

Mars Unit Plan

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SCED 526 – Exploring Mars with a Twist

Background

This is my fourth year as a general education, fourth grade teacher in Colorado Springs, CO. As an elementary school teacher, I am in charge of teaching all subjects – Spelling/Grammar, Reading Writing, Math, Science and Social Studies. My school is part of a small school district in the foothills of the Rocky Mountains that has a reputation known for its tradition in excellence. We have one preschool, five elementary schools, one junior high, one high school and a K-12 charter school. We are ranked fifth in the state with an average of 90% of our high school students graduating. We are near Fort Carson, a large military base, as well as the Air Force Academy and two other smaller military and aeronautical bases. For this reason, we do have a handful of students that come and go throughout the year due to deployments and assignments.

My school, which has approximately 490 students K-6; and most of the district is located in an affluent part of town. Most of my students come from middle to high socio-economic statuses. However, in Colorado, school is open enrollment and not guided by boundaries so we do get students from other towns and economic statuses. Our students in general are very active, involved and high-achieving. We also have a very involved parent community. Each grade has three classrooms, with maximum class sizes of 24 for Kindergarten, 25 in first through third grades and 27 for fourth through sixth grades. In addition to the general education classrooms, our students also get Music, Physical Education and Art, which they rotate through every three days. Students in fourth through sixth grades also have the option to participate in Band. We have a computer lab, library and cafeteria. Students have access to special services-Special Education, Interventionists, Speech, Counseling, ELL, OT/PT. Through our school and district technology departments, we not only have a lab with 30 Apple desktop computers, we also have a mobile cart with apple laptops, three mobile carts with Chrome Books, one cart of touchscreen Chrome Books and one mobile cart of iPads. Each cart has 30 devices. We have also recently purchased about 30 Sphero robots for coding. There is a Google calendar on which teachers can reserve the carts for their classroom for their students to access and use. All Kindergarten through fourth grade classrooms also have three computers permanently in their rooms (two Chrome Books and an Apple desktop). Classrooms are all equipped with a projector and document camera. Some teachers, myself included, also have either a Smart Board, or Mimio Board/Pad.

Teachers are provided with a textbook series for both Reading and Math, but are given the freedom to implement as we see fit/necessary for our students' needs. We are supplied with a Science kit that has been put together for us by employee volunteers. Each grade receives three kits a year and the kits are rotated between the elementary schools. We are given no resources for Social

Studies, other than a resource called Colorado Studies Weekly, which is a weekly “newspaper”. Other than that, teachers have to come up with and create their own lessons and consumables.

Rationale

It is for that reason that I have chosen to create this Mars Unit. While our kits claim to be aligned, they are not truly aligned to the Common Core Standards and our district has not yet adopted the NGSS standards. The Solar System is one of the units/kits for fourth grade. The kit consists of a teacher’s manual with 12 lessons and a test. The lessons focus on the order of the planets, relative size and distance, planetary orbits and making circles, days and years, asteroids, comets, etc., and stars/constellations. Most of the lessons involve a teacher demonstration or the students working out a bunch of calculations and filling out a worksheet. It makes me sad and a bit frustrated because the Solar System is incredibly interesting and there is so much the students could be doing and learning. These last couple of years, my teammates and I have worked to supplement the kit and have found some fun activities and a way to use interactive notebooks but we are always wanting more. Every year, we take a trip to the Space Foundation and the guide for my class that year was so excited about Mars and everything about it. It got me excited and I actually switched into this class after that field trip with the hope that I would be able to bring some great resources, lessons, activities and information back to my teammates and students, which I honestly feel that I can.

Lessons

This unit is designed to take anywhere from 6-10 days.

The unit is comprised of the following lessons:

- 1) Layering & Mapping
- 2) Layer Investigation
- 3) Human Rovers
- 4) Sphero Rovers
- 5) Edible Rovers
- 6) Determining & Creating Life on Mars

Lesson 1: Layering & Mapping

(Grade 4 and up)

Adapted from Mars Activities: Teacher Resources and Classroom Activities

by Mars Education Program, JPL and Arizona State

Original lesson from Exploring the Moon, a Teacher's Guide with Activities for Earth & Space Sciences

Objectives	<p>Students will:</p> <ul style="list-style-type: none"> • Use a model volcano to create multiple lava flows • Make observations, drawings and recordings in order to discuss, argue and explain how a landscape was created
Standards	<p>NGSS</p> <ul style="list-style-type: none"> • 4-ESS1-1: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. • 4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features. • 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • Practice 1: Asking questions and defining problems • Practice 2: Developing and using models • Practice 3: Planning and carrying out investigations • Practice 4: Analyzing and interpreting data • Practice 7: Engaging in argument from evidence <p>CCSS</p> <ul style="list-style-type: none"> • 4.S.3: Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet <p>NOS</p> <ul style="list-style-type: none"> • Understand that models are developed to explain and predict

natural phenomena that cannot be directly observed because they happen over long periods of time. (DOK 1)

Materials

For each group:

Session 1

- 1- 4oz. paper cup, cut to 2.5cm high
- 2- 6-8oz. paper cups
- Cardboard or other flat, study surface- 45cm square
- 4- Playdough or soft clay about the size of a fist (each ball a different color)
- Tape
- Spoon
- $\frac{1}{4}$ cup Baking Soda
- $\frac{1}{2}$ cup vinegar
- Marker or Sharpie
- Paper and pencil
- Paper towels
- Plastic Wrap to cover finished volcanoes
- Student Sheet 1

Session 2

- Volcano model
- Coloring materials
- Ruler (optional)
- Plain 8.5x11 paper
- Student Sheet 2

Time	Session 1: 45 minutes Session 2: 30-45 minutes
Lesson	<p>Session 1</p> <p>Prep:</p> <ul style="list-style-type: none"> -Group students into small groups of 3 or 4 -Pass out materials <p>Share with students:</p> <p><i>All large, rocky planetary objects have volcanoes and sometimes lava flows. We have discovered that Mars has had volcanic activity for quite some time. Olympus Mons is a well-known volcano on the red planet. It is over 20 km (over 12 miles) high and wide enough to cover most states. Some of the volcanoes on Mars are similar to the volcanoes that Hawaii was created from. Geologists studying Mars look at the texture, color and make up of samples from Mars to draw conclusions about how and when lava flows on Mars.</i></p> <p><i>Today, you are going to create a series of volcanic eruptions in order to observe lava flows. You will map each flow in order to draw conclusions.</i></p> <p>Pass out Student Sheet Part 1. While students should be able to do the activity on their own in their groups, you may want to do the first eruption with them and allow them to do the remaining eruptions on their own.</p> <p>When they are finished, groups should cover their volcano with plastic wrap and work to answer the questions on the Results side of their worksheet.</p> <p>Session 2</p> <p>Have students gather their volcanoes and pass out session materials.</p> <p>Share with students:</p> <p><i>Geologists rely on field work in order to collect samples and create maps. When they aren't able to physically observe an object or sample firsthand, they rely on photos taken by rovers, drones, etc. to do the field work for them. While very helpful, this requires a lot of inferring and guesswork. Luckily, advancements in technology are greatly changing the information scientists and researchers receive and observe.</i></p> <p><i>Today, you are going to use the volcano model you created in the last session to help draw a map of your model. Use the bird's eye view example as your guide.</i></p> <p><i>After drawing, work to answer the questions on your student sheet.</i></p>

	After students have completed their drawings, lead a discussion around the differences in the maps, some of the questions from their worksheet. Get them thinking about how they could determine and analyze the interior and layers of rock.
Assessment	Check drawings and answers to results questions for accuracy and understanding.
Resources	<p>Student Sheet 1 (see below) Student Sheet 2 (see below)</p> <p>Panoramic video/photo of Mars: https://www.jpl.nasa.gov/video/details.php?id=1518</p> <p>Volcano Comparison of Mars and Earth (you could also use Google Mars) https://www.lpi.usra.edu/education/MarsMillennium/volcanos_beg.pdf</p>

Student Sheet 1

Activity Procedure

- 1) Take the smaller paper cup (4oz) that has been cut down and tape it onto the cardboard. This will be your eruption source.
- 2) Mark North, South, East and West (Cardinal Directions) on the edges of the cardboard.
- 3) Fill one of the larger cups about halfway with baking soda and the other with vinegar.
- 4) Place a spoonful of baking soda into your eruption cup.
- 5) Slowly pour a small amount of vinegar into your eruption cup and observe the “lava flow”.
- 6) When it stops, quickly trace around the edge of the flow with your marker.
- 7) Wipe up the excess fluid with paper towels.

- 8) Use a thin layer of playdough or clay to cover the area where lava flowed as accurately as you can.
- 9) Repeat steps 4-8 for the remaining flows.
 - a. You can add baking soda and wipe out vinegar mixture in eruption up as necessary.
 - b. Be sure to mark where the lava flowed over previous layers in addition to the cardboard.

Results

- 1) What color is your oldest flow? _____
- 2) What color is your youngest flow?

- 3) Did the flows all follow the same path/direction? Explain.

-
-
- 4) What do you think influenced the direction that each eruption flowed?

-
-
- 5) If you had not watched the last two flows, how would you know that there are different layers of lava?

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- 6) How do you think you could determine different layers on Mars?

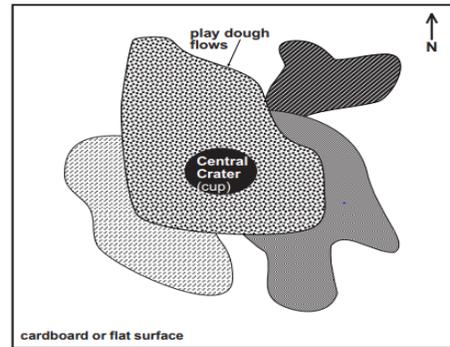
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Student Sheet 2

You will create a drawing to replicate your volcano model. Use the example to the right as a guide.

Use a separate sheet of paper to create your map and attach it to this worksheet.

Example of bird's eye view map of lava flows.



1) How many flows are on your map?

2) Describe your lava flows.

3) Can you easily determine the sequence of flows or are there some areas where you can't tell which came first?

4) Are there parts of flows that are covered? Which ones?

5) How could you determine the shape and size of each flow without moving the playdough?

6) Why would it be harder to map lava flows using just photos from space crafts and rovers?

Lesson 2: Investigating and Analyzing Land Samples (Grade 4 and up)

Adapted from Mars Activities: Teacher Resources and Classroom Activities

by Mars Education Program, JPL and Arizona State

Original lesson from Mission to Mars by Pacific Science Center

Objectives	<p>Students will:</p> <ul style="list-style-type: none"> • Examine & Analyze a “Martian” or “Mars” land sample • Learn how an unknown core sample can be identified by matching it with a known sample • Understand how a core sample can help to understand layering and the history of an area
Standards	<p>NGSS</p> <ul style="list-style-type: none"> • 4-ESS1-1: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes to a landscape over time. • 4-ESS2-1: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind or vegetation. • Practice 3: Planning and carrying out investigations • Practice 7: Engaging in argument from evidence • Practice 8: Obtaining, evaluating and communicating information <p>CCSS</p> <ul style="list-style-type: none"> • 4.S.3.1.a: Gather, analyze, and interpret data about components of the solar system (DOK 1-2) • 4.S.3.1.b: Utilize direct and indirect evidence to investigate the components of the solar system (DOK 1-2) • 4.S.3.1.d: Develop a scientific explanation regarding relationships of the components of the solar system (DOK 1-3)
Materials	<p>For each student (or group):</p> <ul style="list-style-type: none"> • 2- “Fun Size” candy bar (Milky Way, Snickers, 3 Musketeers, Mounds, Almond Joy, Reese’s Peanut Butter Cup tend to work best) • 2- 3in. section of a clear, plastic straw • Paper plate • Plastic knife • Graph paper or ruler • Student Recording Sheet (1 per student, even in groups)

Time	1 session, 30-45 minutes
Lesson	<p><i>"Today, you are being asked to put on the Mars Researcher hat. You will receive a "Martian" sample to analyze and make observations about. Try to gather as much information about your sample and be as specific as you can. In addition to making surface observations, you will also be taking a core sample, recording your findings and answering some questions."</i></p> <p>(Demonstrate what that will look like, without using an actual sample.)</p> <p><i>"You will then receive a second sample. You'll go through the same steps and compare the two samples, noting both similarities and differences."</i></p> <p>Have students come up and gather materials. You can either give them their sample or let them blindly pick from a bag. Students can either get started on their own or read through and answer questions one at a time as a group.</p> <p>After all groups/students have finished, use questions 10-12 on the student recording sheet as a discussion/debate piece as a whole group.</p>
Assessment	Review analysis and drawings for accuracy and understanding - see answer key below
Resources	Student recording sheet (see below)

Student Recording Sheet - Layering Investigation of a Martian Sample

Directions: You have just received a Martian surface sample. It is your job to observe and determine all the scientific information you can from this sample. You will be taking a core sample from this Martian surface sample and answering the following questions. You will then receive a second core sample to compare to the first. List anything that is similar or different between the two samples.

1) Describe the color of your Mars sample:

2) Describe the surface features of your Mars sample:

3) Draw a picture of any surface features you see on your Mars sample:

4) What is your hypothesis (science guess) about the cause of any texture that you see on your Mars sample?

5) How many layers does your Martian core sample contain?

6) Draw a picture showing the layers of your Martian core sample.

7) Which layers were made first, and why?

8) Draw a picture of the second core sample showing any layers and surface features.

9) Compare the two core samples and list any similarities or differences from your first Martian core sample.

10) Would a core sample from Mars be important to the study of Mars? Why?

11) Where would be the best place to study a Martian core sample ... on Earth or on Mars? Why?

12) What would account for the samples being different, if both come from Mars?

Lesson 3: Rover Races

(Grade 4 and up)

Adapted from Mars Activities: Teacher Resources and Classroom Activities

by Mars Education Program, JPL and Arizona State

Objectives	<p>Students will:</p> <ul style="list-style-type: none"> • Create and record a series of directions/commands to “drive” a human rover • Experience the challenges and work as a team to solve problem similar to those of NASA scientists • Use effective communication skills to solve a real-world application problem
Standards	<p>NGSS</p> <ul style="list-style-type: none"> • 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • Practice 2: Developing and using models • Practice 3: Planning and carrying out investigations • Practice 6: Constructing explanations and designing solutions • Practice 8: Obtaining, evaluating and communicating information
Materials	<ul style="list-style-type: none"> • Large, open area (classroom, gymnasium, outdoor field, etc.) • Three blindfolds per team • Pencils and clipboards for “drivers” and “judges” • “Obstacles” - example: large pieces of construction paper (something large but flat for safety) • One stopwatch per team • 1 “Driver” sheet per team • Job cards for each team (index cards or name tags/labels) <ul style="list-style-type: none"> o 1 driver o 3 rovers o 1 timer o 1 judge
Time	45-60 minutes
Lesson	<p>Prep: Have job cards made up and groups of 6 students assigned. *You could also have parent volunteers come and act as judges/timers to allow for larger teams or more teams of students. Lay out the course and obstacles ahead of time. A guide is provided for you; but feel free to create the course as you see fit for the area</p>

you have and need of you students. It should be a course that can be navigated by using simple commands (forward, backward, right, left). DO NOT use obstacles that students could trip on or get injured with.

Lesson:

“Raise your hand if you have ever played a video game or with a remote-controlled toy before.” (Observe student responses)

“Now raise your hand if you think driving a rover on another planet, like Mars, would be similar to that.” (Observe student responses)

“In reality, it’s quite different. Scientists at NASA have to send commands to the rover and can sometimes take many minutes for one command to get to the rover. Imagine that you are in charge of navigating, or steering, the rover on Mars. You send a command for it to turn right. Now due to where the rover is, it can take between 8-20 minutes for the command to get to the rover. The scientist then has to wait for the rover to send a reply back saying that it has turned right. Now you are ready to send another command. Think about all the time that has passed just for those few commands. What could happen in that time?” (Take student responses. If having a hard time, guide them – it could crash, tumble over, etc. without anyone on the spot to help it).

“So, rovers are given, or programmed with “artificial intelligence” that tries to help avoid problems. A team will get together, discuss and map out what they want/plan/hope the rover will do and this information will be sent to the rover while the driver uses a computer screen to view and send commands, similar to interactive virtual reality. The rover then carries out the commands. Today, you are going to pretend to be the rovers and scientists controlling them.”

Here, you could share a video/example of a rover in action through JPL (<https://www.jpl.nasa.gov/>) has great resources.

- 1) Assign the students their teams and give them their jobs. Give the drivers their command sheet.
- 2) The drivers will run through the course first, writing down their instructions/commands that they will use to guide their rover (2 steps forward, 1 step left, etc.)
- 3) Once all drivers are done, the “race” can begin. Explain that the drivers will be commanding the rovers by giving them simple directions to follow.
 - a. They may not “ignore” the driver and must follow the directions they have been “programmed” with. It might be good for the teams to name their rover if multiple groups are working/“racing” at the same time.
 - b. Drivers also cannot deviate from their commands, even if the rover has changed course or not follow directions

	<p>accurately.</p> <ol style="list-style-type: none"> 4) Rovers should line up at the starting line, standing single-file with their blindfolds on and their hands on the shoulders of the person in front of them. <ol style="list-style-type: none"> a. Judges will keep tallies of “foot faults” – how many times a rover’s foot touches an obstacle. b. The timer will simply record how long it takes the rover to complete the course. 5) Teams will all start at the same time. Drivers can walk near their team but may not physically touch them, only their voice can give commands. <ol style="list-style-type: none"> a. Total up the score sheets & the team that completed the course with the best time, least foot faults (and most samples collected if choosing that variation) had “mission success”. 6) After all teams have completed the challenge, allow them time to debrief with each other and as a whole group, discussing the challenges and successes they encountered. 7) Repeat if time allows. 8) Variations: <ol style="list-style-type: none"> a. Set up small cones or something easy for the students to pick up as “rock samples”. Those commands will need to be created and written in. b. Use a video camera, monitor in another room with the driver and a “runner” student to simulate the time delay between commands given and received. c. Change the design/layout of the course to make it easier or harder. d. Use angle measurements instead of directions. <p>Fun Follow Up (or pre-activity): This website has a game where students control/command a rover using similar commands to this activity. https://www.nasa.gov/audience/foreducators/robotics/home/ROVER.html#.WukV3IgbOM8</p>
Assessment	Observe during activity; have groups turn in command sheets and judge’s sheet
Resources	Driver Sheet (see below) Judge’s sheet (see below) Sample Course Layout:

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0 0 0 0
0 0 0 0
0 0 0 0

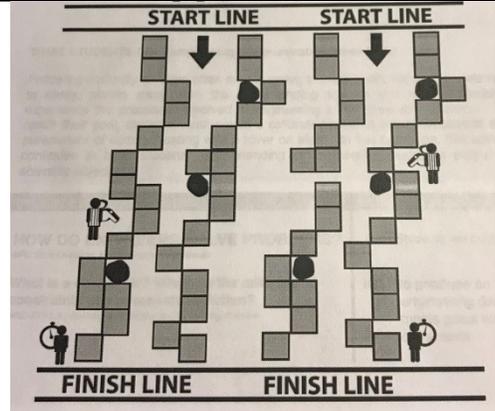
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0 = rover teams

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STARTING LINE
X  X  X  X  X
XX XX XX XX XX
X  X  X  X  X
X  X  X  X  X
X XX XX XX XX X
X  X  X  X  X
XX XX XX XX XX XX
X X  X  X  X  X
FINISH LINE

```



Great short video of NASA problem-solving:
<https://www.jpl.nasa.gov/video/details.php?id=877>

Rover Races

Information Sheet and Course Directions for Driver

Commands:

Right	(R)
Left	(L)
Backward	(B)
Forward	(F)
Stop	(S)
Rock Sample Retrieval	(RSR)

- 1) Write down the course directions for the rover to follow, counting your steps as you walk through the Mars course.
- 2) When the rover is in the correct position for the last person of the rover to collect a rock sample, use the Rock Sample Retrieval command.
- 3) The rover will only be able to follow your set of written commands. The commands to the rover cannot be any different than the ones you have written down.

Commands: (Example - 1. Forward 3 steps. Stop.
2. Turn left 1 step. Stop.)

- | | |
|-----|-----|
| 1. | 11. |
| 2. | 12. |
| 3. | 13. |
| 4. | 14. |
| 5. | 15. |
| 6. | 16. |
| 7. | 17. |
| 8. | 18. |
| 9. | 19. |
| 10. | 20. |

Rover Races

Judges Sheet

Make a mark (example: IIII) every time the first person on the rover team steps on a tile (rock crashes!). Keep track through the whole course and make a total at the end.

NAME OF JUDGE:

NAME OF TIMER:

TOTAL ROCK CRASHES =

TOTAL TIME TO COMPLETE THE COURSE =

TOTAL ROCK SAMPLES COLLECTED

Lesson 4: Sphero Rovers

(Grade 4 and up)

Sessions 1 & 2 self-created, ideas for Session 3 found at <https://edu.sphero.com/cwists/category>

Objectives	Students will: <ul style="list-style-type: none">• Understand the basics of coding• Create and send basic commands and directions to a Sphero robot• Problem-solve to adjust and make corrections
Standards	NGSS <ul style="list-style-type: none">• 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time and cost.• 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem• 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.• 4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.• Practice 2: Developing and using models• Practice 3: Planning and carrying out investigations• Practice 4: Analyzing and interpreting data• Practice 5: Using mathematics and computational thinking• Practice 6: Constructing explanations and designing solutions• Practice 8: Obtaining, evaluating and communicating information CCSS <ul style="list-style-type: none">• 4.ES.3.1.a: Gather, analyze, and interpret data about components of the solar system• 4.ES.3.1.b: Utilize direct and indirect evidence to investigate the components of the solar system (DOK 1-2)• 4.ES.3.1.d: Develop a scientific explanation regarding relationships of the components of the solar system (DOK 1-3)• 4.OA.5: Generate and analyze patterns and identify apparent features of the pattern that were not explicit in the rule itself.• 4.MD: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.• 4.MD.1: Know relative sizes of measurement units within one

	<p>system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec.</p> <ul style="list-style-type: none"> • 4.MD.1: Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. • 4.MD.2: Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. • 4.MD.2: Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
Materials	<p>**You will need a large, open area (gym, cafeteria)**</p> <p>Each student/group will need:</p> <ul style="list-style-type: none"> • Sphero robot • iPad or iPhone with Sphero app • pencil and paper • Ruler/yard stick • Session 1 - Measurement table (see below) • Session 2 - 4 pieces of different colored paper/construction paper • Session 2 - Data table (see below) • Session 3 - materials/worksheets provided in app for chosen activity
Time	<p>Session 1: 30 minutes Session 2: 30-45 minutes Session 3: 45 minutes or more, depending on chosen activity</p>
Lesson	<p>Session 1 - Basic Intro./Getting Comfortable</p> <ol style="list-style-type: none"> 1. Gather students in large area. They should take a robot, an iPad or device, connect the two and log into the Sphero app as a guest. Today's lesson is just allowing the students time to familiarize themselves with the program and tools...some "play time". 2. *Make sure students are spread out* 3. Go into Programs and press the + symbol. 4. Choose the Draw option. <ol style="list-style-type: none"> a. Students use the grid on the device to draw out a line, circle, design, changing the color, steering the robot, turning, bringing it back "home" to you, etc. b. They should record their experiments on the table (one square length on the grid = ___ inches/centimeters in real life) <ol style="list-style-type: none"> i. This will help them in future activities when needing

to create commands.

Session 2 - Basic Programming and Coding

1. Begin as yesterday, having students stop at the Sphero homepage.
2. *Make sure students are spread out*
3. Have students/groups take 3-4 pieces of construction paper – all different colors
4. Pass out data table
5. Go into Programs and press the + symbol
6. Choose the “Blocks” option
 - a. Today’s lesson will give the students a basic/general experience with coding and creating commands.
 - b. Have them put one piece of construction where they are standing as “home” and put another piece directly in front of them, but they can decide exactly how far.
 - c. Teacher Demo:
 - i. Start with the same setup as the students with construction paper
 - ii. In the bottom menu, choose “Movement” and “Roll”
 - iii. Demonstrate how to adjust the speed, time and degree for each roll in order to get to the next piece of paper
 - iv. Note for students that 0’ is forward, 90’ is right, 180’ is backward and 270’ is left.
 - v. Record observations on the table (Example: 0’, 3 seconds and a speed of 75 will make the Sphero go ___ in/cm)
 - vi. Allow students to experiment. Once they are successful, have them add a second piece of paper to direct the Sphero to.
 - vii. Students can also insert a “Delay” option (very helpful), as well as noises and speech (iPad will say “Red” when landing on red paper)
7. To close, discuss with the students and connect this to commanding and steering a rover on Mars. *What would be a challenge? What would help you to be successful?*

Session 3 - Activity/Assessment

At this juncture, I’ve found the following activities to extend/elaborate on this lesson as well as connect with Mars/Solar System units. Activities are always being added, however.

- Spaceship Sphero
- Mission Sprk+
- Lunar Maze
- Space Academy

	-Space (8 lessons/activities) -Asteroids, Craters, Spheros, Oh my! -Martian Mission (8 lessons/activities) -Modeling the Solar System
Assessment	Student success during Session 3
Resources	Measurement collection table (see below) Data collection table (see below)

Practice Measurement Collection Table for Session 1

<u>Length/Distance on grid map</u>	<u>Actual Length/Distance</u>

Practice Measurement Collection Table for Session 1

<u>Length/Distance on grid map</u>	<u>Actual Length/Distance</u>

Data Collection Table for Session 2

<u>Trial #</u>	<u>Degree</u>	<u>Time</u>	<u>Speed</u>	<u>Actual Distance</u>
1				
2				
3				
4				
5				
6				
7				

Data Collection Table for Session 2

<u>Trial #</u>	<u>Degree</u>	<u>Time</u>	<u>Speed</u>	<u>Actual Distance</u>
1				
2				
3				
4				

5				
6				
7				

Lesson 5: Edible Rovers

(Grade 4 and up)

Lesson found at Teach Engineering STEM for K-12

*Contributed by: Integrated Teaching and Learning Program,
College of Engineering, University of Colorado Boulder*

https://www.teachengineering.org/activities/view/cub_mars_lesson03_activity1

Activity adapted from Edible Rover: <http://marsrovers.jpl.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf>

Objectives	<p>Students will:</p> <ul style="list-style-type: none"> • Collaboratively design and construct a rover model using edible materials • Explain and/or argue why they chose the instruments on their rover
Standards	<p>NGSS</p> <ul style="list-style-type: none"> • 3-5-ETS-1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost. • 3-5-ETS-1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • 3-5-ETS-1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • Practice 1: Asking questions & defining problems • Practice 2: Developing and using models • Practice 3: Planning and carrying out investigations • Practice 6: Constructing explanations and designing solutions • Practice 7: Engaging in arguments from evidence • Practice 8: Obtaining, evaluating and communicating

	<p>information</p> <p>CCSS</p> <ul style="list-style-type: none"> • 4.NBT.4: Fluently add and subtract multi-digit whole numbers • 4.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. • 4.W.4.1: Write opinion pieces on topics or texts, supporting a point of view with reasons and information <ul style="list-style-type: none"> o ii. Provide reasons that are supported by facts and details • 4.W.4.7: Comprehending new information for research is a process undertaken with discipline both alone and within groups and Conduct short research projects that build knowledge through investigation of different aspects of a topic.
<p>Material s</p>	<p>Rover parts description & photos</p> <p>For each student group (2 students per group works well):</p> <ul style="list-style-type: none"> • 2 Edible Rover Worksheets • 2 Budget Worksheets • 2 tablespoons of cake icing • Wax paper • Paper towels • 2 plastic straws • 1 plastic knife • 1 plastic spoon • 6-8 toothpicks <p>For the class to share (divided between student groups):</p> <ul style="list-style-type: none"> • candy <p><i>Ideas/options:</i> Oreo's, graham crackers, Kit Kats, string licorice, gumdrops, peppermint candies, Life Savers (gummy works a bit better than hard candy), marshmallows, jelly beans, Fruit Roll Ups, etc.</p>
<p>Time</p>	<p>90 minutes</p>
<p>Lesson</p>	<p>Prep: Lay out all materials students will be able to use for their rovers.</p> <p>Lesson: <i>"Today, you are going to act as NASA engineers and build a rover to send to Mars. What tools/instruments/gadgets do you think might be</i></p>

	<p><i>important to include?" (Record responses on chart paper or the board.)</i></p> <ul style="list-style-type: none"> • Share instruments, description and photo (see resources) <p><i>"With your partner, you will have to decide what instruments to include on your rover. NASA is giving you a strict budget of \$1,350,000 to design and build it. Some of the money is to be used on required instruments, the remaining money you get to decide what it will be spent on. The materials you see laid out for you are the only materials you can use to build with. (Hand out budget worksheets)</i></p> <p><i>"Once you have your budget, draw out a rough sketch of what your rover will look like. Your budget and drawing must be cleared by your manager (me) before you can begin construction.</i></p> <p>Allow students time to complete budget, sketch and construction of their rover. Once groups are done, have them display their rover somewhere in the room for groups to discuss and compare their ideas and final products. Have students complete the final drawing and write up of their rovers.</p> <p>(For 4th grade, I would probably just have the students complete pages 1 & 2 and maybe pick and choose questions from the remaining pages. It would depend on the ability level of the group).</p>
Assessment	<p>Students will write to explain their rover design and the choices they made. They will also draw a picture of their rover model.</p> <p>https://www.teachengineering.org/content/cub_/activities/cub_mars/cub_mars_lesson03_activity1_worksheet.pdf</p>
Resources	<ul style="list-style-type: none"> • Rover Parts/Instruments/Description worksheets <ul style="list-style-type: none"> o (https://www.teachengineering.org/content/cub_/activities/cub_mars/cub_mars_lesson03_activity1_instrumentation.pdf) o https://www.teachengineering.org/content/cub_/activities/cub_mars/cub_mars_lesson03_activity1_spirit.pdf • Budget Worksheet <ul style="list-style-type: none"> o https://www.teachengineering.org/content/cub_/activities/cub_mars/cub_mars_lesson03_activity1_instrumentation.pdf

Lesson 6: Life on Mars

(Grade 4 and up)

Adapted from Mars Activities: Teacher Resources and Classroom Activities

by Mars Education Program, JPL and Arizona State

***Disclaimer: Sessions 2 & 3 of this lesson were not adapted or self-created. They were found in the source listed above. The lessons were great for thinking about how life would survive on Mars and I truly felt they should not be adapted or changed much from the way they are written. I chose to teach the lessons to the plan, which is why I included them in my unit as I found them. If I taught them again, I would still make minimal, if any, changes.**

Objectives	Students will: <ul style="list-style-type: none">• Apply knowledge gained through reading to make inferences about life forms on Mars• Define characteristics and necessities or and for survival• Describe and construct a model of a predicted for of life on Mars
Standards	NGSS <ul style="list-style-type: none">• 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of

	<p>a model or prototype that can be improved</p> <ul style="list-style-type: none"> • 4-LS-1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction. • 4-LS-1-2: Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. • Practice 2: Developing and using models • Practice 6: Constructing explanations and designing solutions • Practice 7: Engaging in argument from evidence • Practice 8: Obtaining, evaluating and communicating information <p>CCSS</p> <ul style="list-style-type: none"> • 4.LS: Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment • 4.LS.1.a: Use evidence to develop a scientific explanation of what plants and animals need to survive (DOK 1-3) • 4.LS.1.d: Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate questions about characteristics of living things (DOK 1- 2) • 4.LS.3.d: Use evidence to develop a scientific explanation on how organisms adapt to their habitat (DOK 1-3) • 4.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others’ ideas and expressing their own clearly. • 4.RL.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
Materials	<p>Session 1</p> <p>For each group of 3-4:</p> <ul style="list-style-type: none"> • butcher paper • Coloring materials • “If You Went to Mars” handout <p>For the class/teacher:</p> <ul style="list-style-type: none"> • Sections of scientific/science fiction novels <ul style="list-style-type: none"> o Examples: <u>Mars</u> by Ben Bova (chapter 7), <u>Out of the Silent Planet</u> by C.S. Lewis (chapter 7), <u>The Martian Chronicles</u> by Ray Bradbury (Feb. 1999-YUa), <u>The Day the Martians Came</u> by Frederick Pohl (chapter 17) o Of course, use options that appropriate for your students

	and grade level. Feel free to find your own as well.
	Session 2 & 3 - see below lesson plan
Time	Session 1: 30 minutes Session 2: 60 minutes Session 3: 45-90 minutes (45 if just constructing, 90 if constructing and presenting)
Lesson	<p>Session 1 - Characteristics of Mars</p> <p><i>"We have not always had the knowledge of Mars that we do today. For many years, people had imagined what it was like and created their own inferences/ideas.</i></p> <p><i>First, I will read one excerpt at a time and I want your group to draw/sketch what you hear/see in your mind's eye."</i></p> <p>Read aloud and allow students time to discuss/draw after. Pass out "If You Went to Mars" handout for students to read through & have them again discuss/draw what they got from that reading.</p> <p>Session 2 - Criteria for Life on Mars (See plan below)</p> <p>Session 3 - Creating a Mars Life Form (See plan below)</p>
Assessment	Assessment will be based on students' critter creation -grading criteria listed on student sheet
Resources	"If You Went to Mars" handout (see below) Lesson Plans (see below) found at https://mars.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf in January 2018.

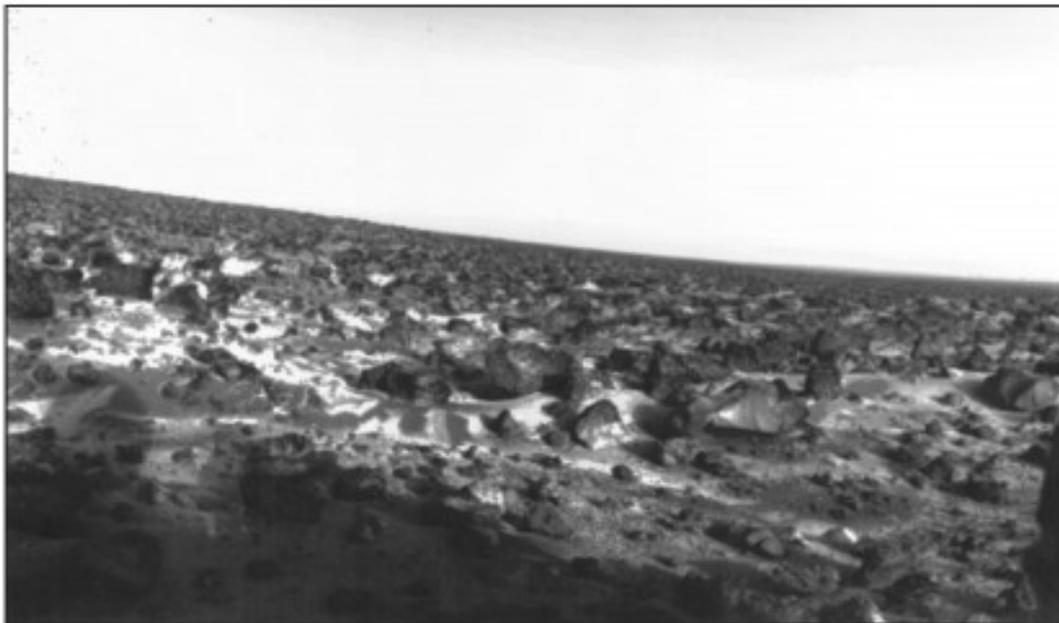
If You Went to Mars

from "Guide to the Solar System,"

by The University of Texas, McDonald Observatory

Mars is more like Earth than any other planet in our solar system but is still very different. You would have to wear a space suit to provide air and to protect you from the Sun's rays because the planet's thin atmosphere does not block harmful solar radiation. Your space suit would also protect you from the bitter cold; temperatures on Mars rarely climb above freezing, and they can plummet to -129°C (200 degrees below zero Fahrenheit). You would need to bring water with you; although if you brought the proper equipment, you could probably get some Martian water from the air or the ground.

The Martian surface is dusty and red, and huge duststorms occasionally sweep over the plains, darkening the entire planet for days. Instead of a blue sky, a dusty pink sky would hang over you.



Session 2

ACTIVITY 2—

LOOKING FOR LIFE

About This Activity

In Activity A students will use research to develop their criteria for life. The class will combine their ideas in a teacher-guided discussion. In Activity B they will then use their definition of life to determine whether there is anything alive in three different soil samples. They will make observations and draw pictures as they collect data from the samples and experiment.

Objectives

Students will:

- form an operational definition of life.
- conduct a simulated experiment with soil samples similar to the experiments on the Mars Viking Lander.
- state relationships between the soil samples using their operational definition of life.
- make an inference about the possibility of life on Mars based on data obtained.

Background

We usually recognize something as being alive or not alive. But when scientists study very small samples or very old fossilized materials, the signs of life or previous life are not easy to determine. Scientists must establish criteria to work within their research. The tests for life used by the Viking Mars missions were based on the idea that life would cause changes in the air or soil in the same way that Earth life does. The Viking tests did not detect the presence of life on Mars. The Viking tests would not have detected fossil evidence of past Mars life or a life form that is very different from Earth life.

Vocabulary

criteria, characteristics, organism, replication, metabolic

PART A: AN OPERATIONAL DEFINITION OF LIFE

About This Part

Students will conduct research to identify characteristics of living and non-living organisms. They will record their observations on a chart that will help the class to come to a consensus about how to identify living things.

Materials

- Student Sheet *Fundamental Criteria for Life Chart* (pg. 38)
- dictionaries and encyclopedias
- examples of living and non-living things (should include plants, animals, and microorganisms—pictures can be substituted for the real thing)

Procedure

Advanced Preparation

1. Gather materials.
2. Review Background and Procedure.

Classroom Procedure

1. Explain to students that their job is to come up with a definition of how living things can be detected.
2. Ask students to state (or write) what characteristics make an individual item alive or not alive. Encourage them to find pictures and definitions of living and non-living things. Allow the students use of dictionaries and encyclopedias. Use the examples on the following page to encourage the students but not to limit them.

Example: Consider a bear and a chair—they both have legs, but one can move on its own and the other would need a motor made by humans; therefore, independent movement might be one characteristic that indicates life.

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Example: Consider a bear and a chair—they both have legs, but one can move on its own and the other would need a motor made by humans; therefore, independent movement might be one characteristic that indicates life.

Not every living organism needs legs or roots. But they do need a mode of locomotion or a way to get nutrients. Also, the bear breathes and the chair does not, another indication of life. Or consider a tree and a light pole. We know that a light pole can not reproduce—it is made by humans—and we know that the tree makes seeds that may produce more trees. The tree also takes in nutrients and gives off gasses and grows. The light uses electricity and gives off light, but it is strictly an energy exchange and there is no growth and there are no metabolic processes.

However, students might not list the fundamental criteria for life. They might go for the more obvious signs like methods of locomotion. The more subtle but fundamental signs of life are:

- metabolic processes that show chemical exchanges which may be detected in some sort of respiration or exchange of gases or solid materials.
 - some type of reproduction, replication or cell division.
 - growth.
 - reaction to stimuli.
3. As a class, discuss the indications of life, asking for examples from a diverse sampling of living things. The teacher will paraphrase and group criteria on the blank chart, then guide the students to summarize the groupings to reflect the fundamental criteria for life.
4. Students will use these criteria for the following activities.

PART B: IT'S ALIVE!

About This Part

Students will take three different soil samples and look for signs of life based on the criteria from Part A.

Materials

- sand or sandy soil sample
- three glass vials, baby food jars, or beakers for soil per group
- sugar- 5 ml (sugar will be added to all soil samples)
- instant active dry yeast- 5 ml added to 50 ml of soil
- Alka-Seltzer tablets crushed- 1 tablet added to 50 ml of soil
- hot water - enough to cover the top of the soil in all jars (not hot enough to kill the yeast!)
- cups for distributing the water
- magnifying lens- 1 per group or individual
- Student Sheets *Data Chart I* and *Data Chart II* (pgs. 43-44)

Procedure

Advanced Preparation

1. Fill all jars 1/4th full of soil. (You will need 3 jars per team.)
2. Add just sugar to 1/3rd of the jars. Label these jars "A."
3. Add instant active dry yeast and sugar to 1/3rd of the jars. Label these jars "B."
4. Add the powdered Alka-seltzer and sugar to the remaining jars. Label these jars "C."
5. Give each group a set of three jars, a magnifying lens, and the chart from previous activity.

Classroom Procedure

(Information for teacher only—do not share all the information with students!)

1. Explain to the students that each team has been given a set of soil samples. No one knows if there is anything alive in them. The assignment is to make careful observations and check for indications of living material in them — based on their criteria.
2. Ask students to observe all three samples. They can smell and touch the samples but not taste them. Encourage students to put a few grains on a flat white surface and observe them with a hand lens. Students should then record their data.
3. Give each group a cup of water. (Use hot tap water (~50°C) for the best results, do not kill the yeast.) Ask students to pour the water so that each sample is covered with the water.
4. Repeat step 2 and record data on a second sheet or in a separate area of the first sheet. Students should look for and record differences caused by adding water. After recording the first observations have students go back and observe again. (After about ten minutes Sample B will show even more activity.)
5. Discuss which samples showed

indication of activity (B and C).

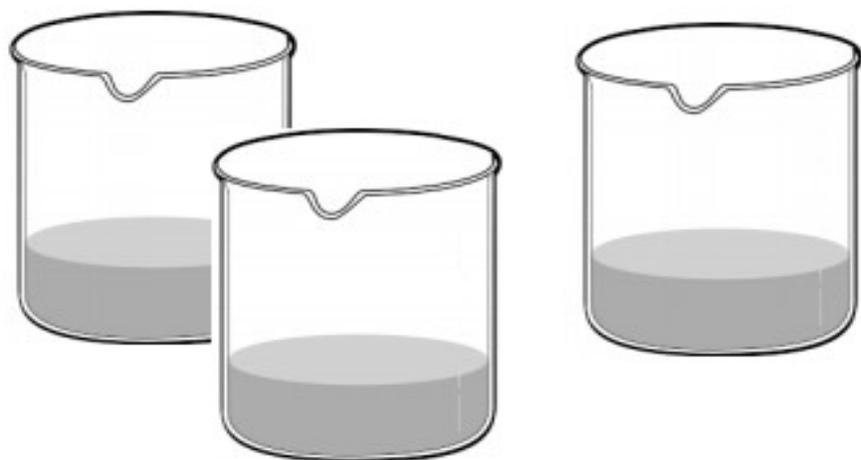
Does that activity mean there is life in both B and C and no life in Sample A?

Are there other explanations for the activity in either B or C?

- Both B and C are chemical reactions
- Sample C reaction stops
- Sample B sustains long term activity
- Sample A is a simple physical change where sugar dissolves

Students should realize that there could be other tests that would detect life in Sample B. There might be microbes in the soil that would grow on a culture medium.

6. Determine which sample(s) contain life by applying the fundamental criteria for indicating life developed in Activity 2.
7. Tell students that Sample B contained yeast and Sample C contained Alka Seltzer. Discuss how scientists could tell the difference between a non-living chemical change (Alka Seltzer) and a life process (yeast) which is also a chemical change.
8. Discuss which of their criteria would identify yeast as living and Alka Seltzer as non-living.



IT'S ALIVE! DATA CHART I

Initial Descriptions (no water added):

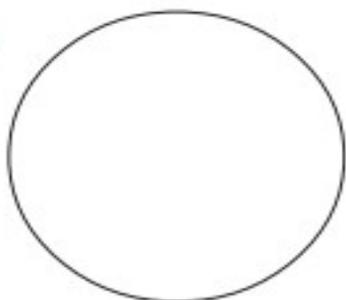
Sample A:

Sample B:

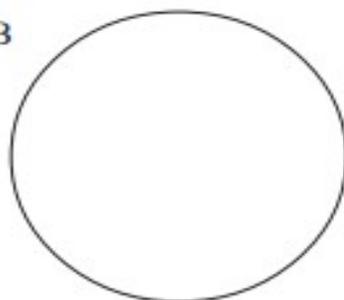
Sample C:

Initial Drawings (no water added):

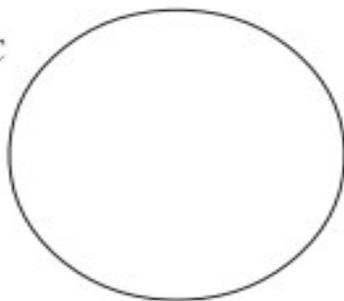
Sample A



Sample B



Sample C



IT'S ALIVE! DATA CHART II

Initial Descriptions (after water is added):

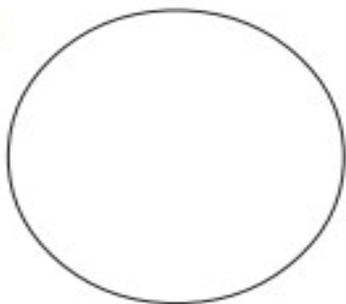
Sample A:

Sample B:

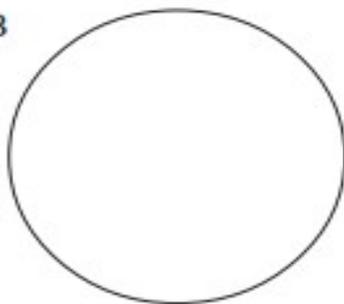
Sample C:

Initial Drawings (after water is added):

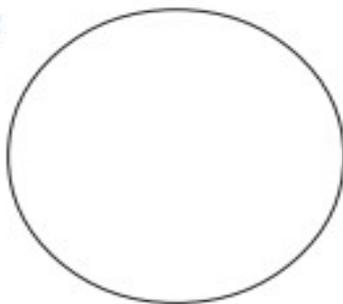
Sample A



Sample B



Sample C



Session 3

ACTIVITY 3—

MARS CRITTERS

About This Activity

In groups or as individuals, students will use their knowledge of Mars and living organisms to construct a model of a plant or animal that has the critical features for survival on Mars. This is a “what if” type of activity that encourages the students to apply knowledge. They will attempt to answer the question: What would an organism need to be like in order to live in the harsh Mars environment?

Objectives

Students will:

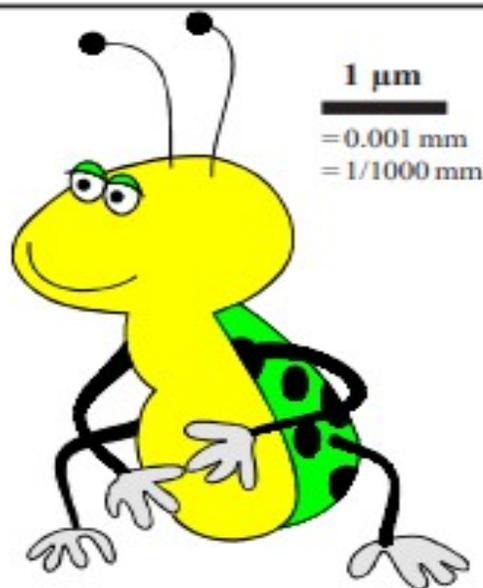
- draw logical conclusions about conditions on Mars.
- predict the type of organism that might survive on Mars.
- construct a model of a possible martian life form.
- write a description of the life form and its living conditions.

National Science Education Standards

- Standard C: Diversity and adaptations of organisms

Background

To construct a critter model, students must know about the environment of Mars. The creature must fit into the ecology of a barren dry wasteland with extremes in temperature. The atmosphere is much thinner than the Earth’s; therefore, special adaptations would be necessary to handle the constant radiation on the surface of Mars. Also the dominant gas in the Mars atmosphere is carbon dioxide with very little oxygen. The gravitational pull is just over 1/3rd (0.38) of Earth’s. In addition, Mars has very strong winds causing tremendous dust storms. Another requirement for life is food—there are no plants or animals on the surface of Mars to serve as food!



Scientists are finding organisms on Earth that live in extreme conditions previously thought not able to support life. Some of these extreme environments include: the harsh, dry, cold valleys of Antarctica, the ocean depths with high pressures and no sunlight, and deep rock formations where organisms have no contact with organic material or sunlight from the surface.

Vocabulary

ecology, adaptations, gravity, geology, atmosphere, radiation exposure, weather, environment

Materials

- paper (construction, tag board, bulletin board, etc.)
- colored pencils
- glue
- items to decorate critter (rice, macaroni, glitter, cereal, candy, yarn, string, beads, etc.)
- pictures of living organisms from Earth
- Student Sheet, *Mars Critters* (pg. 47)
- Student Sheet - Activity 1, *If You Went to Mars* (pg. 37)
- Mars Fact Sheet (pg. 56)

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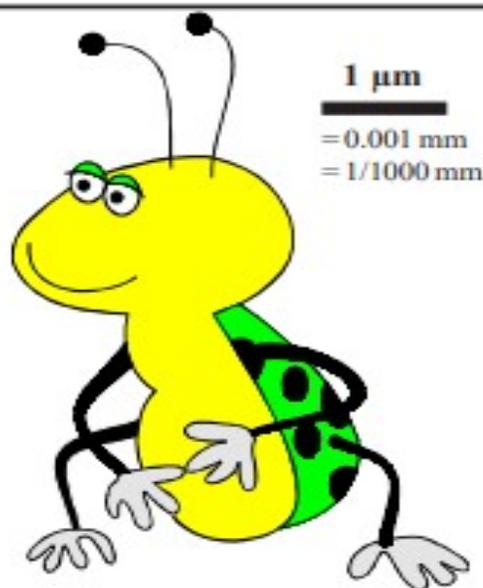
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- Student Sheet - Activity 1, *If You Went to Mars* (pg. 37)
- Mars Fact Sheet (pg. 56)

Procedure

Advanced Preparation

1. Gather materials.
2. Set up various art supplies at each table for either individual work or small group work. This activity may be used as a homework project.
3. Review the "If You Went to Mars" sheet, Mars Fact Sheet, and the background provided above. Other research and reading may be assigned as desired.

Classroom Procedure

1. Ask students to work in groups to construct a model of an animal or plant that has features that might allow it to live on or near the surface of Mars. Have them consider all the special adaptations they see in animals and plants here on Earth. They must use their knowledge of conditions on Mars, consulting the Mars Fact Sheet, *If You Went to Mars*, and other resources such as web pages if necessary. Some key words for a web

search might be "life in space" or "extremophile" (organisms living in extreme environments). They must identify a specific set of conditions under which this organism might live. Encourage the students to use creativity and imagination in their descriptions and models.

2. If this is assigned as homework, provide each student with a set of rules and a grading sheet, or read the rules and grading criteria aloud and post a copy.
3. Review the information already learned about Mars in previous lessons.
4. Allow at least 2 class periods for this project: one for construction, one for presentation.
5. Remind the students that there are no wrong critters as long as the grading criteria are followed.
6. Include a scale with each living organism.

MARS CRITTERS

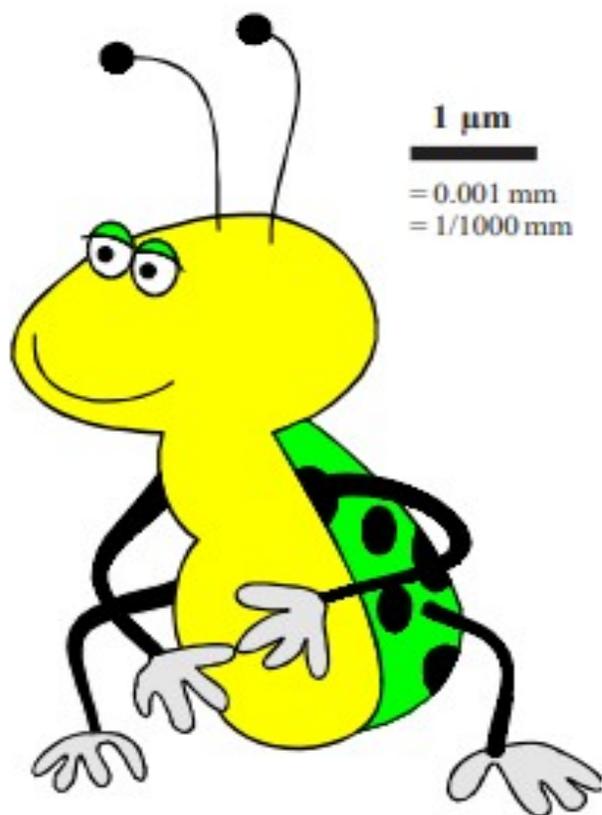
In order to better understand what types of life scientists will look for when they go to Mars, you will construct a model or draw a picture of an organism that has features that might allow it to live on or near the surface of Mars.

Conduct research about the environment on Mars. Consider the geology, gravity, atmosphere, radiation exposure, and weather. Choose a habitat somewhere in the Mars environment for the organism to live. Then construct a model of the plant or animal and include the special features it would need to live in that harsh environment. You may want to research the special adaptations animals and plants have to survive in difficult places here on Earth. Be creative and use your imagination.

Make a scale model or picture of your critter. Answer all the questions on the next page and attach them to the picture or model of your critter.

GRADING

1. Your entry will be graded on scientific accuracy (40%) and creativity (40%). Remember that everything on Mars must obey the laws of nature and your creature must have good martian survival traits. Provide a scale to indicate the true size of your critter.
2. Clear writing and correct grammar count for the remaining 20% of your total score.



Description and Questions

Use another page if more space is needed.

1. The critter's name:
2. Describe the habitat and climate in which your critter lives:
3. How does it move? Include both the form and method of locomotion.
(For example: The miniature Mars Gopher leaps on powerful hind legs).
4. What does it eat or use as nutrients? Is it herbivorous, carnivorous, omnivorous, or other? What is its main food and how does it acquire this food?
5. What other creatures does it prey on, if any? How does it defend itself against predators?
6. How does your creature cope with Mars' extreme cold, unfiltered solar radiation, and other environmental factors?
7. Is it solitary or does it live in large groups? Describe its social behaviors.
8. What else would you like others to know about your critter?