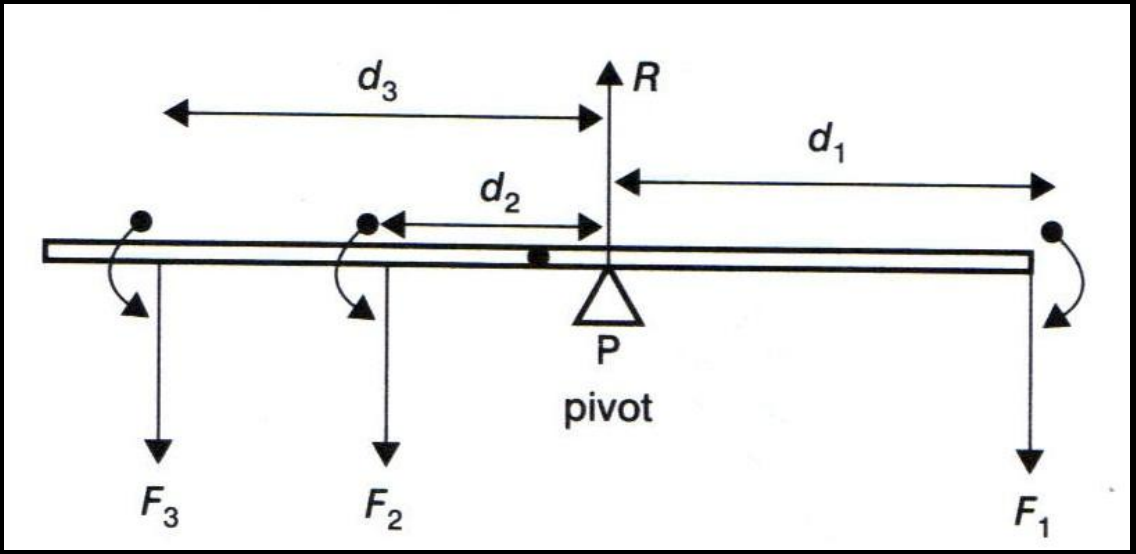
B) If he pulls at an angle as shown, what is the new torque?



Principle of moments

The principle of moments states that for a body to be in equilibrium:

The sum of the external torques on a rigid object must be equal to zero



$$F_1 d_1 = F_2 d_2 + F_3 d_3$$

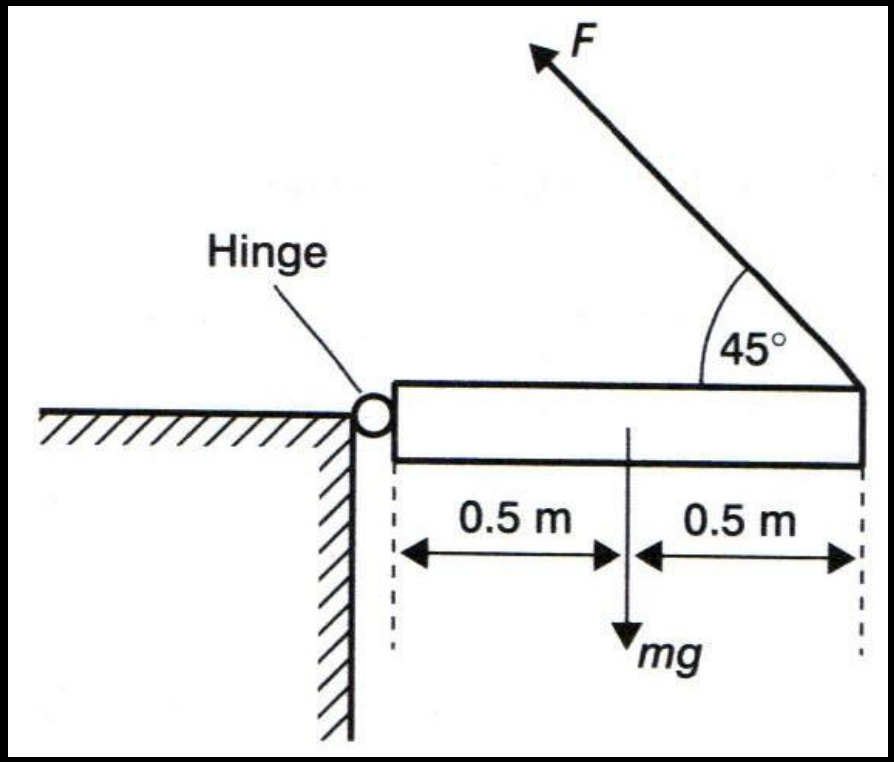
Example 2. Family on seesaw

A young girl wants to sit still with her mother and father on a seesaw. Her father, 70 kg, sits only on one side 2.5 m from the pivot. On the other side, her mother, 50 kg, sits 3 m from the pivot. The girl sits on the same side as her mother. At what distance should the girl, who weighs 20 kg, sit from her mother?

Example 3. Equating moments

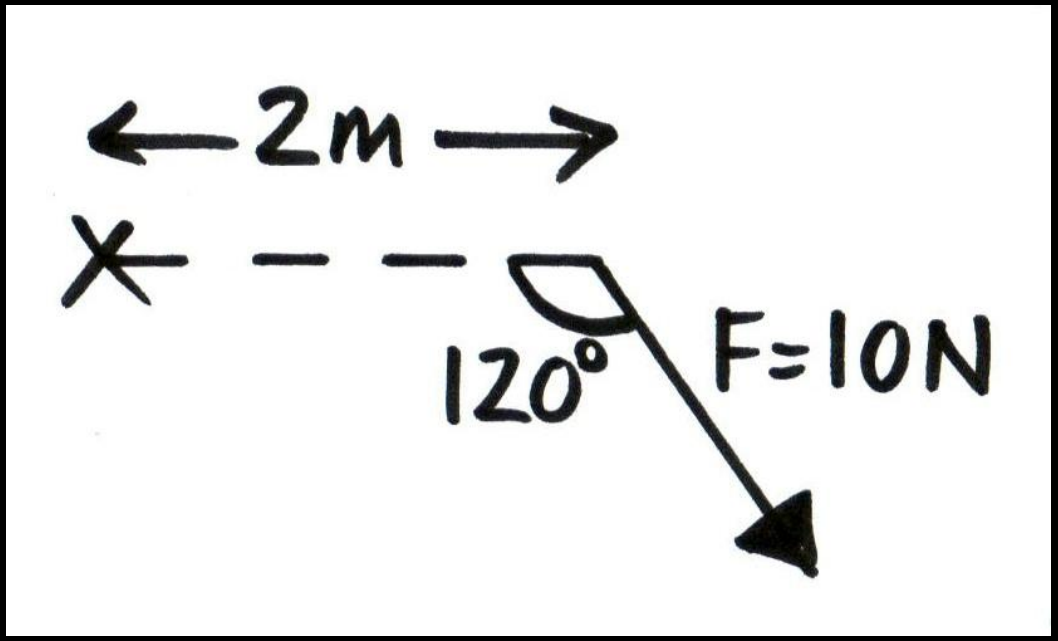
A hinged trap-door of mass 15 kg and length 1.0 m is to be opened by applying a force F at an angle of 45º.

Find F.



Example 4

Find the moment of F about X in the diagram shown.



Hint: redraw the diagram so that the line of action of F is clear.

The vector product (cross product)

From examples 4 and 1, we can see that we might write a general formula for torque:

torque = $F \times r \sin \theta$

where r is the magnitude of the displacement vector from the pivot to the application of F, and θ is the angle between F and r.