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a. (15 pts.) At what time does the ice *start* to melt?

b. (15 pts.) At what time did the temperature start to rise above 0°C?

c. (15 pts.) What was the final temperature of the system?

You may find it helpful to sketch a plot of temperature vs. time.

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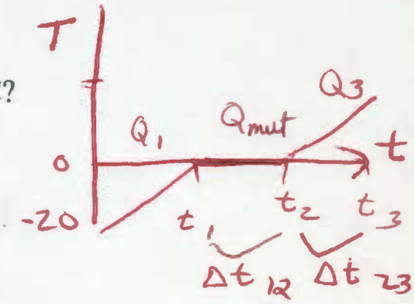

a. $Q_1 = m_i c_i \Delta T_1$

$= (0.600\,kg)(2220\,\frac{J}{kg \cdot K})(20\,K) = 2.66 \times 10^4\,J$

$t_1 = \frac{Q_1}{dQ/dt} = \frac{2.66 \times 10^4\,J}{120\,J/s} = \boxed{222\,s}$

b. To melt the ice, $Q_{melt} = m_i L_f$

$Q_{melt} = (0.600\,kg)(333 \times 10^3\,J/kg) = 1.998 \times 10^5\,J$

$(t_2 - t_1) = \frac{Q_{melt}}{120\,J/s} = 1.67 \times 10^3\,s \quad (1665\,s)$

$t_2 = 222\,s + 1665 = \boxed{1887\,s}$

c. heat it for $(t_3 - t_2)\,s = \left[\left(50\,min \times \frac{60\,s}{min}\right) - 1887\,s\right]$

$\Delta t_{23} = 1113\,s$

$Q_3 = 120\,\frac{J}{s} \cdot 1113\,s = 1.34 \times 10^5\,J$

Lastly $Q_3 = m_i c_w \Delta T$

$\Delta T = T_f - 0°C = T_f = \frac{1.34 \times 10^5\,J}{(0.6\,kg)(4190\,\frac{J}{kg\,K})} = \boxed{53.1\,°C}$

$= \boxed{326.3\,K}$