OBJECTIVES

You will be able to:

- Determine where thermal energy transfers to and from.
- Construct an argument based on evidence.
- Build on other group members' ideas.
- Write a clear and logical argument using evidence.

ESSENTIAL QUESTION

How do we use and control thermal energy in a system?

EVALUATION AND FEEDBACK

Your work will be evaluated using the:

- *Engaging in Arguments* row of the Science and Engineering Practices Rubric.

ENERGY UNIT: Task 2
THERMAL ENERGY TRANSFER

As a group,

- ❑ ***Read Hilton's letter to the Science Wizard.***
- ❑ ***Rotate through 6 thermal energy transfer lab stations.***
- ❑ ***Write an argument using evidence about thermal energy transfer.***
- ❑ ***Respond to Hilton's letter to the Science Wizard.***

MATERIALS AND RESOURCES

- Materials will be specified at each of the 6 lab stations.

CONNECTING TO THE CULMINATING PROJECT

Update your client in your Individual Project Organizer:

- Draw a diagram of your device design labeling the dimensions and materials.
- Draw a diagram of your device design identifying the thermal energy transfers.

SCALE

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Read Hilton's letter and help her out.

Dear Science Wizard,

My mom always yells at me when I leave the fridge open. I know she is right about not holding the door open for a long time, but I disagree with her about why. She says that when I hold the door open, the cold energy in the air in the fridge leaves, making the air in the fridge warm up. I say that when I hold the door open, the warm energy from the outside goes into the fridge, warming it up. Can you help us figure out who is right? Does cold energy leave the fridge, or does warm energy move into the fridge?

Thanks,
Hilton

1. Using prior knowledge, take a vote.

Who do you think is correct?	Mom	Hilton
How many votes?		

Thermal Energy Transfer Lab Stations

For each station you will:

1. Read the task card and complete any instructions on the task card.
2. In your science notebook (see example):
   a. Make a labeled **drawing** of what you observed**.**
   b. Write a short **description** of what you observed**.**
   c. Write an **explanation** of the movement of thermal energy.
   d. Using molecules in a drawing, show why the thermal energy moved in the experiment.

Remember: Follow the directions and use your sense of observation

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Science Notebook Station Notes Format (Example):

Station # : _____ **Station Name: _____**

Quick Labeled Diagram of what you observed:	**Description**
Explanation The thermal energy transferred from _____ to _____ I know this because:	**Using molecules in a drawing, show why the thermal energy moved in the experiment.**

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Discuss:

1. List at least three things you noticed that were the same in each station.

2. Describe which direction the thermal energy transferred in every station.

3. Look back at the question *Hilton* posed in her letter to the Science Wizard. Make an argument explaining the answer to her question, "Does the warm air move into a cold space or does cold air move into a warm space?" Include particle drawings to help make your explanation clear.

   Use the space below for your groups brainstorming and write your own response in your science notebook.

Claim:
Evidence:
Reasoning:

4. Refer back to your definitions page from Task 1. Pick one lab station and write a description of what happened using the words ***kinetic energy, thermal energy,*** and ***temperature***. Use the space below to write your description.

5. Brainstorm with your group 3 more examples of thermal energy transfer that you see in everyday life. Describe where the thermal energy starts, where the thermal energy goes, and the results of the thermal energy transfer.

<u>Do Connecting to the Culminating Project: Update The Client</u>

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ENERGY TRANSFER

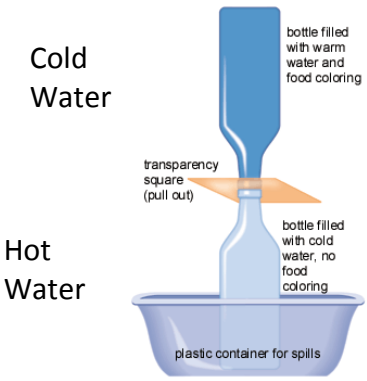
Task Card: Station One : Blue & Red Water

Materials:

- 2 equal size bottles/flasks
- Warm water source (red coloring added)
- Cold water source (blue coloring added)
- 1 index card or piece of flat plastic

Directions:

1. Fill one of the bottles with warm red water – all the way to the top.
2. Fill one of the bottles with cold blue water – all the way to the top.
3. VERY CAREFULLY, set up the bottles as shown below.
   - Place the hot red water bottle on the table or in the pan.
   - Place an index card on top of the cold blue water bottle.
   - CAREFULLY!! Hold the index card in place and flip the cold blue water bottle on top of hot red water bottle.
   - Leave the index card in place for 30 seconds to allow water to settle.
   - Carefully pull out and remove index card.
4. Observe the water in both bottles.



Discuss:

1. What is happening to the blue and red water? Why?
2. Where is the thermal energy transferring from and to?
3. What evidence do you see that supports your claim in question 2?

Write notes in your science notebook.

***Extension Challenge**:*

a. What do you think would happen if you set up the bottles the opposite way – warm water on top and cold water on bottom? Why? (If you have time, try it!)

b. Where is thermal energy transferring from and to? What evidence do you see that supports your claim?

Adapted from: https://www.stevespanglerscience.com/lab/experiments/colorful-convection-currents

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ENERGY TRANSFER

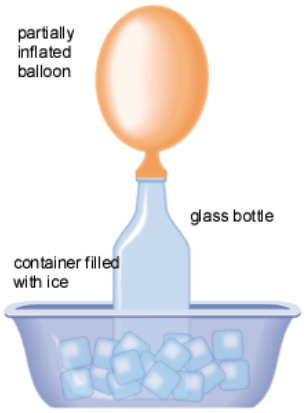
Task Card: Station Two : Cold Water & the Balloon

Materials:

- 1 glass bottle or flask
- Balloon
- Glass container with ice
- Timer

Directions:

1. Attach the balloon onto the bottle/flask.
2. Place the bottle with the attached balloon in the container with ice.
3. Observe for one minute.
4. Put the bottle in the hot water
5. Observe for one minute.
6. Repeat 2-5



Discuss:

1. What is happening to the balloon. Why?
2. Describe what is happening to the thermal energy. Where is the thermal energy transferring from and to?
3. What evidence do you see that supports your claim in question 2?

Write notes in your science notebook.

Adapted from: http://www.nsta.org/publications/news/story.aspx?id=46222

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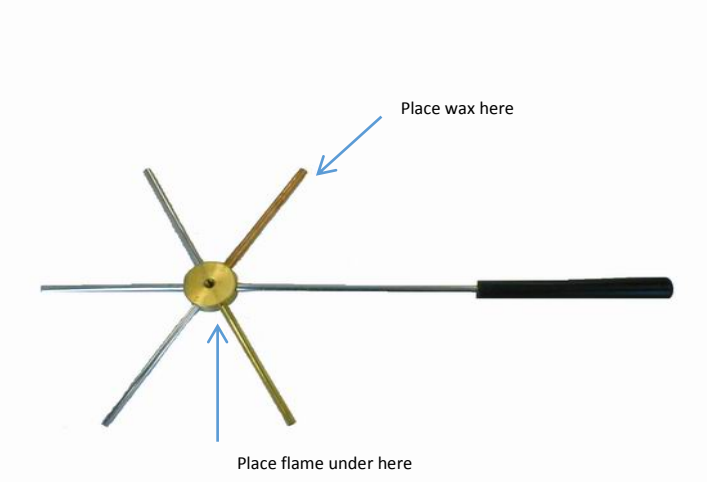
ENERGY TRANSFER
Task Card: Station Three : Conductometer

Materials:

- Flame source (candle, bunsen burner)
- Conductometer
- Wax
- Ice (for Extension Challenge)

Directions:

1. Place a small amount of wax in all 5 small holes on the ends of the metal rods.
2. Hold the conductometer by the black handle with wax facing up.
3. Hold the round center part of the conductometer over the flame source.



Discuss

1. What is happening to the wax? Why?
2. Describe what is happening to the thermal energy. Where is the thermal energy transferring from and to?
3. What evidence do you see that supports your claim in question 2?

Write notes in your science notebook.

Extension Challenge:

a. What do you think would happen if you placed an ice cube on the center part of the conductometer? Why? (if you have time, try it!)

b. Where is thermal energy transferring from and to? What evidence do you see that supports your claim?

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ENERGY TRANSFER
Task Card: Station Four : Butter Boat

Materials:
- Bin
- Hot water (very hot)
- Butter
- Foil
- Ice (for Extension Challenge)

Directions:
1. Create a small foil boat just big enough for your piece of butter.
2. Place a small amount of butter into your foil boat.
3. Carefully set the foil boat into the tub of hot water.

Foil Boat: make yours to fit your butter

Butter

Discuss
1. What is happening to the butter? Why?
2. Describe what is happening to the thermal energy. Where is the thermal energy transferring from and to?
3. What evidence do you see that supports your claim in question 2?

Write notes in your science notebook.

Extension Challenge:
a. What do you think would happen if you moved the foil boat into a bin of ice? (if you have time, try it!)
b. Where is thermal energy transferring from and to? What evidence do you see that supports your claim?

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ENERGY TRANSFER

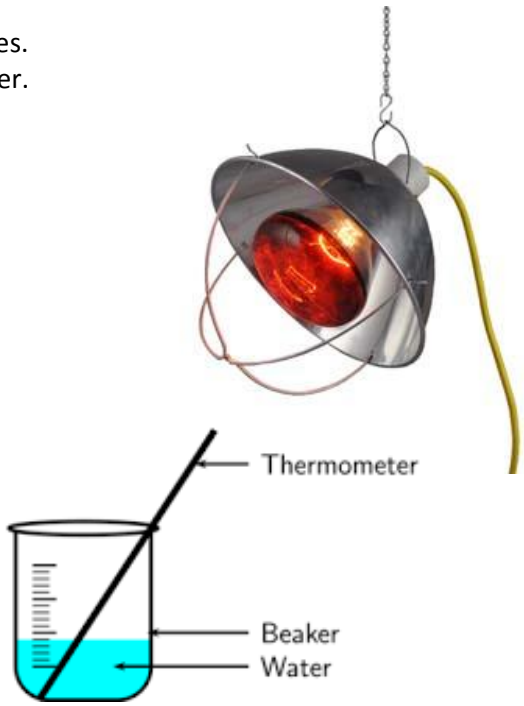
Task Card: Station Five : Heat on Water

Materials:

- Heat Lamp
- Small cup of water
- Thermometer

Directions:

1. Record the temperature of the water.
2. Turn the heat lamp on and wait 3 minutes.
3. Record the final temperature of the water.



Discuss

1. What is happening to the water? Why?
2. Describe what is happening to the thermal energy. Where is the thermal energy transferring from and to?
3. What evidence do you see that supports your claim in question 2?

Write notes in your science notebook.

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ENERGY TRANSFER
Task Card: Station Six : Thermal Blanket

Materials:
- Space Blanket (with reflective side marked)
- Heat lamp

Directions:
1. Cover one hand with the space blanket. Make sure to put the reflective side facing your skin.
2. Place both hands (one covered and one uncovered) under the heat lamp for about 30 seconds.
3. Let all lab partners try the demonstration.

Discuss
1. What is happening to your body? Why?
2. Describe what is happening to the thermal energy. Where is the thermal energy transferring from and to?
3. What evidence do you have that supports your claim in question 2?

Write notes in your science notebook.

Extension Challenge:
- *a. What do you think would happen if you placed the reflective side of the blanket the other direction (facing the heat source)? Why? (if you have time, try it!)*
- *b. Where is thermal energy transferring from and to? What evidence do you see that supports your claim?*

Adapted from: http://bundy.byu.edu/teaching/Projects%202011%20Combined.pdf

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THERMAL ENERGY TRANSFER TERMS (Optional)

1. Review the **Thermal Energy Transfer Resource Card** as a group. Underline definitions.
2. Draw and label a picture to represent the behavior of molecules during **each type of thermal energy transfer**

Draw and label a picture to represent the behavior of molecules during **conduction.**	Draw and label a picture to represent the behavior of molecules during **convection**.
Draw and label a picture to represent the behavior of molecules during **radiation**.	Draw one more example of conduction, radiation, or convection.

3. Determine which stations were an example of conduction, convection, or radiation. Fill in the chart below.

Conduction Stations	Convection Stations	Radiation Stations

4. Pick one example and explain the your choice of energy transfer**.**

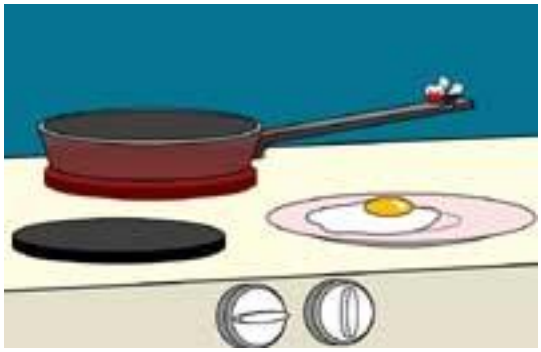
I think the _____ station is an example of _____ *(conduction, convection or radiation)* because _____

_____

Thermal Energy Transfer Resource Card
Instructions:

As you read, underline definitions.

Conduction



Even in solid matter, like hot pots and cold feet, the atoms and molecules are always doing a dance, jiggling up and down and all around. We can't see them jiggle, but we can feel their energy. How? As thermal energy!

Adding thermal energy to matter makes its atoms and molecules jiggle even faster. As they speed up, they bump against their neighbors, and get them jiggling faster too.

Put a cool pan on a hot stove, and soon the pan is hot. If the handle is metal, it will get hot too, as the faster-moving molecules in the metal pass their energy along.

That's conduction: Matter "conducting" energy throughout itself, through molecules bumping into each other.

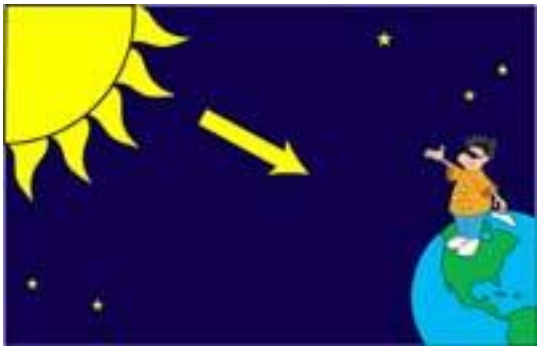
Convection

Like conduction, convection happens in matter too, but only in liquids and gases like water and air. The atoms and molecules in liquids and gases are farther apart than in solids. Because they have more room between them, they are freer to move around. As they heat up and jiggle faster, they move much farther, carrying the thermal energy with them.

The atoms and molecules themselves move in currents. For example, a candle flame (which is made of gases so hot they glow) heats the air right around it. The warmed air rises, making a current. Cooler air moves in to replace the warmed air, gets warmed up too, and rises into the current.

Radiation

Radiation moves energy without any help from matter.



We say the Sun's energy radiates through space to reach Earth. That means it travels in waves and doesn't need atoms and molecules to move along. Energy that travels by radiation is called electromagnetic radiation. Light is one kind of electromagnetic radiation we can see. But light is just one tiny part of all the kinds of electromagnetic radiation.

Although we can't see it, the heat we feel on our skin when we stand in the Sun or put our hands over a hot stove is caused by infrared radiation, another type of electromagnetic radiation.

From http://spaceplace.nasa.gov/beat-the-heat/en/

Other Possible Resources:
Online Resource (animations/examples) http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/
Cartoon Video: http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/heat.htm
Online Resource (Text/diagrams/animation) - page 1 and 2 only:
http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/energy/heatrev1.shtml