Lunar Lander Lab Worksheet – Gen Ed **Name**_____

In this simulation, you will experience Newton's Laws from the standpoint of operating a spacecraft in a frictionless environment. You will learn how to pilot a lunar Lander, also called a Lunar Excursion Module or Lunar Module (LEM, LM) and land that craft on the surface of the moon. However, just like Neil Armstrong in 1969, you will have a limited amount of fuel and time before you will have to find a safe place to land the LM or suffer the consequences.

Objectives:

- To gain an understanding of objects in motion in a straight line will only change their path if a force is applied according to Newton's 1st Law
- To understand the relationship between force, mass, and acceleration according to Newton's 2nd Law.
- To learn the concepts of action/reaction forces according to Newton's 3rd Law.
- To apply the DVAT equations to new situations.

Procedure:

Familiarize yourself with the controls of the LM. Take a few minutes and play around with the Lander to see how it operates. If you can land your craft in between tighter boulders, you can get a higher score. Try flying horizontally and see what happens. Try boosting the LM at full thrust vertically upward and see what happens. Turn on the vector display so that you will visualize the factors acting on your Lander. ***Note that you can pause the program at any time to collect data!***

Newton's Laws:

1. While your LM is above the surface of the moon, fire the engines to gain some altitude. Cut your thrust so that you don't waste all of your fuel. You should be at least 250m above the surface. Once you get to this altitude, tilt the LM so that you are at a 45^0 to the vertical. Fire your engines for a brief burst.

    a. Once you fire your engines what do you notice about the x-Velocity (aka horizontal velocity)?

b. How can you correct your trajectory to compensate for the effect you observed in part (a)?

c. Explain the reason why you have to correct your trajectory using Newton's Laws.

d. What do you have to do in order to get the LM to hover at a constant altitude?

2. Reset the simulation so that your LM has a full tank of fuel. Fire your engines for a short burst so that you gain some altitude. You should be at least 300m from the surface.

   a. Record an initial altitude for the LM and let it fall toward the surface without firing its engine. Notice the y-Velocity on the display monitor. Use this information to calculate the acceleration due to the moon's gravity. Record your solution with the data you collected below. Use the time-independent kinematic equation.

   b. Once you have calculated the moon's acceleration due to gravity, find the maximum acceleration of the LM due to its engines. Explain your solution below and show the data you used and collected. Use the time-independent kinematic equation.