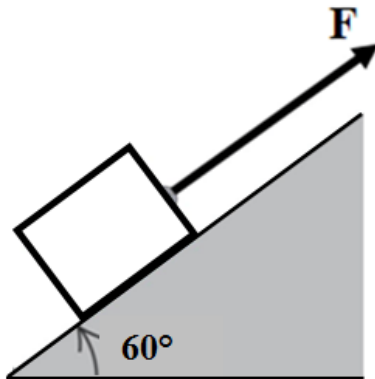


Q1.

A 50-kg box is pulled at constant speed 12 m up a plane  $60^\circ$  above the horizontal by a force parallel to the plane (see **Figure 1**). The coefficient of kinetic friction between the box and the plane is 0.30. How much work is done by the applied force?



A) 6.0 kJ

B) 3.5 kJ

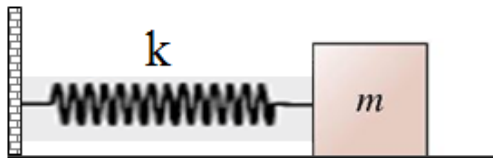
C) 5.3 kJ

D) 0.57 kJ

E) 4.2 kJ

Q2.

A 3.0-kg block is attached to a massless spring of force constant 20 N/m (see **Figure 2**) and rests on a frictionless surface. The block is pulled 2.0 m to the right and released from rest. What is its kinetic energy when it is 1.0 m to the right of the equilibrium position?



A) 30 J

B) 10 J

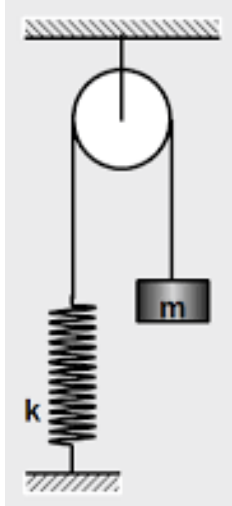
C) 40 J

D) 50 J

E) 25 J

Q3.

A 20-kg mass is attached to a massless spring ( $k = 380 \text{ N/m}$ ) that passes over a frictionless massless pulley, as shown in **Figure 3**. The mass is released from rest with the spring unstretched. What is the speed of the mass at the instant when it has dropped a vertical distance of 0.40 m?



- A) 2.2 m/s
- B) 2.8 m/s
- C) 1.5 m/s
- D) 4.8 m/s
- E) 3.6 m/s

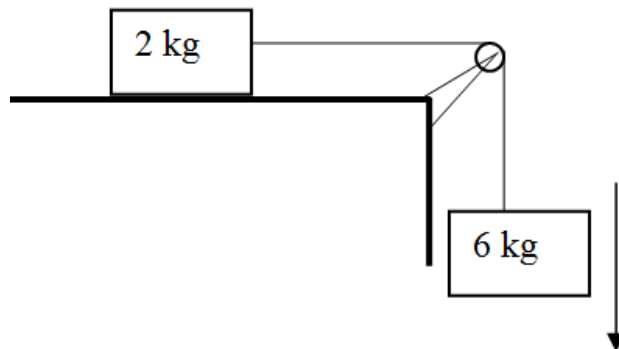
Q4.

A particle moves from the point  $(1.0, 2.0) \text{ m}$  to the point  $(-4.0, -2.0) \text{ m}$  while being acted on by a constant force  $\vec{F} = 4.0 \hat{i} + 2.0 \hat{j} \text{ (N)}$ . What is the work done on the particle by this force?

- A) -28 J
- B) +10 J
- C) +23 J
- D) +17 J
- E) -78 J

Q5.

Two masses are connected and move as shown in **Figure 4**. The coefficient of kinetic friction between the 2.00-kg mass and the surface is 0.400. The system starts from rest. What is the speed of the 6.00-kg mass at the instant when it has fallen 1.50 m? Assume that the pulley is massless and frictionless.



- A) 4.37 m/s
- B) 3.54 m/s
- C) 6.00 m/s
- D) 5.05 m/s
- E) 5.42 m/s

Q6.

A block is pushed on a rough horizontal surface by a 12-N force acting parallel to the surface. If the block moves with a constant speed of 1.5 m/s, how much power is lost due to the frictional force?

- A) 18 W
- B) 11 W
- C) 29 W
- D) 54 W
- E) 31 W

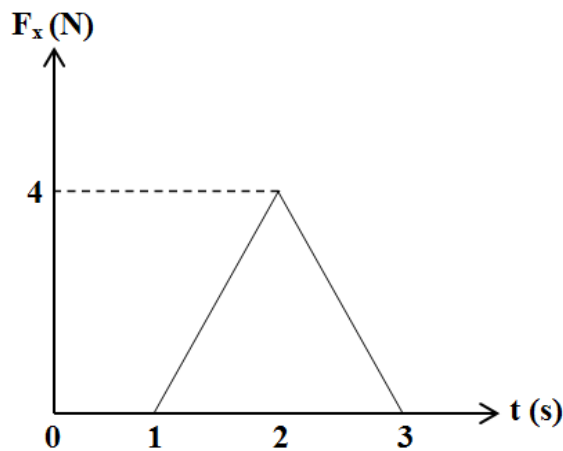
Q7.

Which of the following bodies has the largest kinetic energy?

- A) Mass  $2M$  and speed  $3V$
- B) Mass  $3M$  and speed  $V$
- C) Mass  $3M$  and speed  $2V$
- D) Mass  $M$  and speed  $4V$
- E) Mass  $4M$  and speed  $2V$

Q8.

The only force acting on a 5.0-kg object moving along the  $x$ -axis is shown in **Figure 5**. What is the change in the speed of the object between  $t = 1.0$  s and  $t = 3.0$  s?



- A) 0.80 m/s
- B) 1.1 m/s
- C) 1.6 m/s
- D) 2.3 m/s
- E) 4.0 m/s

Q9.

A 2.0-kg object moving with a velocity of 5.0 m/s in the positive  $x$ -direction collides and sticks to a 3.0-kg object originally moving with a velocity of 2.0 m/s in the positive  $x$ -direction. What is the final speed of the composite object?

- A) 3.2 m/s
- B) 5.0 m/s
- C) 2.0 m/s
- D) 7.0 m/s
- E) 1.2 m/s

Q10.

Three particles are placed in the  $xy$  plane. A 4-kg particle is located at (3, 4) m, and a 6-kg particle is located at (-2, -6) m. Where must a 2-kg particle be placed so that the center of mass of this three-particle system is at the origin?

- A) (0, 10) m
- B) (6, -2) m
- C) (5, 10) m
- D) (9, 16) m
- E) (-2, 4) m

Q11.

A 2.0-kg particle has a velocity of 4.0 m/s in the positive  $x$ -direction, and a 3.0-kg particle has a velocity of 5.0 m/s in the positive  $y$ -direction. What is the speed of their center of mass?

- A) 3.4 m/s
- B) 3.8 m/s
- C) 5.0 m/s
- D) 4.4 m/s
- E) 4.6 m/s

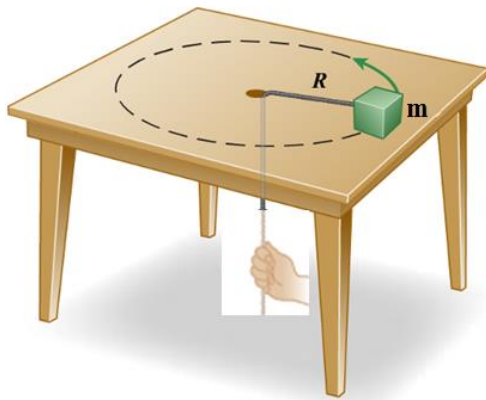
Q12.

A block of mass  $m$  slides on a frictionless surface with speed  $v$ . At one instant, it separates into two equal pieces. One piece is at rest just after the separation. What is the kinetic energy of the second piece immediately after the separation?

- A)  $mv^2$
- B) zero
- C)  $2mv^2$
- D)  $\frac{1}{4}mv^2$
- E)  $\frac{1}{2}mv^2$

Q13.

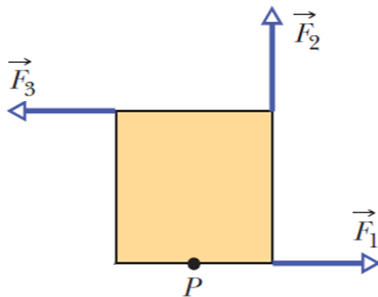
A mass  $m$  is attached to a rope passing through a small hole in a horizontal frictionless surface (**Figure 6**). The mass is initially rotating with a linear speed of 2.25 m/s in a circle of radius  $R$ . The rope is slowly pulled from below, decreasing the radius to  $R/2$ . What is the new linear speed of the mass?



- A) 4.50 m/s
- B) 1.13 m/s
- C) 2.25 m/s
- D) 1.50 m/s
- E) 9.00 m/s

Q14.

In the overhead view of **Figure 7**, three forces of the same magnitude act on a square that is pivoted at point  $P$  (midpoint of the lower side of the square). Rank the forces according to the magnitude of the torque they produce about point  $P$ , greatest first.



- A)  $F_3, F_2, F_1$   
 B)  $F_2, F_3, F_1$   
 C)  $F_3, F_1, F_2$   
 D)  $F_2, F_1, F_3$   
 E) All tie

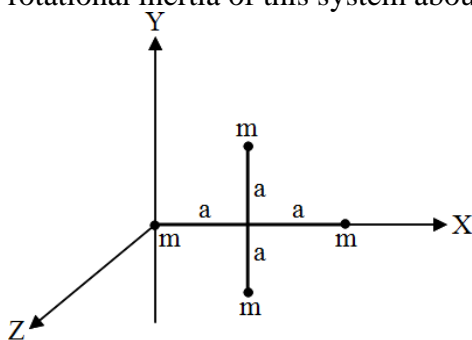
Q15.

A wheel, starting from rest, turns through 8.0 revolutions in a time interval of 17 s. Assuming constant angular acceleration, what is the angular speed of the wheel at the end of this time interval?

- A) 5.9 rad/s  
 B) 8.5 rad/s  
 C) 3.0 rad/s  
 D) 0.90 rad/s  
 E) 1.7 rad/s

Q16.

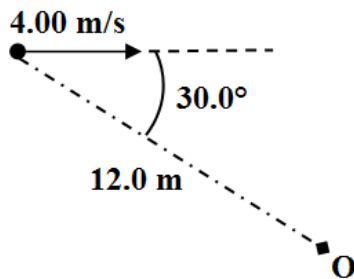
Four identical particles, each of mass  $m$ , are arranged in the  $xy$  plane as shown in **Figure 8**. They are connected by massless rods to form a rigid body. If  $m = 2.0$  kg and  $a = 1.0$  m, the rotational inertia of this system about the  $y$ -axis is



- A) 12 kg.m<sup>2</sup>  
 B) 16 kg.m<sup>2</sup>  
 C) 4.0 kg.m<sup>2</sup>  
 D) 9.6 kg.m<sup>2</sup>  
 E) 4.8 kg.m<sup>2</sup>

Q17.

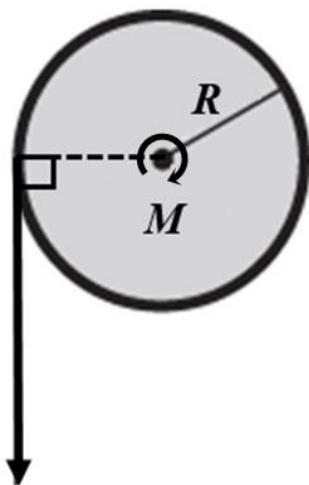
A 6.00-kg particle moves to the right with a speed of 4.00 m/s, as shown in **Figure 9**. The magnitude of its angular momentum about the origin O is



- A) 144 kg.m<sup>2</sup>/s
- B) 288 kg.m<sup>2</sup>/s
- C) 543 kg.m<sup>2</sup>/s
- D) 249 kg.m<sup>2</sup>/s
- E) Zero

Q18.

A 5.0 N force is applied tangentially to a uniform solid disk, as shown in **Figure 10**. The disk has mass  $M = 1.0$  kg and radius  $R = 0.50$  m, and rotates without friction about an axis through its center. What is the magnitude of the angular acceleration of the disk?



5.0 N

- A) 20 rad/s<sup>2</sup>
- B) 10 rad/s<sup>2</sup>
- C) 5.0 rad/s<sup>2</sup>
- D) 40 rad/s<sup>2</sup>
- E) 15 rad/s<sup>2</sup>

Q19.

A uniform solid sphere of mass of 4.00 kg rolls without slipping on a horizontal surface. The linear speed of its center of mass is 4.00 m/s. Its total kinetic energy is

A) 44.8 J

B) 32.0 J

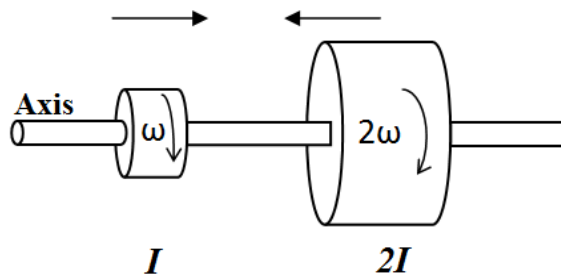
C) 12.8 J

D) 19.2 J

E) 57.6 J

Q20.

Two disks are mounted on a frictionless axis as shown in **Figure 11**. The first disk has a rotational inertia  $I$  and is rotating with an angular speed of 6.00 rad/s. The second disk has a rotational inertia  $2I$  and is rotating with an angular speed of 12.0 rad/s. They then couple and stick together. What is their common angular speed after coupling?



A) 10.0 rad/s

B) 11.4 rad/s

C) 9.17 rad/s

D) 6.00 rad/s

E) 18.0 rad/s