16. Temperature and Change

What effect does temperature have on the time it takes a change to occur?

Materials

Let's Explore

- ☐ Data collection system
- ☐ Temperature sensor
- ☐ Beaker, 250-mL
- ☐ Stir rod
- ☐ Tape
- ☐ Sugar cube (3)
- ☐ Water, room temperature, 200 mL
- ☐ Water, cold, 200 mL
- ☐ Water, hot, 200 mL

Tell Me More

- ☐ Data collection system
- ☐ Temperature sensor
- ☐ Beaker (2), 250-mL
- ☐ Beaker, 600-mL
- ☐ Stir rod
- ☐ Tape
- ☐ Antacid tablet piece (3), ~ 0.5 g
- ☐ Vinegar, room temperature, 200 mL
- ☐ Vinegar, hot, 100 mL
- ☐ Ice, 300 mL
- ☐ Water, ~100 mL

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 "$^{\diamond}$" 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

In this section you will brainstorm what you know already know about dissolving one substance in another.

1. ☐ List four materials that dissolve in water.

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_____

2. ☐ List four materials that do not dissolve in water.

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_____

3. ☐ Describe how a material changes when it dissolves in water.

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4. ☐ Suggest a method for determining how long it takes a material to dissolve.

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5. ☐ Discuss with your group members whether it possible to change the amount of time it takes a material to dissolve.

Let's Explore

In this part of the activity you will use your data collection system to time how long it takes a sugar cube to dissolve in cold water, room temperature water, and hot water.

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

7. ☐ Connect a temperature sensor to your data collection system. (2.1)

8. ☐ Create a graph of Temperature (°C) on the *y*-axis versus Time (s) on the *x*-axis. (7.1.1)

9. ☐ Fill a 250-mL beaker with 200 mL of cold water.

10. ☐ Place the temperature sensor in the beaker so that the tip of the sensor is at the bottom of the beaker.

    Note: If necessary, tape the sensor in place so that it does not come out of the beaker.

11. ☐ Place the sugar cube in the water and immediately start recording data. ◆ (6.2)

12. ☐ Constantly stir the sugar cube and the water until all of the sugar has dissolved.

13. ☐ When all of the sugar has dissolved, stop recording data. ◆ (6.2)

14. ☐ How did you decide when all of the sugar had dissolved?

_____

_____

15. ☐ Use the graph on your data collection system to determine how long it took for the sugar cube to dissolve and the temperature of the water. Record these values in Table 1. (9.1)

➢ Table 1: Time and temperature data collected while dissolving sugar cubes in water

Water	Temperature (°C)	Time to Dissolve (s)
Cold water		
Room temperature water		
Hot water		

16. ☐ Clean and dry your beaker according to your teacher's instructions.

17. ☐ Do you think a sugar cube will take the same amount of time, less time, or more time to dissolve in room temperature water?

_____

_____

18. ☐ Repeat the steps above this time using room temperature water. Collect this run of data on the same graph as the cold water.

19. ☐ Fill in the data you collected with room temperature water in Table 1 above.

20. ☐ Was your prediction correct? Explain.

_____

_____

_____

21. ☐ How much time do you think it will take the sugar cube to dissolve in hot water? Explain your thinking.

_____

_____

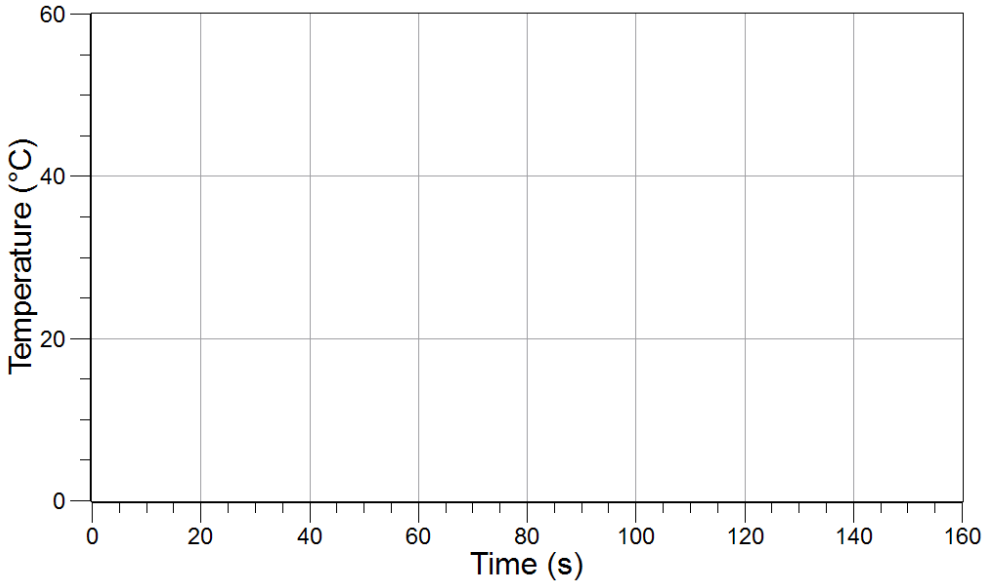
_____

22. ☐ Repeat the steps above this time using hot water. Collect this run of data on the same graph as the cold water and room temperature water.

23. ☐ Fill in the data you collected with hot water in Table 1 above.

24. ☐ Sketch a graph of the Temperature (°C) versus Time (s) data you collected on the axes below. Include all three runs of data.

Time of Dissolving for a Sugar Cube in Different Temperatures of Water



Explain It

In this section you will explain the meaning of the data you collected when dissolving a sugar cube in different temperature water.

25. ☐ What temperature of water dissolved the sugar cube the fastest? How do you know?

26. ☐ What temperature of water dissolved the sugar cube the most slowly? How do you know?

27. ☐ Describe the overall effect that temperature had on the time it took a sugar cube to dissolve in water.

28. ☐ What was the independent variable in this experiment? How do you know?

29. ☐ What was the dependent variable in this experiment? How do you know?

30. ☐ What variables were controlled?

31. ☐ Is dissolving a sugar cube in water a physical change or a chemical reaction? How do you know?

32. ☐ How do you think temperature will affect the time it takes a chemical reaction to occur? Why?

33. ☐ As you have been investigating the effect temperature has on the time it takes a change to occur 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.

➢ Vocabulary and definitions

Temperature	
Temperature sensor	
Dissolve	
Physical change	
React	
Chemical reaction	
Independent variable	
Dependent variable	
Controlled variable	

Tell Me More

In this part of the activity you will use your data collection system to time how long it takes a antacid tablet to react with cold vinegar, room temperature vinegar, and hot vinegar.

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

35. ☐ Connect a temperature sensor to your data collection system.◆(2.1)

36. ☐ Create a graph of Temperature (˚C) on the *y*-axis versus Time (s) on the *x*-axis. ◆(7.1.1)

37. ☐ Create an ice-bath:

    a. Fill a 600-mL beaker halfway full with ice.

    b. Add ~100 mL of water to the ice in the 600-mL beaker.

38. ☐ Fill a 250-mL beaker with 100 mL of room temperature vinegar and label this beaker "cold vinegar".

39. ☐ Carefully place the "cold vinegar" beaker into the ice-bath.

40. ☐ Set the ice-bath with the "cold vinegar" beaker of in it aside to allow the vinegar to become cold.

41. ☐ Fill a second 250-mL beaker with 100 mL of room temperature vinegar and label this beaker "room temperature vinegar".

42. ☐ Place the temperature sensor in the "room temperature vinegar" beaker so that the tip of the sensor is at the bottom of the beaker.

    Note: If necessary, tape the sensor in place so that it does not come out of the beaker.

43. ☐ Place one piece of the antacid tablet in the "room temperature vinegar" beaker and immediately start recording data. ◆ (6.2)

44. ☐ Observe the antacid reacting with the vinegar for one minute (60 seconds).

45. ☐ After one minute, constantly stir the antacid and the vinegar until all of the antacid has reacted.

46. ☐ When the antacid tablet piece has completely reacted with the vinegar, stop recording data. ◆ (6.2)

47. ☐ How did you decide when the antacid had completely reacted?

_____

_____

48. ☐ Using the graph on your data collection system, determine how long it took for the antacid tablet piece to react with the vinegar and the exact temperature of the vinegar. Record these values in the room temperature row of Table 2. ◆ (9.1)

➢ Table 2: Time and temperature data collected while reacting antacid with vinegar

Vinegar	Temperature (°C)	Time to Dissolve (s)
Cold vinegar		
Room temperature vinegar		
Hot vinegar		

49. ☐ Clean and dry your beaker according to your teacher's instructions.

50. ☐ Do you think a piece of an antacid tablet will take the same amount of time, less time, or more time to dissolve in hot vinegar?

_____

_____

51. ☐ Repeat the steps above this time using hot water.

- Collect this run of data on the same graph as the room temperature vinegar.
- Observe the reaction for the first minute (60 seconds) and then stir constantly.

52. ☐ Fill in the data you collected with hot vinegar in Table 2 above.

53. ☐ Was your prediction correct? Explain.

_____

_____

54. ☐ How much time do you think it will take the antacid tablet piece to react in cold vinegar? Explain your thinking.

_____

_____

_____

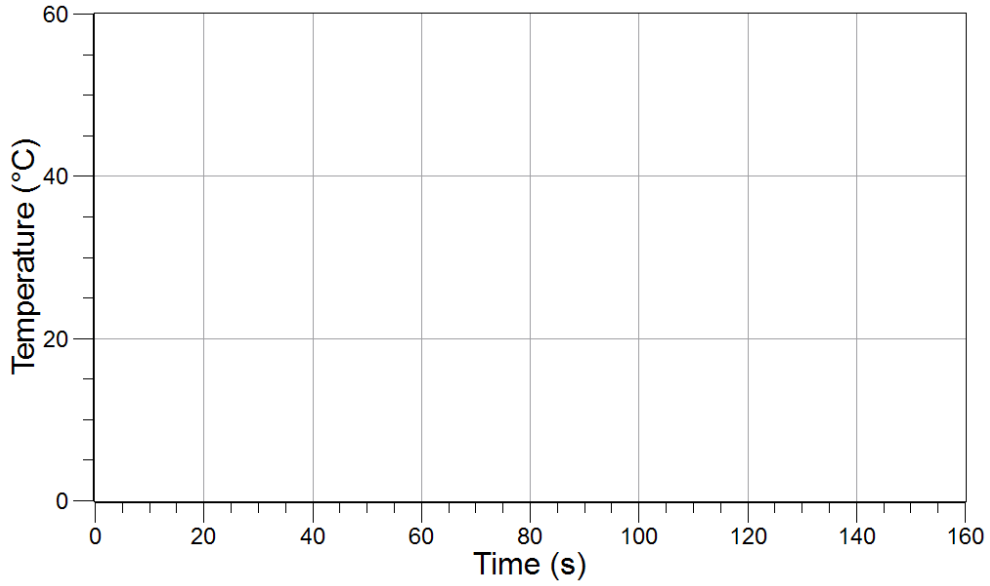
55. ☐ Repeat the steps above this time using vinegar in the beaker that has been cooling in the ice-bath labeled "cold vinegar".

- Keep the beaker of "cold vinegar" in the ice-bath throughout the reaction so that the vinegar stays cold.
- Collect this run of data on the same graph as the room temperature vinegar.
- Observe the reaction for the first minute (60 seconds) and then stir constantly.

56. ☐ Fill in the data you collected with cold water in Table 2 above.

57. ☐ Sketch a graph of the Temperature (˚C) versus Time (s) data you collected on the axes below. Include all three runs of data.

Reaction Time for an Antacid Tablet Piece in Different Temperatures of Vinegar



Sum It Up

Summarize what you have learned through this activity by answering the following questions.

58. ☐ What temperature vinegar reacted with the antacid the fastest? How do you know?

59. ☐ Describe the overall effect that temperature had on the time it took the antacid to react with the vinegar.

60. ☐ What were the independent, dependent, and controlled variables in the experiment we did to determine the effect of temperature on the time it took for antacid to react with vinegar?

➢ Table 3: Variables in the Antacid and Vinegar Experiment

Independent Variable	Dependent Variable	Controlled Variables

62. ☐ What effect does temperature have on the time it takes for changes to occur? Is it different for physical changes and chemical reactions?

Assessment

True or False

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

_____1. Temperature will affect how quickly salt dissolves in water.

_____2. A chemical reaction cannot be speeded up by increasing the temperature.

_____3. Dissolving sugar in water is a chemical reaction.

_____4. Sugar will dissolve more quickly in a cold glass of lemonade than in a hot cup of tea.

_____5. A nail will rust more quickly in hot weather th