

2.7: The Ideal Gas Constant and Boltzmann's Constant

Having developed the ideal gas equation and analyzed experimental results for a variety of gases, we will have found the value of R . It is useful to have R expressed using a number of different energy units. Frequently useful values are

$$\begin{aligned} R &= 8.314 \text{ Pa m}^3 \text{ K}^{-1} \text{ mol}^{-1} \\ &= 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \\ &= 0.08314 \text{ L bar K}^{-1} \text{ mol}^{-1} \\ &= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1} \\ &= 0.08205 \text{ L atm K}^{-1} \text{ mol}^{-1} \end{aligned}$$

We also need the gas constant expressed per molecule rather than per mole. Since there is Avogadro's number of molecules per mole, we can divide any of the values above by \bar{N} to get R on a per-molecule basis. Traditionally, however, this constant is given a different name; it is **Boltzmann's constant**, usually given the symbol k .

$$k = R/\bar{N} = 1.381 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$$

This means that we can also write the ideal gas equation as $PV = nRT = n\bar{N}kT$. Because the number of molecules in the sample, N , is $N = n\bar{N}$, we have

$$PV = NkT.$$

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