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.

$$m_i c_i\left(0^o - T_i\right) + m_i L_f + m_i c_w\left(T_f - 0^o\right) = \left(m_w c_w + m_c c_c\right)\left(T_w - T_f\right)$$

$$40(.5)(78) + 40(80) + 40(1)T_f = \left(560(1) + 80(.0924)\right)\left(25 - T_f\right)$$

$$4750 + 40\,T_f = 14200 - 567\,T_f$$

$$607\,T_f = 9450$$

$$T_f = 15.5^o\,C$$

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 $T_f = 0^oC$, 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.

$$m_i c_i\left(0^o - T_i\right) + X\,L_f = \left(m_w c_w + m_c c_c\right)\left(T_w - 0\right)$$

$$160(.5)(78) + X(80) = \left(560(1) + 80(.0924)\right)25$$

$$6240 + X80 = 14185$$

$$X = 99\,g\ of\ ice\ melts$$

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