TCI
Temperature Control Instrument
Mechatronics Department
Civil Engineering Department
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Lesson Plan

Medium: Smartboard lesson/Labsheet
Aim: What is specific heat?
Subject: Earth Science
Topic: Climate
Subtopic: Properties of water
Time: 1 Double period lab (90 minutes)

Student materials:

- Enough worksheets for each student to record data individually
- 1 or more ESRTs (Earth Science Reference Tables) per group

Station Materials:

- 1 TCI (temperature control instrument)
- 1 Stopwatch per group
- 3 tin cans (preferably 1 pint or so in size)
- Filled 1/2 way or so with water
- Filled 1/2 way or so with sand
- Filled 1/2 way or so with metal filings

Station Set-up:

Laptop with BasicStamp already installed, open and running the "TCI" program. Connected to the computer would be the TCI with the thermocouple submerged in the test material. Place heat strip on a ceramic plate. Have students place the tin can they are sampling on top of the heat strip. The tin can should not touch the table directly while hot or being heated. 24 Volt AC adapters should not be plugged in until it is time for use.

Lesson:

Slide 1:

Do Now:

"A watched pot never boils." Based on that expression what can you tell me about water?
(Expected answers: It takes a very long time to heat up.)

Why is the expression not, "A watched piece of metal does not get hot?"
(Expected answer: Metals tend to heat up much more quickly that water does.)

Slide 2: **Problem**

How long does it take various materials to heat up?

Slide 3: **Hypothesis**

There are 3 sample materials in front of you; water, sand and metal filings. Write your hypothesis as to which material will heat up the quickest.

What about the slowest. _____

Which material do you believe will cool down the fastest, and the slowest? _____

Explain the reasoning for your answers.

Slide 4: **Material Check**

Does your station look like the diagram below?

Raise your hand if you are missing any of the equipment.

Slide 5: **Procedure**

Working in your groups (of 4-5) you are going to be asked to measure the rate of heating and cooling of the materials in front of you. Using the data chart record the temperature every minute for 5 minutes. Then record the cooling rate of each material every minute for 5 minutes.

Place the sample being tested on top of your heating strip. The heating strip should have already been placed on top of the ceramic plate.

IT SHOULD NEVER LEAVE THE TOP OF THE CERAMIC PLATE!

Slide 6: **Instructions**

Run the TCI program from basicstamp. Identify your thermocouple as type 1 to start. After program is already running and specimen is in place, plug in the AC adapter for the heating strip.

Disconnect the power for heat strip after each 5 minute test interval.

You may want to have roles for each group member;

- Recorder or heating
- Materials manager
- Programmer/ Time keeper

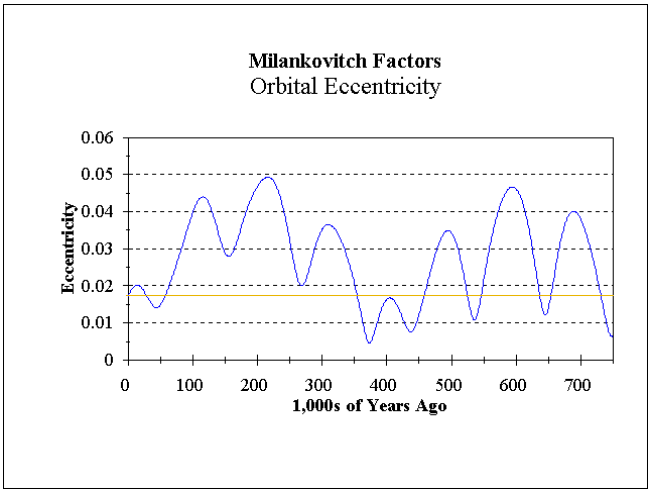
- Recorder of cooling
- (If 5th member) Facilitator

[Not on slide]- Mention to students how the equipment works. Students should not plug in the 24 Voltage AC adapters until the program is already running and the materials are in place for testing. Plugging in the heating coil too early or leaving it plugged in too long can cause injury.

Slide 7: **Graph your results!**

Make sure to include title, labeled axis, and connect data points with a solid line.

Example:



Slide 8: **conclusion**

Answer the questions at the end of the lab.

Slide 9: **Wrap-Up**

Turn in all group members labs together with individual name and group number noted.

Return all materials to original position. Turn off heating strip and program.

Name: _____
Class: _____
Group: _____

Lab: Specific Heat

Purpose

To determine the differences between the specific heats of water and some other earth materials

Background

Jumping into a pool on a hot summer day is refreshing because the water is cooler than the air around you and the ground under your feet. You may wonder why the water is cooler since the water, air, and ground are being heated by the same source—the sun. One reason is that it takes more heat to raise the temperature of some substances than others. The amount of heat required to raise the temperature of 1 g of a substance by 1 degree Celsius is called the specific heat capacity, or specific heat, of that substance. Water, for instance, has a specific heat of 4.18 J/g°C. This value is high compared to the specific heats for other materials, such as concrete or metals. In this experiment, you will compare the specific heat of water and some of the elements in the surface of the earth using a simple calorimeter.

Skills Focus

Measuring, observing, drawing conclusions, applying concepts

Roles

Identify who is doing each of the following roles;

Recorder or heating _____

Materials manager _____

Programmer/ Time keeper _____

Recorder of cooling _____

(5th) Facilitator _____

Instructions

Part I

Pick your first can (sand) and place it on the heat strip, which should be placed on your ceramic plate. Run the TCI program from BasicStamp on your laptop. When asked type in 1 into your debug command box to identify your thermocouple type in order to start. After the program is already running and specimen is in place, place the thermocouple wire into the material. (Be sure to have the wire completely covered and not touching the sides of the container. Now you may plug in the AC adapter for the heating strip. Repeat until all samples are done.

Disconnect the power for heat strip after each 5 minute heating interval.

Sand	**Heating**						
Remember to plug in the heat strip.	0 min	1 min	2 min	3 min	4 min	5 min	Rate of Change (use ESRT)
	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min
	Cooling						
Remember to unplug the Heat Strip!	6 min	7 min	8 min	9 min	10 min	Rate of Change (use ESRT)	Average temperature / 10 minutes
	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min	_____*C/min

Water	**Heating**						
Remember to plug in the heat strip.	0 min	1 min	2 min	3 min	4 min	5 min	Rate of Change (use ESRT)
	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min
	Cooling						
Remember to unplug the Heat Strip!	6 min	7 min	8 min	9 min	10 min	Rate of Change (use ESRT)	Average temperature / 10 minutes
	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min	_____*C/min

Metal Filings	**Heating**						
Remember to plug in the heat strip.	0 min	1 min	2 min	3 min	4 min	5 min	Rate of Change (use ESRT)
	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min
	Cooling						
Remember to unplug the Heat Strip!	6 min	7 min	8 min	9 min	10 min	Rate of Change (use ESRT)	Average temperature / 10 minutes
	_____*C	_____*C	_____*C	_____*C	_____*C		_____*C/min

						_____*C/min	

Part II

Make a multiline graph for each of the materials based on your data above. Make sure to include title, labeled axis, and connect data points with a solid line.

Key

Sand	
Water	
Metal	

Part III

1. **What raised in temperature the fastest? _____**

2. **Did the material that took the longest to heat also the material that took the longest to cool?**

   i. **_____**

3. **In your own words explain why it took so long for the water to raise in temperature.**

4. **Looking back at the background on page one of this hand out would you classify the following materials as having a higher or lower specific heat than water.**

   Sand - _____

   Metal Filings - _____

5. **Does water hold a lot of heat energy or a little? Explain your answer.**

6. **What material had the greatest rate of change? How does this relate to specific heat?**