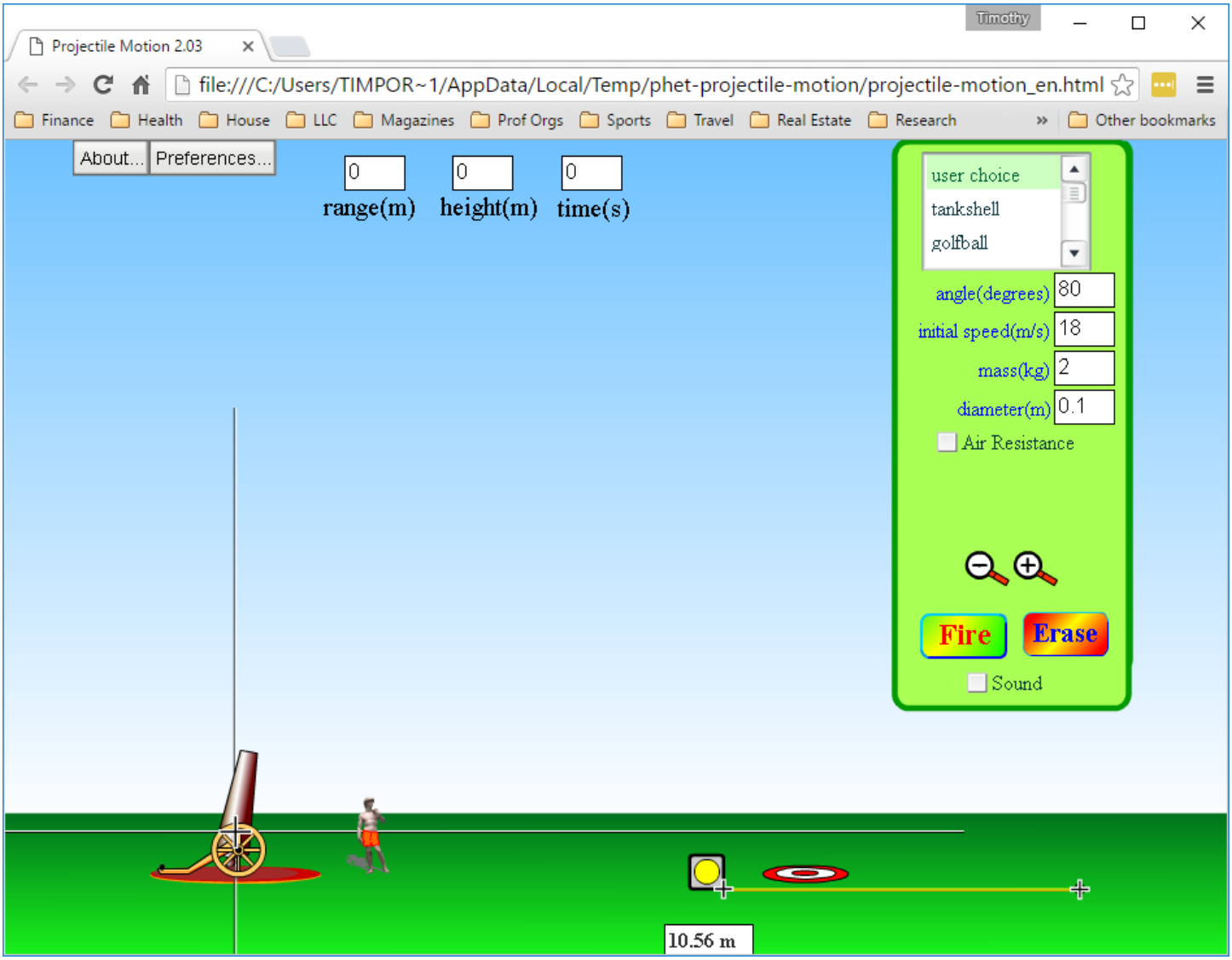
Projectile Motion

Lab Procedure – Provide written answers to the questions in red.

This lab makes use of the simulation "projectile-motion_en.jar".
Run the simulation and take a few minutes to familiarize yourself with the simulation and shoot stuff with the cannon.



Near the lower right of the of the window, there is a "measuring tape" tool. You can click and drag the yellow end of the measuring tape to any point on the graph you would like (the cross is the actual origin for the tape), then click and drag the other end of the tape to any other point on the curve. The tape will read out the linear distance between the two measuring tape crosses. Try it out a few times to see how it works.

When you fire the cannon and generate a curve, there will be black crosses marked on the curve every 1 second of the projectile flight.

1. Fire the projectile launcher straight upwards (angle = 90^{o}) at 18 m/s. Using kinematic equations, determine:

a) The time it should take the tankshell to reach maximum height. Which equation(s) did you use?

b) The maximum height reached by the projectile. Which equation(s) did you use?

c) Now, using the measuring tape, measure the actual height reached by the projectile (remember to measure from the cross at the base of the cannon). Was your answer to (b) the same as this measurement? If it wasn't, check your math over and find your mistake.

2. Pick any initial speed and launch angle, and try out firing all the different objects (golfball -> Buick).

a) How does the mass of an object affect its motion through the air?

b) Explain how, using kinematic equations, how you can calculate the horizontal "range" of a projectile when given the initial speed of the projectile and the initial launch angle of the projectile. Be as detailed in your explanation as possible.

c) For a launch angle of 55 degrees and an initial speed of 14 m/s calculate the horizontal range of a projectile.

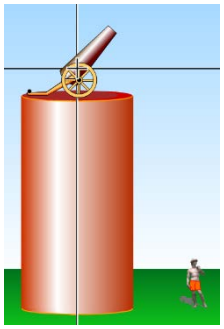
d) Run the simulation for the above parameters and check your calculations. Was your prediction based on kinematics accurate?

3. Fire the projectile launcher at the following angles (with the same initial speed of 18 m/s), then fill in the table below. You will need to use the measuring tape to measure the maximum height and the range.

Angle	Initial Speed (m/s)	Air Time (s)	Maximum Height (m)	Range (m)
10°	18			
20°	18			
30°	18			
40°	18			
50°	18			
60°	18			
70°	18			
80°	18			
90°	18			

a) What is the best angle for maximum height and air time? Explain why you think this is so.

4. Raise your cannon up into the air 6m by dragging it up (see picture below). Use the measuring tape to get the height correct.



a) Explain how you would now use kinematic equations to calculate the horizontal range of a projectile when the cannon is elevated some distance above the x-axis.

b) Calculate the horizontal projectile range with the cannon elevated 6m above the x-axis, with an initial speed of 14 m/s and an initial launch angle of 14 degrees.

c) Perform the experiment with the simulator. How did your calculation compare with the experimental result?