Molar gas constant

Values of ***R***	Units
8.3144621	$J \cdot K^{-1} \cdot mol^{-1}$
0.082057	$L \cdot atm \cdot K^{-1} \cdot mol^{-1}$
8.205736×10^{-5}	$m^3 \cdot atm \cdot K^{-1} \cdot mol^{-1}$
8.3144621	$L \cdot kPa \cdot K^{-1} \cdot mol^{-1}$
8.3144621	$m^3 \cdot Pa \cdot K^{-1} \cdot mol^{-1}$
62.36368	$L \cdot mmHg \cdot K^{-1} \cdot mol^{-1}$
62.36359	$L \cdot torr \cdot K^{-1} \cdot mol^{-1}$
83.144621	$L \cdot mbar \cdot K^{-1} \cdot mol^{-1}$
10.73158	$ft^3 \cdot psi \cdot {}^\circ R^{-1} \cdot lb\text{-}mol^{-1}$
0.73024	$ft^3 \cdot atm \cdot {}^\circ R^{-1} \cdot lb\text{-}mol^{-1}$

The ***R*** value given by the National Institute of Standards and Technology (NIST) is 8.314462 $J \cdot K^{-1} \cdot mol^{-1}$ as of 2010.

The **molar gas constant** (also known as the **universal** or **ideal gas constant** and designated by the symbol ***R***) is an important physical constant which appears in many of the fundamental equations inphysics, chemistry and engineering, such as the ideal gas law, other equations of state and the Nernst equation.

R is equivalent to the Boltzmann constant (designated k_B) times Avogadro's constant (designated N_A) and thus: $R = k_B N_A$. Currently the most accurate value as published by the National Institute of Standards and Technology (NIST) is:[1]

$$R = 8.3144621 \ J \cdot K^{-1} \cdot mol^{-1}$$

A number of values of ***R*** in other units are provided in the adjacent table.

The gas constant occurs in the ideal gas law as follows:

$$PV = nRT$$

or as:

$$PV_m = RT$$

where:

P is the absolute pressure of the gas

T is the absolute temperature of the gas

V is the volume the gas occupies

n is the number of moles of gas

V_m is the molar volume of the gas

The specific gas constant

The gas constant of a specific gas, as differentiated from the above universal molar gas constant which applies for any ideal gas, is designated by the symbol $\boldsymbol{R}_s$ and is equal to the molar gas constant divided by the molecular mass ($\boldsymbol{M}$) of the gas:

$\boldsymbol{R}_s = \boldsymbol{R} \div \boldsymbol{M}$

The specific gas constant for an ideal gas may also be obtained from the following thermodynamicsrelationship:[2]

$\boldsymbol{R}_s = \boldsymbol{c}_p - \boldsymbol{c}_v$

where $\boldsymbol{c}_p$ and $\boldsymbol{c}_v$ are the gas's specific heats at constant pressure and constant volume respectively. Some example values of the specific gas constant are:

- **Ammonia (molecular mass of 17.032 g · mol^{-1}) : $\boldsymbol{R}_s$ = 0.4882 J · K^{-1} · g^{-1}**
- **Hydrogen (molecular mass of 2.016 g · mol^{-1}) : $\boldsymbol{R}_s$ = 4.1242 J · K^{-1} · g^{-1}**
- **Methane (molecular mass of 16.043 g · mol^{-1}) : $\boldsymbol{R}_s$ = 0.5183 J · K^{-1} · g^{-1}**

Unfortunately, many authors in the technical literature sometimes use $\boldsymbol{R}$ as the specific gas constant without designating it as such or stating that it is the specific gas constant. This can and does lead to confusion for many readers.

The U.S. Standard Atmosphere's gas constant

The U.S. Standard Atmosphere is an idealized representation of the Earth's atmosphere from the surface to an altitude of 1,000 kilometers during a period in which solar activity is assumed to be moderate.[3][4]

It consists of a number of models that define values for atmospheric temperature, pressure, density and other properties over that range of altitudes. The first model was published in 1958 by the United States Committee on Extension to the Standard Atmosphere (COESA), and was updated in 1962, 1966 and 1976.

The U.S. COESA models make use of the molar gas constant which is designated as $\boldsymbol{R^*}$ and defined as having a value of:

$\boldsymbol{R^*} = \mathbf{8.31432 \times 10^3\ N \cdot m \cdot kmol^{-1} \cdot K^{-1}}$

which is equivalent to:

$\boldsymbol{R^*} = \mathbf{8.31432\ J \cdot K^{-1} \cdot mol^{-1}}$

The U.S. COESA realizes that their value of $\boldsymbol{R^*}$ differs from NIST's 2010 value of $\boldsymbol{R} = \mathbf{8.3144621\ J \cdot K \cdot mol^{-1}}$ but the difference is evidently deemed not to be significant for their purposes.[3]

References

1. 2010 value of R, from the website of the National Institute of Standards and Technology (NIST).
2. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey (2010), *Fundamentals of Engineering Thermodynamics*, 7th Edition, Wiley, page 131, ISBN: 0-470-49590-1.
3. U.S. Standard Atmosphere 1976, Table 2, PDF page 18 of 241 PDF pages, from the website of the National Aeronautics and Space Administration (NASA).
4. Standard Atmospheres, lists a few errors found in the U.S. Standard Atmosphere 1976, including the value of R.

Units used in this article

- **mol**: The amount of sbstance that has a mass (in grams) equal to its molecular mass (or molecular weight).
- **lb-mol**: The amount of substance that has a mass (in pounds) equal to its molecular mass (or molecular weight).
- **M (molecular mass)**: The ratio of the average mass of one molecule of an element or compound to one twelfth of the mass of an atom of carbon-12.
- **J (joule)**: The Système International (SI) unit of energy.
- **N (newton)**: The SI unit of force.
- **K (kelvin)**: The SI unit of absolute temperature on the Kelvin scale.
- **^{o}R (Rankine)**: A non-SI unit of absolute temperature on the Rankine scale (used mostly in the United States).
- **Pa (pascal)**: The SI unit of pressure.
- **kPa (kilopascal)**: An SI unit of pressure amounting to 1,000 pascals.
- **atm**: A non-SI unit of pressure amounting to 101,325 pascals, equal to the usual atmospheric pressure at sea-level.
- **psi (pound per square inch)**: A non-SI unit of pressure amounting to 6,895 pascals (used mostly in the United States).
- **mmHg (millimeters of mercury)**: A non-SI unit of pressure amounting to 133.32 pascals.
- **torr**: A non-SI unit of pressure amounting to 133.32 pascals.
- **mbar (millibar)**: A non-SI unit of pressure amounting to 100 pascals.
- **m (meter)**: An SI unit of length.
- **m^3 (cubic meter)**: An SI unit of volume.
- **L (liter)**: A non-SI unit of volume amounting to one thousandth of a cubic meter.

Source:
http://www.eoearth.org/view/article/51cbf29e7896bb431f6aa13e/?topic=51cbfc98f702fc2ba812eaa6