Names_____

Assessing Planetary Habitability with Planetary Exploration Rovers

Rover Design,
Mission Execution
(Landing and Surface Operations),
and Data Analysis

Contents:

Section 1: Rover Design
Instructions:

NASA has come to you for help with their next rover mission. They need to assess whether the environmental conditions on the surface of Mars are suitable for human beings. They have given you a budget of 150 Rover Credits. You must design the rover, and choose the power source and instruments necessary to fulfill your mission within the allowed budget. Your rover will then be sent to Mars to execute its mission.

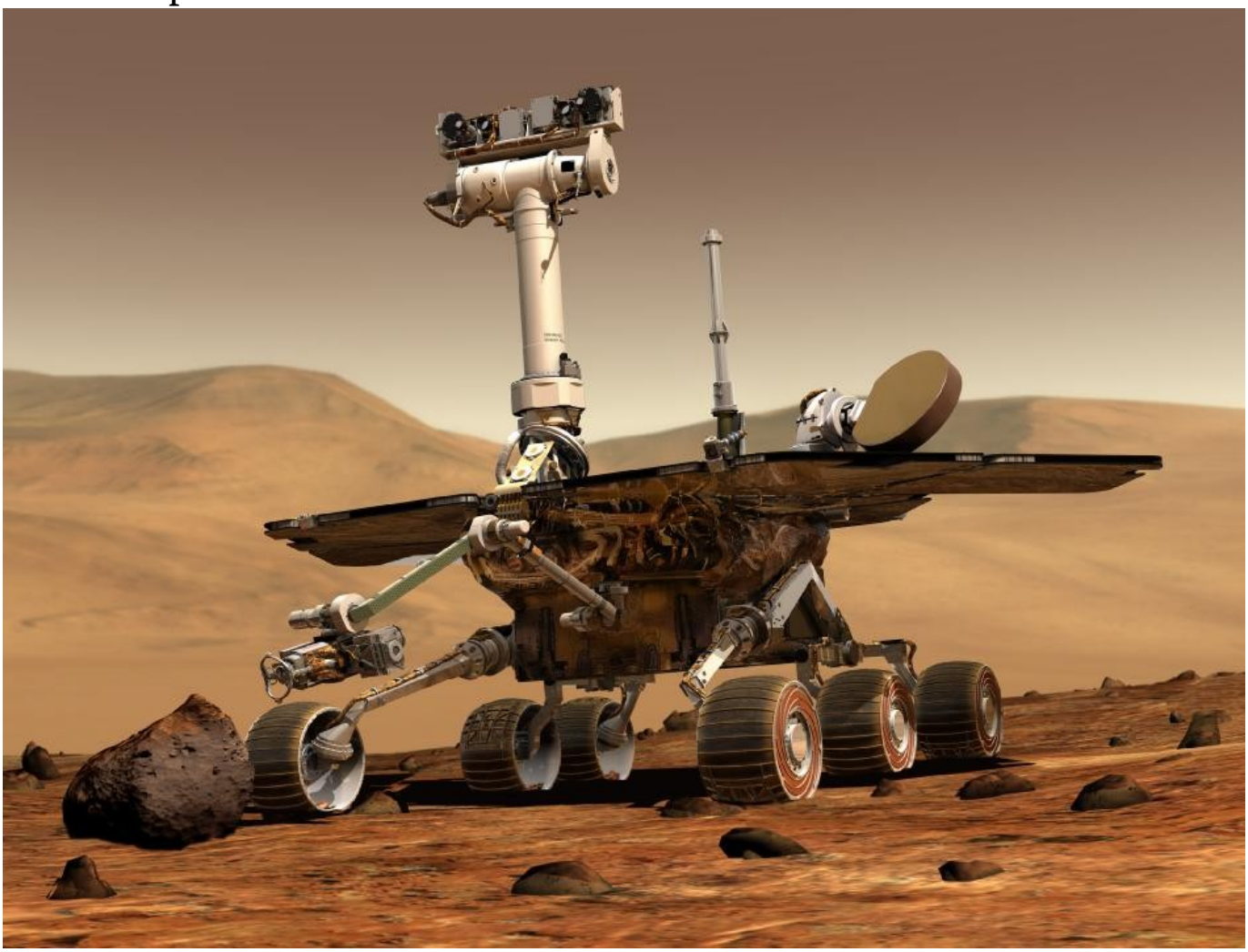
First, you will talk with your group about what planet properties you need to know to determine whether Mars is currently habitable for human beings. (List 3 properties, **5 points**)

You will design a rover capable of gathering this information with the available instrument options. You will keep track of the budget required to build your rover. You will draw your rover design and label all of the instruments included. (**15 points**)

Rover Frame Designs:
Mars Pathfinder: Separate Lander & Rover components:

This rover frame design costs less than the others, but is not very mobile. The small rover must stay within sight of the landing component, which contains the communications equipment, and it can only carry 3 instruments on board.
(30 Rover Credits)

Mars Exploration Rovers: Medium sized rovers

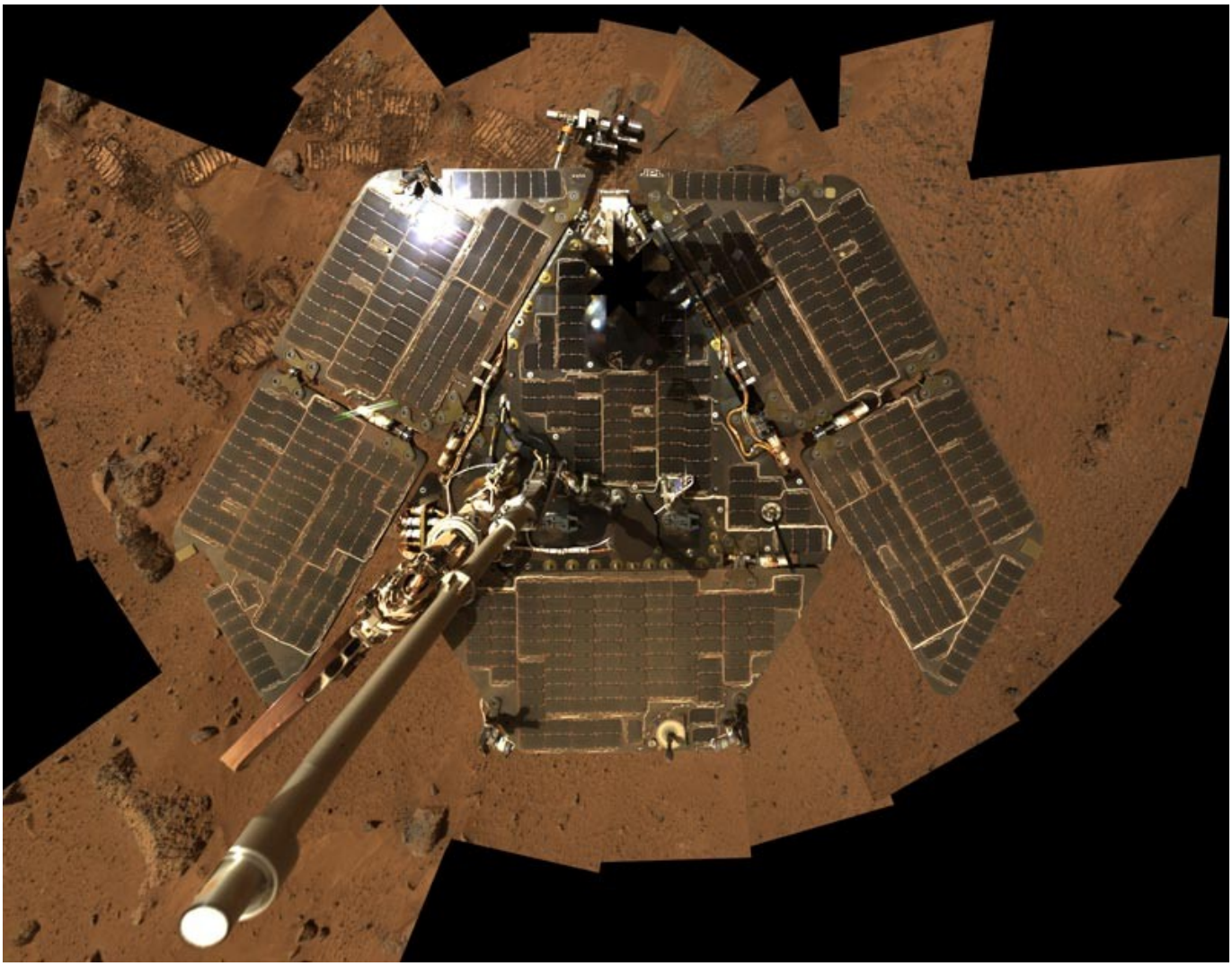


This rover frame design costs more than the Pathfinder design, but is more mobile. It can carry 4 instruments on board.
(35 Rover Credits)

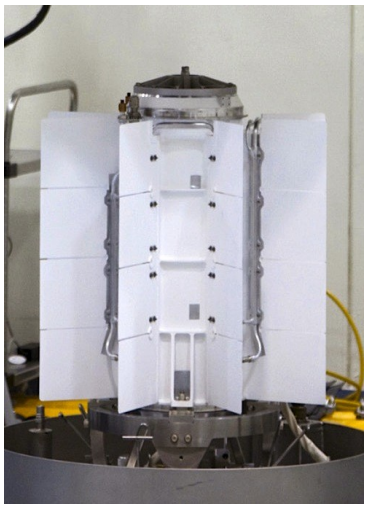
Mars Science Laboratory: Large rover

This rover frame design is the most expensive. It is also highly mobile, and can support 5 instruments. (45 Rover Credits)

Power Sources:
Solar Panels:



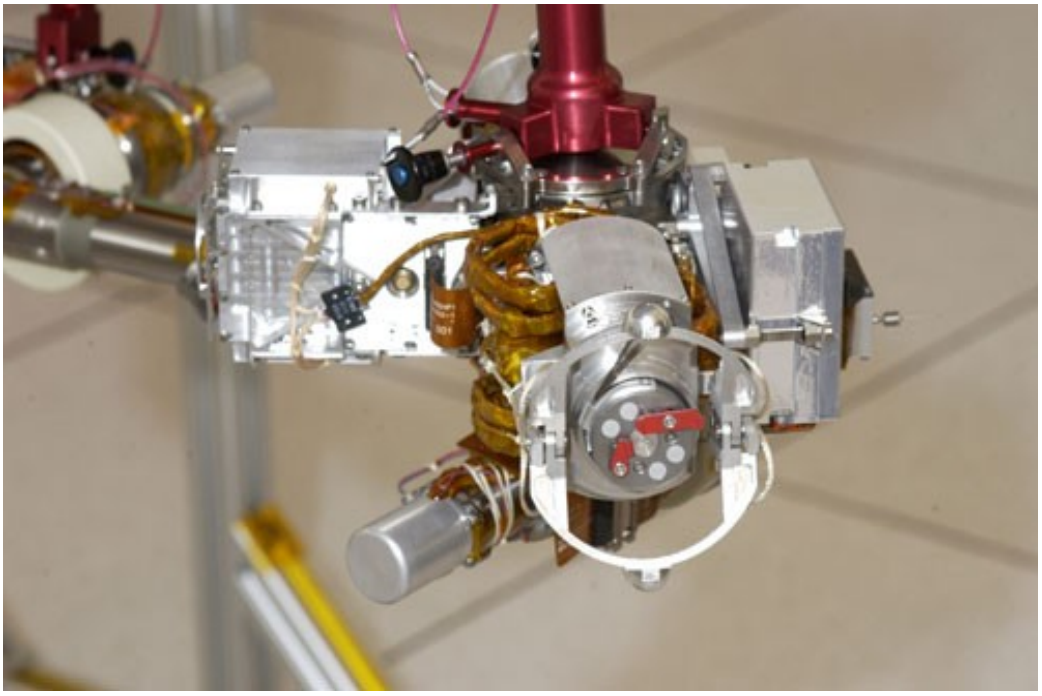
Solar Panels is the less expensive of the two power sources available. They provide a moderate amount of power daily to move the rover and run the instruments on board. Wintertime and dust cause the panels to generate less power. (25 Rover Credits)



Radioisotope Thermoelectric Generator (RTG):

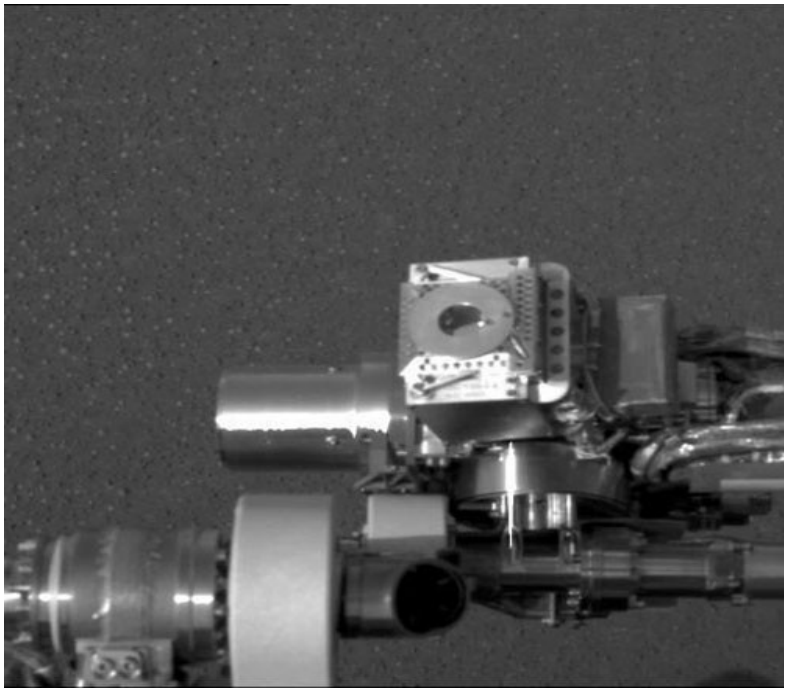
This power source is more expensive, but will last a long time. It requires the largest rover frame to carry it, and because it produces heat, it must be kept away from temperature sensitive instruments. (30 Rover Credits)

Rover Instruments:
Rock Abrasion Tool (RAT):



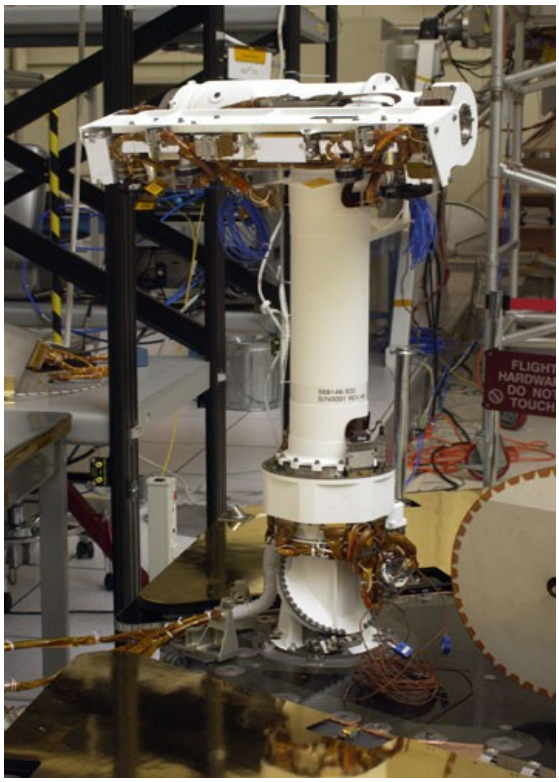
This instrument can scrape away the dusty coatings on rocks for a camera or spectrometer to get a better look. (15 Rover Credits)

Spectrometer:



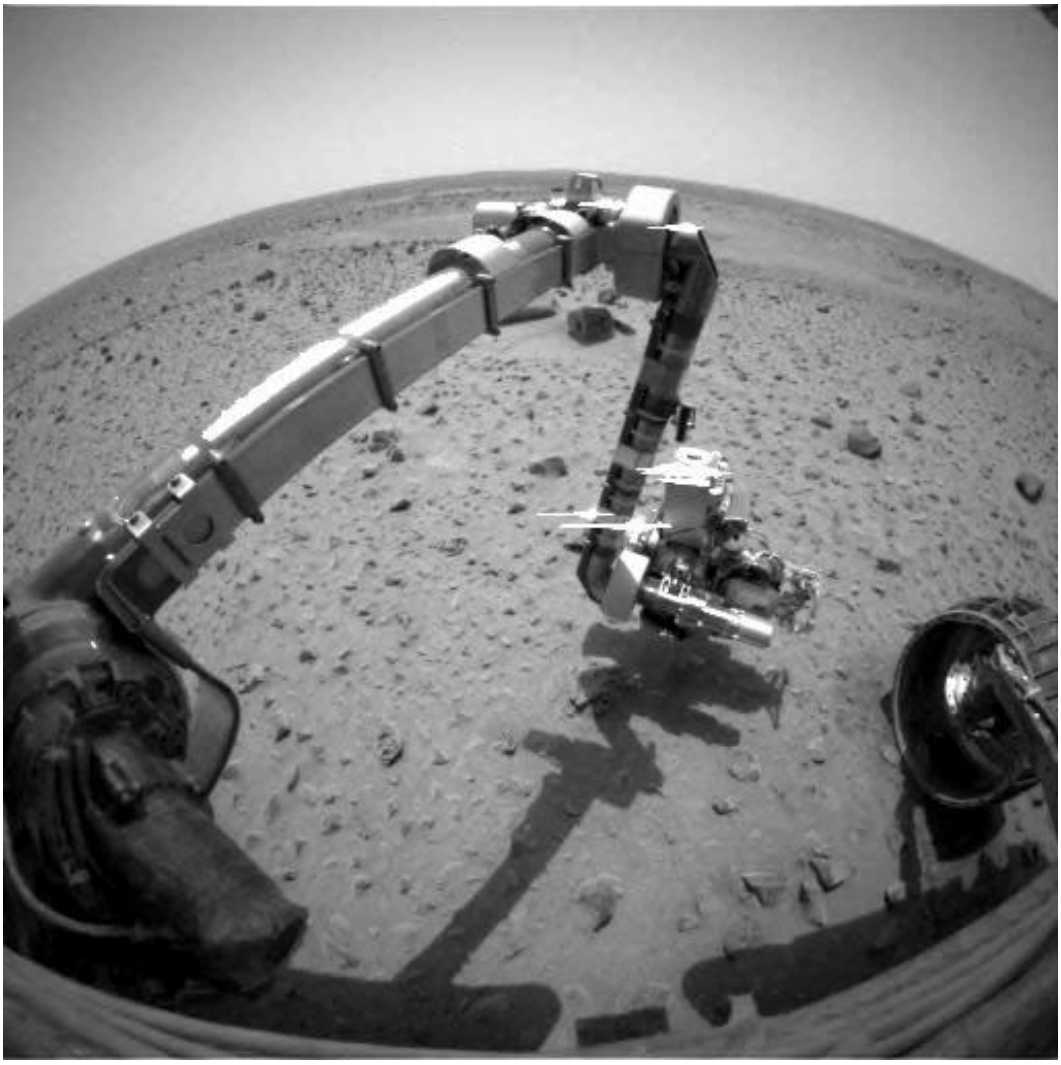
Spectrometers are used for determining the mineral composition of rocks, and can also be used for examining the atmospheric composition. (15 Rover Credits)

Panoramic Camera: PanCam



The panoramic camera is useful for navigation as well as determining the amount of dust in the atmosphere. (15 Rover Credits)

Microscopic Imager:



This instrument is a combination of a microscope and a camera. When attached to a mobile arm, the camera can be used to get a close look at rocks and soil to learn about how they were formed. (15 Rover Credits)

Meteorological Station (MET):

The meteorological station is a mast with three temperature sensors along the pole, a tell-tail at the top for wind speed and direction, a pressure sensor, and a laser-ranging system (LIDAR) used for detecting cloud formation and atmospheric dust.
(15 Rover Credits)

QUESTION: Did you stay within your budget? How difficult was it to stay within the budget? (**5 points)**

QUESTION: Where would you choose to land on Mars and why? (**5 points**)

QUESTION: List each of the instruments you included on your rover and why you included them (**10 points**)

Section 2: Landing on Mars

If the TA has an Xbox 360 + Kinect set up, group members may take turns trying to land the Mars Science Laboratory rover on the surface of Mars via the Rover Landing demo available from Xbox Live. This is a simulation of the "Seven Minutes of Terror" that mission engineers had to program the rover to do on its own! **(5 points)**

If no Xbox 360 is available, Section 3 is worth 15 points.

Section 3: Mission Execution
Instructions:
Your rover has been sent to Mars. Now you will work in teams of 4 to instruct your rover how to traverse around the Martian terrain. You will have 10 minutes to travel to and photograph all of the mission targets. **(10 points)**

Team member 1 (Principal Investigator): You will evaluate the images you receive from the rover and determine which way is the safest to drive the rover in order to photograph each of the available targets.

Team member 2 (Mission Scientist): You will determine the importance of each target, and work with team member 1 to choose the order of each of the available targets and help communicate these to team member 3.

Team member 3 (Rover Pilot): You will drive the rover using the instructions given to you by team members 1 and 2. If you drive the rover off of the Martian landscape, you must return it to the landscape.

Team member 4 (Mission Engineer): You will be available at the rover landing site to save it in case of any mishaps. Your team must spend at least 45 seconds attempting to save the rover using the remote control before you are allowed to intervene.

You will send your rover instructions using the remote control, and only the video you can see on the computer screen. You may not look at the rover itself as you drive it around, unless you are team member 4.

Section 4: Data analysis
Instructions:

To learn about the large temperature changes through 1 Martian day (called a “Sol”), you will convert the temperatures from degrees Kelvin to degrees Fahrenheit make a plot using data given in Table 1. **(10 points)**
Temperatures are given for each hour through one Martian day.

To convert temperature from Kelvin to Fahrenheit:

1. Subtract 273 from the temperature in Kelvin

(this gives the temperature in degrees Celsius)

2. Multiply your answer from step 1 by 9
3. Divide your answer from step 2 by 5
4. Add 32 to your answer from step 3 to get the temperature in Fahrenheit

Table 1
Temperature Change over 1 Day at 45 degrees North Latitude

Time of Day (hours)	Temperature (Kelvin)	Temperature (degrees Fahrenheit)
0	208	
1	206	
2	204	
3	202	
4	201	
5	198	
6	196	
7	197	
8	206	
9	221	
10	236	
11	243	
12	251	
13	259	
14	263	
15	258	
16	251	
17	237	
18	233	
19	228	
20	223	
21	220	
22	216	
23	213	

QUESTION: What time of day is it coldest? What time of day is it warmest? How much does the temperature change during one day (in degrees Fahrenheit)? (**5 points**)

Mars Rover Lab Takehome

Name:_____

Visit NASA's website for the Curiosity Rover: mars.jpl.nasa.gov/msl

1) Look up one instrument on the rover and describe its purpose **(10 points)**

2) Look at the news section and write a brief summary of what MSL is currently doing and why it is doing this. **(10 points)**

3) Find out about one of the discoveries made so far on the MSL mission and write a short summary describing the discovery and why it is important. **(10 points)**