

MARS AND EARTH: A COMPARISON

AT A GLANCE

Students will explore similarities and differences in the geosphere, hydrosphere, atmosphere and biosphere of Earth and Mars.

OBJECTIVES

Students will:

- Compare some of the main characteristics of Earth's and Mars's geosphere, hydrosphere, atmosphere and biosphere.
- Use Google Earth to gather visual data and geographic coordinates of planets' physical features.
- Communicate their findings to the class.

KEY VOCABULARY

Geosphere, hydrosphere, atmosphere, biosphere, volcano, canyon, sand dune, pole

SUGGESTED GRADE

LEVELS: 4—8

ILLINOIS STATE LEARNING GOALS

Late Elementary

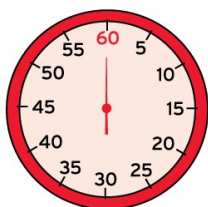
3: B, C; 4: A, B; 12: E, F

Middle/Junior High

3: B; 4: B; 12: E, F

PACE YOURSELF

60 MINUTES



MISSION TO MARS



ADVANCE PREPARATION

1. Download Google Earth (www.google.com/earth/index.html) to computer workstations and/or to a class computer that can be projected so every student can see the screen.
2. If you are not familiar with Google Earth, complete some of these tutorials before you begin:
<http://earth.google.com/support/bin/answer.py?answer=176576>
3. Upload the Mars-Earth Comparison kmz file to each computer.
4. Make copies of the student worksheet.



MATERIALS

Per Group:

Access to a computer with Google Earth installed
Student worksheets and exploration sheets for their assigned sphere



WHAT YOU NEED TO KNOW

Born from the same galactic nebula some 4.6 billion years ago, Mars and Earth are terrestrial planets. At first glance they are very different looking planets: one small and rusty red, the other large and glowing blue, separated by millions of kilometers and seemingly a universe away. You do not need to dig very deeply, however, to realize how alike these neighboring planets are. Let's explore the differences and similarities between these sibling planets by looking at their characteristics one sphere at a time.



GEOSPHERE

One of the most obvious physical features that Mars and Earth share are volcanoes. Take a quick look at the planets' surfaces and you will find many of the coned structures with circular calderas on top. Mars boast the largest volcano in the solar system, Olympus Mons—this behemoth is three times as high as Mount Everest!

MARS-EARTH COMPARISON

Another common landform shared by the planets are canyons. These large, elongated depressions are commonly seen on Earth as a result of the erosional action of rivers, as in the Grand Canyon. On Mars, most canyons were created when the planet initially cooled and shrank rather than by running water. The largest canyon on Mars, Valles Marineris, is so large that it can easily be seen from space: it is 10 times longer (4,000 km/2,500 miles) and four times deeper (7 km/4.4 miles) than the Grand Canyon.

Unlike Mars, the Earth's outer layer (the crust) is divided into several rigid segments—tectonic plates—that move along the surface and interact with each other. This interaction of plates, called plate tectonics, creates mountain ranges, volcanoes, earthquakes and faults, oceanic floor and continental rock and is fueled by heat from the core and the movement of magma in the mantle. There is some evidence that Mars was tectonically active in its very early history but today it is a quiet and stable planet in this regard.

HYDROSPHERE

Mars is a desert landscape of sand and rocks. Liquid water at the surface of Mars is hard to see. NASA has recently posted photos of salt water flows on the surface. Although many features that look like dry river beds and alluvial fans are found throughout the planet, leading many scientists to believe that liquid water has at times existed on the planet's surface. Like Earth, Mars has two polar caps. It is in these caps, as well as under the surface, that scientists believe most of Mars' water is trapped.

Earth is the water planet and it is impossible to look at it from space and not see the massive amount of liquid water that covers our planet. The water cycle moves water through the Earth's spheres, and in the process makes it a key weathering and erosional agent shaping and always changing the surface of the land.

ATMOSPHERE

With relatively similar atmospheric compositions, as well as a rotational axis that is inclined like Earth's, both planets experience distinct seasons and weather patterns throughout the year. The primary mechanism of weather creation on Earth is the cycling of water through the water cycle and its accompanying energy transfer. On Mars, the primary weather events are dust storms—the largest in the Solar System—which can obscure much of the surface for days at a time, and create massive sand dunes throughout the terrain.

Both planets have polar ice caps that grow in winter months and shrink in summer months. The condensation and sublimation that make Mars' polar caps grow and shrink give rise to Earth-like frost on the Martian surface and seasonal large cirrus cloud formation around the poles.

The Earth's biosphere (mainly through photosynthesis) has significantly altered the Earth's atmosphere, forming the primarily oxygen-nitrogen atmosphere of today. This atmosphere supports life, protects us from harmful solar radiation, and circulates energy and matter. Mars has a very thin atmosphere (1% of the Earth's pressure) composed primarily of carbon dioxide. Although Mars' atmosphere can circulate energy and matter (see dust storms above), it does not shield Mars from ultraviolet solar radiation, nor does it support life as we know it.

BIOSPHERE

Life appeared on Earth about 1 billion years after the planet was formed. Earth has been home to millions of species, including humans, that have evolved through time adapting to, as well as altering, the conditions of the Earth's spheres. The physical properties of the Earth, its geologic history and orbit have allowed life to persist through time, and the imprint of that life on the planet is widely seen.

MARS-EARTH COMPARISON

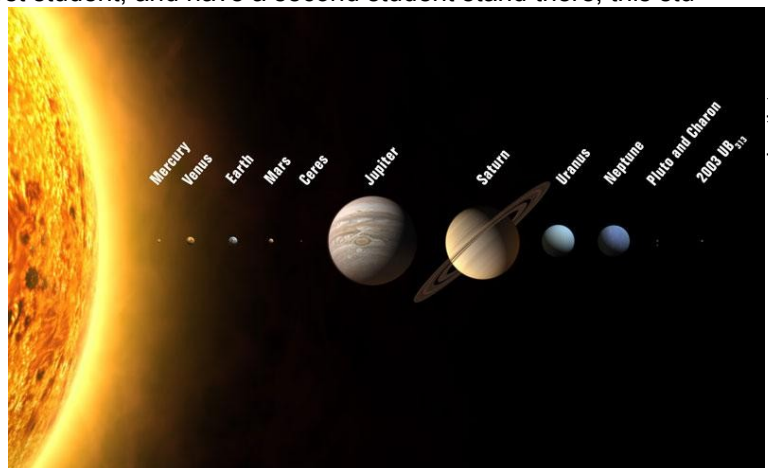
Scientists believe that a key factor for sustaining life on a planet is the availability of liquid fresh water on the surface. Although Mars does not currently meet this requirement, ample evidence suggests that water did flow freely at the surface in the past and may have made Mars more habitable than it is today. An extremely thin atmosphere and a lack of protection from harmful solar radiation bode poorly for life as we know it on Mars, but many are excited for the possibility of microbial life forms found on Mars meteorites, and small quantities of certain life-related gases recently detected by Mars orbiters. The exploration for life on Mars continues to be a big focus for planetary scientists.

By studying Mars we may discover and understand many aspects of our own changing planet. Please visit the sites listed in the Digital Resources section for more in depth information on the planetary characteristics of Mars and Earth.



WARM UP

1. Ask students to take a piece of paper and draw the Sun at one end.
2. Now tell them to draw the Earth and Mars in their positions relative to the Sun. Can they estimate how many miles/kilometers there are between the Sun and Earth? The Sun and Mars?
3. Ask students to draw a circle on the paper to represent the Earth. They can color in the land and oceans to make it more recognizable.
4. Now ask them to draw a second circle next to the Earth to represent Mars. Tell them to be sure to draw the second circle to scale with the first—that is if they think Mars is just as big as the Earth, they should draw circles of equal size, if they think Mars is half as big as Earth, then the second circle should be half as big as the first, and so on.
5. After students are finished with their two sketches, explain that the Earth is 150 million kilometers (93 million miles) from the Sun, and Mars is 228 million kilometers (143 million miles) away from the Sun. Earth is also nearly twice as big as Mars—Earth's radius is 6,400 km (4,000 miles) while Mars' is 3,400 km (2,100 miles).
6. Have one student stand up at one end of the room; they will represent the Sun. Use a tape measure to measure 150 cm from the first student, and have a second student stand there; this student will represent the Earth. Measure another 78 cm (or 228 cm from the Sun); a third student can stand there and represent Mars. In this model one cm equals one million miles. You may want to add Mercury (at 57 cm) and Venus (at 107 cm) you can complete the terrestrial planets.
7. Take a tennis ball and ask the student representing Earth to hold it up. Take a golf ball and ask the student representing Mars to hold it. If the tennis ball represented the Earth in this model, then Mars would be about the size of a golf ball. And the Sun? The Sun would be a ball over 7.5 meters (22.5 feet) tall!



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MARS-EARTH COMPARISON



ACTIVITY

Part 1: Craters

1. In order to familiarize students with the comparison process using Google Earth/Mars, carry out the crater exploration as a whole class. To do this, hand students the Mars and Earth: Impact Crater Exploration Sheet and complete it as a class.
2. Make sure all students are comfortable with the main navigational features of Google Earth: zooming in and out, clicking and double clicking layers, toggling from Google Earth to Google Mars, and opening and closing information bubbles.
3. As you work, guide students to realize that the stability of Mars' surface (no plate tectonics and no known active water cycle) results in the preservation of much older features, such as craters. On Earth, surface materials are recycled at a relatively rapid rate by erosional processes and subduction.
4. Once the exploration is complete, highlight the comparison process that you completed, and explain that Google Earth is the tool used to carry out that comparison.

Part 2: Teams work on one sphere

1. Divide the students into small working groups. Each group should be stationed at a computer workstation.
2. Tell students they will be exploring the similarities and differences between Earth and Mars.
3. Assign each student group a different aspect of the Mars-Earth comparison to explore. They can be:
 - **Planetary Geologist:** Explore the geosphere of Mars and Earth, focusing on volcanoes on the two planets.
 - **Planetary Hydrologist:** Explore the hydrosphere of Mars and Earth, focusing on large water bodies, frozen water and large canyons.
 - **Planetary Meteorologist:** Explore the atmosphere of Mars and Earth, focusing on sand dunes and polar regions.
 - **Planetary Biologist:** Explore the biosphere of Mars and Earth, and dig deeper to find hints and clues of the existence of organisms.
4. Students follow their own sphere's student worksheet to direct them in gathering information.
5. Students share what they have learned via an oral and poster presentation to the class.
6. After students have shared their findings, gather back as a classroom and use guiding questions in the Check For Understanding section to review what they have learned and initiate student sharing and discussion



CHECK FOR UNDERSTANDING

GEOSPHERE

1. How large (height and width) is Olympus Mons?
2. Are there any volcanoes on Earth that large?
3. Based on what you know about how volcanoes are formed, how do you think a volcano can get so big?

MARS-EARTH COMPARISON

4. What are things you might see when a volcano erupts?
5. What do Mt. Fuji, Arenal Volcano and Eyjafjallajökull Volcano have in common?
6. What is the main difference between Earth's and Mars' volcanoes?

HYDROSPHERE

1. How can you tell at first glance that the Earth has water?
2. Why is water such a unique material on Earth?
3. What is one thing you find amazing about the Pacific Ocean?
4. How does the Mississippi River change the land around it?
5. Why is studying meandering streams important for people who want to explore Mars?
6. What features on Mars' surface may indicate the previous existence of liquid water at the surface?

ATMOSPHERE

1. Does the Earth have an atmosphere? How do we know?
2. Do we see this on Mars? Does that mean that Mars has no atmosphere?
3. How else can we "see" the atmosphere? When there is a big storm here on Earth, what happens? Brainstorm ideas with class. They will likely come up with precipitation (rain, snow, etc), lightning and thunder, and tornadoes or hurricanes. These last ones have a main component: WIND. Wind happens in the atmosphere because of unequal heating of the surface by the Sun. This sets air in motion and creates wind. Wind storms are the main weather event on Mars.
4. What features are formed by wind?
5. What are the requirements for a dust storm to occur?

BIOSPHERE

1. What makes the Great Barrier Reef so unique?
2. What are some ways in which the Amazon Rainforest impacts your life?
3. What evidence of life can you see in a city when you look at it from outer space?
4. What are some obstacles for life as we know to exist on Mars?
5. If you were looking for life on Mars, what would you look for? What would you consider conclusive evidence? What would make you stop looking?



EXTENSIONS

LANGUAGE ARTS

You are a NASA scientist in charge of procuring funding for the next Mars mission. Write a letter to Congress outlining the main similarities between Mars and Earth and explaining why studying Mars is so valuable for understanding Earth within the larger context of our solar system.

MATH

Earth is 150 million kilometers (93 million miles) from the Sun, and Mars is 228 million kilometers (143 million miles) away from the Sun. Earth is also nearly twice as big as Mars—Earth's radius is 6,400 km

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(4,000 miles) while Mars' is 3,400 km (2,100 miles). Using that information, answer the following questions:

- What percent closer to the Sun is Earth than Mars?
- What percent smaller is Mars than Earth?



DIGITAL RESOURCES

Mars and Earth content:

<http://nssdc.gsfc.nasa.gov/planetary/planets/marspage.html>

<http://nssdc.gsfc.nasa.gov/planetary/planets/earthpage.html>

<https://phoenix.lpl.arizona.edu/mars101.php#1>

Fun for students who get done early:

<http://marsprogram.jpl.nasa.gov/participate/funzone/>

www.exploremarsnow.org/

Lesson Plan Library from Google Earth:

<http://sitescontent.google.com/google-earth-for-educators/classroom-resources/lesson-plan-library>



RELATED EXHIBITS

Henry Crown Space Center

Earth Revealed