Name: ______________________________________

3 – 2 – 1
Video Reflection

3 things I found interesting…	2 things I learned…	1 question I still have…
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•		

Name: ______________________________________

3 – 2 – 1
Video Reflection

3 things I found interesting…	2 things I learned…	1 question I still have…
•	•	•
•	•	
•		

Exit Ticket: Day 1

Two things I learned today:

1.

2.

The 3 Expedition Mars jobs I am most interested in are (circle your choices):

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This planet is the fourth from the sun.

Mars

This planet has an average temperature of 57°F.

Earth

The atmosphere on this planet is mostly CO_2.

Mars

This planet has a magnetosphere that protects it from the Sun.

Earth

This planet experiences four seasons.

Both

This planet has polar ice caps.

Both

This planet has a lot of iron in the soil.

Mars

This planet experiences significant dust storms that can last for months.

Mars

This planet is a gas giant, made up mostly of hydrogen and helium.

Neither

This planet has 14 known moons.

Neither

This planet takes 687 days to orbit the sun.

Mars

This planet has a denser atmosphere.

Earth

This planet experiences weather.

Both

This planet contains the highest peak in the galaxy, reaching 13.2 miles above sea level.

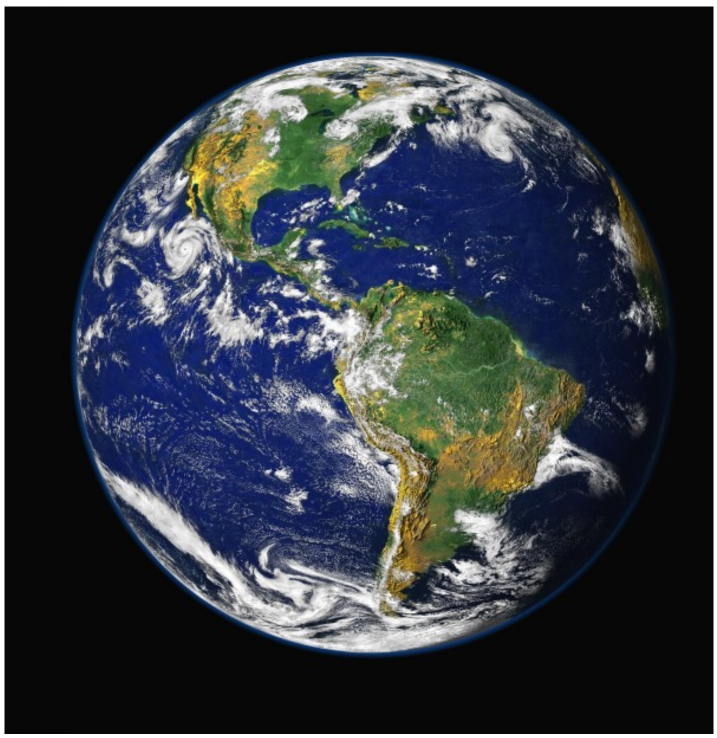
Mars

This planet is the smaller of the two planets.

Mars

BOTH

EARTH



MARS

NEITHER

Name: ______________________________ Class: ____________________

Do Now: Day 2

What do organisms (living things) need to survive? If you need help getting started, think about what humans or plants need.

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Name: ______________________________ Class: ____________________

Do Now: Day 2

What do organisms (living things) need to survive? If you need help getting started, think about what humans or plants need.

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Characteristic	Earth	Mars
Atmospheric Pressure	1,013 millibars (1 atm)	7.5 millibars (0.01 atm)
Tilt	23.45°	25°
Make-up of Atmosphere	Nitrogen (77%) Oxygen (21%) Argon (1%) Carbon Dioxide (0.04%)	Carbon Dioxide (95.3%) Nitrogen (2.7%) Argon (1.6%) Oxygen (0.1%)
Days in a Year	365 Days	687 Earth days
Distance from the Sun (in AU)	1 AU	1.5 AU
Gravity	About 2 ½ times Mars	About 1/3 of Earth
Length of a Day	24 hours	24 hours, 40 minutes
Surface Temperature	57°F	-81°F
Water Abundance	71%	present

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Name: ____ Class: __________________________

Exit Ticket: Day 2

Why is it important for scientists at NASA to study extremophiles? Write 2-3 complete sentences using details from what you learned today to answer the question.

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Name: ____ Class: __________________________

Exit Ticket: Day 2

Why is it important for scientists at NASA to study extremophiles? Write 2-3 complete sentences using details from what you learned today to answer the question.

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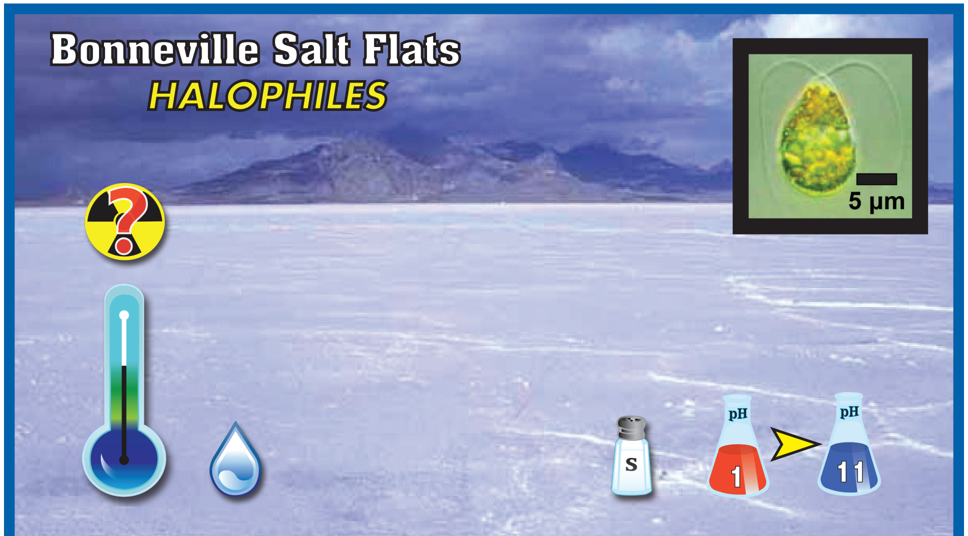

Photo Credit: Bonneville Salt Flats - Utah Bureau of Land Management;
Dunaliella salina - Microbewiki, Kenyon College
For more information visit http://astrobiology.nasa.gov/

Photo Credit: Perito Moreno Glacier, Argentina - Luca Galuzzi;
Chryseobacterium greenlandensis - Penn State.
For more information visit http://astrobiology.nasa.gov/

Photo Credit: Algae flow patterns at Rio Tinto, Spain - Carol Stoker, NASA Ames Research Center;
Ferroplasma acidiphilum - Helmholtz-Centre for Infection Research.
For more information visit http://astrobiology.nasa.gov/

Photo Credit: Courtesy of United States Navy. Firefighters dressed in chemical, biological, radiological (CBR) suits; *Deinococcus radiodurans* - Michael J. Daly, Uniformed Services University.
For more information visit http://astrobiology.nasa.gov/

National Aeronautics and Space Administration

Chryseobacterium greenlandensis is a very small bacterium. It has survived for up to 120,000 years within the ice of a Greenland glacier. It has been found nearly two miles below the surface.

EXTREME ABILITY

Psychrophiles are organisms the grow the best at temperatures below 15° C. To protect their DNA, some produce proteins that act as antifreeze. Not only can they survive in cold places, but many psychrophiles are also halophiles!

EXTREME ENVIRONMENTS

Psychrophiles have been found in arctic soils, deep ocean water, glaciers, snowfields, sea ice, and tundra. Scientists are trying to determine if Jupiter's icy moon Europa harbors cold-loving microbes.

EXTREME EXAMPLES

While many psychrophiles need cold temperatures to survive, some can survive in temperatures from -10 up to 37° C. That is as warm as your body temperature!

www.nasa.gov

National Aeronautics and Space Administration

Dunaliella salina is an algae that lives in salt ponds. To protect itself from sunlight, Dunaliella concentrates betacarotene in its cell wall. This gives it an orange or pinkish color.

EXTREME ABILITY

Halophiles coat themselves with a special protein layer. This layer allows only certain amount of salt into the cell. This layer also helps to seal in water.

EXTREME ENVIRONMENTS

Ocean water is about 3.5% salt. The water in salt ponds is typically 5 to 10 times saltier than ocean water. This means that a gallon of water from some salt ponds contains as much as 2.5 pounds of dissolved salt! D. salina has been flown into space and may survive the UV radiation of space. Most require temperatures between 0° - 35° C to survive.

EXTREME EXAMPLES

These salt lovers live in places like the Great Salt Lake in Utah, Owens Lake in California, and the Dead Sea between Israel and Jordan. Halophilic bacteria also occasionally grow on saltine crackers!

www.nasa.gov

National Aeronautics and Space Administration

The bacterium Deinococcus radiodurans is resistant to drying, ultraviolet light, and large doses of gamma-ray radiation.

EXTREME ABILITY

D. radiodurans can survive doses of radiation that are 500 times greater than the lethal dose for humans. It does not have a radiation shield, its DNA is damaged just like a humans. The difference is that it can repair its DNA much faster. *D. radiodurans* also has multiple copies, or backups, of its DNA.

EXTREME ENVIRONMENTS

Radioresistant fungi were found growing in the remains of the Chernobyl nuclear reactor. Scientists determined that the fungi were using energy from radioactivity to produce food. They can survive at temperatures between 30° - 95° C.

EXTREME EXAMPLES

D. radiodurans is listed in the Guinness Book of World Records as "the world's toughest bacterium." In addition to being resistant to radiation, this bacterium can also survive severe droughts, extreme cold, and strong acids.

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National Aeronautics and Space Administration

Ferroplasma acidiphilum extracts energy from iron. It "eats" the metal and leaves rust behind.

EXTREME ABILITY

Acids, such as the citric acid in lemons, taste sour. Even the word acid comes from the Latin word acidus meaning "sour." Acidophiles survive in very acidic environments where pH rarely rises above 3. When other organisms are exposed to such acidic conditions their DNA is damaged beyond repair.

EXTREME ENVIRONMENTS

These organisms are most commonly found in mine drainages, waste treatment plants, acidic hot springs, and some caves. Scientists think that the toxic clouds of Venus might harbor acidophiles. Acidophiles are found in temperatures between 30 – 92 ° C.

EXTREME EXAMPLES

Acidophiles play a role in acid mine drainage and in coal mining. They are used to recover minerals and to reduce sulfur levels.

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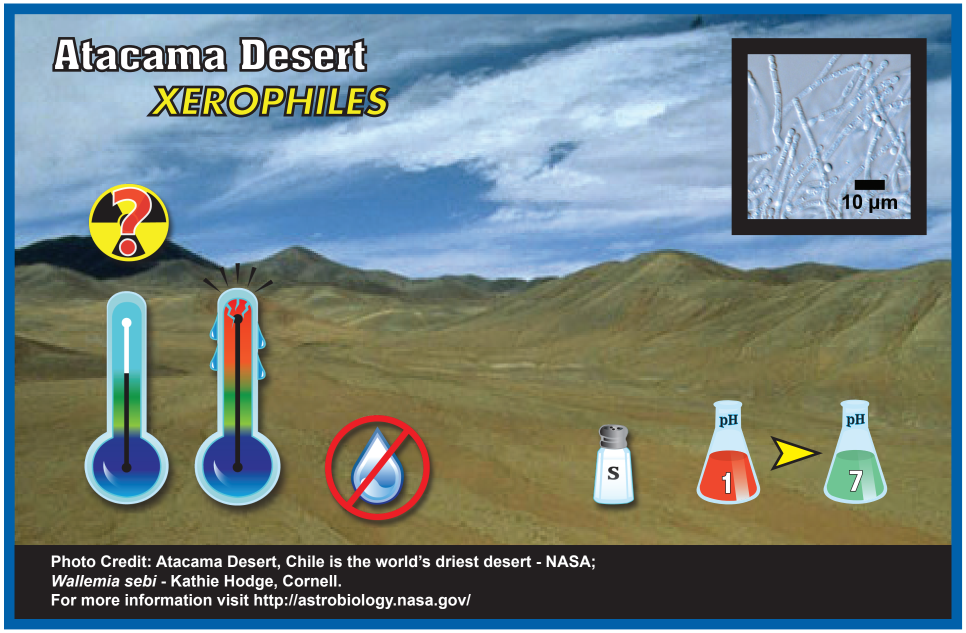
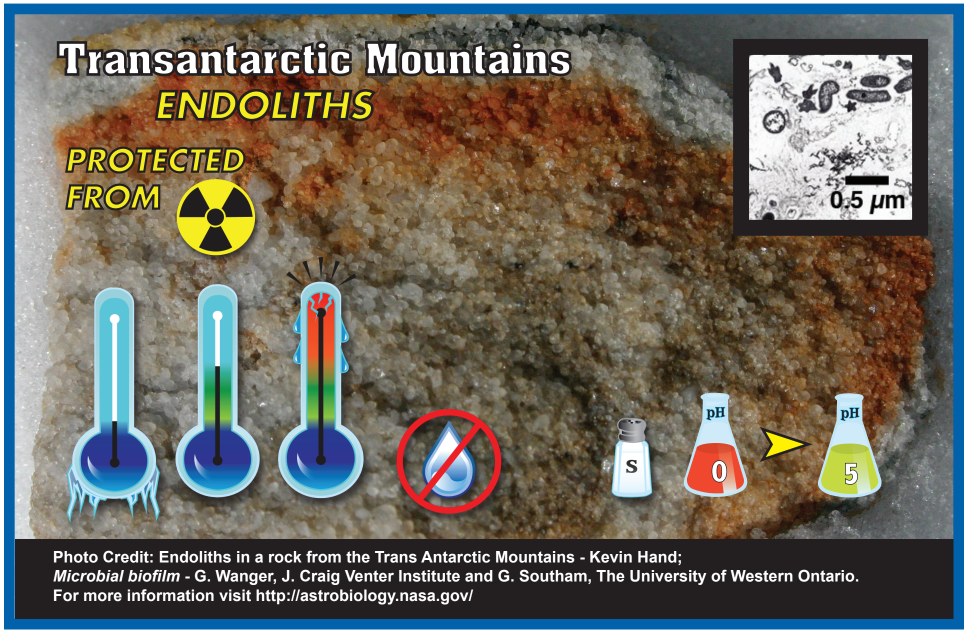

Atacama Desert
XEROPHILES
10 µm
S
pH
1
pH
7
Photo Credit: Atacama Desert, Chile is the world's driest desert - NASA;
Wallemia sebi - Kathie Hodge, Cornell.
For more information visit http://astrobiology.nasa.gov/


Mono Lake
ALKALIPHILES
5 µm
S
pH
9
pH
12
Photo Credit: Mono Lake, California, is 80 times more alkaline than the ocean - Mila Zinkova;
Microcystis - David Patterson and microscope.
For more information visit http://astrobiology.nasa.gov/


Yellowstone National Park
THERMOPHILES
10 µm
S
pH
0
pH
5
Photo Credit: Grand Prismatic Spring at Yellowstone National Park - Mila Zinkova;
Phormidium - Gilberto Benitez and microscope.
For more information visit http://astrobiology.nasa.gov/


Transantarctic Mountains
ENDOLITHS
PROTECTED
FROM
0.5 µm
S
pH
0
pH
5
Photo Credit: Endoliths in a rock from the Trans Antarctic Mountains - Kevin Hand;
Microbial biofilm - G. Wanger, J. Craig Venter Institute and G. Southam, The University of Western Ontario.
For more information visit http://astrobiology.nasa.gov/

National Aeronautics and Space Administration

Colonies of blue-green bacteria called Microcystis flourish in alkaline environments like Mono Lake, California seen on the front of this card.

EXTREME ABILITY

Most alkaliphiles would not be able to survive in drinking water (pH 7). Alkaliphiles love environments typically having pH values ranging from 9 to 11. These organisms have had to evolve a unique metabolism to get energy from their surroundings.

EXTREME ENVIRONMENTS

These microbes live in such places as soda lakes, caves, alkaline hot springs, deserts, and waste dumps from mines. Alkaliphiles can survive at temperatures between 4° - 93° C.

EXTREME EXAMPLES

Alkaliphiles are used in making paper and cleaning up spilled oil. They are also common ingredients in dishwashing detergent and laundry soap.

www.nasa.gov

National Aeronautics and Space Administration

Wallemia sebi is a mold that grows in places with very little water such as dried fruits, salted meats, and the evaporitic beds where sea salt is produced.

EXTREME ABILITY

Xerophiles can grow and reproduce in conditions with little water available. This group of organisms is named from the Greek words xeros meaning “dry”, and philos meaning “loving”.

EXTREME ENVIRONMENTS

Some live in pretty normal places like old food (nuts and jam especially), but others thrive in harsher conditions. Xerophiles can live in deserts where most creatures would dehydrate quickly! Xerophiles can survive at temperatures between 5 - 50° C.

EXTREME EXAMPLES

Many types of mold and yeast are xerophilic. Mold growth on bread is an example of food spoilage by xerophilic organisms. Xerophiles commonly live on food that has been dried for storage outside of the refrigerator.

www.nasa.gov

National Aeronautics and Space Administration

This community of microbes was collected more than one mile deep in a South African platinum mine. It contains star-shaped bacteria that had never been seen before!

EXTREME ABILITY

Endoliths are microbes that make their homes inside of rocks. They can live for hundreds of years by feeding on the traces of iron, potassium, and sulfur in their host rocks.

EXTREME ENVIRONMENTS

Rocks in deserts and on mountain slopes often contain endoliths. Some endoliths have been found within the Earth’s crust at a depth of nearly two miles. Endoliths can survive at temperatures between -15 - 140° C.

EXTREME EXAMPLES

Many scientists think that endoliths are good examples for the type of life most likely to be discovered living on Mars now or in the past. Harsh conditions on Mars may have driven them underground.

www.nasa.gov

National Aeronautics and Space Administration

Phormidium, a type of algae, loves the hot water baths at Yellowstone National Park. This thermophile can make the pools it lives in orange.

EXTREME ABILITY

These microbes have developed special proteins and enzymes that allow them to survive in a wide range of temperatures. Some even require temperatures around 60° C to exist at all.

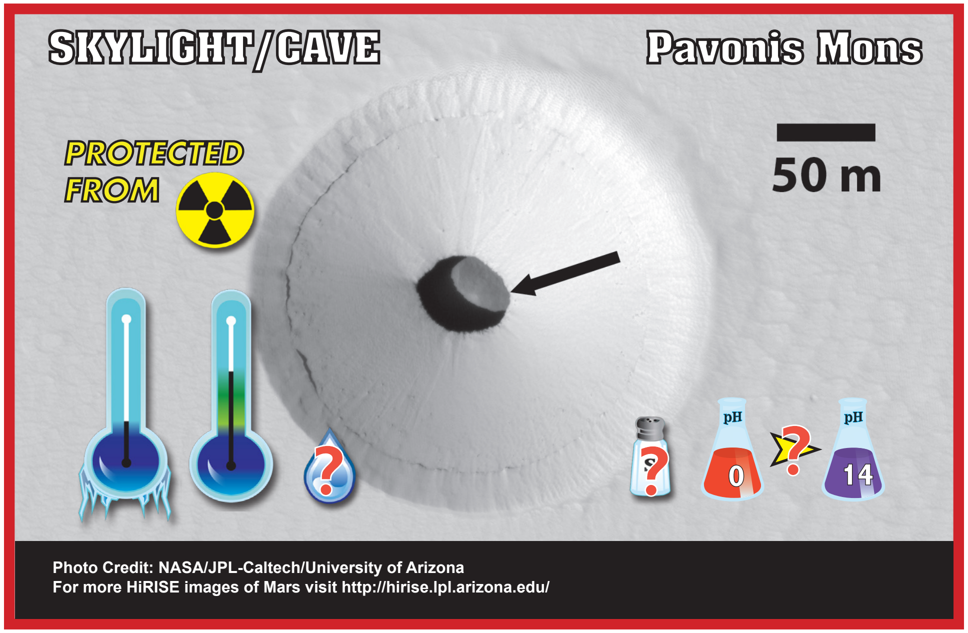
EXTREME ENVIRONMENTS

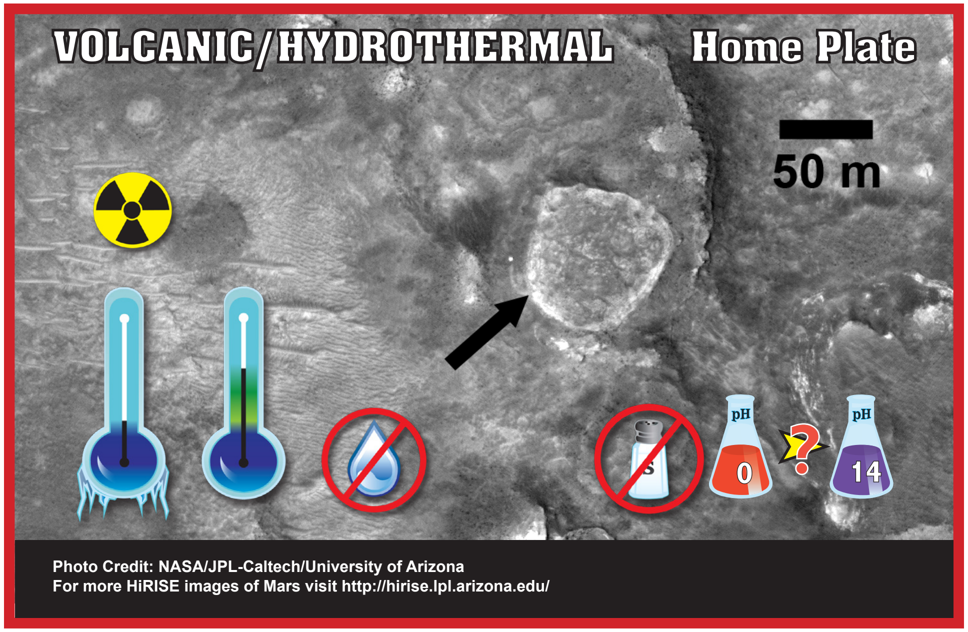
These hardy microbes can be found in places like hot springs, crater lakes, peat bogs, and superheated hydrothermal vents on the sea floor.

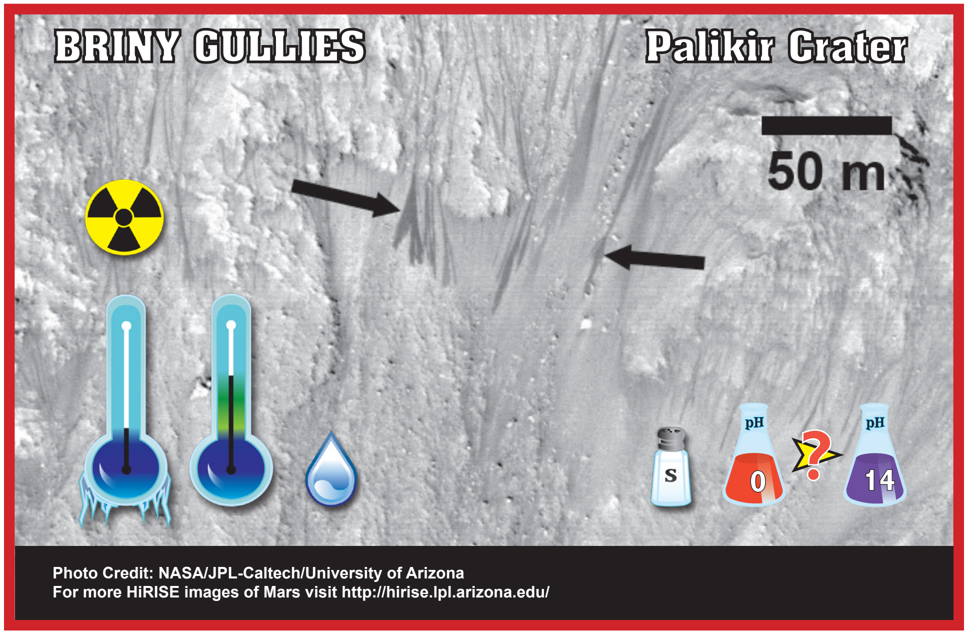
EXTREME EXAMPLES

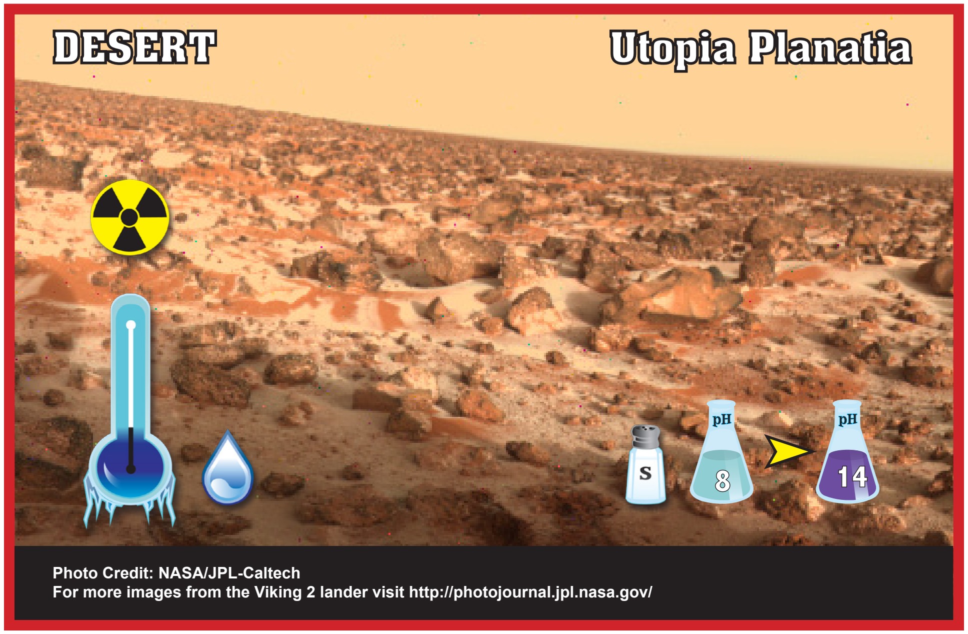
Thermus aquaticus, bacteria found in a Yellowstone hot spring, produce an enzyme that allows for quick DNA replication. This enzyme has revolutionized the biotechnology field.

www.nasa.gov


SKYLIGHT/CAVE
Pavonis Mons
PROTECTED FROM
50 m
S
pH
0
14
Photo Credit: NASA/JPL-Caltech/University of Arizona
For more HiRISE images of Mars visit http://hirise.lpl.arizona.edu/


VOLCANIC/HYDROTHERMAL
Home Plate
50 m
S
pH
0
14
Photo Credit: NASA/JPL-Caltech/University of Arizona
For more HiRISE images of Mars visit http://hirise.lpl.arizona.edu/


BRINY GULLIES
Palikir Crater
50 m
S
pH
0
14
Photo Credit: NASA/JPL-Caltech/University of Arizona
For more HiRISE images of Mars visit http://hirise.lpl.arizona.edu/


DESERT
Utopia Planatia
S
pH
8
14
Photo Credit: NASA/JPL-Caltech
For more images from the Viking 2 lander visit http://photojournal.jpl.nasa.gov/

National Aeronautics and Space Administration

Home Plate is a small plateau roughly 90 m across and 1 m high located within the Columbia Hills in Gusev Crater on Mars. It gets its name from the fact that the outline of the plateau is similar in shape to a baseball home plate. It was visited by the Mars Exploration Rover Spirit.

CURRENT ENVIRONMENT ON MARS

Temperatures range from -110° C at night to 35° C during the day. There is no evidence for salt. Layers in the surface material suggest liquid water dribbled into the ground fairly recently and frequently. Spirit was unable to test the pH of the rocks around Home Plate. Radiation levels are thought to be similar to what astronauts experience on the International Space Station.

PAST ENVIRONMENT ON MARS

The rocks of home plate are thought to have formed from explosive volcanic deposit. Nearby deposits are thought to have formed in hydrothermal conditions. This suggests a wet and hot environment where the pH varried locally from acidic to alkalic.

www.nasa.gov

National Aeronautics and Space Administration

The discovery of skylight or caves has gotten the interest of scientists. The caves might offer safety to future astronauts. The skylight/cave seen on the front of the card is at the bottom of an impact crater.

CURRENT ENVIRONMENT ON MARS

Pavonis Mons is a small shield volcano, like the Hawaiian Islands. Temperatures range from -138° C at night to 20° C during the day. There are no signs of water or salt at the surface but they could be present in the cave/. The pH of the surface material is unknown. Radiation levels at the surface are thought to be similar to what astronauts experience on the International Space Station. In the cave/skylight, the overlying rock would offer protection from deadly solar flare radiation.

PAST ENVIRONMENT ON MARS

Caves often form in volcanic regions like this when lava solidifies on top, but keeps flowing underneath through an underground lava tube. These rivers of lava can then drain away leaving the tube empty.

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National Aeronautics and Space Administration

The Viking 2 Lander was the second successful Mars lander mission. It explored an area of Mars called Utopia Planitia (Nowhere Plain).

CURRENT ENVIRONMENT ON MARS

Air temperatures between -30° C and -120° C were recorded by the lander. Analysis of the surface material revealed it to be alkaline (pH > 8). Salt crusts were also observed. Surface samples heated to 500° C released water vapor. Radiation levels are thought to be similar to what astronauts experience on the International Space Station. Some images from the lander showed a thin layer of white water frost on the surface. Frost was seen for about 100 days during each of the two martian winters observed.

PAST ENVIRONMENT ON MARS

Utopia Planitia appears to be an ancient lava plain with a large number of shallow troughs. Scientists think the troughs are formed from ice-wedge activity caused by permafrost.

www.nasa.gov

National Aeronautics and Space Administration

The dark streaks found on the inner walls of Palikir crater appear in early spring, grow longer in the downslope direction during spring and summer, and fade during fall and winter.

CURRENT ENVIRONMENT ON MARS

Temperatures up to 27° C have been measured on the crater walls. The streaks are thought to form due to the melting of brines (salty water) that remain in the liquid phase much longer than non-salty water. The pH of the liquid is unknown. Radiation levels are thought to be similar to what astronauts experience on the International Space Station.

PAST ENVIRONMENT ON MARS

Terra Sirenum is thought to be an ancient volcanic plain that may have had extensive lakes.

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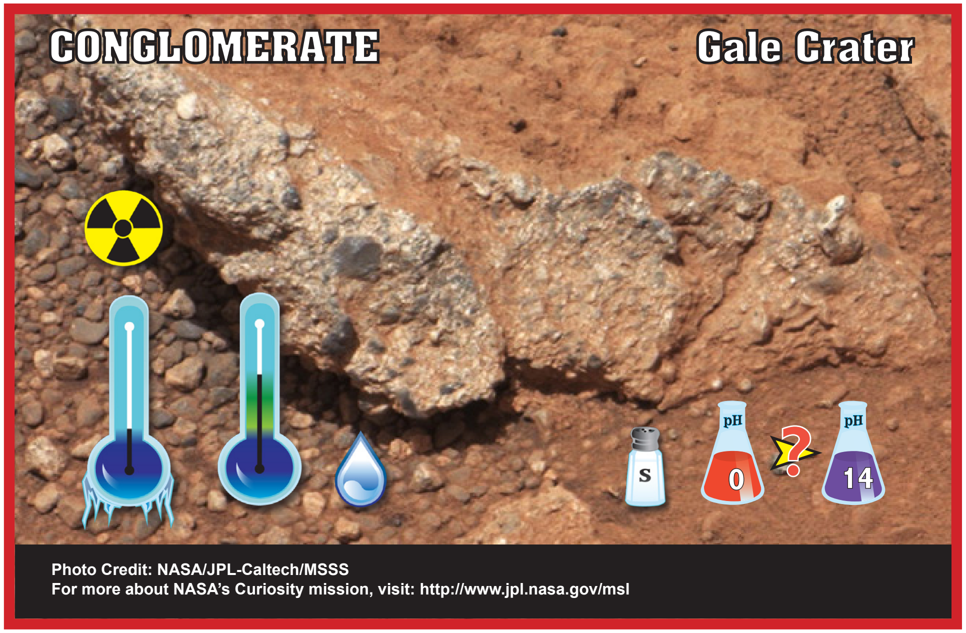
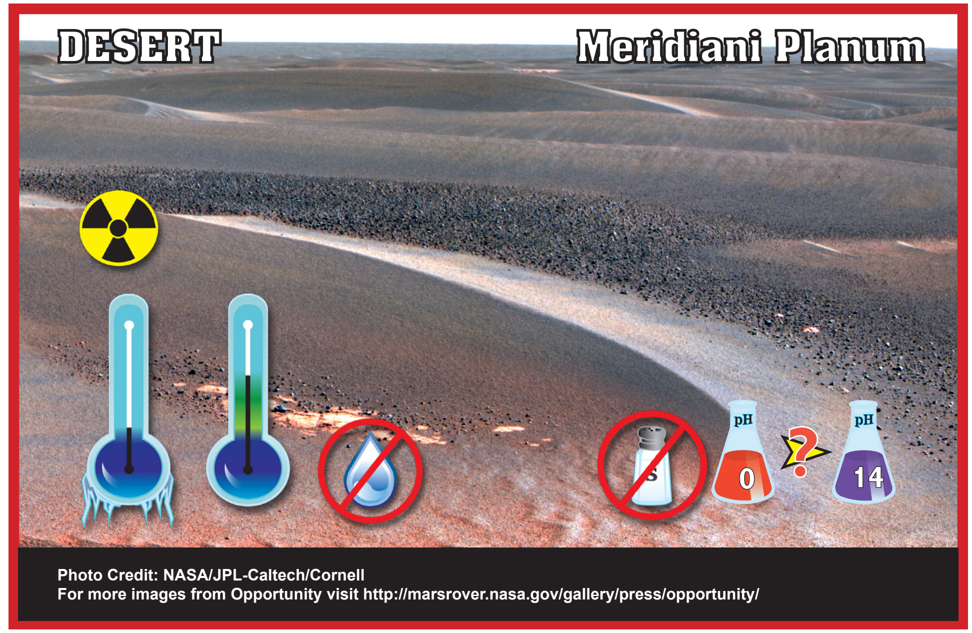
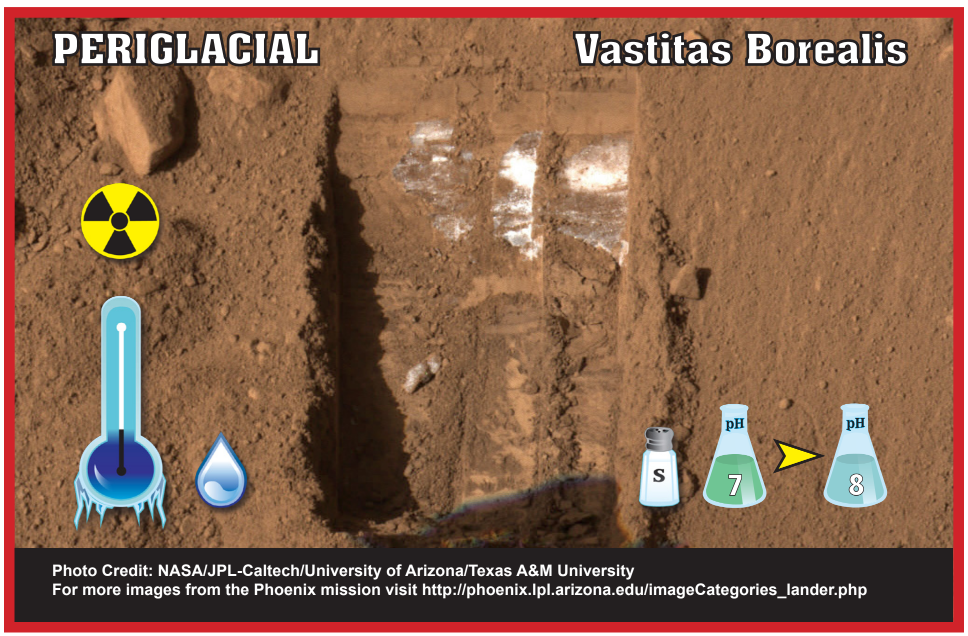
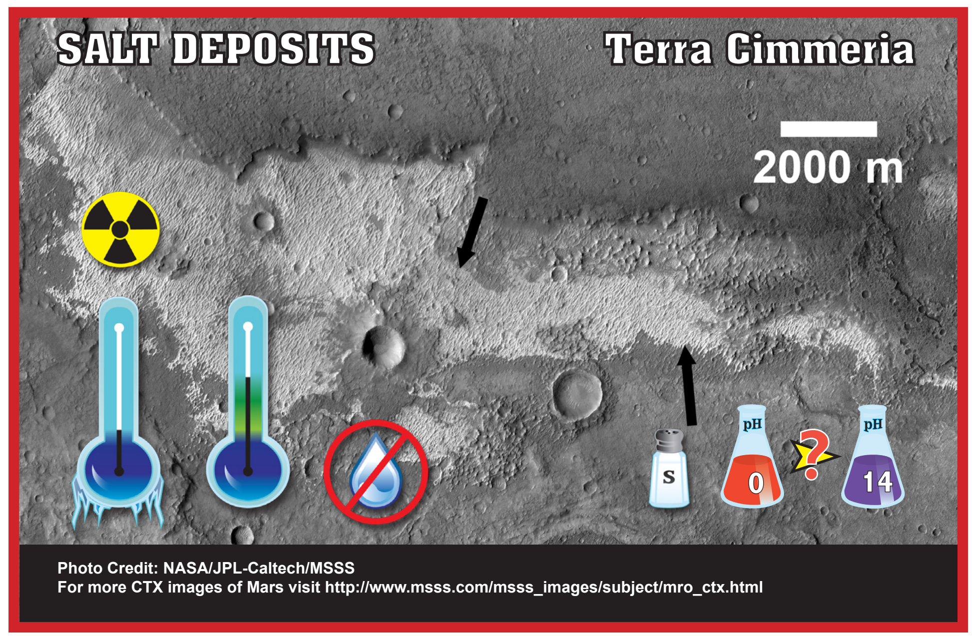

CONGLOMERATE
Gale Crater
S
pH
0
pH
14
Photo Credit: NASA/JPL-Caltech/MSSS
For more about NASA's Curiosity mission, visit: http://www.jpl.nasa.gov/msl


DESERT
Meridiani Planum
pH
0
pH
14
Photo Credit: NASA/JPL-Caltech/Cornell
For more images from Opportunity visit http://marsrover.nasa.gov/gallery/press/opportunity/


PERIGLACIAL
Vastitas Borealis
S
pH
7
pH
8
Photo Credit: NASA/JPL-Caltech/University of Arizona/Texas A&M University
For more images from the Phoenix mission visit http://phoenix.lpl.arizona.edu/imageCategories_lander.php


SALT DEPOSITS
Terra Cimmeria
2000 m
S
pH
0
pH
14
Photo Credit: NASA/JPL-Caltech/MSSS
For more CTX images of Mars visit http://www.msss.com/msss_images/subject/mro_ctx.html

National Aeronautics and Space Administration

This false color image was obtained by the Mars Exploration Rover Opportunity. It shows exposed bedrock and cobble fields between large, wind-blown ripples. The rover had to navigate this!

CURRENT ENVIRONMENT ON MARS

Air temperature ranges from -80° C at night to 30° C during the day. No sign of water or salt deposits were seen. Radiation levels are thought to be similar to what astronauts experience on the International Space Station. Dust devils were observed quite often at this site.

PAST ENVIRONMENT ON MARS

The outcrops exposed in this area indicate they were formed through wind related sand dune formation. Patterns found in the rock show periods of sand dune formation and periods of deposit between sand dune formations. This pattern seems to demonstrate wind formation in older layers, with very shallow water zones or playas in the younger layers. These water playas may have been very salty.

www.nasa.gov

National Aeronautics and Space Administration

The Curiosity rover landed in Gale Crater in search of present or past habitable environments. On its 39th martian day, the rover discovered an outcrop of conglomerate rocks. A conglomerate is made of small pebbles cemented together into a larger rock. These rocks are significant because they form in flowing water.

CURRENT ENVIRONMENT ON MARS

Air temperatures vary from -75° C at night to -5° C during the day. Perchlorate salts (organic) are confirmed in the surface. The pH of the surface has not been measured. Radiation levels are thought to be similar to what astronauts experience on the International Space Station.

PAST ENVIRONMENT ON MARS

Conglomerate rock indicates the area used to have flowing water, like a streambed. The number of channels in the area indicates a long period of repeated or continuous flows. This suggests the temperatures might have remained warm for a long period of time.

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The lighter toned material found in the basin (depression) in the center of the image is thought to be rich in chloride salts.

CURRENT ENVIRONMENT ON MARS

Surface temperatures from -178° C at night to 29° C during the day have been recorded from orbit. The chloride minerals are thought to be salt. The pH of the material has not been measured. No signs of water have been found. Radiation levels are thought to be similar to what astronauts experience on the International Space Station.

PAST ENVIRONMENT ON MARS

The temperature is thought to have been warm enough for salty liquid water to exist on the surface that then evaporated to leave the current salt deposits. The pH of the water is unknown.

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National Aeronautics and Space Administration

The Phoenix mission examined the martian surface and subsurface near the martian north pole. Phoenix dug several trenches to collect surface material for analysis. These trenches exposed underlying water ice.

CURRENT ENVIRONMENT ON MARS

The spacecraft measured temperatures between -98° C at night and -20° C during the day. Icy regolith was found 3-5 cm below the surface in most locations. Snow was observed to fall from low clouds. Tests show the regolith is slightly alkaline (7.7 pH). Traces of an unknown salt were found in several samples. Radiation levels are thought to be similar to what astronauts experience on the International Space Station.

PAST ENVIRONMENT ON MARS

Minerals in the regolith indicate the site probably had a wetter and warmer climate in the past. During seasonal or longer cycles, water may have been present as thin films on the surface.

www.nasa.gov

Put an Extremophile on Mars

Directions: Using the cards, select an extremophile that your group thinks could (or could have in the past) survive on Mars. Select a location on Mars where you think it could have lived and include supporting evidence to describe how and why it could live in that location. Your group will share this response with the class.

Group Members: ____

Extremophile: ____________________ **Mars Location:** ____________________

SCIENCE NEWS DAILY

Article 1: 2020

Aerobraking: The First Stop

Aerobraking: the slowing of a spacecraft by entering a planet's atmosphere to create drag.

Drag: the action of pulling something

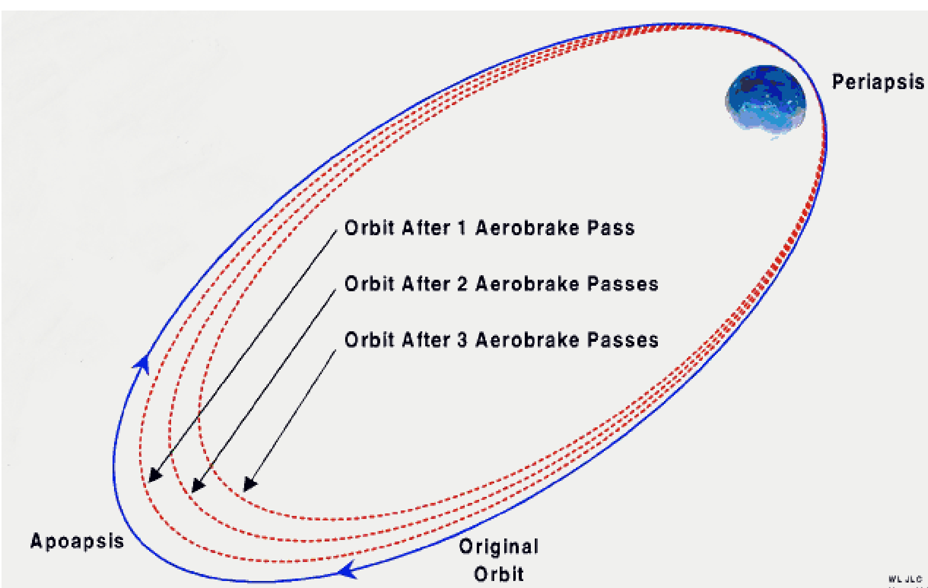
Orbit: the curved path around a planet or other object

Velocity: the speed of something traveling in a given direction

Delta v: (**Δv**) a change in velocity

With the creation of every new rover, NASA must find a way to get the equipment safely to the surface of Mars. Engineers spend billions of dollars and years of planning to build prototypes of solutions that will slow the spacecraft delivering the rover. Slowing down the spacecraft requires a **change in velocity** (v), or speed. In science, change is represented by a delta symbol (Δ), so this is often called **delta v**. The symbol for delta v is **Δv**.

To successfully land a rover on Mars without damaging any of the sophisticated lab equipment on board, scientists and engineers have developed a multi-step approach. The initial slowing happens through **aerobraking**.



Aerobraking helps slow the spacecraft by entering Mars's atmosphere at the low point (periapsis) of orbit. The drag created helps slow the spacecraft.

Aerobraking is using a planet's atmosphere to slow down a spacecraft. When the spacecraft hits Mars's atmosphere, the friction will create drag (pulling something), which slows the spacecraft. This happens many times, making a smaller orbit (curved path around a planet) each time, until the spacecraft is ready for the next landing phase. In the descent of the Inspiration Rover to the red planet, aerobraking will cause a **Δv** of **3750 meters/second (m/s)**.

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Name: ______________________________________ Class: _________________________

Do Now: Day 3

Based on what you've experienced or seen on TV/movies, describe what airplanes do while taking off and landing.

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Name: ______________________________________ Class: _________________________

Do Now: Day 3

Based on what you've experienced or seen on TV/movies, describe what airplanes do while taking off and landing.

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SCIENCE NEWS DAILY

Article 2: 2020

The Power of the Parachute

Parachute – a cloth canopy that fills with air to slow down a falling object

Descent – the action of moving downward

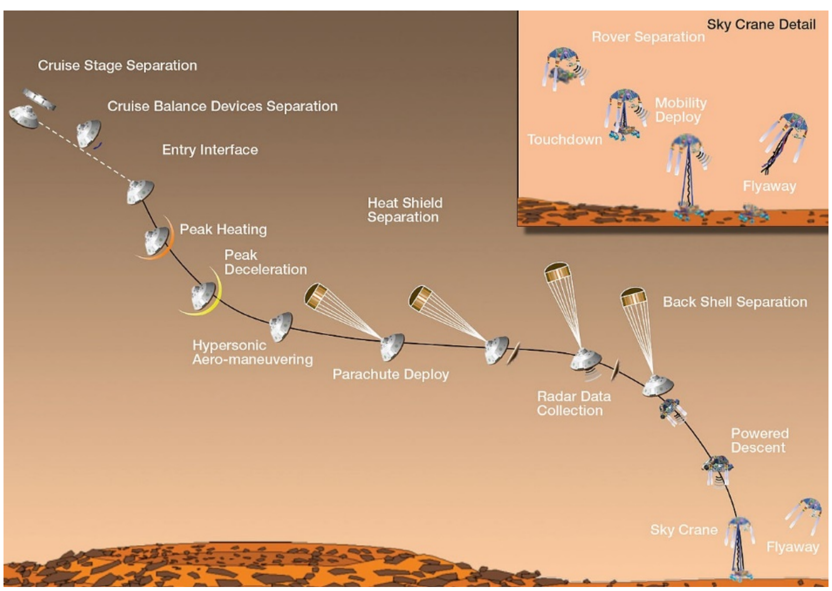
Drag – something that makes an action or progress slower

Velocity – the speed of something traveling in a given direction

Delta v – (**Δv**) a change in velocity

With the creation of every new rover, NASA has to find a way to get the equipment safely to the surface of Mars. Engineers spend billions of dollars and years of planning to build prototypes of solutions that will slow the spacecraft delivering the rover. Slowing down the spacecraft requires a change in **velocity** (v), or speed. In science, change is represented by a delta symbol (Δ), so this change in velocity is often called **delta v**. The symbol for delta v is **Δv**.

To successfully land a rover on Mars without damaging any of the sophisticated lab equipment on board, scientists and engineers have developed a multi-step approach. The slowing occurs through the use of aerobraking, a parachute, and rocket thrusters.



The massive parachute helps slow the descent of the rover towards the surface of Mars.

The second step in the process is deploying a large **parachute**. The parachute traps air to create **drag** and slows the **descent** of the rover. Because Mars has a thinner atmosphere than Earth, the parachute must be large enough to create drag to slow it down. Scientists perform many tests to make sure the parachute is perfect before launch.

In the landing of the Inspiration Rover on Mars, the parachute will provide a **Δv of 350 meters/second (m/s).**

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SCIENCE NEWS DAILY

Article 3: 2020

Rocket Thrusters: The Last Stop

Rocket thrusters – used to move a rocket forward

Deployed – to bring into action and make useable

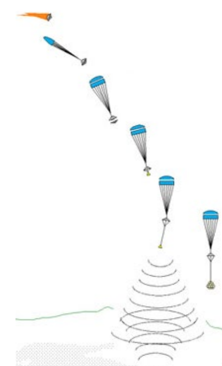
Powered Descent – a multi-step process that allows a safe landing

Velocity – the speed of something traveling in a given direction

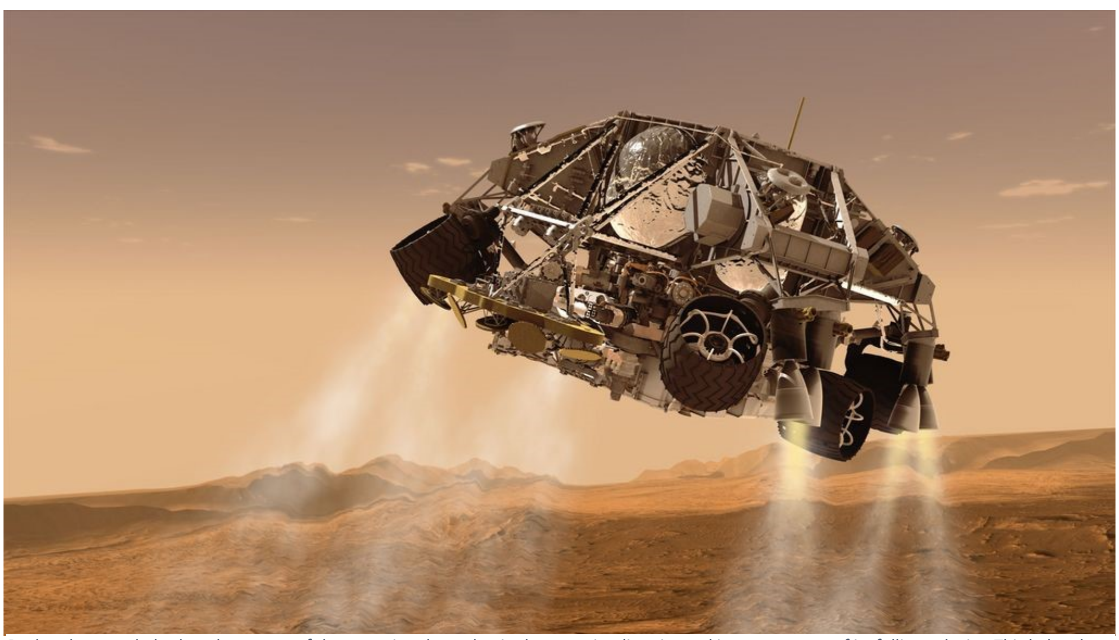
Delta v – (Δ**v**) a change in velocity

With the creation of every new rover, NASA has to find a way to get the equipment safely to the surface of Mars. Engineers spend billions of dollars and years of planning to build prototypes of solutions that will slow the spacecraft delivering the rover. Slowing down the spacecraft requires a **change in velocity** (v), or speed. In science, change is represented by a delta symbol (Δ), so this is often called **delta v**. The symbol for delta v is **Δv**.

To successfully land a rover on Mars without damaging any of the sophisticated lab equipment on board, scientists and engineers have developed a multi-step approach involving the use of aerobraking, a parachute, and rocket thrusters.



This picture shows a rover in a powered descent.



Rocket thrusters help slow the spacecraft by powering the rocket in the opposite direction, taking away some of its falling velocity. This helps slow the spacecraft.

The last step in the multistep approach to landing on Mars is using **rocket thrusters**. After the parachute is **deployed**, the rocket turns on the thrusters to slow the spacecraft. By lifting the rocket upwards, it balances out the spacecraft's fall and decreases the velocity. This also stops the spacecraft from spinning, making it a safer landing. This whole landing process is called a **powered descent**.

In the landing of the Inspiration rover on Mars, rocket thrusters will provide a **Δv of 100 meters/second (m/s).**

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Landing on Mars: The Seven Minutes of Terror

The journey to Mars is a long one. Scientists follow the spacecraft's path carefully to ensure everything is working correctly, but because Mars is so far away from Earth, communication is delayed. Scientists call the 7 minutes from the time they know the spacecraft has entered Mars's atmosphere, to the time they know it is safely on the ground, "the seven minutes of terror." During this time, the spacecraft uses three main techniques to land: aerobraking, parachutes, and rocket thrusters.

Directions: Have each member of your group complete their section of the graphic organizer to land your spacecraft safely. Then, use your values for Δv to find the **final velocity** of the Inspiration Rover as it lands.

Initial Rover Velocity: **4200 m/s**

Summarize your section of the landing process. How does it work? Why is this important?

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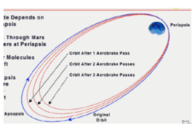
__________ — __________ = __________

(initial velocity) (Δv1) (aerobrake velocity)



Δv1 from aerobraking: __________

____

____

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__________ — __________ = __________

(aerobrake velocity) (Δv2) (parachute velocity)

Δv2 from a parachute: __________

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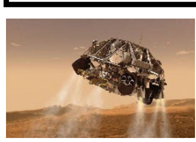
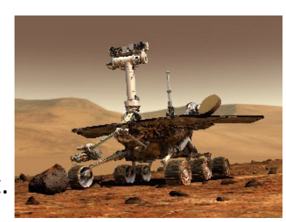
__________ — __________ = __________

(parachute velocity) (Δv3) (final velocity)



Δv3 from thrusters: __________

Congratulations! You have found the final velocity of the Inspiration Rover. Your spacecraft has landed successfully on the surface of Mars. It is now ready to help collect data from the red planet.



Earth and Mars: It's a Match

Directions: Pick two pictures that have similar characteristics. Attach them in the boxes and circle whether you think the picture shows Mars or Earth. Then, answer the questions about the pair.

Mars or Earth　　　　　　　　　　　　Mars or Earth

What are the similarities between these images?

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How do you think these physical features were formed? (Water, wind, meteor, etc.) Why?

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Earth and Mars: It's a Match

Directions: Pick two pictures that have similar characteristics. Attach them in the boxes and circle whether you think the picture shows Mars or Earth. Then, answer the questions about the pair.

Mars or Earth | Mars or Earth

What are the similarities between these images?

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How do you think these physical features were formed? (Water, wind, meteor, etc.) Why?

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Earth and Mars: It's a Match - Example Match

Figure 1

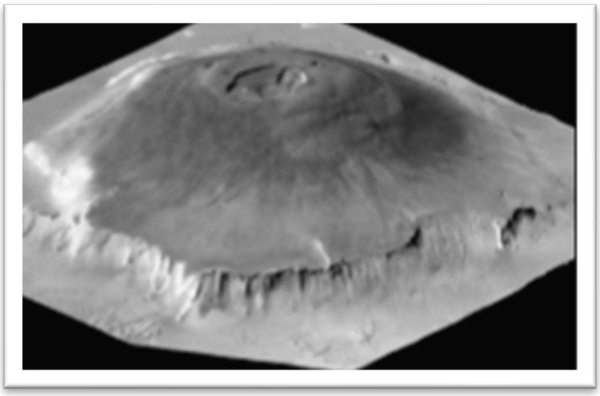

Figure 2

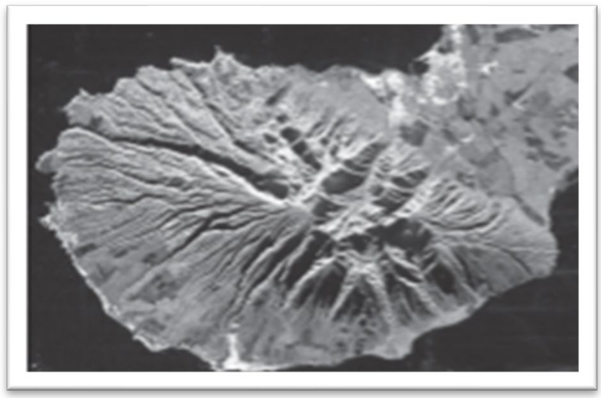

Figure 1 (Mars) and Figure 2 (Earth) are a match. Both have mountains with a volcano and cliffs. These landforms were likely caused by volcanic activity and erosion.

Earth and Mars: It's a Match – Student Cards

FIGURE 3

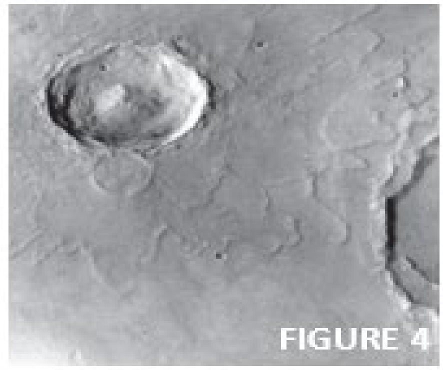

FIGURE 4

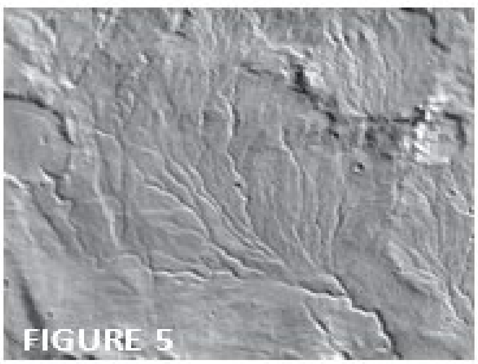

FIGURE 5

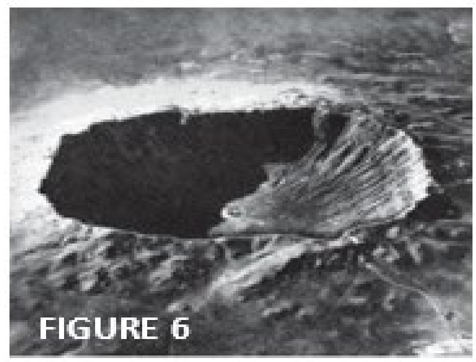

FIGURE 6

FIGURE 7

FIGURE 8

FIGURE 9

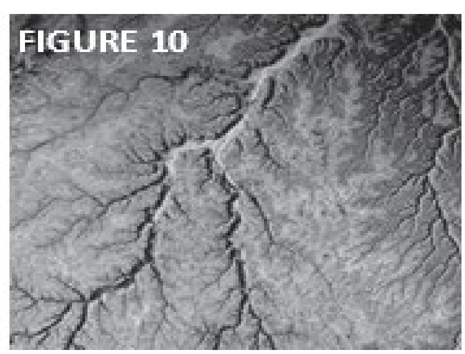

FIGURE 10

Exit Ticket: Day 4

Two things I learned today:

Why is finding water on Mars a significant scientific discovery?

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Name: ____ Class: __________________________

Do Now: Day 5

What do you think happens to your height on Mars? Do you grow, shrink, or stay the same? Explain your answer.

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Name: ____ Class: __________________________

Do Now: Day 5

What do you think happens to your height on Mars? Do you grow, shrink, or stay the same? Explain your answer.

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Keeping Your Body Healthy on Mars

Name: ____

Write about an activity you could do to maintain a healthy body while living on Mars.

Quick sketch: Draw and label how your activity keeps a human body healthy on Mars.

Name ____

Bodies in Space Lab Sheet

Directions: Record what happens at each station in the correct box below.

Remember, scientists write down information, so they can share it with others. You will need to share your results with the class. At the Challenger Learning Center, you will need these recording skills to complete your mission successfully!

Beans in Space

Directions: Do 20 curls with the Earth can. Then, do 20 curls with the Mars can.

Which one took more effort? Why?

Measuring Up

Directions: Follow the center directions to measure your partner.

What happened? Why? Hint: Think about gravity and blood flow.

Bones

Directions: Put your hand flat on the top of the cup and gently push down.

What happens? Why?

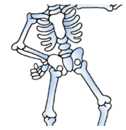
Earth:

Mars:

Beans in Space 

Do 20 curls with the Earth container. Record your observations and describe the effort it took to lift the can.

Do 20 curls with the Mars container. Record your observations and describe the effort it took to lift the can.

Bones! 

Compare the models of the bones on Earth with the bones in space.

- Stand each of the “bones” (cups) upright on a flat surface.
- Place your hand, palm down, on top of the “Earth bone”.
  Gently press down and observe whether it is difficult or easy to crumple.
- Gently press down on the “space bone” and observe how difficult or easy it is to crumple.
- What do you observe? Why do you think that happened?

Measure Up 

Measure the same changes that astronauts experience in space.

- With your partner standing up, wrap the string once around your partner’s ankle. Make a mark where the end of the string comes back into contact with the rest of the string. Using a ruler, measure the distance from the end of the string to the mark and record your measurement.
- Have your partner lay on the floor near a wall with his or her legs in the air leaning against the wall for one minute. After one minute, measure his or her ankle again — while his or her legs still are propped against the wall —with a different color, and record that measurement. Be sure to measure the ankle at the same place.
- What happens to the size of your ankle? Why do you think that happened?

Create a Space Habitat

Name: ____

Design a space habitat for the first humans to live on Mars. Make sure you address the needs and concerns that would arise if a person inhabited Mars. Include details that are based on scientific facts and be creative in your design of the habitat.

Directions: Use the space below to draw your habitat. Clearly label each component of your drawing (ex: gym, kitchen, sleeping quarters). On the back, explain four of the components you labeled.

Name your space habitat: ____

Name: ______________________________________ Class: _________________________

Do Now: Day 5

What do you think happens to your height on Mars? Do you grow, shrink, or stay the same? Explain your answer.

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Name: ______________________________________ Class: _________________________

Do Now: Day 5

What do you think happens to your height on Mars? Do you grow, shrink, or stay the same? Explain your answer.

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Scientific Explanation

In complete sentences, explain four features of your habitat. Why did you create these features for your habitat? What human concern were you addressing? How are these features necessary for survival on Mars?