Mars for Earthlings

LESSON 4: Remote Sensing Mars

In-Class Activity 2
Remote Sensing_MFE
*MOLA Simulation**

Purpose:
Understand how we explore the surface of Mars via remote sensing techniques by performing a ping-pong experiment.

Materials:
Ping pong balls, removable color tape, stop watch, measuring tape, and wood blocks, bricks or stone/ ceramic tiles that can sit on top of books or boxes to create different heights from the floor.

Procedure:
You must have at least 2 people in your group, but 3 is preferable.

Step 1:

1. Place 2 strips of tape on the wall, one approximately 2 meters (200 cm) high and the other 45 cm high. Both should be at least 200 cm long and parallel; you will be using these as the points to start and stop the stopwatch.

2. One partner should hold the ping-pong ball between the first finger and thumb next to the higher piece of tape approximately one inch from the wall.

3. One partner, the "timer", should have a stopwatch and have his/her eyes level with the second piece of tape. A third partner, if available, should record the results of each ball drop using the attached data sheet. *Note: Use a spreadsheet for recording and calculating the data.

4. Drop the ball. Start the stop watch as soon as the ball begins to drop.

5. The timer will stop the watch when the ball rebounds and reaches the lower line, i.e. the clock starts when the ball drops and stops when the ball reaches the second piece of tape. Record the time on the data sheet. Repeat this step four more times.

6. Calculate the velocities (V=D/T). The distance (D) is the combination of the height of the high tape plus the height of the low tape. After finding the velocity for each of the trials, find the average velocity of the ping-pong ball. This average will be used later in this lab as your baseline for comparing data. For each trial are you measuring an average or instantaneous velocity?

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7. Many spacecraft use lasers (light) to determine topography similar to how you are using a ping pong ball. However there is a potential over-simplification in using a ping pong ball as an analog to a laser. What are the issues? (Hint: Think about velocity vs. acceleration.)

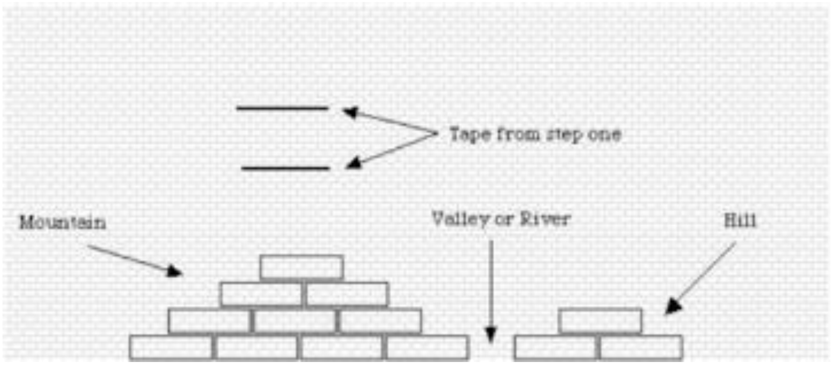
Data Table I (Baseline , datum)

Drop	Distance Ball Traveled	Time (Seconds)	Velocity (distance/time)
1			
2			
3			
4			
5			
		Average Velocity	

Step 2:

Now that you have found the velocity of the ping-pong ball, you will use this information to plot the topography of a transect along the surface of an imaginary asteroid. You will be creating your own asteroid terrain on the floor against the wall where you just did Step 1.

1. Create the topography model of *your* asteroid along the wall where you did Step One. In order to do this, you need to place wooden blocks *against* the wall in a line about 6 feet long. Be sure that you build some hills, mountains, valleys, etc. (see Figure below).



Ping-pong experiment layout diagram.🅭

2. Starting at the beginning of the top piece of tape, place a mark every 20cm. The bottom piece does not need to be marked. Measure and record your topography heights in the far right column of Table II as a check.

3. Again, starting at the 0 cm mark you made at the beginning of the tape, you will drop the ping-pong ball as you did in Step One, and record the time in Data Table II. Drop the ball every 20cm along the tape until you reach the end. Be sure to be as accurate as you can with the timing.

4. Find the average time for each of the intervals and record it in the data table.

5. Exchange your average time data with another student group (Table II) of just the cm interval, the average time. You will interpret each other's data to see if you can identify the topography of the other group's asteroid.

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6. Next, fill in the distance traveled in Table II by multiplying the average velocity from Table I by the average time just calculated at each interval.

7. In Data Table III, take the original distance traveled (height of high tape plus height of low tape, which will be the same for every interval) and fill in the first column of the table.

8. In the second column, take the distance the ball traveled from the column in Table II (last column on right) and copy that information to the 2nd column of Table III. Now, for the last column, simply subtract the 1st column data from the 2nd column data (the difference between the two) to determine the altitude of your modeled topography.

9. Plot the data (with interval/distance on the x-axis and altitude on the y-axis). Connect the dots to create your transect. Does your image match the true topography? If not, explain why it is different.

Data Table II

Interval	Trial 1	Trial 2	Trial 3	Time Average	Distance Ball Traveled = (velocity*average time) (cm)	Known measured height of placed block topography (cm)
0 cm						
20 cm						
40 cm						
60 cm						
80 cm						
100 cm						
120 cm						
140 cm						
160 cm						
180 cm						
200 cm						

---------------- tear here to give Table III to blind student group ----------------
Check their altitude answers with your measured known values in far right column of your Table II.

Data Table III (share with other "blind" student group) Ave Vel. = ___________

*R Interval	Time Average of 3 Trials	Original Distance Ball Traveled (Baseline From Data Table I) {D1}	Distance Ball Traveled = (velocity*average time) (cm) {D2}	Altitude (cm) {D1-D2=Altitude}
0 cm				
20 cm				
40 cm				
60 cm				
80 cm				
100 cm				
120 cm				
140 cm				

160 cm				
180 cm				
200 cm				

Step 3: Optional Plotting and Graphing the Data (if time, check resolution)

Step 4: Expand your thought process

The Laser Rangefinder aboard NEAR sends out a laser beam and "catches" it as it returns from being reflected by the surface of 433 Eros. The instrument records how long it takes the beam to reach the surface and bounce back. The scientists know how *fast* the beam is traveling; therefore, they can calculate how *far* it traveled. By measuring this time and multiplying by the velocity of the beam, they calculate how far the laser has traveled. They must then divide the distance the beam traveled in half.

1. Why did you not divide in half to find the distance to the object in *your* topography model?

Next, the scientist must compare this distance to a "baseline" distance we will call zero. On Earth, we might use sea level as the baseline. Another way to set the baselines is to start at the center of the planetary body being studied and draw a perfect circle as close to the surface of the body as possible. Using this baseline, the altitude compared to zero can be calculated and graphed. (Here on Earth, we often say that some point is a certain number of feet above or below sea level).

1. Why do we not use the term "sea level" for Mars and other planets?

2. You will now calculate the altitude of the points along your model. To do this subtract the distance the ball traveled at each interval (from Data Table II) from the distance the ball traveled in Step 1 (column B, Data Table I). The number you come up with will be zero or greater. Use Data Table III to do your calculations. The number in column B in this table should be the same for every interval. Remember, it is the baseline altitude and does not change.

*This exercise was adapted from Goddard Space Flight Center:
http://mola.gsfc.nasa.gov/pingpong.html