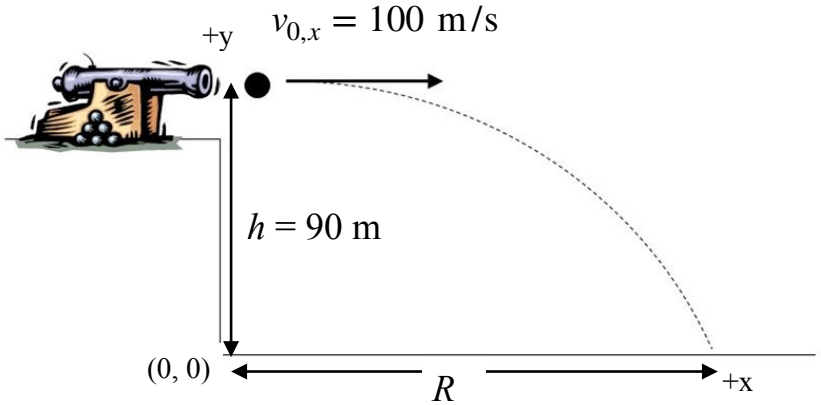
Ch. 10 HW Projectile Motion

Show **ALL WORK**. You may be randomly selected to solve one of the problems next class which will count towards 20% of your final grade.

1) **(20 pts)** A cannon ball is shot from a 90-m height with initial speed 100 m/s and covers a range R.



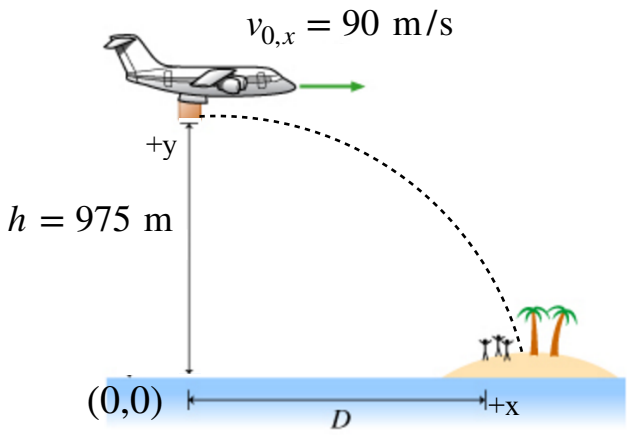
(a) **(5 pts)** *how long* (time) does it take the cannonball to hit the ground ?

(b) **(5 pts)** calculate the *horizontal range* R the cannonball covers

(c) **(5 pts)** calculate the *vertical* and *horizontal* component (v_y, v_x) of the velocity of the cannonball right before it hits the ground

(d) **(5 pts)** calculate the final speed of the cannonball right before it hits the ground

2) **(20 pts)** A relief airplane is delivering a food package to a group of people stranded on an island. The island is too small for the plane to land on and it must drop the package at a distance *D* to ensure it lands on the island



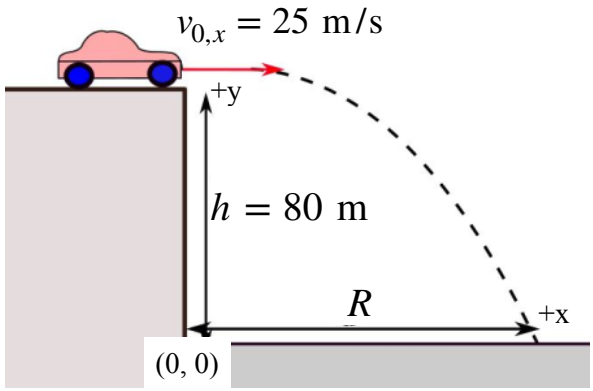
(a) **(5 pts)** *how long* (time) does it take the package to hit the ground ?

(b) **(5 pts)** calculate the *horizontal distance D* the package needs to cover to land on the island

(c) **(5 pts)** calculate the *vertical* and *horizontal* (v_y, v_x) component of the velocity of the package right before it hits the ground

(d) **(5 pts)** calculate the final speed of the package right before it hits the ground

3) **(20 pts)** A car rolls off a 80-m cliff with initial horizontal 25 m/s and lands at a distance R.



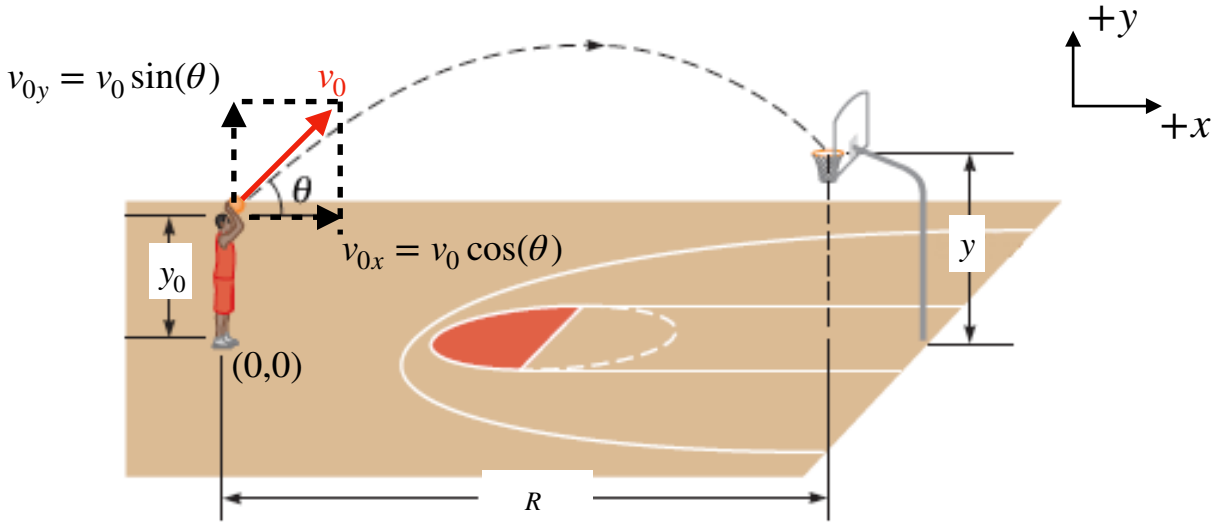
(a) **(5 pts)** *how long* (time) does it take the car to hit the ground ?

(b) **(5 pts)** calculate the *horizontal range* R before it hits the ground

(c) **(5 pts)** calculate the *vertical* and *horizontal* (v_y, v_x) component of the velocity of the car right before it hits the ground

(d) **(5 pts)** calculate the final speed of the car right before it hits the ground

4) **(20 pts)** A basketball player attempts a three-point shot at a range $R = 10$ m from the basket. The player shoots the ball at an angle $\theta = 45^\circ$ from the horizontal, and releases the ball at a height $y_0 = 1.88$ m. The rim of the basket is at a height of $y = 3.05$ m from the floor.

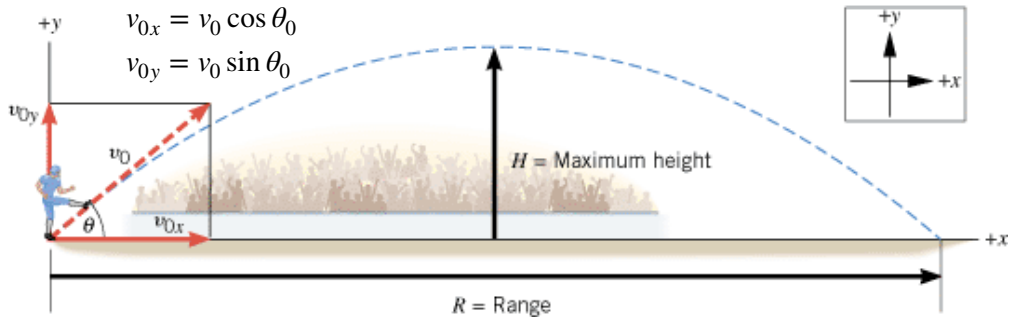


(a) **(5 pts)** write down the acceleration of the basketball at any point of its trajectory to the basket ? Give both a_x, a_y components

(b) **(5 pts)** show that the time it takes the ball to reach the rim can be expressed as $t = \dfrac{R}{v_0 \cos\theta}$

(c) **(10 pts)** calculate the initial speed, v_0, at which the player must throw the basketball so that the ball goes through the hoop without striking the backboard (*hint*: for an angle of 45°, $\sin(45)=\cos(45) = 1/\sqrt{2}$). (Give numerical value in units of m/s)

5) **(20 pts)** You kicked a football with a velocity of v_0 m/s, which leaves the ground at an angle of θ_0. Find a general expression for the following:



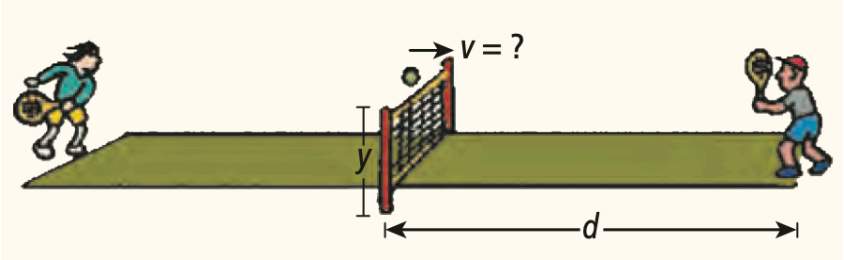
(a)**(5 pts)** time t it takes to reach the maximum height H in terms of v_0, θ_0 and g (*hint*: start with $v_y = v_{0,y} + a_y t$ and solve for t)

(b) **(5 pts)** maximum height H reached during flight in terms of v_0, θ_0 and g (*hint*: start with $y = y_0 + v_{0,y}t + (1/2)a_y t^2$, substitute result from part (a), and solve for the height)

(c) **(5 pts)** total time T it travelled before hitting the ground (*hint:* the time it takes to reach max height is the same time it takes to come back down, hence $T = 2t$; substitute answer for part (a))

(d) **(5 pts)** range R it covered before hitting the ground in terms of v_0, θ_0 and g (*hint*: start with $x = x_0 + v_{0,x}t + (1/2)a_x t^2$, and recall that the time corresponding to the range is the total time travelled, T)

6) **(15 pts)** A horizontally moving tennis ball barely clears the net, a distance y above the surface of the court. To land within the tennis court the ball must not be moving too fast.



(a) **(10 pts)** To remain within the court's border, a horizontal distance d from the bottom of the net, show that the ball's maximum speed over the net is (*hint*: first find an expression for the time it takes the ball to hit floor)

$$v = \frac{d}{\sqrt{2y/g}}$$

(b) **(5 pts)** Find the maximum speed of the horizontally moving ball clearing the net. Suppose the height of the net is 1.00 m, and the court's border is 12.0 m from the bottom of the net. Use $g = 10\ \text{m/s}^2$.