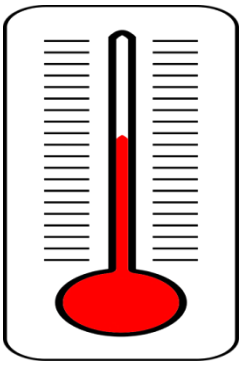
TEMPERATURE FORMULAS



The **Fahrenheit** temperature scale was designed so that water freezes at **32°F** and boils at **212°F**. Later, the **Celsius** (originally called centigrade) scale was created to make the numbers easier to work with. On this new scale, water freezes at **0°C** and boils at **100°C**. We conclude that

0°C = 32°F and

100°C = 212°F

❑ *CREATING THE FORMULA: F = 1.8C + 32*

Our goal here is to create, from scratch, a formula that converts from degrees Celsius to degrees Fahrenheit. All we need to accomplish this goal are two facts:

0°C = 32°F

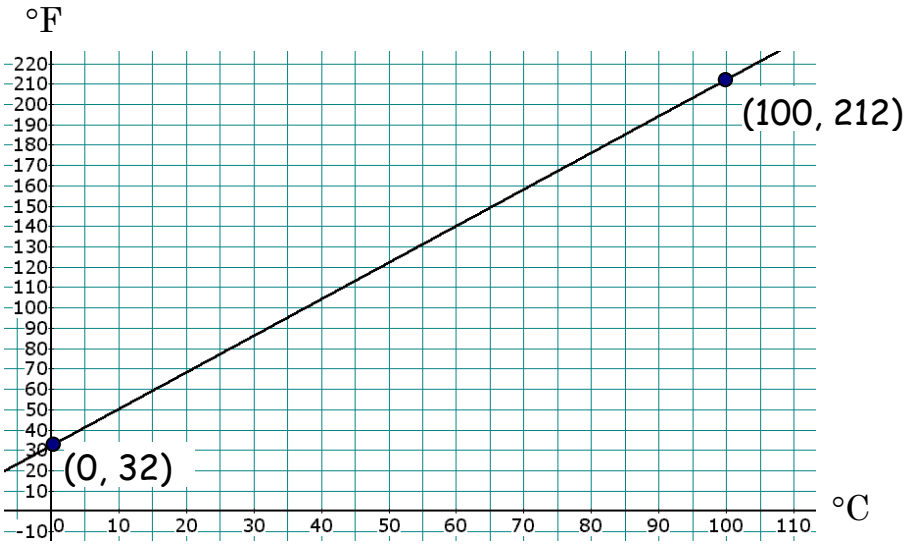
100°C = 212°F

and one assumption:

The relationship is **linear** (the graph is a straight line).

If we label the horizontal axis °C and the vertical axis °F, then the temperature facts above translate into the following two points on the line: (0, 32) and (100, 212).

As we proceed through the derivation, notice that °C is just a new name for x, and °F is a new name for y.



We begin with a linear formula relating °C to °F, where m represents the slope of the line, and b is the "F-intercept."

$$F = mC + b$$ (note that C is the x-value and F is the y-value)

First, we use the two points on the line to calculate the **slope** of the line:

$$m = \frac{\Delta F}{\Delta C} = \frac{212 - 32}{100 - 0} = \frac{180}{100} = 1.8$$

So now our equation is

$$F = 1.8C + b$$

Second, we use one of the given points — we'll use (0, 32) — to find b:

$$\mathbf{32} = 1.8(\mathbf{0}) + b \quad \Rightarrow \quad 32 = 0 + b \quad \Rightarrow \quad 32 = b$$

and we have our equation relating the two temperature scales:

$$\boxed{F = 1.8C + 32}$$

P.S. If using C and F in place of the usual x and y is too confusing, you're welcome to stick with x and y and work through the whole problem. Just be sure you write your final answer using the C and the F, because those are the variables contained in the formula.

❑ CREATING THE FORMULA: $C = \frac{F - 32}{1.8}$

What about the other way around?

> *What if we're given the Fahrenheit temperature and we wish to calculate the Celsius temperature?*

There are three ways we can answer this question.

Answer #1: Use the formula we derived above, $F = 1.8C + 32$, plug in the given Fahrenheit temperature, and solve for C with a little algebra. For example, to convert 50°F to Celsius, we can write

$F = 1.8C + 32$	(the formula we derived)
$\mathbf{50} = 1.8C + 32$	(substitute 50 for F)
$50 = 1.8C + 32$ $\mathbf{-32} \quad\quad \mathbf{-32}$	(subtract 32 from each side)
$18 = 1.8C$	(simplify each side)
$10 = C$	(divide each side by 1.8)

Conclusion: 50°F is equivalent to 10°C.

Answer #2: Just take the formula $F = 1.8C + 32$ and solve for C. After all, why not take advantage of our knowledge of solving formulas?

	$F = 1.8C + 32$	(the formula to find F)
$\Rightarrow$	$F - 32 = 1.8C$	(subtract 32 from each side)
$\Rightarrow$	$\frac{F-32}{\mathbf{1.8}} = \frac{1.8C}{\mathbf{1.8}}$	(divide each side by 1.8)
$\Rightarrow$	$\frac{F-32}{1.8} = C$	(simplify)

And so we now have our Celsius formula: $\boxed{C = \frac{F-32}{1.8}}$

So, to solve the problem stated in Answer #1 — to convert 50°F to °C — we just plug in 50 for F and calculate:

$$C = \frac{F-32}{1.8} = \frac{\mathbf{50}-32}{1.8} = \frac{18}{1.8} = 10$$

and again we conclude that 50°F is equivalent to 10°C.

Answer #3: We could derive the formula for °C by mimicking the derivation of the formula $F = 1.8C + 32$ at the beginning of this chapter.

Homework

1. Derive the temperature formula $C = \frac{F-32}{1.8}$ in the same manner (the graphing) that the formula $F = 1.8C + 32$ was derived.

Solutions

1. Interchange the °C and °F axes, switch the coordinates of the two points on the graph, and proceed with the ideas of slope and intercept.

"It does not matter how slowly you go, as long as you do not stop."

– Confucius –