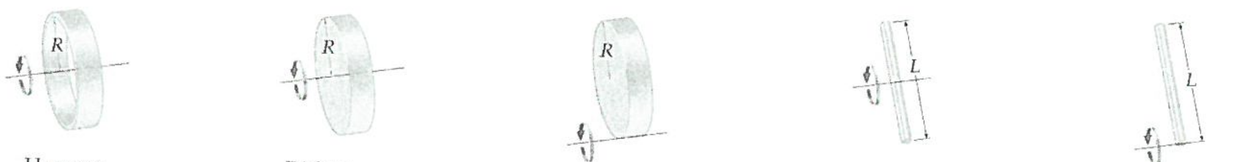
Students 8
Average 26.6 /50
Best 36.5 /50

12th Physics (2017 – 18)

(2nd Q, #1 Mini Test)

Class	No.	Name Solutions

In calculation problems, describe equations clearly and systematically enough to show how to solve the problems.



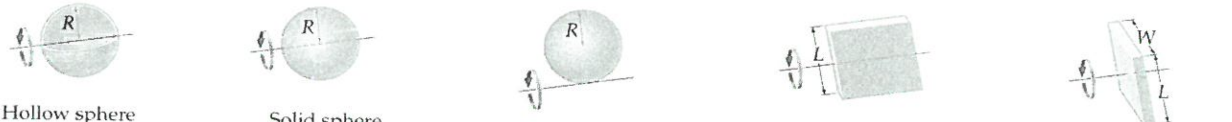
Hoop or cylindrical shell $I = MR^2$

Disk or solid cylinder $I = \frac{1}{2}MR^2$

Disk or solid cylinder (axis at rim) $I = \frac{3}{2}MR^2$

Long thin rod (axis through midpoint) $I = \frac{1}{12}ML^2$

Long thin rod (axis at one end) $I = \frac{1}{3}ML^2$



Hollow sphere $I = \frac{2}{3}MR^2$

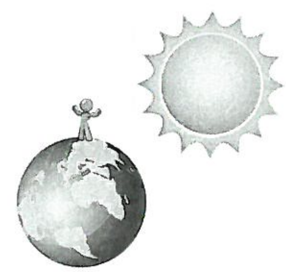
Solid sphere $I = \frac{2}{5}MR^2$

Solid sphere (axis at rim) $I = \frac{7}{5}MR^2$

Solid plate (axis through center, in plane of plate) $I = \frac{1}{12}ML^2$

Solid plate (axis perpendicular to plane of plate) $I = \frac{1}{12}M(L^2 + W^2)$

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Radius of the Earth	$R_E = 6.37 \times 10^6\ m$
Mass of the Earth	$M_E = 5.97 \times 10^{24}\ kg$
Mass of the Sun	$M_{\odot} = 1.9884 \times 10^{30}\ kg$
Angular speed of Earth's Rotation	$\omega = 7.29 \times 10^{-5}\ rad/s$



4 pt/question x 13 questions = 52 pt Max 50 pt

/[Total 50 pt]

(1,2) A discus thrower starts from rest and begins to rotate with a constant angular acceleration of 2.2 rad/s^2.
(1) How many revolutions does it take for the discus throw's angular speed to reach 6.3 rad/s?
(2) How much time does it take?

$\alpha = 2.2 \text{ rad/s}^2$

(1) $\omega^2 - \omega_0^2 = 2\alpha\theta$

$\theta = \dfrac{\omega^2 - \omega_0^2}{2\alpha}$

$= \dfrac{6.3^2 - 0}{2 \times 2.2}$

$= 9.02$ (rad)

$= \dfrac{9.02}{2\pi} = 1.44$ (rev)

$= 1.4$ rev

(2)

$t = \dfrac{\omega}{\alpha}$

$= \dfrac{6.3}{2.2}$

$= 2.86 \rightarrow 2.9$

(1) Answer 1.4 rev (83%)

(2) Answer 2.9 s (75%)

(3) A bicycle coasts downhill and accelerates from rest to a linear speed of 8.90 m/s in 12.2 s. If the bicycle's tires have a radius of 36.0 cm, what is their angular acceleration?
[Equations]

$$a = \frac{v - v_0}{t} = \frac{8.90 - 0}{12.2} = 0.7295 \ (m/s^2)$$

$$a = r\alpha$$

$$\alpha = \frac{0.7295}{0.36}$$

$$= 2.026 \rightarrow 2.03 \ (rad/s^2)$$

(3) Answer

2.03 rad/s²

CW

(75%)

(4) A 1.5 kg-block is tied to a string that is wrapped around the rim of a pulley of radius 7.2 cm. The block is released from rest. Assuming the pulley is a uniform disk with a mass of 0.41 kg, find the speed of the block after it has fallen through a height of 0.50 m.

[Equations]

$m = 1.5$ kg

$M = 0.41$ kg

$R = 0.072$ m

Conservation of mechanical energy

$$K + U = K' + U'$$

$$mgh = \frac{1}{2}mv^2\left(1 + \frac{\frac{1}{2}MR^2}{mR^2}\right)$$

$$mgh = \frac{1}{2}mv^2\left(1 + \frac{M}{2m}\right)$$

$$v = \sqrt{\frac{2gh}{1 + \frac{M}{2m}}}$$

$$= \sqrt{\frac{2 \times 9.80 \times 0.50}{1 + \frac{0.41}{2 \times 1.5}}}$$

$$= 2.936 \longrightarrow 2.9$$

(4) Answer

2.9 m/s

(70%)

(5) A person holds a ladder horizontally at its center. Treating the ladder as a uniform rod of length 3.15 m and mass 9.42 kg, find the torque the person must exert on the ladder to give it an angular acceleration of 0.302 rad/s^2?

Newton's 2nd Law of Rotational Motion

$L = 3.15$ m

$M = 9.42$ kg

$\alpha = 0.302$ rad/s^2

$I = \frac{1}{12} M L^2$

$\tau = I \alpha$

$= \frac{1}{12} M L^2 \cdot \alpha$

$= \frac{1}{12} \times 9.42 \times 3.15^2 \times 0.302$

$= 2.352$

$\rightarrow 2.35$ (N·m)

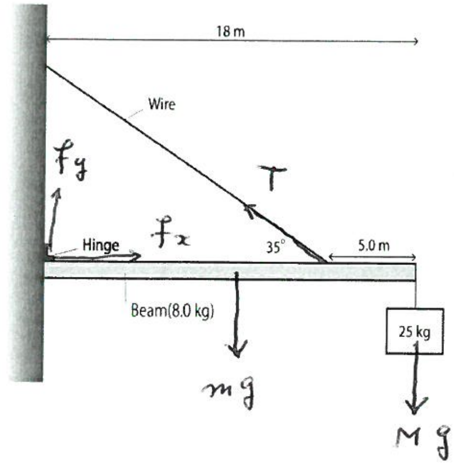
(5) Answer

2.35 N·m

(63%)

11/30/2017 By Tohei Moritani

(6,7) A uniform beam of 8.0 kg is supported with a hinge and a length of wire.
(6) Find the magnitude of tension for the wire.
(7) Find the direction and magnitude of the resistance force at the hinge.



Equilibrium of torque

(6)

$$(18-5.0)\,T\sin 35^\circ = 9.0\times 8.0\times 9.80 + 18\times 25\times 9.80$$

$$T = \frac{9.0\times 8.0\times 9.80 + 18\times 25\times 9.80}{13\sin 35^\circ}$$

$$= 686 \longrightarrow 690$$

(7) Equilibrium of forces

$$f_y + T\sin\theta = (m+M)g$$

$$f_x = T\cos\theta$$

$$f_x = 686\cos 35^\circ = 562\ (N)$$

$$f_y = (8.0+25)\times 9.80 - 686\sin 35^\circ$$

$$= 323.4 - 393.5$$

$$= -70.1$$

$$f = \sqrt{f_x^2 + f_y^2} = 566 \longrightarrow 570$$

$$\theta = \tan^{-1}\left(\frac{f_y}{f_x}\right) = \tan^{-1}\left(\frac{-70.1}{566}\right)$$

$$= -7.06^\circ \rightarrow -7.1^\circ$$

390 N → +1.5

(6) Answer
690 N

(64%)

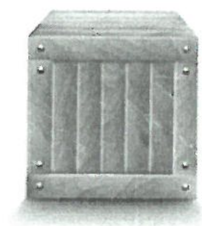
(7) Answer
570 N 7.1° downward from the right

(34%)

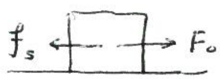
(8,9) A uniform crate with a mass of 16.6 kg rests on a floor with a coefficient of static friction equal to 0.571. The crate is a uniform cube with sides 1.21 m in length.

(8) What horizontal force applied to th6 top of the crate will initiate tipping?

(9) What is the minimum height where the force F can be applied so that the crate begins to tip before sliding?



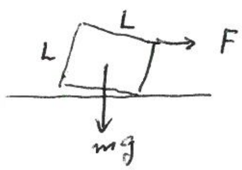
(8)



$f_s = \mu_s N = \mu_s mg$

$= 0.571 \times 16.6 \times 9.80$

$= 92.89$ (minimum magnitude for sliding)

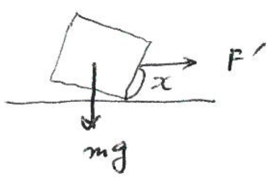


$\frac{1}{2} L \times mg = L \times F$

$F = \frac{1}{2} \times 16.6 \times 9.80 = 81.34 \rightarrow 81.3$ (N)

81.3 (N) < 92.89 (N)

(9)



$\frac{1}{2} L \times mg = x \times F'$ —①

$F' \leqq 92.89$ —②

$\frac{L \times mg}{2x} \leqq 92.89$

$x \geqq \frac{1.21 \times 16.6 \times 9.80}{2 \times 92.89} = 1.059$

$\rightarrow 1.06$ (m)

(8) Answer

81.3 N

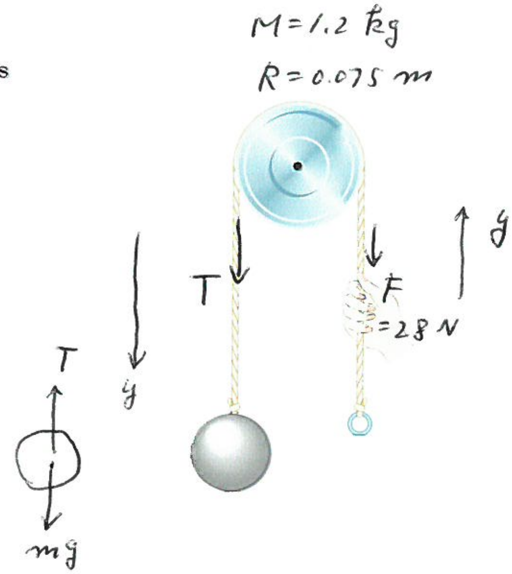
(36%)

(9) Answer

1.06 m

(0)

(10) You pull downward with a force of 28 N on a rope that passes over a disk-shaped pulley of mass 1.2 kg and radius 0.075 m. The other end of the rope is attached to a 0.67-kg mass. Find the tension in the rope on both sides of the pulley.



2nd Law on the mass

$$mg - T = ma$$

$$a = g - \frac{T}{m} \quad \text{—①}$$

2nd Law of the pulley

$$\tau = I\alpha$$

$$\left.\begin{aligned} \tau &= R(T-F) \\ I &= \tfrac{1}{2}MR^2 \\ a &= R\alpha \end{aligned}\right\} \text{—②}$$

$$\tau = I\alpha$$

$$\rightarrow \quad \cancel{R}(T-F) = \frac{1}{2}M\cancel{R^2}\frac{a}{\cancel{R}}$$

$$T - F = \frac{1}{2}M\left(g - \frac{T}{m}\right)$$

$$= \frac{Mg}{2} - \frac{M}{2m}T$$

$$T\left(1 + \frac{M}{2m}\right) = \frac{Mg}{2} + F$$

$$T = \frac{Mg + 2F}{2 + \frac{M}{m}}$$

$$= \frac{1.2 \times 9.80 + 2 \times 28}{2 + \frac{1.2}{0.67}}$$

$$= 17.9 \rightarrow 18$$

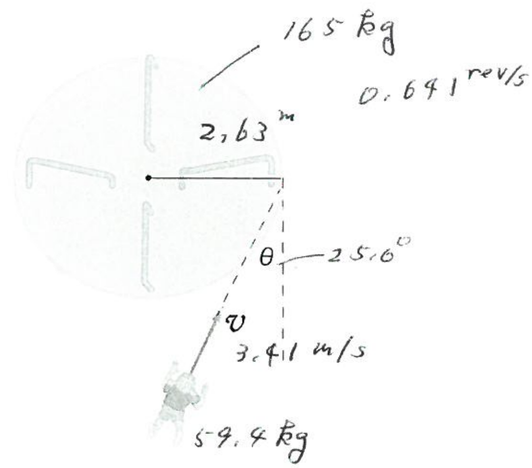
(10) Answer

Right 28 N

Left 18 N

(13%)

(11) A disk-shaped merry-go-round of radius 2.63 m and mass 165 kg rotates freely with an angular speed of 0.641 rev/s. A 59.4-kg person running tangential to the rim of the merry-go-round at 3.41 m/s jumps onto its rim and holds on. Before jumping on the merry-go-round, the person was moving in direction θ =25.0° with respect to the tangential line of the merry-go-round's rim, as shown in the figure. What is the final angular speed of the merry-go-round?



Conservation of angular momentum

$$L = rmv\cos\theta + I\omega$$
$$= rmv\cos\theta + \frac{1}{2}Mr^2\omega$$
$$L' = (I + mr^2)\omega'$$
$$= (\frac{1}{2}Mr^2 + mr^2)\omega' = (\frac{1}{2}M + m)r^2\omega'$$

$$L = 2.63 \times 59.4 \times 3.41 \times \cos 25.0^\circ + \frac{1}{2} \times 165 \times 2.63^2 \times 0.641 \times 2\pi$$
$$= 482.81 + 2298.6 = 2781.4$$
$$L' = (\frac{1}{2} \times 165 + 59.4) \times 2.63^2 \cdot \omega'$$
$$= 981.51 \cdot \omega'$$

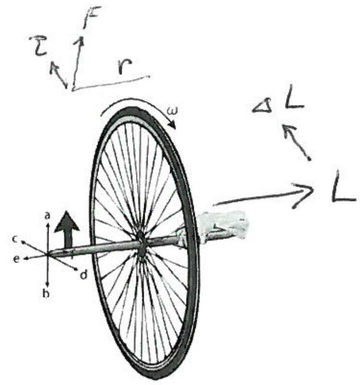
$$L = L'$$
$$\omega' = \frac{2781.4}{981.51} = 2.834 \rightarrow 2.83\ (rad/s)$$
$$= \frac{2.834}{2\pi} = 0.4510 \rightarrow 0.451\ (rev/s)$$

(11) Answer

2.83 rad/s

(25%)

or 0.451 rev/s



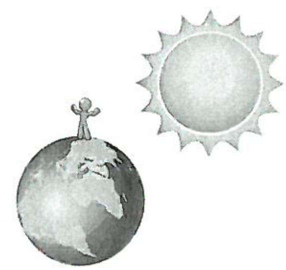
(12) At a physics demonstration, you support a bike wheel spinning in the direction as shown. When you try to move the tip of the wheel in the direction shown by the thick arrow, you feel the wheel moving itself. Choose the direction from a~f.

(12) Answer

d

(100%)

(13) The sun has a mass 333,000 times that of the earth. For a person on earth, the average distance to the center of the sun is 23,500 times the distance to the center of the earth. In magnitude, what is the ratio of the sun's gravitational force on you to the earth's gravitational force on you?



$$\frac{F_{sun}}{F_{earth}} = \frac{G\frac{M_S}{R_S^2}m}{G\frac{M_E}{R_E^2}m}$$

$$= \left(\frac{M_S}{M_E}\right)\times\left(\frac{R_E}{R_S}\right)^2$$

$$= 333\times10^3\times\left(\frac{1}{23.5\times10^3}\right)^2$$

$$= \frac{333}{23.5^2}\times\frac{10^3}{10^6}$$

$$= 0.6030\times10^{-3}$$

$$\rightarrow 6.03\times10^{-4}$$

(13) Answer

6.03×10^{-4}

(48%)