

Chapter 9 Drill

The answers and explanations can be found in Chapter 17.

Section I: Multiple Choice

1. A compact disc has a radius of 6 cm. If the disc rotates about its central axis at an angular speed of 5 rev/s, what is the linear speed of a point on the rim of the disc?

(A) 0.3 m/s
(B) 1.9 m/s
(C) 7.4 m/s
(D) 52 m/s
(E) 83 m/s

2. A compact disc has a radius of 6 cm. If the disc rotates about its central axis at a constant angular speed of 5 rev/s, what is the total distance traveled by a point on the rim of the disc in 40 min?

(A) 180 m
(B) 360 m
(C) 540 m
(D) 720 m
(E) 4.5 km

3. A disc starts at rest and experiences constant angular acceleration of 4 rad/s^2 . When the disc has gone through a total angular displacement of 50 rad, what is its angular speed?

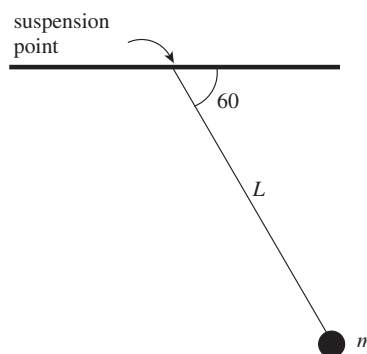
(A) 12 rad/s
(B) 15 rad/s
(C) 16 rad/s
(D) 20 rad/s
(E) 23 rad/s

4. An object, originally at rest, begins spinning under uniform angular acceleration. In 10 s, it completes an angular displacement of 60 rad. What is the numerical value of the angular acceleration?

(A) 0.3 rad/s^2
(B) 0.6 rad/s^2
(C) 1.2 rad/s^2
(D) 2.4 rad/s^2
(E) 3.6 rad/s^2

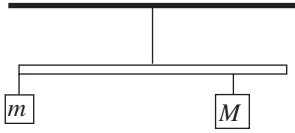
5. Joe and Alice are sitting on opposite ends of a seesaw. The fulcrum is beneath the center of the seesaw, which has a length of 4 m. Given that Joe's mass is 60 kg and Alice's mass is 30 kg, what will be the magnitude of the net torque on the seesaw when it is perfectly level?

(A) $300 \text{ N}\cdot\text{m}$
(B) $600 \text{ N}\cdot\text{m}$
(C) $900 \text{ N}\cdot\text{m}$
(D) $1,200 \text{ N}\cdot\text{m}$
(E) $1,500 \text{ N}\cdot\text{m}$



6. In the figure above, what is the torque about the pendulum's suspension point produced by the weight of the bob, given that the length of the pendulum, L , is 80 cm and $m = 0.50 \text{ kg}$?

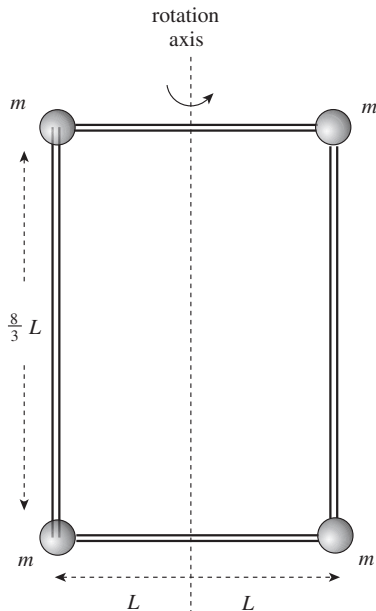
(A) $0.5 \text{ N}\cdot\text{m}$
(B) $1.0 \text{ N}\cdot\text{m}$
(C) $1.7 \text{ N}\cdot\text{m}$
(D) $2.0 \text{ N}\cdot\text{m}$
(E) $3.4 \text{ N}\cdot\text{m}$



7. A uniform meter stick of mass 1 kg is hanging from a thread attached at the stick's midpoint. One block of mass $m = 3$ kg hangs from the left end of the stick, and another block, of unknown mass M , hangs below the 80 cm mark on the meter stick. If the stick remains at rest in the horizontal position shown above, what is M ?

- (A) 4 kg
- (B) 5 kg
- (C) 6 kg
- (D) 8 kg
- (E) 9 kg

8. What is the rotational inertia of the following body about the indicated rotation axis? (The masses of the connecting rods are negligible.)



- (A) $4mL^2$
- (B) $\frac{32}{3}mL^2$
- (C) $\frac{64}{9}mL^2$
- (D) $\frac{128}{9}mL^2$
- (E) $\frac{256}{9}mL^2$

9. The moment of inertia of a solid uniform sphere of mass M and radius R is given by the equation $I = \frac{2}{5}MR^2$. Such a sphere is released from rest at the top of an inclined plane of height h , length L , and incline angle θ . If the sphere rolls without slipping, find its speed at the bottom of the incline.

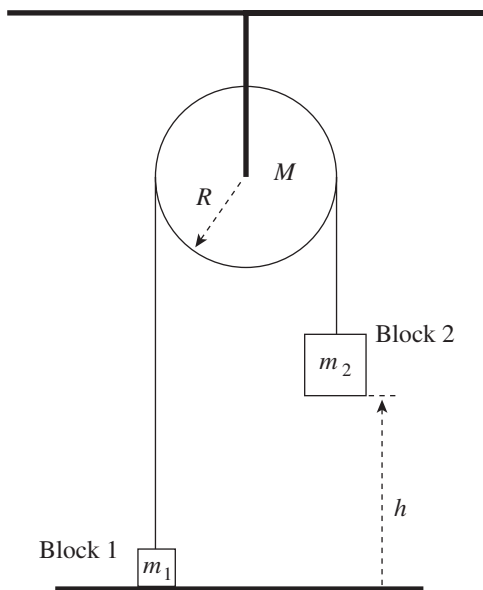
- (A) $\sqrt{\frac{10}{7}gh}$
- (B) $\sqrt{\frac{5}{2}gh}$
- (C) $\sqrt{\frac{7}{2}gh}$
- (D) $\sqrt{\frac{2}{7}gL\sin\theta}$
- (E) $\sqrt{\frac{7}{10}gL\sin\theta}$

10. When a cylinder rolls down an inclined plane without slipping, which force is responsible for providing the torque that causes rotation?

- (A) The force of gravity parallel to the plane
- (B) The force of gravity perpendicular to the plane
- (C) The normal force
- (D) The force of static friction
- (E) The force of kinetic friction

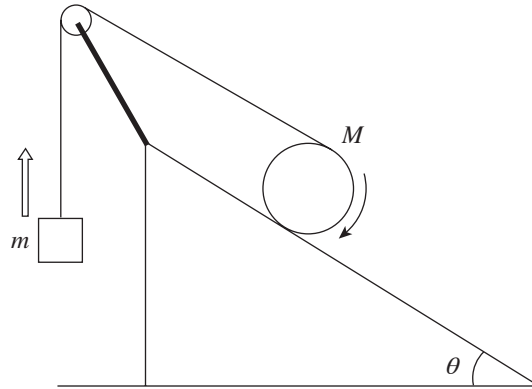
Section II: Free Response

1. In the figure below, the pulley is a solid disk of mass M and radius R , with rotational inertia $MR^2/2$. Two blocks, one of mass m_1 and one of mass m_2 , hang from either side of the pulley by a light cord. Initially the system is at rest, with Block 1 on the floor and Block 2 held at height h above the floor. Block 2 is then released and allowed to fall. Give your answers in terms of m_1 , m_2 , M , R , h , and g .

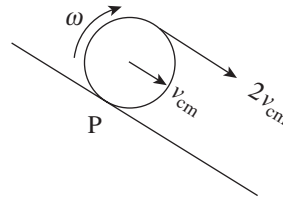


- What is the speed of Block 2 just before it strikes the ground?
- What is the angular speed of the pulley at this moment?
- What's the angular displacement of the pulley?
- How long does it take for Block 2 to fall to the floor?

2. The diagram below shows a solid uniform cylinder of radius R and mass M rolling (without slipping) down an inclined plane of incline angle θ . A thread wraps around the cylinder as it rolls down the plane and pulls upward on a block of mass m . Ignore the rotational inertia of the pulley.

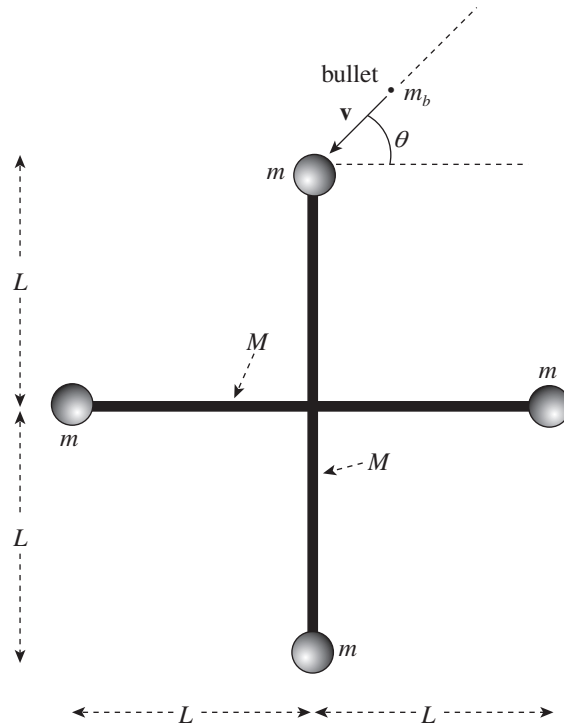


- (a) Show that “rolling without slipping” means that the speed of the cylinder’s center of mass, v_{cm} , is equal to $R\omega$, where ω is its angular speed.
- (b) Show that, relative to P (the point of contact of the cylinder with the ramp), the speed of the top of the cylinder is $2v_{\text{cm}}$.



- (c) What is the relationship between the magnitude of the acceleration of the block and the linear acceleration of the cylinder?
- (d) What is the acceleration of the cylinder?
- (e) What is the acceleration of the block?

3. Two slender uniform bars, each of mass M and length $2L$, meet at right angles at their midpoints to form a rigid assembly that's able to rotate freely about an axis through the intersection point, perpendicular to the page. Attached to each end of each rod is a solid ball of clay of mass m . A bullet of mass m_b is shot with velocity \mathbf{v} as shown in the figure (which is a view from above of the assembly) and becomes embedded in the targeted clay ball.



- Show that the moment of inertia of each slender rod about the given rotation axis, not including the clay balls, is $ML^2/3$.
- Determine the angular velocity of the assembly after the bullet has become lodged in the targeted clay ball.
- What is the resulting linear speed of each clay ball?
- Determine the ratio of the final kinetic energy of the assembly to the kinetic energy of the bullet before impact.