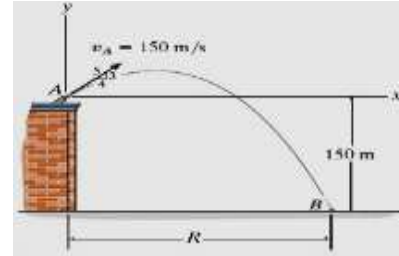
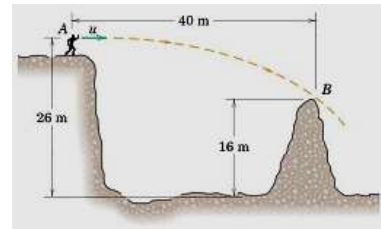


Worksheet 4 projectile motion

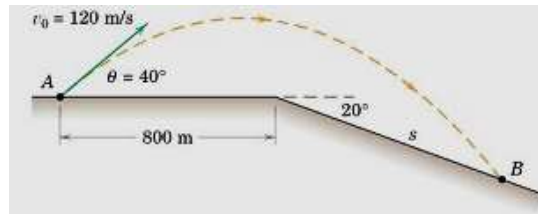
1. A projectile is fired with an initial velocity of $v_A = 120 \text{ m/s}$ off the roof of the building. Determine the range R where it strikes the ground at B.



2. With what minimum horizontal velocity v_0 can a boy throw a rock at A and have it just clear the obstruction at B?

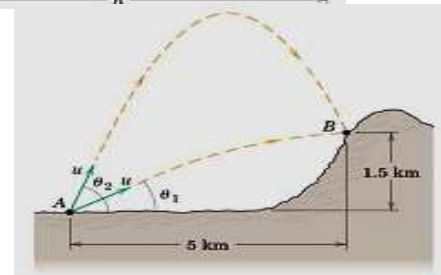
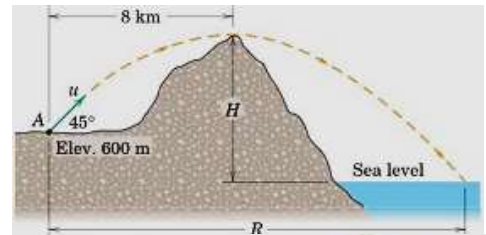


3. A projectile is launched from point A with the initial conditions shown in the figure below. Determine the slant distance s which locates the point B of impact. Calculate time of flight t .

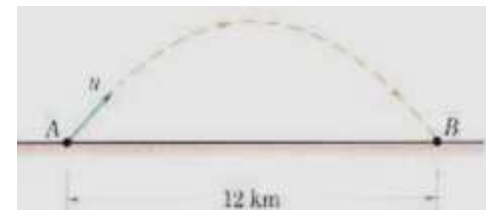


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4. A long range artillery rifle at A is aimed an angle of 45° with the horizontal, and shell is just able to clear the mountain peak at the top of its trajectory. Determine the magnitude of the muzzle velocity, the height H of the mountain above sea level, and the range R to the sea.
5. The muzzle velocity of a long-range rifle at A is $v_0 = 400 \text{ m/s}$. Determine the two angles of elevation θ which will permit the projectile to hit the mountain target B.



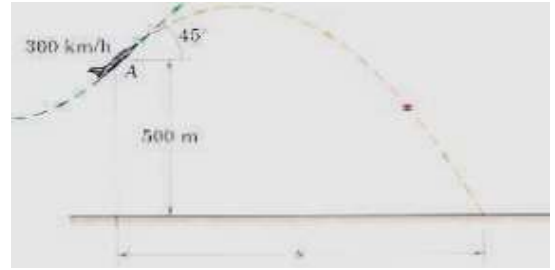
6. Calculate the minimum possible magnitude u of the muzzle velocity which a projectile must have when fired from point A to reach a target at point B on the same horizontal plane 12 km away.
7. A projectile is launched with an initial speed of 200 m/s at an angle of 60° with respect to horizontal. Compute the range R as measured up the incline.



Problems to exercise

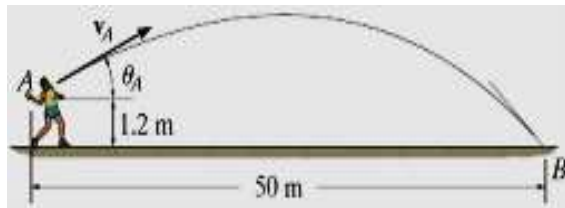
1. The pilots of an air plane pulls in to a steep 450 climb at 300km/h and releases a package at position A. calculate the horizontal distance s and the time t from the point of release to the point at which the package strikes the ground.

ANS: $s = 1.046\text{km}$, $t = 17.75\text{s}$



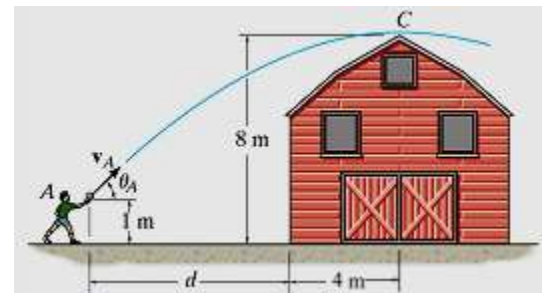
2. It is observed that the time for the ball to strike the ground at B is 25s. Determine the speed v_A and angle θ at which the ball was thrown.

ANS: $v_0 = 23.2\text{m/s}$ $\theta = 30.5^\circ$



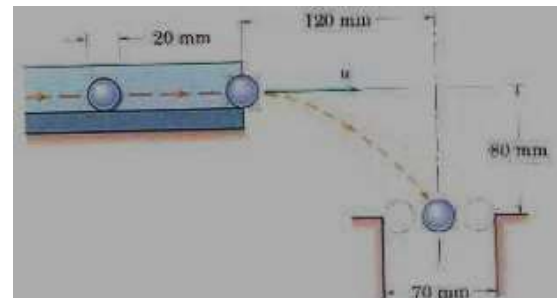
3. The boy at A attempts to throw a ball over the roof of a barn such that it is launched at an angle $\theta_A = 40^\circ$. Determine the minimum speed v_A at which he must throw the ball so that it reaches its maximum height at C. Also, find the distance d where the boy must stand so that he can make the throw.

ANS: $v_0 = 18.2\text{m/s}$ $d = 12.7\text{m}$



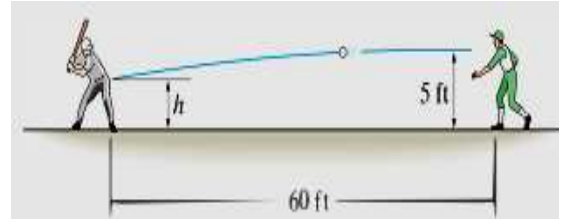
4. Ball bearing leaves the horizontal trough with a velocity of magnitude v and fall through the 70mm diameter hole as shown. Calculate the permissible range of v which will enable the balls to enter the hole. Take the dotted position to represent the limiting conditions.

ANS: $v_{\min} = 0.744\text{m/s}$ $v_{\max} = 1.135\text{m/s}$

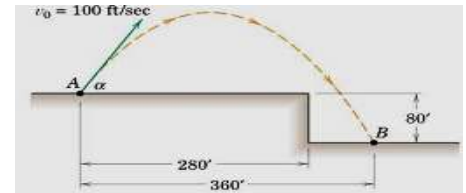


5. The pitcher throws the baseball horizontally with a speed of 140 ft/sec from a height of 5 ft . If the batter is 60 ft away, determine the time for the ball to arrive at the batter and the height h at which it passes the batter.

ANS: $t = 0.429 \text{ s}$ $h = 2.04 \text{ ft}$



6. A projectile is launched from point A with an initial speed of $v_0 = 100 \text{ ft/sec}$, determine the minimum value of the launch angle α for which the projectile will land at point B.



ANS: $\alpha = 50.7^\circ$

7. The pilot of an airplane carrying a package of mail to a remote outpost wishes to release the package at the right moment to hit the recovery location A. what angle θ with the horizontal should the pilot's line of sight to the target make at the instant of release? The airplane is flying horizontally at an altitude of 100 m with a velocity of 200 km/h .



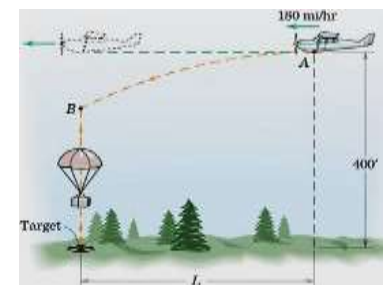
ANS: $\theta = 21.7^\circ$

8. The fireman holds the hose at an angle $\theta = 30^\circ$ with horizontal, and the water is discharged from the hose at A with a speed of $v_0 = 40 \text{ ft/s}$. If the water stream strikes the building at B, determine his two possible distances s from the building.

ANS: $s = 8.68 \text{ ft}$ and $s = 24.4 \text{ ft}$

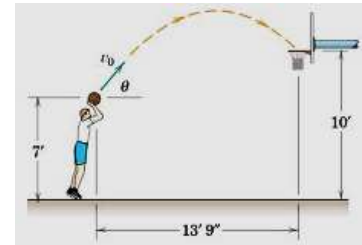


9. A small air plane flying horizontally with a speed of 180 mi/hr at an altitude of 400 ft above a remote valley drops an emergency medical package at A. the package has a parachute which deploys at B and allows the package to descend vertically at the constant rate of 6 ft/sec . if the drop is designed so that the package is to reach the ground 37 seconds after release at A, determine the horizontal lead L so that the package hits the target. Neglect atmospheric resistance from A to B.



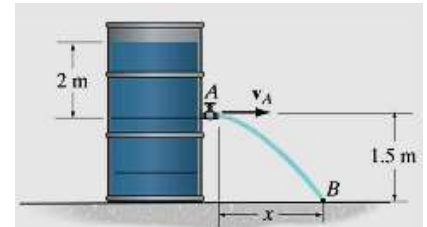
ANS: $L = 928 \text{ ft}$

10. The basketball player likes to release his foul shots an angle of $\theta = 50^\circ$ to the horizontal as shown. What initial speed v_0 will cause the ball to pass through the center of the rim?



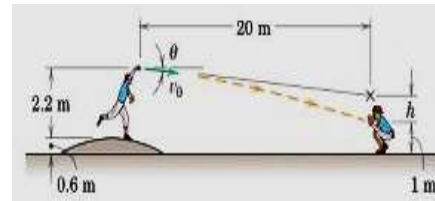
ANS: $v_0 = 23.5 \text{ ft/sec}$

11. The velocity of the water jet discharging from the orifice can be obtained from velocity $v = \sqrt{2gh}$, where $h = m$ is the depth of the orifice from the free water surface. Determine the time for a particle of water leaving the orifice to reach point B and the horizontal distance x where it hits the surface.



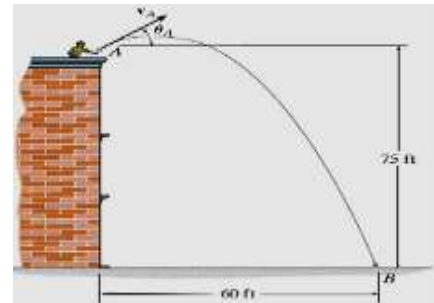
ANS: $t = 0.553 \text{ s}$ $x = 3.46 \text{ m}$

12. Determine the location h of the spot toward which the pitcher must throw if the ball is to hit the catcher's mitt. The ball is released with a speed of 40 m/s .



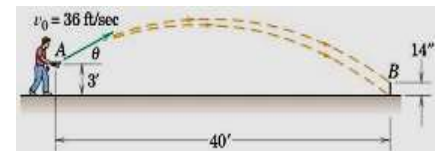
ANS: $h = 1.227 \text{ m}$

13. The ball is thrown off the top of the building. If it strikes the ground at B in 3s, determine the initial velocity v_0 and the inclination angle θ at which it was thrown. Also, find the magnitude of the ball's velocity when it strikes the ground.



ANS: $\theta = 49.36^\circ$ $v_0 = 30.7 \text{ ft/s}$ $v_B = 76.0 \text{ ft/s}$

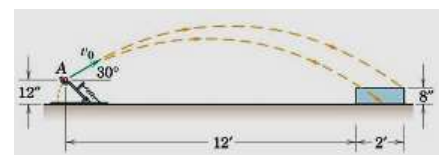
14. A horizontal player releases the horse shoe at A with an initial speed $v_0 = 36 \text{ ft/sec}$. Determine the range for the launch angle θ for which the shoe will strike the 14in vertical stake.



ANS: $\theta_{\text{bottom of stake}} = 31.0^\circ \leq \theta \leq 34.3^\circ$

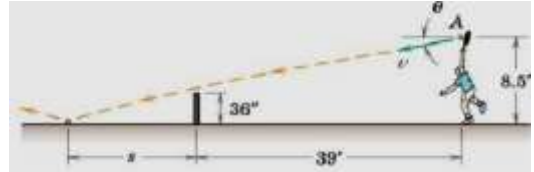
$\theta_{\text{top of stake}} = 53.1^\circ \leq \theta \leq 54.7^\circ$

15. A team of engineering students are designing a catapult to launch a small ball at A so that it lands in the box. If it is known that the initial velocity vector makes a 30° angle with the horizontal determine the range of launch speeds v_0 for which the ball will land inside the box.



ANS: $v_0 = 20.6 \leq v_0 \leq 22.4 \text{ ft/sec}$

16. If the tennis player serves the ball horizontally, calculate its velocity if the center of the ball clears the 36in. also find the distance s from the net to the point where the ball hits the court surface. Neglect air resistance and the effect of ball spin.



ANS: 70 ft/sec , $s = 11.85 \text{ ft}$

17. A roofer tosses a small tool towards a coworker on the ground. What is the minimum horizontal velocity v_0 necessary so that the tool clears point B? Locate the point of impact by specifying the distance s shown in the figure.

ANS: $v_0 = 6.64 \text{ m/s}$, $s = 2.49 \text{ m}$



18. An outfielder experiments with two different trajectories for throwing to home plate from the position shown:

- $v_0 = 140 \text{ ft/sec}$ with $\theta = 8^\circ$
- $v_0 = 120 \text{ ft/s}$ with $\theta = 12^\circ$



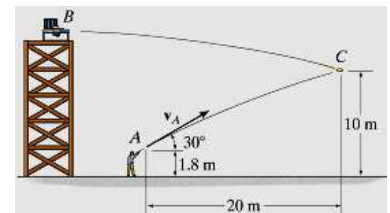
For each set of initial conditions, determine the time t required for the baseball to reach home plate and the altitude h as the ball crosses the plate.

ANS: a). $t = 1.443 \text{ sec}$ $h = 2.10 \text{ ft}$

b). $t = 1.704 \text{ sec}$ $h = 3.27 \text{ ft}$

19. A projectile is fired from the platform at B. The shooter fires his gun from point A at an angle of 30° . Determine the muzzle speed of the bullet if it hits the projectile at C.

ANS: $v_0 = 28.0 \text{ m/s}$



20. It is observed that the skier leaves the ramp A at an angle $\theta = 25^\circ$ with the horizontal. If he strikes the ground at B, determine his initial speed v_A and the time of flight t_{AB}

ANS: $v_0 = 19.4 \text{ m/s}$ $t = 4.54 \text{ s}$

