Please discard the solution posted earlier on 18-04-12. There is a correction in question #8.

Q1.
A force $\vec{F} = \left(12\,\hat{i} + B\,\hat{j}\right)$ N , where B is a constant, acts on an object and does 46 joules work as the object moves from the origin to the point $\vec{r} = \left(13\,\hat{i} + 11\,\hat{j}\right)$ m . The value of B is:

Answer:

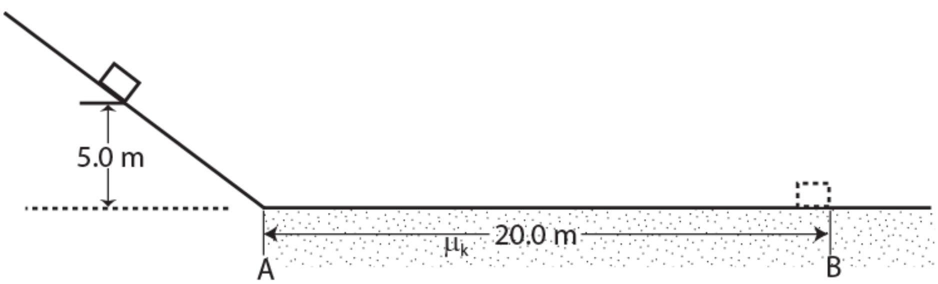
$$W = \vec{F}.\vec{r} = \left(12\,\hat{i} + B\,\hat{j}\right)\cdot\left(13\,\hat{i} + 11\,\hat{j}\right) = (12)(13) + 11B = 46$$

$$\Rightarrow B = \frac{46 - 156}{11} = -10\,\text{N}$$

A) −10 N
B) +10 N
C) −12 N
D) +15 N
E) +14 N

Stat# A_53_DIS_0.45_PBS_0.37_B_19_C_10_D_8_E_10_EXP_60_NUM_472

Q2.
A 9.00-kg box slides from rest down a frictionless incline from a height of 5.00 m as shown in **Figure 1**. A constant frictional force, introduced at point **A**, brings the block to rest at point **B**, 20.0 m to the right of point **A**. What is the coefficient of kinetic friction, μ_k , between the box and surface AB?



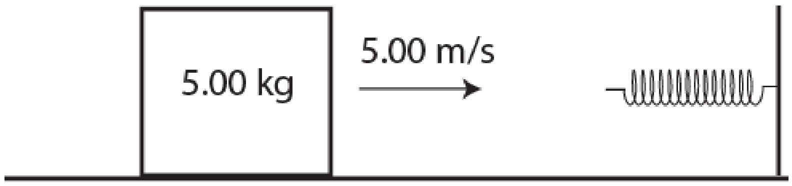
Answer:

$$mgh = \mu_k mgs \Rightarrow \mu_k = \frac{h}{s} = \frac{5.0}{20.0} = 0.25$$

A) 0.25
B) 0.11
C) 0.33
D) 0.47
E) 0.52

Stat# A_52_DIS_0.71_PBS_0.51_B_7_C_12_D_17_E_11_EXP_50_NUM_472

Q3.
In **Figure 2**, a 5.0-kg block is moving at 5.0 m/s along a horizontal frictionless surface toward an ideal spring that is attached to a wall. After the block collides with the spring, the spring is compressed a maximum distance of x_m. What is the speed of the block when the spring is compressed to only $x_m/2$?



Answer:

$$\frac{1}{2}mv_0^2 = \frac{1}{2}kX_m^2,$$

$$\Delta K + \Delta U = 0 \Rightarrow \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2 + \frac{1}{2}k\left(\frac{1}{2}X_m\right)^2 = 0$$

$$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_0^2 - \frac{1}{2}k\left(\frac{1}{2}X_m\right)^2 = \frac{1}{2}mv_0^2 - \frac{1}{8}kX_m^2 = \frac{3}{8}mv_0^2 = \frac{3}{8}m5^2$$

$$v_f = \sqrt{\frac{3}{4}}5 = 4.3 \text{ m/s}$$

A) 4.3 m/s
B) 3.4 m/s
C) 7.1 m/s
D) 5.2 m/s
E) 6.3 m/s

Stat# A_23_DIS_0.26_PBS_0.28_B_41_C_11_D_11_E_14_EXP_45_NUM_472

Q4.

A net force of $\left(50\,\hat{\text{i}}\right)\text{N}$ is acting on a 2.0-kg box that was initially at rest at the origin. At the ***instant*** the object has the position vector $\left(2.0\,\hat{\text{i}}\right)\text{m}$, the rate at which the force is doing work on the box is:

Answer:

$$a = \frac{F}{m} = \frac{50}{2} = 25\ \text{m/s}^2,$$
$$v_f^2 = v_0^2 + 2ax = 0 + 2(25)2 \Rightarrow v_f = 10\ \text{m/s}$$
$$P = Fv_f = (50)(10) = 500\ \text{W}.$$

A) 500 W
B) 250 W
C) 75 W
D) 100 W
E) 300 W

Stat# A_21_DIS_0.25_PBS_0.27_B_18_C_8_D_48_E_5_EXP_55_NUM_472

Q5.

The only force acting on a particle is a conservative force **F**. If the particle is at a point A, the potential energy of the system is 80 J. If the particle moves from point A to point B, the work done on the particle by **F** is +20 J. As the particle reaches point B, the potential energy of the system is:

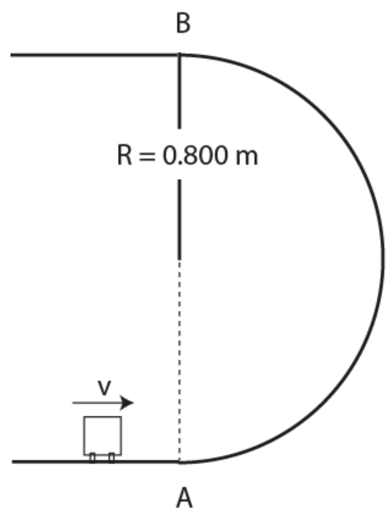
Answer:

$$W_{AB} = -\Delta U = -\left(U_B - U_A\right) \Rightarrow 20 = -\left(U_B - 80\right)$$
$$\Rightarrow\ U_B = 60\ \text{J}$$

A) 60 J
B) 100 J
C) 20 J
D) −100 J
E) − 60 J

Stat# A_48_DIS_0.27_PBS_0.18_B_29_C_6_D_6_E_11_EXP_55_NUM_472

Q6.
A 2.00-kg mass is moved along a rough vertical circular track (radius R = 0.800 m) as shown in **Figure 3**. The speed of the mass at point A is $v_A = 8.00$ m/s, and at point B is $v_B = 5.00$ m/s. How much work is done on the mass between A and B by the force of friction?



Answer:
Work-energy theorem implies:

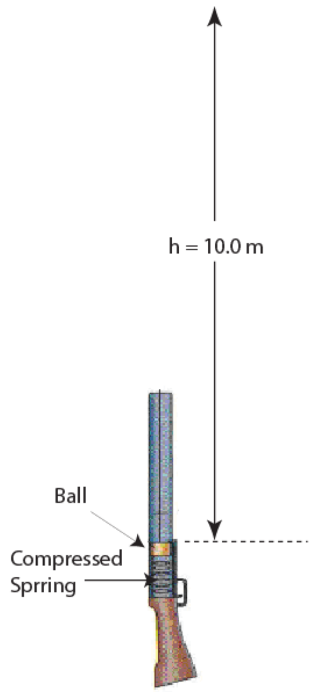
$$W_f = \Delta K + \Delta U = \left(\frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2\right) + mg(2R - 0)$$

$$= \left(\frac{1}{2}2\times 5^2 - \frac{1}{2}2\times 8^2\right) + 2\times 9.8(2\times 0.8 - 0) = -7.64 \text{ J}$$

A) – 7.64 J
B) – 8.23 J
C) – 2.91 J
D) – 3.36 J
E) 0 J

Stat# A_36_DIS_0.39_PBS_0.33_B_8_C_14_D_18_E_23_EXP_45_NUM_472

Q7.
A compressed-spring-gun, with k = 300 N/m, is used to shoot a ball, of mass m = 10 g, straight up into the air, see **Figure 4**. If the ball reaches a maximum height h = 10.0 m, the compressed distance of the spring is: (neglect any friction and assume the spring obeys Hooke's law)?



Answer:

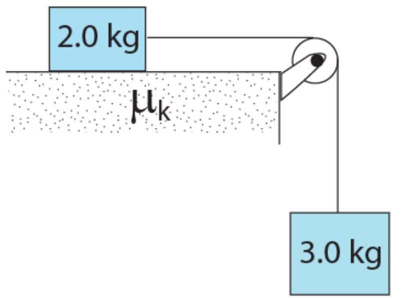
$$mgh = \frac{1}{2}kX_m^2 \Rightarrow 0.01 \times 9.8 \times 10 = \frac{1}{2}(300)X_m^2$$

$$X_m^2 = \frac{0.98}{150} \Rightarrow X_m = 0.081 \text{ m} = 8.1 \text{ cm}$$

A) 8.1 cm
B) 5.5 cm
C) 12 cm
D) 3.0 cm
E) 1.3 cm

Stat# A_47_DIS_0.60_PBS_0.48_B_13_C_7_D_23_E_11_EXP_55_NUM_472

Q8.
The two masses in the **Figure 5** are released from rest. After the 3.0-kg mass had fallen 1.5 m, it reaches a speed of 3.76 m/s. How much work is done during this time interval by the frictional force on the 2.0 kg mass? (Assume that the pulley is frictionless and massless)



Answer:

$$\Delta K + \Delta U + \Delta E_{th} = 0$$

$$\Delta K + \Delta U - W_f = 0$$

$$\Rightarrow$$

$$W_f = \Delta K + \Delta U$$

$$W_f = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 - m_1 g h$$

$$W_f = \frac{1}{2} 3 \times 3.76^2 + \frac{1}{2} 2 \times 3.76^2 - 3 \times 9.8 \times 1.5$$

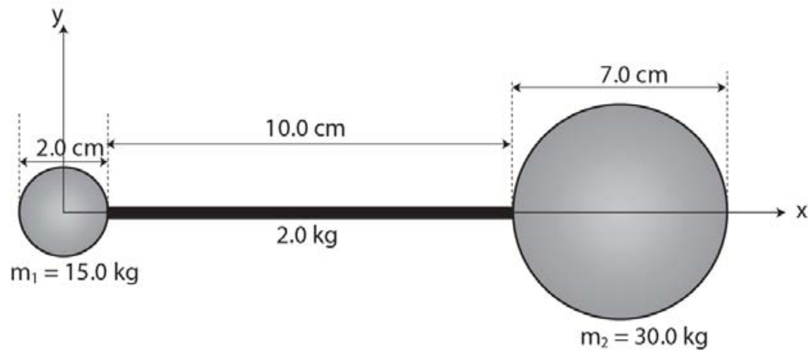
$$= -8.8 \text{ J.}$$

A) – 8.8 J
B) – 6.7 J
C) 20 J
D) – 12 J
E) 28 J

Stat# A_100_DIS_0.00_PBS_0.00_B_0_C_0_D_0_E_0_EXP_50_NUM_472

Q9.

Figure 6 shows a 10.0 cm long uniform rod with mass 2.0 kg, attached to two uniform spheres of masses m_1 = 15.0 kg and m_2 = 30.0 kg and diameters 2.0 cm and 7.0 cm, respectively. Find the x-coordinate of the COM of the system. Center of the small sphere (m_1) is at the origin of the coordinate system.



Answer:

Because of the uniformity and placement of the two spheres at the ends of the uniform sphere, the CM is clearly on a line passing through the rod. Call this the x—axis as shown in the figure. The origin is most easily placed at the center of the 15.0 kg Sphere. Then measuring m in kg and x in cm,

$$MX = m_1x_1 + m_2x_2 + m_3x_3$$

$$47.0\ X = 15(0.0) + 2(1.0 + 5.0) + 30\ (1 + 10 + 3.5)$$

$$47X = 12+435 = 447$$

X = 9.5l cm to the right of the center of the 15.0 kg sphere.

A) 9.51 cm
B) – 1.7 cm
C) 20 cm
D) – 12 cm
E) 2.8 cm

Stat# A_52_DIS_0.41_PBS_0.35_B_9_C_9_D_7_E_23_EXP_50_NUM_472

Q10.

A 10.0 g object with initial velocity $\vec{v}_i = (24.0\,\hat{i})$ m/s has a collision with a wall. After collision, the final velocity of the object is $\vec{v}_f = -(12.0\,\hat{i})$ m/s. If the collision lasted 0.01 s, what is the average force acted on the object during the collision?

Answer:

$\vec{P}_i = 0.01\ \text{kg}(24.0\,\hat{i})\ \text{m/s} = (0.240\,\hat{i})\ \text{kg}\cdot\text{m/s};$

$\vec{P}_f = 0.01\ \text{kg}(-12.0\,\hat{i})\ \text{m/s} = (-0.120\,\hat{i})\ \text{kg}\cdot\text{m/s}.$

$\vec{J} = \Delta\vec{P} = \vec{P}_f - \vec{P}_i = (-0.12\,\hat{i} - 0.24\,\hat{i}) = (-0.36\,\hat{i})\ \text{N}\cdot\text{s},$

$$\vec{F} = \frac{\vec{J}}{\Delta t} = \left(\frac{-0.36\,\hat{i}}{0.01}\right)\text{N} = (-36\,\hat{i})\,\text{N}$$

A) $(-36\,\hat{i})$ N

B) $(-12\,\hat{i})$ N

C) $(24\,\hat{i})$ N

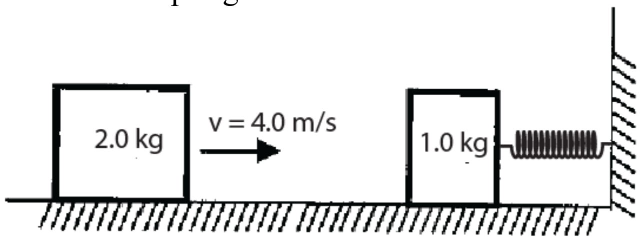
D) $(-16\,\hat{i})$ N

E) $(-48\,\hat{j})$ N

Stat# A_69_DIS_0.48_PBS_0.39_B_15_C_4_D_8_E_4_EXP_50_NUM_472

Q11.

A 1.0-kg block (at rest on a horizontal frictionless surface) is connected to a spring (k = 200 N/m) whose other end is fixed to a wall (see **Figure 7**). A 2.00-kg block, moving at 4.00 m/s, collides with the 1.00-kg block. If the two blocks stick together after the collision, what will be the maximum compression of the spring when the two blocks momentarily stop?



Answer:

Consrevation of momentum $\Rightarrow \quad mv = (m+M)V$

$$\Rightarrow V = \frac{2\times 4}{(2+1)} \approx 2.67\,\frac{\text{m}}{\text{s}}$$

Conservation of mechanical energy after collision

$$\Rightarrow \frac{1}{2}(m+M)V^2 = \frac{1}{2}k\,x^2$$

$$\Rightarrow x = V\sqrt{\frac{(m+M)}{k}} = 2.67\sqrt{\frac{3}{200}} = \underline{0.33\text{ m}}$$

A) 0.33 m
B) 0.22 m
C) 1.12 m
D) 0.13 m
E) 0.08 m

Stat# A_35_DIS_0.50_PBS_0.41_B_22_C_10_D_17_E_16_EXP_45_NUM_472

Q12.
Block A with mass 2.0 kg and block B with mass 3.0 kg are moving towards each other along the x-axis. The velocity of block A is 50 m/s while block B velocity is -20 m/s. Both the blocks undergo inelastic collision. The velocity of the center of mass of the two blocks system after the collision is:

Answer:

Consrevation of momentum of COM $\Rightarrow$ V_{COM} (before collision) $=$ V_{COM} (After collision)

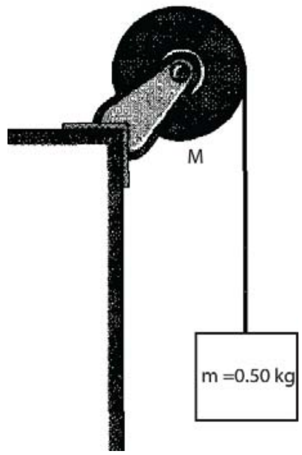
$$\left(m_A + m_B\right)V_{COM} = m_A v_A + m_B v_B = 2.0\times 50 + 3.0\times(-20) =$$

$$\Rightarrow \ V_{COM} = \frac{40}{(2+3)} = 8.0\,\frac{\text{m}}{\text{s}}$$

A) 8.0 m/s
B) 0
C) 5.0 m/s
D) 30 m/s
E) 70 m/s

Stat# A_68_DIS_0.47_PBS_0.41_B_7_C_7_D_14_E_4_EXP_55_NUM_472

Q13.
A wheel (of mass M and radius = 0.20 m) is mounted on a frictionless, horizontal axle. A light cord wrapped around the wheel supports a mass m = 0.50 kg, as shown in the **Figure 8**. When released from rest the mass m falls with a downward acceleration of 5.0 m/s^2. What is the moment of inertia of the wheel about its axle? [Consider the cord does not slip]



Answer:

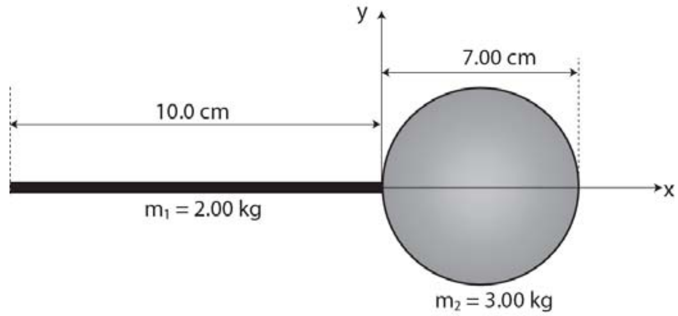
$$ma = mg - T \Rightarrow T = 2.4 \text{ N}$$

$$\text{I} = \frac{\text{Tr}}{\alpha(=\text{a/r})} = \frac{2.4 \times 0.2}{5/0.2} = 0.019 \text{ kg.m}^2$$

A) 0.019 kg·m^2
B) 0.027 kg·m^2
C) 0.016 kg·m^2
D) 0.023 kg·m^2
E) 0.032 kg·m^2

Stat# A_31_DIS_0.53_PBS_0.44_B_18_C_9_D_22_E_19_EXP_55_NUM_472

Q14.
Figure 9 shows a uniform thin rod, with mass $m_1 = 2.00$ kg and length L = 10.0 cm, attached to a uniform solid sphere, of mass $m_2 = 3.00$ kg and diameter 7.00 cm. Find the rotational inertia of the system about the y-axis.



Answer:

$$I_y = \frac{1}{3}m_1L^2 + \left[\frac{2}{5}m_2R^2 + m_2(R)^2\right]$$

$$= \frac{1}{3}2(0.1^2) + \left[\frac{2}{5}3\times 0.035^2 + 3(0.035)^2\right] = 0.0118 \text{ kg.m}^2$$

A) 0.0118 $kg.m^2$
B) 0.0103 $kg.m^2$
C) 0.00814 $kg.m^2$
D) 0.00980 $kg.m^2$
E) 0.00667 $kg.m^2$

Stat# A_26_DIS_0.31_PBS_0.32_B_17_C_27_D_11_E_18_EXP_50_NUM_472

Q15.
A wheel with a 0.10-m radius is rotating at an angular velocity of 36 rev/s. It then slows down uniformly to 15 rev/s over a 3.0-s interval. What is the magnitude of the tangential acceleration of a point on the edge of the wheel?

Answer:

$$\omega_f = \omega_i + \alpha t \Rightarrow \alpha = \frac{15-36}{3} = -7 \text{ rev/s}^2$$

$$a = \alpha r = |7| \times 2\pi \times 0.1 = 4.4 \text{ m/s}^2$$

A) 4.4 m/s^2
B) 1.5 m/s^2
C) 41 m/s^2
D) 0.70 m/s^2
E) 7.0 m/s^2

Stat# A_49_DIS_0.58_PBS_0.45_B_9_C_6_D_21_E_14_EXP_50_NUM_472

Q16.
A fan, initially at rest, is accelerated to angular velocity ω = 2400 rev/min in 40 s by an electric motor. The average power of the motor during this time is 1.2×10^5 W. What is the torque on the fan about the axis of rotation?

Answer:

$$\Delta\theta = \left(\frac{\omega+\omega_o}{2}\right)\Delta t = \left(\frac{\frac{2400\times2\pi}{60}+0}{2}\right)40 = 1600\pi$$

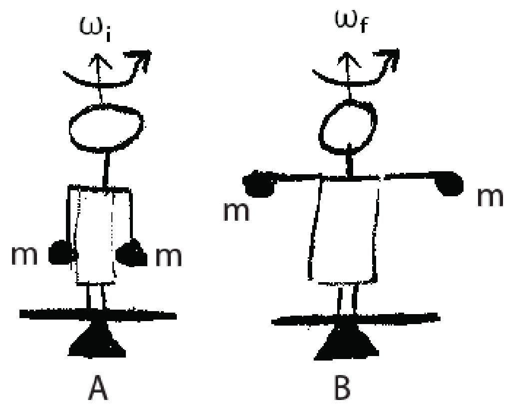
$$P = \frac{\Delta W}{\Delta t} = \tau\frac{\Delta\theta}{\Delta t} \Rightarrow \tau = \frac{P}{\left(\frac{\Delta\theta}{\Delta t}\right)} = \frac{1.2\times10^5}{\left(\frac{1600\pi}{40}\right)} = 955 \text{ N.m}$$

A) 955 N.m
B) 100 N.m
C) 723 N.m
D) 432 N.m
E) 600 N.m

Stat# A_21_DIS_0.29_PBS_0.30_B_11_C_19_D_33_E_15_EXP_50_NUM_472

Q17.

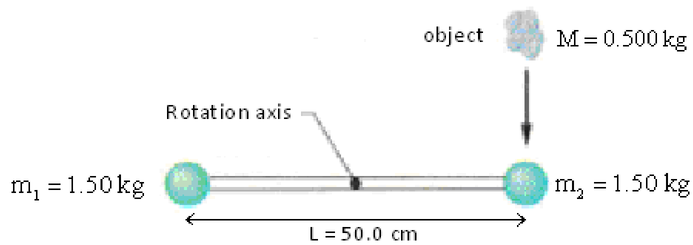
A man, holding equal mass m in each hand, is standing on a frictionless disk, rotating about an axis passing through its center. Initially, the man has both hands down, as shown in **Figure 10A**, and the system (man + disk) rotates with an angular velocity ω_i. Finally the man stretches his arms horizontally, as shown in **Figure 10B**, and the new angular velocity of the system is ω_f. The man's final rotational kinetic energy K_f with respect to his initial rotational kinetic energy K_i:



A) must decrease.
B) must increase.
C) must remain the same.
D) may increase or decrease depending on his initial angular velocity ω_i .
E) may increase or decrease depending on his final angular velocity ω_f .

Stat# A_45_DIS_0.22_PBS_0.18_B_26_C_19_D_4_E_4_EXP_55_NUM_472

Q18.
Two equal masses $m_1 = m_2 = 1.50$ kg are joined with a massless rod with length L= 50.0 cm. The rod is free to rotate in a horizontal plane without friction about a vertical axis through its center. With the rod initially at rest, an object with mass M = 0.500 kg is moving horizontally towards m_2 with a velocity 4.50 m/s , as shown in **Figure 11** (top view). Finally the object collides with m_2 and sticks to it and the rod rotates. The angular speed of the rod-masses system after the collision is:



Answer:

Conservation of angular momentum gives:

$$Mv\,(L/2) = I_{total}\,\omega_f \Rightarrow Mv\left(\frac{L}{2}\right) = (M + 2m)\left(\frac{L}{2}\right)^2 \omega_f$$

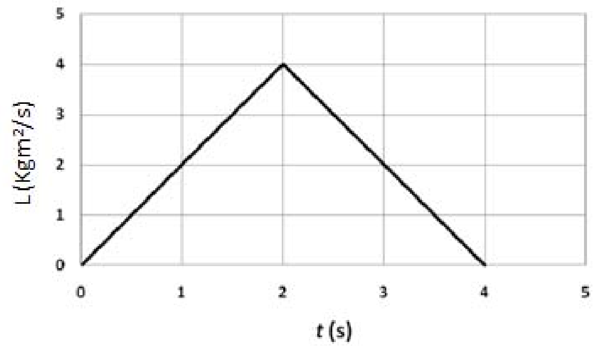
$$\Rightarrow \omega_f = \frac{Mv\left(\frac{L}{2}\right)}{(M+2m)\left(\frac{L}{2}\right)^2} = \frac{0.5\times 4.5}{(0.5+2\times 1.5)\left(\frac{0.5}{2}\right)} = 2.57 \text{ rad/s}$$

A) 2.57 rad/s
B) 1.24 rad/s
C) 0.541 rad/s
D) 5.14 rad/s
E) 1.41 rad/s

Stat# A_31_DIS_0.34_PBS_0.31_B_15_C_12_D_19_E_22_EXP_50_NUM_472

Q19.

A circular disc of mass 4.0 kg and radius 10 cm rotates about a vertical axis passing through its center. The variation of its angular momentum (L) with time (t) is given in the **Figure 12**. Find the angular acceleration of the disc at t = 3.0 s?



Answer:

$$I\alpha = \frac{dL}{dt} \Rightarrow = \alpha = \frac{dL}{Idt} = \frac{1}{\frac{1}{2}\left(4.0\times0.1^2\right)}\frac{0-4}{4-2} = -100 \text{ rad/s}^2$$

A) − 100 rad/s²
B) + 15 rad/s²
C) + 50 rad/s²
D) +100 rad/s²
E) − 5.6 rad/s²

Stat# A_29_DIS_0.46_PBS_0.39_B_18_C_15_D_18_E_20_EXP_50_NUM_472

Q20.
A hoop rolls smoothly, along a horizontal surface, with constant center of mass speed v_{com}. Its rotational kinetic energy is:

A) the same as its translational kinetic energy
B) half its translational kinetic energy
C) twice its translational kinetic energy
D) four times its translational kinetic energy
E) one-third its translational kinetic energy

Stat# A_55_DIS_0.52_PBS_0.39_B_13_C_19_D_6_E_7_EXP_55_NUM_472