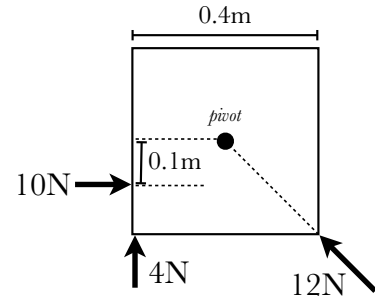


1. Three forces are applied to a square with side 0.4 m, as shown. Consider their associated torques around the pivot, which is at the center of the box.

3

(a) _____ What is the torque due to the 10 N force?

- A)** 0 Nm **B)** 1 Nm **C)** 2 Nm **D)** 4 Nm
E) 10 Nm



3

(b) _____ Which force exerts the largest torque?

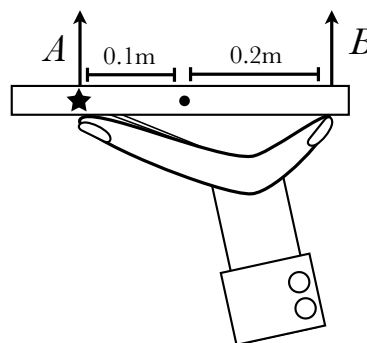
- A)** 4 N **B)** 10 N **C)** 12 N

3

(c) _____ What direction does the 4 N torque point?

- A)** clockwise ⌚ **B)** counterclockwise ⌚

- 4 2. A waiter carries a plate with weight $mg = 6\text{ N}$ in one hand, as shown. The plate is in equilibrium, and its center of mass is at the dot. The fingers exert a force A upward on the plate, and the thumb a force B .

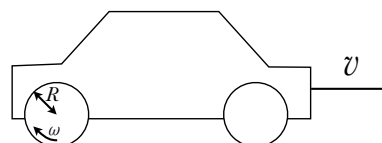


- (a) If upward is positive, write an expression for the net force F_{net} on the plate, in terms of A and B .

- (b) If counterclockwise is positive, write an expression for the net torque τ_{net} on the plate. The pivot is marked by the star.

- (c) Find the magnitude of the force A .

3. A car has wheels of radius $R = 0.21$ m. As the car drives along the road, each wheel spins with an angular velocity of $\omega = 240$ rad/s.



- 3 (a) ____ What is the period of the wheel? That is, how long does it take for the wheel to go around once?

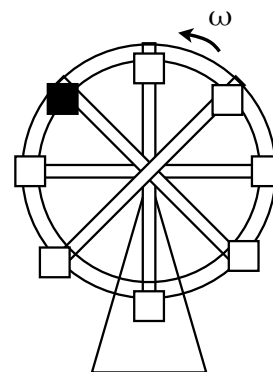
A) 0.0041 s **B)** 0.026 s **C)** 0.038 s **D)** 38 s

- 3 (b) ____ How fast is the car moving? (i.e. What's v ?)

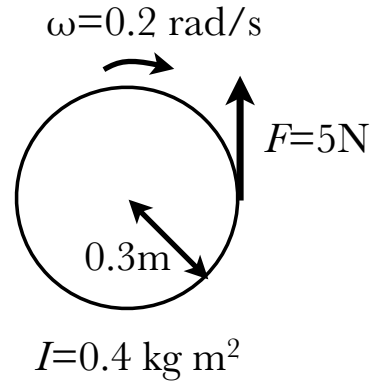
A) 50 m/s **B)** 100 m/s **C)** 240 m/s **D)** 1140 m/s

- 3 4. ____ A Ferris wheel is rotating counterclockwise. If its spin is slowing down, the passengers in the black car will feel an acceleration in which direction?

A) ↖ **B)** ↑ **C)** ↗
D) ← **E)** →
F) ↙ **G)** ↓ **H)** ↘



5. A disk with radius 0.3 m and rotational inertia $I = 0.4\text{ kg} \cdot \text{m}^2$ is spinning clockwise with angular velocity $\omega = 0.2\text{ rad/s}$. A 5 N force is applied upward on the right-hand side of the disk.



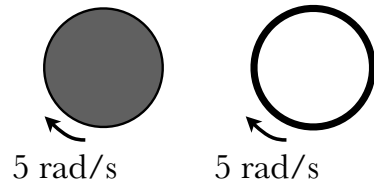
- 3 (a) _____ What is the torque τ on the disk, due to the 5 N force?
A) 1.5 Nm **B)** 5 Nm **C)** 17 Nm

- 3 (b) What is the angular acceleration α of the disk due to the application of the torque?

6. A wheel starts off spinning clockwise with an angular velocity of $\omega_i = 5\text{ rad/s}$. It makes 20 full turns, slowing at a constant rate until it is spinning at $\omega_f = 1\text{ rad/s}$ clockwise instead. How long Δt does the slowing process take? (Fill out this table for partial credit.)

$\Delta\theta$	
ω_i	
ω_f	
α	
Δt	

7. Consider a solid disk (think “cookie”) and a ring (think “hula hoop”), both with the same mass and radius, and both spinning at 5 rad/s.



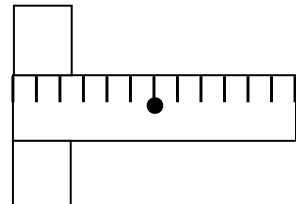
- 3 (a) ____ Which has the larger rotational inertia I ?
A) disk **B)** ring **C)** both the same
- 3 (b) ____ Which has the larger angular momentum L ?
A) disk **B)** ring **C)** both the same

- 3 8. ____ Which of the following is a measure of angular velocity?
A) angular displacement $\Delta\theta$ **B)** frequency f **C)** torque τ

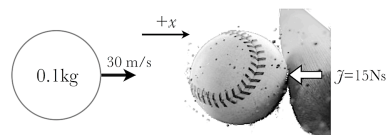
- 3 9. ____ True or False: If I throw a ball across the room, momentum is conserved during its flight (ignoring air resistance).



- 3 10. ____ A T-square is hung on a wall by a nail placed at the point shown. What is the direction of the torque on the square due to gravity?
A) clockwise \odot **B)** counterclockwise \ominus
C) There is no torque.

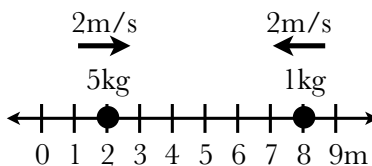


11. A 0.1 kg baseball travels at 30 m/s to the right when it collides with a baseball bat, which imparts an impulse of $J = 15 \text{ Ns}$ to the left on the baseball.



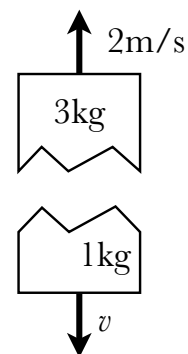
- 3 (a) ____ What is the momentum p_{ix} of the ball before it collides with the bat?
A) 3 Ns **B)** 15 Ns **C)** 30 Ns **D)** 45 Ns
- 3 (b) ____ What is the momentum p_{fx} of the ball right after it collides with the bat? Positive is to the right.
A) -30 Ns **B)** -18 Ns **C)** -12 Ns **D)** -3 Ns **E)** 15 Ns **F)** 18 Ns
- 3 (c) ____ If the ball is in contact with the bat for 0.001 s, what is the average force on the ball?
A) 0.015 N **B)** 7.5 N **C)** 15 N **D)** 15,000 N

12. A 5 kg mass is at $x = 2\text{ m}$, and a 1 kg mass is at $x = 8\text{ m}$, as shown.

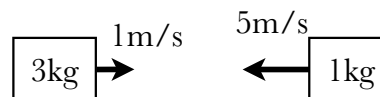


- 3 (a) ____ What is the position x of the particle's center of mass, at the moment pictured?
A) 3 m B) 4 m C) 5 m D) 6 m E) 7 m
- 3 (b) ____ If both blocks are moving at 2 m/s towards each other, what is their total momentum?
A) 0 Ns B) 4 Ns C) 8 Ns D) 12 Ns E) 16 Ns
- 3 (c) As the balls approach one another, the position of their center of mass changes. With what speed is the center of mass moving?

- 3 13. A 4 kg rectangle at rest suddenly explodes into two parts. A 3 kg piece is moving at 2 m/s upward right after the explosion. What is the speed v of the other piece right after the explosion?



- 3 14. ____ A 3 kg block and a 1 kg block, as shown, collide and stick together. How fast will the blocks be moving after the collision? Positive is to the right.



- A)** 0.5 m/s \leftarrow **B)** 3 m/s \leftarrow **C)** 4 m/s \leftarrow **D)** 0 m/s
E) 0.5 m/s \rightarrow **F)** 3 m/s \rightarrow **G)** 4 m/s \rightarrow