

Twice the Ice: What Changes When the Sample Is Bigger?

Learning target: I can graph heating data for two masses of ice, calculate how long each plateau lasts and how fast each temperature rises, and explain the results with a particle model.

Data and graphing

About 45 min

Individual

MS-PS1-4 · practice

MS-PS3-4 · supports

data analysis

independent practice

Name

Date

Period

Directions

The table is a teaching dataset: the numbers were invented to match how real water behaves, not measured by a real class. Graph both samples on the same grid with a ruler, using a different color or symbol for each and a key. Show every calculation with units. Answer in complete sentences when a question asks you to explain.

You will need: This worksheet, Pencil, Ruler, Two colored pencils, Calculator (optional)

The investigation

A science team wanted to know whether a bigger sample of ice melts at a different temperature or just takes longer. They took two beakers of crushed ice from a freezer at $-20\text{ }^{\circ}\text{C}$: one held 100 g of ice and the other held 200 g. Each beaker sat on its own hot plate, and both hot plates delivered energy at the same steady rate. The team stirred both samples and read the temperatures every minute. The room was at normal sea-level air pressure.

Temperature of two ice samples heated on identical hot plates (teaching dataset)

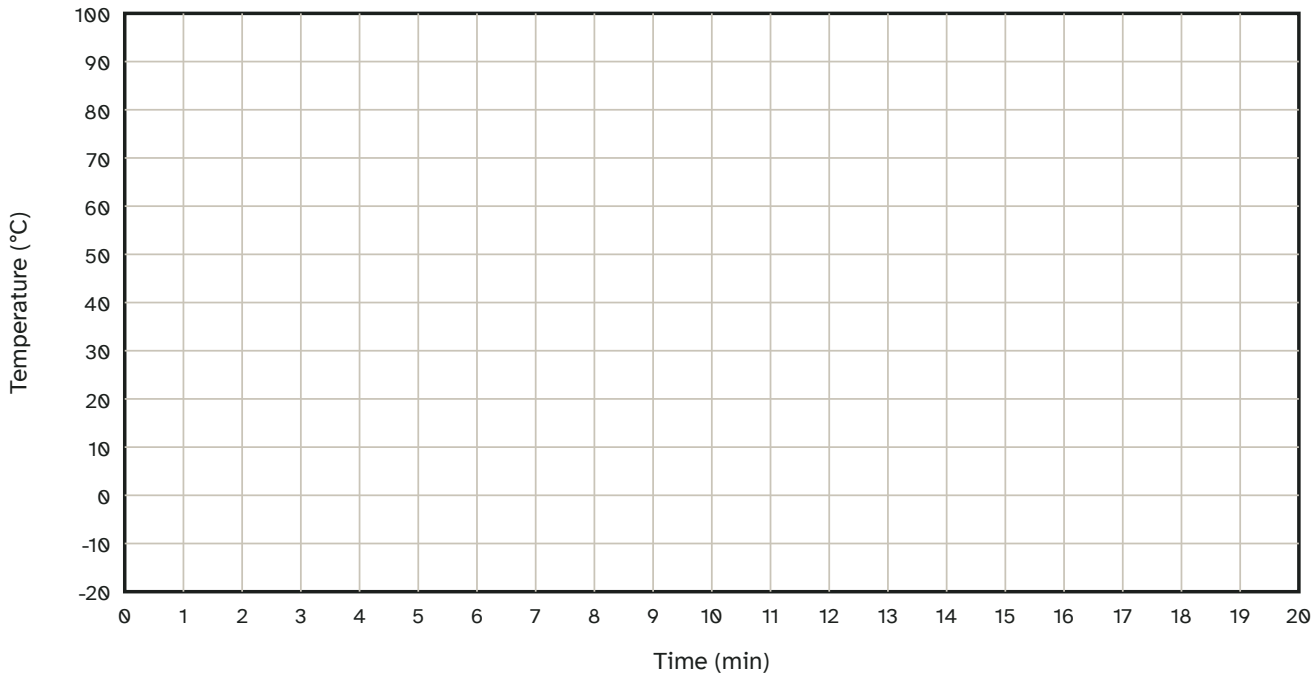
Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Time (min)	100 g sample ($^{\circ}\text{C}$)	200 g sample ($^{\circ}\text{C}$)
0	-20	-20
1	0	-10
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0

Time (min)	100 g sample (°C)	200 g sample (°C)
8	0	0
9	0	0
10	10	0
11	20	0
12	30	0
13	40	0
14	50	0
15	60	0
16	70	0
17	80	0
18	90	0
19	100	5
20	100	10

Simulated, idealized data for teaching: no energy is lost to the room, and readings are rounded to the nearest degree.

Temperature of two ice samples over time



Part A: Read and calculate

1. Describe the shape of each line in one sentence. Name each part as sloping up or level.

2. How many minutes did each sample spend level at 0°C ? Use the first and last minute at 0°C after the ice warmed up. How many times longer was the 200 g plateau?

3. After melting, how fast did the liquid warm? Find the rate for the 100 g sample from minute 10 to minute 18, and for the 200 g sample from minute 18 to minute 20. Give both in $^{\circ}\text{C}$ per minute.

4. How fast did the ice warm before it started to melt? Find the rate in $^{\circ}\text{C}$ per minute for each sample. For the 100 g sample, which warmed faster, the solid ice or the liquid water, and by what factor?

Part B: Interpret and predict

5. Did doubling the mass change the temperature at which the ice melted? Give the evidence from the data.

6. Predict how many minutes the 0°C plateau would last for a 300 g sample and for a 50 g sample on the same kind of hot plate. Explain the pattern you used.

7. If the team had kept going, at about what minute would the 200 g sample start to boil, and what would the thermometer read then? Show your reasoning.

8. A student says, 'At minute 5 the 200 g sample was colder than the 100 g sample because it had more ice in it.' Use the data to evaluate this claim.

9. Explain, using particles, why doubling the mass doubled the length of the plateau but did not change its temperature. Your answer must mention what the hot plate's energy does to the water molecules during the plateau.

10. In a real classroom, some energy would also flow into the beakers from the warm room air. Would that make the real plateaus longer or shorter than in this dataset? Explain.

Rates and durations step by step

A duration is end time minus start time: find where the line first reaches 0 °C and where it last reads 0 °C. A rate is change in temperature divided by change in time: pick two points on a straight, sloping part, subtract the temperatures, subtract the times, then divide. Example with made-up numbers: from 15 °C at 4 min to 27 °C at 7 min is $12\text{ °C} \div 3\text{ min} = 4\text{ °C per minute}$.

Double the hot plate

Suppose the 200 g sample had been heated by a hot plate delivering energy twice as fast as the others. Sketch its predicted temperature line on your graph in a third color, and explain why it would match one of the existing lines. Then describe how you could use two samples and two hot plates to test whether the time a plateau lasts depends on the mass, the heating rate, or both. Name what you would keep the same.