Name: _____ Period: _____ Date: _____

Torque: https://www.stickmanphysics.com/torque/

_____ (τ) is the rotational equivalent of force and creates a _____. Torque occurs around a fulcrum or pivot point, which is the center of rotation. A triangle can represent the fulcrum with a rotation either clockwise (_____) or counterclockwise (_____).

Torque Variables

Name	Variable	Unit	Unit Abbreviation
Torque			
Perpendicular Force			
Distance			

Torque Equation ($\tau = F_{\perp} d$)

Torque increases as distance away from the fulcrum a perpendicular force is applied or if the force itself increases. Perpendicular force and distance directly relate to torque. Therefore, an increase either perpendicular force or distance torque, keeping everything else the same, torque would go up.

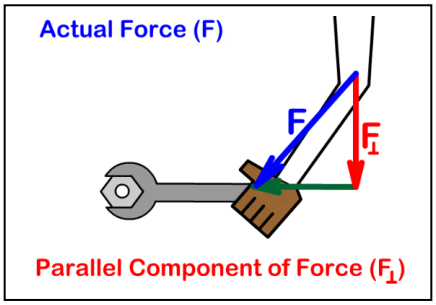
Example Problems:

1. How much torque do you create with a 100 N perpendicular force placed 0.45 meters from the fulcrum?

2. How much force would Joe have to apply perpendicular to create 550 Nm of torque 0.20 meters away from the bolt he is trying to loosen?

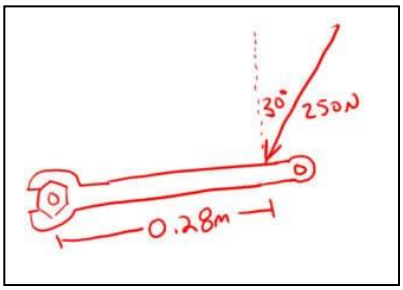
Perpendicular Force Gives the Most Torque and Parallel None

Any force other than one applied parallel can have a perpendicular component seen in the picture. Any parallel component of force is wasted. Torque decreases as force at an angle away from the perpendicular direction increases. 90 degrees is the furthest away from the perpendicular and would be parallel. **You produce _____ when force is parallel.**



Example Problem:

3. What torque results from a 250 N force 30° from perpendicular on a wrench 0.28 meters away from the bolt?



Multiple Torques and Balanced Systems

You add multiple torques after accounting for direction. Any clockwise force will be positive mathematically and counterclockwise negative.

When you have a balanced system, for example, two kids on a teeter-totter, the sum of the forces is equal to zero. See the multiple torque equations, the balanced torque equations are just a version of the sum of all torques when the sum equals zero.

Sum ($\sum$) of Torque

$$\sum Torque = torque_1 + torque_2 + \cdots$$

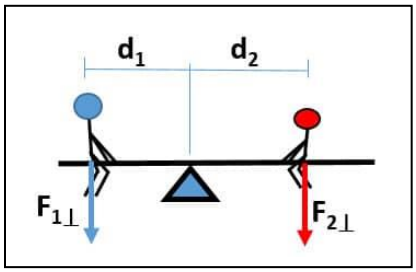
$$\sum Torque = F_{1\perp}d_1 + F_{2\perp}d_2 + \cdots$$

Balanced Torque ($\sum = 0$)

$$0 = F_{1\perp}d_1 + F_{2\perp}d_2 + \cdots$$

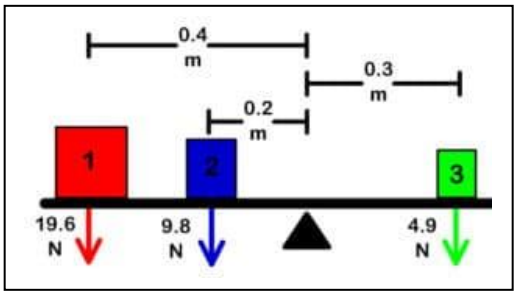
$$\overset{ccw}{\ldots + F_{1\perp}d_1} = \overset{cw}{F_{2\perp}d_2} + \ \ldots$$

In the picture, there are two stickmen on a teeter-totter. The one on the left creates a counterclockwise (CCW) rotation and the other on the right creates a clockwise (CW) one. They balance each other (zero sum of torques) resulting in the equation below them ($F_{1\perp}\, d_1 = F_{2\perp}d_2$). If there was an additional person on the left (counterclockwise torque) this would become ($F_{1\perp}\, d_{1\perp} + F_{2\perp}\, d_2 = F_{3\perp}d_3$). If there was an additional person on the right "instead" it would become ($F_{1\perp}\, d_1 = F_{2\perp}d_2 + F_{3\perp}d_3$). The … in the equations above mean you add as many individual distances and forces to that rotational side.



Example Problems:

4. What is the sum of all torques in the system to the right?



5. Where should you place a 19.6 N weight to balance a 9.8 N weight 0.4 meters on the right?