Physics

Crazy Mixed Up Heat Lab

Purpose & Hypotheses

This lab investigates what happens when you mix hot things with cold things. Let's begin with a few predictions. Imagine a small cup of hot water at 60°C and a large pail of room-temperature water at 20°C. **Write down** answers to all of the following questions **before** beginning the lab:

A. Which do you think is hotter, the cup or the pail?

B. Which do you think has more internal KE?

C. Which would take longer to have its temperature drop by 10°C if they were both placed outside on a freezing cold day?

D. If you put the same amount of red-hot iron into the cup and the pail, which one would change temperature more, the cup or the pail?

Procedure

1. There are two containers of water at the front of the room. One of them holds hot water, and the other holds cold water. Fill one of your white cups about 3/4 full with **cold** water and then bring it back to your table. Make a small mark along the **inside** of your cup to record the water level.
2. Pour all of the water from the first cup into a second white cup. Mark the second cup as you did the first. Finally, pour the water into the third white cup and mark it as well. All three cups should now have marks that show nearly equal measures. **Write down** a reason why the three measures won't be exactly the same.
3. Fill one of the empty cups up to its mark with **hot** water from the container.
4. Measure and **record** the temperature of both cups of water.
5. **Write down** a prediction of the temperature of a mixture of the two cups of water.
6. Pour the two cups of water into the big red cup, stir the mixture with the thermometer, and **record** its temperature. After recording its temperature, discard the mixture into the sink.
7. If there was any difference between your prediction and the recorded temperature, **write down** a possible reason for the difference.
8. Now fill one cup to its mark with **cold** water and two cups up to their mark with **hot** water.
9. Measure and **record** the temperature of all three cups of water. **Don't** rely on your previous measurements!
10. Again, **write down** a prediction of the temperature of a mixture of all three cups of water.
11. Pour all three cups of water into the big red cup, stir the mixture with the thermometer, and **record** its temperature. After recording its temperature, discard the mixture into the sink.
12. Which experienced more of a temperature change when it became part of the mixture, the cold water or the hot water?

13. Repeat **Steps 8-12**, but this time use two cups of **cold** water and one cup of **hot** water. Don't forget to **record** your predictions, your temperature measurements, and your answer to the question in **Step 12**.
14. Go to the front of the room and ask Mr. Schneider for a test object. Place your test object into one of your white cups, and then weigh them together on one of the scales. **Record** the weight of the cup and test object.
15. Use a scale to weigh out roughly the same mass of **cold** water in a second cup. There's no need to spend a long time to be overly precise! Just try to get within a gram or so.
16. Make sure the string attached to your test object hangs over the edge of the cup so that you'll be able to pull the object out of the cup. Fill the cup containing the test object up to its mark with **hot** water and bring it back to your table, along with the cup containing the **cold** water you measured out. Let your object sit in its cup for about two minutes while you **write down** whether you think your test object and the water it's submerged in are approaching the same temperature.
17. Measure and **record** both the temperature of the **cold** water and the temperature of the **hot** water in which your test object is submerged.
18. **Write down** a prediction of the temperature of the mixture if you moved the **hot** test object to the other cup, submerging it in the same mass of **cold** water.
19. Lift the **hot** test object by its string, and quickly (but without splashing) submerge it in the **cold** water. When the temperature of the mixture stops rising, **record** it.
20. Which experienced more of a temperature change when it became part of the mixture, the cold water or the hot object?

Analysis & Conclusions

When equal masses of water at different temperatures are combined, how does the temperature of the mixture compare to the temperatures of the hot and cold water? Even when you combine more than two cups at different temperatures, the temperature of the mixture can still be predicted using a simple formula – what is it? In contrast, when equal masses of water and some other substance are combined, the temperature of the mixture may surprise you. What does this say about water's ability to store heat without changing its temperature by much, at least in comparison to your test object? Remember that for any mixture, the heat lost by the hot part should be equal to the heat gained by the cold part.