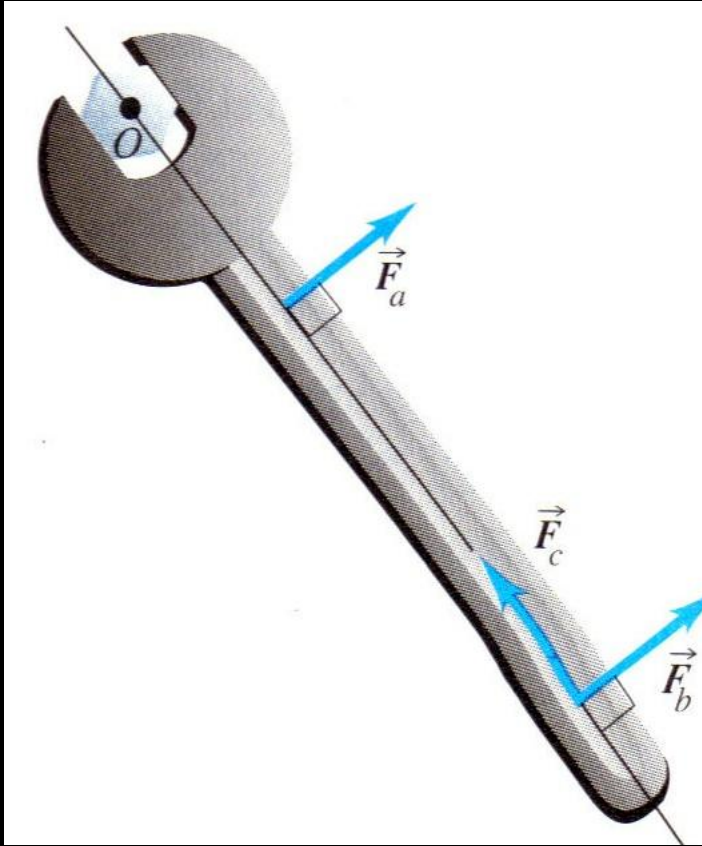


# Torque and Moment

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)



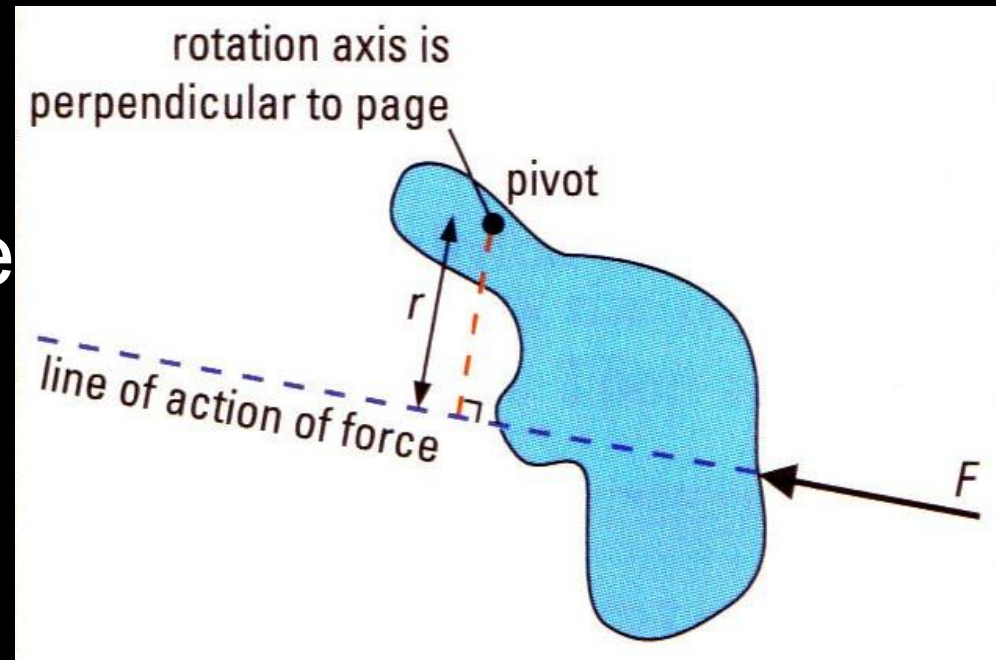
Which of these three forces is most likely to loosen the tight bolt?

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  $\times$   
perpendicular distance  
from line of action of  
force to the pivot

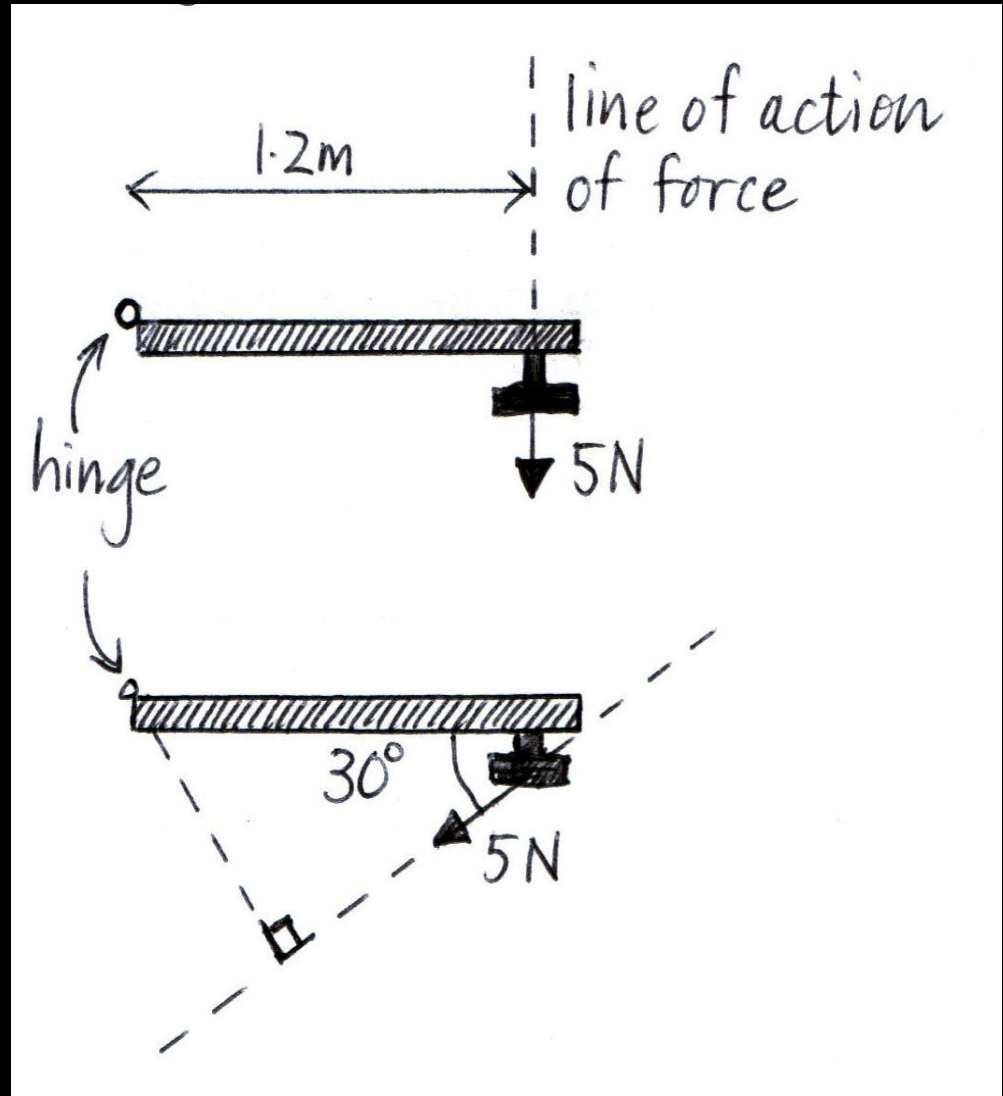


# Example 1. 'Opening doors'

A boy pulls on a door handle.

A) Calculate the torque about the hinge.

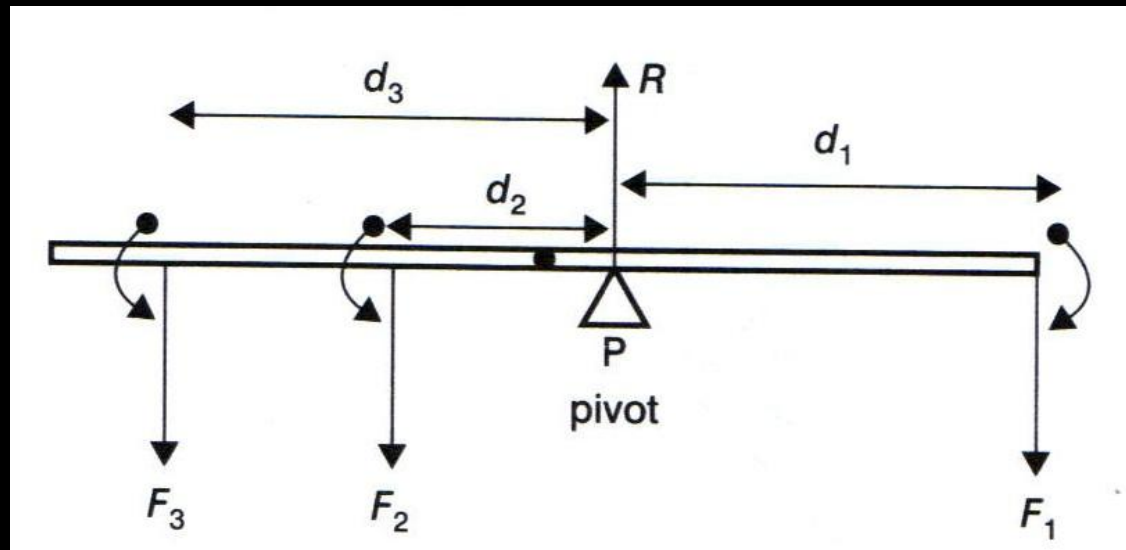
B) If he pulls at an angle as shown, what is the new torque?



# 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



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

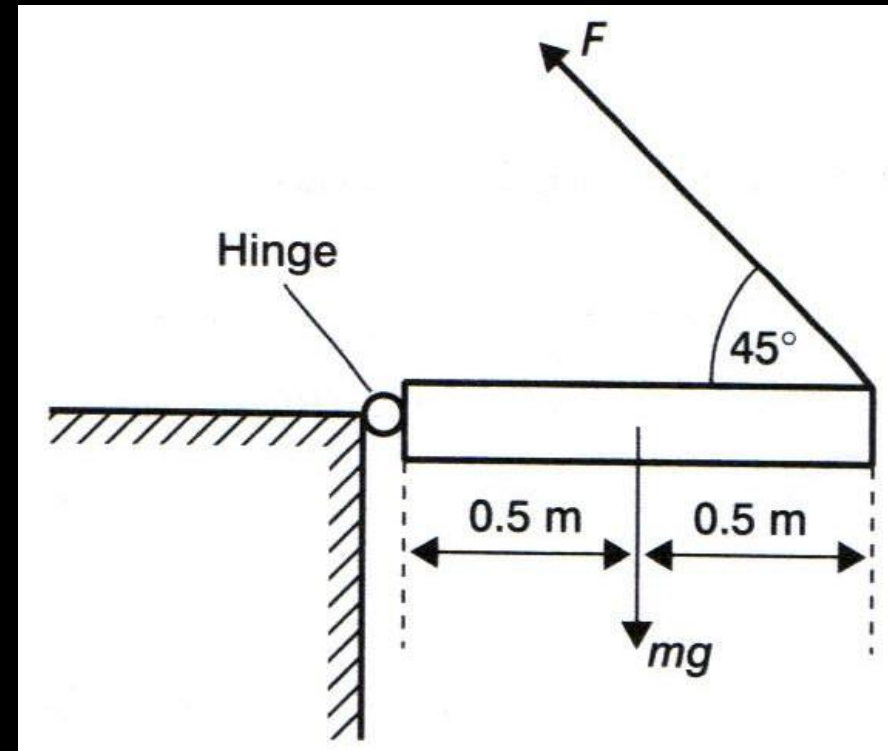
## Example 2. Family on seesaw

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

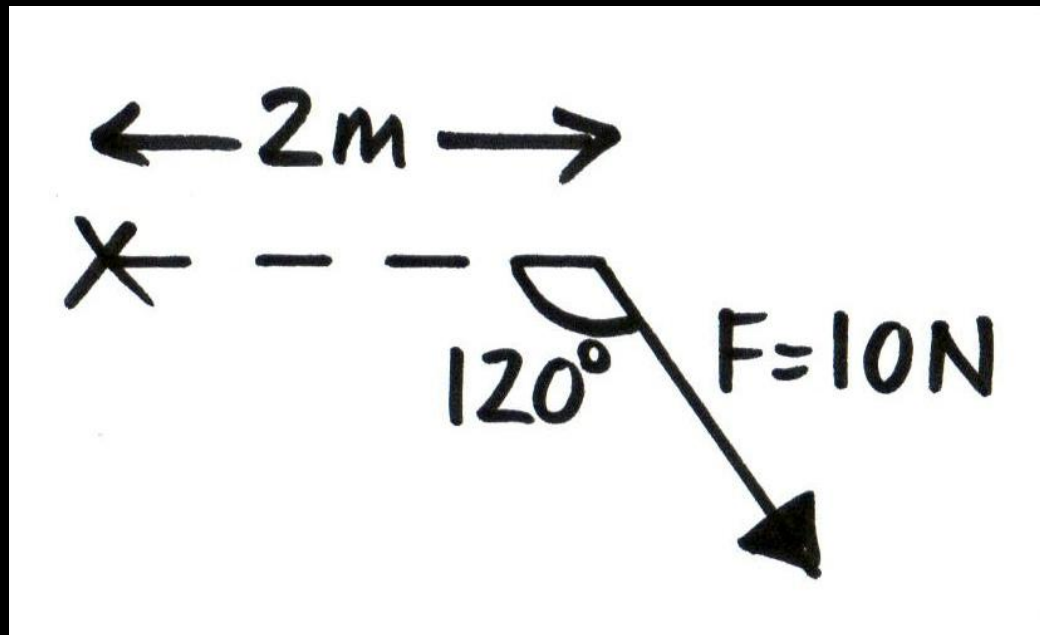
A hinged trap-door of mass 15 kg and length 1.0 m is to be opened by applying a force  $F$  at an angle of  $45^\circ$ .

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.



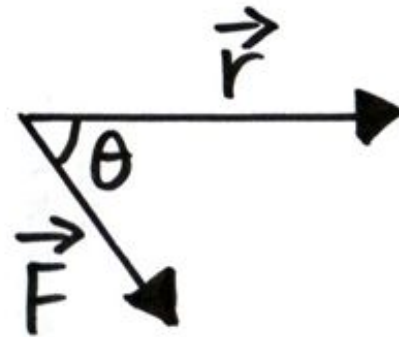
# The vector product (cross product)

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

$$\text{torque} = F \times r \sin \theta$$

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

Example 4 redrawn.



Torque would then be:

$$\tau = |\vec{F}| |\vec{r}| \sin \theta$$