Step 1: Identify the Scope of Your Unit

1A. Identify the Performance Expectations Bundle that This Unit Targets.

MS-LS1-3

- MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

- MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

- MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

1B. Identify the elements from the foundation boxes for the DCIs and CCCs

Disciplinary Core Ideas (DCIs)	Cross-Cutting Concepts (CCCs)
PS3.A: Definitions of Energy • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.(MS-PS3-3)(MS-PS3-4) PS3.B: Conservation of Energy and Energy Transfer • Energy is spontaneously transferred out of hotter regions or objects and	*Cause and effect* • Events have Causes. • A major activity of science is investigating and explaining causal relationships *Scale, Proportion, and Quantity* • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information

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into colder ones (MS-PS3-3) • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.(MS-PS3-4) • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS=PS3-5) <u>ETS1.B: Developing Possible Solutions</u> • A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-PS3-3) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-PS3-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-PS3-3) • Models of all kinds are important for testing solutions. (MS-PS3-3) <u>ETS1.C: Optimizing the Design Solution</u> • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-PS3-3) (MS-PS3-4) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-PS3-3) (MS-PS3-4)	about the magnitude of properties and processes. *Energy and Matter* • The transfer of energy can be tracked as energy flows through a designed or natural system. • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). *Structure and function:* • The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

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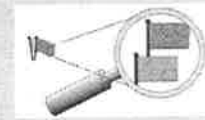
Step 2: Unpacking

2. What are the sub-ideas & implicit understandings of each of the DCI(s) and CCC(s)?

Repeat steps 2A and 2B for each part of the Framework text relevant to your unit.
(Copy and paste this section as a separate table for each phrase you unpack)



2A: Paste a sentence from the Framework text here. Bold a phrase that is important to unpack.

- Temperature is a measure of the average kinetic energy of particles of matter.

2B: Clarify what that specific phrase above means in your own words. Include not just the "what" but also the "how" and "why." Do not simply restate the language of the Framework. Identify the concepts that students must understand that are not written on the page, but are *needed* in order to get to the *key* punchlines of the science.

Students will need to be able to explain that matter is made of molecules that are in constant motion. This motion is known as kinetic energy. Depending on how fast molecules move, the temperature will change.

When molecules are heated, they move faster. A thermometer measures temperature. The liquid inside the thermometer expands due to the transfer of kinetic energy from the molecules in the matter outside of the thermometer bulb (solid, liquid, or gas), to the molecules in the thermometer bulb itself (solid), and then to the liquid inside the thermometer bulb.

Students should be able to design investigations that provide evidence that molecules move, which would lead them to the understanding of how a thermometer works. This is a connection to the fact that *temperature is a measure of amount of kinetic energy in matter.*

2C: Now push further: Take your phrase and look at it through the lens of each of the Crosscutting Concepts (link is located here). (Try

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various CCCs, not just the ones in the foundation boxes.) For example, What *causes* X to occur? How does the *structure* of Y affect the *function* of Y? What exactly is the *scale* of Z? Can Z always be detected? Is Z visible to the eye? What *scale* would students have to experience to be convinced of Z? Record the elaborations elicited by these questions.

- Cause and Effect
  - Heat causes molecules to move faster.
  - The liquid in a thermometer rises due to molecules moving quickly when they are heated, causing the liquid to expand.

- Energy and Matter
  - The transfer of energy can be tracked and seen in a thermometer system.
  - Thermal energy is one example of energy.

Step 2: Unpacking

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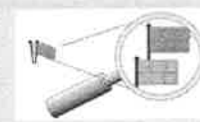

2A: Paste a sentence from the Framework text here. Bold a phrase that is important to unpack.

- The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

2B: Clarify what that specific phrase above means in your own words. Include not just the "what" but also the "how" and "why." Do not simply restate the language of the Framework. Identify the concepts that students must understand that are not written on the page, but are *needed* in order to get to the *key* punchlines of the science.

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The speed at which a material heats up, or how much kinetic energy there is, depends on many different aspects of matter (ex. Density, color, type, state, amount.) Students should be able to design investigations that provide evidence that molecules move differently in different states of matter and different types of matter.

2C: Now push further: Take your phrase and look at it through the lens of each of the Crosscutting Concepts (link is located here). (Try various CCCs, not just the ones in the foundation boxes.) For example, What *causes* X to occur? How does the *structure* of Y affect the *function* of Y? What exactly is the *scale* of Z? Can Z always be detected? Is Z visible to the eye? What *scale* would students have to experience to be convinced of Z? Record the elaborations elicited by these questions.

- *Scale, proportion and quantity*
  - The amount/quantity of energy flow/transfer is dependent upon the amount/quantity of matter in a sample.
  - The amount/quantity of energy flow/transfer will change with different types of matter.
  - Molecules are too small for the human eye to see, which means energy flow/transfer occurs on a microscopic level.
- *Energy and Matter*
  - The amount/quantity of energy flow/transfer is dependent upon the amount/quantity of matter in a sample.
  - The amount/quantity of energy flow/transfer will change with different types of matter.
  - Energy flow/transfer can be tracked into and out of different types of matter and the rate of transfer may change based on the type, state, or amount of the matter.
    - For example, energy transfer through a liquid may occur faster than through a solid, depending on the type of matter in the sample.
- *Structure and function.*
  - The movement of these molecules differ depending on the state of matter.
  - The speed of how quickly these molecules move differs on the type, state, and amounts of matter.

Step 2: Unpacking

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2. What are the sub-ideas & implicit understandings of each of the DCI(s) and CCC(s)?

Repeat steps 2A and 2B for each part of the Framework text relevant to your unit.
(Copy and paste this section as a separate table for each phrase you unpack)

2A: Paste a sentence from the Framework text here. Bold a phrase that is important to unpack.

Energy is spontaneously transferred out of hotter regions or objects and into colder ones

2B: Clarify what that specific phrase above means in your own words. Include not just the "what" but also the "how" and "why." Do not simply restate the language of the Framework. Identify the concepts that students must understand that are not written on the page, but are *needed* in order to get to the *key* punchlines of the science.

The amount of thermal energy in an object depends on how fast the molecules are moving. This thermal energy can be transferred from one object to another. Molecules are moving faster in the hotter object, and this kinetic energy transfers to the colder object. Students should be able to design investigations that provide evidence that thermal energy is transferred from a hotter object to a colder object. (i.e. the steam from boiling water heats up the air around it, a radiator heats up the house).

2C: Now push further: Take your phrase and look at it through the lens of each of the Crosscutting Concepts (link is located here). (Try various CCCs, not just the ones in the foundation boxes.) For example, What *causes* X to occur? How does the *structure* of Y affect the *function* of Y? What exactly is the *scale* of Z? Can Z always be detected? Is Z visible to the eye? What *scale* would students have to experience to be convinced of Z? Record the elaborations elicited by these questions.

- *Energy and Matter*
  - The amount of thermal energy in an object depends on how fast the molecules are moving.
  - The amount of energy in any part of a system will only change when the transfer of energy to another part of the system occurs.
- *Scale, Proportion, and Quantity*
  - The amount of thermal energy in an object depends on how fast the molecules are moving.

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Step 2: Unpacking

2. What are the sub-ideas & implicit understandings of each of the DCI(s) and CCC(s)?

Repeat steps 2A and 2B for each part of the Framework text relevant to your unit.
(Copy and paste this section as a separate table for each phrase you unpack)

2A: Paste a sentence from the Framework text here. Bold a phrase that is important to unpack.

- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

2B: Clarify what that specific phrase above means in your own words. Include not just the "what" but also the "how" and "why." Do not simply restate the language of the Framework. Identify the concepts that students must understand that are not written on the page, but are *needed* in order to get to the *key* punchlines of the science.

More energy is needed to heat up a large volume of matter compared to a smaller volume of matter. The more molecules there are to transfer heat, the faster an object will heat up. The amount of energy needed to heat up a material can differ depending on the type matter. More energy is needed to heat up objects that don't easily conduct heat. The environment can also affect the amount of energy needed to change the temperature (ocean, space, air, etc.) An amount of energy in a large sample of matter will transfer more quickly to a smaller sample of the same type of matter because the molecules will continue to move until the amount of movement is the same in both samples. Heat transfer will continue until the molecules in all samples are moving at the same rate, meaning the amount of heat, and thus temperature, of all samples is the same.

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2C: Now push further: Take your phrase and look at it through the lens of each of the Crosscutting Concepts (link is located here). (Try various CCCs, not just the ones in the foundation boxes.) For example, What *causes* X to occur? How does the *structure* of Y affect the *function* of Y?
What exactly is the *scale* of Z? Can Z always be detected? Is Z visible to the eye? What *scale* would students have to experience to be convinced of Z? Record the elaborations elicited by these questions.

- *Energy and Matter*
  - The amount of energy in any part of a system will only change when the transfer of energy to another part of the system occurs.
- *Scale, Proportion, and Quantity*
  - The quantity of energy needed to heat up an object, differs depending on the type of matter, size of matter, or state of matter.

Step 2: Unpacking

2. What are the sub-ideas & implicit understandings of each of the DCI(s) and CCC(s)?

Repeat steps 2A and 2B for each part of the Framework text relevant to your unit.
(Copy and paste this section as a separate table for each phrase you unpack)

2A: Paste a sentence from the Framework text here. Bold a phrase that is important to unpack.

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

2B: Clarify what that specific phrase above means in your own words. Include not just the "what" but also the "how" and "why." Do not simply restate the language of the Framework. Identify the concepts that students must understand that are not written on the page, but are *needed* in order to get to the *key* punchlines of the science.

When an object heats up, the kinetic energy in the object will change. The fast moving molecules will cause molecules in nearby objects to move

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as well.

2C: **Now push further: Take your phrase and look at it through the lens of each of the Crosscutting Concepts (link is located here). (Try various CCCs, not just the ones in the foundation boxes.) For example, What *causes* X to occur? How does the *structure* of Y affect the *function* of Y? What exactly is the *scale* of Z? Can Z always be detected? Is Z visible to the eye? What *scale* would students have to experience to be convinced of Z? Record the elaborations elicited by these questions.**

- Cause and Effect
  - When the motion energy of an object changes, there is inevitably some other change in energy at the same time.
- Energy and Matter
  - The amount of energy in any part of a system will always change when the transfer of energy to another part of the system occurs.

Step 3: Articulating the Anchoring Phenomenon

3a & 3b. Reference the related NGSS PE(s), then articulate an NGSS-style PE(s) for this unit (grounded in phenomena).

- MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
- MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
- MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

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Phenomenon:

The students will conduct an investigation using thermometers to observe what happens when a thermometer is placed in hot water in a styrofoam cup, metal cup, and paper cup.

Performance based on phenomenon:

They will create a model/diagram to show what they notice about temperature in the water and containers, and include how and why the liquid inside the thermometer expands and contracts.

3c. Create a desired/sample student response in a manner a student would generate it that shows they have met this/these PEs.

Heat is moving molecules. Molecules move faster when heat is added. When these molecules come in contact with a substance of less heat, meaning slower moving molecules, they will cause the "cooler" molecules to move faster. That is why the temperature increases. Some materials allow heat to transfer faster than other materials. For example, the styrofoam cup didn't get as hot as the paper cup because it doesn't allow heat to transfer through it as fast as paper. The styrofoam cup is an insulator, so it traps the heat within the liquid in the cup. Since metal is a conductor of heat, it allows the heat to escape the metal cup more quickly.

Temperature is measured with a thermometer. The hot water had very fast moving molecules which caused the molecules in the thermometer bulb to move faster. Then those molecules caused the molecules in the liquid part of the thermometer to move faster. When a substance is heated, as the molecules move faster, they also spread apart. So the liquid inside the thermometer expands and rises up the thermometer bulb showing that the temperature has increased.

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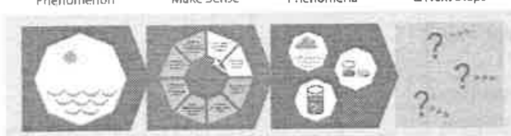
Step 3:

Apply Storyline Tool #1



Storyline Tool #1: Anchoring Phenomenon Analysis

Does the launch of the unit include exploring and going public with noticings about an anchoring phenomenon?		Yes	No	What are the anticipated student/class responses? What adaptations are needed?
Element 1 Explore Anchoring Phenomenon *What do we notice?*	**1A:** Students explore an anchoring phenomenon and notice aspects of it that will require key pieces of the target DCIs to explain.			• Students should observe that the liquid inside the different cups are losing heat at different rates. Students might start to wonder why this is happening and what the different materials have to do with this. • Students should observe that the liquid in the thermometer is moving. Students might start to wonder what causes the liquid in the thermometer to move. • Teacher might need to guide students to include how and why the liquid in the thermometer is moving in addition to how and why the liquid is losing heat at different rates in their initial models.
	1B: Students go public with what they noticed.			
	1C: The class builds a record of what everyone noticed.			

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Does the launch of the unit including generating and going public with initial explanations?		Yes	No	What are the anticipated student/class responses? What adaptations are needed?
Element 2 Attempt to Make Sense *How can we explain this?* *Do our explanations agree?*	**2A:** Students generate initial explanations that elicit competing ideas about the key pieces of the target DCIs.			When things get hot the temperature rises. When temperatures get hotter, the liquid rises up the thermometer. The hotter something is the higher the temperature. Temperature is a measure of how hot or cold something is. The cups get hot because the water is hot and it gives heat off to the cups as well as the air over the cups. But something about the cups makes the paper cup more hot to the touch than the styrofoam. The water inside the cups is cooling because the air around it is cooler. The water is a liquid, the cups are solid, and the air is a gas, but they are all different temperatures because of the hot water.
	2B: Students go public with their explanations.			
	2C: The class builds a record of areas of consensus and disagreement across everyone's explanations.			

Does the launch of the unit include generating and going public with related phenomena?		Yes	No	What are the anticipated student/class responses? What adaptations are needed?
Element 3 Identify Related Phenomena	**3A:** Students generate examples of related phenomena they have experienced.			Students may begin to think about "warming their hands over or on a hot cup of hot chocolate or soup". Some students may connect to weather thermometers or body temp thermometers and wonder how they work.
	3B: Students go public with these related phenomena.			

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Where else does something like this happen?	**3C:** The class builds a record of everyone's experiences.			Students may think about and connect to touch.ng something cold out of the refrigerator. Students might start making connections to a thermos that they use for their soup, a coffee travel mug, a cold water bottle, a cooler, lunchbox, refrigerator, insulation in your house, etc.

Does the launch of the unit include generating and going public with questions?		**Yes**	**No**	**What are the anticipated student/class responses? What adaptations are needed?**
Element 4 Develop Questions & Next Steps *What do we need to figure out to explain all of this?*	**4A:** Students generate questions that could potentially lead to uncovering important ideas in the target DCIs.			Why does the liquid in the thermometer rise when it's placed in something hot (like the hot water)? Why doesn't the styrofoam cup get as hot as the paper cup?
	4B: Students go public with their questions.			Maybe we should test cold liquids and compare it to the hot liquids.
	4C: The class builds a record of everyone's questions.			Can we try testing hot water in other materials and compare?
	4D: Students generate ideas for investigations that could potentially lead to uncovering important ideas in the target DCIs.			How does the heat go into the thermometer? How do things get hot?
	4E: Students go public with ideas for investigations.			How do things get cold? How does what water is made of allow it to rise in the thermometer?

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	4F: The class builds a record of everyone's ideas for investigations.			How does the heat go into the thermometer? How does the top of the thermometer get hot? Why do the molecules in the hot water slow down when they are in in contact with the cold water. (How do things get cold?) How does the volume of a material affect the rate at which it heats up or cools down, and if so, WHY does it happen? In the original phenomenon - why is the paper cup so much hotter than the styrofoam cup?

Step 4: Target Student Products for Having Put the Pieces Together

4. Create one or more desired/sample student products that shows what the response that you want a student to provide (written in student language) that shows they have met this/these PEs.

4A: **Challenge: There is a Monkeypox outbreak in the Central African Republic. There is a medicine to treat the disease, but it needs to be transported at a specific temperature (35°F - 46°F) or (2°C - 8°C) in order to maintain effectiveness. You must develop a temperature controlled container that will transport the medicine to the remote African village at the appropriate temperature.**

4B: What is the **student response** to the prompt? If students "got" this bundle of PEs, what could they do or explain at the end of the unit or a particular milestone to demonstrate their understanding?

As a group:

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Students will design, build and test a device that incorporates the principles of heat as energy and the transfer of energy through different types and amounts of matter (MS-PS3-3, MS-PS3-4). They will be given materials such as cardboard (different thicknesses), paper, wax paper, tinfoil, cotton balls, etc.

Using evidence, explain why your device should be chosen to store the Monkeypox vaccine. You can explain this using one of the following options (Google Slides Presentation, Glogster, drawn model, written explanation, video/advertisement, etc.).

Engineering Rubric

Independent (Claim, Evidence, Reasoning)

Does your device work? Explain how and why your device works using evidence and reasoning. Make sure to include any scientific principles involved (i.e. heat energy).

CER Rubric

Example of Independent Student Response

We created a container using thick cardboard lined with tinfoil on the inside. The tinfoil held the liquid, but the cardboard was used as an insulator to prevent heat on the outside of the container from transferring through conduction to the liquid. The matter that the cardboard is made of does not allow thermal energy to transfer through it very quickly. The molecules inside the liquid continue to move slowly since there is not much heat being transferred. The air molecules are moving faster than the molecules in the cardboard. The molecules in the cardboard will begin to move slightly faster causing it to gain heat due to thermal energy transfer, but the rate at which it heats up will be slow due to the type of matter it is made of. Therefore, the liquid in the container stays cool for longer periods of time because there is very little transfer of kinetic energy.

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Step 5: Identify a Sequence of Connected Investigations

Lesson Question *Does the question come from phenomena related to the driving question or from gaps in what we figured out so far? Does the question ask how & why, and not just about facts?*	**Phenomena** *Is there something about the phenomenon that needs to be explained? Will investigation of this phenomena help answer the question for this lesson and figure out new pieces of the puzzle?*	**What Students Figure Out** *What pieces of your unpacking will students be able to figure out through investigating this phenomena?* *What new questions would come out of doing this investigation that could motivate the next investigation?*
1. Why does the liquid in the thermometer rise when it's placed in something hot (like the hot water)?	1. Demo: red and blue food coloring in water. The red goes in the hot water and the blue goes in the cold water (or use the same . Observe. 2. Class Discussion- Students will discuss what they've observed. Then they will watch the following video to learn more about water: 3. Changing Water- States of Matter 4. . Demo ice in a frying pan and have students draw a model of what they think is happening to the molecules as the ice melts and evaporates.	When they observe the red/blue food coloring phenomenon, they will see that the red food coloring moves more quickly in hot water than cold water. Why does this happen? Why is the food coloring spread out in the hot water but not the cold water? How does the makeup of water that make it behave/react the way it does? After watching the video, students will figure out that all things are made of matter and that the same "particles/molecules" make up solids, liquids and gases, but they move differently in each one. The video shows that water exists in three states but doesn't explain what causes the change from solid to liquid to gas. Students will now wonder why it changes states. After watching the ice in the frying pan demonstration, students will figure out that solid ice melts and changes to liquid water when thermal energy is transferred to it. They will also observe how liquid water changes state to water vapor when thermal energy is transferred to it. They will be able to see all three states of matter, but might wonder what is happening with the molecules in these three different states. The molecule simulation will allow them to explore the differences and reach consensus that heat = faster movement of molecules, which will now be referred to as Kinetic Energy. They will make the connection that molecules spread out when they are heated up and change states of matter, just like in the ice demonstration.

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	5. Molecule Simulation- Students will click on “states of matter” and then click on “water.” They will then observe what happens to water molecules when they get heated and cooled. 6. Thermometer Simulation- Students will interact with this simulation and write down their observations in their notebooks.	Students should now be able to explain that temperature is a measurement of kinetic energy (because they previously figured out that temperature is a measurement of heat). (PS3.A) Students should be able to create a model that shows how the liquid in a hot thermometer moves compared to a cold thermometer. Through the thermometer simulation students will observe how molecules in the thermometer speed up when heated and slow down when cooled. They might also wonder how the heat gets from the hot water into the thermometer. How does heat go from one place to another? For example, how does it go from the hot liquid outside the thermometer to the liquid inside the thermometer?
2. How does the heat go from the hot water into the thermometer liquid?	Students will increase the temperature of tap water from 20 to 60 degrees C using any/all of the following materials: tap water, red water at 85+ degrees C, various containers such as plastic vials, plastic cups, styrofoam cups. Conduction Video	Students will figure out that the cold water will increase in temperature without electricity. They will figure out that the heat had to come from red water because that’s the only place it could come from. They will figure out that heat can move from one place to another when they are in contact. After watching the video, students will learn that molecules hit other molecules, causing heat to transfer from one place to another. They will also figure out that the heat traveled through the plastic cup or vial that is holding one sample of water and should be able to apply the information they learned about all matter (solid, liquid, gas) is made of particles/molecules which move faster when they are heated. They should observe that heat is transferring from the liquid water to the solid vial or cup and then into the cooler liquid water. Students should make the connection to the thermometer and be able to answer the question that heat transfers into objects of lesser temperature, as hot water transfers it’s heat to a thermometer. They will also connect the thermometer bulb to the plastic cup or

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		vial in the investigation. They can demonstrate understanding by modifying the model they created about the movement of the liquid in the thermometer . (PS3.B) Students will notice and wonder about the temperature decrease in the hot red water and ask how the faster moving molecules of one substance cause molecules to move faster in another substance. They might wonder why the molecules in the hot water slow down when they are in the cold water (addresses with lesson question 5). When observing the investigations of other groups, students will wonder if the amount (or volume) of a material such as water makes a difference when heat is transferring from one place to another (addressed with lesson question 6). Lesson question 4 may be answered within this phenomenon.
3. Why is the top of the thermometer hot even though it isn't touching the hot water?	Investigation- Students will test an aluminum bar and a steel bar with temperature strips, placed in hot water.	Students will observe how different materials heat up at different rates. They will see how the temperature strip heats up and make the connection that the molecules are bumping into each other at different rates in different materials. They will also see how heat travels up the metal bar, just like with the metal thermometer.
4 . Why do the molecules in the hot water slow down when they are in in contact with the cold water. (How do things get cold?)	Demonstration: Using two balls, place one ball stationary on the floor. Take the other ball and roll it into the stationary ball. Have the students discuss what they observe. How Does Heat Transfer from Hot to Cold	Students will observe that the moving ball will cause the stationary ball to move, but the moving ball stops moving. They should make the connection that the moving ball represents quickly moving molecules (which are hot) and that the stationary ball represents slow moving molecules (which are cold). When a heated liquid touches a cooler liquid, the faster moving molecules in the heated liquid begin bumping into the molecules in the cooler liquid causing them to move faster and heat up. In addition, the hotter liquid loses heat and molecules slow down causing it to cool down. This is just like the moving ball that stops moving in the demonstration because it has transferred its kinetic energy to the other ball.
5 . How does the volume of a material affect the rate at which it heats up or cools down, and if so, WHY does it happen?	Using the materials from lesson question 2, students will design their own investigations to answer the question about volume.	Students will figure out that YES, the a substance's volume/amount will affect the rate at which a substance heats and cools. After all groups present their investigations and evidence to the class, students will figure out that the larger the volume, the longer it will take to heat.

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		They should also figure out that the ratio of the hot volume to cool volume makes a specific difference when heat is transferring from one to other. They will be able to use evidence from their investigations to support their argument in each case. Productive discussion and a review of prior lessons about kinetic energy will lead them to figure out that the reason for this is that there are more molecules to heat up in a larger amount of water than in a smaller amount. Additionally, a smaller amount of hot water has less energy to transfer into a larger volume of cold water causing it to heat more slowly.
In the original phenomenon - why is the paper cup so much hotter than the styrofoam cup?	Review original phenomenon. Students will research these materials to see why different materials allow heat to transfer through them more quickly.	Students will use articles, websites, videos, microscopes, magnifying glasses, etc. to research these materials. They should realize that the amount of air between molecules can affect the rate at which heat is transferred (density). They might wonder about other materials besides paper and styrofoam and will be encouraged to test materials if interested (tinfoil, glass , clay, ceramic mug, metal thermos). They might also make connections to other materials that are good insulators like styrofoam in addition to materials that are good conductors such as metal. They should make connections to the metal bars activity and how those heated up at different rates due to the different types of matter.

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Name: ______________________ Date: ______________ Period: ______

This is a pre/baseline assessment and will be an assessment later in the unit:

Explain why the top of the thermometer felt hot. State a claim about heat transfer and use evidence and reasoning to support your answer.

Name: ______________________________ Date: ____________________ Period: ________

Name ______________________ Date ______________ Period ________

1. On the lines below name each state of matter and in the box draw how the molecules would look in that state.

1. ______________ 2. ______________ 3. ______________

Write the name of each of the three states of matter and give two examples of each.

State of Matter	Example #1	Example #2
1.		
2.		
3.		

Think about the "Ice in the Frying Pan" phenomenon. The ice was put in a hot frying pan and then it melted and eventually evaporated. In your own words, explain what happens to molecules as a solid changes to a liquid and then a gas.

Scientific Explanation Rubric

CER	Excellent 4	Good 3	Average 2	Below 1
Claim *Statement about the results of an investigation.*	• Claim is clearly stated and answers the question.	• Claim is clearly stated and connected to the question.	• Claim is stated but unclear.	• Not present
Evidence *Scientific data used to support the claim.*	• Data, results, or research is included, clearly supports the stated claim, with elaboration using scientific terminology.	• Data, results, or research is included and clearly supports the stated claim.	• Data, results, or research is included but does not clearly support the stated claim.	• Not present
Reasoning *Ties together the claim and evidence.*	• Clearly and completely explains why the evidence supports the claim. • Completely and accurately explains the underlying science concepts.	• Clearly explains how the evidence supports the claim.	• Explanation of how the evidence supports the claim is somewhat unclear.	• Not present

Created by Southington School District/Sixth Grade Science