Lathrop Intermediate

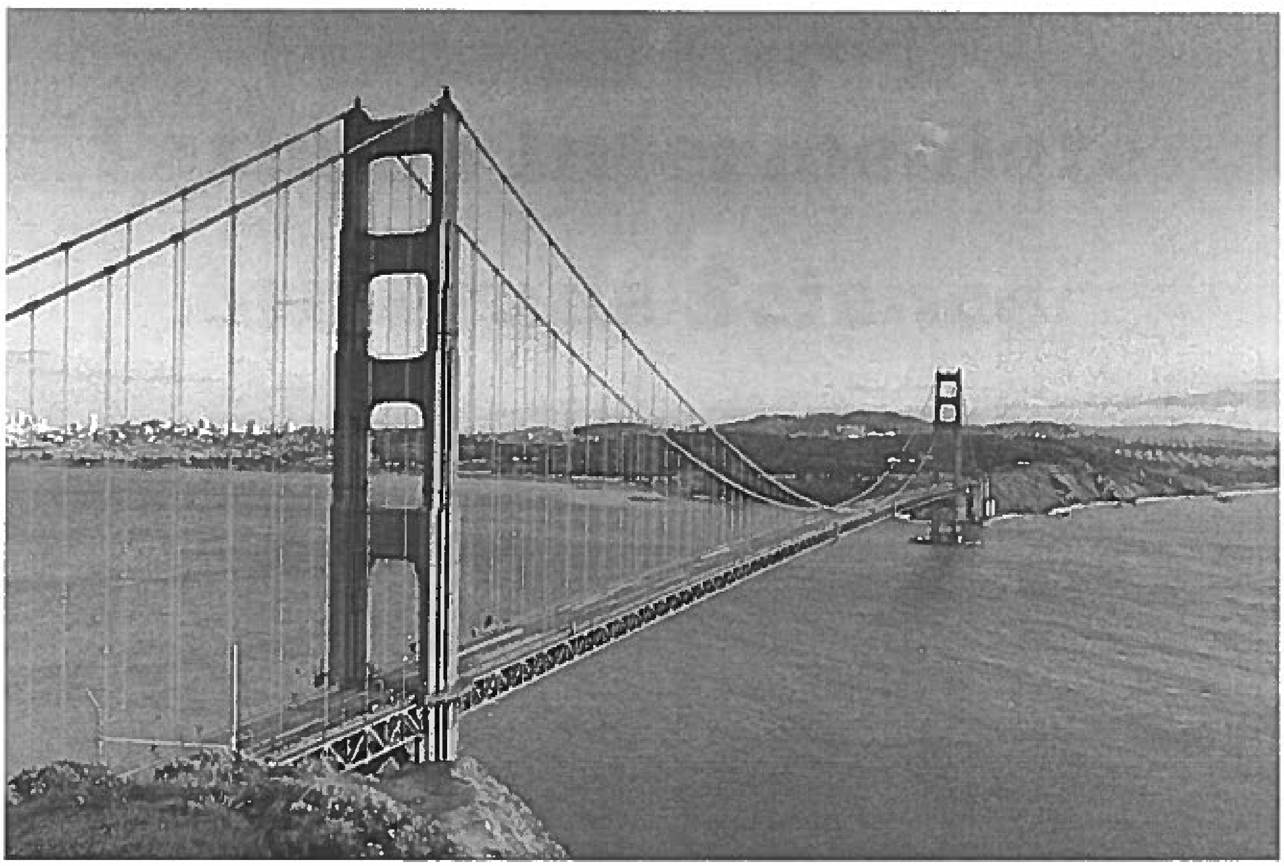
6th grade Science
1st Semester

Name: ______________________________

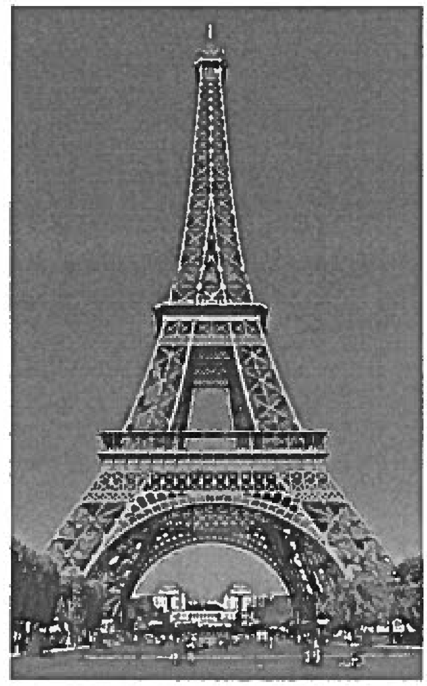
Teacher: ______________________________

Period: ______________________________

Lathrop Intermediate
6th grade Science
Engineering Unit



Guiding Question: How do we talk and work together like engineers?



Introduction

What is the tallest building you have ever been inside? Have you ever wondered what the engineers need to think about and do to build that structure? Throughout the year you will be asked to think and work like an engineer to design and build different types of things to solve a specific problem.

Task

You will need to work together as a team of engineers to build the tallest possible structure. When designing and building your prototype, you will need to think about how you will use the materials provided and follow the list of constraints.

Materials: (per group)

- 20 sticks of spaghetti
- 1 meter of tape
- I meter of string
- 1 marshmallow

Tower Prototype Constraints	
Materials	You may use as much or as little of the materials supplied as you'd like.
	You may use the materials provided.
	You may break/cut the spaghetti, tape or string.
Structure	You must place the whole marshmallow at the very top of the structure.
	The structure shouldn't touch anything except the table that it is built upon.
	The structure must be free standing (nothing propping it up and not taped down to the table).
Time	You have exactly 18 minutes.

Part I. The Quiet Brainstorm (12-minutes)

1. Each team member has 5-minutes to draw a model of a tower they think their team should build.
2. Rotate models to the teammate to the left. Each team member has 2-minutes to write clarifying question(s) and/or add comment(s) to the model.
3. Again rotate models to the left. Write clarifying question(s) and/or add comment(s) to the

model.

4. Rotate drawings to the left for the last 2-minutes. Write clarifying question(s) and/or add comment(s) to the model.
5. Pass the models back to their owners. You have 1-minute to review the question(s) and/or comment(s) and make revisions to your model.

Part II. Coming to Consensus (5-minutes)

- Take turns discussing how your team will build a tower.
- Discuss how your team will use the materials to build a tower. Remember, your tower must follow all the constraints.
- Draw a group model that represents your team's tower design.

Part III. Building a Tower Prototype (18-minutes)

- Everyone must participate in building a team tower prototype.

Part IV. Tower Prototype Analysis (5-minutes)

- As a class, record observations in the data table and analyze each tower prototype.

Part IV. Reflection (10-minutes)

Teamwork

- Complete the Collaboration and Teamwork Rubric.
- As a team, be prepared to share your team's thinking and decision-making process.

Individual Reflective Questions

Answer the following questions individually in your notebook.

1. What were the main structural features of your prototype? How did your team decide on these features?
2. How could you improve the design of your prototype?
3. What previous science knowledge or experiences did you use to design and build your prototype? Explain how your knowledge or previous experiences helped you to design and build your prototype.
4. What were some of the strengths of working together as engineers for the task? What are some areas that your team needs to improve when you work on the next task together?

Tower Prototype Data Table

Design 1

Team #	Height (cm)	Observations

Tower Prototype Redesign Graphic Organizer

Name: ______________________ Period: ____ Date: __________

Design 1	Design 2

Redesign in Prototype Description (C)

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Evidence (E)

1. ______________________

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2. ______________________

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3. ______________________

Redesign: Structure and Function Explanation (R)

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Tower Prototype Data Table

Design 2 (Redesign)

Team #	Height (cm)	Observations

Report to the City Planner

Directions:
You are an engineer investigating structures to build towers for the future.
Write a report updating the city planner on your plan to build a tower prototype.

In your report, include the following:

1. Explain how your team will work together to design the tower prototype.
2. Describe main structural features for the tower your team might include. Use evidence based on your previous experience(s).

Word Bank

design	collaboration	infer	function
model	evidence	reinforcement	
prototype	observe	structure	engineering design process

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C.H.A.T. To The Text

C – **Circle** the **vocabulary** words that you don't know or that might be challenging for other students in your class

H – **Highlight** the **evidence** to support the author's claim

A – **Annotate** the Text. **Add comments**, questions, connections, A-Ha moments or summarizing statements in the margins of the text. Every time you highlight something, you must add an annotation!

T – **Talk** to the Text. Underline, label and explain any **Cross Cutting Concepts**. You may want to use different colors to help show different CCC's.

1. **Patterns:** Do you see any patterns in what you read to the real world or to other science topics?
2. **Cause and Effect:** Do you see variables that you could test? Does one variable cause an effect on the other variable?
3. **Scale, Proportion, and Quantity:** If you changed the variables to a different size, amount of time, or energy, would there be a proportional change to another variable?
4. **Systems and System Models:** Could you design a system or use a current system to predict changes or design a solution to a current societal need or want?
5. **Energy and Matter:** If you were to track how the energy transferred or how the matter changed, could it help you understand how a system works or make any new conclusions?
6. **Structure and Function:** Can you see any way that the structures are shaped relate to the job they have to do or the way they behave?
7. **Stability and Change:** Can you see a way that a system is working to reach stability? Or, can you see how changes to a system can affect the stability of a system?

1. Annotate title
2. Annotate pictures
3. # paragraphs

Read through #1

4. Circle vocab
5. Add definitions/synonyms based on context for circled vocab

Read through #2

6. Highlight important details of article

Read through #3

7. Add annotation for ALL highlights (questions you have about it, why is it important, what does it mean?)
8. Underline the main sentence(s) that let you know what the cross cutting concept is and put CC: (and the concept it is) next to it

"CHAT To The Text" and Annotating List Rubric

TASK	5	4	3	2	1
Annotate the Title Explain what you know or want to know about the subject					
Annotate Pictures Explain drawings, pictures, or graphs in your own words					
Vocabulary Circle vocabulary words and words you do not know Add definitions using context clues, notes, or class discussions					
Highlight Evidence to support or refute the author's claim.					
Annotate Highlighted Passages With: Questions that pop up for you as you read. <u>OR</u> Connections between the reading and your self, the world or something else you've read.					
Underline and Identify Cross Cutting Concepts					

Stopping A Toppling Tower

by Mary Kay Carson

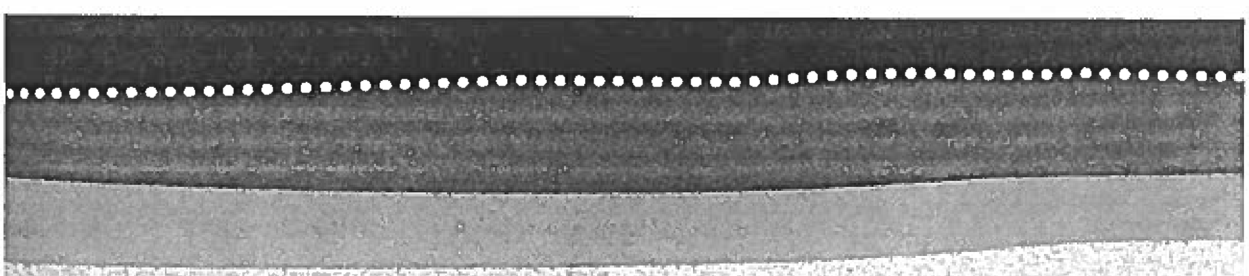
Every year, the Leaning Tower of Pisa (PEA-zuh) tilts a fraction of an inch farther! If it tilts too far, this famous Italian building could topple or crash to the ground. Scientists had to find a way to save the tower—without making it a "Straight Tower of Pisa."

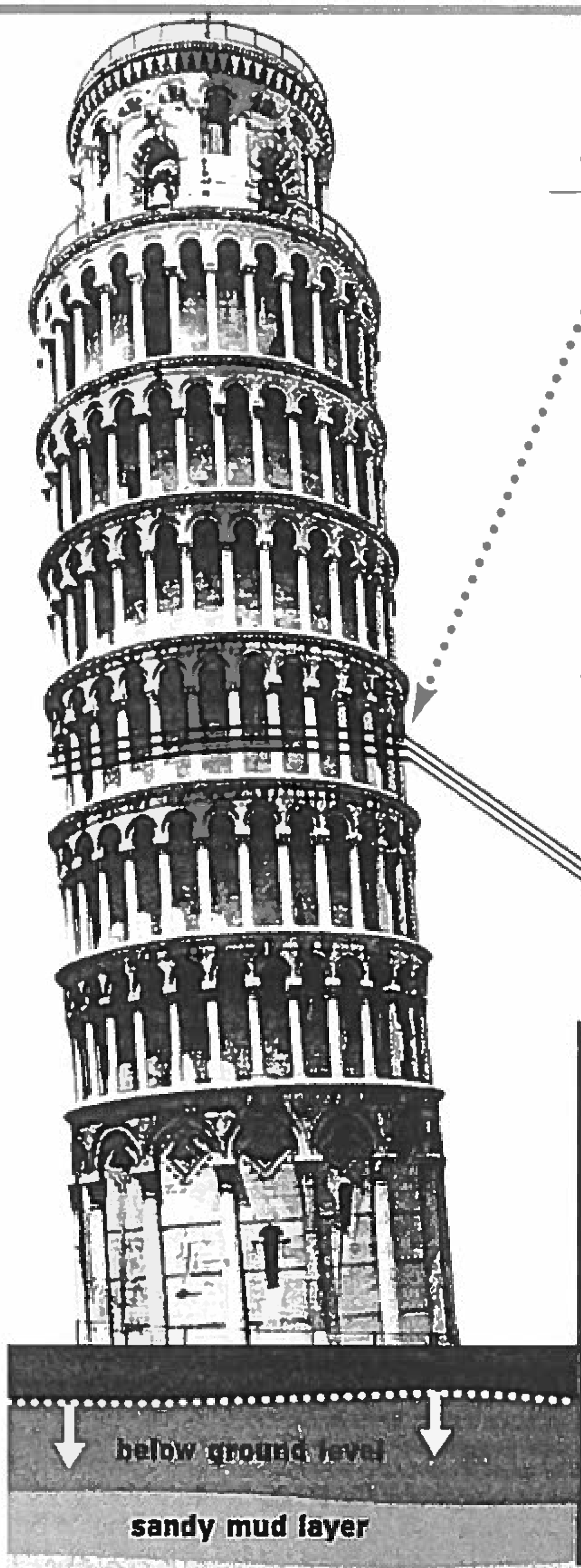
It's amazing but true that the tower has been tilted ever since it was built more than 900 years ago. The problem is that each year it leans a tiny bit more. In 1990 **engineers** said that the tower was in danger of toppling. The building was no longer safe. It had to be closed to visitors.

For years, engineers and scientists had been thinking about how to stop the tower from falling over. After considering many ideas, they agreed on a possible solution. In 1998, engineers started work to save the **landmark**.

The Problem

1. The tower weighs 14,000 tons. Wind pushes from the sides. Sometimes there are small earthquakes that rattle the building. These forces weaken the slanted tower.
2. Tall, skinny shapes are hard to balance. A skinny tower has a small **foundation**. That makes it easy for it to tilt too far to one side. Then—TIMBER!
3. The tower is built on soft sand and clay. The heavy building squishes the soft soil beneath it. That makes the tower slowly sink. Why does it lean? The soil is softest under the tower's low side, so that side sinks more.
4. As the tower leans, more of its weight rests on the lower side. That **compression**, or squeezing, could cause the tower to tip over.





The Solution

1. First, workers wrapped steel **cables** around the tower. The cables were heavy ropes made of steel wire. Workers hooked the ends of the cables to heavy weights. If the tower started to topple, the cables would hold it up.
2. The workers started to dig under the high side of the tower (the right side in the photo). They slowly and carefully took away some of the soil. They hoped that the tower would sink a little on that side. It did—by one inch! That may not sound like much, but it was enough to make the tower straighter.
3. No one can see the change in the tilt of the tower, but now it's safe. It was reopened in January 2002. Once again, visitors come from all over the world to see it and climb to the top. Engineers expect that the tower will stand—tilted—for centuries to come.

Thanks, But No Thanks...

People have sent hundreds of tower-fixing ideas to the Italian government. Why do you think these four ideas were rejected? What ideas do you have?

1. Freeze the ground under the tower.
2. Slice off the top to make the tower lighter.
3. Hitch a car to the tower and pull the tower straight.
4. Stuff rice and beans under the low side. When the foods absorb water, they will swell and push up the tower.

Name: ______________________________ Period: ____ Date: ________

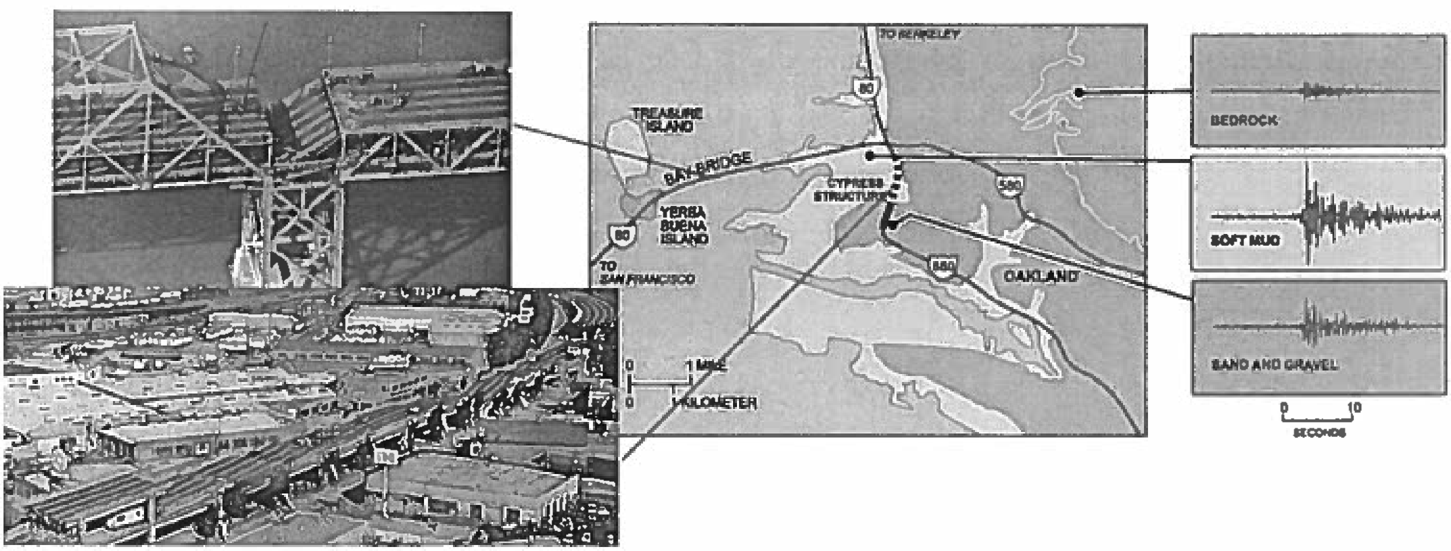
6.0.1 Resource Sheet - **Loma Prieta Exposed Weakness** Reading

Focus Question: *What caused structures to fail and how can they be fixed?*

Eastern Span of the Bay Bridge

When the two-level bridge was originally built, it was designed to carry car traffic on the top deck and trains and trucks on the lower deck. Over the years, the use of cars increased and the bridge was reconfigured to carry more car traffic on the top and lower decks.

During the 1989 Loma Prieta Earthquake, the Bay Bridge suffered severe damage, as a section of the upper deck on the eastern side fell onto the deck below. The quake caused the bridge to shift 18 cm to the east causing the bolts of one section to unhinge off and sending that 230 ton section of road crashing down. The bolts were not long enough to allow movement in an earthquake.



Cypress Street Viaduct or Cypress Structure

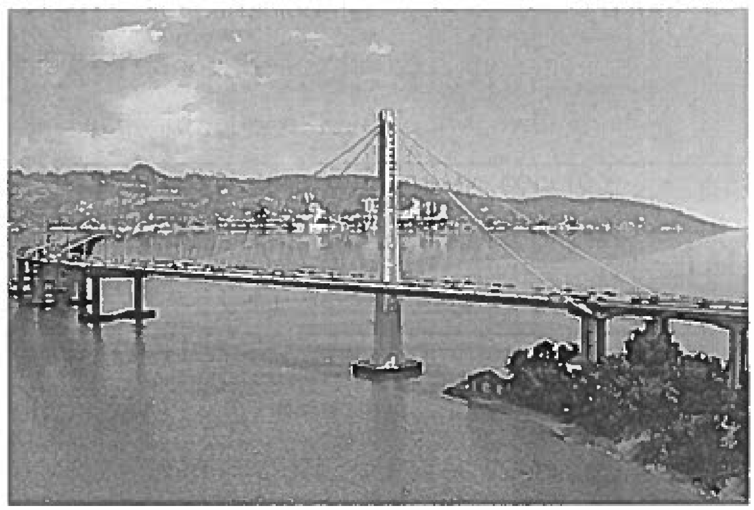
The worst disaster of the Loma Prieta earthquake was the collapse of the two-level Cypress Structure. Built in the late 1950s, the structure was made of inflexible reinforced concrete. Half of the land the Cypress Structure was built on was marshland that had been filled in and the other half was on a stable soil mixture. After the 1971 San Fernando earthquake, a limited amount of earthquake reinforcement materials were added to the Cypress Structure but no tests were made of possible failures. When Loma Prieta hit, the shaking was amplified by the former marshland.

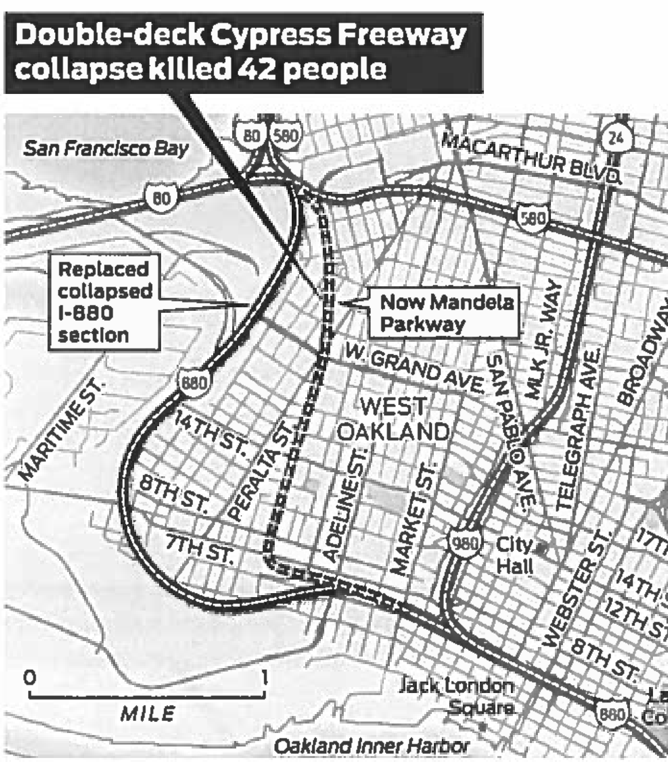
The upper deck in some sections was not securely fastened to the lower deck, making this

concrete susceptible to vibrations. As the bridge vibrated during the earthquake, the pins connecting the upper level to the lower level also began to vibrate, causing the concrete surrounding the pins to crumble and break away. Without the presence of concrete under the support columns, the columns slid sideways under the weight of the upper deck and allowed a large portion of the upper deck to collapse.

Solutions:

Following the Loma Prieta Earthquake, repairs were been made to the Bay Bridge but repairs did not include retrofitting. Replacing the eastern span of the Bay Bridge would be cheaper than retrofitting the existing bridge.





The Cypress Structure was rebuilt around the outskirts of West Oakland and included more reinforcement materials. The section that replaced the I-880 section is a single level structure. The Mandela Parkway now occupies the previous location of the Cypress Structure.

6.0.1 Task - What Happened Here? (Print 2 copies and place in plastic sleeves)

Reading(s): **Stopping a Toppling Tower & Loma Prieta Exposed Weaknesses**

Guiding Question: What caused structures to fail and how can they be fixed?

Directions: Answer the following Text Dependent Questions in your Interactive Notebook.

1. How does this structure not function properly?
    a. Why is that a problem?

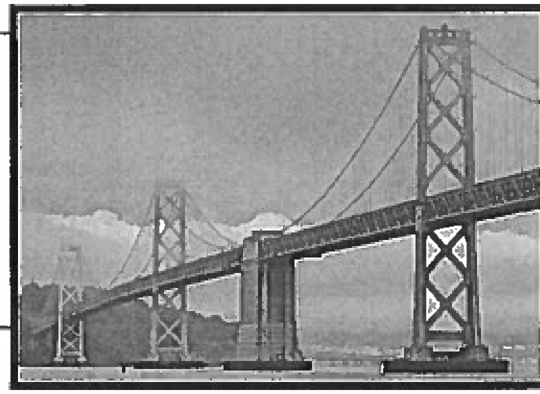
2. What structural feature(s) cause this structure to "fail?"

3. How was the problem(s) fixed?
    a. How did the engineers fixing the problem have to be innovative?

4. What are somethings engineers could have learned from the mistakes made with this structure?
    a. How could engineers apply these learnings to future structures?

6.0.S Task Card: Building a Bridge (Print 2 copies and place in plastic sleeves)

Guiding Question: *How can failure lead to innovation?*



Summative Task Description:

You are an **engineer** designing a bridge. Each team will design a free standing bridge that can hold some weight using limited resources. At the end of the unit, your team will design, build, test, redesign, and test your bridge again.

Materials: (per team)

- 20 straws
- 1 meter of tape
- scissors

Bridge Constraints	
Dimensions	Bridge must be at least 15-centimeters (~6-inches) in length. The roadway must have at least a 5-centimeters (~2-inches) clearance under the bridge and be free standing. The width of the bridge is at least 5-centimeters.
Weight	Bridge must be able to hold at least 1000-grams (~2-pounds).
Materials	Only straws and masking tape can be used to make your structure. You may use as much or as little of the materials supplied as you'd like. You may break/cut the straws or tape.
Innovations	Your new bridge must have at least 1 structural redesign or change.

Before you begin building, as a team:

- Discuss how you will use the materials to build the bridge
- Draw an annotated model that represents your design.

After you finish the task, as a team:

- Be prepared to share your thinking and decision-making process using an annotated model.

Bridge Prototype Checklist:

Categories	Required evidence for analyzing:
Annotated Model	❑ Create a model of your bridge ❑ Label the model: Materials, 2 structural supports and their functions, and 1 structural change/Innovation

Analyze Redesign	❑ Explanation of your redesign's structural functional effect on the bridge.
	❑ 3 pieces of evidence supporting your claim
	    ❑ Previous in class activities/testing
	    ❑ Research
	    ❑ Evidence from other teams models

Prototype	❑ Construct a prototype that meets all constraints that include ❑ Dimensions, Weight, Material, and Innovation.
Innovation	❑ Gather 3 pieces of evidence from your revision that explains how failure leads to innovations.

Individual Task: Reflective Questions

Answer the following questions individually in your notebook.

1. Did your redesign hold more weight? Why or why not?
2. What were the main structural features of your bridge? How did your team decide on these features?
3. What previous science knowledge or experiences did you use to redesign and build your bridge? Explain how your knowledge or previous experiences helped you to design and build your bridge.
4. What were some of the strengths of working together as engineers for the task? What are some areas that you need to improve on when you work in other teams for future tasks?
5. How does this task provide evidence for or against the statement "Failure leads to innovation"?

Name: ______________________________ Period: ____ Date: __________

6.0.S Bridge Prototype Data Table

Design 1

Team #	Height (cm)	Length (cm)	Predict if their bridge will hold and explain	Observations

Bridge Prototype Redesign Graphic Organizer

Name: ______________________ Period: ____ Date: ____________

Design 1	*Design 2*

Redesign in Prototype Description (C)

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Evidence (E)

1. ______________________

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2. ______________________

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3. ______________________

Redesign: Structure and Function Explanation (R)

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6.0.S Bridge Prototype Data Table

Design 2 (Redesign)

Team #	Height (cm)	Length (cm)	Observations

Report to the City Planner

Directions:
You are an engineer investigating structures to build bridges for the future.
Write a report updating the city planner on your plan to build a bridge prototype.

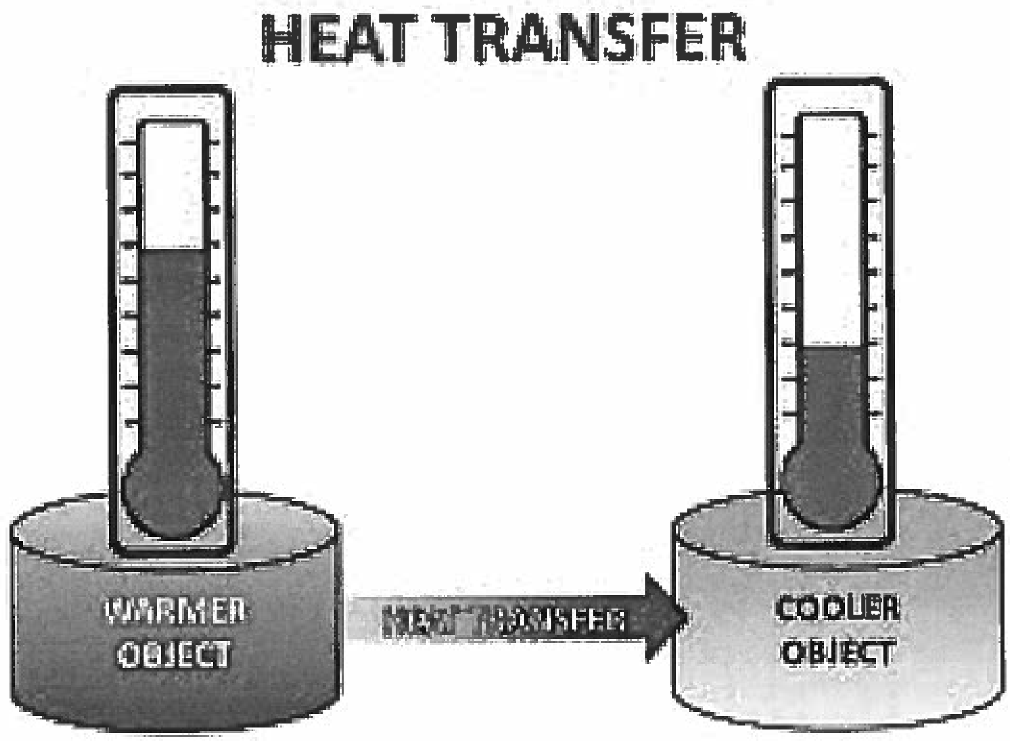
In your report, include the following:

1. Explain how your team will work together to design the bridge prototype.
2. Describe main structural features for the bridge your team might include. Use evidence based on your previous experience(s).

Word Bank

design	collaboration	infer	function
model	evidence	reinforcement	
prototype	observe	structure	engineering design process

Lathrop Intermediate
6th grade Science
Heat Transfer Unit



6.1.0 - Investigating Hot and Cold Task Card (Print 2 copies and place in plastic sleeves)

Focus Question: *What causes feelings of "hot" or "cold?"*

Introduction: In this activity, students will see heat can be transferred between objects that touch. Additionally, students will experience the direction heat always travels in order to understand how materials become cold.

Task: Investigate how heat transfers through different objects

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- 2 containers - Ice water and hot water (not hot enough to burn) - IR thermometer - clock/timer

Task Steps (Investigation - 20 min)

Part 1:

1. Assign group roles, including who will touch the water.
2. Your team will be provided 2 containers. One contains very cold water and the other contains hot water (not hot enough to burn).
3. Label each cup, "hot" or "cold." Record the **INITIAL** temperature of the **water** in each container in your data table.
4. Using the IR thermometer, measure and record the **INITIAL** temperature of each hand before they are placed in any containers.

Modified Image from ____

5. Place your:
   a. **Left hand** in the **hot water**
   b. **Right hand** in the **cold water.**
6. Leave them in for **60 seconds**.
7. Once the time is up, take them out and measure and record the **FINAL** temperature of each hand using the IR thermometer.
8. Take and record the temperature of the water in each cup as well.

(see data table on the next page)

6.1.0 - Investigating Hot and Cold Task Card (Print 2 copies and place in plastic sleeves)

(Record your data and answers in your science journal)

Data Table:

	Initial Temp. of Water (ºC)	**Initial** Temp. of Hand (ºC)	**Final** Temp. of Water (ºC)	**Final** Temp. of Hand (ºC	**How did your hand feel in each cup?**
Hot Water (Left Hand)					
Cold Water (Right Hand)					

Part 2:

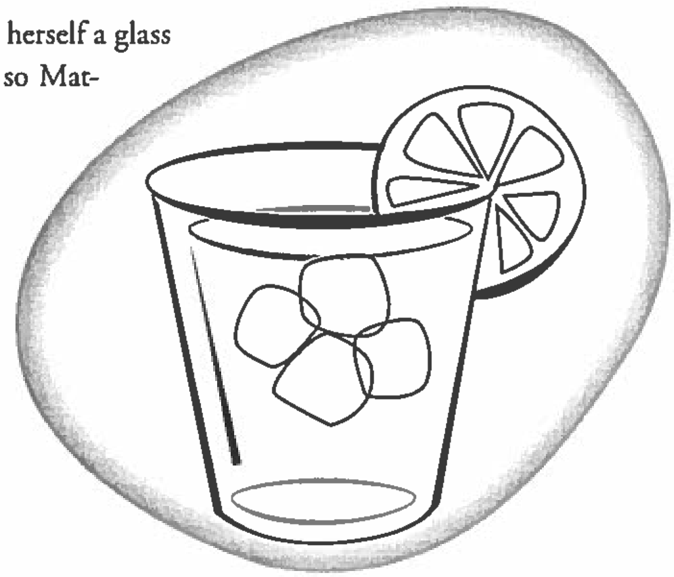
1. Place your Right hand back in the cold water for 60 seconds then immediately once time is up, place it in the hot water (right away!)
   a. What happened when the **cold** hand (finger) was placed into the **hot** water?
   b. What direction did the heat travel? (hint: Was the coldness of the ice cube going into your hand or was heat leaving your hand?)
   c. What evidence can support your claim?
   d. Draw a LABELED group diagram of what happened **before** the hand touched the hot water and what happened **after** the hand touched the *hot water*, including anything that changed or moved.
2. Now see what happens when you place the left hand (finger) in the hot water for 60 seconds then immediately once time is up, place it in the ice water (right away!).
   a. What happened when the **hot** hand (finger) was placed into the **cold** water?
   b. What direction did the heat travel? (hint: Was the coldness of the ice cube going into your hand or was heat leaving your hand?)
   c. What evidence can support your claim?
   d. Draw a LABELED group diagram of what happened **before** the hand touched the cold water and what happened **after** the hand touched the *cold water*, including anything that changed or moved.

Evaluation Criteria:

Conduct investigations
- ☐ Collaborate to gather data and make observations
- ☐ Identify data that could be used as evidence for modeling or explanations

Responsible Decision Making:
- ☐ Each member contributes their ideas.
- ☐ All members encourage each other to participate.
- ☐ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.
- ☐ The group identifies the best ideas that everyone can live with.

Ice-Cold Lemonade



It was a hot summer day. Mattie poured herself a glass of lemonade. The lemonade was warm, so Mattie put some ice in the glass. After 10 minutes, Mattie noticed that the ice was melting and the lemonade was cold. Mattie wondered what made the lemonade get cold. She had three different ideas. Which idea do you think best explains why the lemonade got cold? Circle your answer.

A The coldness from the ice moved into the lemonade.

B The heat from the lemonade moved into the ice.

C The coldness and the heat moved back and forth until the lemonade cooled off.

Explain your thinking. Describe the "rule" or reasoning you used for your answer.

Scientists say they know why koalas spend so much time in trees

By Los Angeles Times, adapted by Newsela staff on 06.06.14
Word Count **589**

A koala watches tourists visiting in southeastern Australia. Photo: Lisa Vorderbrueggen/Contra Costa Times/MCT

Koalas don't hug trees because they love them. The trees keep them cool, scientists say.

On a hot day in Australia, a koala's thick fur makes it hard to stay cool. The over-heated marsupials don't seek shelter. And water can be hard to come by. In the wild, many koalas die when the heat becomes extreme, according to a report published Wednesday in the journal Biology Letters.

The authors of the study guessed that koalas must do something to cool off in hot weather. To figure out what that was, they put radio collars on 37 koalas in southeastern Australia. They tracked koalas' movements during the winter of 2009 and the summer of 2010-11. In the land Down Under, summer lasts from December to March.

Watching Their Every Move

The researchers kept detailed records of what the koalas did. They noted their body position and whether they liked high or low branches. The scientists also used a portable weather station. The device recorded the temperature near where the koalas made themselves comfortable.

For comparison, the scientists also observed 130 koalas that weren't wearing collars.

What they discovered was that the koala behaved differently on hot days than on cooler days. In the summer, the animals positioned themselves in trees in a way that exposed more of their surface area. This often meant hugging a tree trunk or a large branch closer to the ground, with arms and legs outstretched. In the winter, koalas climbed higher in the tree and farther out onto the branches.

Why would different parts of the tree be appealing in different seasons? To answer this, the researchers took the temperatures of four species of trees in the heat of summer. Three of the trees were eucalyptus and one was an acacia.

With heat-imaging cameras, they discovered that the tree trunks were cooler than the branches or canopies. The trunks were also cooler than the surrounding air. This seemed to explain why koalas stayed closer to the base of the tree in the summer and up higher in winter.

Of all the trees tested, the coolest ones were the Acacia mearnsii trees, the scientists found. In summer, the koalas spent 29 percent of their time in these trees, but only 5 percent of their time in the winter. Koalas can't eat the leaves of these trees. But now scientists believe they know why they're so appealing to koalas, especially in summer.

The Math Behind The Tree Hugging

The scientists needed to check their theory. So they came up with an equation to determine how much heat a koala could lose by hugging a cool tree. The equation took into account the thickness of a koala's fur and how it conducts heat. They also measured how much of the koala's fur is in contact with the tree. They calculated that a 25-pound male koala could shed 68 percent of its excess heat on a 95-degree day by hugging a cool tree in a shady spot. That could mean the difference between life and death when water is scarce.

It's a clever way to chill out. And koalas probably aren't the only animals that realize it, the researchers wrote.

“Cool tree trunks are likely to provide important microhabitat for a broad range of tree-dwelling species ... during hot weather,” they wrote. That would include primates, leopards, birds and insects.

This will help humans predict how animals will adapt to a warming climate. It will also help them choose the kinds of environments most critical to preserve, the researchers added.

6.1.1 - Thermal Energy: Investigation Plan Part 1 (Print 2 copies and place in plastic sleeves) Page: 33

Focus Question: *How can what I CANNOT see help explain what I CAN see?*

Introduction: In this activity, you will investigate the relationship between temperature and thermal energy.

Task:

- Plan and conduct an investigation to determine the relationship between thermal energy and temperature by controlling specific variables.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- thermometer (alcohol or digital) - digital scale - stirrer - tray or plate to transport and catch water - ice (to make the water cold) - water kettle - hot and cold water - 3 foam cups with at least 200mL capacity

Prediction:

Individually...Read the procedure for the investigation. Write your prediction for the following in your notebook.

1. *What do you think the temperature will be of the mixture of water at 50℃ and 0℃ seen below? Why?*
2. ***Thermal energy** relates to how fast the particles are moving that make up a substance. Which cup do you think has more thermal energy?*

Task Steps (Investigation and Discussion - 15 min):

As a group...

1. Prepare water containers containing 100g each of hot and cold water.

Investigation: Two foam cups contain equal masses of water. One cup contains cold water with a temperature of ~0°C. The other contains hot water with a temperature of ~50°C. The hot water is mixed with the cold water and stirred.

Figure 1.

2. Copy the following data table in your notebook to collect data.

Cold Water Temp. (ºC)	Hot Water Temp. (ºC)	Mixture Water Temp. (ºC)

3. Measure and record temperatures before mixing.
4. Mix the water, stir well, and measure the final temperature.

As a group, discuss…

a. *Did the results of the investigation agree with your prediction? Support with evidence.*
b. *What was <u>different</u> between the two cups of water? What did we <u>control</u> to make sure it was <u>kept the same</u> between the two cups of water?*
   i. *Copy Figure 1 above in your notebook. Label it "Trial 1" and put a box around the* differences *you identified above and circle the* controls *(kept the same).*
c. *How do your results show the relationship between temperature and thermal energy?*
d. *You just completed one trial of the investigation. As scientists, in order to support our ideas, we need to gather evidence for what we think.*
   i. *How many more trials (times) do we need to do in order to really support the relationship you came up with in question c?*
   ii. *Is there anything we need to change between trials that could better prove our ideas? Explain your idea.*

Task Steps (Group diagrams and planning - 15 min):

As a group…

5. Draw out your trials as labeled diagrams (one diagram per trial) on your Group Investigation Plan Output sheet. Be sure to include:
   a. how many trials you will conduct
   b. what changes AND what stays the same between trials. Use boxes and circles as above.
6. Below the diagrams, make sure to include what data you will gather to prove the relationship between temperature and thermal energy.
7. Once your diagrams are approved by another group, you may conduct your investigation.

<u>Evaluation Criteria:</u>

Conduct and plan investigations

- ☐ Collaborate to gather data and make observations
- ☐ Plan fair tests where ONE variable is tested at a time
- ☐ Plan fair tests where the OTHER variables are CONTROLLED
- ☐ Revise original experimental design to gather data that could be used as evidence for determining relationships

Responsible Decision Making:

- ☐ Each member contributes their ideas.
- ☐ All members encourage each other to participate.
- ☐ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.
- ☐ The group identifies the best ideas that everyone can live with.

6.1.1 - Thermal Energy: Investigation Plan Part 2 (Print 2 copies and place in plastic sleeves)

Focus Question: *How can what I CANNOT see help explain what I CAN see?*

Introduction: In this activity, you will investigate the relationship between mass, temperature and thermal energy.

Task:

- Plan an investigation to determine the relationship between mass, thermal energy and temperature by controlling specific variables.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- thermometer (alcohol or digital) - digital scale - stirrer - tray or plate to transport and catch water - ice (to make the water cold) - water kettle - hot and cold water - 3 foam cups with at least 200mL capacity

Task Steps (Group planning and investigation- 30 min):

Individually…

1. Mass is the amount of matter in a substance. What if we wanted to test how different masses (amounts) of hot water and cold water affected the temperature if they were mixed together. How would we test that? Draw labeled diagrams of trials using boxes and circles, if needed.

[differences] (controls)

As a group, discuss…

a. *What should we change between trials?*
b. *What will you measure to find out relationships between mass, thermal energy and temperature?*
c. *How many more trials (times) do we need to do in order to really prove the relationship?*

As a group…

5. Come to consensus on your group's plan with labeled diagrams, including what data you will gather to determine the relationship.

Evaluation Criteria:

Conduct and plan investigations
- ❑ Plan fair tests where ONE variable is tested at a time
- ❑ Plan fair tests where the OTHER variables are CONTROLLED
- ❑ Revise original experimental design to gather data that could be used as evidence for determining relationships

Responsible Decision Making:
- ❑ Each member contributes their ideas.
- ❑ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.
- ❑ The group identifies the best ideas that everyone can live with.

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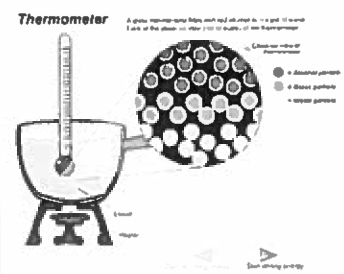
6.1.1 - Thermal Energy: Heat and Moving Particles (Print 2 copies and place in plastic sleeves)

Focus Question: *How can what I CANNOT see help explain what I CAN see?*

Introduction: Scientists use models to represent and explain what they see in the real world, especially things that are not easily seen. Models are not perfect though and have limitations as to how well they represent the real thing.

Task: In this activity, you will use a model to show how adding thermal energy to water affects the movement of the water particles.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- Computer - Heat Energy and Moving Molecules Simulation - Simulation screenshot



Task Steps (Simulation Exploration - 15 min):

Individually…

1. The picture in the model shows "a room temperature pot of water with a thermometer in it." Predict what will happen to the particles of water in the pot and to the particles of alcohol in the thermometer. Explain why you think so in your notebook.

In pairs...

2. Explore the simulation for 1 minute. .
3. Annotate your screenshot. Pay close attention to ALL the parts/components of this model.
    a. Label all the parts you see.
    b. Try to find any relationships between parts of the model.
4. Discuss the following and record your pair's answers in your notebook:
    a. *What do you notice is happening to the movement of the water particles as the water is heated?*
    b. *How is the spacing between the water particles changing?*
    c. *What does not change about the water particles?*
    d. *What evidence do you notice that the water is gaining thermal energy?*
    e. *If the water and thermometer are defined as the system, what inputs are going into this system? What outputs are leaving the system?*

Task Steps (Connecting the seen to unseen - 7 min):

Individually...

5. Looking back at the water mixture investigation, develop a model of what happened when you observed the two cups of hot and cold water were mixed together, including what you could not observe.

Investigation: Two foam cups contain equal masses of water. One cup contains cold water with a temperature of ~0°C. The other contains hot water with a temperature of ~50°C. The hot water is mixed with the cold water and stirred.

Figure 1.

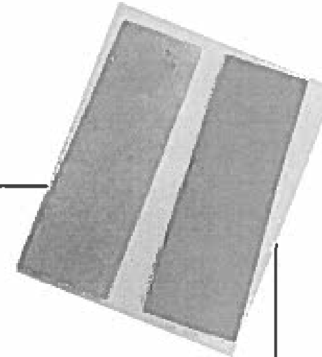
Evaluation Criteria:

Modeling
- ❑ Develop a model based on evidence from investigations and the simulation.
- ❑ Includes observable and unobservable components and processes.

Systems
- ❑ Identify inputs into the system and outputs leaving the system.
- ❑ Model processes that are part of the flow of inputs and/or outputs.

6.1.2 Task Card - Misconception About Temperature (Print 2 copies and place [illegible] sleeves)

Focus Question: *Why do some objects feel warmer than others?*



Task: In this activity, you will investigate how much energy (heat) reaches an object using different materials.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- 5cm x 15xm piece of metal - 5cm x 15cm piece of cardboard - 10cm x 10cm piece of aluminium - 10cm x 10cm piece of paper - IR thermometer - 2 ice cubes

Task Steps (30 min):

In groups...

Part 1

1. Before your team is given materials, predict <u>*which one do you think will feel warmer - a piece of metal or a piece of cardboard.*</u> Write your prediction and explanation in your notebooks.
2. Share your prediction and explanation with your partner.
3. Observe and touch the materials. Do not touch the item for more than 10-seconds each.
4. Record your observations in your notebook using a half page graphic organizer.
5. After everyone in your team has had a chance to observe and touch the materials, add and/or revise your initial thinking.

Metal Chair Leg	Desk
Both	

Part 2

1. As a class, watch the video clip <u>Misconceptions About Temperature</u>.
2. Your teacher will stop the video clip. Gather your materials:
    - IR thermometer - 1 per team
3. Use the IR thermometer to measure the temperature of the piece of metal and desk.
4. Record the temperatures in the graphic organizer.

Part 3

1. Gather materials: 2nd pair of materials
    - 10cm x 10cm piece of aluminium
    - 10cm x 10cm piece of paper
2. Observe which material feels warmer and colder.

Aluminum piece	Paper piece
Both	

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3. Record your observations in your notebook using a new half page graphic organizer.
4. Gather materials:
    - 2 ice cubes per team
5. Place one ice cube on the aluminum and the other ice cube on the paper. Observe what happens and record your observations in the graphic organizer.

Task Steps (15 min):

In groups, discuss...

Explanations - in your notebook.

a. *Why do you think the temperature of metal and cardboard pieces were close?*
b. *Why do you think the ice cube melts faster in one material then the other?*
c. *What patterns did you notice between the metal/cardboard and the aluminum/paper?*
d. *How could the investigation be changed to give different results?*

Modeling:

Individually...

6. Create a model of what happens in part 3 when the ice is placed on the pieces of aluminum and paper in your notebook.

In pairs, individuals take turns...

7. Use the model to explain how materials feel "colder" than others using energy transfer.

Evaluation Criteria:

Modeling
- ☐ Develop a model based on evidence from investigations and previous learning experiences.
- ☐ Includes observable and unobservable components and processes.
- ☐ Use the model to connect what is observed when we feel "coldness" to energy transfer.

Systems
- ☐ Identify inputs into the system and outputs leaving the system.
- ☐ Model processes that are part of the flow of inputs and/or outputs.

Metal

Cardboard

Both

Aluminum

Paper

Both

1. Why do you think the temperature of the metal and cardboard pieces were close?

2. Why do you think the ice cube melts faster on one material than the other?

3. What patterns did you notice between the metal/cardboard and the aluminum/paper?

4. How could the investigation be changed to give different results?

Draw a model explaining what happens when ice is placed on the pieces of aluminum and paper.	Draw a model to explain why materials feel "colder" than other using energy transfer.

Conductors	Insulators

6.1.2 Task Card - Heat Transfer (Print 2 copies and place in plastic sleeves) **Page: 47**

Focus Question: *How can we control how much energy reaches an object?*

Task: In this activity, you will investigate how much energy (heat) reaches an object using different materials.

Group Roles:
- *Facilitator* - Read Task Card out loud, keep group focused
- *Timekeeper* - Keep time, report to group time left during task
- *Resource Manager* - Manage collection/appropriate use/return of activity materials
- *Inquirer* - Only person to ask questions of the teacher/others

Prediction: Read the procedure for the investigation. Write your prediction and explain your reasoning for the following in your notebook.

1. *Of the materials used throughout the investigation, which materials will be better heat conductors and which ones will better insulators of heat?*

Task Steps (40 min):

In groups...

Part 1. Conduction

Materials:

- 1 plastic spoon
- clock / timer
- 1 large wooden craft stick
- styrofoam cup with a capacity of 200mL
- hot water
- 1 metal spoon

Procedure:

1. Fill ¾ of a cup with hot water.
2. Place the large wooden craft stick, metal spoon, and plastic spoon in the water at the same time.
3. After a minute or so, feel the exposed end of the large wooden craft stick, metal spoon, and plastic spoon. Which object feels warmer, cooler, or in-between?

Analysis and Conclusion: Answer the following questions in your notebook.

1. *Did the result of the investigation agree with your predictions?*
2. *Design and annotate a model in your notebook illustrating:*
    a. *The thermal energy in the cup and the utensils*
    b. *Arrows indicating where energy is flowing to and from in the investigation*
3. *Add to your t-chart.*

Evaluation Criteria:

Modeling
- ☐ Develop a model based on evidence from investigations and previous learning experiences.
- ☐ Includes observable and unobservable components and processes.
- ☐ Use the model to connect what is observed when we feel "coldness" to energy transfer.

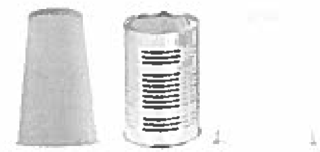
Systems
- ☐ Identify inputs into the system and outputs leaving the system.
- ☐ Model processes that are part of the flow of inputs and/or outputs.

Part 2. Radiation

Materials:

- heat lamp
- plastic cup
- tin can
- paper cup
- sheet of black paper
- IR thermometer

Procedure:



1. Place a black sheet of paper on the table.
2. Record the temperature of the black sheet of paper.
3. Place the paper cup, tin can, and plastic cup upside down on the black sheet of paper.
4. Place a heat lamp above the cups and turn it on. Leave it on for a ~ 5-minutes.
5. After ~ 5-minutes, lift up the cups one at a time to measure and record the temperature of the black sheet of paper under each cup.

Black Paper Temperature under...	Paper Cup	Tin Cup	Plastic Cup
Temp. (°C) Before			
Temp. (°C) After			

Analysis and Conclusion: Answer the following questions in your notebook.

1. *Did the result of the investigation agree with you predictions?*
2. *Design and annotate a model in your notebook illustrating:*
   a. *The thermal energy surrounding the containers, in each container, and in the black sheet of paper.*
   b. *Arrows indicating where energy is flowing to and from in the investigation*
3. *Add to your t-chart.*

Evaluation Criteria:

Modeling

- ❑ Develop a model based on evidence from investigations and previous learning experiences.
- ❑ Includes observable and unobservable components and processes.
- ❑ Use the model to connect what is observed when we feel "coldness" to energy transfer.

Systems

- ❑ Identify inputs into the system and outputs leaving the system.
- ❑ Model processes that are part of the flow of inputs and/or outputs.

Part 3. Convection

Materials:

- 3 styrofoam cup with a capacity of 200mL
- piece of aluminum foil
- piece of cardboard
- a closed sandwich bag
- IR thermometer

Procedure:

1. Take three-cups and fill each cup with ¾ hot water.
2. Place a piece of cardboard to cover the first cup, a piece of aluminum foil to cover the second cup, and a closed sandwich bag to cover the third cup. Leave the cups covered for ~ 3-minutes.

3. After ~3-minutes, take off each covered one at a time. Measure and record the temperature on top of the cover and underneath the cover (the side closest to the hot water).

Temperature (°C)	Cardboard	Aluminum	Sandwich Bag
Top of Cover			
Under the Cover			

Analysis and Conclusion: Answer the following questions in your notebook.

4. *Did the result of the investigation agree with your predictions?*
5. *Design and annotate a model in your notebook illustrating:*
   a. *The thermal energy in each cup and cover.*
   b. *Arrows indicating where energy is flowing to and from in the investigation*
6. *Add to your t-chart.*

Evaluation Criteria:

Modeling

- ❑ Develop a model based on evidence from investigations and previous learning experiences.
- ❑ Includes observable and unobservable components and processes.
- ❑ Use the model to connect what is observed when we feel "coldness" to energy transfer.

Systems

- ❑ Identify inputs into the system and outputs leaving the system.
- ❑ Model processes that are part of the flow of inputs and/or outputs.

6.1.2 Output sheet

1. Predict—which material will be better heat conductors and which ones will be better insulators?

Part 1—Conduction

1. After placing the objects in the cup, wait for a minute. Then feel the three objects. Which object feels warmer, cooler, in-between?

2. Did the result of the investigation agree with your predictions?

3. Design and annotate a model showing:

   A. Thermal energy in the cup and the utensils

   B Arrows indicating where energy is flowing to and from in the investigation

6.1.2 Output sheet

Part 2—Radiation

Black Paper Temperature under...	Paper Cup	Tin Cup	Plastic Cup
Temp Before			
Temp After			

1. Did the result of the investigation agree with your predictions?

2. Design and annotate a model showing:

A. Thermal energy surrounding the containers, in each container, and in the black sheet of paper.

B Arrows indicating where energy is flowing to and from in the investigation

6.1.2 Output sheet

Part 2—Radiation

Temperature	Cardboard	Aluminum	Sandwich Bag
Top of Cover			
Under Cover			

1. Did the result of the investigation agree with your predictions?

2. Design and annotate a model showing:

   A. Thermal energy in each cup and cover

   B Arrows indicating where energy is flowing to and from in the investigation

Name: ______________________________ Period: ____ Date: **Page: 55**

6.1.2 - Output Sheet - Letter to LunchBox Designer

Energy Efficient Building

Focus Question: *How can we control heat transfer to match our needs?*

Task:

Using what you learned so far about heat transfer, materials, particles, and thermal energy:

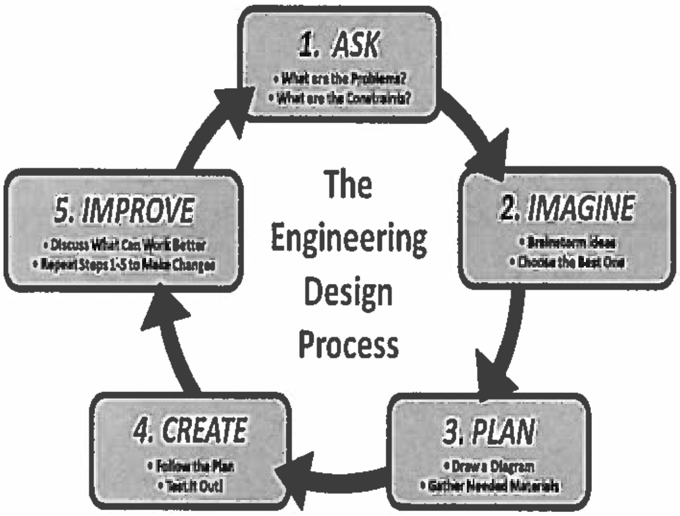
- Write a letter recommending the design materials for a lunchbox that under hot climate conditions will keep food cold.
- Justify your recommendations with evidence from previous activities.

Name: ______________________

Date:____________ Per. _____

Spacewalk

Since humans are approximately 75% water, your astronauts will be made from a water bottle. You need to design a spacesuit for your astronaut to minimize energy loss in space. Consider the NGSS process below.



Engineering Design Step 1: "ASK"

Scenario: You are a NASA scientists who will design a future spacesuit for an astronaut who will be going on a spacewalk. Throughout the unit you will find out how energy moves through objects.

Your space suit needs to maintain a safe temperature for your astronaut because an astronaut in a fully functioning spacesuit would warm or cool to unsafe (250^{0}F to -250^{0}F) levels in a matter of minutes while in space. Thus, the amount of energy an astronaut receives in space can vary dramatically. Your astronaut will be placed under a heat lamp will be used to model the sun.

Engineering Design Step 2: IMAGINE

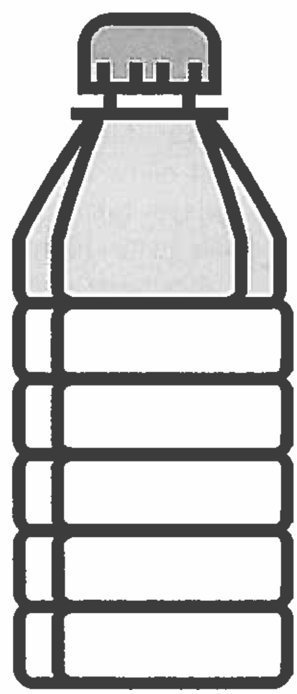
Challenge: To maintain successfully the body temperature of an astronaut in space. The space suit must allow the astronaut to survive for 10 minutes in a testing area.

Brainstorm: How can your astronaut minimize energy loss?

Possible Materials to Work with: cotton, felt, bubble wrap, white paper, aluminum foil, plastic wrap, scissors, styrofoam, masking tape, rubber bands, cardboard, plastic bags, fabric, tissue paper, etc.

Directions: Draw and label your design of a space suit. Keep in mind, the water bottle is your astronaut and you must maintain his/her body temperature.

Part 1: Label all materials you choose to insulate your astronaut with.



Part 2: Add justifications (explain) why you chose each item.

Material	Justification

Engineering Design Step 3: PLAN

Directions: Gather needed materials and begin to BUILD!!!

Engineering Design Step 4: CREATE and TEST

Data Table: **Trial #1**

Item		Results		
		Initial temp (Degrees Celsius)	Ending temp (Degrees Celsius)	Change in temp
Astronaut Suit (exterior) Temperature	Hot Environment			
	Cold Environment			

Item		Results		
		Initial temp (Degrees Celsius)	Ending temp (Degrees Celsius)	Change in temp
Astronaut (water) Temperature	Hot Environment			
	Cold Environment			

Engineering Design Step 5: IMPROVE

MODIFY: What were the **results** of your testing? Was there something you didn't expect to happen? How will you **improve** your design for the next trial?

____

____

____

____

____

Data Table: **Trial #2**

Item		Results		
		Initial temp (Degrees Celsius)	Ending temp (Degrees Celsius)	Change in temp
Astronaut Suit (exterior) Temperature	Hot Environment			
	Cold Environment			

Item		Results		
		Initial temp (Degrees Celsius)	Ending temp (Degrees Celsius)	Change in temp
Astronaut (water) Temperature	Hot Environment			
	Cold Environment			

Conclusion:

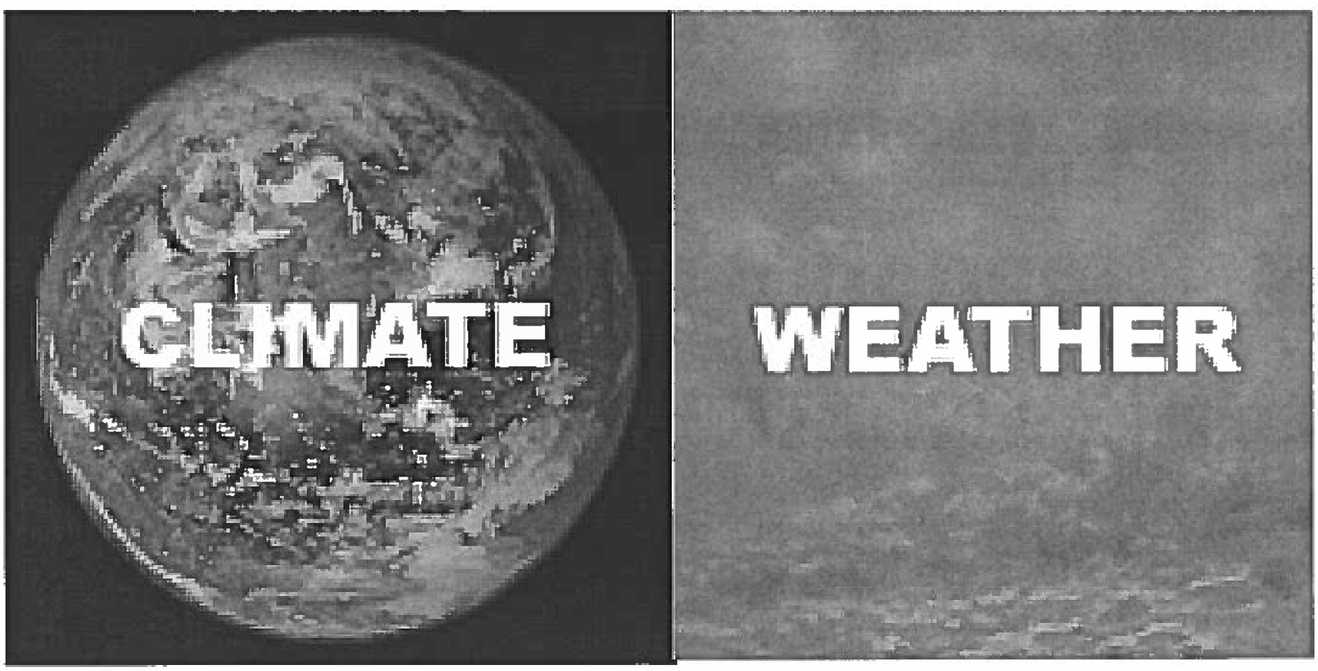
1) In which direction is heat flowing in the HOT environment?

2) In which direction is heat flowing in the COLD environment?

3) How did you track energy flow in your design?

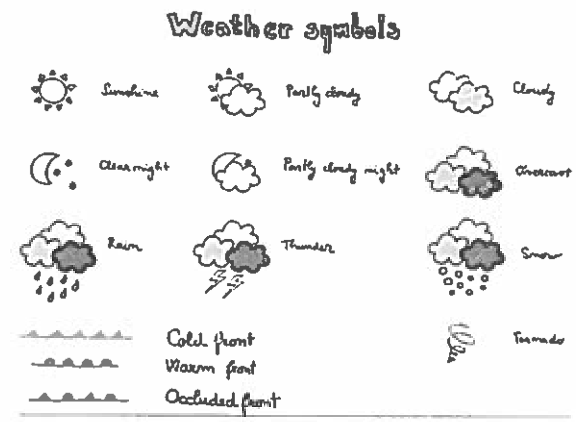
4) What materials helped to reduce energy loss for your astronaut? Why? (Hint: Think about the letter to the Lunch Box Designer.)

Lathrop Intermediate
6th grade Science
Weather and Climate Unit



Name ______________________ Period: ____ Date: __________

6.1.0 Output Sheet



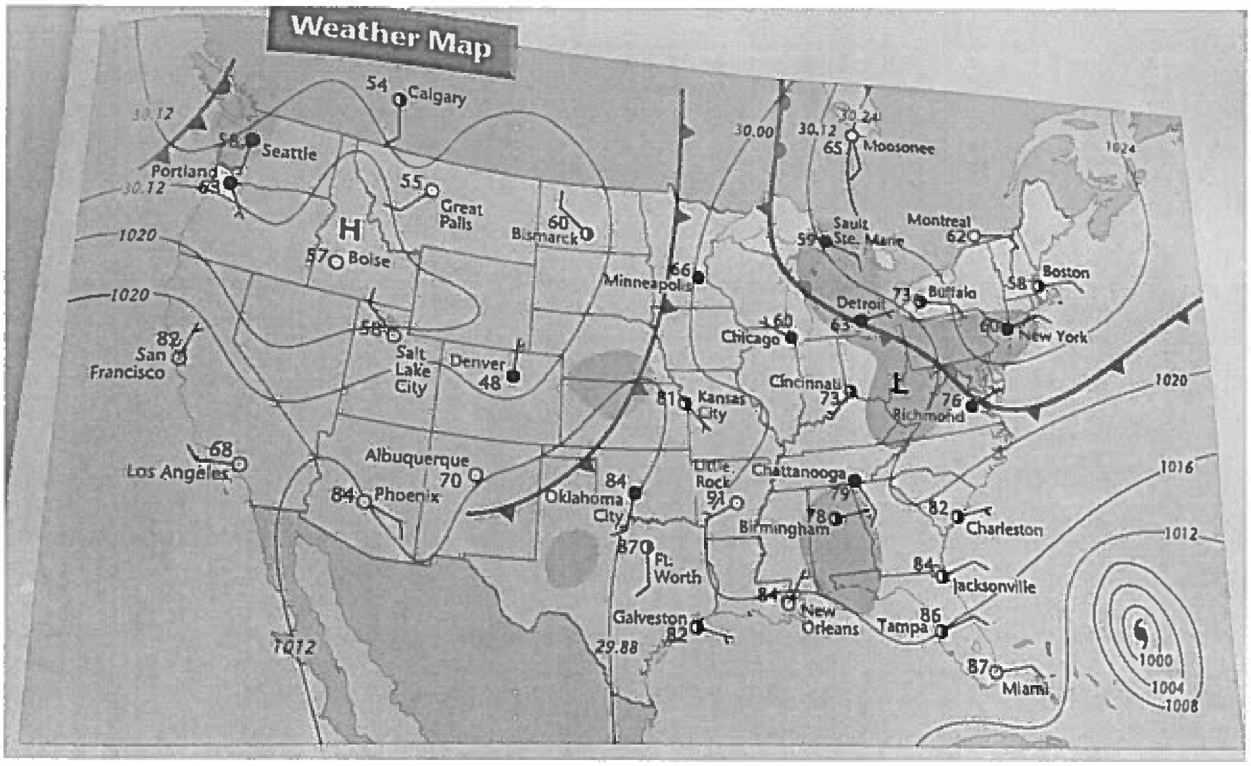
Homework - Watching the Forecast

Directions: For a week (7 days), watch the news for the local weather forecast. Do not skip a day. Record information from the forecast in the table below.

Day, Date							
Time							
Channel / News Station / Website							
Temperature for Santa Ana *(high and low)*	/	/	/	/	/	/	/
Wind Speed and Direction							
Sun Partial Clouds Fog (See chart above for examples)							
Precipitation / Rainfall (in inches) If it did not rain, write 0.							

6.1.0 Entry Task - Exploring a Weather Map (Print 2 copies and place in plastic sleeves)

Resource Sheet



Definition of Fronts

EXPLANATION OF FRONTS

Cold Front
Boundary between a cold air mass and a warm air mass. Brings brief storms and cooler weather.

Warm Front
Boundary between a warm air mass and a cold air mass. Usually accompanied by precipitation.

Stationary Front
Boundary between a warm air mass and a cold air mass when no movement occurs. Brings long periods of precipitation.

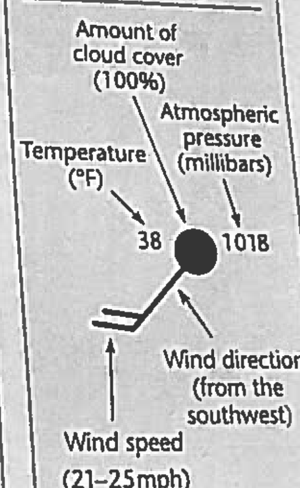
Occluded Front
Boundary on which a warm front has been overtaken by a cold front. Brings precipitation.

Weather	Symbol
Drizzle	
Fog	
Hail	
Haze	
Rain	
Shower	
Sleet	
Smoke	
Snow	
Thunderstorm	
Hurricane	

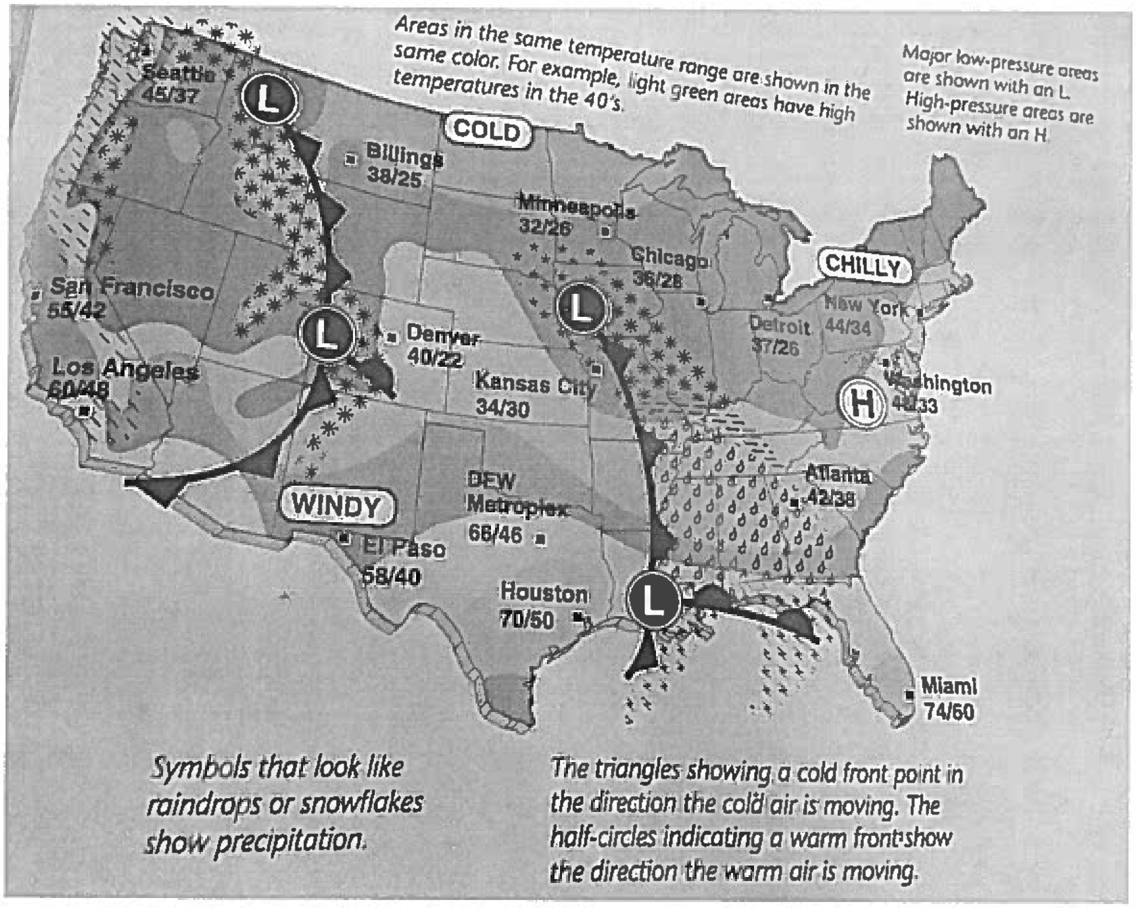
Wind Speed (mph)	Symbol
1–2	
3–8	
9–14	
15–20	
21–25	
26–31	
32–37	
38–43	
44–49	
50–54	
55–60	
61–66	
67–71	
72–77	

Cloud Cover (%)	Symbol
0	
10	
20–30	
40	
50	
60	
70–80	
90	
100	

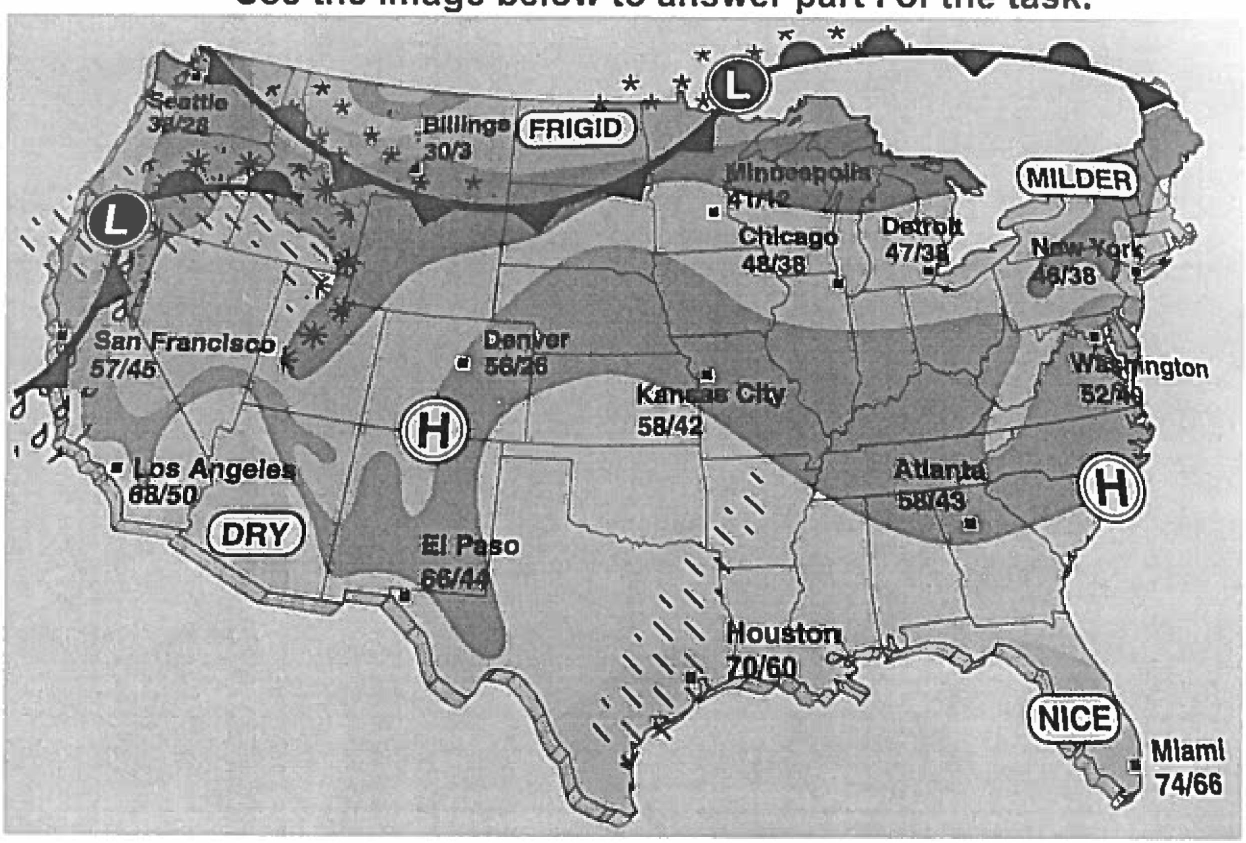
How Symbols Are Used on a Weather Map



Adapted from Prentice Hall Focus on Earth Science



Use the image below to answer part I of the task.



6.1.0 Entry Task - Exploring a Weather Map (Print 2 copies and place in plastic sleeves)

Guiding Question: *How does a weather map communicate data?*

In this task, you will interpret data from a weather map to describe weather conditions in various places.

Part I.

Procedure:

1. Refer to the Resource Sheet for definitions and examples.
2. Observe the different colors on the weather maps.
3. Find the symbol for snow and rain.
4. Locate the warm fronts and cold fronts.
5. Locate the symbols for high and low pressure.

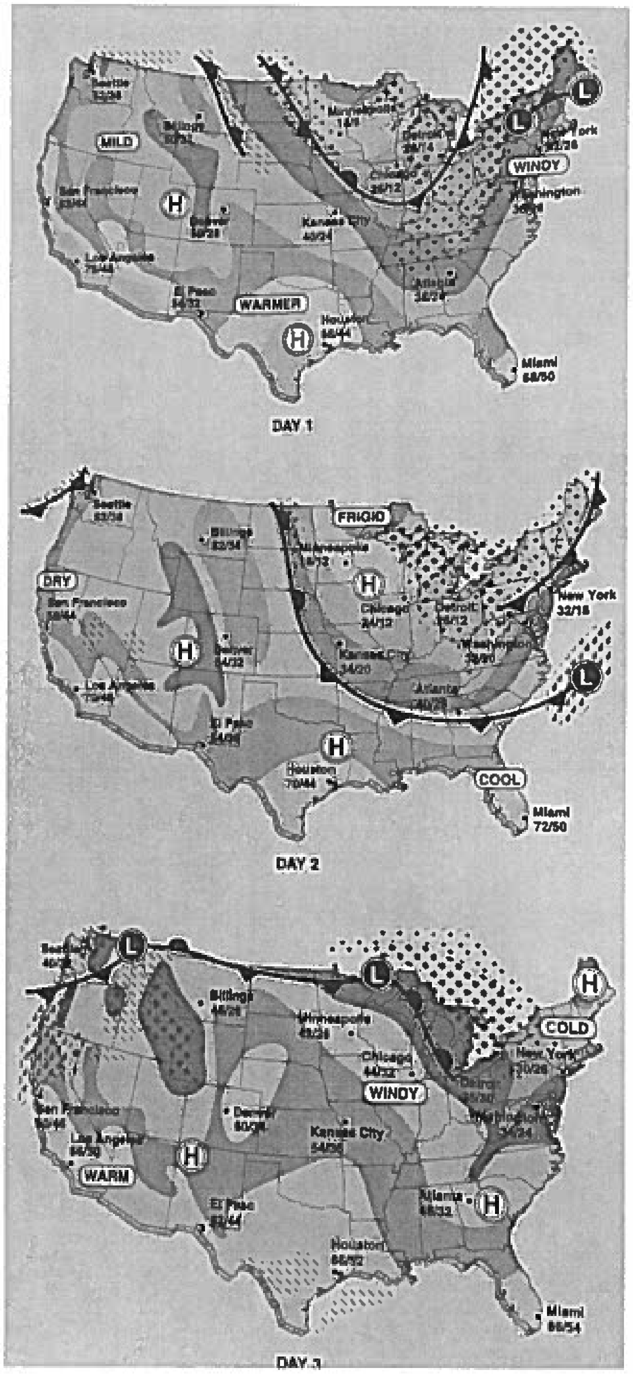
Analyze and Conclude: ***Write your answer in your Interactive Notebook.***

1. What color represents the highest temperatures? What color represents the lowest temperatures?
2. What city has the highest temperature? What city has the lowest temperature?
3. Where on the map is it raining? Where on the map is it snowing?
4. How many different kinds of fronts are shown on the map?
5. How many areas of low pressure are shown on the map? How many areas of high pressure are shown on the map?
6. What season does this map represent? How do you know?
7. The triangles △ and semicircles ◠ on the front lines show which way the front is moving. What front is moving towards Minneapolis? What kind of weather do you think it will bring?

6.1.0 Entry Task - Exploring a Weather Map (Print 2 copies and place in plastic sleeves) **Page: 68**

Part II.

<u>Predict</u> what the weather would look like on **<u>Day 4</u>** and **<u>Day 5</u>**.

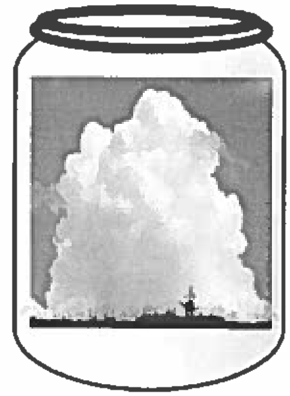


<u>Day 4</u>

<u>Day 5</u>

Guiding Question: How do clouds form?

Task
Create a model of how a cloud forms in a jar.



Materials: (per group)

- Boiling water (tea kettle)
- Bag of ice
- Glass jar
- Matches
- 6.2.U Clouds Anchor Phenomenon RRR

Directions:

1. Fill the glass jar with hot water.
2. Let the water stay in the jar for about a minute then pour out most of it, leaving only about two inches of hot water in the bottom.
3. Your teacher will then come around and light a match then place the match in the jar.
4. Take the bag of ice and place it on top of the jar.
5. Revise your model based on what you observed.

Part IV. Reflection (10-minutes)

Teamwork

- Complete the Collaboration and Teamwork Rubric.
- As a team, be prepared to share your team's thinking and decision-making process.

Activity 8.3.0 -1 Student Roles

FACILITATOR	INQUIRER
Name: ________________	Name________________
RECORDER	**RESOURCE MANAGER**
Name________________	Name________________
TIME KEEPER	**REPORTER**
Name________________	Name________________

Adapted from Cloud in a Jar Water Cycle Demo Created by Laura Candler-Teaching Resources-www.lauracandler.com

6.0.0 Task - Cloud in a Jar (Print 2 copies and place in plastic sleeves)

Teamwork: completed during the experiment

1. Draw, label and describe what you see.

2. Explain why swirling clouds form in the jar.

3. Do you see any water droplets? If so, what causes it?

Individual Reflective Questions: completed after the experiment

Answer the following questions individually.

1. Explain how clouds formed in the jar.

First we…

Then we…

The cloud was formed when…

2. Did you see any water droplets? If so, what caused them?

3. What does each part of the cloud in a jar system represent in the real water cycle?

Condensation=

Evaporation=

Precipitation=

Adapted from Cloud in a Jar Water Cycle Demo Created by Laura Candler-Teaching Resources-www.lauracandler.com

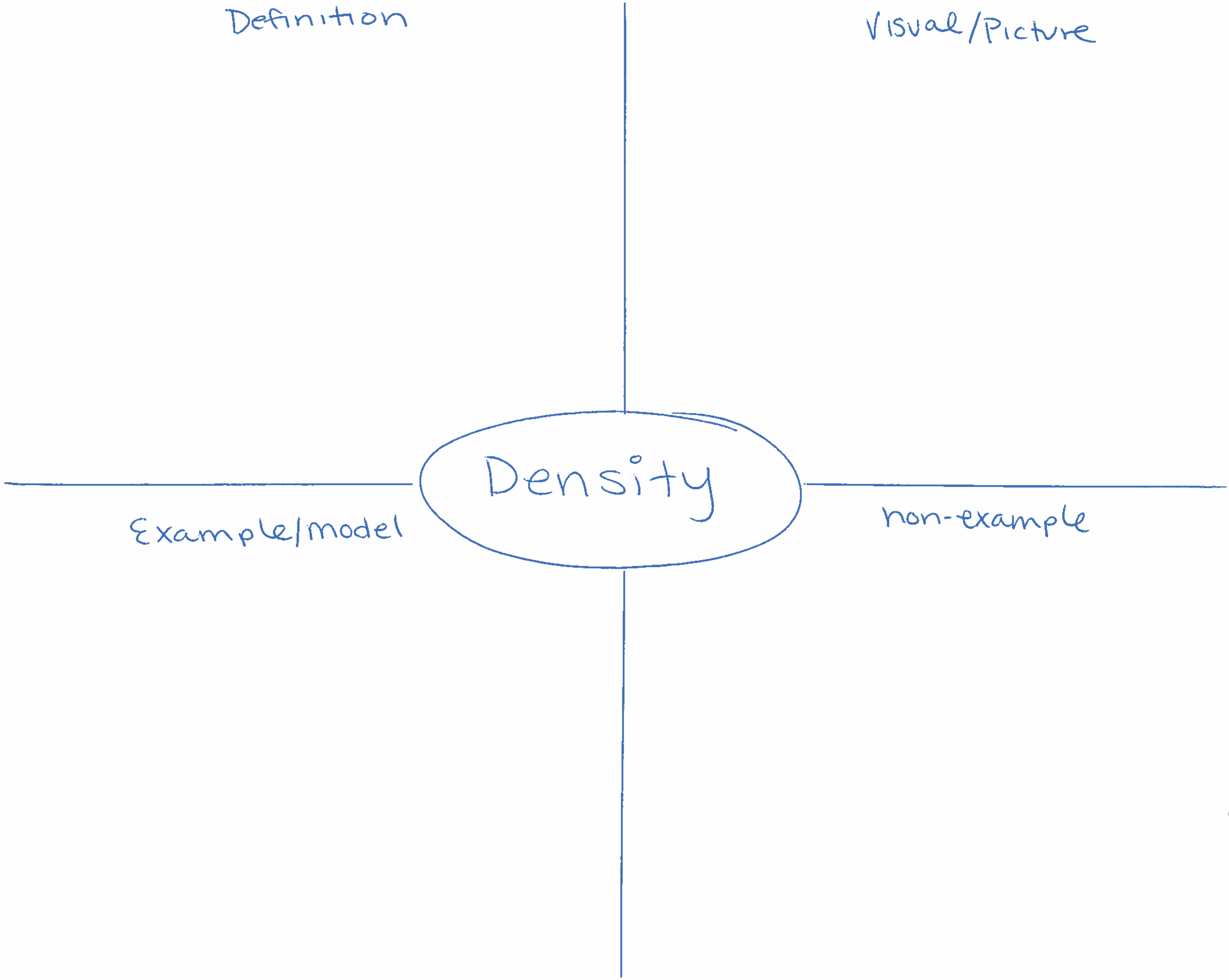
4. How is the process of creating a mini cloud **similar and different to** the way natural clouds are formed? (use a thinking map to complete this question)

Mini Clouds in a Jar

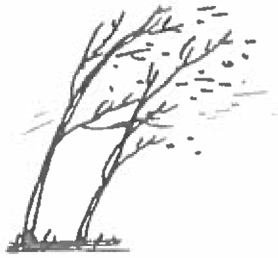
Naturally Made Clouds

Evaluative Criteria

- ❏ Model shows all components needed to make a cloud
- ❏ Includes an explanation of how clouds form


Definition
Visual/Picture
Density
Example/model
non-example

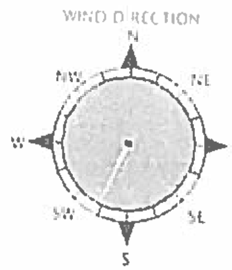
Graphic Notes: What causes weather?



What Is Wind?

Wind is the movement of air over the earth's surface. The upward movement of air is known as an updraft; the downward movement downward is known as a downdraft. Wind is an important element of weather.

A wind is named for the direction from which it blows. Thus a wind blowing from southeast to northwest is a southeast wind. Wind direction is important to weather observers, sailors, aviators, artillerymen, and hunters. A **weather vane** is used to show the direction that the wind is blowing.

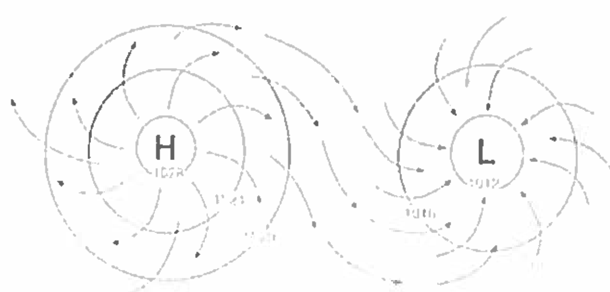


Wind speed can vary greatly. Near the earth's surface, it is measured by an instrument called an **anemometer**. In the upper atmosphere, wind speed is determined by tracking a balloon or a balloon-borne object, usually by radar. Wind speed is measured in knots (nautical miles per hour), or in meters or feet per second.

What Causes Winds?

Wind is caused when air moves from places of higher air pressure to places of lower air pressure. These differences in pressure are caused by the uneven heating and cooling of air. Warm air is lighter than cold air so it rises. The warmer air also has a lower air pressure. For instance, during the day along the coastline, the land heats up faster than the water and this warmer air rises. Cooler air from the sea has higher air pressure. The heavier cool air from the sea sinks and rushes in beneath the rising warm air on land and a sea breeze or lake breeze forms.

The direction that wind takes is influenced by the rotation of the earth. If the earth did not rotate, wind would move in a straight path from a high- to a low-pressure area. Because the earth rotates, the wind is deflected or shifted from this path—to the right in the Northern Hemisphere and to the left in the Southern—by the turning of the earth on its axis.



The arrows show how the wind is deflected to the right to circle around the low air pressure zone

Lathrop Intermediate
6th grade Science
Climate Change Unit

6.3.0 Resource Sheet: Calculating Ecological Footprint *(Print two and place each* **Page: 78** *eeves)*

Guiding Question: *How can I lower my ecological footprint?*

Task: *Calculate your ecological footprint and personalize your mitigation strategies.*

Time: ~20min

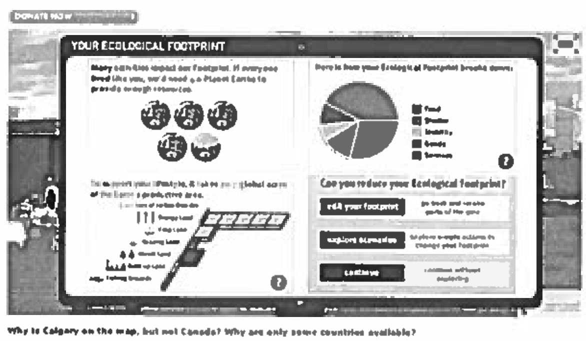
10 min

Procedure:

1. Calculate your Ecological Footprint on the following website:

   http://tinyurl.com/6j6vot

2. Pick your location, you are a new user, create your character and answer a series of questions.
   At the end you will receive your Ecological Footprint.



Analysis: *Answer the following in your notebook.*

3. How many planets worth of resources would it take if EVERYONE lived like you?

4. What are the two largest areas on the pie chart of your Ecological Footprint?

5. How many acres of Earth's productive area would it take to support your lifestyle?

Further Explore: *Chose the button to "explore scenarios" and select "what if…?"*

6. What did you choose to do to reduce your ecological footprint?

   a. How much would that reduce the number of Earths needed to support everyone at your lifestyle?

10 min

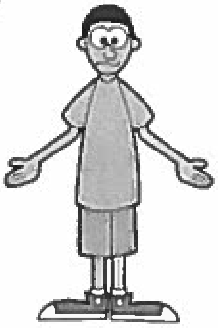
Group Discussion:

7. Discuss your results for questions #3-6
8. What contributes to an ecological footprint?
9. What does calculating our ecological footprint allow us to do?

Be ready to share out to whole class.

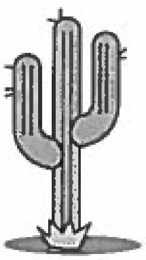
What is “Global Climate Change”?

Is the climate of the whole Earth really changing?



Yes! Earth has been getting warmer—and fast.

Global climate is the average climate over the entire planet. And the reason scientists and folks like you are concerned is that Earth's global climate is changing. The planet is warming up fast—faster than at any time scientists know about from their studies of Earth's entire history.

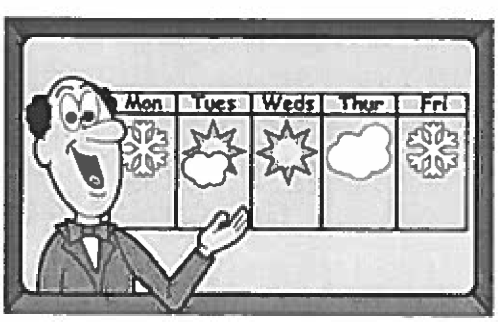


What is climate?

"Climate" describes conditions over the long term and over an entire region.

Climate is the big picture. It is the big picture of temperatures, rainfall, wind and other conditions over a larger region and a longer time than weather. For example, the **weather** was rainy in Phoenix, Arizona, last week. But this city usually gets only about 7 inches of rain each year. So the **climate** for Arizona is dry. Much of Southern California also has a dry, desert climate. Brazil has a tropical climate, because it's warm and rains there a lot.

What is weather?



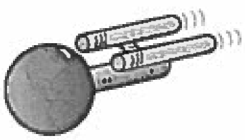
TV weather reporters need all the information they can get in order to predict the weather for just a few days.

Weather is local and temporary.

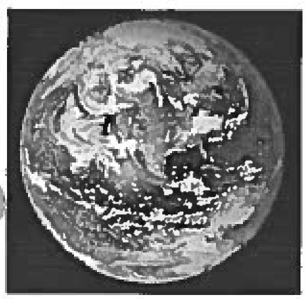
On our own Earth, we cannot control weather by turning a thermostat up to make it warmer or down to make it cooler. The best we can do is try to predict the weather. Weather scientists, called meteorologists, try to foresee what's going to happen next.

Is that big black cloud going to let loose over San Francisco, or wait until it gets to Sacramento? Will that new storm forming in the Atlantic Ocean turn into a hurricane? Conditions are just right for tornadoes. Will any form? And where might they touch the ground and cause trouble?

Weather happens at a particular time and place. Rain, snow, wind, hurricanes, tornadoes—these are all weather events.



Do we care if Earth is getting warmer?



The whole Earth as seen from 22,300 miles away, out in space.

Yes, we care! After all, Earth is our spaceship.

It carries us on a 583-million-mile cruise around the Sun every year. It even has its own "force field." Earth has a magnetic field that protects us from killer radiation and brutal solar wind. For its life-support system, Earth has all the air, water, and food we need.

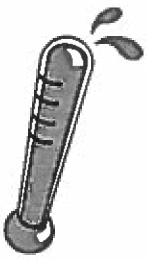
Just like astronauts on a long space voyage, we need to monitor all our "ship's" **vital functions** and keep our Earth "ship shape."

Does what we do matter?

Earth's fate is in our hands.

Everything that happens here affects something over there.

Earth has its own control system. The oceans, the land, the air, the plants and animals, and the energy from the Sun all affect each other to make everything work in harmony. Nothing changes in one place without changing something in another place. The overall effect gives us our **global climate**.



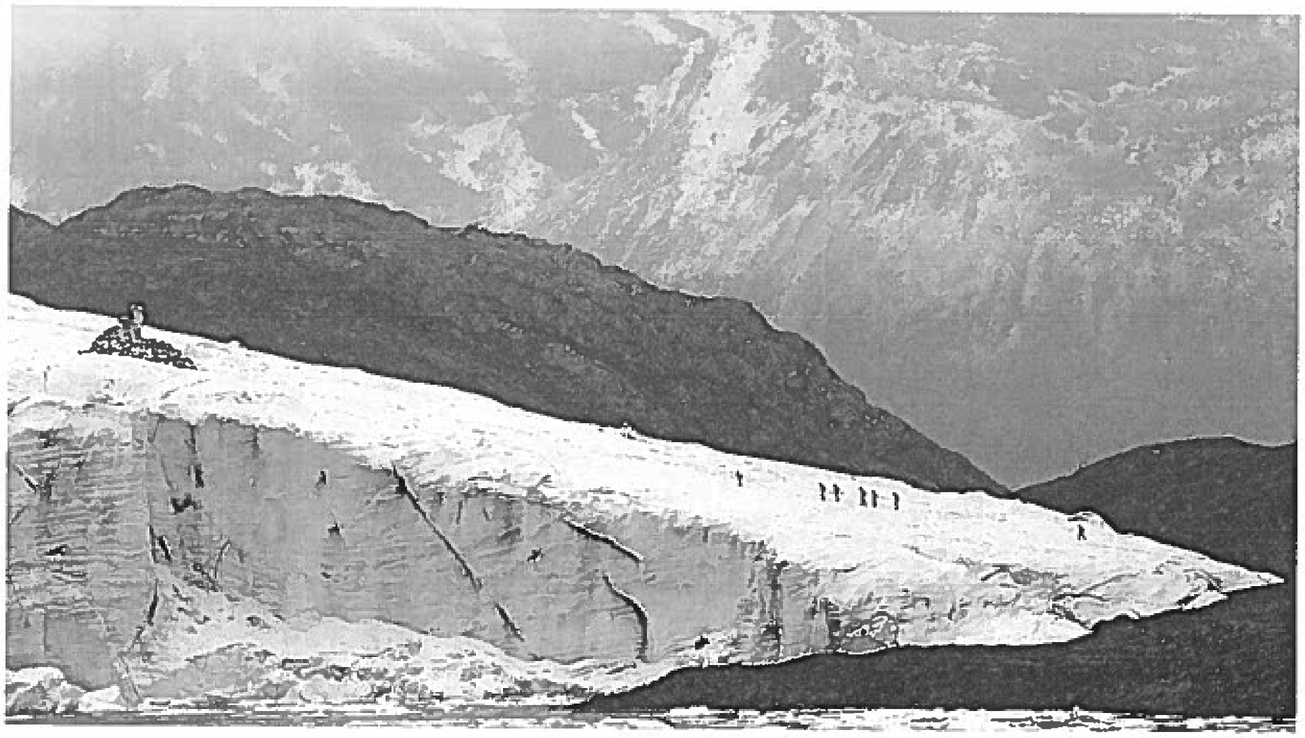
What is making Earth's climate warmer?

Scientists have discovered that humans are causing this warming.

But how do they know that? What are we doing that could cause the whole planet to get warmer? And how could warming happen so fast? What will happen to people and other living things if the planet keeps getting warmer? And what can we do to slow down or stop the warming?

Climate change confirmed? Last year called the warmest on record

By Los Angeles Times, adapted by Newsela staff on 01.22.15
Word Count **886**



Members of the glaciology unit of Peru's national water authority walk on the Pastoruri glacier in Huaraz, Peru, Dec. 4, 2014. The glaciology unit was studying the measurement of ice thickness. AP Photo/Rodrigo Abd

Scientists began recording average surface temperatures on Earth in 1880. Last year, 2014, was the warmest year ever recorded since that time.

The planet is warming over the long term, scientists announced Friday. The Earth's average temperature has risen 1.4 degrees Fahrenheit since 1880.

While a less than two-degree difference may seem small, this rise in temperatures could cause big problems. Flooding along coastlines, more severe storms, and global droughts are all threats, climate experts from NASA and the National Oceanic and Atmospheric Administration (NOAA) said.

Scientists from NASA, the U.S. space agency, and NOAA used data collected from around the world. They had 6,300 weather stations on land, ships and floating buoys in the world's oceans, and research stations in Antarctica.

The Warmest Years Yet

Experts from both agencies found 2014's temperatures to be higher than average temperatures in the 1900s.

Sometimes high temperatures on the Earth's surface are caused by El Nino: a change in currents and temperatures in the Pacific Ocean. Scientists are worried because the high global temperatures in 2014 were not tied to El Nino.

December 2014 was the warmest month ever measured, NOAA reported. May, June, August and September set new records for monthly highs.

A hotter 2014 continued a trend: 9 of the 10 warmest years ever recorded have occurred since 2002, NOAA said.

The climate scientists said that this warming trend — temperatures going up over a long period of time — could only be explained if you looked at human activity. They blamed burning fossil fuels. Burning fossil fuels, such as coal, release greenhouse gases into the Earth's atmosphere. These greenhouse gases help to trap in heat.

"Greenhouse gas trends are responsible for the majority of the trend that we see," said NASA scientist Gavin Schmidt.

Because more greenhouse gases are being released, Schmidt added, "we may anticipate further record highs in the years to come."

Blazing Heat And Other Hot Spells

Land temperatures in 2014 were just the fourth warmest of all time. It was record-high temperatures in the oceans that moved the global average up. Ocean water holds in heat longer than land. As water heats up, ice melts, causing sea levels to rise.

"This was very clearly the warmest year in the ocean records," Schmidt said. "It wasn't quite the warmest year in the land records, but combined, this did actually give the warmest year" since 1880.

Last year was the warmest ever despite a colder-than-usual U.S. winter caused by a "polar vortex," the scientific agencies said. The colder U.S. winter was balanced out by hotter periods elsewhere: blazing heat in the Western U.S., and hot spells in Europe and Australia.

Both Alaska, and Siberia in northern Russia, saw warmer-than-usual temperatures in 2014. The city of Anchorage, Alaska, did not have temperatures drop below zero degrees in 2014. It was the first time ever.

Temperatures in the far northern latitudes of the Earth: northern Canada, Russia and Scandinavia, for example, are rising twice as fast as areas closer to the equator. The rising temperatures in the north are melting snow. Less snow means the Earth can reflect less heat.

"A lot of additional heat is gained because there's less snow to reflect the sunlight back to space," said Tom Karl, head of NASA's National Climatic Data Center in North Carolina.

Arctic sea ice melted more due to higher summer temperatures, Schmidt said, with ice at the Earth's far north at its sixth lowest level ever.

Steady Rise Since 1970s

Meanwhile, Antarctic sea ice — at the south of the planet — hit record highs in 2014. This is "a little surprising given the warmth on the rest of the planet," Schmidt said.

Antarctic sea ice is less tied to global temperatures, Schdmit said, and more influenced by local factors including wind and fresh water from melting ice on land.

Skeptics who doubt global warming often point to record-high temperatures in 1998 to argue that the warming has slowed down, or stopped. But NASA and NOAA scientists said the new data clearly showed that there has been a steady rise in temperatures since the 1970s.

"2014 is exactly where we would've expected, before 1998," Schmidt said. "There are going to be periods when short-term trends go up and go down. But there's no evidence that the long-term trend is much different from what it has been."

Tim Barnett, a marine physicist with the Scripps Institution of Oceanography at the University of California, San Diego, said the evidence showed that warming had not paused since the late 1990s.

"You have to interpret what you're seeing over the long haul," he said. "You have to look at a couple of decades at least before you begin to see that things have changed."

Running Hot And Cold

Until last year, the warmest years ever were 2005 and 2010. The global average for 2014 was higher than those years by 0.07 degree Fahrenheit, government scientists said.

Between 1880 and 1970, the global annual temperature increased at an average rate of 0.11 degree Fahrenheit per decade. Since then, it has increased by 0.28 degree Fahrenheit per decade, NOAA data show.

In the U.S., California, Alaska, Nevada and New Mexico saw all-time warm years in 2014. At the same time, most of the Midwest and East Coast experienced temperatures far lower than usual, NOAA said.

Quiz

1 How is the author's analysis structured in the article?

(A) as a comparison between short- and long-term changes in the Earth's temperature

(B) as an analysis of the gradually increasing temperature of the Earth in the last century

(C) as a central discussion of the effect of greenhouse gases on the Earth's temperature

(D) as a description of the extensive research conducted by the weather department

2 The article describes the seriousness of the temperature rise of the Earth by:

(A) showing that 2014 was warmer than two of the warmest years in the last decade

(B) highlighting the consequences of greenhouse gas trends on the Earth's climate

(C) illustrating the melting of ice that causes the Earth to absorb sunlight

(D) revealing that the temperature rise is a direct result of El Nino

3 Why does the author include the first four paragraphs in the article?

(A) to show that the collected data confirms a gradual increase in temperature over the years

(B) to illustrate that the average rise in Earth's temperature has been happening since 1880

(C) to illustrate how an ever so small increase in temperature can lead to big problems like storms and droughts

(D) to show how climate experts from NASA and NOAA have been collecting data from around the world

4 Why is paragraph 5 of the section "Blazing Heat And Other Hot Spells" important to the article?

(A) It shows how the increase in temperature means less snow in the northern latitudes of the Earth.

(B) It shows that colder regions closer to the equator are experiencing a greater increase in temperature.

(C) It shows that the melting of ice because of global warming further adds to an increase in temperature.

(D) It shows how the effect of global warming is widespread and can be seen even on the colder regions of the Earth.

6.3.1 Task Card: Climate Change-CO_2 and Air Temperature

Focus Question: *How does the greenhouse effect work?*

Background Informations:
Carbon dioxide is a gas that has existed in our atmosphere for billions of years. Scientists were not around billions of years ago to measure the small amounts of CO_2, but past CO_2 levels can be accurately measured by using ice core samples from glaciers. The gas was trapped in the glaciers as the glaciers formed. The CO_2 levels are measured in parts per million. Carbon dioxide is released to the atmosphere when fossil fuels and other hydrocarbons are burned. Also, carbon dioxide is released through animal respiration. Recently, the highest levels of carbon dioxide on record have been observed. What effect will carbon dioxide have on temperature?

Hypothesis: The temperature inside the closed plastic bottle will be ________________ the temperature in the open plastic bottle.
higher than, lower than, same temperature as

Group Roles:	Materials: (per team)
• Facilitator - Read Task Card out loud, keep group focused, encourage equity of voice • Timekeeper - Keep time, keep group on track • Recorder - Record key points of pair dialogue & ensure everyone records / keeps up with recording • Resource Manager - Organize materials and enforces referencing materials	• 2- 500mL clear plastic bottles • Tape • 2-thermometers • heat lamp or access to sunlight

Procedure:

1. For the closed plastic bottle, tape the thermometer to the inside of the lid.
2. For the open plastic bottle, tape the thermometer to the opening of the plastic bottle.
3. Copy the data table in your Interactive Notebook. Record the initial temperature in your data table.
4. Place both bottles into sunlight or near a heat lamp.
5. Record the temperature of each bottle after 20 minutes in your data table.

	Initial Temperature	Temperature after ____ minutes	Change in temperature
Closed plastic bottle			
Open plastic bottle			

6. Calculate the change in temperature.
7. At the end, draw a model of this activity in your Interactive Notebook. Annotate the draw use the following terms: heat, sun, carbon dioxide, air, atmosphere and temperature.

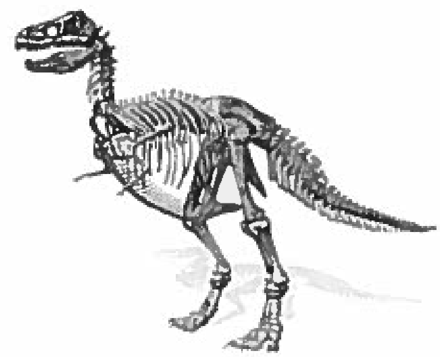
Adapted from NASA's Global Precipitation Measurement Mission

6.3.1 model.

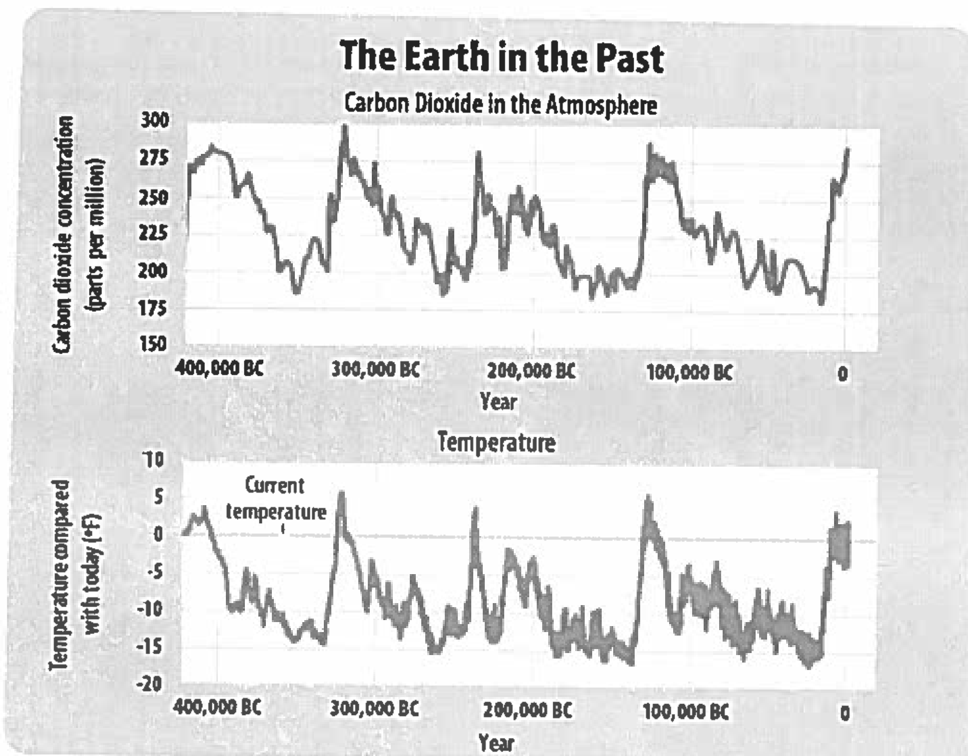
-Draw a model of the activity. Please use the following terms: heat, sun, carbon dioxide, air, atmosphere, and temperature.

The Earth's Climate in the Past

The Earth was formed about 4.5 billion years ago—that's a very long time ago! It's hard to say exactly what the Earth's daily weather was like in any particular place on any particular day thousands or millions of years ago. But we know a lot about what the Earth's *climate* was like way back then because of clues that remain in rocks, ice, trees, corals, and fossils.



These clues tell us that the Earth's climate has changed many times before. There have been times when most of the planet was covered in ice, and there have also been much warmer periods. Over at least the last 650,000 years, temperatures and carbon dioxide levels in the atmosphere have increased and decreased in a cyclical pattern. Can you see this pattern in the graph below?



These graphs are based on the Vostok Ice core from Antarctica. They do not include the most recent increases in carbon dioxide and temperature caused by humans. Notice the strong connection between carbon dioxide and temperature. *Source:* *EPA's Climate Change Indicators (2016)* *and* *Petit et al. (2001)*.

People didn't cause the climate change that occurred thousands or millions of years ago, so it must have happened for other natural reasons.

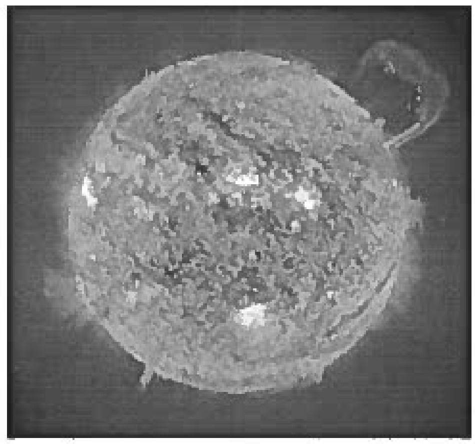
Explore the list below to learn about some natural factors that have changed the Earth's climate in the past.

Changes in the Earth's orbit

The shape of the Earth's orbit around the sun naturally changes over time, and so does the way the Earth tilts toward the sun. Many of these changes happen in cycles that repeat over tens of thousands of years. These changes affect how much of the sun's energy the Earth absorbs, which in turn affects the Earth's temperature. Over at least the last few million years, these cycles likely caused the Earth to alternate between cold and warm periods. For the last few thousand years, we've been in a relatively warmer period.

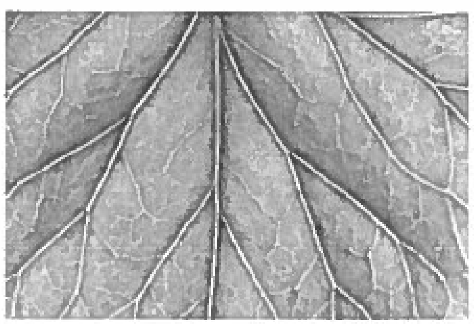
About 20,000 years ago, ice sheets covered large parts of North America, where they extended as far south as where Chicago is now. In some places, this ice was a mile deep! *Source: Adapted from* *NASA (2011)*.

Changes in the sun's energy



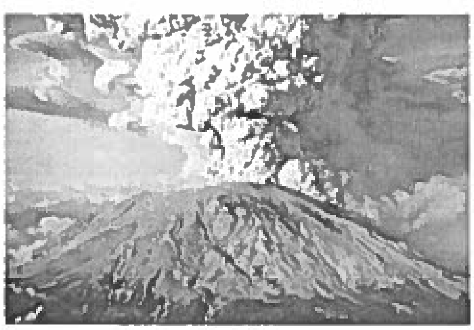
The sun goes through sunspot cycles every 11 years or so. During times when there are sunspots, dark spots—some as big as 50,000 miles wide—move across the surface of the sun. When this happens, the sun gives off slightly more energy, which makes the Earth a bit warmer. The sun also goes through longer term changes that affect how much energy it gives off.

Photosynthesis



The Earth's first billion years were very different from the conditions today. The sun was cooler then, but the planet was generally warmer. That's because there were a lot of greenhouse gases, like carbon dioxide and methane, in the atmosphere. Also, the atmosphere back then contained very little oxygen. It was a very different world—a world without people or the kinds of plants and animals that thrive in today's climate. But photosynthesis, which became common about 2 billion years ago, changed all that. During photosynthesis, plants take carbon dioxide out of the atmosphere and replace it with oxygen. Photosynthesis permanently changed the atmosphere by adding more oxygen to the air while reducing the amount of greenhouse gases.

Volcanic eruptions



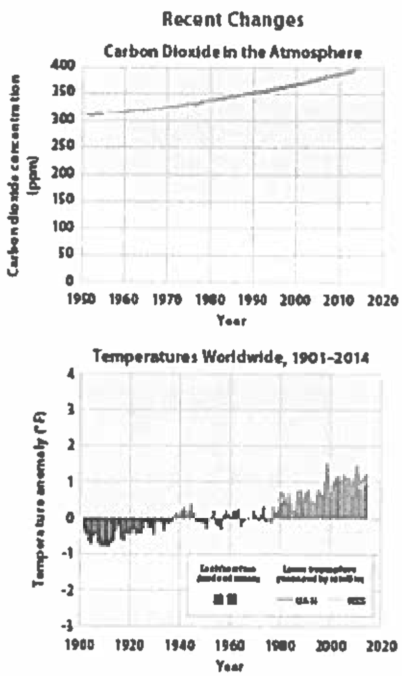
When volcanoes erupt, they spew more than red hot lava! They also add carbon dioxide to the atmosphere, along with dust, ash, and other particles called aerosols. At certain times during the history of the Earth, some very active volcanoes added a lot of carbon dioxide to the atmosphere, causing the planet to get warmer. However, most of the time, including today, the major effect from volcanoes is actually cooling the Earth because aerosols block some sunlight from reaching us. If an eruption is big enough to launch these particles high into the atmosphere, it can lead to slightly cooler temperatures around the world for a few years.

Scientists around the world agree that today's global climate change is mainly caused by people's activities.

Today's Climate Change Is Different!

Today's climate change is different from past climate change in several important ways:

1. **Natural causes are not responsible.** None of the natural causes of climate change, including variations in the sun's energy and the Earth's orbit, can fully explain the climate changes we are seeing today. Learn more about how we know this.
2. **People's activities are the main cause.** By burning lots of fossil fuels like coal, oil, and natural gas, people are overloading the atmosphere with carbon dioxide and adding to the greenhouse effect. People are also adding other heat-trapping greenhouse gases, such as methane and nitrous oxide, to the atmosphere.
3. **Greenhouse gases are at record levels in the atmosphere.** For hundreds of thousands of years, the concentration of carbon dioxide in the atmosphere stayed between 200 and 300 parts per million. Today, it's up to nearly 400 parts per million, and the amount is still rising. Along with other greenhouse gases, this extra carbon dioxide is trapping heat and causing the climate to change.



Source: EPA's Climate Change Indicators (2016)

Task Card: Increase Temperature Affects

Focus Question: *How will increase temperature affect people and the environment?*

Group Task: Predict what will happen to the resource as temperatures increase.

Time: ~30 min

Group Roles:	**Materials:**
• Facilitator - Read Task Card out loud, keep group focused, encourage equity of voice • Timekeeper - Keep time, keep group on track • Recorder - Record key points of pair dialogue & ensure everyone records in their notebook / keeps up with recording • Resource Manager - Organize materials and enforces referencing materials	• Resource Cards • Whiteboard and dry erase markers

Procedure:

As a group, predict what will happen to each of the 6 resources as temperature increases.

Group Task Criteria: *Must...* - Write a prediction for what will happen to each of the 6 resources as temperatures increase - Provide a least 1 source of evidence for each prediction ****Recorder**: Capture group thinking on whiteboard but everyone recordings in their notebook.

DCI - ESS3.D: Global Climate Change	*Meets all of the Proficient criteria and...* *Student imagines and design solutions to reduce our impact on the environment.*	Describes the relationships between consumption of natural resources and impacts on the Earth. Identifies both positive and negative impacts human have.	Explains how human activities can impact the biosphere and therefore, other living things.	Explains how human activities impact living things.
CCC 1 - Patterns	*Meets all of the Proficient criteria and...* Patterns used as evidence in an explanation or argument.	Rates of change analyzed to determine how the patterns may be changing or how humans may be impacting the patterns.	Uses graphs, charts, and images to identify patterns. Patterns are used to identify cause and effect relationships and make predictions.	Identifies patterns given graphs, charts, and images.
CCC 2- Cause and Effect	*Meets all of the Proficient criteria and...* *Provides multiple examples to show how phenomenon may have more than one cause and how a cause can have direct and indirect effects.*	Uses cause and effect language correctly and explains how cause and effect relationships can be used to predict phenomena.	Uses cause and effect language correctly to explain change.	Provides examples of cause and effect

6.3.3 - Group Output Sheet

Resource	Prediction	Evidence

Model

- Create a model depicting how increased temperatures will affect you.