Chemistry

Unit 2: Heat and Energy in the Earth's Systems

Workbook 1

Name: ______________________________ Period: ______

Guiding Question:	
Do Now:	

Important Definitions and Equations:

Notes:

- Thermodynamics is the study of how energy moves between different substances.
- Heat moves from areas of high concentration (lots of heat or very hot) to areas of lower concentration (little heat or cold).
- An ______________________________ process has heat (energy) leaving (exo=exit) the system or substance and going into the surroundings
    - Ex. The hand warmer is exothermic because the reaction inside releases heat from the molecules (system) and it warms your hand (surroundings)
- An ______________________________ process has heat (energy) going into (endo=into) the system or substance from the surroundings
    - Ex. The hand boiler is endothermic because your hand (surroundings) heats up the liquid and air inside (system) causing the liquid to boil.
- ________________________ occurs when heat is transferred between two solids of different temperatures. Heat moves from the warmer object to the cooler object.
    - Ex.
- ________________________ occurs when heat is transferred from one place to another by the movement of fluids.
    - Ex.
- ________________________ occurs when heat is transferred through empty space by __________________________________ and requires no contact between objects.
    - Ex.

Response:

1 Hot or Not?
Discovery of Heat Transfer

Purpose

To investigate the movement of heat in everyday objects and develop an understanding of convection, conduction, and radiation.

Read this:

Endothermic processes involve the absorption of energy (as light or heat) into a system (object, reaction, or container) from its surroundings. In contrast exothermic processes release energy into the surroundings from a system. Almost all phenomena that we can observe and study involve energy transfer of some sort. Energy moves between objects and systems through three methods: convection, conduction, and radiation. We will discover a way to talk about this and why some things absorb heat or release heat better than others.

Do This First:

For each word, write a definition of that word (in your own words) explaining what it is. Then, create a visual representation. When your whole group is finished, show your teacher to get it signed off and begin your lab.

Term	Definition	Visual Representation (Drawing)
Convection		
Conduction		
Radiation		
Endothermic Process		
Exothermic Process		

Workbook 2.1 Date:

<u>Directions</u>: With your group, rotate through the different heat stations. Pay attention to the station number and what number you are on in the activity here. Listen for the teacher to indicate when it is time to rotate to the next station.

Station 1: Lava Lamp

1. Describe what is happening in the lava lamp (explain what you see).

2. Why do you think this is occurring?

3. Diagram the lava lamp to show how energy is moving in the lamp.

Station 2: Pool

1. Examine the image of a pool and think to previous experiences with pools. How does the cement feel around the pool on a hot summer day?

2. How does the water in the pool feel on the same, hot summer day?

3. Assuming that they are both exposed to the same amount of sunlight, why do you think they feel different?

Station 3: Water Boiling

1. Observe what is happening to the water. What is happening to the particles of water in the beaker? Draw a picture.

2. Is the water taking in heat or releasing heat? Explain your answer.

Workbook 2.1 Date:

Station 4: Hot Water but Cold?

1. Using your hands, place one hand in the tub of hot water and one in the tub of cold water. Quickly switch the bucket your hands are in after at least 30 seconds. Describe what your hands are feeling.

2. Why do you think your hands felt different temperatures than what was initially felt? What could be causing this phenomenon? Explain your answer.

Station 5: Wood vs. Metal

1. Place your hands on the objects at the same time. What do you feel?

2. Why do you think there is a difference in what you feel in the blocks?

Station 6: Beaker of Ice Water

1. Examine the beaker. Draw what you see below and label the relative temperatures you might expect to measure (which area is warmer and which is colder).

2. Use a thermometer to measure the temperature of the water at the bottom and at the top of the beaker (do not stir the beaker). Record your data below.

3. How do you think energy is moving in this system? (From where to where; ice and liquid water) Explain your answer.

Station 7: Hand Warmers

1. Hold the hand warmer in your hand. What do you feel?

2. Where is the heat coming from? Where is the heat going to?

3. Endothermic means that heat or energy is leaving a system (object, reaction, or container) while exothermic means that heat or energy is entering a system. Which part of this station set up (hand or hand warmer) is exothermic and which part is endothermic? Explain your answer.

Station 8: Hand Boiler

1. Carefully pick up the glass container and hold the bulb in your palm. What happens? (If nothing happens, try someone else holding it)

2. Why does this happen? Explain.

Guiding Question:	
Do Now:	
Important Definitions and Equations:	**Notes:** Terms to think about: ● Heat: ● Thermal Energy: ● Temperature: ● Kinetic Energy: ● Chemical Potential Energy: After the experiment: ● A ______________________ is a material that allows energy in the form of heat, to be transferred within the material, without any movement of the material itself. These substances have low specific heat capacities. ● A ______________________ is something that prevents heat from moving from one place to another. These substances have high specific heat capacities.
Response:	

2 Icy Tiles
Modeling Heat Transfer using Kinetic Molecular Theory

Purpose
Students will start to understand the relationship between temperature and heat (thermal transfer)

Materials
- 2 Black Tiles
- IR Thermometer (shared between two groups)
- 2 Ice Cubes
- Paper towels

Part 1
Observe each of the tiles. Consider how you can use different senses to make observations about the tiles.

1. Write down any and all observations you make. What do you think the tiles are made of?

Tile A	Tile B
Possible Identity:	**Potential Identity:**
Observations (at least 3):	**Observations (at least 3):**

2. Which tile feels warmer?

3. Make predictions
    a. Predict which tile (A or B) has a higher temperature:

    ____

    b. Predict the actual temperature of each tile:

    Tile A: __________ Tile B: _________

Part 2

Test your temperature predictions. Flip the tiles over and use an IR thermometer to test the temperature of each tile. Record the Temperatures:

Tile A: _________ Tile B: __________

4. Did your prediction match the actual temperatures of each tile?

5. Try to explain your results individually. Consider both drawing a picture and writing your ideas about what may be happening.

6. As a table group, draw what you think is happening on the big white board at your table. There is no right or wrong, no one knows the answer yet. Each group will share out.

7. Suppose you were going to place an ice cube on each tile. Based on your group's explanation, predict which tile (A or B) will melt the ice cube faster, if either. Explain your prediction.

Part 3

When your teacher indicates, place one ice cube on each tile. Make observations of the ice on each of the tiles.

1. Write down any and all observations that you made.

1. Record the temperature of the tiles after 2 minutes:

Tile A: _________ Tile B: ________

10. Individually:
    a. Summarize the results of all your observations so far in the table below.

	Tile A	**Tile B**
Feeling		
Temperature (before ice)		
Relative rate of ice melting		
Temperature (after ice)		
Other observations:		

b. Given temperature is a measure of the average kinetic energy of the particles, what can you conclude about the average kinetic energy of Tile A and Tile B before the ice was placed on them?

c. What do you think happened to the kinetic energy of the particles in Tile A compared to Tile B after the ice was placed on them?

d. Refine your explanation (from Part 2) in light of these new observations. Make sure to specifically reference how temperature is changing and how it is observed at the molecular level (how particles are moving). You need to use data from the table above to help you with your explanation.

Part 4

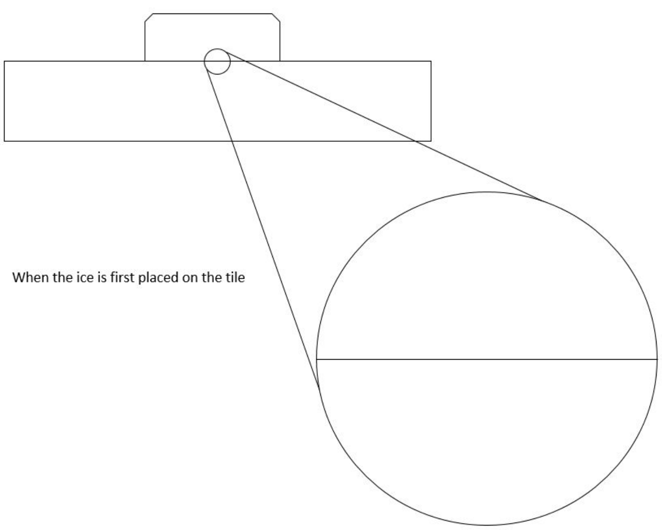
Now share your ideas with your group. As a group, think about how the difference in melting time can be explained in terms of the behavior and interaction of the particles that make up the tiles and the ice. The model you develop should explain your observations.

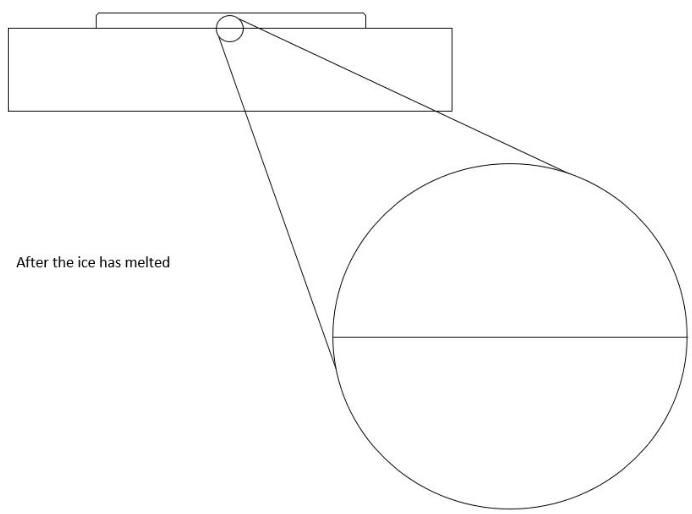
Use the questions below as a guide for developing your model. Represent your model using a set of particulate drawings (show the actual particles) that describe the interactions between ice particles and tile particles. A written explanation should be included.

11. How do the particles that make up the ice interact with the particles that make up the tile?

12. How does the behavior of the particles that compose the tile change when the temperature of the tile changes?

13. Consider the role that energy (heat) plays in your model. How is energy transfer represented in your model? Include a key for particles and energy.





Draw your final model on the piece of butcher paper provided. Two people in your group should work on the visual representation and two people should work on writing the explanation.

Part 5 Analysis Questions:

14. At the beginning of the experiment, you felt two tiles and then were asked to find their actual temperature using the IR thermometer. Why do you think that it was important to flip the tiles over before taking the temperature?

For the next two questions, use macroscopic ideas (like temperature, phase change, etc.) to help with your explanations.

15. Tile A conducts thermal energy better than Tile B (we call Tile A a *thermal conductor*). What does it mean to conduct thermal energy? Do thermal conductors have high or low specific heat capacities? How do you know?

16. A good insulator is the opposite of a conductor. What do you think it means if something is a good insulator? Do thermal insulators have high or low specific heat capacities? How do you know?

17. Do you think something that feels warm, like a sweater, is a conductor or an insulator?

Claim	
Evidence	
Reasoning	

Workbook 2.1 Date:

Guiding Question:	
Do Now:	
Important Definitions and Equations:	**Notes:** ● ______________________ is the total amount of energy a sample contains. It depends on both the temperature (how fast the molecules are moving) and the size of the sample (how many molecules you have). ● A sample with greater thermal energy has the potential to transfer ______________________. ● Different substances respond to heat differently ○ When you add hot water to a metal sample, the temperature of water decreases by only a small amount, but the temperature of the metal changes a great deal. This indicates that less thermal energy is required to change the temperature of a metal than to change the temperature of water. ● The unit of thermal energy is the ________________ ○ A calorie is the amount of energy it takes to raise the temperature of 1g of water by 1˚C. ● We can measure the amount of heat that is transferred to an object using specific heat capacities. The specific heat capacity is the heat required to raise the temperature of 1 g of a substance by 1 °C. $q = m \bullet Cp \bullet \Delta T$

3 Heat Transfer

Station Rotation

Purpose

Develop an understanding of how heat transfers between different systems and apply this understanding to law of conservation of energy and calorimetry.

Directions

With the assigned group you are placed with, you will rotate through the groups and complete the task at each station. You cannot move ahead until directed and you need to work efficiently to avoid having to complete tasks at home.

Your Starting Station: __________

Your group members (names):

Station 1: Reading *Energy Likes to Move*

(http://www.physics4kids.com/files/thermo_transfer.html)

Notes:

Define and Apply:

Term	Definition (your words)	Lab example from L1 Hot or Not?
Conduction		
Convection		
Radiation		

Station 2: Convection Lab

Procedure:

1. Obtain "Ice Cold Water" (approximately 200mL); use 250mL beaker (medium sized)
2. Obtain a pipet of hot, red water.
3. Lower the tip of the pipet until it is near the bottom of the beaker.
4. Carefully release two drops of hot red water into the cold water. Observe what happens, looking at the side and top of the jar. Write and draw your observations.
5. Add ten more drops, two drops at a time, observing what happens between each. Write your observations
6. Once you have added all the hot red liquid drops, observe the jar for an additional five minutes. Draw and write your observations.
7. **CLEAN UP**: Pour cold water down the drain and replace; empty pipet can be placed in small beaker near the hot water.

Observations

	Written Observation	Drawing
2 drops water added		
10 drops added, 2 at a time		
After all drops added and have waited 5 minutes.		

Station 3: Conduction Lab

Procedure:

1. Observe the 3 different spoons in the beaker of hot/boiling water. Fill in the data table below with how they are different
2. Using your hand, place your hand close (but not touching) and observe the relative temperatures of each spoon. Record in the table their relative heats.
3. Now, using the IR thermometers, record their temperatures in °C.
4. **CLEAN UP:** Reset lab station to what it was before you joined it.

Workbook 2.1 Date:

Data

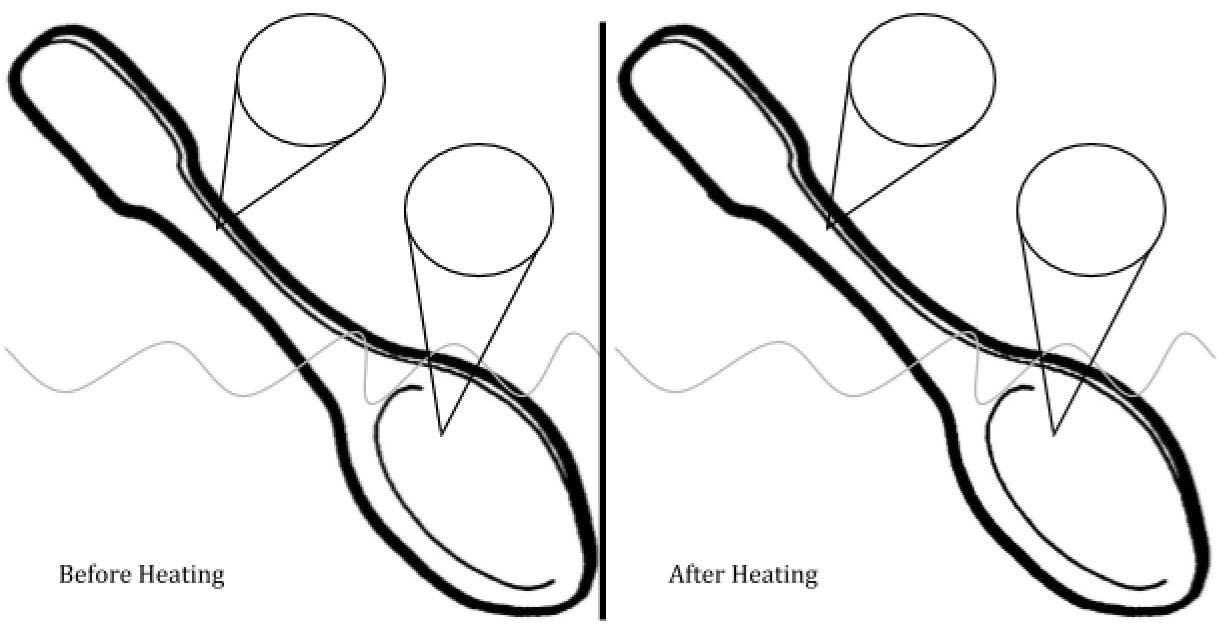
Spoon Material	**Relative Heat**	**Temperature (°C)**

Analysis

1. Explain why each spoon had a different temperature, assuming that they were placed in the water at the ***exact same time***.

2. Using the definition of conduction that you have determined before (either today or in L1 Hot or Not), explain how each spoon heats up.

3. Using the diagram below, create a before and after microscopic zoom in showing how heat is conducted through the spoon and heats it up.



Station 4: Radiation Lab

<u>Procedure:</u>

1. Water should already be heating on a hot plate for your lab.
2. Record the temperature of the water
3. Record the colors of the mugs in the data table below
4. Fill each coffee mug approximately half way full.
5. Place each mug inside your lab station cabinet.
6. Wait 15 minutes.
7. Remove from cabinet and record temperature of each mug.
8. **CLEAN UP:** Pour the water back into the hot water beaker carefully, rinse all the mugs with cool faucet water. Place upside down on the dry tray. Reset lab station to previous set up.

<u>Data</u>

	Color of Mug	Temperature (°C)
Hot Water Beaker		
Coffee Mug #1		
Coffee Mug #2		
Coffee Mug #3		

<u>Analysis</u>

1. Remember back to middle school or your last earth science class. What colors tended to absorb the most energy and what colors tended to not absorb energy?

2. Using this idea that dark colors absorb more energy and lighter colors do not, explain the results you got from the lab using your data above. You need to make specific reference to the data and think of how that show the energy is moving in (or out of) the coffee mugs.

Station 5: Video Notes

Directions:
Use the QR code or the link to access the video for the notes. Follow the notes as they go along and record them on page 13. When indicated, turn back to this page and complete the example problems below. When you are finished, write down 3 struggles you are having or think you will have. (https://youtu.be/M8dAHtywWIs)

Example 1
You have a 100g sample of water and you heat it 15°C. Determine the amount of energy in calories that is required to achieve this. C_{water}=1.00cal/g°C

Step 1: ______________________________

Step 2: ______________________________

Step 3: ______________________________

Example 2
You have a 75g sample of copper and you heat it from 25°C to 525°C. Determine the amount of energy in calories that is required to achieve this. C_{copper}=0.0923cal/g°C

Step 1: ______________________________

Step 2: ______________________________

Step 3: ______________________________

<u>Questions Remaining:</u>

Station 6: Tutorial with Teacher

<u>Directions:</u>
Follow along with the example below as your teacher walks you through it. When you are finished, you will have time to ask questions of your teacher. Record any additional notes in the space provided

<u>Example 3</u>
An unknown sample of metal with a mass of 125g takes 3200cal of energy to heat it 30°C. Determine the specific heat capacity of the metal and use that and the reference chart provided to determine the identity of the metal.

<u>Example 4</u>

1500cal of energy is added to 75g of aluminum ($C_{aluminum}$=0.215cal/g°C). What is the temperature change of the sample of aluminum?

Extra Notes

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

- You can determine the specific heat of a substance by graphing how the ______________________ of a known amount of substance changes ______________________.
- The steeper the slope of the line, the ______________________ the specific heat capacity because the temperature is changing more quickly.
- A slope that is ______________________ indicates that the temperature is changing ______________________. This means that the substance requires a greater amount of energy to increase its temperature and thus has a ______________________ specific heat.

Response:

4 I Demand Representation

Calorimetry and Specific Heat

Purpose

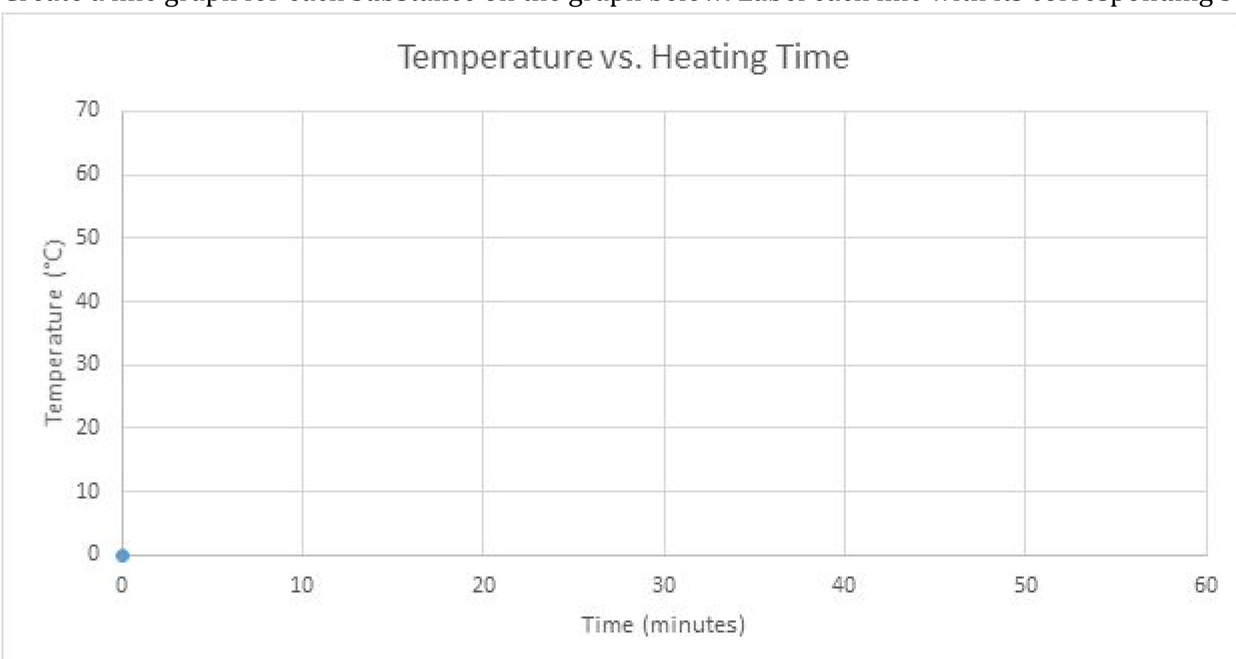
To be able to visually represent specific heat by graphing, as well as calculating the amount of heat lost or gained using the appropriate equation.

Specific Heat Capacities

Heating substances in the sun: The following table shows the temperature after 10.0 g of 4 different substances have been in direct sunlight for 60.0 minutes.

Time (minutes)	Air (˚C)	Water (˚C)	Sand (˚C)	Metal (˚C)
0 (initial T)	25	25	25	25
15.0	28.9	26.2	30	35
30.0	32.5	27.5	35	45
45.0	36.2	28.8	40	55
60.0	40	30	45	65

Step 1: Create a line graph for each substance on the graph below. Label each line with its corresponding substance



Step 2: Answer Questions

1. Order the substances based on the time required to heat them:

   Slowest ⟶ **fastest**

2. Which do you think will cool the fastest? Explain

3. When you boil water in a pot on a stove, which heats faster, the metal or the water? Explain.

4. Why do you think different substances heat up and cool down at different rates?

Specific Heat Capacity: The amount of heat needed to raise the temperature of 1 g of a substance by 1 ˚C.

5. Based on the definition above, which of the four substances do you think has:
   a. The highest specific heat capacity:
   b. The lowest specific heat capacity:

6. Here are the specific heat capacities of the four substances: **0.11 cal/g·˚C ,1 cal/g·˚C, 0.16 cal/g·˚C, and 0.24 cal/g·˚C.** Match each of the four substances on the previous page with their specific heat capacities and label them on the graph.

7. If something has a **high specific heat capacity** will it take a lot of heat or a little heat to change its temperature? Use evidence from the graph to support your answer.

8. Using the definition of thermal energy from the previous page, which will take longer to heat up, a bath tub or a swimming pool? Why?

Workbook 2.1 Date:

Calculations Involving Specific Heat

We will use the equation $\mathbf{q = m \cdot C_p \cdot \Delta T}$. Label each variable by name and write the units associated with it.

Practice: Perform the following calculations using the specific heat equation and indicate whether each process will be endothermic or exothermic. Draw a picture to defend your choice.

9. Gold has a specific heat of 0.54 cal/g·˚C. How many calories of heat energy are required to raise the temperature of 15 g of gold from 22 ˚C to 85˚C?

10. An unknown substance with a mass of 100 g requires 615 calories of heat to warm up by 15 ˚C. What is the specific heat capacity of the substance? Use the table on your practice sheet to identify the substance.

11. If the temperature of 34.4 g of ethanol increases from 25˚C to 78.8˚C, how much heat has been absorbed by the ethanol? The specific heat of ethanol is 0.57 cal/g·˚C.

12. Copper has a specific heat of 0.09 cal/g·˚C. A piece of copper loses 2000 calories of heat as it cools from 200 ˚C to 100 ˚C. What is the mass of the piece of copper?

13. If 335 grams of water at 65.5 ˚C loses 40,794 calories of heat, what is the final temperature of the water? Liquid water has a specific heat of 1 cal/g·˚C.