Space Exploration
PBL

- Students describe the history and future of space exploration, including the types of equipment and transportation needed for space travel.
- Students design a lunar buggy and landing pod considering the affects of gravity; a force of attraction between two or more masses.
- Students experiment with gravitational attraction exhibited by an object increases with increasing mass.
Student and Group Contract

This contract is a binding document and governs the group until the assigned project deadline. You must agree to the conditions listed below in order to work on this project. Your signature is required.

Personal Responsibility:

Student takes responsibility for and completes his or her tasks within the group. Your job is to remain on task and engaged in whatever the group is doing. You must use feedback in a constructive way and discuss your opinions within the group in a positive manner.

Team Work Policy:

If a group member will be absent on a day in which work is due, they must tell another group member a day in advance and have all work that they are responsible for turned in. All group members must stick to the provided agenda to have the assignments completed on time. If there will be an unexpected absence, the absent group member is to complete the work from home and bring it the next day.

Each group member will work to the best of their ability, making sure to complete the work is up to standards, and that they completed it on time. If one member is not doing their work, the group may have a meeting to discuss the problems with the teacher as a mediator.

At the beginning of the project, a leader will be chosen by the teacher. Each group will have team roles that each individual will be held responsible. Team roles are leader, academic manager, engineer/architect, and project manager.

My role is: _________________________________________

My responsibilities are: ______________________________________________________________________________________

My group members are: __________________________________________ , __________________________________________
____________________________________________________________________________ , __________________________________________

Contacting Group members:

You need to provide outside of school contact information to your group members. It can be a phone number or email. Group members must be able to contact you outside of school in order to work on this project.

By signing this contract the following group members abide to the agreements above.

Signature: _______________________________________________          Date: ____________________

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Due Date</th>
<th>Possible Points</th>
<th>My Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>/ /2014</td>
<td>___ Out of ___</td>
<td></td>
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Background:

History of Space Exploration

Until the 20th century, space exploration required looking through a telescope. Beginning in the late 1950s, scientists advanced space study by leaps and bounds. In 1957, Sputnik 1 was launched by the Soviet Union and it was the first satellite, or man-made object, to orbit Earth. Satellites have vastly improved our ability to explore space, forecast the weather, and monitor changes to Earth’s surface. The first successful weather satellite, Tiros 1, was launched by the U.S. in 1960. Other uses for satellites include communications, reconnaissance, navigation, and search and rescue.

In this PBL, you will be able to design and build a Lunar Buggy model to transport astronauts and cargo on the Moon. Before humans can travel to other planets, they first must send robotic buggys to these remote locations to investigate the surface of that planet.

The first probe sent into space by the U.S. was Pioneer 1 in 1958. It reached a height of 70,700 miles above Earth’s surface. Since this first probe, the U.S. has sent many more probes further and further into space. Pioneer 10 in 1972 was the first man-made object to travel through the asteroid belt located between the orbits of Mars and Jupiter. The Voyager 2 probe was launched in 1977 and travelled past Jupiter in 1979 and past Uranus in 1986. Several probes, both orbiting and buggys, have been sent to explore Mars, including the Mars Pathfinder buggy, which landed on Mars in 1977, and the Mars Spirit and Opportunity buggys, which landed in 2003.

In 1958 the National Aeronautics and Space Administration (NASA) was founded. By considering the characteristics of our solar system, NASA’s space program decides what equipment, accommodations, and transportation are needed for space exploration (from orbiting Earth to putting a man on the Moon).

Investigate the robotic buggys that NASA has already built and used to explore other planets. For example, you can learn about the challenges in building the Mars Exploration Buggys from this website: http://marsbuggy.nasa.gov/gallery/video/challenges.html
Introduction: Lunar Buggy

Let’s Go for a Ride!

During the first set of activities, you have spent some time thinking about how to get to the Moon. Now you need to think about landing on the Moon, and how to deliver cargo to the Moon. Astronauts will need a mode of transportation in order to investigate different areas of the Moon. During the Apollo missions, astronauts drove a Lunar Buggy several kilometers away from their spacecraft. Today you get to be the engineers designing a new Lunar Buggy that can perform functions the Apollo Lunar Buggy could not. Your challenge is to build a model of a Lunar Buggy that astronauts will eventually use to carry astronauts and cargo on the Moon.
Our Project

Our challenge is to construct a model of a lunar buggy/roving vehicle that can actually move, by gravity.

For example, the Apollo lunar roving vehicle was a battery-powered space buggy. The astronauts on Apollo, used it to explore their landing sites and to travel greater distances than astronauts on earlier missions. The lunar buggy neatly folded up inside the lunar lander during trips to the Moon. Once on the Moon’s surface, it unfolded with the help of springs.

The lunar buggy carried two astronauts and was manually driven. It was designed to climb steep slopes, to go over rocks, and to move easily over the Moon’s regolith. It was able to carry more than twice its own weight in passengers, scientific instruments, rocks, and regolith samples. The wheels on the buggy were made of wire mesh (piano wire) with titanium cleats for treads. Engineers did not use solid or air-filled rubber tires because they would have been much heavier than were the wire mesh wheels.

The Apollo spacecraft had a fixed amount of mass (payload) it could deliver to the surface, including the buggy, buggy batteries, scientific instruments, sample collection devices, etc. Hence, the wire mesh wheels were important to the overall payload mass.

This buggy was not designed for prolonged use, and it is uncertain if future lunar explorers would use similar designs and materials for their vehicles.

Your design challenge is to build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon and to determine the best slope of ramp for the buggy to travel the farthest distance.
Draw your Lunar Buggy and provide a close-up view of your wheel and axle design. Make sure to label all the parts of your design.

**Buggy Design:**

**Wheel and Axle Design:**
Lunar Buggy Blueprint

List of necessary materials:

_________________________________________________________

___________________________________________________________________________________

___________________________________________________________________________________

___________________________________________________________________________________
### Lunar Buggy Distance and Modification Data Table

<table>
<thead>
<tr>
<th>Trial</th>
<th>Distance Traveled (cm)</th>
<th>Modification to make to design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>Final</td>
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</table>

Use the space below to draw any modifications
Your team will make to your buggy.
Now that you have designed a Lunar Buggy that will transport astronauts around the lunar surface, you need to think about safely delivering this vehicle to the Moon. When NASA sent its two robotic rovers, Spirit and Opportunity, to Mars, they landed on Mars in a very interesting fashion. They fell out of the Martian sky, slowed down by a parachute and then bounced on the surface until they came to a stop! How did they do that? The rovers were inside a landing pod made of AIR BAGS! But the Martian atmosphere and surface is very different from the Moon, so to repeat this on the Moon would require several design modifications.
Our Project

Each team must design and build a Landing Pod that will safely deliver your Lunar Buggy to the Moon's surface. The Landing Pod must meet the following constraints:

1. The Landing Pod must safely deliver your Lunar Buggy to the surface from a height given by the teacher.
2. The Landing Pod must land in such a way that all cargo remains intact and safe.
3. Materials of the Landing Pod must be reusable for other missions on the lunar surface. If tape folds over on itself, those items are no longer reusable.
4. The Landing Pod must have a hatch or door for release of the Lunar Buggy, and should then roll out with no more than a nudge onto the ramp. Therefore, the Lunar Buggy cannot be taped or glued inside the Landing Pod.
5. The Lunar Buggy should not suffer any damage from the lunar landing and still be able to roll down a ramp.

View the video titled “Entry, Decent, and Landing (EDL).” Pay particular attention to the ways NASA slowed the rovers down as they entered the atmosphere. Note the difference between the Martian atmosphere and that of the Moon. Explain that with no atmosphere on the Moon, a parachute will not work!

http://marsrovers.nasa.gov/gallery/video/challenges.html
Landing Pod Design

Draw your Landing Pod and provide a description of how you will ensure the safety of the astronauts and their cargo. Make sure to label all the critical parts of your design.

How will you keep the astronauts and their cargo safe?
# Landing Pod Drop Height and Modification Table

<table>
<thead>
<tr>
<th>Trial</th>
<th>Drop Height (cm)</th>
<th>Modification to make to design</th>
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<td>4</td>
<td></td>
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<tr>
<td>Final</td>
<td></td>
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</tbody>
</table>

## Results

<table>
<thead>
<tr>
<th>Did the astronauts land safely?</th>
<th>Did the cargo land safely?</th>
<th>Is the Landing Pod reusable?</th>
<th>What improvements could you make?</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
Video Script

My group includes ___________________________________. We believe that our landing pod will land safely because ____________________________________________________________

(OR, we believe that our landing pod will NOT land safely because ____________________________________________________________).

We know that gravity will pull the shuttle down, so to protect our cargo we ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ 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**Assessments and Reflections**

**Project Rubrics**

**Daily Grade**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Due Date</th>
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<th>My Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>/ /2014</td>
<td>_____ Out of ____</td>
<td></td>
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<tr>
<td>(rubric)</td>
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</tbody>
</table>

**Quiz/Lab Grades**

<table>
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<tr>
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<th>My Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lunar Buggy Trials</td>
<td>/ /2014</td>
<td>_____ Out of ____</td>
<td></td>
</tr>
<tr>
<td>Landing Pod Trials</td>
<td>/ /2014</td>
<td>_____ Out of ____</td>
<td></td>
</tr>
</tbody>
</table>

**Major/Project Grade**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Due Date</th>
<th>Possible Points</th>
<th>My Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video with Script</td>
<td>/ /2014</td>
<td>_____ Out of ____</td>
<td></td>
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</tbody>
</table>
Project Reflection

Reflect on your involvement by completing the following statements.

1. How did our team work well together in this PBL project?

2. How could our team work better together in the next PBL project?

3. What did I like best about the PBL experience?

4. What would I like to change about the PBL experience?
Self Reflection

Reflect on your involvement by completing the following statements.

1. What have I learned about the subject matter?

2. What questions do I still have?

3. What have I learned about working in a group?

4. What are my strengths?

5. What are my weaknesses?

6. What would I do differently next time?

Additional Comments: