

# Tuesday Reading Assessment: Unit 9, Torque and Angular Momentum

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## 1 Memory Bank

- $\tau = rF \sin \theta$  ... Definition of torque.
- Torque is the angular version of force. It is the result of a force  $F$ , separated from a pivot by a distance  $r$ , that rotates the system about the pivot. The angle between the force  $F$  and the distance  $r$  is  $\theta$ .
- For systems in *static equilibrium*, the net force is zero, and the net torque is zero.

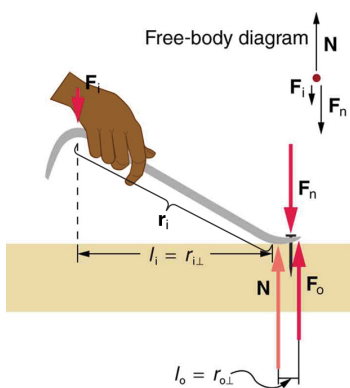


Figure 1: A crowbar is used to pry a nail loose.

## 2 Torque

1. Suppose a doorknob is a distance of  $r = 1.2$  meters from the hinges of a door. If a force of  $F = 3.0$  N is applied at an angle  $\theta = 90$  degrees relative to the door, what is the torque?
2. Consider Fig. 1. The distance  $r_{1\perp}$  corresponds to the torque caused by  $F_1$ . The length of the crowbar is  $r_1 = 20$  cm, and it makes a 45 degree angle with the wood. The little distance from the tool to the nail is  $r_{0\perp} = l_0 = 4$  cm, and that distance corresponds to the force  $F_0$ .
  - Use trigonometry to determine  $r_{1\perp}$  from  $r_1$  and the angle between the bar and the wood.
  - If the nail is not yet budging, this means the net torque is zero. Set the torque on the left side of the nail ( $r_{1\perp}$  and  $F_1$ ) equal to the torque on the right-hand side ( $r_0$  and  $F_0$ ). Solve algebraically for  $F_0$ .
  - If  $F_1$  is 40 N down, what is the magnitude of  $F_0$ , and in what direction is it?
  - If 180 N is the force required to pop the nail, how hard must someone push on the crowbar ( $F_1$  down)?