

Your Name
Mr. Young P8
today's date

The Effect of Surface Area on the Rate of Melting in Ice Cubes

Introduction

Solid ice has a melting temperature of 0°C. When an ice cube is placed on a countertop, it will slowly melt and turn into liquid water leaving a small puddle that will eventually evaporate. How fast the ice cube melts depends on a number of factors. Some of these factors include the temperature of the room, air pressure and if there are any air currents moving past the cube.

Comment [dgy1]: The introduction talks about the science behind the investigation you are conducting and adds other information that is important to the research.

In current times we are concerned also with the melting of very large ice cubes at the Earth's poles. Global warming is increasing the rate of polar ice melt and other factors such as the salinity of sea water may also have an effect (Melting Ice).

Comment [dgy2]: All sources of information are cited using MLA format.

The research question for this investigation is:

How does the surface area of an ice cube affect the rate that it melts?

Comment [dgy3]: The research question is clearly stated and easy to recognize

Variables

	Variables	Manipulated, Measured or Controlled by:
Independent	surface area	Five different sizes of ice cubes will be used. Surface area will be calculated from the dimensions of the cubes.
Dependent	rate of melting	The mass of melted water will be measured after 15 minutes (900 s) for each cube. The rate will be calculated by dividing this mass by the time interval.
Controlled	room temperature	Room temperature will be kept as constant as possible and monitored regularly.
	air currents	The AC will be switched off and all windows closed.
	shape of ice cube	Cubes will be made as square as possible
	time	The melting time is the same for all cubes

Comment [dgy4]: I use a table to identify and organize the variables. The third column is the most important .

Hypothesis

If the surface area of the cube increases, then the rate of melting will increase as well. This is because a larger surface area means more ice is in contact with the surrounding air and can absorb more heat. This means more heat is transferred to each cube in the time interval and more melting will occur.

Comment [dgy5]: An if . . . then statement that is explained scientifically. The hypothesis shows that you have been applying known scientific concepts and are being thoughtful about possible outcomes to the experiment.

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Materials

FIVE different size square ice cube trays
THREE square pieces of wire mesh
THREE small beakers
ONE stopwatch
ONE ruler
ONE electronic balance

Procedure

1. Add the same amount of water to each section of the first ice cube tray. Place the tray in the freezer for 24 hours.
2. Label three clean and dry beakers #1, #2 and #3. Measure the mass of each beaker and record.

do this step in the freezer to minimize melting

3. When the cubes are frozen, take them out of the tray. Choose 3 cubes that are close to the same size. Measure the length, width and height of one of the cubes and record.
4. Place an ice cube on the wire mesh over the top of each beaker.
5. Start the stopwatch.
6. After 15 minutes (900 s), remove the ice cubes. Tap the mesh a few times to allow any trapped water to drip into the beaker.
7. Measure the mass of each beaker and the melt water.
8. Repeat these steps for the other 4 ice cube trays.



Comment [djy6]: A complete and detailed list. A diagram is really helpful.

Comment [djy7]: Written as a series of commands. Should clearly indicate when measurements are to be made. The procedure also includes directions to keep the experiment controlled to ensure a fair test.

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Data Collection and Processing

Qualitative Observations

- ice cubes began to melt quite quickly and drip water into the beaker
- some liquid water was trapped in the wire mesh even after tapping

Comment [djy8]: Qualitative observations outline what you saw, heard, smelled while doing the lab but did not measure

Mass of Empty Beakers

Beaker A: 45.26 ± 0.05 g

Beaker B: 47.13 ± 0.05 g

Beaker C: 44.67 ± 0.05 g

Comment [djy9]: all measurements should have an uncertainty value – ask your teacher for help

Table 1: Dimensions and calculated surface areas of different size ice cubes used

Cube	Length ± 1 mm	Width ± 1 mm	Height ± 1 mm	Surface Area mm^2
cube 1	11	10	12	132
cube 2	15	15	14	176
cube 3	20	21	21	248
cube 4	25	25	25	300
cube 5	30	25	32	348

Comment [djy10]: Column headings must have titles and units

Sample Calculation: Surface Area of Ice Cube (for cube 1)

$$\begin{aligned}\text{SURFACE AREA} &= [2(l \times w) + 2(l \times h) + 2(w \times h)] \\ \text{SURFACE AREA} &= 2(11 \times 10) + 2(11 \times 12) + 2(10 \times 12) \\ \text{SURFACE AREA} &= 132 \text{ mm}^2\end{aligned}$$

Comment [djy11]: One example calculation is shown for each different calculated value. The equation is clearly outlined and all of the math is shown.

Table 2: Raw data showing the combined mass of beakers and melt water for different surface area ice cubes after 900 s of melting at room temperature

Surface Area (mm^2)	Mass of beaker and melt water (g)		
	Beaker A Trial 1	Beaker B Trial 2	Beaker C Trial 3
132	45.73	47.68	45.2
176	46.01	47.81	45.36
248	46.21	48.04	45.69
300	46.52	48.34	45.75
348	46.57	48.59	46.08

Comment [djy12]: Each table has a descriptive title. If more than one table, then each table is numbered.

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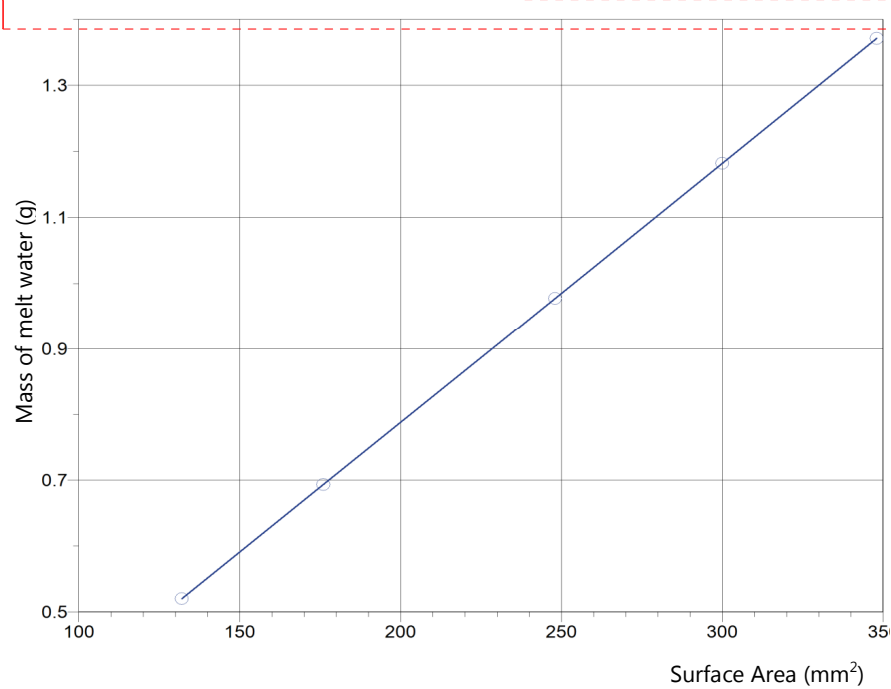
Table 3: Processed data showing average mass of melt water for different surface area ice cubes after 900 s of melting at room temperature.

Surface Area (mm ²)	Mass of melt water (g)			
	Beaker A Trial 1	Beaker B Trial 2	Beaker C Trial 3	Average
132	0.47	0.55	0.53	0.52
176	0.75	0.68	0.69	0.71
248	0.95	0.91	1.02	0.96
300	1.26	1.21	1.08	1.18
348	1.31	1.46	1.41	1.39

Sample Calculation: Mass of melt water (132 mm² cube, Trial 1)

MASS = (Mass of beaker + water) – mass of empty beaker
MASS = 45.73 – 45.26 = 0.47 g

Graph 1: The relationship between the surface area of an ice cube and the amount of melt water produced in 900 s at room temperature.



Comment [dgy13]: Graph has a descriptive title. Axis are labeled with units. Graph takes up at least half of the page

Comment [dgy14]: Graphs should be constructed using computer software. Trendlines, equations, error bars and other features are added based on the requirements of the lab. Ask your teacher.

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Graph Calculations: Slope and y-intercept

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{1.39 - 0.52}{348 - 132} = 0.004 \text{ g / mm}^2$$

Comment [djy15]: Calculations from the graph are not always necessary and depend on the lab. Ask your teacher.

Conclusion

It can be observed from Graph 1 that **as the surface area of an ice cube increases, the mass of melt water produced in 15 minutes also increases.** The graph is a straight line which shows that an increase in surface area will produce a corresponding increase in the amount of melt water. Since the time was constant for each trial, it can also be stated that the surface area directly affects the rate of melting.

Comment [djy16]: Be direct when making a conclusion, make sure the research question is addressed and that the conclusion statement is supported clearly by the data

The hypothesis was supported but this conclusion is limited only to the range of surface areas tested and cannot be extended to larger or smaller ice cubes. The increase in melting due to more surface area can be explained by more of the ice cube surface being in contact with the surrounding air and therefore absorbing heat energy faster. Even though larger cubes seem to melt faster, they may still take more time to melt because there is more ice and as they melt, their surface area decreases.

Evaluation

There are some important weaknesses with this investigation. It was difficult to get all the water out of the wire mesh so that the total mass of melt water could be measured accurately. This would mean that the mass measured was less than the actual mass. As the ice cubes were still wet when removed from the mesh, some melt water was lost that way as well. Evidence from the data that indicates this problem is that there was some variation in the mass of melt water measured between the three trials. One solution to this would be to measure the mass of the ice cube at the start of the timing period, and then quickly dry it and measure the mass again at the end of the timing period. The mass of melt water could then be determined by subtraction.

Comment [djy17]: Focus on weaknesses, limitations of the procedure in this section. DO NOT comment on human error. Try to provide evidence (from the data) when a weakness is identified. This shows you are not just guessing but have support from the actual experiment results.

Comment [djy18]: Here is my evidence

A second weakness was that the ice cubes had different surface areas but were not uniform volumes. The variables would be controlled better if all the ice cubes used were of consistent shape (for example cubes) and of consistent size. This problem may also be responsible for the variation in the amount of melt water between trials. To improve this care must be taken to select only ice cubes of consistent dimensions. More trials could also be performed to collect more data before calculating the mean melt water mass.

Comment [djy19]: Make a realistic suggestion to improve the investigation that would help reduce the weakness identified

Finally, there was no evidence that the room temperature was constant for the entire experiment due to not taking any actual measurements. Temperature should be recorded every few minutes to ensure there are no major fluctuations.

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References

"Melting Ice." *Gulf of Maine Aquarium*. N.p., n.d. Web. 2 Nov. 2011.
<<http://www.gma.org/surfing/human/melting.html>>.

Comment [djy20]: All citations need to be mentioned here.