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Inspire Meaningful Engagement with Hands-On Learning in the Middle School Classroom

Experiments

A Hot Hand

- Go Direct Temperature Probe

Reflectivity of Light

- Go Direct Light and Color Sensor

Friction

- Go Direct Force and Acceleration Sensor

Get a Grip

- Go Direct Gas Pressure Sensor

Workshop Presenters

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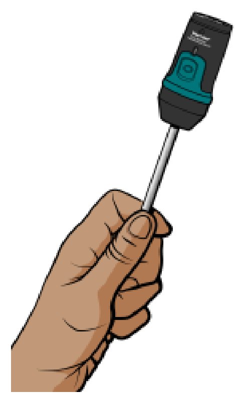
A Hot Hand

You will measure the temperature of the palm of your hand and the palm temperatures of your teammates in this experiment. In the process, you will learn how to use the data-collection equipment you will be using throughout the school year. You will also get to know your teammates better.

OBJECTIVES

- Use a temperature probe to measure temperature.
- Calculate temperature averages.
- Compare results.



MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct Temperature
beaker
water
paper towel

PROCEDURE

1. Launch Graphical Analysis. Connect the Temperature Probe to your Chromebook, computer, or mobile device.

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

3. Measure the temperature of the palm of your hand.

   a. Click or tap Collect to start data collection.

   b. Pick up the Temperature Probe and hold its tip in the palm of your hand as shown in Figure 1. Data collection will end when 60 seconds have gone by.

4. Record your highest temperature.

   a. When data collection is complete, a graph of temperature *vs*. time will be displayed. To examine the data pairs on the displayed graph, click or tap any data point. As you tap each data point, the time and temperature values of the point are displayed. **Note**: You can also adjust the Examine line by dragging the line.

   b. Record your highest temperature.

5. Prepare the Temperature Probe for the next run.

    a. Cool the Temperature Probe by placing it into a beaker of room-temperature water until its temperature reaches the temperature of the water. The temperature of the probe is displayed in a meter on the screen.

    b. Use a paper towel to dry the probe. Be careful not to warm the probe as you dry it.

6. Repeat Steps 3–5 for each person in your group.

DATA

Student name	Maximum temperature (°C)
Group average	

PROCESSING THE DATA

1. Calculate the group average for the highest temperatures. Record the result in the data table.
2. How did the maximum temperature for each person compare?
3. Who had the "hottest hand"?

EXTENSION

Determine the class average for maximum temperature.

Reflectivity of Light

Light is reflected differently from various surfaces and colors. In this experiment, you will be measuring the percent reflectivity of various colors. You will measure reflection values from paper of the various colors using a Light Sensor and then compare these values to the reflection value of aluminum foil. You will then calculate percent reflectivity using the relationship

$$\% \text{ reflectivity} = \frac{\text{value for paper}}{\text{value for aluminum}} \times 100$$

OBJECTIVES

- Use a Light Sensor to measure reflected light.
- Calculate percent reflectivity of various colors.
- Make conclusions using the results of the experiment.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct Light and Color
white paper
black paper
aluminum foil
2 other pieces of colored paper
ring stand
utility clamp

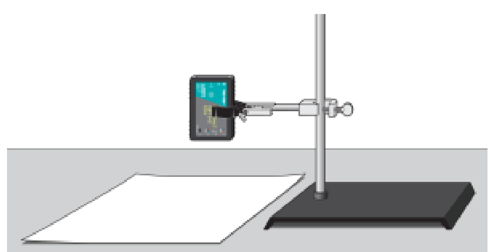


Figure 1

PROCEDURE

1. Launch Graphical Analysis. Connect the Light Sensor to your Chromebook, computer, or mobile device.

2. Click or tap View, ⊞, turn on Meters, and turn off Graph. Then, dismiss the View menu.

3. Use a utility clamp and ring stand to fasten a Light Sensor 5 cm from and perpendicular to the surface of the table (see Figure 1). The classroom lights should be on.

4. Position a piece of aluminum foil under the Light Sensor.

5. When the reading stabilizes, record the reflected light value (in lux). Lux is the SI unit for brightness of light (which is called illuminance).

6. Obtain pieces of white paper and black paper. Repeat Steps 4–5.

7. Obtain two other pieces of paper of other colors. Repeat Steps 4–5. When you record light values, record the color of the paper as well.

8. Before closing Graphical Analysis, continue to the Processing the Data section.

DATA

Color	Reflection value	Percent reflectivity
Aluminum		100%
Black		
White		
________________		
________________		

PROCESSING THE DATA

1. Calculate the percent reflectivity of each color using the formula given in the introduction. Show your work in the data table.

2. Which color, other than aluminum, has the highest reflectivity?

3. Which color has the lowest reflectivity?

4. What surfaces might give a planet a high reflectivity? Explain.

5. Does the planet Earth have high reflectivity? Why or why not?

EXTENSIONS

1. Design an experiment to test the reflectivity of sand, soil, water, and other materials. Perform the experiment you designed.

2. Design an experiment to determine if there is a relationship between reflected light and heat absorbed by various colors or materials. Perform the experiment you designed.

Friction

(Force Sensor)

Friction is a force that resists motion. It involves objects in contact with each other, and it can be either useful or harmful. Friction helps when you want to slow or stop a bicycle, but it is harmful when it causes wear on the parts of a machine. In this activity, you will study the effects of surface smoothness and the nature of materials in contact on sliding friction. You will use a Force Sensor to measure frictional force, in Newtons (N), as you pull a block across different surfaces.

OBJECTIVES

- Measure sliding friction.
- Measure friction between a wooden block and smooth-surface wood.
- Measure friction between a wooden block and rough-surface wood.
- Make predictions about other surfaces.
- Test your predictions.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct Force and Acceleration
wooden block (with a hook)
paper clip
wood with smooth surface
wood with rough surface
sandpaper

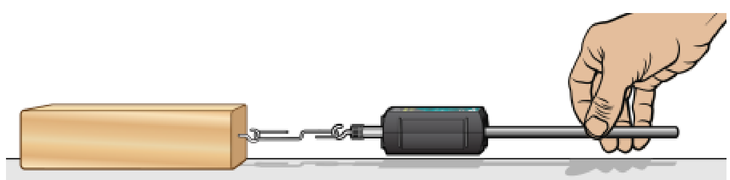


Figure 1

PROCEDURE

Part I Smooth and Rough Surfaces

1. Launch Graphical Analysis. Connect the Force Sensor to your Chromebook, computer, or mobile device.

2. Click or tap Mode to open Data Collection Settings. Change End Collection to 3 s. Click or tap Done.

3. Zero the Force Sensor.

   a. Lay the Force Sensor on the tabletop in the position shown in Figure 1.

   b. When the readings on the screen stabilize, click or tap the Force meter and choose Zero. When the process is complete, the readings for the sensor should be close to zero.

4. Get a wooden block (with a hook on one end). Partly straighten a paper clip—leaving a hook at each end. Use the paper clip to attach the wooden block to the Force Sensor.

5. Slowly pull the wooden block across a piece of wood with a smooth surface. Hold the Force Sensor by its handle and pull it toward you, as demonstrated by your teacher. The Force Sensor should be held parallel to and about 1 cm above the surface. Once the wooden block is moving at a steady rate, click or tap Collect to start data collection.

6. Determine and record the force used to pull the block.

   a. After data collection stops, click or tap Graph Tools, , and choose View Statistics.

   b. Record the mean (average) force (in N).

7. Repeat Steps 5–6 as you pull the block over a piece of wood with a rough surface.

Part II Predicting Friction

8. You will measure friction as the block is pulled across your desktop, the floor, and sandpaper. In the space provided in the data table below, predict the order of friction for these surfaces—from lowest to highest.

9. Repeat Steps 5–6 for each of the surfaces.

DATA

Part I Smooth and rough surfaces		
Surface	Smooth wood	Rough wood
Force (N)		

Part II Predicting friction		
Predicted order of values for desktop, floor, and sandpaper		
(Lowest)		(Highest)

Surface	Desktop	Floor	Sandpaper
Force (N)			

PROCESSING THE DATA

1. What is the effect of surface roughness on friction?
2. How did you decide the order of your predictions in Part II?
3. How good were your predictions? Explain.
4. Give two examples of situations where friction is helpful.
5. Give two examples of situations where it is best to reduce friction.
6. Summarize the results of this experiment.

EXTENSIONS

1. Test the friction of other surfaces, such as glass, metals, rubber, and different fabrics.
2. Investigate how frictional force varies with contact area and mass.
3. Design an experiment to test methods of reducing friction.

Get a Grip!

In this experiment, you will measure your gripping power. You will see if your gripping power changes as you grip an object over a period of time. You will also compare your gripping power with your classmates.

OBJECTIVES

- Use a gas pressure sensor to measure your gripping power.
- See which of your hands has the greater gripping power.
- Learn what happens to your gripping power as time goes by.
- Compare your gripping power with your classmates.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct Gas Pressure
equipment for your setup:
  plastic tubing and bulb assembly
  or
  plastic bottle and plastic tubing with stopper assembly

PROCEDURE

1. Connect the bulb to the Gas Pressure Sensor as shown in Figure 1. If you are using a plastic bottle, see Figure 2.
2. Launch Graphical Analysis. Connect the Gas Pressure Sensor to your Chromebook, computer, or mobile device.
3. Click or tap Mode to open Data Collection Settings. Change End Collection to 60 s. Click or tap Done.
4. Grip the bulb or bottle as hard as you can with one hand, then click or tap Collect to start data collection. Keep gripping as hard as you can until data collection ends. **Note**: Do not lean your hand or arm on anything.
5. Determine and record your 0–60 s grip average.
   a. Click or tap Graph Tools, , and choose View Statistics.
   b. Record the mean (average) pressure (in kPa) for the 60 second period in Table 1.
   c. Dismiss the Statistics box.

6. Determine and record your 0–10 s grip average.
   a. Select the first 10 seconds of data.
   b. Click or tap Graph Tools, ⩘, and choose View Statistics.
   c. Record the mean (average) pressure (in kPa) for the 0–10 second period in Table 1.
   d. Dismiss the Statistics box.
7. Determine and record your 50–60 s grip average.
   a. Select the last 10 seconds of data (from 50 to 60 seconds).
   b. Click or tap Graph Tools, ⩘, and choose View Statistics.
   c. Record the mean (average) pressure (in kPa) for the 50–60 second period in Table 1.
   d. Dismiss the Statistics box.
8. Repeat Steps 4–7 using your other hand. **Note**: The previous data set is automatically saved.

DATA

Table 1: Your Results		
	Left hand	Right hand
0–60 s grip average (kPa)		
0–10 s grip average (kPa)		
50–60 s grip average (kPa)		
Difference between 0–10 s avg. and 50–60 s avg.		

Table 2: Group and Class Results	
Name	Strong hand average for 0–60 s (kPa)
Group average	
Class average	

PROCESSING THE DATA

1. In the space provided in Table 1, subtract to find the difference between your 0–10 s average and your 50–60 s average for each hand.

2. Record the 0–60 s results for the other students in your group in Table 2. Calculate and record your group average. Calculate and record the class average for 0–60 s.
3. Which of your hands is stronger? Explain your decision.
4. Did your gripping power increase or decrease during the 60 s period? Why did it change?
5. How does your grip compare with the class average?
6. What did you learn about your strength in this experiment? Were you surprised?

EXTENSION

See if you can increase your gripping power with practice.