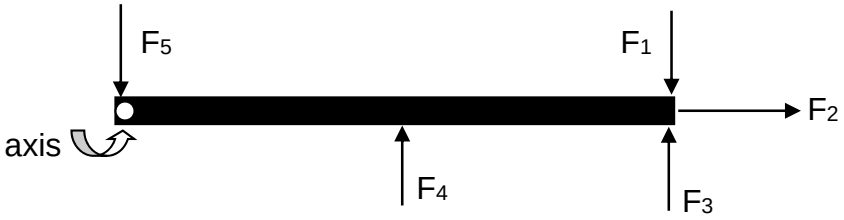
PHYS:1200 Physics of Everyday Experience

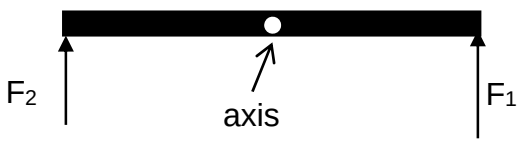
Review questions and exercises for Lecture 10

1. Show using a diagram the definition of torque.
2. What maximum torque could be applied with a force of 50 N using a crowbar that is 1 m long?
3. If the net force on an object is zero, do this imply that the net torque must also be zero?
4. Can there be a net force on an object if the net torque on it is zero?
5. What considerations are involved in determining whether or not an object will tip over?
6. What property of a rigid body determines what rotational acceleration it will have for a given torque applied to it?
7. What feature of the shape of the Washington monument makes it stable?
8. A bolt requires a minimum torque of 30 N m to be removed. If you use a wrench that is 25 cm long and you are able to exert a maximum force of 100 N, will you be able to remove this bolt? If the answer is NO, what might you do to remove this bolt?

9. A rod can rotate about an axis through one end. There are 5 possible forces that might act on this rod. Which force would be most effective in producing rotation in the counterclockwise (CCW) direction?



10. A rod 80 cm in length can rotate about an axis through its center as shown. Two forces are applied to its ends, F_1 = 50 N, and F_2 = 30 N. What is the net torque on the rod?



Solutions: (Try to do the problems before reading the solutions.)

1. Torque = force x level arm
2. Torque = 50 N x 1 m = 50 N m.
3. If the forces on an object are of equal magnitude but in opposite directions, the net force will be zero but the net torque will not be zero.
4. If the forces on an object are of equal magnitude and are applied in the same direction, there is a net force but no net torque.
5. If the center of gravity of an object is above a point of support, the object will be stable.
6. The rotational inertia depends on the applied torque and the rotational inertia of the object.
7. It is widest at its base which lowers its center of gravity. Objects whose center of gravity are low, tend to be stable.
8. Torque = 100 N x ¼ m = 25 N m. This is less than the required torque. The torque could be increased by increasing the length of the lever arm in some way.
9. The largest counterclockwise torque would be provided by F_3.
10. Take the counterclockwise direction as the positive direction for torque. Then

    Net torque = $\tau_1 + \tau_2 = + F_1 L_1 - F_2 L_2 = 50$ N (0.4 m) – 30N (0.4 m) = 20 Nm – 12 Nm = + 8 N m.

    The net torque is +, so it is counterclockwise and the rod will rotate in the counterclockwise direction.