Test 6

Corrected

A 2.3-kg object traveling at 6.1 m/s collides head-on with a 3.5-kg object traveling in the opposite direction at 4.8 m/s. If the collision is perfectly elastic, what is the final speed of the 2.3-kg object?

Item 1

- 3.8 m/s
- 4.3 m/s
- 7.1 m/s
- 0.48 m/s
- 6.6 m/s

$$v_1 = \frac{u_1(m_1 - m_2) + 2m_2u_2}{m_1 + m_2} \cdot v_2 = \frac{u_2(m_2 - m_1) + 2m_1u_1}{m_1 + m_2}$$

$$v_1 = \frac{6.1(2.3 - 3.5) + (2 * 3.5 * ((-4.8))}{(2.3 + 3.5)} = |-7.06\ \text{m/s}| \quad \text{Absolute value only}$$

u_1 = 6.1 m/s

m_1 = 2.3-kg

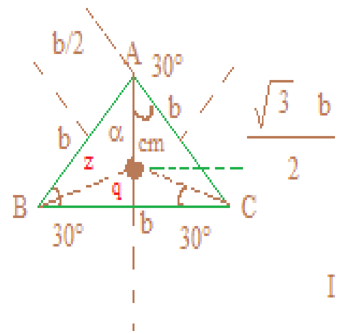
u_2 = -4.8 m/s , opposite direction

m_2 = 3.5-kg

A piece of thin uniform wire of mass m and length $3b$ is bent into an equilateral triangle. Find the moment of inertia of the wire triangle about an axis perpendicular to the plane of the triangle and passing through one of its vertices.

Item 2

- $\frac{2}{3}mb^2$
- $\frac{1}{3}mb^2$
- $\boxed{\frac{1}{2}mb^2}$
- $\frac{7}{12}mb^2$
- $\frac{7}{4}mb^2$



$$I = [(1/3)(m/3)b^2] + [(1/3)(m/3)b^2] + [(1/12)(m/3)b^2] + (m/3)[b\cdot\cos(30°)^2]$$

$$I = (1/9)mb^2 + (1/9)mb^2 + ((1/36)+(1/4))mb^2$$

$$I = ((2/9)+(10/36))mb^2 = (1/2)mb^2$$

$$T = 2\pi\sqrt{\frac{I}{m\cdot g\cdot d}}$$

$$q + z = b\cdot\cos(30°)$$

$$q = z\cdot\sin(30°)$$

$$\left(1+\frac{1}{2}\right)z = \frac{\sqrt{3}\ b}{2}$$

$$z = \frac{b}{\sqrt{3}}$$

A solid uniform sphere of mass 1.85 kg and diameter 45.0 cm spins about an axle through its center. Starting with an angular velocity of 2.40 rev/s, it stops after turning through 18.2 rev with uniform acceleration. The net torque acting on this sphere as it is slowing down is closest to

Item 3

- 0.149 N · m.
- 0.0372 N · m.
- 0.0466 N · m.
- 0.0620 N · m.
- 0.00593 N m.

$\omega = 2\pi * [2.4 + 0] / 2 = 2.4$ p radian /s.

$\phi = 2\pi * 18.2$ radian.

Time taken, $T = 2\pi * 18.2 / (2.4\pi) = 15.16$ s.

$\alpha = 2\pi$ [N2-N1] / T where N2= 0 and N1 =2.4 rev/s.

$\alpha = 2\pi (-2.4) / 15.16 = 0.995$ rad/ s^2

Torque τ = I a where I = $2mr^2/5$ and r = 0.45 /2 = 0.225 m

$\boxed{I * a = 0.4 * 1.85 * 0.225 * 0.225 * 0.995 = 0.0372 \text{ N*m}}$

A string is wrapped around a pulley with a radius of 2.0 cm and no appreciable friction in its axle. The pulley is initially not turning. A constant force of 50 N is applied to the string, which does not slip, causing the pulley to rotate and the string to unwind. If the string unwinds 1.2 m in 4.9 s, what is the moment of inertia of the pulley?

Item 4

- 0.20 $kg\cdot m^2$
- 0.17 $kg\cdot m^2$
- 14 $kg\cdot m^2$
- 17 $kg\cdot m^2$
- 0.017 $kg\cdot m^2$

Let the linear velocity of the rope(=of pulley) is v m/s

By v = u + at

v = 0 + 4.9a

v = 4.9a

By v^2 = u^2 + 2as

v^2 = 0 + 2 x v/4.9 x 1.2 ; s = 1.2m, a = (v / t) where t = 4.9s

4.9v^2 - 2.4v = 0

=>v(4.9v - 2.4) = 0 ; v = 0 or 4.9v = 2.4

=>v = 2.4/4.9 = 0.49 m/s

Thus by $v = r \cdot \omega$

ω = v/r = 0.49/0.02 = 24.49 rad/sec

BY W = F * s = 50 * 1.2 = 60 J

KE(rotational) = W = 1/2 * I * ω^2

60 = 1/2 * I * (24.49)^2

I = 0.20 $kg\text{-}m^2$

A uniform solid 5.25-kg cylinder is released from rest and rolls without slipping down an inclined plane inclined at 18° to the horizontal. How fast is it moving after it has rolled 2.2 m down the plane?

- 3.7 m/s
- 4.3 m/s
- 3.0 m/s
- 5.2 m/s
- 2.6 m/s

Item 5

vertical height loses by the cylinder

(h) = L sin(ϕ) = 2.2 x sin18* = 0.68m

By the law of energy conservation:-

Δ PE(loss) = Δ KE(gain)

m x g x h = KE(linear) + KE(rotational)

mgh = 1/2mv^2 + 1/2Iomega^2

mgh = 1/2mv^2 + 1/2 x 1/2 x m x r^2 x (v/r)^2 [as v = r x omega]

mgh = 1/2mv^2 + 1/4mv^2

mgh = 3/4mv^2

v = sqrt[4/3gh]

v = sqrt[4 x 9.8 x 0.68/3]

v = 2.98 m/s

$\boxed{\text{v = 3m/s}}$

Calculate the minimum average power output necessary for a 50.8 kg person to run up a 12.0 m long hillside, which is inclined at 25.0° above the horizontal, in 3.00 s. You can neglect the person's kinetic energy. Express your answer in horsepower. (1 hp = 746 W)

Item 6

- 1.13 hp
- 2.67 hp
- 1.7 hp
- 0.680 hp

Given

Mass of person $m = 50.8\ \text{kg}$

Length of hillside $L = 12.0\,\text{m}$

Angle $\theta = 25.0^\circ$

Time $t = 3.00\,\text{s}$

The average power output is

$$
\begin{aligned}
P &= \frac{mgh}{t} \\
&= \frac{mgL\sin\theta}{t} \\
&= \frac{(50.8\text{kg})(9.80\,\text{m/s}^2)(12.0\,\text{m})\sin(25.0^\circ)}{3.00\,\text{s}} \\
&= 841.585\,\text{W}\left(\frac{1\text{hp}}{746\ \text{W}}\right) \\
&= 1.12813\ \text{hp} \\
&= \boxed{1.13\ \text{hp}}
\end{aligned}
$$

A 72.0-kg person pushes on a small doorknob with a force of 5.00 N perpendicular to the surface of the door. The doorknob is located 0.800 m from axis of the frictionless hinges of the door. The door begins to rotate with an angular acceleration of 2.00 rad/s^2. What is the moment of inertia of the door about the hinges?

- 2.74 kg·m^2
- 7.52 kg·m^2
- 0.684 kg·m^2
- 4.28 kg·m^2
- 2.00 kg·m^2

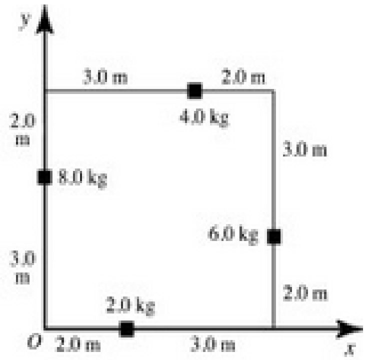
Item 7

$$\tau = F^*r = 5^*0.8 = 0.4\ \mathrm{N}$$

$$\alpha = 2.00\ \mathrm{rad/s^2}$$

$$I = \frac{\tau}{\alpha} = \frac{(5.00\ \mathrm{N} * 0.800\ \mathrm{m})}{2.00\ \mathrm{rad/s^2}} = \boxed{2.00\ \mathrm{kg{\cdot}m^2}}$$

In the figure, four point masses are placed as shown. The x and y coordinates of the center of mass are closest to



- (2.3 m, 2.7 m).
- (2.2 m, 2.6 m).
- (2.3 m, 2.8 m).
- (2.2 m, 2.7 m).
- (2.3 m, 2.6 m).

Item 8

The expression for x-coordinate of the center of mass is,

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + m_4 x_4}{m_1 + m_2 + m_3 + m_4}$$

$$= \frac{(2\text{ kg})(2\text{ m}) + (6\text{ kg})(5\text{ m}) + (4\text{ kg})(3\text{ m}) + (8\text{ kg})(0)}{(2\text{ kg} + 6\text{ kg} + 4\text{ kg} + 8\text{ kg})}$$

$$= 2.3\text{ m}$$

The expression for y-coordinate of the center of mass is,

$$y_{cm} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3 + m_4 y_4}{m_1 + m_2 + m_3 + m_4}$$

$$= \frac{(2\text{ kg})(0) + (6\text{ kg})(2\text{ m}) + (4\text{ kg})(5\text{ m}) + (8\text{ kg})(3\text{ m})}{(2\text{ kg} + 6\text{ kg} + 4\text{ kg} + 8\text{ kg})}$$

$$= 2.8\text{ m}$$

Hence, x and y coordinates of the center of mass is $(2.3\text{ m}, 2.8\text{ m})$. Therefore, option (3) is correct.

A 1.10-kg wrench is acting on a nut trying to turn it. The length of the wrench lies directly to the east of the nut. A force 150.0 N acts on the wrench at a position 15.0 cm from the center of the nut in a direction 30.0° north of east. What is the magnitude of the torque about the center of the nut?

Item 9

- [x] 11.3 N·m
- [ ] 22.5 N·m
- [ ] 1949 N·m
- [ ] 19.5 N·m
- [ ] 2250 N·m

$\tau = (150\ N) * \sin(30°) * 0.15m$; $(15\ cm = 0.15\ m)$

$\tau = \boxed{11.25\ N.m}$

A figure skater rotating at 5.00 rad/s with arms extended has a moment of inertia of 2.25 kg·m^2. If the arms are pulled in so the moment of inertia decreases to 1.80 kg·m^2, what is the final angular speed?

Item 10

- 2.25 rad/s
- 0.810 rad/s
- 6.25 rad/s
- 1.76 rad/s
- 4.60 rad/s

The angular momentum of the system is conserved because there is no external resultant torque that's messing with the system. When everything is conserved, like in this problem, it's basically plug and chug.

Conservation of angular momentum is defined as $L_i = L_f$ and then remember $L = I\omega$. So then you get:

$L_i = L_f$

$I_i \omega_i = I_f \omega_f$

$\omega_f = (I_i / I_f)\, \omega_i$

Knowing the ω_i = 5.00 rad/s, I_i = 2.25 kg*m^2 and I_f = 1.80 kg*m^2, ω_f = 6.25 rad/s.

$$\omega_f = \frac{2.25 \text{ kg*m}^2}{1.80 \text{ kg*m}^2} \times 5.00 \text{ rad/s} = \boxed{6.25 \text{ rad/s.}}$$