1.6: Units of Measurement (part 1)
(sections 1.4 and 1.6 of OpenStax Chemistry 2e)

- In chemistry, **units**—standard quantities used to specify measurements—are critical.
- **The two most common unit systems are:**
  - **Metric system**, used in most of the world
  - **English system**, used in the United States
- Scientists use the **International System of Units (SI)**, which is based on the metric system.
  - The abbreviation *SI* comes from the French phrase *Système International d' Unités.*

Advantages of the Metric System

(1) Universality

Same system used by scientists all over the world

(2) Ease of calculations

Different levels of units are related by powers of 10

(3) Units are based on the physical world

Examples: properties of water, size of the earth

Standard Units

TABLE 1.1 SI Base Units

Quantity	Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

The Meter: A Measure of Length

- The **meter (m)** is slightly longer than a yard (1 yard is 36 inches, while 1 meter is 39.37 inches).

Yardstick

Meterstick

- 1 meter = 1/10,000,000 of the distance from the equator to the North Pole (through Paris).
  - The International Bureau of Weights and Measures now defines it more precisely as the distance light travels through a vacuum in a certain period of time, 1/299,792,458 second.

The Kilogram: A Measure of Mass

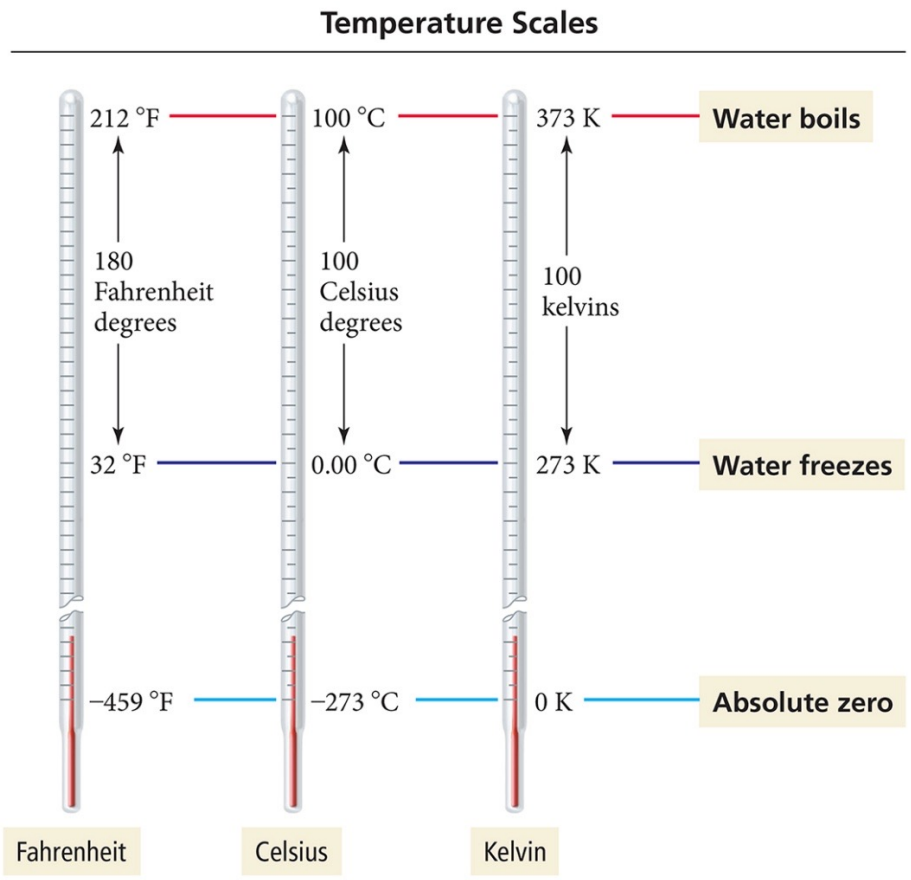
- The **mass** of an object is a measure of the quantity of matter within it.
- The SI unit of mass = kilogram (kg)
  - 1 kg = 2.205 lb
- A second common unit of mass is the gram (g).
  - One gram is 1/1000 kg.
- The **weight** of an object is a measure of the *gravitational pull* on its matter.

The Kelvin: A Measure of Temperature

- The **temperature** is a measure of the average amount of kinetic energy of the atoms or molecules that compose the matter.
- Temperature also determines the direction of transfer of thermal energy, or what we commonly call heat.
- Thermal energy transfers from hot to cold objects.
- The **kelvin (K)** is the SI unit of temperature.

The Kelvin Scale

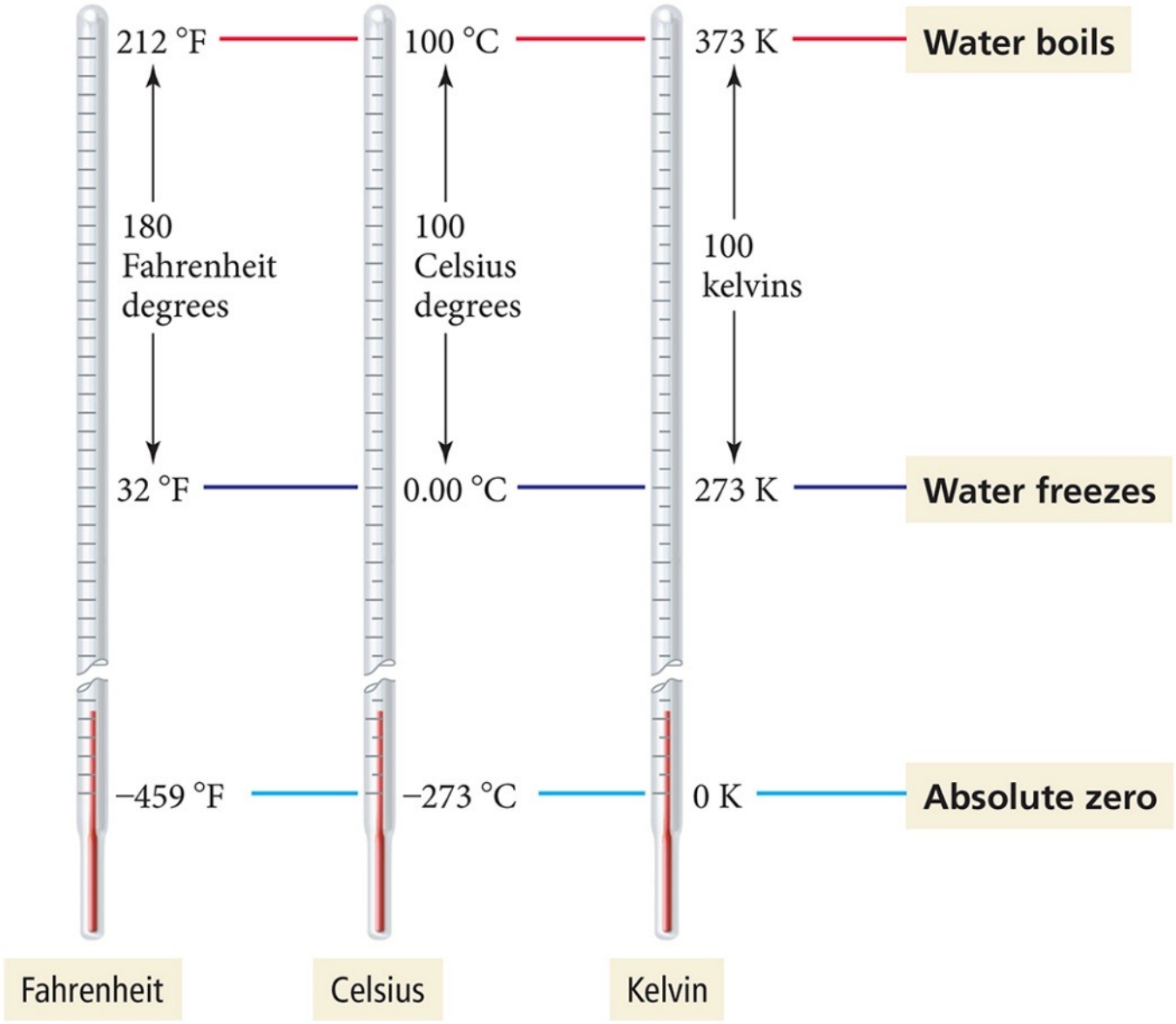
- **Kelvin scale** (*absolute scale*) assigns 0 K (absolute zero) to the coldest temperature possible.
- Absolute zero (–273 ˚C or –459 ˚F) is the temperature at which molecular motion virtually stops. Lower temperatures do not exist.



Temperature Scales: Celsius and Fahrenheit

- In science, temperature is often measured in degrees Celsius (ºC), another metric (but not SI) unit.
- In daily life in the U.S., temperature is generally measured on the Fahrenheit scale.
- The three temperature scales (K, C, and F) have different reference points for the boiling and freezing points of water.
- The temperature differences between the boiling and freezing points of water are divided into degrees.
- This difference is 100 degrees on the Celsius and Kelvin scales, and 180 degrees on the Fahrenheit scale.

Temperature Scales



Temperature Conversions

- The Fahrenheit degree is five-ninths the size of a Celsius degree.
- The Celsius degree and the kelvin degree are the same size.
- Temperature scale conversion is done with the formulas on the right.
- Conversions take into account differences in the zero point as well as degree size.

$$^{\circ}F = 1.8\,^{\circ}C + 32$$

$$^{\circ}C = \frac{(^{\circ}F - 32)}{1.8}$$

$$K = {}^{\circ}C + 273.15$$

Learning Check

The normal body temperature of a chickadee is 105.8 º F. What is that temperature on the Celsius and Kelvin scales?

$$^{\circ}F = 1.8\ ^{\circ}C + 32$$

$$^{\circ}C = \frac{(^{\circ}F - 32)}{1.8}$$

$$K = ^{\circ}C + 273.15$$

Solution to Learning Check

First, convert F to C:

$$T_C = \frac{(T_F - 32\ ^\circ)}{1.8}$$

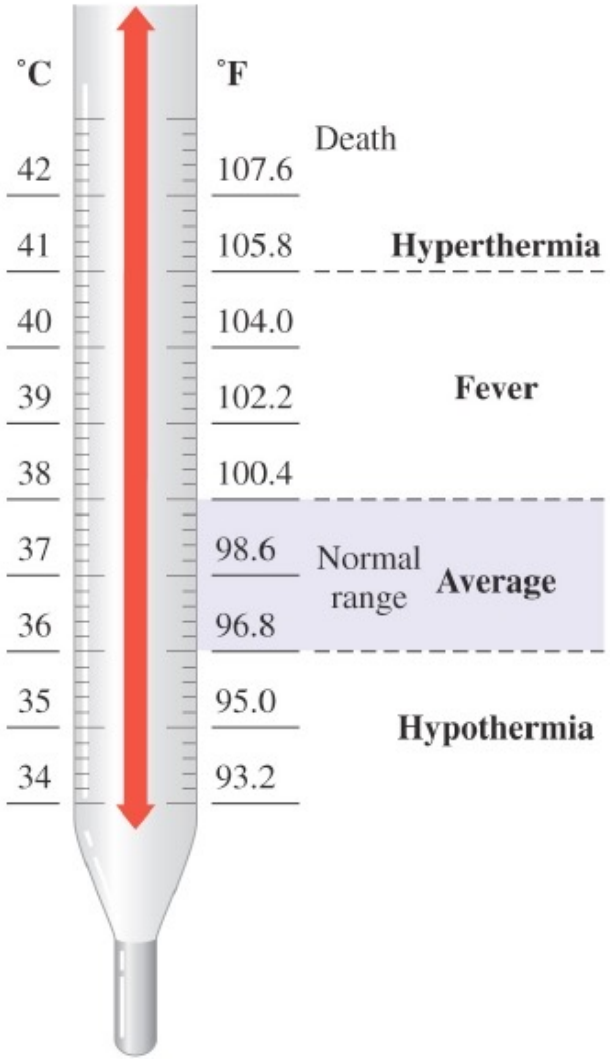
$$= \frac{(105.8\ ^\circ - 32\ ^\circ)}{1.8}$$

$$= \frac{73.8\ ^\circ F}{1.8} = \mathbf{41.0\ ^\circ C}$$

Next, convert C to K:

$$T_K = T_C + 273.15 = 41.0 + 273.15 = \mathbf{314.2\ K}$$

Human Body Temperatures



Typical Normal Temperatures in Various Animals

Animal	° F	° C
Human	98.6	37.0
Dog	102.0	38.9
Cat	102.2	39.0
Horse	101.0	38.3
Rat	99.1	37.3
Cattle	101.5	38.6
Elephant	97.7	36.5

Naked mole rat 30-32
(temp regulated by environment)