PH 201 Homework Assignment Chapter on 2 Dimensional Kinematics – 26 Problems Total

1. 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 frisky 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 the first tree, landing on it at a spot that is 1.7 m 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?

Solution for Problem 1

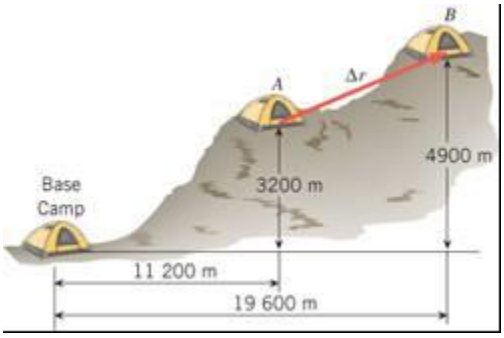
2. A meteoroid is traveling east through the atmosphere at 18.3 km/s while descending at a rate of 11.5 km/s. What is its speed, in km/s?

Solution for Problem 2

3. 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.

Solution for Problem 3

4. A mountain-climbing expedition establishes two intermediate camps, labeled *A* and *B* in the drawing, above the base camp. What is the magnitude Δ*r* of the displacement between camp *A* and camp *B*?



Solution for Problem 4

5. A skateboarder, starting from rest, rolls down a 12.0-m ramp. When she arrives at the bottom of the ramp her speed is 7.70 m/s. **(a)** Determine the magnitude of her acceleration, assumed to be constant. **(b)** If the ramp is inclined at 25.0° with respect to the ground, what is the component of her acceleration that is parallel to the ground?

Solution for Problem 5

6. The earth moves around the sun in a nearly circular orbit of radius 1.50×10^{11} m. During the three summer months (an elapsed time of 7.89×10^6 s), the earth moves one-fourth of the distance around the sun. **(a)** What is the average speed of the earth? **(b)** What is the magnitude of the average velocity of the earth during this period?

Solution for Problem 6

7. A spacecraft is traveling with a velocity of $v_{0x} = 5480$ m/s along the $+x$ direction. Two engines are turned on for a time of 842 s. One engine gives the spacecraft an acceleration in the $+x$ direction of $a_x = 1.20$ m/s^2, while the other gives it an acceleration in the $+y$ direction of $a_y = 8.40$ m/s^2. At the end of the firing, find **(a)** v_x and **(b)** v_y.

Solution for Problem 7

8. As a tennis ball is struck, it departs from the racket horizontally with a speed of 28.0 m/s. The ball hits the court at a horizontal distance of 19.6 m from the racket. How far above the court is the tennis ball when it leaves the racket?

Solution for Problem 8

9. A spider crawling across a table leaps onto a magazine blocking its path. The initial velocity of the spider is 0.870 m/s at an angle of 35.0° above the table, and it lands on the magazine 0.0770 s after leaving the table. Ignore air resistance. How thick is the magazine? Express your answer in millimeters.

Solution for Problem 9

10. A horizontal rifle is fired at a bull's-eye. The muzzle speed of the bullet is 670 m/s. The gun is pointed directly at the center of the bull's-eye, but the bullet strikes the target 0.025 m below the center. What is the horizontal distance between the end of the rifle and the bull's-eye?

Solution for Problem 10

11. A golfer hits a shot to a green that is elevated 3.0 m above the point where the ball is struck. The ball leaves the club at a speed of 14.0 m/s at an angle of 40.0° above the horizontal. It rises to its maximum height and then falls down to the green. Ignoring air resistance, find the speed of the ball just before it lands.

Solution for Problem 11

12. A space vehicle is coasting at a constant velocity of 21.0 m/s in the +*y* direction relative to a space station. The pilot of the vehicle fires a RCS (reaction control system) thruster, which causes it to accelerate at 0.320 m/s^2 in the +*x* direction. After 45.0 s, the pilot shuts off the RCS thruster. After the RCS thruster is turned off, find **(a)** the magnitude and **(b)** the direction of the vehicle's velocity relative to the space station. Express the direction as an angle measured from the +*y* direction.

Solution for Problem 12

13. A criminal is escaping across a rooftop and runs off the roof horizontally at a speed of 5.3 m/s, hoping to land on the roof of an adjacent building. Air resistance is negligible. The horizontal distance between the two buildings is *D*, and the roof of the adjacent building is 2.0 m below the jumping-off point. Find the maximum value for *D*.

Solution for Problem 13

14. A fire hose ejects a stream of water at an angle of 35.0° above the horizontal. The water leaves the nozzle with a speed of 25.0 m/s. Assuming that the water behaves like a projectile, how far from a building should the fire hose be located to hit the highest possible fire?

Solution for Problem 14

15. A major-league 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?

Solution for Problem 15

16. A quarterback claims that he can throw the football a horizontal distance of 183 m (200 yd). Furthermore, he claims that he can do this by launching the ball at the relatively low angle of 30.0° above the horizontal. To evaluate this claim, determine the speed with which this quarterback must throw the ball. Assume that the ball is launched and caught at the same vertical level and that air resistance can be ignored. For comparison, a baseball pitcher who can accurately throw a fastball at 45 m/s (100 mph) would be considered exceptional.

Solution for Problem 16

17. Suppose the water at the top of Niagara Falls has a horizontal speed of 2.7 m/s just before it cascades over the edge of the falls. At what vertical distance below the edge does the velocity vector of the water point downward at a 75° angle below the horizontal?

Solution for Problem 17

18. A rocket is fired at a speed of 75.0 m/s from ground level, at an angle of 60.0° above the horizontal. The rocket is fired toward an 11.0-m-high wall, which is located 27.0 m away. The rocket attains its launch speed in a negligibly short period of time, after which its engines shut down and the rocket coasts. By how much does the rocket clear the top of the wall?

Solution for Problem 18

19. 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. **(b)** Relative to the ground, determine the angle of the velocity vector of the package just before impact.

Solution for Problem 19

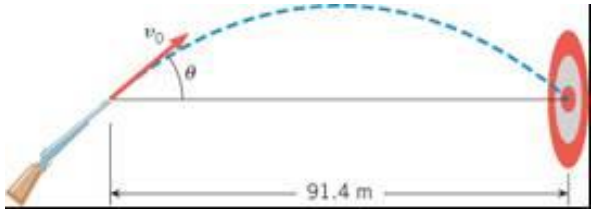
20. A marble is thrown horizontally with a speed of 15 m/s from the top of a building. When it strikes the ground, the marble has a velocity that makes an angle of 65° with the horizontal. From what height above the ground was the marble thrown?

Solution for Problem 20

21. A child operating a radio-controlled model car on a dock accidentally steers it off the edge. The car's displacement 1.1 s after leaving the dock has a magnitude of 7.0 m. What is the car's speed at the instant it drives off the edge of the dock?

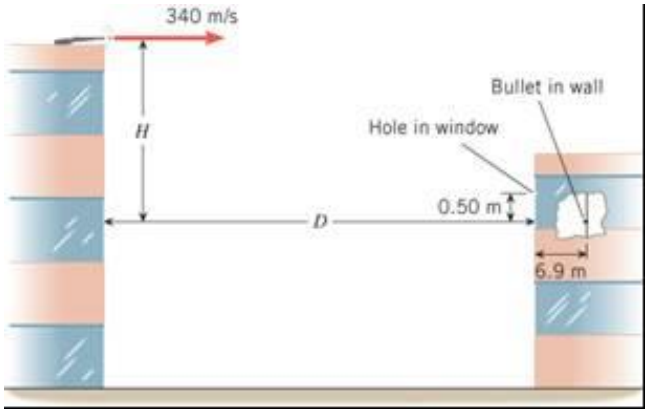
Solution for Problem 21

22. The drawing shows an exaggerated view of a rifle that has been "sighted in" for a 91.4-meter target. If the muzzle speed of the bullet is v_0 = 427 m/s, what are the two possible angles θ_1 and θ_2 between the rifle barrel and the horizontal such that the bullet will hit the target? One of these angles is so large that it is never used in target shooting. (*Hint: The following trigonometric identity may be useful:* 2sin(θ)cos(θ) = sin(2θ).)



Solution for Problem 22

23. From the top of a tall building, a gun is fired. The bullet leaves the gun at a speed of 340 m/s, parallel to the ground. As the drawing shows, the bullet puts a hole in a window of another building and hits the wall that faces the window. Using the data in the drawing, determine the distances *D* and *H*, which locate the point where the gun was fired. Assume that the bullet does not slow down as it passes through the window.

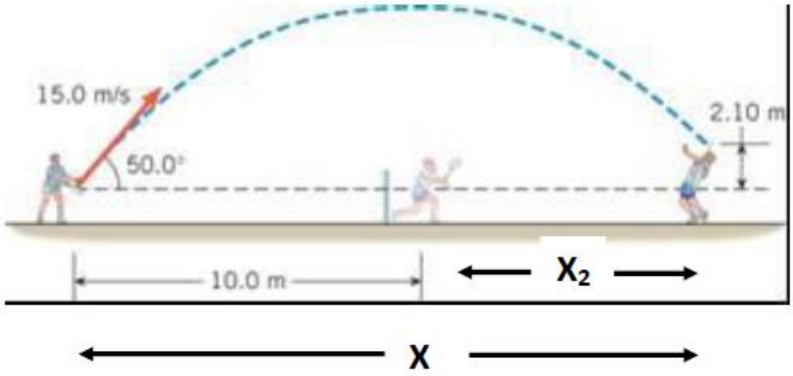


Solution for Problem 23

24. In the annual battle of the dorms, students gather on the roofs of Jackson and Walton dorms to launch water balloons at each other with slingshots. The horizontal distance between the buildings is 35.0 m, and the heights of the Jackson and Walton buildings are, respectively, 15.0 m and 22.0 m. Ignore air resistance. **(a)** The first balloon launched by the Jackson team hits Walton dorm 2.0 s after launch, striking it halfway between the ground and the roof. Find the direction of the balloon's initial velocity. Give your answer as an angle measured above the horizontal. **(b)** A second balloon launched at the same angle hits the edge of Walton's roof. Find the initial speed of this second balloon.

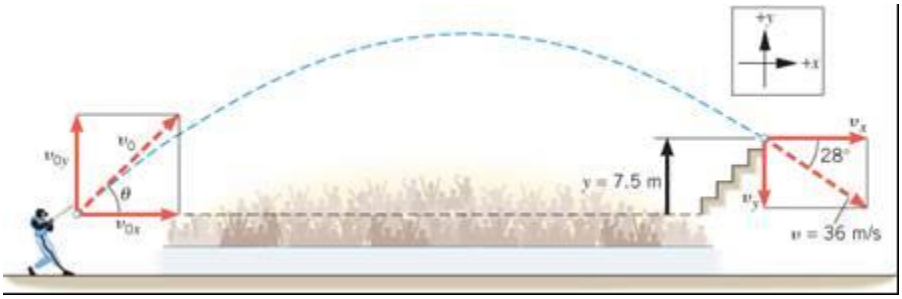
Solution for Problem 24

25. The lob in tennis is an effective tactic when your opponent is near the net. It consists of lofting the ball over his head, forcing him to move quickly away from the net (see the drawing). Suppose that you lob 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.)



Solution for Problem 25

26. A baseball player hits a home run, and the ball lands in the left-field seats, 7.5 m above the point at which it was hit. It lands with a velocity of 36 m/s at an angle of 28° below the horizontal (see the drawing). The positive directions are upward and to the right in the drawing. Ignoring air resistance, find the magnitude and direction of the initial velocity with which the ball leaves the bat.



Solution for Problem 26

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