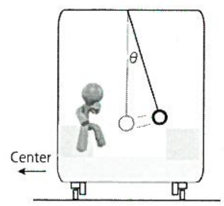
Student	8
Average	49.4 /100
Best	85.5 /100

12thG Physics (2018 – 19)

1st Q Exam

(October 30, 2018)

Name Solutions



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

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 $R_E = 6.378 \times 10^6\ m$
Mass of the Earth $M_E = 5.972 \times 10^{24}\ kg$

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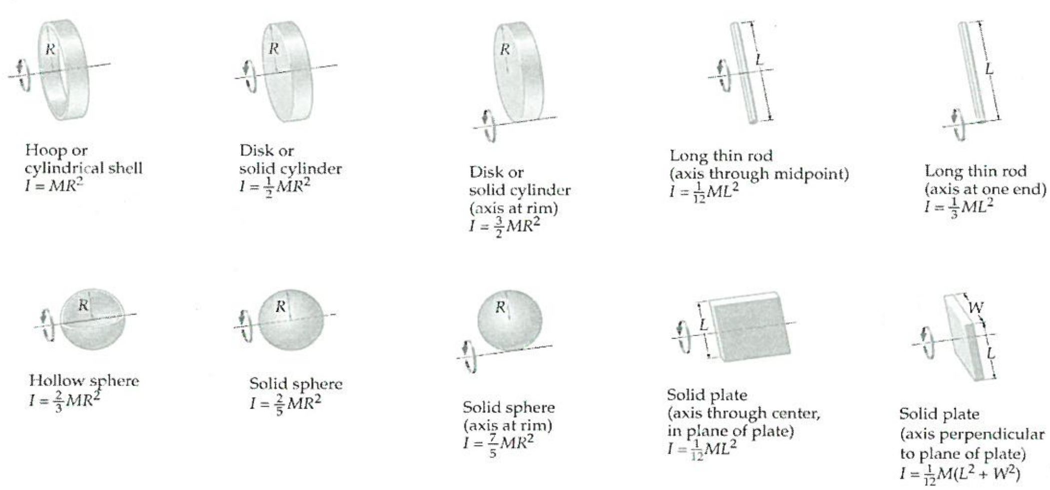
5 pt/question x 21 questions = 105 pt Max 100 pt

Exam ／[Total 100 点]

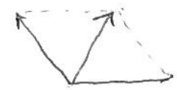
Number of Full Reports	/2	Score

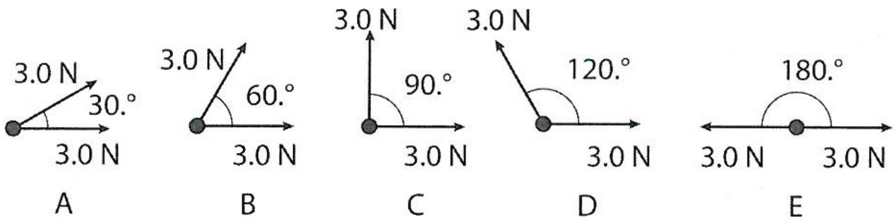
Homework	Score



ei Moritani…

(1) Two 3.0-N forces act on an object. In which diagram would the forces produce a net force with a magnitude of 3.0 N?



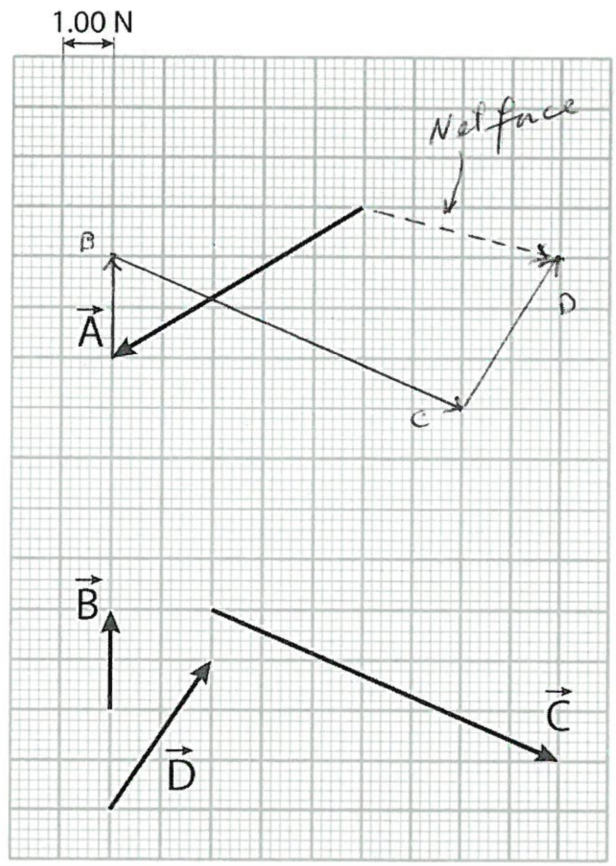


(1) D

(63%)

(2) Determine the net of the four forces, $\vec{A}$, $\vec{B}$, $\vec{C}$ and $\vec{D}$ by using the graphical method. Find the magnitude of the net vector.
(Equations)

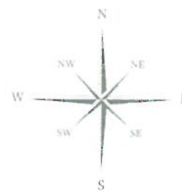
$F = \sqrt{4^2 + 1^2} \approx 4.123$

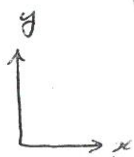


(2) Answer Draw inside above.
Magnitude: 4.12 N

(55%)

(3) What are the direction and magnitude of your total displacement if you have traveled due west with a speed of 27 m/s for 125 s then due south at 14 m/s for 66s?
(Equations)





$x = -27 \text{ m/s} \times 125\text{ s} = -3375 \text{ m}$

$y = -14 \text{ m/s} \times 66 = -924 \text{ m}$

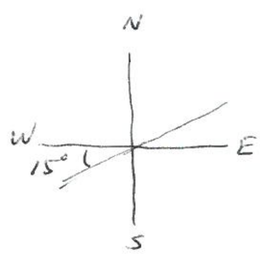
$d = \sqrt{x^2 + y^2}$

$= \sqrt{(-3375)^2 + (-924)^2}$

$= 3499 \rightarrow 3500$

$\theta = \tan^{-1}\left(\frac{-924}{-3375}\right)$

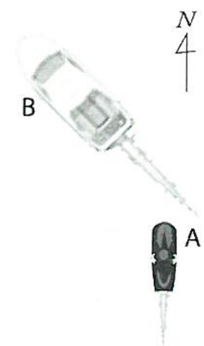
$= 15.31^\circ \rightarrow 15^\circ$



(3) Answer 3500 m
15° South from west

(66%)

(4) A jet ski-A is moving due north at a speed of 15 m/s while the motorboat-B is traveling to northwest at a speed of 12 m/s. How does the driver on the jet ski-A experience the velocity (magnitude and direction) of B?
(Equations)



$$\vec{v} = \vec{v}_B - \vec{v}_A$$

$$\begin{cases} v_x = v_{Bx} - v_{Ax} \\ v_y = v_{By} - v_{Ay} \end{cases}$$

$$v_x = -12\cos 45^\circ - 0 = -8.485$$

$$v_y = 12\cos 45^\circ - 15 = $$
$$= 8.485 - 15 = -6.516 \text{ (one digit)}$$

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(-8.485)^2 + (-6.516)^2}$$
$$= 10.69 \longrightarrow 10 \text{ (m/s)}$$

$$\theta = \tan^{-1}\left(\frac{-6.516}{-8.485}\right)$$
$$= 37.52^\circ \longrightarrow 40^\circ$$

(4) Answer

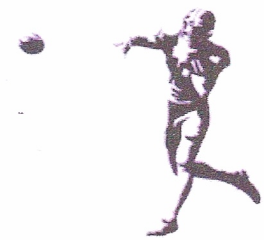
10 m/s

40° south from west

(61%)

10/30/2018 By Tohei Moritani…

(5) A football is thrown horizontally with an initial velocity of (16.6 m/s) $\hat{x}$. Ignoring air resistance , the average acceleration of the football over any period of time is $(-9.80\mathrm{m/s^2})\,\hat{y}$.
(5a) Find the velocity vector of the ball 1.75 s after it is thrown.
(5b) Find the magnitude and direction of the velocity at this time.
(Equations)



(a) $\vec{v} = 16.6\hat{x} - 9.80 \times 1.75\,\hat{y}$

$= 16.6\hat{x} - 17.15\hat{y}$

$\rightarrow 16.6\hat{x} - 17.2\hat{y}$

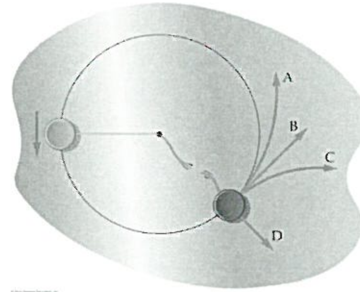
(b) $v = \sqrt{16.6^2 + (-17.15)^2} = 23.86 \rightarrow 23.9$ (m/s)

$\theta = \tan^{-1}\left(\frac{-17.15}{16.6}\right) = -45.93° \rightarrow -45.9°$

(5-a) Answer $(16.6\,\mathrm{m/s})\hat{x} - (15.0\,\mathrm{m/s})\hat{y}$
(5-b) Answer 23.9 m/s, −45.9°

(43%)

(6~8) A 0.15-kg pack attached to a 0.75 m string undergoes circular motion on an air table.
(6-a) What force is working as the centripetal force?
(6-b) Find the magnitude of the acceleration when the speed of the pack is 2.0 m/s.



The string breaks when the tensile strength is equal to 19.6 N or more.
(7) Find the rotation per min when the string breaks.
(8) Find how fast and to which direction the pack flies at the moment the string breaks. Choose A ~ D in the figure.
(Equations)

(6) $a = \frac{v^2}{r} = \frac{2.0^2}{0.75} = 5.33 \longrightarrow 5.3\ (m/s^2)$

(7) $F = mr\omega^2$

$\omega = \sqrt{\frac{F}{mr}} = \sqrt{\frac{19.6}{0.15 \times 0.75}} = 13.20\ (rad/s)$

$13.20\ \frac{rad}{s} \times \frac{rev}{2\pi\ rad} \times \frac{60\ s}{1\ min} = 126.0\ rpm \longrightarrow 130\ rpm$

(8) $v = r\omega$

$= 0.75 \times 13.20$

$= 9.90 \longrightarrow 9.9\ (m/s)$

(6-a) Answer
Tensile force of the string
(6-b) Answer
$5.3\ m/s^2$

(66%)

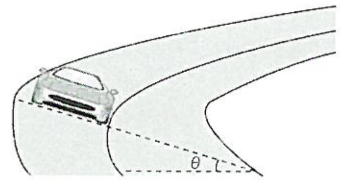
(7) Answer
130 rpm

(58%)

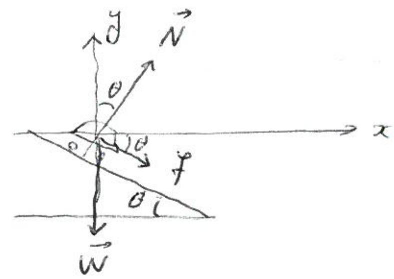
(8) Answer	
Speed	9.9 m/s
Direction	B

(68%)

(9) A 1200.-kg car rounds a corner of radius r=50.0 m and with banking at $\theta = 30.0°$. If the coefficient of static friction between the tires and the road is $\mu = 0.821$, what is the greatest speed the car can have in the corner without skidding?



(Equations)



$$x: \; N\sin\theta + f\cos\theta = m\frac{v^2}{r} \quad — ①$$

$$y: \; N\cos\theta = f\sin\theta + W \quad — ②$$

$$f = \mu N \quad — ③$$

$$W = mg \quad — ④$$

$$y: \; \frac{\sqrt{3}}{2}N = \frac{1}{2}\times 0.821\,N + 1200 \times 9.80$$

$$(0.8660 - 0.4105)N = 11760$$

$$N = 25816 \; (N)$$

$$x: \; \frac{1}{2}N + \frac{\sqrt{3}}{2}\times 0.821\,N = 1200 \times \frac{v^2}{50.0}$$

$$v = \sqrt{\frac{(0.5 + 0.7110)\times 25816 \times 50}{1200}}$$

$$= 36.09$$

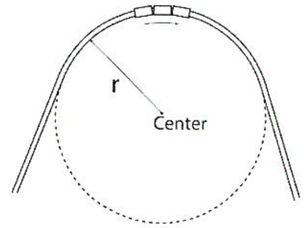
$$\rightarrow 36.1 \; (m/s)$$

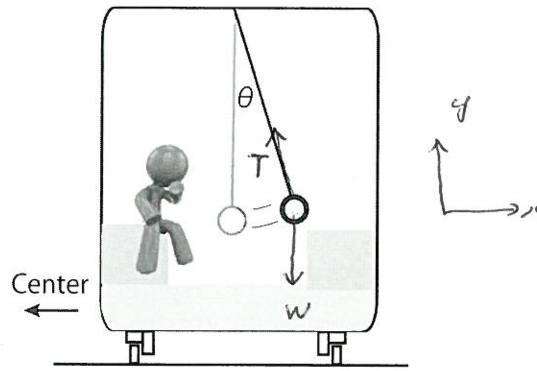
(9) Answer

36.1 m/s

(1%)

(10) When a train is traveling at 25.0 m/s and rounds a corner of radius r=105 m, a 50.0 g object hanging with light string inside the train tilts θ from the vertical.
(10-a) Find θ.
(10-b) Find the magnitude and direction of the centrifugal force.
(Equations)





(a)

$$x: \quad -T\sin\theta = -m\frac{v^2}{r} \quad —①$$

$$y: \quad T\cos\theta = mg \quad —②$$

$$\frac{x}{y}: \quad \tan\theta = \frac{v^2}{rg}$$

$$= \frac{25.0^2}{105 \times 9.80}$$

$$= 0.6074$$

$$\theta = \tan^{-1}(0.6074)$$

$$= 31.27°$$

$$\rightarrow 31.3°$$

(b)

$$|F| = m\frac{v^2}{r}$$

$$= 0.050 \times \frac{25.0^2}{105}$$

$$= 0.2976 \rightarrow 0.298\ N$$

(10-a) Answer
31.3°
(10-b) Answer
0.298 N outward

(opposite to the center)

(48%)

10/30/2018 By Tohei Moritani…

(11) A 0.144 kg baseball is moving toward home plate with a speed of 41.0 m/s. When it is hit, it flies upward vertically at 19.0 m/s. The contact time between the ball and the bat is 1.40 ms (1.40×10^{-3} s). Find the magnitude and direction of the impact force the bat exerts on the ball.

(Equations)

$$\vec{F}\Delta t = m\vec{v}' - m\vec{v}$$

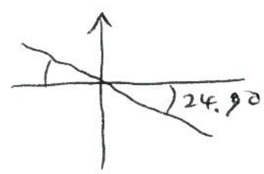
$$\begin{cases} F_x = \dfrac{m}{\Delta t}(v_x' - v_x) = \dfrac{m}{\Delta t}(0-41) = -\dfrac{m}{\Delta t}\cdot 41 \\ F_y = \dfrac{m}{\Delta t}(v_y' - v_y) = \dfrac{m}{\Delta t}(19-0) = \dfrac{m}{\Delta t}\cdot 19 \end{cases}$$

$$F = \frac{m}{\Delta t}\sqrt{F_x^2+F_y^2} = \frac{m}{\Delta t}\sqrt{41^2+19^2} = \frac{0.144}{1.40\times 10^{-3}} \times 45.19$$

$$= 4.648 \times 10^3 \rightarrow 4.65 \times 10^3 (N)$$

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{19}{-41}\right) = -24.86^\circ$$

$$\rightarrow -24.9^\circ$$



(11) Answer

4.65×10^3 N

24.9° upward from the direction toward pitcher

(65%)

(12) An 85 kg lumberjack stands at one end of a 380 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)

$\longrightarrow x$

$$0 = m_1 v_1 + m_2 v_2$$
$$= 85 v_1 + 380 v_2 \quad \text{— ①}$$

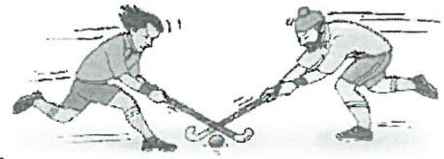
$$v_{12} = v_1 - v_2 = 2.7$$
$$\rightarrow v_2 = v_1 - 2.7 \quad \text{— ②}$$

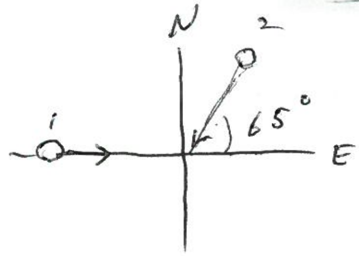
$$85 v_1 + 380 (v_1 - 2.7) = 0$$
$$465 v_1 = 1026$$
$$v_1 = 2.206$$
$$\rightarrow 2.2 \, (m/s)$$

(12) Answer
2.2 m/s

(25%)

(13) Two 72.0-kg hockey players skating at 5.34 m/s: one is moving due east while the other 65° south from west. They collide and stick together. Find their speed and direction after the collision?
(Equations)





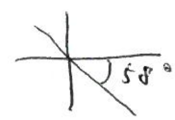
$$m\vec{v}_1 + m\vec{v}_2 = 2m\vec{v}$$

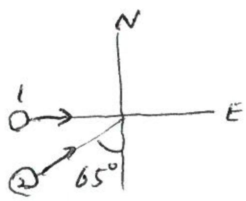
$$2v_x = v_{1x} + v_{2x}$$
$$= 5.34 - 5.34\cos 65^\circ = 3.083$$

$$2v_y = v_{1y} + v_{2y}$$
$$= 0 - 5.34\sin 65^\circ = -4.840$$

$$v = \sqrt{v_x^2 + v_y^2} = \frac{1}{2}\sqrt{3.083^2 + (-4.840)^2} = 2.869 \rightarrow 2.9 \,(\text{m/s}$$

$$\theta = \tan\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{-4.840}{3.083}\right) = -57.50 \longrightarrow -58^\circ$$





$$2v_x = 5.34 + 5.34\sin 65^\circ$$
$$= 10.18$$

$$2v_y = 0 + 5.34\cos 65^\circ$$
$$= 2.257$$

$$v = \frac{1}{2}\sqrt{\quad} = 5.213$$

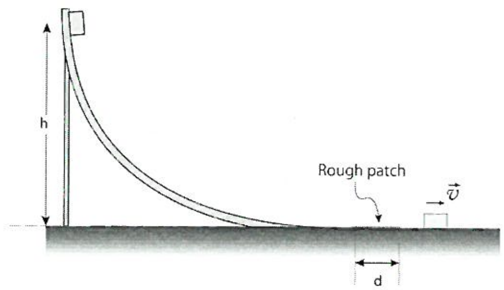
$$\theta = \tan^{-1}(\quad) = (\quad)$$
$$= 12.50^\circ$$

5.2 m/s
~~[illegible]~~ 13° north from east

(13) Answer
2.9 m/s
58° south from east

(58%)

(14) The figure shows a 1.95 kg block at rest on a ramp of height h. When the block is released, it slides without friction to the bottom of the ramp, and then continue across a surface that is frictionless except for a rough patch of width d = 80.0 cm that has a coefficient of kinetic friction $\mu' = 0.640$. Find h such that the block's speed after crossing the rough patch is 3.50 m/s.



(Equations)

$$mgh - fx = \frac{1}{2}mv^2 \quad —①$$

$$f = \mu' N = \mu' mg \quad —②$$

①,② $\cancel{m}gh - \mu'\cancel{m}gx = \frac{1}{2}\cancel{m}v^2$

$$h = \mu' x + \frac{v^2}{2g}$$

$$= 0.640 \times 0.80 + \frac{3.50^2}{2 \times 9.80}$$

$$= 0.\overline{512}0 + 0.\overline{625}0$$

$$= 1.1370$$

$$\longrightarrow 1.137 \text{ m}$$

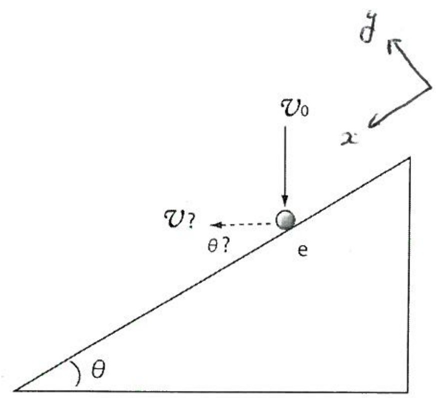
(14) Answer

1.137 m

(38%)

1.14 m ok

(15) A small boll falls vertically and collides to a slope with an angle of $\theta = 26.0°$ from the horizontal surface. The speed at the collision is 1.80 m/s and the rebound coefficient is 0.480. Find the speed and direction after the collision.



(Equations)

$v_0 = 1.80$ m/s

$(v_{0x}, v_{0y}) = (1.80 \sin 26°, -1.80 \cos 26°)$

$(v_x', v_y') = (v_{0x}, -e\, v_{0y})$

$= (0.7891, 0.7766)$

$v' = \sqrt{v_x'^2 + v_y'^2}$

$= \sqrt{0.7891^2 + 0.7766^2}$

$= 1.107 \longrightarrow 1.11$ (m/s

$\theta = \tan^{-1}\left(\frac{v_y'}{v_x'}\right) = \tan^{-1}\left(\frac{0.7766}{0.7891}\right)$

$= 44.54° \longrightarrow 44.5°$

(15) Answer

1.11 m/s

44.5° from the slope

(44%)

(16) When a pitcher throws a curve ball, the ball is given a fairly rapid spin. A 0.15 kg baseball with a radius of 3.7 cm is thrown with a linear speed of 48 m/s, and the angular speed of 42 rad/s. Assume the ball is a uniform, solid sphere.
(16-a) How much is its translational kinetic energy?
(16-b) How much is its rotational kinetic energy?
(Equations)

$$K_t = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.15 \times 48^2 = 172.8 \longrightarrow 170 \text{ (J)}$$

$$K_r = \frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{2}{5}MR^2\omega^2$$

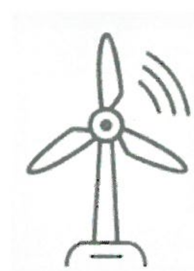
$$= \frac{1}{2} \times \frac{2}{5} \times 0.15 \times 0.037^2 \times 42^2$$

$$= 0.0724 \longrightarrow 0.072 \text{ (J)}$$

(16-a) Answer
170 J
(16-b) Answer
0.072 J

(56%)

(17) As the wind dies, a windmill that was rotating at 3.2 rad/s begins to slow down with a constant angular acceleration of 0.39 rad/s^2. How long does it take for the windmill to come to a complete stop?
(Equations)



$$\alpha = \frac{\omega - \omega_0}{t}$$

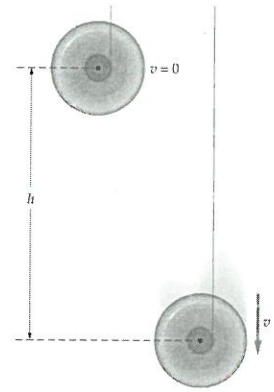
$$t = \frac{\omega - \omega_0}{\alpha} = \frac{0 - 3.2}{-0.39}$$

$$= 8.205 \longrightarrow 8.2 \text{ (s)}$$

(17) Answer
8.2 s

(86%)

(18) You release a yo-yo from rest and allow it to drop, as you keep the top end of the string stationary. The mass of the yo-yo is 0.068 kg, its moment of inertia is 3.1×10^{-5} kg・m^2, and the radius r, of the axle the string wraps around is 0.0071 m. What is the linear speed, v, of the yo-yo after it has dropped through a height h = 0.60 m? (Equations)



$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 \quad — ①$$

$$\omega = \frac{v}{r} \quad — ②$$

①, ② $$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{r^2}$$

$$\left(m + \frac{I}{r^2}\right)v^2 = 2mgh$$

$$v = \sqrt{\frac{2mgh}{m + \frac{I}{r^2}}} = \sqrt{\frac{2 \times 0.068 \times 9.80 \times 0.60}{0.068 + \frac{3.1 \times 10^{-5}}{0.0071^2}}}$$

$$= \sqrt{1.1708}$$

$$= 1.082$$

$$\rightarrow 1.1$$

(18) Answer

1.1 m/s

(28%)

(19) A person holds a ladder horizontally at its center. Treating the ladder as a uniform rod of length 3.45 m and mass 8.65 kg, find the torque the person must exert on the ladder to give it an angular acceleration of 0.432 rad/s^2.
(Equations)

$$\tau = I\alpha$$

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

$$\tau = \frac{1}{12} \times 8.65 \times 3.45^2 \times 0.432$$

$$= 3.707$$

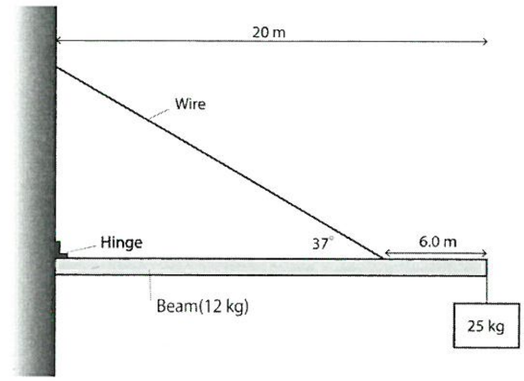
$$\longrightarrow 3.71 \ N\cdot m$$

(19) Answer
3.71 N·m

(38%)

10/30/2018 By Tohei Moritani…

(20) A uniform beam of 12 kg is supported with a hinge and a length of wire.
(20-a) Find the magnitude of tension for the wire.
(20-b) Find the magnitude and direction of the resistance force exerting on the beam at the location of the hinge.



Equations

(a) Torque

$$14 \times T \sin 37^\circ = (10 \times 12 + 20 \times 25) \times 9.80$$

$$T = \frac{(120 + 500) \times 9.80}{14 \sin 37^\circ} = 721.2 \rightarrow 720 \, (N)$$

(b) $f_x = T \cos 37^\circ = 721.2 \cos 37^\circ = 575.9 \rightarrow 580 \, (N)$

$$f_y + T \sin 37^\circ = (12 + 25) \times 9.80$$

$$f_y = (12 + 25) \times 9.80 - 721.2 \sin 37^\circ$$

$$= 362.6 - 433.3 = -70.7 \text{ (one digit)}$$

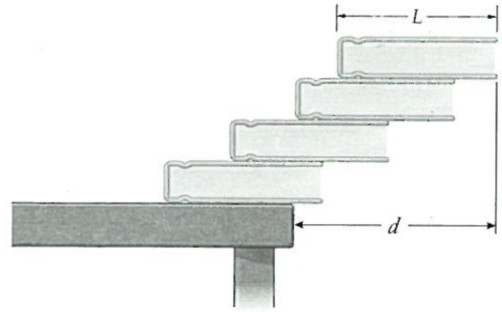
$$f = \sqrt{f_x^2 + f_y^2} = \sqrt{575.9^2 + 70.7^2} = 580.3 \longrightarrow 600 \, (N)$$

$$\theta = \tan\left(\frac{f_y}{f_x}\right) = \tan\left(\frac{-70.7}{575.9}\right) = -6.999 \rightarrow -7^\circ$$

(20-a) Answer 720 N
(20-b) Answer 600 N 7° downward from right

(25%)

(21) Four identical, uniform books of length L are stacked one on top the other. Find the maximum overhang distance d in the figure such that the books do not fall over.



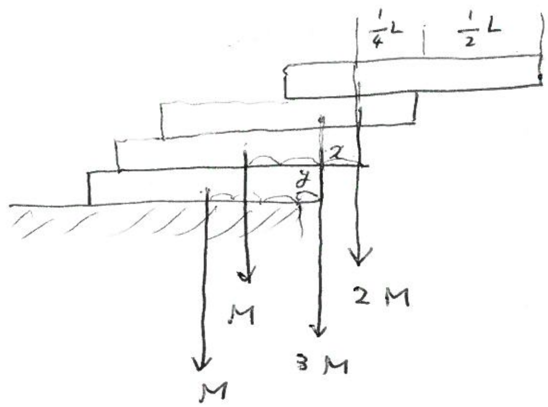
$$x = \frac{1}{2}L \times \frac{1}{3} = \frac{1}{6}L$$

$$y = \frac{1}{2}L \times \frac{1}{4} = \frac{1}{8}L$$

$$d = \left(\frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8}\right)L$$

$$= \frac{12 + 6 + 4 + 3}{24} L$$

$$= \frac{25}{24} L$$



(21) Answer

$$\frac{25}{24} L$$

(25%)