CSI:

Mars Alien Encounter

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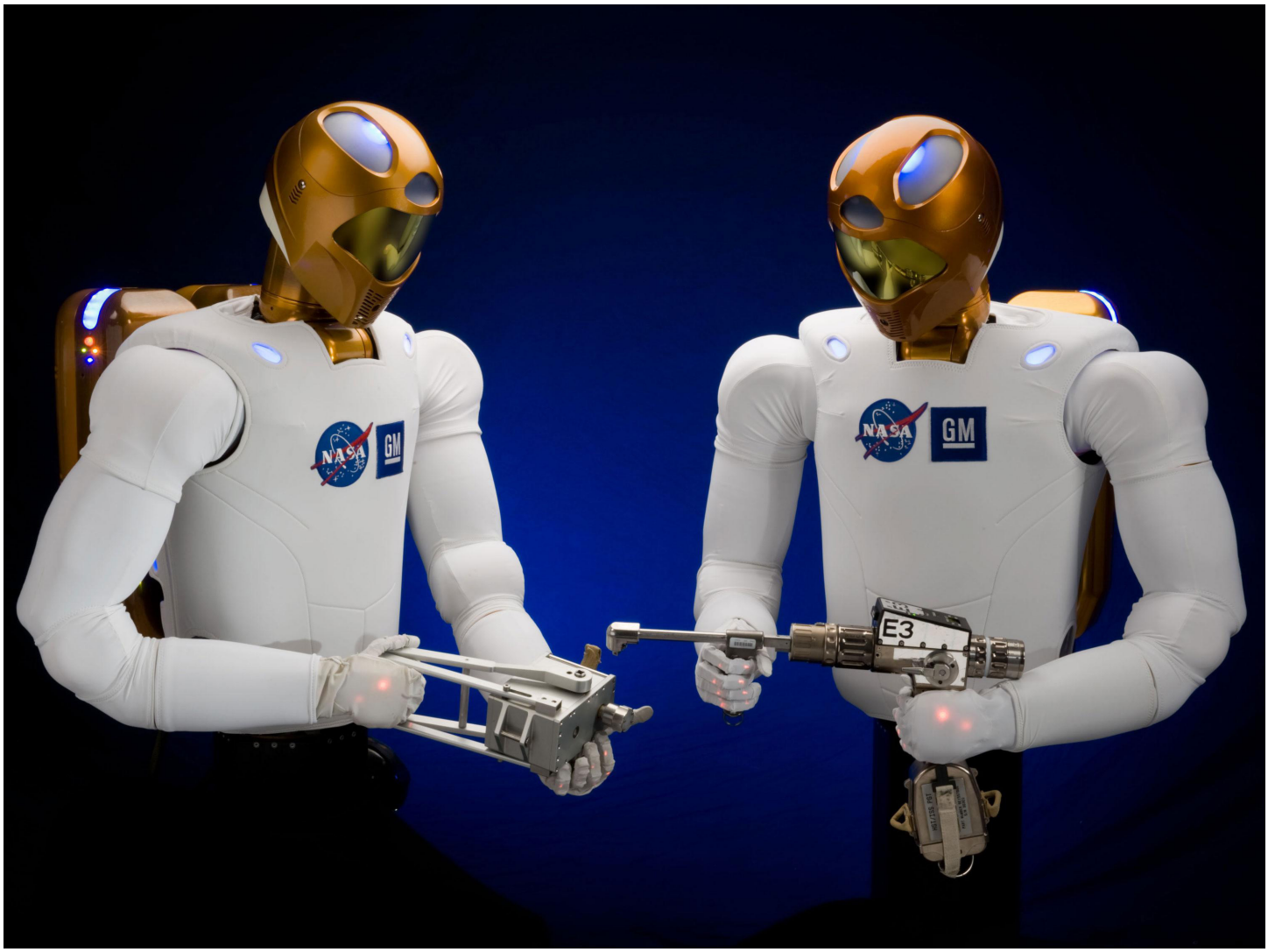
Acknowledgments



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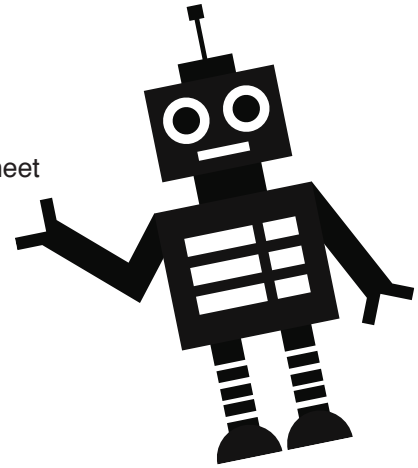
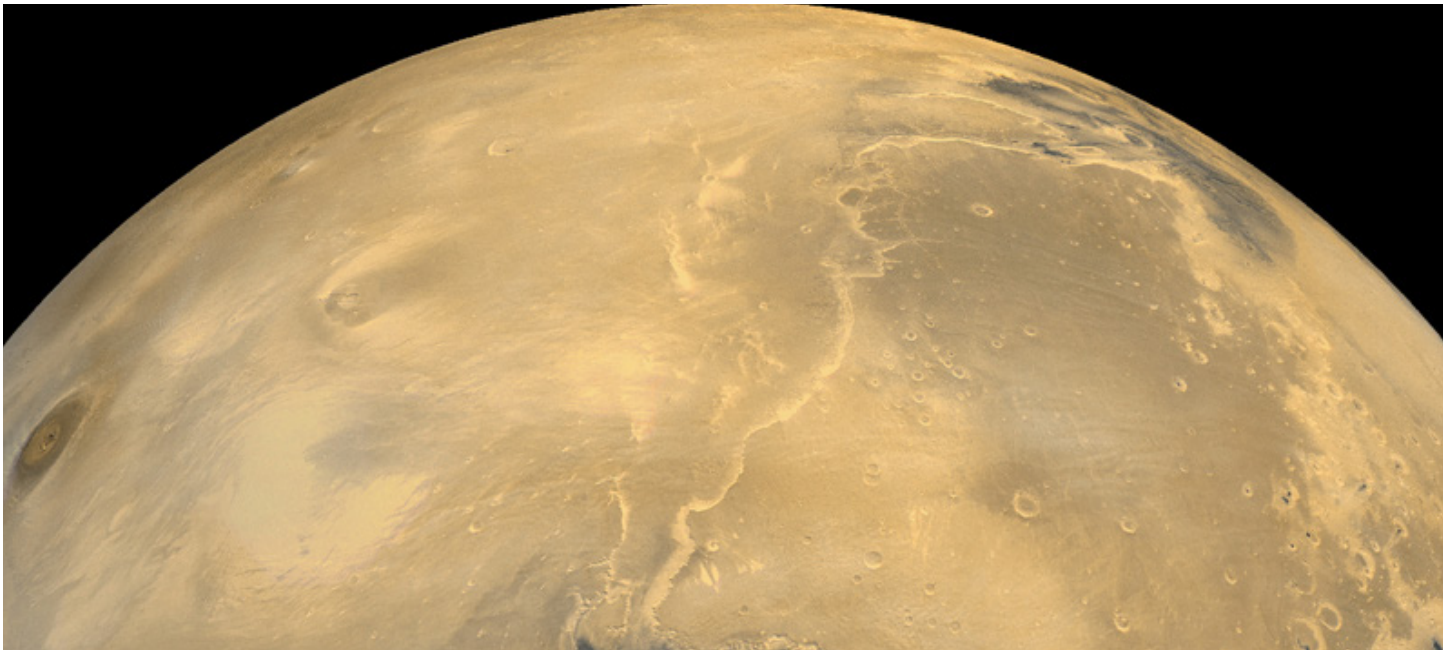


Aligning with National Standards

by Number	Curriculum Activities						
NGSS Standards (5-8)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Physical Science Structures and Properties of Matter Forces and Interactions, Energy, Waves & Electromagnetic Radiation	✔		✔	✔	✔	✔	✔
Life Science Structure, Function and Information Process, Hereditary & Inheritance and Variation of Traits, Biological Evolution		✔	✔				
Earth and Space Science Space Systems, History of Earth, Earth's System, Human Impact							✔
Engineering Defining the Problem, Developing Possible Solutions, Improving Designs	✔	✔	✔	✔	✔	✔	✔



Aligning with National Standards

	Curriculum Activities by Numbers					
Texas Essential Knowledge & Skills	**Grade**	**TEKS**				
	6th	**A**	**B**	**C**	**D**	**E**
Scientific Investigations and Reasoning						
Lab Safety	**1**	all	all			
Inquiry	**2**	all	all		all	all
Scientific Method	**3**	all			all	
Tools	**4**	all	all			
Elements and Compounds	**5**				4	
Physical Properties	**6**		4	4		
Energy Resources	**7**		✗			
Rock Cycle	**10**		6			
Solar System	**11**	✗	✗	✗		

	7th	**A**	**B**	**C**	**D**	**E**
Lab Safety	**1**	all	all			
Inquiry	**2**	all	all		all	all
Scientific Method	**3**	all			all	
Tools	**4**	all	all			
Force, Motion and Energy	**7**	5				
Human Impact on Earth Systems	**8**					
Solar System	**9**	✗	✗			

	8th	**A**	**B**	**C**	**D**	**E**
Lab Safety	**1**	all	all			
Inquiry	**2**	all	all		all	all
Scientific Method	**3**	all			all	
Tools	**4**	all	all			
Chemical and Physical Properties	**5**				4	
Force, Motion and Energy	**6**			2,3,5		
Natural Impacts on Earth Systems	**9**		✗			

Mars : By the Numbers

Discovery
Date of Discovery: Unknown
Discovered By: Known by the Ancients
Namesake: Roman god of war

Orbit Size Around Sun
Metric: 227,943,824 km
English: 141,637,725 miles
Scientific Notation: 2.2794382 x 108 km
Astronomical Units: 1.523662 A.U.
By Comparison: 1.524 x Earth

Mean Orbit Velocity
Metric: 86,677 km/h
English: 53,858 mph
Scientific Notation: 2.4077 x 104 m/s
By Comparison: 0.808 x Earth

Orbit Eccentricity
0.0933941
By Comparison: 5.589 x Earth

Equatorial Inclination
25.2

Equatorial Radius
Metric: 3,389.5 km
English: 2,106.1 miles
Scientific Notation: 3.3895 x 103 km
By Comparison: 0.5320 x Earth

Equatorial Circumference
Metric: 21,296.9 km
English: 13,233.3 miles
Scientific Notation: 2.12969 x 104 km

Volume
Metric: 163,115,609,799 km3
English: 39,133,515,914 miles3
Scientific Notation: 1.63116 X 1011 km3
By Comparison: 0.151 x Earth

Mass
Metric: 641,693,000,000,000,000,000,000 kg
Scientific Notation: 6.4169 x 1023 kg
By Comparison: 0.107 x Earth

Density
Metric: 3.934 g/cm3
By Comparison: 0.714 x Earth

Surface Area
Metric: 144,371,391 km2
English: 55,742,106 square miles
Scientific Notation: 1.4437 x 108 km2
By Comparison: 0.283 x Earth

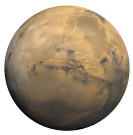
Surface Gravity
Metric: 3.71 m/s2
English: 12.2 ft/s2
By Comparison: If you weigh 100 pounds on Earth, you would weigh 38 pounds on Mars.

Escape Velocity
Metric: 18,108 km/h
English: 11,252 mph
Scientific Notation: 5.030 x 103 m/s
By Comparison: Escape velocity of Earth is 25,030 mph.

Sidereal Rotation Period
1.026 Earth Days
24.623 Hours
By Comparison: Earth's rotation period is 23.934 hours.

Surface Temperature
Metric: -153 to +20 °C
English: -225 to +70 °F
Scientific Notation: 120 to 293 K

Atmospheric Constituents
Carbon Dioxide, Nitrogen, Argon
Scientific Notation: CO2, N2, Ar
By Comparison: CO2 is responsible for the Greenhouse Effect and is used for carbonation in beverages.
N2 is 80% of Earth's air and is a crucial element in DNA. Ar is used to make blue neon light bulbs.



NASA: Solar System Exploration/Mars
http://solarsystem.nasa.gov/planets/mars

Mars: 10 Need-To-Know Things

1

Small Planet

If the sun were as tall as a typical front door, Earth would be the size of a nickel, and Mars would be about as big as an aspirin tablet.

2

Fourth Rock

Mars orbits our sun, a star. Mars is the fourth planet from the sun at a distance of about 228 million km (142 million miles) or 1.52 AU.

3

Longer Days

One day on Mars takes just a little over 24 hours (the time it takes for Mars to rotate or spin once). Mars makes a complete orbit around the sun (a year in Martian time) in 687 Earth days.

4

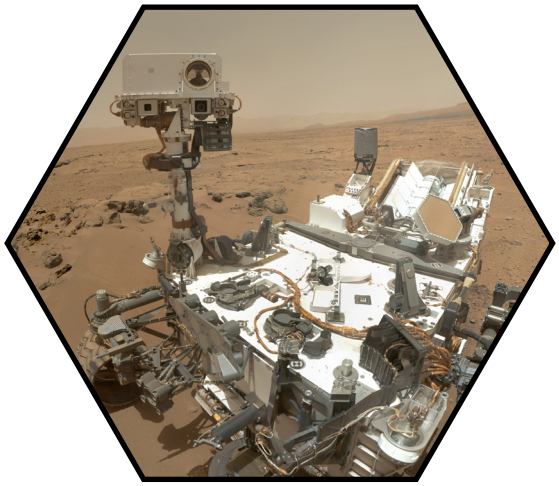
Rugged Terrain

Mars is a rocky planet, also known as a terrestrial planet. Mars' solid surface has been altered by volcanoes, impacts, crustal movement and atmospheric effects such as dust storms.

5

Bring a Spacesuit

Mars has a thin atmosphere made up mostly of carbon dioxide (CO_2), nitrogen (N_2) and argon (Ar).



6

Double Moons

Mars has two moons named Phobos and Deimos.

7

Ringless

There are no rings around Mars.

8

Many Missions

Several missions have visited this planet, from flybys and orbiters to rovers on the surface of the Red Planet. The first true Mars mission success was Mariner 4 in 1965.

9

Tough Place for Life

At this time in the planet's history, Mars' surface cannot support life as we know it. Current missions exploring Mars on the surface and from orbit are determining Mars' past and future potential for life.

10

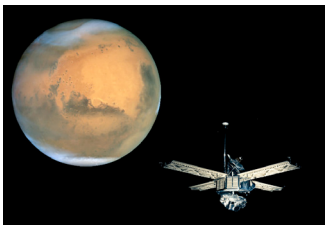
Rusty Planet

Mars is known as the Red Planet because iron minerals in the Martian soil oxidize, or rust, causing the soil -- and the dusty atmosphere -- to look red.

NASA: Solar System Exploration/Mars
http://solarsystem.nasa.gov/planets/mars

Mars: Missions

So far, the exploration of Mars has occurred in three stages:



Flybys:
When we were just starting out in solar system exploration, the very first missions simply flew by Mars, taking as many pictures as possible on their way past.
Flyby missions include: Mariner 3-4 (1964) | Mariner 6-7 (1969)

Orbiters:
As our knowledge and technologies grew, we began putting spacecraft in orbit around Mars for longer term, global studies.

Orbital missions include: Mariner 8-9 (1971) | Viking 1-2 (1975-76) | Mars Observer (1992) | Mars Global Surveyor (1996-97) | Mars Climate Orbiter (1998) | 2001 Mars Odyssey | Mars Express (2003) | Mars Reconnaissance Orbiter (2005-06) | MAVEN - Mars Atmosphere and Volatile Evolution (2013-14) | NASA In 2016 ExoMars Orbiter

Landers & Rovers:
Then, with even more capabilities over the years, we began to land on the surface. Today, we're not only landing in one place, but have shown that we can be mobile on the surface of Mars.

Landed missions include: Viking 1-2 (1975-76) | Pathfinder (1996-97) | Polar Lander/ Deep Space 2 (1999 – lost on arrival) | Mars Exploration Rovers – Spirit (2003-10) and Opportunity (2003-current) | Phoenix (2007-08) | Mars Science Laboratory – Curiosity (2011-current) | NASA In 2018 ExoMars Rover | 2020 Mission Plans

In the future, Mars exploration may bring:

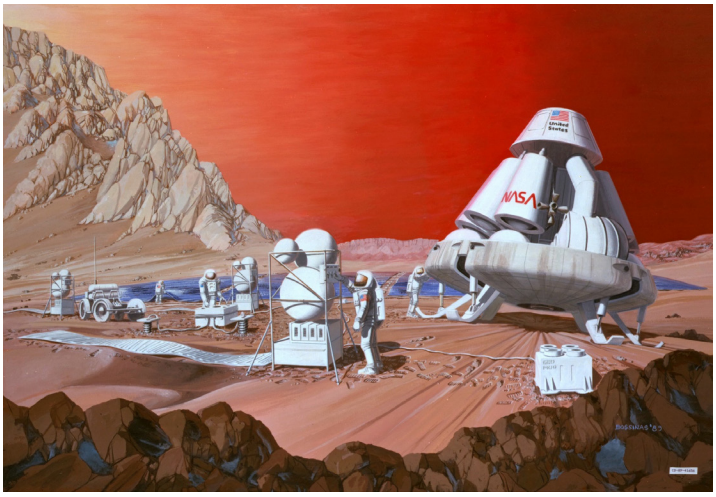
Airplanes & Balloons:
We may send craft that can study the planet from a perspective we've never achieved before: soaring views from the Martian sky.

Subsurface Explorers:
Going below the ground will tell us more about the geology of the planet, the presence of water, and maybe even clues about whether Mars was ever a habitat for life.

Sample Returns:
Bringing samples of Martian rocks, soils, and atmosphere back to Earth would give us the opportunity to study the red planet close-up, in laboratories here on Earth.

NASA: Mars Exploration – Programs & Missions
http://mars.nasa.gov/programmissions/missions/

Living on Mars



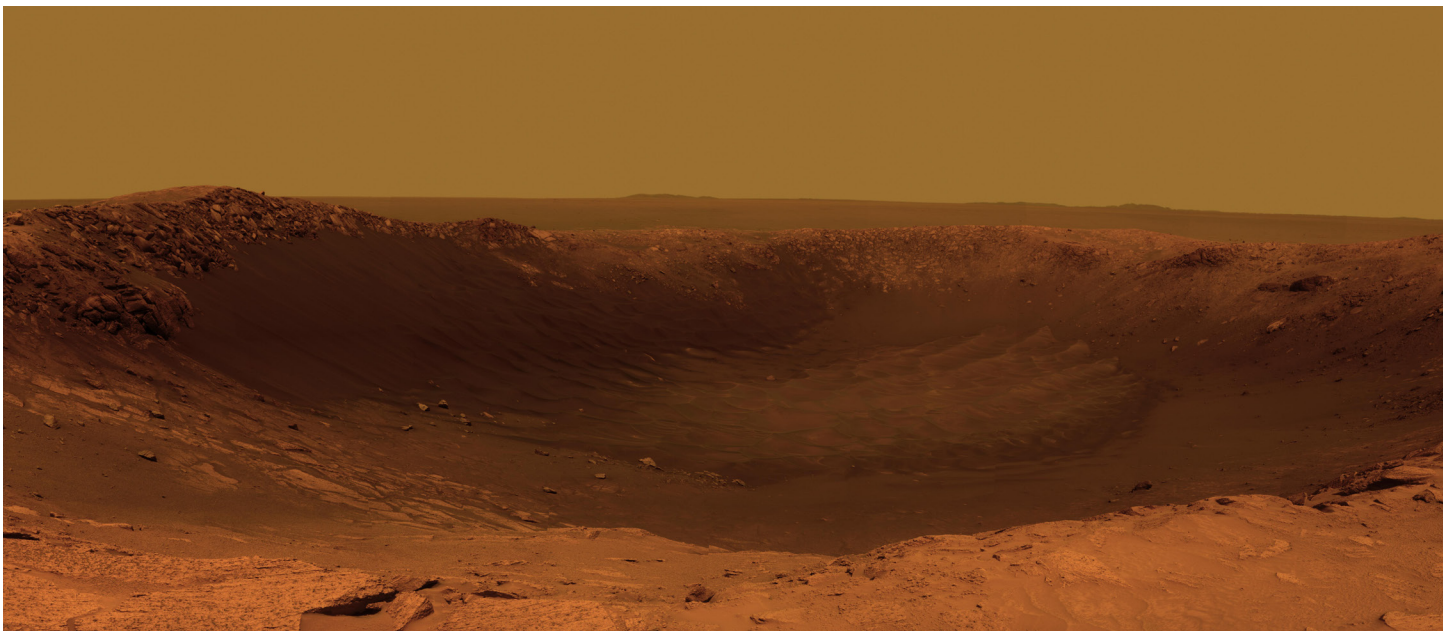
With its thin carbon dioxide based atmosphere which will not support liquid water on the surface and the cold rocky terrain Mars does not currently support life. In order for humans to inhabit Mars we would have to supply all basic needs, such as breathable air/oxygen, water, food, and pressurized shelters, suits and vehicles. The supplies would only allow for a predetermined mission length since limited launch windows would make restocking supplies difficult. Scientists believe, in order to inhabit Mars, we would have to learn to use the resources Mars provides along with the supplies carried or sent ahead in order to develop ways in which we can supply for the basic needs of humans for the long term.

Articles:

What Would It Be Like to Live on Mars? By Joseph Castro, Space.com Contributor
http://www.space.com/28557-how-to-live-on-mars.html

Nasa reveals plan to get humans living on Mars
http://www.bbc.co.uk/newsround/34528622

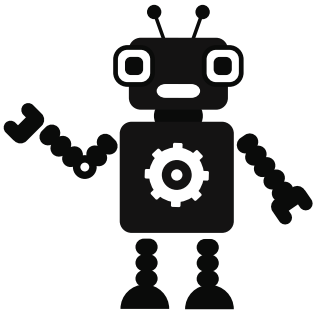
How Can We Live on Mars?
http://www.universetoday.com/111462/how-can-we-live-on-mars/



CSI: Mars Alien Encounter

Scenario:

In the year 2030, NASA has made great strides in establishing an outpost site on Mars for future human habitation. NASA relies on advances in automation to perform a significant amount of the routine activities with a robotic surface mission. Key technologies have been developed and demonstrated by robonauts to test settlement issues that were potentially imposing a substantial workload on the future Mars exploration crew. With NASA being very conscious about the value of human life, MARS (Mars Astronaut Robotic System) robonauts have been developed to build the structures that are necessary for humans to exist on Mars for a long period of time. NASA's decision to send the robonauts first was based on the limited care they would need on Mars to survive.



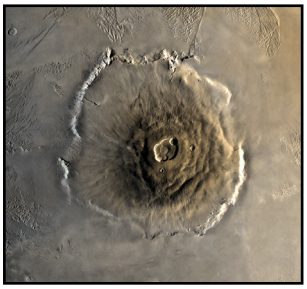
Each MARS robonaut is unique as they were modeled after their ancestors that helped build and repair the International Space Station. The MARS robonauts were designed, created, and operated by specific NASA personnel called BRAINS- R-US (Basic Robotic Assistants in Negotiating Space Robots in the United States) using telepresence communication. The selected NASA employees are the only individuals who can operate their assigned MARS robonaut, with their thumbprint necessary to activate its functions. Each MARS robonaut was built to complete a series of assigned tasks that require specialized tools and operational limbs that are unique to them only.

The MARS robonauts were built to endure the conditions that would be problematic for humans on Mars, such as extreme temperatures, excess carbon dioxide, lack of oxygen, limited food resources, and lack of water. By sending the MARS robonauts, NASA creates a safer and more economical way to establish a base on Mars for future missions and habitation. The MARS robonauts will set up base camps for astronauts in advance and can stay behind whenever they leave. The robonauts will use solar power for charging so they can connect with their telepresence partners back on Earth. If a task is too dangerous for a person, the machine could go out and if need be, sacrifice itself. It's OK as long as it is not human. We can build another machine, we cannot replace a human.

Lubrication of each robonaut is also crucial to their operational performance. Due to temperature changes during specific job assignments, each robonaut utilizes a specific type of oil, which allows designated tasks to be completed. The feet on the robonaut were made from a magnetic material to help maintain an artificial gravitational field while working on the outpost site. The use of Rover Vehicles (RV's) allow the MARS robonauts to complete their assignments in building the Mars outpost site.

The robotic surface mission has many goals including: establishing land and surface operational safety, finding scientifically interesting locations for research, looking for water, analyze the radiation environment, and build a habitat to protect humans from the harsh environment on Mars.

Additional responsibilities for the MARS robonauts are to assist in developing ways to use Martian resources to produce an atmosphere inside the outpost, provide spacecraft propulsion fuel for transportation on the planet, and a way to store consumables for human habitation. They will also complete mineralogical and chemical analysis of rocks, soils, and atmosphere for use in providing alternate fuels for Earth Return Vehicles and Rover Vehicles on Mars.



Olympus Mons is the largest volcano in our solar system and is located on Mars. It is an extinct shield volcano. Six collapsed craters, known as calderas, stack on top of one another to create a depression at the summit that is 53 miles wide (85 km). As magma chambers beneath the calderas emptied of lava, most likely during an eruption, the chambers collapsed, no longer able to support the weight of the ground above. The MARS robonauts are building an outpost site inside this depression. The volcanic mountain created a protective covering from the extreme temperature changes on Mars, provided a water source, and reduced the amount of material that would be necessary to create a dome like structure around the outpost site. While developing the outpost side, the MARS robonauts built the necessary structures inside the volcano depressions and started the vegetation to produce the oxygen for humans to survive.

The Mars outpost site is close to completion and plans are imminent for humans to begin their journey to inhabit Mars. Just as the date was set for the launch, one of the robonauts apparently malfunctioned and destroyed one of the other robonauts that was assigned to complete the final steps for humans to arrive. The robonaut could be repaired, but the tool and bolts that were vital to finishing the MAV approach pad are missing from the scene. Without the approach pad bolts and the tool necessary to install them, the mission has been brought to a standstill. NASA is investigating what happened.

Did a robonaut malfunction?
Did an operator on Earth sabotage the mission?

The Mars Habitation by Human's mission is being delayed until the crime can be solved, the MARS robonaut repaired, and the tool and the approach pad bolts returned. The timing is crucial to complete the project as the first colonists on Mars are scheduled to launch at the end of the month. The approach pad bolts not only have to be installed but they also need to be tested for the correct tension to hold the MAV during violent storms on Mars. NASA is anxious for the Mars project to be completed as scheduled due to the launch window coinciding with the closeness of Mars and Earth for this short period of time.

Your job is to solve the crime and find the reason for the malfunction <u>or</u> the person behind it.

CRIME SCENE STATISTICS

Five MARS robonauts are assigned to the MAV approach pad-building project. Each one has a specific duty to complete during construction of the approach pad for the MAV. The BRAINS-R-US at NASA have been practicing this mission for the past year to make sure everything would go perfectly – as the alignment of the bolts is crucial to the landing and securing of the MAV.

The day has come to install the approach pad bolts and a catastrophe has occurred. As the MARS robonauts prepare to depart for the approach pad, one MARS robonaut is missing. On Earth, the missing robonaut's assigned BRAINS-R-US is frantic that the partner in this crucial mission is not responding to attempts to be located, let alone to maneuver it into position to perform its mission. They had practiced the mission one last time the day before, and the assigned BRAINS-R-US had put the robonaut to bed (so to speak).

To conserve the necessary energy for the mission, NASA has turned the cameras off at the construction site. This leaves no documentation of any of the site's activities. As the NASA MARS robonaut supervisors start to search each of the outpost building sites, they make a grave discovery at the approach pad – the missing MARS robonaut is found – in pieces, but the special tool and bolts are missing.

- The MARS robonaut has been hit on the head and run over by one of the RV's. The RV used was not designated for use at this specific location or for the MARS robonauts transportation.
- Oil from the damaged MARS robonaut is splattered over the area around the approach pad and smeared in several other areas as well.
- A tool that does not belong to the assigned MARS robonaut was used at the location where the bolts were to be installed. The four other MARS robonauts have access to other tools and have the mechanical limbs to operate them.
- A type of mineral residue is found on the disabled MARS Robonaut where its unique tool should be located.
- At NASA headquarters, a thumbprint was found on the BRAINS-R-US virtual operating equipment that does not match the required thumbprint to make the MARS robonaut operation for this mission, but this robonaut did make it to the launch pad intact.
- Evidence reflects that two robonauts were involved. Officials must search for two BRANS-R-US operators.
- The two mission control rooms at NASA show no sign of tampering and all appearances show they are exactly as they were left the night before.
- Your job is to review evidence, decipher all clues, and solve the mystery.

The launch clock at NASA is clicking to send the first Mars mission specialists toward their ultimate goal – to become the first human inhabitants on Mars.

Materials and Supplies

Card Stock – for oil and soil sample experiments

2 Rulers – tire base measurements

Hand Magnifier and Lighted Magnifier – soil samples

Magnet – soil sample

Flathead Screwdriver – tool experiment

Phillips Head Screwdriver – tool experiment

Pliers – tool experiment

Play-Doh (can) – tool experiment

Play-Doh with tool mark sample from crime scene

Play-Doh with tire treads marked from crime scene

Straws – oil experiment

Oil Samples (5 types – motor, sewing machine, vegetable)

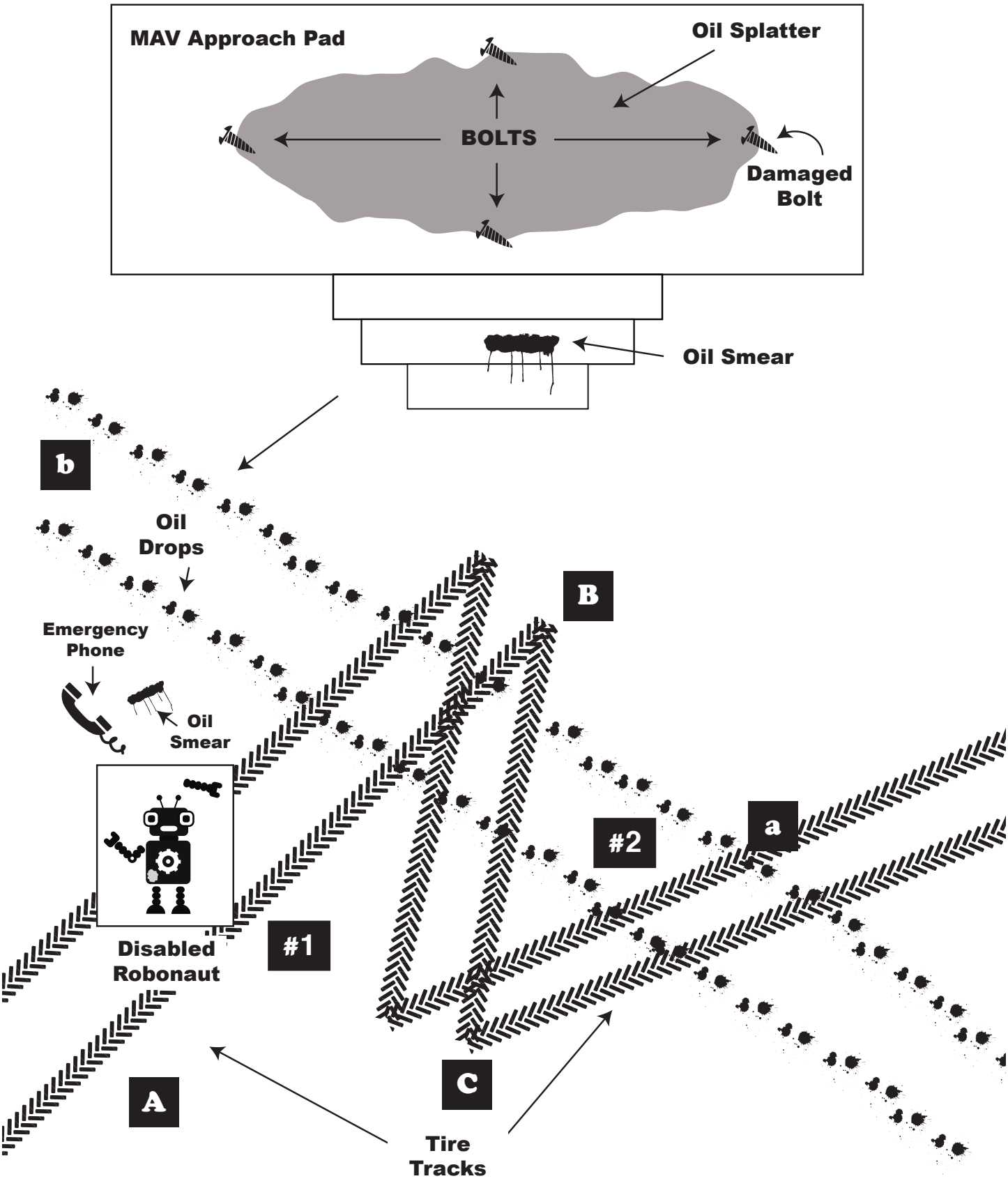
    Mark one “S” for crime scene sample

Toy Cars – tire tread

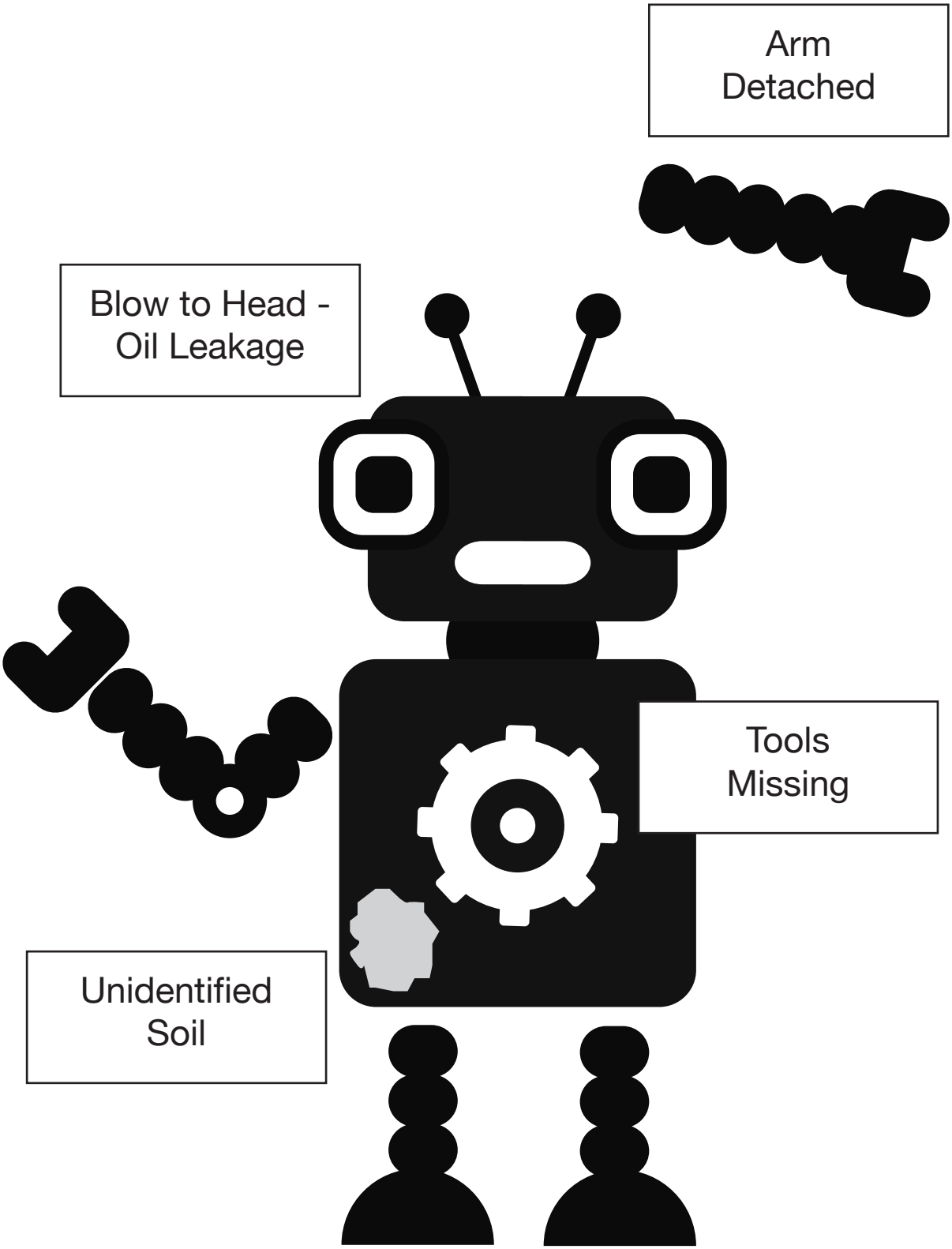
Soil samples (5 varieties)

    Mark one “S” for crime scene sample

Mars Robonaut Crime Scene Map

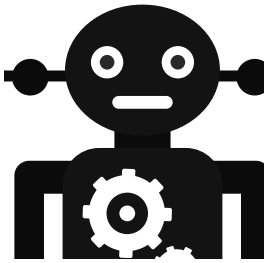


MARS Robonaut Crime Scene Data

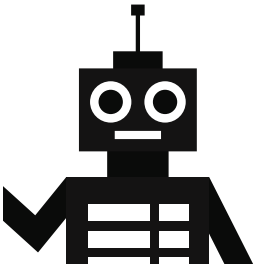


MARS Robonauts

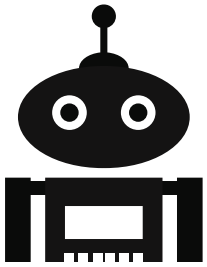
There are five MARS robonauts that have access to the approach-landing site. You will need to fill in the graph with facts about each of the MARS robonauts to help you solve the crime.



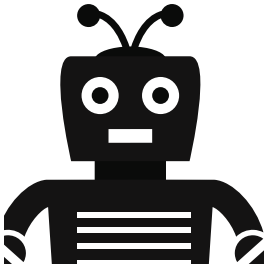
Olympus – The three BRAINS-R-US operators are 1, 2, and 3. The main function of this robonaut is to work inside of the outpost building the habitat structures for the humans. This robonaut is able to use the RV that transports equipment within the outpost site and in areas close by. The limb of this robonaut has the ability to move up and down, such as using a wedge, hammer, or crow bar. This robonaut's hand has the ability to clutch onto objects with only two fingers.



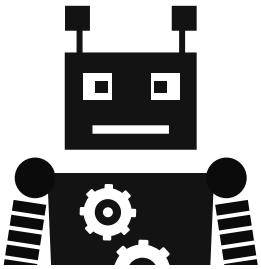
Viking – The three BRAINS-R-US operators are 4, 5, and 6. The main function of this robonaut is to work inside or outside of the outpost site conducting research experiments on the different types of rocks and soils that are found on Mars. This robonaut is able to use the RV that is equipped with research equipment within the outpost site and in areas close by. The limb of this robonaut has the ability to move up and down, such as using a wedge, hammer, or shovel. This robonaut's hand has the ability to clutch onto objects or dig with two fingers.



Aries – The three BRAINS-R-US operators are 7, 8, and 9. The main function of this robonaut is to work on the building structures that will be needed outside of the outpost site, such as the fuel storage, solar rays, and the approach pad. This robonaut is able to use the RV that transports heavy equipment outside of the outpost site and into the main storage area. The limb of this robonaut has the ability to rotate its tools, like a screwdriver or wrench. It also can move its limbs up or down, such as using a wedge, hammer or crow bar. This robonaut's hand has the ability to clutch onto objects with five fingers, making it have almost the same abilities as a human.



Phobos – The three BRAINS-R-US operators are 10, 11, and 12. The main function of this robonaut is to work outside of the outpost site building the approach pad and other structures. This robonaut is able to use the RV that transports heavy equipment outside of the outpost site and into the main storage area. The limb of this robonaut has the ability to rotate its tools, like a screwdriver or wrench. It also can move its limbs up or down, such as using a wedge, hammer or crow bar. This robonaut's hand has the ability to clutch onto objects with five fingers, making it have almost the same abilities as a human.



Deimos - The three BRAINS-R-US operators are 13, 14, and 15. The main function of this robonaut is to work inside or outside of the outpost site keeping track of the workers and checking the progress of the work being done. It records the details of the work that has been finished and sends it directly to NASA. This robonaut is able to use the RV that is equipped to operate all equipment within the outpost site and in areas close by. The limb of this robonaut has the ability to move up and down or in a twisting motion. This robonaut's hand has the ability to clutch onto objects or dig with two fingers.

CRIME SCENE DATA CHART EXAMPLE

Example of Crime Scene Data Chart - Students should keep their own copy of their results to compare with other students.

MARS Robonaut	Brains-R-Us	Thumbprint	Function	Oil	RV Type #	RV function	Tires	Wheelbase	Tool	Soil	Limb
Olympus	1,2,3		Inside	Light	1	Transport Eq			wedge/ hammer		2/up and down
Viking	4,5,6		In or outside	Medium	2	Research Veh			wedge/ hammer		2/up and down
Ares	7,8,9		Outside	Heavy	3	Transport Eq			all tools		5 - full movement
Phobos	10,11,12		Outside	Heavy	1	Transport Eq			all tools		5 - full movement
Deimos	13,14,15		In or outside	Heavy	2	All Vehicles			screwdriver		2/full movement

CRIME SCENE DATA CHART

MARS Robonaut	Brains-R-Us	Thumbprint	Function	Oil	RV Type #	RV function	Tires	Wheelbase	Tool	Soil	Limb
Olympus											
Viking											
Ares											
Phobos											
Deimos											

TOOL MARK EXPERIMENT

BACKGROUND:

A tool mark is any impression, cut, or scratch, caused by a tool or other objects. Tool marks are found at any location where the tool has forced entry or been used in a specific area. Tool marks make impressions that are unique to their identity. The size and shape are important factors, as well as the scratches, nicks, and breaks that are found on the area that have been forced. To identify which tool has been used, a picture or an impression must be made to determine the exact one.

OBJECTIVE:

In this activity, students will identify the unique characteristics of each tool used by each robonaut, identify each tool, and match tested tools to the crime scene.

MATERIALS:

- 3 - 4 cm square clay bricks
- 3 tools (each different)
- Labels for each sample
- Ruler
- Data Table
- Microscope

PROCEDURE:

Make a picture or impression of the tool that has been used at the crime scene. Have the students use 4 cm squared clay bricks to make impressions of the different tools that are used by the five MARS robonauts. Place each tool on a clay block. Label each of the samples. Press. Remove from the block. Measure the width of the impression and record results on the data table. Sketches should also be drawn and other specific details such as scratches, dents or nicks that are noted. Using the crime scene sample or picture, have the students use a microscope to compare their samples with it and choose the one that matches.

Sample Tool	Measurements	Special Features	Sketch

Tool Marks Worksheet

Sample Tool	Measurements	Special Features	Sketch

HAND DEXTERITY EXPERIMENT

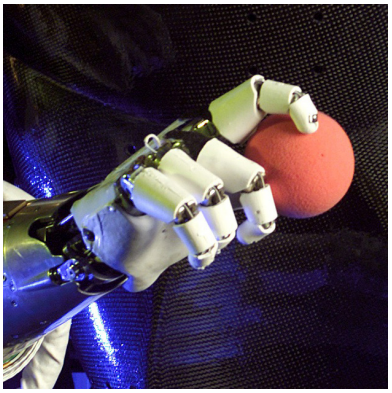
BACKGROUND:

Even though robotics is not the depth and breadths of human performance, the MARS Robonauts were designed specifically to use the range of motion, the strength, and endurance capabilities of an EVA astronaut equivalent. Their robotic system includes mechanisms, avionics, computational architecture, and telepresence control that are above and beyond the capabilities of their ancestors.

Since developing and producing robots with hands that have the dexterity of all five fingers is costly, NASA has designed two types of robonauts for the Mars inhabitation project. The first highly functional robonauts were designed to have fully functional hands that would do the most detailed work, with both vertical and horizontal limb capabilities. These robonauts are capable of exerting just the right amount force and control to perform precise and critical jobs. The second type of robonaut, also known as a robonaut drone, has limited limb movement and only “2” fingers for use in clamping onto tools and equipment.

OBJECTIVE:

In this activity, students will test the two types of robotic hands to determine which tools each has the ability to operate.



MATERIALS:

- 5 finger robotic hand
- 2 finger robotic hand
- 3 Tools
- Data Sheet

PROCEDURE:

In this experiment, students will test the two types of robotic hands to see if they had the capabilities of using the tool that created the marks on the space where the crucial bolt mechanism were designated for. The students will test the three types of tools and note the type of arm movements that would be required to perform the tasks. Students will need to record their findings on the crime scene data sheet with each of the appropriate robonauts.

	Tool #1	Tool #2	Tool #3
Robonaut with 5 fingers			
Robonaut with 2 fingers			

Hand Dexterity Worksheet

	Tool #1	Tool #2	Tool #3
Robonaut with 5 fingers			
Robonaut with 2 fingers			

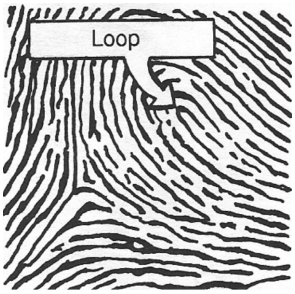
FINGERPRINT EXPERIMENT

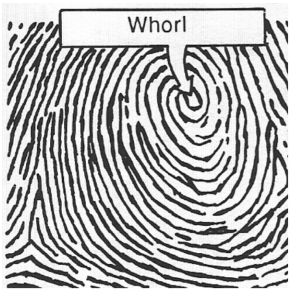
BACKGROUND:

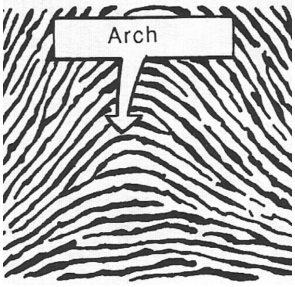
Fingerprints are impressions created by ridges on the skin. Everyone has a unique pattern of skin ridges from birth throughout their entire life – they only difference is that this unique pattern is larger as they grow older. Because of this unique quality, NASA chose to use the thumbprint of the BRAINS-R-US to operate the MARS robonauts. Each MARS robonaut has at least three people who can activate it and operate it to maximize its work potential.

Since each BRAINS-R-US fingerprint is on file, this fingerprint may be used to identify the person who was operating the robonaut, who was completing the job, and the robonaut who made the attack. NASA keeps a computerized record of each robonaut, when it is operated, and who used it last. By using the fingerprints of the BRAINS-R-US, you can identify the operator and the robonaut attacker.

Fingerprints have general patterns of ridges that allow them to be classified and compared. All fingerprints are divided into three groups, based on their ridge patterns:







Two ways are used to identify fingerprints. Dusting hard surfaces such as glass and tile with powder or using chemicals that produce a vapor will help identify the attacker. If you do not have time to complete this lab, use an **inkpad** or **graphite** to produce your assailant's fingerprints. Using the three types of fingerprints and any other markings (scars) from each thumbprint will help to identify the attacker.

OBJECTIVE:

The student will study and identify fingerprints taken at the crime scene to the fingerprints of the BRAINS-R-US operators, attacker, and victim in order to assist in solving the crime.

MATERIALS:

- White paper
- Inkpad or graphite
- Tape
- Data Sheet
- BRAINS-R-US Fingerprints

PROCEDURE:

Make a fingerprint sample of the chosen attacker and the victim for identification on a card for each group of students. See the attached fingerprint chart of the BRAINS-R-US operators. *To have prints that are easier to identify, make your own charts as copying the fingerprints actually distorts the results.*

Use one of the following methods for taking fingerprints:

Method 1:
Using an **inkpad or graphite**, place the thumb in the middle and roll it back and forth. Place a strip of **clear tape** on the print, remove it and stick it to a sheet of white paper. Label each print with the appropriate name. Make an identification card for each student to use to identify the BRAINS-R-US operator.

Method 2:

MATERIALS:

Light Bulb or small lamp
Aluminum can
Aquarium
Glass slides
Gloves
Labels

Follow the following directions to set up the **Super Glue@ lab**.

1. Place a light bulb or small lamp into aluminum can with the top cut off of it. Put this set up into a large clean aquarium with a top.
2. Make several different slides for each class on a glass slide. Use clean gloves when making the samples. Label each slide for identification.
3. Place the slides in the aquarium for fuming. To fume, drop a little Super Glue© on the can.
4. Cover the aquarium and turn on the lamp.
5. White prints will form within 15 minutes.
6. When prints are visible, remove the slides and have the students match them to the fingerprint from the crime scene.

Have the students record their findings in the data table.

Attacker	Loops	Whorls	Arches	Distinct Features

Fingerprint Worksheet

Attacker	Loops	Whorls	Arches	Distinct Features

CSI: FINGERPRINT EXAMINATION KIT

CRIME SCENE INVESTIGATION™

CONGRATULATIONS ON PURCHASING YOUR CSI FINGERPRINT EXAMINATION KIT. WITH THIS KIT YOU WILL BE ABLE TO EXAMINE AN AREA WHERE A CRIME MAY HAVE BEEN COMMITTED JUST LIKE A REAL CRIME SCENE INVESTIGATOR. REAL CSI'S COLLECT FINGERPRINTS AT A CRIME SCENE FOR COMPARISON TO THE FBI DATABASE, WHICH IS SHARED BY LAW ENFORCEMENT ORGANIZATIONS ALL OVER THE WORLD. USING THE INFORMATION IN THIS BOOKLET AND THE ITEMS IN YOUR KIT, YOU WILL BE ABLE TO FIND PRINTS, AND DISCOVER WHOM THEY BELONG TO.

ABOUT FINGERPRINTS

A FINGERPRINT IS THE PATTERN CREATED BY FRICTION RIDGES ON THE TIPS OF FINGERS. THIS PATTERN MAY BE TRANSFERRED FROM THE FINGERS TO OBJECTS IN DIFFERENT FORMS. CSI INVESTIGATORS USUALLY DEAL WITH LATENT PRINTS AT A CRIME SCENE, WHICH ARE FINGERPRINTS LEFT CASUALLY OR WITHOUT KNOWLEDGE OF LEAVING THEM. THESE PRINTS ARE VERY DIFFICULT OR IMPOSSIBLE TO SEE AND REQUIRE SOME COLORING. PATENT PRINTS ARE EASILY SEEN BECAUSE FOREIGN SUBSTANCES SUCH AS DIRT, PAINT , OR BLOOD MAKE CLEARLY VISIBLE MARKS. PRINTS LEFT IN PUTTY, CLAY, OR SOFT EARTH ARE ALSO CALLED PATENT PRINTS. AN INKED PRINT IS THE TERM USED BY INVESTIGATORS WHEN REFERRING TO THE PRINTS TAKEN FOR RECORDING AND COMPARISON PURPOSES.

NO TWO FINGERPRINTS ARE ALIKE; THEREFORE CAN BE USED TO POSITIVELY IDENTIFY PEOPLE. EVEN IDENTICAL TWINS, WHILE POSSESSING THE SAME DNA, HAVE ABSOLUTELY DIFFERENT PRINTS. THIS FACT IS CRUCIAL IN CONNECTING CRIMINALS TO CRIME SCENES, PAST CONVICTIONS, OR OTHER ALIASES. HAIR COLOR, WEIGHT, AND OTHER PERSONAL CHARACTERISTICS CHANGE. FINGERPRINTS, HOWEVER, REMAIN CONSTANT FROM BIRTH ALL THE WAY THROUGH DEATH.

PATTERN TYPES

A PRINT IS NOT ONLY MADE OF A COLLECTION OF RIDGE LINES, BUT ALL THE RIDGE LINES TOGETHER FORM A SPECIAL PATTERN. THERE ARE SEVEN DIFFERENT TYPES OF PRINTS:

ARCH- RIDGE LINES FLOW ACROSS THE FINGER, AND RISE OR WAVE IN THE CENTER.
TENTED ARCH- LIKE THE ARCH, BUT RISING SHARPLY IN THE CENTER
LOOP- RIDGES FLOW FROM ONE SIDE OF THE FINGER, CURVE IN THE MIDDLE AND EXIT THE SAME SIDE.
CENTRAL POCKET LOOP- LIKE THE LOOP BUT WITH A SMALL CIRCLE IN THE CENTER OF THE FINGER.
WHORL- RIDGES FLOW INTO A CIRCLE LIKE PATTERN.
DOUBLE LOOP WHORL- TWO LOOPS COMING FROM OPPOSITE SIDES OF THE FINGER AND CURING IN THE CENTER.
ACCIDENTAL- A PATTERN CONSISTING OF A COMBINATION OF TWO DIFFERENT PATTERN TYPES

Arch Loop Whorl

Accidental Double Loop Pocket Loop Tented Arch

OIL EXPERIMENT

BACKGROUND:

Each MARS robonaut has a specific type of oil that allows it to tolerate the extreme temperature changes that take place on Mars. If their assigned job takes place outside of the outpost site – such as at the approach pad, they had to have oil that is denser. If they work on the inside of the outpost site, the oil needs to be less dense. The third type of oil is used for the robonaut that works in both inside and outside the outpost sites when the temperature is at a moderate level. The type of oil also leads to the identification of the weapon used in the crime, the height, angle, and number of the blows, and the position of the victim when the attack occurred.

The type of oil used by the robonauts is like a signature - a specific type for each one. Therefore, to help identify a robonaut's oil, certain testing procedures must be used. By checking the oil **density**, identification of the robonaut can be broken down to the specific type it is and what work location it comes from.

The density also attributes to the interpretation of the **oil spatter on impact**. The basic understanding of the principles of oil splatter analysis may reveal critical information such as the position of the victim, the assailant, and objects at the scene. Oil will form a sphere due to its surface tension when it is free falling or projected into the air. This helps to identify the **angle of impact** (AOI) of the attack on the robonaut. The smaller the drop of oil, the more spherical its shape will be during a fall. Oil spatter will also fall around the robonaut, leaving a vacant spot, indicating where the attack actually occurred and the position of the victim. A simple oil droplet can provide the speed at the time of impact, the direction of the droplet travels, and the approximate size of the oil drop.

When a sphere of oil strikes a flat surface, the diameter of the sphere will equal the width of stain on the surface. As a drop falls through the air, it accelerates until it reaches a constant or terminal velocity. The type of impact will influence the speed or velocity of the oil – which is based on three types.

Low velocity – 3mm in size was based on 5 feet per second (fps), which is normal gravity. This could be created by dripping oil or a trail, and is more spherical.

Medium velocity – 1 – 3 mm in size – 5 to 25 fps would be a blunt or sharp force trauma. It could also be based on weapon cast off, which can be oval or elliptical in shape due to weapon movement.

High velocity – less than 1mm in size – 100 fps would be from an explosive force like a weapon that uses force. It would be more of a misty spatter.

If a droplet is straight on, it is usually round. If it is a hard, smooth surfaces produce round droplets with smooth edges. Higher velocities and rougher surfaces produce drops with more ragged edges. If the droplet falls at an angle, it will have elongated shapes. The larger the angle of the drop, the more elliptical the droplet will be. **Height** of the oil spatter will also help identify the position of the robonaut.

Oil that has been **smeared** would indicate that the victim's body had been moved from the location of the crime.

OBJECTIVE:

By conducting various experiments, the student will determine what type of oil was used, the height of the oil droplet, the type of surface, oil spatter, and oil smear.

MATERIALS:

3 types of Oil
Straws
3 surfaces – flat, gentle angle, steep
White Paper
Data Sheet

Oil Types

Using straws, dip each one into the different types of oil separately. Hold each one up and time how fast the oil drips from the bottom of the straw. Record your answer in the crime scene data chart. By determining the speed by which the oil, identify the type of robonaut it comes from – the faster the oil drips the less dense the oil is.

Height of Oil Spatter on Different Types of Surfaces

Prepare an example from the crime scene for comparison.
Provide three types of surfaces to test – flat/ gentle surface/ steep surface.
Measure and record oil droplets from different heights, shape, and sizes. Record it in the data table below. Use your results to compare with the sample from the crime scene.

Shape & size of droplet	Type of slope- flat/gentle/steep	Height from which it fell

Oil Spatter

Make a sample of the three types of oil spatter – low, medium, and high velocity. Also, make a sample of oil smear and the oil spatter around the robonaut. Have the students identify each one by its type. After they have practiced identifying the different types, give them the examples from the crime scene and have them record their results on the crime scene data chart.

Low	Medium	High

Oil Smear

Make a sample smear of all oil types. Compare with the crime scene and record results.

Oil #1	Oil #2	Oil #3	Oil #4	Oil #5

Oil Drop Worksheet

Shape/Size of Droplet	Type of slope (flat, gentle, steep)	Height from which it fell

Oil Splatter Worksheet

LOW	MEDIUM	HIGH

Oil Smear Worksheet

Oil Sample #1	Oil Sample #2	Oil Sample #3	Oil Sample #4	Oil Sample #5

Robotic Vehicles – Tire Tread Experiment

BACKGROUND:

The Robotic Vehicles leave evidence by their tire tracks and the tire tread. The tire track will tell you the width of the tire base and the direction in which the robotic vehicle (RV) has traveled. With careful measurements, they can reveal vehicle tire track width, and front and rear tread patterns. Tire treads are patterns of the tread design from the tire. Tire treads from each of the robotic cars are unique to the vehicle's specific size, weight, and height.

OBJECTIVE:

Using measurement and observation skills, students will make tire tread and track samples to assist in identifying the vehicle used at the crime scene.

MATERIALS:

Toy Cars
White Paper
Rulers
Data Sheet

Tire Track Evaluation -

Practice – Make a sample of tire tracks from one of several different types of toy cars. Have the students make a copy of each car's tire track on a sheet of paper. Make sure the students use a three-point turn to help identify the type of car that made the tracks. Have the students measure the width between the wheelbase and the tire track. The tire track width is the distance in inches between the middle of the two front tires on the two back tires of a vehicle.

From the crime scene, make samples of tire tracks from the different types of RV's that are related to the different MARS robonaut's RV's.

A. **Tire Treads** - Tread width is the distance in inches across the tread pattern. Measure the tire treads from the different types of RV's.
B. **Tire Tracks** – Make tire prints for each of the RV's from the crime scene. Include a turn to measure the wheelbase of the RV's

Vehicle #	Tire Track Width	Front Tire Tread Width	Rear Tire Tread Width

C. **RV's Maneuvering Capabilities** - Have the students test the ability of each car to maneuver over the victim without tipping over.

Identify the wheelbase and tire tread of the RVs and compare them to the ones taken at the crime scene. Record your results on the crime scene data sheet.

RV #	Wheel Base Measurement	Tire Tread	Tipping?

Robotic Vehicle – Tire Treads Worksheet

Vehicle #	Tire Track Width	Front Tire Tread Width	Rear Tire Tread Width

Robotic Vehicle – RV Maneuvering Worksheet

RV #	Wheel Base Measurement	Tire Tread	Tipping?

Soil Sample Experiment

BACKGROUND:

At the crime scene, foreign mineral samples are found within the tire tracks and/or on the disabled robonaut.

OBJECTIVE:

The students will test various soil samples to find a match to foreign mineral sample found at crime scene.

MATERIALS:

Mineral Samples
Data Sheet

PROCEDURE:

Provide students with several types of mineral dust samples. Conduct various tests on all samples – Do particles dissolve? Is one magnetic? Place under microscope for investigation of particles size. Have the students test the mineral dust against the foreign soil found at the crime scene. Students will record findings on the crime scene data sheet. To make it more interesting, you can include the different types of rock found at the various workstations.

Soil Samples

Mineral Sample	Color	Consistency	Magnetic	Other Test

Soil Sample Worksheet

Mineral Sample	Color	Consistency	Magnetic	Other Test

WHO DID IT??????

POSSIBLE SCENARIO:

Robonaut Deimos was the attacker and the victim was Robonaut Phobos. (Ironically the two sons of Aries) Two of the BRAINS-R-US operators who were very competitive wanted to be the one to install the last bolt into the launch pad, as it was an historical event. Because their robonauts had different assignments, each of the BRAINS-R-US operators worked in separate operation rooms. They both planned to sneak in and complete their assignment early to earn their place in history! The Deimos BRAINS-R-US wanted to complete the job early to prove that his robonaut was just as worthy as the Phobos robonaut. The Phobos robonaut BRAINS-R-US was so excited and nervous to finish his assignment he decided to finish his work early. He came into his workroom and discovered the other robonaut already at work, attempting to install the bolt. Deimos was having trouble installing the bolt because he did not have the right tool. This gave the other operator enough time to get his robonaut to the site. Phobos quickly went toward Deimos and tried to pull him away when a fight broke out between the two robonauts. Deimos overpowered Phobos and hit him in the head with his tool. He grabbed Deimos's tool and quickly threw it and the bolt away toward some rocks, got into his RV and left the scene. Phobos attempted to make it to the emergency phone, but he lost too much of his oil to make it to the phone. The bolt and tool were eventually found under a pile of rocks close by when the Sun reflected light off of the tool's handle and caught the eye of one of the other robonaut's operators who was documenting the crime scene for NASA.

OR!!!!!!!!

Actually - Make it your own plot by the evidence you choose to leave behind!

Some additional ideas…….

- Have the students write their own version of the ending to support their data findings. Have the students present their findings and take a class vote whose is the most realistic or believable!

- Add twists to <u>your</u> plot – change it for different class periods (make extra samples) – that eliminates the possibility of students letting the cat out of the bag.

  <u>Example</u>: The sons of two of the operators could possibly have entered the NASA research facility by forging a copy of the parent's thumbprints. They did it out of revenge because of their parent's dedication to the project, and their neglecting them all of the time.

  <u>OR</u>: An alien from Mars came out of hiding (or was invisible) after watching the robonauts build the outpost. He had the capability to make the robonauts fight (for fun) by interrupting the telepresence communication by using telepathic communication. Or he wanted to sabotage the project so he would not be discovered.

Make it INTERESTING!!!!

Make it FUN!!!!

Make it EDUCATIONAL!!!!

Make it a Crime Scene Investigation!!!!

References and Resources:

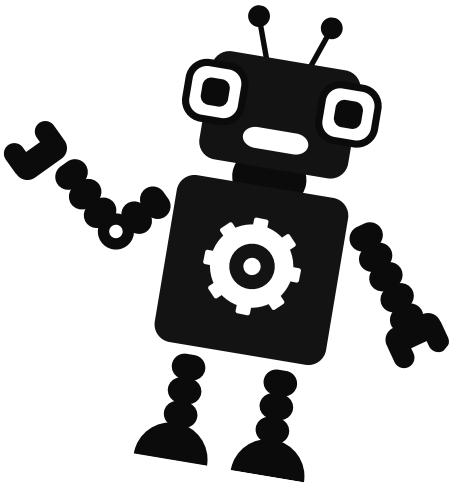
CSI: Crime Scene Investigation –Fingerprint Examination Kit Activity Handbook, 2003.

Fingerprints: Great Explorations in Math and Science Project, Lawrence Hall of Science, 1987

Walker, P. and Elaine Wood (1998). Crime Scene Investigations, Jossey-Bass.

The following Mars Resources can be found at: http://marsed.asu.edu/stem-lesson-plans

- Mars Robotic Lessons
- Mars Student Imaging Project
- Mapping the Surface of a Planet
- Mars Activities
- Mars Bound: Mission to the Red Planet



WEB SITES:

- http://education.nasa.gov/home/index.html
- http://phoenix.lpl.arizona.edu/education.php
- http://mars.nasa.gov/mer/classroom/
- http://mars.nasa.gov/participate/marsforeducators/
- http://mars.nasa.gov/education/teachers.html

CSI Mars Alien Encounter Rubric

	Poor 1	Average 2	Good 3	Excellent 4
Crime Scene Notes	Minimal description of the crime scene; could not reconstruct the scene based on these notes	Crime scene described but not in detail; it would be difficult to reconstruct the crime scene	Fairly good description; could reconstruct most of the crime scene; may be lacking some detail	Clearly detailed description including the layout of the rooms; anyone could reconstruct the crime scene using these notes
Suspect Evaluation	Suspects included or excluded based on theory but not evidence	Some evidence used to include/ exclude suspects	Most of the evidence is included in the suspect evaluation but not all	Each suspect either included or excluded based on evidence
Crime Theory	Seems to have made up a theory; it is not clear the student looked at the evidence	There is a theory but it is not directly tied to the evidence	The theory does make some sense but details of the suspects background or critical evidence is not included	Theory of the crime is clearly based on evidence and suspect background
Writing Mechanics	Filled with spelling and grammatical errors	Several spelling and grammatical errors but can still be followed	Less than 2 spelling or grammatical errors	No spelling or grammatical errors