The FUTURES Channel®

MOVIE GUIDE

MOVIE NUMBER 3001

Searching for Water on Mars

The Movie:

If we can find water on Mars, then astronauts won't have to take it with them. But how do you find the water before you send a manned mission? Featured: Laszlo Keszthelyi, geologist; George Powell, planetary engineer. *(Movie length 1:41)*

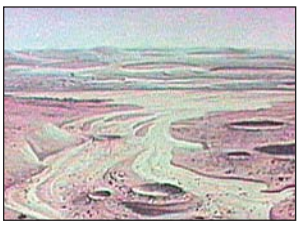
Background:

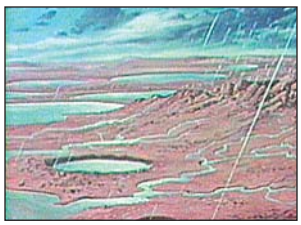
The surface of Mars is an inhospitable environment: cold, dry, dusty, a thin atmosphere and never a cloud in the sky. But it wasn't always that way. Thirty years of close-up investigation, accomplished through a remarkable series of NASA missions, have revealed that at one time Mars had flowing water on its surface. Why did it change so dramatically? Is there any water left? Did Mars ever support life? Does it now? The only way to answer these questions is to analyze the rocks on the Martian surface. And since we can't bring those rocks to us, we must send the analysis instruments to Mars—carried on the back of a strangely shaped vehicle called a rover.

Curriculum Connections:

Fractions — 1

The batteries on a rover don't last forever; after a while they don't hold as much energy as when they are new. Suppose a new battery can hold enough energy to run a 100-watt light for 40 hours. After being used for a while, it can only hold 17/20 as much energy. How many hours could it run the 100-watt light bulb then?





Measurement (rate) — 2

The closest Mars gets to Earth is 57,000,000 kilometers. Radio signals travel at the speed of light, which is about 300,000 kilometers per second. How long would it take a radio signal from Earth to get to Mars when Mars is closest to Earth?

Percents — 3

Rovers are powered by batteries. Suppose a rover uses 2 percent of the energy stored in its batteries to travel 25 meters. How many meters could the rover travel before it used up 50 percent of the energy stored in its batteries? (Assume it starts with fully-charged batteries.)

Decimals, Measurement (area) — 4

It is very important to keep the weight of a rover as low as possible for a trip to Mars. For a rover which is shaped like a rectangular prism (a box) with dimensions of 150 cm by 40 cm by 20 cm, what is the surface area? If the material used for the body has a mass of 5.24 grams per square centimeter, what is the total mass of the body?

Probability

5

Once a rover gets to Mars, it cannot be repaired if it breaks down. For this reason, engineers build in back-up systems to take over if something no longer works correctly.

From the data below, what is the probability that both components A and B will fail in 1,000 hours of operation? If there is no backup system for component C or D, then the rover will fail if either of those components fail. What is the probability of that?

If you can only install a backup system for component C or component D, which would you choose? Why?

Component	Probability of failure in 1000 hours of operation
A	.0003
B (backup to A)	.005
C	.002
D	.04

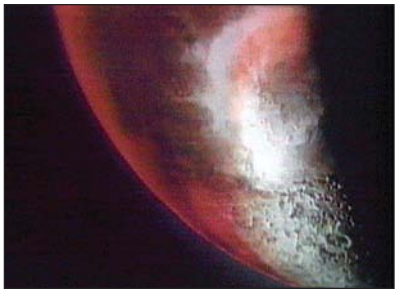
Algebra (patterns and functions)

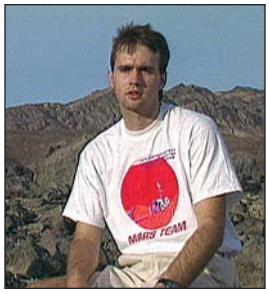
8

Suppose that the table below represents data collected from previous missions to Mars. The tables tells us that, in one 10-meter by 10-meter area, there were 1,440 rocks that ranged in size from 5 to 6 centimeters; 780 rocks with sizes of 6 to 7 centimeters; and so on.

Size of rocks (centimeters)	Number of rocks in an area
	10 m x 10 m
5 – 6	1440
6 – 7	780
7 – 8	460
8 – 9	290
9 – 10	190

Can you use this data to predict how many rocks would be from 10 to 11 centimeters, or 4 to 5 centimeters?





Geometry (right triangles)

6

Suppose the rover starts at a position 10 meters directly north of the lander and travels to a position 15 meters directly east of the lander. How many meters would it travel? If it travels at a rate of 50 centimeters per hour, how long would it take the rover to make the trip?

Geometry (circles, ellipses)

7

The Earth and Mars both travel around the sun in elliptical orbits. The Earth's orbit is very nearly circular with a radius of 150 million kilometers, and the distance from Mars to the sun varies from 206,000 kilometers to 249,000 kilometers. What is the closest the two planets ever get to each other? The farthest?

Geometry (solid figures)

9

Mars is smaller than Earth, but it still has a very large surface area. The radius of Mars is about 3,480 kilometers. What is its surface area?

Integers

10

The temperature on Mars can range from -140˚ Fahrenheit to 95˚ Fahrenheit. What is the difference between these two temperatures?

To: Engineering Assistants
From: Team Leader, Rover Project
Subject: Area of exploration

The scientists who wish to investigate the surface of Mars want the rover to cover as much area as possible in the time available. They have asked me to consider increasing the size of the rover's wheels. Please help me gather the data I need on the relationship between the rover's wheel diameter and the area it can explore.

Specifications	
Wheel diameter	15 cm
Rotation speed	one rotation per minute

1. If the rover moved away from the lander in a straight line for 20 minutes, how far could it go?
2. Suppose we want the rover to always be able to return to the lander within 20 minutes. Given that requirement, how much area could the rover explore?
3. Suppose we doubled the rover's wheel diameter. What would the circumference of the new wheel be? How far would the rover move each time the wheels made one complete rotation? What would the rover's speed be? We would still want the rover to be able to return to the lander within 20 minutes. How much area could the rover explore with the new wheels and speed?
4. Calculate the area the rover could explore for several other wheel diameters. Use this graph to show the relationship between wheel diameter and the area explored.

Teaching Guidelines:
Area of Exploration

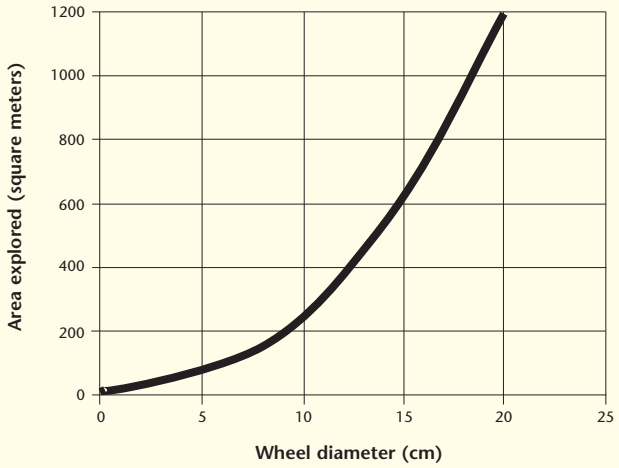
Procedure:

This activity can be done by students working individually or in teams of two.

Distribute the handout and read the first paragraph aloud. Discuss the relationship between the size of the wheels, their rate of rotation and the speed of the vehicle, and that each time the wheel makes one complete rotation the vehicle will move forward a distance equal to the circumference of the wheel. Ask each student to draw a diagram which shows this relationship.

Have students work on the rest of the activity individually or in their teams. Circulate as they do so and get students to explain to you exactly how they are approaching the problem.

Students should find that doubling the wheel diameter enables the rover to explore four times as much area, and tripling it increases the area of exploration by a factor of 9. Their graphs should look something like this:



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Voyage of the Ventana Series, #2011–2015	A remotely operated, deep-ocean vehicle, equipped with a camera, sonar and manipulating arms, collects images and unusual creatures that live in the extreme pressures of the deep.