Thermal Energy Task

07-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.]

Part I: After obtaining and evaluating information on the way the transfer of energy is affecting the lives of penguins, develop three investigable questions that might identify causal relationships that would affect the amount of energy being transferred into glaciers.

Teacher Notes:
Using the QFT, guide the students to develop questions around the relationship among the energy transferred, the type of matter, and the mass.

Task: (Formative)
I. After watching the video on glacier ice melting, generate questions about the factors that determine the amount of energy transfer being transferred into the glaciers.
II. Working with your team, analyze your questions to determine which ones can be explored through investigation (not research).
III. As a team, rank your questions in order of importance and then choose the top 3 questions.

Teacher Notes:
Guide students to generate questions about how the type of water (Salt or Fresh) affects the amount of thermal energy transferred over time measured by temperature change, how the amount of water (Best one from previous investigation) affects the amount of thermal energy transferred over time measured by temperature change, and how the amount of available ice affects the amount of thermal energy transferred over time measured by temperature change. Pull out one of the questions to use as a summative evaluation. I chose the question about the amount of available ice to use for individual assessment. If you choose to use a different question, you will need to give students some generated data that will support a claim to that question. Conduct investigations to generate data to answer the questions.

Part II: After developing investigable questions that might identify causal relationships that would affect the amount of energy being transferred into glaciers and choosing the top 3, select 1 question and plan an investigation to generate data to answer the question and construct a scientific argument supported by evidence to support a claim.

Teacher Notes:
Explain to the class that you have pulled one of the questions to use as a summative evaluation at the end of the unit.

Task: (Formative)
I. Your teacher has pulled one of the three questions you generated in Part I to use as a summative assessment at the end of the unit. He/she conducted investigations around the two remaining questions and generated data to answer to the question. As a whole class, choose 1 of the 2 remaining questions from Part I and analyze the generated data. Plan an investigation that would have produced the given data.

II. With your team, analyze the data from your investigation and construct a scientific argument supported by evidence from your investigation.

Question: How does the type of water (fresh vs. salt) affect the amount of thermal energy transferred over time measured by temperature change?

Data:

50ml of fresh water	**50 ml of salt water that contains (20g of salt)**	**Temperature every minute (degrees Fahrenheit)**	
Initial Temperature 60	Initial Temperature 60	1 min. 64	62
		2 min. 66	64
		3 min. 68	66
		4 min. 68	66
		5 min. 70	68
		6 min. 70	68
		7 min. 72	68
		8 min. 72	70
		9 min. 72	70
		10 min. 74	70

Part III: After working as a class to plan an investigation that would have produced a given set of data to answer the selected question from part I about the causal factors that affect the amount of energy transferred into the glaciers, and constructing a scientific explanation, select a different question and plan an investigation that would produce a given set of data to answer and construct a scientific explanation supported by evidence to support a claim.

Task:

I. With a partner, choose the second question from Part I and plan an investigation that would produce the given data.

II. With your partner, analyze the given data and construct a scientific argument supported by evidence from your investigation.

Question: How does the amount of water (best one from Part I) affect the amount of thermal energy transferred over time measured by temperature change.

Data:

50ml of salt water that contains (20g of salt)	**100 ml of salt water that contains (20g of salt)**	**Temperature every minute (degrees Fahrenheit)**	
		50ml of salt water	100 ml of salt water
Initial Temperature 60	Initial Temperature 58	1 min. 64	60
		2 min. 66	60
		3 min. 66	62
		4 min. 68	64
		5 min. 68	64
		6 min. 70	66
		7 min. 72	68
		8 min. 74	68
		9 min. 74	68
		10 min. 76	70

Part IV: After working with as a whole class and with a partner to plan an investigation that would produce given data to answer the selected question from part I about the causal factors that affect the amount of energy transferred into the glaciers, analyzing given data and constructing a scientific argument in teams and with a partner, select the remaining question and individually plan an investigation that would produce a given set of data, analyze the given set of data, generate a claim, and construct a scientific explanation that uses evidence to support a claim.

Teacher Notes: Students should have had multiple experiences constructing scientific explanations (CER) before this task. If you selected a different question from Part 1 to use as a summative evaluation, you will need to generate data to provide for the students. The given data I used was generated through an investigation I did.

Prompt:
Now that you have generated questions, planned investigations around the generated questions, analyzed given data from the planned investigations, and constructed scientific arguments, complete the following task.

I. Individually, use the question selected by your teacher that was generated in Part I and plan an investigation that would produce the given data.

II. Analyze the given data, make a claim, and construct a scientific argument supported by evidence from your investigation and the given article to support the generated claim.

Thermal Energy and the Effects on Melting Glaciers and Sea Ice

Thermal energy can be defined as the total amount of kinetic energy contained in all the particles of a substance. The more kinetic energy the particles in a substance have, the more thermal energy the substance has. Not only does thermal energy depend on the kinetic energy of the particles, it also depends on the number of particles a substance has. The more particles a substance has, the more thermal energy the substance will have. Since particles in a substance do not move at the same rate, the average kinetic energy of the particles is referred to as temperature.

Temperature is only affected by the movement of the particles, not the amount of particles. The more the particles in a substance move, the more kinetic energy they will have, therefore the substance will have a higher temperature. The two common units for temperature are degrees Celsius and degrees Fahrenheit.

Thermal energy is often confused with heat. Heat is the transfer of thermal energy between substances that are at differ temperatures. When heat is transferred, it always transfers from a warmer substance to a cooler substance. Heat will continue to transfer until the temperature of the substances are equal. This is called Thermal Equilibrium.

Heat can be transferred three ways, through conduction, convection, and radiation. When objects are in direct contact, heat will transfer through a process called conduction. If heat is transferring through liquids or gasses it is referred to as convection. When heat transfers through electromagnetic waves it is called radiation. Materials that allow heat to transfer easily are called conductors, whereas material that does not allow heat to transfer easily are called insulators.

The amount of thermal energy being transferred is affected by the type of matter it is transferring to or from, and the mass of the material the energy is transferring to or from. When thermal energy transfers, the average kinetic energy of the particles will either be increased or decreased. This all has an effect on melting glaciers and sea ice.

Sea ice is simply frozen ocean water. It forms, grows, and melts in the ocean. In contrast, icebergs, glaciers, ice sheets, and ice shelves all originate on land. Sea ice grows during the winter months and melts during the summer months, but some sea ice remains all year in certain regions. About 15 percent of the world's oceans are covered by sea ice during part of the year.

Even though sea ice occurs primarily in the polar regions, it influences our global climate. Sea ice has a bright surface, so much of the sunlight that strikes it is reflected back into space. As a result, areas covered by sea ice don't absorb much solar energy, so temperatures in the polar regions remain relatively cool. If gradually warming temperatures melt sea ice over time, fewer bright surfaces are available to reflect sunlight back into space, more solar energy is absorbed at the surface, and temperatures rise further. This chain of events starts a cycle of warming and melting.

Sea ice also affects the movement of ocean waters. When sea ice forms, most of the salt is pushed into the ocean water below the ice, although some salt may become trapped in small pockets between ice crystals. Water below sea ice has a higher concentration of salt and is more

dense than surrounding ocean water, and so it sinks. In this way, sea ice contributes to the ocean's global "conveyor-belt" circulation. Cold, dense, polar water sinks and moves along the ocean bottom toward the equator, while warm water from mid-depth to the surface travels from the equator toward the poles. Changes in the amount of sea ice can disrupt normal ocean circulation, thereby leading to changes in global climate.

The most basic difference is that sea ice forms from salty ocean water, whereas icebergs, glaciers, and lake ice form from fresh water or snow. Sea ice grows, forms, and melts strictly in the ocean. Glaciers are considered land ice, and icebergs are chunks of ice that break off of glaciers and fall into the ocean. Lake ice is made from fresh water and freezes as a smooth layer, unlike sea ice, which develops into various forms and shapes because of the constant turbulence of ocean water.

The process by which sea ice forms is also different from that of lake or river ice. Fresh water is unlike most substances because it becomes less dense as it nears the freezing point. This difference in density explains why ice cubes float in a glass of water. Very cold, low-density fresh water stays at the surface of lakes and rivers, forming an ice layer on the top.

In contrast to fresh water, the salt in ocean water causes the density of the water to increase as it nears the freezing point, and very cold ocean water tends to sink. As a result, sea ice forms slowly, compared to freshwater ice, because salt water sinks away from the cold surface before it cools enough to freeze. Furthermore, other factors cause the formation of sea ice to be a slow process. The freezing temperature of salt water is lower than fresh water; ocean temperatures must reach -1.8 degrees Celsius (28.8 degrees Fahrenheit) to freeze. Because oceans are so deep, it takes longer to reach the freezing point, and generally, the top 100 to 150 meters (300 to 450 feet) of water must be cooled to the freezing temperature for ice to form.

http://nsidc.org/cryosphere/seaice/index.html

Question: How does the amount of available ice affect the changes in water temperature?

Data:

Amount of ice in 50 ml of water	**Initial Temperature (degrees Fahrenheit)**	**Temperature every minute (degrees Fahrenheit)**	
2 ice cubes	82 degrees	1 min.	44
		2 min.	42
		3 min.	40
		4 min.	41
		5 min.	42
4 ice cubes	86 degrees	1 min.	42
		2 min.	39
		3 min.	36
		4 min.	36
		5 min.	34
6 ice cubes	86 degrees	1 min.	36
		2 min.	34
		3 min.	32
		4 min.	32
		5 min.	32

Scoring Rubric: Scientific Argument

	2 points	1 point	0 points
Claim	Makes an accurate claim	Makes an inaccurate claim	Does not make a claim
Evidence	Provides accurate organized evidence	Provides accurate evidence but not organized or provides inaccurate evidence	Does not provide evidence
Reasoning	Accurately explains the scientific principals related to the claim and supports the claim with a correct analysis of data	Inaccurately explains the scientific principals related to the claim and/or supports the claim with an incorrect analysis of data or does not make any analysis of data	Does not explain the scientific principals related to the claim

Scientific Principles that should be discussed:

- What thermal energy is
- How is thermal energy transferred
- Relationship between type of matter and amount of thermal energy
- Relationship between mass and the amount of thermal energy
- How temperature (average kinetic energy of particles changes) changes when thermal energy is transferred.

Scoring Rubric: Planning an Investigation

	2 points	1 point	0 points
Question		Identifies the question to be investigated	Does not provide a question to be investigated
Materials	Provides a list of materials with the amount of each material listed	Provides a list of materials but not an amount of each material	Does not provide a list of materials
Procedures	Provides a logical step by step set of procedures to follow that includes the following: • Type of materials to be used • Amount of materials to be used • How mass of materials is to be measured • How the temperature is to be measured • Time the temperature is to be measured • Explanation of how the data is to be collected and recorded	Provides a step by step set of procedures with one or more of the required parts missing and /or the procedures are not organized in a logical way	Does not provide a step by step set of procedures
Variables and Controls	• Identifies the correct independent variable and dependent variable being tested • Identifies the correct control(s) being used	Identifies the incorrect independent variable and/or dependent variable or incorrect control(s)	Does not provide a list of variables and controls

Part III: Use evidence from the article to answer the following questions.

1. **What is the relationship between thermal energy, heat, and temperature?**

2. **How does the type of material affect the amount of thermal energy that transfers?**

3. **What two things affect the amount of thermal energy something has?**

4. **What two things does sea ice affect?**

5. **Why is sea ice important to the ocean?**

6. **The data from the investigations in class showed that the less ice there is the warmer the water would be and the more water you have the warmer it is. How does this data relate to the glaciers and sea ice melting?**