Physics I

Projectiles

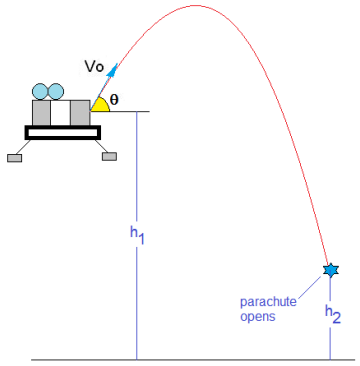
In free fall $x = v_x t$ in the horizontal direction and in the vertical direction:

$$y = v_{y1}t + \frac{1}{2}a_y t^2 \qquad v_{y2} = v_{y1} + a_y t \qquad {v_{y2}}^2 = {v_{y1}}^2 + 2a_y y \qquad \langle v_y \rangle = \frac{v_{y1} + v_{y2}}{2} = \frac{y}{t}$$

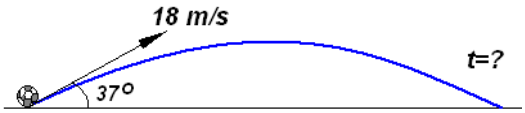
Range of a projectile thrown at ground level: $R = \dfrac{V_o^2 \sin(2\theta)}{g}$

Problem 1.- In an emergency an astronaut ejects from a lunar landing simulator at a height h_1=75m and an initial velocity V_o = 24m/s that makes an angle $\theta = 53^\circ$ with the horizontal.

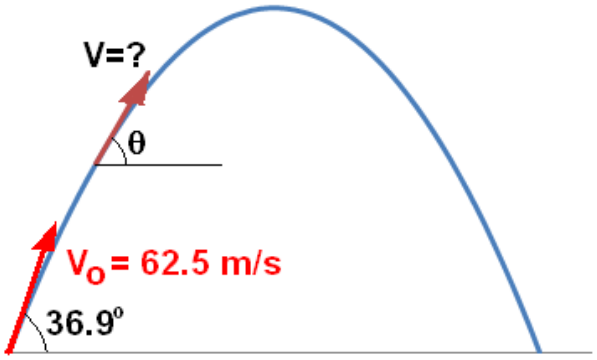
Calculate how much time there is to open the parachute knowing that it has to be opened at least h_2=25m above the ground.



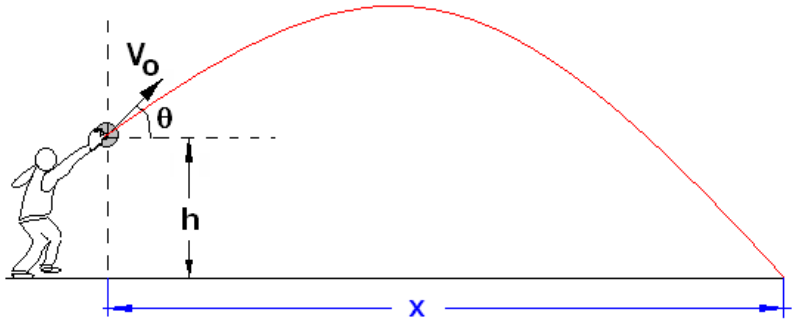
Problem 2.- A football is kicked at ground level with a speed of 18.0 m/s and at an angle of 37.0 degrees to the horizontal. Calculate the range, how long it is in the air, the maximum height reached and the velocity at the top of the trajectory.



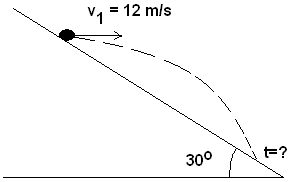
Problem 3.- A projectile is fired with an initial speed of 62.5 m/s at an angle of 36.9º above the horizontal on a long flat firing range. Determine the velocity (in magnitude and angle) 1.25 seconds after firing [neglect air resistance].



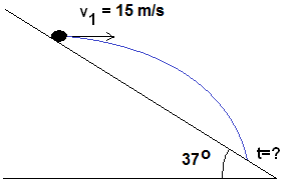
Problem 4.- A shot-putter throws the shot with an initial speed of **V_o=14.5** m/s at an angle **θ=35.5°** to the horizontal. Calculate the horizontal distance traveled by the shot if it leaves the athlete's hand at a height of **h= 2.15** m above the ground.



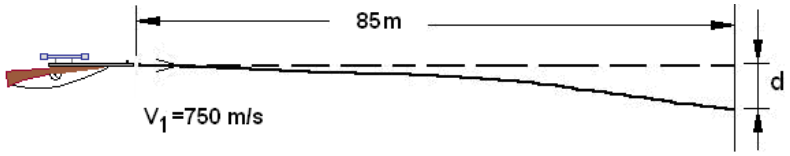
Problem 5.- A person kicks a rock horizontally as shown in the figure. Calculate the time it takes to hit the ground.



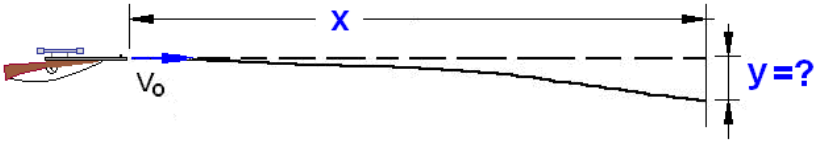
Problem 5a: A person kicks a rock horizontally as shown in the figure. Calculate the time it takes to hit the ground.



Problem 6.- A shooter knows that if she aims directly at a target, which is at the same level, she'll miss (as shown in the figure). Calculate the angle that she should use to correct the trajectory and hit the target.
[Neglect air resistance]

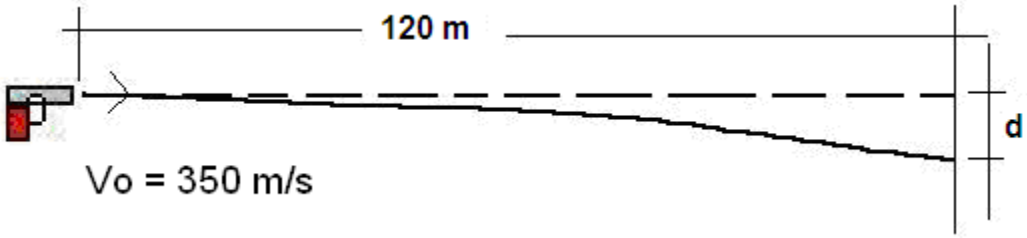


Problem 6a.- A shooter aims directly at a target which is at the same level, a distance $x = 120m$ away. If the bullet leaves the gun at a speed $v_{\circ} = 650m/s$, by how much will it miss the target? [Neglect air resistance]

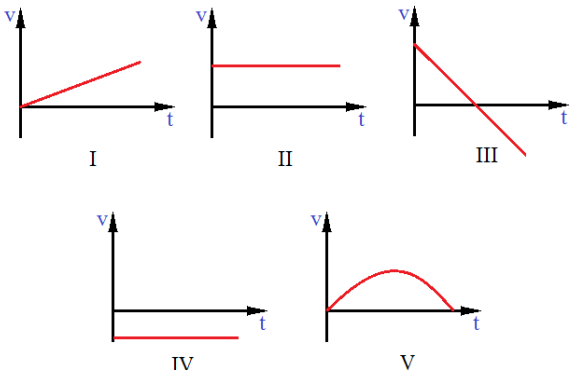


Problem 6b.- A shooter aims directly at a target which is at the same level, 120 m away.

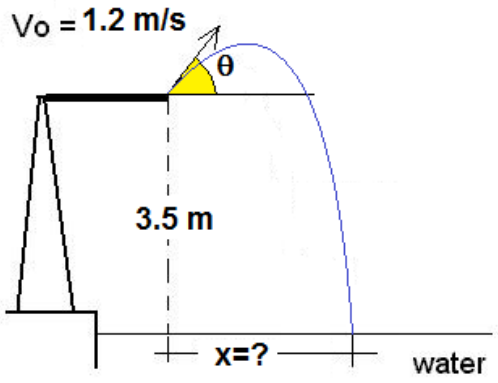
a) Calculate by how much he will miss
b) What angle of elevation is needed to correct the effect of gravity?



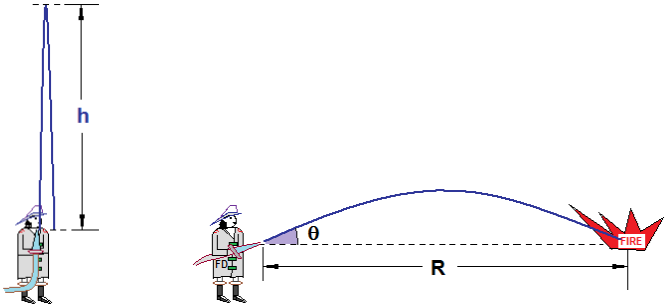
Problem 7.- A stone is thrown at an angle of 45° above the horizontal x-axis in the positive x-direction. If air resistance is ignored, which of the velocity versus time graphs shown below best represents V_x versus t and V_y versus t, respectively?



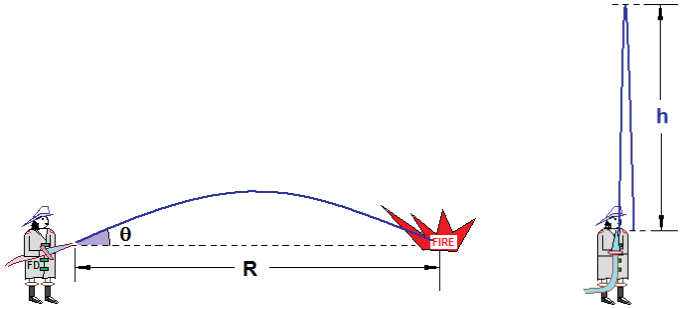
Problem 8.- A diver leaves the end of a 3.5 m-high diving board with an initial velocity of 1.2 m/s at an angle $\theta = 30^{\circ}$ with respect to the horizontal. Find the value of x.



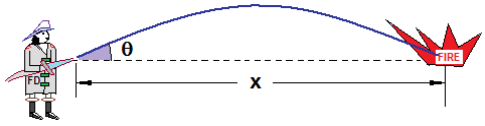
Problem 9.- The water from a fire hose pointing straight up reaches a height of h=35 m. What is the maximum horizontal range R that you can get with the same nozzle velocity?



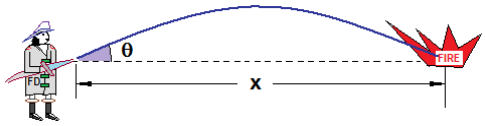
Problem 9a.- A fire hose shoots water at 25 m/s and you can point the nozzle in any direction you want. Calculate the distance R that you reach horizontally shooting at $\theta = 25^{\circ}$ above the horizontal and the maximum height h that you can reach pointing the nozzle straight up.



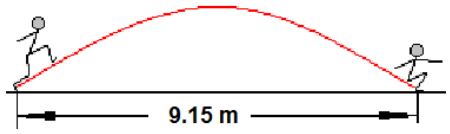
Problem 9b.- A fire hose shoots water at 25 m/s. Calculate the angle θ needed to reach a fire x=30 m away and at the same height as the nozzle. Neglect air resistance.



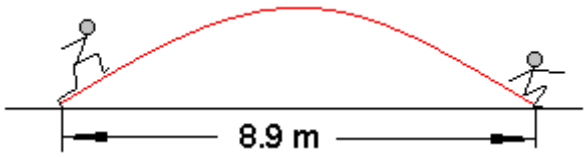
Problem 9c.- A fire hose shoots water at an angle $\theta = 30^{\circ}$. Calculate the speed needed to reach a fire located x=44 m away and at the same height as the nozzle. Neglect air resistance.



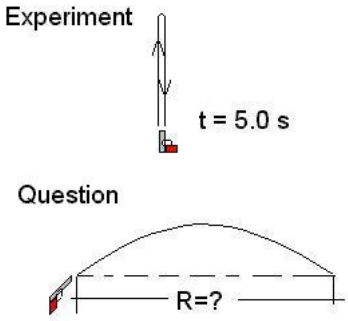
Problem 10.- According to witnesses Carl Lewis had a long jump of 9.15m in 1982. Assuming it is true, estimate his initial speed considering a launch angle of 35°



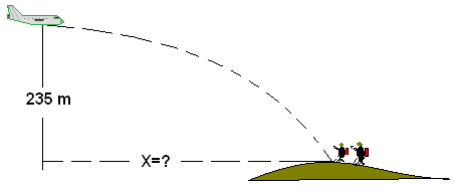
Problem 10a.- Bob Beamon's spectacular long jump of 8.90 m at the Mexico City Olympics in 1968 would last as a world record for 22 years. Estimate Bob Beamon's take off speed assuming he left the ground at a launch angle of 35.3°



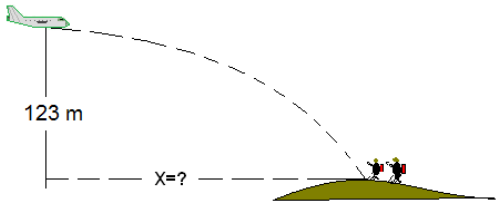
Problem 11.- You want to find the maximum horizontal range (R) of a plastic dart gun that you just bought, so you do a little experiment to find the initial speed of the dart. You shoot the gun straight up and measure 5.0 seconds for the dart to land back at the barrel. How much is the maximum range of the gun?



Problem 12.- A rescue plane drops supplies to isolated mountain climbers on a rocky ridge 235m below. If the plane is traveling horizontally at 70 m/s, how far in advance (x) should the goods be dropped?

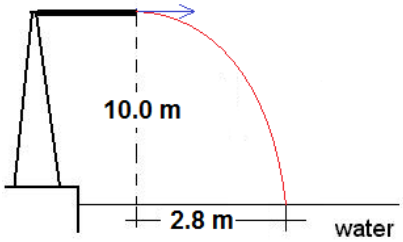


Problem 12a.- A rescue plane drops supplies to isolated mountain climbers on a rocky ridge 123m below. If the plane is traveling horizontally at 80 m/s, how far in advance (x) should the goods be dropped?



Problem 13.- Punt: A football left the punter's foot at a height of 1.2 m above the ground with an initial velocity of 20m/s at an angle of 37º above the horizontal. How far does the football travel before hitting the ground?

Problem 14.- A diver pushes horizontally off a platform 10.0m above the water. If the diver hits the surface 2.8 m beyond the platform, how much was his initial velocity?



Problem 15.- Two golfers each hit a ball with the same speed, but one at 25º with the horizontal and the other at 65º. Which ball goes further? Which one hits the ground first?

Ignore air resistance.