ORBITAL MECHANICS:
LANDING ON THE MOON

INTRODUCTION

In this lesson, students are divided into small groups to work together to try and successfully land a valuable “payload” on the moon. The small groups are responsible for the safe passage of the valuable item and are given the full authority to select a landing angle. In this simulation, students are trying to figure out the best way to safely land an object on the moon.

LESSON OVERVIEW

Subject & Grade Level: Science, 5 – 8 Grade

Length: 60 minutes

Objectives

At the conclusion of this lesson students will be able to:

- Construct rovers that can land intact closest to the landing zone.
- Analyze and conclude what makes the best landing rover.
- Reproduce basic physics knowledge through quality air ship designs.

Key Questions

- Why do we not fly straight to where we see the moon?
- What is the most effective way to land an unmanned vehicle?
- What forces allow a rover and rocket to move?

Standards

- NGSS MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- NGSS MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- NGSS MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- Common Core MP.2: Reason abstractly and quantitatively.

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Materials Needed:

Each group of 4 to 5 students will need the following item to complete this lesson.

- OM Reproducible 1
- 2 large sheets of cardboard (boxes from the cafeteria will suffice)
- 1 small rock/egg (about the same size, teacher's choice if you want it to be messy)
- 1 roll of duct tape
- 10-15 wooden unsharpened pencils
- 2 (8" x 11") sheets of construction paper
- 10-20 cotton balls
- 1 bottle of glue or glue stick
- 1 bandana/piece of cloth
- 2-3 balloons
- 1-2 plastic soda bottles
- 1 roll masking tape

Background Information: Teacher Knowledge

Trying to leave our atmosphere is not as easy as it sounds. Trying to land when returning is sometimes even more difficult. In both of these examples several differing equations are calculated to ensure that the astronauts and their cargo is kept safe throughout the entire process.

For many years, the main system of returning to Earth was varying kinds of drag chutes and parachutes that slowly lowered the capsule. On the moon this is not possible because of the lack of atmosphere. Since there is no atmosphere, the parachutes would not be useful as they cannot be used in correlation with air resistance.

Another way to land on the moon or land on Earth is the idea of powered descent. In this technique, the ship or capsule utilizes rockets to slow itself down before quietly touching down on the surface. This was the technique utilized by the Apollo missions in the 1960s and 1970s.

The final example is the technique of lithobraking. Lithobraking, demonstrated in this lab, is the act of absorbing all of the kinetic energy and dispersing it through direct impact. To ensure the survival of the object, it is usually covered in a series of airbag-like devices that act as cushions for the landing. This technique was most recently explored during the Mars missions, and a similar technique to modern day lithobraking was utilized in the moon missions.

In the 1960s, Ranger missions to the moon utilized a different type of lithobraking because of the mission's focus. The Ranger missions were focused on what could be done prior to impact on the moon's surface. On the other hand, the recent Mars missions focused on payload survival and the ability to continue exploration.

Resources

Orbital Spaceflight
http://www2.jpl.nasa.gov/basics/bsf3-4.php

Lithobraking
http://en.wikipedia.org/wiki/Lithobraking

Historical Moon Landings
http://science.howstuffworks.com/apollo-spacecraft6.htm

http://airandspace.si.edu/explore-and-learn/topics/apollo/apollo-program/landing-missions/apollo11.cfm

http://science.nasa.gov/missions/ranger/

http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1969-059C

https://www.youtube.com/watch?v=RMINSD7MmT4

LESSON STEPS

Teacher Preparation

To prepare for this lesson, teachers must have reviewed the basic resources and created the basic "target" for their students. Teachers will create this target using masking tape to mimic a bullseye. This will be what students will aim for when they attempt their different designs. Teachers need to prepare all of the above mentioned materials. It might be easier if students were given a box/basket that contained all of the materials so everything can be easily prepared.

Warm-Up

Divide the class into groups of 4 to 5 students

Show the following video (https://www.youtube.com/watch?v=RMINSD7MmT4). Pause the video interminably (about every 15 seconds). Have students analyze what they are seeing and what they think they are seeing in each segment. (Utilize OM REPRODUCIBLE 1 to guide their talking points). Accuracy is not important in their responses, but active analysis and participation is key.

Show Image 1 from OM REPRODUCIBLE 2 on the screen and provide another 30 seconds to analyze.

Have a larger group discussion sharing everyone's input about what they think is going on and why it is happening.

A few sample questions to help guide the discussion:

What is going in this video?

What do you think we are discussing today?

When do you think this happened/happens?

Where are the men located?

How do you think they got to this location?

This leads into a brief discussion-based learning period where all the answers above are given definite answers. (For example: What is going on in this video? Man is on the moon's surface for the first time.)

Activity

At this point, explain to the students that their task is to continue following in the footsteps of these men. Their simulation is a little different however. There is already a base on the moon, they just need to get supplies to the group. Create a rover that will land and maintain functionality through the lithobreaking landing technique. (Example can be shown with OM REPRODUCIBLE 2)

They must create a rover that can carry the rock/egg provided and will land safely on the bullseye. (Additional instructions included on OM REPRODUCIBLE 1)

After giving the students a small amount of time to build their object, each group will come up one at a time and test their rover with the "landing vehicle" (the bucket) to attempt to land it on the bullseye. Measure and make note of how close each rover landed, as well as how intact it was when it landed.

After each group has attempted their landing, have a brief class discussion about what they saw and have students write down on the back of the worksheet three things they learned from today, two things they would do to improve the design, and one thing they liked about another design that they would use in the future.

Name_____ Date_____

Orbital Mechanics: Landing a Rover

In today's lesson you will be responsible for designing and landing your own rover on the moon. You will have limited resources and only one attempt at landing, so be sure you think through your plan very carefully.

Information Gathering

Look at the two images your teacher displays. Within your group, discuss the following questions:

1. What is taking place on in this image? and why?
2. What shapes do you see in these images?
3. How do these two images relate to what we are going to do in class? (make a guess if you do not know)

Information into Action

You will be designing a rover that will have to carry the provided rock as well as land safely on the landing pad (the bullseye). You will have 15 minutes to work with your group to brainstorm and create the best design. Here are a few things to keep in mind:

1. Is the valuable mineral (the rock) secure and immovable?
2. Will the rover still be functional after it falls below?
3. How can you angle the bucket during launch to get the best angle for your rover?

Materials to Build Your Rover

- 2 large sheets of cardboard (boxes from the cafeteria will suffice)
- 1 small rock/egg (about the same size, teacher's choice if you want it to be messy)
- 1 roll of duct tape
- 10-15 wooden unsharpened pencils
- 2 (8" x 11") sheets of construction paper
- 10-20 cotton balls
- 1 bottle of glue or glue stick
- 1 bandana/piece of cloth
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Conclusion: What did you learn?

Write three things you learned today:

Describe two ways you would improve your team's design:

Describe one idea that you would borrow or use from another team's design in your future models:


39
4C
4D
4E
53
30