

BRILLIANT LABS

MISSION: MARS



MISSION: MARS CHALLENGE GUIDE

Showcase your Mission: Mars Rover. Complete these challenges during the Provincial or Atlantic School Maker Faires to earn points and badges.



ABOUT THE ATLANTIC SCHOOL MAKER FAIRE

Brilliant Labs working in collaboration with **MAKE** and our provincial EECD partners would like to welcome students and teachers to **Provincial School Maker Faires** in May, an Atlantic Virtual Mission: Mars Challenge (June 2nd) and the virtual **Atlantic Canadian School Maker Faire on June 9th, 2022**.

These School Maker Faires will showcase projects from across the region and will be filled with hands-on workshops to engage participants of all ages.

All year long we have been challenging youth to create, design and inspire innovation through our **four challenges**. These challenges will be a part of the School Maker Faire showcase along with Mission: Mars.

MISSION: MARS CHALLENGE SHOWCASE

Are you on track to complete your Mars Rover by early May? If so, Brilliant Labs welcomes you to send your rover to Maker Mars for the Mission: Mars Challenge (1 of 5 in-person Provincial School Maker Faires or the Atlantic Virtual Mission: Mars Challenge, June 2nd). This is your chance to showcase your work and participate in 10 mission challenges. Each challenge, when completed successfully, will earn points and badges. The Mission: Mars engineers with the most points will win the Mission: Mars Challenge Showcase.

ABOUT THIS GUIDE

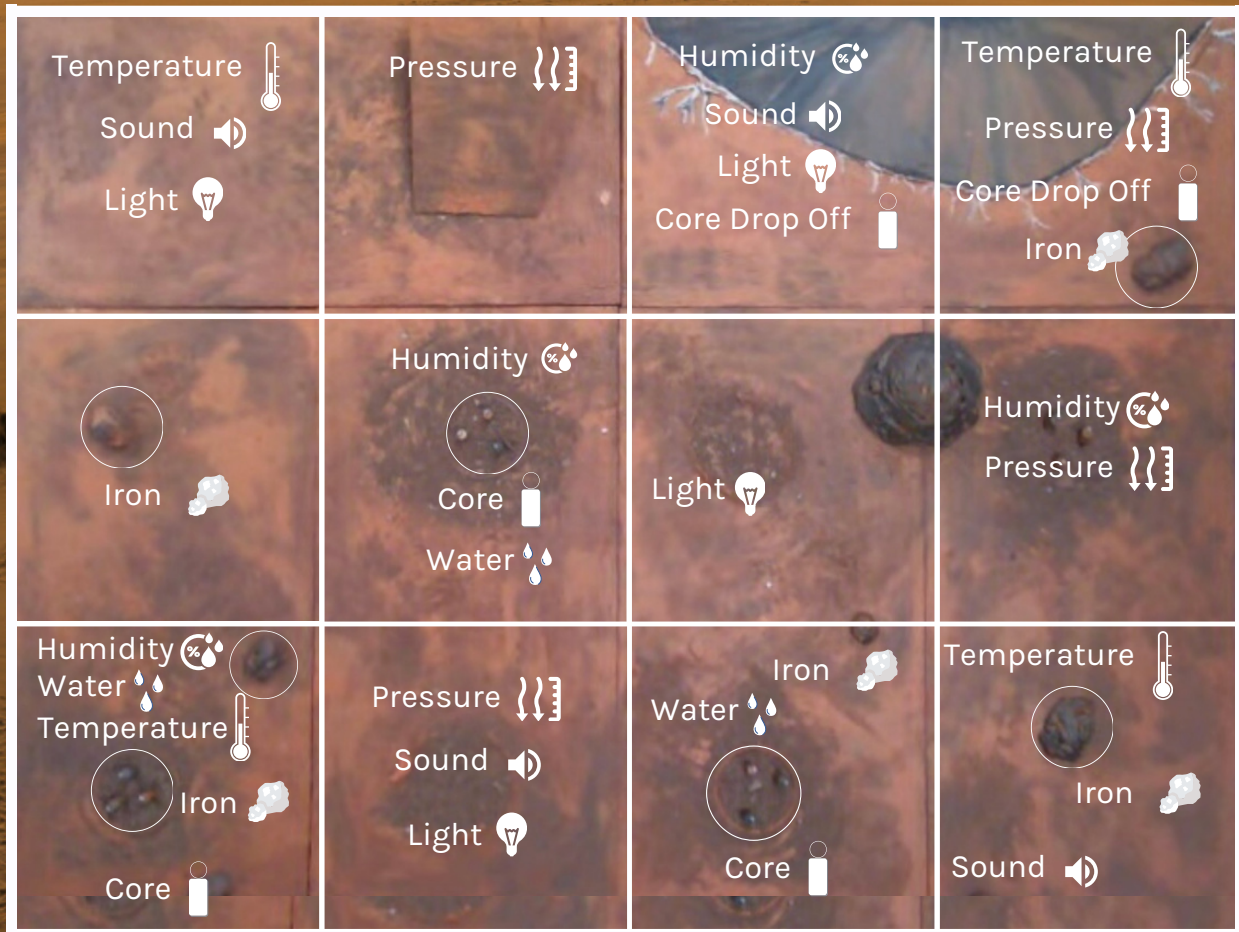
In this Mission: Mars Challenge Guide you will learn about the challenges and the point system. To get 'how-to' instructions for each challenge and register to send your rover to Maker Mars [visit Mission: Mars Innovation Challenge webpage](#).

HAVE QUESTIONS OR NEED SUPPORT?

Let's connect you with Neil Gray, Mission Mars lead at Brilliant Labs. Email Neil with Mission:Mars in the subject: Neil@brilliantlabs.ca



MISSION: MARS SURFACE

THIS IS YOUR MISSION: MARS SURFACE MAP

There are 10 Mission: Mars Showcase Challenges. Using your Mission: Mars Surface Map complete each challenge outlined in this showcase guide. For detailed help for each mission visit the [Mission: Mars Innovation Challenge at BrilliantLabs.ca/Innovation-challenges](https://BrilliantLabs.ca/Innovation-challenges).

MISSION: MARS TEMPERATURE



Mission Overview:

Rovers will report the surface temperature of Mars using the Weather Click at up to 4 different designated locations. Additional points will be awarded for reporting the low, average and high of the 4 designated locations.



MIKROE-1978 by Mikroo

Point Requirements:

Hello World

The rover must use a Weather Click and report the temperature in Celsius from any location on the [map](#). Only one temperature submission will be accepted and must be within +/- 2 degrees.

Radio Key Name: "Temp"

- Requirement: A temperature recording (Celsius) [anywhere](#) on the surface of Mars ([map](#)).

Points: 2 points for reporting the temperature (Celsius) anywhere on the surface of Mars. One submission only.

Intermediate

The rover must use a Weather Click and report the temperature in Celsius from up to 4 different designated locations on the [map](#). +/-2 degrees accuracy accepted.

Radio Key Name: "Temp"

- Requirements: Report the temperature value while at a designated temperature recording location as indicated on the [map](#).

Points: 1 point per location (up to 4). 3 points for first submission if [Hello World](#) has not been completed.

Brilliant

Competitors must use all 4 previously reported values to calculate the average, low and high temperature.

Radio Key Name (Average): "TempA"

Radio Key Name (High): "TempH"

Radio Key Name (Low): "TempL"

- Requirements: Report the calculated average, high and low temperature readings from all 4 locations on the [map](#).

Points: 1 point per calculated value (3 total)

Consider This!

Mars, like every planet, has its own unique weather system. Temperatures on Mars average about -62 °C (-81°F), but do vary depending on the season. For example, winter at the poles is very cold averaging a chilly -140 °C (-220°F) to a warm summer day of 30 °C (86°F) in the lower latitudes.

NASA. (2021, February 2). Mars facts. <https://mars.nasa.gov/all-about-mars/facts>.

MISSION: MARS HUMIDITY



Mission Overview:

Rovers will report the relative humidity of Mars using the Weather Click at up to 4 different designated locations. Additional points will be awarded for reporting the low, average and high of the 4 designated locations.



Point Requirements:

Hello World

The rover must use a Weather Click and report the relative humidity in % from any location on the [map](#). Only one humidity submission will be accepted and must be within +/- 5 %.

Radio Key Name: "Humid"

- Requirement: A humidity reading (%) [anywhere](#) on the surface of Mars ([map](#)).

Points: 2 points for reporting the humidity (%) anywhere on the surface of Mars. One submission only.

Intermediate

The rover must use a Weather Click and report the humidity in percentage from up to 4 different designated locations on the [map](#). +/- 5 % accuracy accepted.

Radio Key Name: "Humid"

- Requirements: Report the humidity value while at a designated humidity recording location as indicated on the [map](#).

Points: 1 point per location (up to 4). 3 points for first submission if [Hello World](#) has not been completed.

Brilliant

Competitors must use all 4 previously reported values to calculate the average, low and high humidity levels.

Radio Key Name (Average): "HumidA"

Radio Key Name (High): "HumidH"

Radio Key Name (Low): "HumidL"

- Requirements: Report the calculated average, high and low humidity readings from all 4 humidity locations on the [map](#).

Points: 1 point per calculated value (3 total)

Consider This!

On Mars, humidity is directly connected to temperature fluctuations. At night, relative humidity levels can rise to 80 to 100 percent, with the air sometimes reaching atmospheric saturation (meaning humidity levels are at their max and no more water vapor can be absorbed). The daytime air has less humidity and is drier because temperatures are warmer.

NASA. (2021, February 2). Mars facts. <https://mars.nasa.gov/all-about-mars/facts>.

MISSION: MARS PRESSURE



Mission Overview:

Rovers will report the atmospheric pressure of Mars using the Weather Click at up to 4 different designated locations ([map](#)). Additional points will be awarded for reporting the low, average and high of the 4 designated locations.



MIKROE-1978 by MikroE

Point Requirements:

Hello World

The rover must use a Weather Click and report the pressure in Pascals(Pa) from any location on the [map](#). Only one pressure submission will be accepted and must be within +/- 200 Pa.

Radio Key Name: "Press"

- Requirement: A pressure reading (Pa) [anywhere](#) on the surface of Mars ([map](#)).

Points: 2 points for reporting the pressure (Pa) [anywhere](#) on the surface of Mars. One submission only.

Intermediate

The rover must use a Weather Click and report the pressure in pascals from up to 4 different designated locations on the [map](#). +/-200 pascals accuracy accepted.

Radio Key Name: "Press"

- Requirements: Report the pressure while at a designated pressure recording location as indicated on the [map](#).

Points: 1 point per location (up to 4). 3 points for first submission if [Hello World](#) has not been completed.

Brilliant

Competitors must use all 4 previously reported values to calculate the average, low and high pressure.

Radio Key Name (Average): "PressA"

Radio Key Name (High): "PressH"

Radio Key Name (Low): "PressL"

- Requirements: Report the calculated average, high and low pressure readings from all 4 locations on the [map](#).

Points: 1 point per calculated value (3 total)

Consider This!

The atmosphere of Mars is about 100 times thinner than Earth's, and it is 95 percent carbon dioxide. Scientists believe that early in Mar's history (about 3.5 billion years ago) Mars had an atmosphere that supported water. Images of the planet show many river plains and maybe even ocean boundaries. Mars rovers have found evidence of surface rocks that had moisture (such as hematite or clay). Scientists are exploring reasons why the Mars atmosphere thinned.

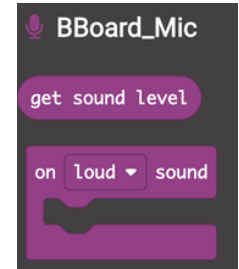
Space.com (2017, September 11). Mars' Atmosphere: Composition, Climate & Weather. <https://www.space.com/16903-mars-atmosphere-climate-weather.html>

MISSION: MARS SOUND



Mission Overview:

Rovers will report the sound levels of Mars using the b.Board microphone at up to 4 different designated locations. Additional points will be awarded for reporting the low, average and high values of the 4 designated locations.



Point Requirements:

Hello World

The rover must use the b.Board microphone and report the sound level from any location on the [map](#). Only one sound level reading will be accepted.

Radio Key Name: "Sound"

- Requirement: A sound level reading [anywhere](#) on the surface of Mars.
Points: 2 points for reporting the sound level [anywhere](#) on the surface of Mars. One submission only.

Medium

The rover must use the b.Board microphone and report the sound levels from up to 4 different designated locations on the map.

Radio Key Name: "Sound"

- Requirements: Report the sound level while at a designated sound level reading location as indicated on the [map](#).
Points: 1 point per location (up to 4). 3 points for first submission if [Hello World](#) has not been completed.

Brilliant

Competitors must use all 4 previously reported values to calculate the average, low and high sound levels.

Radio Key Name (Average): "SoundA"

Radio Key Name (High): "SoundH"

Radio Key Name (Low): "SoundL"

- Requirements: Report the calculated average, high and low sound levels from all 4 locations on the map.

Points: 1 point per calculated value (3 total)

Consider This!

What does it sound like on Mars? According to information from NASA: the atmosphere, temperature, density and chemistry on Mars is entirely different from Earth. On Mars, you would hear a quieter, more muffled version of what you normally hear, and sounds emitted would take slightly longer for you to hear it.

NASA. (2021.). Sounds of Mars. <https://mars.nasa.gov/mars2020/participate/sounds/>

MISSION: MARS LIGHT



Mission Overview:

Rovers will report the light levels of Mars using the micro:bit light level sensor at up to 4 different designated locations (map). Additional points will be awarded for reporting the low, average and high values of the 4 designated locations.

Point Requirements:

Hello World

The rover must use the micro:bit light level sensor and report the light level from any location on the map. Only one light level reading will be accepted.

Radio Key Name: "Light"

- Requirement: A light level reading anywhere on the surface of Mars.

Points: 2 points for reporting the light level anywhere on the surface of Mars. One submission only.

Intermediate

The rover must use the micro:bit light level sensor and report the light levels from up to 4 different designated locations on the map.

Radio Key Name: "Light"

- Requirements: Report the light level while at a designated light level reading location as indicated on the map.

Points: 1 point per location (up to 4). 3 points for first submission if Hello World has not been completed.

Brilliant

Competitors must use all 4 previously reported values to calculate the average, low and high light levels.

Radio Key Name (Average): "LightA"

Radio Key Name (High): "LightH"

Radio Key Name (Low): "LightL"

- Requirements: Report the calculated average, high and low light levels from all 4 locations on the map.

Points: 1 point per calculated value (3 total)

Consider This!

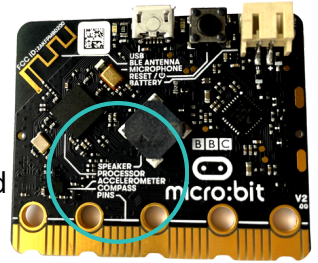
According to information from NASA: Mars receives half the amount of light that Earth does? This is because Mars is farther away from the Sun than Earth. On Mars, the Sun also appears about two-thirds the size we would normally see on Earth.

NASA. (2019, May 17). What Does a Sunrise-Sunset Look Like on Mars? – NASA Solar System Exploration. NASA. <https://solarsystem.nasa.gov/news/925/what-does-a-sunrise-sunset-look-like-on-mars/>.

MISSION: MARS SEISMIC

Mission Overview:

At two separate times throughout each rover's session on Mars, there will be periods of seismic activity or "Marsquakes". The webcam image will flash 5 times followed by a 5 second quake. Reporting involves sending the vibrational (accelerometer) strength to the appropriate Key name as outlined below and must happen during the quake. 2 points will be awarded for reporting the vibrational strength outside of a quake.



Point Requirements:

Hello World

The rover must use the micro:bit accelerometer to report the acceleration strength level from **anywhere** on the map. Only one strength reading will be accepted.

Radio Key Name: "Quake"

- Requirement: A micro:bit acceleration strength reading **anywhere** on the surface of Mars.

Points: 2 points for reporting the acceleration strength level **anywhere** on the surface of Mars ([map](#)). One submission only.

Intermediate

Following 5 white flashes on the webcam feed, a "Marsquakes" will occur for 5 seconds. The rover must use the micro:bit accelerometer to record and submit the acceleration strength from anywhere on the surface of Mars ([map](#)). Points will only be awarded if the rover submits the reading during the 5 second quake.

Radio Key Name: "Quake"

- Requirements: Report the acceleration strength level during a "Marsquake" from any location on the [map](#).

Points: 5 points per quake (2 quakes total). An additional 2 points for first submission if **Hello World** submission was not previously completed.

Brilliant

Competitors must use both previously reported values to calculate the average, low and high light levels.

Radio Key Name (Average): "QuakeA"

Radio Key Name (High): "QuakeH"

Radio Key Name (Low): "QuakeL"

- Requirements: Report the calculated average, high and low quake levels from the two previously reported values.

Points: 1 point per calculated value (3 total)

MISSION: MARS WATER

Mission Overview:

There are 3 Martian soil locations indicated on the [map](#). Rovers will probe the soil for measurements of moisture to determine the presence of water. Additional points for correctly reporting all 3 soil locations along with the lowest, highest and average levels of moisture of the designated areas.

Point Requirements:

Hello World

The rover must use electrically conductive probes and analog readings to report the electrical conductivity of the Mars soil using an analog reading from the micro:bit. 5 points per soil moisture reading (3 locations total, [map](#)).

Radio Key Name: "Water"

- Requirement: A micro:bit analog value reading at one (or more) of the Mars soil locations as indicated on the [map](#) of the surface of Mars.

Points: 5 points for each reading (3 locations total)

Intermediate

If all 3 locations are successfully reported, an additional 3 points will be awarded.

Brilliant

Competitors must have reported moisture levels for all 3 Mars soil [locations](#) to calculate the average, low and high levels. Calculated/submitted values will be compared against the values computed by the Mars base station.

Radio Key Name (Average): "WaterA"

Radio Key Name (High): "WaterH"

Radio Key Name (Low): "WaterL"

- Requirements: Report the calculated average, high and low soil moisture levels from the three previously reported values.

Points: 1 point per calculated value (3 total)

Consider This!

While the earth is covered in around 70% water, the low pressures and temperatures on Mars do not allow for water to exist in stable liquid form. Therefore, water on Mars is usually in the form of ice and vapor in the atmosphere. New research also suggests that there is a lot of water below the surface on Mars. As humans, we require water to live, so finding water on this dusty planet is top priority! Using satellite imagery, we've been able to narrow down a small area of Martian soil that we believe may contain moisture.

Greicius, T. (2021, June 24). Study Looks More Closely at Mars' Underground Water Signals. NASA, <https://www.nasa.gov/feature/jpl/study-looks-more-closely-at-mars-underground-water-signals/>.

MISSION: CORE SAMPLE

Mission Overview:

At the designated Martian soil locations on the [map](#), there will be core samples available for extraction. The centre of the 10mm inner diameter metal loop of each core sample will be sticking approximately 4 cm above the surface of the soil.

Competitors will be awarded points for intentionally extracting a core sample and dropping off a sample at the designated area. Further points will be awarded for successfully extracting and dropping off 2 samples total.

Point Requirements:

Hello World

The rover must successfully extract a core sample from the soil such that it is being suspended or pulled from the rover in a controlled manner. 5 points per sample extracted to a maximum of 2 unique samples.

Intermediate

The rover must successfully drop-off a previously extracted core sample to the designated drop off zone as indicated on the map. 5 points per extracted sample dropped off to a maximum of 2 unique samples.

Brilliant

Competitors will be awarded an additional 5 points for successfully extracting and dropping off two samples.

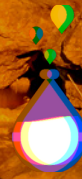


Consider This!

They say that rocks can't talk, but if you look close enough, they can tell you so much! Every rock is a unique composition of minerals that can freeze time and tell us all about a planet's history. Earth and Mars have fairly similar compositions with rock and iron in their interiors. Core sampling is the process of drilling into rocks and examining the layers and materials inside. Since humans haven't been to Mars yet, we rely on robots like Mars rovers to collect rocks and soil, so that scientists can study them in the future.

NASA. (2021, February 25). Student Project: Explore Rocks Using Core Sampling. NASA. <https://www.jpl.nasa.gov/edu/learn/project/explore-rocks-using-core-sampling/>.

MISSION: MARS IRON ORE



Mission Overview:

There is a Martian rock placed at each of the 5 designated locations on the [map](#). The competitors rover must report any value to the Key Name "Iron" while within the designated location if iron ore is detected (magnetic field detected). Points will be awarded for correctly identifying one or both of the iron ore rocks. However, points will be deducted for an incorrect guess.



Point Requirements:

Hello World

The rover must use the micro:bit's magnetometer to report the magnetic force strength in μT at any location on the surface of Mars.

Radio Key Name: "Magnet"

- Requirement: A micro:bit magnetic force strength in μT [anywhere](#) on the [map](#).
Points: 2 points

Intermediate

The rover must successfully report the presence of iron ore (strong magnetic force near a rock) while within the designated area containing the Martian rock. Points will only be awarded if the rover is within an area bounded by a red rectangle on the webcam containing the rover AND the suspected iron-ore rock. Points will be deducted for incorrect answers.

Radio Key Name: "Iron"

- Requirement: Rover is correctly positioned in the designated area for reporting iron ore detection (webcam feed shows red rectangle around area of interest that rover is in).

Points: 10 points per correctly indicated Martian rock with iron ore. Maximum of 2 rocks with iron ore. -10 points per incorrectly reported rock. Maximum of 2 incorrect guesses.

Brilliant

Competitors will receive an additional 5 points for having correctly reported both iron-ore Martian rocks.

Consider This!

Some types of ore contain iron, which is a critical component in steel, the metal we use to build things like cars, appliances and use for construction on Earth. Iron is really strong, and it loves magnets! It will stick to magnets as hard as it can.

There are a lot of metals on Mars, particularly iron. Mars is known as the Red Planet because iron minerals in the Martian soil oxidize, or rust, causing the soil and atmosphere to look red. Using spectrometers, which measures chemicals elements, scientists have determined many different minerals on Mars. Unlike Earth however, Mars has a more limited magnetic field, so these ions are likely to behave differently than those on Earth's atmosphere.

Birnbaum, D., (2017, May 28). Metal On Mars. Science in the News.
<https://sitn.hms.harvard.edu/flash/2017/metal-on-mars/>.

MISSION: MARS OBSTACLE AVOIDANCE

Mission Overview:

There are multiple obstacles along the surface of Mars. Any rover that is able to successfully demonstrate the use of the ultrasonic sensor for a distance reading will be awarded 5 points. Additional points will be awarded for code demonstrating obstacle avoidance and artificial intelligence in obstacle navigation.

Point Requirements:

Hello World

The rover must report a distance to any object using the ultrasonic sensor.

Radio Key Name: "Ultra"

Requirement: An ultrasonic sensor distance reading in centimetres.

Points: 5 points

Intermediate

The rover must successfully implement a simplistic obstacle avoidance using the ultrasonic sensor for 10 points. Code will be verified by judge(s).

Brilliant

Competitors must demonstrate not only simple obstacle avoidance, but additional strategies of obstacle avoidance automation and/or artificial intelligence utilizing data collected from, but not limited to, the ultrasonic sensor. 20 points will be awarded upon code verification.

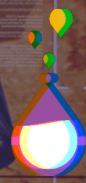


Consider This!

Scientists and engineers use remote controlled rovers to trek around the surface of Mars each day. The rovers are designed to move around 100 meters each Martian day (around 24 hours and 40 minutes), and are solar powered. Rovers have specific tasks like collecting data for further study, analyzing minerals, and conducting measurements. Engineers and scientists also have to figure out how far the rover has travelled, use hazard avoidance, create maps to guide the rover, understand which direction the rover is facing to make sure the rover is traversing far and well.

NASA. (2021). Moving around Mars. NASA.
<https://mars.nasa.gov/mer/mission/timeline/surfaceops/navigation/#traverse>.

MISSION:MARS CHALLENGE RUBRIC



Rubric:

Now that you have considered the challenges let's review how points will be awarded. Each challenge is divided into 3 categories: Easy (collect data and report it), Intermediate (Need to be able to navigate rover and collect/submit data) and Brilliant (Requires computations).

Mission	Easy (Hello World)		Pts	Intermediate		Pts	Advanced (Brilliant)		Pts	Total
Temperature	Action	Temperature	2	Action	High, Low, Average	1 per/ Max 4	Action	Temperature	1 per/ Max 3	9
	Location	Map: Anywhere		Location(s)	Map: Specific		Location	Map: Specific		
Humidity	Action	Humidity	2	Action	Humidity	1 per/ Max 4	Action	High, Low, Average	1 per/ Max 3	9
	Location	Anywhere		Location(s)	Map: Anywhere		Location	Map: Specific		
Pressure	Action	Pressure	2	Action	Pressure	1 per/ Max 4	Action	High, Low, Average	1 per/ Max 3	9
	Location	Anywhere		Location(s)	Map: Specific		Location	Anywhere		
Sound	Action	Sound Level	2	Action	Sound Level	1 per/ Max 4	Action	High, Low, Average	1 per/ Max 3	9
	Location	Anywhere		Location(s)	Map: Specific		Location	Anywhere		
Light	Action	Light Level	2	Action	Light Level	1 per/ Max 4	Action	High, Low, Average	1 per/ Max 3	9
	Location	Anywhere		Location(s)	Map: Specific		Location	Anywhere		
Seismic	Action	Mars Vibrations	2	Action	Detect Quake	5 per/ Max 2	Action	High, Low, Average	1 per	15
	Location	Anywhere		Location	Anywhere		Location	Anywhere		
Water	Action	Soil Moisture	5	Action	All 3 locations	3	Action	High, Low, Average	3	21
	Location(s)	Map: Specific		Location	Map: Specific		Location	Anywhere		
Core	Action	Core Retrieval	5 per (2max)	Action	Core Drop-Off	5 per/ Max 2	Action	2 pick up and drop off	5	25
	Location(s)	Map: Specific		Location	Map: Specific		Location	Anywhere		
Iron Ore	Action	Magnetic Field Strength	2	Action	Find Iron Ore Rock	10 per/ Max 20	Action	Both Correct	5	27
	Location(s)	Anywhere		Location	Map: Specific		Location	Map: Specific		
Obstacle	Action	Distance To Object	5	Action	Obstacle Avoidance	10	Action	Artificial Intelligence	20	32
	Location(s)	Anywhere		Location	Anywhere		Location	Anywhere		