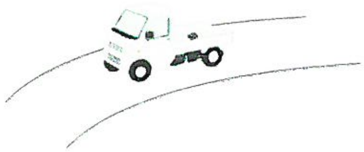
Student 9
Average 56.8/100
Best 71.5/100

12thG Physics (2019 – 20)

1st Q Exam

(October 31, 2019)



In calculation problems, describe equations clearly and systematically enough to show how to solve the problems. <u>If not enough, you won't get any points.</u>

Name	Solutions

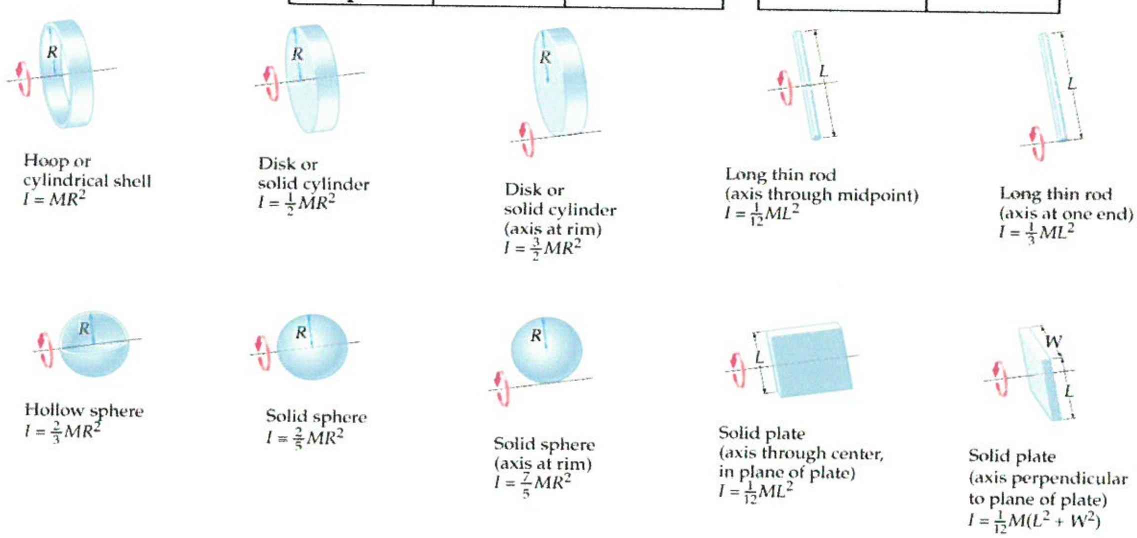
Gravitational acceleration rate	g = 9.80 m/s²
Universal Gravitational Constant	G = 6.67 x 10^{-11} N · m²/kg²
Radius of the Earth	R_E = 6.378 x 10^{6} m
Mass of the Earth	M_E = 5.972 x 10^{24} kg

5 pt/question x 21 questions = 105 pt. Max 100 pt.

Exam	/[Total 100 点]

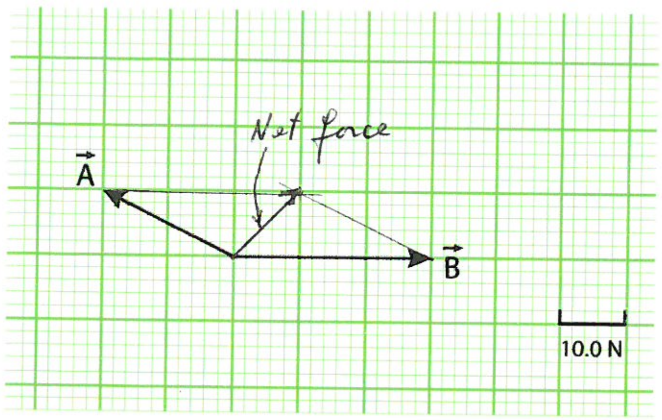
Number of Lab Reports	/2	Score

Homework	Score



(1) Find the net force vector of the following combinations of forces, (a) and (b). Find the magnitude of the net displacement.

(1-a)



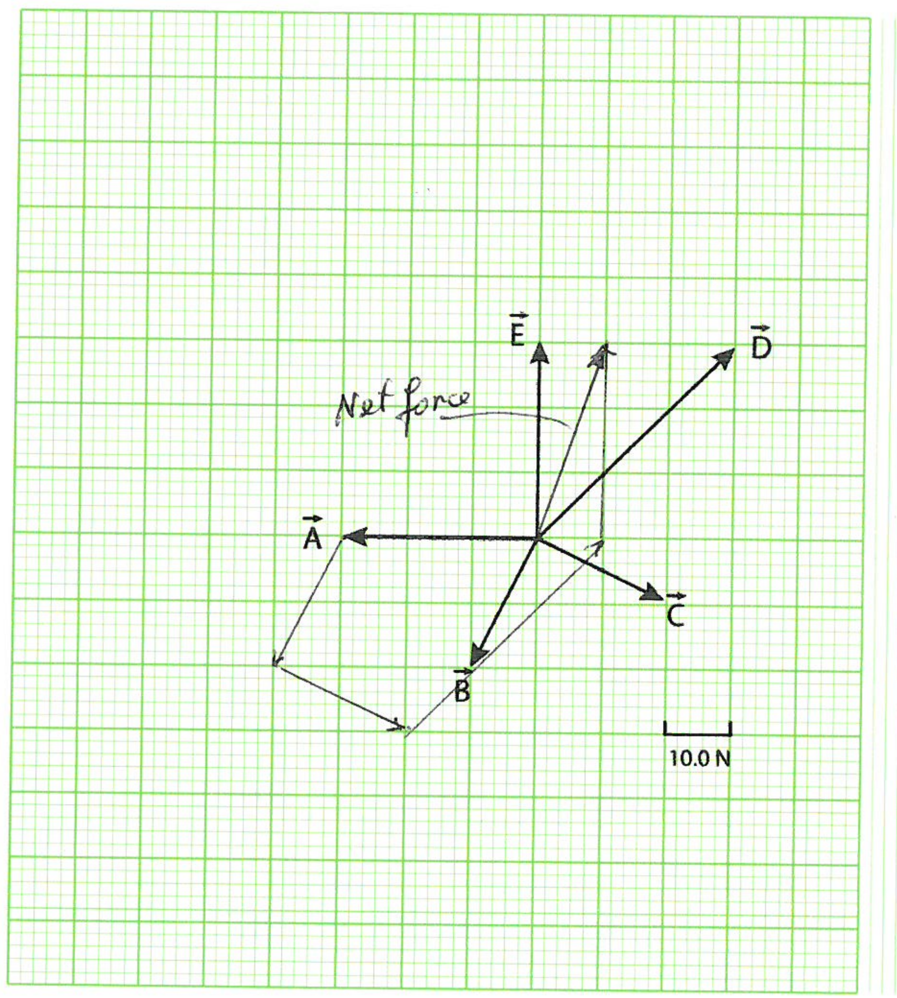
(3-a) Answer
Draw inside the graph. Magnitude : 14.1 N
(3-b) Answer
Draw inside the graph. Magnitude : 31.6 N

44%

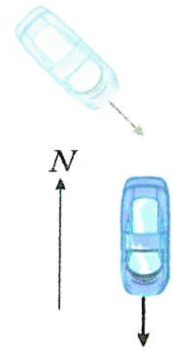
(a) $F = \sqrt{10^2+10^2} = 14.14 \longrightarrow 14.1\ N$

(b) $F = \sqrt{10^2+30^2} = 31.62 \longrightarrow 31.6\ N$

(1-b)



(2) You drive a car 10.0 m/s to southeast, then9.00 s later13.0 m/s to south. What are the direction and magnitude of your average acceleration rate?
Equations



$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} = \frac{1}{9.00}(\vec{v}_f - \vec{v}_i)$$

$$a_x = \frac{1}{9.00}(0 - 10.0\cos 45^\circ)$$

$$= \frac{1}{9.00}(-7.0711) = -0.7857$$

$$a_y = \frac{1}{9.00}\{-13.0 - (-10.0\sin 45^\circ)\}$$

$$= \frac{1}{9.00}(-13.0 + 7.071) = \frac{1}{9.00} \times (-5.929)$$

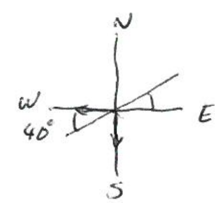
$$= -0.6588$$

$$a = \sqrt{0.7857^2 + 0.6588^2} = \sqrt{0.6173 + 0.4340}$$

$$= 1.025 \longrightarrow 1.03 \ (m/s^2)$$

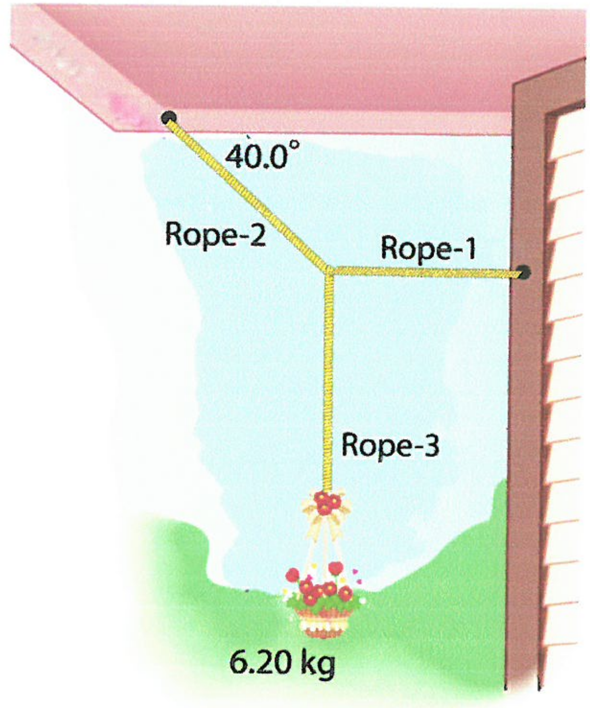
$$\begin{array}{r} 0.6173 \\ +\ 0.4340 \\ \hline 1.0513 \end{array}$$

$$\theta = \tan^{-1}\left(\frac{-0.6588}{-0.7857}\right) = 39.98^\circ \longrightarrow 40^\circ$$



(2) Answer	$1.03 \ m/s^2$
40° south from west	

44%



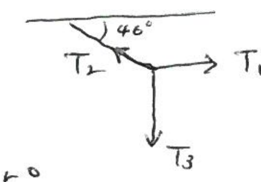
(3) To hang a 6.20 kg pot of flowers, a gardener uses three ropes – one attached horizontally to a wall, the second sloping upward at an angle 40.0° and attached to a ceiling, and the third hanging the flower basket. Find the tension in each rope.

Equations

$$\vec{T}_1 + \vec{T}_2 + \vec{T}_3 = 0$$

$$\begin{cases} T_{1x} + T_{2x} + T_{3x} = 0 \\ T_{1y} + T_{2y} + T_{3y} = 0 \end{cases}$$

$$\begin{cases} T_1 - T_2 \cos 40^\circ + 0 = 0 \\ 0 + T_2 \sin 40^\circ - T_3 = 0 \end{cases}$$



$$T_3 = mg = 6.20 \times 9.80 = 60.76 \rightarrow 60.8\,(N)$$

$$T_2 = \frac{T_3}{\sin 40.0^\circ} = \frac{60.76}{\sin 40.0^\circ} = 94.52^\circ \rightarrow 94.5^\circ$$

$$T_1 = T_2 \cos 40.0^\circ = 94.52 \cos 40.0^\circ = 72.41^\circ \rightarrow 72.4^\circ$$

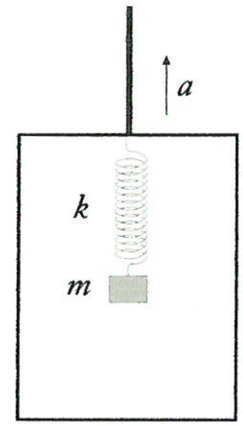
(3) Answer	
Rope1	72.4 N
Rope2	94.5 N
Rope3	60.8 N

94%

(4,5) A 1.5 kg weight hangs from a spring with a spring constant of 77 N/m supported from the roof of an elevator that has an upward acceleration of 2.5 m/s².

(4) How much does the spring change in length in reference to the elevator at rest.

(5) Find the direction and magnitude of the inertial force.



Newton's 2nd law

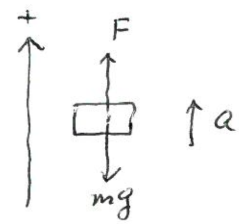
$$\sum F = ma$$

$$F - mg = ma \quad \text{——} ①$$

$$F = m(a+g)$$

$$= 1.5\,(2.5 + 9.80)$$

$$= 18.45 \quad (N)$$



Hooke's law

$$F = kx \rightarrow x = \frac{F}{k} = \frac{18.45}{77} = 0.2396 \ (m)$$

$$= 23.96 (cm) \rightarrow 24 \ cm$$

From ①

$$(F - mg) + (-ma) = 0$$

The second term, $-ma$, can be an inertial force directed downward, and its magnitude is ma.

$$ma = 1.5 \times 2.5 = 3.750$$

$$\rightarrow 3.8 \ (N)$$

(4) Answer

24 cm extended. 23%

(5) Answer

3.8 N downward 26%

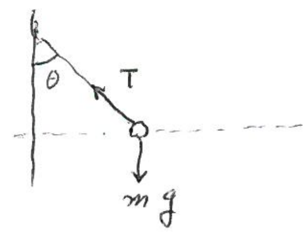
(6, 7) The figure at the right is a popular ride at amusement parks. Riders are at a distance of 15 m from the axis of rotation and move with a speed of 22 km/h.

(6) What kind of force works as a centripetal force?

(7) Find the angle θ the supporting wires make with the vertical.
Equations

$$22\,\frac{\cancel{km}}{\cancel{h}} \times \frac{1\,\cancel{h}}{3.6\times 10^{\cancel{3}}\,s} \times \frac{10^{\cancel{3}}\,m}{1\,\cancel{km}} = \frac{22}{3.6}\ m/s$$

$$= 6.111\ (m/s)$$



$$T\cos\theta = mg$$

$$-T\sin\theta = -m\frac{v^2}{r}$$

$$\tan\theta = \frac{\frac{v^2}{r}}{g} = \frac{v^2}{rg} \doteqdot \frac{6.111^2}{15\times 9.80} = 0.2541$$

$$\theta = \tan^{-1} 0.2541 = 14.2546^\circ \longrightarrow 14^\circ$$

(6) Answer

The horizontal component of the tensional force

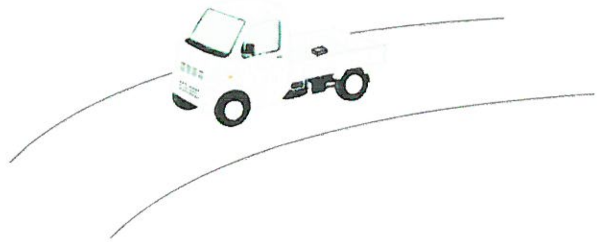
88%

(7) Answer

14°

31%

(8) A 3.0 kg box is resting on the flat floor in the rear of a truck moving at 15 m/s. What is the minimum radius of a turn the truck can make if the box is not to slip? Assume 0.40 as a static frictional coefficient. (Equations)



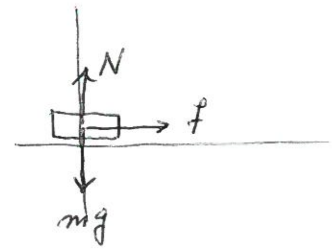
$$f = m\frac{v^2}{r}$$

$$N = mg$$

$$f \leq f_{max} = \mu N = \mu mg$$

$$m\frac{v^2}{r} \leq \mu N = \mu mg$$

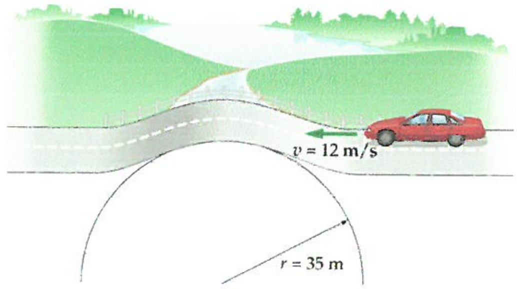
$$r \geq \frac{v^2}{\mu g} = \frac{15^2}{0.40 \times 9.80} = 57.40 \longrightarrow 57 \text{ (m)}$$



(8) Answer

57 m

77%

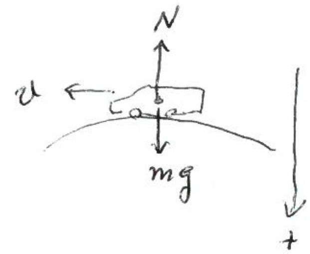


(9,10) Driving in your car with a constant speed of 12 m/s, you encounter a bump in the road that has a circular cross section, as indicated in the figure. The radius of curvature of the bump is 35 m.

(9) Find the apparent weight of 67 kg person in your car as you pass over the top of the bump.

(10) In the previous problem, at what speed must you go over the bump if people in your car feel "weightless"?

(Equations)



(9) $\sum F = ma$

$$mg - N = m\frac{v^2}{r}$$

$$N = m\left(g - \frac{v^2}{r}\right)$$

$$\frac{N}{g} = m\left(1 - \frac{v^2}{gr}\right)$$

$$= 67\left(1 - \frac{12^2}{9.80 \times 35}\right) = 67 \times 0.580 = 38.9 \rightarrow 39\ (kg)$$

(10)

$$N = 0 \rightarrow 1 - \frac{v^2}{gr} = 0$$

$$\rightarrow v = \sqrt{gr}$$

$$= \sqrt{9.80 \times 35}$$

$$= 18.52 \longrightarrow 19\ m/s$$

(9) Answer
39 kg

56%

(10) Answer
19 m/s

67%

(11) A player bounces a 0.43 kg soccer ball off her head, changing the velocity of the ball from $\vec{v_i} = (8.8\,m/s)\hat{x} + (-2.3\,m/s)\hat{y}$ to $\vec{v_f} = (5.2\,m/s)\hat{x} + (3.7\,m/s)\hat{y}$. If the ball is in contact with the player's head for 6.7 ms, what are the direction and magnitude of the impulsive force delivered to the ball?

(Equations)

momentum change and impulse

$$m v_f - m v_i = f \Delta t$$

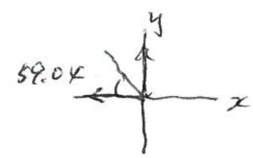
$$f = \frac{0.43}{6.7\times10^{-3}} \{(5.2\hat{x} + 3.7\hat{y}) - (8.8\hat{x} - 2.3\hat{y})\}$$

$$= \frac{0.43}{6.7\times10^{-3}}(-3.6\hat{x} + 6.0\hat{y})$$

$$f = \frac{0.43}{6.7\times10^{-3}}\sqrt{3.6^2+6.0^2} = \frac{6.9971\times0.43}{6.7\times10^{-3}} = 0.449\times10^{3}$$

$$\longrightarrow 4.5\times10^{2}\ (N)$$

$$\theta = \tan^{-1}\left(\frac{60}{-3.6}\right) = -59.04$$



$$180^\circ - 59.04^\circ = 120.96^\circ \longrightarrow 121^\circ$$

(11) Answer

4.5×10^{2} N

121° from positive x axis

62%

(12) A 75 kg lumberjack stands at one end of a 330 kg floating log, as shown in the figure. Both the log and the lumberjack at rest initially. If the lumberjack now trots toward the other end of the log with a speed of 2.7 m/s relative to the log, what is the lumberjack's speed relative to the shore? Ignore friction between the log and the water.

(Equations)

G Ground
W Wood
P Person

Relative velocities

$$v_{PG} = v_{WG} + v_{PW}$$

$$\rightarrow v_{PG} = v_{WG} + 2.7 \quad —①$$

Conservation of momentum

$$0 = 75 \times v_{PG} + 330\, v_{WG} \quad —②$$

①, ② $$0 = 75 \times (v_{WG} + 2.7) + 330\, v_{WG}$$

$$(75 + 330)\, v_{WG} = -75 \times 2.7$$

$$\rightarrow v_{WG} = -0.5000$$

$$v_{PG} = -0.5000 + 2.7$$

$$= 2.200 \longrightarrow 2.2 \text{ m/s}$$

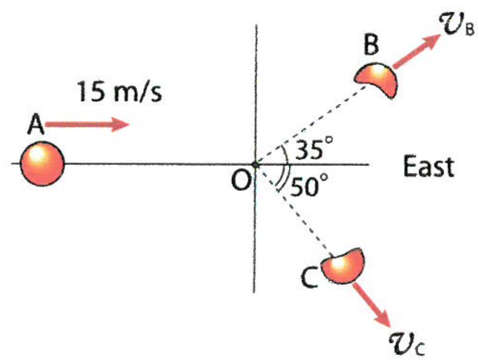
$$\begin{array}{r} 2.7 \\ -)\ 0.500 \\ \hline 2.200 \end{array}$$

(12) Answer

2.2 m/s

63%

(13) A 8.0 kg body, A, moving with a speed of 15 m/s to due east explodes at a point, O, by a small amount of gunpowder inside it and splits into two bodies, B of 3.0 kg and C of 5.0 kg. B travels to the direction 35° north of east whereas C travels to the direction 50° south of east, as shown the figure. Find the speed of B and C after the split.
(Equations)



Conservation of momentum

$$m_A \vec{v}_A = m_B \vec{v}_B + m_c \vec{v}_c$$

$$\begin{cases} m_A v_{Ax} = m_B v_{Bx} + m_c v_{cx} \\ m_A v_{Ay} = m_B v_{By} + m_c v_{cy} \end{cases}$$

$$\begin{cases} 8.0 \times 15 = 3.0 \times v_B \cos 35^\circ + 5.0\, v_c \cos 50^\circ \\ 0 = 3.0 \times v_B \sin 35^\circ - 5.0\, v_c \sin 50^\circ \end{cases}$$

$$\begin{cases} 2.4575\, v_B + 3.2139\, v_c = 120 \\ 1.7207\, v_B - 3.8302\, v_c = 0 \end{cases}$$

$$2.4575 \times 1.7207\, v_B + 3.2139 \times 1.7207\, v_c = 120 \times 1.7207$$

$$- \big[\quad \text{''} \quad - 3.8302 \times 2.4547\, v_c = 0$$

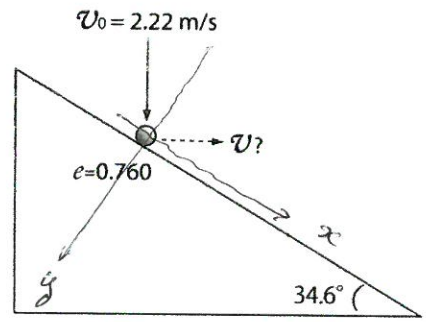
$$14.9229\, v_c = 206.48 \rightarrow v_c = 13.818 \rightarrow 14 \text{ m/s}$$

$$v_B = \frac{3.8302 \times 13.818}{1.7207} = 30.76 \rightarrow 31 \text{ m/s}$$

(13) Answer		
B	31	m/s
C	14	m/s

40%

(14) A small ball falls vertically and collides at 2.22 m/s with a frictionless slope with an angle of 34.6° from the horizontal. The restitution coefficient of the slope is 0.760. Find the direction and speed of the ball after the collision.



(Equations)

$$\begin{array}{lcc} & x & y \\ \text{Before} & (v_0 \sin\theta, & v_0\cos\theta) \\ \text{after} & (v_x, & v_y) \end{array}$$

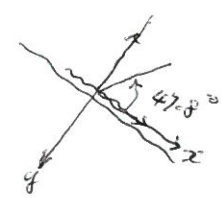
$$v_x = v_0 \sin\theta = 2.22 \sin 34.6^\circ = 1.2606$$

$$e = -\frac{-v'}{v} \rightarrow 0.760 = -\frac{v_y}{v_0\cos\theta}$$

$$v_y = -0.760 \times 2.22 \cos 34.6^\circ = -1.3888$$

$$v = \sqrt{1.2606^2 + 1.3888^2} = 1.876 \rightarrow 1.88 \text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{-1.3888}{1.2606}\right) = 47.77^\circ \rightarrow 47.8^\circ$$



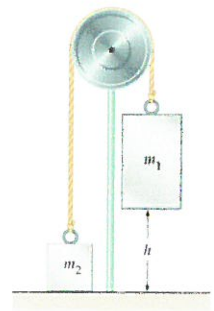
(14) Answer

Speed: 1.88 m/s

Direction: 47.8° upward from the slope

47%

(15) The two masses (m_1 = 5.0 kg and m_2 = 3.0 kg) in the Atwood machine shown in the figure are released from the rest, with m_1 at a height of 0.75 m above the floor. When m_1 hits the ground its speed is 1.8 m/s. The pulley is a uniform disk with a radius of 12 cm. Find the pulley's mass.



(Equations)

Before $U_i = mgh = 5.0 \times 9.80 \times 0.75$

$= 36.75$

After $U_f = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 + m_2 g h + \frac{1}{2} I \omega^2$

$\omega = \frac{v}{r}$, $I = \frac{1}{2} M r^2$

$U_f = \frac{v^2}{2}(m_1 + m_2) + m_2 g h + \frac{1}{2} \cdot \frac{1}{2} M \cancel{r^2} \times \frac{v^2}{\cancel{r^2}}$

$= \frac{1.8^2}{2} \times 8 + 3 \times 9.8 \times 0.75 + \frac{1}{4} M \times 1.8^2$

$= 35.01 + 0.8100\,M$

$U_1 = U_2$

$36.75 = 35.01 + 0.8100\,M$

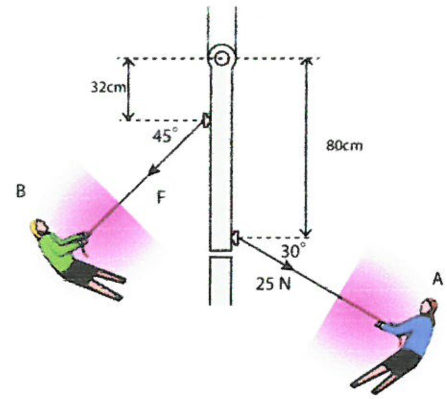
$M = \frac{36.75 - 35.01}{0.81} = \frac{2.148}{0.81} = 2.148 \rightarrow 2$ (kg)

(15) Answer

2 kg

11%

(16) Two fairies pull a revolving door. A fairy A's force is 25 N at 30° relative to a tangential line while the other fairy B's force is at 45°. The door is in equilibrium and does not revolve. Find the magnitude of the fairy B's force.
(Equations)



$\Sigma r \cdot F_{\perp} = 0$

$80 \times 25\cos 30^\circ - 32 \times F\cos 45^\circ = 0$

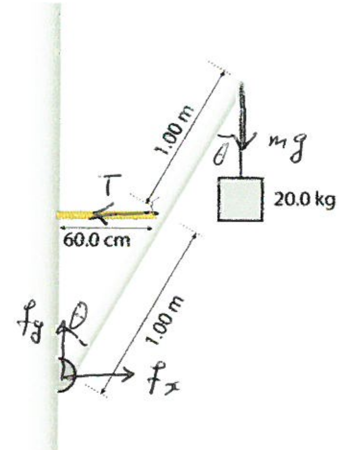
$F = \frac{80 \times 25\cos 30^\circ}{32\cos 45^\circ} = 76.55 \rightarrow 77\,(N)$

(16) Answer

77 N

73%

(17, 18) The lower end of weightless rod 2.00 m long is hinged to a wall, and a 20.0 kg weight is suspended from its upper end, as in the figure. A horizontal rope 60.0 cm long joins the middle of the rod to the wall.



(17) Find the tension in the rope.

(18) Find the direction and magnitude of the resistant force at the hinge.

(Equations)

$\sum rF = 0$

$$1.00\cos\theta \times T - 2.00\sin\theta \times 20.0 \times 9.80 = 0 \quad \text{①}$$

$\sum F_x = 0 \qquad T = f_x \quad$ ②

$\sum F_y = 0 \qquad f_y = mg = 20.0 \times 9.80 = 196 \quad$ ③

$$\sin\theta = \frac{60.0}{100} = 0.600 \qquad \theta = \sin^{-1} 0.600 = 36.8699^\circ$$

①: $$T = \frac{392\sin\theta}{\cos\theta} = 392 \times \tan 36.8699^\circ = 294.00\ (N)$$

$\rightarrow 294 (N)$

$f_x = 294.0 \qquad f_y = 196.0$

$$f = \sqrt{294^2 + 196^2} = 353.3 \rightarrow 353\ (N)$$

$$\theta = \tan^{-1}\left(\frac{196}{294}\right) = 33.6901^\circ$$

$\rightarrow 33.7^\circ$

(17) Answer

294 N

0%

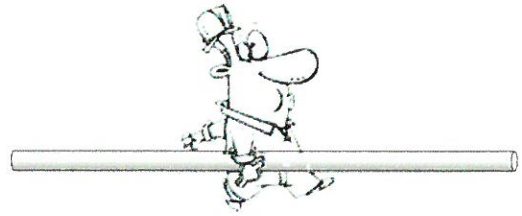
(18) Answer

353 N

33.7° above the horizontal

0%

(19) A person holds a uniform rod horizontally at its center. The rod has a length 3.15 m and mass 8.42 kg. Find the torque the person must exert on the rod to give it an angular acceleration of 0.302 rad/s^2.
(Equations)



$$\tau = I\alpha$$

$$I = \frac{1}{12} ML^2$$

$$\tau = I\alpha = \frac{1}{12} ML^2 \alpha$$

$$= \frac{1}{12} \times 8.42 \times 3.15^2 \times 0.302$$

$$= 2.103 \longrightarrow 2.10 \quad (N \cdot m)$$

(19) Answer

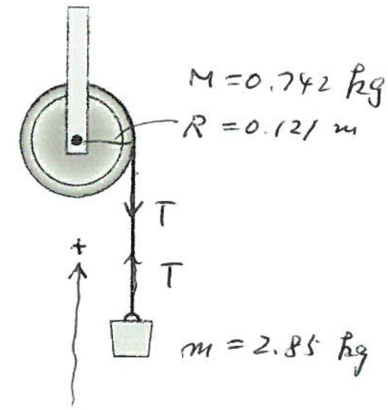
$2.10 \ N \cdot m$

96 %

(20, 21) A 2.85 kg bucket is attached to a disk-shaped pulley of radius 0.121 m and mass 0.742 kg. The bucket is allowed to fall.

(20) What is the linear acceleration of the bucket?

(21) How far does the bucket drop in 1.50 s?
(Equations)



(20)

$\sum F = ma$: $T - mg = ma$ — ①

$\sum \tau = I\alpha$: $-T\cancel{R} = \frac{1}{2}M R^{\cancel{2}}\left(\frac{a}{\cancel{R}}\right)$ — ②

$\rightarrow$ $-T = \frac{1}{2}Ma$ — ②'

①, ②'

$mg + ma = -\frac{1}{2}Ma$

$2mg + 2ma = -Ma$

$a(2m + M) = -2mg$

$a = -\dfrac{2mg}{2m+M} = -\dfrac{2 \times 2.85 \times 9.80}{2 \times 2.85 + 0.742} = -8.671 \rightarrow -8.67 (m/s^2)$

(21) $y = \frac{1}{2}at^2$

$= -\frac{1}{2} \times 8.671 \times 1.5^2$

$= 9.7549$ (m)

(20) Answer

8.67 m/s^2 downward

13%

(21) Answer

9.75 m

0%

Your opinions