



what if?



The book: **What If?** Serious Scientific Answers to Absurd Hypothetical Questions

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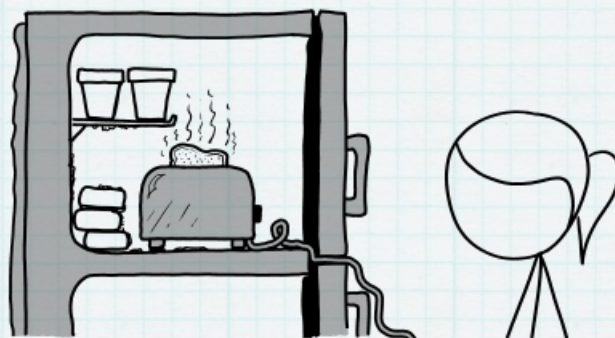
Toaster vs. Freezer

Would a toaster still work in a freezer?

—My Brother, My Brother and Me, Episode 343, discussing a Yahoo Answers question

On [a recent episode](#) of Justin, Travis, and Griffin McElroy's terrific advice podcast, *My Brother, My Brother and Me*, the brothers pondered a Yahoo Answers question about what would happen if you put a toaster inside a freezer. (The discussion comes around the 36-minute mark.)

They have a fun discussion of a few aspects of the problem before eventually moving on to the next question. Since they don't really settle on a final answer, I thought we could help them out by taking a closer look at the physics of freezer toasters.

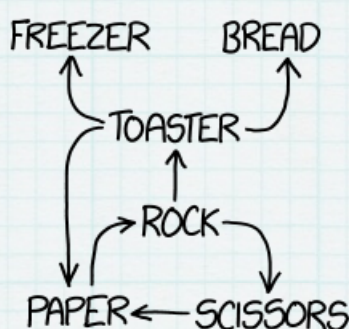


(A quick safety note: If you actually do this, keep in mind that the toaster may melt some of the ice in the freezer, leaving you with a running electrical appliance in a pool of water.)

Griffin sums up the situation like this:

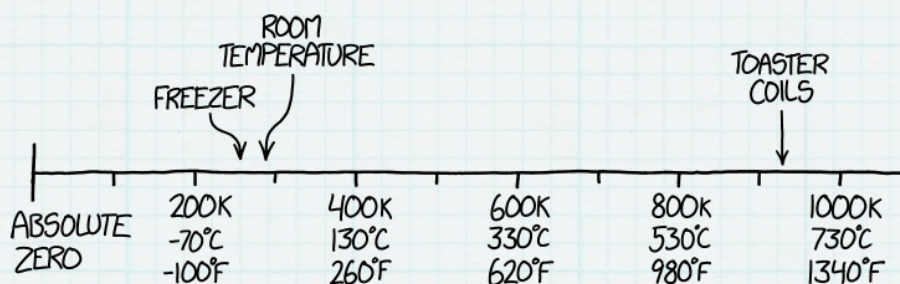
*You put a toaster in a freezer. You run the extension cord in there. You put some good bread in there. You click it down. What even **happens**, right? Because if your answer is, "it would get hot," then the freezer hasn't done its job. But if you say "it would get cold," then the toaster hasn't done **its** job.*

For starters, the answer: The toaster would win. The freezer wouldn't do its job. Toasters beat freezers.



It's easy to think of a toaster and freezer as equivalent—one cools things down and the other warms them up. But toasters heat things up a *lot* more than freezers cool them down.

The coils in regular toasters get hot enough to glow, which means they're over about 600°C . Since the toaster is operating at such high temperatures, it would hardly notice whether the surrounding environment is 20°C (room temperature), 4°C (a fridge), or -15°C (a freezer). [\[1\]](#)



The toaster needs to heat its coils from room temperature to somewhere over 600°C . From the toaster's point of view, a 20- or 40-degree change in starting temperature hardly matters. The coils will get hot, and then the bread will get hot, too. If the bread is colder at the start, the toaster

will have to heat it a little longer to get it up to ideal toasting temperature, but it will have no trouble getting there. As anyone who's ever burned a piece of toast knows, toasters are definitely capable of heating bread to above the ideal temperature for toast.

In their discussion, the McElroys brought up another question: Even if the toaster can still toast bread at first, would it struggle to stay warm over time? If you left both the toaster and the freezer running, who would win in the long term?

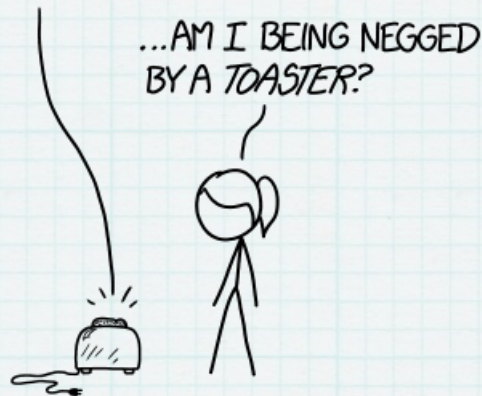
The answer is that the toaster would still win. A toaster produces about a thousand watts of heat, and the cooling system in a household freezer can't remove heat that fast. In fact, since freezers are so well insulated, the inside of the freezer would probably get much hotter than the rest of the house, and eventually the toaster and/or the freezer would probably overheat. ^[2]

Refrigerators and freezers work by soaking up heat from their interior and dumping it out the back. ^[3] In a sense, they're more efficient than toasters. Fridges have a "coefficient of performance" of 2 or 3, which means it only takes them 1 unit of electrical energy to move 2 or 3 units of heat energy from the interior to the exterior. A toaster, on the other hand, produces 1 unit of heat from 1 unit of electricity. But since the compressor in a fridge-freezer typically only uses 100 or 150 watts when it's running, ^[4] so even with the efficiency multiplier, it can't keep up with the toaster's 1000+ watts of heat production.

Eventually, the toaster will start to heat up the inside of the freezer. Even if the freezer were as powerful as the toaster, it wouldn't be able to keep the toaster coils themselves from getting hot and toasting bread. The freezer can make the air around the toaster cold, but remember, to the toaster, *all* our air is cold.

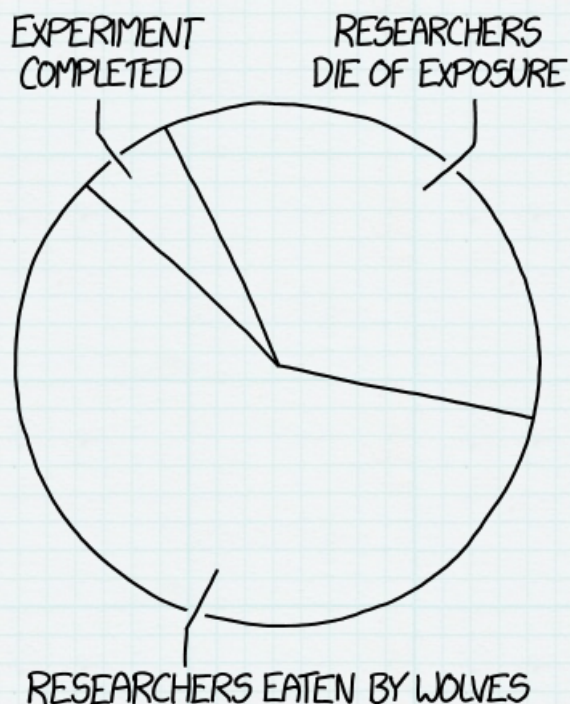
HI, WELCOME TO MY HOUSE!

LET ME KNOW IF THE ROOM GETS
TOO HOT- I KNOW YOU'RE PROBABLY
TOO POLITE TO SAY WHEN LITTLE
20° FLUCTUATIONS BOTHER YOU.



If you happen to live in the Canadian city of Winnipeg, you can check this experimentally. The winter temperature at night in Winnipeg is about the same as the inside of a freezer, so the environment there effectively simulates a freezer with infinite capacity to absorb heat. Suppose you put a toaster out on your porch one night, plugged in by an extension cord, and leave it running for a few hours, going outside every so often to collect the toast and put in some fresh bread. What will happen? Simple: You'll quickly be eaten by wolves.

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But assuming you survive the experiment, you should find that the toaster doesn't have trouble working in the cold air. It may take a bit longer to get the bread properly browned, but unless the wind is extremely strong, it should be able to manage it fine. After all, to a toaster, all weather is cold.

The difference between what humans consider "cold" and "warm" is negligible in a lot of high-temperature processes. For example, Antarctica has a [well-equipped fire department](#). It might seem strange to worry about things getting too hot in the coldest place on Earth, but fire poses a [serious threat](#) to the researchers there. After all, the place is dry, windy, and doesn't have a lot of liquid water sitting around to douse a flame with. Sure, it's cold—but to a fire, *everything* is cold.

On the other hand, there are no wolves in Antarctica. So as long as you don't mind a trip—and you get clearance from the Antarctica fire department—you can go there to enjoy your outdoor freezer toast in peace.

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