Chapter 1 - Matter and Measurement

Section 3 - Temperature and Density

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Introduction

- Temperature is the measure of heat.
- There are three units for measuring temperature: degree centigrade or Celsius (^oC), degree Fahrenheit (^oF) and Kelvin (K).
- Density is a secondary unit, which means a unit from calculation of two units, in this case mass and volume. Density is mass per volume unit.
- A secondary unit can also be area (cm^2) or pressure (force/unit area).

Temperature Scale

Temperature is the measure of hotness. Heat flows from higher temperature to lower temperatures. Of the three units, Kelvin is the SI unit.

Units:

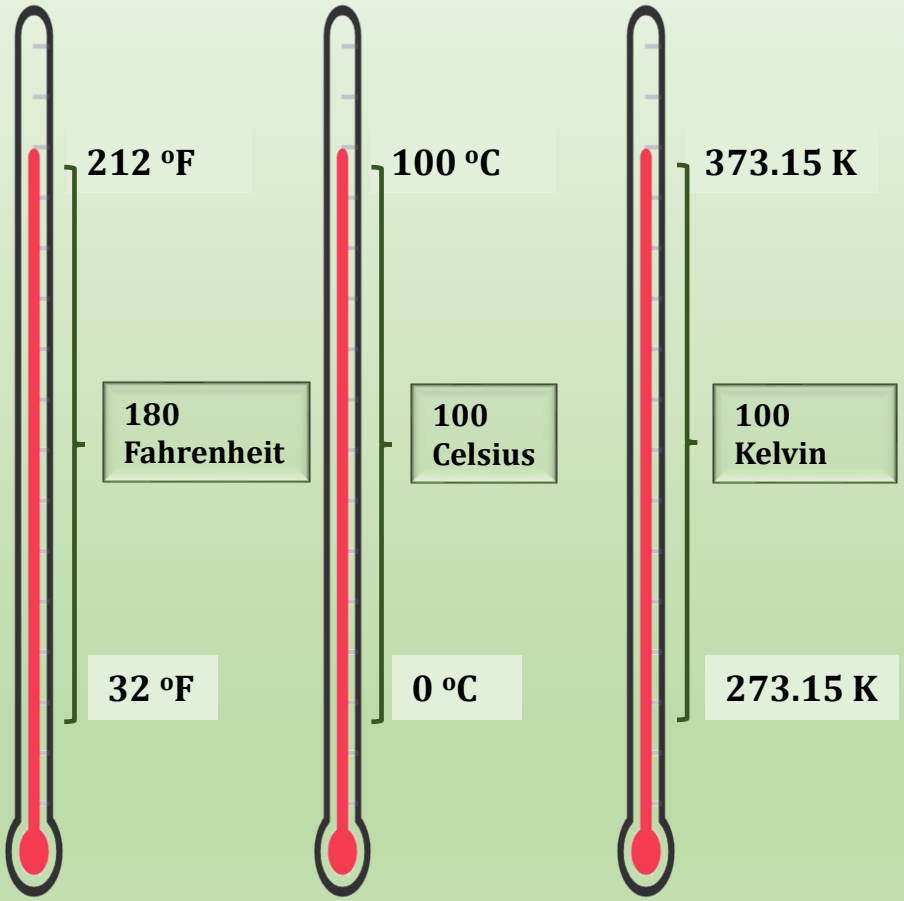
Celsius, °C
Fahrenheit, °F
Kelvin, K

Temperature Unit Conversions:

$^oC = (^oF - 32) \times 0.56$

$^oF = (1.8 \times {}^oC) + 32$

$K = {}^oC + 273$



Solved Problem:
In winter, the average low temperature in interior Alaska is -36.2 °F. What is this temperature in degrees Celsius and in Kelvin?

$^oC = (^oF-32) \times 0.56$
$^oF = (1.8 \times {}^oC) + 32$
$K = {}^oC + 273$

$^oC = (^oF-32) \times 0.56$
$= (-36.2 - 32) \times 0.56$
$= -68.2 \times 0.56$
$= -38.192$
$= -38.2\ ^oC$

$K = {}^oC + 273$
$= -38.192 + 273$
$= 234.808$
$= 235\ K$

Derived or Secondary Units

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

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

- Density gives an idea of how dense a substance is. As an example: a cork will float on water, but stone will sink in water; this implies that cork is lighter or less dense that water, but stone is denser or heavier than water.
- Mathematically density can be calculated as mass per unit volume.
- The units for density can be g/cm^3 (solids), g/mL (liquids and gases).

Some densities:

Aluminum – 2.7 g/cc

Iron – 7.87 g/cc

Gold – 19.3 g/cc

Oil – about 0.80 g/mL

Density is calculated by dividing mass by volume. Make sure you have the correct units.

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

Solved Problem: Calculating density

Oil of wintergreen is a colorless liquid used as a flavoring. A 23.2 g sample of oil of wintergreen has a volume of 20.7 mL. What is the density of oil of wintergreen?

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

$$d = \frac{23.2\ \text{g}}{20.7\ \text{mL}} = 1.12\ \text{g/mL}$$

Solved Problem: Calculating volume using density

A sample of gasoline has a density of 0.325 g/mL. What is the volume of 460. g of gasoline?

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

$$\text{V} = \frac{460\ \text{g}}{0.325\ \frac{\text{g}}{\text{mL}}} = 1415.38\ \text{mL} = 1.42 \times 10^3\ \text{mL}$$

Key Words/Concepts

- Temperature
- Density