Specific Heat Problems

1) How much heat must be absorbed by 375 grams of water to raise its temperature by 25° C?

2) What mass of water can be heated from 25.0° C to 50.0° C by the addition of 2825 J?

3) What is the final temperature when 625 grams of water at 75.0° C loses 7.96 x 10^4 J?

4) A copper cylinder has a mass of 76.8 g and a specific heat of 0.092 cal/g·C. It is heated to 86.5° C and then put in 68.7 g of turpentine whose temperature is 19.5° C. The final temperature of the mixture is 31.9° C. What is the specific heat of the turpentine?

5) A 65.0 g piece of iron at 525° C is put into 635 grams of water at 15.0° C. What is the final temperature of the water and the iron?
Solutions

1) \( m_w = 375 \text{ g} \)

\( c_w = 4.18 \text{ J/g·K} \)

\( \Delta T = 25^\circ \text{ C} = 25 \text{ K} \)

\[ q_g = m_w c_w \Delta T_w \]

\[ q_g = 375 \text{ g} \times 4.18 \text{ J/g·K} \times 25 \text{ K} = 3.9 \times 10^4 \text{ J} \]

2) \( m_w = ? \)

\( c_w = 4.18 \text{ J/g·K} \)

\( \Delta T = 50.0^\circ \text{ C} - 25.0^\circ \text{ C} = 25.0 \text{ K} \)

\[ q_g = m_w c_w \Delta T_w \]

\[ m = q_g / c\Delta T \]

\[ m = 2825 \text{ J} / (4.18 \text{ J/g·K} \times 25.0 \text{ K}) = 27.0 \text{ g H}_2\text{O} \]
3) \( m_w = 625 \text{ g} \)
\[ c_w = 4.18 \text{ J/g·K} \]
\( T_i = 75.0^\circ \text{ C} \)
\( q_l = 7.96 \times 10^4 \text{ J} \)

\[ q_l = m_w c_w \Delta T_w \]
\[ \Delta T_w = q_l / (m \times c) \]
\[ \Delta T_w = 7.96 \times 10^4 \text{ J} / (625 \text{ g} \times 4.18 \text{ J/g·K}) = 30.5 \text{ K} = 30.5^\circ \text{ C} \]

\[ \Delta T = T_i - T_f \]
\[ T_f = T_i - \Delta T = 75.0^\circ \text{ C} - 30.5^\circ \text{ C} = 44^\circ \text{ C} \]

4) \( m_c = 76.8 \text{ g} \quad \text{m}_t = 68.7 \text{ g} \)
\[ c_c = 0.092 \text{ cal/g·C} \quad \text{c}_t = ? \]

\[ \Delta T = T_i - T_f \quad \Delta T = T_f - T_i \]
\[ \Delta T = 86.5^\circ \text{ C} - 31.9^\circ \text{ C} = 54.6^\circ \text{ C} \quad \Delta T = 31.9^\circ \text{ C} - 19.5^\circ \text{ C} = 12.4^\circ \text{ C} \]

\[ \Delta q = 0 \]

\[ q_l = q_g \]
\[ m_c c_c \Delta T_c = m_t c_t \Delta T_t \]
\[ c_t = m_c c_c \Delta T_c / m_t \Delta T_t \]
\[ c_t = 76.8 \text{ g} \times 0.092 \text{ cal/g·C} \times 54.6^\circ \text{ C} / (68.7 \text{ g} \times 12.4^\circ \text{ C}) = 0.45 \text{ cal/g·C} \]
5) \( m_{\text{iron}} = 65.0 \text{ g} \quad m_w = 635 \text{ g} \)

\( c_{\text{iron}} = 0.451 \text{ J/g} \cdot \text{K} \quad c_w = 4.18 \text{ J/g} \cdot \text{K} \)

\( T_i = 525^\circ \text{ C} \quad T_i = 15^\circ \text{ C} \)

\( \Delta q = 0 \)

\( q_l = q_g \)

\( m_i c_i \Delta T_i = m_w c_w \Delta T_w \)

\( 65.0 \text{ g} \times 0.451 \text{ J/g} \cdot \text{K} \times (525^\circ \text{ C} - T_f) = 635 \text{ g} \times 4.18 \text{ J/g} \cdot \text{K} \times (T_f - 15^\circ \text{ C}) \)

\( T_f = 20.6^\circ \text{ C} \)