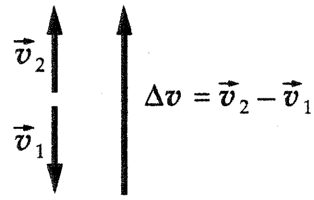
19 ••
Determine the Concept The acceleration vector is in the same direction as the *change in velocity vector,* $\Delta\vec{v}$.

The sketch is shown to the right.



20 •
Determine the Concept We can decide what the pilot should do by considering the speeds of the boat and of the current.

Give up. The speed of the stream is equal to the maximum speed of the boat in still water. The best the boat can do is, while facing directly upstream, maintain its position relative to the bank. $\boxed{(d) \text{ is correct.}}$

***21 •**
Determine the Concept True. In the absence of air resistance, both projectiles experience the same downward acceleration. Because both projectiles have initial vertical velocities of zero, their vertical motions must be identical.

22 •
Determine the Concept In the absence of air resistance, the horizontal component of the projectile's velocity is constant for the duration of its flight.

At the highest point, the speed is the horizontal component of the initial velocity. The vertical component is zero at the highest point. $\boxed{(e) \text{ is correct.}}$

23 •
Determine the Concept In the absence of air resistance, the acceleration of the ball depends only on the *change in its velocity* and is independent of its velocity.

As the ball moves along its trajectory between points A and C, the vertical component of its velocity decreases and the *change* in its velocity is a downward pointing vector. Between points C and E, the vertical component of its velocity increases and the *change* in its velocity is also a downward pointing vector. There is no change in the horizontal component of the velocity. $\boxed{(d) \text{ is correct.}}$

24 •
Determine the Concept In the absence of air resistance, the horizontal component of the velocity remains constant throughout the flight. The vertical component has its maximum values at launch and impact.

(*a*) The speed is greatest at A and E.

Substitute for v_o in the expression for a_o to obtain:

$$a_o = \frac{4\pi^2 r}{T_o^2}$$

Substitute numerical values and evaluate a_o:

$$a_o = \frac{4\pi^2(1.5\times10^{11}\text{ m})}{\left[(365\text{ d})\left(\frac{24\text{ h}}{1\text{ d}}\right)\left(\frac{3600\text{ s}}{1\text{ h}}\right)\right]^2}$$

$$= 5.95\times10^{-3}\text{ m/s}^2 = \boxed{6.07\times10^{-4}\,g}$$

74 ••

Picture the Problem We can relate the acceleration of the moon toward the earth to its orbital speed and distance from the earth. Its orbital speed can be expressed in terms of its distance from the earth and its orbital period. From tables of astronomical data, we find that the sidereal period of the moon is 27.3 d and that its mean distance from the earth is 3.84×10^8 m.

Express the centripetal acceleration of the moon:

$$a_c = \frac{v^2}{r}$$

Express the orbital speed of the moon:

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

Substitute to obtain:

$$a_c = \frac{4\pi^2 r}{T^2}$$

Substitute numerical values and evaluate a_c:

$$a_c = \frac{4\pi^2(3.84\times10^8\text{ m})}{\left(27.3\text{ d}\times\frac{24\text{ h}}{\text{d}}\times\frac{3600\text{ s}}{\text{h}}\right)^2}$$

$$= 2.72\times10^{-3}\text{ m/s}^2$$

$$= \boxed{2.78\times10^{-4}\,g}$$

Remarks: Note that $\frac{a_c}{g} = \frac{\textit{radius of earth}}{\textit{distance from earth to moon}}$ **(a_c is just the acceleration due to the earth's gravity evaluated at the moon's position). This is Newton's famous "falling apple" observation.**

75 •

Picture the Problem We can find the number of revolutions the ball makes in a given period of time from its speed and the radius of the circle along which it moves. Because the ball's centripetal acceleration is related to its speed, we can use this relationship to express its speed.

Use the brick's coordinates when it strikes the ground to obtain:

$$0 = (\tan\theta_0)R - \frac{g}{2v_{0x}^2}R^2$$

where R is the range of the brick.

Solve for v_{0x} to obtain:

$$v_{0x} = \sqrt{\frac{gR}{2\tan\theta_0}}$$

Substitute numerical values and evaluate v_{0x}:

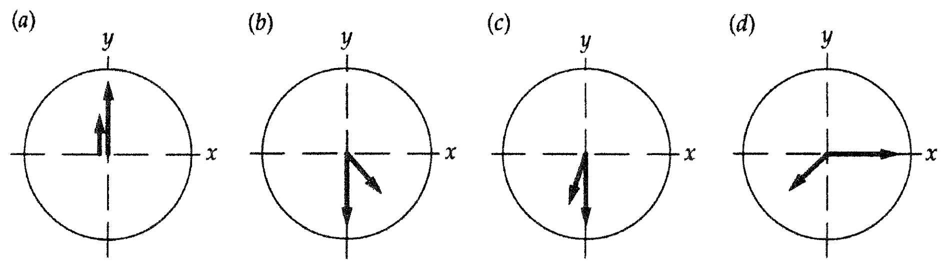
$$v_{0x} = \sqrt{\frac{(9.81\,\text{m/s}^2)(44.5\,\text{m})}{2\tan 45°}} = \boxed{14.8\,\text{m/s}}$$

Note that, at the brick's highest point, $v_y = 0$.

Vectors, Vector Addition, and Coordinate Systems

38 •

Picture the Problem Let the positive y direction be straight up, the positive x direction be to the right, and $\vec{A}$ and $\vec{B}$ be the position vectors for the minute and hour hands. The pictorial representation below shows the orientation of the hands of the clock for parts (*a*) through (*d*).



(*a*) The position vector for the minute hand at12:00 is:

$$\vec{A}_{12:00} = \boxed{(0.5\,\text{m})\hat{j}}$$

The position vector for the hour hand at 12:00 is:

$$\vec{B}_{12:00} = \boxed{(0.25\,\text{m})\hat{j}}$$

(*b*) At 3:30, the minute hand is positioned along the $-y$ axis, while the hour hand is at an angle of (3.5 h)/12 h × 360° = 105°, measured clockwise from the top.

The position vector for the minute hand is:

$$\vec{A}_{3:30} = \boxed{-(0.5\,\text{m})\hat{j}}$$

Find the x-component of the vector representing the hour hand:

$$B_x = (0.25\,\text{m})\sin 105° = 0.241\,\text{m}$$

Find the y-component of the vector representing the hour hand:

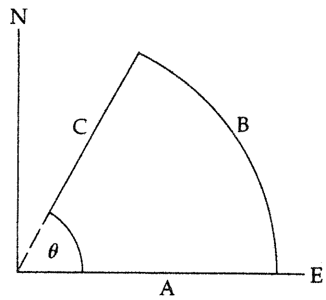
$$B_y = (0.25\,\text{m})\cos 105° = -0.0647\,\text{m}$$

The position vector for the hour hand is:

$$\vec{B}_{3:30} = \boxed{(0.241\,\text{m})\hat{i} - (0.0647\,\text{m})\hat{j}}$$

42 •

Picture the Problem The figure shows the paths walked by the Scout. The length of path A is 2.4 km; the length of path B is 2.4 km; and the length of path C is 1.5 km:



(*a*) Express the distance from the campsite to the end of path C:

$$2.4\text{ km} - 1.5\text{ km} = \boxed{0.9\,\text{km}}$$

(*b*) Determine the angle θ subtended by the arc at the origin (campsite):

$$\theta_{\text{radians}} = \frac{\text{arc length}}{\text{radius}} = \frac{2.4\,\text{km}}{2.4\,\text{km}}$$
$$= 1\,\text{rad} = 57.3°$$

$$\boxed{\begin{array}{l}\text{His direction from camp}\\ \text{is 1 rad north of east.}\end{array}}$$

(*c*) Express the total distance as the sum of the three parts of his walk:

$$d_{\text{tot}} = d_{\text{east}} + d_{\text{arc}} + d_{\text{toward camp}}$$

Substitute the given distances to find the total:

$$d_{\text{tot}} = 2.4\text{ km} + 2.4\text{ km} + 1.5\text{ km}$$
$$= 6.3\text{ km}$$

Express the ratio of the magnitude of his displacement to the total distance he walked and substitute to obtain a numerical value for this ratio:

$$\frac{\text{Magnitude of his displacement}}{\text{Total distance walked}} = \frac{0.9\,\text{km}}{6.3\,\text{km}}$$
$$= \boxed{\frac{1}{7}}$$

43 •

Picture the Problem The direction of a vector is determined by its components.

$$\theta = \tan^{-1}\left(\frac{-3.5\,\text{m/s}}{5.5\,\text{m/s}}\right) = -32.5°$$

The vector is in the fourth quadrant and $\boxed{(b)\text{ is correct.}}$

44 •

Picture the Problem The components of the resultant vector can be obtained from the components of the vectors being added. The magnitude of the resultant vector can then be found by using the Pythagorean Theorem.

A table such as the one shown to the right is useful in organizing the information in this problem. Let $\vec{D}$ be the sum of vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$.

Vector	x-component	y-component
$\vec{A}$	6	−3
$\vec{B}$	−3	4
$\vec{C}$	2	5
$\vec{D}$		

Determine the components of $\vec{D}$ by adding the components of $\vec{A}$, $\vec{B}$, and $\vec{C}$.

$D_x = 5$ and $D_y = 6$

Use the Pythagorean Theorem to calculate the magnitude of $\vec{D}$:

$$D = \sqrt{D_x^2 + D_y^2} = \sqrt{(5)^2 + (6)^2} = 7.81$$

and $\boxed{(d)\text{ is correct.}}$

45 •

Picture the Problem The components of the given vector can be determined using right-triangle trigonometry.

Use the trigonometric relationships between the magnitude of a vector and its components to calculate the x- and y-components of each vector.

	A	θ	A_x	A_y
(*a*)	10 m	30°	8.66 m	5 m
(*b*)	5 m	45°	3.54 m	3.54 m
(*c*)	7 km	60°	3.50 km	6.06 km
(*d*)	5 km	90°	0	5 km
(*e*)	15 km/s	150°	−13.0 km/s	7.50 km/s
(*f*)	10 m/s	240°	−5.00 m/s	−8.66 m/s
(*g*)	8 m/s²	270°	0	−8.00 m/s²

***46** •

Picture the Problem Vectors can be added and subtracted by adding and subtracting their components.

Write $\vec{A}$ in component form:

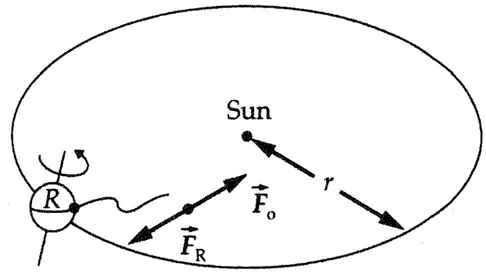
$$A_x = (8\text{ m})\cos 37° = 6.4\text{ m}$$
$$A_y = (8\text{ m})\sin 37° = 4.8\text{ m}$$
$$\therefore \vec{A} = (6.4\text{m})\hat{i} + (4.8\text{m})\hat{j}$$

(*a*), (*b*), (*c*) Add (or subtract) x- and y-components:

$$\vec{D} = \boxed{(0.4\text{m})\hat{i} + (7.8\text{m})\hat{j}}$$
$$\vec{E} = \boxed{(-3.4\text{m})\hat{i} - (9.8\text{m})\hat{j}}$$
$$\vec{F} = \boxed{(-17.6\text{m})\hat{i} + (23.8\text{m})\hat{j}}$$

73 •

Picture the Problem The diagram includes a pictorial representation of the earth in its orbit about the sun and a force diagram showing the force on an object at the equator that is due to the earth's rotation, $\vec{F}_R$, and the force on the object due to the orbital motion of the earth about the sun, $\vec{F}_o$. Because these are centripetal forces, we can calculate the accelerations they require from the speeds and radii associated with the two circular motions.



Express the radial acceleration due to the rotation of the earth:

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

Express the speed of the object on the equator in terms of the radius of the earth R and the period of the earth's rotation T_R:

$$v_R = \frac{2\pi R}{T_R}$$

Substitute for v_R in the expression for a_R to obtain:

$$a_R = \frac{4\pi^2 R}{T_R^2}$$

Substitute numerical values and evaluate a_R:

$$a_R = \frac{4\pi^2\left(6370\times10^3\,\text{m}\right)}{\left[(24\,\text{h})\left(\frac{3600\,\text{s}}{1\,\text{h}}\right)\right]^2} = 3.37\times10^{-2}\,\text{m/s}^2 = \boxed{3.44\times10^{-3}\,g}$$

Note that this effect gives rise to the well-known latitude correction for g.

Express the radial acceleration due to the orbital motion of the earth:

$$a_o = \frac{v_o^2}{r}$$

Express the speed of the object on the equator in terms of the earth-sun distance r and the period of the earth's motion about the sun T_o:

$$v_o = \frac{2\pi r}{T_o}$$

Express the number of revolutions per minute made by the ball in terms of the circumference c of the circle and the distance x the ball travels in time t:

$$n = \frac{x}{c} \qquad (1)$$

Relate the centripetal acceleration of the ball to its speed and the radius of its circular path:

$$a_c = g = \frac{v^2}{R}$$

Solve for the speed of the ball:

$$v = \sqrt{Rg}$$

Express the distance x traveled in time t at speed v:

$$x = vt$$

Substitute to obtain:

$$x = \sqrt{Rg}t$$

The distance traveled per revolution is the circumference c of the circle:

$$c = 2\pi R$$

Substitute in equation (1) to obtain:

$$n = \frac{\sqrt{Rg}t}{2\pi R} = \frac{1}{2\pi}\sqrt{\frac{g}{R}}t$$

Substitute numerical values and evaluate n:

$$n = \frac{1}{2\pi}\sqrt{\frac{9.81\,\text{m/s}^2}{0.8\,\text{m}}}(60\,\text{s}) = \boxed{33.4\,\text{min}^{-1}}$$

Remarks: The ball will oscillate at the end of this string as a simple pendulum with a period equal to 1/*n*.

Projectile Motion and Projectile Range

76 •

Picture the Problem Neglecting air resistance, the accelerations of the ball are constant and the horizontal and vertical motions of the ball are independent of each other. We can use the horizontal motion to determine the time-of-flight and then use this information to determine the distance the ball drops. Choose a coordinate system in which the origin is at the point of release of the ball, downward is the positive y direction, and the horizontal direction is the positive x direction.

Express the vertical displacement of the ball:

$$\Delta y = v_{0y}\Delta t + \tfrac{1}{2}a_y(\Delta t)^2$$

or, because $v_{0y} = 0$ and $a_y = g$,

$$\Delta y = \tfrac{1}{2}g(\Delta t)^2$$

Divide both sides by v_{0x}^2 and solve for v_{0y}/v_{0x} to obtain:

$$1+\frac{1}{2}\frac{v_{0y}^2}{v_{0x}^2}=\frac{9}{16}\left(1+\frac{v_{0y}^2}{v_{0x}^2}\right)$$

and

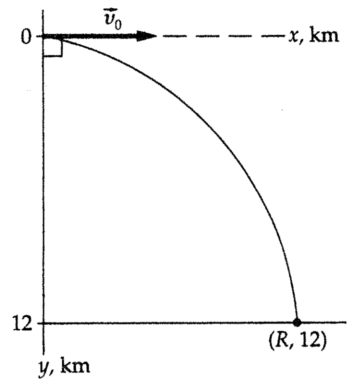
$$\frac{v_{0y}}{v_{0x}}=\sqrt{7}$$

Using $\tan\theta = v_{0y}/v_{0x}$, solve for θ:

$$\theta=\tan^{-1}\left(\frac{v_{0y}}{v_{0x}}\right)=\tan^{-1}\left(\sqrt{7}\right)=\boxed{69.3°}$$

84 •

Picture the Problem The horizontal speed of the crate, in the absence of air resistance, is constant and equal to the speed of the cargo plane. Choose a coordinate system in which the direction the plane is moving is the positive x direction and downward is the positive y direction and apply the constant-acceleration equations to describe the crate's displacements at any time during its flight.



(a) Using a constant-acceleration equation, relate the vertical displacement of the crate Δy to the time of fall Δt:

$$\Delta y = v_{0y}\Delta t+\tfrac{1}{2}g(\Delta t)^2$$

or, because $v_{0y}=0$,

$$\Delta y=\tfrac{1}{2}g(\Delta t)^2$$

Solve for Δt:

$$\Delta t=\sqrt{\frac{2\Delta y}{g}}$$

Substitute numerical values and evaluate Δt:

$$\Delta t=\sqrt{\frac{2(12\times10^3\text{ m})}{9.81\text{m/s}^2}}=\boxed{49.5\text{s}}$$

(b) The horizontal distance traveled in 49.5 s is:

$$R=\Delta x=v_{0x}\Delta t$$
$$=(900\text{km/h})\left(\frac{1\text{h}}{3600\text{s}}\right)(49.5\text{s})$$
$$=\boxed{12.4\text{km}}$$

(c) Because the velocity of the plane is constant, it will be directly over the crate when it hits the ground; i.e., the distance to the aircraft will be the elevation of the aircraft.

$$\Delta y=\boxed{12.0\text{km}}$$

(*a*) Using a constant-acceleration equation, express the vertical displacement of the plug:

$$\Delta y = v_{0y}\Delta t + \tfrac{1}{2}a_y(\Delta t)^2$$

or, because $v_{0y} = 0$ and $a_y = -g$,

$$\Delta y = -\tfrac{1}{2}g(\Delta t)^2$$

Solve for the flight time Δt:

$$\Delta t = \sqrt{-\frac{2\Delta y}{g}}$$

Substitute numerical values and evaluate Δt:

$$\Delta t = \sqrt{-\frac{2(-1.00\,\text{m})}{9.81\,\text{m/s}^2}} = \boxed{0.452\,\text{s}}$$

(*b*) Using a constant-acceleration equation, express the horizontal displacement of the plug:

$$\Delta x = v_{0x}\Delta t + \tfrac{1}{2}a_x(\Delta t)^2$$

or, because $a_x = 0$ and $v_{0x} = v_0$,

$$\Delta x = v_0\Delta t$$

Substitute numerical values and evaluate R:

$$\Delta x = R = (50\,\text{m/s})(0.452\,\text{s}) = \boxed{22.6\,\text{m}}$$

94 ••

Picture the Problem An extreme value (i.e., a maximum or a minimum) of a function is determined by setting the appropriate derivative equal to zero. Whether the extremum is a maximum or a minimum can be determined by evaluating the second derivative at the point determined by the first derivative.

Evaluate $dR/d\theta_0$:

$$\frac{dR}{d\theta_0} = \frac{v_0^2}{g}\frac{d}{d\theta_0}[\sin(2\theta_0)] = \frac{2v_0^2}{g}\cos(2\theta_0)$$

Set $dR/d\theta_0 = 0$ for extrema and solve for θ_0:

$$\frac{2v_0^2}{g}\cos(2\theta_0) = 0$$

and

$$\theta_0 = \tfrac{1}{2}\cos^{-1}(0) = 45°$$

Determine whether 45° is a maximum or a minimum:

$$\left.\frac{d^2R}{d\theta_0^{\,2}}\right|_{\theta_0=45°} = \left[-4\left(v_0^2/g\right)\sin 2\theta_0\right]_{\theta_0=45°} < 0$$

$\therefore$ R is a maximum at $\theta_0 = 45°$

Find the horizontal distance traveled in this time:

$\Delta x = (10 \text{ m/s})(2.22 \text{ s}) = 22.2 \text{ m}$

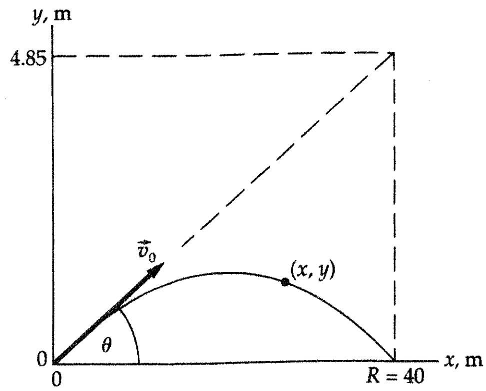
The distance from the wall is:

$\Delta x - 4 \text{ m} = \boxed{18.2\,\text{m}}$

Hitting Targets and Related Problems

105 •

Picture the Problem In the absence of air resistance, the acceleration of the pebble is constant. Choose the coordinate system shown in the diagram and use constant-acceleration equations to express the coordinates of the pebble in terms of the time into its flight. We can eliminate the parameter *t* between these equations and solve for the launch velocity of the pebble. We can determine the launch angle from the sighting information and, once the range is known, the time of flight can be found using the horizontal component of the initial velocity.



Referring to the diagram, express θ in terms of the given distances:

$$\theta = \tan^{-1}\left(\frac{4.85\,\text{m}}{40\,\text{m}}\right) = 6.91°$$

Use a constant-acceleration equation to express the horizontal position of the pebble as a function of time:

$$x = x_0 + v_{0x}t + \tfrac{1}{2}a_x t^2$$

or, because $x_0 = 0$, $v_{0x} = v_0\cos\theta$, and $a_x = 0$,

$$x = (v_0\cos\theta)t \qquad (1)$$

Use a constant-acceleration equation to express the vertical position of the
the
pebble as a function of time:

$$y = y_0 + v_{0y}t + \tfrac{1}{2}a_y t^2$$

or, because $y_0 = 0$, $v_{0y} = v_0\sin\theta$, and $a_y = -g$,

$$y = (v_0\sin\theta)t - \tfrac{1}{2}gt^2$$

Eliminate the parameter *t* to obtain:

$$y = (\tan\theta)x - \frac{g}{2v_0^2\cos^2\theta}x^2$$

At impact, $y = 0$ and $x = R$:

$$0 = (\tan\theta)R - \frac{g}{2v_0^2\cos^2\theta}R^2$$

Solve for v_0 to obtain:

$$v_0 = \sqrt{\frac{Rg}{\sin 2\theta}}$$

Substitute numerical values and evaluate v_0:

$$v_0 = \sqrt{\frac{(40\,\text{m})(9.81\,\text{m/s}^2)}{\sin 13.8°}} = \boxed{40.6\,\text{m/s}}$$

Substitute in equation (1) to relate R to t_{flight}:

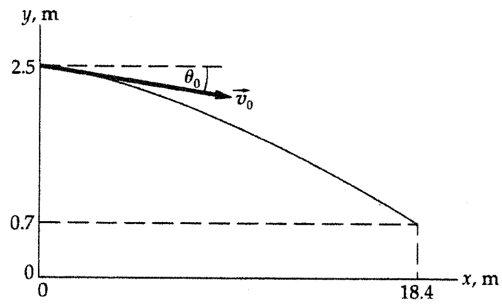
$$R = (v_0 \cos\theta) t_{\text{flight}}$$

Solve for and evaluate the time of flight:

$$t_{\text{flight}} = \frac{40\,\text{m}}{(40.6\,\text{m/s})\cos 6.91°} = \boxed{0.992\,\text{s}}$$

***106 ••**

Picture the Problem The acceleration of the ball is constant (zero horizontally and –g vertically) and the vertical and horizontal components are independent of each other. Choose the coordinate system shown in the figure and assume that v and t are unchanged by throwing the ball slightly downward.



Express the horizontal displacement of the ball as a function of time:

$$\Delta x = v_{0x}\Delta t + \tfrac{1}{2}a_x(\Delta t)^2$$
or, because $a_x = 0$,
$$\Delta x = v_{0x}\Delta t$$

Solve for the time of flight if the ball were thrown horizontally:

$$\Delta t = \frac{\Delta x}{v_{0x}} = \frac{18.4\,\text{m}}{37.5\,\text{m/s}} = 0.491\,\text{s}$$

Using a constant-acceleration equation, express the distance the ball would drop (vertical displacement) if it were thrown horizontally:

$$\Delta y = v_{0y}\Delta t + \tfrac{1}{2}a_y(\Delta t)^2$$
or, because $v_{0y} = 0$ and $a_y = -g$,
$$\Delta y = -\tfrac{1}{2}g(\Delta t)^2$$

Substitute numerical values and evaluate Δy:

$$\Delta y = -\tfrac{1}{2}(9.81\,\text{m/s}^2)(0.491\,\text{s})^2 = -1.18\,\text{m}$$

The ball must drop an additional 0.62 m before it gets to home plate.

$y = (2.5 - 1.18)$ m
= 1.32 m above ground

Calculate the initial downward speed the ball must have to drop 0.62 m in 0.491 s:

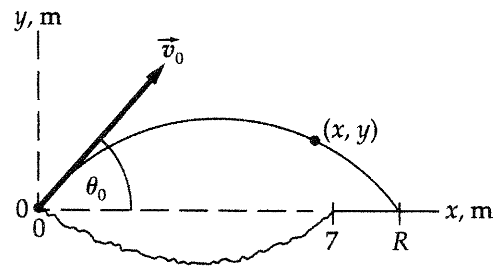
$$v_y = \frac{-0.62\,\text{m}}{0.491\,\text{s}} = -1.26\,\text{m}$$

Find the angle with the horizontal:

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{-1.26\,\text{m/s}}{37.5\,\text{m/s}}\right)$$
$$= \boxed{-1.92°}$$

108 ••

Picture the Problem In the absence of air resistance, the acceleration of Carlos and his bike is constant and we can use constant-acceleration equations to express his x and y coordinates as functions of time. Eliminating the parameter t between these equations will yield y as a function of x … an equation we can use to decide whether he can jump the creek bed as well as to find the minimum speed required to make the jump.



(*a*) Use a constant-acceleration equation to express Carlos' horizontal position as a function of time:

$$x = x_0 + v_{0x}t + \tfrac{1}{2}a_x t^2$$

or, because $x_0 = 0$, $v_{0x} = v_0\cos\theta$, and $a_x = 0$,

$$x = (v_0 \cos\theta)t$$

Use a constant-acceleration equation to express Carlos' vertical position as a function of time:

$$y = y_0 + v_{0y}t + \tfrac{1}{2}a_y t^2$$

or, because $y_0 = 0$, $v_{0y} = v_0\sin\theta$, and $a_y = -g$,

$$y = (v_0 \sin\theta)t - \tfrac{1}{2}gt^2$$

Eliminate the parameter t to obtain:

$$y = (\tan\theta)x - \frac{g}{2v_0^2\cos^2\theta}x^2$$

Substitute $y = 0$ and $x = R$ to obtain:

$$0 = (\tan\theta)R - \frac{g}{2v_0^2\cos^2\theta}R^2$$

Solve for and evaluate R:

$$R = \frac{v_0^2}{g}\sin(2\theta_0) = \frac{(11.1\,\text{m/s})^2}{9.81\,\text{m/s}^2}\sin 20°$$

$$= 4.30\,\text{m}$$

He should apply the brakes!

(*b*) Solve the equation we used in the previous step for $v_{0,\text{min}}$:

$$v_{0,\text{min}} = \sqrt{\frac{Rg}{\sin(2\theta_0)}}$$

Letting $R = 7$ m, evaluate $v_{0,\text{min}}$:

$$v_{0,\text{min}} = \sqrt{\frac{(7\,\text{m})(9.81\,\text{m/s}^2)}{\sin 20°}}$$

$$= 14.2\,\text{m/s} = 51.0\,\text{km/h}$$

Substitute in equations (1) and (2) to obtain:

$$x = (19.0\,\text{m/s})t$$
and
$$y = 14\,\text{m} + (19.0\,\text{m/s})t + \tfrac{1}{2}(-9.81\,\text{m/s}^2)t^2$$

Eliminate t between these equations to obtain:

$$y = 14\,\text{m} + x - \frac{4.905\,\text{m/s}^2}{(19.0\,\text{m/s})^2}x^2$$

At impact, $y = 0$ and $x = R$:

$$0 = 14\,\text{m} + R - \frac{4.905\,\text{m/s}^2}{(19.0\,\text{m/s})^2}R^2$$

Solve for R (you can use the "solver" or "graph" function of your calculator) to obtain:

$$R = \boxed{85.6\,\text{m}}$$

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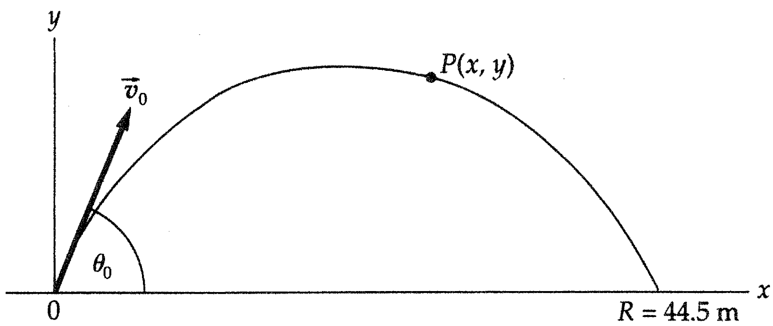
Picture the Problem We'll ignore the height of Geoff's release point above the ground and assume that he launched the brick at an angle of 45°. Because the velocity of the brick at the highest point of its flight is equal to the horizontal component of its initial velocity, we can use constant-acceleration equations to relate this velocity to the brick's x and y coordinates at impact. The diagram shows an appropriate coordinate system and the brick when it is at point P with coordinates (x, y).



Using a constant-acceleration equation, express the x coordinate of the brick as a function of time:

$$x = x_0 + v_{0x}t + \tfrac{1}{2}a_x t^2$$
or, because $x_0 = 0$ and $a_x = 0$,
$$x = v_{0x}t$$

Express the y coordinate of the brick as a function of time:

$$y = y_0 + v_{0y}t + \tfrac{1}{2}a_y t^2$$
or, because $y_0 = 0$ and $a_y = -g$,
$$y = v_{0y}t - \tfrac{1}{2}gt^2$$

Eliminate the parameter t to obtain:

$$y = (\tan\theta_0)x - \frac{g}{2v_{0x}^2}x^2$$