

WIHA

WHAT IS TORQUE?

Torque is a measure of how much a force acting on an object causes that object to rotate. The object rotates about the **pivot point**, and will label 'O'. We will call the force '**F**'. The distance from the pivot point to the point where the force is applied and is denoted by '**r**'. Note that this distance, '**r**', is also a vector, and points from the axis of rotation to the point of application of the force. (See the following diagram for a pictorial representation of these definitions.)

Torque is defined as $\tau = \mathbf{r} \times \mathbf{F} = r F \sin(\theta)$.

In other words, torque is the cross product between the distance vector (the distance from the pivot point to the point of application of the force) and the force vector **F**.

Using the **right hand rule**, we can find the direction of the torque vector. If we put our fingers in the direction of the force vector and curl them towards the distance vector, our thumb points in the direction of the torque vector.

Imagine pushing a door to open it. The force of your push (**F**) causes the door to rotate about its hinges (the pivot point). The distance from the hinges to the point where you push is **r** (and several other things, but let's ignore them now). The closer you are to the hinges (i.e. the smaller **r** is), the more torque you create. If you push a door on the wrong side, the torque you created on the door is smaller than it would have been had you pushed on the correct side.

Note that the force applied, **F**, and the moment arm, **r**, are independent of the object. Furthermore, a force applied at the pivot point (**r** = 0) creates no torque.

Another way of expressing the above equation is that torque is the product of the magnitude of the force and the perpendicular distance from the pivot point to the line of action of the force.

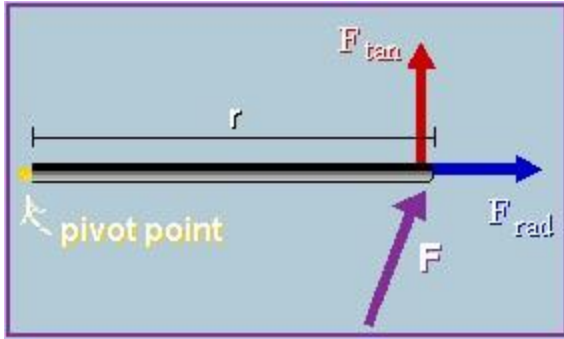


Figure 2 Tangential and radial components of force **F**

Let the force acting on an object be broken up into its tangential (F_{tan}) and radial (F_{rad}) components (see Figure 2). The radial component of the force has no contribution to the torque, while the tangential component is perpendicular to the moment arm, while the radial component is parallel to the moment arm.) The radial component of the force has no contribution to the torque, while the tangential component of the force which affects torque (since it is perpendicular to the line between the pivot point and the point of application of the force).

There may be more than one force acting on an object, and each of these forces may act on different point on the object. **the individual torques.**

Rotational Equilibrium is analogous to translational equilibrium, where the sum of the forces are equal to zero. **words, there is no net torque on the object.**

$$\sum \tau = 0$$

Note that **the SI units of torque is a Newton-meter**, which is also a way of expressing a Joule (the unit for energy). The distinction arises because energy is a scalar quantity, whereas torque is a vector.