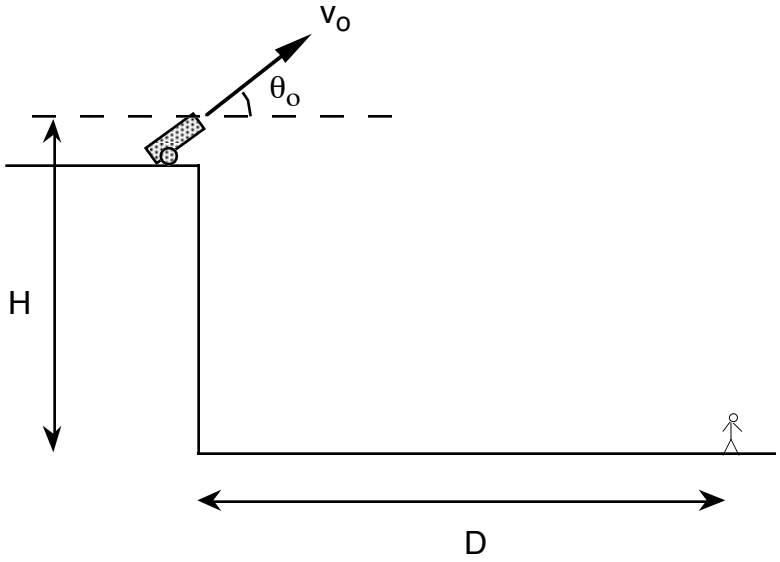
4. A water-balloon cannon sits at the edge of a cliff, at a height H above the ground. The cannon is set to fire a water balloon at an angle θ_o with respect to the horizontal. We would like for the water balloon to hit your physics professor, who is standing on the ground a horizontal distance D from the cannon. We will arrange for this to happen by adjusting the "muzzle speed" v_o appropriately.



(a) Sketch the trajectory of the balloon on the figure above. (Ignore air resistance.)
(b) Sketch on separate axes: a_x vs. t; v_x vs. t, and x vs. t;
a_y vs. t; v_y vs. t, and y vs. t.
(c) In terms of D, θ_o, and the unknown v_o, find the time T at which the balloon hits the professor. Check the units of your algebraic expression.
(d) Now using your answer to (b), find the "muzzle speed" v_o required to hit the professor. Answer in terms of D, H, and θ_o. (Hint: At time T, the y-position of the ballooon should be ground level.)
(e) What is the x- component of the velocity of the balloon when it hits the professor? What is the y-component of velocity at the same instant? [Note: The answers here are not "zero." When we ask questions like this, really we mean "the instant before" the balloon hits.]
(f) At what horizontal distance from the cliff does the balloon reach its peak height?

[Note: This problem has nearly all of projectile motion in it. Before moving onto other projectile problems, look back over your work and determine what the key steps were. You will use these strategies often.]

5. A body lies on the ground, fifteen feet from the base of a building. Eighty feet above, there is an open window. Would you guess the death to be accidental? Why or why not?