ScienceNews

Activity Guide for Students: What's that Smell?

Directions:

During the activity, you will work with a partner or small group to determine what factors affect the intensity of a scent and a person's perception of it. You and your partner(s) will record the scents that you each smell from different samples, first at room temperature (or "cold") and then after warming in a water bath. You will compare your results with each other and with your class, so it is important that you record your own observations before discussing them with your partner(s).

Notes on safety

Because this activity involves laboratory equipment and chemicals, it is also important that you wear lab safety gear (goggles and gloves) and that you follow your teacher's additional instructions. Your teacher will show you the method for wafting scents from a sample toward yourself. This is the method that scientists use so they aren't overwhelmed by powerful scents and don't expose themselves to corrosive or toxic chemicals. While the chemicals you are using in this activity are commonly found as additives for flavor and odor in foods, cosmetics and other products and are therefore relatively safe in small amounts, you should not be directly touching, tasting or smelling laboratory chemicals. The chemicals used in this experiment are:

Methyl salicylate — a chemical commonly used to treat minor aches and pains and as a flavoring agent. According to the Material Safety Data Sheet for methyl salicylate, exposure to a solution greater than 99% in concentration may cause eye or skin irritation, respiratory tract irritation if inhaled and can cause nausea and vomiting if swallowed. The boiling point for methyl salicylate is 222° Celsius at 760 mm Hg.

Ethyl cinnamate — a chemical commonly used as a flavoring agent in foods and in air care products. According to the MSDS for ethyl cinnamate, it may cause eye or skin irritation and respiratory tract irritation if inhaled. The boiling point for ethyl cinnamate is 271° C at 760 mm Hg.

Hexyl hexanoate — a chemical commonly used as a flavoring agent in foods and in air care products. According to the MSDS for hexyl hexanoate, it may cause mild skin irritation. The boiling point for hexyl hexanoate is 246° C at 760 mm Hg.

Benzyl salicylate — a chemical commonly used in soaps and cosmetics as a fragrance, as well as sunscreens and deodorants. According to the MSDS for benzyl salicylate, exposure to a solution greater than 98% in concentration may cause eye or skin irritation, respiratory tract irritation if inhaled and can cause nausea and vomiting if swallowed. The boiling point for benzyl salicylate is 320° C at 760 mm Hg.

If at any time during the activity you feel light-headed, nauseous or dizzy, tell your partner(s), put the test tube you are holding in the rack and go with your partner to sit in a well-ventilated area. Partner(s) should be sure to turn off the hot plate and notify the teacher immediately.

Do not pour chemicals down the drain, as this can contaminate animal habitats. Follow your teacher's instructions on disposing of chemicals when the activity is completed.

Part 1: Experiment

Preparing the equipment

Your teacher will assign your partner(s) and station. Each station will be equipped with a thermometer, test tube rack, test tubes, beakers, warm water bath (or hot plate and boiling stones for creating your own) and a permanent marker. Your teacher will provide the samples and room temperature water.

To prepare your laboratory equipment for the activity, use the permanent marker to label your test tubes 1 through 4 and place them in your test tube rack. Your teacher will come to your station and add 1 milliliter of each solution in separate test tubes (methyl salicylate in test tube 1, ethyl cinnamate in test tube 2, hexyl hexanoate in test tube 3 and benzyl salicylate in test tube 4) and then place a stopper on the top of each of the test tubes.

You will need to ensure that the contents of your test tubes are all the same temperature for your "cold" smell test. Your teacher will have a jug of room-temperature water for you to use. Fill one beaker with about 50 to 75 milliliters of water and place it on your station. Place the test tubes in the beaker with the thermometer and wait several minutes for the test tubes and samples to reach the same temperature before recording the thermometer reading.

Finally, to warm the test tubes for the warm smell test, you will need a water bath. A water bath helps distribute heat evenly to all the samples. To set up your water bath (if your teacher hasn't done it for you), add about 50 to 75 milliliters of water to a beaker and place three to four boiling chips into the beaker. Turn on the hot plate to a medium setting, and place the beaker on the hot plate. Monitor the temperature until it reaches about 60° to 70° Celsius, adjusting the hot plate temperature as needed. While this water is warming, complete the cold smell test portion of the experiment.

Cold smell test

Remove the stopper from each sample one at a time and, using the wafting technique your teacher showed you (holding test tubes 20 centimeters from your nose and waving the air above the test tube toward your nose four times), take turns with your partner(s) smelling the contents of each of the test tubes. After everyone on your team has smelled the contents of a test tube, place that test tube, without its stopper, in the warm water bath so that it will warm while you continue your experiment.

1. Create a data table and record your observations. Your data table should include the type of test (cold), the test tube number, the chemical name, what you smell (a description of the smell and a rating of its strength) and what your partner(s) smell (a description of the smell and its strength). Rate the strength of the smell on a scale from 0 to 5, where 0 is no smell, 3 is a medium smell and 5 is a very strong smell. Once you have recorded your data and that of your partner(s), share the data with your teacher.

2. What is the temperature of the "cold" water bath?

3. Did you and your partner(s) always describe the scents in the same way? Explain.

4. Could something affect the way the samples smell to you and your partner? What could that be?

5. Did you and your partner(s) ever use different words to describe the same smell?

6. Why do you think the words you chose to describe the scents might differ? Use an example from your table, discuss with your partner(s) and explain your reasoning.

Warm smell test

Move your thermometer to the water bath and leave it there while you complete the warm smell test. Using the same wafting technique used for the "cold" smell test, take turns with your partner(s) smelling the contents of each of the warmed test tubes.

7. Record your findings and those of your partner(s) in a data table. Your data table should include the type of test (warm), the test tube number, the chemical name, what you smell (a description of the smell and a rating of its strength) and what your partner(s) smell (a description of the smell and its strength). Rate the strength of the smell on a scale from 0 to 5, where 0 is no smell, 3 is a medium smell and 5 is a very strong smell. Once you have recorded your data and that of your partner(s), share the data with your teacher.

8. What is the temperature of the warm water bath?

9. Look at both of your tables. List all of the variables in this experiment.

Part 2: Data analysis and graphing

Review the class data, then answer the following questions.

10. For which of the cold test tubes did the class have the most different descriptions of smell? What were those descriptions?

11. For which of the cold test tubes did the class have the most similar descriptions for the smell? What were those descriptions?

12. Were there any cold test tubes where some members of the class were able to detect a scent while others were not?

13. Use graph paper, a computer or a calculator to create your own graph of the data from Parts 1 and 2 of your assessment of the strength of each sample's scent versus the temperature of the test tubes.

14. What trend do you see in the graph? How did heating the test tubes affect the scents?

15. Why do you think this occurred? What changed by heating the test tubes?

16. When the rate of evaporation/vaporization equals the rate of condensation of a liquid at a certain temperature in a closed container, the vapor pressure is defined as the pressure exerted by the gaseous molecules above the surface of the liquid. As the temperature of a liquid changes in a closed container, the number of gaseous molecules above the surface of the liquid changes, which in turn changes the vapor pressure.

The vapor pressures of three liquids at different temperatures are listed in the table below. Use graph paper, a computer or a calculator to graph the data from the table of the vapor pressure versus temperature.

	Vapor pressure (mm Hg)		
Temperature (degrees Celsius)	Water	Ethanol	Benzene
0	4.6	12.2	33.0
5	6.5	17.3	43.0
10	9.2	23.6	56.0
15	12.8	32.2	71.0
20	17.5	43.9	91.0
25	23.8	59.0	114.0
30	31.8	78.8	143.0
35	42.2	103.7	176.0
40	55.3	135.3	216.0
45	71.9	174.0	263.0
50	92.5	222.2	317.0
55	118.0	280.6	379.0
60	149.4	352.7	451.0
65	190.0	448.8	531.0
70	233.7	542.5	622.0
75	289.1	666.1	720.0
80	355.1	812.6	843.0
85	433.6	986.7	968.0
90	525.8	1187.0	1122.0

95	633.9	1420.0	1270.0
100	760.0	1693.3	1463.0

17. What trend do you see in the graph of vapor pressures?

18. Does this trend make sense to you? Why or why not?

19. Is the trend in this graph consistent with the data from your experiment? Explain your reasoning.

20. Based on what you have learned about vapor pressure, why was it important to leave the stoppers off the test tubes when you were warming them?

Part 3: Article-based questions

Now, read the *Science News* article "People who lack olfactory bulbs shouldn't be able to smell. But some women can" and answer the following questions.

21. According to the article, how are scents detected?

22. What is the function of the nose in this process? Is it just a tube that funnels scents directly to the brain, or does it serve another function?

23. Does what you found in your experiment support this explanation for how smell works? Why or why not?

24. How does the research in this article challenge this understanding of how people detect scents?

25. How do researchers hope this research will be helpful to people?

26. Why is a sense of smell important? Think of ways that people use scents every day.

27. Based on your experience with your experiment, what advice might you give to the scientists in the article to help them reduce the variables in their experiment?