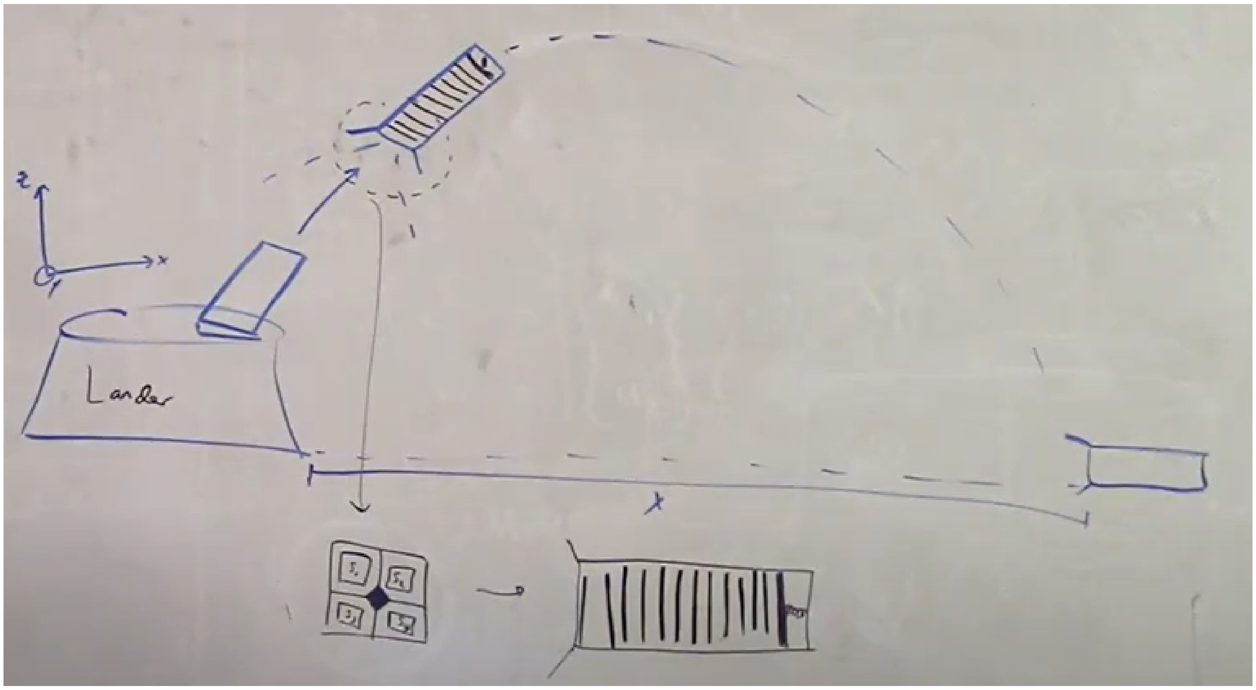
Colorado Space Grant Consortium - GLEE | Audrey Viland

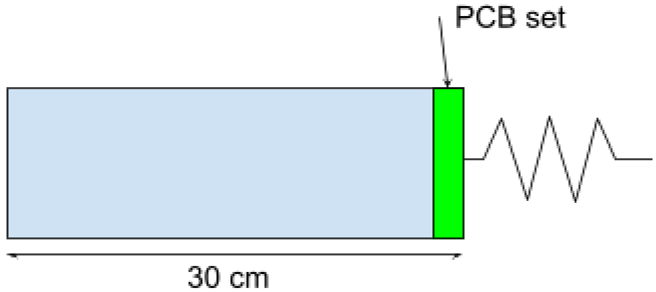


Spacecraft holding 500 satellites (PCBs) (in groups of 4 PCBs): 125 layers
Satellites collect information and communicate with each other via RF, solar panels to survive for 2 lunar weeks
Goal: deploy 500 satellites on the lunar surface within a specific dispersion parameter
3U Satellite: 30 cm long and 10 cm^2
While flying through the air: it's losing mass

  Mass of container = 0.5 kg
  Mass of all satellites = 2.5 kg

Model where the carrier will land and where the satellites will land
Dispersion parameter: 250 m^2
45 degree bumper launches small satellites left and right
Based on carrier's instantaneous orientation, where will all of the PCBs land?
Spring in carrier forces satellites out in opposite direction of motion

Problem 1: We want to test different spring constants in the carrier spring. So, we place the carrier horizontally on the ground where it is stationary. We load one satellite (set of PCBs) in the carrier and compress the spring fully to 30 cm. What is the spring constant if the relative satellite exit velocity from the carrier is 2 m/s and friction forces are negligible?

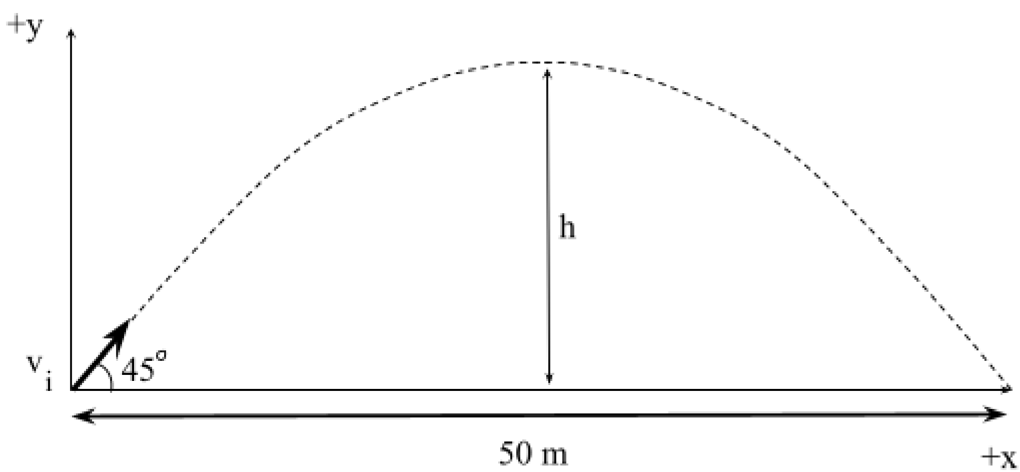


Problem 2

Now we want to start modeling to achieve the dispersion parameter of 250 m^2. In this early model, we assume that the mass of the container is constant throughout the duration of its flight. The lunar lander will launch the container at a 45° angle to the lunar surface.

What must be the initial velocity of the container as it leaves the craft in order to travel 50 m?

What is the maximum height the container will reach?



Problem 3

Now that we have an estimate for our launch velocity (problem 2) and spring constant (problem 1), let's combine the two to determine how the carrier might behave while launching PCBs mid-flight. While these steps greatly simplify the problem, they help develop our understanding of the problem so that we can work up to more complex tools for modeling the intricacies of the craft's motion.

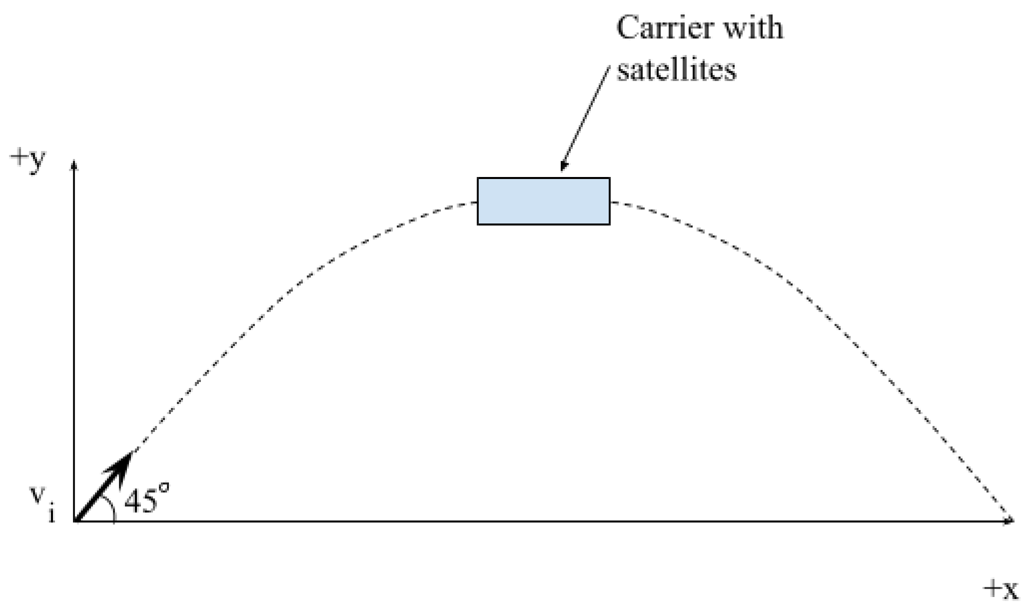
Let's say the carrier is at the top of its arc, mid-flight ($v_y = 0$). It is oriented parallel to the lunar surface. It was launched with the initial velocity and angle from Problem 2.

Like Problem 1, it is loaded with 1 satellite (set of 4 PCBs) having a mass of 0.02 kg. The spring is fully compressed (30 cm) and has the spring constant we found in problem 1. Once the carrier reaches the top of its arc, the spring is released, launching the PCBs in the opposite direction.

After deploying the PCBs:

What is the new velocity of the carrier, relative to the lunar surface?

What is the velocity of the PCB relative to the lunar surface?



Problem 4

Now let's look at the dispersion of a single PCB unit after being ejected from the carrier. Let's use the same scenario as Problem 3 where the PCBs were ejected horizontally from the carrier. This means that they are oriented perpendicular to the lunar surface.

We also know from the problem setup that they will be launched at a 45 degree angle. Let's assume that each PCB has the same mass so they will move symmetrically with the same initial velocity (conservation of linear momentum). Let's also assume that none of the PCBs are rotating.

Finally, since we're using the same scenario as Problem 3, the PCBs are launched at the top of the carrier's arc. This means they start out with zero velocity in the y direction.

What must be the initial separation velocity of the PCBs in order to reach the 250 m^2 dispersion parameter? i.e. what does v_0 have to be in order for s_1 to travel 25 m in the +z direction before landing on the lunar surface?

*Note: for right now, we're focusing on how to reach 25 m in +z. We aren't concerned with the x component of the final landing position.