That ice melting question.

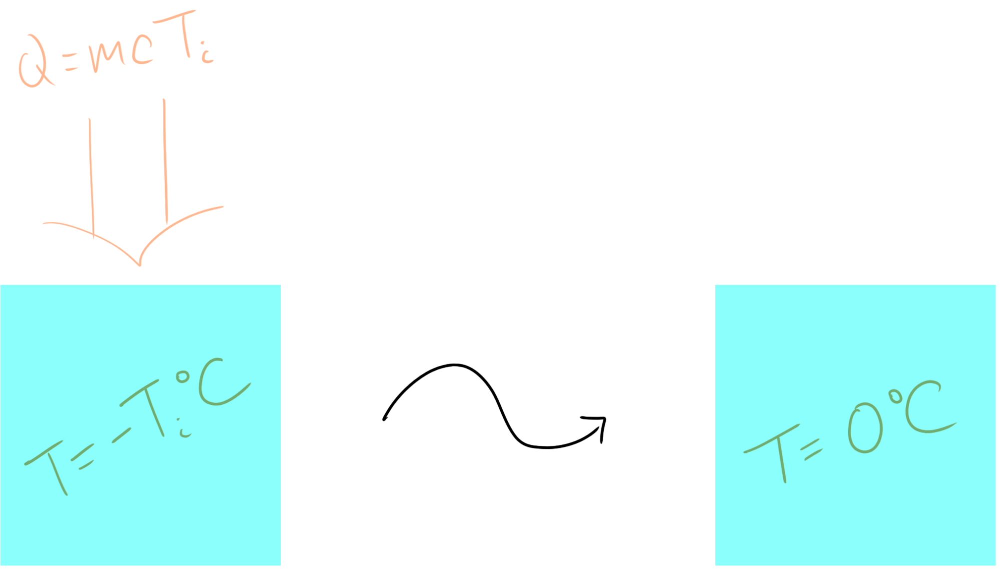
Having done a number of textbook exercises and past papers I'm sure you realise that one question that comes up quite often is *that one that asks about ice melting in a liquid*. If you're not sure what I'm talking about, it's the question that goes "*5g of ice at -2ºC is put into 100g of 30ºC water. Find the final temperature of the water after all the ice has melted.*"

It's quite annoying to answer this one sometimes since it involves a lot of steps, but I hope to use this to make the journey to solving the problem clearer.

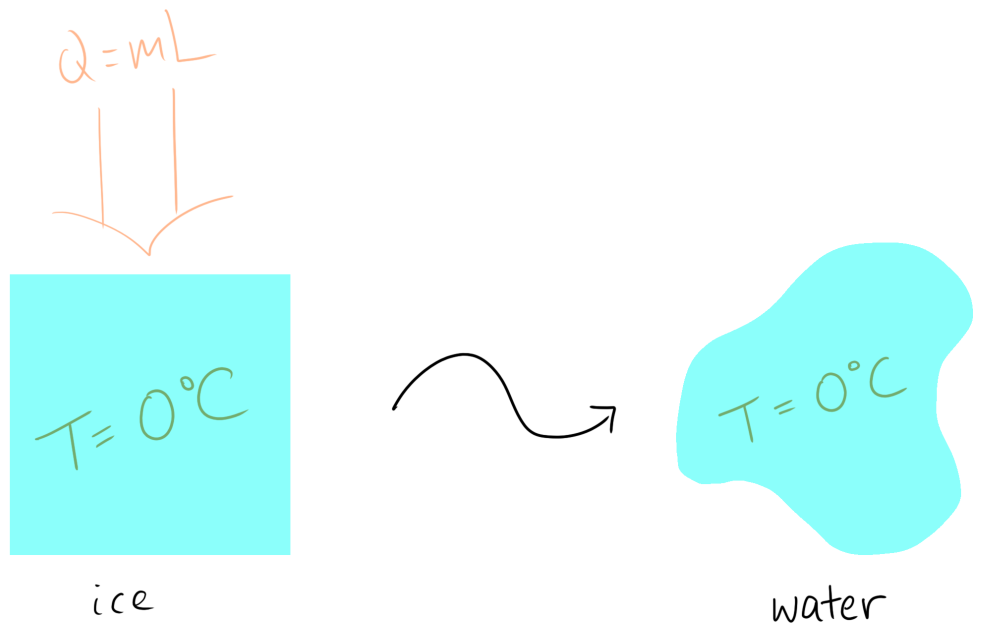
1. **Deal with the ice first.**

The first step would be to find the heat energy used to melt the ice. This occurs in two steps: the ice gets to 0ºC, and then it turns into liquid.

1a. Find the energy needed to raise the temperature of the ice to 0ºC using $Q = m_{\text{ice}} c_{\text{ice}} \Delta T$.

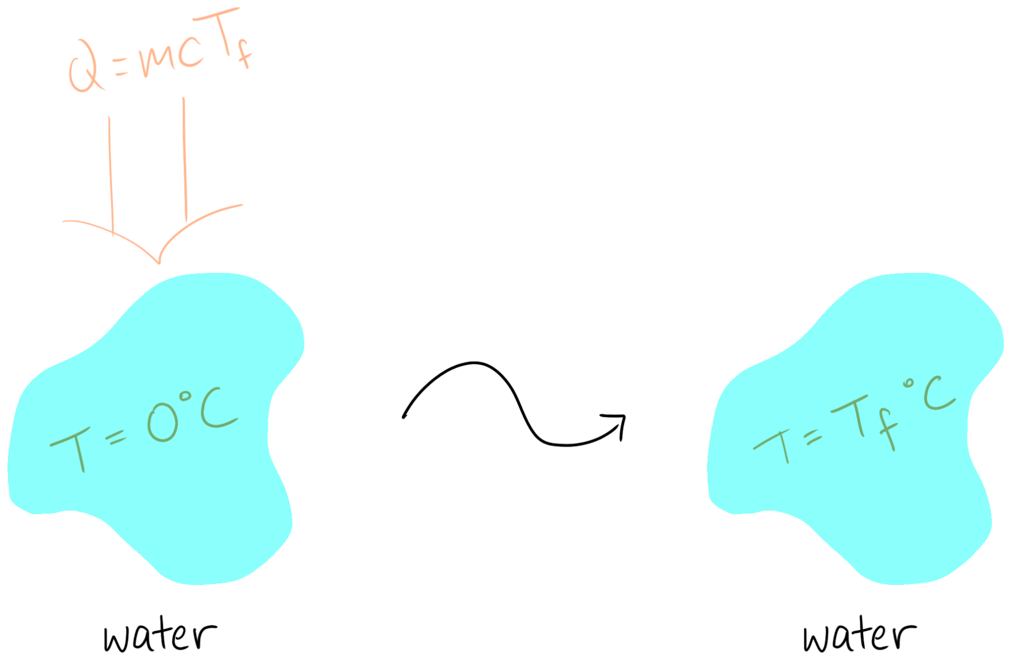


1b. Find the energy needed to melt the ice, using $Q = m_{\text{ice}} L$.



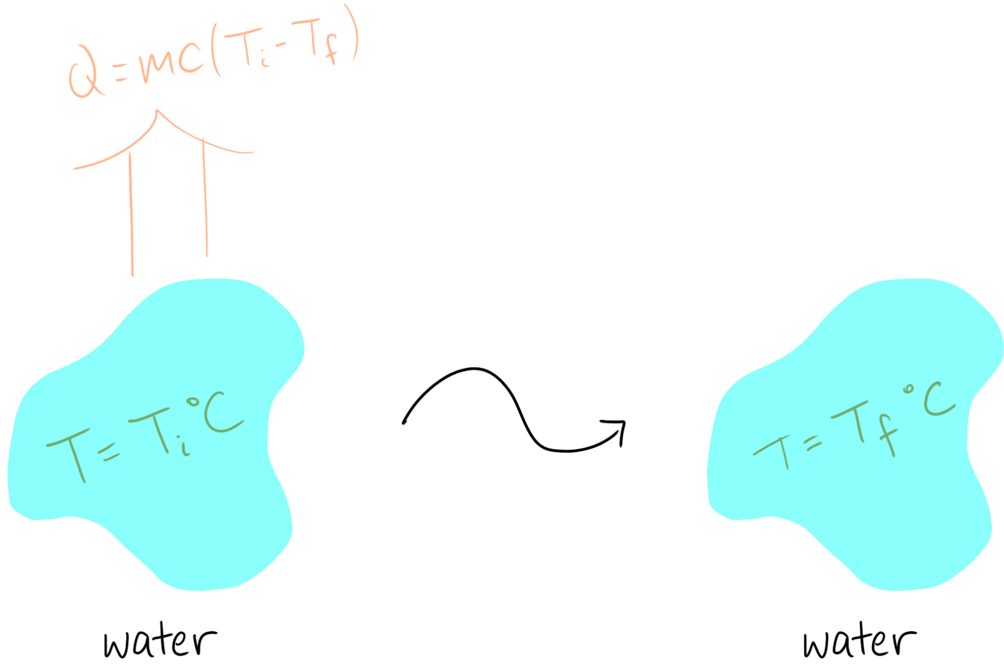
2. **The 0°C now needs to be heated to the final temperature T_f.**

The energy needed in this step would be $Q = m_{\text{ice}} c_{\text{water}} T_f$.



3. **Consider where all this energy comes from.**

The heat energy needed to get convert ice at its initial temperature to water at T_f comes solely from the warm water it started in. All that happens to this water is it cools from its initial temperature T_i to T_f, losing heat energy equal to $Q = m_{\text{water}} c_{\text{water}} (T_i - T_f)$. Notice that since the water cools, $T_i > T_f$, so this Q is a positive quantity telling us how much heat energy is *lost*.



4. **Equate the two equations by conservation of energy.**

The heat energy lost by the warm water is gained by the ice, so sum the energies found in 1a, 1b, and 2, and equate it to the energy lost found in step 3.