

Student Directions *Lunar Lander Lab* Activity 1: Finding a maximum impact velocity

Objectives: In this simulation students will test

- The effects that a rocket thruster has in space
- Be able to determine the relationship between how much fuel is used and altitude
- Evaluate the way to obtain a maximum impact velocity on the moon

Directions

- 1.) Open Lunar Lander Phet simulation.
- 2.) Familiarize yourself with the controls of the Lunar Lander lab, find how much fuel you have, find how high you are (altitude), find what your current velocity is and how your main thruster affects that. What makes your velocity positive or negative?
- 3.) Conduct four experiments resetting the game after each one. In these experiments you need to find how high you can go in relation to fuel. You do not need to burn all of your fuel to achieve the desired graph. For our experiment we only burned 74 kg of fuel for the first test.
- 4.) For these experiments press the space bar once to turn the fuel all the way on and press it once more to turn it all the way off. Be sure to note how much fuel is in the tank at the beginning of the run and then subtract how much is left when you stop thrusting to determine the fuel burned.
- 5.) Create a graph using the data gathered in step three. Add a trendline to the data (polynomial is the best fit because the fuel and altitude are directly related). You will need to use this graph on your calculator further on in the lab.
- 6.) Run four tests in which you use up more than half of your fuel, and then let the Lander coast (even though you will not be able to see it, it will still be going up). To make sure you are not accelerating with the thruster **PRESS THE SPACEBAR ONCE TO COMPLETELY TURN ON THE THRUSTER AND PRESS IT AGAIN TO TURN IT COMPLETELY OFF.** Turn the Lander around so that it is facing straight down, when your velocity turns negative. To do this use the left and right arrow keys to align the arrow in the simulation so that it is facing the ground. Then use your main thruster to boost the Lander towards the ground. Try to use up all of your fuel right before you hit the ground as this will yield the maximum speed.
- 7.) Once you have completed these four experiments plot a graph of the four points and add a polynomial trendline. You can use the fourth calc feature to find a maximum point on the parabola. This point will be your optimum altitude for the most speed. When you find this point go back to the graph you created in step four and find out how much fuel you need to burn to achieve this altitude.
- 8.) Run a series of three tests while trying to obtain the optimum altitude and fuel level using the same technique as step five. This should yield the maximum impact speed of the Lunar Lander module. **(NOTE: You must burn your fuel in one continuous stream or else the data will be inconsistent.)**
- 9.) Evaluate your experiment and give a conclusion with results.