

JUSSSST RIGHT !!!!!

Santa is always in a hurry on X'mas Night. Wouldn't it be nice to leave him a recipe for hot cocoa that's not *toooo* hot and not *toooo* cool, but *jussst* right ! With a thermos of hot water, a thermos of cold water, a packet of cocoa mix, and a little mathematics you can do just that.

First we need to know the temperature of each liquid before they are mixed, the volume of our mug, and the final temperature our mixture should be. Using the variables defined below, we will be ready to apply our algebra skills to solve the problem.

V_1 = the volume of cool water V_2 = the volume of hot water
 T_1 = the temperature of the cool water T_2 = the temperature of the hot water
 T_m = the temperature of the mixture (Santa's treat!)

$$T_1 V_1 + T_2 V_2 = T_m (V_1 + V_2)$$

We will practice using this formula with an example. The data needed will be collected using the EA-100 and two temperature probes. You will record the temperature and volume of the water in two cups and then find the final temperature when the contents of the two cups are mixed.

Materials: 1 EA-100 Data Analyzer, 2 temperature probes, 1 graduated measuring cup with metric markings, hot and cold water, 2 large insulated cups.

Procedure:

1. Set your cups on pieces of paper labeled "1" and "2" respectively.
2. Plug one temperature probe into *channel 1* and the other temperature probe into *channel 2*. Push the red "ON" button on the Data Analyzer. If you do not see the word "multimeter" in the bottom left of the screen, push the **MODE** button until it appears. The words "sampling" and "done" should be flashing on your screen.
3. Fill cup "1" with 150 mL of cool water. Fill cup "2" with 100 mL of hot water. (Do not put ice in the cool water cup.)
4. Put the probe plugged into *channel 1* into cup 1 and the probe plugged into *channel 2* into cup 2. Push the **CH-View** button **if** *channel 1* does not appear in the upper left hand corner. Wait 30 seconds, then push **TRIGGER** on the data analyzer and record the temperature reading in the window as T_1 . Push the **CH-View** button until *channel 2* appears in the upper left hand corner. Wait 10 seconds. Record this temperature reading as T_2 . Push **TRIGGER**.

5. Push **CH-View** until you once again see **CH1** in the upper left hand corner of the screen. Quickly remove the temperature probe from cup 2 and pour the contents of cup 2 into cup 1. When the reading stabilizes (fluctuations $\leq \pm 0.2^\circ\text{C}$), record the final temperature of the mixture as T_m .

Data Analysis:

1. Using the equation given in the introduction which relates the temperature and volume of mixed solutions and the data you just recorded, solve for the temperature of the mixture.

DATA TABLE

	TRIAL 1	TRIAL 2
V_1		
V_2		
T_1		
T_2		
T_m		

2. How does your calculated (theoretical) value compare to your experimental (actual) value? Explain any differences.

Application: (Now for Santa's recipe)

Santa's special mug holds 10 ounces of liquid. If the temperature of the cold water is 6°C and the hot water is 90°C , how many ounces of each should Santa mix for his cocoa to be 40°C (jussst right to gulp down in a hurry)?

Extensions:

- 1. A pharmacist wishes to make 1.5L of a 10% solution of boric acid by mixing 8% and 12% solutions. How much of each type of solution should be used?*
- 2. How much pure antifreeze must be added to 10L of a 40% solution of antifreeze to obtain a 60% solution?*
- 3. How much water must be evaporated from a 500 L tank of a 3% salt solution to obtain a 5% solution?*

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