Temperatures below zero

Zero on a thermometer is not the coldest it can get. How do you name a temperature below zero, compare two of them, and say how far the temperature moved?

WORDS TO KNOW

Degrees Celsius (°C) and Fahrenheit (°F): two temperature scales. Water freezes at 0°C.

Size: the number without its sign, its absolute value. It says how many degrees the reading is from zero.

Range: how far apart a day's high and low are, the high minus the low.

Negative temperature: a temperature below zero. −7°C is read "negative seven degrees Celsius" or "seven degrees below zero".

Change: how much the temperature rose or fell, later minus earlier.

KEY IDEAS

1. Higher on the scale is warmer

A thermometer is a number line stood on end. The numbers grow upward, so the reading higher on the scale is both warmer and the greater number. Below zero, a bigger size means colder: −12°C is 12 degrees below zero, lower than −3°C.

Compare by position on the scale, never by size alone.

$$-12 < -3$$

Every positive temperature is warmer than every negative one, and 0 sits between them.

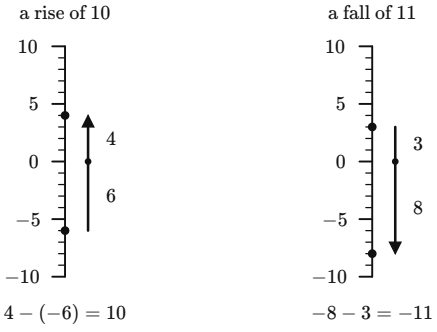
2. Change is later minus earlier

The change is the number you add to the earlier reading to get the later one.

$$\text{change} = \text{later} - \text{earlier} \qquad \text{earlier} = \text{later} - \text{change}$$

A positive change is a rise. A negative change is a fall.

On the left of the picture the temperature climbs 6 degrees to reach zero and 4 more. The subtraction $4 - (-6) = 4 + 6 = 10$ counts both pieces, because subtracting a negative is adding its opposite.



Free sample from math.wiki for classroom use. Do not post. math.wiki

WATCH OUT

- **Do not compare by size.** 25 > 3, but −25°C is colder than −3°C.
- **Subtract later minus earlier.** Swapping the order gives the opposite number, which turns a rise into a fall.
- **"How far apart" has no direction.** The readings −3°C and −16°C are 13 degrees apart in either order. A change has a direction and a sign.
- **Use one scale.** Never subtract a Celsius reading from a Fahrenheit one.

WORKED EXAMPLES

Example 1. Order these temperatures from coldest to warmest: −10°C, 4°C, −3°C, −16°C.

1. The only positive reading, 4, is the warmest.
2. The three negatives sit below zero. The one with the biggest size is the lowest, so −16, then −10, then −3.

Answer: −16°C, −10°C, −3°C, 4°C.

Example 2. At 6 a.m. it is −11°C, at 3 p.m. it is 4°C, and at midnight it is −3°C. Find the change from 6 a.m. to 3 p.m., and from 3 p.m. to midnight.

1. Later minus earlier for the first change.

$$4 - (-11) = 4 + 11 = 15$$

   It is positive, a rise of 15 degrees: 11 up to zero and 4 more.
2. Later minus earlier for the second change.

$$-3 - 4 = -3 + (-4) = -7$$

   It is negative, a fall of 7 degrees.

Answer: a rise of 15 degrees, then a fall of 7 degrees. **Check:** −11 + 15 = 4 and 4 + (−7) = −3.

Example 3. After falling 4 degrees, the temperature is −10°F. What was it before the fall?

1. A fall of 4 is a change of −4. Undo it: earlier = later − change.

$$-10 - (-4) = -10 + 4 = -6$$

Answer: −6°F. **Check:** −6 + (−4) = −10.

Free sample from math.wiki for classroom use. Do not post. math.wiki