PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

MOTION IN TWO AND THREE DIMENSIONS

Sample Problems

1. A rabbit runs across a parking lot on which a set of coordinate axes has, strangely enough, been drawn . The coordinates (meters) of the rabbits position as functions of time t (seconds) are given by

$x = 0.31t^2 + 7.2t + 28$

and $y = 0.22t^2 - 9.1t + 30$

(a) At t =15 s , what is the rabbits position vector $\vec{r}$ in univector notation and in magnitude - angle notation ?

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2. A rabbit runs across a parking lot on which a set of coordinate axes has, strangely enough, been drawn . The coordinates (meters) of the rabbits position as functions of time t (seconds) are given by

$x = -0.31t^2 + 7.2t + 28$

and $y = 0.22t^2 - 9.1t + 30$

For the rabbit in the precending sample problem , find the velocity $\vec{v}$ at time t = 15s .

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3. A rabbit runs across a parking lot on which a set of coordinate axes has, strangely enough, been drawn . The coordinates (meters) of the rabbits position as functions of time t (seconds) are given by

$x = -0.31t^2 + 7.2t + 28$

and $y = 0.22t^2 - 9.1t + 30$

For the rabbit in the precending sample problem find the acceleration $\vec{a}$ at time t = 15 s

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4. A proton initially has $\vec{v} = 4.0\hat{i} - 2.0\hat{j} + 3.0\hat{k}$ and then 4.0 s later has $\vec{v} = -2.0\hat{i} - 2.0\hat{j} + 5.0\hat{k}$ (in meter per second) for that 4.0s what are (a) the proton's average acceleration $\vec{a}_{avg}$ in unit vector notation (b) the magnitude of $\vec{a}_{avg}$ and (c) the angle between $\vec{a}_{avg}$ and the positive direction of the x axis ?

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5. In fig. a rescue plane flies at 198 km/h (= 55.0 m/s) and constant height h = 500 m toward a point directly over a victim , where a rescue capsule is to land .

(a) what should be the angle ϕ of the pilots line of sight to the victim when the capsule release is made ? (b) as the capsule reaches the water , what is the velocity $\vec{v}$?

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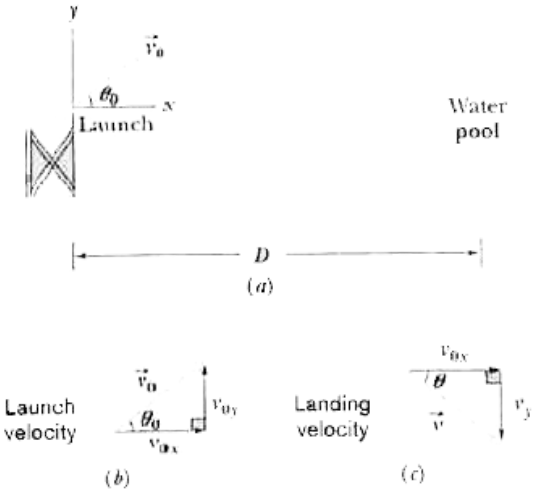
6. One of the most dramatic videos on the web (but entirely fictitious) supposedly shows a man sliding along a long water slide and then being launched into the air to land in a water pool. Let's attach some reasonable numbers to such a flight to calculate the velocity with which the man would have hit the water. Figure a indicates the launch and landing sites and includes a superimposed coordinate system with its origin conveniently located at the launch site. From the video we take the horizontal flight distance as D = 20.0 m, the flight time as t = 2.50 s, and the launch angle as $\theta_0 = 40.0^\circ$. Find the magnitude of the velocity at

launch and at landing.



(a) Launch from a water slide, to land in a water pool. The velocity at (b) launch and (c) landing.

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7. A ball is shot from the ground into the air. At the height of 9.1 m, its velocity is $v = (7.6m/s)\hat{i} + (6.1m/s)\hat{j}$, with $\hat{i}$ horizontal and j upward. (a) To what maximum height does the ball rise? (b) What total horizontal distance does the ball travel? What are the (c) magnitude and (d) angle (below the horizontal) of the ball's velocity just before it hits the ground?

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8. In Fig. , a ball is launched with a velocity of magnitude 10.0 m/s, at an angle of 50.0° to the horizontal. The launch point is at the base of a ramp of horizontal length d_1 = 6.00 m and height d_2 = 3.60 m. A plateau is located at the top of the ramp. (a) Does the ball land on the ramp or the plateau? When it lands, what are the (b) magnitude and (c) angle of its displacement from the launch point?

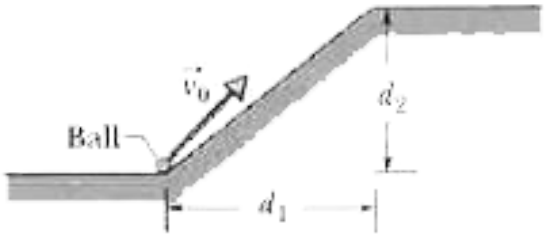

Figure 4-28 A ball launched at the base of a ramp landing on the plateau located at the top of the ramp.

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9. A football kicker can give the ball an initial speed of 25 m/s. What are the (a) least and (b) greatest elevation angles at which he can kick the

ball to score a field goal from a point 50 m in front of goalposts whose horizontal bar is 3.44 m above the ground?

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10. From the platform edge located 10.0 m above the surface of the water, a high diver pushes off horizontally with a speed of 2.00 m/s. (a) At what horizontal distance from the edge is the diver 0.800 s after pushing off? (b) At what vertical distance above the surface of the water is the diver just then? (c) At what horizontal distance from the edge does the diver strike the water?

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11. Suppose that barbara's velocity relative to alex is a constant $v_{BA} = 52km/h$ and car P is moving in the negative direction of the x axis

(a) If alex measures a constant $v_{PA} = -78km/h$ for car P , what velocity v_{PB} will barbara measure ?

(b) If car P brakes to a stop relative to alex (and thus relative to the ground) in time t = 10 s at constant acceleration , what is its acceleration a_{PA} relative to alex ?

(c) What is the acceleration a_{PB} of car P relative to barbara during the braking ?

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12. A plane moves due east while the pilot points the plane somewhat south of east, toward a steady wind that blows to the northeast. The plane has velocity $\vec{v}_{PW}$ relative to the wind, with an airspeed (speed relative to the wind) of 215 km/h, directed at angle θ south of east. The wind has velocity $\vec{v}_{WG}$ is relative to the ground with speed 65.0 km/h, directed 20.0° cast of north. What is the magnitude of the velocity $\vec{}(PG)$ of the plane relative to the ground, and what is θ ?

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13. A 200m - wide river flows due east at a uniform speed of 2.0 m//s . A boat with a speed of 8.0 m/s relative to the water leaves the south bank pointed in a direction 30° west of north . What are the (a) magnitude and (b) direction of the boat's velocity relative to the ground ? (c) how long does the boat take to cross the river ?

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14. A train travels due south at 30 m/s (relative to the ground) in a rain that is blown toward the south by the wind. The path of each raindrop makes an angle of 70 with the vertical, as measured by an observer stationary on the ground. An observer on the train, however, sees the drops fall perfectly vertically. Determine the speed of the raindrops relative to the ground.

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15. A wooden boxcar is moving along a straight railroad track at speed v_1. A bullet (initial speed v_2) is fired at it from a high - powered rifle . The bullet passes through both lengthwise walls of the car , its entrance and exit holes being exactly opposite each other is viewed from within the car . from what direction , relative to the track . is the bullet fired? Assume that the bullet is not deflected upon entering the car, but that its speed decreases by 20%. Take v_1 85 km/h and v_2 650 m/s. (Why is the width of the boxcar not relevant in this calculation?)

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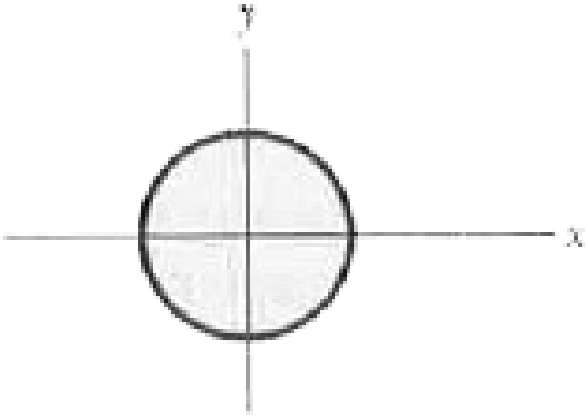
Checkpoint

1. The figure shows a circular path taken by a particle. If the instantaneous velocity of the particle is $\vec{v} = (2m/s)\hat{i} - (2m/s)\hat{j}$, through which quadrant is the particle moving at that instant if it is traveling (a) clockwise and (b) counterclockwise around the circle? For both cases,

draw $\vec{v}$ on the figure.



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2. Here are four descriptions of the position (in meters) of a puck as it moves in an xy plane:

(1) $x = -3t^2 + 4t - 2$ and $y = 6t^2 - 4t$

(2) $x = -3t^3 - 4t$ and $y = -5t^2 + 6$

(3) $\vec{r} = 2t^2\hat{i} - (4t + 3)\hat{j}$

(4) $\vec{r} = (4t^3 - 2t)\hat{i} + \hat{j}$

Are the x and y acceleration components constant? Is acceleration $\vec{a}$ constant?

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3. A fly ball is hit to the outfield. During its flight (ignore the effects of the air), what happens to its (a) horizontal and (b) vertical components of velocity? What are the (c) horizontal and (d) vertical components of its acceleration during ascent, during descent, and at the topmost point of its flight?

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Problems

1. The position vector for an electron is $\vec{r} = (6.0m)\hat{i} - (4.0m)\hat{j} + (3.0m)\hat{k}$. (a) Find the magnitude of $\vec{r}$.

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2. A watermelon seed has the following coordinates: x = -5.0 m, y = 9.0 m, and z = 0 m. Find its position vector (a) in unit-vector notation and as (b) a magnitude and (c) an angle relative to the positive direction of the x axis. (d) Sketch the vector on a right-handed coordinate system. If the seed is moved to the xyz coordinates (3.00 m, 0 m, 0 m), what is its displacement (e) in unit-vector notation and as (f) a magnitude and (g) an angle relative to the positive x direction?

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3. An elementary particle is subjected to a displacement of $\Delta\vec{r} = 2.0\hat{i} - 4.0\hat{j} + 8.0\hat{k}$, ending with the position vector $\vec{r} = 4.0\hat{j} - 5.0\hat{k}$, in meters. What was the particle's initial position vector?

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4. The minute hand of a wall clock measures 12 cm from its tip to the axis about which it rotates. The magnitude and angle of the displacement vector of the tip are to be determined for three time intervals. What are the (a) magnitude and (b) angle from a quarter after the hour to half past, the (c) magnitude and (d) angle for the next half hour, and the (e) magnitude and (f) angle for the hour after that?

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5. A train at a constant 60.0 km/h moves east for 40.0 min, then in a direction 50.0° east of due north for 20.0 min, and then west for 50.0 min. What are the (a) magnitude and (b) angle of its average velocity during this trip?

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6. An electron's position is given by $\vec{r} = 3.00\hat{i} - 4.00t^2\hat{j} + 2.00\hat{k}$, with t in seconds and $\vec{r}$ in meters. (a) In unit-vector notation, what is the

electron's velocity $\vec{r}(t)$? At t = 3.00 s, what is $\vec{v}$ (b) in unitvector notation and as (c) a magnitude and (d) an angle relative to the positive direction of the x axis?

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7. In a particle accelerator, the position vector of a particle is initially estimated as $\vec{r} = 6.0\hat{i} - 7.0\hat{j} + 3.0\hat{k}$ and after 10 s, it is estimated to be $\vec{r} = -3.0\hat{i} + 9.0\hat{j} - 3.0\hat{k}$, all in meters. In unit vector notation, what is the average velocity of the particle?

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8. A plane flies 483 km east from city A to city B in 48.0 min and then 966 km south from city B to city C in 1.50 h. For the total trip, what are the (a) magnitude and (b) direction of the plane's displacement, the (c) magnitude and (d) direction of its average velocity, and (e) its average speed?

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9. Figure 4-26 gives the path of a squirrel moving about on level ground, from point A (at time t = 0), to points B (at t = 5.00 min), C (at t = 10.0 min), and finally D (at t = 15.0 min). Consider the average velocities of the squirrel from point A to each of the other three points. Of them, what are the (a) magnitude and (b) angle of the one with the least magnitude and the (c) magnitude and (d) angle of the one with the greatest magnitude?

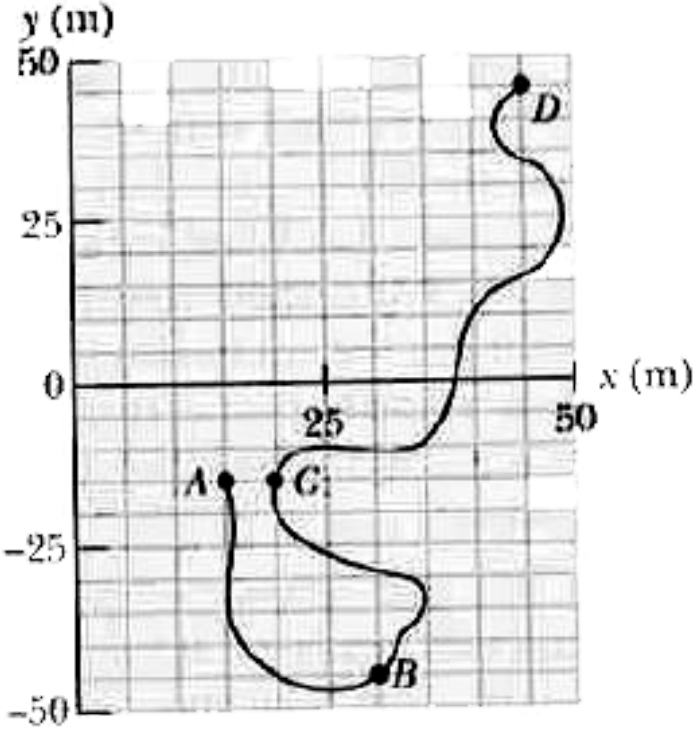

Figure 4-26 Problem 9.

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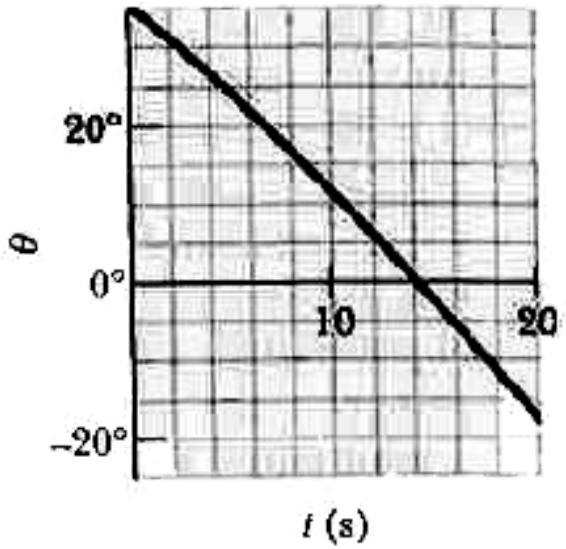
10. The position vector $\vec{r} = 5.00t\hat{i} + \left(et + ft^2\right)\hat{j}$ locates a particle as a function of time t. Vector $\vec{r}$ is in meters, t is in seconds, and factors e and f are constants. Figure 4-27 gives the angle θ of the particle's direction of travel as a function of t (θ is measured from the positive x direction). What are (a) e and (b) f, including units?



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11. A particle that is moving in an xy plane has a position vector given by $\vec{r} = \left(3.00t^3 - 6.00t\right)\hat{i} + \left(7.00 - 8.00t^4\right)\hat{j}$, where $\vec{r}$ is measued in meters and t is measured in seconds. For t = 3.00 s, in unitvector notation, find (a) $\vec{r}$, (b) $\vec{v}$, and (c) $\vec{a}$. (d) Find the angle between the positive direction of the x axis and a line that is tangent to the path of the particle at t = 3.00 s.

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12. At one instant a bicyclist is 30.0 m due east of a park's flagpole, going due south with a speed of 10.0 m/s. Then 30.0 s later, the cyclist is 40.0 m due north of the flagpole, going due east with a speed of 10.0 m/s. For the cyclist in this 30.0 s interval, what are the (a) magnitude and (b) direction of the displacement, the (c) magnitude and (d) direction of the average velocity, and the (e) magnitude and (f) direction of the average acceleration?

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13. An object moves in such a way that its position (in meters) as a function of time (in seconds) is $\vec{r} = \hat{i} + 3t^2\hat{j} + t\hat{k}$. Give expressions for (a) the velocity of the object and (b) the acceleration of the object as functions of time.

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14. From the origin, a particle starts at t = 0 s with a velocity $\vec{v} = 7.0\hat{i}m/s$ and moves in the xy plane with a constant acceleration of $\vec{a} = \left(-9.0\hat{i} + 3.0\hat{j}\right)m/s^2$. At the time the particle reaches the maximum x coordinate, what is its (a) velocity and (b) position vector?

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15. The velocity $\vec{v}$ of a particle moving in the xy plane is given by $\vec{v} = \left(6.0t - 4.0t^2\right)\hat{i} + 8.0\hat{j}$, with $\vec{v}$ in meters per second and $t(>0)$ in seconds. (a) What is the acceleration when t = 2.5 s? (b) When (if ever)

is the acceleration zero ? (c) When (if ever) is the velocity zero? (d) When (if ever) does the speed equal 10 m/s?

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16. A motorbike starts from the origin and moves over an xy plane with acceleration components $a_x = 6.0m/s^2$ and $a_y = -3.0m/s^2$. The initial velocity of the motorbike has components $v_{0x} = 12.0m/s$ and $v_{0y} = 18.0m/s$. Find the velocity of the motorbike, in unt-vector notation, when it reaches its greatest y coordinate.

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17. The acceleration of a particle moving only on a horizontal xy plane is given by $\vec{a} = 3t\hat{i} + 4t\hat{j}$, where $\vec{a}$ is in meters per secondsquared and t is in seconds. At t = 0, the position vector $\vec{r} = (20.0m)\hat{i} + (40.0m)\hat{j}$ locates the particle, which then has velocity vector $\vec{v} = (5.00m/s)\hat{i} + (2.00m/s)\hat{j}$. At t = 4.00 s, what are (a) its position

vector in unit-vector notation and (b) the angle between its direction of travel and the position direction of the x axis?

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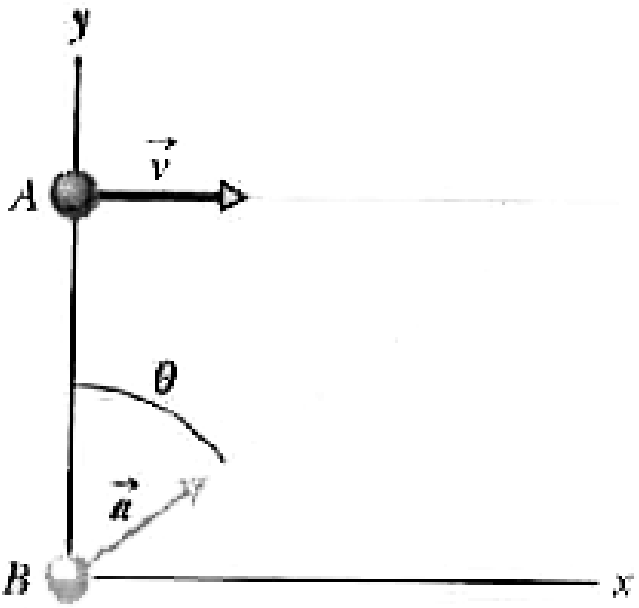
18. In Fig. 4-28, particle A moves along the line y = 30 m with a constant velocity $\vec{v}$ of magnitude 3.0m/s and parallel to the x axis. At the instant particle A passes the y axis, particle B leaves the origin with a zero initial speed and a constant acceleration $\vec{a}$ of magnitude $0.40m/s^2$. What angle θ between $\vec{a}$ and the positive direction of the y axis would result in

a collision?



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19. A small ball rolls horizontally off the edge of a tabletop that is 1.50 m high. It strikes the floor at a point 1.52 m horizontally from the table edge. (a) How long is the ball in the air? (b) What is its speed at the instant it leaves the table?

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20. A shell, which is initially located at a distance of 40.4 m above a horizontal plane, is fired horizontally with a muzzle velocity of 285 m/s to strike a target on the horizontal plane. (a) How long does the projectile remain in the air? (b) At what horizontal distance from the firing point does the shell strike the plane? What are the magnitudes of the (c) horizontal and (d) vertical components of its velocity as it strikes the ground?

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21. A stone is catapulted at time t = 0, with an initial velocity of magnitude 18.0 m/s and at an angle of 40.0° above the horizontal. What are the magnitude of the (a) horizontal and (b) vertical components of its displacement from the catapult site at t = 1.10 s? Repeat for the (c) horizontal and (d) vertical components at t = 1.80 s, and for the (e) horizontal and (f) vertical components at t = 5.00 s.

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22. A certain airplane has a speed of 290.0 km/h and is diving at an angle of $\theta = 30.0^\circ$ below the horizontal when the pilot releases a radar decoy. The horizontal distance between the release point and the point where the decoy strikes the ground is d = 700 m. (a) How long is the decoy in the air? (b) How high was the release point?

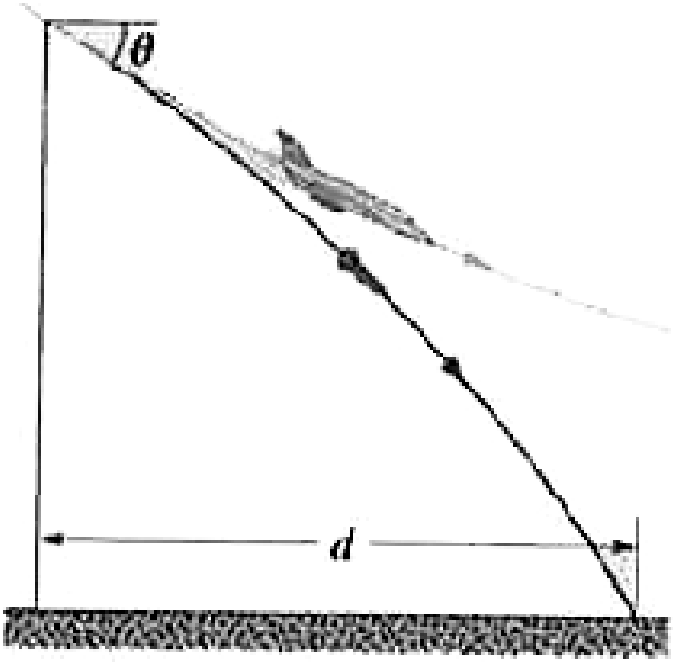

Figure 4-29 Problems 23.

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23. In Fig. 4-30 a stone is projected at a cliff of height h with an initial speed of 42.0 m/s directed at angle $\theta_0 = 60.0^\circ$ above the horizontal. The stone strikes at A, 5.50 s after launching. Find (a) the height h of the cliff, (b) the speed of the stone just before impact at A, and (c) the maximum height H reached above the ground.

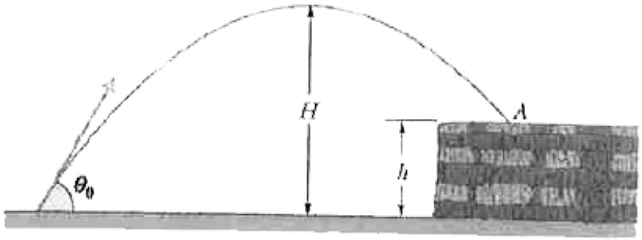

Figure 4-30 Problem 24.

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24. A projectile's launch speed is 6.00 times that of its speed at its maximum height. Find the launch angle θ_0.

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25. A soccer ball is kicked from the ground with an initial speed of 21.3 m/s at an upward angle of 45°. A player 55 m away in the direction of the kick starts running to meet the ball at that instant. What must be his average speed if he is to meet the ball just before it hits the ground?

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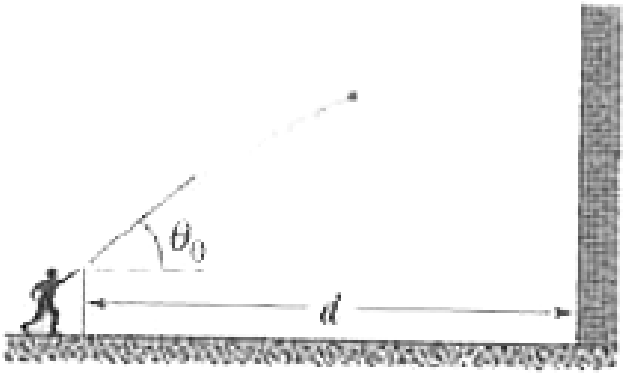
26. You throw a ball toward a wall at speed 25.0 m/s and at angle $\theta_0 = 40.0^\circ$ above the horizontal. The wall is distance d = 22.0 m from the release point of the ball. (a) How far above the release point does the ball hit the wall? What are the (b) horizontal and (c) vertical components of its velocity as it hits the wall? (d) When it hits, has it passed the highest

point on its trajectory?



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27. A defense air force plane, diving with constant speed at an angle of 52.0° with the vertical, drops a shell at an altitude of 720 m. The shell reaches the ground 6.00 s after its release. (a) What is the speed of the plane? (b) How far does the shell travel horizontally during its flight? What are the (c) horizontal and (d) vertical components of its velocity just before reaching the ground? Assume an x axis in the direction of the horizontal motion and an upward y axis.

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28. A rifle that shoots bullets at 460 m/s is to be aimed at a traget 45.7 m away. If the center of the target is level with the rifle, how high above the target must the rifle barrel be pointed so that the bullet hits dead center?

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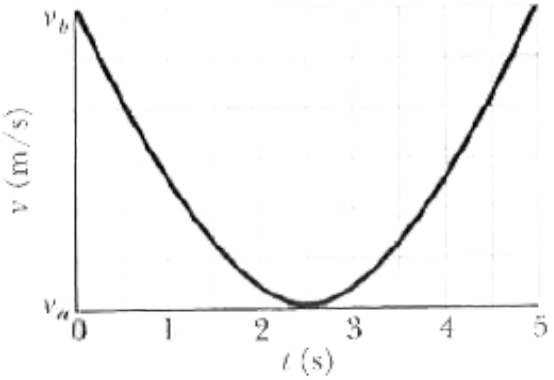
29. A golf ball is struck at ground level. The speed of the golf ball as a function of the time is shown in, where t = 0 at the instant the ball is struck. The scaling on the vertical axis is set by $v_a = 19m/s$ and $v_b = 31m/s$. (a) How far does the golf ball travel horizontally before returning to ground level? (b) What is the maximum

height above ground level attained by the ball?



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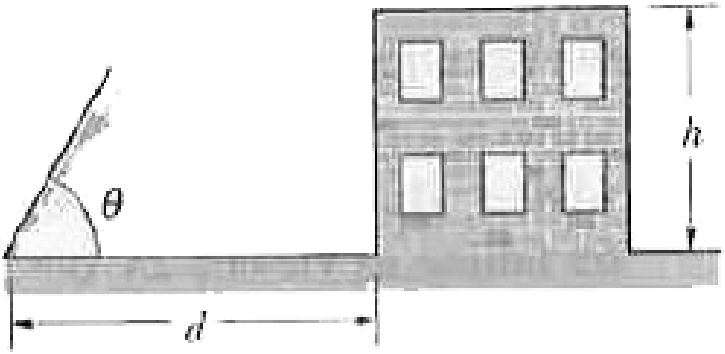
30. In a ball is thrown leftward from the left edge of the roof, at height h above the ground. The ball hits the ground 1.50 s later, at distance d = 25.0 m from the building and at angle $\theta = 60.0^\circ$ with the horizontal. (a) Find h. (Hint: One way is to reverse the motion, as if on video.) What are the (b) magnitude and (c) angle relative to the horizontal of the velocity at which the ball is thrown? (d) Is the angle above or below the

horizontal?



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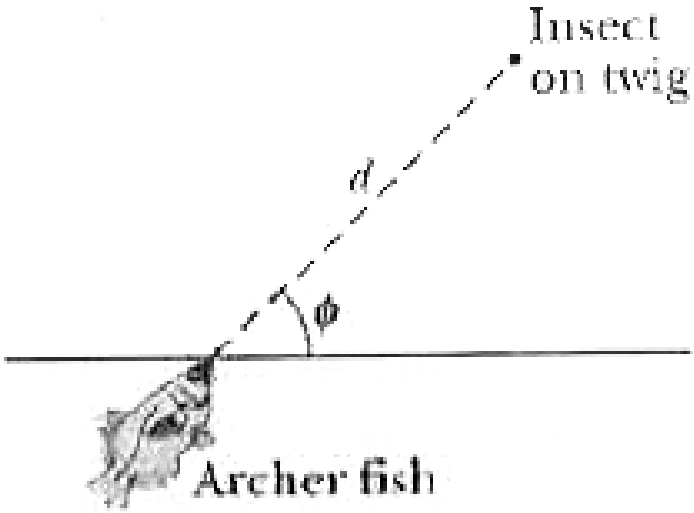
31. Upon spotting an insect on a twig overhanging water, an archer fish squirts water drops at the insect to knock it into the water. Although the insect is located along a straightline path at angle ϕ and distance d, a drop must be launched at a different angle θ_0 if its parabolic path is to intersect the insect. If $\phi = 36.0^\circ$ and d = 0.900 m. what launch angle θ_0 is required for the drop to be at the top of the parabolic path when it

reaches the insect?



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32. A golfer hits a golf ball into the air over level ground. The velocity of the ball at a height of 10.3 m is $\vec{v} = \left(8.6\hat{i} + 7.2\hat{j}\right) m/s$, with $\hat{i}$ horizontal and $\hat{j}$ upward. Find (a) the maximum height of the ball and (b) the total horizontal distance traveled by the ball. What are the (c) magnitude and (d) angle (below the horizonatl) of the balls velocity just before it touches the ground?

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33. A baseball leaves a pitcher's hand horizontally at a speed of 153 km/h. The distance to the batter is 18.3 m. (a) How long does the ball take to travel the first half of that distance? (b) The second half? (c) How far does the ball fall freely during the first half? (d) During the second half? (e) Why aren't the quantities in (c) and (d) equal?

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34. A batter hits a pitched ball when the centre of the ball is 1.22 m above the ground. The ball leaves the bat at an angle of 45° with the ground. With that launch, the ball should have a horizontal range (returning to the launch level) of 107 m. (a) Does the ball clear a 7.32-m-high fence that is 9.75 m horizontally from the launch point? (b) At the fence, what is the distance between the fence top and the ball center?

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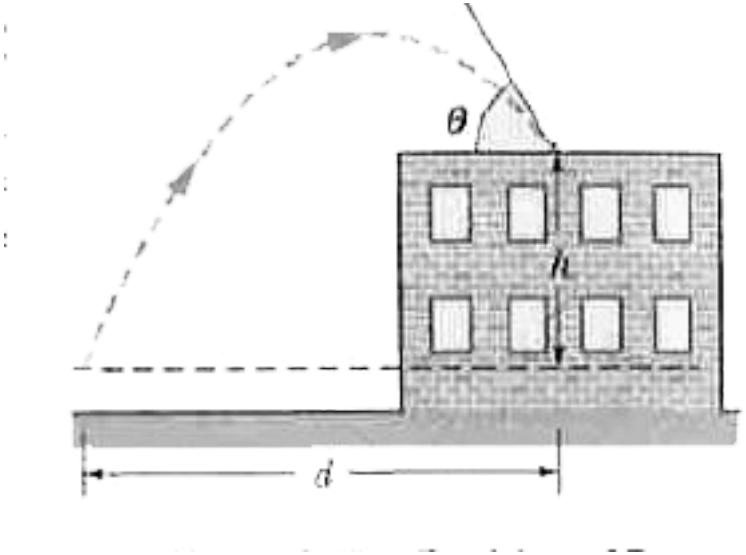
35. A ball is thrown up onto a roof, landing 4.50 s later at height h = 20.0 m above the release level. The ball's path just before landing is angled at $\theta = 60.0^\circ$ with the roof. (a) Find the horizontal distance d it travels. What are the (b) magnitude and (c) angle (relative to the horizontal) of the ball's initial velocity?



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36. Two seconds after being projected from ground level, a projectile is displaced 40 m horizontally and 58 m vertically above its launch point. What are the (a) horizontal and (b) vertical components of the initial

velocity of the projectile? (c) At the instant the projectile achieves its maximum height above ground level, how far is it displaced horizontally from the launch point?

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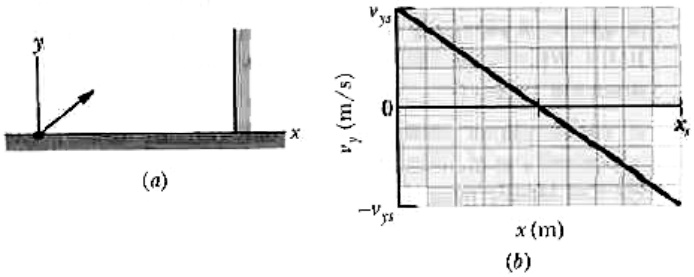
37. A ball is to be shot from level ground toward a wall at distance x. Figure 4-36b shows the y component v_y of the ball's velocity just as it would reach the wall, as a function of that distance x. The scaling is set by $v_{ys} = 5.0m/s$ and $x_s = 20m$. What is the launch angle?



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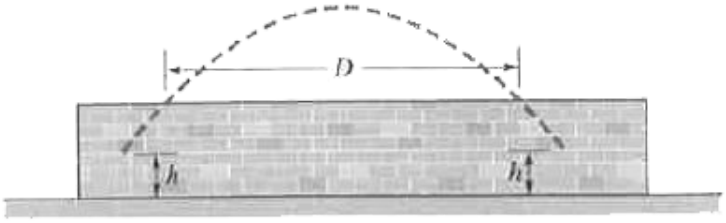
38. A baseball is hit at a height h = 1.00 m and then caught at the same height. It travels alongside a wall, moving up past the top of the wall 1.00 s after it is hit and then down past the top of the wall. 4.00 s later, at distance D = 50.0 m farther along the wall. (a) What horizontal distance is traveled by the ball from hit to catch? What are the (b) magnitude and (c) angle (relative to the horizontal) of the ball's velocity just after being hit? (d) How high is the wall?



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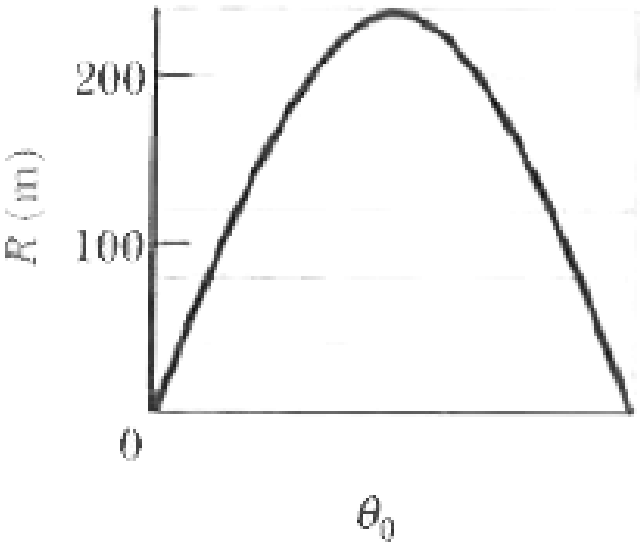
39. A ball is to be shot from level ground with a certain speed. Figure 4-38 shows the range R it will have versus the launch angle θ_0. The value of θ_0 determines the flight time, let $t_{\max}$ represent the maximum flight time. What is the least speed the ball will have during its flight if θ_0 is chosen

such that the flight time is $0.500t_{\max}$?



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40. A cameraman on a pickup truck is traveling westward at 20 km/h while he records a cheetah that is moving westward 30 km/h faster than the truck. Suddenly, the cheetah stops, turns, and then runs at 45 km/h eastward, as measured by a suddenly nervous crew member who stands alongside the cheetah's path. The change in the animal's velocity takes 2.0 s. What are the (a) magnitude and (b) direction of the animal's

acceleration according to the cameraman and the (c) magnitude and (d) direction according to the nervous crew member?

View Text Solution

41. A boat is traveling upstream in the positive direction of an x axis at 14 km/h with respect to the water of a river. The water is flowing at 8.2 km/h with respect to the ground. What are the (a) magnitude and (b) direction of the boat's velocity with respect to the ground? A child on the boat walks from front to rear at 6.0 km/h with respect to the boat. What are the (c) magnitude and (d) direction of the child's velocity with respect to the ground?

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42. A suspicious-looking man runs as fast as he can along a moving sidewalk from one end to the other, taking 2.50 s. Then security agents appear, and the man runs as fast as he can back along the sidewalk to his

starting point, taking 10.0 s. What is the ratio of the man's running speed to the sidewalk's speed?

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43. A rugby player runs with the ball directly toward his opponent's goal, along the positive direction of an x axis. He can legally pass the ball to a teammate as long as the ball's velocity relative to the field does not have a positive x component. Suppose the player runs at speed 3.5 m/s relative to the field while he passes the ball with velocity $\vec{v}_{BP}$ relative to himself. If $\vec{v}_{BP}$ has magnitude 6.0m/s, what is the smallest angle it can have for the pass to be legal?

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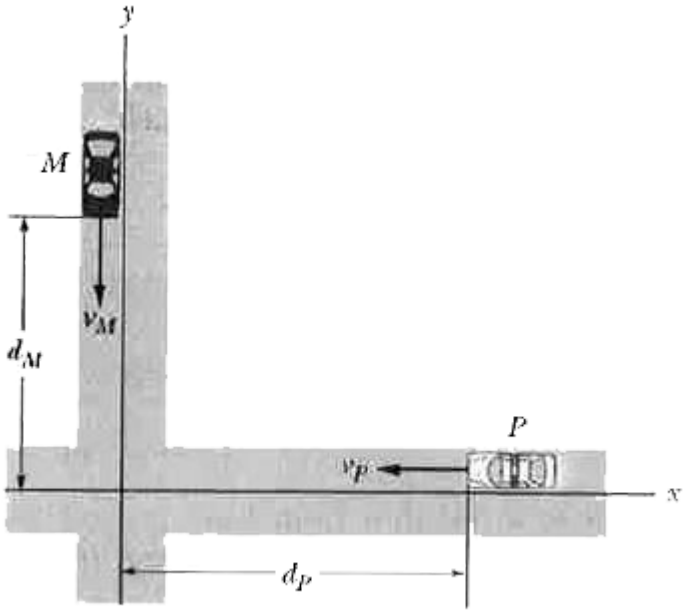
44. Two highways intersect as shown in Fig. 4-39. At the instant shown, a police car P is distance $d_p = 800m$ from the intersection and moving at speed $v_p = 80km/h$. Motorist M is



distance $d_M = 600m$ from the intersection and moving at speed $v_M = 60km/h$. (a) In unit-vector notation, what is the velocity of the motorist with respect to the police car? (b) For the instant shown in Fig. 4-39, what is the angle between the velocity found in (a) and the line of sight between the two cars? (c) If the cars maintain their velocities, do the answers to (a) and (b) change as the cars move nearer the intersection?

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45. After flying for 18 min in a wind blowing 42 km/h at an angle of 20° south of east, an airplane pilot is over a town that is 55 km due north of the starting point. What is the speed of the airplane relative to the air?

Watch Video Solution

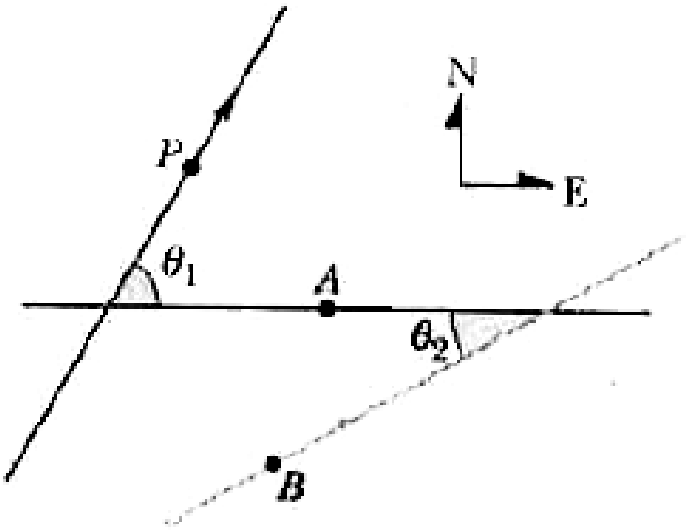
46. A light plane attains an airspeed of 500 km/h. The pilot sets out for a destination 900 km due north but discovers that the plane must be headed 20.0° east of due north to fly there directly. The plane arrives in 2.00 h. What were the (a) magnitude and (b) direction of the wind velocity?

Watch Video Solution

47. Snow is falling vertically at a constant speed of 8.0 m/s. At what angle from the vertical do the snowflakes appear to be falling as viewed by the driver of a car traveling on a straight, level road with a speed of 50 km/h?

Watch Video Solution

48. In the overhead view of Fig. 4-40, Jeeps P and B race along straight lines, across flat terrain, and past stationary border guard A. Relative to the guard, B travels at a constant speed of 25.0 m/s, at the angle $\theta_2 = 30.0^\circ$. Relative to the guard, P has accelerated from rest at a constant rate of $0.400 m/s^2$ at the angle $\theta_1 = 60.0^\circ$. At a certain time during the acceleration, P has a speed of 40.0 m/s. At that time, what are the (a) magnitude and (b) direction of the velocity of P relative to B and the (c) magnitude and (d) direction of the acceleration of P relative to B?



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49. Two ships, A and B, leave port at the same time. Ship A travels northwest at 24 knots, and ship B travels at 28 knots in a direction 40° west of south (1 knot = 1 nautical mile per hour, see Appendix D). What are the (a) magnitude and (b) direction of the velocity of ship A relative to B? (c) After what time will the ships be 160 nautical miles apart? (d) What will be the bearing of B (the direction of B's position) relative to A at that time?

View Text Solution

50. Ship A is located 4.0 km north and 2.5 km east of ship B. Ship A has a velocity of 22 km/h toward the south, and ship B has a velocity of 40 km/h in a direction 37° north of east. (a) What is the velocity of A relative to B in unit-vector notation with toward the east? (b) Write an expression (in terms of $\hat{i}$ and $\hat{j}$) for the position of A relative to B as a function of t, where t = 0 when the ships are in the positions described above. (c) At

what time is the separation between the ships least? (d) What is that least separation?

View Text Solution

Practice Questions Single Correct Choice Type

1. A diver springs upward from a board that is three meters above the water. At the instant she contacts the water her speed is 8.90 m/s and her body makes an angle of 75.0° with respect to the horizontal surface of the water. Determine her initial velocity, both magnitude and direction.

A. $4.52m/s, 59.4^\circ$

B. $2.49m/s, 59.4^\circ$

C. $4.21m/s, 36.7^\circ$

D. $1.99m/s, 36.7^\circ$

Answer: A

View Text Solution

2. An arrow is shot horizontally from a height of 4.9 m above the ground. The initial speed of the arrow is 45 m/s. Neglecting friction, how long will it take the arrow to hit the ground?

A. 9.2 s

B. 1.0 s

C. 6.0 s

D. 1.4 s

Answer: B

Watch Video Solution

3. A basketball player is running at a constant speed of 2.5 m/s when a player tosses a basketball upward with a speed of 6.0 m/s. How far does the player run before he catches the ball? Ignore air resistance.

A. 3.1 m

B. 4.5 m

C. The ball cannot be caught because it will fall behind the player.

D. 6.0 m

Answer: A

Watch Video Solution

4. The altitude of a hang glider is increasing at a rate of 6.80 m/s. At the same time, the shadow of the glider moves along the ground at a speed of 15.5 m/s when the Sun is directly overhead. Find the magnitude of the glider's velocity.

A. 4.72 m/s

B. 14.1 m/s

C. 9.44 m/s

D. 16.9 m/s

Answer: D

Watch Video Solution

5. Rain is falling vertically with a speed of $20ms^{-1}$., A person is running in the rain with a velocity of $5ms^{-1}$ and a wind is also blowing with a speed of $15ms^{-1}$ (both from the west) The angle with the vertical at which the person should hold his umbrella so that he may not get drenched is:

A. $\tan^{-1}\left(\frac{1}{2}\right)$

B. $\tan^{-1}\left(\frac{1}{3}\right)$

C. $\tan^{-1}\left(\frac{1}{4}\right)$

D. $\tan^{-1}(2)$

Answer: A

Watch Video Solution

6. A delivery truck leaves a warehouse and travels 2.60 km north. The truck makes a right turn and travels 1.33 km east before making another right turn and then travels 1.45 km south to arrive at its destination. What is the magnitude and direction of the truck's displacement from the warehouse?

A. 1.76 km, 40.8° north of east

B. 1.15 km, 59.8° north of east

C. 1.33 km, 30.2° north of east

D. 2.40 km, 45.0° north of east

Answer: A

Watch Video Solution

7. In a football game a kicker attempts a field goal. The ball remains in contact with the kicker's foot for 0.050 s, during which time it experiences an acceleration of $340 m / s^2$. The ball is launched at an angle of 51°

above the ground. Determine the horizontal and vertical components of the launch velocity.

A. v_x $13m/s$ v_y $11m/s$

B. v_x $21m/s$ v_y $11m/s$

C. v_x $11m/s$ v_y $13m/s$

D. v_x $17m/s$ v_y $21m/s$

Answer: C

Watch Video Solution

8. At time t = 0 s, a disk is sliding on horizontal table with a velocity 3.00 m/s, 65.0° above the +x axis. As the disk slides, a constant acceleration acts on it that has the following components: $a_x = -0.460m/s^2$ and $a_y = -0.980m/s^2$. What is the velocity of the puck at time t = 1.50 s?

A. 1.83 m/s, 62.0° above the +x axis

B. 2.04 m/s, 71.3° above the +x axis

C. 1.38 m/s, 65.2° above the +x axis

D. 1.06 m/s, 58.7° above the +x axis

Answer: C

Watch Video Solution

9. A volleyball is spiked so that it has an initial velocity of 15 m/s directed downward at an angle of 55° below the horizontal. What is the horizontal component of the ball's velocity when the opposing player fields the ball?

A. 6.8 m/s

B. 8.6 m/s

C. 12 m/s

D. 18 m/s

Answer: B

Watch Video Solution

10. A pitcher can throw a baseball in excess of 41.0 m/s. If a ball is thrown horizontally at this speed, how much will it drop by the time it reaches a catcher who is 17.0 m away from the point of release?

A. 0.422 m

B. 1.19 m

C. 0.844 m

D. 1.68 m

Answer: C

Watch Video Solution

11. A car drives straight off the edge of a cliff that is 54 m high. The police at the scene of the accident observe that the point of impact is 130 m from the base of the cliff. How fast was the car traveling when it went over the cliff?

A. 39 m/s

B. 53 m/s

C. 22 m/s

D. 45 m/s

Answer: A

Watch Video Solution

12. A passenger at rest on a flatbed train car fires a bullet straight up. The event is viewed by observers at rest on the station platform as the train moves past the platform with constant velocity. What is the trajectory of the bullet as described by the observers on the platform?

A. A straight horizontal path in the direction of the train's velocity.

B. A straight vertical path up and down.

C. A circular path centered on the gun.

D. A parabolic path.

Answer: D

Watch Video Solution

13. A particle moving with velocity V changes its direction of motion by an angle θ without change in speed. Which of the following Statement is not correct?

A. The magnitude of the change in its velocity is $2v\sin(\theta/2)$.

B. The change in the magnitude of its velocity is zero.

C. The change in its velocity makes an angle $(\pi/2+\theta/2)$ with its initial direction of motion.

D. The change in velocity is equal to the negative of the resultant of the initial and final velocities.

Answer: D

Watch Video Solution

14. A bicyclist is riding at a constant speed along a straight-line path. The rider throws a ball straight up to a height a few meters above her head. Ignoring air resistance, where will the ball land?

A. Behind the rider

B. In front of the rider

C. In the same hand that threw the ball

D. In the opposite hand to the one that threw it.

Answer: C

Watch Video Solution

15. Two trees have perfectly straight trunks and are both growing perpendicular to the flat horizontal ground beneath them. The sides of the trunks that face each other are separated by 1.3 m. A squirrel makes three jumps in rapid succession. First, he leaps from the foot of one tree to a spot that is 1.0 m above the ground on the other tree.Then he jumps back to first tree, landing on it at a spot that is 1.7m above the ground Finally, he leaps back to the other tree, now landing at a spot that is 2.5 m above the ground. What is the magnitude of the squirrel's displacement?

A. 1.3 m

B. 2.8 m

C. 2.5 m

D. 3.4 m

Answer: B

Watch Video Solution

16. A spot light S rotates in a horizontal plane with a constant angular velocity of $0.1rad/s$. The spot of light P move along the wall at a disatnce $3m$. What is the velocity of the spot P when $\theta = 45^\circ$?

A. 0.3 m/s

B. 0.6 m/s

C. 0.8 m/s

D. 1.2 m/s

Answer: B

Watch Video Solution

17. A particle moves in the plane xy with constant acceleration 'a' directed along the negative y-axis. The equation of motion of the particle has the form $y = px - qx^2$ where p and q are positive constants. Find the velocity of the particle at the origin of co-ordinates.

A. $\sqrt{\left[\frac{a(p^2+1)}{2q}\right]}$

B. $\sqrt{\left[\frac{(p^2+1)}{q}\right]}$

C. $\sqrt{\left[\frac{2a(p^2-1)}{q}\right]}$

D. $\sqrt{\left[\frac{a(1-p^2)}{2q}\right]}$

Answer: A

Watch Video Solution

18. A bird watcher travels through the forest, walking 0.50 km due east, 0.75 km due south, and 2.15 km in a direction 35.0° north of west. The time required for this trip is 2.50 h. Determine the magnitude and direction (relative to due west) of the bird watcher's average velocity. Use kilometers and hours for distance and time, respectively.

A. 0.540 km/h, 21° north of west

B. 1.43 km/h, 17° south of west

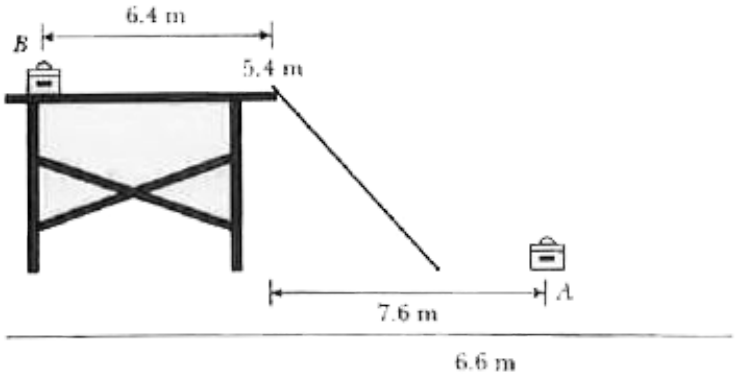
C. 1.22 km/h, 18° north of west

D. 1.08 km/h, 25° north of west

Answer: A

Watch Video Solution

19. A toolbox is carried from the base of a ladder at point A as shown in the figure. The toolbox comes to a rest on a platform 5.0 m above the ground. What is the magnitude of the displacement of the toolbox in its movement from point A to point B?



A. 15 m

B. 19 m

C. 11 m

D. 13 m

Answer: D

Watch Video Solution

20. On a spacecraft, two engines are turned on for 684 s at a moment when the velocity of the craft has x and y components of $v_{ox} = 4370m/s$ and $v_{oy} = 6280m/s$. While the engines are firing, the craft undergoes a displacement that has components of $x = 4.11 \times 10^6 m$ and $y = 6.07 \times 10^6 m$. Find the x and y components of the spacecraft's acceleration.

A. a_x a_y
$9.58m/s^2$ $5.06m/s^2$

B. a_x a_y
$6.39m/s^2$ $10.1m/s^2$

C. a_x a_y
$4.79m/s^2$ $7.59m/s^2$

D. a_x a_y
$5.06m/s^2$ $9.58m/s^2$

Answer: C

Watch Video Solution

21. A man swims across the river which flows with a velocity of 3 km/h due east. If the velocity of man relative to water is 4 km/h due north, then what is his velocity and its direction relative to the shore of the river?

A. 4 km/h, $63^\circ 50'$ west of north

B. 5 km/h, $36^\circ 52'$ west of north

C. 4 km/h, $63^\circ 50'$ east of north

D. 5 km/h, $36^\circ 52'$ east of north

Answer: D

Watch Video Solution

22. A golfer imparts a speed of 30.3 m/s to a ball, and it travels the maximum possible distance before landing on the green. The tee and the green are at the same elevation. How much time does the ball spend in the air?

A. 4.37 s

B. 2.68 s

C. 3.51 s

D. 1.84 s

Answer: A

Watch Video Solution

23. A boat is traveling relative to the water at a speed of 5.0 m/s due south. Relative to the boat, a passenger walks toward the back of the boat at a speed of 1.5 m/s. What is the magnitude and direction of the passenger's velocity relative to the water?

A. 5.2 m/s, south

B. 3.5 m/s, south

C. 3.5 m/s, north

D. 6.5 m/s, south

Answer: B

Watch Video Solution

24. A marble is thrown horizontally with a speed of 15 m/s from the top of a building. When it strikes the ground, the marble has a velocity that makes an angle of 65° with the horizontal. From what height above the ground was the marble thrown?

A. 19 m

B. 38 m

C. 53 m

D. 47 m

Answer: C

Watch Video Solution

25. Baseball player A strikes the ball by hitting it in such a way that it acquires an initial velocity of 1.9 m/s parallel to the ground. Upon contact with the bat the ball is 1.2 m above the ground. Player B wishes to duplicate this strike, in so far as he also wants to give the ball a velocity parallel to the ground and have his ball travel the same horizontal distance as player A's ball does. However, player B hits the ball when it is 1.5 m above the ground. What is the magnitude of the initial velocity that player B's ball must be given?

A. 1.3 m/s

B. 1.9 m/s

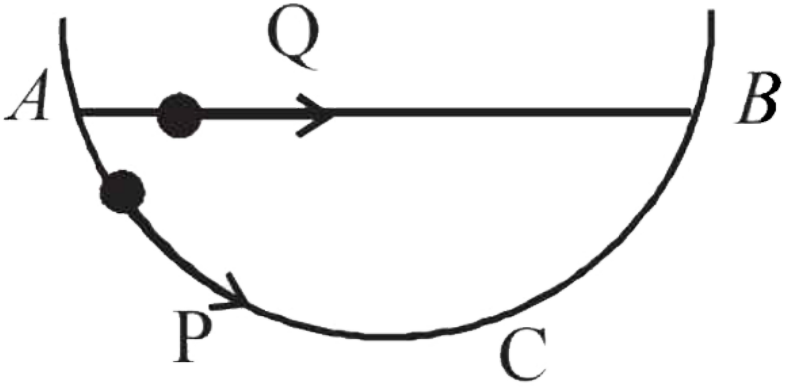
C. 1.7 m/s

D. 2.1 m/s

Answer: C

Watch Video Solution

26. A particle P is sliding down a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time, the horizontal component of its velocity is v. A bead Q of the same mass as P is ejected from A at $t = 0$ along the horizontal string AB, with the speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q be the respective times taken by P and Q to reach the point B. Then:



A. $t_P < t_Q$

B. $t_P = t_Q$

C. $t_P > t_Q$

D. $\frac{t_P}{t_Q} = \frac{\text{length of arc ACB}}{\text{length of chord AB}}$

Answer: A

Watch Video Solution

27. A baseball is hit into the air at an initial speed of 36.6 m/s and an angle of 50.0° above the horizontal. At the same time, the center fielder starts running away from the batter, and he catches the ball 0.914 m above the level at which it was hit. If the center fielder is initially $1.10 \times 10^2 m$ from home plate, what must be his average speed?

A. 3.5 m/s

B. 5.0 m/s

C. 4.2 m/s

D. 6.9 m/s

Answer: C

Watch Video Solution

28. A player in the football team tries to kick a football so that it stays in the air for a long "hang time". If the ball is kicked with an initial velocity of 25.0 m/s at an angle of 60.0° above the ground, what is the "hang time"?

A. 4.42 s

B. 3.36 s

C. 2.21 s

D. 1.68 s

Answer: A

Watch Video Solution

29. A rifle is used to shoot twice at a target, using identical cartridges. The first time, the rifle is aimed parallel to the ground and directly at the center of the bull's-eye. The bullet strikes the target at a distance of H_A below the center, however. The second time, the rifle is similarly aimed, but from twice the distance from the target. This time the bullet strikes the target at a distance of H_B below the center. Find the ratio H_B / H_A.

A. 2

B. 4

C. 3

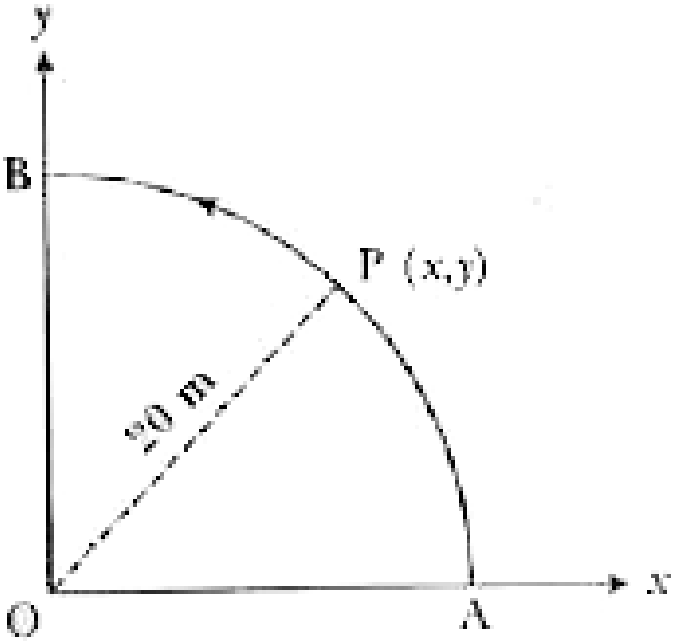
D. 5

Answer: B

Watch Video Solution

30. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that it sweeps out a

length $s = t^3 + 5$, where s is in meters and t is in seconds. The radius of the path is 20 m. The acceleration of P when t = 2 s is nearly



A. $14m/s^2$

B. $13m/s^2$

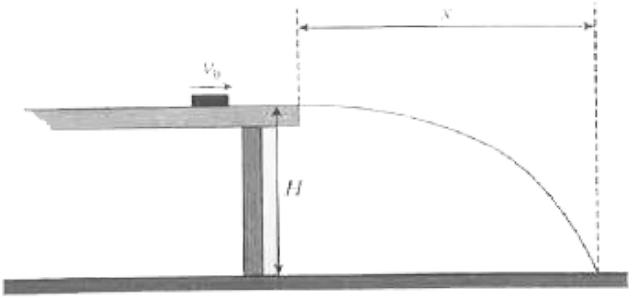
C. $12m/s^2$

D. $7.2m/s^2$

Answer: A

Watch Video Solution

31. A disk slides across a smooth, level tabletop at height H at a constant speed v_0. It slides off the edge of the table and hits the floor a distance x away as shown in the figure.



What is the relationship between the distances x and H?

A. $x = v_0\sqrt{\frac{2H}{g}}$

B. $x = \frac{v_0^2}{gH}$

C. $x = \frac{v_0^2}{2gH}$

D. $H = v_0\sqrt{\frac{2x}{g}}$

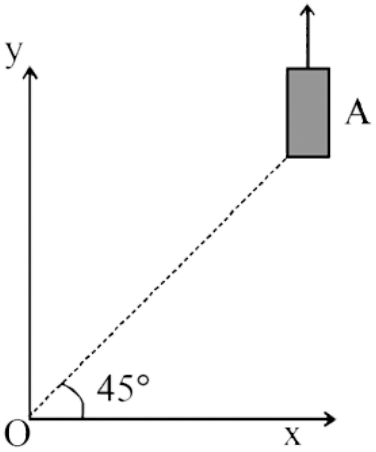
Answer: A

Watch Video Solution

32. On a frictionless horizontal surface , assumed to be the $x-y$ plane , a small trolley A is moving along a straight line parallel to the $y-a\xi s($ see figure) with a constant velocity of $\left(\sqrt{3}-1\right)m/s$. At a particular instant , when the line OA makes an angle of $45(\circ)$ with the $x-a\xi s$, a ball is thrown along the surface from the origin O. Its velocity makes an angle ϕ with the $x-a\xi s$ and $ithitsthetrol \leq y.(a)Themotionoftheballisobservedomthe$ theta$madebythevelocity \longrightarrow roftheballwiththe$ x-axis in this frame .

(b) Find the speed of the ball with respect to the surface , if

$\phi = (4\theta)/(4).$



A. 2 m/s

B. 5 m/s

C. 7 m/s

D. 10 m/s

Answer: A

Watch Video Solution

33. A bullet is fired from a rifle that is held 1.6 m above the ground in a horizontal position. The initial speed of the bullet is 1100 m/s. Find the time it takes for the bullet to strike the ground and the horizontal distance traveled by the bullet.

A. 0.24 s, 693 m

B. 0.57 s, 630 m

C. 0.32 s, 440 m

D. 0.63 s, 352 m

Answer: B

Watch Video Solution

34. An airplane with a speed of 97.5 m/s is climbing upward at an angle of 50.0° with respect to the horizontal. When the plane's altitude is 732 m, the pilot releases a package, (a) Calculate the distance along the ground,

measured from a point directly beneath the point of release, to where the package hits the earth.

A. $+425m$

B. $+1380m$

C. $-678m$

D. $-2880m$

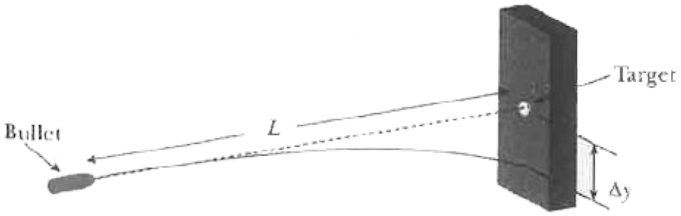
Answer: B

Watch Video Solution

35. A bullet is aimed at a target on the wall a distance L away from the firing position. Because of gravity, the bullet strikes the wall a distance Δy below the mark as suggested in the figure. The drawing is not to scale.

If the distance L was half as large and the bullet had the same initial

velocity, how would Δy be affected?



A. Δy will double.

B. Δy will be half as large.

C. Δy will be four times larger.

D. Δy will be one fourth as large.

Answer: D

Watch Video Solution

36. In the javelin throw at a track-and-field event, the javelin is launched at a speed of 29 m/s at an angle of 36° above the horizontal. As the javelin travels upward, its velocity points above the horizontal at an angle that

decreases as time passes. How much time is required for the angle to be reduced from 36° at launch to 18°?

A. 0.96 s

B. 1.12 s

C. 1.04 s

D. 1.16 s

Answer: A

Watch Video Solution

37. Take the z-axis as vertical and the xy plance as horizontal .A particle A is projected at $4\sqrt{2}$ m/s at an angle of 45° to the horizotal , in the xz plane .Particle B is projected at 5 m/s at an angle $\theta = \tan^{-1}(4/3)$ to the y-axis , in th yz plance . which of the following is not correct for the velocity of B With respect to A?

A. Its initial magnitude is 5 m/s.

B. Its magnitude will change with time.

C. It lies in the xy plane.

D. It will initially make an angle $(\theta + \pi/2)$ with the positive x axis.

Answer: B

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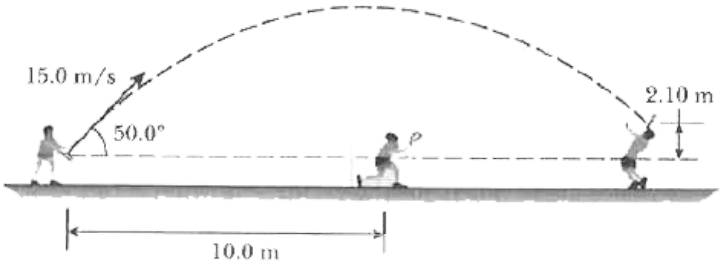
38. An effective tactic in tennis, when your opponent is near the net, consists of lofting the ball over his head, forcing him to move quickly away from the net (see figure). Suppose that you loft the ball with an initial speed of 15.0 m/s, at an angle of 50.0° above the horizontal. At this instant your opponent is 10.0 m away from the ball. He begins moving away from you 0.30 s later, hoping to reach the ball and hit it back at the moment that it is 2.10 m above its launch point. With what minimum average speed must he move? (Ignore the fact that he can stretch, so

that his racket can reach the ball before he does.)



A. 4.98 m/s

B. 5.79 m/s

C. 5.14 m/s

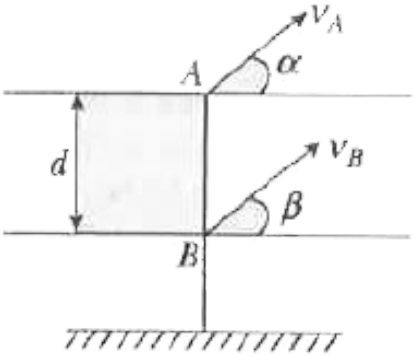
D. 9.64 m/s

Answer: B

Watch Video Solution

39. Two particles A and B are thrown simultaneously from two different floors of tower having distance d between them. Velocities of particle A is v_A at angle α from horizontal while velocities of particle B is v_B at an

angle β from horizontal. If two particles collide in mid-air, then $\frac{v_A}{v_B}$.



A. $\frac{\cos\beta}{\cos\alpha}$

B. $\frac{\sin\alpha}{\sin\beta}$

C. $\frac{\tan\alpha}{\tan\beta}$

D. $\frac{\cot\alpha}{\cot\beta}$

Answer: A

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40. On a spacecraft two engines fire for a time of 565 s. One gives the craft an acceleration in the x direction of $a_x = 5.10m/s^2$, while the other

produces an acceleration in the y direction of $a_y = 7.30 m/s^2$. At the end of the firing period, the craft has velocity components of $v_x = 3775 m/s$ and $v_y = 4816 m/s$. Find the magnitude and direction of the initial velocity. Express the direction as an angle with respect to the +x axis.

A. $1130 m/s, 52.3^\circ$

B. $793 m/s, 37.7^\circ$

C. $1130 m/s, 37.7^\circ$

D. $793 m/s, 52.3^\circ$

Answer: C

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41. Two cars, A and B, are traveling in the same direction. Although car A is 186 m behind car B. The speed of A is 24.4 m/s, and the speed of B is 18.6 m/s. How much time does it take for A to catch B?

A. 32.1 s

B. 11.8 s

C. 23.6 s

D. 8.33 s

Answer: A

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42. Starting from one oasis, a camel walks 25 km in a direction 30° south of west and then walks 30 km towards the north to a second oasis. What distance separates the two cases?

A. 15 km

B. 48 km

C. 28 km

D. 53 km

Answer: C

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43. A speed ramp at an airport is a moving conveyor belt on which you can either stand or walk. It is intended to get you from place to place more quickly. Suppose a speed ramp is 120 m long. When you walk at a comfortable speed on the ground, you cover this distance in 86 s. When you walk on the speed ramp at this same comfortable speed, you cover this distance in 35 s. Determine the speed at which the speed ramp is moving relative to the ground.

A. 3.4 m/s

B. 1.4 m/s

C. 2.0 m/s

D. 2.4 m/s

Answer: C

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44. The captain of a plane wishes to proceed due west. The cruising speed of the plane is 245 m/s relative to the air. A weather report indicates that a 38.0 m/s wind is blowing from the south to the north. In what direction, measured with respect to due west, should the pilot head the plane relative to the air?

A. 81.1° south of west

B. 17.8° south of west

C. 8.92° south of west

D. 8.82° north of west

Answer: C

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45. A jetliner can fly 6.00 hours on a full load of fuel. Without any wind it flies at a speed of $2.40 \times 10^2 m/s$. The plane is to make a round-trip by heading due west for a certain distance, turning around, and then heading due east for the return trip. During the entire flight, however, the plane encounters a 57.8 m/s wind from the jet stream, which blows from west to east. What is the maximum distance that the plane can travel due west and just be able to return home?

A. 1870 km

B. 2160 km

C. 2440 km

D. 1950 km

Answer: C

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46. You are traveling in a car with convertible roof with the top down. The car is moving at a constant velocity of 25 m/s, due east along flat ground. You throw a tomato straight upward at a speed of 11 m/s. How far has the car moved when you get a chance to catch the tomato?

A. 66 m

B. 44 m

C. 56 m

D. 28 m

Answer: C

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47. The highest barrier that a projectile can clear is 13.5 m, when the projectile is launched at an angle of 15.0° above the horizontal. What is the projectile's launch speed?

A. 15.7 m/s

B. 62.8 m/s

C. 44.4 m/s

D. 22.2 m/s

Answer: B

Watch Video Solution

48. Relative to the ground, a car has a velocity of 18.0 m/s, directed due north. Relative to this car, a truck has a velocity of 22.8 m/s, directed 52.1° south of east. Find the magnitude and direction of the truck's velocity relative to the ground.

A. 4.8 m/s, 37.9° north of east

B. 22.8 m/s, 37.9° south of east

C. 14.0 m/s, due east

D. 20.4 m/s, 68.2° north of east

Answer: C

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49. Two boats are heading away from shore. Boat 1 heads due north at a speed of 3.00 m/s relative to the shore. Relative to Boat 1, Boat 2 is moving 30.0° north of east at a speed of 1.60 m/s. A passenger on Boat 2 walks due east across the deck at a speed of 1.20 m/s relative to Boat 2. What is the speed of the passenger relative to the shore?

A. 4.60 m/s

B. 2.71 m/s

C. 2.53 m/s

D. 3.14 m/s

Answer: A

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Practice Questions More Than One Correct Choice Type

1. The coordinates of a particle moving in a plane are given by $x(t) = a\cos(pt)$ and $y(t) = b\sin(pt)$ where $a, b(<a)$ and p are positive constants of appropriate dimensions. Then

A. the path of the particle is an ellipse.

B. the velocity and acceleration of the particle are normal to each other at $t = \pi/(2p)$.

C. the acceleration of the particle is always directed toward a focus.

D. the distance traveled by the particle in time interval t = 0 to $t = \pi/(2p)$ is a.

Answer: A::C

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2. A man can swim with velocity v relative to water. He has to cross a river of width d flowing with a velocity $u(u > v)$. The distance through which he is carried down stream by the river is x. Which of the following statements is correct?

A. If he crosses the river in minimum time, $x = d \times \frac{v}{u}$

B. x cannot be less than $d \times \frac{v}{u}$

C. For x to be minimum, he has to swim in a direction making an angle of $\pi/2 + \sin^{-1}(v/u)$ with the direction of the flow of water.

D. x will be maximum if he swims in a direction making an angle of $\pi/2 - \sin^{-1}(v/u)$ with the direction of the flow of water.

Answer: A::C

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3. Two shells are fired from a canon successively with speed u each at angles of projection α and β, respectively. If the time interval between the firing of shells is dt and they collide in mid-air after a time t from the firing of the first shell. Then

A. $t\cos\alpha = (t - dt)\cos\beta$

B. $\alpha > \beta$

C. $(t - dt)\cos\alpha = dt\cos\beta$

D. $(u\sin\alpha)t - \frac{1}{2}gdt^2 = (u\sin\beta)t - dt - \frac{1}{2}g(t - dt)^2$

Answer: A::B::D

View Text Solution

Practice Questions Linked Comprehension

1. During a one-hour trip, a small boat travels 80.0 km north and then travels 60.0 km east.

What is the boat's displacement for the one-hour trip?

A. 20 km

B. 140 km

C. 100 km

D. 280 km

Answer: C

Watch Video Solution

2. During a one-hour trip, a small boat travels 80.0 km north and then travels 60.0 km east.

What is the direction of the boat's average velocity for the one-hour trip?

A. due east

B. 41.7° north of east

C. 53.1° north of east

D. 49.2° north of east

Answer: C

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3. A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

At what angle is the projectile fired (measured with respect to the horizontal)?

A. 37°

B. 45°

C. 40°

D. 53°

Answer: D

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4. A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

Approximately how long does it take the projectile to reach the highest point in its trajectory?

A. 1 s

B. 4 s

C. 2 s

D. 8 s

Answer: B

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5. A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

What is the speed of the projectile when it is at the highest point in its trajectory?

A. 0 m/s

B. 30 m/s

C. 20 m/s

D. 40 m/s

Answer: B

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6. A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

What is the acceleration of the projectile when it reaches its maximum height?

A. zero m / s^2

B. $9.8 m / s^2$, downward

C. $4.9 m / s^2$, downward

D. less than $9.8 m / s^2$ and non-zero.

Answer: B

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7. A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

What is the magnitude of the projectile's velocity just before it strikes the ground?

A. zero m/s

B. 30 m/s

C. 50 m/s

D. 9.8 m/s

Answer: C

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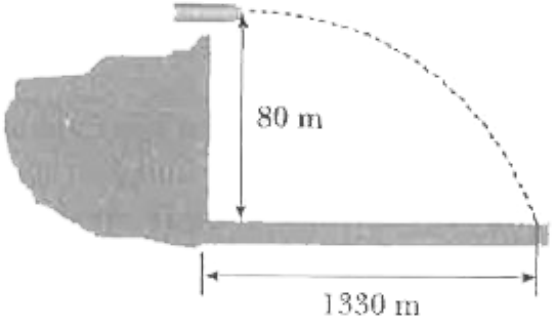
8. A shell is fired with a horizontal velocity in the positive x direction from the top of an 80 m high cliff. The shell strikes the ground 1330 m from the base of the cliff. The drawing is not to scale.



What is the speed of the shell as it hits the ground?

A. 4.0 m/s

B. 330 m/s

C. 9.8 m/s

D. 170 m/s

Answer: B

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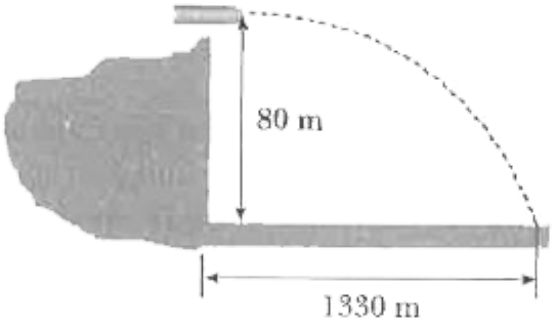
9. A shell is fired with a horizontal velocity in the positive x direction from the top of an 80 m high cliff. The shell strikes the ground 1330 m from the base of the cliff. The drawing is not to scale.



What is the magnitude of the acceleration of the shell just before is strikes the ground?

A. $4.0m/s^2$

B. $82m/s^2$

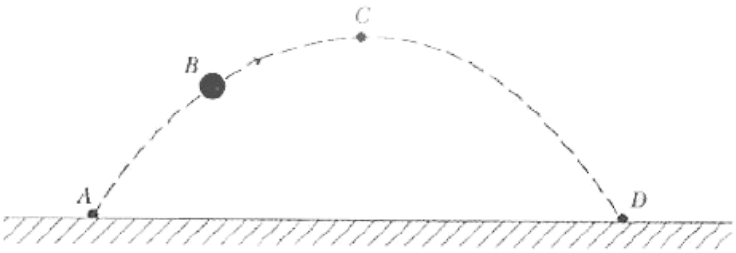
C. $9.8m/s^2$

D. $170m/s^2$

Answer: C

Watch Video Solution

10. A tennis ball is thrown upward at an angle from point A. It follows a parabolic trajectory and hits the ground at point D. At the instant shown, the ball is at point B. Point C represents the highest position of the ball above the ground.



While in flight, how do the x and y components of the velocity vector of the ball compare at the points B and C?

A. The velocity components are non-zero at B and zero at C.

B. The x components are the same, the y component at C is zero m/s.

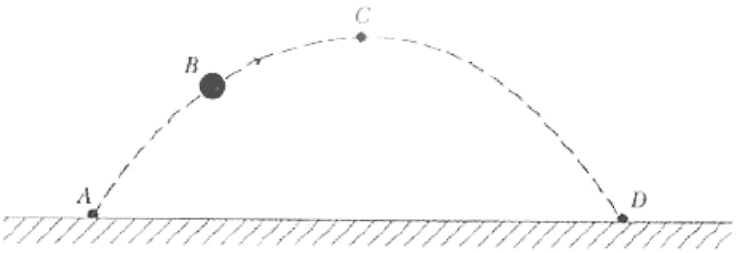
C. The x components are the same, the y component has a larger magnitude at C than at B.

D. The x component is larger at C than at B, the y component at B points up while at C, it points downward.

Answer: B

Watch Video Solution

11. A tennis ball is thrown upward at an angle from point A. It follows a parabolic trajectory and hits the ground at point D. At the instant shown, the ball is at point B. Point C represents the highest position of the ball above the ground.



While in flight, how do the x and y components of the velocity vector of the ball compare at the points A and D?

A. The velocity components are non-zero at A and are zero m/s at D.

B. The velocity components are the same in magnitude and direction at both points.

C. The velocity components have the same magnitudes at both points, but their directions are reversed.

D. The velocity components have the same magnitudes at both points, but the directions of the y components are reversed.

Answer: D

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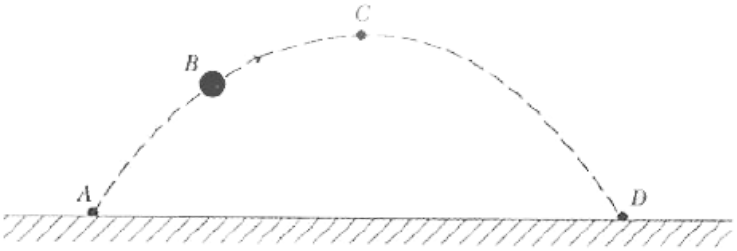
12. A tennis ball is thrown upward at an angle from point A. It follows a parabolic trajectory and hits the ground at point D. At the instant shown, the ball is at point B. Point C represents the highest position of the ball above the ground.



Which statement is true concerning the ball when it is at C, the highest point in its trajectory?

A. The ball's velocity and acceleration are both zero.

B. The ball's velocity is perpendicular to its acceleration.

C. The ball's velocity is not zero, but its acceleration is zero.

D. The ball's velocity is zero, but its acceleration is not zero.

Answer: B

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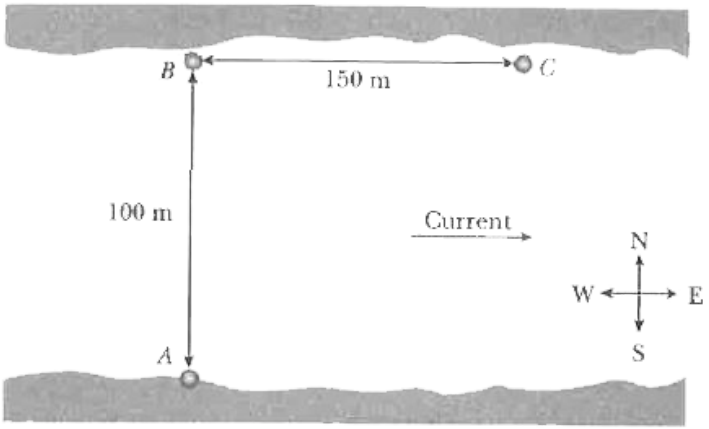
13. A man at point A directs his rowboat due north toward point B, straight across a river of width 100 m. The river current is due east. The man starts across, rowing steadily at 0.75 m/s and reaches the other side of the river at point C, 150 m downstream from his starting point.



What is the speed of the river?

A. 0.38 m/s

B. 1.1 m/s

C. 0.67 m/s

D. 6.7 m/s

Answer: B

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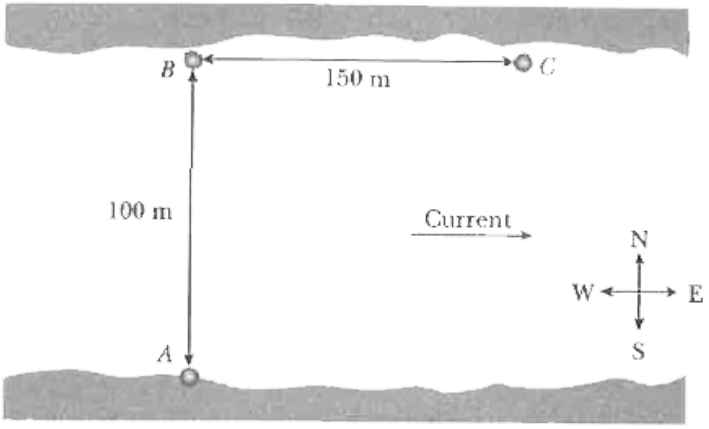
14. A man at point A directs his rowboat due north toward point B, straight across a river of width 100 m. The river current is due east. The

man starts across, rowing steadily at 0.75 m/s and reaches the other side of the river at point C, 150 m downstream from his starting point.



While the man is crossing the river, what is his velocity relative to the shore?

A. 1.35 m/s, 34° north of east

B. 2.11 m/s, 34° north of east

C. 2.00 m/s, 56° north of east

D. 1.74 m/s, 34° north of east

Answer: A

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Practice Questions Matrix Match

1. Trajectory of particle in a projectile motion is given as: $y = x - \left(x^2/80\right)$ (x and y are in meters). Take $g = 10m/s^2$.

Column I	Column II
(a) Angle of projection	(p) 20 m
(b) Angle of velocity with horizontal after 4 s	(q) 80 m
(c) Maximum height	(r) 45°
(d) Horizontal range	(s) $\tan^{-1}(1/2)$

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2. A body is projected with a velocity of 60 m/s at 30° to horizontal (assume positive x-axis and positive y axis as horizontal and vertical

directions, respectively, and take $g = 10m/s^2$).

Column I	Column II
(a) Initial velocity vector (in SI units)	(p) $60\sqrt{3}\hat{i} + 40\hat{j}$
(b) Velocity after 3 s (in SI units)	(q) $-10\hat{j}$
(c) Displacement after 2 s (in SI units)	(r) $30\sqrt{3}\hat{i} + 30\hat{j}$
(d) Centripetal acceleration after 2 s (in SI units)	(s) $30\sqrt{3}\hat{i}$

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3. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

A ball is projected from the ground with velocity v such that its range is maximum. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I		Column II		Column III	
(I)	Velocity	(i)	half of its maximum height	(J)	$v_x\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(II)	Acceleration	(ii)	at maximum height	(K)	$\frac{v_x}{\sqrt{2}}\hat{i}$
(III)	Change in velocity	(iii)	At initial point	(L)	$\frac{v_x}{\sqrt{2}}\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(IV)	Average velocity	(iv)	At final point	(M)	$\frac{v_x}{\sqrt{2}}\hat{i}+v_y\hat{j}$

Which is the correct option to represent a point on trajectory at which the particle has only one component of which quantity?

A. (III) (i) (L)

B. (IV) (iii) (J)

C. (II) (ii) (K)

D. (I) (iv) (M)

Answer: C

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4. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

A ball is projected from the ground with velocity v such that its range is maximum. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I	Column II	Column III
(I) Velocity	(i) half of its maximum height	(J) $v_x\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(II) Acceleration	(ii) at maximum height	(K) $\frac{v_x}{\sqrt{2}}\hat{i}$
(III) Change in velocity	(iii) At initial point	(L) $\frac{v_x}{\sqrt{2}}\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(IV) Average velocity	(iv) At final point	(M) $\frac{v_x}{\sqrt{2}}\hat{i}+v_y\hat{j}$

Which of the following is the correct columns match ?

A. (IV) (iii) (K)

B. (II) (iv) (L)

C. (III) (ii) (M)

D. (I) (i) (J)

Answer: D

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5. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

A ball is projected from the ground with velocity v such that its range is maximum. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I	Column II	Column III
(I) Velocity	(i) half of its maximum height	(J) $v_x\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(II) Acceleration	(ii) at maximum height	(K) $\frac{v_x}{\sqrt{2}}\hat{i}$
(III) Change in velocity	(iii) At initial point	(L) $\frac{v_x}{\sqrt{2}}\hat{i}+\frac{v_y}{\sqrt{2}}\hat{j}$
(IV) Average velocity	(iv) At final point	(M) $\frac{v_x}{\sqrt{2}}\hat{i}+v_y\hat{j}$

In which case are the horizontal and vertical velocity components of the particle are the same?

A. (III) (iii) (L)

B. (I) (ii) (K)

C. (IV) (i) (M)

D. (II) (iii) (J)

Answer: A

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6. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

The particle is projected in projectile motion with velocity u at an angle θ with horizontal is represented by $y = Px - Qx^2$. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I	Column II	Column III
(I) Range	(i) $\frac{P}{Q}$	(J) $\frac{2u}{g}\sin\theta$
(II) Maximum Height	(ii) P	(K) $\tan\theta$
(III) Time of flight	(iii) $\frac{P^2}{4Q}$	(L) $\frac{u^2}{g}\sin 2\theta$
(IV) Tangent of the angle of projection	(iv) $\left(\sqrt{\frac{2}{Qg}}\right)P$	(M) $\frac{u^2}{2g}\sin^2\theta$

For which quantity of projectile motion P and Q are linearly dependent to each other and what is the relation between them?

A. (II) (iv) (K)

B. (IV) (ii) (M)

C. (III) (iii) (J)

D. (I) (i) (L)

Answer: D

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7. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

The particle is projected in projectile motion with velocity u at an angle θ with horizontal is represented by $y = Px - Qx^2$. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I	Column II	Column III
(I) Range	(i) $\frac{P}{Q}$	(J) $\frac{2u}{g}\sin\theta$
(II) Maximum Height	(ii) P	(K) $\tan\theta$
(III) Time of flight	(iii) $\frac{P^2}{4Q}$	(L) $\frac{u^2}{g}\sin 2\theta$
(IV) Tangent of the angle of projection	(iv) $\left(\sqrt{\frac{2}{Qg}}\right)P$	(M) $\frac{u^2}{2g}\sin^2\theta$

Which of the following combination shows the correct relation of quantities when total displacement of the particle is zero?

A. (I) (i) (M)

B. (III) (iv) (J)

C. (I) (iii) (L)

D. (IV) (ii) (K)

Answer: B

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8. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

The particle is projected in projectile motion with velocity u at an angle θ with horizontal is represented by $y = Px - Qx^2$. Answer the questions by appropriately matching the information given in the three columns of the following table.

Column I	Column II	Column III
(I) Range	(i) $\frac{P}{Q}$	(J) $\frac{2u}{g}\sin\theta$
(II) Maximum Height	(ii) P	(K) $\tan\theta$
(III) Time of flight	(iii) $\frac{P^2}{4Q}$	(L) $\frac{u^2}{g}\sin 2\theta$
(IV) Tangent of the angle of projection	(iv) $\left(\sqrt{\frac{2}{Qg}}\right)P$	(M) $\frac{u^2}{2g}\sin^2\theta$

At what point is the velocity of the particle is minimum?

A. (II) (iii) (M)

B. (I) (iv) (L)

C. (IV) (ii) (K)

D. (III) (i) (J)

Answer: A

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9. Two swimmers leave point A on the bank of the river to reach point B lying right across on the other bank. One of them crosses the river along

the straight line AB while the other swims at right angles to the stream and then walks the distance that he has been carried away by the stream to get to point B. What was the velocity u of his walking if both swimmers reached the destination simultaneously? The stream velocity $v_0 = 2.0km/hour$ and the velocity v' of each swimmer with respect to water equals to $2.5km$ per hour.

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10. A cannon fires successively two shells with velocity $v_0 = 250m/s$, the first at the angle $\theta_1 = 60^\circ$ and the second at the angle $\theta_2 = 45^\circ$ to the horizontal, the azimuth being the same. Neglecting the air drag, find the time interval between firings leading to the collision of the shells.

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