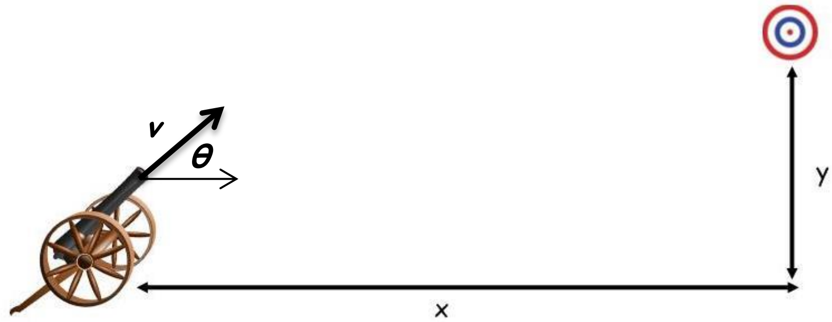
/30



a) Given the launch velocity of a projectile is *v*, and target coordinates are (x, y) relative to the launch position; derive the equation below which is necessary for finding the angle of attack:

$$\frac{gx^2}{2v^2}\tan^2\theta + x\tan\theta + \frac{gx^2}{2v^2} - y = 0$$

b) Program an Excel spreadsheet to display the angle of attack (in degrees showing one decimal place) after the user inputs *v*, *g*, *x*, and *y* (allow those parameters to be easily changed).
   i. Excel displays radians when calculating angles so you will have to convert to degrees.
   ii. Each group must submit their spreadsheet file.

c) Check your spreadsheet accuracy using the PhET projectile motion simulator. Neglecting air resistance and weather systems, use the spreadsheet to calculate the angles necessary to hit a target located (x, y)=(10m, 5m) for the following initial velocities: 13, 15, 17, and 19 m/s.
   i. Use the scale in PhET to place the target at (x, y) and enter the velocity and corresponding angles.
   ii. Save or print your PhET simulation after going through all four velocities.

d) In the PhET simulation, drag the canon so it fires from a point above the ground. Place your target somewhere below the canon and use the scale to determine (x, y). Input that (x, y) into your formula and generate trajectory angles for two initial velocities of your choosing. Save/Print your simulation.
   i. Feel free to test your formula for various target locations but you only have to submit your work for part (d).

e) Does there exist a target location where the projectile can be launched at only one angle to hit that target? Explain your reasoning.

f) Solve the equation in (a) for θ given the special case that the initial velocity is much, much larger than x. Use your spreadsheet and PhET to test out your answer.