HUMIDITY

Name_____

Lab Partner_____

Section_____

Introduction

Humidity refers to the amount of moisture or water vapor in the air. The air in our environment is rarely ever dry. The amount of moisture present varies from essentially zero to about 4% by volume.

Moisture present can be expressed in terms of vapor pressure. The vapour pressure represents that amount of the total pressure that results from the water vapour in the air. For example if the normal air pressure is 1000 mb (millibars) and the vapor pressure is 20 mb the 2% of the air molecules are water vapour. **The actual vapour pressure (or actual humidity, AH)** is related to the amount of water vapour actually present in the air.

The relative humidity is defined as the ratio of the vapor pressure (actual humidity) to the maximum possible vapor pressure (Saturation vapour pressure or Saturation Humidity):

$$RH = \frac{\text{VaporPressure}}{\text{Saturation VaporPressure}} \qquad (1)$$

where RH = relative humidity at a given temperature, the vapour pressure and saturation vapour pressure can be found from the dew-point temperature and air temperature respectively.

$$\begin{aligned} \text{VaporPressure} &\leftrightarrow \text{Dew Point Temperature} \\ \text{Saturation VaporPressure} &\leftrightarrow \text{Air Temperature} \end{aligned} \qquad (2)$$

Relative humidity can be expressed either as a fraction or as a percentage. The fraction can be converted to a percentage by multiplying the fraction by 100:

$$RH = \frac{\text{VaporPressure}}{\text{Saturation VaporPressure}} \times 100\%$$

The actual vapor pressure of an air sample can be determined if the dew point is known. The dew point of the air refers to the temperature at which the air becomes saturated and dew begins to form on nearby surfaces. At the dew point temperature the rate of condensation for water vapor just exceeds the evaporation rate and dew forms on surfaces. The dew point temperature is directly related to the actual humidity. Moist air has a relatively high dew point temperature and very dry air has a relatively low dew point temperature.

The relative humidity really depends on two things: 1) how moist the air actually is and 2) the air temperature. The air temperature is what determines the maximum possible vapour pressure or the saturation humidity.

Table 1 or the graph on the last page can be used to determine either:

1) the **dew point temperature** given **the actual humidity** (or visa versa)

2) the **saturation humidity** of the air given the **room temperature** (or visa versa)

For example: Refer to Table 1.

If the dew point temperature is 6 °C then the actual humidity is 9.0 mb.

If the room temperature is 22 °C, then the saturation humidity is 23.3 mb (SH).

Thus, the relative humidity is

$$RH = \frac{9.0}{23.2} \times 100\% = 39\%$$

Warm up Questions:

Using Table 1 Find:

1. The dew point if Vapor Pressure=12.2 mb Dew Point Temperature=_____

2. The dew point if Vapor Pressure =23.3 mb Dew Point Temperature=_____

3. The Vapor Pressure if the dew point is 8 °C Vapor Pressure =_____

4. The Vapor Pressure if the dew point is 20.0 °C Vapor Pressure =_____

5. The Saturation Vapor Pressure if the actual air temperature is 28 °C. SVP=_____

6. The Saturation Vapor Pressure if the air temperature is 6 °C SVP=_____

7. The relative humidity if the temperature is 28 °C and the dew point is 8 °C.

Vapor Pressure =_____ SVP=_____ RH= ——— =_____

Part 1 Learning Objectives

After completing this experiment you should be able to do the following:

1. Define humidity, actual humidity and relative humidity. State their units of measurement and give an example of each.

2. Determine experimentally the actual and relative humidity of the air.

3. Calculate the relative humidity from given and inferred data.

Apparatus

Thermometer, small tin can (250 ml), cup to hold ice water, ice cubes, sling psychrometer.

Procedure

1. Put about ½ inch of tap water into the tin can. Thoroughly clean the outside of the can to eliminate smudges or finger prints with a dry tissue. Set the thermometer probe under the can's center and on top of the foam pad to obtain an estimate of the temperature just outside the can. Slowly add about 1/ 4 inches of ice water (no ice just water) to the can's water stirring gently with the stirring rod (keep the ice cubes from flowing into the can). Wait about 30 seconds to see if dew forms on the can. If not add a little more ice water to the water in the can and wait another 30 seconds to see if dew forms. Repeat this procedure slowly until dew forms. When it does form, stop adding any more ice water and wait 2 to 3 minutes to record the lowest reading on the thermometer. Record as the dew point temperature in the Data Table as Trial #1.

2. Repeat step 1 again for Trial #2 but start by removing all but ½ inch of the cool water from the can and then add a little tap water to obtain a starting temperature just warm enough for there to be no dew on the can's outside. This will allow you to start at a temperature just above the dew point and then more carefully determine the dew point.

3. Repeat step 2 for a third time (Trial #3) so you can get a good estimate of the dew point.

4. Determine the actual humidity of the air using Table 1 or Graph 1, and the average value for the dew point. Refer to the example in the introduction. Record the value in the Data Table.

5. Using a thermometer measure the Room's temperature.

Data Table

Trial #	**dew point temperature in degrees Celsius**
1.	
2.	
3.	
4. Average Dew point from trials 1 through 3 *(calculate this)*	
5. Room Temperature (C)	

Calculations

1. Determine the **Saturation Vapor Pressure** for the room using **Table 1** and the value of **room temperature (row 5 in Data Table).** Record here.

   SVP =_____ mb

2. From the average dew point recorded in the data table (row 4), find the actual Vapor Pressure (VP) and record this below.

   VP=_____mb

3. Calculate the relative humidity of the air. Show your work.

4. If the room temperature dropped by 2 ^{o}C would the relative humidity **increase or decrease**? (show your work)

Part 2. Using a Sling Psychrometer.

1. Determine the relative humidity of the laboratory using the dry-bulb wet-bulb psychrometer and the online calculator at http://www.electro-optical.com/unitconv/convertcalcs/atmospheric/humidity.htm (see link from lab page)

Enter:

Dry Bulb Temp = _____ °C

Wet Bulb Temp = _____ °C

Click Calculate to find:

RH = _____

and

dew point temperature =_____

Compare these values of RH and dew point temperature with those calculated using the dew point tin can method.

6. Determine the relative humidity **outside** using the dry-bulb wet-bulb psychrometer and the online calculator. Make sure that you wait long enough for the thermometer to reach equilibrium temperatures.

Dry Bulb Temp = _____ °C

Wet Bulb Temp = _____ °C

Click Calculate to find:

RH = _____

and

dew point temperature =_____

Does the air inside the lab or outside have the greatest relative humidity? _____

Does the air inside the lab or outside have the greatest actual amount of water vapour (compare dew point temps)? _____

Use the relative humidity meters connected to the lab computer and computer upstairs to find the relative humidity in the lab and outside the lab. Summarize all results in the table below.

	Inside	outside
Tin can		**********
Sling Psychrometer		
Computer RH meter		

Questions

1. Distinguish between actual humidity and relative humidity.

2. What two physical quantities can be used to find the relative humidity? circle all that apply.
   a. air temperature and dew point temperature
   b. air temperature and saturation vapour pressure
   c. vapour pressure and saturation vapour pressure
   d. vapour pressure and dew point temperature
   e. saturation vapour pressure and dew point temperature
   f. vapour pressure and air temperature

3. If the relative humidity of the air in a laboratory is 25%, what is the vapour pressure? Assume that the laboratory temperature is 20 °C. Hint: Since $RH = {}^{VP}/_{SVP}$ then
   $VP = RH\ (SVP)$ where you use the fractional relative humidity of 0.25 and must find the SVP from Table 1 using 20°C for room temp)

4. On a rainy day the temperature outside is 4 °C and the relative humidity is 100% (RH=1.0).
   What is the actual vapour pressure (VP) outside?_____

   The temperature inside is 22 °C and the relative humidity is 60% (RH=0.60).
What is the saturation vapour pressure for 22 °C ?_____

   What is the actual vapour pressure inside?_____
Does the air inside contain more or less water than the air outside?
By how much?

If the outside air is mixed equally with the inside air the actual humidity will end up being about halfway between the original vapour pressure of each. What is this value?

vapour pressure of outside inside mixture=_____

After this mixture is heated back up to 22 °C the Saturation vapour pressure is the same as that for the inside air. What is this value?

SVP for 22 °C **=_____**

From these to value estimate the relative humidity of this new mixture.

RH=_____

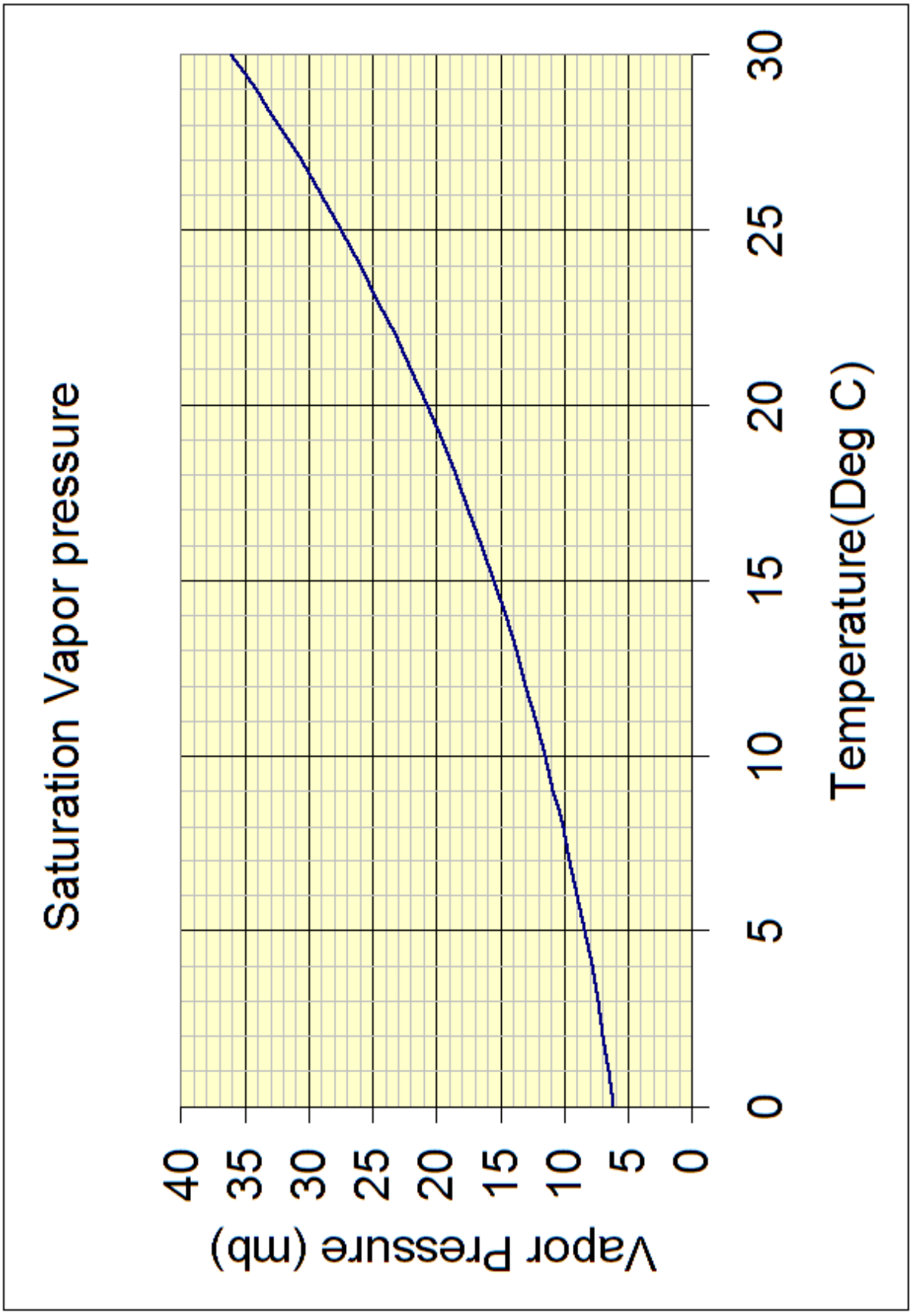
If your windows were fogging up inside, would opening the windows and letting some cold air in and some warm air out make the windows fog up **more or less**?

Table 1

Temperature vs Vapor Pressure

T	VP		T	VP		T	VP		T	VP
deg C	mb		deg C	mb		deg C	mb		deg C	mb
-10	3.1		0	6.1		10	11.5		20	20.8
-9	3.3		1	6.5		11	12.2		21	22.0
-8	3.6		2	7.0		12	13.0		22	23.3
-7	3.8		3	7.4		13	13.8		23	24.6
-6	4.1		4	7.9		14	14.7		24	26.0
-5	4.4		5	8.4		15	15.5		25	27.5
-4	4.7		6	9.0		16	16.5		26	29.1
-3	5.0		7	9.6		17	17.5		27	30.7
-2	5.4		8	10.2		18	18.5		28	32.4
-1	5.7		9	10.8		19	19.6		29	34.2
0	6.1		10	11.5		20	20.8		30	36.1

***use dew point temp with Actual Vapor Pressure**
***use air temp with Saturation Vapor Pressure**


Saturation Vapor pressure
Vapor Pressure (mb)
0
5
10
15
20
25
30
35
40
Temperature(Deg C)
0
5
10
15
20
25
30