20sep10

- HW ✓ & Q&A
- LAB: free fall determination of g in the CDC atrium

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31. (II) A projectile is shot from the edge of a cliff 125 m above ground level with an initial speed of 65.0 m/s at an angle of 37.0° with the horizontal, as shown in Fig. 3–35. (*a*) Determine the time taken by the projectile to hit point P at ground level. (*b*) Determine the range *X* of the projectile as measured from the base of the cliff. At the instant just before the projectile hits point P, find (*c*) the horizontal and the vertical components of its velocity, (*d*) the magnitude of the velocity, and (*e*) the angle made by the velocity vector with the horizontal. (*f*) Find the maximum height above the cliff top reached by the projectile.

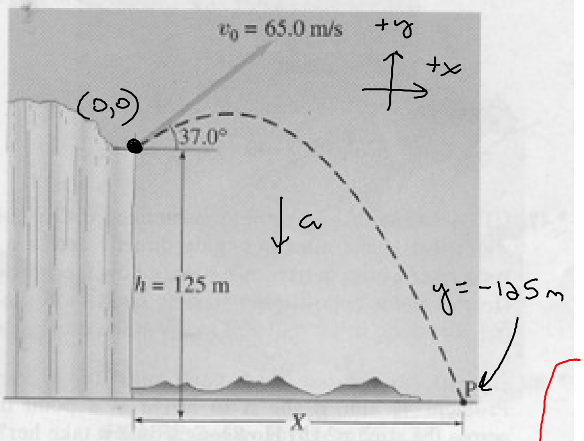

FIGURE 3–35 Problem 31.

$V_x = 65\,\text{m/s} \cos 37° = 51.911\,\text{m/s}$

$V_{oy} = +65\,\text{m/s} \sin 37° = +39.118\,\text{m/s}$

(a) $y = v_{oy}t + \frac{1}{2}at^2$

$-125\,\text{m} = 39.118\,\text{m/s}\,t + \frac{1}{2}(-9.8\,\text{m/s}^2)\,t^2$

$-4.9t^2 + 39.118t + 125 = 0$

$\boxed{t = 10.429\,\text{s}}$

(b) $x = v_x t = (51.911\,\text{m/s})(10.429\,\text{s})$

$= \boxed{541.380\,\text{m}}$

(c) $v_x = \boxed{51.911\,\text{m/s}}$

$y = \dfrac{v_y^2 - v_{oy}^2}{2a} \Rightarrow v_y = \boxed{-63.089\,\text{m/s}}$

(e) 51.911 m/s, −63.089 m/s, θ, v

$\theta = \tan^{-1}\left|\dfrac{63.089}{-51.911}\right|$

$\boxed{= 50.552° \text{ below } +\hat{x}}$

(f) $y_{max} = \dfrac{\cancel{v_y^2}^{\,0} - v_{oy}^2}{2a} = \boxed{78.072\,\text{m above the cliff top}}$

(d) $v = \sqrt{(51.911\,\text{m/s})^2 + (-63.089\,\text{m/s})^2} = \boxed{81.701\,\text{m/s}}$

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35. (III) A rescue plane wants to drop supplies to isolated mountain climbers on a rocky ridge 235 m below. If the plane is traveling horizontally with a speed of 250 km/h (69.4 m/s), (a) how far in advance of the recipients (horizontal distance) must the goods be dropped (Fig. 3–37a)? (b) Suppose, instead, that the plane releases the supplies a horizontal distance of 425 m in advance of the mountain climbers. What vertical velocity (up or down) should the supplies be given so that they arrive precisely at the climbers' position (Fig. 3–37b)? (c) With what speed do the supplies land in the latter case?

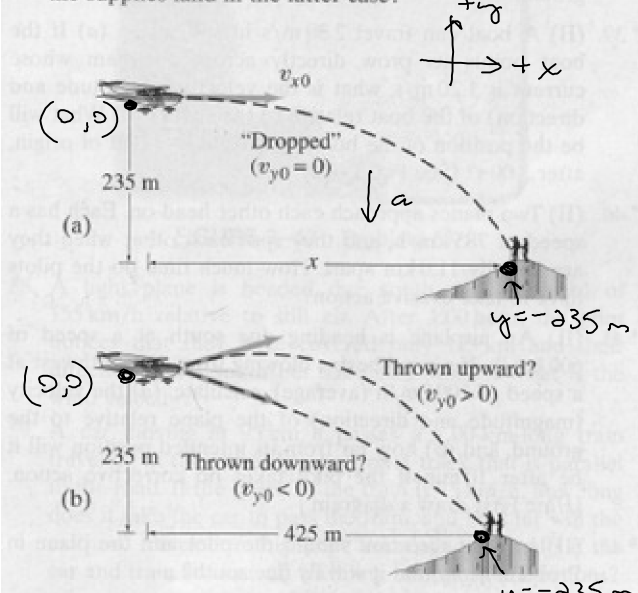
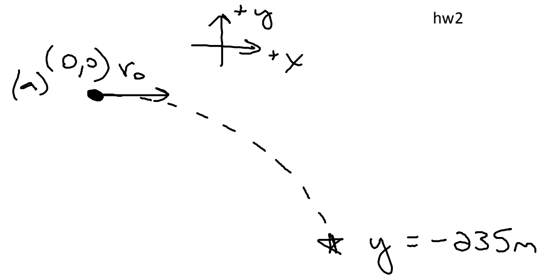


FIGURE 3–37 Problem 35.



$v_0 = 250 \frac{km}{h} = 69.444 m/s$

(a) $y = \cancel{v_{oy}}^{0} t + \frac{1}{2} a t^2$

$t = 6.925 s$

$x = v_x t = (69.444 m/s)(6.925 s)$

$= \boxed{480.9 m}$

(b) $x = 425 m \quad y = -235 m$

$v_x = \frac{x}{t} \Rightarrow t = \frac{x}{v_x} = \frac{425 m}{69.444 m/s}$

$= 6.120 s$

$y = v_{oy} t + \frac{1}{2} a t^2$

$v_{oy} = \frac{y - \frac{1}{2} a t^2}{t}$

$= \frac{(-235 m) - \frac{1}{2}(-9.8 m/s^2)(6.120 s)^2}{6.120 s}$

$= -8.411 m/s$

$\boxed{8.411 m/s \text{ down}}$

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65. Spymaster Paul, flying a constant 215 km/h horizontally in a low-flying helicopter, wants to drop secret documents into his contact's open car which is traveling 155 km/h on a level highway 78.0 m below. At what angle (to the horizontal) should the car be in his sights when the packet is released (Fig. 3–46)?

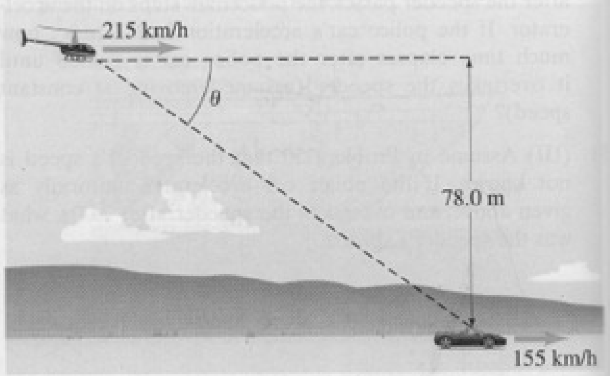
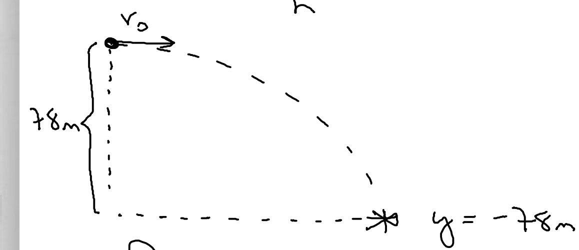


FIGURE 3–46 Problem 65.

$$V_{relative} = V_{helicopter} - V_{car}$$

$$= 215\frac{km}{h} - 155\frac{km}{h}$$

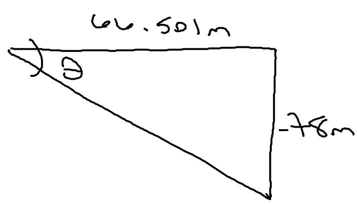
$$= 60\frac{km}{h} = 16.667\,m/s$$



$$y = \cancel{v_{oy}t}^{\,0} + \tfrac{1}{2}at^2$$

$$t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2(-78m)}{-9.8\,m/s^2}} = 3.990s$$

$$x = v_x t = (16.667\,m/s)(3.990s) = 66.501\,m$$



$$\theta = \tan^{-1}\left|\frac{-78}{66.501}\right| = \boxed{49.550°}$$

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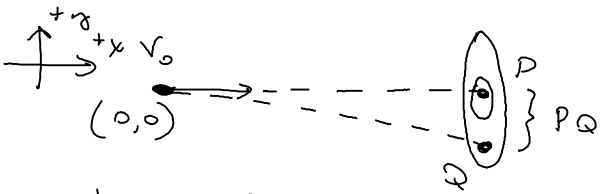
•25 A dart is thrown horizontally with an initial speed of 10 m/s toward point P, the bull's-eye on a dart board. It hits at point Q on the rim, vertically below P, 0.19 s later. (a) What is the distance PQ? (b) How far away from the dart board is the dart released?



(a) $t = 0.19\,s$

$v_x = 10\,m/s \qquad v_{oy} = 0$

$$y = \cancel{v_{oy} t}^{\,0} + \tfrac{1}{2} a t^2 = \tfrac{1}{2}(-9.8\,m/s^2)(0.19\,s)^2 = -0.177\,m$$

$$\boxed{PQ = 0.177\,m}$$

(b) $$v_x = \frac{x}{t} \Rightarrow x = v_x t = (10\,m/s)(0.19\,s) = \boxed{1.9\,m}$$

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•58 What is the magnitude of the acceleration of a sprinter running at 10 m/s when rounding a turn of a radius 25 m?

$r = 25m$

$v = 10 m/s$

$$a_c = \frac{v^2}{r} = \frac{(10 m/s)^2}{25m} = \boxed{4 m/s^2}$$

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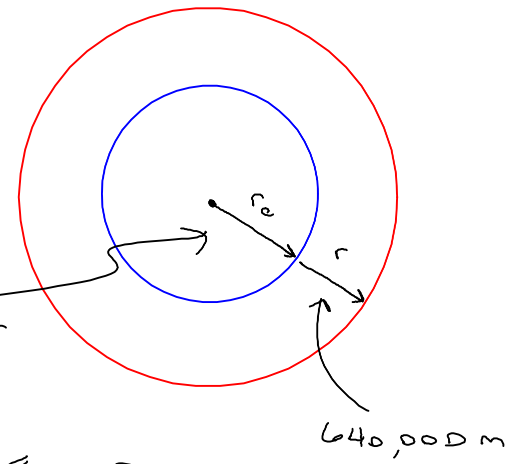
•60 An Earth satellite moves in a circular orbit 640 km above Earth's surface with a period of 98.0 min. What are the (a) speed and (b) magnitude of the centripetal acceleration of the satellite?

$640\,km = 640{,}000\,m$

$98\,min = 5880\,s$



radius of Earth

$6{,}378\,km = 6{,}378{,}000\,m$

effective radius is $r_e + r = 7{,}018{,}000\,m$

(a) $v = \dfrac{2\pi r}{T} = \dfrac{2\pi(7{,}018{,}000\,m)}{5800\,s} = \boxed{7{,}602.654\ m/s}$

(b) $a_c = \dfrac{v^2}{r} = \dfrac{(7{,}602.654\ m/s)^2}{7{,}018{,}000\,m} = \boxed{8.236\ m/s^2}$

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•62 A rotating fan completes 1200 revolutions every minute. Consider the tip of a blade, at a radius of 0.15 m. (a) Through what distance does the tip move in one revolution? What are (b) the tip's speed and (c) the magnitude of its acceleration? (d) What is the period of the motion?

(a) $C = 2\pi r = 2\pi(0.15\,m)$

$= 0.3\pi\ m$

$\approx \boxed{0.942\,m}$

(b) $? \frac{m}{s} = 1200\ \frac{rev}{min} \times \frac{2\pi(0.15\,m)}{1\,rev} \times \frac{1\,min}{60\,s} = \boxed{18.850\ \frac{m}{s}}$

(c) $a_c = \frac{v^2}{r} = \frac{(18.850\,m/s)^2}{0.15\,m} = \boxed{2{,}368.817\ m/s^2}$

(d) $\left(\frac{1200\ rev}{min}\right)^{-1} = 8.333 \times 10^{-4}\ \frac{min}{rev}$ or $\boxed{0.05\ s/rev}$

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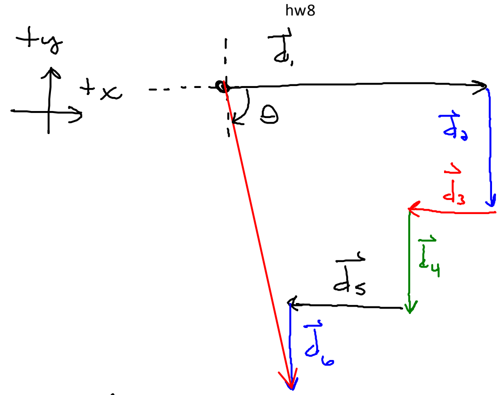
83 You are kidnapped by political-science majors (who are upset because you told them political science is not a real science). Although blindfolded, you can tell the speed of their car (by the whine of the engine), the time of travel (by mentally counting off seconds), and the direction of travel (by turns along the rectangular street system). From these clues, you know that you are taken along the following course: 50 km/h for 2.0 min, turn 90° to the right, 20 km/h for 4.0 min, turn 90° to the right, 20 km/h for 60 s, turn 90° to the left, 50 km/h for 60 s, turn 90° to the right, 20 km/h for 2.0 min, turn 90° to the left, 50 km/h for 30 s. At that point, (a) how far are you from your starting point, and (b) in what direction relative to your initial direction of travel are you?

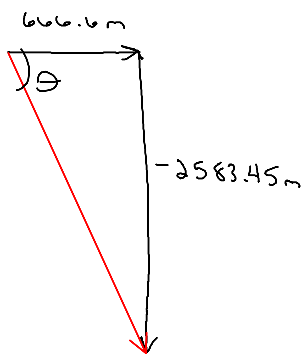
hw8



$\vec{d}_1$	① $50\,\frac{km}{h} = 13.889\,m/s$	$2\,min = 120\,s$	$+1666.680\,m\,\hat{x}$
$\vec{d}_2$	② $20\,\frac{km}{h} = 5.556\,m/s$	$4\,min = 240\,s$	$-1333.440\,m\,\hat{y}$
$\vec{d}_3$	③ $20\,\frac{km}{h} = 5.556\,m/s$	$60\,s$	$-333.360\,m\,\hat{x}$
$\vec{d}_4$	④ $50\,\frac{km}{h} = 13.889\,m/s$	$60\,s$	$-833.340\,m\,\hat{y}$
$\vec{d}_5$	⑤ $20\,\frac{km}{h} = 5.556\,\frac{m}{s}$	$2\,min = 120\,s$	$-666.720\,m\,\hat{x}$
$\vec{d}_6$	⑥ $50\,\frac{km}{h} = 13.889\,m/s$	$30\,s$	$-416.670\,m\,\hat{y}$

$$\vec{d}_r = +666.6\,\hat{x} - 2583.45\,\hat{y}$$

$$\|\vec{d}_r\| = \boxed{2668.065\,m}$$



$$\theta = \tan^{-1}\left|\frac{-2583.45\,m}{666.6\,m}\right|$$

$$= 75.532°\text{ below } +\hat{x}$$

or $\boxed{75.532° \text{ to the right of } \vec{d}_1}$
∴ clockwise

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- Study for the test on FRIDAY
- labs & scan due on FRIDAY
- READ the first 3 sections of LHE Chapter 1

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