Elementary Science with Vernier

Measure. Analyze. Learn.™

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HANDS-ON ACTIVITIES

How do Mittens Keep You Warm (Chromebook and GA4)
- Go Direct Temperature Sensor

Learning to Use Go! Motion (Chromebook and GA4)
- Go!Motion Motion Detector

Get a Grip! (Chromebook and LabQuest 2)
- Go Direct Gas Pressure Sensor

Exploring the Poles (LabQuest 2)
- Go Direct 3-Axis Magnetic Field Sensor

How Do Mittens Keep You Warm?

Do you have a favorite pair of mittens or gloves? Even if you do not live in a cold place, it is possible that you have been somewhere cold or will go to a cold place when you are older. When you wear mittens or gloves to keep you warm, where do you think the warmth comes from? In this experiment, you are going to find the source of the heat.

OBJECTIVES

- Find the temperature of the classroom and the temperature of your hand.
- Try to predict temperature changes that happen when the Temperature Probe is placed in various locations.
- Test how warm mittens help your hands stay warm.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis 4 app
Go Direct Temperature
mitten

KEY QUESTION

Do mittens make heat or hold heat in?

HYPOTHESIS

Choose one of the following by checking the box in front of the statement that you think is right.

□ 1. Mittens make their own heat.

□ 2. Mittens hold heat in.

Why do you think so?

_____

_____

_____

PROCEDURE

1. Get the equipment ready for data collection:

   a. Launch Graphical Analysis.

   b. Connect the Temperature Probe to your Chromebook, computer, or mobile device.

   c. Put the Temperature Probe on the desk and don't touch it until you are told to do so later on.

2. Click or tap Mode to open Data Collection Settings. Set End Collection to 60 s. Click or tap Done.

3. Do the following to find the temperature of the classroom:

   a. Make sure the Temperature Probe is lying on the desk and hasn't been touched by anyone. If it has been lying there for a few minutes, it will be the temperature of the room.

   b. Look at the meter and write down the temperature as the Room temperature in the Data Table.

Data Table		Room temperature _____ °C	
	Prediction (°C)	Maximum temperature (°C)	Was your prediction high or low?
Open hand			
Empty mitten			
Open hand in mitten			

4. Make a prediction:

   a. Think about what will happen to the temperature on the screen if you hold the probe across the palm of your open hand during data collection. Think about your body temperature compared to the room temperature.

   b. Guess how high the temperature will be at the end of data collection and write down your prediction in the Data Table.

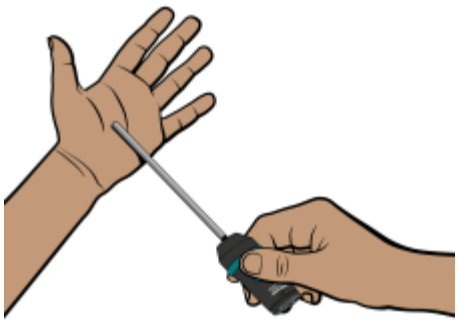

Figure 1

5. Now, collect data for the temperature of your open palm:

   a. Make sure the temperature values on the meter are very close to the value you recorded as the room temperature in your Data Table in Step 3.

   b. Click or tap Collect to start data collection.

   c. Place the tip of the metal part of the probe in the middle of your open palm, holding it by the black end with your other hand. **Important**: The tip of the probe should be gently touching your palm. Don't close your fingers over the metal part.

   d. Hold the probe in the correct position during data collection.

6. Do the following to find the maximum temperature of your open palm:

   a. Click or tap View, , and choose Graph and Table.

   b. Look through the data table on the screen and find the maximum (largest) temperature value.

   c. Record this value in the correct place on the Data Table.

7. After you have finished finding the temperature of your open palm, place the Temperature Probe on your table and allow it to sit there without being touched. This way, the probe will cool down to the temperature of the room. While it cools, continue with the next step.

8. During this part of the experiment, you will place the Temperature Probe inside the mitten so you can measure the temperature inside the mitten. You will not have a hand inside the mitten, just the Temperature Probe.

   a. Think about what will happen to the temperature inside a mitten while it is sitting on the desk. The Temperature Probe will be inside the mitten but your hand will not be.

   b. Now, guess how high the temperature will be at the end of data collection and write down your prediction in the Data Table.

   c. Without touching the Temperature Probe, look at the temperature values in the digital meter on the screen. Make sure the temperature is very close to the value you recorded as

the room temperature in your Data Table in Step 4. If the temperature is not very close, wait until it is.

d. Place the mitten on the table and slip the Temperature Probe into the mitten. Make sure you do not touch the metal part of the probe.

e. Click or tap Collect to start data collection. **Note**: The first data set is automatically saved.

f. When data collection is done, look through the data table on the screen.

g. Find the maximum (largest) temperature value for the Latest data. Record this value in the correct place on the Data Table.

h. Place the Temperature Probe on the table and allow it to sit there without being touched.

9. During this part of the experiment, you will measure the temperature of your hand inside the mitten.

a. Think about what will happen to the temperature of your hand inside the mitten.

b. Now, make a prediction about how high the temperature will be at the end of data collection and write down your prediction in the Data Table.

c. Without touching the Temperature Probe, look at the temperature values in the digital meter on the screen. Make sure the temperature is very close to the value you recorded as the room temperature in your Data Table in Step 3.

d. Place the mitten on your hand and slip the Temperature Probe into the mitten (see Figure 2). Position the tip of the probe in the middle of your palm. Leave your hand open during data collection, do not close your fist.

e. Start data collection.

f. When data collection is done, look through the data table on the screen.

g. Find the maximum (largest) temperature value for the Latest data. Record this value in the correct place on the Data Table.

Figure 2

ANALYZE YOUR DATA

1. What is the source of heat in this experiment?

2. If the mitten does not produce heat on its own, then how do mittens keep your hands warm?

3. Thinking about the previous question, explain the difference between heat production and heat retention.

Learning to Use a Motion Detector

You can use a Motion Detector to measure the position of objects as they move. In this activity, you will learn how to use a Motion Detector.

OBJECTIVES

- Learn to use a Motion Detector.
- Measure the distance between a book and the Motion Detector.
- Match a shape by moving a book up and down above a Motion Detector.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis 4 app
Vernier data-collection interface
Motion Detector
book

PROCEDURE

Part I Learn about the Motion Detector

1. Do the following to set up the Motion Detector for data collection:

   a. The detector (gold circle) is located on the part of the Motion Detector called the "head." Rotate the head open as shown in Figure 1.

   b. Locate the switch under the head and set it to the Ball/Walk position (see Figure 2).

   c. Rotate the head back down.

   d. Connect the Motion Detector to the data-collection interface, and then connect the interface to your Chromebook, computer, or mobile device.

   e. Launch Graphical Analysis.

   f. Click or tap View, , and choose 1 Graph. This will display a graph of position *vs*. time.

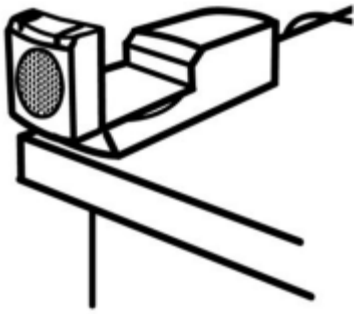

Figure 1

Figure 2

2. Collect data:

   a. Put the Motion Detector on a table or chair with the detector facing up towards the ceiling (see Figure 3). Make sure there is nothing in the path of the signal coming out of the detector. **Note**: When you are done collecting data, you will record your observation by answering a few questions. You can look at the Observations Sheet in the next step to see the questions you will answer.

   b. Have one person stand holding a book about 0.5 meters above the Motion Detector.

   c. Look at the screen and click or tap Collect to start data collection.

   d. Slowly move the book straight upwards and watch what happens on the graph on the screen.

   e. Now slowly move the book down toward the sensor, but don't get closer than about 15 cm. Watch to see what happens when you move closer to the Motion Detector.

   f. Now, move the book upwards very quickly and watch what happens.

   g. Data collection will stop after 5 seconds.

   h. You can try it again by starting data collection again.

Figure 3

3. Use your experiences in Step 2 to complete the statements in the Observations Sheet.

Observations Sheet
1. When I slowly move the book up and away from Motion Detector, _____ _____
2. When I slowly move the book down and towards the Motion Detector, _____ _____
3. When I lift the book up very quickly the graph is different than when I move it slowly because _____ _____

Part II Make a snake with the Motion Detector

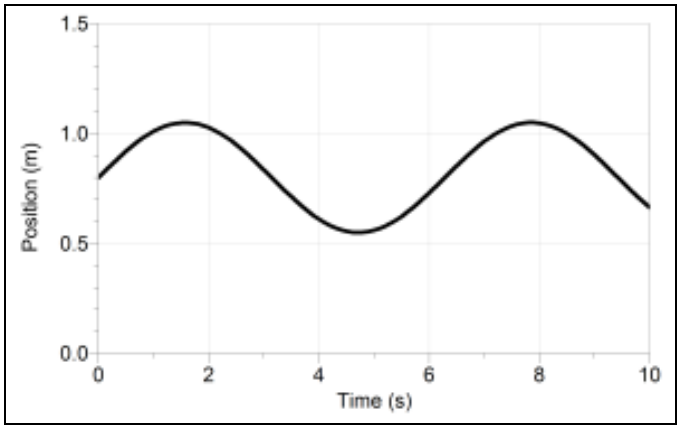

Figure 4

4. In this part of the activity, you will match the shape of the snake. An example of what this might look like is shown in Figure 4. Before you start, think about what happened when you moved the book in front of the Motion Detector. Fill in the blanks as a plan for matching the shape on the Graph.

   a. Start with the book _____ meters above the Motion Detector.

   b. Move the book _____ (up or down) so that the book is about _____ meters above the Motion Detector.

c. Move the book _____ (up or down) until it is about _____ meters above the Motion Detector.

d. Move the book _____ (up or down) until it is about _____ meters above the Motion Detector.

e. Move the book _____ (up or down) until it is about _____ meters above the Motion Detector.

5. Click or tap Collect to start data collection, then follow the plan you wrote in Step 4, trying to match the snake.

6. If the data you collected matches the snake shape on the screen, congratulations! If you want to try to match the snake again, just start data collection and repeat the plan you wrote in Step 4.

Get a Grip!

In this experiment, you will measure your grip strength. You will see if your grip strength changes as you grip an object for a longer time. You will also compare your grip strength with your classmates.

OBJECTIVES

- Use a computer and a Pressure Sensor to measure your grip strength.
- See which of your hands has the greater grip strength.
- Learn what happens to your grip strength as time goes by.
- Compare your grip strength with your classmates.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis 4 app
Go Direct Gas Pressure Sensor
plastic bottle
plastic tubing and stopper assembly

PROCEDURE

1. Assemble your equipment as shown in Figure 1.

Figure 1

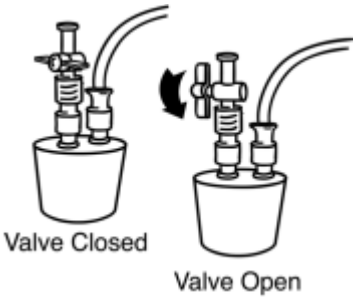

Figure 2

2. Make sure the valve is in the closed position as shown in Figure 2.

3. Launch Graphical Analysis. Connect the Pressure Sensor to your Chromebook, computer, or mobile device.

4. Click or tap Mode to open Data Collection Settings. Set End Collection to 60 s. Click or tap Done.

5. Each person in the group will have a chance to test their griping strength. Decide who will go first.

6. When it is your turn, collect data for your right hand first:

   a. Pick up the bottle with your right hand and begin squeezing as hard as you can.
   b. Have a teammate click or tap Collect to start data collection.
   c. Keep gripping as hard as you can until data collection stops. Do not lean your hand or arm on anything!

7. To find out your average pressure for the time period that you were gripping the bottle, do the following:

   a. Click or tap Graph Tools, , and choose View Statistics.
   b. If this was your turn to squeeze the bottle, record the average (mean) pressure for the 60-second period in Table 1.

Table 1	
	0–60 s average pressure (kPa)
My right hand	
My left hand	

8. Now collect data on your left hand by doing the following:

   a. Pick up the bottle with your left hand and begin squeezing as hard as you can.
   b. Have a teammate start data collection.
   c. Keep gripping as hard as you can, but do not lean your hand or arm on anything!

9. Do the following to find out the average pressure for your data:

   a. Click or tap Graph Tools, , and choose View Statistics.
   b. If this was your turn to squeeze the bottle, record the average (mean) pressure for the 60-second period in Table 1.

10. Repeat Steps 6–9 for each person in your group. **Note**: The previous data set is automatically saved each time you click or tap Collect.

ANALYZE YOUR DATA

1. What happened to your gripping strength during the 60 seconds that data were collected?

2. Which of your hands is stronger? Use your data to explain your decision.

3. Do you use your stronger hand to write or do other things? Give examples of what you think you could do to make your weaker hand as strong as your strong hand.

4. What did you learn about your strength in this experiment? Were you surprised?

5. In Table 2, record the 0–60 s results for the strong hand of the other students in your group. Calculate and record your group average. Calculate and record the class average for 0–60 s.

Table 2: Group and Class Results	
Name	Strong hand average for 0–60 seconds (kPa)
Group average (Group mean sum ÷ number of group members)	
Class average	

6. How does your grip compare with the class average?

_____

_____

Get a Grip!

In this experiment, you will measure your grip strength. You will see if your grip strength changes as you grip an object for a longer time. You will also compare your grip strength with your classmates.

OBJECTIVES

- Use a computer and a Pressure Sensor to measure your grip strength.
- See which of your hands has the greater grip strength.
- Learn what happens to your grip strength as time goes by.
- Compare your grip strength with your classmates.

MATERIALS

LabQuest
Vernier Gas Pressure Sensor
plastic bottle
plastic tubing and stopper assembly

PROCEDURE

1. Assemble your equipment as shown in Figure 1.

Figure 1

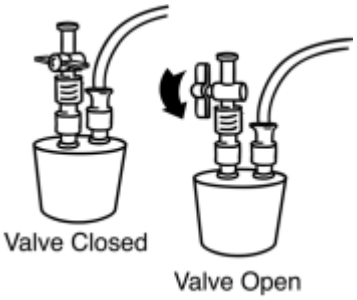

Figure 2

2. Make sure the valve is in the closed position as shown in Figure 2.

3. Make sure the Pressure Sensor is connected to LabQuest.

4. Choose New from the File menu.

5. On the Meter screen, tap Duration. Change the data-collection duration to 60 seconds. Select OK.

6. Each person in the group will have a chance to test their griping strength. Decide who will go first.

7. When it is your turn, collect data for your right hand first:

   a. Pick up the bottle with your right hand and begin squeezing as hard as you can.
   b. Have a teammate start data collection.
   c. Keep gripping as hard as you can until data collection stops. Do not lean your hand or arm on anything!

8. Find the average pressure for the time period that you were gripping the bottle:

   a. Choose Statistics from the Analyze menu.
   b. If this was your turn to squeeze the bottle, record the average (mean) pressure for the 60-second period in Table 1.

Table 1	
	0–60 s average pressure (kPa)
My right hand	
My left hand	

9. Tap the File Cabinet icon to store your data.

10. Now collect data for your left hand:

    a. Pick up the bottle with your left hand and begin squeezing as hard as you can.
    b. Have a teammate start data collection.
    c. Keep gripping as hard as you can, but do not lean your hand or arm on anything!

11. Find the average pressure for your data:

    a. Choose Statistics from the Analyze menu.
    b. If this was your turn to squeeze the bottle, record the average (mean) pressure for the 60-second period in Table 1.

12. Repeat Steps 7–11 for each person in your group.

ANALYZE YOUR DATA

1. What happened to your gripping strength during the 60 seconds that data were collected?

2. Which of your hands is stronger? Use your data to explain your decision.

3. Do you use your stronger hand to write or do other things? Give examples of what you think you could do to make your weaker hand as strong as your strong hand.

4. What did you learn about your strength in this experiment? Were you surprised?

5. In Table 2, record the 0–60 s results for the strong hand of the other students in your group. Calculate and record your group average. Calculate and record the class average for 0–60 s.

Table 2: Group and Class Results	
Name	Strong hand average for 0–60 seconds (kPa)
Group average (Group mean sum ÷ number of group members)	
Class average	

6. How does your grip compare with the class average?

_____

_____

Exploring the Poles (Without Leaving Your Classroom!)

Magnets have north and south poles. Do you think that the poles of differently shaped magnets are in different places? In this activity, you will use the Magnetic Field Sensor to find the poles of various magnets, make diagrams of them, and then see how the poles of one magnet make it behave with the poles of another magnet.

OBJECTIVES

- Make observations about the poles of differently shaped magnets.
- Diagram the position of the poles of differently shaped magnets.
- Draw conclusions about the poles of magnets.

MATERIALS

LabQuest
Vernier Magnetic Field Sensor
several differently shaped magnets (bar, disk, horseshoe, cow magnet, etc.)
paper and markers or crayons
small stickers

PROCEDURE

Part I Make a Map of Your Magnets

1. Set up the Magnetic Field Sensor for data collection:

   a. Set the switch on the Magnetic Field Sensor to the 6.4 mT setting.

   b. Make sure the Magnetic Field Sensor is connected to LabQuest.

   c. Choose New from the File menu.

   d. Bend the tip of the Magnetic Field Sensor so that it looks like the picture in Figure 1. Find the white dot near the end of the Magnetic Field Sensor. This is the part of the sensor that senses the magnetic field.

Exploring the Poles (Without Leaving Your Classroom)

Figure 1

2. Find the north and south poles of one of your magnets:

   a. Choose one of the magnets and trace its outline on a piece of paper.

   b. Place the Magnetic Field Sensor on the table with the white dot facing up towards the ceiling. Tape the sensor in place.

   c. Slowly move the magnet over the sensor as you watch the live reading on the screen. If you see a minus sign (–) in front of the number, mark that place on your picture of the magnet with an "N," for north. If the number you see has no minus, mark an "S," for south on your picture.

   positive number = south pole

   negative number = north pole

   d. Put a sticker with an "S" on the south pole of the magnet and a sticker with an "N" on the north of the magnet.

3. Repeat Step 2 to find the north and south poles on your other magnets.

4. Record your observations on the Observations Sheet.

Observations Sheet

Part II Find How the Poles Interact

5. Find out how the poles of the different magnets interact with each other.

   a. Choose two of your magnets. Find the north pole of one magnet, and put it right next to the south pole of the other magnet. Write down what happens in the Data Table.

   b. Now put the north pole of the first magnet near the north pole of the other magnet. Write down what happens in the Data Table.

Data Table	
Position of the Magnets	What Happens
North near South	
North near North	
South near South	

Prediction

Write what you think will happen if you put the south pole of one magnet near the south pole of another magnet.

I think the south poles of the two magnets will

_____

6. Now test your prediction. Write down what happens in the Data Table.

ANALYZE YOUR DATA

1. Write down what you have learned about magnets.

_____

_____

_____

2. Look at the different diagrams you made. Choose two of your magnets and tell about their shapes and where their poles are.

_____

_____

_____

3. Write a sentence that tells how the poles of magnets behave when the same (or like) poles are pushed together and when opposite (or different) poles are pushed together.

_____

_____

_____