Inquiry-Based Activity 2: Hot Pot

Student Name _____

The following experiment is going to simulate cooking on a stove. One pot with water will be heated on a hot plate while a second pot, also with water, will sit on the lab bench. You will be comparing the temperatures of each of the pots at the marked locations and record them in the table provided. Following the experiment, there will be a series of questions to answer about what was observed in the experiment.

***Materials**:*

2 Covers for the pots
1 Hot plate
1 Infrared thermometer
1 Timer or stopwatch
Either
3 computer-enabled thermocouples, and a computer with data-logging software
or
at least 2 thermocouples or thermometers

Safety:

In this laboratory you will be boiling water and several objects can get extremely hot and will have the potential of burning you. Carefully follow the instructions and only touch objects where and when you are instructed to do so.

***Directions**:*

1. You are going to be heating the water until it is boiling, in a pot with a metal handle. When the water is boiling, do you believe the handle will be at a high enough temperature to burn you? Why or why not?

2. When your group is finished answering the first part, put one pot of water on the hot plate. Set the second pot on the lab bench to the side of the hot plate.
3. Place a lid on each of the pots. Position the lid so that half of the holes on the side of the lid are visible at the sides as shown in the picture on the following page.

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4. Measure the initial temperatures for both pots at the marked locations and record these values in the table on the next page (if using an computer data logger, you need not record the temperatures by hand).
5. Turn it on to the highest setting and start the timer or stopwatch.
6. After each minute, take measurements of the temperature at the marked locations for the pot on the hot plate. Record the temperatures in the table on the next page. Take periodic measurements on the counter-top pot, as shown in the table.
7. Once the water starts to boil, turn the setting down to half of the maximum power. The goal is to maintain the boiling water at a low but constant rate of evaporation.
8. Continue taking measurements while the pot is boiling until temperatures measured at each location remain constant.
9. **Do NOT actually do this, but think about the situation.** While the pot on the hot plate is boiling at steady-state, would you consider putting your hand in the water? Would you consider touching the hot plate? What about the handle in the marked spot?

10. The OSHA standard for a stovetop burn is about 120°F (50°C). Could the marked spot on the handle burn you?

11. If your measurements indicate that the handle is safe to touch, if someone is comfortable doing so, have him or her pick up the pot in the appropriate spot. Did that person get burned?

12. Turn off the hot plate and save your data if you are using the computer.

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Table 1: Temperature Data

	Hot Plate Pot			Lab Bench Pot		
Time (min)	Location 1	Location 2	Location 3	Location 1	Location 2	Location 3
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Analysis *– to do after class/lab and hand in:*

1. What did you see in this experiment and how does your observation compare with your prediction? If what was observed contrasts your prediction, explain what happened and why. Discuss this with your group before answering.
2. For the pot on the hot plate, plot the temperature at a given location as a function of time. What happens to the temperature?
3. For the pot on the lab bench, plot the temperature at a given location as a function of time. What happens to the temperature?
4. For each of the pots consider the temperature profile at points 1-3. How do the temperatures compare throughout?
5. Using your answer from the previous question, which pot was at steady state but not equilibrium? Which pot came to thermal equilibrium?

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6. Using the terms unsteady state, steady state, and equilibrium, which one applies to each of the following situations and why:
    a. A pot just filled with room temperature water is heated by an open flame for a few minutes and does not come to a boil. (system: water in pot)
    b. A heat exchanger continuously cools styrene monomer from 150°C to 60°C using 20°C water. (system: styrene monomer flowing through exchanger)
    c. A distillation column continuously separating a 50:50 mixture of ethanol and water to 80% by mole of ethanol in the distillate. (system: mixture in column)
    d. A single tray of a distillation column performing the same separation mentioned in part c. (system: vapor and liquid mixing on the tray)
    e. A turkey that has been in the oven at the 250°C for 12 hours. (system: turkey)
    f. A piece of road is heated by the sun on a hot summer day (system: road surface over the course of the day)
7. Determine if the following situations would burn you if you grabbed the handle of the hot pot at point 3:
    a. The temperature of the pot is in equilibrium with the air.
    b. The temperature of the pot is in equilibrium with the hot plate.
    c. The temperature of the pot is at steady state with the heat transferred from the hot plate.
8. Please visit the website link provided by your professor to answer a few questions about this activity. Don't forget to include your name / identifying number.

Important Notes:

- You should discuss your answers with at least 2 other students and agree on what happened and why.

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