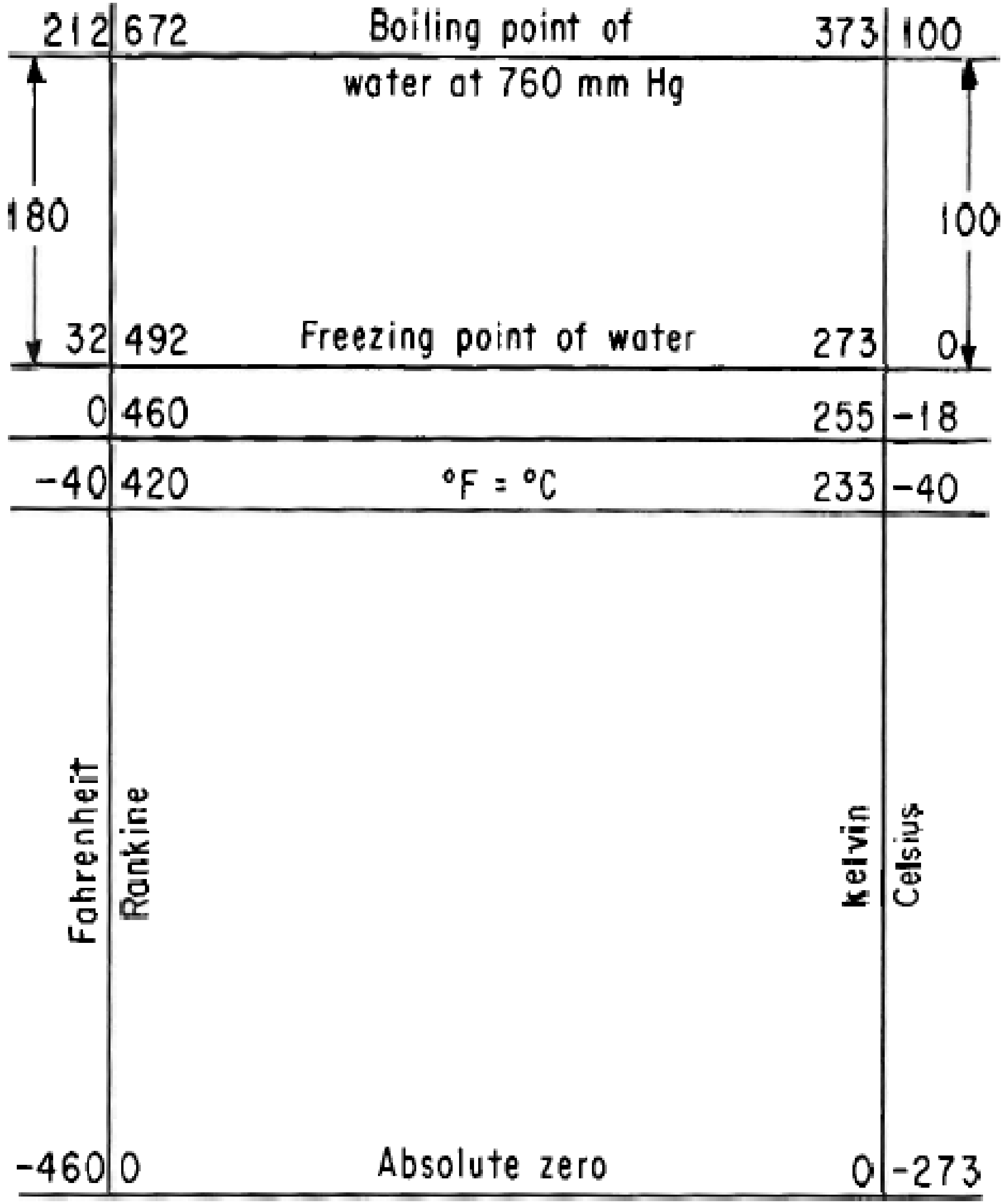
CHAPTER 4: TEMPERATURE

- Temperature is a measure of the energy (mostly kinetic) of the molecules in a system.

- We use four types of temperature, two based on a relative scale, degrees **Fahrenheit** (^{O}F) and **Celsius** (^{O}C), and two based on an absolute scale, degree **Rankine** (^{O}R) and **kelvin** (K)..



212
672
Boiling point of water at 760 mm Hg
373
100
180
100
32
492
Freezing point of water
273
0
0
460
255
-18
-40
420
°F = °C
233
-40
Fahrenheit
Rankine
Kelvin
Celsius
-460
0
Absolute zero
0
-273

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$$\Delta°F = \Delta°R$$

$$\Delta°C = \Delta K$$

$$\frac{\Delta°C}{\Delta°F} = 1.8 \qquad \text{or} \qquad \Delta°C = 1.8\,\Delta°F$$

$$\frac{\Delta K}{\Delta°R} = 1.8 \qquad \text{or} \qquad \Delta K = 1.8\,\Delta°R$$

$$T_{°F} = a + bT_{°C}$$

$$T_{°F} = a_{°F} + \left(\underbrace{\frac{1.8\,\Delta°F}{\Delta°C}}_{b}\right) T_{°C}$$

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$$T_{°R} = T_{°F}\left(\frac{1\ \Delta°R}{1\ \Delta°F}\right) + 460°R$$

$$T_{K} = T_{°C}\left(\frac{1\ \Delta K}{1\ \Delta°C}\right) + 273\ K$$

$$T_{°F} - 32°F = T_{°C}\left(\frac{1.8\ \Delta°F}{1\ \Delta°C}\right)$$

$$T_{°C} = (T_{°F} - 32°F)\left(\frac{1\ \Delta°C}{1.8\ \Delta°F}\right)$$

Example: Convert 100°C to (a) K, (b) ^{O}F, and (c) ^{O}**R.**

Solution:

$$\text{(a)}\quad (100 + 273)^{\circ}\text{C}\,\frac{1\ \Delta\text{K}}{1\ \Delta^{\circ}\text{C}} = 373\ \text{K}$$

$$\text{(b)}\quad (100^{\circ}\text{C})\frac{1.8\ \Delta^{\circ}\text{F}}{1\ \Delta^{\circ}\text{C}} + 32^{\circ}\text{F} = 212^{\circ}\text{F}$$

$$\text{(c)}\quad (212 + 460)^{\circ}\text{F}\,\frac{1\ \Delta^{\circ}\text{R}}{1\ \Delta^{\circ}\text{F}} = 672^{\circ}\text{R}$$

Example: The heat capacity of sulfuric acid has the units J/(g mol)(^{O}C), and is given by the relation:

heat capacity = 139.1 + 1.56 x 10^{-1}T

where T is expressed in ^{O}C. Modify the formula so that the resulting expression has the associated units of Btu/(lb mol) (^{O}R) and T is in ^{O}R.

Solution:

$$\text{heat capacity} = \left\{139.1 + 1.56 \times 10^{-1}\left[\overbrace{(T_{°R} - 460 - 32)\frac{1}{1.8}}^{T_{°C}}\right]\right\}$$

$$\times \frac{1\ \text{J}}{(\text{g mol})(°\text{C})}\left|\frac{1\ \text{Btu}}{1055\ \text{J}}\right|\frac{454\ \text{g mol}}{1\ \text{lb mol}}\left|\frac{1°\text{C}}{1.8°\text{R}}\right. = 23.06 + 2.07 \times 10^{-2}T_{°R}$$