

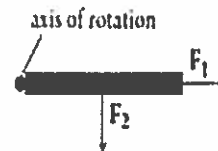
Name: Key

Period:       
Pre-AP Physics

## Torque and Rotational Equilibrium Problems

Answer each of the following questions on your own sheet of paper. Be sure to show all work and box your answer(s) when applicable.

1. Which of the forces acting on the rod in the diagram to the right will produce a torque about the axis at the left end of the rod? Explain.



$F_2$  - Perpendicular to the axis of rotation.

2. If the net force on a system is zero, is the net torque also zero? If the net torque on a system is zero, is the net force also zero? Explain.  $F_{net} = 0$   $F_{torque} = 0 \Rightarrow$  Equilibrium <sup>No</sup> <sup>Rotate</sup> - rot equilb.

$\downarrow \downarrow \tau$   
Net force doesn't take into acct where force applied

3. Can a small force exert a greater torque than a larger force? Explain.

Yes - distance from axis of rotation determines torque - door example.

4. A water faucet is turned on when a force of 2 N is exerted on the handle, at a distance of .06 m from the pivot point. How much torque must be produced to turn the handle?

$$\tau = Fr \sin \theta = (2)(.06) = \boxed{.12 \text{ Nm}}$$

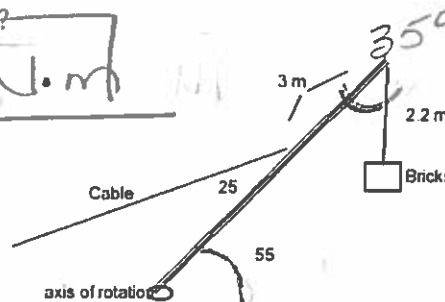
5. The bolts on a car wheel require tightening to a torque of 90 Nm. If a 30 cm long wrench is used, what is the magnitude of the force required when the force is perpendicular to the wrench?

$$F = \frac{\tau}{r \sin \theta} = \frac{90 \text{ N}\cdot\text{m}}{.30} = \boxed{300 \text{ N}}$$

6. A force of 150 N is applied to the end of a 5-meter pole at an angle of  $53^\circ$ . What is the amount of torque exerted by the force if the pole rotates about the opposite end?

$$\tau = 150(5) \sin 53^\circ = \boxed{598.98 \text{ N}\cdot\text{m}}$$

7. 250 kg of cargo is placed in a box and lifted by a crane, as in the diagram to the right. How much torque is exerted on the crane arm by the weight of the cargo if the arm is at an angle of  $55^\circ$  from the ground and the cargo is attached 34 meters from the axis of rotation?



$$\tau = Fr \sin \theta = (250 \text{ kg})(9.8 \text{ m/s}^2)(34) (\sin 35^\circ) = .428$$

$$\tau = \boxed{35652.40 \text{ N}\cdot\text{m}}$$