Flyby, Orbiter, or Lander

Suggested Grade Level: 3–9

Summary

- Students will plan and carry out a sequence of simulated planetary missions in the classroom.
- Students will make a series of observations of an unknown planet.

Standards

- NM Science Content Standards: Strand III, Science and Society National Science Standards: Standard E, Technological Design

Background Information

Spacecraft missions to explore another planet usually go through a sequence of mission-types. Each type of mission represents increasing technological difficulty and increasing abundance of data. The first mission to another planet is usually a flyby mission, designed to encounter the planet in its orbit around the sun and take as many images or other data as possible while zooming past the planet. This is frequently the first look at the surface of a planet, and sometimes it can be misleading since the spacecraft can image only a portion of one hemisphere during its flight past the planet.

If all goes well on the flyby, the next type of mission is usually a reconnaissance orbiter, a spacecraft with one or more instruments, that goes into permanent orbit around the planet and sends back data or images covering the entire planet for the lifetime of the orbiting spacecraft.

The next step in exploration is usually a lander. Lander missions are always a balancing act between science and engineering. The scientists on the mission want to land somewhere interesting, but the mission engineers want to land in a safe area, and the more interesting sites are usually more dangerous. In general, lander missions usually land in safe, flat, (geologically) uninteresting sites. This type of mission usually returns the first analysis of the surface sand or rocks of the planet, but is limited to analysis at the specific landing site.

The solution is the next step in planetary exploration, a rover mission. With a rover, you can land somewhere safe and then travel to a more scientifically interesting area(s). The next logical step after a series of increasingly longer-distance and larger, more capable rovers is a sample-return mission. There are many types of analysis that cannot be accomplished with a lander. In order to acquire a complete chemical analysis and the age of a rock from Mars, scientists will need to send one or more sample-return missions. Ultimately, after

flyby, orbiter, lander, rover, and sample return, the next step for Mars will probably be human missions, estimated to occur in 2020 to 2040. In this activity, each student team will model the sequence of missions that we have sent to Mars and make observations about a planet created by another team. The series of observations will consist of (1) Earth-based telescope views of the planet, (2) flyby mission past the planet, (3) orbiter mission around the planet, and (4) lander mission to the planet's surface. The Flyby, Orbiter, or Lander Mission Data Sheet will be used for each mission and team members will record their observations and questions to be explored in future missions to the planet.

Materials

1. Flyby, Orbiter, or Lander Mission Data Sheet included in this activity.

2. Materials to use in making planets: styrofoam balls, plastic or rubber balls, clay, Playdoh™, fruit.

3. Materials to use in making surface or atmospheric features on the planets: vinegar, perfume, small stickers, sequins, candy, grapes, leaves, cotton balls, metal charms, milagros, or anything small and interesting.

4. Toothpicks, push-pins or glue to attach planet features.

5. A special tool called the Planetary Viewing Scope, which can be made from toilet paper or paper towel cardboard roll with blue cellophane covering one end (use a rubber band to hold it on).

6. Towels, one for each planet. Lightweight dish cloths, tea towels, paper towels, or thin hand towels, that are large enough to cover each of the planets, can be used.

Preparation

1. Collect the materials listed above for use in making planets and planetary features. Collection of materials can also be assigned to the students prior to the activity.

2. Collect toilet paper or paper towel cardboard rolls and a towel for each student team, or ask students to collect them.

3. Cut small square sheets of blue cellophane. Make the Planetary Viewing Scopes, or have students make them as an introduction to the activity.

4. Print and photocopy Data Sheet as a double-sided sheet (or tape or staple two pages together) for each student team.

Introduction for Students

Planetary scientists study other planets, but they cannot go to those planets themselves. How do they study the planets (telescopes, spacecraft missions, scientific instruments)? Usually, scientists plan a series of missions that keep getting closer and closer to the planet and send back more and more details about the planet. Why would this be a good way to study another planet? Why not just send a lander or rover or humans immediately? What type of things could you learn about a planet with each type of mission (flyby, orbiter, lander, rover)? What are the problems with each of these mission types?

Procedure

1. Each team of students will make a planet by choosing a selection of the objects listed above. Some suggested features could include making clouds using the cotton balls, using a grape on a toothpick to depict a moon or satellite, embedding or gluing stickers or other features to the surface, and applying scent sparingly to a specific place on the planet.

2. When the planets are completed, they should be placed in the corners of the classroom or in a larger area, and each planet should be covered with a towel. Each planet should be separated from the others with space around it, and all of them should be at least five feet apart from each other and a classroom-distance away from an area in the classroom that will be designated as Mission Control.

3. Choose one side of the room to be Mission Control and gather the teams there. Each team can have their own small area and a table or desk which they will use when recording their observations. The teams cannot move out of their area until directed to do so by the teacher.

4. Assign a planet to each team (teams should be assigned planets made by other teams). Each team will perform a pre-mission reconnaissance of their assigned planet by using their Planetary Viewing Scope (this models an Earth-bound observation through a telescope where the blue cellophane represents Earth's atmosphere). The teacher or an assistant should remove the towel from each planet for one minute only and each team should be directed to observe their planet through their Planetary Viewing Scope and write down their observations and questions. After one minute, the towels should be replaced over all of the planets.

5. Each team will perform a flyby planetary mission. Each team will have a turn at walking single-file quickly by the planet at a distance of five feet. The teacher or an assistant should raise one half of the towel, on the flyby side, and the other side of the planet should remain hidden under the towel. The towel should be replaced over both hemispheres of the planet and team members should reconvene at mission control and record their observations and questions.

6. Each team will perform an orbiter mission. The teacher or assistant should remove the towel and allow each team two minutes to orbit (walk in a circle around) the planet at a distance of two feet. After two minutes, the towel should be replaced over the planet and the team members reconvene at mission control and record their observations and questions. The observations and questions from the orbiter mission should include the selection of a proposed landing site on the planet for the next mission.

7. Each team will perform a lander mission. The team should first select a specific landing site on the planet, based on their prior flyby and orbiter missions. The teacher or assistant should remove the towel. Each team should approach their assigned planet and one team member marks the previously selected landing site with a push pin or a small dot. Team members take turns observing the local area at the landing site by placing their Planetary Viewing Scope (without the blue cellophane) about one inch above the planet at that site and looking through the scope. They cannot use the Planetary Viewing Scope to examine any other area except their selected landing site. After five minutes the team members return to Mission Control to record and compile all of their observations.

Process/Closure

Each team should select a spokesperson to present their discoveries about their assigned planet to the class. The presentation should include the answers to the following questions: What was learned from each mission? What was not learned from each mission? What were the problems encountered during each mission? What are the features of this planet? What is still unknown about this planet? What would be the goal of the next mission to this planet if your team could send another mission? What type of mission should be planned for a follow-up mission (another lander, rover, sample-return, or human mission)?

Extension/Enrichment

Have the teams write a complete mission plan (landing site, equipment, scientific instruments to be included, goals of the mission) for a follow-up mission to their assigned planet.

Credits

Adapted by Kathy Jones, Albuquerque Public Schools, from the activity entitled Strange New World, from the ASU Mars K-12 Education Program, and the information entitled How to Explore a Planet in NASA Education Brief EB-112.

Name(s) _____

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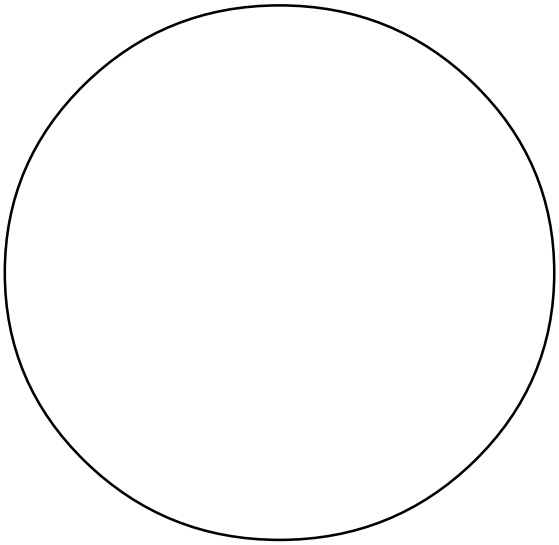
Date _____

Flyby, Orbiter, or Lander

Mission 1: Earth Observation



Data/observations:

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Problems with this mission:

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Goal for the next mission:

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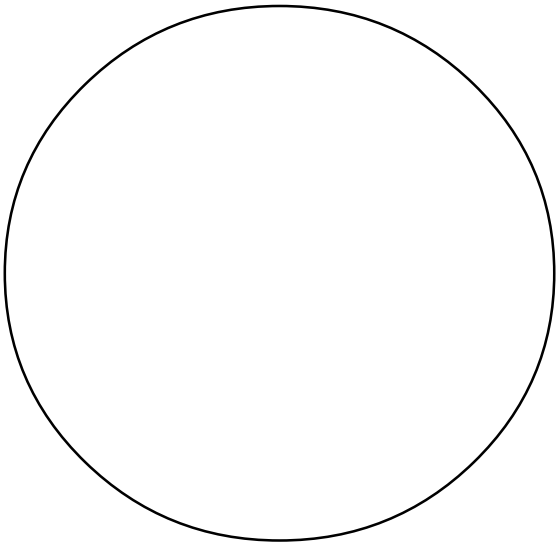
Mission 2: Flyby



Data/observations:

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Problems with this mission:

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Goal for the next mission:

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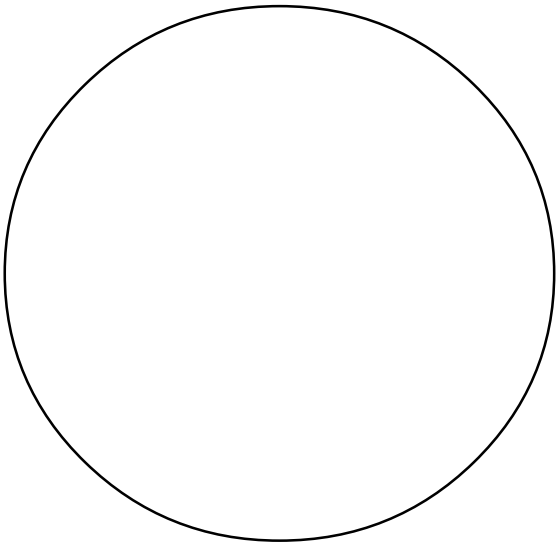
Mission 3: Orbiter



Data/observations:

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Problems with this mission:

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Goal for the next mission:

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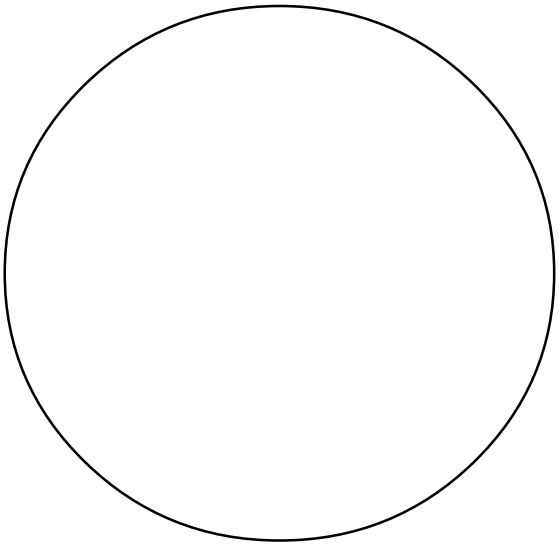
Mission 4: Lander



Data/observations:

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Problems with this mission:

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Goal for the next mission:

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