Physics 7AW Homework 4 — Theory of Motion in 2D

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Physics 7AW - Introduction to Mechanics, WAT 2020 edition

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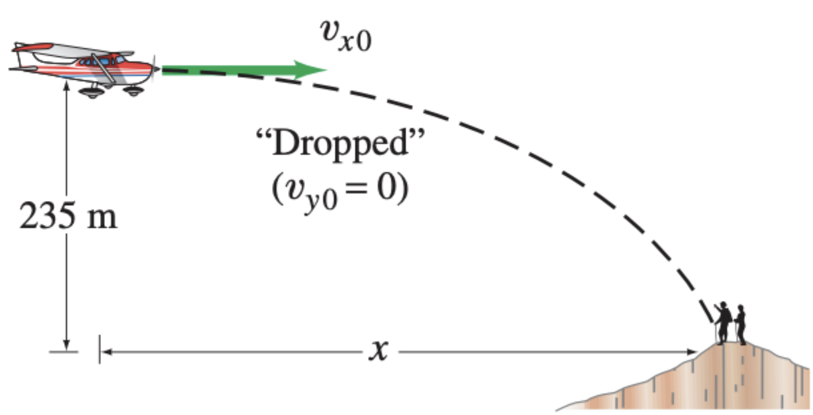
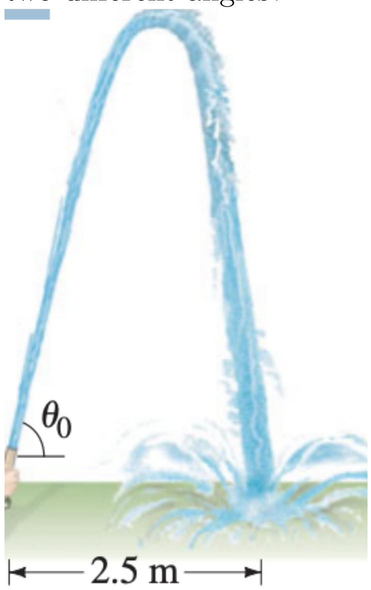
Exercise 1. A rescue plane wants to drop supplies to isolated mountain climbers on a rocky ridge 235m below. If the plane is traveling horizontally with a speed of 69.4 m/s (I didn't write this problem!) how far in advance of the recipients (horizontal distance) must the goods be dropped? (See picture)



Exercise 2. A plane going at 50 m/s West drops a loot box at $t_0 = 0$.The loot box drops 1,600m westwards from where it was dropped. Assume no air resistance.

***a*)** How high was the altitude of the plane, h?
***b*)** At what speed did the loot box hit the ground?
***c*)** What angle did the velocity vector make with respect to the ground?

Exercise 3. A fire hose held near the ground shoots water at a speed of 6.5m/s At what angle(s) should the nozzle point in order that the water land 2.5 m away? Why are there two different angles?



Exercise 4. Ten seconds after being fired, a cannonball strikes a point 400m horizontally and 100m vertically above the point of launch.

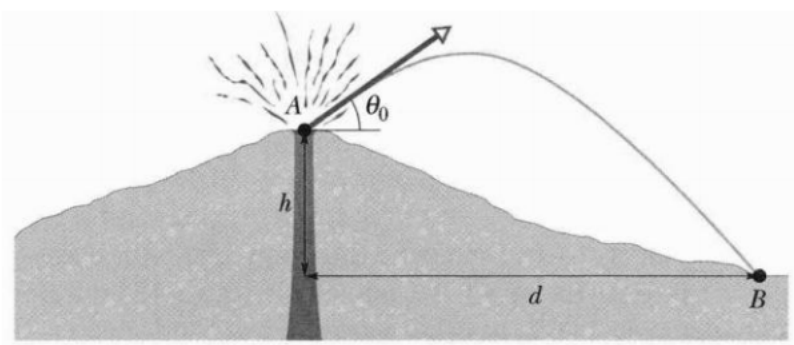
a) With what initial velocity v_0 (direction and magnitude) was the cannonball launched?
b) What maximum height was attained by the ball?
c) What is the magnitude and direction of the ball's velocity just before it strikes the given point?

Note: For part a) I would want to see $v_0 = v_x\hat{x} + v_y\hat{y}$ where you have found v_x and v_y right when the cannon launched.
Part c) is similar to a)

Exercise 5. During volcanic eruptions, chucks of solid rock can be blasted out of the volcano; these projectiles are called volcanic bombs. The figure shows a cross section of Mt. Fuji, in Japan.

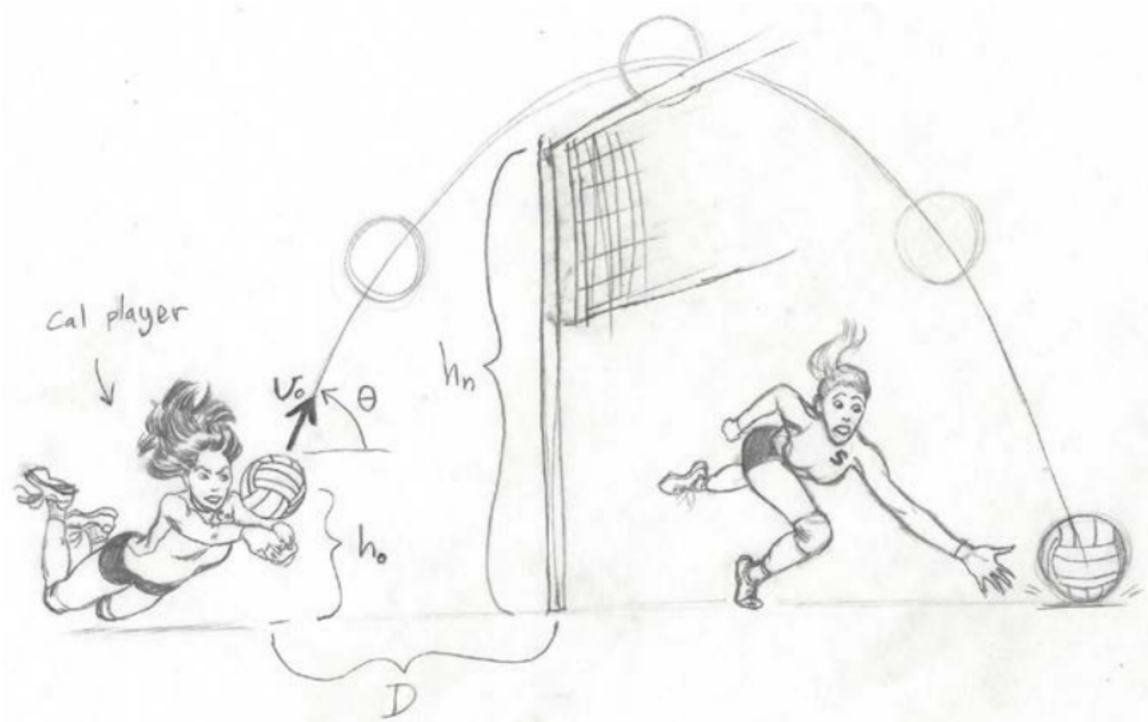
(a) At what initial speed would a bomb have to be ejected, at angle $\theta = 35°$to the horizontal from the vent at point A in order to fall at the foot of the volcano at B at vertical distance $h = 3300$m and horizontal distance $d = 9400$m? Ignore, for the moment, the effects of air on the bomb's travel.

(b) What would be the time of flight?



Note: Part b) is actually very similar to the 1D problem of throwing an object straight up from a cliff of Height H with initial velocity v_0 and having a final position y_f = -H. The difference now is that we have the initial velocity at some angle.

Exercise 6. The Berkeley women's volleyball team is ahead by one point over Stanford near the end of a grueling contest; a two point lead is needed to win. During the final play of the match, a Cal player dives for the ball and hits the ball from a height of h_0 above the ground with an initial speed of v_0 at an angle θ above the horizontal, as shown in the diagram. The top of the volleyball net is at a height h_n above the ground and the net is a horizontal distance D from the Cal player. You may neglect wind resistance and the finite size of the ball.



a) How much time does it take for the ball to reach a point directly over the net? Express your answer as a function of D, v_0, and θ. As always, show your work and/or justify your answer.

b) What is the magnitude of the ball's acceleration at the highest point of its trajectory?

c) What is the minimum speed of the ball over its trajectory?

d) How much time does it take for the ball to hit the ground? Express your answer as a function of v_0, h_0, θ, and any relevant physical constants.

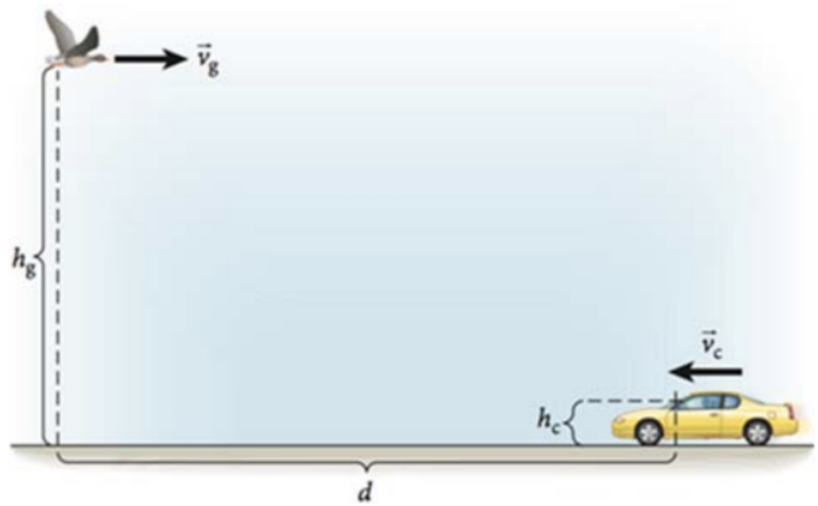
e) (optional) What is the minimum value for the initial speed v_0 to ensure that the ball makes it over the net? Express your answer as a function of h_0, h_n, θ, D, and any relevant physical constants. (You may assume that $\tan(\theta) > (h_n - h_o)/D$.)

Hints: For part a) let the zero position be the floor. That means your starting position is $y_0 = h_0$ since the volley ball is launched at this height as shown in the picture.

For part b) its very quick you don't have to do any computations I'm just making sure you understand something..

For part c) remember speed is $\|\mathrm{v}\| = \sqrt{\mathrm{v}_x^2} + v_y^2$ (there should only be one absolute value sign idk why I can't type only one... and the square root covers both $v_x^2 + v_y^2$... sorry)

Exercise 7. Wild geese are known for their lack of manners. One goose is flying at a constant altitude h_g when it sees a car in the distance moving towards itself. The goose is flying at a speed of v_g and the car is moving at a speed of v_c relative to the ground. The center of the windshield is h_c off the ground.



The goose decides to poop on the windshield of the car. At what horizontal separation d between the goose and the windshield does the goose need to take action?