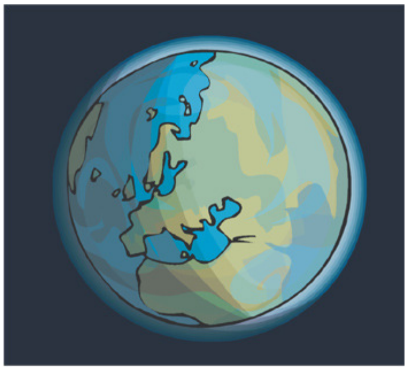


Passports: Adventures in Learning
A Traveler's Guide through the Solar System
Earth & Mars
Curriculum Guide grades 6-8

Objectives:

Language Arts

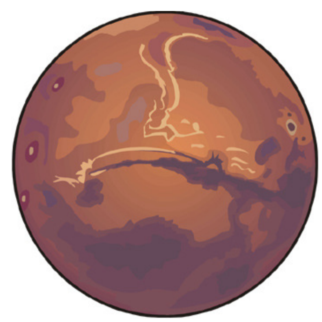
- Organize and apply factual information using a Venn diagram.
- Develop a Press Kit that represents every aspect of a fictional mission to Mars.

Science

- Describe the physical properties of Earth, the Moon, and Mars.
- Compare Mars' geography to harsh environments that can be found on Earth.
- To demonstrate meteorite impacts on various surfaces, and to analyze impact data.

Mathematics

- Understand measurable attributes of objects and the units, systems and processes of measurements
- Apply appropriate techniques, tools, and formulas to determine measurements To demonstrate meteorite impacts on various surfaces, and to analyze impact data.



Vocabulary:

Satellite – anything that orbits a planet

Moon – the proper name of the object that orbits around the Earth

Mantle – The region between the core and lithosphere and is about 1,740 miles (2,800 kilometers) thick and consists of three regions: the upper mantle, the intermediate mantle, and the inner mantle. The mantle is composed of solid rocky material.

Core – the center of the Earth with a radius of about 2,160 miles (3,480 kilometers).; The core is believed to consist of two layers: 1) the inner core which has a radius of about 780 miles (1,255 kilometers) and is solid metal (mostly iron and nickel) and 2) the outer core which is composed of liquid metal.

Lithosphere – The outermost layer, the lithosphere, is about 50 miles (80 kilometers) thick. The lithosphere includes the crust which varies in thickness from place to place and composed of the crust and uppermost part of the mantle, which move together as plates on top of the Earth's surface.

Eclipse – The passage of one celestial body in front of another, cutting off the light from the second body (e.g. an eclipse of the sun by the moon, or one star in a binary system eclipsing the other). It may also be the passage of all or part of one body through the shadow of another (e.g. a lunar eclipse in which the moon passes through the Earth's shadow).

Lunar – pertaining to the Moon

Crater – a basin resulting from the collision of an object with a planetary surface

Axis – an imaginary line through the center of a planet. A planet spins on its axis.

Gravity – the force of attraction that exists between one heavenly body and another; the more massive an object, the greater its gravity

Meteorite – A small body from space that survives passage through the Earth’s atmosphere and reaches the surface.

Tectonics – the process that forms planetary features such as continents, mountains, and faults by the motion of sections (plates) of the Earth’s crust driven by convection currents in the Earth’s mantle

Weight – the force with which the Earth’s gravity pulls down on something

Activity 1

Before participating in Earth & Mars, engage students in the following activity:
Using the KWL Chart, have the students complete the sections “What I Know” and “What I want to Know” about Earth and Mars.

Activity 2

Students will complete the KWL Chart section “What I learned” after participating in Earth and Mars.

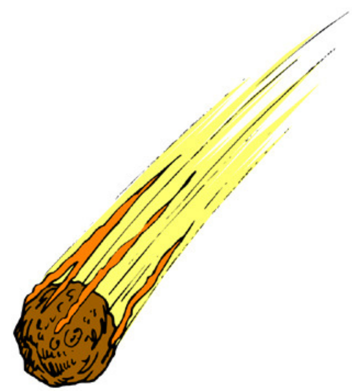
Activity 3 – Watch Out!
Background:
Finding meteorites is quite difficult because most meteorites look like Earth rocks to the casual or untrained eye. Even to the trained eye, recognizing meteorites can be difficult. In many cases meteorites break apart into many fragments as they pass through the atmosphere or impact the Earth. These smaller fragments are harder to find than one large meteorite. Meteorites are rarely found in forests or fields, where they become buried or lost among the plants. In rocky areas, meteorites are hard to find because they tend to be dull black, gray or white, and do not stand out among the much more common Earth rocks. Iron meteorites are the exception. There are few natural sources of metal except meteorites. Old iron implements can be (and often are) mistaken for meteorites. In many cases, a chemical analysis is required to distinguish a meteorite from an Earth rock.

In their experiments, students will likely discover that good places to retrieve meteorites are surfaces that have no similar rocks, are very flat, have a contrasting background, and do not have thick vegetation. These conditions are best met on Earth by the polar ice cap in Antarctica, where in fact, thousands of meteorites have been found since 1969. Lots of meteorites have been found in deserts, especially in the Sahara and in southern Australia, where there are flat areas with few other rocks.

Water balloons filled with pebbles help students model the distribution of materials after meteorite impacts. The pebbles represent the meteorite fragments. Students will model to draw conclusions about where it would be easiest to find meteorites.

Materials:
Per student

- Student Sheets
- One balloon (Round works best.)
- 10 to 20 small pebbles (Colored aquarium rocks work well.)
- Graph paper
- Protective goggles



Per group or classroom

- Water faucet to fill balloons
- Funnel (one per group)
- Thin stick or skewer
- Section of a cardboard box
- Dirt area or sandy area – can use cement area
- Grassy area
- “woody” area – can use shrubs or bushes
- Rocky area – can use an area with landscaping river rock

Procedure:
1. Distribute Student Sheet and Data Table
2. Look at or discuss the selected impact sites prior to predicting on Student Sheet.
    a. Dirt/Sandy/ or Cement area – represents the Sahara Desert and Antarctica
    b. Grassy area – represents grasslands around the world
    c. Woody area – represents forests around the world (including rainforests)
3. Have students collect materials and follow the student procedure.
4. Discuss results and lead to conclusions that Antarctica and deserts are likely the easiest places to find meteorites.

Activity 4 – Investigating the Moon

Materials:

1. Investigating the Moon Student Sheet
2. pencil

Key Question: Why study the Moon?

Procedure:

1. Handout Investigating the Moon Student Sheet
2. Each student complete each question on the map. Encourage the students to draw illustrations to go with their answers.
3. Use the students' answers as an informal method to assess prior knowledge by starting a class discussion. Students' answers will vary. Below are some examples of where to lead the discussion:

Examples of Student Responses	Discussion Points
a. the Moon changes appearances	Discuss the phases of the Moon and the orbital motions that generate its change in appearance.
b. The Moon has a lot of crater	Discuss what contributes to the comparatively large amounts of craters on the Moon's surface, such as lack of atmosphere and erosion.
c. The Moon has light and dark areas	Talk about maria and lunar highlands, and investigate why the smooth maria appear darker than the surrounding terrain.
d. People have walked on the Moon	Talk about the Apollo space program and future plans to return humans to the Moon.
e. The Moon is the only natural satellite of the Earth	Talk about theories of how the Moon may formed.

Activity 5 – Where on Earth?

This activity would be best completed in a computer lab with multiple computers with Internet access.

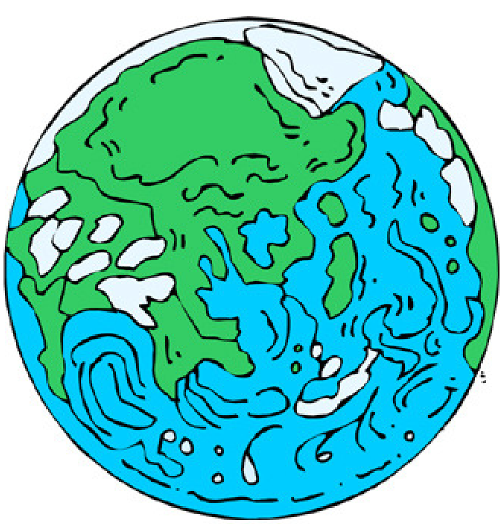
Background: In order to better prepare astronauts and equipment for the harsh conditions of space, NASA has been doing some research here on our home planet. While the space environments cannot be copied here on Earth, one can find similarities Extreme Earth environments, representing a wide range of conditions, can help NASA prepare for everything from the isolation of the vacuum of space to the alien surface of another world. This activity will allow students to research the geography of the Red Planet, and to link to different regions to areas of harsh environment found on Earth.

Procedure:

1. Explain to the students that they will be comparing locations on Earth to locations that can be found on Mars.
2. Hand out the Student Sheets. Using information from the Internet and the reading, have students fill in characteristics of the five locations listed in the article. This information goes in the Earth Region Table.
3. Explain that the students are going to learn about different regions on Mars and compare them to the locations they just listed from the article.
4. Have students go to the Web site listed on the Student Sheet and read about Mars.
5. Students should fill in the Mars Region Table with the information they learn at the Web site.
6. Once students have completed the Mars Region Table, have students finish the Student Sheets.

Discussion/Wrap Up:

- Have students share their findings from the Earth Location Table and the Mars Region Table.
- Go over the answers to the questions on the Student Sheets.
- Discuss the importance of testing materials and how people work in harsh conditions found on Earth before exploring other parts of the solar system.



Activity 6 – Mars Press Kit

Have each student imagine that he/she is a team member of a Mars Mission. This press kit will represent every aspect of the fictional mission from beginning to end. The way it is presented should be up to the student, but below are some guidelines to get started:

- A press release announcing the mission and its team members
- A biography sheet of the student with title of job and how the job relates to the mission.
- A mission statement including a timeline, plan for research, and goals.
- Pictures of the spacecraft inside and out.
- Pictures of the Mars Outpost.
- A graph showing when Mars aligns properly with the Earth and how the spacecraft will properly launch to Mars.
- Pictures or samples of plants that will be taken along.
- A dietary plan.

Critical Thinking Skills:

What information did you learn about Earth and Mars that surprised you the most? Explain why.

Websites:
http://photojournal.jpl.nasa.gov/index.html
http://seds.lpl.arizona.edu/nineplanets/nineplanets/overview.html

http://www.seds.org/billa/tnp/luna.html
http://www.kidsastronomy.com
http://mars.jpl.nasa.gov/
http://solarsystem.nasa.gov/index.cfm
http://www.tsgc.utexas.edu/everything/moon/

National Mathematics Standards:

Number and Operations – Understand numbers, ways of representing number, relationships among numbers, and number systems; proportion, estimation

Problem solving – representation of a real world situation with models

Algebra – Use mathematical models to represent and understand quantitative relationships.

Measurement – Use visualization, spatial reasoning, and geometric modeling to solve problems.

Communication

Using math in another subject and critical thinking using mathematics

National Science Standards:

Abilities necessary to do scientific inquiry; Understandings about scientific inquiry

Physical Science – Properties of objects and materials

Earth and Space Science – objects in the sky

History and Nature of Science – Science as a human endeavor

Nature of Science – Science process skills

KWL Chart

What I know about Earth	What I want to know about Earth	What I learned about Earth
What I know about Mars	What I want to know about Mars	What I learned about Mars

Watch Out! Student Sheet

Materials:

Per Student
Student Sheet
1 balloon
10-20 small aquarium pebbles
Graph paper
Safety glasses

Per Group
water faucet
funnel
thin stick or skewer

Procedure:

Designate Groups: This activity is designed to be done in groups of 2-3 students. Although each student launches (throws) a balloon filled with water and pebbles, students should work as a group to choose areas, make predictions, record observations, and draw conclusions.

Designate Target Areas: Working with your teacher, find 3-4 locations of various surfaces where balloons filled with water and pebbles can be exploded. Surfaces commonly found at a school site are concrete pavement, sand pit, grassy area, gravel, pebble, or shell surface, snow, ice, and water. Be sure to get permission to use all areas.

Classroom Procedure:

1. Gather all equipment
2. Choose or assign terrain target areas for each student group
3. Record information on Data Table
4. Make predictions and record on Data Table.
5. Count the number of pebbles you have, noting the color and number of each.
6. Add pebbles one at a time.
7. Fill balloon ¾ full with water. Be sure to tie the balloon securely.
8. Put safety glasses on.
9. Launch balloons one at a time in designated areas. Try to throw the balloon at an angle. Record observations at your launch site.
10. Retrieve as many colored pebbles from your balloon.
11. Record the number and color of your pebbles.
12. Clean up all balloon fragments and leave the impact areas as clean as possible.

Watch Out! – Data Sheet

Predict the number of pebbles you will recover___________________

Launch Site Description ____
Launch Specifics:
Impact angle (estimate) _____________________________
Impact velocity (fast or slow) __________________________
Sketch of impact site:

Pebbles:

Color	Number (begin)	Number Recovered	% recovered

Construct a circle graph of the percentage starting and percentage recovered:

Percentage of each color (begin)

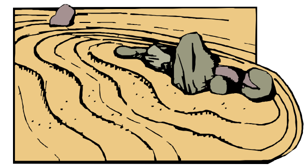
Percent recovered

Questions:

1. Based on your data, which surface was the easiest for recovery? Why?

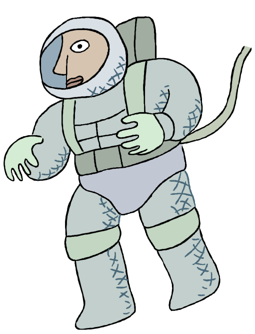
2. What kind of land surface might be most productive for searching for meteorites? Why?

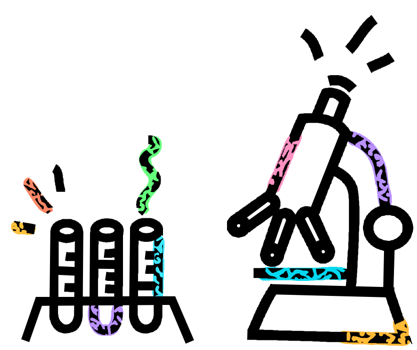
Investigating the Moon – Student Sheet



I know the Moon is…….

I know the Moon has…….





I would like to visit the Moon because …….

If I went to the Moon I would study…….

Where on Earth? Reading

Space: there's nothing on Earth like it. Or is there? To get astronauts and equipment ready for the **harsh** conditions of space, NASA has been doing some research here on our home planet. While the space environments cannot be copied here on Earth, some places have similar conditions. Extreme Earth environments can help NASA prepare for everything from the **isolation** of space to the alien surface of another world.

Many people see space as mankind's next great **frontier**. For many years, the ocean was the focus of exploration. This has caused many people to compare space to the ocean. Now, NASA is using this comparison to its advantage. Over the past 2 years, several crews of astronauts have manned an underwater station off the coast of Florida. Believe it or not, living underwater is helping these astronauts learn more about living in space. In the Aquarius Underwater Research Facility, astronauts see what it's like to live in isolation, deal with complex equipment, and perform scientific research similar to that being done in space.

Since 1999, groups of researchers from NASA and the Mars Society have spent part of their summers on Devon Island in Canada. Devon Island is the largest **uninhabited** island in the world. Researchers are looking at this island because it has features they believe are similar to those found on Mars. The island is a polar desert, and has a meteor impact crater. Camps have been set up on the **rubble** near the crater. Here, they test habitats, equipment, and technology similar to what might be used on a manned Mars mission in the future. Plus, researchers are looking for clues to help them find water under the surface of Mars.

Antarctica is also seen as an ideal location for Mars **analog** research. Its harsh environment lets scientists see how equipment (and humans) functions in extreme environments. Plus, scientists can study the microbes that live in this frozen place. This gives them clues to what kinds of life could exist on places like Mars or Europa, one of Jupiter's moons. This may one day lead to the discovery of alien life in our solar system.

Earth's deserts are also a good place to study what life might be like on the Martian surface. One of the most famous spots that scientists like to study is Death Valley, California. Scientists are looking at how the desert environments on Earth have been shaped. This will help scientists understand how the Martian landscape has taken form. For example, researchers have found dunes and landforms on Mars that are similar to those found in deserts on Earth. There are even areas of Mars that look like dried lake beds found on Earth. This makes scientists think there may have once been large bodies of water on Mars.

While most of these places are extremely **remote**, some of them aren't too hard to get to. Many of Earth's volcanoes, for example, are quite similar to those found on Mars. Mount Etna in Italy has a pattern of channels very similar to channels seen on the Moon, Venus, and Mars. Other volcanoes on Earth look a lot like those seen on Mars. These volcanoes, called large-shield volcanoes, have low slopes and large diameters. And, other volcanoes are surrounded by huge lava flows just like many Martian volcanoes.

Someday, a place even more remote than the frozen wastelands or **barren** deserts of Earth may be used to prepare for a trip to Mars. Some people have brought up the idea of returning to the Moon for extended stays to get ready for a mission to Mars. After all, what better place is there to learn about being on another world than on the surface of another world?

Where on Earth? Student Sheet

Materials:
- Internet
- Where on Earth? Reading

Procedure:
1. Use the information from the reading and the Internet to complete the table below.

Earth Region Table

Harsh Location on Earth	Characteristics
Aquarius Underwater Research Facility	
Devon Island, Canada	
Antarctica	
Death Valley, California	
Mount Etna, Italy	

2. On the Internet, go to http://science.howstuffworks.com/mars.htm to complete the table below.

Mars Region Table

Region on Mars	Characteristics
Southern Highlands	
Northern Highlands	
Olympus Mons	
Valles Marineris	
Polar Regions	

3. Answer the following question:
For each of the regions on Mars, list a location on Earth that would serve as a good analog for that region. More than one Earth location can be used for each Mars region.