22. Keeping Warm

Are some materials better-suited for warm clothing than other materials?

Materials

- ☐ Data collection system
- ☐ Temperature sensor
- ☐ Cup with hot water
- ☐ Cup with cold water
- ☐ Tape (optional)
- ☐ Rubber band (optional)
- ☐ Test tubes (2)
- ☐ Test tube rack
- ☐ Hot water to fill test tubes (~500 mL)
- ☐ Funnel
- ☐ Insulating clothing materials such as cotton,
- ☐ Polartec®, and wool
- ☐ Paper towels (2-3)

Safety

Always follow your teacher's directions when doing any activity.

Investigation

After you complete a step or answer a question, place a check mark in the box (☐) next to that step.

When you see the symbol "[2]" with a superscripted number following a step, refer to the numbered Tech Tips listed in the Tech Tips appendix that corresponds to your PASCO data collection system. There you will find detailed technical instructions for performing that step.

Get Started

Clothing designers are always trying to invent new materials to protect us from the cold. You will test some of these materials to see how well they work.

1. ☐ Carefully observe the materials and items of clothing your teacher has shown you. Discuss among your group which of these items are made from natural fibers, and which are made from synthetic fibers.

   Classify the clothing or fabric samples into two groups according to whether their fibers are natural or synthetic.

2. ☐ Predict which of the fabric or clothing items will be best at keeping a test tube of hot water from losing heat. Be prepared to explain your thinking.

_____

Let's Explore

In this part of the activity you will use the temperature sensor to measure the temperature of the air in the room, the temperature of cold water from the faucet, and the temperature of hot water from the faucet.

3. ☐ Start a new experiment on the data collection system. (1.2)

4. ☐ Connect a temperature sensor to the data collection system. (2.1)

5. ☐ Display your data in a graph display with Temperature on the *y*-axis and Time on the *x*-axis (7.1.1)

6. ☐ Start data recording. (6.2)

7. ☐ Hold the temperature sensor in the air to measure the air temperature. Continue recording until the temperature reading stabilizes.

8. ☐ Stop data recording. (6.2) Write the air temperature in data Table 1 below.

➢ Table 1: Temperature data

Sample Tested	Temperature (°C)
Air in the classroom	
Cold water	
Hot water	

9. ☐ Get a cup of cold water from the sink or faucet.

10. ☐ Place the temperature sensor into the cup of cold water.

11. ☐ Start data recording. (6.2)

12. ☐ Continue recording until the temperature reading stabilizes.

13. ☐ Stop data recording. (6.2) Write the cold water temperature in data Table 1 above.

14. ☐ Get a cup of hot water from the sink or faucet.

15. ☐ Place the temperature sensor into the cup of hot water.

16. ☐ Start data recording. (6.2)

17. ☐ Continue recording until the temperature reading stabilizes.

18. ☐ Stop data recording. (6.2) Write the hot temperature in data Table 1 above. Set aside your cup of hot water for the next part of the activity.

19. ☐ Examine the temperature data in Table 1. What is the difference in temperature between the cold water and the air temperature in the room?

_____

What is the difference in temperature between the cold water and the hot water?

_____

_____

Explain It

What happens to your hot water as time goes by? Does the paper cup keep the water hot or does the water lose some of its heat to the air around it? What does this tell us about the cup's ability to insulate against heat loss?

20. ☐ Place the temperature sensor back into your cup of hot water.

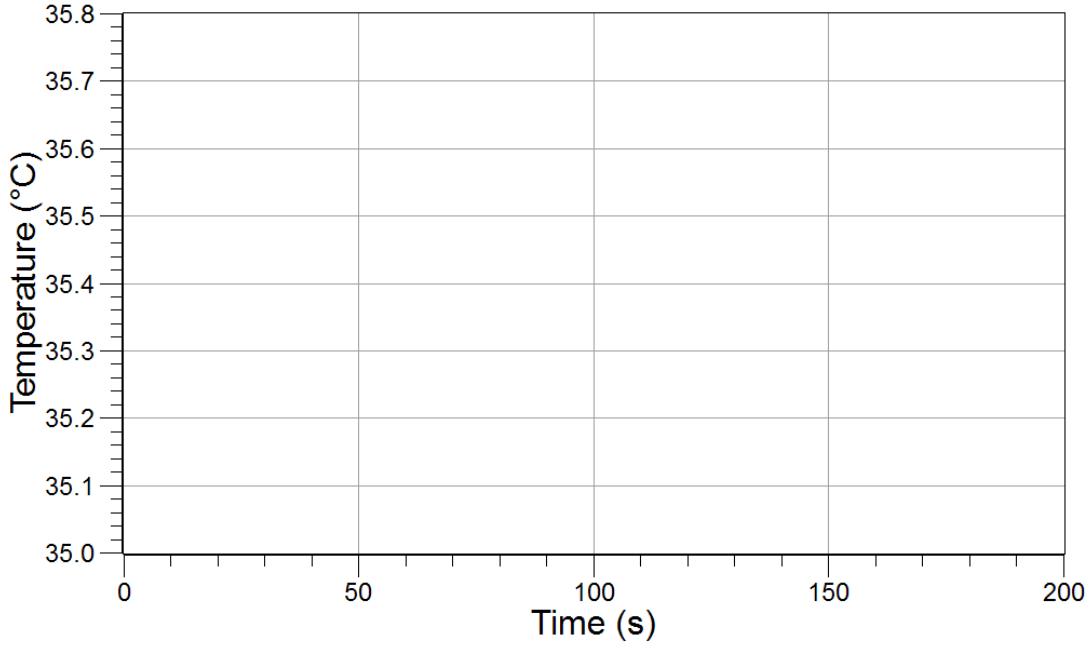
21. ☐ You may choose to hide the data you have already recorded. (7.1.7)

22. ☐ Begin data recording. (6.2)

23. ☐ Continue recording temperature data for five minutes. You may want to adjust the scale of your graph as you record this data so you can more clearly see any change in temperature. (7.1.2)

24. ☐ After five minutes, stop data recording. (6.2)

25. ☐ Examine your temperature data. Did the temperature of the hot water change during the five minutes? If so, by how many degrees did it change?



26. ☐ Look back at your temperature data from the Table 1 in the "Let's Explore" section. How much did the temperature of the hot water in the cup change from when you first measured it until you stopped recording data at the end of the five minutes?

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_____

27. ☐ Has the cup insulated the hot water or allowed some heat to flow into the surrounding air? Use evidence from your data and observations to support your statement.

_____

_____

Tell Me More

In this part of the activity you will design a covering for a test tube that will insulate the hot water inside the tube. You will try to minimize the heat loss from the insulated test tube, so that the water in the tube stays as warm as possible for three minutes. Later, you will compare your results with those of other groups in class.

Your control will be a non-insulated test tube of the same type that is filled with the same volume of hot water as your insulated test tube.

28. ☐ Fill one of your test tubes to the top with hot water from the faucet. Use a funnel if necessary. If any water spilled on the outside of the tube, be sure to dry it.

29. ☐ Place the temperature sensor into the middle of the test tube. Keep the tip away from the sides of the tube. This test tube is the control.

30. ☐ Begin data recording. ◆(6.2)

31. ☐ Continue recording temperature data for three minutes. Observe the graph as the water cools. You may want to adjust the scale of your graph as you record this data so you can more clearly see any change in temperature. ◆(7.1.2)

32. ☐ After three minutes, stop data recording. ◆(6.2)

33. ☐ Discuss with the members of your group which type of material you think will make the best choice for insulation.

34. ☐ After deciding which material your group will use to insulate the test tube, describe the material and write an explanation for why you chose this particular material.

_____

_____

35. ☐ Figure out how you will cover the test tube with the insulation. Depending on your materials, you may need to use tape or a rubber band to hold the insulation in place. You will need to be able to cover the test tube first, and then fill it with hot water.

36. ☐ Insulate the test tube and fill it to the top with hot water, using the funnel if necessary.

37. ☐ Place the temperature sensor into the middle of the tube. Keep the tip away from the sides of the test tube.

38. ☐ Begin data recording. ◆(6.2)

39. ☐ Continue recording temperature data for three minutes. Observe the graph as the water cools. You may want to adjust the scale of your graph as you record this data so you can more clearly see any change in temperature. ◆(7.1.7)

40. ☐ After three minutes, stop data recording. ◆(6.2)

41. ☐ Save your experiment. ◆(11.1)

42. ☐ As you have been investigating what makes some clothing warmer than others you have been learning some new scientific ideas. These ideas have their own terms. In science it is important to be able to discuss your results using these words and terms correctly.

    Write the meaning of the following terms in your own words using what you have learned from the activity.

Temperature sensor	
Insulate	
Heat	
Natural fiber	
Man-made fiber	
Control	
Variable	

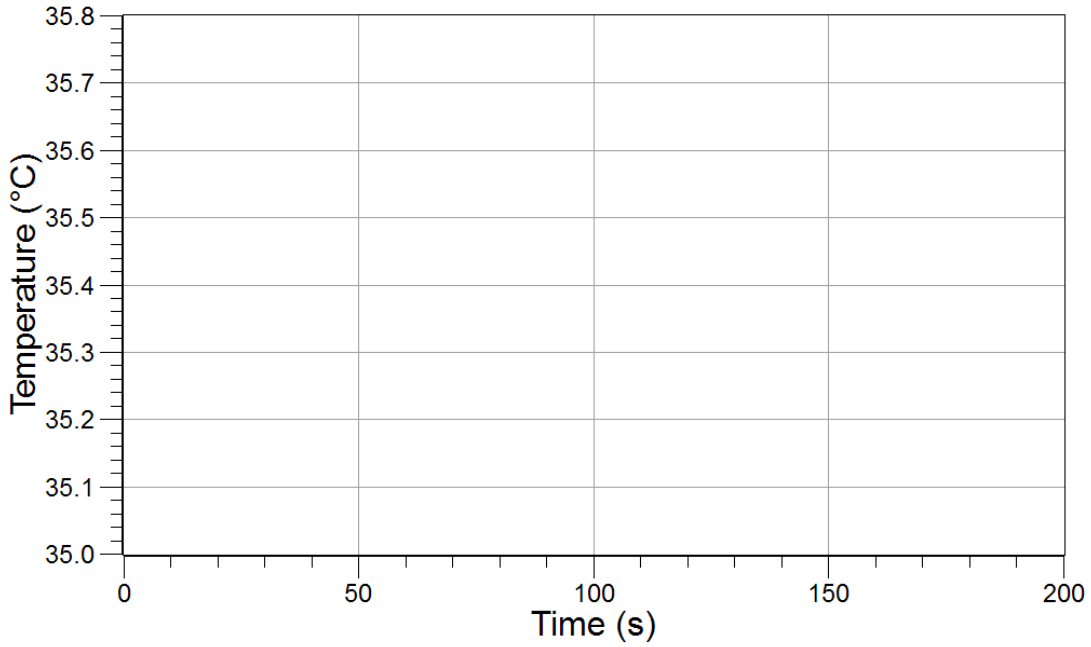
43. ☐ Illustrate two terms of your choice in the spaces below.

➢ Word: _____.

➢ Word: _____.

Sum It Up

44. ☐ Review your temperature data for the two test tubes. How much did the temperature change in the control (non-insulated) test tube?



45. ☐ How much did the temperature change in the insulated test tube?

46. ☐ Check the results of other groups in your class. For the insulated test tube what was the biggest change in temperature measured in the class?

What material or fabric did this group use to insulate their test tube?

47. ☐ After comparing the results of all the groups for the temperature changes in the insulated test tubes, discuss in your own group how the prediction you made in the Get Started section compares to your experimental results. Summarize your discussion

_____

_____

If you want to dress to be outdoors in a very cold climate and need your clothing to prevent heat being transferred away from your body, which of the materials tested in your class would you want your clothing to be made of?

_____

48. ☐ The air in the room is cooler than the hot water in your test tube. What will eventually happen to the temperature of the hot water if it is allowed to sit out in the room until tomorrow? If you measured the air temperature and the temperature of the water in your test tube tomorrow, what would you expect to find?

_____

_____

49. ☐ Why is some clothing warmer than others?

_____

_____

Assessment

Multiple Choice

Darken the circle of the best answer to each of the questions below. Be prepared to give the reasons for your choices.

1. When a material has a lower temperature after five minutes than it had at the start, it

   Ⓐ Has lost heat

   Ⓑ Is well insulated

   Ⓒ Has gained heat

2. A material that is a good insulator

   Ⓐ Allows heat to flow through it easily

   Ⓑ Prevents heat from flowing through it easily

   Ⓒ Is also a good conductor of heat

3. The following pairs of beginning and ending temperatures were taken in three different containers of hot water. Which pair of temperatures shows that the container was insulated?

   Ⓐ Beginning temperature: 36 °C, ending temperature: 29 °C

   Ⓑ Beginning temperature: 32 °C, ending temperature: 29 °C

   Ⓒ Beginning temperature: 32 °C, ending temperature: 31 °C

True or False

Enter a "T" if the statement is true or an "F" if it is false.

_____1. Some materials are better than others at allowing heat to flow through them.

_____2. All materials used for warm clothing are made of natural fibers