ScienceNews

Answer Key for Teachers: What's that Smell?

Activity questions

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.

Sample student data table:

Cold test tubes		*What I smell*		*What my partner(s) smell*	
Test tube #	*Chemical name*	*Smell description*	*Strength of the smell (0–5)*	*Smell description*	*Strength of the smell (0–5)*
1	*Methyl salicylate*	*minty*	*4*	*toothpaste*	*4*
2	*Ethyl cinnamate*	*spicy*	*3*	*plums*	*2*
3	*Hexyl hexanoate*	*fruity*	*3*	*fruit*	*4*
4	*Benzyl salicylate*	*flowers*	*1*	*no smell*	*0*

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

The temperature of the "cold" water bath is 20° Celsius.

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

No, sometimes we did, but sometimes we did not.

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

My partner and I have different noses, so maybe that affects the way things smell to us. Also, if we had a cold or an allergy, that could affect our ability to smell because our noses would be stuffed up.

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

Yes, we used different words to describe the smell of methyl salicylate.

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.

My partner uses mint-flavored toothpaste, so the smell of mint makes my partner think of toothpaste. We don't use mint toothpaste in my house, so mint scents don't make me think of toothpaste. This is why my partner described methyl salicylate as toothpaste, but I did not.

Also, we eat a lot of spicy food in my family, so I am used to smelling spices. My partner does not eat spicy foods so may not know how to describe the spicy smell of ethyl cinnamate and may have used the closest smell she could think of, which was plums.

Warm smell test

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.

Sample student data table:

Warmed test tubes		*What I smell*		*What my partner(s) smell*	
Test tube #	*Chemical name*	*Smell description*	*Strength of the smell (0–5)*	*Smell description*	*Strength of the smell (0–5)*
1	*Methyl salicylate*	*minty*	*5*	*toothpaste*	*5*
2	*Ethyl cinnamate*	*spicy*	*3*	*plums*	*3*
3	*Hexyl hexanoate*	*fruity*	*5*	*fruit*	*5*
4	*Benzyl salicylate*	*flowers*	*2*	*musky*	*2*

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

The temperature of the warm water bath is 60° Celsius.

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

The variables in this experiment are the temperatures of the test tubes, the difference between me and my partners' noses and differing experiences and vocabulary that affect how we describe scents.

Part 2: Data analysis and graphing

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

The test tube of ethyl cinnamate had the most different descriptions. It was described as fruity, fruit, plums, spicy, spices, berries, raspberries, sweet and powdery.

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

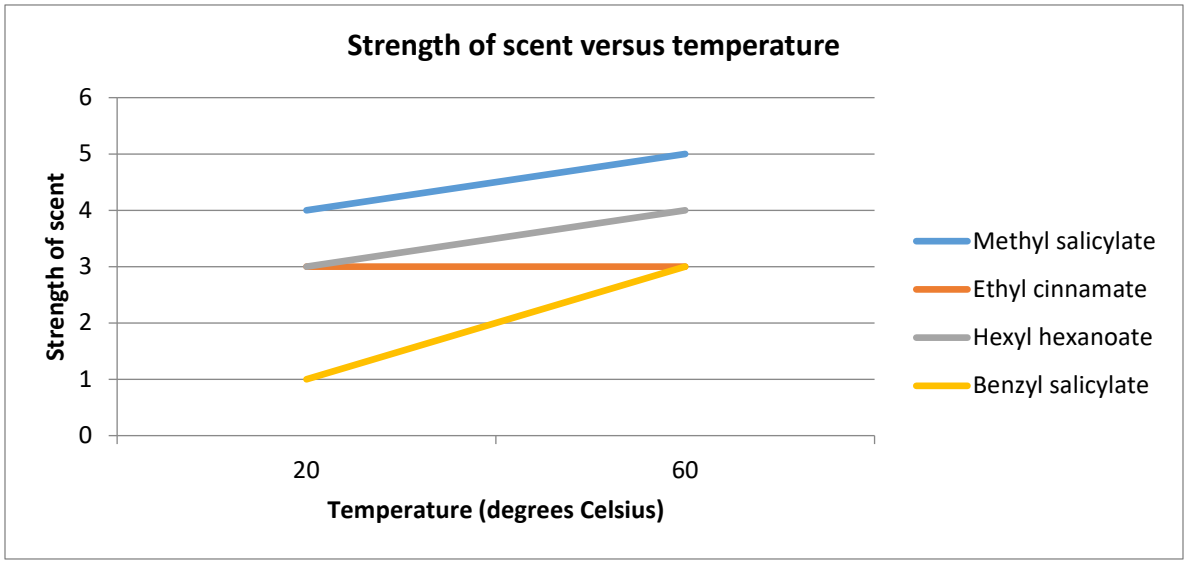
The entire class agreed that the test tube containing methyl salicylate smelled like mint, but we used different words for mint including "minty," "toothpaste," "gum" and "spearmint."

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

Many people in the class couldn't smell the benzyl salicylate when it was cold. Also, one student (who has a cold) couldn't smell any of the samples except for the methyl salicylate.

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.

Sample student graph:



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

The trend of the lines is a positive slope for all of the samples except ethyl cinnamate, which stayed the same. Heating the test tubes made many of the scents stronger.

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

Heating the test tubes caused more of the solutions to evaporate. This increased the concentration of gaseous molecules of the samples in the air, which increased our ability to smell the odors.

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,

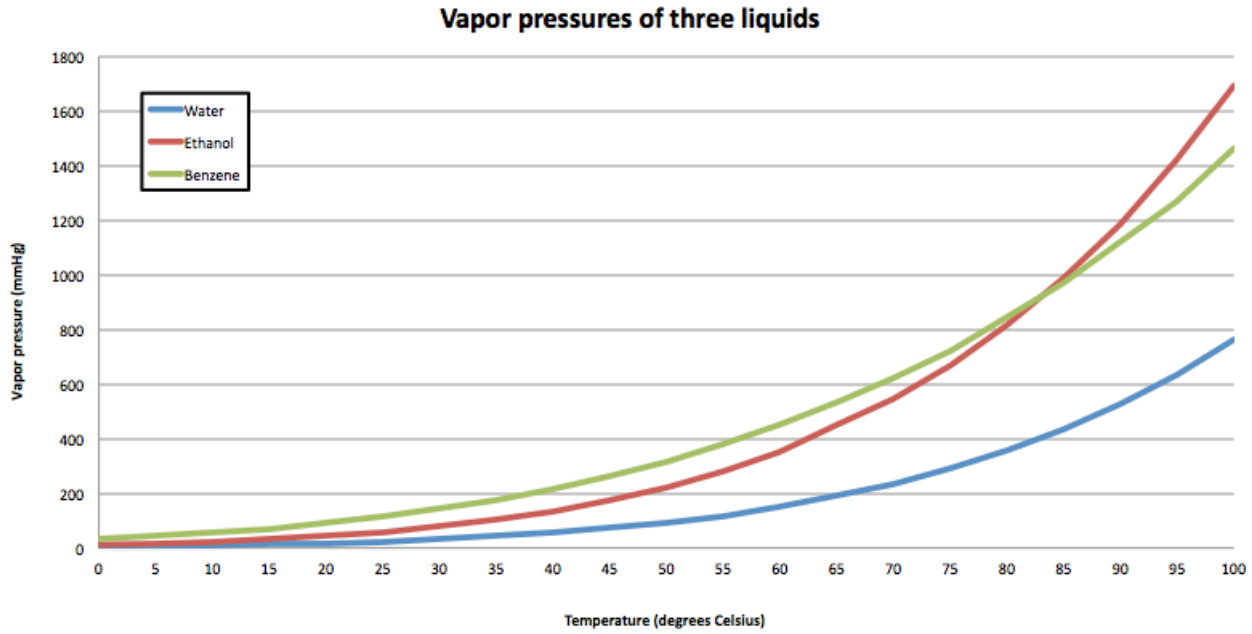
the number of gaseous molecules above the surface of the liquid changes, which in turn changes the vapor pressure.

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

Sample student graph:



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

The vapor pressures increase as the temperature increases.

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

Yes, it makes sense because more gaseous molecules will exist above the surface of the liquid the warmer the liquid is.

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

Yes, the trend is consistent with the data from my experiment. The warmer a liquid is, the more gaseous molecules of the sample there are in the air above the liquid. This is why the scents were stronger when the temperature of the test tubes was increased.

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?

As the test tubes got warmer, more gaseous molecules would go into the space above the liquid in each test tube, increasing the pressure. If the stoppers had been on the test tubes, the pressure inside the test tubes might have broken the test tubes or launched the stoppers into the air.

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?

The article says that there are structures in the brain called olfactory bulbs. Each bulb is made up of about 5,500 nerve clusters that receive signals about scents from the nose and relay them to other parts of the brain to be interpreted.

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?

The nose does not just funnel scents directly to the brain. There are sensory cells in the nose, and these detect the scents. Then signals about the detections are sent to the olfactory bulbs in the brain.

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

My experiment supports this explanation. The sensory cells in the nose pick up the gaseous molecules from the sample, and the more molecules that are sensed, the stronger the smell. Since heat increases the number of gaseous molecules above the surface of a liquid, there were more molecules in the air above the warm samples, so the cells in my nose sensed more molecules for the warm samples and sent stronger signals to my brain, which told me the smell was stronger.

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

There are two women in the article who do not have the olfactory bulb structures in their brains, but the women are still able to detect scents.

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

The scientists are hoping that they will be able to determine how the women are able to smell, and then use that knowledge to help other people with smell disorders.

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

Smell is important for safety. Smell can tell us when food is ready to eat or when it has spoiled. Smells can also tell us when something is burning or toxic and so alert us to danger.

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?

I would suggest providing a list of words for participants to choose from in describing scents. This would ensure that the descriptive words are all the same, and that smells aren't categorized as different when they are really just different words for the same smell, like how we used many different words for "mint" when describing methyl salicylate.