

PHYS101 Second Major – zero version

Q1.

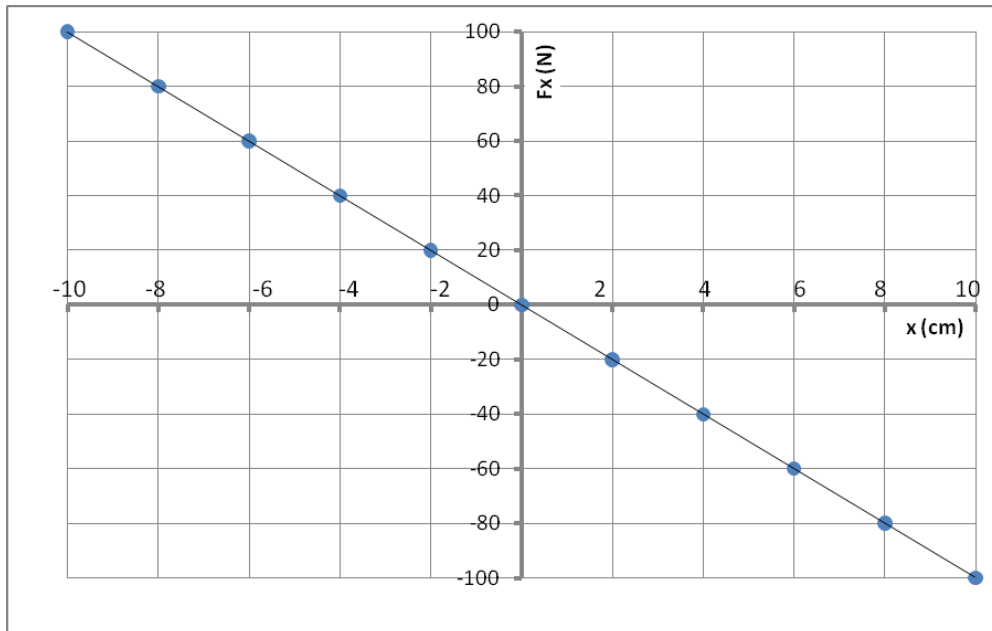
A stone of mass 1.0 kg, tied to a rope of length 2.0 m, is rotating in a horizontal circle on a frictionless table top with a speed of 1.0 m/s. Find the work done by the force of tension in the rope when the stone has completed one revolution.

- A) 0 J
- B) 25 J
- C) 50 J
- D) 6.3J
- E) 12 J

Q2.

Figure 1 shows the spring force F_x as a function of position x for a spring-block system resting on a frictionless table. The block is released at $x = +10$ cm. How much work (in Joules) does the spring do on the block when the block moves from $x_i = +8.0$ cm to $x_f = -4.0$ cm?

Fig#



- A) +2.4
- B) -2.4
- C) +3.2
- D) -3.2
- E) +5.8

Q3.

A particle is acted on by a constant force $\vec{F} = (2.0 \text{ N})\hat{i} - (5.0 \text{ N})\hat{j}$ and is displaced from an initial position of $\vec{d}_i = (0.50 \text{ m})\hat{i} + (0.80 \text{ m})\hat{j}$ at time $t = 0 \text{ s}$ to a final position of $\vec{d}_f = (3.5 \text{ m})\hat{i} + (9.8 \text{ m})\hat{j}$ at time $t = 10 \text{ s}$. Find the average power (in Watts) on the particle due to this force in this time interval.

- A) -3.9
- B) +3.9
- C) -6.6
- D) +6.6
- E) -39

Q4.

A single force acts on a 5.0 kg object. The position of the object as a function of time is given by $x = 10t - 5.0t^2$, where x is in meters and t is in seconds. Find the work done by this force on the object in the interval from $t = 0 \text{ s}$ to $t = 5.0 \text{ s}$.

- A) $3.8 \times 10^3 \text{ J}$
- B) $3.0 \times 10^2 \text{ J}$
- C) $2.5 \times 10^3 \text{ J}$
- D) $1.7 \times 10^4 \text{ J}$
- E) $5.8 \times 10^3 \text{ J}$

Q5.

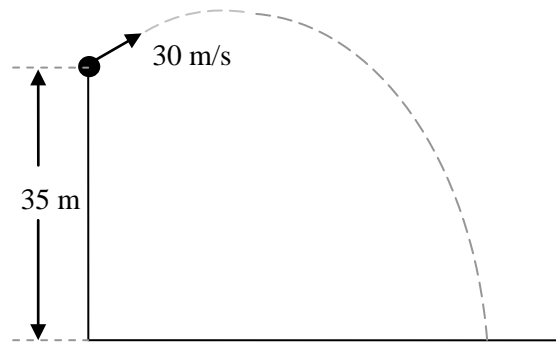
An object of mass 1.0 kg is moving in a straight line over a rough horizontal surface. The coefficient of kinetic friction between the object and the floor is 0.20. What is the power that must be supplied to the object in order to keep it moving at a constant speed of 2.0 m/s?

- A) 3.9 W
- B) 0.39 W
- C) 5.3 W
- D) 7.4 W
- E) 0.65 W

Q6.

A projectile is fired from a height of 35 m with a speed of 30 m/s as shown in **Figure 2**. Find its speed when it hits the ground. Ignore air resistance.

Fig#

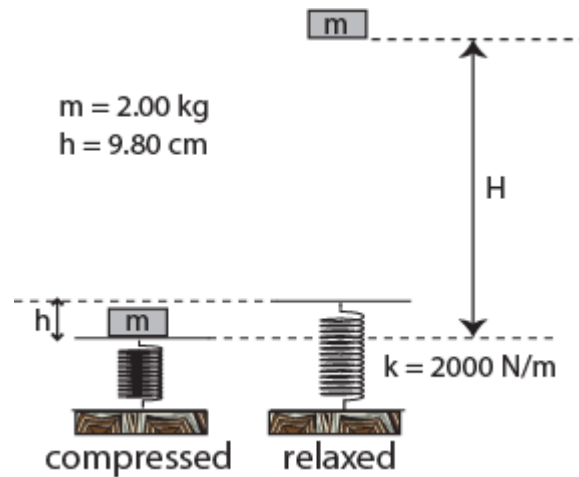


- A) 40 m/s
- B) 30 m/s
- C) 10 m/s
- D) 20 m/s
- E) 50 m/s

Q7.

A spring is compressed a distance of $h = 9.80$ cm from its relaxed position and a 2.00 kg block is put on top of it (**Figure 3**). What is the maximum height, H , that the block will reach when the spring is released? The spring constant is $k = 2.00 \times 10^3$ N/m.

Fig#

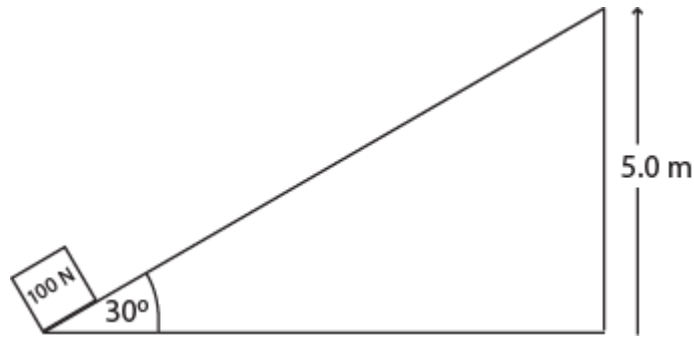


- A) 49.0 cm
- B) 9.80 cm
- C) 19.6 cm
- D) 4.90 cm
- E) 98.0 cm

Q8.

A man pulls a 100-N crate up a frictionless 30.0° - incline to a height 5.00 m, as shown in **Figure 4**. Assuming that the crate moves at a constant speed, the work done on the crate by the man is:

Fig#

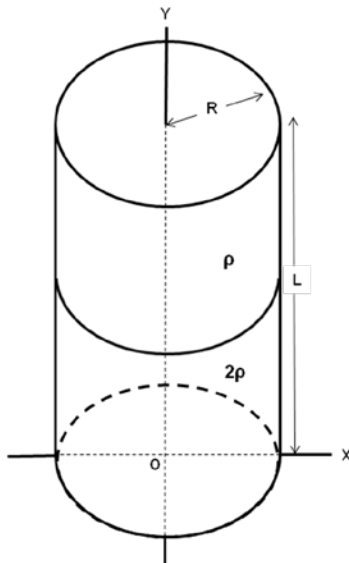


- A) +500 J
- B) -250 J
- C) 0 J
- D) +250 J
- E) -500 J

Q9. A cylindrical can is filled with two liquids of equal volume with density ρ and 2ρ as shown in **Figure 5**. L is the length and R is the radius of the cylindrical can. The center of the circular base is at the origin of coordinate axis. Find the coordinates of center of mass (x, y) of the can filled with the two liquids, in terms of R and L .

Ignore the mass of the cylindrical can and assume that the two liquids **do not mix** with each other.

Fig#



- A) $\left(0, \frac{5}{12}L\right)$
- B) $\left(0, \frac{1}{2}L\right)$
- C) $\left(R, \frac{1}{2}L\right)$
- D) $\left(\frac{5}{12}L, 0\right)$
- E) $\left(\frac{1}{2}L, 0\right)$

Q10.

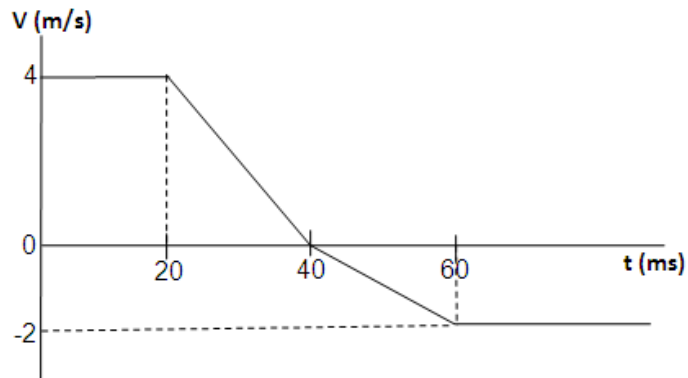
An object of mass m is moving with constant velocity of $4\hat{i}$ m/s on a frictionless horizontal surface in the xy -plane. The object explodes (due to internal forces) into three pieces with masses $m/4$, $m/4$, and $m/2$. If the two pieces of mass $m/4$ each move with velocities $-2\hat{i} + 2\hat{j}$ and $-2\hat{i} - 2\hat{j}$ m/s, find the velocity (in m/s) of the center mass of these three pieces after explosion.

- A) $4\hat{i}$
- B) $8\hat{i} + 4\hat{j}$
- C) $8\hat{i}$
- D) $4\hat{i} + 4\hat{j}$
- E) $4\hat{i} + 2\hat{j}$

Q11.

Figure 6 shows the velocity versus time graph of a particle of mass 1.0 kg moving along the x -axis towards a wall. The particle was in contact with the wall during time interval between $t = 20$ ms and $t = 60$ ms. Find the magnitude of the average force (in N) exerted by the wall on the ball during contact.

Fig#

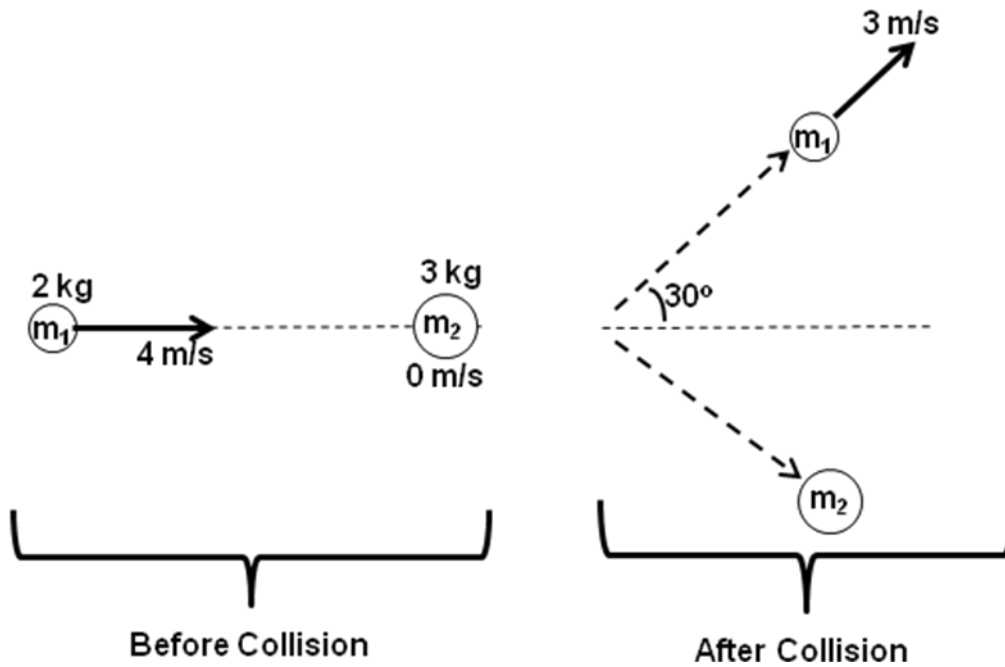


- A) $1.5 \times 10^{+2}$
- B) $2.0 \times 10^{+2}$
- C) $1.0 \times 10^{+2}$
- D) $8.9 \times 10^{+1}$
- E) $1.8 \times 10^{+2}$

Q12.

An object of mass $m_1 = 2.0$ kg is moving with a velocity of 4.0 m/s along the x-axis on a frictionless horizontal surface and collides with another object of mass $m_2 = 3.0$ kg initially at rest. After collision both masses continue to move on the frictionless surface as shown in **Figure 7**. If m_1 moves with a velocity of 3.0 m/s at an angle of 30° with respect to the x-axis, what will be the magnitude of the x- and y-components of the momentum of mass m_2 (in kg·m/s)?

Fig#



- A) 2.8 and 3.0
- B) 5.2 and 3.0
- C) 8.0 and 0.0
- D) 1.3 and 3.0
- E) 5.2 and 0.0

Q13.

The moment of inertia of an object does **not** depend on

- A) its angular velocity.
- B) its mass.
- C) its size and shape.

- D) the location of the axis of rotation.
- E) the distribution of its mass.

Q14.

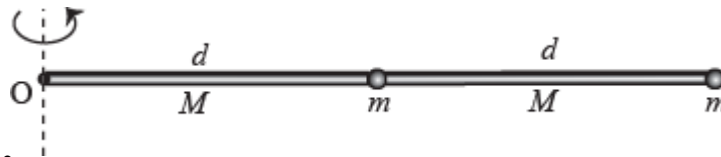
A turntable rotating at 33 revolutions per minute is switched off. It comes to rest in 2.0 minutes with constant angular acceleration. Find the radial acceleration of a point 10 cm from the axis of rotation at time $t = 1.0$ minute.

- A) 0.30 m/s^2
- B) 0.25 m/s^2
- C) 0.54 m/s^2
- D) 0.65 m/s^2
- E) 0.12 m/s^2

Q15.

In **Figure 8**, two particles, each with mass $m = 1.0 \text{ kg}$, are fastened to each other, and to a rotation axis at point O, by two thin rigid rods. Each rod has length $d = 1.0 \text{ m}$ and mass $M = 1.0 \text{ kg}$. Find the moment of inertia of the system about a perpendicular axis through point O as shown in the Figure.

Fig#

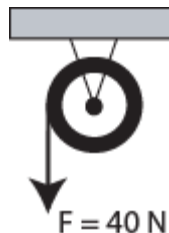


- A) $7.7 \text{ kg}\cdot\text{m}^2$
- B) $5.3 \text{ kg}\cdot\text{m}^2$
- C) $6.3 \text{ kg}\cdot\text{m}^2$
- D) $3.4 \text{ kg}\cdot\text{m}^2$
- E) $9.4 \text{ kg}\cdot\text{m}^2$

Q16.

A rope is wound around the rim of a wheel (radius = 2.0 m, and moment of inertia about the rotation axis, $I = 5.0 \text{ kg}\cdot\text{m}^2$). A constant force $F = 40 \text{ N}$ is applied (**Figure 9**) to one end of the rope for 1.0 s causing the wheel to rotate starting from rest. Find the length of the rope unwound during this period of time.

Fig#



- A) 16 m
- B) 6.3 m

- C) 8.0 m
- D) 3.1 m
- E) 4.0 m

Q17.

A thin hoop of mass M and radius R rolls without slipping down an inclined plane. The ratio of its rotational kinetic energy to its total kinetic energy is:

- A) $1/2$
- B) $2/3$
- C) $1/3$
- D) $1/4$
- E) 2

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 $\vec{r}' = 2.0 \hat{i}$, its acceleration is $\vec{a} = 2.0 \hat{i} + 3.0 \hat{j}$, where \vec{r}' is in meters and \vec{a} is in m/s^2 . Find the torque acting on the particle about the point P (0, 2.0) m.

- A) $+40 \hat{k} \text{ N} \cdot \text{m}$
- B) $-40 \hat{k} \text{ N} \cdot \text{m}$
- C) $+16 \hat{i} - 24 \hat{j} \text{ N} \cdot \text{m}$
- D) $+32 \hat{j} \text{ N} \cdot \text{m}$
- E) $-32 \hat{j} \text{ N} \cdot \text{m}$

Q19.

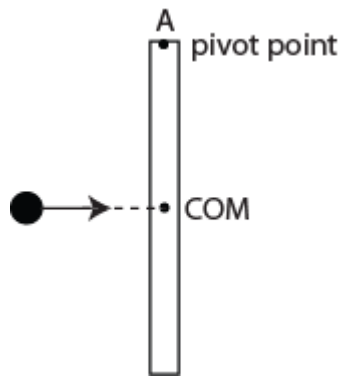
A boy of mass $m = 30.0$ kg stands at the center of a platform which rotates about a frictionless axle making one revolution in 6.00 seconds. The platform is a uniform circular disk with mass $M = 100$ kg and radius $R = 2.00$ m. If the boy walks radially to a position 1.00 m from the platform center, find the angular speed of the boy-platform system after the boy has reached this position.

- A) $9.11 \times 10^{-1} \text{ rad/s}$
- B) 1.05 rad/s
- C) 2.10 rad/s
- D) $5.40 \times 10^{-1} \text{ rad/s}$
- E) 3.56 rad/s

Q20.

A uniform thin rod of mass $M = 50$ g and length $L = 1.0$ m hangs from a pivot at point A at the edge (**Figure 10**). A ball of clay of mass $m = 10$ g moving with a horizontal velocity $v = 25$ m/s strikes the rod at its center of mass (COM) at right angle and remains stuck to the rod. Find the angular speed of the clay-rod system just after the collision.

Fig#



- A) 6.5 rad/s
- B) 0.0 rad/s
- C) 10 rad/s
- D) 5.0 rad/s
- E) 2.3 rad/s