Ch 10 Supplemental [Edit]

Overview Summary View Diagnostics View **Print View with Answers**

Ch 10 Supplemental

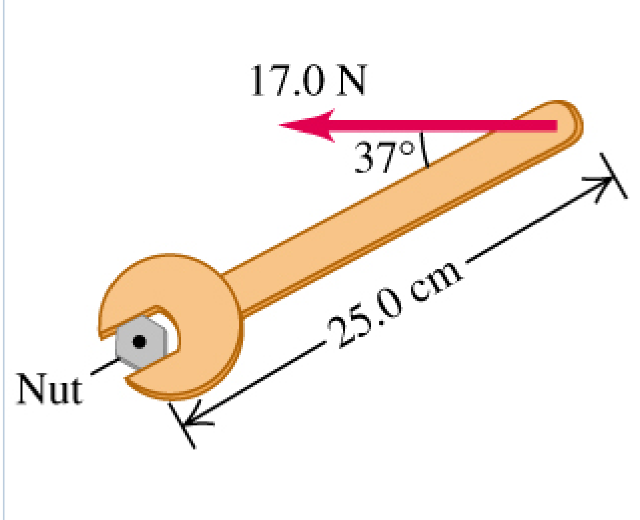
Due: 6:59pm on Wednesday, November 16, 2016

To understand how points are awarded, read the Grading Policy for this assignment.

Exercise 10.7

Description: A machinist is using a wrench to loosen a nut. The wrench is 25.0 cm long, and he exerts a 17.0-N force at the end of the handle at 37 degree(s) with the handle (the figure). (a) What is the magnitude of the torque does the machinist exert about...

A machinist is using a wrench to loosen a nut. The wrench is 25.0 cm long, and he exerts a 17.0-N force at the end of the handle at 37 $^\circ$ with the handle (the figure).



Part A

What is the magnitude of the torque does the machinist exert about the center of the nut?

ANSWER:

$|\tau|$ = 2.56 $\mathrm{N \cdot m}$

Part B

What is the direction of the torque in part (A).

ANSWER:

- (selected) counterclockwise
- clockwise

Part C

What is the maximum torque he could exert with this force?

ANSWER:

$|\tau|$ = 4.25 $\mathrm{N \cdot m}$

Part D

How should the force mentioned in part (C) be oriented ?

ANSWER:

- ○ The force is directed into the page.
- ○ The force is directed out of the page.
- ◉ The force is perpendicular to the wrench.
- ○ The force is parallel to the wrench.

Exercise 10.11

Description: A machine part has the shape of a solid uniform sphere of mass m and diameter d. It is spinning about a frictionless axle through its center, but at one point on its equator it is scraping against metal, resulting in a friction force of 0.0200 N at...

A machine part has the shape of a solid uniform sphere of mass 225 g and diameter 4.30 cm . It is spinning about a frictionless axle through its center, but at one point on its equator it is scraping against metal, resulting in a friction force of 0.0200 N at that point.

Part A

Find its angular acceleration. Let the direction the sphere is spinning be the positive sense of rotation.

ANSWER:

α = $\frac{\frac{-0.0200d}{2}}{\frac{\frac{2}{5}md^2}{4}}$ = -10.3 $\mathrm{rad/s^2}$

Part B

How long will it take to decrease its rotational speed by 21.0 $\mathrm{rad/s}$?

ANSWER:

t = $\frac{om}{\frac{\frac{0.0200d}{2}}{\frac{\frac{2}{5}md^2}{4}}}$ = 2.03 s

Exercise 10.13

Description: A textbook of mass m_1 rests on a frictionless, horizontal surface. A cord attached to the book passes over a pulley whose diameter is d, to a hanging book with mass m_2. The system is released from rest, and the books are observed to move a distance...

A textbook of mass 2.08 kg rests on a frictionless, horizontal surface. A cord attached to the book passes over a pulley whose diameter is 0.170 m , to a hanging book with mass 2.98 kg . The system is released from rest, and the books are observed to move a distance 1.29 m over a time interval of 0.750 s .

Part A

What is the tension in the part of the cord attached to the textbook?

ANSWER:

$\frac{m_1 \cdot 2s}{\Delta t^2}$ = 9.54 N

Part B

What is the tension in the part of the cord attached to the book?

Take the free fall acceleration to be g = 9.80 $\mathrm{m/s^2}$.

ANSWER:

$m_2 \left(g - \frac{2s}{\Delta t^2}\right)$ = 15.5 N

Part C

What is the moment of inertia of the pulley about its rotation axis?

Take the free fall acceleration to be g = 9.80 $\mathrm{m/s^2}$.

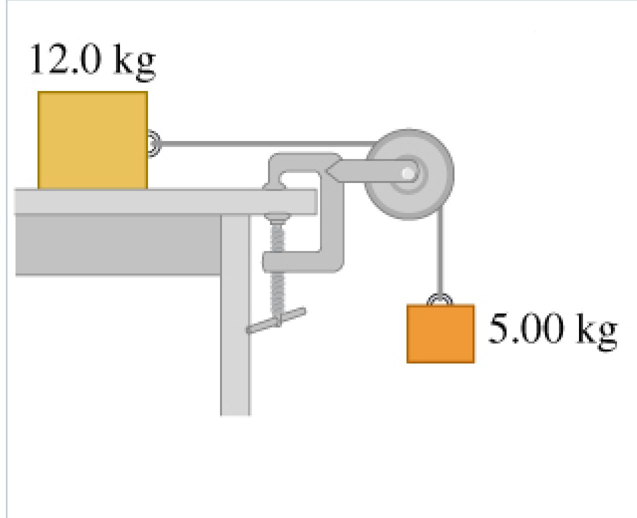
ANSWER:

$\frac{\left(m_2 \left(g - \frac{2s}{\Delta t^2}\right) - \frac{m_1 \cdot 2s}{\Delta t^2}\right)\left(\frac{d}{2}\right)^2}{\frac{2s}{\Delta t^2}}$ = 9.44×10^{-3} $\mathrm{kg \cdot m^2}$

Exercise 10.16

Description: A 12.0-kg box resting on a horizontal, frictionless surface is attached to a 5.00-kg weight by a thin, light wire that passes without slippage over a frictionless pulley (the figure). The pulley has the shape of a uniform solid disk of mass M and...

A 12.0-kg box resting on a horizontal, frictionless surface is attached to a 5.00-kg weight by a thin, light wire that passes without slippage over a frictionless pulley (the figure). The pulley has the shape of a uniform solid disk of mass 2.40 kg and diameter 0.400 m .



Part A

After the system is released, find the horizontal tension in the wire.

ANSWER:

$|T_h| = \frac{12 \cdot 5.00 \cdot 9.8}{12.0+5.00+0.5M}$ = 32.3 N

Part B

After the system is released, find the vertical tension in the wire.

ANSWER:

$|T_v| = 5.00\left(9.8 - \frac{5.00 \cdot 9.8}{12.0+5.00+0.5M}\right)$ = 35.5 N

Part C

After the system is released, find the acceleration of the box.

ANSWER:

$a = \frac{5.00 \cdot 9.8}{12.0+5.00+0.5M}$ = 2.69 $\mathrm{m/s^2}$

Part D

After the system is released, find magnitude of the horizontal and vertical components of the force that the axle exerts on the pulley.

Express your answers separated by a comma.

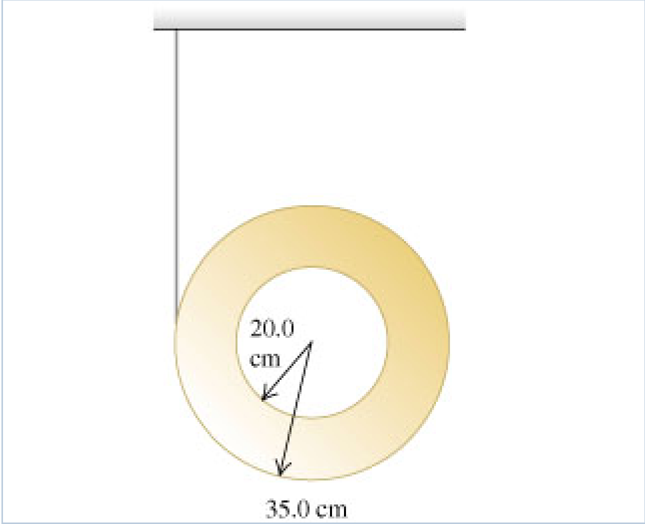
ANSWER:

F_x, F_y = $\frac{12 \cdot 5.00 \cdot 9.8}{12.0+5.00+0.5M}, M \cdot 9.8+5.00\left(9.8-\frac{5.00 \cdot 9.8}{12.0+5.00+0.5M}\right)$ = 32.3, 59.1 N

Exercise 10.25

Description: A thin light string is wrapped around the outer rim of a uniform hollow cylinder of mass ## kg having inner and outer radii as shown in the figure . The cylinder is then released from rest. (a) How far must the cylinder fall before its center is...

A thin light string is wrapped around the outer rim of a uniform hollow cylinder of mass 4.60 kg having inner and outer radii as shown in the figure . The cylinder is then released from rest.



Part A

How far must the cylinder fall before its center is moving at 6.76 $\mathrm{m/s}$?

ANSWER:

d = $\frac{\left(1+\frac{1}{2}\left(1+\left(\frac{20}{35}\right)^2\right)\right)v^2}{2 \cdot 9.8}$ = 3.88 m

Part B

If you just dropped this cylinder without any string, how fast would its center be moving when it had fallen the distance in part A?

ANSWER:

v = $\sqrt{1+\frac{1}{2}\left(1+\left(\frac{20}{35}\right)^2\right)}v$ = 8.72 $\mathrm{m/s}$

Part C

Why do you get two different answers? The cylinder falls the same distance in both cases.

ANSWER:

3515 Character(s) remaining

In part (a) the cylinder has rotational as well as translational kinetic energy and therefore less translational speed at a given kinetic energy. The kinetic energy comes from a decrease in gravitational potential

Exercise 10.34

Description: An airplane propeller is s in length (from tip to tip) and has a mass of m. When the airplane's engine is first started, it applies a constant torque of tau to the propeller, which starts from rest. (a) What is the angular acceleration of the...

An airplane propeller is 2.28 m in length (from tip to tip) and has a mass of 112 kg . When the airplane's engine is first started, it applies a constant torque of 1920 $\mathrm{N \cdot m}$ to the propeller, which starts from rest.

Part A

What is the angular acceleration of the propeller? Treat the propeller as a slender rod.

Hint 1. Hint

The moment of inertia of a slender rod pivoted about an axis through its center is $\frac{1}{12}ML^2$.

ANSWER:

α = $\frac{\tau}{\frac{ms^2}{12}}$ = 39.6 $\mathrm{rad/s^2}$

Part B

What is the propeller's angular speed after making 5.00 rev ?

ANSWER:

ω = $\sqrt{\left(\frac{2\tau}{\frac{ms^2}{12}}n\right)}$ = 49.9 $\mathrm{rad/s}$

Part C

How much work is done by the engine during the first 5.00 rev ?

ANSWER:

$W = \tau n = 6.03 \times 10^4$ J

Part D

What is the average power output of the engine during the first 5.00 rev ?

ANSWER:

$$P_{\mathrm{av}} = \frac{\frac{\tau \sqrt{\left(\frac{2\tau}{\frac{ma^2}{12}} n\right)}}{2}}{1000} = 47.9 \quad \mathrm{kW}$$

Part E

What is the instantaneous power output of the motor at the instant that the propeller has turned through 5.00 rev ?

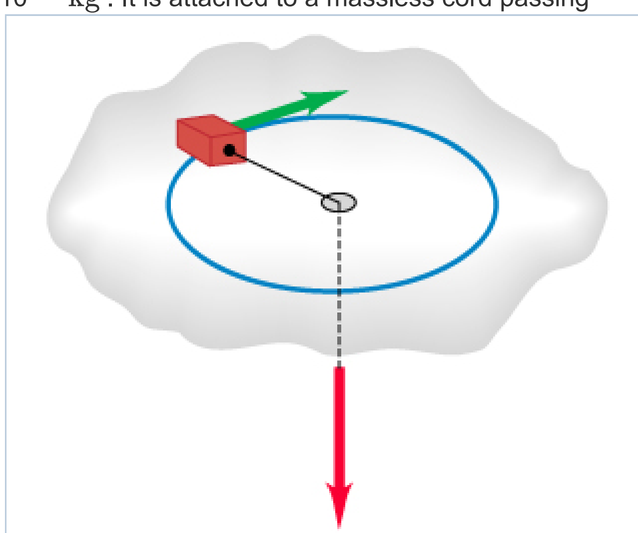
ANSWER:

$$P = \frac{\tau \sqrt{\left(\frac{2\tau}{\frac{ma^2}{12}} n\right)}}{1000} = 95.7 \quad \mathrm{kW}$$

Exercise 10.40

Description: A small block on a frictionless, horizontal surface has a mass of ## kg. It is attached to a massless cord passing through a hole in the surface . The block is originally revolving at a distance of 0.300 m from the hole with an angular speed...

A small block on a frictionless, horizontal surface has a mass of 2.20×10^{-2} kg . It is attached to a massless cord passing through a hole in the surface . The block is originally revolving at a distance of 0.300 m from the hole with an angular speed of 2.97 $\mathrm{rad/s}$. The cord is then pulled from below, shortening the radius of the circle in which the block revolves to 0.150 m. Model the block as a particle.



Part A

Is angular momentum of the block conserved?

ANSWER:

- (selected) yes
- no

The net force is due to the tension in the rope, which always acts in the radial direction, so the angular momentum with respect to the hole is constant.

Part B

What is the new angular speed?

ANSWER:

ω_2 = $\omega \cdot 4$ = 11.9 $\mathrm{rad/s}$

Part C

Find the change in kinetic energy of the block.

Express your answer with the appropriate units.

ANSWER:

ΔK = $1.5m\left(\omega \cdot 0.3\right)^2$ = 2.62×10^{-2} J

Part D

How much work was done in pulling the cord?

Express your answer with the appropriate units.

ANSWER:

W = $1.5m\left(\omega \cdot 0.3\right)^2$ = 2.62×10^{-2} J

Exercise 10.45

Description: A large wooden turntable in the shape of a flat uniform disk has a radius of 2.00 m and a total mass of ## kg. The turntable is initially rotating at ## rad/s about a vertical axis through its center. Suddenly, a ##-kg parachutist makes a soft landing ...

A large wooden turntable in the shape of a flat uniform disk has a radius of 2.00 m and a total mass of 110 kg . The turntable is initially rotating at 4.00 $\mathrm{rad/s}$ about a vertical axis through its center. Suddenly, a 70.0-kg parachutist makes a soft landing on the turntable at a point near the outer edge.

Part A

Find the angular speed of the turntable after the parachutist lands. (Assume that you can treat the parachutist as a particle.)

ANSWER:

ω_2 = $\frac{\omega}{1+\frac{2m2}{m1}}$ = 1.76 $\mathrm{rad/s}$

Part B

Compute the kinetic energy of the system before the parachutist lands.

ANSWER:

K_1 = $0.25m1\left(\omega\cdot 2\right)^2$ = 1760 J

Part C

Compute the kinetic energy of the system after the parachutist lands.

ANSWER:

K_2 = $0.5\left(0.5m1\cdot 4+m2\cdot 4\right)\left(\frac{\omega}{1+\frac{2m2}{m1}}\right)^2$ = 774 J

Part D

Why are these kinetic energies not equal?

ANSWER:

3677 Character(s) remaining

In changing the parachutist's horizontal component of velocity and slowing down the turntable, friction does negative work.

Exercise 10.48

Description: A thin uniform rod has a length of l and is rotating in a circle on a frictionless table. The axis of rotation is perpendicular to the length of the rod at one end and is stationary. The rod has an angular velocity of w and a moment of inertia about...

A thin uniform rod has a length of 0.410 m and is rotating in a circle on a frictionless table. The axis of rotation is perpendicular to the length of the rod at one end and is stationary. The rod has an angular velocity of 0.36 $\mathrm{rad/s}$ and a moment of inertia about the axis of 2.60×10^{-3} $\mathrm{kg\cdot m^2}$. A bug initially standing on the rod at the axis of rotation decides to crawl out to the other end of the rod. When the bug has reached the end of the rod and sits there, its tangential speed is 0.112 $\mathrm{m/s}$. The bug can be treated as a point mass.

Part A

What is the mass of the rod?

Express your answer with the appropriate units.

ANSWER:

$m_{\rm rod}$ = $\frac{3I}{l^2}$ = $4.64\times10^{-2}\,\mathrm{kg}$

Part B

What is the mass of the bug?

Express your answer with the appropriate units.

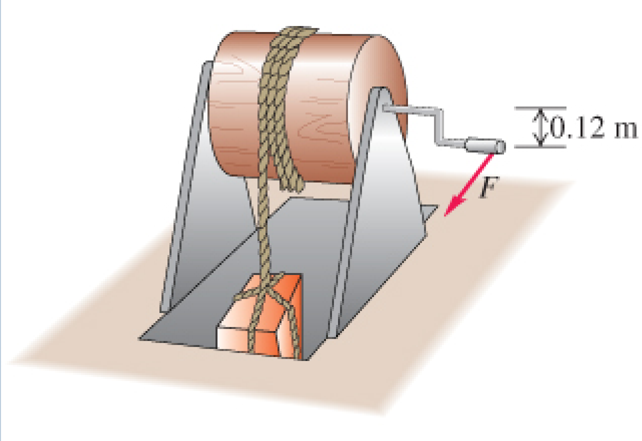
ANSWER:

$m_{\rm bug}$ = $\frac{I}{l^2}\left(\frac{wl}{v}-1\right)$ = $4.92\times10^{-3}\,\mathrm{kg}$

Problem 10.60

Description: The mechanism shown in the figure is used to raise a crate of supplies from a ship's hold. The crate has total mass m. A rope is wrapped around a wooden cylinder that turns on a metal axle. The cylinder has radius r and a moment of inertia I about the ...

The mechanism shown in the figure is used to raise a crate of supplies from a ship's hold. The crate has total mass 63 kg . A rope is wrapped around a wooden cylinder that turns on a metal axle. The cylinder has radius 0.23 m and a moment of inertia I = 2.6 $\mathrm{kg\cdot m^2}$ about the axle. The crate is suspended from the free end of the rope. One end of the axle pivots on frictionless bearings; a crank handle is attached to the other end. When the crank is turned, the end of the handle rotates about the axle in a vertical circle of radius 0.12 m , the cylinder turns, and the crate is raised.



Part A

What magnitude of the force $\vec{F}$ applied tangentially to the rotating crank is required to raise the crate with an acceleration of 1.40 $\mathrm{m/s^2}$? (You can ignore the mass of the rope as well as the moments of inertia of the axle and the crank.)

Express your answer using two significant figures.

ANSWER:

F = $\frac{m(g+a)r+\frac{a}{r}I}{120}$ = 1.5 kN

Also accepted: $\frac{m(9.81+a)r+\frac{a}{r}I}{120}$ = 1.5

Problem 10.67

Description: A yo-yo is made from two uniform disks, each with mass m and radius R, connected by a light axle of radius b. A light, thin string is wound several times around the axle and then held stationary while the yo-yo is released from rest, dropping as the...

A yo-yo is made from two uniform disks, each with mass m and radius R, connected by a light axle of radius b. A light, thin string is wound several times around the axle and then held stationary while the yo-yo is released from rest, dropping as the string unwinds.

Part A

Find the linear acceleration of the yo-yo.

Express your answer in terms of g, b, R, m.

ANSWER:

a = $\frac{2g}{2+\left(\frac{R}{b}\right)^2}$

Part B

Find the angular acceleration of the yo-yo.

Express your answer in terms of g, b, R, m.

ANSWER:

α = $\frac{2g}{2b+\frac{R^2}{b}}$

Part C

Find the tension in the string.

Express your answer in terms of g, b, R, m.

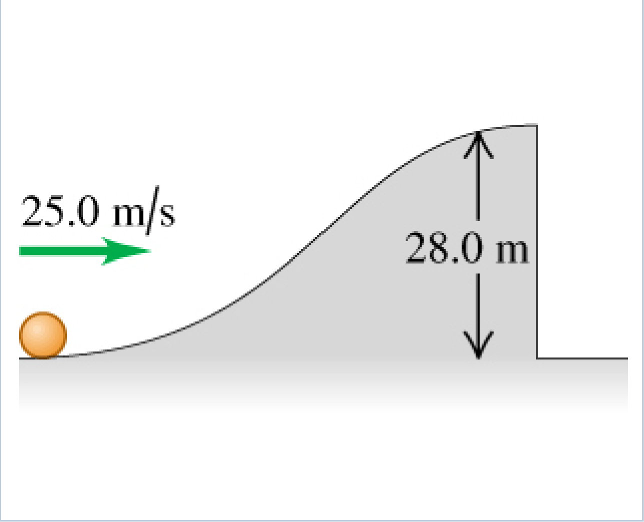
ANSWER:

$T = \frac{2mg}{2\left(\frac{b}{R}\right)^2 + 1}$

Problem 10.70

Description: A solid, uniform ball rolls without slipping up a hill, as shown in the figure . At the top of the hill, it is moving horizontally, and then it goes over the vertical cliff. (a) How far from the foot of the cliff does the ball land? (b) How fast is...

A solid, uniform ball rolls without slipping up a hill, as shown in the figure . At the top of the hill, it is moving horizontally, and then it goes over the vertical cliff.



Part A

How far from the foot of the cliff does the ball land?

ANSWER:

l = 36.5 m

Part B

How fast is it moving just before it lands?

ANSWER:

v = 28.0 $\mathrm{m/s}$

Part C

Notice that when the balls lands, it has a greater translational speed than when it was at the bottom of the hill. Does this mean that the ball somehow gained energy? Explain!

ANSWER:

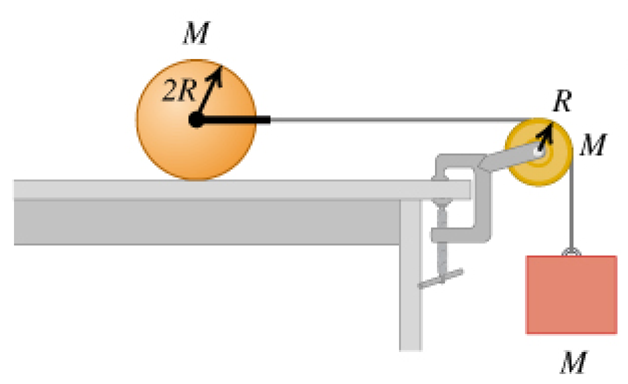
3395 Character(s) remaining

At the bottom of the hill, omega=v/r=(25.0 m/s)/r. The rotation rate doesn't change while the ball is in the air, after it leaves the top of the cliff, so just before it lands omega=(15.3 s)/r. The total kinetic energy is the same at

Problem 10.75

Description: A uniform, solid cylinder with mass M and radius 2R rests on a horizontal tabletop. A string is attached by a yoke to a frictionless axle through the center of the cylinder so that the cylinder can rotate about the axle. The string runs over a...

A uniform, solid cylinder with mass M and radius $2R$ rests on a horizontal tabletop. A string is attached by a yoke to a frictionless axle through the center of the cylinder so that the cylinder can rotate about the axle. The string runs over a disk-shaped pulley with mass M and radius R that is mounted on a frictionless axle through its center. A block of mass M is suspended from the free end of the string (the figure). The string doesn't slip over the pulley surface, and the cylinder rolls without slipping on the tabletop.



Part A

Find the magnitude of the acceleration of the block after the system is released from rest.

Express your answer in terms of the variables M, R, and appropriate constants.

ANSWER:

a_{block} = 3.27

Problem 10.87

Description: A runner of mass m runs around the edge of a horizontal turntable mounted on a vertical, frictionless axis through its center. The runner's velocity relative to the earth has magnitude v. The turntable is rotating in the opposite direction with an...

A runner of mass 55.0 kg runs around the edge of a horizontal turntable mounted on a vertical, frictionless axis through its center. The runner's velocity relative to the earth has magnitude 3.60 $\mathrm{m/s}$. The turntable is rotating in the opposite direction with an angular velocity of magnitude 0.190 $\mathrm{rad/s}$ relative to the earth. The radius of the turntable is 3.40 m , and its moment of inertia about the axis of rotation is 85.0 $\mathrm{kg \cdot m^2}$.

Part A

Find the final angular velocity of the system if the runner comes to rest relative to the turntable. (You can treat the runner as a particle.)

ANSWER:

$\frac{I\omega - mrv}{I + mr^2}$ = -0.912 $\mathrm{rad/s}$

Also accepted: $\frac{-1\left(I\omega - mrv\right)}{I + mr^2}$ = 0.912