WARD'S™
DataHub
The Power of Twelve
The Convenience of One

Temperature Variation:
Measuring Thermal Oscillation and Luminosity During a Full Day
(Teacher's Guide)

For technical assistance,
call WARD'S at 1-800-962-2660

OVERVIEW

Students will perform a measurement of room temperature and luminosity inside their school over a 24-hour period, using the built-in Ward's DataHub temperature and light sensors. They will then draw a graphic to observe the existing correlation between the thermal oscillation of their areas and the quality of light in the environment, in order to compare the hypothesis with the results.

MATERIALS NEEDED

Ward's DataHub
USB connector cable*

** – The USB connector cable is not needed if you are using a Bluetooth enabled device.*

NUMBER OF USES

This demonstration can be performed repeatedly.

FRAMEWORK FOR K-12 SCIENCE EDUCATION © 2012

* The Dimension I practices listed below are called out as **bold** words throughout the activity.

Dimension 1 Science and Engineering Practices				
	✓	Asking questions (for science) and defining problems (for engineering)		Use mathematics and computational thinking
	✓	Developing and using models		Constructing explanations (for science) and designing solutions (for engineering)
	✓	Planning and carrying out investigations	✓	Engaging in argument from evidence
	✓	Analyzing and interpreting data	✓	Obtaining, evaluating, and communicating information

Dimension 2 Cross Cutting Concepts				
	✓	Patterns	✓	Energy and matter: Flows, cycles, and conservation
	✓	Cause and effect: Mechanism and explanation		Structure and function
		Scale, proportion, and quantity		Stability and change
	✓	Systems and system models		

Dimension 3 Core Concepts	Discipline	Core Idea Focus
	Earth and Space Science	ESS1: Earth's Place in the Universe
		ESS1.B: Earth and the Solar System
		ESS2: Earth's Systems
		ESS2.A: Earth Materials and Systems
		ESS2.D: Weather and Climate

NGSS Standards	Middle School Standards Covered	High School Standards Covered
	MS.ESS-SS: Space Systems	HS.ESS-SS: Space Systems
	MS.ESS-HE: The History of Earth	HS.ESS-ES: Earth Systems
	MS.ESS-EIP: Earth's Interior Processes	HS.ESS-CC: Climate Change
	MS.ESS-ESP: Earth's Surface Processes	
	MS.ESS-WC: Weather and Climate Systems	

NATIONAL SCIENCE EDUCATION STANDARDS © 2002

Content Standards (K-12)			
✓	Systems, order, and organization		Evolution and equilibrium
✓	Evidence, models, and explanation	✓	Form and Function
✓	Constancy, change, and measurement		

Earth and Space Science Standards Middle School		Earth and Space Science Standards High School	
✓	Structure of the Earth System	✓	Energy in the Earth System
	Earth's History		Geochemical Cycles
✓	Earth in the Solar System		Origin and Evolution of the Earth System
			Origin and Evolution of the Universe

✓ Indicates Standards Covered in Activity

LEARNING OBJECTIVES

Core Objectives (National Standards):

- Develop the ability to refine ill-defined questions and direct to phenomena that can be described, explained, or predicted through scientific means.
- Develop the ability to observe, measure accurately, identify and control variables.
- Decide what evidence can be used to support or refute a hypothesis.
- Gather, store, retrieve, and analyze data.
- Become confident at communicating methods, instructions, observations, and results with others.

Activity Objectives:

The purpose of this activity is to study the temperature and luminosity changes produced during the day and night in a given area, by formulating a hypothesis and proceeding to check it using the Ward's DataHub light and temperature sensors.

Time Requirement:

20-30 minutes to set up, 24 hours to collect data, 30-45 minutes to analyze data

VOCABULARY

Day: A period of twenty-four hours as a unit of time, reckoned from one midnight to the next, corresponding to a rotation of the Earth on its axis.

Luminosity: A measurement of brightness.

Night: The period of darkness in each twenty-four hours.

Temperature: The degree or intensity of heat present in a substance or object.

Thermal Oscillation: Periodic variation in temperature.

Teacher Notes

INTRODUCTION

During the day we can observe different changes in the environment. Humidity, atmospheric pressure, noise, luminosity and other factors are constantly changing as the hours pass, and we can even predict how some of them will change during a full day. Thus we can say, for example, that the temperature at 7 a.m. is lower than at 3 p.m., and as night approaches, the temperature falls again.

- **Why do you think fluctuations in temperature during a full day occur? Explain.**

- **Thermal oscillations cause us to wrap up or uncover, according to how we feel, but have you ever thought how animals and plants adapt to daily temperature fluctuations? Explain.**

Carry out the experiment activity with your class so that at the end students will be able to answer the following question:

- **What differences in temperature and luminosity are produced between day and night in the area where you live?**

BACKGROUND

Thermal oscillation takes place within a thermal range which is the difference between the highest and the lowest temperature registered in a place during a given period of time. Its value is given mainly by the geography of a place and its effect determines many of the activities that living organisms do in a certain territory. An example is life in the desert, where few clouds are formed, the heat of the sun directly affects the soil, and therefore temperature can reach very high values. However, at night, temperature falls abruptly even below 0 °C, so there are extremely big thermal oscillations. For example, in the Arizona desert located in the United States, there can be thermal oscillations of up to 56 °C, meaning that the local species must present adaptations in order to withstand the weather.

DID YOU KNOW?

It takes 23 hours, 56 minutes and 4.09 seconds for the stars to come back to the same place in the night sky. This is called a sidereal day (star day).

It takes 24 hours for the Sun to come back to the same position in the sky each day. This is a solar day.

The solar day and the star day are not exactly the same because the Earth moves one degree further around the Sun each day, making the solar day slightly longer.

Some of the adaptations that plants have generated in order to live in the desert are very small leaves covered with wax, long roots and specialized tissues to accumulate water; all in order to increase absorption, diminish perspiration and avoid dehydration. Animals also have adaptations which allow them to live in this kind of environment. For example, they increase their internal temperature to avoid losing water through perspiration; these animals excrete very concentrated urine to eliminate waste in the smallest possible volume. They also have habits adapted to weather conditions, like hunting at night and hiding during the day.

Now students are encouraged to raise a hypothesis which must be tested with an experiment. Students may find it helpful to formulate their hypothesis as an answer to the following question.

- **If you had to establish a temperature range variation during a complete day in the place where you live, what do you think that variation would be?**

CONNECTING THE WARD'S DATAHUB TO A COMPUTER

If you are using a Bluetooth communication device:

Right click on the Bluetooth icon in the lower right corner of the screen and select the Ward's DataHub you are using. The icon will change from gray to blue, as shown at right, indicating that the Ward's DataHub and the computer are now connected.

If you are using a USB communication device:

In order to use USB communication, connect the Ward's DataHub and the computer with the USB cable supplied. Click on the USB icon at the lower right corner of the screen. This icon will change from gray to blue, as shown at right, indicating that the Ward's DataHub is connected to the computer via USB.

USING THE WARD'S DATAHUB

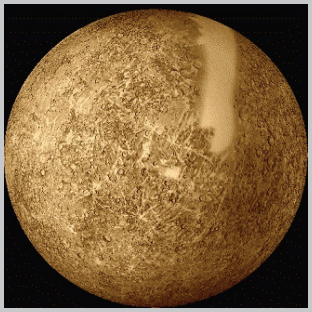
= Select key = On/Off and Escape key = Scroll key

To collect measurements with the Ward's DataHub, it must first be configured as follows:

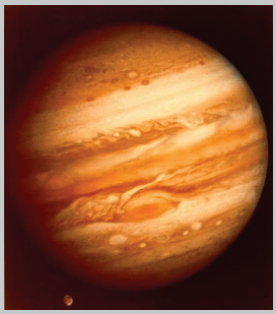
1. Turn on the Ward's DataHub by pressing the On/Off/Esc key.	
2. Go to setup by using the Scroll key then select Setup by pressing the Select key.	then
3. Select the Set Sensors option by pressing the Select key.	
4. If any sensor(s) appear on the screen, press the key representing that sensor to deactivate it. Select External Temperature by pressing the **Temperature Sensor** key twice. Also press the **Light Sensor** key.	x 2
5. Press the On/Off/Esc key once to return to the setup menu.	
6. Press the Scroll key to highlight the Sampling Rate and then press the Select Key	then
7. Press the Scroll key until "**1/Min**" is highlighted, then press the Select key.	then
8. Press the On/Off/Esc key to return to the setup menu.	
9. Press the Scroll key to highlight the Number of Samples and then press the Select Key.	then
10. Press the Scroll key until "**10,000**" is highlighted then press the Select key.	then
11. Press the On/Off/Esc key three times to return to the main operating screen.	x 3
12. **Press the Select key to start measuring.** (You are collecting data when there is an icon of a runner in the upper left hand corner of the screen.)	
13. Once you have finished measuring, stop the Ward's DataHub by pressing the Select key, followed by the Scroll key.	then

DID YOU KNOW?

One day on Mercury lasts 59 Earth days, because it takes almost two months for Mercury to spin around.



One day on Jupiter lasts less than 10 hours because it spins so fast.



ACTIVITY

1. Find a location in your school where the Ward's DataHub can be placed without danger of interference during a whole day (24 hours).
2. Put the Ward's DataHub in the previously selected location and activate it to register the temperature and luminosity data.
3. Register the sensor activation time. (Be sure it is on the hour; for example, 9:00 am.)
4. After measuring for a period of 24 hours, stop the sensor.

RESULTS AND ANALYSIS

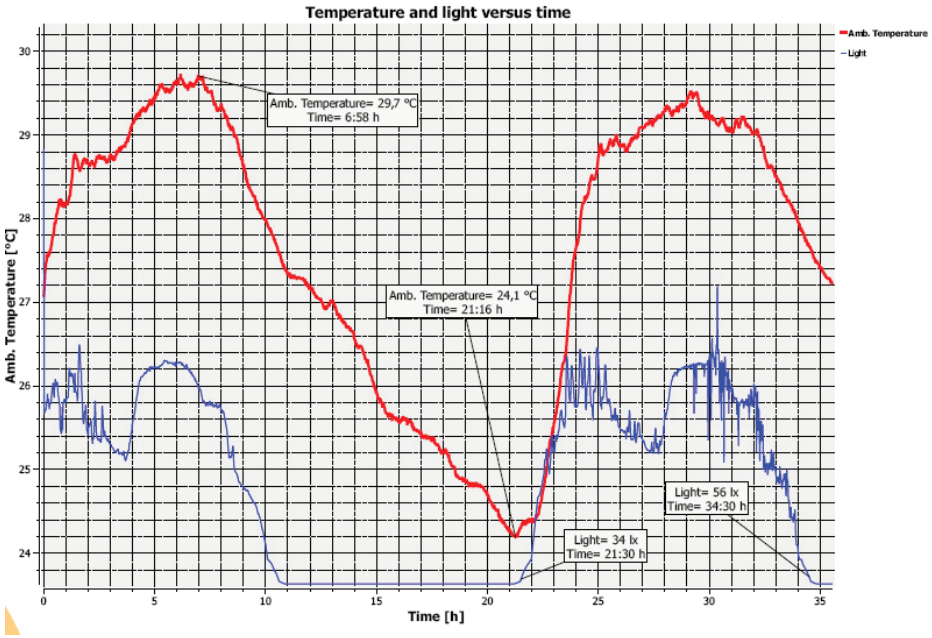
The following steps explain how to analyze the experiment results.

1. Connect the Ward's DataHub to the computer using the Bluetooth wireless communication channel or USB connector.
2. In the top menu, click in the  button and select the  button.
3. Select the last experiment on the list.
4. Observe the graph displayed on the screen.
5. Press the  button and write notes on the graph specifying the date and time of data taken.
6. Click the  button and select points on the graph. Pick one representative point for each shift (morning, noon, afternoon, night, midnight, dawn).
   - **Did you find differences between what you registered with the Ward's DataHub and what you predicted in the hypothesis? What were they?**
   - **If you compare the place where you live with a desert (like the Arizona desert), what differences exist at the level of thermal range and luminosity? Explain.**

RESULTS AND ANALYSIS

(continued)

The graph below should be similar to the one the students came up with.



DID YOU KNOW?

Daytime starts at sunrise and ends at sunset. Therefore the length of daylight is measured by the time that the Sun is visible in the sky. Interestingly, daylight hours are exactly opposite for the Southern and Northern Hemispheres because the Earth rotates around the Sun. Your position on the Earth has an effect on the length of day you observe. At latitude 0° (the equator) there are approximately 12 hours of daylight. As latitude increases to 80 ° (the polar circles), daylight increases to 24 hours or decreases to zero hours, depending on the time of year.

CONCLUSIONS AND ASSESSMENTS

1. Did you **observe** temperature differences during the different shifts of the day? Which ones?

   It is intended that students interpret the graph and observe that in fact room temperature changes as a full day passes.

2. Did you **observe** any relation between luminosity and room temperature? What was it?

   It is intended that students observe and analyze the graph and, from this, establish that there is a correlation between luminosity and temperature, and that the higher the luminosity, the higher the temperature.

3. If you had to classify the thermal oscillation of the place where you live into high, medium, or low, how would you do it and why? **Explain.**

   Students should classify the thermal oscillation obtained in their schools. They should indicate why and according to which factors they made this classification.

4. Do you think it is important to know the weather forecast for the highest and lowest temperature predicted in a day? **Explain** why.

   It is intended that students use their experience and indicate if at any moment they have given importance to highest and lowest temperature predictions from their areas, for example at the moment of choosing what to wear the following day.

5. What environmental and geographical factors do you think are involved in the thermal variations found in your area? **Argue** your answer with evidence from the experiment.

   Students should analyze the place where they are and mention the factors they believe could be important at the moment of establishing a thermal oscillation of a given place, like the presence of mountains or hills, water masses, clouds, etc.

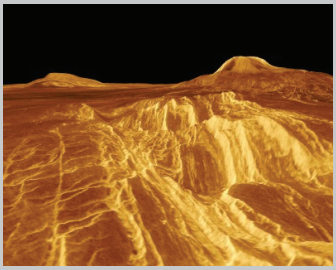
6. Write a **concluding** paragraph describing what you observed during the experiments.

   Students should reach the following conclusions:

   The difference between the highest and the lowest temperature registered in a full day corresponds to the thermal range and it is given by the geography of the place, season of the year, etc. Between day and night there are differences in temperature, thus, during the day the sunlight shines directly on the area, increasing the ambient temperature, while at night, when the Sun's rays fall on the opposite face of the Earth, the temperature is lower. Therefore, there is a correlation between the luminosity of a place and the temperature it presents.

DID YOU KNOW?

Mars has a very different heating and cooling cycle than Earth does. The temperature may reach a high of about 70 °F during the daytime at the equator, or as low as -225 °F at the poles at night.



ACTIVITIES FOR FURTHER APPLICATION

The aim of this section is for students to extrapolate the knowledge acquired during this class and apply it to different contexts and situations. Furthermore, it is intended that students question and present possible explanations for the experimentally observed phenomena.

1. Do you believe that at the Poles there is a big thermal range? Justify your answer.

   It is intended that students understand that there should not be a big daily thermal range at the Poles, because there is not a big difference between the highest and the lowest temperature registered in a day, due to the Earth's positioning regarding the Sun.

2. If you had to forecast the weather, what factors would you consider to make the prediction?

   Students should point out the factors such as humidity, geography, elevation, presence or absence of water, atmospheric pressure, season of the year, etc.

3. Do you believe there are places on the Earth where it is hotter at night than during the day?

   Students should realize that there should not be places on the Earth where it is hotter at night than in the day, because during the day the Sun heats the atmosphere.

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Temperature Variation: Measuring Thermal Oscillation and Luminosity During a Full Day *(Student Guide)*

INTRODUCTION

During the day we can observe different changes in the environment. Humidity, atmospheric pressure, noise, luminosity and other factors are constantly changing as the hours pass, and we can even predict how some of them will change during a full day. Thus we can say, for example, that the temperature at 7 a.m. is lower than at 3 p.m., and as night approaches, the temperature falls again.

- **Why do you think fluctuations in temperature during a full day occur? Explain.**

- **Thermal oscillations cause us to wrap up or uncover, according to how we feel, but have you ever thought how animals and plants adapt to daily temperature fluctuations? Explain.**

After carrying out this experiment, you should be able to answer the following question:

- **What differences in temperature and luminosity are produced between day and night in the area where you live?**

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EXPERIMENT

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4. After measuring for a period of 24 hours, stop the sensor.

RESULTS AND ANALYSIS

1. Connect the Ward's DataHub to the computer using the Bluetooth wireless communication channel or USB connector.
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   - **Did you find differences between what you registered with the Ward's DataHub and what you predicted in the hypothesis? What were they?**

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   - **If you compare the place where you live with a desert (like the Arizona desert), what differences exist at the level of thermal range and luminosity? Explain.**

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CONCLUSIONS AND ASSESSMENTS

1. Did you **observe** temperature differences during the different shifts of the day? Which ones?

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2. Did you **observe** any relation between luminosity and room temperature? What was it?

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3. If you had to classify the thermal oscillation of the place where you live into high, medium, or low, how would you do it and why? **Explain.**

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4. Do you think it is important to know the weather forecast for the highest and lowest temperature predicted in a day? **Explain** why.

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5. What environmental and geographical factors do you think are involved in the thermal variations found in your area? **Argue** your answer with evidence from the experiment.

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6. Write a **concluding** paragraph describing what you observed during the experiments.

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