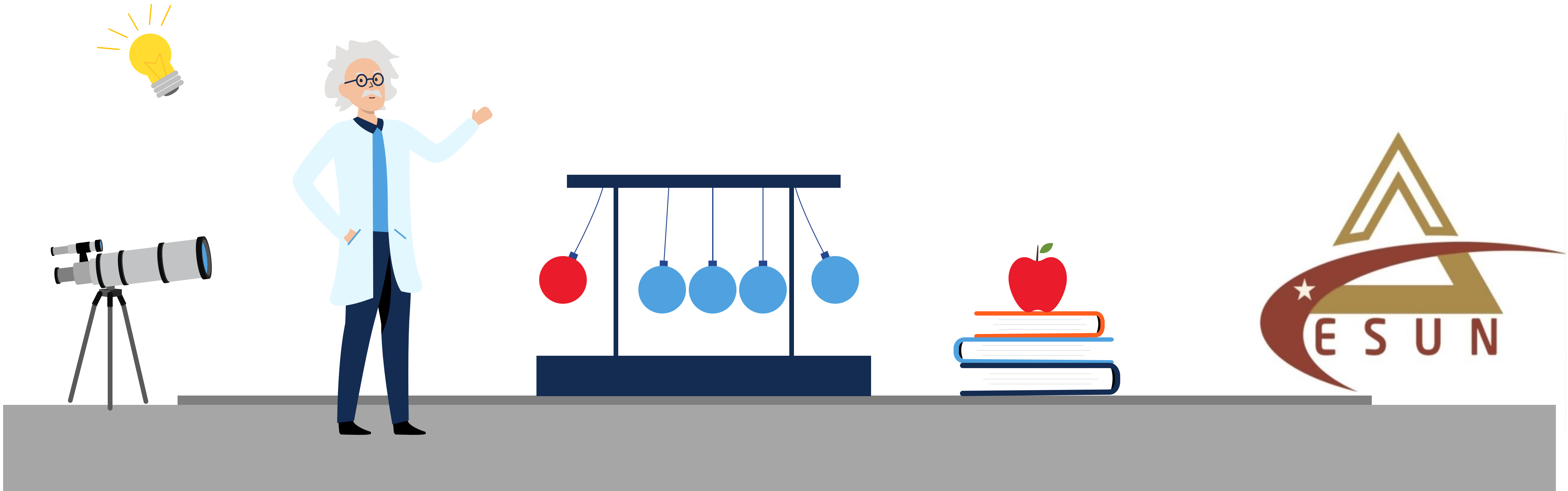
Mid-Term Revision

Physics1

PhD. C. Louay Karaker



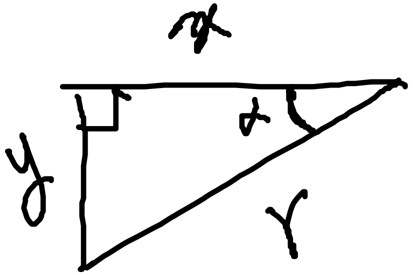
Question 1:

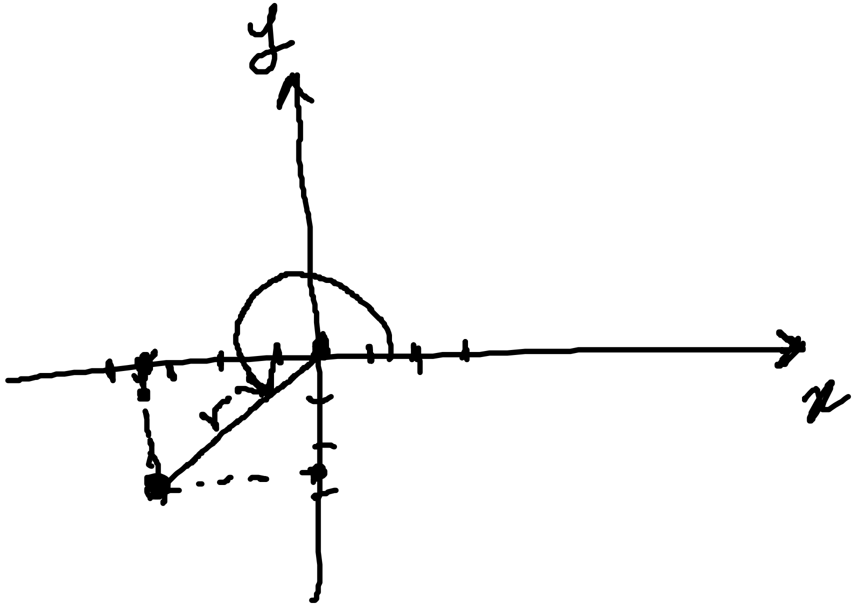
The cartesian coordinate of a point in the xy plane are (x,y) = (-3.~~00~~,-2.~~00~~). Find the corresponding plane polar coordinate of this point.

cm cm

$\left(\tan 56.3^\circ = \frac{3}{2}\right)$

$$(r, \theta) = (\sqrt{13}, 236^\circ)$$





$$r = \sqrt{x^2+y^2} = \sqrt{(-3)^2 + (-2)^2}$$

$$= \sqrt{9+4} = \sqrt{13} \text{ cm}$$

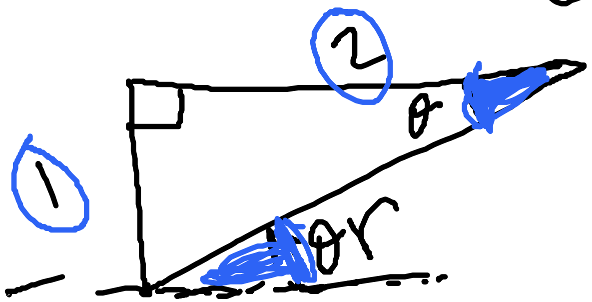
$$\alpha = \tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}\left(\frac{3}{2}\right) \simeq 56.3^\circ$$

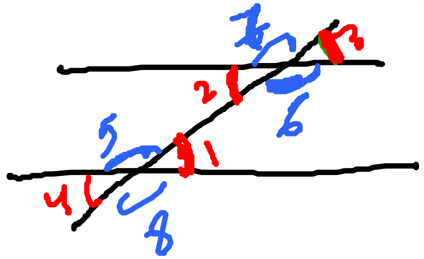
$$\theta = 56.3^\circ + 180$$

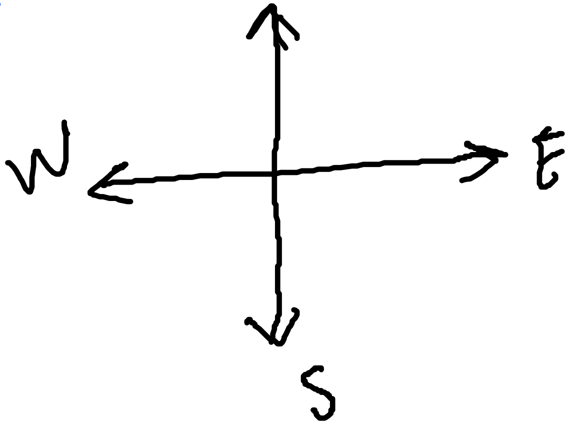
$$\theta = 236^\circ$$

Question 2:

If you will walk 1.00 km north and then 2.00 km east on a horizontal field, how far and in what direction is you from the starting point? (Hint (tan 26.6 = ½))

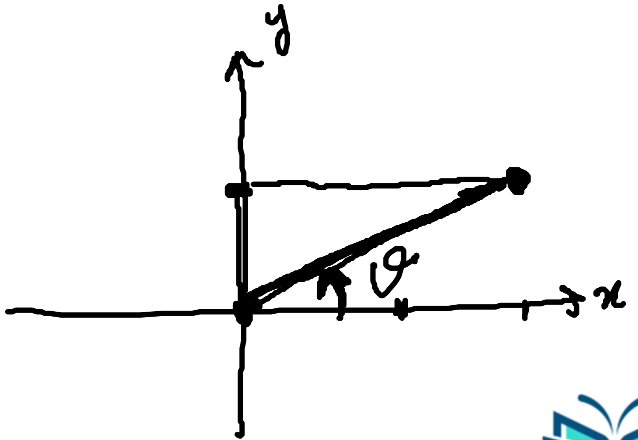






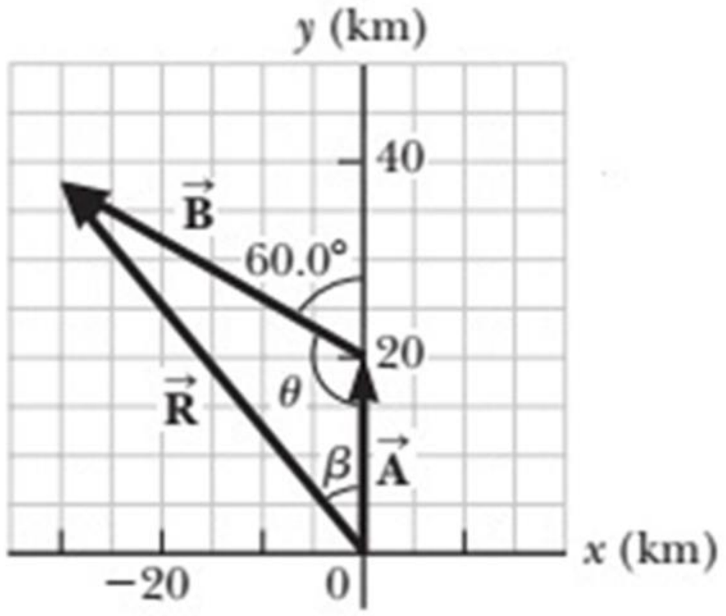
$$r = \sqrt{(1.00)^2 + (2.00)^2} = \sqrt{5}\ \text{km}$$

$$\theta = \tan^{-1}\left(\frac{1}{2}\right) = 26.6^{\circ}$$



Question 3:

A car travels 20.0 km due north and then 35.0 km in a direction 60.0° west of north as shown in the Figure. Find the magnitude and direction of the car's resultant displacement.



Question 4:

Find the sum of two vectors $\vec{A}$ and $\vec{B}$ lying in the xy-plane and given by

$\vec{A} = (2.0\,\hat{i} + 2.0\,\hat{j})$ and $\vec{B} = 2.0\,\hat{i} - 6.0\,\hat{j}$.

$$\vec{A} + \vec{B} = (2.0\,\hat{i} + 2.0\,\hat{j}) + (2.0\,\hat{i} - 6.0\,\hat{j})$$

$$\boxed{\vec{A} + \vec{B} = 4.0\,\hat{i} - 4.0\,\hat{j}}$$

Add

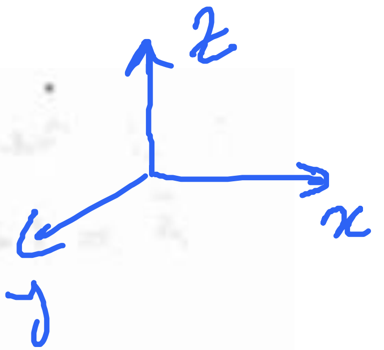
Find $\vec{A} - \vec{B} = (2.0\,\hat{i} + 2.0\,\hat{j}) - (2.0\,\hat{i} - 6.0\,\hat{j})$

$$= 0\,\hat{i} + 8.0\,\hat{j} = 8.0\,\hat{j}$$

Question 5:

Magnitude of vector

$$|\vec{R}| = \sqrt{R_x^2 + R_y^2 + R_z^2}$$



Given the two displacements

$\vec{D} = (6.00\hat{i} + 3.00\hat{j} - 1.00\hat{k})$ m and

$\vec{E} = (4.00\hat{i} - 5.00\hat{j} + 8.00\hat{k})$ m.

Find the magnitude of the displacement $2\vec{D} - \vec{E}$.

$$2\vec{D} - \vec{E} = 2(6.00\hat{i} + 3.00\hat{j} - 1.00\hat{k}) - (4.00\hat{i} - 5.00\hat{j} + 8.00\hat{k})$$

$$= (12.0\hat{i} + 6.00\hat{j} - 2.00\hat{k}) - (4.00\hat{i} - 5.00\hat{j} + 8.00\hat{k})$$

$$2\vec{D} - \vec{E} = 8.00\hat{i} + 11.0\hat{j} - 10.0\hat{k}$$

$$|2\vec{D} - \vec{E}| = \sqrt{(8.00)^2 + (11.0)^2 + (-10.0)^2} = \sqrt{285} \text{ m}$$

Question 6:

A particle undergoes three consecutive displacement:

$\Delta\vec{r}_1 = (15\hat{i} + 30\hat{j} + 12\hat{k})$ cm,

$\Delta\vec{r}_2 = (23\hat{i} - 14\hat{j} - 5.0\hat{k})$ cm, and

$\Delta\vec{r}_3 = (-13\hat{i} + 15\hat{j})$ cm.

sum

Find unit-vector notation for the resultant displacement and its magnitude in terms of m.

$$\Delta r = 25\hat{i} + 31\hat{j} + 7\hat{k} \text{ cm}$$

$$\boxed{\Delta\vec{r} = 0.25\hat{i} + 0.31\hat{j} + 0.07\hat{k} \text{ m}}$$

cm $\rightarrow$ m

$\div$

$\times$

$$|\Delta\vec{r}| = \sqrt{25^2 + 31^2 + 7^2} = 40.4 \text{ cm}$$

$$= 0.404 \text{ m}$$

Question 7:

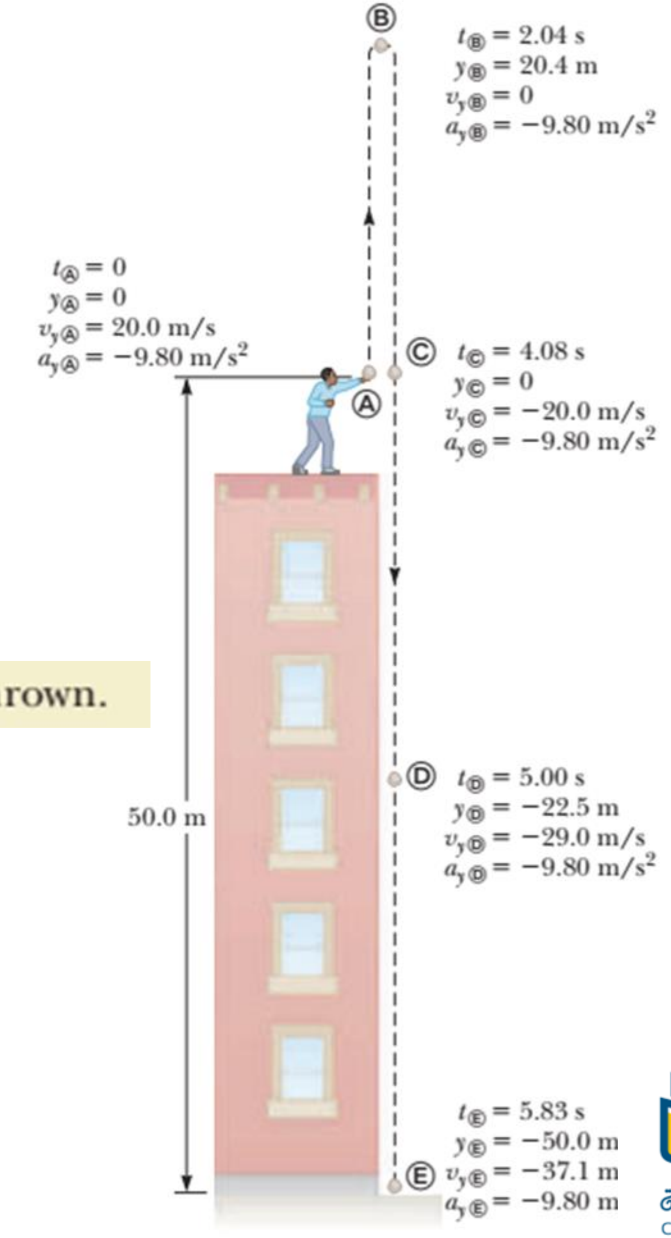
A stone thrown from the top of a building is given an initial velocity of 20.0 m/s straight upward. The stone is launched 50.0 m above the ground, and the stone just misses the edge of the roof on its way down as shown in Figure 2.14.

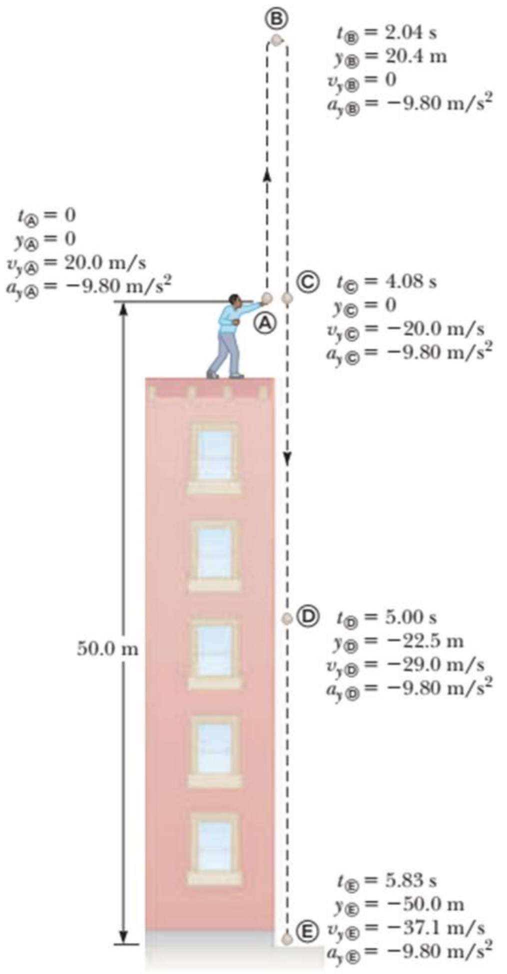
(A) Using $t_{Ⓐ} = 0$ as the time the stone leaves the thrower's hand at position Ⓐ, determine the time at which the stone reaches its maximum height.

(B) Find the maximum height of the stone.

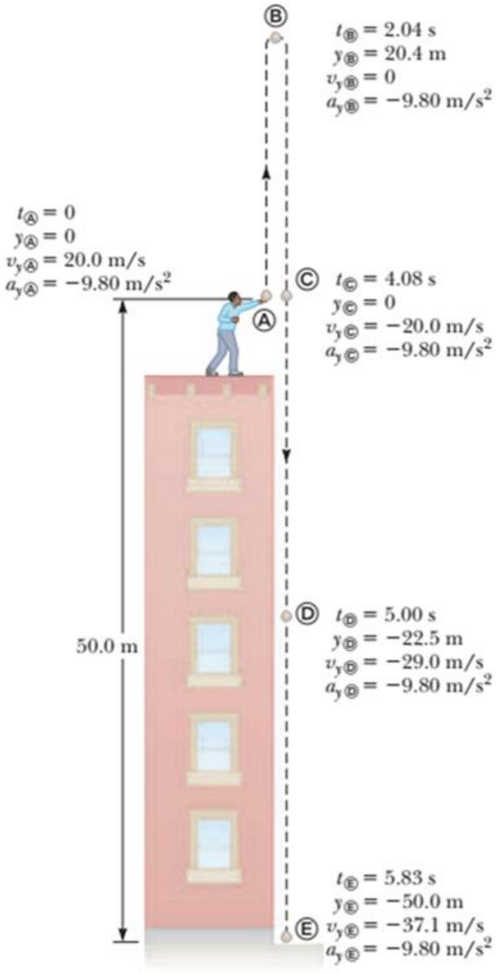
(C) Determine the velocity of the stone when it returns to the height from which it was thrown.

(D) Find the velocity and position of the stone at $t = 5.00$ s.





$t_Ⓑ = 2.04$ s
$y_Ⓑ = 20.4$ m
$v_{yⒷ} = 0$
$a_{yⒷ} = -9.80$ m/s^2
$t_Ⓐ = 0$
$y_Ⓐ = 0$
$v_{yⒶ} = 20.0$ m/s
$a_{yⒶ} = -9.80$ m/s^2
$t_Ⓒ = 4.08$ s
$y_Ⓒ = 0$
$v_{yⒸ} = -20.0$ m/s
$a_{yⒸ} = -9.80$ m/s^2
50.0 m
$t_Ⓓ = 5.00$ s
$y_Ⓓ = -22.5$ m
$v_{yⒹ} = -29.0$ m/s
$a_{yⒹ} = -9.80$ m/s^2
$t_Ⓔ = 5.83$ s
$y_Ⓔ = -50.0$ m
$v_{yⒺ} = -37.1$ m/s
$a_{yⒺ} = -9.80$ m/s^2


Ⓑ
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$v_{yⒷ} = 0$
$a_{yⒷ} = -9.80$ m/s^2
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Ⓐ
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50.0 m
Ⓓ
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$v_{yⒹ} = -29.0$ m/s
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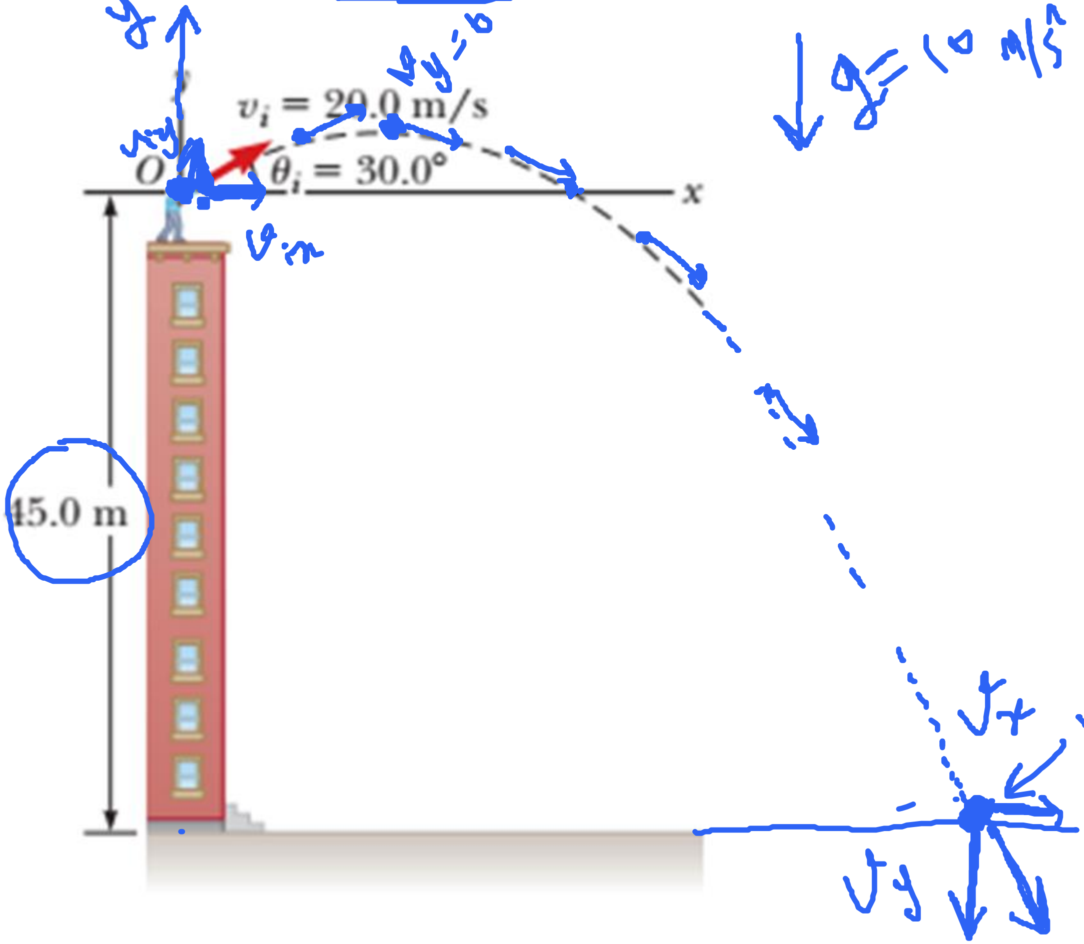
Ⓔ
$t_{Ⓔ} = 5.83$ s
$y_{Ⓔ} = -50.0$ m
$v_{yⒺ} = -37.1$ m/s
$a_{yⒺ} = -9.80$ m/s^2

Question 8:

A stone is thrown from the top of a building upward at an angle of 30.0° to the horizontal with an initial speed of 20.0 m/s as shown in Figure 4.13. The height from which the stone is thrown is 45.0 m above the ground.

(A) How long does it take the stone to reach the ground?

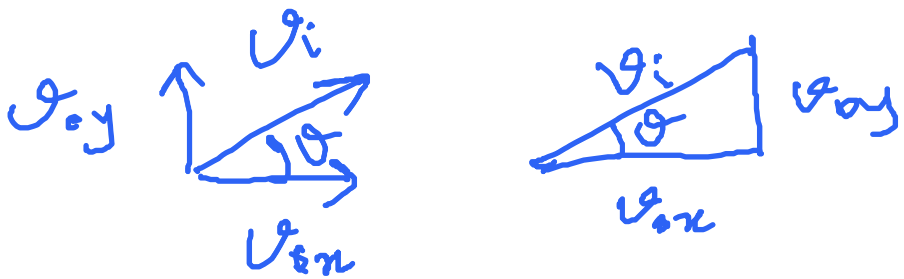
(B) What is the speed of the stone just before it strikes the ground?



$g = 10\ m/s^2$

Projectile motion

$x\ (a_x = 0)$	$y\ (a_y = -g)$
$\boxed{x = x_0 + v_{0x} t} + \cancel{\frac{1}{2} a_x t^2}$	$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$
$\boxed{v_x = v_{0x}} + \cancel{a_x t}$	$\boxed{v_y = v_{0y} - g t}$



$$y = y_0 + v_{oy} t - \frac{1}{2} g t^2$$

$$v_{oy} = v_i \cdot \sin\theta = 20 \times \sin 30 = 10 \text{ m/s}$$

$$v_{ox} = v_i \cos\theta = 20 \times \cos 30 = 10\sqrt{3} \text{ m/s}$$

$$-45 = 0 + 10t - \frac{1}{2}(10) t^2$$

$$5t^2 - 10t - 45 = 0$$

$$t^2 - 2t - 9 = 0$$

$$\boxed{t_1 = 4.16 \text{ s}} \checkmark$$

$$t_2 = -2.16 \quad \times$$

$$v_x = v_{ox} = 10\sqrt{3} \text{ m/s}$$

$$v_y = v_{oy} - gt = 10 - (10)(4.16) = -31.6 \text{ m/s}$$

$$\boxed{\vec{v} = 10\sqrt{3}\,\hat{i} - 31.6\,\hat{j}}$$

$$|\vec{v}| = \sqrt{(10\sqrt{3})^2 + (-31.6)^2}$$

speed

$$\boxed{v = 36 \text{ m/s}}$$

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Question 9:

A long jumper (Fig. 4.11) leaves the ground at an angle of 20.0° above the horizontal and at a speed of 11.0 m/s.

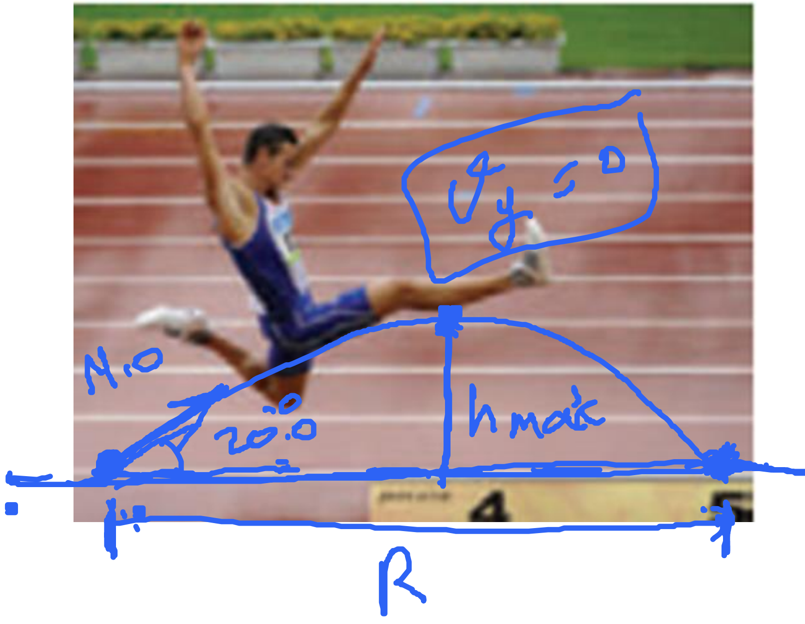
(A) How far does he jump in the horizontal direction?

(B) What is the maximum height reached?

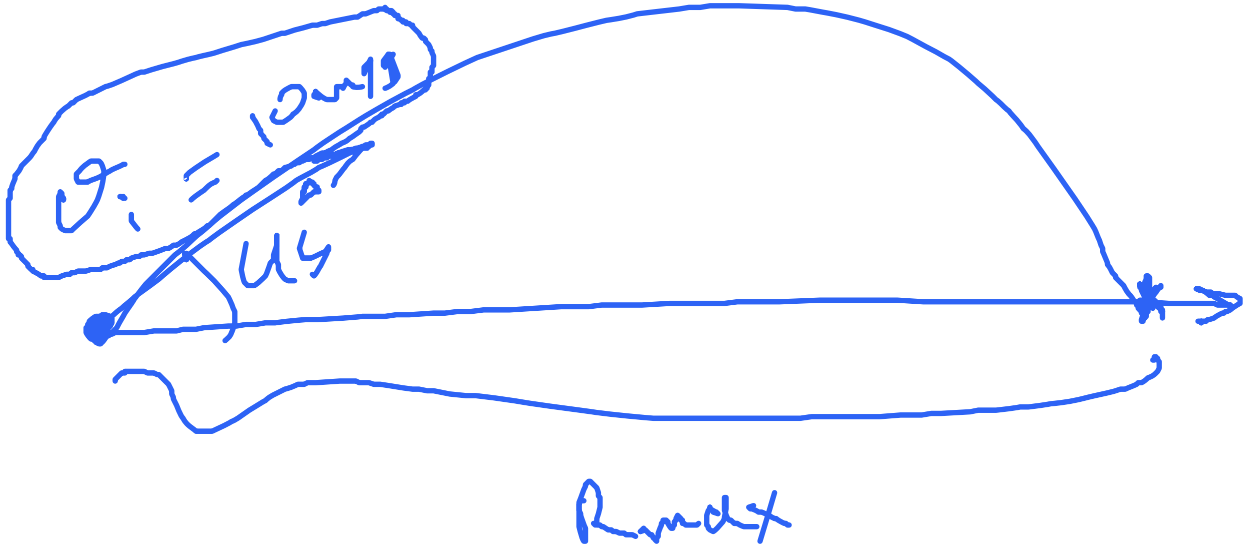
$g = 9.8\ m/s^2$

$$R = \frac{v_i^2 \sin 2\theta_i}{g} = \frac{(11.0)^2 \sin(2\times 20°)}{9.80}$$

$$= 7.94\ m$$



$$h = \frac{v_i^2 \sin^2\theta_i}{2g} = \frac{(11.0)^2 \sin^2(20)}{2 \times 9.8} = 0.722\ \text{m}$$



$$\sin(2\theta_i) = 1$$

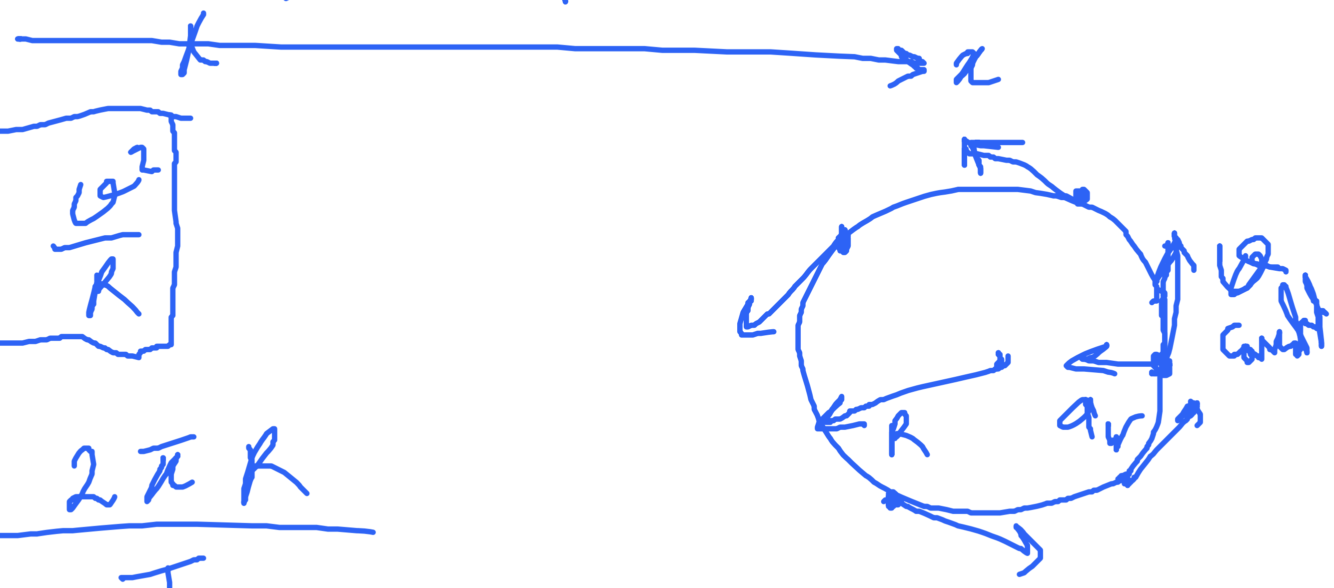
$$2\theta_i = 90^\circ$$

$$\theta_i = 45^\circ$$

Question 10:

Passengers on a carnival ride move at constant speed in a horizontal circle of radius 5.0 m making a complete circle in 4.0 s, what is their acceleration? Hint: take $\pi = 3.14$.

$v = \text{constant} \Rightarrow a = 0$



$$\boxed{a_r = \frac{v^2}{R}}$$

$$v = \frac{2\pi R}{T}$$

$$v = \frac{\text{مسافة}}{\text{زمن}}$$

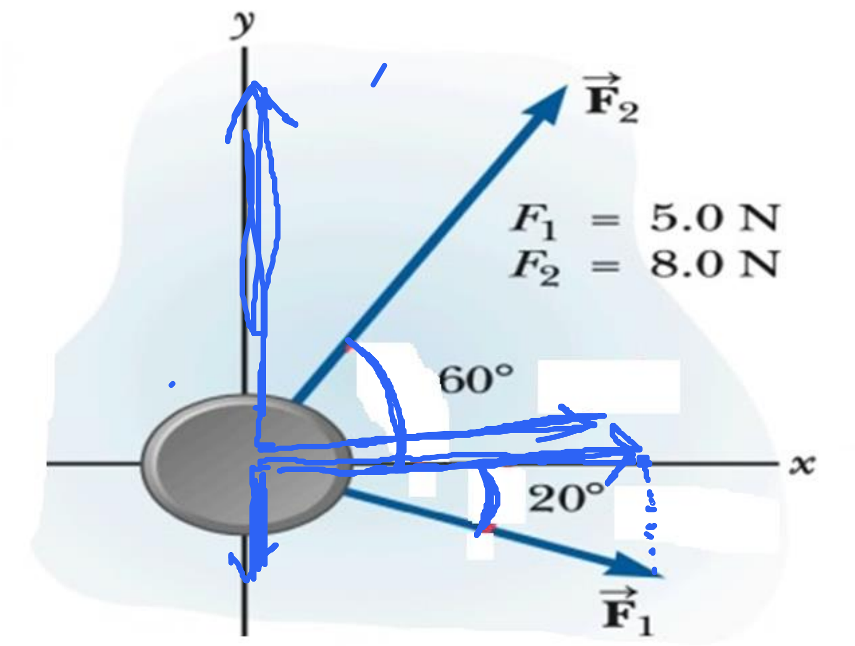
$$a_r = \frac{\left(\frac{2\pi R}{T}\right)^2}{R} = \frac{4\pi^2 R^{\cancel{2}}}{T^2 \cancel{R}} = \frac{4\pi^2 R}{T}$$

$$a_r = \frac{4(3.14)^2 \times 5}{4} = 49 \ m/s^2$$

Question 11:

A hockey puck having a mass of 0.30 kg slides on the **frictionless**, horizontal surface of an ice rink. Two hockey sticks strike the puck simultaneously, exerting the forces on the puck shown in next Figure. The force $\vec{F}_1$ has a magnitude of 5.0 N, and is directed at $\theta = 20^o$ below the x axis. The force $\vec{F}_2$ has a magnitude of 8.0 N and its direction is $\phi = 60^o$ above the x axis. Determine both the magnitude and the direction of the puck's acceleration.

Hint: Take $cos\ (-20^o) = 0.94$, $cos\ (60^o) = 0.5$ and $sin\ (-20^o) = -0.34$, $sin\ (60^o) = 0.86$.



$$\boxed{\sum \vec{F} = m\vec{a}}$$

$$\sum F_x = m a_x$$

$$F_{1x} + F_{2x} = m a_x$$

$$4.7 + 4 = 0.3\, a_x$$

$$a_x = 29\ m/s^2$$

$$\sum F_y = m a_y$$

$$F_{1y} + F_{2y} = m a_y$$

$$-1.7 + 6.88 = 0.3\, a_y$$

$$a_y = 17.3\ m/s^2$$

$F_{1x} = F_1 \cos(-20^\circ) = 5 \times 0.94 = 4.7 \ N$

$F_{1y} = F_1 \sin(-20^\circ) = 5 \times (-0.34) = -1.7 \ N$

$F_{2x} = F_2 \cos(60^\circ) = 8 \times 0.5 = 4 \ N$

$F_{2y} = F_2 \sin 60^\circ = 8 \times 0.86 = 6.88 \ N$

$\vec{a} = 29 \hat{i} + 17.3 \hat{j}$

$|\vec{a}| = \sqrt{(29)^2 + (17.3)^2} =$

$\theta = \tan^{-1}\left(\frac{17.3}{29}\right) =$

Question 12:

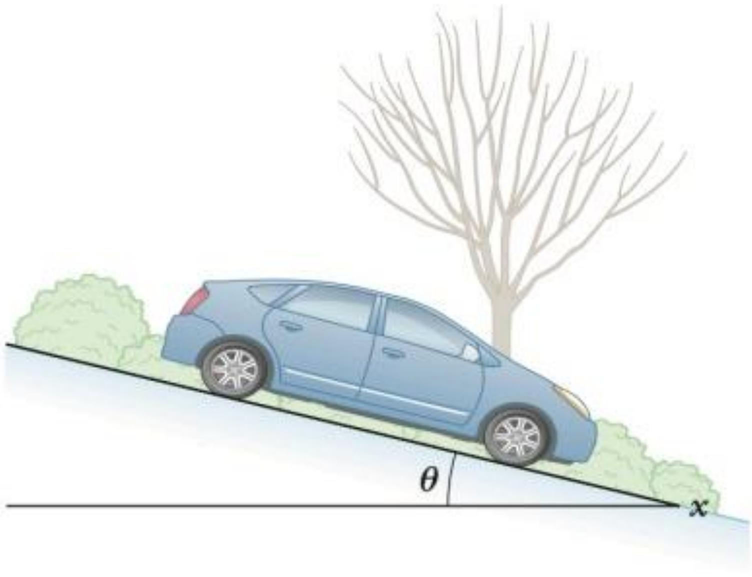
A car of mass m is on an icy driveway inclined at an angle θ as in next Figure.

(a) Find the acceleration of the car, assuming the driveway is **frictionless**.

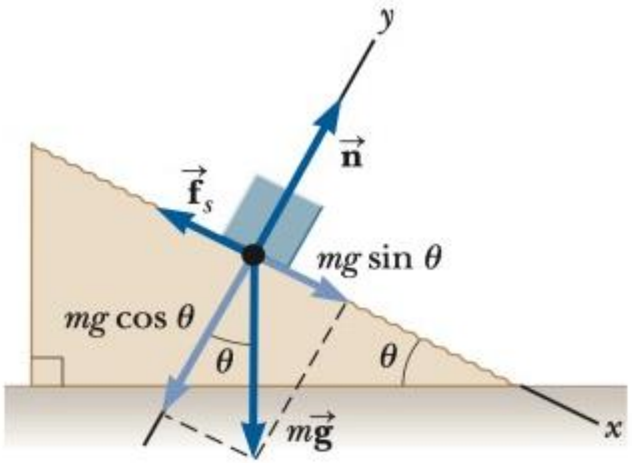
(b) When your angle $\theta = 90^o$, find a_x.

(c) Suppose the car is released from rest at the top of the incline and the distance from the car's front bumper to the bottom of the incline is d. How long does it take the front bumper to reach the bottom of the hill, and what is the car's speed as it arrives there?

(d) Please, obtain the parts (a) and (c) by taking $g = 10.0 m\ s^{-2}$, $\theta = 60.0^o$, $sin(60.0^o) = 0.86$, $m = 30.0kg$, and $d = 0.5km$.

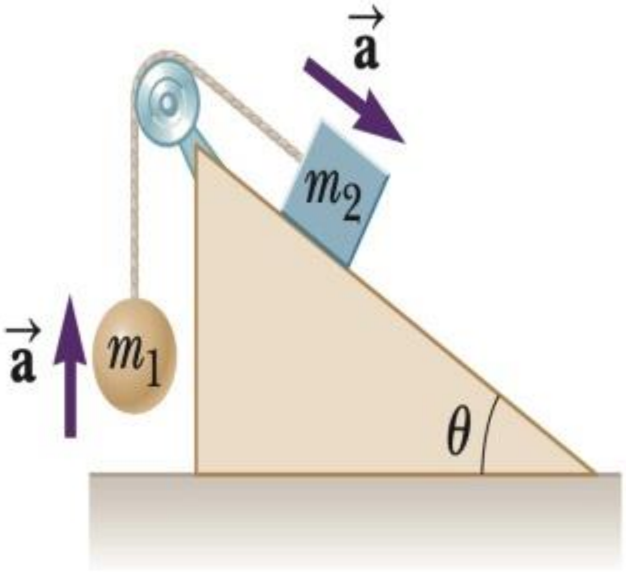


Question 13:



Let us show that we can obtain μ_s by measuring the critical angle θ_c at which this slipping just occurs. Let us try to get μ_s for $\theta = 20.0^o$.

Question 14:



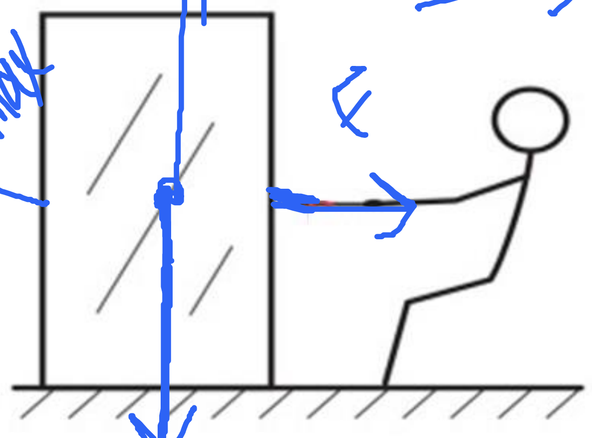
A ball of mass m_1 and a block of mass m_2 are attached by a lightweight cord that passes over a *frictionless* pulley of negligible mass as in the Figure.

The block lies on a **frictionless** incline of angle θ.

Find the magnitude of the acceleration of the two objects and the tension in the cord.

Please, obtain your all results by taking $m_1 = 30.0kg$, $m_2 = 20.0kg$, $g = 10m\ s^{-2}$, $\theta = 53.0^o$, and $sin(53.0^o) = 0.80$.

Question 15:



mx

w (Force) Fg

You want to move a 500N crate across a level floor. To start the crate moving, you have to pull with a 230N horizontal force. Once the crate starts to move, you can keep it moving at constant velocity with only 200N. What are the coefficients of static and kinetic friction?

1 Fg

$$\Sigma F_y = 0$$

$$F_N - F_g = 0$$

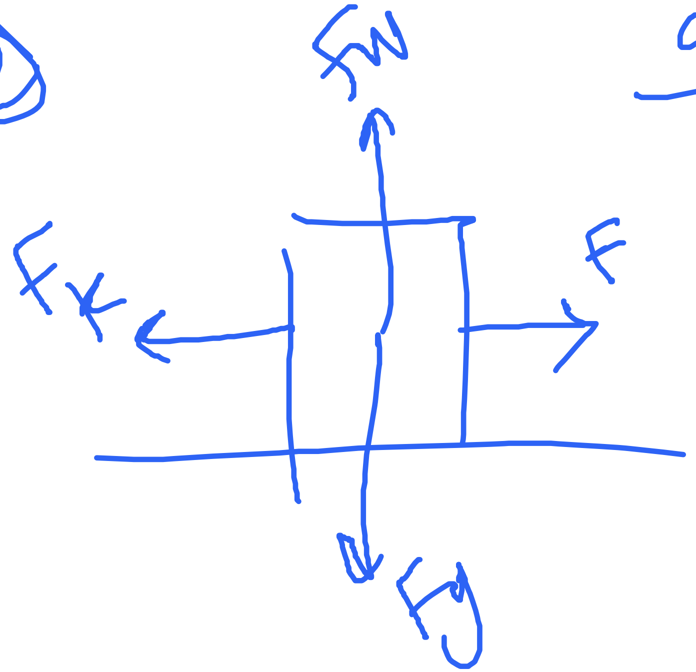
$$F_N = F_g = 500N$$

$$F_{s\,max} = \mu_s \cdot F_N$$

$$230 = \mu_s (500)$$

$$\mu_s = \frac{230}{500} = 0.46$$

(2)



$\xrightarrow{a=0}$ (v = const)

$\sum F_x = 0$

$F - F_k = 0$

$F = F_k$

$F_k = 200\ N$

$\sum F_y = 0$

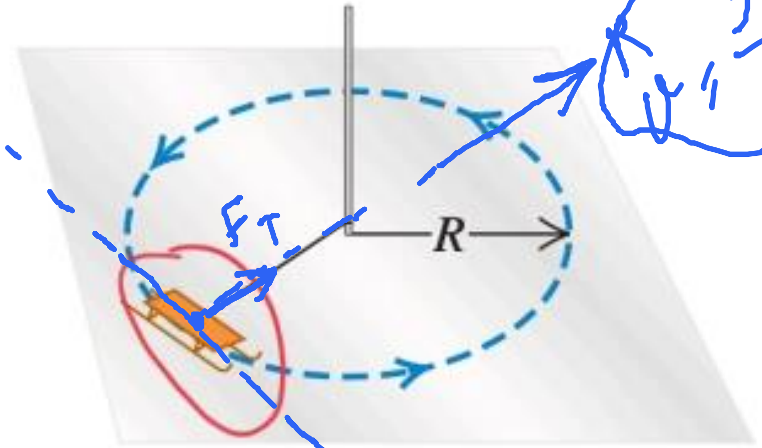
$F_N - F_g = 0$

$F_N = F_g = 500$

$$F_k = \mu_k \cdot F_N$$

$$\mu_k = \frac{F_k}{F_N} = \frac{200}{500} = 0.4$$

Question 16:



A sled with a mass of 25.0 kg rests on a horizontal sheet of essentially **frictionless** ice. It is attached by a 5.00 m rope to a post set in the ice. Once given a push, the sled revolves uniformly in a circle around the post in Figure. If the sled makes **FIVE complete revolutions every minute**, find the force F exerted on it by the rope.

$$v = \frac{5 \times 2\pi R}{60} = \frac{1}{6}\pi R$$

$$\boxed{5 \text{ rev/min}}$$

$$\omega = 5 \text{ rev/min} = \frac{5 \times 2\pi \text{ (rad)}}{1 \times 60 \text{ (s)}} = \frac{1}{6}\pi$$

$$\sum \vec{F} = m\vec{a}$$

$$\sum \vec{F}_R = m\vec{a}_R$$

$$F_T = m a_R$$

$$a_R = \frac{v^2}{R}$$

$$a_R = \frac{\left(\frac{1}{6}\pi R\right)^2}{R} = \frac{\frac{1}{36}\pi^2 R^2}{R}$$

$$\boxed{a_R = \frac{1}{36}\pi^2 R}$$

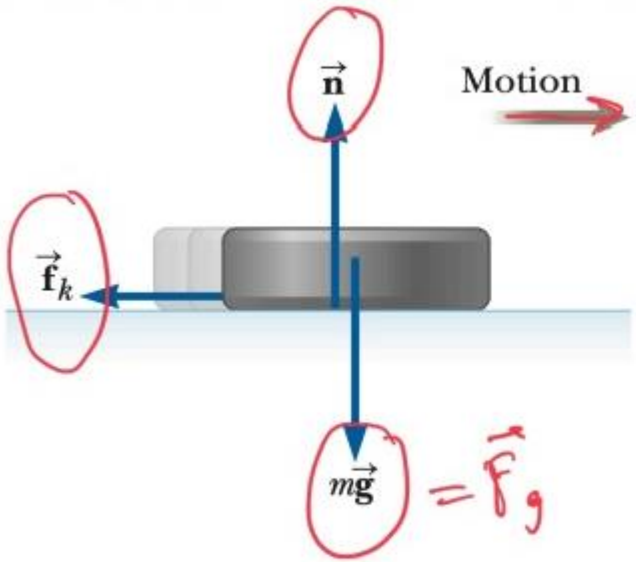
$v = \omega R$

$$\boxed{v = \frac{1}{6}\pi \times R}$$

$F_T = 25 \times \left(\frac{1}{36}\pi^2(5)\right)$

$$\boxed{F_T = \qquad N}$$

Question 17:



A hockey puck on a frozen pond is given an initial speed of 20.0 ms^{-1}. If the puck always remains on the ice and slides 115 m before coming to rest, determine the coefficient of kinetic friction between the puck and ice.

Hint: Take $g = 9.80 ms^{-2}$.

Question 18:

A snowboarder moves down a slope for which $\theta = 22^o$. Suppose the coefficient of kinetic friction between his board and the snow is 0.21, and his velocity, which is along the direction of the slope, is measured as $8.3 ms^{-1}$ at a given instant.

(a) Assuming a constant slope, what will be the speed of the snowboarder along the direction of the slope, 100m farther down the slope?

(b) How long does it take the snowboarder to reach this speed?

Hint: Take $g = 9.81 ms^{-2}$, $sin(22^o) = 0.375$, $cos(22^o) = 0.927$.

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