Assignment IV, PHYS 101 (Introductory Physics I)
Fall 2020
Due via pdf upload to OAKS prior to Thursday, September 17th at 9:25 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units. As always, if you have questions feel free to email me or send me a DM in the slack.

1. A cannonball is launched on the moon where the acceleration due to gravity is only about 1.63 m/s^2 (down towards the core of the moon, of course). The cannonball is launched at a 23.8° angle with an initial velocity of 45.0 m/s.

   a) How far away from its launch point does the cannonball land?

   b) What is the maximum height reached by the cannonball?

   c) How long is the cannonball airborne?

   d) If you took the same cannon back to Earth and wanted to launch it at an optimal 45° angle, what launch velocity would you need to get the same range that the cannon got on the moon in part (a)?

2. You stand on top of a tower of height 18.0 m and throw a stone at an angle of +27.0° with respect to the horizontal at a speed of 14.0 m/s.

   a) How long does it take for the stone to hit the ground?

   b) At what horizontal distance from the tower does the stone hit the ground?

   c) What is the speed of the stone just before it hits the ground?

3. A baseball batter hits a ball that comes off the bat at an angle of 32 degrees. The ball is moving at 38 m/s as it leaves the bat. You may assume the batter hits the ball from ground level.

   a) Assuming no air resistance, how far from the batter would this hit land? Leave your answer in feet. (You'll get an unrealistically large answer; that's because air resistance really isn't totally negligible here).

   b) The center field fence is 410 feet from home plate. The fence is twenty feet tall. Assuming no air resistance, will this baseball fly over the fence for a home-run? (Support your answer with calculations.)

4. A bird flies horizontally at 8.4 m/s with a fish in its claws. The bird is startled and suddenly drops the fish. Assuming the bird was flying high enough when dropping the fish, how long until the fish's speed doubles?

5. Something I find interesting is that if you launch a projectile from level ground with launch angle θ above the horizontal and launch speed v_i it has the exact same horizontal range as a projectile fired with angle $90^\circ - \theta$ and launch speed v_i. (If you don't believe me, try it with the applet!) Here's the question – even though these two launches end up with a projectile landing in the same place, is it necessarily true that the two different trajectories are airborne for the same amount of time? Clearly justify your answer.