# 26. Dew and Frost

## Under what conditions will dew and frost form?

## Materials

- ☐ Data collection system
- ☐ Fast response temperature sensor
- ☐ Weather sensor
- ☐ Beaker, 250-mL
- ☐ Stirring stick or spoon
- ☐ Crushed ice, 180 mL
- ☐ Water, distilled, 125 mL
- ☐ Salt, 20 mL
- ☐ Rubber band

## 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 "◆" 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

1. ☐ In this activity, you will use a data collection system including an electronic temperature sensor to measure changing air temperatures and investigate the weather conditions required for dew and frost to form. A temperature sensor is a kind of thermometer.

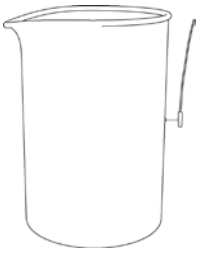
2. ☐ In addition to the data collection system and temperature sensor, you will need to get a 250-mL beaker, about 125 mL (4 oz.) of distilled water, 180 mL (6 oz.) crushed ice, about 20 mL (3 tsp.) of salt, a spoon and a rubber band from your teacher.

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

4. ☐ Connect a temperature sensor. ◆(2.1)

5. ☐ Display temperature in a digits display. ◆(7.3.1)

6. ☐ Hold the temperature sensor approximately 1 cm from the outside of the beaker.

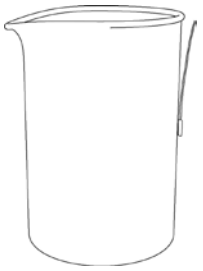


7. ☐ Measure the air temperature by recording a run of data. ◆(6.2)

8. ☐ When the temperature stops changing, record the temperature in the top row of Table 1 below.

9. ☐ Delete the previous run of data. ◆(8.1)

10. ☐ Hold the temperature sensor against the outside of the beaker. Measure the outside surface temperature by recording a run of data. ◆(6.2) When the temperature stops changing, record the outside surface temperature of the beaker in Table 1 below.



11. ☐ Delete the previous run of data. ◆(8.1)

Table 1: Air temperature and the temperature of the outside surface of a beaker

| Measurement | Temperature (°C) |
|---|---|
| Air temperature 1 cm away from the beaker | |
| Outside surface of the beaker | |

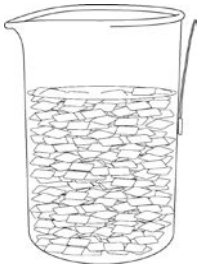
12. ☐ What do you notice about the air temperature and the temperature of the outside surface of the beaker?

_____

_____

13. ☐ Set up to display data in a graph. ◆(7.1.1)

14. ☐ Fill the beaker ¾ full with crushed ice and then add 125 ml of distilled water. Wipe the outside of the beaker with a paper towel to remove any moisture that has started to form.



15. ☐ Place the temperature sensor against the outside of the beaker and use a rubber band to hold it in place.

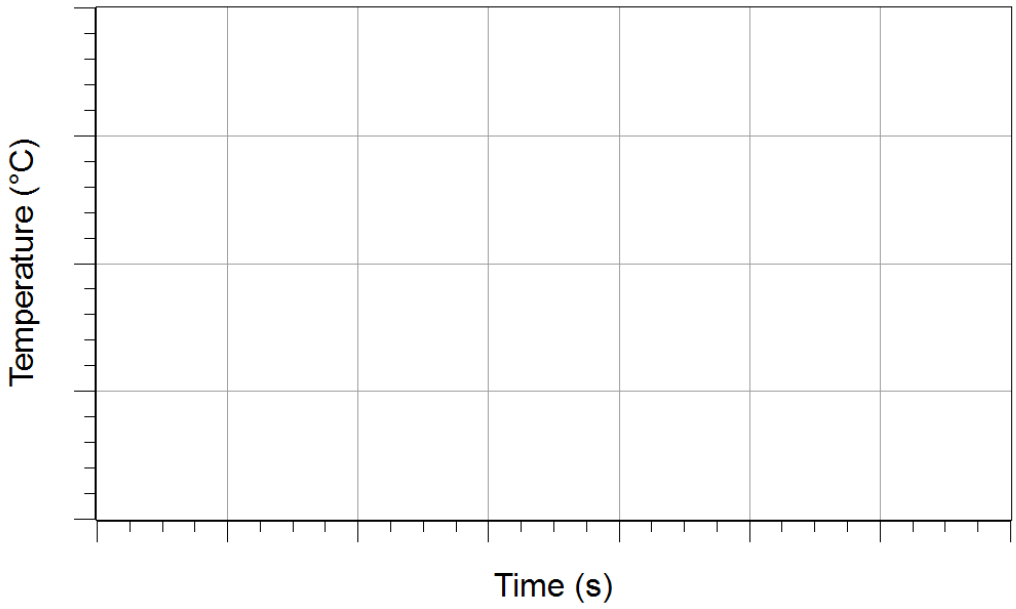
16. ☐ Record a run of data ◆(6.2) and stir the ice water while continuing to record data until water droplets begin to form on the outside of the beaker.

17. ☐ Stop recording data. ◆ (6.2)

18. ☐ Adjust the scale of the graph to be able to properly view the data. ◆(7.1.2)

19. ☐ Save the graph ◆(7.1.2) and name it "Temperature Graph of Dew Forming".

20. ☐ Sketch the graph below.




21. ☐ Label on the graph the point at which you first observed moisture forming on the outside of the beaker.

22. ☐ Delete the previous run of data. ◆(8.1)

23. ☐ Where did the water come from that formed water droplets on the outside surface of the beaker?

_____

_____

24. ☐ Why were there no water droplets forming on the outside of the beaker before water and ice were added to the bottle?

_____

_____

25. ☐ Consider the "Temperature Graph of Dew Forming." What weather conditions were necessary for "dew" to form on the outside of the beaker? Explain.

_____

_____

26. ☐ Delete the previous run of data. ◆(8.1)

Let's Explore

27. ☐ Why is salt sprinkled on icy sidewalks to help clear the sidewalk? What does the addition of salt do to the water?

_____

_____

_____

_____

28. ☐ We want to get frost to form on the beaker, not dew. What will have to be true for the temperature of the surface for frost to form?

_____

_____

29. ☐ Predict what the temperature of the beaker's surface will be in order for frost to form.

_____

_____

30. ☐ Explain why the addition of salt to the beaker of water will help the water cool to your predicted temperature.

_____

_____

31. ☐ Add 3 tablespoons of salt to the beaker containing ice and distilled water.

32. ☐ Stir the beaker vigorously for 10 seconds to help the salt dissolve.

33. ☐ Add more ice to replace any that may have melted. Dry the outside of the beaker with a paper towel.

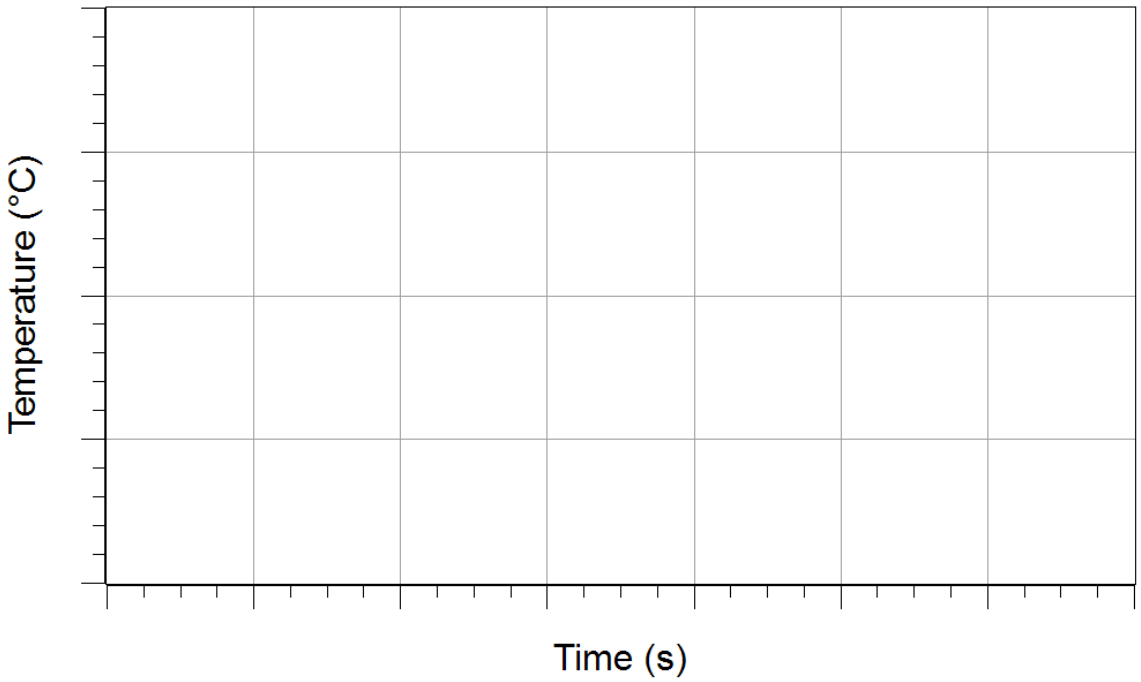
34. ☐ Ensure that the temperature sensor is still held in place with the rubber band to the outside surface of the beaker.

35. ☐ Start recording data (6.2) while stirring constantly and continue recording until frost begins to form on the outside of the beaker.

36. ☐ Scratch lightly with your fingernail on the outside of the beaker to tell exactly when the "frost" has formed.

37. ☐ Stop recording data. (6.2) Adjust the scale of the graph to be able to properly view the data. (7.1.2)

38. ☐ Save the graph ⁽⁷.¹.²⁾ and name it "Temperature Graph of Frost Forming".




39. ☐ Carefully observe the temperature at which frost begins to form on the outside of the beaker and label it on the graph. How does this compare to your prediction? Explain.

_____

_____

40. ☐ Delete the previous run of data. ⁽⁸.¹⁾

## Explain It

41. ☐ What weather conditions have to exist for dew and frost to form?

42. ☐ At what temperature does frost form?

43. ☐ In our model, what parts of the Earth and the environment might the surface of the beaker represent?

44. ☐ If the cold beaker is a model of the Earth's surface where dew and frost can form, what is missing to make it a better model? How can this model be improved?

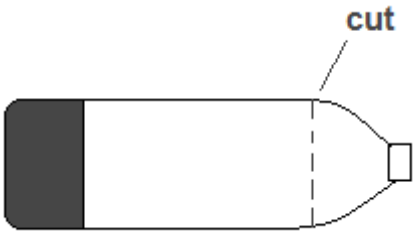
45. ☐ In your investigation of the formation of dew and frost you learned some new scientific ideas and terms. It is important to be able to discuss your results using these words and terms correctly.

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

| | |
|---|---|
| Condensation | |
| Dew | |
| Dew point | |
| Evaporation | |
| Frost | |
| Temperature | |
| Humidity: | |
| Relative humidity | |
| Precipitation | |

## Tell Me More

46. ☐ We will improve our model to better show how dew and frost form on surfaces by including living and non-living materials found on the Earth's surface. You will need a 2-liter plastic soda bottle.




47. ☐ Draw a line around the bottle with a permanent marker where the curve of the bottle meets the straight sides and use a pair of sharp scissors to cut the top part off of the plastic soda bottle. Retain the lid and set the top aside.

48. ☐ Prepare a soil mixture of potting soil and soil amendments. Fill the bottom of the soda bottle terrarium to a depth of 10 cm with the soil mixture and gently tamp it down.

49. ☐ Plant three small plants of the same type in the soil mixture in the bottom of the bottle and carefully add 100 ml of warm water to the soil.

➢ Top turned upside down and taped to the bottom of the bottle

50. ☐ Using sharp scissors, poke a hole in the soda bottle cap just large enough for the temperature sensor to fit through. Turn the top part of the soda bottle upside down and tape it inside the bottom part of the bottle so the cap is pointing towards the soil.

**Note:** Make sure the top of the bottle is sealed to the bottom of the bottle with tape all the way around.

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

52. ☐ Connect a temperature sensor. (2.1)

53. ☐ Display temperature in a digits display. (7.3.1)

54. ☐ Place the temperature sensor inside the bottle through the opening in the cap to measure the air temperature inside the bottle, and record a run of data. (6.2)

**Note:** Make sure the sensor does not touch the sides or the soil.

55. ☐ When the temperature stops changing, record the air temperature inside of the soda bottle in Table 2 below.

56. ☐ Delete the previous run of data. (8.1)

57. ☐ Place the temperature sensor through the opening of the bottle cap and touch it to the surface of the soil.

58. ☐ Measure the temperature of the surface of the soil by recording a run of data. (6.3)

**Note:** Make sure the sensor stays in contact with the surface of the soil the entire time.

59. ☐ When the temperature stops changing, record the temperature of the surface of the soil in Table 2 below.

60. ☐ Delete the previous run of data. (8.1)

➢ Table 2: Air and Soil Surface Temperatures in ºC

| Measurement | Temperature (°C) |
|---|---|
| Air temperature inside the bottle | |
| Soil surface temperature | |

61. ☐ Allow the temperature sensor to rest on the top surface of the soil mixture.

62. ☐ Fill a gallon-sized plastic re-sealable bag with chips of dry ice.

63. ☐ Place the soda bottle model on top of the bag with the dry ice pieces wrapped around the bottom and sides of the soil area of the bottle.

64. ☐ Record a run of data. (6.2)

65. ☐ Continue recording until dew forms on the surface of the soil, the sides of the bottle or the leaves of the plants. Record the temperature for the dew formation in Table 3 below.

66. ☐ Raise the temperature sensor up off the soil and record the temperature of the air. Record this in Table 3. Delete the previous run of data. (8.1)

67. ☐ Record a run of data (6.2) and continue recording until the "dew" begins to change into frost on the surface of the soil, the sides of the bottle or the leaves of the plants.

68. ☐ Record the temperature at which dew becomes frost in Table 3 below.

Table 3: Temperature when dew and frost form

| Measurement | Temperature (°C) |
|---|---|
| Temperature of the soil when dew forms | |
| Temperature of the air after dew formed | |
| Temperature of the soil when frost forms | |

69. ☐ Delete the previous run of data. ◆(8.1)

## Sum It Up

70. ☐ Where did the water come from that formed dew and frost on the surface of the soil, the sides of the bottle or the leaves of the plants?

_____

_____

71. ☐ What caused the water vapor in the air to form dew and then frost on the surfaces of the living and non-living parts of the soda bottle model?

_____

_____

72. ☐ How is the formation of dew and frost on the beaker similar to the formation of dew and frost in the terrarium?

_____

_____

73. ☐ What is different about the formation of dew and frost in the terrarium compared to the beaker?

_____

## 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. For dew to form, the surface temperature of the Earth must be cooler than the air above it and there must be

   Ⓐ no water vapor in the air

   Ⓑ a river or an ocean nearby

   Ⓒ water vapor in the air

   Ⓓ rain falling

2. For frost to form, the surface temperature of the soil must be

   Ⓐ above 0º C

   Ⓑ at or below 0º C

   Ⓒ 100 0º C

   Ⓓ warmer than the temperature of the air above the surface

## True or False

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

_____1. Humidity and temperature are the two most important variables for precipitation to form.

_____2. Dew and frost are a form of precipitation.

_____3. The independent variable in this experiment is the temperature of the water.

## Key Term Challenge

**Fill in the blanks from the list of randomly ordered.**

| | | | |
|---|---|---|---|
| precipitation | evaporation | condensation | humidity |
| dew | dew point | frost | temperature |

1. The temperature at which dew will form is called the _____ _____.

2. The process that causes water to lose energy as it forms a liquid on surfaces is called _____.

3. A measure of the amount of water vapor in the air is called_____.

4. _____ forms when condensation happens at the freezing point of water.

5. Water vapor gets into the air through the process of_____.