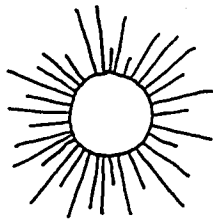


## **Teaching Activity: Interpreting a Data Table** **(The Goldilocks Effect)**

**Introduction:** Over billions of years, living organisms have adapted to a wide range of temperature conditions on Earth. However, as far as we can tell, life has not gained a foothold on either the intensely hot world of Venus or the freezing surfaces of Mars.

For many years, climatologists wondered why there are such great temperature difference between the three planets. Initially it was thought that Mars was much colder than Earth because it was farther from the Sun; and Venus was much hotter because it was closer to the Sun. However, it is now known that the major factor in determining the average global temperatures of Venus, Earth and Mars is not their distances from the Sun, but rather the amounts of certain gases in their atmospheres.



VENUS  
+ 840° F



EARTH  
+ 59° F



MARS  
-10° F

It its early stage of development, Mars had a thicker atmosphere than it does today. It was much warmer than it is today and liquid water flowed on its surface. Over the past 3-4 billion years, Mars lost most of its atmosphere. With little atmosphere to trap heat from its surface, it got very cold and its oceans and rivers dried up.

In contrast, Venus is much hotter than it would be if it had an atmosphere like our. Because of its bright clouds, Venus reflects much of the Sun's energy, so it actually absorbs less energy than the Earth. However, its dense atmosphere is so efficient at trapping heat that the surface of Venus is hotter than Earth's.

The set of factors that has enabled the Earth to maintain conditions that are "just right" for life, while Venus is "too hot" and Mars is "too cold", has aptly been described as the "Goldilocks Effect".

### **Objective:**

- To analyze a data table of the characteristics of Venus, Earth and Mars;
- To present the information from the data table in a visual format;
- To identify those factors which appear to be the most important in determining the habitability of a planet;

**Important Terms:** Mass, albedo, radius, solar constant, cloud cover, atmospheric mass, greenhouse warming;

**Materials:** Reference materials on the three planets, copy of student activity sheets, paper/pencil, drawing paper, colored pencils / crayons, ruler;

**Procedure:**

1. Read over and discuss the **Introduction** with the class.
  - Review new or unclear vocabulary.
2. Create a viewgraph of the **Data Table** and use it to discuss the information with the entire class.
3. Once you feel that students understand the information that you have presented, instruct the class to create a drawing of each of the three planets as explained on their activity sheet:
  - Provide reference materials for use in class or make time available on the computer or on the library for research.
  - Provide drawing materials.
4. Instruct students to complete the questions in the **Analysis and Comprehension** section.

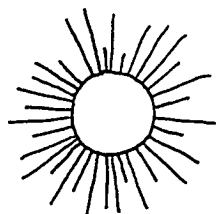
**Data Table: Characteristics of the Terrestrial Planets:**

| Characteristic         | Venus         | Earth       | Mars            |
|------------------------|---------------|-------------|-----------------|
| Total Mass             | 5             | 6           | 0.6             |
| Radius (km)            | 6049          | 6371        | 3390            |
| Atmospheric Mass       | 100           | 1           | 0.06            |
| Distance to Sun (M km) | 108           | 150         | 228             |
| Solar Constant         | 2613          | 1380        | 589             |
| Albedo (%)             | 75            | 30          | 15              |
| Cloud Cover (%)        | 100           | 50          | Variable        |
| Surface temp. (* C)    | 427           | 15          | -53             |
| Nitrogen (%)           | <2            | 78          | <2.5            |
| Oxygen (%)             | <1 ppm        | 21          | < 0.25          |
| Carbon dioxide (%)     | > 98          | 0.035       | >96             |
| Water vapor (%)        | < 0.0001      | < 1         | < 0.001         |
| Sulfur dioxide (%)     | 150 ppmv      | < 1ppbv     | 0               |
| Cloud composition      | Sulfuric acid | Water vapor | Dust, water, CO |
| Greenhouse Warming.    | 15            | 1           | 0.1             |

## ***Student Activity Sheet: Interpreting a Data Table*** ***(The Goldilocks Effect)***

***Introduction:*** Over billions of years, living organisms have adapted to a wide range of temperature conditions on Earth. However, as far as we can tell, life has not gained a foothold on either the intensely hot world of Venus or the freezing surfaces of Mars.

For many years, climatologists wondered why there are such great temperature difference between the three planets. Initially it was thought that Mars was much colder than Earth because it was farther from the Sun; and Venus was much hotter because it was closer to the Sun. However, it is now known that the major factor in determining the average global temperatures of Venus, Earth and Mars is not their distances from the Sun, but rather the amounts of certain gases in their atmospheres.



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### ***Objective:***

- To analyze a data table of the characteristics of Venus, Earth and Mars;
- To present the information from the data table in a visual format;
- To identify those factors which appear to be the most important in determining the habitability of a planet;

**Procedure:**

1. Read over and discuss the **Introduction** with your teacher.
2. Review the **Data Table** with your teacher.
  - Ask questions regarding any terms that are unclear to you.
3. Create a drawing of each of the terrestrial planets discussed in the **Data Table**.
  - Illustrate the information about each of the planets:
  - Include: a drawing of the surface of the planet, its distance to the Sun, the solar constant, % albedo, % cloud cover, surface temperature, % of greenhouse gases, cloud composition, greenhouse warming potential;
4. Complete the activities in the **Analysis and Comprehension** section.

**Data Table: Characteristic of the Terrestrial Planets**

| Characteristic         | Venus         | Earth       | Mars           |
|------------------------|---------------|-------------|----------------|
| Total Mass             | 5             | 6           | 0.6            |
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| Sulfur dioxide (%)     | 150 ppmv      | < 1ppbv     | 0              |
| Cloud composition      | Sulfuric acid | Water vapor | Dust,water, CO |
| Greenhouse Warming.    | 15            | 1           | 0.1            |

**Student Activity Sheet #1: Interpreting a Data Table**

**ANALYSIS AND COMPREHENSION**

1. What question about Venus, Earth and Mars has bothered scientists for many years? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

2. What was initially thought to be the reason for this difference?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. After years of research, what has been determined to be the major factor in determining the temperatures of these three planets? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

3. How do the atmospheric carbon dioxide concentrations of the three planets compare? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

4. Venus has an albedo more than twice that of the Earth. If Venus reflects such a large percentage of the incoming solar energy, why is its surface temperature still so high? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

5. What three factors appear to be the most important in determining the surface temperatures of these planets? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

6. Liquid water has been determined to be a necessary condition for life to evolve. Why do you think that Earth is the only planet of the three to support life?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

