Exploring the Dynamics of Heat and Temperature with EasySense

Windows Edition

Acknowledgements

Lessons developed by
Antony Bullock

Page Layout and Graphics by

Andrew Marles

Edited by

Dave Marles
Craig Ecclestone

Document No: **D0 119**

Contact Information:

Data Harvest Group Ltd
1 Eden Court
Leighton Buzzard
Beds. LU7 4FY

Tel: 01525 373666
Fax: 01525 851638
E-mail: sales@data-harvest.co.uk
www.data-harvest.co.uk

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Exploring the Dynamics of Heat and Temperature with EasySense

Notes to the Teacher:

The purpose of this unit is to introduce teachers and students to the concepts related to the dynamics of heat using data logging applied in real scientific investigations. Each lesson uses science process and content from the National Science Education Standards at the Middle School Level. Lessons can be easily adapted to the senior secondary level as well. Using temperature probes and the EasySense data logger, students collect data and then use the Sensing Science Laboratory software to analyze the data collected..

While the unit is designed to be used sequentially Teachers should feel free to pick and choose lessons in any order they feel is appropriate. This allows teachers to modify the material to meet the needs of students as well as local curriculum requirements.

Our general goals are listed below:

a. to introduce the concept of data logging in science
b. to teach students how to use the EasySense Advanced and the various probes
c. to allow teachers an opportunity to encourage kids to investigate questions and set up experiments

Some Notes About the Lesson Format

1. The **Suggestions for Teachers** tries to give the teacher a little help with planning the lesson. It will indicate interesting aspects of the lesson, potential problems with data collection, and offer suggestions for discussion topics.

2. If time does not permit a discussion of all the Analyzing the data questions and the Building the Bridge questions, **Suggestions for Evaluation** indicates which questions are critical to the goals of the lesson.

3. **Easy Sense**: will indicate which of the many EasySense features we will be using - particularly those that may be new. For example: how to use the Analysis Tools.

4. **Featured Cognitive Skill**: will indicate which of the many cognitive skills needed to effectively complete the lessons will be featured in this lesson i.e. Comparing and Contrasting.

5. **Content**: will indicate the specific piece of information or knowledge we are trying to impart in this lesson i.e. the connection between evaporation and heat.

6. **Gathering the Data**: indicates what needs to be set-up with the Easy Sense, how to set up the equipment, and what the students should actually do to carry out the investigation.

7. **Advanced √ :** indicates that the Advanced option in the Display button menu **must** be selected. This option gives access to more analysis tools and other remote data collection options. If **Advanced √** does not appear it may be selected but it is not important.

8. **Presenting the Data**: indicates how the graphs should be setup and how the data should be presented.

9. **Analyzing the Data**: asks questions that relate to the collection of the data and how the results might be interpreted.

10. **Building the Bridge**: attempts to relate the skills(cognitive and content) to other ideas and concepts in the students world and , in some cases, attempts to extend their understanding or implications of the content.

11. **Weblinks**: at the end of each lesson, a website address has been provided so students can extend their research on the Internet and learn about the educational resources available.

Special Note about printouts in Graph:

Students have at least three ways they could identify their work:

a. Use the Title tool and include their name (or group name) in the Title
b. Use the Text tool and place their names in an agreed upon place
c. Use a pen or pencil.

The date and time of the data collection are automatically recorded and printed by the Graph software.

Curriculum Connections:

In the development of science lessons the curriculum developers ensure a close correlation between the Data Harvest Units and the National Science Education Standards. The lessons can then quickly be correlated to State And Local standards as required.

A Sampling of Cognitive Issues Addressed in this Unit:

Design and conduct a scientific investigation
Use appropriate tools and techniques to gather, analyze and interpret data
… including mathematics…. The use of computers for the collection, summary and display of evidence …
Develop descriptions, explanations, predictions and models using evidence
Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description …
Think critically and logically
Communicate scientific procedures and explanations
Use mathematics in all aspects of scientific inquiry
Understanding about scientific inquiry

…technology used to gather data enhances accuracy and allows scientists to analyze and quantify…

… [Scientific investigations] can lead to new investigations

A Sampling of Evaluation Issues Addressed in this Unit:

"… 'Authentic Assessment'. This movement calls for exercises that closely approximate the intended outcomes of science education"

"Rather than checking whether students have memorized certain items of information, assessments need to probe for students' understanding, reasoning, and utilization of knowledge."

"Classroom assessments can take many forms including observations of student performance during instructional activities …"

It is important to understand that any one lesson could have many references chosen from the related Content Standards just as any one lesson uses more than the one cognitive goal that we have chosen to highlight in each lesson plan. The lessons encompass the objectives quoted below:

The correlations are organized in the following manner:

Source indicates the relevant sections of the "Content Standard: K – 12" document:

UP indicates the 'Unifying Concepts and Processes' chapter of the document.
5-8 indicates the 'Content Standards: 5 – 8' section.
9-12 indicates the 'Content Standards: 9-12' section.
A, B, C etc indicates a Content Standard of the 5-8 or 9-12 section: i.e. Content Standard A. (There are sections A to G in both 5-8 and 9-12)
Page refers to the page of the published text.

It is important to understand that any one lesson could have many references chosen from the related Content Standards just as any one lesson uses more than the one Cognitive Skill that we have chosen to highlight in each lesson plan.

Source: 5–8 A: Science as Inquiry

"This standard should not be interpreted as advocating a "scientific method". The conceptual and procedural abilities suggest a logical progression, but they do not imply a rigid approach to scientific inquiry. On the contrary, they imply co-development of the skills of students in acquiring scientific knowledge, in using high level reasoning, in applying their existing understanding of scientific ideas, and in communicating scientific information. This standard cannot be met by having the students memorize the abilities and understandings. It can be met only when students frequently engage in active inquiries."

Lesson 1: Probes and the sensor

Source: UP ; 5-8, A;
"Changes in systems can be quantified." p. 118
"The use of computers for the collection, summary, and display of evidence is part of this standard." p.145

Lesson 2 Analyzing

Source: 5-8, A; 9-12, A
"Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations." p. 148
"Students also need to learn how to analyze evidence and data." p.174

Lesson 3: Fahrenheit and Celsius

Source: UP ; 9-12, A
"Different systems of measurement are used for different purposes …Fahrenheit when reporting weather to the public …scientific reports …use degrees Celsius." p118
"Mathematics plays an essential role in all aspects of inquiry." p.175

Lesson 4: Insulation Part 1

Source: 5-8, A; 9-12, A
"Students should develop general abilities such as … identifying and controlling variables." p.145
"They should demonstrate appropriate procedures …conceptual understanding of scientific investigations." p. 175

Lesson 5: Insulation Part 2

Source: 5-8, E; 9-12, E
"…the study of technology …for example, by comparing the various characteristics of competing consumer products …´ p.165
"Students should present their results to students, teachers, and others …in writing and other forms, including … diagrams…." p. 192

Lesson 6: Heat loss and surface area

Source: 5-8, E; 9-12, A
"In the middle school years, students' work with scientific investigations can be complemented by activities that are meant to solve … a human problem…" p.161
"Students should … demonstrate the logical connections between the scientific concepts guiding the hypothesis and the design of the experiment." p. 175

Lesson 7: Insulation and Cold

Source: UP ; 5-8, G;
"Scientific explanations incorporate existing scientific knowledge and new evidence from observations …" p. 117
"It is part of scientific inquiry to evaluate the results of scientific investigations …." p.171

Lesson 8: Heat loss contest

Source: 5-8, E; 9-12, E
"Students should organize materials and other resources , plan their work, make good use of group collaboration where appropriate …." p.165
"In the course of solving any problem where students try to meet certain criteria with constraints, they will find the ideas and methods of science that they know …can be powerful aids." p.190

Lesson 9: Equilibrium

Source: UP ; 9-12, B
"Interacting units of matter tend toward equilibrium states …." p.119
"Examples are the transfer of energy from hotter to cooler objects by conduction …." p. 180

Lesson 10: Average Temperature

Source: 5-8, A; 9-12, A
"Thinking critically about evidence includes … accounting for anomalous data." p. 145

"Teachers of science can ask questions, such as … 'How confident do you feel about the accuracy of the data?' " p.174

Lesson 11: Heat Conduction 1

Source: 5-8, B; 9-12, A
"Substances are often placed in groups … ;metals is an example of such a group." p.154

"…[students] must actually use the cognitive and manipulative skills associated with the formation of scientific explanations." p.173

Lesson 12: Heat Conduction 2

Source: 5-8, B; 9-12, A
"Energy is a property of many substances and is associated with heat, …." p.155

"[Students need to] make connections between evidence and explanations …." p.174

Lesson 13: Heat Conduction 3

Source: UP; 5-8, B;
"Heat moves in predictable ways, flowing from warmer objects to cooler ones." p.155

"Energy can be transferred …[but] the sum of energy remains the same." p.118

Lesson 14: Radiation

Source: 5-8, B; 9-12, A
"Light interacts with matter by … absorption…" p.155

"Students also need to learn how to analyze evidence and data." p.174

Lesson 15: Friction and Heat 1

Source: 5-8, B; 9-12, A
"Student's everyday experience is that friction causes all moving objects to slow down and stop." p.149

"…students must use evidence, apply logic, and construct an argument for their proposed explanations." p.175

Lesson 16: Friction and Heat 2

Source: 5-8, B; 9-12, B
"The intent at this level is for students to improve their understanding of energy by experiencing many kinds of energy transfer." p.154

"Heat consists of random motion and the vibration of atoms, molecules and ions." p. 180

Lesson 17: Electricity and Heat

Source: 5-8, B; 9-12, B
"Electrical circuits provide a means of transferring electrical energy when heat … [is] produced." p.155

"In some materials, such as metals, electrons flow easily …." p.181

Lesson 18: Chemicals and Heat

Source: 5-8, B; 9-12, B
"At this level, elements and compounds can be defined operationally from their chemical characteristics…." p. 149

"Chemical reactions may release or consume energy." p. 179

Lesson 19: Evaporation

Source: 5-8, A; 9-12, B
"Specifically, students should be able to review data … and form logical arguments about the cause-and-effect relationships…." p. 145

"… in liquids molecules or atoms move around each other but do not move apart ; in gases molecules …are mostly far apart." p.179

Lesson 20: Further Data Analysis

Source: 5-8, C; 9-12, A
"Observations and investigations should [incorporate] the use of computers and conceptual and mathematical models." p.155
"Data manipulation and analysis strategies need to be modeled by teachers of science and practiced by students." p.174

Lesson 21: Condensation

Source: 5-8, A; 5-8,D
"…students should be able to review data from a simple experiment … and form a logical argument about the cause-and-effect relationships in the experiment." p.145
"Clouds, formed by condensation of water vapor, affect weather and climate." p.160

Lesson 22: Boiling Point

Source: 5-8, A; 5-8, B;
"Students should develop general abilities, such as systematic observation…." p.145
"A substance has characteristic properties, such as .. a boiling point … [that is] independent of the amount of the sample." p..154

Lesson 23: Freezing Point

Source: 5-8, B; 9-12, B
"… students observe and measure characteristic properties, such as … melting points…." p. 149
"… high school students can investigate energy transfers quantitatively by measuring variables such as temperature change …" p. 178

Lesson 24: Relative Humidity

Source: UP ; 5-8, A;
"Mathematics is essential for accurately measuring change …" p.118
"Mathematics can be used to ask questions; to gather , organize, and present data …." p. 148

Lesson 25: Rates of Cooling

Source: 5-8, A; 9-12, A
"Abilities necessary to do a scientific inquiry:- design and conduct a scientific investigation." p. 145
"…all students should develop: - the abilities necessary to do scientific inquiry" p.173

Lesson 26: Research Paper

Source: UP ; 5-8, A; 9-12, E
"They [students] should remain open to and acknowledge different ideas and explanations" p.148
"… design tasks should explore a range of contexts including … those immediately familiar in the homes, …" p.191

Lesson 27: The Coffee Cup problem

Source: 5-8, A; 9-12, A
"Different kinds of questions suggest different kinds of scientific investigations." p.148
"Students should develop sophistication in their abilities and understanding of scientific inquiry." p.173

Lesson 28: The Huddle Problem

Source: 5-8, C; 9-12, C
"An organism's behavior evolves through adaptation to its environment." p.157
"Organisms have behavioral responses to … external stimuli." p.187

Lesson 29: The Rainmaker

Source: UP 5-8, D;
"Water evaporates from the earth's surface, rises and cools, … condenses as rain or snow …." p.160
"Models are tentative schemes or structures that correspond to real structures and that have explanatory power." p.117

LESSON 1

Probes and the Sensor

A Teacher Lesson Plan

Lesson overview:

EasySense Goals:
Remote Data Collection

Featured Cognitive Skills:
Comparing and Contrasting

Lesson Content:
Observing the different reactions of the temperature probes and the internal temperature sensor.

Time:
45 to 60 minutes

Involvement:
either groups or individuals depending o class size and number o Easy Sense Units.

National Science Education Standards

Source: UP ; 5-8, A;
"Changes in systems can be quantified." p. 118
"The use of computers for the collection, summary, and display of evidence is part of this standard." p.145

Suggestions for Teachers:

This lesson serves two purposes.

One, it introduces the students to the hardware and the software and two, it makes the point that the probes and the internal sensor are going to react differently. They will discover that the probes react quickly to changes in temperature and that the plastic enclosed sensor reacts much more slowly.

When the students select **Save As,** the default folder is usually My Documents. It may be useful for the students to create folders labeled with their class name in order to keep their data separate from other data collected by other groups.

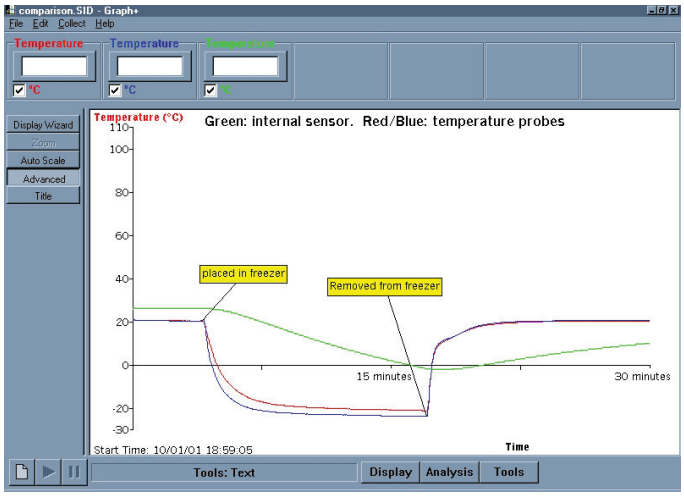
You may need a short presentation on using the EasySense LCD menu so they can enable the internal sensor. See the Teachers' Guide.

What the Students Are Going to Do:

1. Load the Graph software.
2. Attach the two temperature probes to the EasySense.
3. Enable the internal temperature sensor.
4. Program the EasySense to collect data remotely and download that data to Graph.

5. Compare the internal sensor with the probes in terms of how fast they react to temperature changes and how sensitive they are to heat..

They need an EasySense, two temperature probes and access to a freezer or a refrigerator. The graph on the disk is an example of how the students' graphs might look.



The above file is called compare.sid and is on the disk supplied.

Suggestions for Evaluation:

1. The fact that they have data indicates that they were able to set up correctly.

2. Analyzing Data questions 4 and 5 review comparing and contrasting as does Building the Bridge Question 2.

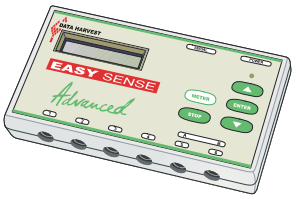
3. You need to check each group to determine if they have saved the data correctly. They need this data for Lesson 2.

LESSON 1

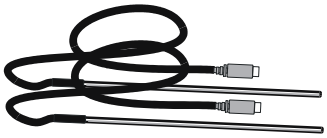
Probes and the Sensor

A Student Lesson

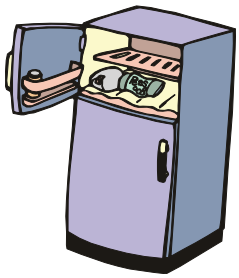
What you will need:



EasySense logger



2 temperature probes



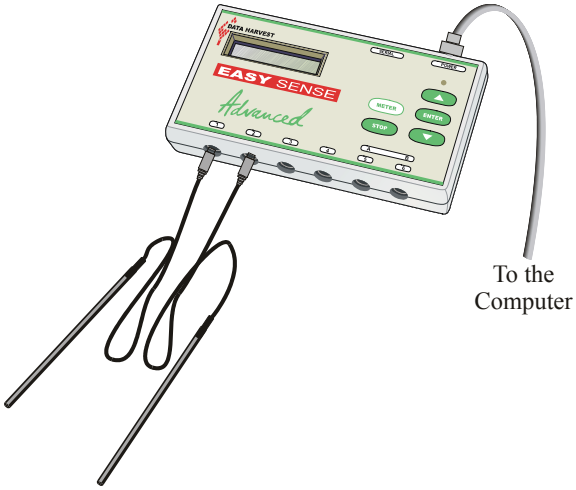
access to a freezer or refrigerator

Student Notes:

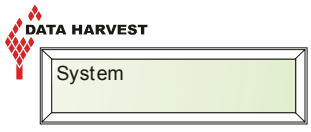
You have two different ways to collect temperature data with your EasySense. You can use the Temperature probes or the Internal Temperature Sensor. We are going to examine how they react to being moved from one environment to another.

Gathering the Data:

1. Attach the temperature probes to the EasySense. Use inputs 1 and 2.



2. Use the Arrows to find the entry "**System"** in the EasySense LCD.



Press <ENTER>

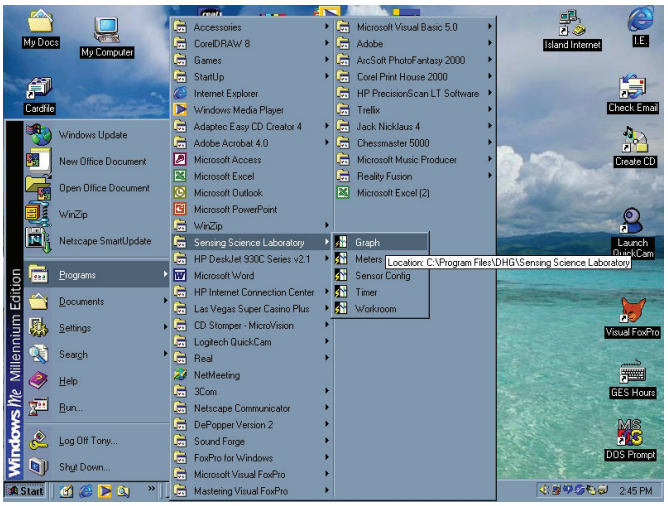
a. Continue pressing the Down Arrow key until the LCD reads "**Internal Temp …**"

b. If the LCD reads "**Internal Temp Now Enabled**", skip to instruction 'd.'

c. If the LCD reads "**Internal Temp Now Disabled**", press the <ENTER> key.

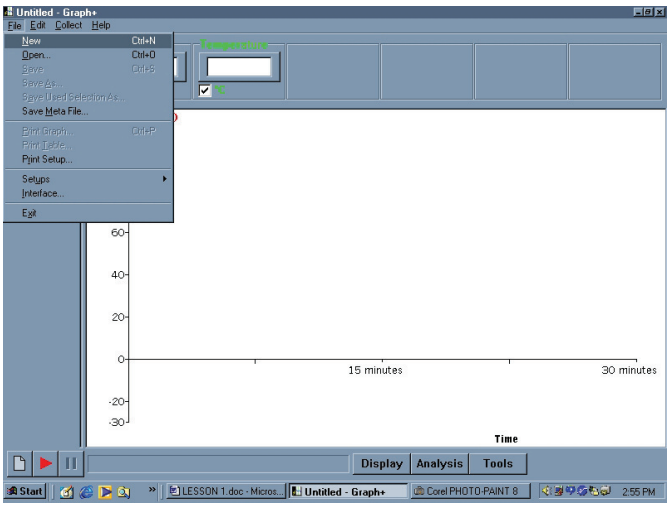
d. Press <STOP>.

3. Load the Graph module of the Sensing Science Laboratory.

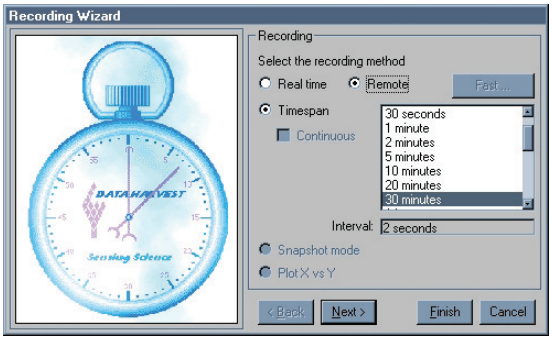


(Start … Programs … Sensing Science Laboratory … Graph)

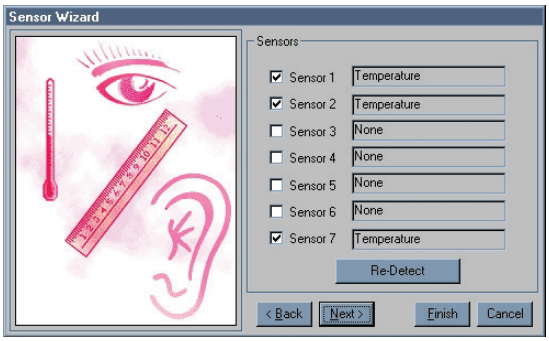
4. From the File menu select **New.**



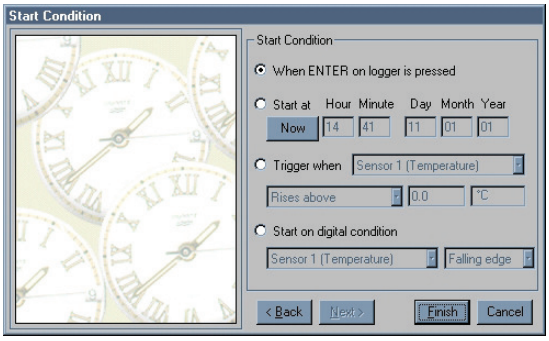
5. In the Recording Wizard, select **Remote** and **Timespan**, and **30 minutes.** Click **Next.**



6. In the Sensor Wizard make sure that sensors 1,2, and 7 are selected and say "Temperature". The enabled Internal Temperature is sensor 7. Click **Next.**



7. In the Start Condition Wizard make sure the "When ENTER on logger is pressed" is selected. Click **Finish.**



8. If you do NOT see the message screen “EasySense is setup for remote logging” , go back to step 4 above.

9. Disconnect the EasySense from the computer (remove the serial cable).

10. Place the EasySense on a table or desk.

11. Press <ENTER>.

12. After about 5 minutes, place the EasySense and the two probes in a refrigerator or a freezer. Have one probe hanging clear and the other touching the side or the bottom of the freezer.

13. After about 15 minutes, remove the EasySense and the probes and replace the EasySense on the table or desk.

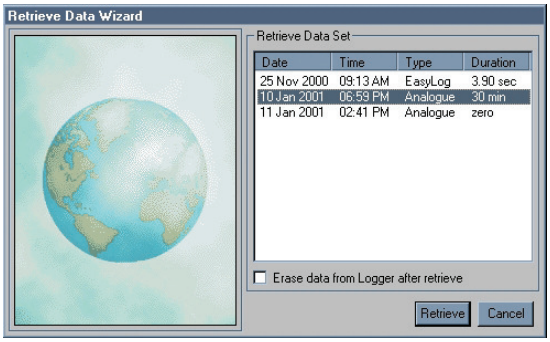
14. Wait until the EasySense has stopped collecting data.

Presenting the Data:

1. Make sure the EasySense is connected to the computer.

2. Load the Graph software.

3. From the Collect menu select “Collect remote data” to see the Retrieve Data Wizard.

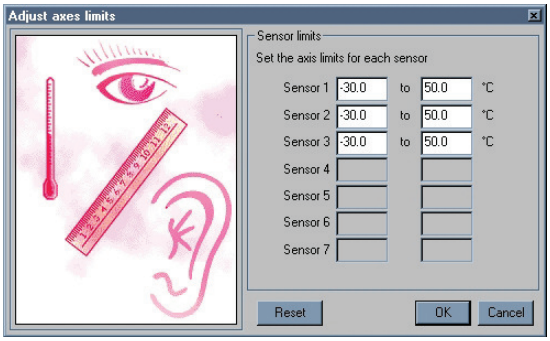


4. Select the data you just collected. Look carefully, there may be other data sets collected by other people. Click on Retrieve.

5. When the remote data has been downloaded, Graph will draw the graph.

6. From the Display button, select “Sensor axis limits …”

7. Edit the entries so all of them display (–30) for the lower number and 50 for the higher. Click on ‘OK’.



Analyzing the Data:

In the next lesson you will learn how to read the graph more accurately. Today we will settle for approximations.

1. When the equipment was ready to be placed in the freezer, Graph shows the following temperatures:

   Probe 1: _____ Probe 2: _____ Internal Sensor: _____

2. When the equipment was ready to be removed from the freezer, Graph shows the following temperatures:

   Probe 1: _____ Probe 2: _____ Internal Sensor: _____

3. At the end of the time (30 minutes), Graph shows the following temperatures:

   Probe 1: _____ Probe 2: _____ Internal Sensor: _____

4. In what way did the probes and the sensor react the same?

   _____
   _____
   _____
   _____
   _____

5. In what ways did the probes and the sensor react differently?

6. Were both probes exactly the same? Any ideas why?

7. What property of the sensor causes it to react the way it does?

Save the data by choosing "Save As…" from the File menu. Your teacher will tell you where to save the Graph file – you may need to create a new folder. **Call the file Lesson1.sid**. This data will be retrieved and used in the next lesson.

Building the Bridge:

1. In Question 4 above you are **comparing** the probes and the sensor. In Question 5 above you are **contrasting** the probes and the sensor. What is the difference between comparing and contrasting?

Weblinks:

Have a look at this site to get information about the equipment you are working with.

www.data-harvest.co.uk/science/sci_index.html

