# Summative: Projectile Motion Spreadsheet

*The kicker on a football team can give the ball an initial speed of 25.0 m/s. Within what angular range must he kick the ball to score a field goal from a point 50.0 m in front of the goalposts whose horizontal bar is 3.44 m above the ground?*

Start by drawing a picture of the problem and labeling it with the values you are given. Don't forget you also know the acceleration due to gravity. NOTE THAT the picture below is not quite accurate as he is punting rather than kicking from the ground but it gives you the idea that a minimum and a maximum angle are possible.

"Guess and check" each angle from 1° to 89°.with a spreadsheet (Google Sheets) which does repeated calculations.

Let the first column of your spreadsheet be the angles from 1° to 89°. In cell A1, type "angle". In cell, A2, type "1". In cell A3, type "=A2+1". The = sign is how you must start all formulas. Copy this formula (Ctrl-C). Highlight cells A3 through A90 by left clicking. Press Ctrl-V to paste the formula down the row.

Now you must figure out what other calculations you must do to find the answer. Let the first cell of each column be a text label showing what you are calculating (for example "horizontal velocity" or "time in air"). The cell below it will be the formula. Some things to know:

- Formulas must start with an =
- To put a cell label in your formula (such as A2), you can either type the label or just click on the cell
- In Google Sheets, trig functions work for radians so if your angle is in degrees you must first convert to radians – example of formula =COS(RADIANS(A2))
- multiply is *, divide is /, raise to the power is ^, squareroot is SQRT( )
- You can use the "Format>Number>Number" to change the number of decimal places shown to 2. Highlight all your columns first.

If you have time, see if you can make a graph or chart which shows both the height of the goal posts and the maximum vertical displacement for each angle to give a visual representation of the angle.

**BONUS +10:** Answer the above by solving for the angle algebraically. You may NOT just guess and check angles and your angles must be accurate to one decimal place. (hint – you will have to use several trig identities, see the following link http://www.sosmath.com/trig/Trig5/trig5/trig5.html )