Jennifer Walton

MATH TOPICS ADDRESSED:
- Interpreting scientific notation
- Identifying exponents of different variables
- Using mathematical terminology

The Heat Index

It's 90° outside, so why does it feel like 100°? The temperature on the thermometer is not always the same as the temperature we perceive. This perceived temperature is called the *heat index* and is often reported along with the actual temperature. The heat index takes into account the relative humidity in the air.

The formulas in the box below can be used to compute the heat index, which is dependent on two variables: T, the temperature in Fahrenheit, and R, the relative humidity. Both formulas assume that the temperature is at least 80°F and that the relative humidity is at least 40%.

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This is a **rough-estimate formula,** where R is written as a decimal:

$$1.9 \times T \times R + 10$$

This **more accurate formula** uses R written as a whole number:

$$\begin{aligned}\text{Heat index} \approx &-42.379 + 2.049 \times T + 10.143 \times R - 0.225 \times T \times R \\ &- 6.83 \times 10^{-3} \times T^2 - 5.482 \times 10^{-2} \times R^2 \\ &+ 1.228 \times 10^{-3} \times T^2 \times R + 8.528 \times 10^{-4} \times T \times R^2 \\ &- 2 \times 10^{-6} \times T^2R^2\end{aligned}$$

PROBLEMS

1. Combining nine terms creates the more accurate formula. Each term after the first involves a cluster consisting of a number and powers of variables T and/or R. The eighth term is $8.528 \times 10^{-4} \times T \times R^2$.

a. What is the exponent of T? How do you know?

b. What is the exponent of R? What does that indicate?

c. What is the coefficient when not written in scientific notation? Write the coefficient using words.

2. In July, if the temperature in Washington, D.C., is 98°F and the relative humidity is 75%, what is the heat index using each formula?

3. In Cleveland, the temperature is also 98°F, but the relative humidity is only 45%. What is the heat index using each formula?

4. How does humidity affect the feeling of heat?

5. See the heat-index table at http://www.nsis.org/weather/heatindex.html. How accurate are the formulas compared with the table?

This department highlights math concepts in the context of problem solving in the real world. Readers are encouraged to submit ideas or work with someone they know to create a manuscript. Submit your ideas to **mtms@nctm.org**.

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The solutions are appended to the online version of "Math for Real" at **www.nctm.org/mtms**.

solutions to math for real

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TEACHER'S NOTE

Teachers can ask students to input the formula into a graphing calculator or equation solver, and then use the calculator or computer application to find these values. Student can also input the entire calculation into the calculator each time.

ANSWERS

1. a. The exponent of the temperature is 1. When we see a number or a variable without an exponent, 1 is assumed.

b. The exponent of relative humidity is 2, which means that it is multiplied by itself.

c. 0.0008528. Eight thousand, five hundred twenty-eight ten millionths.

The Heat Index

Air Temp (°F)	Relative Humidity (percentage)																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
135°	120	126																			
130°	117	122	131																		
125°	111	116	123	131	141																
120°	107	111	116	123	130	139	148														
115°	105	107	111	115	120	127	135	143	151												
110°	99	102	105	108	112	117	123	130	137	143	150										
105°	95	97	100	102	105	109	113	118	123	129	135	142	149								
100°	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144	150					
95°	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136	140	150		
90°	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122	126	131
85°	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80°	73	74	75	76	77	77	78	79	79	80	81	81	82	83	84	85	86	87	88	89	90
75°	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70°	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

- = Heatstroke risk extremely high
- = Heat exhaustion likely, heatstroke possible
- = Heat exhaustion possible
- = Fatigue possible

2. The estimated heat index:

$$1.9(98)(.75) + 10 \approx 150°F$$

The more accurate formula:

$$-42.379 + 2.049(98) + 10.143(.75) - 0.225(98)(.75) - 6.83 \times 10^{-3}(98)^2 - 5.482 \times 10^{-2}(.75)^2 + 1.228 \times 10^{-3}(98)^2(.75) + 8.528 \times 10^{-4}(98)(.75)^2 - 2 \times 10^{-6}(98)^2(.75)^2 \approx 140°F$$

3. The estimated heat index:

$$1.9(98)(.45) + 10 \approx 94°F$$

The more accurate formula:

$$-42.379 + 2.049(98) + 10.143(.45) - 0.225(98)(.45) - 6.83 \times 10^{-3}(98)^2 - 5.482 \times 10^{-2}(.45)^2 + 1.228 \times 10^{-3}(98)^2(.74) + 8.528 \times 10^{-4}(98)(.45)^2 - 2 \times 10^{-6}(98)^2(.45)^2 \approx 92°F$$

4. Humidity makes the temperature feel warmer. When the relative humidity is high, we feel hotter; the humidity makes sweat, our body's cooling mechanism, less efficient because the sweat evaporates from our skin at a slower rate. For this reason, higher temperatures are much more tolerable in dryer climates.

5. For Washington, D.C., the heat index is 144°F. For Cleveland, the heat index is 110°F. The formula seems to be more accurate for the higher temperature and relative humidity values.

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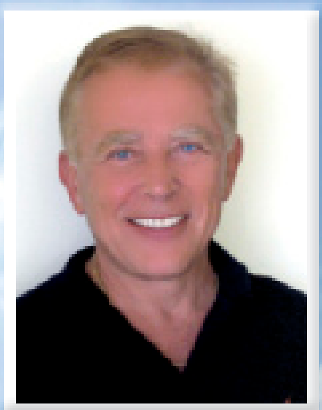

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