the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Relative Humidity

Grade Level	8, 9, 10	**Subject**	Earth Science

Objective(s):

To understand the concept of relative humidity and how it is measured using a sling psychrometer.

Identify how temperature can affect relative humidity.

Sling psychrometers use two thermometers. The dry bulb measures air temperature. The wet bulb (you wet the "sock" over the bulb) will evaporate, cooling the temperature, which is an important concept. This difference is used to determine the relative humidity.

SOL Addressed:

ES.1 The student will plan and conduct investigations in which

a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;
b) technologies, including computers, probeware, and geospatial technologies, are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
c) scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted;

ES.12 The student will investigate and understand that energy transfer between the sun and Earth and its atmosphere drives weather and climate on Earth. Key concepts include

a) observation and collection of weather data;

Next Generation Science Standards:

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [

MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

HS-PS3-4: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth systems result in changes in climate.

<table>
<tr><td>Materials Needed Per Class of 30

and

Prior Knowledge</td><td colspan="2">30 Relative humidity charts
Practice worksheets (attached)
12 sling psychrometers
Graph paper</td></tr>
<tr><td>Ways to differentiate this lesson plan</td><td colspan="2">• EXTENSION Graph data and explain trends. Use CEED data (RH and temps) to graph relationships. Be able to explain relationships between dry bulb and wet bulb temperatures and relative humidity.

• MODIFICATIONS</td></tr>
<tr><td>Introduction/ Anticipatory Set</td><td>Anticipatory Set: From the CEED data, observe data over the day: Watch for trends of changing temperatures, and the effect on relative humidity. Discuss how air feels in the summer versus the winter in relation to RH.

Questions to ask students:
• What trends are observed from CEED data?
• Why do you think this happens?
• What causes warmer air to have a different RH than cooler air?</td><td>Introduction: Relative humidity (RH) is the amount of moisture in the air compared with the amount of moisture the air can hold at that temperature, given as a percentage. So, warm air holds more moisture than cooler air; winter air is drier and summer air is more humid/sticky.

Describe how or review that when water evaporates, heat is absorbed, causing the surface to feel cooler. This is why we sweat, to help cool our bodies. Apply this to the wet bulb of a sling psychrometer. It will cool as it evaporates, recording a cooler temperature. If no evaporation occurs, it will record the same temperature as the dry bulb (actual air temp.)

The larger difference between the wet bulb and dry bulb temperatures, the lower the relative humidity.</td></tr>
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Guided Practice	Practice using the relative humidity charts to be sure students understand how to read them. *sample worksheet attached. Illustrate how to use sling psychrometers.
Independent Practice	Have students hypothesize the relative humidity of indoor versus outdoor areas at school, different rooms in the building (bathrooms, classrooms, hallways, etc.), determining their own test areas. Use the sling psychrometers and charts to collect data and analyze.
Closure (Summary of Lesson)	Have students explain the way a sling psychrometer works, what happens to RH when temperatures rise or fall, how air temperature affects relative humidity.
CEED Building Application/ Sensor Data	Compare RH of incoming versus outgoing air using the CEED dashboard. What factors may be causing the RH to change? Discuss changes.
Assessment	Evaluate the use of a relative humidity chart with given data. Give students temperature data from a sling psychrometer and they should describe without the charts if the RH is higher or lower based on the temperature differences.

Name:_____ Period:_____

Relative Humidity Worksheet

Complete the chart below using the relative humidity table.
Note the Wet Bulb Depression is the difference between the wet-bulb and dry-bulb thermometers. The dry-bulb temperature is the air temperature.

	Dry Bulb Temp (°C)	Wet Bulb Temp (°C)	Wet Bulb Depression (°C)	Relative Humidity (%)
1	26	16		
2	22	18		
3	20	18		
4	4	-2		
5	18	16		
6	15	10		
7	23	22		
8	0	-2		
9	24	24		
10	24	19		
11	21		3	
12	16		5	
13		16	5	
14		12	6	
15			8	49

ANSWERS

Relative Humidity Worksheet

Complete the chart below using the wet bulb/dry bulb table.
Note the Wet Bulb Depression is the difference between the wet-bulb and dry-bulb thermometers. Dry-bulb is the same as the air temperature.

	Dry Bulb Temp (°C)	Wet Bulb Temp (°C)	Wet Bulb Depression (°C)	Relative Humidity (%)
1	26	16	10	34%
2	22	18	4	68
3	20	18	2	82
4	4	-2	6	14
5	18	16	2	81
6	15	10	5	54
7	23	22	1	92
8	0	-2	2	63
9	24	24	0	100
10	24	19	5	69
11	21	18	3	75
12	16	11	5	54
13	21	16	5	60
14	18	12	6	48
15	30	22	8	49

To determine relative humidity:

1. Subtract the wet-bulb temperature from the dry-bulb temperature.
2. Find this number—the difference in degrees—at the top of the chart and place your finger on it.
3. Find the dry-bulb temperature in the first column on the left. Place your finger on it.
4. Bring your fingers down the column and across the row. The relative humidity percentage appears where column and row intersect on the chart.

Relative Humidity (%)

Dry-Bulb Temperature (°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