Title: THE ATMOSPHERIC ENGINE

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Eulalie R. Rivera Elementary School-

Grade Level: 4-6

Concepts:	**Disciplines:**
1. The Sun	1.Earth Science
6. Natural Resources	

Objective:
With the information supplied and with the use of special charts, students will complete the activities and record information, correctly identifying different cloud types and making weather predictions.

Rationale:
The principal information that the forecaster needs about the atmosphere is its weight (atmospheric pressure), temperature, moisture content (humidity) and movement (wind speed and direction). All weather phenomena are the result of two basic occurrences: the constant radiation energy from the sun and the 24hour rotation of the earth alone with the 12-month orbit around the sun.

In the Eastern Caribbean there is very little correlation between barometric pressure and winds. The wind comes from the East 99% of the time and about half the time from the Southeast. Occasionally when a "Bermuda High" forms off the North Carolina coast we get a change in wind direction.

Materials Needed:

Sling Psychrometer (two thermometers)	Wind Velocity Chart
Barometer	Relative Humidity Chart
Cloud Charts (Helpful)	Anemometer
	Forecasting Worksheet

What Causes Weather:

Because of the complicated factors which go into weather forecasting, go over the following information with the students. The discussion is only cursory; any additional material or audio-visuals would be helpful.

All of the sunlight that drives the various cycles of weather and climate must come through the atmosphere before reaching the Earth's surface. Some particulate matter can increase atmospheric reflection (NOX or S02)- Other compounds such as

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$C0_2$ increases the absorption of radiation from below. Some of these things in the atmosphere are natural, but most are manmade. The atmosphere is also a transport medium for heat and water vapor, as well as for kinetic energy (wind).

The ocean stores heat that comes to it from the sun far better than does the land. Subsurface currents, which are affected by basin contours, temperature gradients and other factors, can carry heat from one area to another. The ocean is also the major repository of water for evaporation and precipitation. (These processes, because they involve phase changes, can transport large amounts of heat without significant temperature changes). By contrast, land heats rapidly during the day and cools rapidly at night; this cyclic behavior affects weather patterns and gives rise to the extreme climates of inland areas.

Local weather conditions depend on the specific circumstances in that area. Because of its great heat-holding capacity, water serves to temper the climate of the earth. Islands like ours are noted for their year around mildness of climate. Note on the weather and climate chart a simplified pattern of global air movement Notice the effect of the earth's rotation on the routes taken by the currents which are pushed back to the surface at the 300 "Horse" latitudes. In the Northern Hemisphere all air currents deflect to the right. So the currents that head back to the equator do not go directly. south but veer to the west. These are the steady "trade winds" upon which the old mariners depended to get to the islands:(Then caught the gulf stream and returned to Europe.)

Directions/Activity:

The make-up of the air can affect the weather. Humidity is a measure of the amount of water vapor in the air. The amount of water vapor in the air can be measured with an instrument called a sling psychrometer. The psychrometer consists of two thermometers. One measures the true air temperature. The other thermometer is covered with a piece of cloth which is dipped in water. This thermometer will show a lowered temperature based on cooling caused by evaporation of the water. The two thermometers are mounted on a board with a chain attached. The psychrometer is swung around for a specific time period. The two temperatures are read and from the chart the relative humidity is found.

The amount of water vapor air can contain before precipitation occurs depends on the temperature. The higher the temperature the greater the amount of water which can be held in the sky. Thus, if you have a high temperature during the day and humidity of 50% you probably wouldn't get any rain or fog. If at night the temperature cools, the air can't hold the water as well so the humidity could chance to 100% and dew, fog drizzling might occur.

The air containing the water vapor is moving most of the time. This air movement or wind is caused by differences in air temperature and air pressure. We can measure the wind speed with an instrument called an anemometer. A sudden change in wind speed or direction often means a chance in weather.

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Air has weight which can change depending on the density or thickness of the air. We call this weight the air pressure. The air pressure is measured in inches on an instrument called a barometer. If you have watched the weatherman on TV you have probably noticed the highs and lows written on the weather map The highs are areas with high pressure and usually mean fair weather. Highs have winds which circulate in a clockwise manner A low is an area with low pressure and usually means cloudy weather. Lows 

have winds which circulate in a counter-clockwise direction. Where highs and lows meet there is a change in wind direction, a change 

in temperature and a change in weather. A CHANGE IN AIR PRESSURE indicates A CHANGE IN WEATHER. (See barometer pressure chart) A change in temperature causes water vapor to form into visible water droplets called clouds.

Clouds are formed by the air temperature and water vapor content at different levels in the atmosphere. Clouds affect the earth in two ways:

1. They absorb energy from the sun.

2. They reflect heat energy from the earth back down, acting like a blanket to help keep the earth warm. This is especially true at night.

The name of a cloud may describe the appearance and the altitude in which they were formed.

The term strato means layer-like; stratus clouds are thin, layered clouds and are a sign of fair weather.

The term cumulo means pile or heap; cumulus clouds usually are rain clouds.

The term cirro means curl; cirrus clouds usually indicate a change to rainy weather.

The term nimbo means rain; nimbus clouds are rain clouds.

To visualize the basic cloud types and the many variations, cloud charts should be used.

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FORECASING WORKSHEET

1. Type of clouds _____

2. General meaning of cloud type_____

3. Wind velocity estimated from chart_____

4. Wind velocity from anemometer_____

5. Wind direction_____

6. Barometer reading _____

7. Is the barometer rising, steady or falling?_____

8. Use the wet-dry bulb thermometer to determine the relative humidity
_____

9. What were the high and low temperature readings for the past 24 hours?

High_____ **Low**_____

10. What is the present temperature?_____

11. What is your weather forecast? Why?_____

12. (After 24 hours) What was the weather really like?
_____
_____
_____
_____

Teacher Reference:

V.I. Energy Office - Activities with wind
U.S.D.A. Rainfall charts
Project Introspection - Hurricanes

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From all the above information and the measurements you will make, you should be able to predict the weather.

Evaluation:

1. Compare the daily weather forecasts on Channel 10 evening news, The Scene Today, with the actual weather conditions.

2. How did the Channel 10 forecast compare with the one you made?

3. Do you think we should change weather if we have the ability to do so? Why or why not. Stage a debate on the subject or write a paper.

4. Why would we want to change the weather?

5. How does pollution in the air affect weather?

6. How does pollution in the air affect the rain and the ground where the rain falls?

7. Make a rough calculation of the distance the sand has traveled during the hazy weather we experience in the islands which is caused by sand blown from the Sahara region in Africa.

8. Members of the class may build their own weather instruments for taking basic recordings.(e.g., sling psychrometer; wind vane; anemometer
mercurial barometer rain gauge, etc.)

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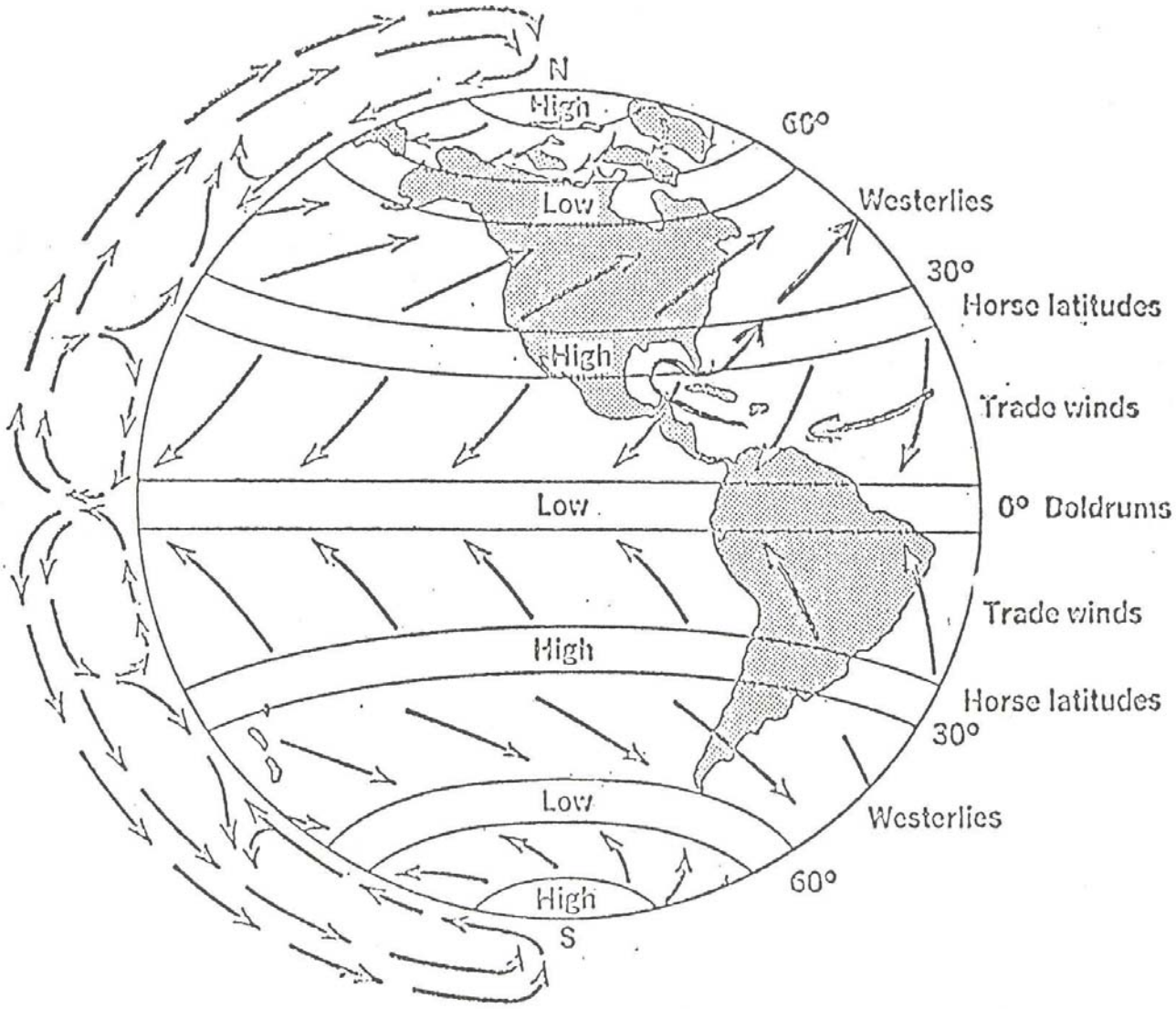
WEATHER AND CLIMATE



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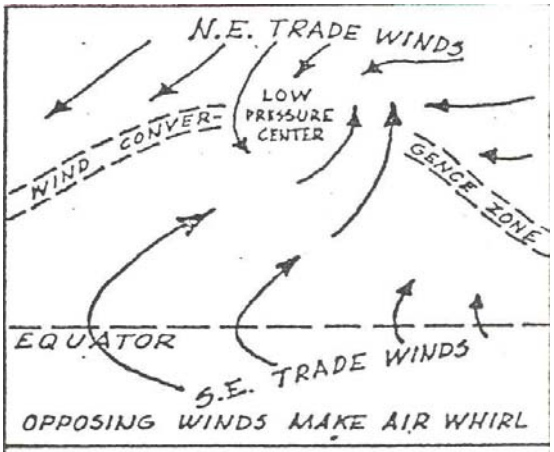
Birth of Hurricanes

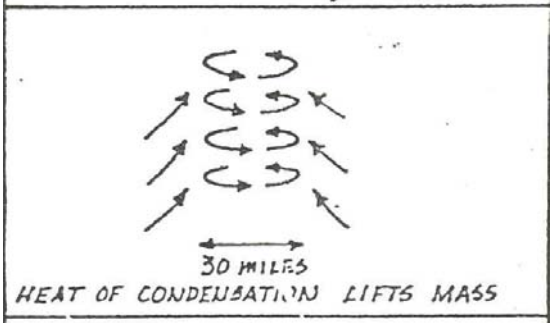
A hurricane is born in a hot moist air mass over the ocean. The cyclonic motion is often started as opposing trade winds whirl around each other. This occurs during the summer months when the Northeast and Southeast trade winds converge north of the equator.

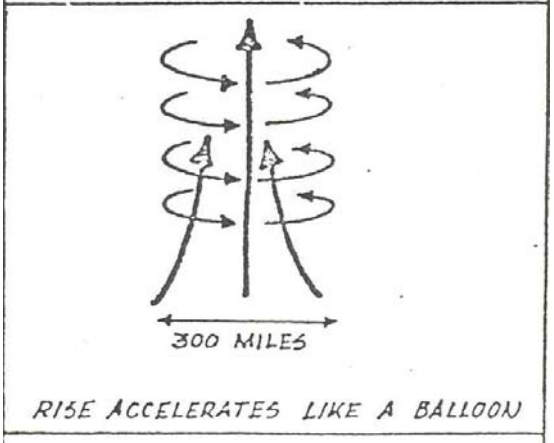
The rotating low pushes air toward its center, forcing the-hot moist air there to rise. As the moist air rises, it slowly cools and the moisture condenses. The condensing moisture (rain) gives off heat, further warming the rotation air mass which becomes even lighter and rises more rapidly.

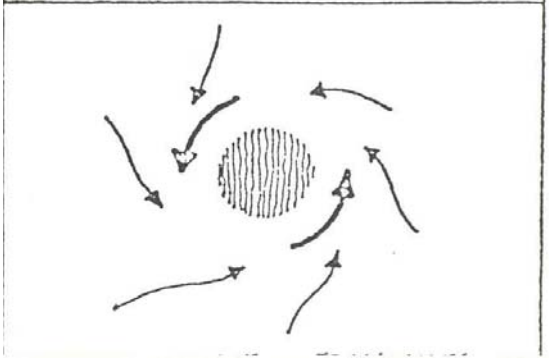
As this whirling air rises, more warm moist air flows in behind to replace it. More condensation occurs, more heat is produced, more warm moist air flows in and the storm increases.

Hurricanes are so violent because of the tremendous amounts of energy(heat) released by the continuous condensation. This is similar to a thunderstorm over land; however, the hurricane has a virtually inexhaustible supply of moist hot air to feed it. The heat given off by condensation causes the air in the hurricane to rise faster and faster. Surrounding air sweeps in rapidly until the hurricane?

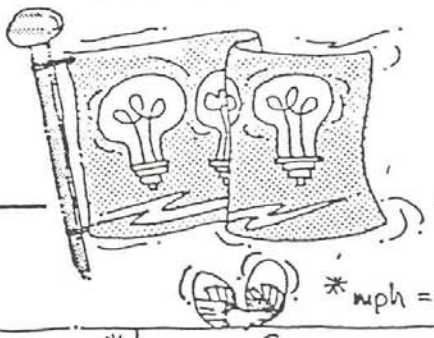








AT WHAT TIME OF DAY IS THERE ENOUGH WIND TO MAKE ELECTRICITY WHERE YOU LIVE?



(no materials required)

Measure the wind with the Beaufort Wind Scale.
(Any wind over 8mph can be used to generate electricity.)

Keep a record of the wind speeds at different times of day.

At what time of day do the fastest winds usually occur?

* mph = miles per hr

Beaufort number	Description*	Observation
0	calm (0-1 mph)	smoke rises vertically
1	light air (2-3 mph)	smoke drifts slowly
2	slight breeze (4-7 mph)	leaves rustle; windvane moves
3	gentle breeze (8-12 mph)	twigs move; flags extended
4	moderate breeze (13-18 mph)	branches move; dust and paper rise
5	fresh breeze (19-24 mph)	small trees sway
6	strong breeze (25-31 mph)	large branches sway; wires whistle
7	moderate gale (32-38 mph)	trees in motion; walking difficult
8	fresh gale (39-46 mph)	twigs break off trees
9	strong gale (47-54 mph)	branches break; roofs damaged
10	whole gale (55-63 mph)	trees snap; damage evident
11	storm (64-72 mph)	widespread damage
12	hurricane	extreme

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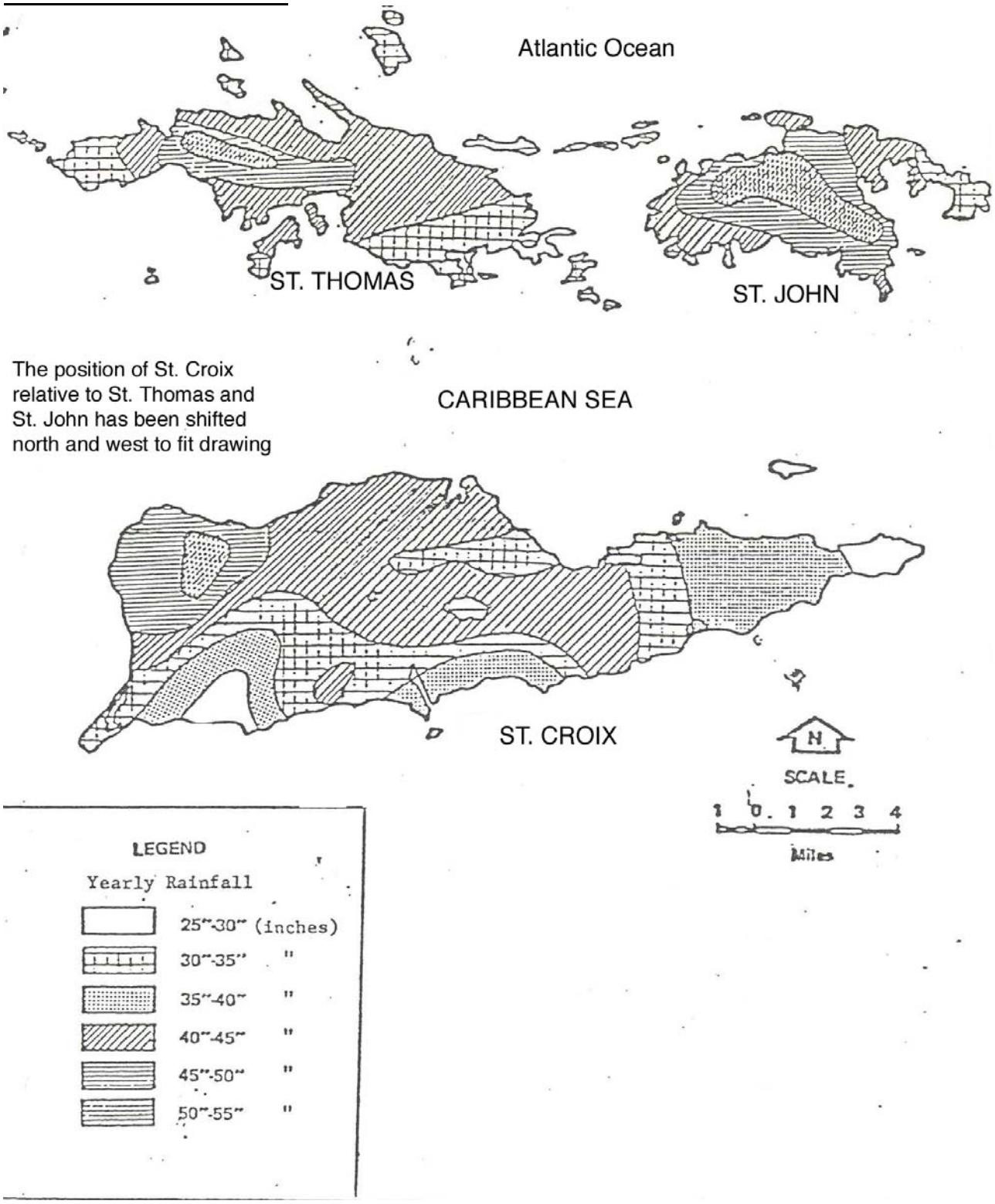

The position of St. Croix relative to St. Thomas and St. John has been shifted north and west to fit drawing

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PSYCHROMETIC TABLE FOR RELATIVE HUMlDITY Fahrenheit Temperatures 700 to 1080

DIFFERENCE BETWEEN DRY AND WET BULB READINGS.

PSYCHROMETIC TABLE FOR RELATIVE HUMIDITY Fahrenheit Temperatures 70° to 108°

DIFFERENCE BETWEEN DRY AND WET BULB READINGS

DRY BULB READING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
70	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	26	23	20	17	13	10	7	4	1				
72	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	28	25	22	19	16	13	10	7	4	1			
74	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21	18	15	12	9	7	4	1		
76	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	32	29	26	23	20	17	14	12	9	6	4	1	
78	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37	34	31	28	25	22	19	16	14	11	9	6	4	1
80	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	35	32	29	27	24	21	18	16	13	11	8	6	4
82	96	92	88	84	80	76	72	69	65	62	58	55	52	49	46	43	40	37	34	31	28	25	23	20	18	15	13	10	8	6
84	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41	38	35	32	30	27	25	22	20	17	15	12	10	8
86	96	92	88	85	81	77	74	70	67	63	60	57	54	51	48	45	42	39	37	34	31	29	26	24	21	19	17	14	12	10
88	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	41	38	35	33	30	28	25	23	21	18	16	14	12
90	96	92	89	85	81	78	75	71	68	65	62	59	56	53	50	47	44	42	39	37	34	32	29	27	24	22	20	18	16	14
92	96	92	89	85	82	78	75	72	69	65	62	59	57	54	51	48	45	43	40	38	35	33	30	28	26	24	22	19	17	15
94	96	93	89	86	82	79	75	72	69	66	63	60	57	54	52	49	46	44	41	39	36	34	32	29	27	25	23	21	19	17
96	96	93	89	86	82	79	76	73	70	67	64	61	58	55	53	50	47	45	42	40	37	35	33	31	29	26	24	22	20	18
98	96	93	89	86	83	79	76	73	70	67	64	61	59	56	53	51	48	46	43	41	39	36	34	32	30	28	26	24	22	20
100	96	93	90	86	83	80	77	74	71	68	65	62	59	57	54	52	49	47	44	42	40	37	35	33	31	29	27	25	23	21
102	96	93	90	86	83	80	77	74	71	68	65	63	60	57	55	52	50	47	45	43	41	38	36	34	32	30	28	26	24	22
104	97	93	90	87	84	80	77	74	72	69	66	63	61	58	56	53	51	48	46	44	41	39	37	35	33	31	29	27	25	24
106	97	93	90	87	84	81	78	75	72	69	66	64	61	59	56	54	51	49	47	45	42	40	38	36	34	32	30	28	27	25
108	97	93	90	87	84	81	78	75	72	70	67	64	62	59	57	54	52	50	47	45	43	41	39	37	35	33	31	29	28	26

PSYCHROMETIC TABLE FOR RELATIVE HUMIDITY Fahrenheit Temperatures 30° to 68°

DIFFERENCE BETWEEN DRY AND WET BULB READINGS

DRY BULB READING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30	89	78	68	57	47	37	27	17	8																					
32	90	79	69	60	50	41	31	22	13	4																				
34	90	81	72	62	53	44	35	27	18	9	1																			
36	91	82	73	65	56	48	39	31	23	14	6																			
38	91	83	75	67	59	51	43	35	27	19	12	4																		
40	92	84	76	68	61	53	46	38	31	23	16	9	2																	
42	92	85	77	70	62	55	48	41	34	28	21	14	7																	
44	93	85	78	71	64	57	51	44	37	31	24	18	12	5																
46	93	86	79	72	65	59	53	46	40	34	28	22	16	10	4															
48	93	87	80	73	67	60	54	48	42	36	31	25	19	14	8	3														
50	93	87	81	74	68	62	56	50	44	39	33	28	22	17	12	7	2													
52	94	88	81	75	69	63	58	52	46	41	36	30	25	20	15	10	6													
54	94	88	82	76	70	65	59	54	48	43	38	33	28	23	18	14	9	5												
56	94	88	82	77	71	66	61	55	50	45	40	35	31	26	21	17	12	8	4											
58	94	89	83	77	72	67	62	57	52	47	42	38	33	28	24	20	15	11	7	3										
60	94	89	84	78	73	68	63	58	53	49	44	40	35	31	27	22	18	14	10	6	2									
62	94	89	84	79	74	69	64	60	55	50	46	41	37	33	29	25	21	17	13	9	6	2								
64	95	90	85	79	75	70	66	61	56	52	48	43	39	35	31	27	23	20	16	12	9	5	2							
66	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26	22	18	15	11	8	5	1						
68	95	90	85	81	76	72	67	63	59	(55)	51	47	43	39	35	31	28	24	21	17	14	11	8	4	1					

Example: If dry bulb reading is 68° and wet bulb readings is 58° the relative humidity will be found in the 10° difference column opposite 68°. In this case 55% as circled.

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CLOUD FORMATION AND WEATHER