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Chemistry 2, Lesson 6

Vapor Pressure Lowering

Understand What Vapor Pressure Is

Watch the "Vapor Pressure" YouTube video:
https://www.youtube.com/watch?v=re9r0kzQp_M
Take notes in your Note-Taking Guide as you watch the video.

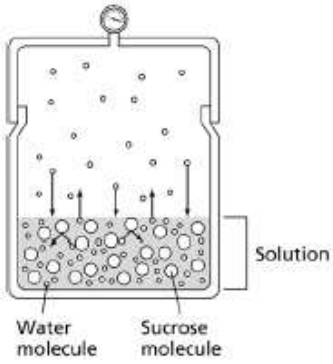
- When boiling water in a closed container is given time, the area above the water becomes filled with water vapor.
- Water vapor may return to water.
- When the amount of water leaving the body and returning to the body is equal, equilibrium may be said to be established.
  - The pressure at this equilibrium is called vapor pressure.

Read and Answer Questions About Vapor Pressure Lowering

APPLYING PRACTICES

Vapor Pressure Lowering

You have learned that *vapor pressure* is the pressure exerted by a vapor over a liquid in a closed container. The types of molecules that make up a liquid determine its vapor pressure. If the intermolecular forces (electrical forces) between molecules are strong, the vapor pressure is low. If the forces are weak, the pressure is higher. When a non-volatile solute (for example, sucrose) is added to a solvent (for example, water), the vapor pressure above the resulting solution (the vapor pressure of the solvent) is lower than the vapor pressure above the solvent alone. The vapor pressure changes as the solution concentration changes. A non-volatile solute is a solute that does not vaporize and therefore does not have its own vapor pressure.



1. What happens to the vapor pressure of water as the concentration of sucrose increases?

   As the concentration of sucrose increases, the vapor pressure of water lowers.

2. Why do the sucrose molecules in the solution lower the vapor pressure of the water?

   "When a non-volatile solute (for example, sucrose) is added to a solvent (for example, water), the vapor pressure above the resulting solution (the vapor pressure of the solvent) is lower than the vapor pressure above the solvent alone."

3. What happens to the vapor pressure when the temperature of the solution increases? Explain why this happens.

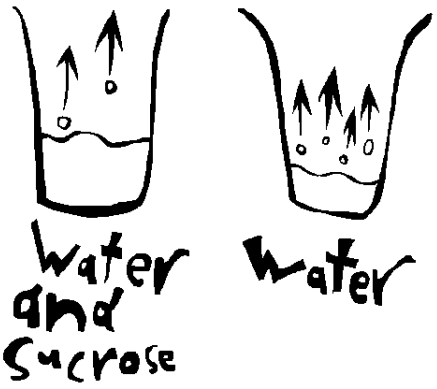
When the temperature of the solution increases, the vapor pressure increases, as a result of an increase in evaporation of the solvent.

4. Explain what will happen when the temperature at which the vapor pressure of the liquid equals the atmospheric pressure.

This is not semantically correct enough English for me to be sure of the question being asked, however I may assume. When the vapor pressure equals the atmospheric pressure, the temperature imposed by the vapor pressure will be the same as the vapor pressure imposed by the atmospheric pressure.

5. Suppose that you have a second container with an equal amount of water but no sucrose. Which will boil first, the water or the water-sucrose solution? Explain your answer by drawing a model at the macroscopic scale (similar to the drawing on the first page) that illustrates the motion and relative position of the particles.

The water alone will boil first, due to having a lower boiling point.



6. Would you expect the water vapor in the container to behave according to the ideal gas law? Explain your answer.

Not totally, due to not being a non-existent ideal gas.

Research Vapor Pressure in a Real-Life Context

Because you will be investigating how vapor pressure is used in pressure cooking, presentation of your findings should be details and include visuals, like drawings, images, and/or videos. As you research, be sure to use information only from trusted sources, such as government organizations, universities, and acceptable news sources. Additionally, take care to only use information that you understand and that is completely clear to you. Start your research by reviewing the sources listed below. Note that these sources are only suggestions, and you are encouraged to find others.

Pressure Cooking – Exploratorium.edu:
https://www.exploratorium.edu/food/pressure-cooking

How Pressure Cookers Actually Work:
https://www.seriouseats.com/how-pressure-cookers-work

How Pressure Cookers Actually Work
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The pressure cookers of today are built for safety and e ciency. First-generation pressure cookers are simple, and allow for a singular pressure. Second-generation pressure cookers allow two or more pressures, and feature general improvments to operational noisiness. Third-generation pressure cookers are totally electrical in heat generation, allow running via a timer, and feature cuisine-specific pressure settings. Water is boiled in a sealed chamber, and the resulting steam is trapped in the container, increasing pressure and in doing so increasing heat. Pressure cooking is ruled by the ideal gas law. As pressure in the sealed chamber increases, the boiling point of the water within increases. This allows the higher heating of food without burning it. The pressure built inside a pressure cooker is supplementary to atmospheric pressure. Should atmospheric pressure be lower than expected, temperature and therefore cooking time will be alternate.

Pressure Cooking
https://www.exploratorium.edu/food/pressure-cooking
A pressure cooker's internal space is increased in pressure by increases in evaporated water, that which becomes trapped water vapor. That increase in pressure induces an increase in temperature, that which provides an increase in cooking speed. The pressure within a pressure cooker may reach approximately 2 atm, twice the usual atmospheric pressure. "Water in liquid form cannot be a higher temperature than its boiling point." Increasing the boiling point of water allows the liquid water to be at a higher temperature, and so allows food to be cooked at a higher temperature.

How Do Pressure Cookers Work?
https://www.thespruceeats.com/how-do-pressure-cookers-work-1328706
"steam pressure cooking [is]faster than baking, steaming, or boiling." Water is a good conductor of heat, whereas air is more accurately an insulant. When a gas can not increase in volume, it must increase in pressure. How Pressure Cookers Work
https://modernistcuisine.com/mc/how-pressure-cookers-work/
In a pressure cooker, "Risotto takes six minutes instead of 25." A pressure cooker is largely a sealed pot and a valve that controls internal pressure. Temperature within can reach 120°C, while retaining a moist environment. A seal is maintained usually by a rubber gasket.

Share Your Findings

Now that you understand how vapor pressure works and is used in a real-life context, choose one of the following ways to share your findings:

- Option A:

  Write a two-paragraph summary in your own words. Your summary should include a description of what vapor pressure is and how it works, along with a review of how pressure cookers use vapor pressure.
- Option B:

  Make a drawing of how vapor pressure works and what vapor pressure looks like when operating a pressure cooker.

Option A

When water boils, particles of water become gaseous, generally described as water vapor. That water vapor may eventually settle, and return to liquid water. In a closed space, boiled water may leave and join a body of water, until an equilibrium of water becoming gaseous and vapor becoming liquid is met. The pressure induced by this equilibrium is called vapor pressure; vapor pressure is the pressure caused by an equilibrium of evaporating and settling water vapor. This pressure is supplementary to atmospheric pressure.

Devices with varyling levels of control of vapor pressure are common-place in many kitchens, under the name “pressure cooker.” In basic, a simple pressure cooker consists of a sealable pot and a valve that controls pressure within the pot. Water is boiled within the pot, steam is trapped, and the trapped steam increases the interal pressure. The increased pressure induces both higher temperature and higher boiling point. Each of these allow for cooking moist food at temperatures otherwise impractical, that which allows for much quicker cooking speed. In particular, a Risotto that otherwise takes twenty-five minutes to cook may take six when pressure cooked. Due to pressure cookers working supplementarity to atmospheric pressure, areas with particularly low atmospheric pressure, usually those with high elevations, feature higher boiling points, resulting in lesser maximum temperatures for a pressure cooker.