1. You throw a ball upward. When the ball is moving up, what can you conclude about the gravitational force exerted on the ball?

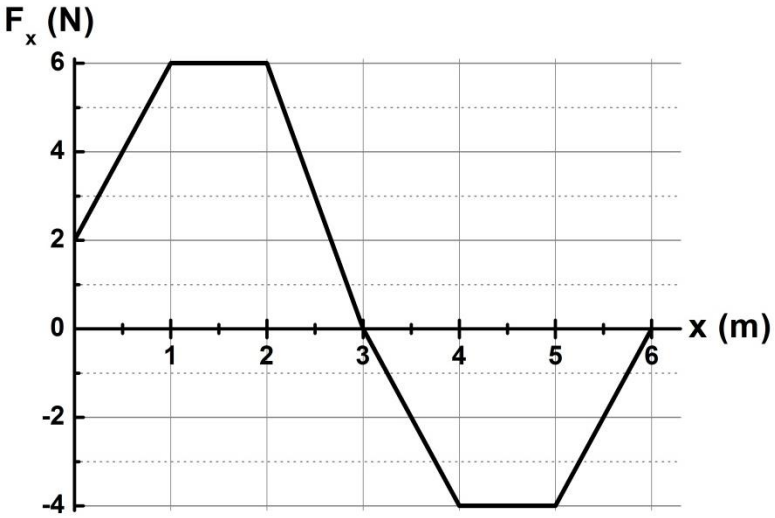
A) The gravitational force does positive work on the ball and decreases its kinetic energy.
B) The gravitational force does negative work on the ball and increases its kinetic energy.
C) The gravitational force does positive work on the ball and increases its kinetic energy.
D) The gravitational force does negative work on the ball and decreases its kinetic energy.
E) The gravitational force does no work on the ball and decreases its kinetic energy.

2. A 3.50 kg book slides along a rough horizontal surface. Initially the book is traveling at 2.25 m/s. At some later point, the book is traveling at 1.87 m/s. What is the work done on the book?

A) -2.74 J
B) -7.40 J
C) -8.62 J
D) -5.52 J
E) -4.14 J

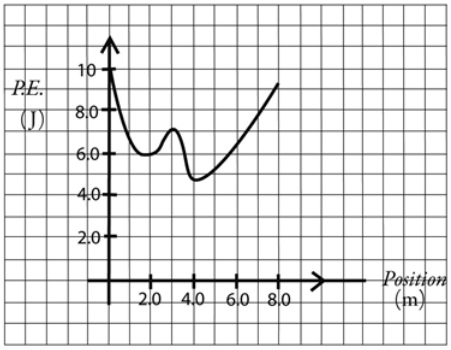
3. A force F_x is applied to a 3.0 kg box parallel to the x-axis as it moves in a straight line. The force varies with the x-coordinate of the box as shown in the figure. Initially, at x = 0 m, the box is traveling at a speed of 1.0 m/s. What is the speed of the box at x = 5.0 m?

A) 2.4 m/s
B) 1.7 m/s
C) 3.5 m/s
D) 4.5 m/s
E) 1.4 m/s



4. A 2.0-kg object is moving without friction along the x-axis. The potential energy curve as a function of position is shown in the figure, and the system is conservative. If the speed of the object at the origin is 4.0 m/s, what will be its speed at 7.0 m along the +x-axis?

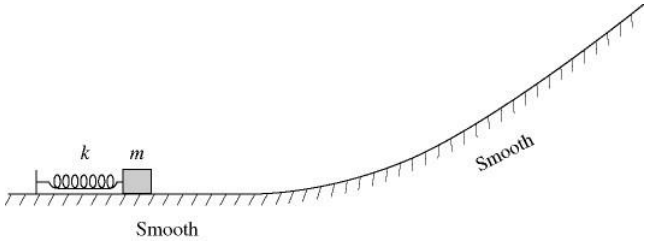
A) 4.2 m/s
B) 2.7 m/s
C) 5.1 m/s
D) 6.1 m/s
E) 7.3 m/s



5. A spring-loaded dart gun is used to shoot a dart straight up into the air, and the dart reaches a maximum height of 24 meters above its point of release. The same dart is shot up a second time from the same gun, but this time the spring is compressed only half as far (compared to the first shot). How far up does the dart go this time? (Neglect friction and assume the spring is ideal and massless.)

A) 6.0 m
B) 12 m
C) 3.0 m
D) 48 m
E) 7.8 m

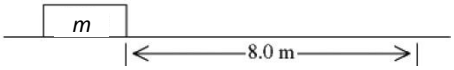
6. A box of mass *m* is pressed against (but is not attached to) an ideal spring of force constant *k* and negligible mass, compressing the spring a distance *x*. After it is released, the box slides up a frictionless incline as shown in the figure and eventually stops. If we repeat this experiment but instead compress the spring a distance of 2*x*



A) the box will go up the incline twice as high as before.
B) just as it moves free of the spring, the box will be traveling twice as fast as before.
C) just as it moves free of the spring, the box will be traveling four times as fast as before.
D) just as it moves free of the spring, the box will have twice as much kinetic energy as before.
E) just before it is released, the box has twice as much elastic potential energy as before.

7. In the figure, an object of mass *m* moves a distance of 8.0 m on a rough horizontal surface. During this motion the speed changes from 9.0 m/s to 2.0 m/s. What is the coefficient of kinetic friction between the object and the rough surface?

A) 0.30
B) 0.37
C) 0.49
D) 0.54
E) 0.61



8. A 0.500 kg steel ball is dropped from an initial height y_i = +2.00 m above a solid metal floor. The ball rebounds vertically upward, stopping at a final height y_f = +1.60 m above the floor. The vertical impulse that the floor exerts on the ball is

A) 8.37 Ns. B) 0.330 Ns C) 5.93 Ns. D) 2.09 Ns. E) 4.20 Ns.

9. In a collision between two objects having unequal masses, how does the magnitude of an impulse imparted to the lighter object by the heavier one compare with the magnitude of an impulse imparted to the heavier object by the lighter one?

A) The lighter object receives the larger magnitude of an impulse.
B) The heavier object receives the larger magnitude of an impulse.
C) Both objects receive the same impulse.
D) The answer depends on the ratio of the masses.
E) The answer depends on the ratio of the speeds.

10. A 0.2-kg ball moving at 2.0 m/s perpendicular to a wall rebounds from the wall at 1.5 m/s. The impulse given to the ball is:

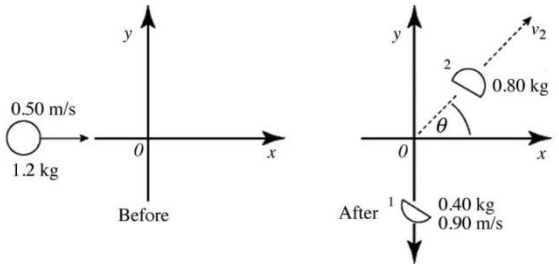
A) zero
B) 3.5 N-s away from wall
C) 3.5 N.s toward wall
D) 0.7 N-s away from wall
E) 0.7 N-s toward wall

11. A 70 kg man is floating at rest near his spaceship. He throws a 1.5 kg wrench away from the ship at a speed of 10 m/s in order to move himself toward it. With what speed does he move toward the ship?

A) 4.62 m/s
B) 1.46 m/s
C) 0.21 m/s
D) 0.13 m/s
E) None of the above

12. A 1.2-kg spring-activated toy bomb slides on a smooth surface along the *x*-axis with a speed of 0.50 m/s. At the origin *0*, the bomb explodes into two fragments. Fragment 1 has a mass of 0.40 kg and a speed of 0.90 m/s along the negative *y*-axis. In the figure, the angle θ, made by the velocity vector of fragment 2 and the *x*-axis, is closest to

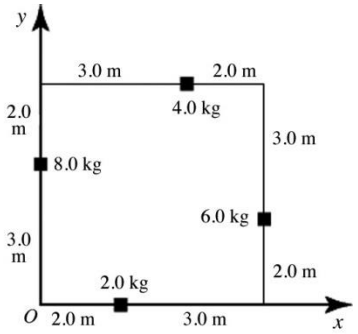
A) 31°.
B) 37°.
C) 38°.
D) 53°.
E) 59°.



13. A 310 g air track cart is traveling at 1.25 m/s and a 260 g cart traveling in the opposite direction at 1.33 m/s. What is the speed of the center of mass of the two carts?

A) 2.80 m/s
B) 0.0732 m/s
C) 0.131 m/s
D) 1.47 m/s
E) 1.29 m/s

14. In the figure, four point masses are placed as shown. The *x* and *y* coordinates of the center of mass are closest to



A) (2.3 m, 2.8 m)
B) (2.2 m, 2.6 m)
C) (2.2 m, 2.7 m)
D) (2.3 m, 2.6 m)
E) (2.3 m, 2.7 m)

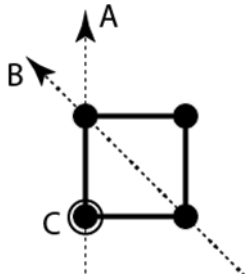
15. A ball on the end of a string is rotating with constant speed in a horizontal plane. When the ball is moving North it is located to the East of the pivot point. At that time the angular velocity of the ball points in what direction?

A) up
B) down
C) East
D) West
E) North

16. A machinist turns the power on to a grinding wheel, which is at rest at time t=0.0. The wheel accelerates uniformly for 10 s and reaches the operating angular velocity of 25 rad/s The wheel is run at that angular velocity for 37 s and then power is shut off. The wheel decelerates uniformly at 1.5 rad/s^2 until the wheel stops. In this situation, the time interval of angular deceleration (slowing down) is closest to

A) 17 s. B) 15 s. C) 19 s. D) 21 s. E) 23 s.

17. Four identical point masses are attached to each corner of a massless and rigid square frame as in the figure. A and B are axes on the surface of page pointing to the directions in the figure. The axis C is perpendicular to the page and goes through the center of the left bottom mass. I_A, I_B and I_C are the rotational inertia about the axis A, B, and C. Which of the following is correct?



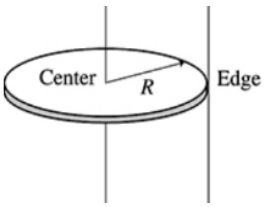
A) $I_A > I_B > I_C$
B) $I_C > I_A > I_B$
C) $I_B > I_A > I_C$
D) $I_A > I_C > I_B$
E) $I_A = I_B = I_C$

18. While spinning down from 500.0 rpm to rest, a solid uniform disk does 5.1 kJ of work. If the radius of the disk is 1.2 m, what is its mass? ($I_{disk} = \frac{1}{2}MR^2$)

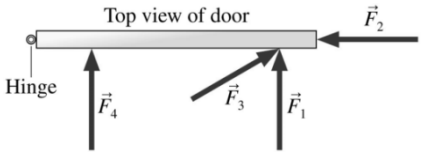
A) 5.2 kg B) 4.4 kg C) 6.0 kg D) 6.8 kg E)8.9 kg

19. A solid flat disk of mass M = 4.0 kg and radius R = 0.20 m is rotating about an axis passing through its center as shown in the right figure. The moment of inertia of the disc about an axis passing through center of mass is ½ MR^2. What is the moment of inertia of the disc about an axis passing through its edge?

A) 0.08 kg m^2
B) 0.16 kg m^2
C) 0.24 kg m^2
D) 0.08 kg m_2
E) None of the above.

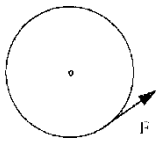


20. The four forces shown have the same strength. Which force produces the least torque about the hinge?



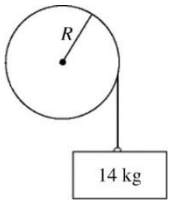
A) Force $\overrightarrow{F_1}$
B) Force $\overrightarrow{F_2}$
C) Force $\overrightarrow{F_3}$
D) Force $\overrightarrow{F_4}$.
E) Either $\overrightarrow{F_1}$ or $\overrightarrow{F_4}$

21. A metal disk rotates on an axis through its center (I = 0.2 *kg* m^2) with angular velocity -3.3 *radians/s* and a torque equal to +1.6 *Nm* is applied to it by pushing on its outer rim. What is the resulting angular acceleration of the disk?



A) -4.0 radians/s^2
B) +4.0 radians/s^2
C) -8.0 radians/s^2
D) +8.0 radians/s^2
E) none of the above

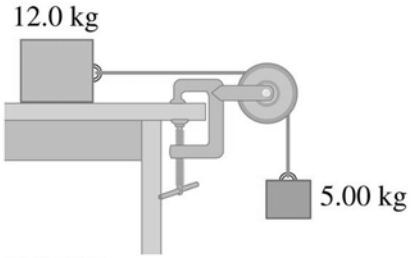
22. In the figure, a very light rope is wrapped around a wheel of radius *R* = 2.0 meters and does not slip. The wheel is mounted with frictionless bearings on an axle through its center. A block of mass 14 kg is suspended from the end of the rope. When the system is released from rest it is observed that the block descends 10 meters in 2.0 seconds. What is the moment of inertia of the wheel?



A) 15 kg •m^2
B) 28 kg •m^2
C) 54 kg • m^2
D) 65 kg m^2
E) 72 kg m^2

23. A 12.0 kg box resting on a horizontal frictionless surface is attached to a 5.00 kg weight by a thin wire that passes over a frictionless pulley. See figure. The pulley has the shape of a uniform solid disk of mass M = 2.00 kg. The rotational inertia of a disk is ½ MR2. After the system is released, what is the tension acting on the 5.0 kg mass?

A) 3.95 N
B) 35.4 N
C) 24.0 N
D) 19.5 N
E) 127 N



24. A shell explodes into two fragments, one fragment 25 times heavier than the other. If any gas from the explosion has negligible mass, then

A) the momentum change of the lighter fragment is 25 times as great as the momentum change of the heavier fragment.
B) the momentum change of the heavier fragment is 25 times as great as the momentum change of the lighter fragment.
C) the kinetic energy change of the heavier fragment is 25 times as great as the kinetic energy change of the lighter fragment.
D) the kinetic energy change of the lighter fragment is 25 times as great as the kinetic energy change of the heavier fragment.

25. A 5.00 kg object is moving at 12.0 m/s on a frictionless floor when it collides with and sticks to another 5.00 kg object that is initially at rest. See the figure below. After the collision, how high above the floor will the combined objects go?

A) 0.54 m
B) 1.84 m
C) 2.78 m
D) 3.56 m
E) 4.12 m