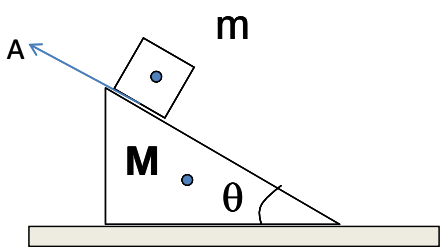
Sample Midterm Questions from Previous Years

1. In the figure, when m slides down from M, which direction is the friction force on M by m?

(a) Left
(b) Right
(c) Direction A
(d) Opposite to direction A
(e) No enough information to decide.

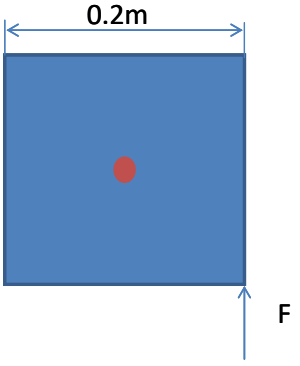


2. A child pulls on a toy car with a horizontal force of 75 N. If the toy car moves horizontally a total of 42 m in 3.0 min, what is the average power generated by the child?

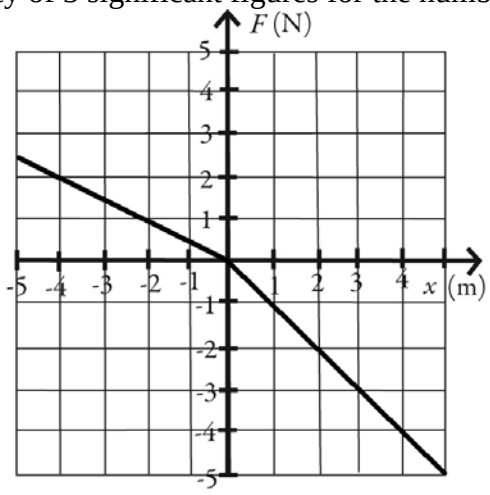
(a) 18 W (b) 24 W (c) 27 W (d) 22 W (e) 30 W

3. A square metal plate 0.20 m on each side is pivoted about an axis through point O at its center and perpendicular to the plate (figure below). What is the magnitude of the net torque about this axis due to the force F at one of the corner if F=10.0N?

(a) 1.4 Nm
(b) 1.0 Nm
(c) 0.71 Nm
(d) 2.0 Nm
(e) 0.5 Nm



4. A graph of the force on an object as a function of its position is shown in the figure. Determine the amount of work done by this force on the object during a displacement from x = -2.00 m to x = 2.00 m. (Assume an accuracy of 3 significant figures for the numbers on the graph.)

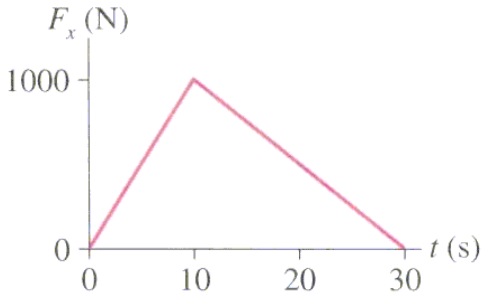


(a) 12.0 J (b) -3.00 J (c) 3.00 J (d) -12.0 J (e) -1.00 J

5. Two identical balls are thrown directly upward, ball A at speed v and ball B at speed 2v, and they feel no air resistance. Which statement about these balls is correct?

(a) The balls will reach the same height because they have the same mass and the same acceleration.
(b) At its highest point, ball B will have twice as much gravitational potential energy as ball A because it started out moving twice as fast.
(c) Ball B will go four times as high as ball A because it had four times the initial kinetic energy.
(d) At their highest point, the acceleration of each ball is instantaneously equal to zero because they stop for an instant.
(e) Ball B will go twice as high as ball A because it had twice the initial speed.

6. Far in space, where gravity is negligible, a 500 kg rocket traveling at 75 m/s fires its engines. The figure shows the thrust force as a function of time. The mass lost by the rocket during these 30 s is negligible. The impulse to the rocket and the maximum speed are respectively:

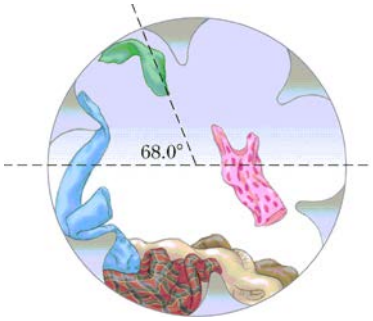


(a) (37500 Ns, 105 m/s) (b) (30000 Ns, 135 m/s) (c) (30000 Ns, 60 m/s)

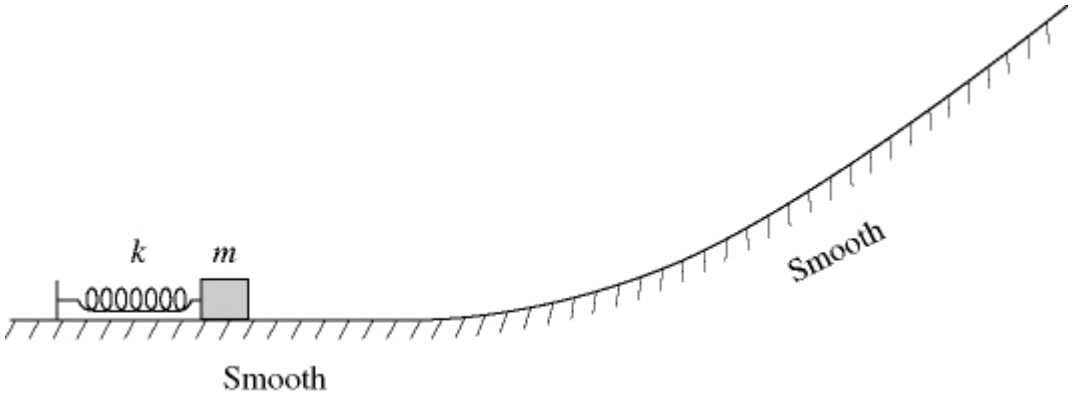
(d) (15000 Ns, 30 m/s) (e) (15000 Ns, 105 m/s)

7. In a home laundry dryer, a cylindrical tub containing wet clothes is rotated steadily about a horizontal axis as shown in the figure, where gravity points downwards. To make the clothes dry uniformly, they are made to tumble. The rate of rotation of the smooth-walled tub is chosen so that a small piece of cloth will lose contact with the tub when the cloth is at an angle of $\theta = 68.0^{o}$ above the horizontal. If the radius of the tub is r = 0.330 m, what rate of revolution is needed?

(a) 30 rev/minute (b) 45 rev/minute (c) 50 rev/minute
(d) 60 rev/minute (e) 63 rev/minute

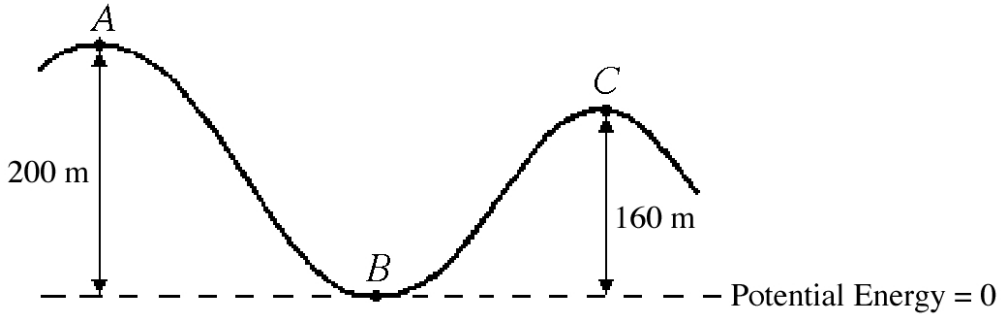


8. A box of mass *m* is pressed against (but is not attached to) an ideal spring of force constant *k* and negligible mass, compressing the spring a distance *x*. After it is released, the box slides up a frictionless incline as shown in the figure and eventually stops. If we repeat this experiment but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



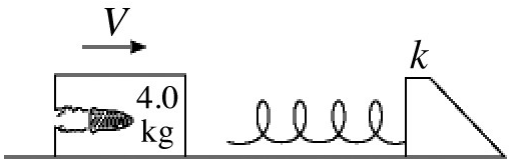
(a) just as it moves free of the spring, the box will be traveling four times as fast as before.
(b) just before it is released, the box has twice as much elastic potential energy as before.
(c) just as it moves free of the spring, the box will have twice as much kinetic energy as before.
(d) just as it moves free of the spring, the box will be traveling twice as fast as before.
(e) the box will go up the incline twice as high as before.

9. A roller coaster of mass 80.0 kg is moving with a speed of 20.0 m/s at position *A* as shown in the figure. The vertical height above ground level at position *A* is 200 m. Neglect friction. What is the speed of the roller coaster at point *C*?



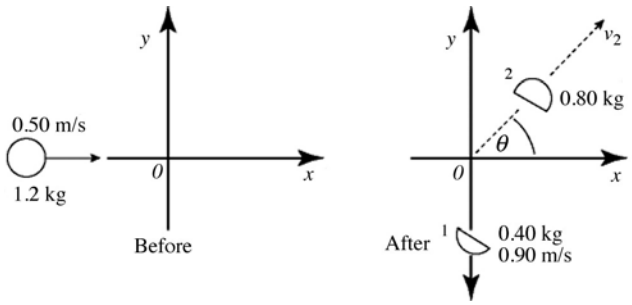
(a) 34 m/s (b) 28 m/s (c) 66 m/s (d) 60 m/s (e) 56 m/s

10. An 8.0-g bullet is shot into a 4.0-kg block, at rest on a frictionless horizontal surface (see the figure). The bullet remains lodged in the block. The block moves into an ideal massless spring and compresses it by 8.7 cm. The spring constant of the spring is 2400 N/m. The initial velocity of the bullet is closest to:



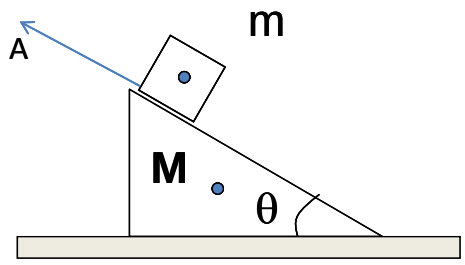
(a) 1200 m/s (b) 900 m/s (c) 1300 m/s (d) 1000 m/s (e) 1100 m/s

11. 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 energy released by the explosion is closest to



(a) 0.20 J (b) 0.36 J (c) 0.24 J (d) 0.32 J (e) 0.28 J

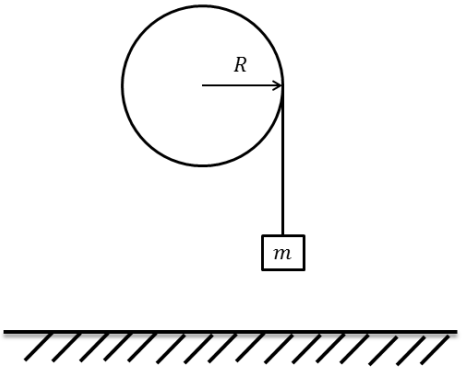
12. In the figure, m stays on M and does not slide down from M. Which of the following statement is correct?



(a) The direction of the friction force on M due to the table is to the left.
(b) The direction of the friction force on M due to the table is to the right.
(c) The direction of the friction force on M due to m is to the left.
(d) The direction of the friction force on M due to m is to the right.
(e) The friction force on M due to table is zero

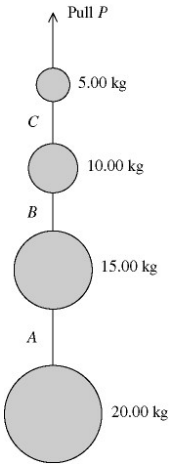
13. A thin, light wire is wrapped around the rim of a disk. The disk rotates without friction about a stationary horizontal axis that passes through the center. The disk has uniform density, mass of 4 kg and a radius of 0.25 m. An object of mass 2 kg is suspended from the free end of the wire. The system is released from rest and the mass falls by 3 meters to hit the ground. Find the speed of the mass when it hits the ground.

(a) 5.4 m/s
(b) 7.7 m/s
(c) 9.8 m/s
(d) 11 m/s
(e) 15 m/s



14. A series of objects connected by very light cords are given an acceleration of 4.00 m/s^2 by a pull *P* on a frictionless table, as shown in the figure. *A*, *B*, and *C* are the tensions in the connecting cords. The SMALLEST of the three tensions, *A*, *B*, and *C*, is closest to

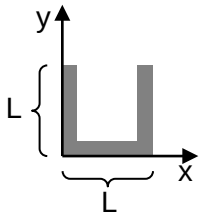
(a) 80.0 N (b) 621 N (c) 276 N (d) 196 N (e) 483 N



15. A uniform U-shaped object is made of three identical rods with length L, see the figure. The thickness of the rod can be neglected. In the xy coordinate shown in the figure, the center of mass is at (x, y) = _____

(a) (0,0) (b) (L/2, L/2) (c) (L/2, L/3)

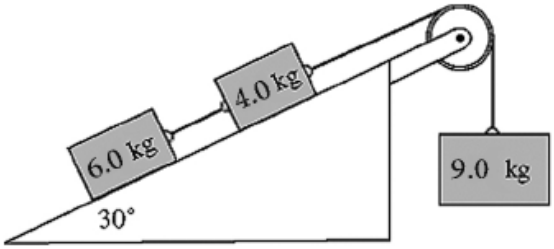
(d) (L/2, L/4) (e) (L/4, L/2)



16. You want to swim straight across a river that is 76 m wide. You find that you can do this if you swim at an angle of θ = 28° from the upstream direction at a constant rate of 1.5 m/s relative to the water. At what rate does the river flow? The angle θ is measured from the river bank (directly upstream is θ = 0° while directly across the river is θ = 90°).

(a) 1.8 m/s (b) 1.3 m/s (c) 1.6 m/s (d) 0.70 m/s (e) 2.1 m/s

17. A system comprising blocks, a light frictionless pulley, a frictionless incline, and connecting ropes is shown in the figure. The 9.0-kg block accelerates downward when the system is released from rest. The tension in the rope connecting the 6.0-kg block and the 4.0-kg block is closest to



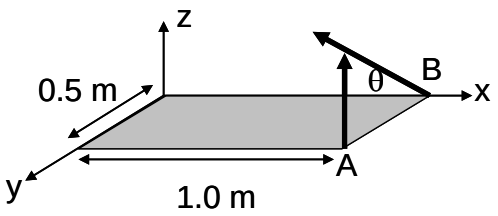
(a) 33 N (b) 42 N (c) 30 N (d) 39 N (e) 36 N

18. A projectile is fired from ground level at an angle of 40.0° above horizontal at a speed of 30.0 m/s. What is the speed of the projectile when it has reached a height equal to 50.0% of its maximum height?

(a) 28.7 m/s (b) 27.4 m/s (c) 28.1 m/s <u>(d) 26.7 m/s</u> (e) 26.0 m/s

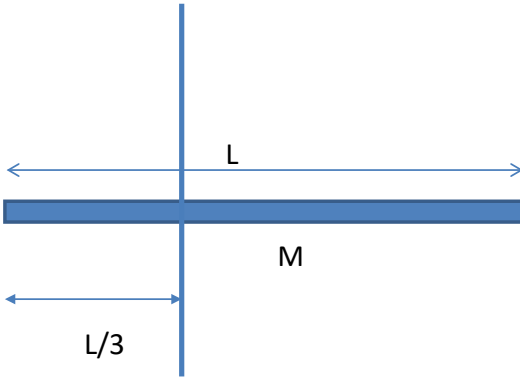
19. A 2.00-kg rigid plate of 1.0 m long and 0.5 m wide is placed on the xy-plane. The plate can rotate around the y-axis. There are two forces acting on the corners A and B respectively. The force at A is 1.0N and perpendicular to the plate (along the Z-axis), and the force at B has a magnitude 2.0N, and is inside the x-z plane and at $\theta = 30^o$ with the x-axis. What is the magnitude of the net torque on the plate about the y-axis? (Ignoring gravity)

(a) 1.0 Nm
(b) 1.5 Nm
<u>(c) 2.0 Nm</u>
(d) 2.5 Nm
(e) none of the above



20. A thin uniform rod of length L and mass M rotates about an axis through a point at 1/3 of rod length and perpendicular to the rod. The moment of inertial of the rod with respect to this axis is:

(a) (1/12) ML^2
(b) (1/3) ML^2
(c) (1/2) ML^2
(d) ML^2
(e) (1/9) ML^2



21. Two balls with the same mass undergo an elastic collision as shown in the picture (the angle between the final velocities may not be accurate in the picture). The initial velocity of one ball is zero. The final velocities of the two balls are nonzero. The angle between the final velocities is:

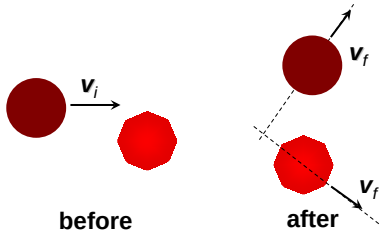
(a) < 90°

(b) = 90°

(c) > 90° and < 180°

(d) > 180°

(e) Cannot be determined



22. A disk can rotate freely around a fixed axis passing through the center of the disk. The disk isinitially at rest and undergoes a constant acceleration of a 5.0 rad/s2 until it reaches the final stable angular velocity of 30 rad/s. How many turns does the disk need to rotate before it reaches its stable state?

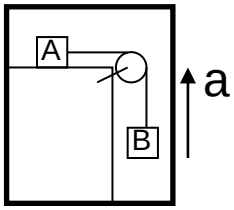
(a) 120 turns (b) 24 turns (c) 6 turns (d) 90 turns (e) 14 turns

23. A uniform solid cylinder with length L and a uniform cylindrical shell with length 2L havethe same mass and the same radii. Both objects rotate about their symmetry axis and have the same rotational kinetic energy. Find the ratio of the angular velocity of the solid cylinder to the cylindrical shell.

(a) 2.0 (b) 0.50 (c) 1 (d) 1.4 (e) 0.70

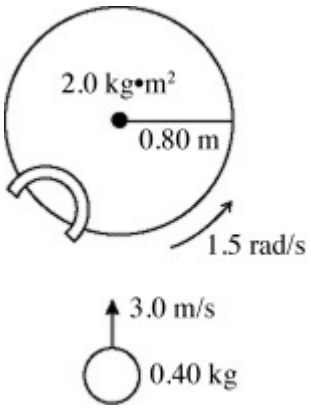
24. The system in the lift is moving upwards with an acceleration a=g/2 as shown in the figure (ignore all frictions). Objects A and B have the same mass *m*, and are connect by a string over a pulley. The masses of the string and the pulley can be neglected. Gravity points downwards. The tension of the string is

(a) *mg* (b) *mg*/2 (c) 3*mg*/4 (d) 2*mg* (e) 3*mg*/2



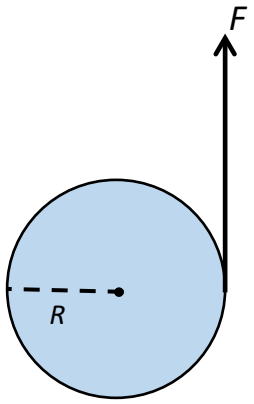
The following questions concern Lectures 10 and 11.

25. A turntable has a radius of 0.80 m and a moment of inertia of 2.0 kg · m^2. The turntable is rotating with an angular velocity of 1.5 rad/s about a vertical axis though its center on frictionless bearings. A very small 0.40-kg ball is projected horizontally toward the turntable axis with a velocity of 3.0 m/s. The ball is caught by a very small and very light cup-shaped mechanism on the rim of the turntable (see figure). The percentage of the initial kinetic energy of the system that is lost during the capture of the ball is closest to



A) 60% B) 65% C) 51% D) 45% E) 55%

26. A yo-yo made of a solid cylindrical disc with radius *R* and mass *M* shown in the diagram below is pulled by a vertically upward force, *F*, such that the center of mass of the yo-yo is stationary. Find the angular acceleration of the yo-yo.



A) $2g/R$
B) $3g/2R$
C) $4g/3R$
D) $2g/3R$
E) $g/2R$