Specific Heat Capacity problems # 2

When hot water is added to cold water, the hot water releases heat (ΔE_h) to the cold water. The hot water will experience a drop in temperature and the cold water will experience a gain in temperature. This will continue until they both reach the same temperature. At this point the heat flow stops and the combined mass of water will have the same temperature.

Example

An insulated container contains 475 g of water at a temperature of 15°C. If 325 g of hot water at a temperature of 80.0°C is added, what is final temperature of the water after it is completely mixed?

→ Start with a simple equation that describes the flow of heat from the hot water to the cold.

$$\text{Heat lost by hot water} = (-1)^{\text{Heat gained by cold water}}$$

$$M_h(\Delta T_h)C_w = -M_c(\Delta T_c)C_w$$

- M_h: mass of hot water (g)
- $T_{Final} - T_{initial}$ of hot water (will be negative)
- M_c: mass of cold water
- C_w: Specific Heat Capacity of water

$$(0.325)(T_2 - T_1)(4180) = (0.475)(T_2 - T_1)4180$$

$$0.325(T_2 - 80.0) = -0.475(T_2 - 15.0)$$

$$0.325T_2 - 26 = -0.475T_2 + 7.13$$

$$-26 - 7.13 = -0.475T_2 - 0.325T_2$$

$$-33.13 = (-.800)T_2$$

$$41.4^\circ C = T_2$$

This question was simplified because the Specific Heat Capacity of water $\left(4180 \frac{J}{Kg\,^\circ C}\right)$ cancelled out on both sides of the equation

If we were to mixed two different liquids together the specific heat capacities would not cancel out!

Example:

When 0.300kg of lead $\left(c = 130 \frac{J}{kg\,^\circ C}\right)$ at a temperature of 165°C is added to water at a temperature of 15.0°C, the temperature of the water raises to 25.0°C. What is the mass of the water?

Heat lost by hot lead $= (-1)$ Heat gained by water (cold)

$$m_{Pb}(\Delta T) C_{Pb} = (-1)\, m_w (\Delta T_w) C_w$$

$$(0.300)(25 - 165)\, 130 = -1\, m_w (25 - 15)\, 4180$$

$$-5460 = -41800\, m_w$$

$$\frac{-5460}{-41800} = m_w$$

$$\boxed{m_w = 0.131 \text{ kg}}$$

Note: Lead is in a solid state not liquid!