

Kool Aid problem - full answer

17-6b

$$\Delta Q_{\text{tot}} = Q_{\text{ice accepts}} + Q_{\text{kool aid yields}} = 0$$

$$\rightarrow m_{\text{ice}} C_{\text{ice}} (T_f - T_{0,\text{ice}}) + m_{\text{ice}} L_{\text{f,ice}} + m_{\text{kool}} C_{\text{kool}} (T_f - T_{0,\text{kool}}) = 0$$

$$\rightarrow T_f = \frac{-m_{\text{ice}} L_{\text{f,ice}} + m_{\text{ice}} C_{\text{ice}} T_{0,\text{ice}} + m_{\text{kool}} C_{\text{kool}} T_{0,\text{kool}}}{m_{\text{ice}} C_{\text{ice}} + m_{\text{kool}} C_{\text{kool}}}$$

$$= 277.9 \text{ K}$$

→ no, the kool aid cannot reach 0°C or 273.15 K

$$m_{\text{kool}} = 4 \text{ gallons} \frac{3.788 \text{ L}}{1 \text{ gallon}} \frac{10^{-3} \text{ m}^3}{\text{L}} \frac{10^3 \text{ kg}}{\text{m}^3} = 15.152 \text{ kg}$$

$$m_{\text{ice}} = \frac{1}{4} \text{ gallon} \frac{3.788 \text{ L}}{\text{gallon}} \frac{0.92 \cdot 10^3 \text{ kg}}{\text{m}^3} \frac{10^{-3} \text{ m}^3}{\text{L}} = 0.87124 \text{ kg}$$

$$C_{\text{ice}} = 2100 \frac{\text{J}}{\text{kg} \cdot \text{K}} \quad C_{\text{kool}} = 4190 \frac{\text{J}}{\text{kg} \cdot \text{K}}$$

$$L_{\text{f,ice}} = 334 \cdot 10^3 \frac{\text{J}}{\text{kg}}$$

$$T_{0,\text{ice}} = -20^\circ\text{C} = 253.15 \text{ K}$$

$$T_{0,\text{kool}} = 10^\circ\text{C} = 283.15 \text{ K}$$