Using a Simulation to Solve A Problem: Projectile Motion: Navigate to the program linked here: [Projectile Motion] and make a copy of it on your own Glowscript account.

Get Acquainted:

1. Run the program and watch what happens.
2. Read through the code line by line and follow along with what happens at each step. Answer the following questions:
   a. What causes the program to finish running?
   b. What causes the program to print the time and x-position values when it stops running.
   c. Look carefully at the very last line:
      i. What is the syntax used to print a value assigned to a variable?
      ii. What is the syntax used to print a literal symbol
3. Try altering some parts of the code and see what happens. Change the initial velocity and/or the acceleration. Try changing some of the other values. It's okay if you mess it up, you can always change it back.

Create Modifications to this Program to Complete The Following Tasks: Remember, utilize the help resources. If you're really stuck, check in with me.

1. If the projectile is launched such that its v_x = 40 and v_y = 40 use the simulation to determine:
   a. The horizontal displacement that it travels before striking the ground.
   b. The maximum height it achieves

2. If the projectile is launched with the same initial velocity, but is now on the surface of the moon (about ⅙ Earth's gravity), determine:
   a. The horizontal displacement that it travels before striking the ground.
   b. The time it spends airborn.
   c. The maximum height it achieves.

3. Keep the same initial velocity that the projectile had in part 1, but now launch it from a height that is 100 above the ground (assume Earth gravity -10). Determine:
   a. The horizontal displacement that it travels before striking the ground.
   b. The maximum height it achieves.
   c. The time it takes to reach its maximum height.
   d. The time it takes to fall from its maximum height back down to the ground.

4. Now, let's say we want to account for the lessening of gravitational acceleration magnitude as the ball gets higher from the ground. ***This isn't a realistic model*** (a realistic model would be more complicated) but for learning's sake, let's say that gravitational acceleration decreases with height as given by the following function: $g(y) = \frac{-1000}{y+100}$
   a. Check the end-behavior of this function. What happens as y→0 from the positive side? what about as y→∞ ? Although this function doesn't have *exactly* the right shape, its end-behavior should make sense.
   b. Modify the program code to reflect this new mathematical model for gravitational acceleration. (Create a copy of the original program to do this so that you don't lose your original work.)
   c. Redo problem number 1 with this modified code. How do the results differ from the results obtained with uniform acceleration? Does the difference meet your expectations?

5. Your final goal is now to create a ***realistic mathematical model*** for gravitational acceleration. So far, you've been working in unitless quantities. Let's say we are working in standard units (meters, seconds, etc).

   Again, create another copy of the projectile program code.

   Utilize the equation for Newton's Universal Law of Gravitation: $F = \frac{GmM}{r^2}$ to modify your code to realistically reflect the gravitational force. You will need to look up the radius and mass of the Earth as well as Newton's Gravitational Constant.

   Once you've updated your code to reflect this realistic model, try changing the initial launch velocity. Switch back and forth between this modified code and the original projectile code (with *g = -10*) and determine the launch velocity at which you start to see significantly different behavior for the two projectiles.