1A Measuring Flow Rate

How can we measure the rate at which water is flowing?

Science is a process that lets us try to answer questions about the world. Scientists study things often by measuring them. In this investigation, you will measure the flow rate of water from a bucket. Once you have measured the water flowing out of the bucket and calculated the flow rate, you will learn how to organize the information you have collected.

Materials

- Stream table stage
- Bucket with spigot
- Displacement Tank
- Stopwatch
- Water
- Simple calculator
- Graph paper

1 Setting up

1. Turn the spigot on the bucket to the closed position. Then, fill the bucket with water up to the fill line.
2. Put the bucket on the stream table stage with the displacement tank underneath the spigot of the bucket. The displacement tank will be used to collect the water.

Safety Note: Do not stand on the stage! This piece of equipment can only support up to a mass of 10 kilograms.

2 Collecting data

In this part of the investigation, you will measure the volume of water (in milliliters) flowing out of the bucket in 20-second intervals.

1. One partner will use the stopwatch to time 20 seconds. Another partner will open, and then close the spigot when 20 seconds have elapsed. (Always open the spigot to the mark for each trial during this investigation).
2. Measure and record the amount of water (in mL) collected by the displacement tank in the second column of Table 1. Make sure the displacement tank is flat on the table when you read and record the amount in the data table.
3. Empty the displacement tank back into the bucket. Make sure the water level is back up to the original fill line.
4. Repeat the process for Trial 2 and Trial 3. Remember to fill the bucket up to the fill line before starting the next trial to make up for any spilled water.

Table 1: Volume when spigot is turned to the notch

Trial	Volume of water (mL)	Time (seconds)
1		
2		
3		

3 Using your measurements

1. Flow rate is the term used to describe an amount of water flowing during a specific time period. For this investigation, we will use units of mL/sec to describe the flow rate of the bucket. How can you use what you have measured to calculate the amount of milliliters of water flowing out of the bucket per second? Calculate the flow rate for each of the three intervals and fill in the second column of Table 2.
2. Once you have calculated the three flow rates in mL/sec, average them and record your answer in Table 2.

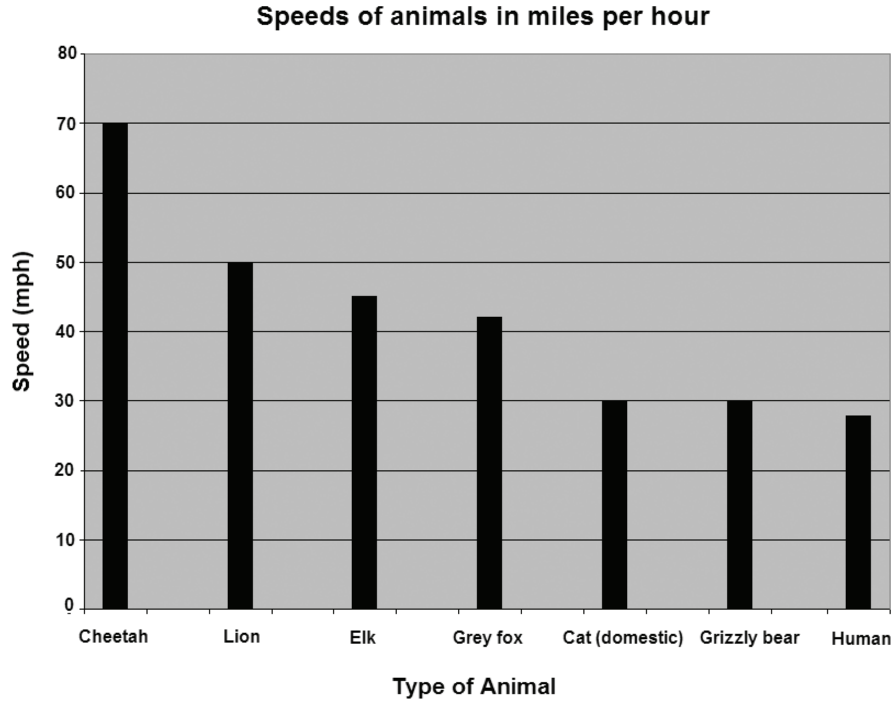
Table 2: Flow rate when spigot is turned to the notch

Trial	Flow rate (mL/sec)
1	
2	
3	
Average flow rate (1 + 2 + 3) ÷ 3	

4 Thinking about what you observed

a. Flow rate describes how fast or slow water is flowing. Speed is also a rate. It is often used in units of miles per hour to describe how fast or slow objects like cars, comets, or even particles of light are moving. What are some other rates that you know?

b. A bar graph is a useful tool for organizing information. Look at the bar graph below. It shows the top speeds at which different animals can travel.



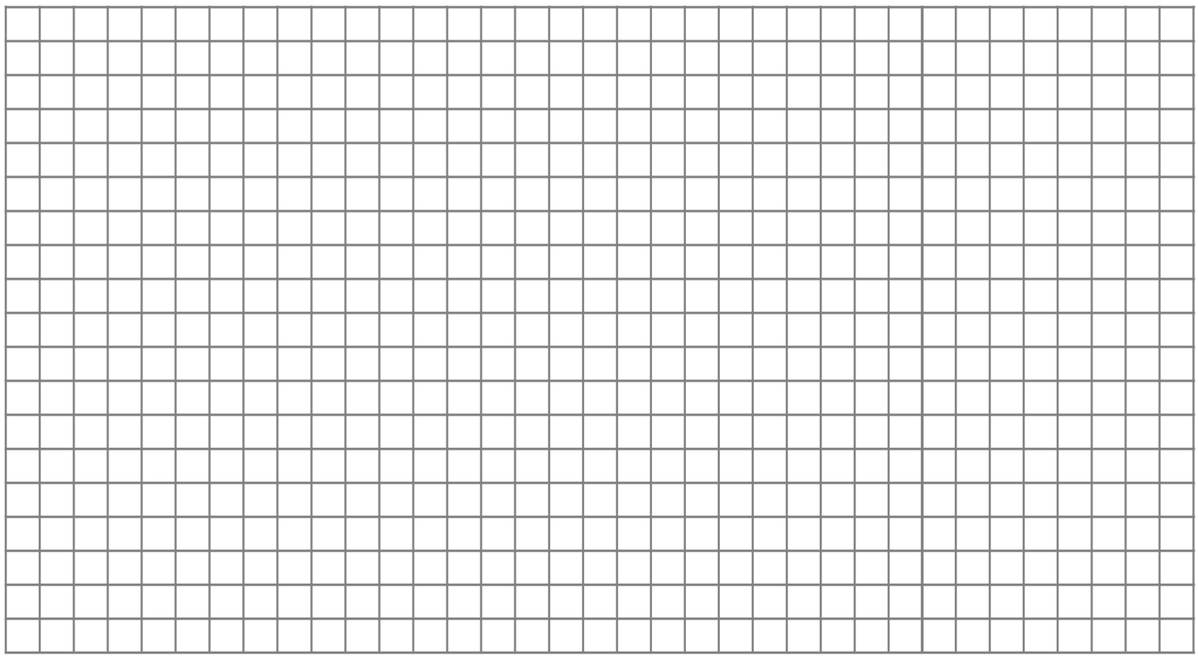
Make a bar graph of the flow rates from the objects in Table 3. Be sure to label each vertical bar on your bar graph.

Table 3: Flow rates of common objects

Object	Flow rate (mL/sec)
drinking fountain	40
bathroom faucet	60
kitchen faucet	140
super-efficient shower head	160
garden hose	220
non-efficient shower head	410

Title: ______________________________

y label: ______________________________



x label: ______________________________

a. Where does your bucket fit onto the flow rate graph? Draw it in on your flow rate graph.

b. Was the flow rate similar or very different for each of your 3 trials? Why do you think that was?

c. Do you think the flow rate is the same no matter how much water is in the bucket?

d. What would you do to test your idea (your answer to question **e**)?

5 Try it at home

a. Find a measuring cup, or another container of known volume and measure the amount of water that flows into it at 20-second intervals.

b. Before you perform this water flow activity, think of a use for the water you will collect. Watering plants, boiling food like rice or pasta, or even drinking are all good uses.

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c. Make a data table and calculate the flow rate of your faucets, shower heads, garden hose, or other water dispensing devices. How do they compare to Table 3 values?

Table 4:

Object	Volume of water in 20-sec. interval (mL)	Flow rate (mL/sec)

d. Make a bar graph with the data you were able to collect at home.

Title: ______________________________

y label: ______________

x label: ______________________

e. How does your data collected at home compare to the data you collected in school?

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1B Observation, Question, and Hypothesis

Is the flow rate constant no matter how much water is in the bucket?

In the last investigation, you observed the flow rate of the bucket by measuring the volume of water that flowed out of the bucket during three 20-second intervals. For each trial, you started with the same amount of water in the bucket, so the flow rate was similar for each trial.

In this investigation, you will answer the key question after you state a *hypothesis*. You will collect new data and learn how to organize this data in the form of a graph.

Materials

- Stream table stage
- Bucket with spigot
- Bucket without a spigot
- Displacement tank
- Stopwatch
- Water
- Simple calculator
- Graph paper

1 Getting started

In the last investigation, you made some observations and found that the flow rate of water emptying out of the bucket was very close to being constant for each of your three trials. You filled the bucket up to the fill line at the top of the bucket with water, so each trial had the same amount of water. But what if we didn't keep filling it back up? What if we let all the water run out of the bucket?

2 Setting up

1. Turn the spigot on the bucket to the closed position. Then, fill the bucket half-way with water.
2. Put the bucket on the stream table stage. Place the second bucket under the spigot of the water-filled bucket on the stage.

Safety note: Do not stand on the stage! This piece of equipment can only support up to a mass of 10 kilograms.

3 Making observations

In this part of the investigation, you will observe the flow of the water as it empties out of the bucket. You won't measure the flow, but you and the other members of your team will watch the flow of the water. Try and be specific with your observations.

1. Is the flow rate getting faster as the bucket empties?
2. Is the flow rate getting slower as the bucket empties?

4 Thinking about what you observed

Now that you have observed the water emptying out of the bucket, it is time to form a hypothesis based on the key question.

a. Make a prediction based on the key question: ***Is the flow rate constant no matter how much water is in the bucket?***

b. How do you think the flow rate will change?

- Will the flow rate increase and let more water out for each 20-second interval as the bucket empties?
- Will the flow rate decrease and let less water out for each 20-second interval as the bucket empties?
- Will the flow rate remain constant for each 20-second interval as the bucket empties?
- Will the flow rate increase for some intervals and decrease with others as the bucket empties with no obvious pattern that we can see?

c. Combine your answers to questions a and b. This will be your hypothesis. State if you think the flow rate will change. If you think it will change, say how it will change.

5 Testing your hypothesis by doing an experiment

To test your hypothesis, you will measure the volume of water that flows out of the bucket for each 20-second interval until the bucket is empty. You will then calculate the flow rate during each of the 20-second intervals. From this data, you will decide if your hypothesis was correct or not.

1. Turn the spigot on the bucket to the closed position. Then, fill the bucket up to the fill line with water.
2. Put the bucket on the stream table stage. Place the displacement tank under the spigot of the bucket.
3. One partner will use the stopwatch to time 20 seconds. Another partner will open, and then close the spigot when 20 seconds have elapsed. (Always open the spigot to the mark for each trial during this investigation).
4. Measure and record the amount of water (in mL) collected by the displacement tank in the second column of Table 1. Make sure the displacement tank is flat on the table when you read and record the volume in the data table.
5. Remember, do not pour the collected water back into the bucket on the stage. Pour the water into the collection bucket provided by your teacher.
6. Repeat the 20-second intervals until the bucket is empty, or no more water flows out of the spigot..

Table 1: Volume when spigot is turned to the notch

Interval	Volume of water (mL)	Time (seconds)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

6 Using your measurements

1. Once you have completed your measurements, use your data to calculate the flow rate for each interval.
2. Record the values in Table 2.

Table 2: Flow rate when spigot is turned to the notch

Interval	Flow rate (mL/sec)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

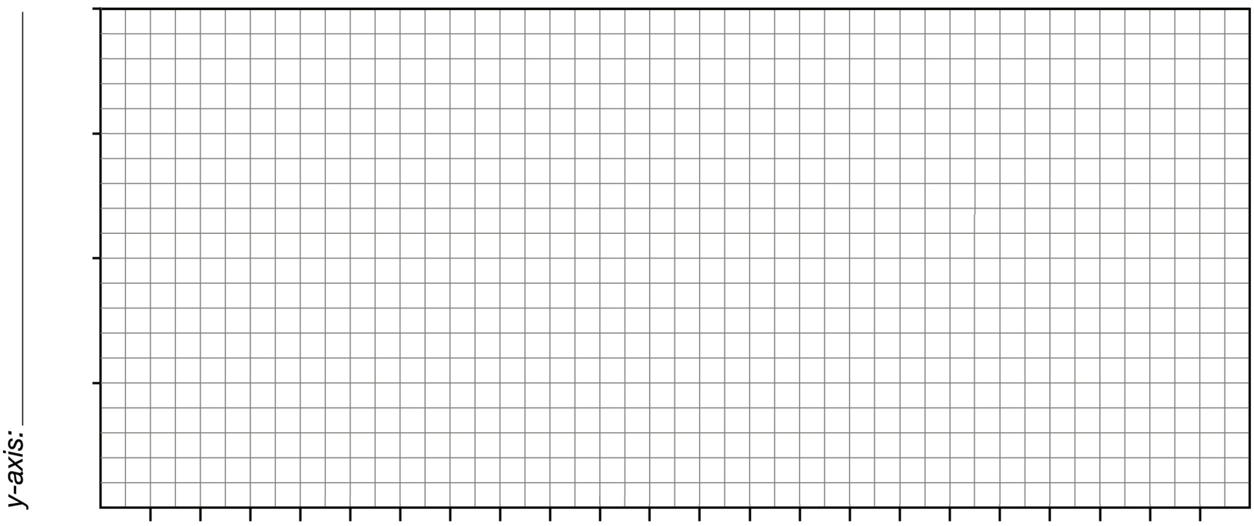
7 Making a graph

You have collected data. Now you need to interpret this data. One way to interpret data is to make a picture of it. A graph is a picture of data. It can help you identify patterns, trends, or other important information that may help to verify a hypothesis or make a prediction. A graph compares two types of information.

1. The two types of data in this investigation are flow rate and the interval number. You are going to make a graph of flow rate versus interval number.

2. There are many kinds of graphs. Each is useful in certain situations. You are going to use a bar graph for this investigation. A bar graph is useful to indicate specific amounts of things, like flow rate at different time intervals.
3. On the graph below, plot your data. You will put the flow rate on the *y*-axis, and the interval number on the *x*-axis. Draw each bar so that it is two squares wide. The height of each bar equals the flow rate for one interval.
4. Color in all the bars the same color with a pencil, pen, or colored pencil.

Title: ______________________________



x-axis: ______________________________

8 Analyzing your data

a. Was your hypothesis correct? The answer to this question is known as your conclusion. Write a short paragraph to answer this question. Use your graph to help you answer this question.

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b. Compare your data with the data collected by other lab groups. Did the data from the other lab groups support your hypothesis?

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c. Did you find it easier to understand your data in number form on your data tables, or in picture form on your graph?

d. How can you make data presented in a table easier to understand? How can you make data presented in a graph easier to understand?

e. What condition was kept constant during each interval?

f. What condition changed and was not kept constant for each interval?

2A SI Units

How can you become more familiar with SI units?

Measuring is an important part of understanding our world. It helps us answer questions like: How much do I need? How far do we still have left to drive? Is it cooked all the way? To make communicating easier, scientists around the globe have agreed to use the *Metric System*. In 1960, the name "Metric System" was changed to "the International System of Units" or "SI Units" for short. In this investigation, you will become familiar with *SI Units*.

Materials

- Triple beam or electronic balance
- 1 cup of sand, 1 cup of clay, 1 cup of soil, and 1 cup of gravel in paper cups
- Variety of everyday objects: paperclips, pennies, dimes, etc.
- Meter stick and trundle wheel
- Thermometer
- 3 cups of water at different temperatures

1 Stop and think

a. How often in your daily life do you use measurements or products that require measurements? List at least three things you have done where it was necessary for you to use a measurement in either length, mass, volume, or temperature. For example: I took my temperature when I was sick.

b. SI units are used in science. Predict why scientists have agreed to use SI units such as centimeters, meters, and kilometers instead of the English system of inches, feet, and yards.

c. Teachers always tell you to include units, such as grams or centimeters, when writing your answers. Why is it so important to include units?

2 Doing the activity

A. Measuring and estimating different masses

1. When estimating, it is important to have a point of reference. In other words, if you are familiar with an object that has a particular measurement, then it is easier to make estimates by using your object of reference as a comparison. For example, if you know that an average large paperclip's mass is one gram, then when you think about the mass of other objects, you can always compare their mass to the mass of the reference object, the paperclip.
2. Knowing that a paperclip is one gram, what other everyday objects might have a similar mass? List at least three possible objects in Table 1. Then determine if you are correct by measuring the mass of each object. Record your results in Table 1.

Table 1: Objects estimated to measure 1 gram

Object	Actual mass
large paperclip	**1 g**

3. Measure the mass of an empty cup, and record your measurements in Table 2.
4. Collect a cup containing the pre-measured amount of sand. Feel the mass in your hand. Using the paperclip as your reference point of one gram, estimate the mass of the sand in grams, including the cup. Record your estimate in Table 2.
5. Measure the mass of the cup of sand in grams, including the cup, and record your results in Table 2.
6. You measured the mass of the cup while the sand was in it, so how do you know the mass of the sand? If you subtract the mass of the empty cup from the measured mass of the cup with the sand in it, you are left with the mass of the sand.

$$\text{Mass of cup with sand in it} - \text{Mass of empty cup} = \text{Mass of sand in cup}$$

7. Record the actual mass of the sand you calculated from step 6 in Table 2.
8. Calculate the difference between your estimated mass and the actual mass in Table 2.
9. Repeat steps 3 - 8 for the cup of clay, soil, gravel, and water.

Table 2: Estimated and actual mass of different materials

Material	Mass of empty cup	Estimated mass of material	Mass of cup with material in it	Actual mass of material	Difference between actual mass and estimated mass
sand					
soil					
gravel					
water					

B. Measuring and estimating distances and areas

1. Again, it is important to create a point of reference. You are probably already familiar with the length of a meter stick. If not, your teacher will hold one up for you to see. Look around the room. In Table 3, list at least three objects you predict will be about one meter in length, then record the actual measurement in meters, in Table 3.

Table 3: Objects estimated to measure 1 meter in length

Object	Actual length
1.	
2.	
3.	

2. Your teacher has set up three pre-measured spaces for you labeled space A, B, and C. Using a meter stick, or other object of your choice, as a reference point, estimate the length of each space and record the data in Table 4.

Table 4: Estimates and measurements of length and width of each space

Space	Estimated length	Actual length	Difference between actual and estimated length	Estimated width	Actual width	Difference between actual and estimated width
A						
B						
C						

Area is a calculation of the length times the width. Using either the trundle wheel or the meter stick, measure the actual space and record your measurements in Table 5.

Table 5: Estimates and calculations of area of each space

Space	Estimated length x width (from Table 4)	Estimated area	Actual length x width (from Table 4)	Actual area	Difference between estimated and actual area
A					
B					
C					

C. Estimating and measuring temperature

1. Room temperature is usually between 20° to 25° Celsius. This is equivalent to 68° to 77° Fahrenheit, the more common temperature scale used in the U.S. However, as scientists, we will stick to SI units and use Celsius. So let's use room temperature as our reference point.
2. Collect a cup of water from your teacher. This will be Cup A. In Table 5, using room temperature of 20°- 25° C as a reference point, estimate the temperature of the water. Then use the thermometer to measure and record the actual temperature.
3. Repeat step 2 for the other two cups of water.

Table 6: Estimates and Measurements, in Celsius, of each cup of water

Cup of water	Estimated temperature	Actual temperature	Difference between actual and estimated temperature
A			
B			
C			

3 Thinking about what you observed

a. Which was the easiest to estimate: mass, length, area, or temperature? Explain why.

b. Why do you think it is helpful to practice using SI units?

c. What are the benefits of using SI units over the English system?

d. The U.S. is one of the only countries to still use the standard system of units in everyday use. What do you think would be necessary to help the U.S. change to using SI units as their primary system instead of the English system?

e. All scientists use measurements. List at least three scientists and the measurements they would take. You can use any type of scientist such as a scientist who studies life, stars, chemistry, atoms, weather, etc. For example, a biologist would measure the body temperature of animals.

4 Exploring on your own

a. How familiar are adults in the U.S. with SI units? Create a survey to answer this question. After getting approval from your teacher, conduct the survey, and report your findings using a graph as a visual.

b. Volume is another unit of measurement. Design an experiment to determine how familiar you are with metric units of volume. After getting approval from your teacher, conduct your experiment.

c. Create an outline for a board game to help fellow students learn the SI units measuring system. After you get your teacher's approval, create your board game.

2B Modeling a River

Which variables affect the formation of a river?

When an experiment is done, usually one variable is tested to see how it affects another variable. In this investigation, you will learn about variables. You will manipulate variables in an experiment that uses a stream table.

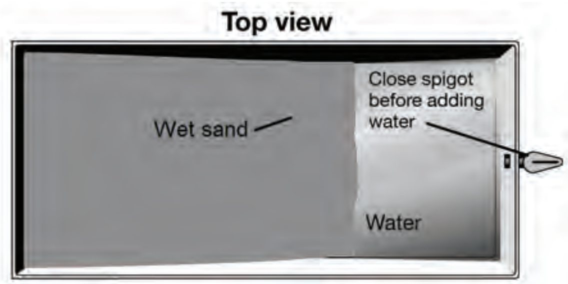
A stream table is a model of a river system. You cannot easily change variables that affect a real river. You can for a model river in a stream table! What variables might you be able to change? You will find out in this investigation!

Materials

- Stream table stage
- Stream table
- Bucket with spigot
- Bucket without spigot
- Displacement tank
- Stopwatch
- Water
- Simple calculator

1 Setting up

1. Fill the top 2/3 of the stream table with sand. Pour some water onto the sand and mix it all up so it is completely wet. The sand should fill the tray up so it reaches just about 2 centimeters below the edge of the tray.
2. Smooth the surface of the sand out as much as you can so it is nice and flat.
3. Place the stream table on one of the rungs of the stand.
4. Move the spigot on the bucket to the closed position. Then, fill this bucket with water. Place it on top of the stage with the spigot pointing over the distribution trough that channels the water into the stream table.
5. Place the empty bucket (the one without the spigot) below the spigot of the stream table to catch water that will run out of the tray once water starts to run into the table.
6. Make sure the spigot on the stream table is in the closed position.



2 Looking at a system

What is a system? A system is a group of objects and the variables that affect those objects. We'll be looking at the stream table as a system. Examine the stream table set up with your group and answer the following questions;

a. What are the objects that make up the stream table?

b. What are the variables that affect the objects in the system?

c. What are some variables that probably do not affect the system?

3 Doing the activity

1. Look at the lists of variables that affect the objects in the stream table system you made in part 2.
2. With your group, observe how these variables affect the process of making a stream, and the final effects on the sand in the tray.
3. Make sure your spigot at the bottom of the sand tray is closed. Place the bucket without the spigot under the spigot on the sand tray.
4. Open the spigot on the bucket that is holding the water and let the water flow into the trough, and down onto the stream table.
5. Carefully observe what happens as the water flows onto the sand and down the tray. Make notes of your observations with your group.
6. Close the spigot when your observations are over.
7. If water gets to the point where it may spill over, open the spigot on the tray and drain some water in the bucket below the spigot.

Observation notes

4 More about variables

Variables are factors that affect a system. In Part 2 you listed variables that affected the stream table system. In Part 3, you made observations. You watched what happened, and made notes about how you and your group thought the variables affected the system. In an experiment, the investigator usually wants to see how one variable affects the system. Variables in an experiment can be categorized into independent variables, control variables, and dependent variables. These different types of variables are explained below.

Variables in an experiment

Independent variable – A variable that is changed in an experiment.	**Control variable –** A variable that is held constant in an experiment.	**Dependent variable –** A variable that is affected by the change to the independent variable.

How does a change in the independent variable affect the dependent variable?

5 Posing a scientific question—an inference

Every experiment begins with a question:

- How large is Earth?
- How fast do mountains grow?
- What is the best fertilizer for roses?
- How old is this glacier?

Asking questions helps to focus on what we want to know. Once we find out what it really is that we want to know, we consider the possibilities based on what we have observed. Then, we make a prediction about what we think is true. In science, this is called a hypothesis. The purpose of an experiment is to test if a hypothesis is true.

1. Examine your list of variables you made in part 2, and your observations you made in part 3.
2. With your group, look at your list of variables and decide on a question that involves the formation of a stream in your tray and how changing one of those variables will change the stream.
3. There should be a cause and effect relationship between the variable and its effect on the system. For example; Does making an object heavier make it fall to the ground faster when it is dropped?
4. What is your group's question?

6 Hypothesis and variables

Once you have your question formed, it is time to make a hypothesis—what do you and your group think will happen to your dependent variable when you change your independent variable. Your hypothesis is a possible answer to this question.

Table 1: Your hypothesis, variables, and experiment

What is your question?	
What is your hypothesis?	
What is your independent variable?	
What are your control variables?	
What is your dependent variable?	

7 Designing your experiment

It is time to plan what you will do to test your hypothesis. This is what designing an experiment is all about. Answer the questions below and present your proposal to your teacher for final approval.

a. What are you going to change about your independent variable?

____

____

____

____

b. How will you measure and record this change? (Hint: make a data table)

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____

____

____

c. What are you going to measure concerning your dependent variable?

____

____

____

____

d. How will you measure and record any change?

e. What will you do to ensure your control variables remain the same?

f. What is the procedure for your experiment?

g. How will you know if your hypothesis is correct or not?

8 Setting up and performing your experiment

Once you have approval from your teacher, carefully follow your group's plan and perform your experiment. Be sure to take notes about observations, things you may or should have done differently, or things you did well as your experiment is underway. Good luck!

9 Evaluating your data

a. Was your experiment able to answer your question?

b. Did this experiment lead you to think of any other scientific questions? What are they?

c. What would you have done differently next time you design and perform an experiment?

d. What was successful that you would try again in your next experiment?

e. Can you present your data graphically, or in some other way that would help you to communicate your findings?

10 Conclusions

a. Was your hypothesis correct?

b. If not, can you tell why it was not correct?

c. Did you make any interesting observations that were not part of the original experiment?

11 Presenting your findings

As time permits, gather your data together, make any graphs, charts, or diagrams that would be helpful, and present your findings to your class as a group. All members should have some part in the presentation. Write up a report that summarizes your experience.

3A Convection in Earth's Atmosphere

How is convection responsible for the movement of air through the atmosphere?

If you have ever seen a hot air balloon in the sky, you may have asked yourself a few questions: "How does the balloon rise up?" or "How does it sink back to the ground?" In a hot air balloon, a flame is ignited inside the balloon to warm the air, causing it to become less dense. The less dense air in the balloon causes it to take flight. When the flame is allowed to go out, the air inside the balloon cools off and becomes denser so the balloon sinks back toward the ground. In this investigation, you will explore how *convection* moves air from one place to another, forming winds.

Materials

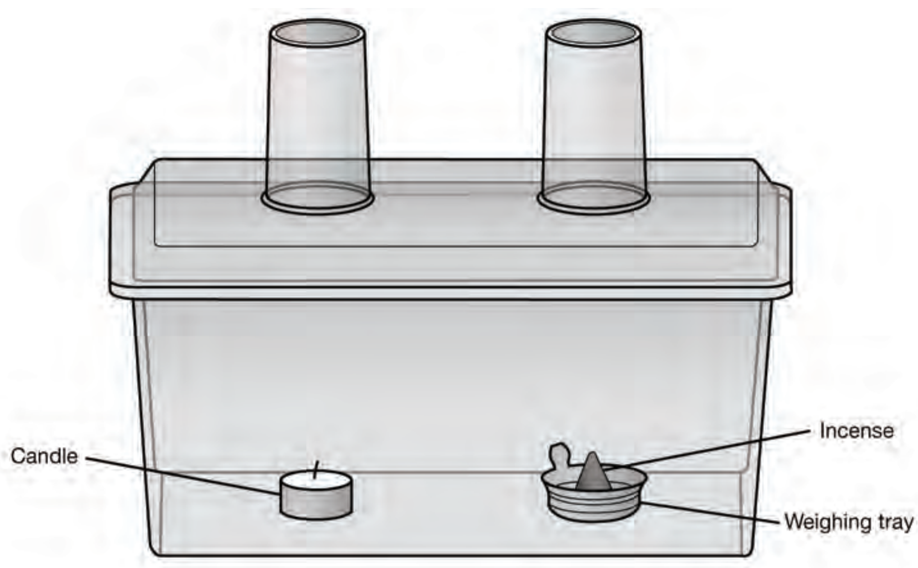
- GeoBox (to be used as a convection chamber)
- Candle
- Long fireplace matches
- Safety goggles
- Incense
- Aluminum weighing dish
- A small piece of cardboard

WARNING — This lab contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

1 Setting up and making observations

Safety tip: Use caution when working with an open flame. Long hair should be tied back. Loose or bulky outer layers of clothing should be removed.

1. Gather the materials listed above. Remove the lid of the GeoBox
2. Carefully place the candle into the GeoBox so that it will be under one of the two chimneys that are on the lid. Put the incense in the weighing tray and place it in the GeoBox so that it will be under the other chimney. See the diagram below.
3. Carefully, light the candle. Place the lid back onto the box.
4. Place your hand over the chimney above the candle. What do you feel with your hand?
5. Remove the lid from the GeoBox, and light the incense. Place the lid back on, and observe what you see inside the box.



6. Observe what is happening inside the box and chimneys for several minutes. In the space below, sketch your observations.

2 Stop and think

a. Define convection. Where is the air rising and sinking in the box/convection chamber?

b. Describe the movement of the smoke inside the box. Be sure to describe the movement of smoke in the two chimneys as well.

c. What is the purpose of the smoke from the burning incense?

d. Based on your sketch in part 1 and your answers to these questions (a - c), make a diagram that illustrates how convection is taking place in the GeoBox. Draw and label where air is rising, sinking, becoming less dense, and becoming more dense.

3 Further exploration

1. Place your fingers inside the two chimneys. Take note of what you feel. Is the air rising or sinking in each of the chimneys?

2. Cover the chimney above the candle with the piece of cardboard. Observe what happens to the movement of the air inside the GeoBox.

3. Now, cover the chimney above the burning incense with the piece of cardboard. Observe what happens to the movement of the air inside the GeoBox.

4 Thinking about what you observed

a. Describe the motion of the air in the GeoBox above the candle. Be sure to describe the change in density of the air and whether or not air is rising or sinking.

b. Describe the motion of the air in the box above the incense. Be sure to describe the change in density of the air and whether air is rising or sinking.

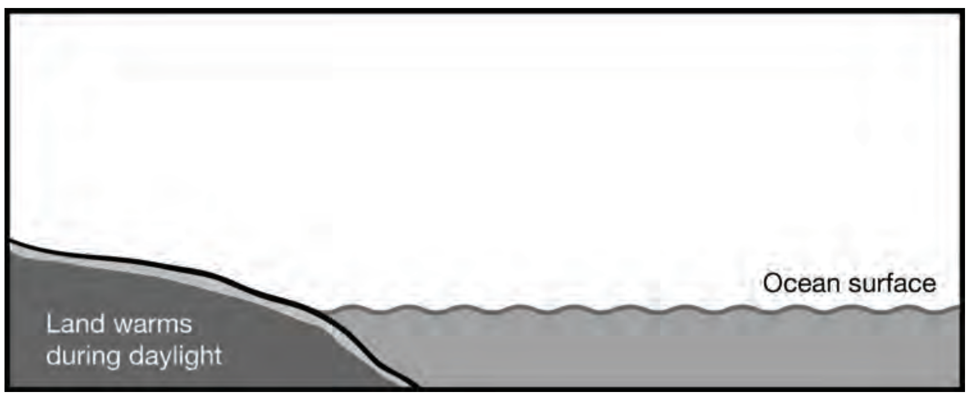
c. Why is the air rising in the chimney above the candle? Why is the air sinking in the chimney above the incense?

d. Describe how the air is moving between the candle and the incense. How can you explain this movement in terms of convection?

e. Think about what you observed inside the GeoBox. Explain how convection currents in the atmosphere form and how they are related to wind.

5 Exploring on your own

a. A sea breeze is a type of wind that is commonly found along coastal areas during daytime hours. During the day, the sand of a beach absorbs more heat than the ocean, causing it to become warmer. This causes a wind known as a sea breeze to flow from the ocean to the land. Using arrows, draw how convection currents would form in the situation in the picture. Label the sea breeze, the location where air becomes less dense, and the location where the air becomes denser.



b. A land breeze is a type of wind that is commonly found along coastal areas during the night time. During the night the ocean tends to retain more heat than the sand on the beach. This causes the ocean temperature to typically become warmer than the sand on the beach. This temperature difference causes convection currents to form and winds to blow from the beach out to the ocean. Using arrows, draw how convection currents would form in this situation. Label the land breeze, the location where air becomes less dense, and the location where air becomes denser.

3B Density

Why do some objects float in water, while others sink?

Density is an important earth science concept. Understanding density is useful for understanding weather systems and plate tectonics. So, what is density?

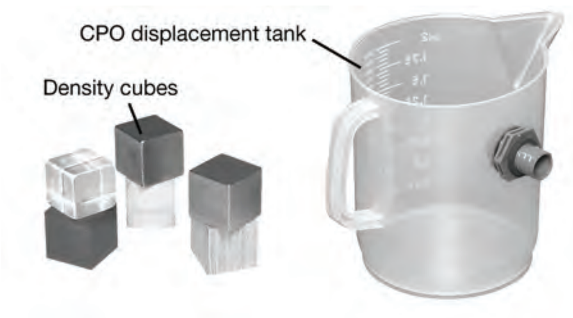
Density is the ratio of mass to volume. It is a property of solids, liquids, and gases. In this investigation, you will determine the densities of cubes made of different materials. Based on the density of each cube, you will predict and test whether they float or sink in water.

Materials

- Displacement tank
- Density cubes (steel, wood, aluminum, copper, PVC)
- A digital balance or a triple beam balance
- Metric ruler
- 100-milliliter graduated cylinder
- A 250-milliliter beaker
- Water
- Paper towels
- Disposable cup
- Simple calculator

1 Setting up

1. Your setup should include density cubes (steel, wood, aluminum, copper, and PVC), a balance, a metric ruler, and a displacement tank.
2. Examine and hold each cube, and predict whether it will sink or float in water. Record your predictions in Table 1.



2 Stop and think

Table 1: Density Table

Material of solid cube	Prediction (Sink or Float?)	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Results (Sink or Float?)
Steel					
Wood					
Aluminum					
Copper					
PVC					

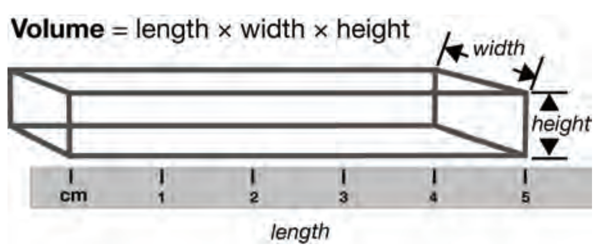
a. Consider the cubes. How is each cube similar? Different?

b. What factors will determine whether the cube will float or sink in water?

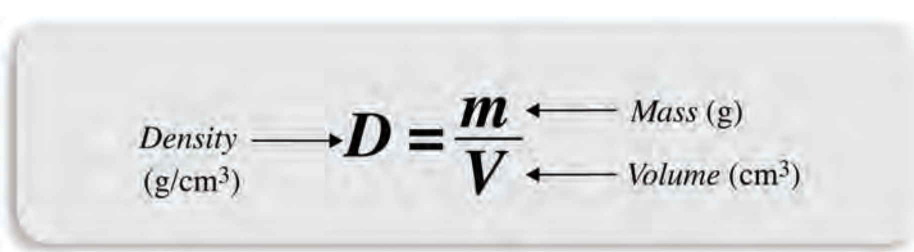
c. What is density? How does the density of a solid cube (g/cm^3) relate to the density of water (g/mL)?

3 Doing the experiment

1. Use a balance to determine the mass of the steel cube, and record in Table 1.
2. Determine the volume of the steel cube and record it in Table 1.
   Note: To find the volume of a regularly-shaped object, measure the length, width, and height of the object, and multiply these dimensions.



3. Calculate the density of the steel cube. Divide the mass by the volume:
   Density (g/cm^3) = mass (g) / volume (cm^3). Record the density values in Table 1.
4. Repeat steps 1-4 using the other cubes.



5. Find the volume of each cube using the displacement tank.
- Place a disposable cup under the spout to catch the overflow of water.
- Fill the tank with water until it just begins to run out of the spout. The volume of water in the tank will be approximately 1,400 mL.
- When the water stops, remove the cup and place a dry beaker under the spout.
- When you place your object in the tank, water will flow out of the spout. As soon as the water stops flowing, pour the water from the beaker into a graduated cylinder to measure the volume of water. This volume is equal to the volume of your object.

4 Thinking about what you observed

a. Describe how to find the density of a regularly-shaped object like a solid cube.

b. Explain why these cubes have similar volumes but different masses.

c. Explain why these cubes have different densities.

d. Do you notice any correlation (pattern) between the density of an object and its ability to sink or float?

e. As a geologist, how would you determine the densities of different rocks found in a field?

f. Did you observe a difference in the depth in which an object floated or the rate in which the object sunk in the water? Explain your answer.

5 Further exploration—Finding the density of an irregularly-shaped object

1. With your group, select a few objects that are irregularly-shaped. List the objects in Table 2. Record the data you collect in steps 2 through 6 in Table 2.
2. Predict whether the objects will sink or float in water.
3. Find the mass of each object.
4. Use the displacement tank to find the volume of each object.
5. Use the mass and volume information to calculate the density of each object.
6. Record the results of your test in the last column of Table 2.
7. Write a short paragraph describing your results. State whether or not your predictions were correct.

Table 2: Density Table

Object	Prediction (Sink or Float?)	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Results (Sink or Float?)