Vapor Pressure Lab

Vapor pressure of a liquid is the pressure the vapor exerts at the surface of the liquid. It's measure of how readily the liquid's molecules escape from the surface. In this lab we will seek to determine the vapor pressure over water at various temperatures and compare these findings to the published vapor pressures located in Appendix B of your textbook.

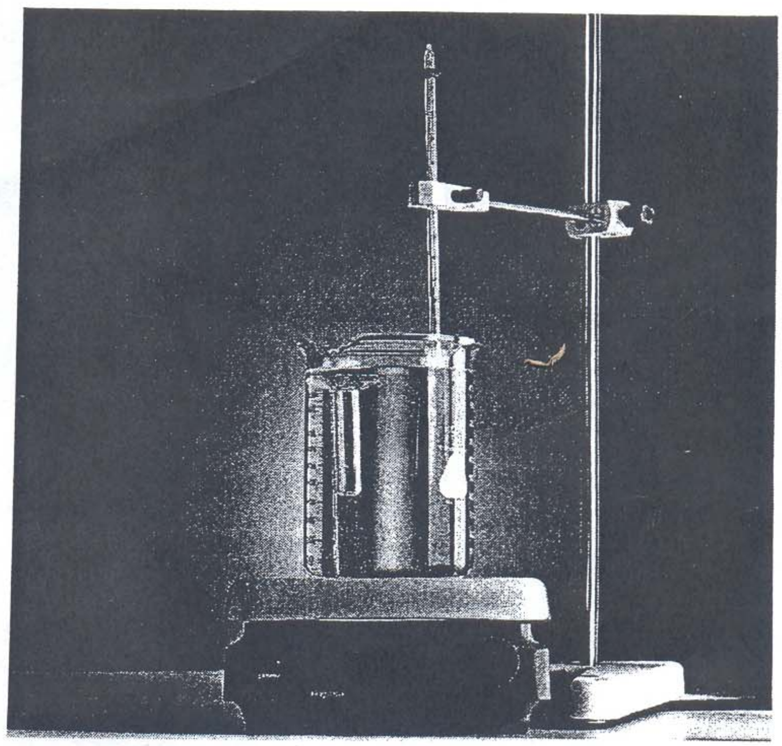
Chemicals and Equipment

- De-ionized water
- 1-liter beaker
- 10-ml graduated cylinder
- Ring stand with clamps
- Hotplate

Procedure

1.) Fill the graduated cylinder with 6mL of de-ionized water and close the top with your finger. Invert the cylinder in the beaker, which should have enough water to cover the cylinder.

2.) Place a thermometer in the beaker and record the temperature, initial volume of air in the cylinder and the distance from the top of the water in the cylinder and the top of the water in the beaker. Place the beaker on the hot plate and increase the temperature to 70° C. Record the volume of air in the cylinder.



3.) Allow the water to cool and record the volume of air at 5° C intervals. An ice bath may be used to speed the cooling process. Take a minimum of 10 readings including one at 0° C. (Some sodium chloride can be added to the ice bath to lower the temperature)

4) Record and draw a graph plotting air volume vs. temperature for all data.

Lab Report and Discussion

On A separate sheet of paper perform the following calculations. Enter the data into the Excel calculation sheet for this lab and compare your values to the stated values in Appendix B of your textbook.

** Examples of how to perform the calculations are included in the directions for each part below.

1.) Explain why the volume of air, and therefore the vapor pressure, increases with temperature.
(Adding energy (heat) increases the energy of the molecules and therefore the speed at which the move around the solution. Because they are moving faster, more molecules will be able to break through the surface of the solution and into the air space.)

2.) Calculate the total pressure in the cylinder using the distance h, between the water in the cylinder and the water in the beaker, to correct for the weight of the water:

$$P_{cyl.} = P_{atm.} + h(\text{mm } H_2O) \times \frac{1 \text{ mm Hg}}{13.6 \text{ mm } H_2O}$$

mm Hg

where $P_{atm.}$ Is the atmospheric pressure and $P_{cyl.}$ is the pressure in the cylinder in mm Hg.
(If $P_{atm.}$ Is 745mmHg and h = 50mm H_2O, then $P_{cyl.}$ Is 749mm Hg.)

3.) Calculate the number of moles of trapped air at 0 ° C using the Ideal Gas Equation. Assume that the vapor pressure of water is negligible at this temperature.

$$n_{air} = \frac{P_{cyl.} V_{cyl.}}{RT}$$

where n_{air} is moles of trapped air, R is the gas constant(8.314J/mol K) and T is the temperature in ° K.

(If the volume of air is 5mL, then the moles of trapped air is 2.18×10^{-4} moles. Note: convert R to mmHg, which is 62.4mm Hg)

4.) Calculate the partial pressure of the air in the cylinder for each temperature reading:

$$P_{air} = \frac{n_{air}RT}{V_{cyl}}$$

↓ 62.4 mm Hg ↙ Kelvin ↑ in Liters @ each Temp.

(Partial pressure of the air in the cylinder at 70° C is 631mm Hg)

5.) Calculate the vapor pressure of water at each temperature:

$$P_{water} = P_{cyl} - P_{air}$$

(Vapor pressure of water at 70° C is 118mm Hg)

Name ___________________________________ **Vapor Pressure Lab**

Lab Data Sheet

Initial Temperature of Water: _______________

Initial Volume of air in test tube: ______________

Distance between top of water in test Tube and top of Water in Beaker (mm) ______

Vapor Pressure of De-ionized Water

Temperature	#2) Volume of Air in Cylinder
70	
65	
60	
55	
50	
45	
40	
35	
30	
25	
20	
15	
10	
5	