Chapter 1
Temperature and Density

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Temperature Scale

This is a measure of hotness. Heat will flow from higher temperature to lower temperatures.

Units:

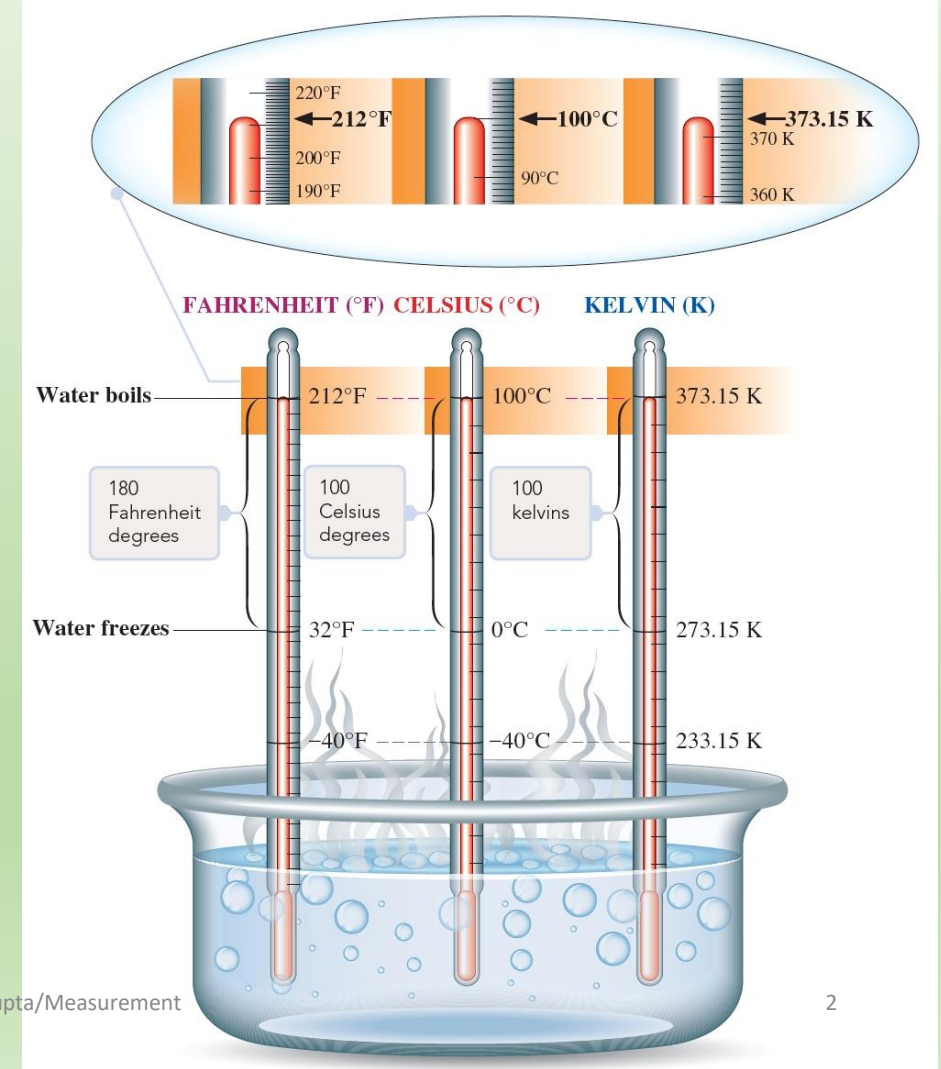
Celsius, °C
Fahrenheit, °F
Kelvin, K

Temperature Unit Conversions:

$^oC = (^oF-32) \times 5/9$

$^oF = 9/5 \times {}^oC + 32$

$K = {}^oC + 273$



Solved Problem:

In winter, the average low temperature in interior Alaska is -30.°F (two significant figures). What is this temperature in degrees Celsius and in kelvins?

$$t_C = (t_F - 32°F)\frac{5°C}{9°F}$$

$$t_C = (-30.°F - 32°F)\frac{5°C}{9°F}$$

$$t_C = (-62°F)\frac{5°C}{9°F}$$

$$t_C = -34.4444444°C$$

$$t_C = -34°C$$

$$t_K = \left(t_C \times \frac{1K}{1°C}\right) + 273.15\,K$$

$$t_K = \left(-34°C \times \frac{1K}{1°C}\right) + 273.15\,K$$

$$t_K = -34\,K + 273.15\,K$$

$$t_K = 239.15\,K$$

$$t_K = 239\,K$$

Derived Units

- These are a combination of the same unit (m^2)or two different units (m/s).

Quantity	Definition of Quantity	SI Unit
Area	length × length	m^2
Volume	length × length × length	m^3
Density	mass per unit volume	kg/m^3
Speed	distance per unit time	m/s
Acceleration	change in speed per unit time	m/s^2

Density

- Mass per unit volume
- Units: g/cm^3 (solids), g/mL (liquids and gases)

Solved Problem:

Oil of wintergreen is a colorless liquid used as a flavoring. A 28.1-g sample of oil of wintergreen has a volume of 23.7 mL. What is the density of oil of wintergreen?

$m = 28.1\,\text{g}$

$V = 23.7\,\text{mL}$

$$d = \frac{m}{V}$$

$$d = \frac{28.1\,\text{g}}{23.7\,\text{mL}}$$

$$d = 1.18565491\,\frac{\text{g}}{\text{mL}}$$

$$d = 1.19\,\frac{\text{g}}{\text{mL}}$$

Solved Problem:

A sample of gasoline has a density of 0.718 g/mL. What is the volume of 454 g of gasoline?

$$\mathrm{m} = 454\ \mathrm{g}$$

$$\mathrm{d} = 0.718\ \frac{\mathrm{g}}{\mathrm{mL}}$$

$$d = \frac{m}{V} \qquad V = \frac{m}{d}$$

$$\mathrm{V} = \frac{454\ \mathrm{g}}{0.718\ \frac{\mathrm{g}}{\mathrm{mL}}}$$

$$V = 632.311978\ \mathrm{mL}$$

$$V = 632\ \mathrm{mL}$$

Dimensional Analysis

- A systematic way of calculating by using units during calculations.
- Start with what you know and then sequentially use conversion factors to get the right answer.
- Tips for Problem Solving
  - Read carefully; find information given and what is asked for
  - Find appropriate equations, constants, conversion factors
  - Check for sign, units and significant figures
  - Check for reasonable answer

Solved Problem:

Convert 12.00 inches to meters.

Conversion factors needed:

2.54 cm = 1 in and 100 cm = 1 meter

$$12.00\,\text{in} \times \frac{2.54\,\text{cm}}{1\,\text{in}} \times \frac{1\,\text{m}}{100\,\text{cm}} = 0.3048\,\text{m}$$

Solved Problem:

The Food and Drug Administration (FDA) recommends that dietary sodium intake be no more than 2400 mg per day. What is this mass in pounds (lb), if 1 lb = 453.6 g?

$$2400\,\text{mg} \times \frac{1\,\text{g}}{1000\,\text{mg}} \times \frac{1\,\text{lb}}{453.6\,\text{g}} = 5.3 \times 10^{-3}\,\text{lb}$$

Key Words/Concepts

- Temperature
- Density
- Dimensional Analysis