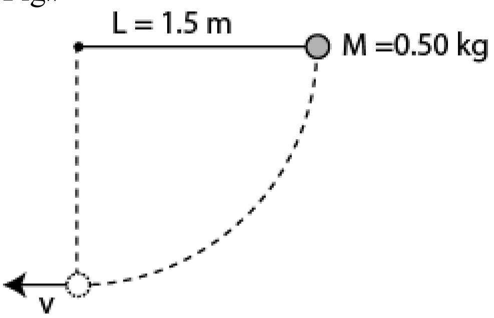
Q1.
Fig 1 shows a simple pendulum, consisting of a ball of mass M = 0.50 kg, attached to one end of a massless string of length L = 1.5 m. The other end is fixed. If the ball is initially released from rest with the string horizontal, then its speed at the lowest point is

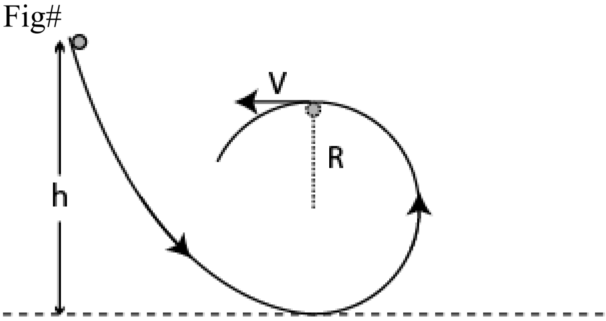
Fig#



A) 5.4 m/s
B) 4.4 m/s
C) 9.8 m/s
D) 17 m/s
E) 2.2 m/s

Q2.
A ball slides without friction around a loop-the-loop (see Fig 2). A ball is released, from rest, at a height *h* from the left side of the loop of radius *R*. What is the ratio (*h/R*) so that the ball has a speed $V = \sqrt{Rg}$ at the highest point of the loop? (g = acceleration due to gravity)

Fig#



A) (5/2)
B) (3/2)
C) (2/1)
D) (7/2)
E) (9/2)

Q3.
A person pushes horizontally a 10 kg box at a constant velocity 1.5 m/s. The coefficient of kinetic friction between the box and the horizontal floor is 0.30. What is the rate of work that the person does in pushing the box?

A) 44W
B) 23W
C) 54W
D) 16W

E) 0 W

Q4.
A worker does 500 J of work in moving a 20 kg box a distance *D* on a rough horizontal floor. The box starts from rest and its final velocity after moving the distance *D* is 4.0 m/s. Find the work done by the friction between the box and the floor in moving the distance *D*.

A) –340 J
B) –500 J
C) –160 J
D) – 98 J
E) 0 J

Q5.
A 2.0 kg block is released from rest 60 m above the ground. Take the gravitational potential energy of the block to be zero at the ground. At what height above the ground is the kinetic energy of the block equal to half its gravitational potential energy?
(Ignore air resistance).

A) 40 m
B) 30 m
C) 20 m
D) 10 m
E) 25 m

Q6.
A 2.2 kg block starts from rest on a rough inclined plane that makes an angle of 30° above the horizontal. The coefficient of kinetic friction is 0.25. As the block moves 3.0 m down the plane, the change in the mechanical energy of the block is:

A) –14 J
B) −9.8 J
C) 9.8 J
D) −18 J
E) 18 J

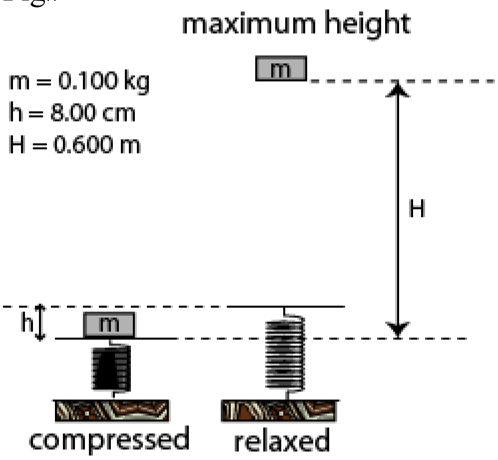
Q7.
A 0.50 kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. The speed of the block is 0.50 m/s, when the spring is stretched by 4.0 cm. The maximum speed the block can have is:

A) 0.71 m/s
B) 0.32 m/s
C) 0.55 m/s
D) 0.23 m/s
E) 0.93 m/s

Q8.

A block (mass = 0.100 kg) is pushed against a vertical spring compressing the spring a distance of h = 8.00 cm (see Fig 3). The block is not attached to the spring. When released from rest, the block rises to a maximum height of H = 0.600 m. Calculate the spring constant.

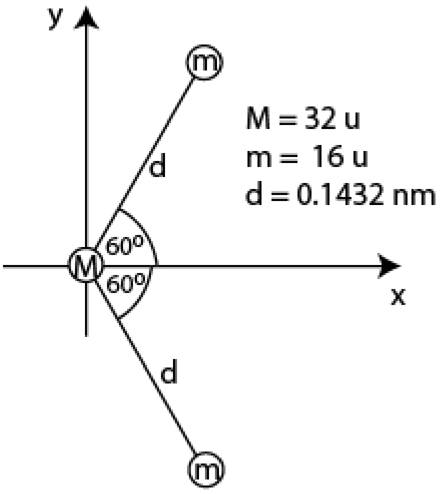
Fig#



A) 184 N/m
B) 155 N/m
C) 131 N/m
D) 115 N/m
E) 198 N/m

Q9.
A sulfur dioxide molecule SO_2 consists of a Sulfur atom (M = 32 u) located at the origin with two Oxygen atoms each of mass (m = 16 u) bound to it as in Fig 4. The angle between the two bonds is 120°. If each bond is 0.1432 nm long, what is the location of the center of mass of the molecule (x,y)?

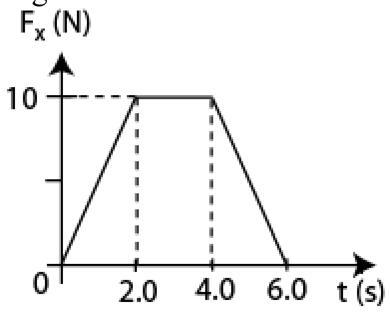
Fig#



A) (0.0358, 0) nm
B) (0.1432, 0) nm
C) (0, 0.0358) nm
D) (0.0716, 0.1432) nm
E) (0, 0.0716) nm

Q10.
A 10.0 kg toy car is moving along the *x* axis. The only force F_x acting on the car is shown in Fig. 5 as a function of time (t). At time $t = 0$ s the car has a speed of 4.0 m/s. What is its speed at time $t = 6.0$ s?

Fig#



A) 8.0 m/s
B) 4.0 m/s
C) 2.0 m/s
D) 10 m/s
E) 12 m/s

Q11.
An object of mass M moving on a frictionless frozen lake with speed V explodes into two equal pieces, one moving at 6.0 m/s due north, and the other at 8.0 m/s due west. Determine V.

A) 5.0 m/s
B) 10 m/s
C) 2.0 m/s
D) 3.0 m/s
E) 4.0 m/s

Q12.
A 4.0 kg block with a velocity of $\left(2.0\,\hat{i}\right)$m/s makes an elastic collision with a 2.0 kg block moving with a velocity of $\left(2.0\,\hat{i} + \hat{j}\right)$m/s. What is the total kinetic energy of the two blocks after the collision?

A) 13 J
B) 21 J
C) 14 J
D) 32 J
E) 72 J

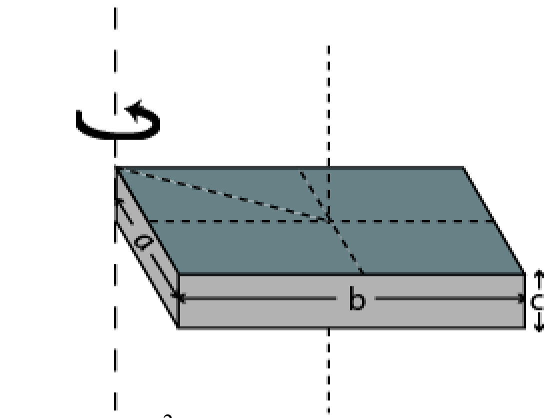
Q13.
Assume that a disk starts from rest and rotates with an angular acceleration of 2.00 rad/s^2. The time it takes to rotate through the first three revolutions is:

A) 4.34 s

B) 3.54 s
C) 0.80 s
D) 0.35 s
E) 12.5 s

Q14.
A uniform **slab** of dimensions: *a* = 60 cm, *b* = 80 cm, and *c* = 2.0 cm (see Fig. 6) has a mass of 6.0 kg. Its rotational inertia about an axis perpendicular to the larger face and passing through one corner of the slab is:

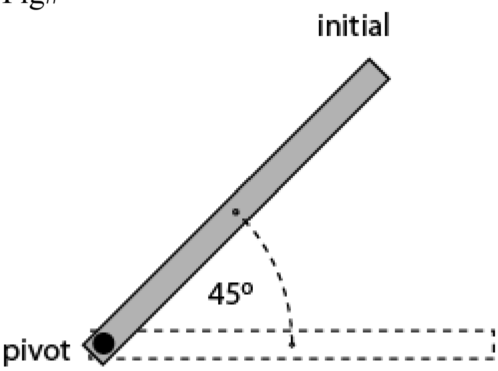
Fig#



A) 2.0 kg.m^2
B) 0.5 kg.m^2
C) 1.5 kg.m^2
D) 2.6 kg.m^2
E) 8.0 kg.m^2

Q15.
A thin rod of mass 0.50 kg and length 2.0 m is pivoted at one end and can rotate in a vertical plane about this horizontal frictionless pivot (axis). It is released from rest when the rod makes an angle of 45° above the horizontal (Fig. 7). Find the angular speed of the rod as it passes through the horizontal position.

Fig#

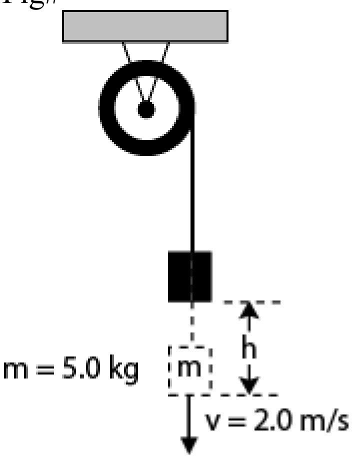


A) 3.2 rad/s
B) 6.9 rad/s
C) 1.2 rad/s
D) 4.8 rad/s

E) 2.4 rad/s

Q16.
A wheel of radius R = 0.20 m is mounted on a fixed frictionless horizontal axis. The rotational inertia I of the wheel about this axis is 0.50 kg.m^2. A massless cord wrapped around the circumference of the wheel is attached to a m = 5.0 kg box (Fig. 8). The box is then released from rest. When the box has a speed of v = 2.0 m/s, the distance (h) through which the box has fallen is:

Fig#



A) 0.71 m
B) 1.2 m
C) 0.20 m
D) 9.8 m
E) 1.9 m

Q17.
A force $\vec{F} = \left(2.0\,\hat{i} + 3.0\,\hat{j}\right)$ N is applied to an object that is pivoted about a fixed axis aligned along the z-axis. If the force is applied at the point of coordinates (4.0, 5.0, 0.0) m, what is the applied torque (in N.m) about the z axis?

A) $2.0\,\hat{k}$
B) $-2.0\,\hat{k}$
C) $22\,\hat{k}$
D) $-22\,\hat{k}$
E) zero

Q18.
A uniform solid disk of mass 3.0 kg and radius 0.20 m rotates about a fixed axis perpendicular to its face. The axis passes through a point midway between the center and the edge of the disk. The angular speed of rotation is 6.0 rad/s. What is the magnitude of the angular momentum (in kg.m^2/s) of the disk about this axis?

A) 0.54
B) 0.36
C) 0.72

D) 0.18
E) 0.12

Q19.
A merry-go-round of radius R = 2.0 m has a rotational inertia I = 200 kg.m^2 and is rotating at 10 rev/min, about a frictionless vertical axle. A 50 kg boy jumps onto the edge of the merry-go-round and sits down on the edge. Considering the boy to be a point mass, the new angular speed of the merry-go-round is:

A) 5.0 rev/min
B) 10 rev/min
C) 20 rev/min
D) 2.5 rev/min
E) 15 rev/min

Q20.
A uniform hoop (ring) is smoothly rolling from the top of a 30° inclined plane of height 5.0 m, starting from rest. Find the speed of its center of mass when it reaches the bottom of the incline.

A) 7.0 m/s
B) 8.0 m/s
C) 9.0 m/s
D) 10 m/s
E) 5.0 m/s
