A 40 g block of ice is cooled to -78°C. It is added to 560 g of water in an 80 g copper calorimeter at a temperature of 25°C. Determine the final temperature. The specific heat of ice is 0.500 cal/g and the heat of fusion of ice is 80 cal/g.

\[ m_i c_i (0^\circ - T_i) + m_i L_f + m_i c_w (T_f - 0^\circ) = (m_w c_w + m_c c_c)(T_w - T_f) \]

\[ 40(0.5)(78) + 40(80) + 40(1)T_f = (560(1) + 80(0.0924))(25 - T_f) \]

\[ 4750 + 40T_f = 14200 - 567T_f \]

\[ 607T_f = 9450 \]

\[ T_f = 15.5^\circ C \]

Now, what if you started with 160 g of ice? Clearly the heat given up by the ice in coming to 0°C and then melting is 19000c instead of 4750c. If you do the calculation above you would obtain \( T_f \) negative. What does this mean?

There are two possibilities: 1) not all the ice melts at \( T_f = 0^\circ C \), or 2) the water freezes and the final temperature is less than 0°C.

Let’s try the first possibility where only \( X \) grams of the ice melts and the system ends up at 0°C, i.e.

\[ m_i c_i (0^\circ - T_i) + X L_f = (m_w c_w + m_c c_c)(T_w - 0) \]

\[ 160(0.5)(78) + X(80) = (560(1)+80(0.0924))25 \]

\[ 6240 + X80 = 14185 \]

\[ X = 99 \text{ g of ice melts} \]

Thus, at equilibrium you would find 60 g of ice, 660 g of water and the calorimeter at 0°C.