Data Analysis Investigation 9-A

Materials

• calculator

Math Skills

Go to **Math Skills Toolkit 3** for information about how to organize your data into a graph

Understanding Ice-Core Data

As you learned in Section 9.1, the relative amounts of isotopes of oxygen and hydrogen in ice can indicate global temperature in the past. In this investigation, you will investigate how the composition of ice can provide scientists with data about ancient temperatures.

Question

How can analyzing data about oxygen isotopes in ice provide information about past climate?

Organize the Data

Follow these steps to learn how scientists convert information about oxygen isotopes into information about temperature.

1. Construct a graph. Label the x-axis "Time (years before present)," and use the range of 0 years to 20 000 years, with an interval of 2000 years. Label the y-axis "$^{18}O:^{16}O$ Ratio (parts per thousand)," and use the range of –30 to –45, with an interval of 1. Title the graph "Changes in $^{18}O:^{16}O$ Ratio Over Time."

2. The data in the table below show the ratio of ^{18}O to ^{16}O at eleven points in time. Plot these data on your graph.

**Changes in the Oxygen-18 to Oxygen-16 Ratio in Ice Cores from 0 to 20 000 Years Ago**

Time (years before present)	Ratio of $^{18}O:^{16}O$ (parts per thousand)	Time (years before present)	Ratio of $^{18}O:^{16}O$ (parts per thousand)
0	-35.19	12 000	-41.38
2000	-35.03	14 000	-39.71
4000	-35.07	16 000	-42.18
6000	-34.96	18 000	-41.69
8000	-34.13	20 000	-43.87
10 000	-35.29		

3. **a.** What was the average ratio of $^{18}O:^{16}O$ over the last 20 000 years?

   b. Identify years in which the ratio of $^{18}O:^{16}O$ was above average and the ratio was below average.

   c. Compare your graph to the graph of global average temperature below. Does an above-average ratio of $^{18}O:^{16}O$ represent a warmer-than-average global temperature or cooler-than-average global temperature? (**Hint:** remember that you are working with negative numbers.)

Analyze and Interpret

Now that you have seen how scientists use $^{18}O:^{16}O$ ratios to identify warm and cold periods, use that information to evaluate the graphs on this page.

1. How many warm periods and how many cold periods occurred between 0 and 20 000 years ago?

2. How has the average global temperature changed since about 20 000 years ago?

Changes in Global Average Temperature, 20 000 years ago to Present
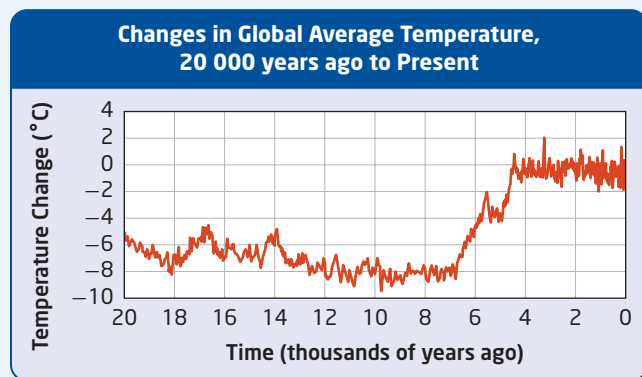
3. How closely does the plot of carbon dioxide concentration resemble that of methane concentration? of temperature? Describe any patterns you see.

Carbon Dioxide Concentration in Ice Cores, 20 000 years ago to Present

Methane Concentration in Ice Cores, 20 000 years ago to Present
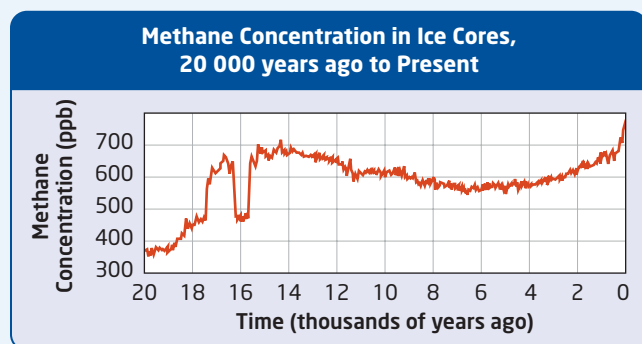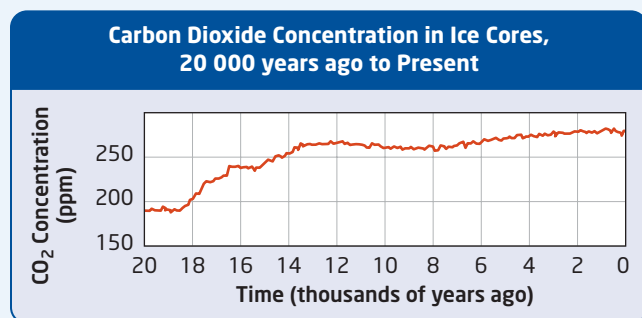
4. The atmospheric carbon dioxide concentration in 2009 was 388 ppm, and the concentration of methane was 1745 ppb. Calculate the rate of change in carbon dioxide and methane concentrations over the last 20 000 years.

Conclude and Communicate

5. How do the ice-core data support the idea that changing concentrations of greenhouse gases are related to global temperature?

6. How accurate do you think the concentrations of oxygen isotopes, methane, and carbon dioxide in ice cores are as a record of temperature? Explain your answer.

7. Create a flowchart that demonstrates how changes in global temperature can be recorded in ice layers.

Extend Your Inquiry and Research Skills

8. Inquiry Design a model that shows how scientists use oxygen isotopes to learn about past climates.

9. Research The current average temperature at Vostok, Antarctica, is –60°C. Research the estimated temperature of Vostok 20 000 years ago based on ice-core and sediment-core data. Is Vostok colder or warmer today than it was 20 000 years ago?

Real World Investigation 9-B

Skill Check

Initiating and Planning

Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Materials

- calculator

Evaluating the "Food Miles" Initiative

A study in the United Kingdom called the "Food Miles" Initiative gathered information about the CO_2 emissions associated with food choices. Use the data to investigate the validity of the slogan "think globally, buy locally."

Question

Are locally-grown items or transported items better for the environment?

Organize the Data

1. Imagine that you are shopping in a supermarket in the United Kingdom. You have four items on your shopping list: apples, onions, tomatoes, and lamb. You want to choose the more environmentally friendly option.

2. Calculate the total carbon footprint of each item in the table below.

Analyze and Interpret

1. Compare the carbon footprint of each item by source. To lower your carbon footprint, which source would you choose for each?

2. What might account for the difference in the emissions related to produce from tropical and temperate sources?

Conclude and Communicate

3. What would you say to advocates of the "think globally, buy locally" initiative about purchasing food from distant sources?

Extend Your Inquiry and Research Skills

4. **Research** Research other information that would help you choose between the different sources of grocery items.

Comparison of Carbon Emissions for Production, Storage, and Transport of Grocery Items in a United Kingdom Supermarket

Food	Source	CO₂ Emissions During Production (kg CO₂/tonne product)	CO₂ Emissions from Storage and/or Transport (kg CO₂/tonne product)
Apples	New Zealand	60.1	124.9
	United Kingdom	186.0	85.8
Onions	New Zealand	58.9	125.6
	United Kingdom	42.3	127.8
Tomatoes	Spain	519.0	111.0
	United Kingdom	2394.0	0.0
Lamb	New Zealand	563.2	129.4
	United Kingdom	2894.1	0.0