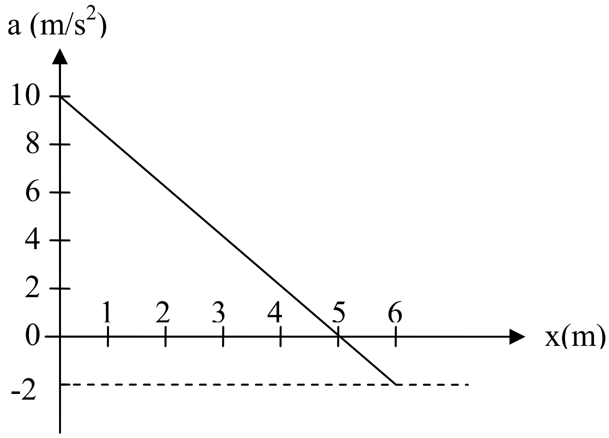
Q1.
Figure 1 shows the acceleration of a 2 kg particle as a single force acts on it along the x-axis, from x = 0 to x = 6 m. Find the work done by the force on the particle.



A) 48 J
B) 52 J
C) 0.0 J
D) 26 J
E) 36 J

Q2.
A 0.2-kg stone tied to a string is rotated in a horizontal circle of radius 0.5 m. The speed of the stone is kept constant at 1.0 m/s. Find the work done by the tension of the string on the stone in one rotation.

A) 0.0 J
B) 0.4 J
C) 1.3 J
D) 6.2 J
E) 0.6 J

Q3.
A 60-kg boy runs from the 1st floor to the 2nd floor, using the stairs, in 12 s. The stairs are made up of 30 steps, each 10 cm high. Calculate the average power required by the boy.

A) 147 W
B) 980 W
C) 55.0 W
D) 588 W
E) 49.0 W

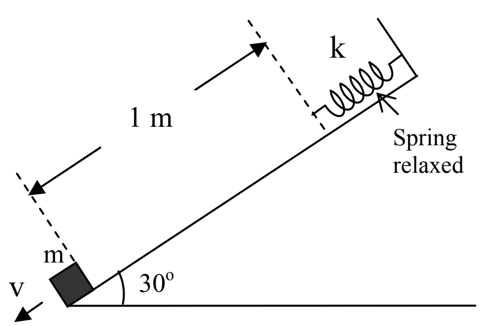
Q4.
A 2-kg block slides across a horizontal frictionless floor with a speed of 2.0 m/s. It then runs into and compresses a spring of spring constant k = 800 N/m. The block comes momentarily to rest after compressing the spring a distance d. Find the distance d.

A) 10 cm
B) 20 cm
C) 30 cm
D) 5.0 cm
E) 25 cm

Q5.
A 2-kg object is dropped vertically from rest. After falling a distance of 50 m, it has a speed of 25 m/s. Calculate the work done by the air resistance on the object during this fall.

A) – 355 J
B) – 230 J
C) – 105 J
D) – 1200 J
E) 0.0 J

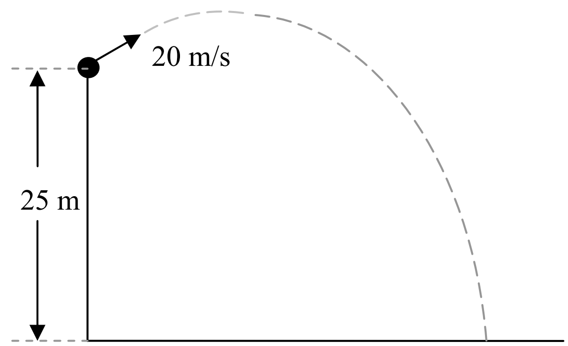
Q6.
A spring with spring constant k = 106 N/m is attached to the top of a frictionless 30^0 incline as shown in Figure 2. The distance between the lower end of the incline and the relaxed end of the spring is 1 m. A 1-kg block is pushed against the spring until the spring is compressed by 0.2 m and released from rest. Find the speed of the block when it reaches the lower end of the incline. (ignore the size of the block).



A) 4.0 m/s
B) 2.7 m/s
C) 3.7 m/s
D) 2.3 m/s
E) 0.0 m/s

Q7.

A projectile is fired from a height of 25 m with a speed of 20 m/s as shown in Figure 3. Find its speed when it hits the ground. Ignore air resistance.



A) 30 m/s
B) 20 m/s
C) 10 m/s
D) 40 m/s
E) 50 m/s

Q8.
As an object moves from point A to point B, only two forces act on it: one force is conservative and does 10 J of work, the other is non conservative and does –20 J of work. What happens to the energy of the object between points A and B?

A) Kinetic energy decreases, mechanical energy decreases.
B) Kinetic energy decreases, mechanical energy increases.
C) Kinetic energy increases, mechanical energy decreases.
D) Kinetic energy increases, mechanical energy increases.
E) Mechanical energy is conserved.

Q9.
A ball of mass 60 g traveling horizontally at 14 m/s hits a vertical wall and bounces back with a speed of 12 m/s. If the duration of impact is 2.0 ms, what is the magnitude of the force of the wall on the ball?

A) 780 N
B) 60.0 N
C) 9.00 N
D) 900 N
E) 18.0 N

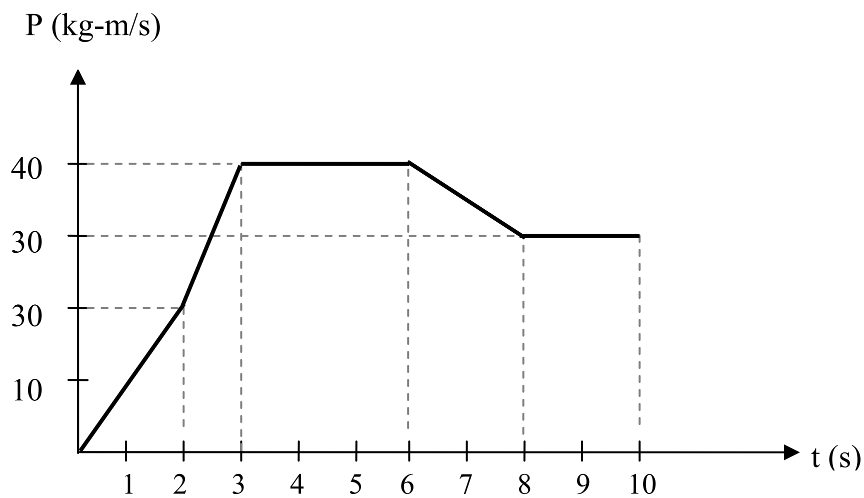
Q10.
An object of mass 5 kg is moving on a frictionless table toward the North. It explodes into two pieces, m_1 moving at a speed of 3 m/s, 45^0 East of North, and m_2 moving at a speed of 5 m/s, 45^0 West of North. Find m_1 and m_2 in kilograms.

A) $m_1 = 3.1$ $m_2 = 1.9$
B) $m_1 = 2.5$ $m_2 = 2.5$
C) $m_1 = 0.60$ $m_2 = 4.4$
D) $m_1 = 1.0$ $m_2 = 4.0$
E) $m_1 = 4.4$ $m_2 = 0.60$

Q11.
Two **identical** red and blue cars are moving along the same track in opposite directions. The red car has 5 times the momentum of the blue car. They undergo a perfectly inelastic collision. The speed after the collision is

A) twice the initial speed of the blue car
B) half the initial speed of the blue car
C) one fifth the initial speed of the blue car
D) five times the initial speed of the blue car
E) three times the initial speed of the blue car

Q12.
Figure 4 shows the momentum versus time graph of a particle moving along the x-axis. The force on the particle is maximum in the time interval

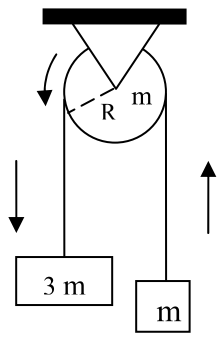


A) 2 to 3 s
B) 0 to 2 s
C) 3 to 6 s
D) 6 to 8 s
E) 8 to 10 s

Q13.
A disk is rotating about an axis perpendicular to the disk and passing through its center of mass. The angular position of a reference line on the disk is given by $\theta(t) = 2 - 0.8t + 1.5t^3$, where t is in seconds and θ in radians. Find the average angular acceleration of the disk during the time interval t = 2.0 s and t = 4.0 s.

A) 27.0 rad/s^2
B) 45.0 rad/s^2
C) 102 rad/s^2
D) 21.0 rad/s^2
E) 33.3 rad/s^2

Q14.
Figure 5 shows two masses m and 3m that are initially held at rest and then released. If the pulley has mass m and radius R, what is the angular acceleration of the pulley?



A) $\frac{4g}{9R}$

B) $\frac{g}{9R}$

C) $\frac{4g}{R}$

D) $\frac{g}{R}$

E) $\frac{9g}{4R}$

Q15.
A disk of mass M and radius R is free to rotate about an axis through its center. A tangential force **F** is applied to the rim (edge) of the disk. What must one do to maximize the angular acceleration of the disk?

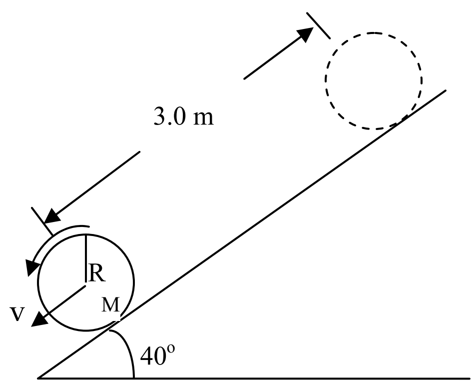
A) Make **F** as large as possible and M and R as small as possible
B) Make **F** and M as large as possible and R as small as possible
C) Make M as large as possible and **F** and R as small as possible
D) Make R as large as possible and **F** and M as small as possible
E) Make **F**, M, and R as large as possible

Q16.

Consider a square plate of mass M = 2.0 kg and side L = 2.0 m. Calculate the kinetic energy of the plate if it is rotated with an angular speed of 10 rad/s about an axis passing through one of the corners of the plate and perpendicular to it. The rotational inertia of the plate about an axis passing through the center of mass of the plate and perpendicular to it is $ML^2/6$.

A) 267 J
B) 376 J
C) 125 J
D) 209 J
E) 102 J

Q17.
A uniform disk of mass M and radius R rolls smoothly from rest down a 40^0 incline as shown in Figure 6. Find the speed of the disk after it has moved a distance of 3.0 m down the incline.

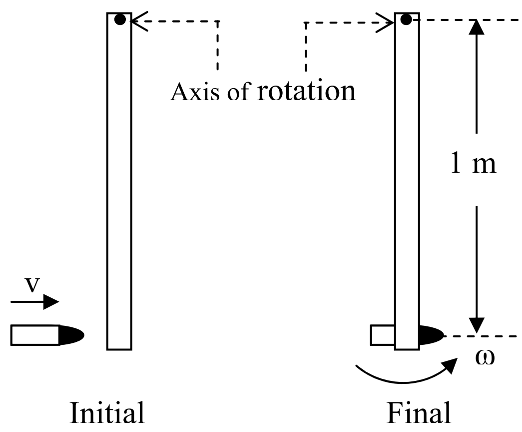


A) 5.0 m/s
B) 2.0 m/s
C) 22 m/s
D) 9.0 m/s
E) 10 m/s

Q18.
A 4.0 kg particle moves in an x-y plane. At the instant when the particle's position relative to the origin is $\vec{r} = 2.0\hat{i} + 4.0\hat{j}$, its acceleration is $\vec{a} = 2.0\hat{i}$, where $\vec{r}$ is in meters and $\vec{a}$ is in m/s^2. Find the torque acting on the particle about the origin.

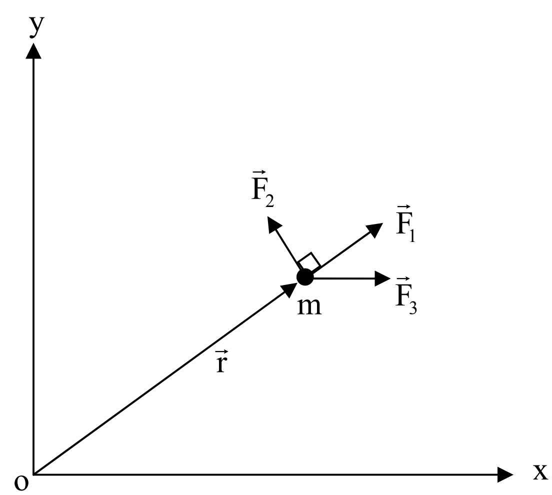
A) $-32\hat{k} \quad N \cdot m$
B) $-42\hat{k} \quad N \cdot m$
C) $+12\hat{i} \quad N \cdot m$
D) $+42\hat{i} \quad N \cdot m$
E) $+32\hat{i} \quad N \cdot m$

Q19.
A uniform thin rod of length 1.0 m and mass 3.0 kg can rotate freely in a vertical plane about a horizontal axis through one end. The rod is at rest when a 10 g bullet is fired into the free end of the rod as shown in Figure 7. The speed of the bullet just before impact is 250 m/s. If the bullet is embedded into the rod, what is the angular speed just after the collision?



A) 2.5 rad/s
B) 12 rad/s
C) 7.5 rad/s
D) 10 rad/s
E) 0.75 rad/s

Q20.
Figure 8 shows the position vector $\vec{r}$ of a particle at a certain instant, and three forces that act on the particle. All three forces are equal in magnitude and lie in the x-y plane. Rank the forces according to the magnitude of the torque they produce on the particle about the origin O, the greatest first.



A) F2, F3, F1
B) F2, F1, F3
C) F3, F2, F1
D) F1, F2, F3
E) F1, F3, F2