

Determining Lava Temperatures

Overview:

Taking the temperature of lava is not as simple as sticking a thermometer into a flow. Thermocouples and radiometric instruments can be used, as well as an indirect method that involves taking a sample of hot lava, then quenching it rapidly in cool water. The cooled lava is taken to a lab and analyzed for magnesium oxide (MgO) content. The formula for determining the temperature of the lava is Temperature in Centigrade = $(23 \times \text{MgO}) + 1012$. The greater the concentration of magnesium oxide, the hotter the lava was.

Objectives:

The student will:

- calculate the temperature of lava from MgO content;
- make a graph comparing MgO content to temperature;
- find the temperature of lava samples using data from the Mauna Loa 1984 eruption; and
- understand the relationship between lava temperature and MgO content.

Materials:

- Calculators
- Student Worksheet: “Determining Lava Temperature”

Activity Procedure:

1. Ask students how scientists find the temperature of lava.
2. Explain there are several direct methods: electronic thermocouples can be placed directly into the lava, and radiometric instruments (which look similar to a video camera) pointing at the lava can record the temperature of the surface. Radiometric instruments often read the cooler area around the lava as well, so getting an accurate reading using this method can be difficult. Indirect measuring techniques, such as chemical analysis, also can be used to determine lava temperature. Lava contains magnesium oxide. The percentage of magnesium oxide in lava enables scientists to determine the temperature of the lava just before it was cooled.
3. Distribute calculators and the Student Worksheets: “Determining Lava Temperature.” Read and discuss the Testable Question. Ask students to complete their hypotheses then finish calculating the data for Table #1.
4. Demonstrate how to plot data on Graph #1. Ask students to complete their graphs.
5. Explain that in Data Analysis questions 3 and 4, students will calculate the temperature of real lava samples, then plot and label these samples on a graph. Demonstrate, then ask students to complete their Student Worksheets.
6. Discuss student conclusions.

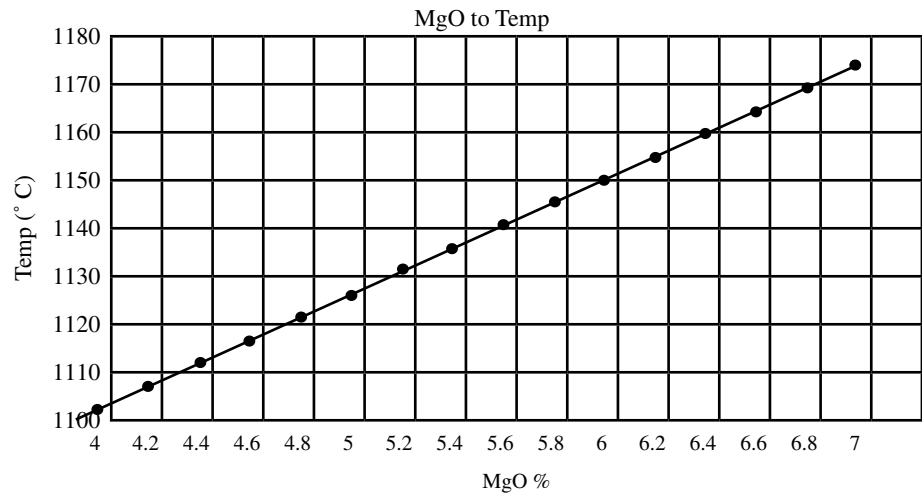
Determining Lava Temperature

Answers to Student Worksheet:

Data Table 1:

MgO%	Temp. (° C)
4	1104
4.2	1108.6
4.4	1113.2
4.6	1117.8
4.8	1122.4
5	1127
5.2	1131.6
5.4	1136.2
5.6	1140.8
5.8	1145.4
6	1150
6.2	1154.6
6.4	1159.2
6.6	1163.8
6.8	1168.4
7	1173

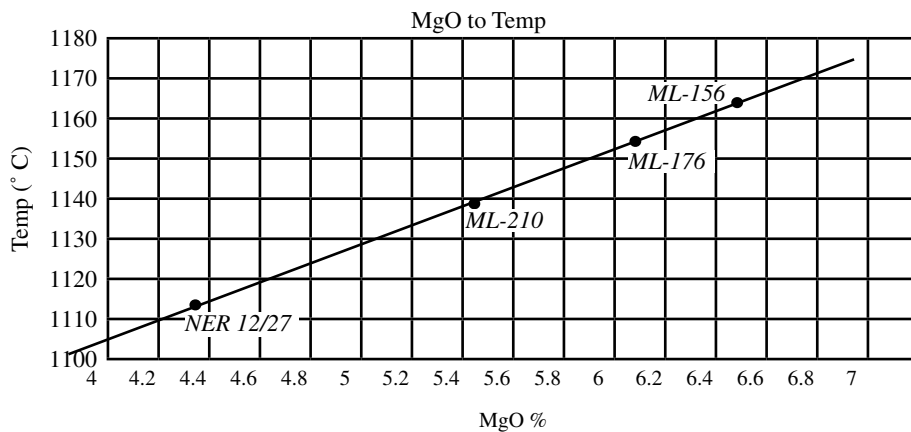
Analysis of Data #1:



Analysis of Data #2:

Sample	Date	Distance (km)	MgO %	Temperature (° C)
ML-156	3/25/84	0.0	6.57	1163.11
ML-176	3/25/84	8.76	6.17	1153.91
NER-12/27	3/30/84	14	4.42	1113.66
ML-210	4/15/84	21.63	5.48	1138.04

Analysis of Data #3:



Analysis of Data #4:

MgO content
 4.1% = ~1106° C
 5.9% = ~1148° C

Conclusion:

Answers will vary but should indicate: as MgO content rises, temperature rises; as MgO content falls, temperature falls.

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Testable Question:

How is lava temperature related to the amount of Magnesium Oxide (MgO) found in the lava?

Background Information:

Taking the temperature of lava is not as simple as sticking a thermometer into hot lava. Thermocouples and radiometric instruments can be used, as well as an indirect method that involves taking a sample of hot lava then quenching it rapidly in cool water. The cooled lava is taken to a lab and analyzed for its magnesium oxide (MgO) content. Scientists apply a math formula to the percentage of MgO to determine the temperature of the lava. In this activity you will determine the temperature of several lava samples taken from the 1984 Mauna Loa eruption.

Hypothesis:

How is the temperature of lava related to the amount of Magnesium Oxide found in the lava? Write your hypothesis as an if-then statement on the lines below.

If _____,
then _____.

Data:

- Table #1 compares the percentage of MgO (magnesium oxide) to the temperature of lava. Some of the temperatures are missing. Use the formula below to complete the table.

$$(23 \times \text{MgO}\%) + 1012 = \text{Temperature } (^{\circ}\text{C})$$

Example: *To find the temperature of a sample that had 5% MgO:*

$$T = (23 \times 5) + 1012$$

$$T = 115 + 1012$$

$$T = 1127^{\circ}\text{C}$$

Table #1:

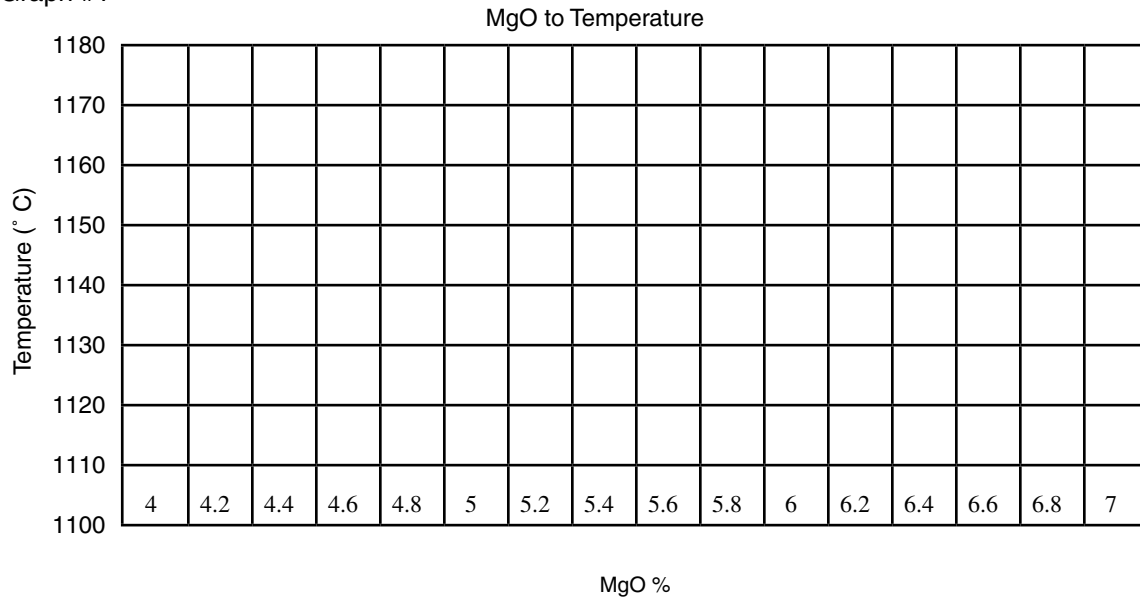
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6.2	1154.6
6.4	
6.6	
6.8	1168.4
7	1173

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Analysis of Data:

- Using the data from Table #1, make a graph comparing the percentage of MgO to Temp.

Graph #1



- Below is data taken from the 1984 eruption of Mauna Loa. The sample number, date, distance from the vent the sample was taken, and percentage of MgO are given. For each of the samples calculate the temperature of the lava when the sample was taken. Use the formula: $\text{Temperature } (^{\circ}\text{C}) = (23 \times \text{MgO}\%) + 1012$.

Table #2:

Sample	Date	Distance (km)	MgO %	Temperature (° C)
ML-156	3/25/84	0.0	6.57	
ML-176	3/25/84	8.76	6.17	
NER-12/27	3/30/84	14	4.42	
ML-210	4/15/84	21.63	5.48	

- When you complete the table above with the temperature for each sample, plot the samples on Graph #1. Be sure to label each point on the graph with the sample number given.
- Using the graph, estimate the temperature of the lava if the MgO content was:
 4.1% _____ 5.9% _____

Name: _____

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Conclusion:

Write your conclusion as a complete sentence on the lines below.

Was your hypothesis proved or disproved? Explain your answer.
