Name: _____ Physics 1 - Miguel Rocha Date: _____

Lab 9: Temperature Mix

Purpose

To predict the final temperature of a mixture of cups of water at different temperatures.

Introduction

If you mix a cup of cold water with a cup of hot water the temperature of the mixture will be between the two initial temperatures. The final equilibrium temperature T will depend on the initial temperature of the water in each cup and on the amount of water (mass) in each cup.

The specific heat capacity equation tell us by how much the temperature of a material changes when heat is absorbed or released,

$$\Delta T = \frac{\text{Heat Transferred}}{\text{Mass} \times \text{Heat Capacity}} = \frac{Q}{mc}, \quad \textbf{Eq. 1}$$

where c is the heat capacity of the material, a constant telling us the resistance of the material to change its temperature.

We can use Eq.1 to predict the ratio of the change in temperature of the water in each cup when we mix them up. Since the heat capacity c is the same for both cups and the heat transferred Q is also the same but with opposite sign ($Q_C = -Q_H$ — the cold water absorbs heat while the the hot water releases it), the ratio of the change in temperature of the water in each cup would be given by

$$\frac{\Delta T_H}{\Delta T_C} = \frac{T - T_H}{T - T_C} = -\frac{m_C}{m_H}, \quad \textbf{Eq. 2}$$

where T is the final equilibrium temperature. Solving for T we get that the final equilibrium temperature is given by

$$T = \frac{T_H + T_C \frac{m_C}{m_H}}{1 + \frac{m_C}{m_H}}. \quad \textbf{Eq. 3}$$

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In this lab you are going to mix different ratios of hot and cold water and use Equation 3 to make predictions for the final equilibrium temperature of the mix.

Procedure

Being by marking your three cups equally at about the 1/3 level.

Equal Mass

1. Fill one of your cups up to the 1/3 mark with hot water.
2. Fill another one of your cups up to the 1/3 mark with cold water.
3. Record the temperature of each cup.
4. Predict the equilibrium temperature when you mix the two cups using Eq. 3
5. Mix the water in the cups and record the temperature of the mix.

Unequal Mass (2/3 hot)

1. Fill two of your cups up to the 1/3 mark with hot water.
2. Fill the third cup up to the 1/3 mark with cold water.
3. Record the temperature of the cold cup and of one of the hot cups.
4. Predict the equilibrium temperature when you mix the three cups using Eq. 3
5. Mix the water in the three cups and record the temperature of the mix.

Unequal Mass (2/3 cold)

1. Fill one of your cups up to the 1/3 mark with hot water.
2. Fill two of your cups up to the 1/3 mark with cold water.
3. Record the temperature of the hot cup and of one of the cold cups.
4. Predict the equilibrium temperature when you mix the three cups using Eq. 3
5. Mix the water in the three cups and record the temperature of the mix.

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Data Collection

Equal Mass

T_H = Temperature of Hot cup = _____

T_C = Temperature of Cold cup = _____

$T_{predicted}$ = Predicted Equilibrium Temperature = _____

$T_{observed}$ = Observed Equilibrium Temperature = _____

Unequal Mass (2/3 hot)

T_H = Temperature of Hot cups = _____

T_C = Temperature of Cold cup = _____

$T_{predicted}$ = Predicted Equilibrium Temperature = _____

$T_{observed}$ = Observed Equilibrium Temperature = _____

Unequal Mass (2/3 cold)

T_H = Temperature of Hot cup = _____

T_C = Temperature of Cold cups = _____

$T_{predicted}$ = Predicted Equilibrium Temperature = _____

$T_{observed}$ = Observed Equilibrium Temperature = _____

Analysis

1. Complete the Lab 9 quiz on Canvas.