1. The specific heat of water is greater than that of copper.

A piece of copper metal is put into an insulated calorimeter which is nearly filled with water. The mass of the copper is the same as the mass of the water, but the initial temperature of the copper is lower than the initial temperature of the water. The calorimeter is left alone for several hours.

During the time it takes for the system to reach equilibrium, will the temperature change (number of degrees Celsius) of the copper be more than, less than, or equal to the temperature change of the water? Please explain your answer.

\[ Q = mc\Delta T \]

\[ |Q_{Cu}| = |Q_W| \quad \text{and} \quad m_{Cu} = m_W \]

\[ \Rightarrow c_{Cu} \Delta T_{Cu} = c_W \Delta T_W \]

\[ \Delta T_{Cu} = \frac{c_W}{c_{Cu}} \Delta T_W \]

\[ c_W > c_{Cu} \Rightarrow \Delta T_{Cu} > \Delta T_W \]

Notation: \[ \Delta T \equiv \text{absolute value of temperature change} \]
2. Suppose we have two separate containers: One container holds Liquid A, and another contains Liquid B. The mass and initial temperature of the two liquids are the same, but the specific heat of Liquid A is three times that of Liquid B. Each container is placed on a heating plate that delivers the same rate of heating in joules per second to each liquid beginning at initial time \( t_0 \).

a) On the grid below, graph the temperature as a function of time for each liquid, A and B. Use a separate line for each liquid, even if they overlap. Make sure to clearly label your lines, and use proper graphing techniques.

![Graph of Temperature vs. Time for Liquid A and Liquid B](image)

b) Please explain the reasoning that you used in drawing your graph. (Please continue on the back of the page.)

The top line, which has a slope of 1 (unit temperature per unit time), corresponds to the rate of temperature change of Liquid B with respect to time. The bottom line, which has a slope of 1/3, corresponds to the rate of temperature change of Liquid A. Note that these specific lines are not the only solutions. Any two lines with the proper 1:3 slope ratio constitute a correct solution.

\[ Q = mc\Delta T \]

The mass of Liquid A and Liquid B are equal, \( m_A = m_B \), and both liquids are receiving the same amount of heat transfer from the heating plate per unit time, \( Q_A = Q_B \). The specific heat of Liquid A is three times the specific heat of Liquid B, \( c_A = 3c_B \), therefore the change in temperature per unit time for Liquid A is 1/3 of that for Liquid B, \( \Delta T_A = (1/3)\Delta T_B \):

\[
\Delta T_A = \frac{Q_A}{m_A c_A} = \frac{Q_B}{m_B c_A} = \frac{Q_B}{m_B (3c_B)} = \frac{1}{3} \frac{Q_B}{3 m_B c_B} = \frac{1}{3} \Delta T_B
\]