When Heat Hides

Trace energy through a change of state

PHY.3.6 "Enrichment: Design, conduct, and communicate investigations that explore how temperature and thermal energy relate to molecular motion and states of matter."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what Mira measures or observes, circle what she keeps the same, and number the three stages of heating from solid ice to liquid water so you can connect her evidence to molecular motion.

The Ice That Kept Warming

1. At a school science fair, Mira asks whether adding thermal energy always raises the temperature of ice. She places 100 g of crushed ice and a temperature probe in a metal cup. A low-power heater supplies energy at a nearly steady rate while she stirs gently. She records the temperature and whether the cup contains solid ice, liquid water, or both every minute. To compare trials, she keeps the ice mass, cup, and heater setting the same. A teacher handles the heater, and Mira keeps electrical parts away from spills. Time is an approximate measure of energy added because the heater runs steadily.

2. In one trial, the ice begins at −8 °C. As heating starts, its temperature climbs toward 0 °C, and the molecules' average kinetic energy increases. For several minutes, the probe stays close to 0 °C while visible ice shrinks and liquid water collects. The heater is still supplying energy during this interval. That energy mainly loosens the attractions holding water molecules in the solid arrangement, rather than increasing their average kinetic energy. Once the last ice disappears, the temperature rises above 0 °C. In liquid water, the added energy again increases the molecules' average kinetic energy and their average motion.

3. Mira repeats the trial twice and finds the same pattern, though the nearly flat interval does not last exactly the same number of minutes. Some energy escapes to the air, so elapsed time cannot give an exact value for energy absorbed by the ice. A larger ice sample would require more energy to melt completely at the same starting temperature. If the heater's power stayed the same, its melting interval would probably be longer. Mira reports both her temperature readings and her notes on the changing amounts of ice and water. Together, these observations support a narrower claim: temperature can stay nearly constant while a substance absorbs energy and changes state.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which measurements and observations let Mira test whether adding energy always raises temperature? Explain why she needs both kinds of evidence.

2. Identify the interval when added energy mainly changes the arrangement of molecules instead of their average kinetic energy. Give two observations that identify this interval.

3. Suppose Mira repeats the trial with 200 g of ice at the same starting temperature and heater setting. What would she predict about the melting interval, and why?

4. Why should Mira not claim that the ice absorbed no energy while the temperature stayed near 0 °C? Why can she not calculate the exact energy absorbed from elapsed time alone?

3 YOUR TURN

Your own words

Design an investigation of how water's starting temperature affects the time it takes to freeze. In five to seven sentences, identify what you will change and keep the same, what temperature and state observations you will record, and a prediction about energy transfer and molecular motion.

When Heat Hides

PART 1 · READ AND MARK

Underline what Mira measures or observes, circle what she keeps the same, and number the three stages of heating from solid ice to liquid water so you can connect her evidence to molecular motion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which measurements and observations let Mira test whether adding energy always raises temperature? Explain why she needs both kinds of evidence.	**She records temperature and time, along with whether ice, water, or both are present. Time approximates energy added, while the temperature and state observations show that the ice melts even when the temperature stays near 0 °C.**
2	Identify the interval when added energy mainly changes the arrangement of molecules instead of their average kinetic energy. Give two observations that identify this interval.	**It is the melting interval. The temperature stays near 0 °C while visible ice shrinks and liquid water collects.**
3	Suppose Mira repeats the trial with 200 g of ice at the same starting temperature and heater setting. What would she predict about the melting interval, and why?	**The melting interval would probably last longer because more ice requires more energy to melt, while the heater supplies energy at about the same rate.**
4	Why should Mira not claim that the ice absorbed no energy while the temperature stayed near 0 °C? Why can she not calculate the exact energy absorbed from elapsed time alone?	**The heater kept supplying energy as the ice melted. Some energy escaped to the air, so elapsed time does not show exactly how much energy the ice absorbed.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I will place equal masses of water at 10 °C and 30 °C in identical freezer-safe plastic containers. I will put both containers on the same freezer shelf at the same time. I will use freezer-safe probes to record each temperature every five minutes and check when ice first appears and when each sample is fully frozen. Starting temperature is the variable I change, while mass, container, and freezer location stay the same. I predict the 30 °C water will usually take longer to freeze because more thermal energy must leave it. As water cools, its molecules' average kinetic energy falls, while freezing near 0 °C releases energy as the molecules form a more ordered solid arrangement.

Accept other workable freezing investigations that change starting temperature, control key conditions, record both temperature and state, and connect the prediction to energy transfer and molecular motion. A prediction need not claim that warmer water always freezes later.