

## GOOD VIBRATIONS

### Remote Sensing Data Collection: Thermal Emission Spectrometer (TES)

#### **Background:**

Thermal emission spectroscopy is a technique currently being used by a Mars Global Surveyor spacecraft instrument called TES (Thermal Emission Spectrometer). The purpose of TES is to measure the thermal infrared energy (heat) being emitted from Mars. From this data, scientists can learn much about the geology (rocks and minerals) and atmosphere of Mars.

The Mars Global Surveyor spacecraft had a two year intensive mapping mission. During this time, the TES instrument systematically built a mineral map of Mars. This information is used to understand the rocks on Mars, the composition of the Mars atmosphere, and the temperature variations that occur on its surface. With this information, future Mars missions can plan interesting landing sites, know what kind of mineral resources are available on the surface, and understand more of the history of Mars.

A comprehensive background on the TES instrument and infrared spectroscopy is available at our website: <http://tes.asu.edu/newwhatstes.html>.

#### **Objective**

Upon completion of this activity, students will be able to:

- learn about the use of thermal emission spectroscopy.
- gain knowledge about a planet's surface and atmosphere.
- relate current remote sensing planetary exploration techniques

#### **Instructional Time**

45 Minutes

#### **Participants**

- Sun
- Timer
- Communication Center
- Mars Mineral Shakers (up to 12)
- TES
- Data Stream
- Scientist

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#### Materials:

Any materials can be used as props.

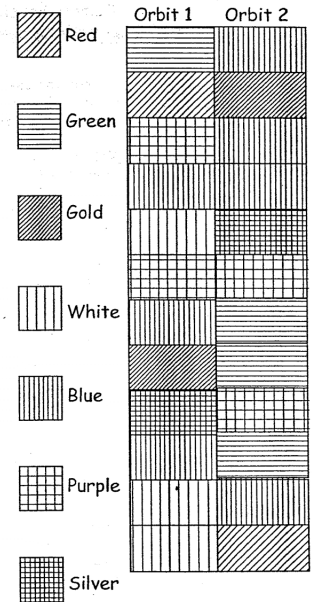
Here are some suggestions:

- Cool sunglasses
- Stopwatch
- Headset or telephone
- Mars mineral shakers (small pom-pom)
- Clip board, pencil, and data sheet
- Mirrored CD
- Portable radio (for radio waves)
- Rock or mineral book
- Hula-hoop or rope circle
- Colored chalk or dry-eraser markers

NOTE: We are trying to change the stereotypes of scientists; please, no white lab coats, glasses, or pocket protectors!

Orbit 1	Orbit 2
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	

Sample of Completed Data Set



▲ Figure #1 - This diagram can be drawn on a chalk board or white board. Each column represents a different orbit and each row represents a different rock reading from TES.

▶ Figure #2 - A sample of a completed data set. This could be done on a chalk or dry-erase board and recorded by the scientist.

#### Procedure:

An open classroom area is needed to demonstrate the TES data collection.

1. Select students to fill the positions listed in the participant list. You can draw names or have the students apply for positions.
2. Make a color key for the mineral shaker colors on the white board or chalk board, (see Figure #2).
3. Draw a table on the board to simulate the data return (Figure #1). The scientist will color in the portion of the orbit according to the mineral color. This simulates the way that data is collected and image maps are produced in TES data. The table on the board should be numbered 1-12 to match the data sheet being returned to the communication center. The communication center person will then read back the data collected by TES to the scientist, and the scientist will color the appropriate mineral color in the squares 1-12.
4. The Sun is positioned in the center of the open area (with glasses!). The Mars minerals each get one shaker to start. They should all hold onto the hula-hoop with their left hand and have their shaker in their right hand. Tell the students to hold their shakers on the floor until the game is explained. The TES instrument is located in the locale of the Sun, because the instrument reads the heat emission best when the surface is warmed during the day (approximately 2:00pm).
5. TES instrument (CD mirror around neck) is positioned next to the Sun.

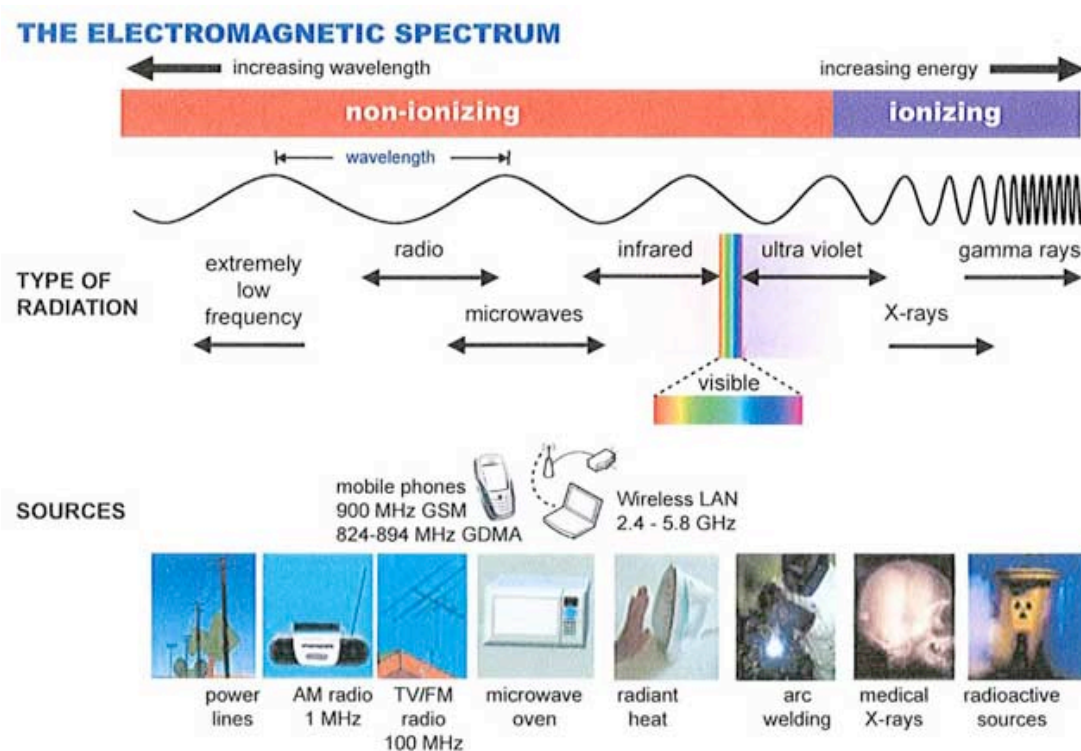
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6. The Data Stream is located next to the TES instrument (with the portable radio). These radio waves will transmit the TES data back to Earth.
7. Timer (optional): A timer with the stopwatch can be used to time the actual data readings from TES (1 every 2 seconds).
8. The Communication Center person will read the data delivered by the Data Stream to the Scientist.
9. The Scientist will record the data for interpretation by the class. Are there any similarities or differences in the way racks were sequenced?
10. The second orbit can be repeated as in the first orbit with students in a different order or with multiple shakers given to the students to simulate real rocks. In this case each numbered box may have more than one color. Students can then compare the two orbits.

### Conclusion

This activity will help students to understand the thermal infrared science that has been conducted during the Mars Global Surveyor mission, the 2001 orbiter mission, and the 2003 rover mission. We hope that this information is helpful and appropriate for your students and welcome any feedback.



Student Name \_\_\_\_\_ Date \_\_\_\_\_

## **GOOD VIBRATIONS**

### Remote Sensing Data Collection: Thermal Emission Spectrometer (TES) DATA SHEET

DIRECTIONS. Complete the following data sheets.

**ORBIT #1—TAKE DATA EVERY 2 SECONDS. RECORD EACH COLOR VIBRATION IN BOXES 1-12 BY MAKING A MARK. MAKE ONLY ONE MARK UNDER ONE COLOR FOR EACH LINE.**

	<b>RED</b>	<b>GOLD</b>	<b>GREEN</b>	<b>WHITE</b>	<b>BLUE</b>	<b>PURPLE</b>	<b>SILVER</b>
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

Student Name \_\_\_\_\_ Date \_\_\_\_\_

## GOOD VIBRATIONS

### Remote Sensing Data Collection: Thermal Emission Spectrometer (TES) DATA SHEET

DIRECTIONS. Complete the following data sheets.

**ORBIT #2—TAKE DATA EVERY 2 SECONDS. RECORD EACH COLOR VIBRATION IN BOXES 1-12 BY MAKING A MARK. MAKE ONLY ONE MARK UNDER ONE COLOR FOR EACH LINE.**

	RED	GOLD	GREEN	WHITE	BLUE	PURPLE	SILVER
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

Student Name \_\_\_\_\_ Date \_\_\_\_\_

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### Remote Sensing Data Collection: Thermal Emission Spectrometer (TES)

DIRECTIONS. Once you have finished the data collection, answer the following questions.

1. How do scientists learn about rocks on Mars?

2. What do the rocks help us learn about Mars?

3. Why do you think that scientists are interested in the kinds of rocks that Mars has?

