


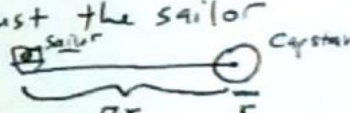
$$\tau = r F \sin \phi$$

$\phi$  = angle between radial line and the direction of force.

① When a person starts to go on a pedal bike, why is it difficult to get going when the pedal is at the highest point? 

② Steven is trying to open a stuck door. He pushes it at a point .75 meters from the hinges with a 240 N force directed  $20^\circ$  away from being perpendicular to the door. The natural pivot point is the hinges. What torque does Steven exert? How could he exert more torque?

③ Bianca uses a 20 cm long wrench to tighten a bolt, turning it clockwise. The wrench handle is tilted  $30^\circ$  above the horizontal, and Bianca pulls straight down on the end with a force of 100 N. How much torque does Bianca exert on the bolt?

④ A capstan is a device used on old sailing ships to raise the anchor. A sailor pushes the long lever, turning the capstan and winding up the anchor rope. Suppose the rope tension due to the anchor's weight is 1500 N. The distance from the axis center to where the sailor pushes is seven times the radius of the capstan. With what force must the sailor push if net torque on the capstan is zero? 

⑤ A 3.2 kg flagpole extends from a wall at an angle of  $25^\circ$  from the horizontal. Its center of gravity is 1.6 meters from the point where the pole is attached to the wall. What is the gravitational torque on the flagpole about the point of attachment?

⑥ Center of gravity can be found using the following equations:

$$x_{cg} = \frac{x_1 m_1 + x_2 m_2 + \dots}{m_1 + m_2 + \dots}$$

$$y_{cg} = \frac{y_1 m_1 + y_2 m_2 + \dots}{m_1 + m_2 + \dots}$$

A 1 meter long dumbbell has left mass of 10 kg and a 5 kg mass on the right. Find the position of the center of gravity.

⑦ A 2 meter long dumbbell has a mass of 15 kg on the left and a 40 kg mass on the right. Find the position of the center of gravity.