Measuring Humidity

Name:__________________________________ **Date:**____________ **Lab #**_____

Data Table A:

Capacity of Water in Air @ 1000mb

Temp °C	Capacity (g/kg)
-10	2.6
-9	2.9
-8	3.2
-7	3.5
-6	3.8
-5	4
-4	4.3
-3	4.7
-2	5.1
-1	5.6
0	6.1
1	6.5
2	7
3	7.5
4	8.1
5	8.7
6	9.3
7	10
8	10.7
9	11.4
10	12.2
11	13
12	13.9
13	14.8
14	15.8
15	16.9
16	18
17	19.2
18	20.5
19	21.8
20	23.2
21	24.6
22	26.1
23	27.8
24	29.6
25	31.4
26	33.4
27	35.5
28	37.6
29	39.7
30	41.9

Directions: Read through the information below and all questions that follow.

Introduction:

Water vapor is the source of moisture for clouds and rain. Meteorologists measure both dew point and relative humidity to determine how much water vapor is in the air and to predict chances of precipitation.

Materials:

Metal cans	Ice	Celsius thermometers
Stirring rods	Room temperature water	Sling psychrometer

Objectives:

1. To observe dew formation and compute relative humidity using two different methods.
2. Calculate the base cloud height from the measured and calculated data.

Procedure: Part A

1. Measure the room temperature and record in *Data Table B.*
2. Determine the capacity of air to hold water vapor for room air temperature using **Data Table A**.
3. Fill the metal can halfway with water. Place the thermometer in the water. Add a small amount of ice.
4. Using the stirring rods, NOT the thermometer, stir the water slowly while observing for dew formation on the outside of the can.
5. The instant you see dew form (it should appear wet, and feel wet to the touch) on the side of the can, record the temperature in *Data Table B.*
6. Repeat steps 3-5 one more time for accuracy and record in *Data Table B.*
7. Average your two dew point temperatures and record in *Data Table B.*
8. Use Table A (to the left) to determine air capacity for the average dew point temperature –record in *Data Table B*

The capacity at dew point = specific humidity

9. Calculate relative humidity and record in *Data Table B*

Data Table B

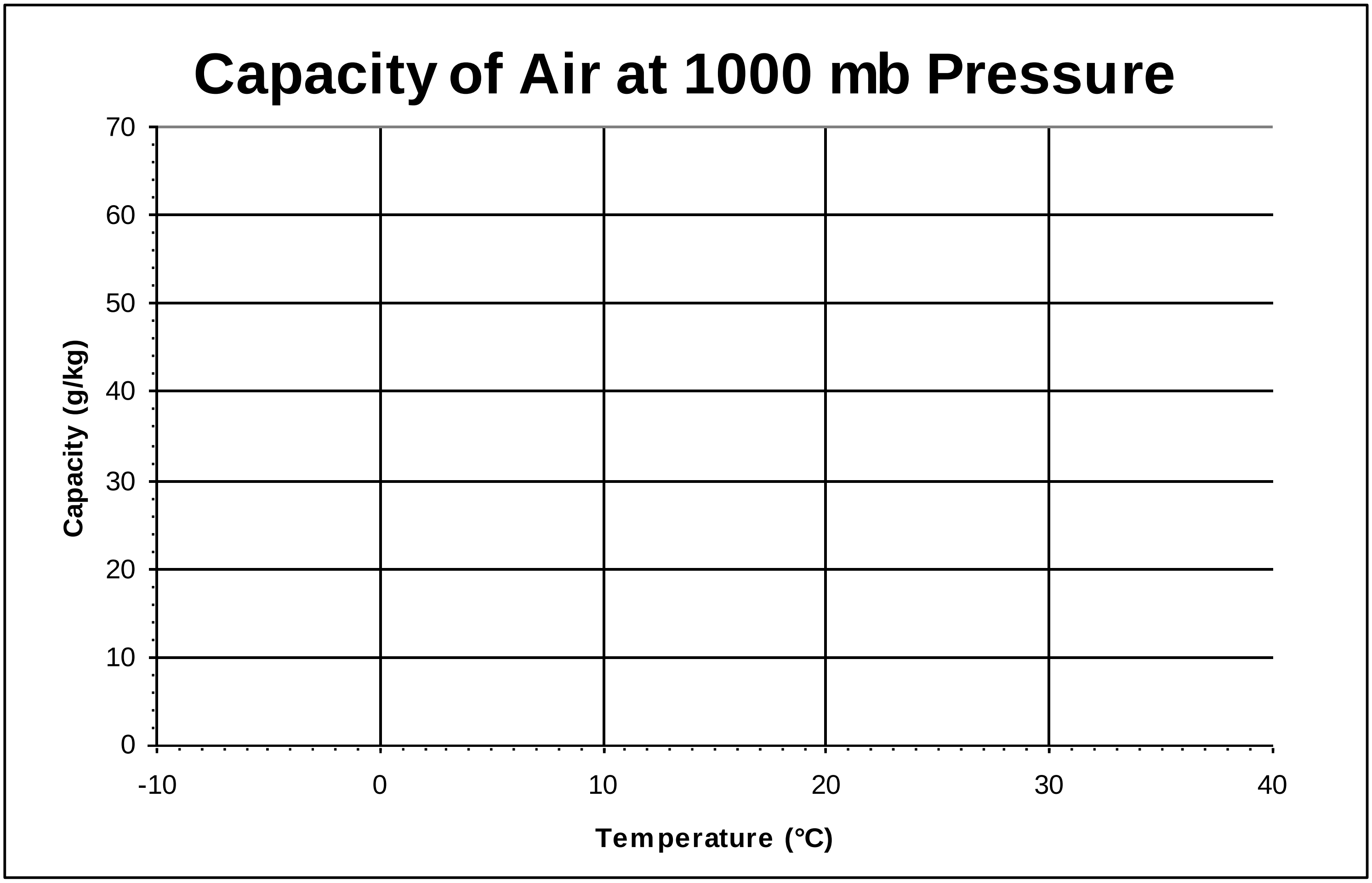
Measurement	Data
1. Temperature of room air	
2. Air *capacity* at room temperature (g/kg)	
3. Dew point – trial 1 (°C)	
4. Dew point – trial 2 (°C)	
5. Average dew point temperature (°C)	
6. Air capacity at dew point (specific humidity) (g/kg)	
7. *Relative humidity* – (use the formula below) (%)	

$$\textit{Relative humidity} \; (= \frac{\textit{Specific Humidity}}{\textit{Capacity}}) \times 100$$

10. Plot the data from **<u>Data Table A</u>** in the graph below.

   a. Make sure to connect all data points.

   b. Estimate/ extrapolate your graph to predict the capacity of water in air at **40°C**. What is your predicted capacity for this temperature: ____________g/kg



Part B

1. Read room temperature and record dry bulb temperature in *Data Table C*.
2. Use a sling psychrometer to determine wet bulb temperature and record in *Data Table C*.

Figure 1: A Basic Sling Psychrometer

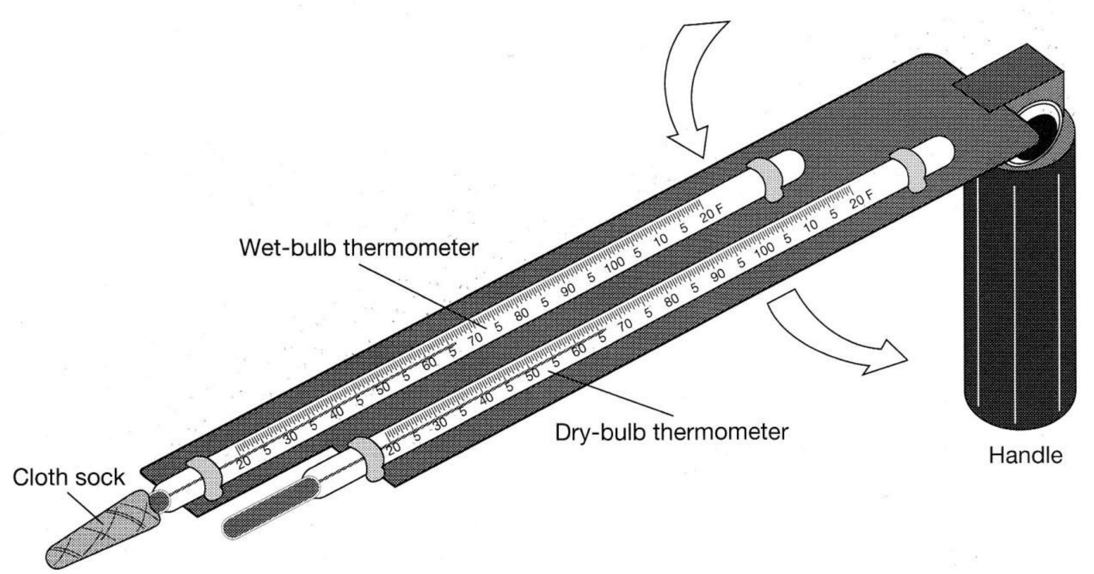


Figure 1 (in the page before) shows the basic design of a sling psychrometer. The instrument consists of two thermometers, one of which has a cloth sock on the bulb. This is known as the wet-bulb side and is the thermometer used to take the wet-bulb reading after "slinging," or swinging, the thermometers. The other thermometer has no cloth sock and is known as the dry-bulb side. It is used to take the dry-bulb, or existing air-temperature, reading.

Wet the sock of the wet-bulb thermometer thoroughly with room temperature-like water. Swing the psychrometer, checking periodically to see when the wet-bulb temperature stops dropping. CAUTION: *Be sure to stand away from other students when swinging the psychrometer.* If the surrounding air is saturated, no evaporation will take place from the wet bulb and there will be no wet-bulb temperature drop. Since evaporation is a cooling process, the greater the evaporation from the wet bulb, the greater the temperature drop, or wet-bulb depression, which is the difference between the wet- and dry-bulb temperatures. Generally, the greater the wet-bulb depression, the lower the relative humidity.

The dew point is a direct measure of water vapor pressure, or the contribution that water vapor makes to the total atmospheric pressure.

3. Determine the difference between wet and dry bulbs and record on *Data Table C*.

Data Table C: Sling Psychrometer Measurements

Measurement	**Data**
1. Temperature of room air (dry bulb) (°C)	
2. Wet bulb temperature (INSIDE) (°C)	
3. Difference between wet and dry bulb (°C) (wet bulb depression) (INSIDE)	
4. Dew Point temperature (INSIDE) (°C)	
5. Relative humidity (from table below) (%)(INSIDE)	
6. Temperature of OUTSIDE air (dry bulb) (°C)	
7. Wet bulb temperature (OUTSIDE) (°C)	
8. Difference between wet and dry bulb (°C) (wet bulb depression) (OUTSIDE)	
9. Dew Point temperature (OUTSIDE) (°C)	
10. Relative humidity (from table below) (%)(OUTSIDE)	

4. Use the charts on the next page, **Figure 2: Relative Humidity & Dew Point Temperature Tables**, (and the example given) to determine relative humidity and dew point values both inside and outside.

5. After finding the dew point and relative humidity from the two methods above (**Procedure Parts A** and **B**), compare them to the dew points and relative humidity of the high school's weather station that you should place in **Data Table D**.

Data Table D: High School Weather Station Values:

	Dew Point Temperature (°C)	Relative Humidity (%)
INSIDE		
OUTSIDE		

a. Which method (sling psychrometer or ice in a metal can) was closer to the CR weather station's values for INSIDE? ___________________________________

b. Which method (sling psychrometer or ice in a metal can) is PROBABLY the most accurate for measuring dew point and relative humidity? _____________________________

Explain, with substantiated reason, why you chose the method you stated above: ________________________

____

____

____

Figure 2: Relative Humidity & Dew Point Temperature Tables

Relative Humidity(%)

Dry-Bulb Tempera-ture (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	100	28														
-18	100	40														
-16	100	48														
-14	100	55	11													
-12	100	61	23													
-10	100	66	33													
-8	100	71	41	13												
-6	100	73	48	20												
-4	100	77	54	32	11											
-2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Dewpoint Temperatures (°C)

Dry-Bulb Tempera-ture (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	-20	-33														
-18	-18	-28														
-16	-16	-24														
-14	-14	-21	-36													
-12	-12	-18	-28													
-10	-10	-14	-22													
-8	-8	-12	-18	-29												
-6	-6	-10	-14	-22												
-4	-4	-7	-12	-17	-29											
-2	-2	-5	-8	-13	-20											
0	0	-3	-6	-9	-15	-24										
2	2	-1	-3	-6	-11	-17										
4	4	1	-1	-4	-7	-11	-19									
6	6	4	1	-1	-4	-7	-13	-21								
8	8	6	3	1	-2	-5	-9	-14								
10	10	8	6	4	1	-2	-5	-9	-14	-28						
12	12	10	8	6	4	1	-2	-5	-9	-16						
14	14	12	11	9	6	4	1	-2	-5	-10	-17					
16	16	14	13	11	9	7	4	1	-1	-6	-10	-17				
18	18	16	15	13	11	9	7	4	2	-2	-5	-10	-19			
20	20	19	17	15	14	12	10	7	4	2	-2	-5	-10	-19		
22	22	21	19	17	16	14	12	10	8	5	3	-1	-5	-10	-19	
24	24	23	21	20	18	16	14	12	10	8	6	2	-1	-5	-10	-18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	-4	-9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	-3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

Part C

Clouds are major atmospheric features that are a direct result of the dew-point temperature being reached. As air rises, it tends to expand. This expansion causes air to cool and is referred to as an **adiabatic temperature change**. In the reverse of this process, air that sinks is compressed and warms. These temperature changes occur independently of external heat loss or gain, with the exception of situations where water vapor is present. In this case adiabatic processes can be measured, but adjustments in lapse, or temperature change, rates must be made to allow for the presence of water (dry vs. moist lapse rates).

Other factors, such as the presence of condensation nuclei, or particles that allow water vapor molecules to collect or coalesce, aid in cloud formation. These nuclei are often particles of sea salt, soil, or volcanic ash.

The figure on the next page shows how dew point and air temperature change with an increase in altitude. Use this diagram (**Figure 2**) to calculate cloud base heights for dry-bulb (air temperature) and the dew-point data you have already obtained for the OUTSIDE from CR's weather station. Record the data in the space below.

Data Table E: Cloud Height:

Surface air temperature (dry bulb) _______ºC
Surface dew point temperature ________ºC
Calculated cloud base height (to the nearest tenth) ________km

Conclusion questions:

1. What is the definition of "dew point temperature"? What can be said about air which is at its dew point?

2. What factors affect or determine the relative humidity of the air?

3. If all other factors remain unchanged, what happens to the relative humidity of an air mass when the temperature rises? Explain.

4. If all other factors remain unchanged, what happened to the relative humidity of an air mass as more water evaporates into the air? Explain.

5. If a cloud's base altitude forms at a height a height of 2.5 km and the air temperature at earth's surface is 28 ºC, what is the dew point temperature at earth's surface?

References Used: http://regentsearth.com/Illustrated%20ESRT/Page%2012%20(DP%20&%20RH)/ESRT%20page%2012%20index.htm (10/25/11

Figure 2: Cloud Height Graph