

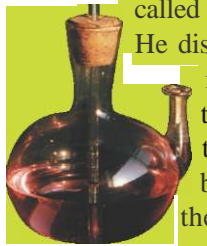
# MEASURE FOR MEASURE

**T**hink about this the next time you eat an ice cream cone. The cone feels cold, but it contains heat energy. In fact, everything contains heat energy, including the hottest and coldest objects in the universe. Check out all the ways we measure heat energy.

## Thermo-WHAT?!

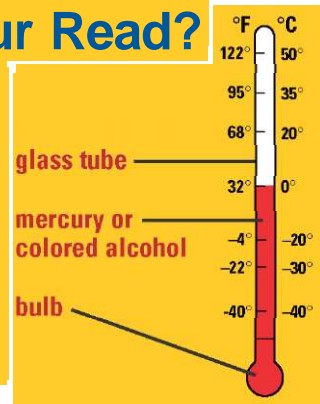
Around 1600 Galileo developed the first primitive thermometer, called a thermoscope (left).

He discovered that when materials heat up, they expand, and when they cool down, they contract. Although the thermoscope was not very accurate, it became the basis for all modern thermometers.



## What's Your Read?

The temperature of an object is a measure of heat energy. We measure it with a thermometer. There are many types, but the mercury thermometer is the most common type.



## TO THE POINT

Some common temperatures to compare

	Fahrenheit	Celsius	Kelvin
Freezing point of water	32°	0°	273 K
Boiling point of water	212°	100°	373 K
Human body	98.6°	37°	310 K
Room temperature	68°	20°	293 K

## A MATTER OF SCALE

Thermometers measure temperatures in three scales: Fahrenheit (F), Celsius or Centigrade (C), and Kelvin (K). Unlike the rest of the world, most people in the United States use the Fahrenheit scale to measure body and air temperatures. Although most scientific labs and most school classrooms use the metric system (the Celsius and Kelvin scales), scientists and students occasionally need to use the Fahrenheit scale. Here's how to convert one scale to another.

1 Fahrenheit to Celsius:  $^{\circ}\text{C} = 5/9(^{\circ}\text{F} - 32)$

2 Celsius to Fahrenheit:  $^{\circ}\text{F} = 9/5(^{\circ}\text{C} + 32)$

3 Celsius to Kelvin:  $\text{K} = ^{\circ}\text{C} + 273$

## MAXIMUM COLD

Absolute zero (0 K, -459°F, or -273°C) is as cold as any substance can get. At absolute zero there is no motion. Scientists have not yet achieved this in the lab, though they have created temperatures that are within a fraction of a degree of absolute zero. Compare it with these temperatures:



Liquid hydrogen in the space shuttle's main engine = 20 K (-423°F or -253°C)

Outer space = 3K (-454°F or -270°C)

# BLISTERING TEMPS

The hottest things are right over your head! Go outside on a cloudless night and look up: The temperatures of stars range from thousands to several billion degrees Celsius. Check out these fiery temperatures.

	Fahrenheit	Celsius	Kelvin
Kitchen stove flame	1,832°F	1,000°C	1,273 K
Molten lava	3,632°F	2,000°C	2,273 K
Light bulb filament	723°F	4,000°C	4,273 K
Surface of the Sun	10,832°F	6,000°C	6,273 K
Lightning bolt	99,032°F	55,000°C	55,273 K
Center of the Sun	27,000,032°F	15,000,000°C	15,000,273 K

# COOLIT

Thermodynamics is the study of the movement of heat.

**Thermo = heat**  
**Dynamics = movement**

One physical law of heat says that heat can only pass from hotter objects to cooler objects.



Ever notice how much colder you feel when the wind is blowing? Lower temperatures and the wind work together to take away your body heat. Weather reporters call this the windchill factor. If it's 25°F outside, and there's a 30-mph wind, it feels like 10°

below zero. The table below shows the air temperature on the top row and the wind speed on the left side. You can find out the windchill factor by plotting where the two scales meet in the center of the table. Bundle up!

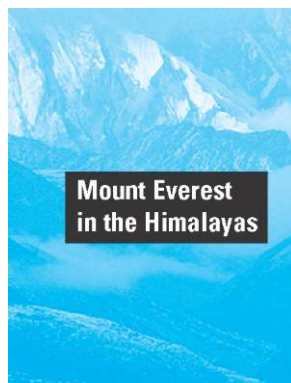
		AIR TEMPERATURE (°F)										
		35	30	25	20	15	10	5	0	-5	-10	-1
WIND SPEED (MPH)	10	22	16	10	3	-3	-9	-15	-22	-27	-34	-40
	20	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60
	30	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71
	40	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76

# COOKS BEWARE!

Water boils at 212°F, right? Yes, but this changes depending on altitude. At higher altitudes, water boils at lower temperatures. Air pressure is lower at higher altitudes, so recipes must be adjusted. Check out the chart at right.

PLACE	ALTITUDE	BOILING POINT
Mt. Everest, Nepal	29,035 feet	159.8°F
London, England	Sea level	212°F
Miami, Florida	11 feet	210°F
Dead Sea, Israel	-1,296 feet	213.8°F
Denver, Colorado	5,280 feet	203°F
Mt. McKinley, Alaska	20,320 feet	176°F
Death Valley, California	-282 feet	213°F

*Note: Temperatures are approximate.*



# Activity

**BOIL IT DOWN** Choose four cities and find data on each city's altitude and the boiling point of water in each city. Create a graph with this data. Then choose four additional cities and try to predict the boiling points in these cities.