



Thermal Energy:

How can containers keep stuff from
warming up or cooling down?

Student Work Pages

Core Knowledge Science



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Thermal Energy:

How can containers keep stuff from warming up or cooling down?

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Name: _____

Date: _____

Investigation Plan: _____

The question we want to answer

Investigation question:

To change, measure, or keep constant

A **variable** is a factor you want to change or control in an investigation. There are three types of variables you should think about for your investigation:

- Independent variable—This is the variable to change because you want to test it. You should only have 1 independent variable in your investigation.
- Dependent variable—This is the variable to observe for effects caused by the change in the independent variable. You can have more than 1 of this kind of variable.
- Controlled variables—These are variables that are kept the same to keep each test consistent across an investigation. You should have several of these variables.

Discuss the types of variables with your class. Work with your group to decide what you will change, control, and observe (measure) in your investigation.

Independent variable:

Dependent variable(s):

Controlled variables:

Procedures

Your ideas for procedures	Class agreed-upon procedures
1.	1.

Name: _____

Date: _____

Explanations and Predictions of Lids and Covers

Use the ideas we developed to answer the questions below. After you write a response, circle the part of the response that uses some of the ideas we added to our Progress Tracker today.

1. Why does adding a lid help decrease the amount of water leaving the system?

2. Why does adding a lid help decrease the amount that the water temperature changes?

3. What are some other systems (besides a cup) in which you think adding or removing a cover would affect the amount of liquid in the system over time and/or affect the temperature of the liquid in that system?

4. If we could completely seal off the cup so that no matter could get in or out, do you think the temperature of the liquid inside would still change if the liquid were cold water? Hot water? Why?

Initial Model of Mass Loss in the Cup with No Lid

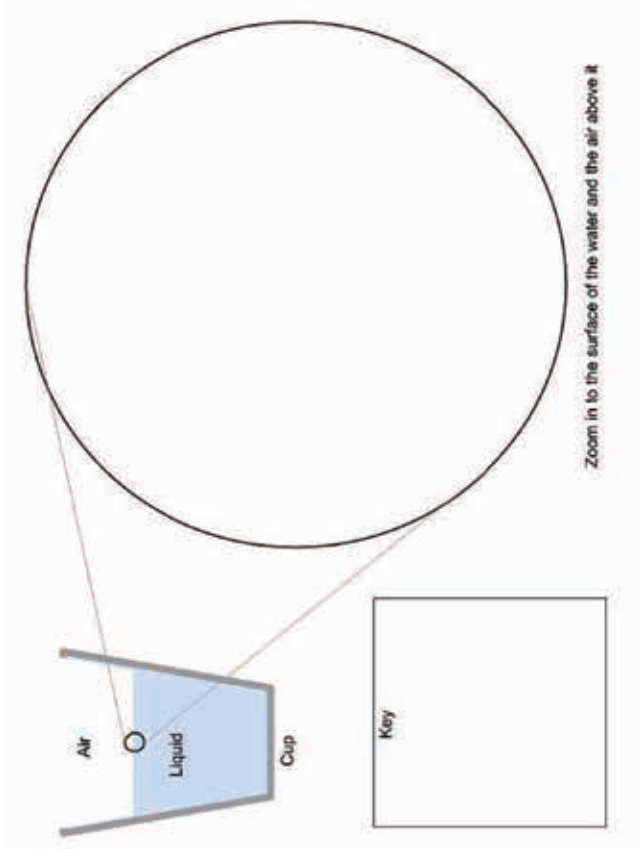
Develop a model to answer the question:

What is happening to the liquid water that can explain why the mass of the cup system decreases over time?

Draw a zoomed-in view of the surface of hot water in a cup with no lid.

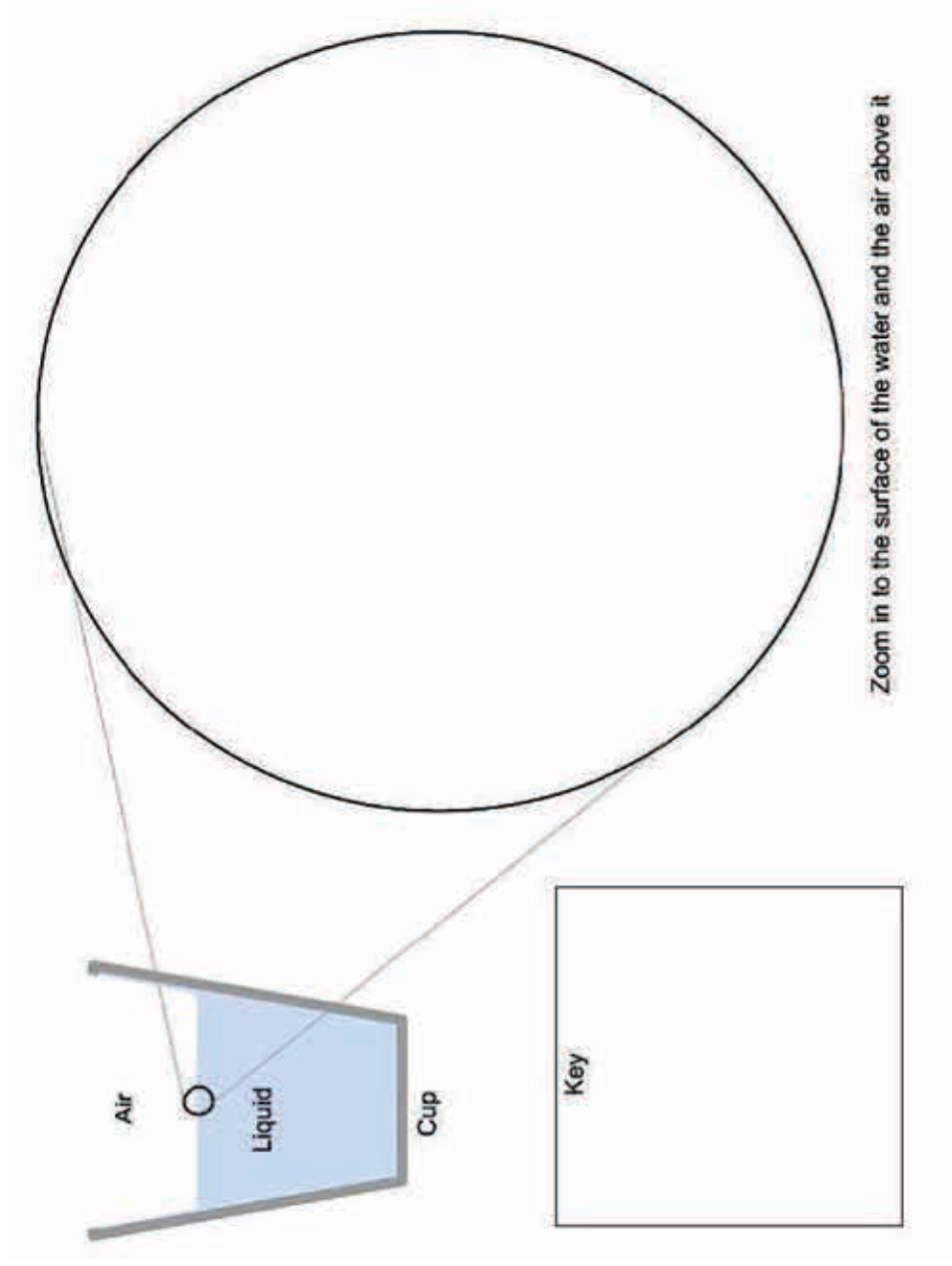
What you draw should show what you picture is going on (at a scale much smaller than you can see) that would help answer the question above.

Use *pictures, symbols, and words* to represent what you think is happening, and include a key.



Use your model to make a prediction: If we left this system out in the room overnight, do you think the system would have the same amount of water in it tomorrow as it does right now? How about a week later? Why?

Manipulative Mat for a Model of Matter at the Surface of the Liquid



Name: _____

Date: _____

Procedure: Measuring Changes in Mass in the Cups

Our Modified Procedure	
1.	

Our New Data Table

	(A) Cup with no lid	(B) Cup with lid
Prediction: Do you think the amount of matter in this system will change over 5 minutes' time?		
Initial mass for our group (g)		
Final mass for our group (g)		
Change in mass for our group (g)		
Average change in mass for all of the class data (g)		

Making Sense of Our Data

Progress Tracker

Question	Source of evidence
What we figured out in words/pictures	

Progress Tracker

Question	Source of evidence
What we figured out in words/pictures	

Name: _____

Date: _____

Water Droplet Investigation

Part A

Procedures:

- Pour equal amounts of ice-cold water into each cup system.
- Close the cup systems by adding the lids (with tape over the straw hole).
- Using digital scales, quickly measure and record the mass of each cup system.
- Leave the cup systems on the scales. Measure and record the mass after 10 minutes.

Make a prediction: We measured and recorded the mass of the cup systems as soon as we poured cold water in them. What might we see when we measure the mass of the cups after water droplets form on the outside? Explain your thinking.

Water can leak through the walls of the cup.	Water cannot leak through the walls of the cup.

Make observations: Document our data and your observations of the cold cup systems.

Cup system	Starting mass (g)	Mass (g) after 10 min	Mass change (g)
Single-walled plastic			
Single-walled metal			

Include a drawing of what you observed:

Analyze data and draw conclusions:

- 1. Did the mass of the cup systems change? If so, in what way?
- 2. What does this new data and observation mean? Support your thinking with evidence.

Part B

Procedures:

- Pour equal amounts of ice-cold water into each cup system.
- Add 6-8 drops of food coloring to the water in each cup and stir.
- Close the cup systems by adding the lids (with tape over the straw hole).

Make a prediction: Since we added food coloring to the water in each cup system, what might you expect to see when water droplets form on the outside? Explain your thinking.

Water can leak through the walls of the cup.	Water cannot leak through the walls of the cup.

Make observations: Document what you notice as you observe the cold cup systems. Include a drawing of what you observed.

Analyze data and draw conclusions:

- 1. How do the water droplets on the outside of each cup system compare to the water on the inside?
- 2. What conclusion can you draw based on what you see? Support your thinking with evidence.

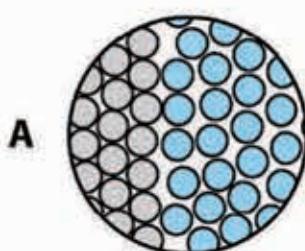
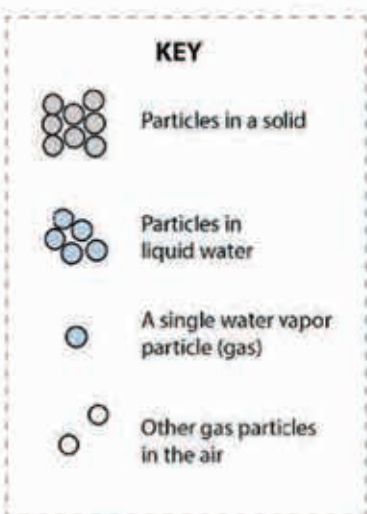
Name: _____

Date: _____

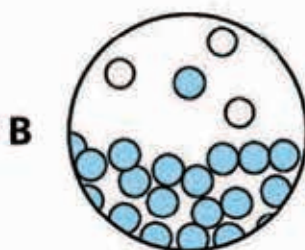
Analogy Map for Chips and Marbles

<i>Manipulative in a previous activity. . .</i>	<i>manipulative in this activity. . .</i>	<i>is like this thing in the cup system. . .</i>	<i>because. . .</i>
A blue plastic chip			
A yellow plastic chip			

Particle Representations for Matter in the Cup System

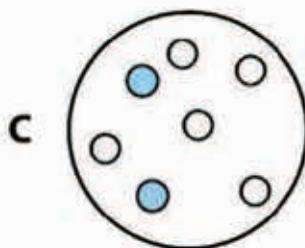
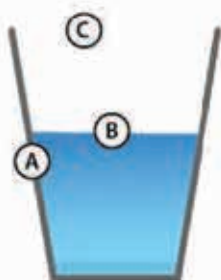


What is happening where the water particles in the liquid meet the particles of the solid plastic wall of the cup?



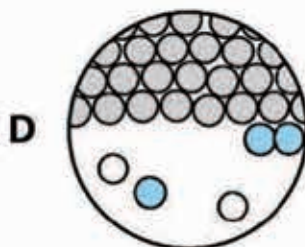
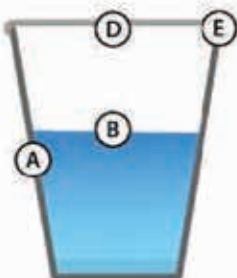
What is happening where the water particles in the liquid meet the air above it?

Cup with no lid

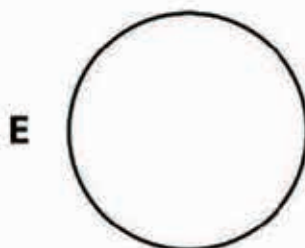


What is happening where the water particles that go into the air when there is no lid on top?

Cup with a lid



What is happening where the water particles that reach the solid plastic lid?



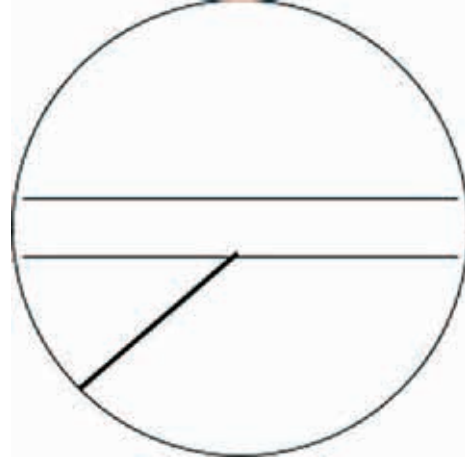
If there is a gap where the lid meets the wall that is wider than a single water molecule, what do you predict would happen to some of the water particles in the air when they reach this spot in the system?

Name: _____

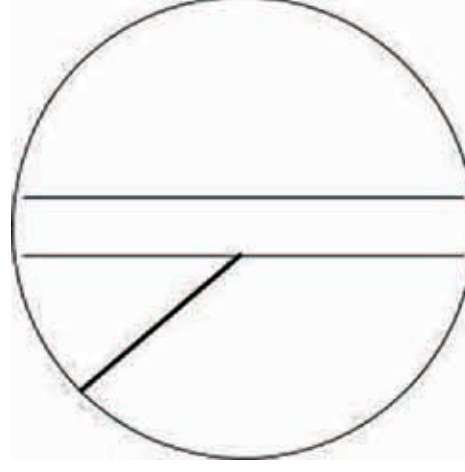
Date: _____

Explaining Temperature Changes in Each Cup

Use drawings and words to explain how each cup surface affected how light warmed up the water differently.

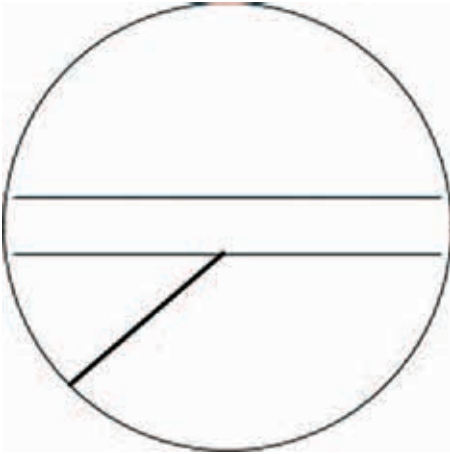


Clear plastic cup (light)

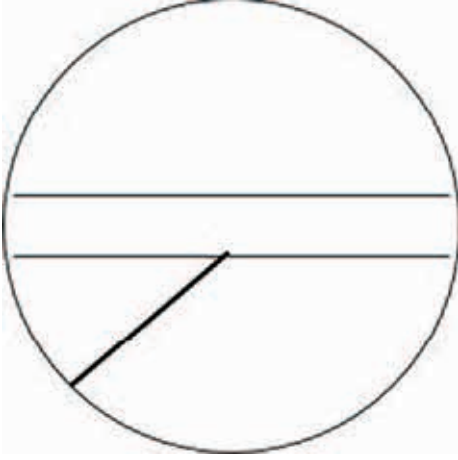


Clear plastic cup (dark)

How did you explain why the clear plastic cup in the dark was different from the other cups?

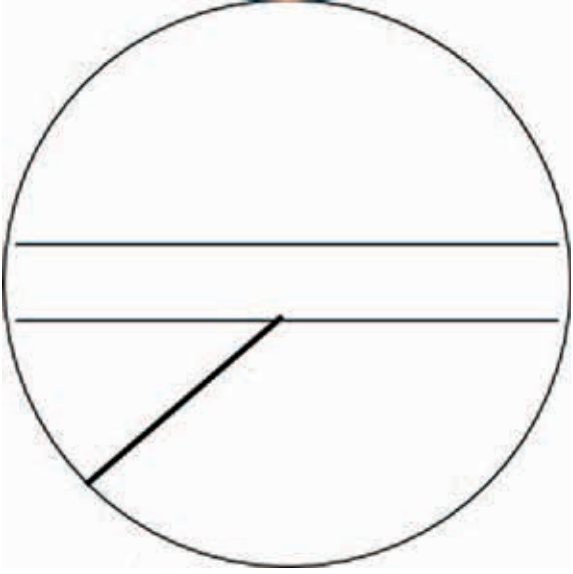


Black cup



White cup

How did you explain how the water in the black-painted cup warmed up compared to the water in the white-painted cup?



Foil cup

How did you explain how the water in the foil-covered cup warmed up differently compared to the other cups?

What questions do you have about what happened in the cups?

Name: _____

Date: _____

Investigating Light's Effect on Warming Up Water

Investigation Questions

In this investigation, we will be answering 2 questions:

1. Does light affect the temperature of the water inside the cup system?
2. How does the cup surface affect how light warms up the water inside the cup?

Predictions

In which cup do you think water would warm up the most? The least?

Materials

Group A's and Group B's: 1 lamp with 100-W light bulbs, 1 copy of *Light Measurement Template*, 2 thermometers, 1 500-mL beaker, timer (optional), 800 mL of chilled water

- Group A: clear plastic cup and foil-wrapped cup (both with lids)
- Group B: white-painted cup and black-painted cup (both with lids)

Dark Group(s): 4 thermometers, 1 500-mL beaker, timer (optional), 1600 mL of chilled water, clear plastic cup, foil-wrapped cup, white-painted cup, and black-painted cup (all with lids)

Water Temperature Procedures

Group A's and Group B's: Arrange the lamp so that it is standing vertically as possible (perpendicular to the table) and shining directly at the cups.



Place the Light Measurement Template in front of the lamp so that the lamp's edge is flush with the template's edge and the center line is aligned with the light bulb.



All Groups

Place a thermometer through the straw hole in each lid. Place the lids and thermometers to the side of your cups until you are ready to close the cups.



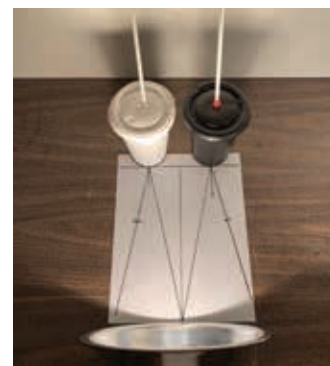
Groups A and B, place the cups on the other end of your template. Then fill the beaker with 400 mL of cold water and pour it into the first cup. Repeat for the second cup.



Dark group, place your cups on a flat surface in a completely dark space. Then fill the beaker with 400 mL of cold water and pour it into the first cup. Repeat for the second cup.



Seal the cups with the lids, positioning the thermometer in each cup at a level where it will take a temperature measurement from the middle of the water and where you can read it easily.



Wait 20 seconds and record your starting temperature measurement. You will measure the water temperature after 15 minutes. While you wait, go to the Scientists Circle to collect light measurements with your class.

After 15 minutes, return to your cups to record the final temperature measurement. Calculate the change in water temperature for each cup type and record it on the class data table.

Water Temperature Data

Water Temperature over Time (°C)

Starting water temperature: _____

Air temperature around the cups: _____

Group A - Light		
Condition	15 min	ΔT
Clear		
Foil		

Average (clear): _____

Average (foil): _____

Group B - Light		
Condition	15 min	ΔT
Black		
White		

Average (black): _____

Average (white): _____

Dark Group		
Condition	15 min	ΔT
Clear		
Foil		
Black		
White		

Light Measurements Data (lux)

Light Measurements (lux)

Condition	Incoming	Transmitted	Reflected
Clear			
Foil			
Black			
White			

Light Measurements (percentages of incoming light)

3. Calculate the percentages of incoming light that transmit through and reflect off the cup wall.

$$\% \text{ Transmitted light} = \frac{\text{Amount of transmitted light (lux)}}{\text{Amount of incoming light (lux)}}$$

$$\% \text{ Reflected light} = \frac{\text{Amount of reflected light (lux)}}{\text{Amount of incoming light (lux)}}$$

Condition	Transmitted	Reflected
Clear		
Foil		
Black		
White		

Analysis

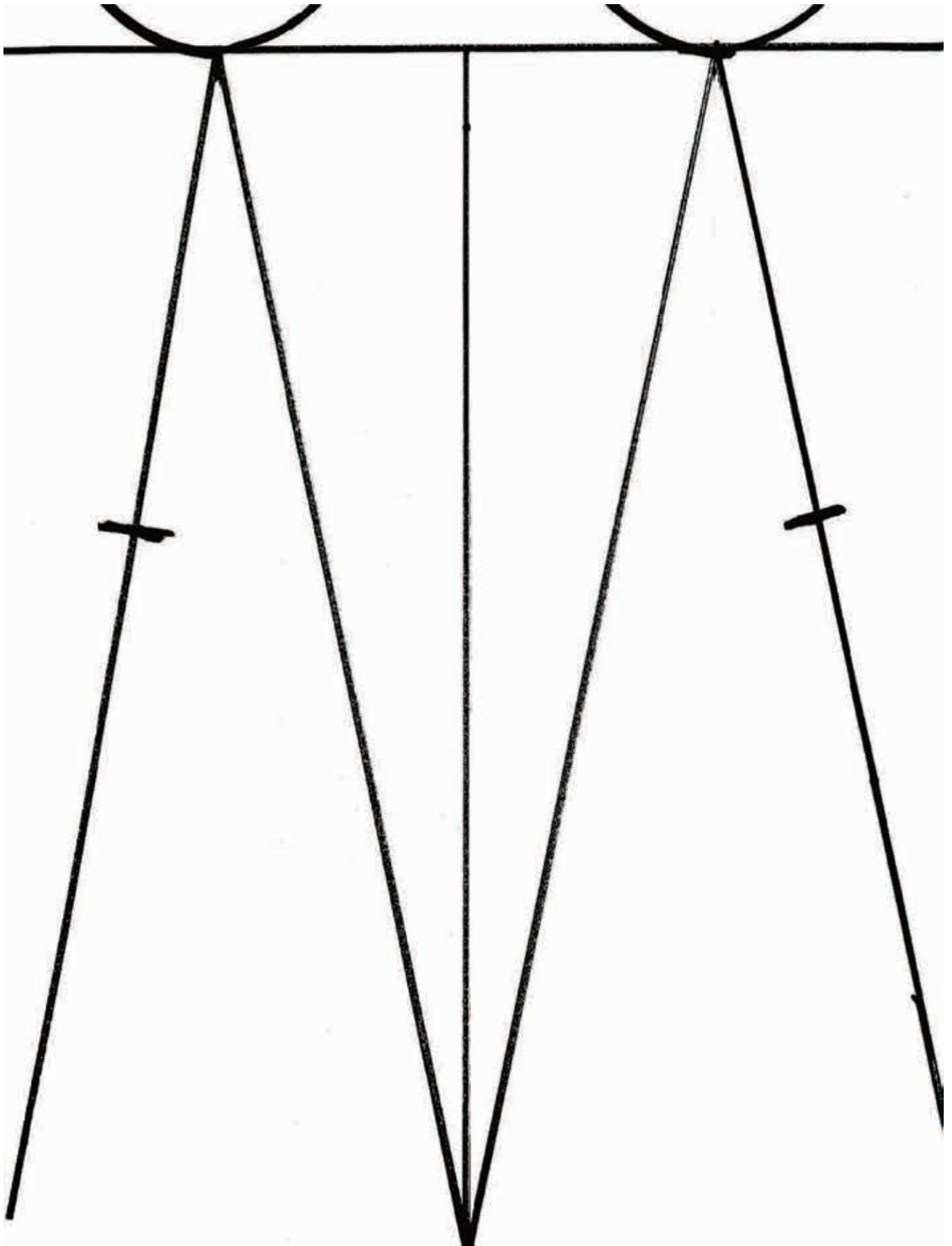
1. Combine the average temperatures and the percentages of incoming light in the table below.

Average Water Temperature Change vs. Light Measurements (% Incoming Light)

	Condition	ΔT	Transmitted	Reflected
Light	Clear			
	Foil			
	White			
	Black			
Dark	Clear		0	0
	Foil		0	0
	White		0	0
	Black		0	0

2. What do you notice and wonder about how light changes (or does not change) the water temperature in each cup type?

Notice	Wonder



Name: _____

Date: _____

Class Investigation: Heat or Cold Through the Cup Wall

Part 1: Investigation Plan

The question we want to answer

Investigation question: How does changing _____
affect _____?

To change, measure, or stay constant

Decide what we will change, control, and measure in our investigation.

Independent variables: Water inside the cup (cold or hot), water outside the cup (cold, hot, or room temperature)

Dependent variables: Temperature inside the cup, temperature outside the cup in the water bath

2. Discuss the following issues. Take notes to include in our procedures.

- where to place the thermometers inside and outside the cup to get the most accurate measurement
- when to take the first measurement
- when to take the final measurement
- how to take the measurement to get the most accurate temperature

3. What things should we keep the same during our tests?

Control variables:

_____	_____
_____	_____
_____	_____
_____	_____

Part 2: Carry Out Investigation and Record Data

- 1. Fill 2 containers with 200 mL room-temperature water, 1 container with 200 mL cold water, and 1 container with 200 mL hot water.
- 2. Fill 2 cups with 200 mL cold water and 2 cups with 200 mL hot water.
- 3. Place a thermometer in each of the 4 cups and 4 containers.
- 4. Wait for 10 seconds, then record the first temperature measurement. Remove the thermometers from the cups and containers.
- 5. Pair up the cups and containers into the following combinations and label them with a, b, c, and d:
 - a. hot cup, room-temperature container
 - b. hot cup, cold container
 - c. cold cup, room-temperature container
 - d. cold cup, hot container
- 6. Place each cup inside its paired container. Seal each container with its lid, with the cup inside.
- 7. Wait 5 minutes and then open the containers.
- 8. Take the cups out of the containers to stop the cup and water bath systems from interacting.
- 9. Place a thermometer in each of the 4 cups and 4 containers.
- 10. Wait for 10 seconds, then record the final temperature measurement. Calculate and record the change in temperature.

Data Table

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Hot			
Outside: Room temperature			

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Hot			
Outside: Cold			

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Cold			
Outside: Room temperature			

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Cold			
Outside: Hot			

Part 3: Making Sense of Our Data

1. What patterns do you notice in the data?
2. What patterns do you notice about the final temperature measurements?
3. What happens when the temperature difference between the water inside the cup and the water outside the cup is increased?

Name: _____

Date: _____

Data Set and Analysis: Heat or Cold Across the Cup Wall

Observed data

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Hot	54.5	38.0	-16.5
Outside: Room temperature	27.0	37.0	+10.0

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Hot	43.0	23.0	-20.0
Outside: Cold	8.0	23.0	+15.0

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Cold	6.0	18.0	+12.0
Outside: Room temperature	27.0	21.0	-6.0

	Start temperature 10 seconds	Final temperature 5 minutes	Δ Temperature
Inside: Cold	8.5	23.0	+14.5
Outside: Hot	51.5	27.0	-24.5

Making sense of the data

1. What patterns do you notice in the data?
2. What patterns do you notice about the final temperature measurements?
3. What happens when you increase the temperature difference between the water inside the cup and outside the cup?

Name: _____

Date: _____

Small-Group Investigation: Heat or Cold Through the Cup Wall

Part 1: Investigation Plan

The question we want to answer

Investigation question:

How does changing _____ affect
_____?

To change, measure, or stay constant

Decide what we will change, control, and measure in our investigation.

1. What variables do we want to test?

Independent variable(s): _____

Dependent variables: Temperature inside the cup, temperature outside the cup in the water bath

2. Discuss the following issues. Take notes to include in our procedures.

- where to place the thermometers inside and outside the cup to get the best measurement
- when to take the first measurement
- when to take the final measurement
- how to take the measurement to get the most accurate temperature

3. What things should we keep the same during our tests?

Control variables:

_____	_____
_____	_____
_____	_____
_____	_____

Procedures

Your group's procedures	Edits or notes
1.	

Part 2: Carry Out Investigation and Record Data

Data Table

Start time: _____

Final time: _____

	Start temperature	Final temperature	Δ Temperature
Inside: _____			
Outside: _____			

	Start temperature	Final temperature	Δ Temperature
Inside: _____			
Outside: _____			

Part 3: Making Sense of Our Data

1. What patterns do you notice in the data?
2. What patterns do you notice about the final temperature measurements?
3. What happens when the temperature difference between the water inside the cup and the water outside the cup is increased?

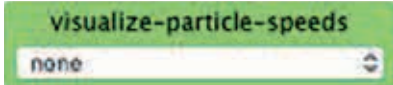
Particle Interactions in Gases

Part A: Exploring the Interactive Simulation

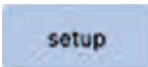
1. Open a web browser and go to the following address: <https://openscienced.org/gas-particle-motion/>
2. Select the following settings on the simulation:

a. 

b. 

3. Next, open the drop-down menu for  and select any of the options.

4. Record your selections in the **Setup** table for **Trial 1**.

5. Input your selections into the simulation by clicking on 

6. Start the simulation by clicking on 

7. Let the simulation run for 10-15 seconds, then record the data from the 4 yellow data boxes in the Record **Data table** for **Trial 1**.

8. After you record the data, click on  to follow the motion of 1 particle, then let the simulation run for about 10-15 seconds.

9. Record what you observe in the **Observations** table for **Trial 1**.

10. Repeat steps 2-9 two more times. For each trial, change the settings in the three green boxes (for temperature, number, and speed of particles), record the settings in the trial's **Setup** table, and then record the data from the four yellow data boxes in the trial's **Record Data** table.

11. Don't forget to click on  and document what you observe in the **Observations** table for each trial.

Trial 1

Setup	
Green slider/Drop-down menu	Selected setting
Initial gas temperature	
Initial # of particles	
Visualize particle speeds	

Record Data	
Yellow data box	Data
Temperature of the entire gas	
Total kinetic energy	
Speed of the slowest particle	
Speed of the fastest particle	

Observations

Trial 2

Setup		Record Data	
Green slider/Drop-down menu	Selected setting	Yellow data box	Data
Initial gas temperature		Temperature of the entire gas	
Initial # of particles		Total kinetic energy	
Visualize particle speeds		Speed of the slowest particle	
		Speed of the fastest particle	

Observations

Trial 3

Setup		Record Data	
Green slider/Drop-down menu	Selected setting	Yellow data box	Data
Initial gas temperature		Temperature of the entire gas	
Initial # of particles		Total kinetic energy	
Visualize particle speeds		Speed of the slowest particle	
		Speed of the fastest particle	

Observations

Particle Interactions in Gases

Part B: Collecting Data

1. Fill in the setup information for your small group:

Setup				
Group	Keep the same	Setting	Change	Settings

2. Investigate the particle interactions that occur in the simulation as you make changes in the variable that you are assigned to change. Remember to record all settings and data.

Trial 1

Setup		Record Data	
Green slider or Drop-down menu	Selected setting	Yellow data box	Data
Initial gas temperature		Temperature of the entire gas	
Initial # of particles		Total kinetic energy	
Visualize particle speeds			

Trial 2

Setup		Record Data	
Green slider or Drop-down menu	Selected setting	Yellow data box	Data
Initial gas temperature		Temperature of the entire gas	
Initial # of particles		Total kinetic energy	
Visualize particle speeds			

Trial 3

Setup	
Green slider or Drop-down menu	Selected setting
Initial gas temperature	
Initial # of particles	
Visualize particle speeds	

Record Data	
Yellow data box	Data
Temperature of the entire gas	
Total kinetic energy	

Trial 4

Setup	
Green slider or Drop-down menu	Selected setting
Initial gas temperature	
Initial # of particles	
Visualize particle speeds	

Record Data	
Yellow data box	Data
Temperature of the entire gas	
Total kinetic energy	

Observations
What patterns in your data do you notice? What do those patterns help you figure out?

Name: _____

Date: _____

Investigating Particle Collisions Within and Between Solids

Activity	Question we are investigating	Prediction	Observations
5	How will the motion of particles in a solid at a lower temperature compare with the motion of particles in a solid at a higher temperature?		
6	What will happen to the motion of the particles over time in a hot solid and a cold solid when they are touching each other?		
7	How does the amount of a solid's surface in contact with another solid's surface affect the amount of temperature change in both solids?		
8	How does the amount of particles in 2 solids in contact with each other affect the amount of temperature change in both solids?		

Name: _____

Date: _____

Investigating Particle Collisions in Different States of Matter

Activity	What did we use to represent particles?	What state of matter is this similar to?	What interactions did we see between the particles that resulted in speed changes?	How does this connect to what can cause changes in the kinetic energy of the particles in the cup system?
1	Computer-simulated particles spaced far apart, moving about freely			
2	Rolling 2 marbles into each other along a tray			
3	Rolling 1 marble into a cluster of marbles			
4	Rolling 1 marble into a cluster of marbles with a layer of magnetic marbles in between			

Making Sense

Apply what you just did to the particles of matter in our previous cup experiments. We put room-temperature water inside a cup and surrounded it with cold water. The cold water outside the cup increased in temperature and the room-temperature water inside the cup decreased in temperature. What did you figure out today about particle collisions that could help explain these temperature changes?

Evidence Sorting Chart

Heat moving	Cold moving
Heat and cold moving	

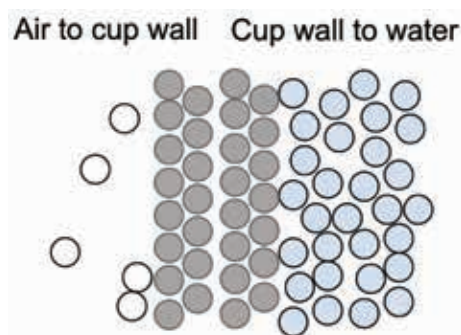
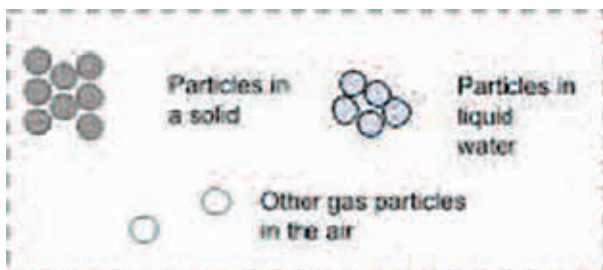
Name: _____

Date: _____

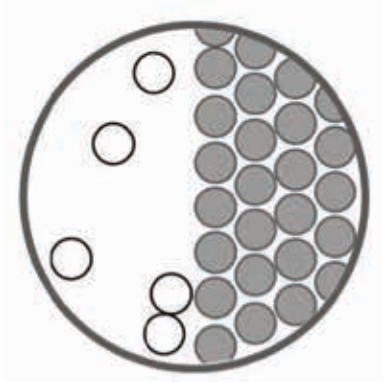
Modeling What Is Happening at the Cup Wall

In Lesson 6, you constructed a model to explain how a cup with a lid helps to keep water cold longer than a cup without a lid. Now, we're going to zoom in on what happens around the cup wall to explain how the cold water in the cup system warmed up.

In particular, we're going to look at 2 different places: where the air meets the cup wall and where the cup wall meets the water.



Annotate these models by drawing and writing descriptions on them to explain what happens at the 2 locations when the temperature of cold water inside the cup system increases over time.

Air and cup wall	Cup wall and water
 A circular diagram showing a cross-section of a cup. The left half is white and contains several white circles representing gas particles. The right half is filled with grey circles representing the solid cup wall. The boundary between the air and the wall is on the right.	 A circular diagram showing a cross-section of a cup. The entire circle is filled with a mixture of grey circles (solid cup wall) and blue circles (liquid water particles). The boundary between the wall and the water is on the right.

Name: _____

Date: _____

Evaporative Cooling

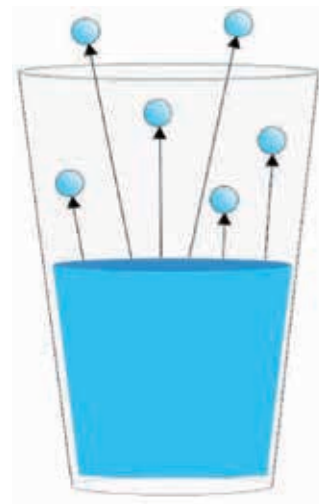
The lid on a hot drink does more than just protect a person from a spill. The lid also helps to keep the hot drink warm for a longer time. You gathered evidence of this in your investigations. But if drinks warm up or cool down because energy is transferring into or out of the cup system, then why does the lid matter so much? And why does the lid matter more for keeping drinks hot as opposed to keeping drinks cold?



A cup with a lid on it is better at keeping liquids hot than a cup without a lid. This is because the lid slows down matter loss from the system. Matter is lost when some of the liquid particles at the surface get enough energy to turn into a gas. These gas particles float out of the cup. This process is called *evaporation*.

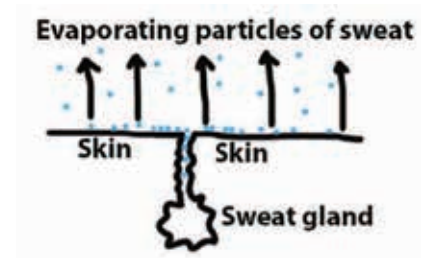
As water evaporates out of a cup of hot tea, you might see steam. This steam is caused by evaporation, but it is not gas particles that you see. When gas particles that evaporated float away from the hot tea, they begin to cool off. Some of the water condenses back into water droplets that float in the air above the cup. These droplets form the clouds above the cup that we call steam.

As a particle of gas leaves the cup system, the energy of that particle's movement also leaves the system. The particles that evaporate have above-average kinetic energy. When they evaporate, it lowers the average kinetic energy of the remaining liquid. This means there will be a temperature drop. This is called *evaporative cooling*.



Evaporative cooling is a process that allows energy to transfer from a hot system to a cooler system. More surface area for evaporation helps speed up the energy transfer. So, a cup without a lid allows more evaporative cooling to happen compared to a cup that has a lid with only small gaps and holes.

Evaporative cooling is not just a process that cools hot beverages. It is also the process that your body uses to cool off on a hot day. Your sweat glands push water through tiny holes in your skin until your body is coated in sweat. The water evaporates, taking energy away with it. This lowers the average kinetic energy at the surface of your skin, cooling you off.



Summarize important ideas you learned from the reading.

Name: _____

Date: _____

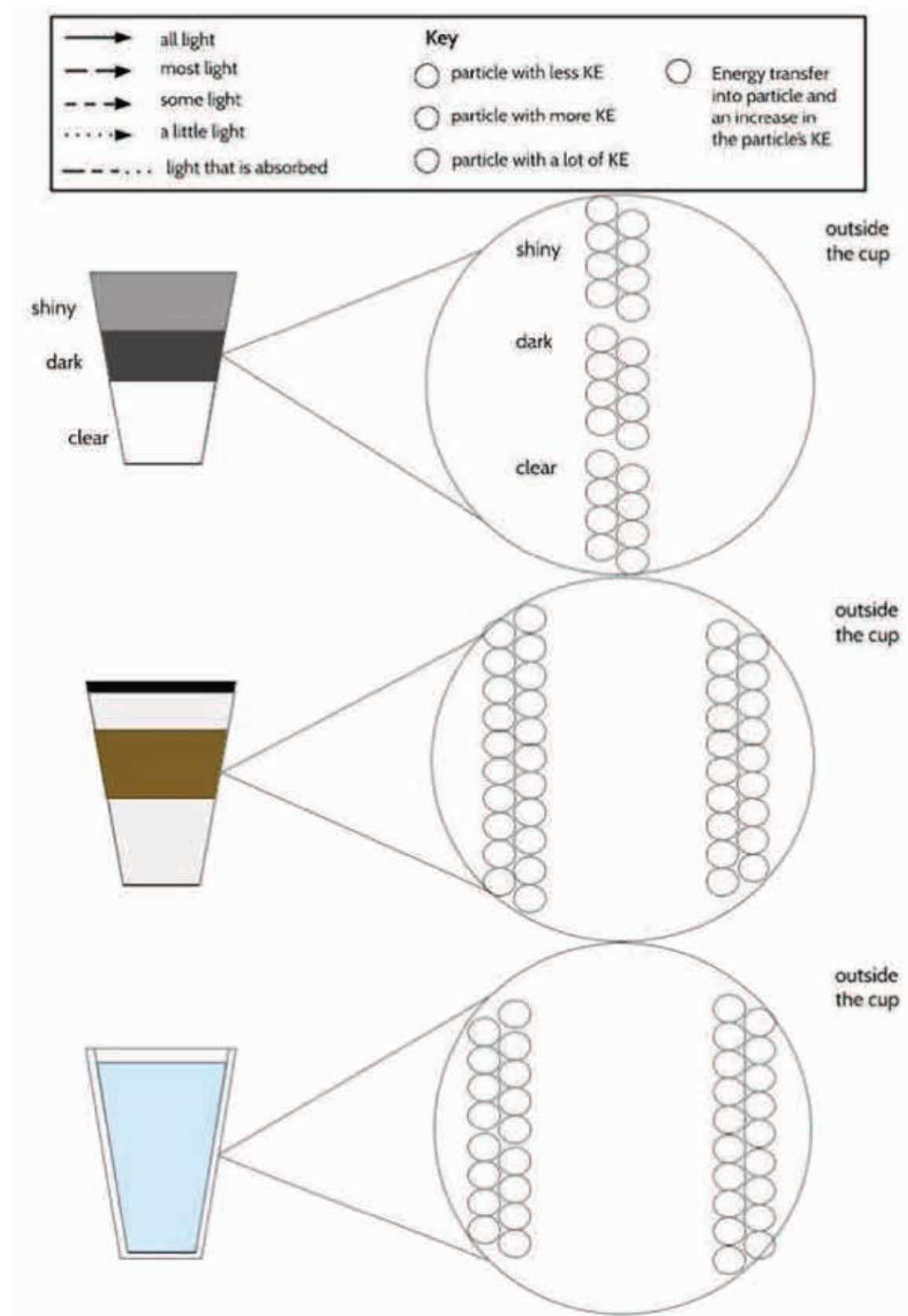
Features of Cups that Keep Drinks Cool

What works	Why it works	Still need to know

Name: _____

Date: _____

Final Cup Consensus



Name: _____

Date: _____

How Double Walls Work

When you want to buy a new water bottle, there are many choices. Some companies claim that their new bottles work better than other bottles. A few others claim that their bottles keep ice inside them from melting for over 24 hours and also keep drinks hot for 12 hours. These high-performing bottles can be expensive.

Those bottles are so good at keeping liquids cold or hot because they have a vacuum between the 2 walls. A vacuum is space without particles. Each bottle wall is made from particles tightly packed together as in other solids, but there are no particles, or very few, between the two solid walls.

Let's take a closer look at how the double-walled vacuum design works.

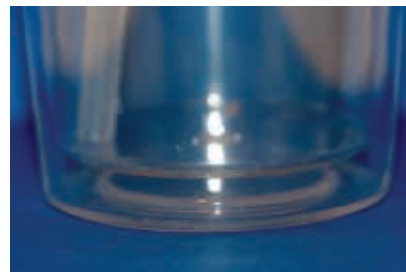


The first vacuum-insulated bottle was designed in the 1890s by a scientist named James Dewar. His bottles were made of 2 layers of glass. Between the 2 layers was a vacuum, or completely empty space. Well, it was mostly empty space but probably had a few gas particles still lingering between the glass layers.

About 10 years later, other inventors took Dewar's design and started making thermos containers for drinks. The early glass containers were breakable, so engineers looked for other materials to use, such as metal and plastic. The new bottles available today are the result of over 100 years of scientific research and engineering.

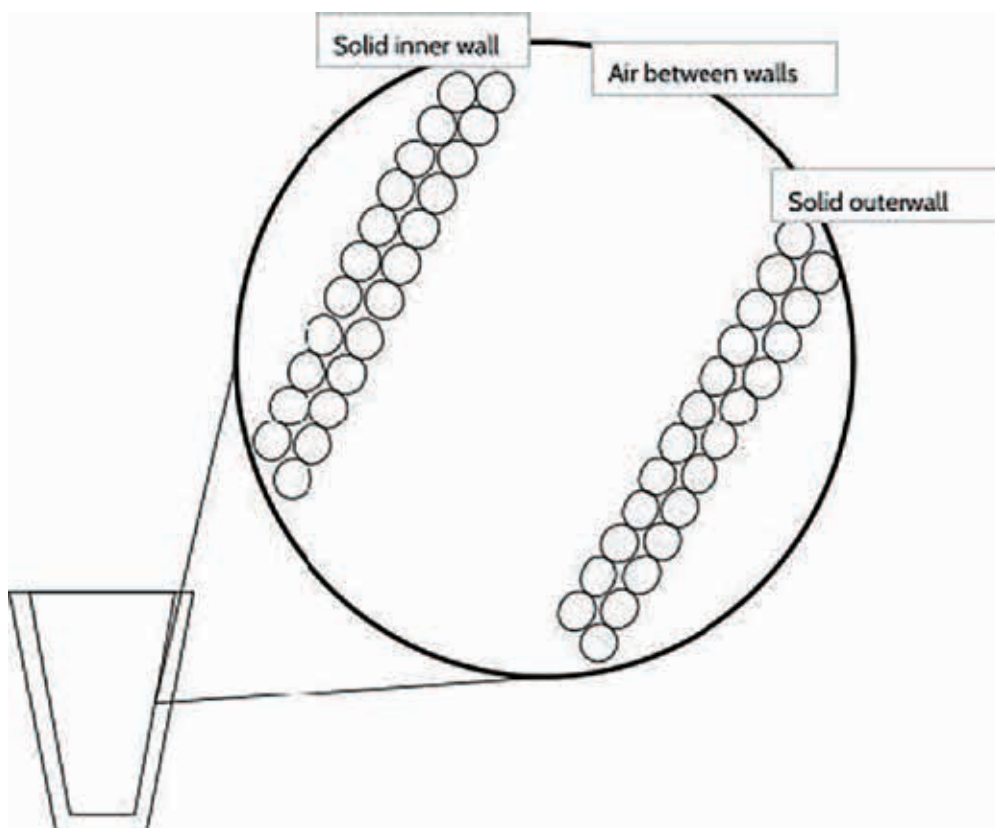


The price of vacuum-insulated bottles is high. A cheaper option is air-insulated bottles, which have a layer of gas particles between the 2 solid walls. Air-insulated bottles don't work as well as vacuum-insulated bottles, but they still do better than regular single-walled bottles. How can having air between the 2 solid layers help so much?



1. Using what you know about energy transfer through particle collisions, why do you think a double-walled air-insulated design would be helpful in keeping a drink cold? Draw a model to show how the layer of air slows down energy transfer.

Model for Double-Walled Air Insulation



2. Two popular materials for water bottles are metal and plastic. Both materials normally transfer energy really fast. How did designers use materials that normally transfer energy fast in a way that slows down energy transfer instead?

3. Why does a vacuum perform better than air between the bottle's double wall?

Name: _____

Date: _____

How Light Warms Up Matter

Light does a few different things when it shines on matter. When light shines on something, some of the light reflects off the particles. This is called reflection. When light reflects off a mirror, for example, we see an image reflected back at our eye. This only happens when light shines on a surface that is very smooth, like the surface of mirrors and glass. If the surface is bumpy, light still reflects off particles, but it scatters in all directions, and only some of that light reaches our eyes.



Sometimes light moves right past the particles. This is called transmission. When light transmits through a transparent material, like a window, we can see everything on the other side. Sometimes light transmits through one transparent material, like a clear plastic cup, but cannot transmit as well through the drink inside, like coffee or tea.



Sometimes light does not reflect off or transmit through a material. When this happens, the light transfers energy directly into a particle of matter. This is called absorption. For example, when light from the sun is absorbed by our skin, the energy from light is absorbed by our skin particles, and we start to feel warm. This means our skin particles are starting to move more and have more kinetic energy.



What determines whether light is reflected, transmitted, or absorbed? It all depends on the kind of light, and how the particle moves before light shines on it. When light reaches a particle, if the kind of light matches the way the particle normally moves, the energy from the light transfers into the particle. The particle starts moving more. We call this movement *kinetic energy*. So, the energy from light is now the kinetic energy of the particle's movement.

Over time, the particle will transfer that kinetic energy into the other particles around it, and the temperature of the matter will go up. Eventually, if the light is no longer shining on the matter, the kinetic energy of the particles will go back to normal.

Questions to answer with your group:

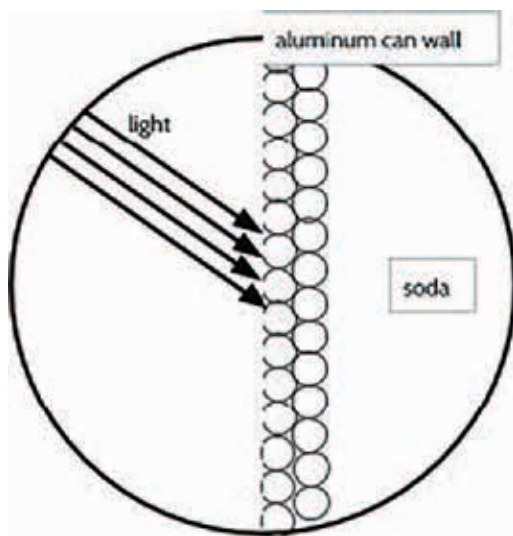
1. For each of the images below, use the conventions from the light unit to draw a diagram of the light when it shines on the wall of cups made from different materials.



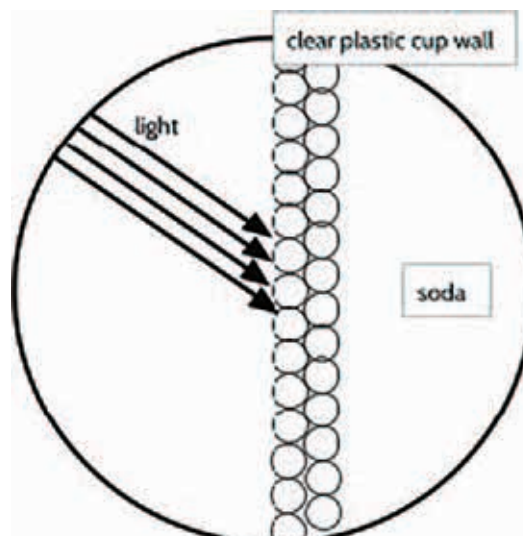
Key	
	All light
	Most light
	Some light
	A little light
	Absorbed light
	Reflective
	Transmissive
	Absorptive
	Energy transfer to a particle = more kinetic energy

2. Based on the information presented in the reading, why do you think soda in an aluminum can will stay cooler for longer than soda in a clear plastic cup? To support your explanation, draw a model of light hitting the wall of an aluminum soda can at a particle scale, and a model of light hitting the wall of a clear plastic cup at a particle scale. Use the symbols from the key above.

Light hitting the particles on the wall of an aluminum soda can



Light hitting the particles on the wall of a clear plastic cup



Name: _____

Date: _____

How Styrene, Neoprene, and Cardboard Sleeves Work

During the past 100 years, our drink containers have changed a lot. This began in the 1940s, 1950s, and 1960s when more Americans wanted disposable cups for their coffees and sodas. The first material used for disposable cups was paper. With paper cups, people did not like that their fingers burned when there was a hot drink inside. In the 1960s, a father and son from Michigan, both named William Dart, invented and sold the first styrene cups (most people call these styrofoam cups, but styrofoam is actually a different material used for different things). Styrene cups do a good job at keeping drinks cold and hot.



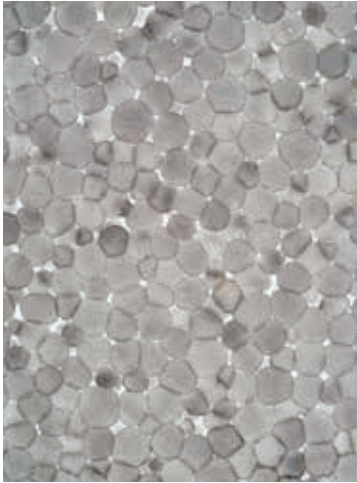
However, many coffee companies chose to use paper cups instead of styrene. This led Jay Sorenson from Oregon to invent the first Java Jacket in 1991, which is the cardboard sleeve that wraps around a paper cup to keep hot drinks from burning people's fingers. Sorenson was not an engineer or a scientist. He was a consumer who was tired of burning his fingers. He first thought to make a foam cup, but he later realized the sleeve was more affordable and a better design for his goal. Nowadays, billions of cardboard coffee cup sleeves are sold worldwide.



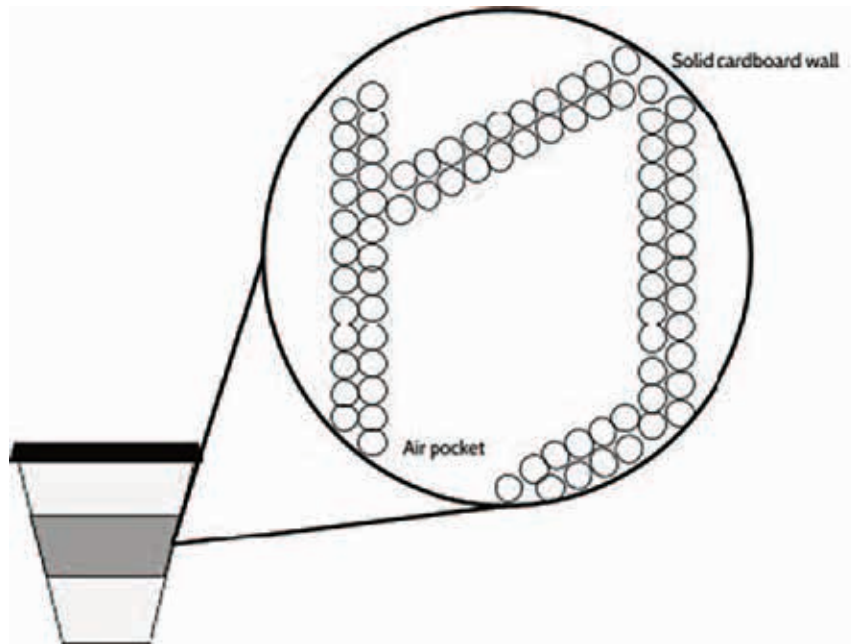
Similar to a coffee cup sleeve, people also use something called a drink koozie, or cozy, to keep drinks cold. The cozy was first designed in 1981 by Bonnie McGough from Idaho. Bonnie got the idea for the cozy from her hobby of quilting. She designed a cozy to keep a cold 12-ounce soda can cold for a long time. Her cozy was made from 2 layers of fabric with a layer of goose feathers in between. Around the same time, the Radio Cap Corporation also designed a koozie made from foam. Today, drink koozies and cozies come in all shapes and sizes, but most of them use foam and neoprene to insulate the drinks.



These 3 designs share some common features. They are porous, which means they contain air pockets. Look at the close-up images below and use them to develop a model for why materials with air pockets slow down energy transfer between the drink and the outside air.

Polystyrene magnified	Coffee cup sleeve taken with a regular camera and close-up lens	Drink cozy taken with a regular camera and close-up lens
		

1. Using what you know about energy transfer through particle collisions, why do you think these materials would be helpful in keeping a drink cold or hot? Draw a model of the cardboard coffee sleeve to show how the air pockets slow down energy transfer.



2. Most of these inventors were trying to develop something that worked better than paper cups. How would your model be different with a paper cup? Draw and use words to describe the difference.

Name: _____

Date: _____

Part 1: Define the Problem and Setup the Design Challenge

Problem: Iced drinks bought from coffee shops and restaurants warm up and water down too quickly, especially on warm, sunny days. Stores sell reusable cups that keep drinks colder for longer and reduce environmental impacts, but these cups can be expensive.

Goal: Using everyday materials, design a cup that uses the best design features we know about to keep a drink as cold as the store bought cups.

Criteria: a standard that must be met by the design.

1. Temperature change of less than 1°C after 12 minutes in regular light.
2. Temperature change of less than 2°C after 12 minutes in bright light.
3. Other: _____

Constraint: a limitation to what can be designed.

1. Use no more than two 16 oz plastic cups.
2. Materials must be recyclable or reusable to reduce waste if cup is thrown away. Cannot use styrofoam because this material is harmful to the environment.
3. Can use up to 3 materials, not including the cup itself.
4. Fit in a typical car cup holder (10 cm wide at a height of 8 cm deep).
5. Keep cost low and affordable (less than \$0.50 for the whole cup).
6. Other: _____

Tests to conduct:

- Diameter test
- 12-minute regular light-temperature test
- 12-minute bright light-temperature test
- Environmental impact test
- Price check test
- Other: _____



Part 2: First Design Ideas

Sketch your design Label three design features using the numbers 1, 2, and 3. (Structures)	Design features Describe the feature and explain how it minimizes energy transfer. (Function)
	Feature 1
	Feature 2
	Feature 3
Look back at the criteria and constraints (C&C). Describe what your cup design does well and where your cup might not meet the C&C.	
Pros—what the cup does well	Cons—where your cup may not meet the C&C

Part 3: Test 1

What were your results?

[illegible]

Part 4: Evaluate your design

Explain your results given the design features.

What worked and why did it work?

What is not working and why?

What are suggestions you received from your peers or teacher that you may want to consider?

List the design features that worked well for many of the cup designs in your class and explain why they work.

What worked well across cups? (Structure)	How did it slow energy transfer? (Function)

Part 5: Redesign ideas

Sketch your design Label three design features using the numbers 1, 2, and 3. (Structures)	Design features Describe the feature and explain how it minimizes energy transfer. (Function)
	Feature 1
	Feature 2
	Feature 3

Changes	Which test will it perform better at?	How will it help?

Part 6: Test 2

What were your results?

Tests to conduct	Observations
Diameter test	Measurements: At 8 cm deep, the cup is _____ cm wide.
12-minute regular light-temperature test	Record temperature change in °C 0 min temp 12 min temp Δ temp
12-minute bright light-temperature test	Record temperature change in °C 0 min temp 12 min temp Δ temp
Environmental impact test	Reusable: Recyclable: Landfill:
Price check test Use the Cup Design Price Sheet	Cost of your cup: _____ <i>Show your math here:</i>

Part 7: Evaluate your 2nd design

Explain your results given the new design features you modified.

Test	How did your redesigned cup perform compared to your first design? (Better, worse, or the same and why do you think this is the case?)
Diameter test	
12-minute regular light-temperature test	
12-minute bright light-temperature test	
Environmental impact test	
Price check test	

If you were going to build a 3rd design, what would you change and why?

I would change... (Structure)	This would minimize energy transfer because... (Function)

Part 8: The best performing design features

Look across your class' designs and test results to compare performance of cup designs.

Pick 3 design features that are supported by evidence to minimize energy transfer. Imagine building a cup that uses the best three design features from all the cups in your class. Draw a sketch of this cup and describe how each feature works to minimize energy transfer.

Sketch your design Label three design features using the numbers 1, 2, and 3. (Structures)	Design features Describe the feature and explain how it minimizes energy transfer. (Function)
	Feature 1
	Feature 2
	Feature 3

Name: _____

Date: _____

Design Evaluation: Peer Feedback

Instructions: First, check that the test results met the criteria. Then, check that the cup design met the agreed upon constraints. Finally, write feedback to the group about what works well and what can be improved in the design.

Criteria: how did the test results compare to the criteria?

- Temperature change of less than 1°C after 12 minutes in regular light.
 - Test result: _____ (Δ temp)
- Temperature change of less than 2°C after 12 minutes in bright light.
 - Test result: _____ (Δ temp)
- Other: _____

Constraints: did they meet the agreed upon constraints?

- Use no more than two 16 oz plastic cups.
- Cannot use styrofoam because this material is harmful to the environment. Materials must be recyclable or reusable to reduce waste if cup is thrown away.
 - Test result: _____ (were there any landfill materials used?)
- Can use up to 3 materials.
- Fits in a typical car cup holder (10 cm wide at a height of 8 cm deep).
 - Test result: _____ (cm)
- Must be affordable to build.
 - Test result: _____ cost)
- Other: _____
- Other: _____

Feedback

What do you think works well about the design?

How can this group improve their design so that it performs even better? What can they change and how might it help?

Name: _____

Date: _____

Let's Answer Questions from Our Driving Question Board!

Look through the list of questions from our DQB. Mark questions that you think the class has answered by putting different symbols next to each question:

- We did not answer this question or any parts of it yet: ?
- Our class answered some parts of this question, or the ideas we developed help me see how I could now answer some parts of this question: ✓
- Our class answered this question, or the ideas we developed help me see how I could now answer this question: ✓✓

Then pick three of the questions you have marked and write what you think that answer would be.

Question	Answer and Supporting Evidence

Question	Answer and Supporting Evidence

Science Literacy Exercise Page 1

Use with Reading Collection 1

Roadmap for Reading

This week's reading collection focuses on the effects of hot and cold temperatures on Earth and on humans. The selections include a piece of fiction by well-known early 20th-century author Jack London. Together, the selections provide data on the ranges of temperatures humans experiences on Earth.

"Collection 1: People and Temperature" consists of five selections.

- 1 "To Build a Fire" (Part 1)
- 2 Extreme Temperatures
- 3 Temperature Scales
- 4 Heat and Industry
- 5 Greenhouse Effect

As you read:

- Consider the general purpose of each part: is it a narrative, a description, an explanation, a procedure, or an attempt to persuade?
- Consider how images, data, and graphics support the text and how the text clarifies the images, data, and graphics.
- Determine the main idea of each selection.

Written Response

Your writing exercise is to create an interesting graphic organizer that shows a range of temperatures on Earth using a relative (nonnumerical) scale.

- Draw your graphic organizer on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Sketch a large vertical thermometer—much like the one you are using to test your drink cups.
- On scrap paper, make a list of all the situations described by temperature in the five reading selections. Be sure to note which scale (Fahrenheit, Celsius, Kelvin) is used for each.
- Select nine or more of these temperatures and list them from warmest to coolest.
- Write them alongside the drawing of the thermometer, placing them in order to show the relative scale. The coolest temperature should be placed near the bottom of the thermometer and the warmest at the top.
- Draw lines to connect the labels to locations on the thermometer, showing how the temperatures relate to one another.
- Write a title for your graphic organizer that summarizes its key point.

Science Literacy Exercise Page 1 continued

Evaluation Guidelines

- ☐ The thermometer drawn looks like the one used in class and is drawn to fill the page.
- ☐ At least nine places/situations in the reading selections where temperature is described.
- ☐ The places/situations are ordered from warmest at top to coolest at bottom along the thermometer.
- ☐ The labels are spaced vertically to show relative temperatures.
- ☐ The title is properly capitalized and clearly explains the main idea of the graphic.

Additional Feedback Notes:

Science Literacy Exercise Page 2

Use with Reading Collection 2

Roadmap for Reading

This week's reading collection focuses on water and ice on Earth and temperature changes. Two of the selections are about ice and three are about cold and warm ocean currents.

"Collection 2: Water, Ice, and Temperature Change" consists of five selections.

- 1 The 19th-Century Ice King
- 2 Ice in Glaciers
- 3 Global Conveyor Belt Current
- 4 Astronaut Blog
- 5 Eddies

As you read:

- Consider the author's purpose for writing each selection: is it a description, an explanation, a procedure, or an attempt to persuade?
- Consider how the author's point of view affects the style of the selection.
- Think about how each of the readings relates to your investigations into how ice and water change temperature in closed and open systems.

Written Response

After completing this week's reading selections, your writing exercise is to complete an outline that summarizes the science in each of the selections.

- Copy the partially written outline on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Go back and review the readings, looking especially at topic sentences, vocabulary, and concluding paragraphs. Write the details needed to summarize each reading and complete the outline.
- Include details that discuss melting, warmth, thermal energy, and water particles.
- Write your own title above the outline, summarizing the entire collection of readings.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

I. Keeping Pond Ice from Melting

A. Icehouses and Iceboxes

1. Icehouses stored large blocks of ice cut in winter.
- 2.

B. Ice Shipping

- 1.
- 2.

II. Melting Glaciers

A. The Fox Glacier

- 1.
- 2.

B. Glaciers around the World

- 1.
- 2.

III. The Global Conveyor Belt

A. Where Water Moves

- 1.
- 2.

B. The Effects on the Ocean Characteristics

1. Mixes salty and less salty water
- 2.

IV. Currents of North America

A. The California Current

- 1.
- 2.

B. The Gulf Stream

- 1.
- 2.

Science Literacy Exercise Page 2 continued

V. Fishing in Eddies

A. What Eddies Are

- 1. Water spun off from the Gulf Stream
- 2.

B. The Effects of Eddies

- 1.
- 2.

Evaluation Guidelines

Element	1	2	3	Feedback
Outline Title	Inadequately summarizes the collection of readings or connects to Lessons 4 and 5	Clearly summarizes either the entire collection of readings or connects to Lessons 4 and 5 science investigations	Clearly summarizes the entire collection of readings and connects to Lessons 4 and 5 science investigations	
Supporting Details	Incomplete or inaccurate statements, or details irrelevant to the heading above	Complete or accurate statements, but lacking in support from the reading, or unclear relationship with the heading above	There are at least two third-level details under each second-level heading. Detail sentence address important main ideas appropriate to the heading above them.	
Outline Structure	Outline format and structure from the model were not followed or followed with many errors.	Outline format and structure from the model were followed with few errors.	Proper outline format and structure were used as modelled in the directions. All three levels are present. There are at least two details for each heading.	
Grammar and Mechanics	Six or more errors in punctuation, capitalization, and spelling	Three to five errors in punctuation, capitalization, and spelling	Fewer than three errors in punctuation, capitalization, and spelling	

Science Literacy Exercise Page 3

Use with Reading Collection 3

Roadmap for Reading

This week's reading collection focuses on systems involving temperature that are sometimes difficult to control because they are so complex or big. The selections include closed and open systems. All involve changes in energy.

"Collection 3: Temperature in Systems" consists of five selections.

- 1 "To Build a Fire" (Part 2)
- 2 Beebe, Barton, and the Bathysphere
- 3 Biosphere 2
- 4 Turning Windows into Solar Cells
- 5 Heat Too Powerful to Control

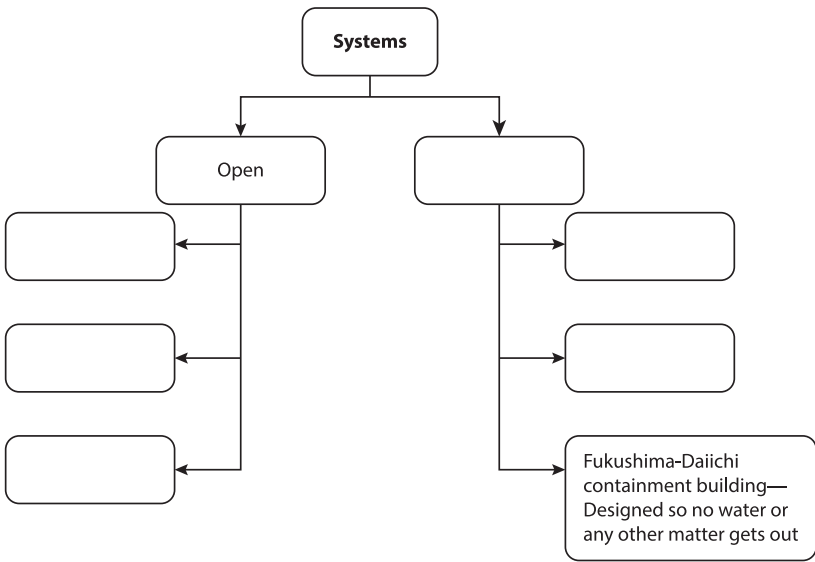
As you read:

- Consider the general purpose and point of view of each part:
 - Is it a fictional narrative?
 - Is it a true-life narrative?
 - Is it a description of an old or new technology?
 - Is it an explanation of how and why an event occurred?
 - Is it written from a first-person, second-person, or third-person point of view?
- Consider how images and diagrams support and clarify the text.
- Identify a theme related to your lesson investigations that unites all the parts.

Written Response

After completing this week's reading, your writing exercise is to produce a graphic organizer showing examples and reasoning related to two types of systems.

- Sketch your graphic organizer to fill one side of a separate sheet of paper; use the partially completed organizer shown on the next page as your template. Attach this page to the front of it when you turn it in.
- Use what you have learned from your investigations and class discussions to complete the missing subheading under "Systems."
- Your organizer should show examples from the readings of systems and your reasoning about what kind of system each one is.
- Review the reading selections to find examples of each of the two kinds of systems.
- Draw a text bubble for each example, writing the name of the example and your reasoning for why it is that kind of system.
- Add color to improve your design. Check the arrows and the overall design and text to make sure they are attractive and readable.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.



Evaluation Guidelines

Element	1	2	3	Feedback
Content	The missing subconcept is not appropriate. Two or more examples are missing, and some of the reasoning is missing or illogical.	The one blank subconcept is identified accurately. One example is missing, or some of the reasoning is missing or illogical.	The one blank subconcept is identified accurately. Accurate examples with logical reasoning from at least three reading selections are shown for each of the two subconcepts.	
Relationships of Concepts	Some arrows do not show relationships correctly, and the three levels of organization are not entirely clear.	Linking arrows show relationships correctly, but the three levels of organization are not entirely clear.	Linking arrows show relationships correctly. The three levels of organization are clear.	
Design	Major improvements are needed in the design of missing heading, shapes, arrows, and arrangement to fill the page.	All but one of the following are well executed: Headings, details, and shapes are attractive and easy to read. Color is used effectively to show organization of concepts. Fills the whole page effectively.	Headings, details, and shapes are attractive and easy to read. Color is used effectively to show organization of concepts. Fills the whole page effectively.	
Grammar and Mechanics	Five or more errors in punctuation, capitalization, and spelling	One to four errors in punctuation, capitalization, and spelling	No errors in punctuation, capitalization, and spelling	

Science Literacy Exercise Page 4

Use with Reading Collection 4

Roadmap for Reading

This week's reading collection focuses on how heat moves from warm objects to cool objects and what materials can prevent heat transfer. The selections include explanations of adaptations that allow organisms to survive at a variety of temperatures.

"Collection 4: Temperature and Organisms" consists of five selections.

- 1 "To Build a Fire" (Part 3)
- 2 Too Cold, Too Hot
- 3 Animals and Body Temperature
- 4 Water and Blubber
- 5 Arctic Ground Squirrel

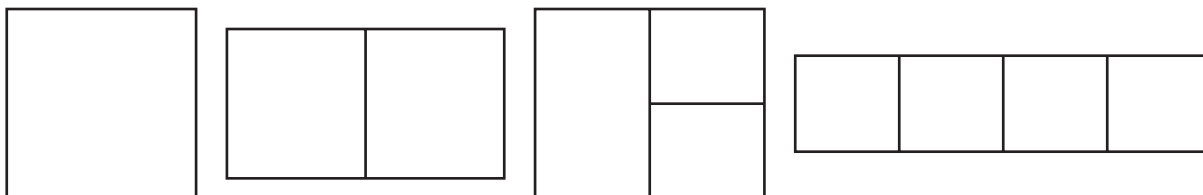
As you read:

- Consider the general purpose of each part: is it a narrative, a description, an explanation, a procedure, or an attempt to persuade?
- Decide if the author's point of view is first person, second person, or third person.
- Try "reading" the images first to predict what the text will develop.
- Look for science vocabulary that you have acquired in your investigations and class discussions. Consider how their meanings support your understanding of the readings.

Written Response

Your writing exercise is to create an amusing and informative cartoon related to heat, cold, energy, temperature, and survival.

- Draw your comic on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Choose two organisms as your characters. The characters should come from two different selections in this collection.
- Choose the number of panels and layout you will use. Some ideas are shown below.
- Use word or thought balloons to have your characters talk to one another about life, death, heat, and cold. It's okay if nonhuman animals talk!
- The dialogue you write can be funny, sad, or whimsical, but it must connect to the science related to Collection 4 and Lessons 9–11 investigations.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.



Evaluation Guidelines

Element	1	2	3	Feedback
Content	Only one character is shown. The dialogue about heat, cold, temperature, particles, energy, life, and death has three or more errors.	There are two characters, but they are from the same reading. The dialogue about heat, cold, temperature, particles, energy, life, and death has only one or two minor errors.	Two characters, each from a different reading selection, are included. The dialogue about heat, cold, temperature, particles, energy, life, and death is accurate.	
Creativity	Lacking in creative details that could have contributed to reader enjoyment	There is at least one creative detail that contributes to reader enjoyment.	Many creative details contribute to reader enjoyment.	
Organization and Illustrations	The number and arrangement of panels is too few or too many for the content. The main characters are not identified. The dialogue is difficult to read.	The number and arrangement of panels is reasonably suited to the content. The main characters are poorly identified. The dialogue is reasonably easy to read.	The number and arrangement of panels is well suited to the content. The main characters are clearly identified. The dialogue is easy to read.	
Grammar and Mechanics	More than three errors in punctuation, capitalization, and spelling	One to three errors in punctuation, capitalization, or spelling	No errors in punctuation, capitalization, or spelling	

Additional Feedback Notes:

Science Literacy Exercise Page 5

Use with Reading Collection 5

Roadmap for Reading

This week's reading collection focuses on heat through conduction. The selections include writing from social media, websites, scientific logs, and movie reviews.

"Collection 5: Heat through Conduction" consists of five selections.

- 1 A Basement Gymystery
- 2 Hot Mug as Hand Warmer
- 3 Steam Power
- 4 Cold Water, Cold Feet
- 5 Freezing in Space

As you read:

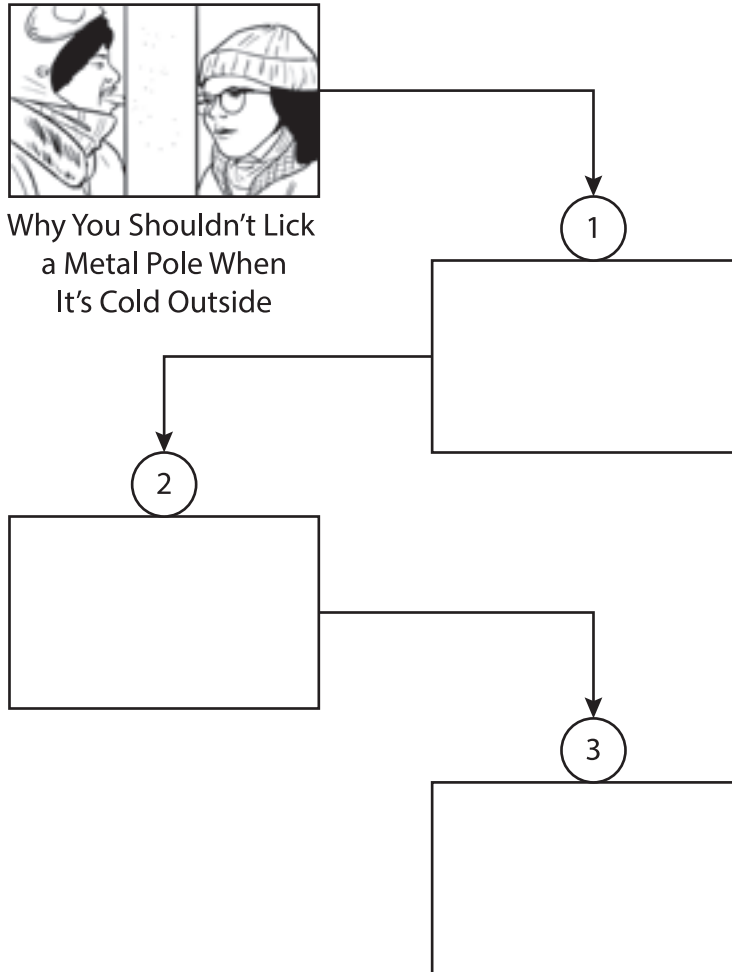
- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- What can you tell about the writer that gives you confidence in the science?
- Consider how each part of the collection relates to knowledge you gained from the previous part.

Written Response

Your writing exercise is to develop an infographic that explains why you shouldn't lick a metal pole when it's well below freezing outside.

- Compose your infographic on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Think of your audience as students in Grades 3–6 and what level of science understanding they have.
- Decide what science ideas you need to get across by thinking about what you learned in Lessons 13 and 14. HINT: There is watery saliva on your tongue.
- Sketch a layout that helps "sell" the science. You can adopt the template shown on the next page or design your own layout.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Science Literacy Exercise Page 5 continued



Evaluation Guidelines

Content

- ☐ There are at least three well-chosen and accurate science statements that explain the answer.
- ☐ The statements are in an order that makes sense for the explanation.

Text

- ☐ The text is clearly worded and easy to read.
- ☐ Spelling, grammar, and punctuation are correct.

Design

- ☐ Color is used effectively for contrast.
- ☐ Any drawings or symbols used are easy to interpret.

Additional Feedback Notes:

Roadmap for Reading

This week’s reading collection focuses on how materials are used to insulate people and structures from environments that are too hot or too cold. Three of the selections are about insulating gear you can wear, and the last two are about materials that are designed to insulate homes and other structures.

“Collection 6: Insulation” consists of five selections.

- 1 Suiting Up for Water
- 2 Extreme Heat Protection
- 3 Down Jackets
- 4 Home Insulation Timeline
- 5 Insulation and R-Values

As you read:

- Consider the general purpose of each selection: is it a description, an explanation, a consumer guide, or an attempt to persuade?
- Consider how graphics and subheadings support the main ideas.
- Consider how each part of the collection relates to knowledge you gained from your investigations and class discussions.

Written Response

You are a manager in an engineering company planning to design new insulating materials, objects, and structures. Before developing criteria and constraints for specific projects, you think about general factors to consider. Your task is to list several important factors for the team that will design wearable insulators and another group of factors for the team that will design insulation for buildings.

- Using the template shown below, compose your T-chart on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Use details from the reading selections to identify important factors.
- Then try to add a couple of factors that the readings did not discuss.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Factors to Consider When Designing Insulating Wearable Gear	Factors to Consider When Designing Insulating Structures

Evaluation Guidelines

Element	1	2	3	Feedback
Content	Minimal evidence that the student can identify factors related to energy transfer by conduction or those that make use of the gear or structure practical. Ideas are related to less than three reading selections.	Factors related to energy transfer by conduction or factors that make use of the gear or structure practical are included. Ideas are related to three or four reading selections.	Factors related to energy transfer by conduction and factors that make use of the gear or structure practical are included. Ideas are related to all five reading selections.	
Comparing and Contrasting	The chart shows that the two engineering teams will have no factors in common.	The chart shows that the two engineering teams will have at least one factor in common.	The chart shows that the two engineering teams will have two or more factors in common.	
Organization	None of the factors that the two sides of the chart have in common are in the same rows for easy comparison.	Most factors that the two sides of the chart have in common are in the same rows for easy comparison.	All factors the two sides of the chart have in common are in the same rows for easy comparison.	
Grammar and Mechanics	Six or more errors in punctuation, capitalization, and spelling	Three to five errors in punctuation, capitalization, and spelling	Fewer than three errors in punctuation, capitalization, and spelling	

Additional Feedback Notes:

Science Literacy Exercise Page 7

Use with Reading Collection 7

Roadmap for Reading

This week's reading collection focuses on some large-scale and small-scale effects of heat. The selections include one that revisits the mystery of the ice-covered orange trees that you read about in the beginning of this unit.

"Collection 7: Heat in Nature and Design" consists of four selections.

- 1 The Albedo Effect
- 2 Heat Islands Editorial
- 3 Ice as Insulator
- 4 Heat in Athletic Fields

As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- Notice how data and graphics support the text and how text clarifies the data and graphics.
- Preview subheadings to understand how each reading is organized.

Written Response

After completing your reading of this week's collection, your writing exercise is to complete a thoughtful paragraph that supports the claim "*Heat* doesn't mean *hot*."

- Compose your paragraph on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Use evidence and reasoning from your investigations and class discussions.
- Write a strong topic sentence, and follow it with a logical order of supporting details.
- Mention the example about the orange trees with the ice on them from the unit opener/preface reading and this collection within the evidence that supports your reasoning.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	Inadequate support of a topic sentence claiming that <i>heat</i> and <i>hot</i> are not the same, with minimal relevant details from the readings about ice on the orange trees or from investigations and class discussions	Adequate support of a topic sentence claiming that <i>heat</i> and <i>hot</i> are not the same, but with only a few relevant details from the readings about ice on the orange trees and from investigations and class discussions	Thorough support of a topic sentence claiming that <i>heat</i> and <i>hot</i> are not the same, citing relevant details from the readings about ice on the orange trees and from investigations and class discussions	
Supporting Sentences	Incomplete sentences and only one or two details relevant that support the topic sentence	Three to five complete sentences, encompassing at least two major science ideas that support the topic sentence	At least six complete sentences, encompassing three major science ideas that support the topic sentence	
Organization and Transitions	Statements with little clear relationship to the topic sentence or each other	Key supporting details present, but absent or choppy transitions	Ideas in an order that helps the topic make increasingly more sense	
Grammar and Mechanics	Six or more errors in punctuation, capitalization, and spelling	Three to five errors in punctuation, capitalization, and spelling	Fewer than three errors in punctuation, capitalization and spelling	

Additional Feedback Notes:



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