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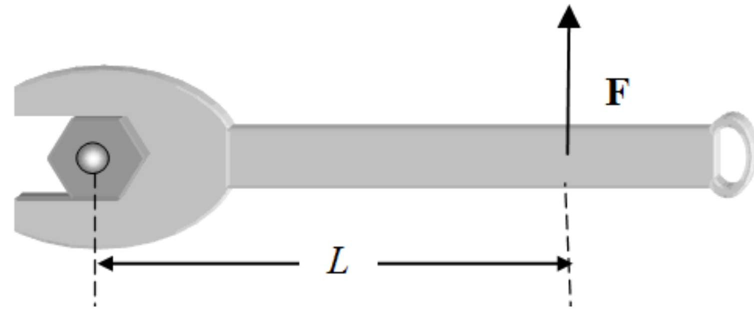
Cutnell/Johnson
Physics

Classroom Response System Questions

Chapter 9 Rotational Dynamics

Interactive Lecture Questions

9.1.1. You are using a wrench in an attempt to loosen a nut by applying a force as shown. But this fails to loosen the nut. Which one of the following choices is most appropriate for loosening this tough nut?



a) Tie a rope of length 2*L* to the wrench at the same location and apply the same force as shown.

b) Place a pipe of length 2*L* over the handle of the wrench and apply the same force to the opposite end (farthest from the nut).

c) Double the force you applied at length L.

d) Doubling the length or doubling the force will have the same result, but doubling the length is easier.

e) Continue applying the same force as in the drawing and eventually the nut will loosen.

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9.1.2. A 1.5-kg ball is tied to the end of a string. The ball is then swung at a constant angular velocity of 4π rad/s in a horizontal circle of radius 2.0 m. What is the torque on the stone?

a) 18 N·m

b) 29 N·m

c) 36 N·m

d) 59 N·m

e) zero N·m

9.1.3. A 1.0-m long steel bar is suspended from a rope from the ceiling as shown. The rope is attached to the bar at its mid-point. A force $\overline{\mathbf{F}_1}$ directed at an angle θ is applied at one end. At the other end, a force $\overline{\mathbf{F}_2}$ is applied perpendicular to the bar. If the magnitudes of the two forces are equal, for which one of the following values of the angle θ will the net torque on the bar have the smallest magnitude? The net torque is the sum of the torques on the bar.

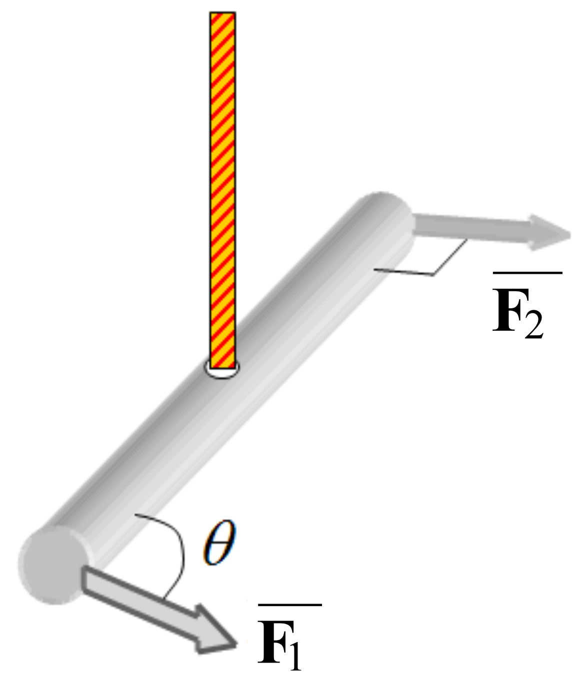
a) 0°

b) 90°

c) 135°

d) 180°

e) 270°



9.1.4. An interesting method for exercising a dog is to have it walk on the rough surface of a circular platform that freely rotates about its center as shown. When the dog begins walking near the outer edge of the platform as shown, how will the platform move, if at all? Assume the bearing on which the platform can rotate is frictionless.

a) When the dog walks clockwise, the platform will rotate counterclockwise when viewed from above.

b) When the dog walks clockwise, the platform will rotate clockwise when viewed from above.

c) When the dog walks clockwise or counterclockwise, the platform will not rotate.

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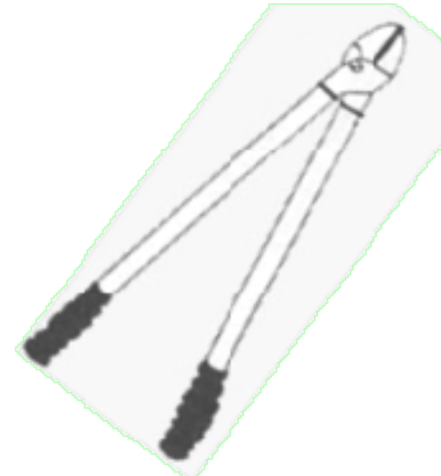
9.1.5. When using pruning shears, such as the pair shown, to cut a branch from a tree, it is better to insert the branch closer to the hinge than near the end of the shears. Which one of the following statements best explains the reason this observation is true?



a) The torque acting on the branch is smallest near the hinge.

b) The torque acting on the branch is largest near the hinge.

c) The torque exerted on the shears yields the greatest force on the branch near the hinge.

d) The long handles determine the force exerted on the branch, which is the same no matter where on the shears the branch is placed.

e) The same torque is exerted on the shears and the branch, regardless of the force applied to the handles.

9.1.6. An object with a triangular cross-section is free to rotate about the axis represented by the black dot shown. Four forces with identical magnitudes are exerted on the object. Which one of the forces, if any, exerts the largest torque on the object?

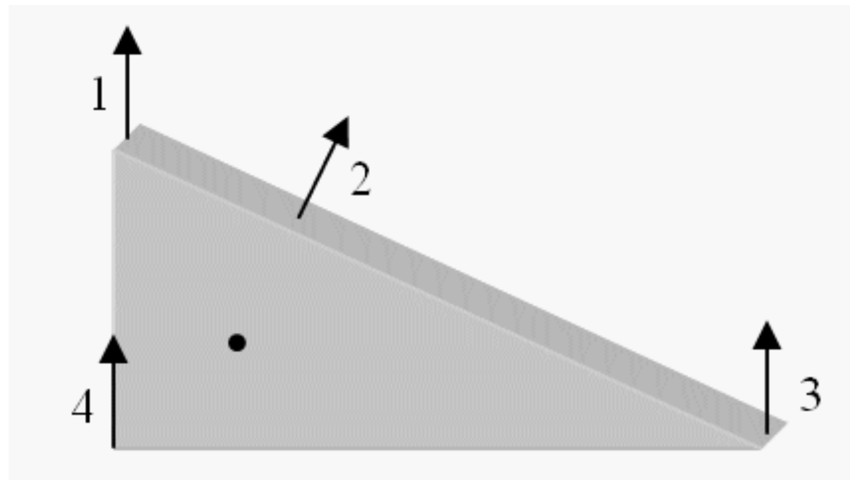
a) 1

b) 2

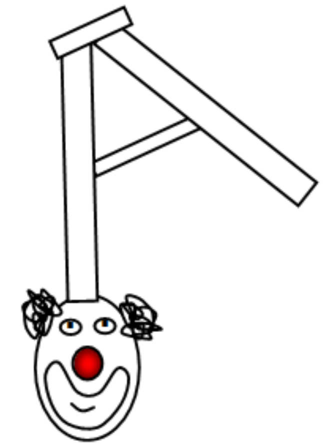
c) 3

d) 4

e) The same torque is exerted by each force.



9.2.1. At the circus, a clown balances a step ladder on his forehead. A few people in the audience notice that he is continually moving to keep the ladder from falling off his forehead. Why is this movement necessary?



a) The clown is trying to apply a torque to the ladder in the direction opposite to other torques on the ladder.

b) The clown is trying to keep the center of mass of the ladder directly above his head so that the torque due to the gravitational force is zero N·m.

c) By rocking the ladder on his forehead, the ladder will be more stable than if it were stationary. This is similar to riding a bicycle. You can easily balance a bicycle when it's rolling, but not when it's stationary.

d) This movement is not necessary. The clown is trying to make this look harder than it really is for entertainment value. The ladder will easily balance on the clown's forehead.

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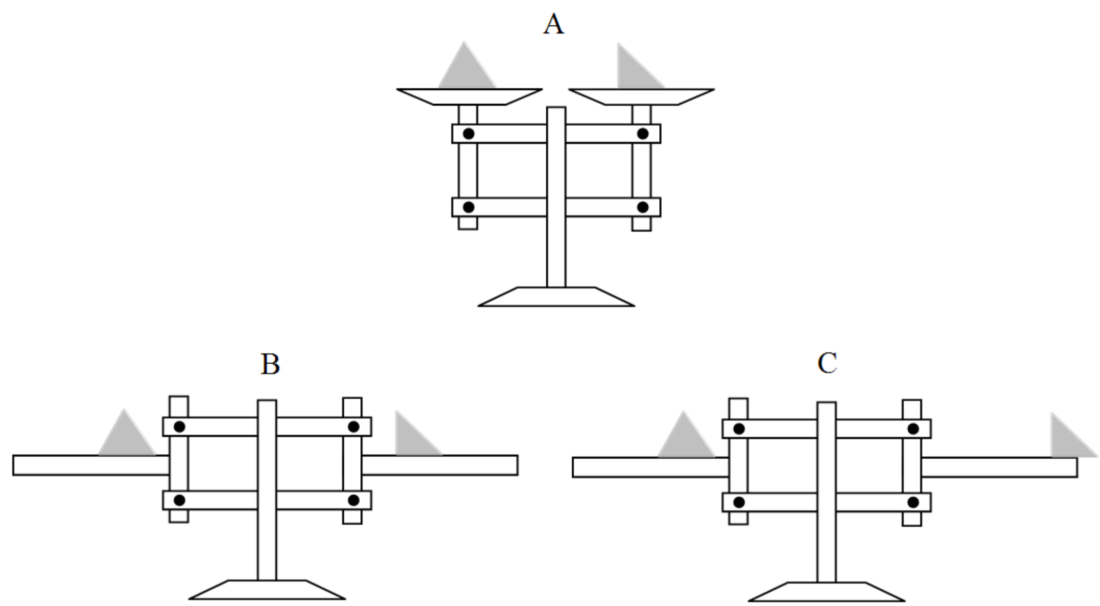
9.2.2. In the seventeenth century, French mathematician Gilles de Roberval developed a balance, shown in part A in the figure, for commercial weighing; and it is still in use today. A variation of this device, shown part B of the figure, is used for physics demonstrations. In this case, the two triangular objects have equal mass and rest on the two horizontal arms at an equal distance from the vertical bars. When the system is released, there is no movement because the system is in equilibrium. One of the objects is then slid to the right as shown in part C, what will happen when the system is released?



a) The arm on the right will go up.

b) The arm on the left will go up.

c) Neither arm will move.

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9.2.3. Consider the three situations shown in the figure. Three forces act on the triangular object in different ways. Two of the forces have magnitude F and one of the forces has a magnitude $2F$. In which case(s), if any, will the object be in equilibrium? In each case, the forces may act at the center of gravity or at the center of a corner.

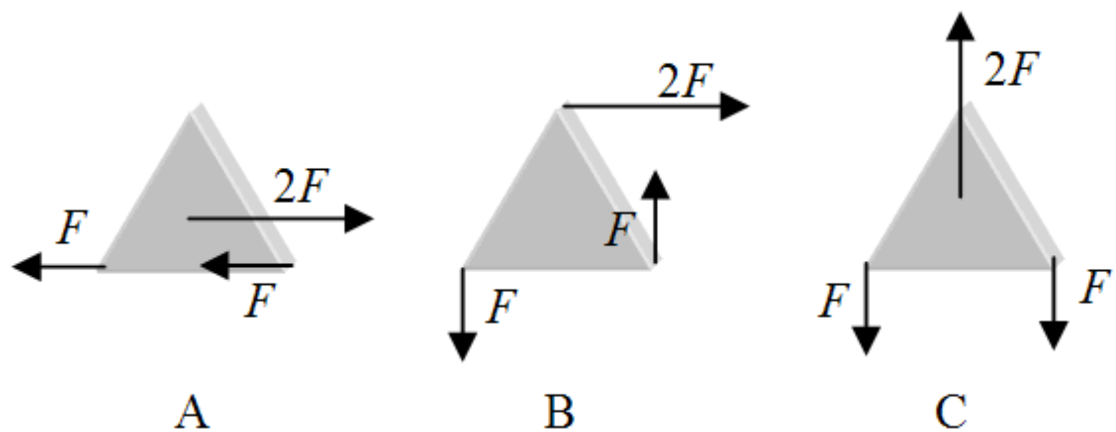
a) A only

b) B only

c) C only

d) A and C

e) A and B



9.2.4. A 4.0-m board is resting directly on top of a 4.0-m long table. The weight of the board is 340 N. An object with a weight of 170 N is placed at the right end of the board. What is the maximum horizontal distance that the board can be moved toward the right such that the board remains in equilibrium?

a) 0.75 m

b) 1.0 m

c) 1.3 m

d) 1.5 m

e) 2.0 m

9.2.5. Jack is moving to a new apartment, so he has loaded a hand truck with four boxes: box A is full of books and weighs 133 N, box B has more books and weighs 111 N, box C contains his music collection on CDs and weighs 65 N, and box D contains clothes and weighs 47 N. The height of each box is 0.30 m. The center of gravity of each of the boxes is located at its center. In preparing to pull the hand truck up the ramp of the moving truck he rotates it to the position shown. What is the magnitude of the force that Jack is applying to the hand truck at a distance of 1.4 m from the axel of the wheel?

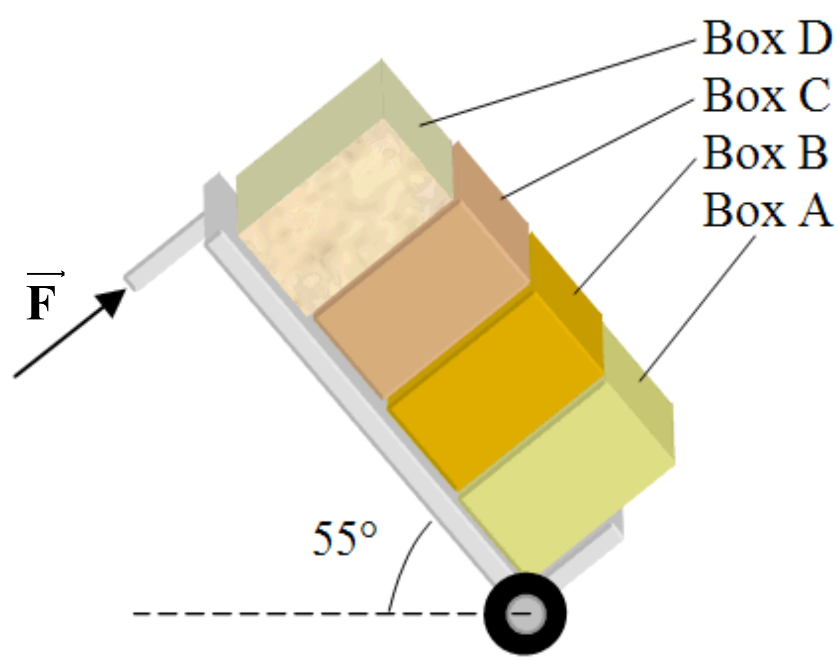
a) 360 N

b) 200 N

c) 150 N

d) 96 N

e) 69 N



9.2.6. A pair of fuzzy dice is hanging from the rearview mirror of a sports car. As the car accelerates smoothly, the strings of the dice are tilted slightly toward the rear of the car. From the perspective of the driver, which one of the following statements is true, if the dice are stationary?

a) The dice are in static equilibrium.

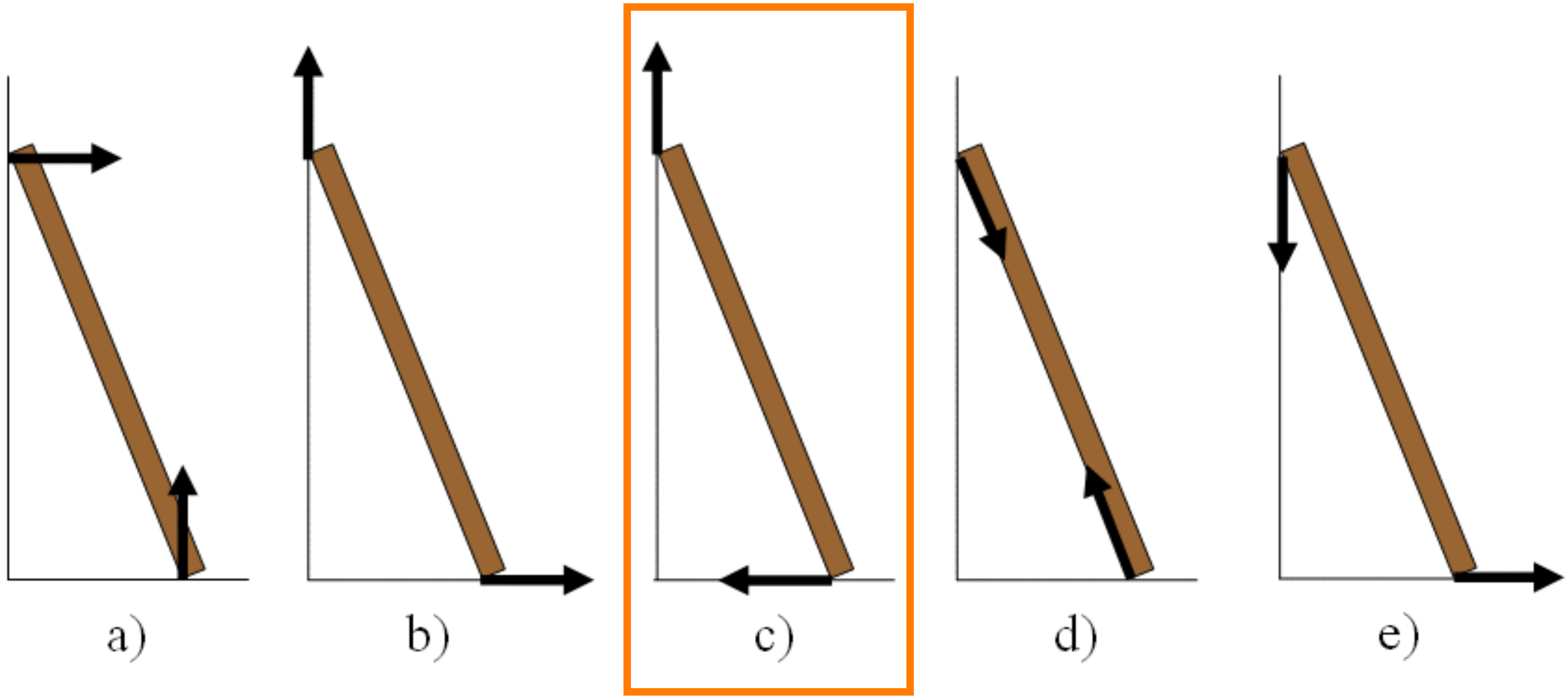
b) The dice are not in equilibrium because the torque on the dice is not zero.

c) The dice are in equilibrium, but not static equilibrium.

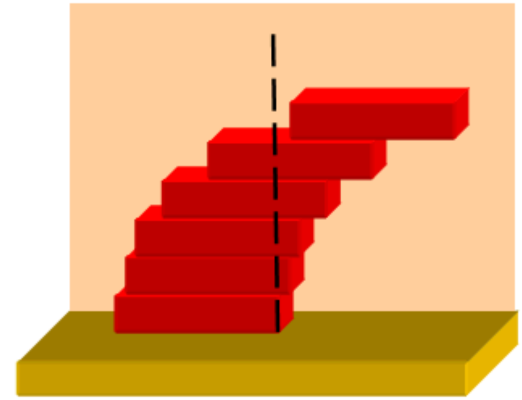
d) The dice are not in equilibrium because the linear momentum of the dice is not zero.

e) None of the above statements are true.

9.2.7. Which one of the following pictures best represents just the forces (or components) that prevent the ladder from slipping while someone is standing on it?



9.3.1. Six identical bricks are stacked on top of one another. Note that the vertical dashed line indicates that the left edge of the top brick is located to the right of the right side of the bottom brick. Is the equilibrium configuration shown possible, why or why not?



a) Yes, this is possible as long as the combined center of gravity of the blocks above a given brick does not extend beyond the right side of the brick below.

b) Yes, this is possible as long as the left side of each block is directly above the center of gravity of the brick directly below it.

c) Yes, this is possible as long as the center of gravity of the blocks above a given brick remains directly above the center of gravity of the blocks below that brick.

d) No, this is not possible because the center of gravity of the top two blocks extends beyond the right edge of the bottom two blocks.

e) No, because the center of gravity of the top block is to the right of the third block from the top.

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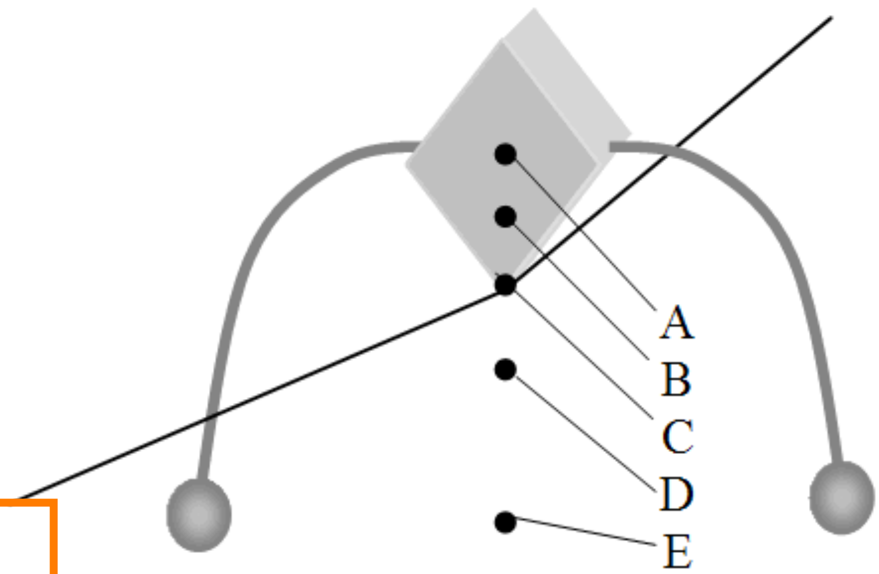
9.3.2. Consider the diamond-shaped object shown that is designed to balance on a thin thread like a tight rope walker at a circus. At the bottom of the diamond, there is a narrow notch that is as wide as the thickness of the thread. The mass of each of the metal spheres at the ends of the wires connected to the diamond is equal to the mass of the diamond. Which one of the points indicated is the most likely location of the center of gravity for this object?



a) A

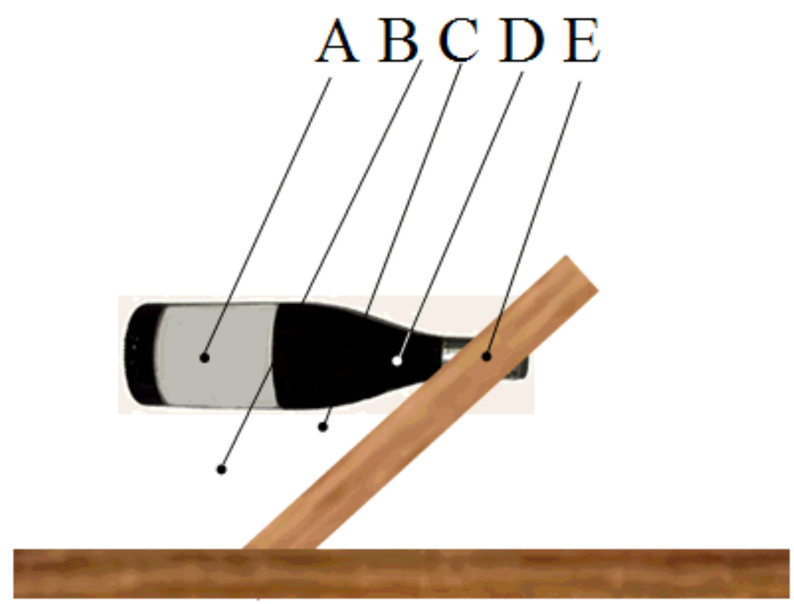
b) B

c) C

d) D

e) E

9.3.3. Consider the object shown. A bottle is inserted into a board that has a hole in it. The bottle and board are then set up on the table and are in equilibrium. Which of the points indicated is the most likely location for the center of mass for the bottle and board system?



a) A

b) B

c) C

d) D

e) E

9.4.1. Two solid disks, which are free to rotate independently about the same axis that passes through their centers and perpendicular to their faces, are initially at rest. The two disks have the same mass, but one of has a radius R and the other has a radius $2R$. A force of magnitude F is applied to the edge of the larger radius disk and it begins rotating. What force must be applied to the edge of the smaller disk so that the angular acceleration is the same as that for the larger disk? Express your answer in terms of the force F applied to the larger disk.

a) $0.25F$

b) $0.50F$

c) F

d) $1.5F$

e) $2F$

9.4.2. The corner of a rectangular piece of wood is attached to a rod that is free to rotate as shown. The length of the longer side of the rectangle is 4.0 m, which is twice the length of the shorter side. Two equal forces with magnitudes of 22 N are applied to two of the corners. What is the magnitude of the net torque on the block and direction of rotation, if any?

a) 44 N·m, clockwise

b) 44 N·m, counterclockwise

c) 88 N·m, clockwise

d) 88 N·m, counterclockwise

e) zero N·m, no rotation

9.4.3. Consider the following three objects, each of the same mass and radius:

(1) a solid sphere (2) a solid disk (3) a hoop

All three are released from rest at the top of an inclined plane. The three objects proceed down the incline undergoing rolling motion without slipping. In which order do the objects reach the bottom of the incline?

a) 1, 2, 3

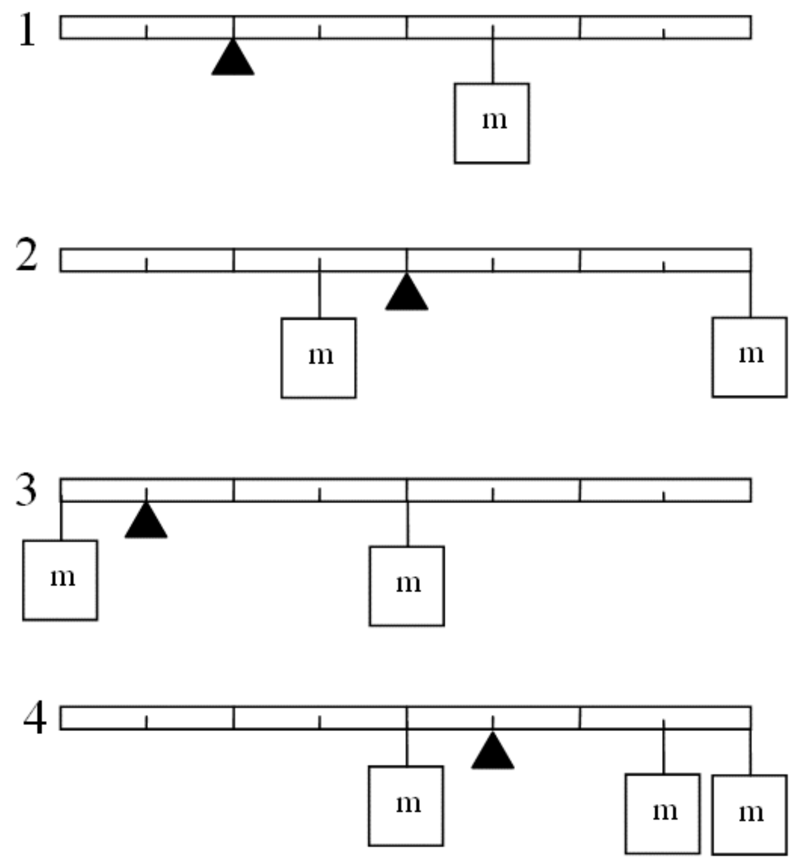
b) 2, 3, 1

c) 3, 1, 2

d) 3, 2, 1

e) All three reach the bottom at the same time.

9.4.4. A long board is free to rotate about the pivot shown in each of the four configurations shown. Weights are hung from the board as indicated. In which of the configurations, if any, is the net torque about the pivot axis the largest?



a) 1

b) 2

c) 3

d) 4

e) The net torque is the same for all four situations.

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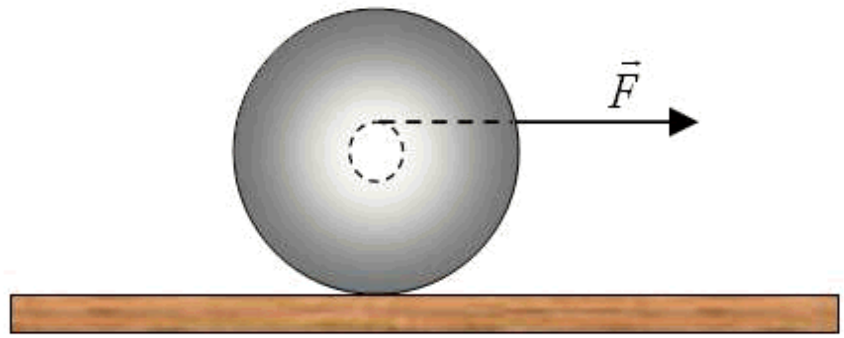
9.4.5. The drawing shows a yo-yo in contact with a tabletop. A string is wrapped around the central axle. How will the yo-yo behave if you pull on the string with the force shown?



a) The yo-yo will roll to the left.

b) The yo-yo will roll to the right.

c) The yo-yo will spin in place, but not roll.

d) The yo-yo will not roll, but it will move to the left.

e) The yo-yo will not roll, but it will move to the right.

9.5.1. Four objects start from rest and roll without slipping down a ramp. The objects are a solid sphere, a hollow cylinder, a solid cylinder, and a hollow sphere. Each of the objects has the same radius and the same mass, but they are made from different materials. Which object will have the greatest linear speed at the bottom of the ramp?

a) Since they are all starting from rest, all of the objects will have the same linear speed at the bottom as a result of the conservation of mechanical energy.

b) solid sphere

c) hollow cylinder

d) solid cylinder

e) hollow sphere

9.5.2. A bowling ball is rolling without slipping at constant speed toward the pins on a lane. What percentage of the ball's total kinetic energy is translational kinetic energy?

a) 50 %

b) 71 %

c) 46 %

d) 29 %

e) 33 %

9.5.3. A hollow cylinder is rotating about an axis that passes through the center of both ends. The radius of the cylinder is r. At what angular speed ω must the this cylinder rotate to have the same total kinetic energy that it would have if it were moving horizontally with a speed v without rotation?

a) $\omega = \dfrac{v^2}{2r}$

b) $\omega = \dfrac{v}{r}\sqrt{2}$

c) $\omega = \dfrac{v}{r}$

d) $\omega = \dfrac{v}{2r}$

e) $\omega = \dfrac{v^2}{r^2}$

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9.5.4. Two solid cylinders are rotating about an axis that passes through the center of both ends of each cylinder. Cylinder A has three times the mass and twice the radius of cylinder B, but they have the same rotational kinetic energy. What is the ratio of the angular velocities, ω_A/ω_B, for these two cylinders?

a) 0.25

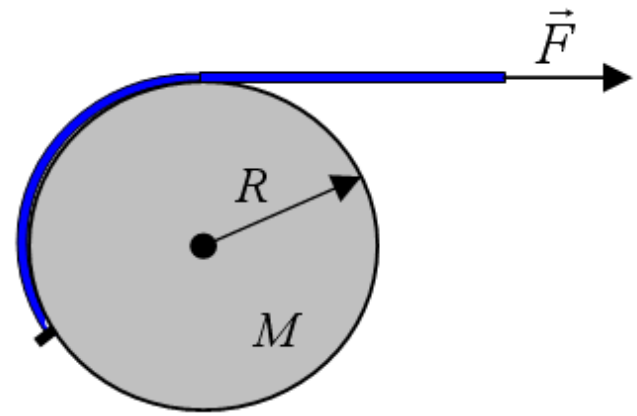
b) 0.29

c) 1.0

d) 0.50

e) .86

9.5.5. Consider the drawing. A rope is wrapped around one-third of the circumference of a solid disk of radius R = 2.2 m that is free to rotate about an axis that passes through its center. The force applied to the rope has a magnitude of 35 N; and the disk has a mass M of 7.5 kg. Assuming the force is applied horizontally as shown and the disk is initially at rest, determine the amount of rotational work done until the time when the end of the rope reaches the top of the disk?



a) 140 N

b) 160 N

c) 180 N

d) 210 N

e) 250 N

9.6.1. A star is rotating about an axis that passes through its center. When the star "dies," the balance between the inward pressure due to the force of gravity and the outward pressure from nuclear processes is no longer present and the star collapses inward; and its radius decreases with time. Which one of the following choices best describes what happens as the star collapses?

a) The angular velocity of the star remains constant.

b) The angular momentum of the star remains constant.

c) The angular velocity of the star decreases.

d) The angular momentum of the star decreases.

e) Both angular momentum and angular velocity increase.

9.6.2. A solid sphere of radius R rotates about an axis that is tangent to the sphere with an angular speed ω. Under the action of internal forces, the radius of the sphere increases to $2R$. What is the final angular speed of the sphere?

a) $\omega/4$

b) $\omega/2$

c) ω

d) 2ω

e) 4ω

9.6.3. While excavating the tomb of Tutankhamen (d. 1325 BC), archeologists found a sling made of linen. The sling could hold a stone in a pouch, which could then be whirled in a horizontal circle. The stone could then be thrown for hunting or used in battle. Imagine the sling held a 0.050-kg stone; and it was whirled at a radius of 1.2 m with an angular speed of 2.0 rev/s. What was the angular momentum of the stone under these circumstances?

a) $0.14\ kg \cdot m^2/s$

b) $0.90\ kg \cdot m^2/s$

c) $1.2\ kg \cdot m^2/s$

d) $2.4\ kg \cdot m^2/s$

e) $3.6\ kg \cdot m^2/s$

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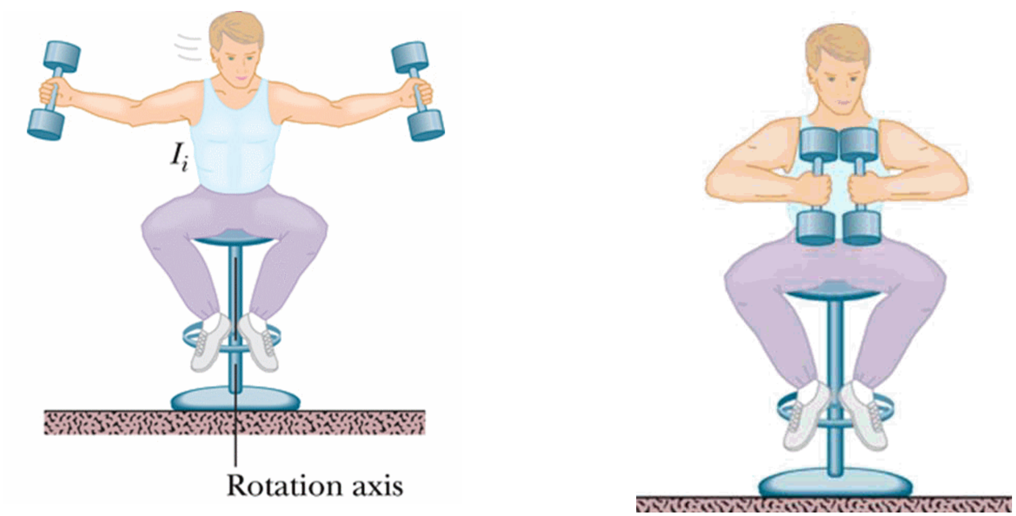
9.6.4. Joe has volunteered to help out in his physics class by sitting on a stool that easily rotates. As Joe holds the dumbbells out as shown, the professor temporarily applies a sufficient torque that causes him to rotate slowly. Then, Joe brings the dumbbells close to his body and he rotates faster. Why does his speed increase?



a) By bringing the dumbbells inward, Joe exerts a torque on the stool.

b) By bringing the dumbbells inward, Joe decreases the moment of inertia.

c) By bringing the dumbbells inward, Joe increases the angular momentum.

d) By bringing the dumbbells inward, Joe increases the moment of inertia.

e) By bringing the dumbbells inward, Joe decreases the angular momentum.

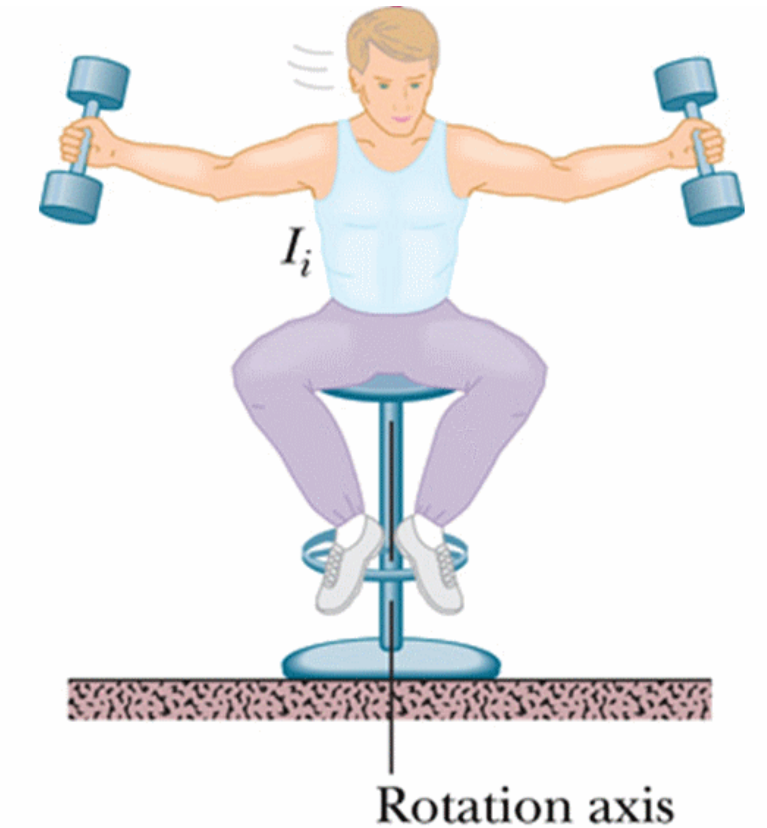
9.6.5. Joe has volunteered to help out in his physics class by sitting on a stool that easily rotates. Joe holds the dumbbells out as shown as the stool rotates. Then, Joe drops both dumbbells. How does the rotational speed of stool change, if at all?

a) The rotational speed increases.

b) The rotational speed decreases, but Joe continues to rotate.

c) The rotational speed remains the same.

d) The rotational speed quickly decreases to zero rad/s.



9.6.6. Joe has volunteered to help out in his physics class by sitting on a stool that easily rotates. Joe holds the dumbbells out as shown as the stool rotates. Then, Joe drops both dumbbells. Then, the angular momentum of Joe and the stool changes, but the angular velocity does not change. Which of the following choice offers the best explanation?

a) The force exerted by the dumbbells acts in opposite direction to the torque.

b) Angular momentum is conserved, when no external forces are acting.

c) Even though the angular momentum decreases, the moment of inertia also decreases.

d) The decrease in the angular momentum is balanced by an increase in the moment of inertia.

e) The angular velocity must increase when the dumbbells are dropped because the torque due to gravity increases.

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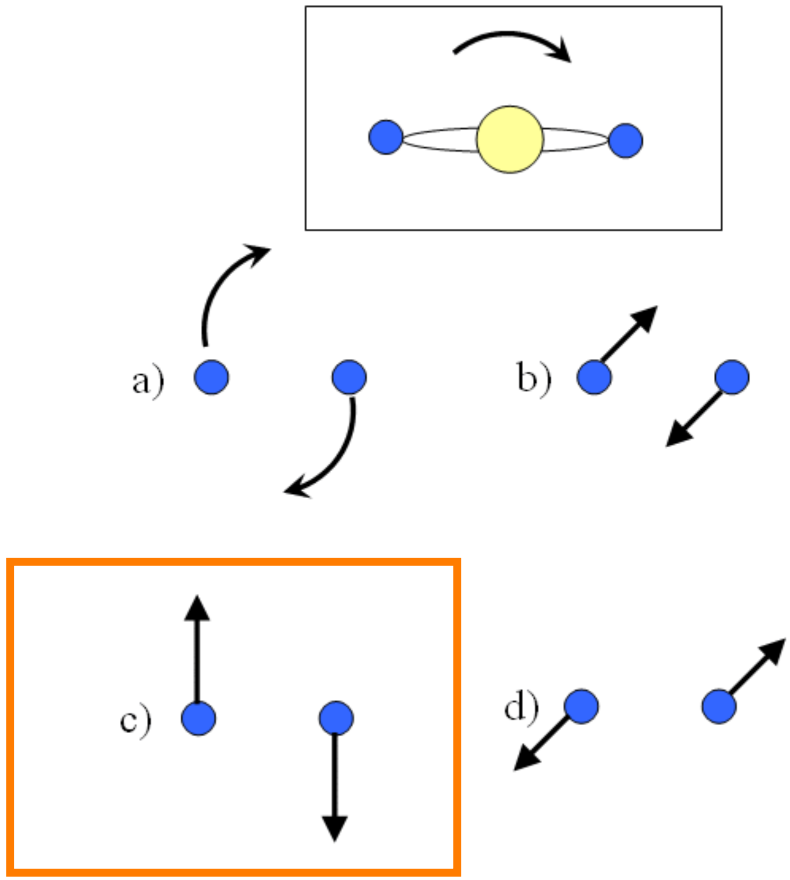
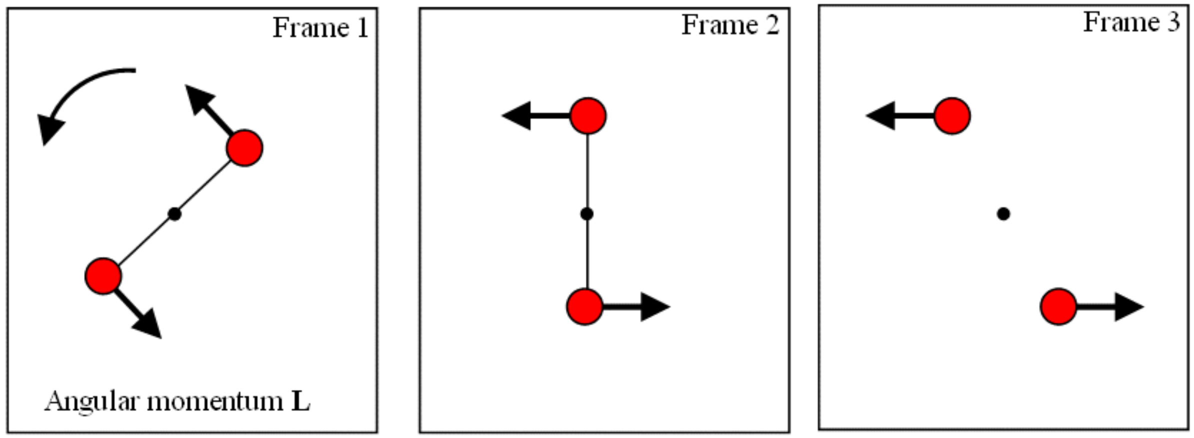
9.6.7. Sarah has volunteered to help out in her physics class by sitting on a stool that easily rotates. The drawing below shows the view from above her head. She holds the dumbbells out as shown as the stool rotates. Then, she drops both dumbbells at the instant pictured. Which one of the four trajectories illustrated best represents the motion of the dumbbells after they are dropped?



9.6.8. Two ice skaters are holding hands and spinning around their combined center of mass, represented by the small black dot in Frame 1, with a total angular momentum *L*. When the skaters are at the position shown in Frame 2, they release hands and move in opposite directions as shown in Frame 3. What is the total angular momentum of the skaters in Frame 3?



a) zero kg · m^2/s

b) a value that is greater than zero kg · m^2/s, but less than *L*

c) a value less than *L* and decreasing as they move further apart

d) a value that is greater than *L*

e) *L*