TABLE A-2—UNIVERSAL GAS CONSTANT FOR DIFFERENT UNITS

Pressure Unit	Volume Unit	Temperature Unit	Mass (mole) Unit	Gas Constant *R*
psia	ft^3	°R	lbm	10.7315
psia	cm^3	°R	lbm	303,880
psia	cm^3	°R	g	669.94
bar	ft^3	°R	lbm	0.73991
atm	ft^3	°R	lbm	0.73023
atm	cm^3	°R	g	45.586
Pa	m^3	K	kg	8314.3
Pa	m^3	K	g	8.3143
kPa	m^3	K	kg	8.3143
kPa	cm^3	K	g	8314.3
bar	m^3	K	kg	0.083143
bar	cm^3	K	g	83.143
atm	m^3	K	kg	0.082055
atm	cm^3	K	g	82.055
Energy Unit				
Btu		°R	lbm	1.9858
Btu		°R	g	0.0043780
calorie		°R	lbm	500.76
calorie		°R	g	1.1040
kcal		°R	lbm	0.50076
kcal		°R	g	0.0011040
calorie		K	kg	1985.8
calorie		K	g	1.9858
erg		K	kg	8.3143×10^{10}
erg		K	g	8.3143×10^{7}
J		K	kg	8314.3
J		K	g	8.3143

where R is the universal gas constant given in Appendix A for various units (Table A-2). In customary units,

$$R = 10.73146 \frac{\text{psia} \times \text{ft}^3}{^\circ\text{R} \times \text{lbm mol}}, \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.23)$$

while for other units, R can be calculated from the relation

$$R = 10.73146 \left(\frac{p_{\text{unit}}}{\text{psia}}\right)\left(\frac{^\circ\text{R}}{T_{\text{unit}}}\right)\left(\frac{V_{\text{unit}}}{\text{ft}^3}\right)\left(\frac{\text{lbm}}{m_{\text{unit}}}\right). \quad \ldots\ldots\ldots \quad (3.24)$$

For example, the gas constant for SPE-preferred SI units is given by

$$\begin{aligned} R &= 10.73146 \times \left(6.894757 \frac{\text{kPa}}{\text{psia}}\right) \times \left(1.8 \frac{^\circ\text{R}}{\text{K}}\right) \\ &\quad \times \left(0.02831685 \frac{\text{m}^3}{\text{ft}^3}\right) \times \left(2.204623 \frac{\text{lbm}}{\text{kg}}\right) \\ &= 8.3143 \frac{\text{kPa} \cdot \text{m}^3}{\text{K} \cdot \text{kmol}}. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.25) \end{aligned}$$

The gas constant can also be expressed in terms of energy units (e.g., $R = 8.3143$ J/mol · K); note that $\text{J} = \text{N} \cdot \text{m} = (\text{N/m}^2)\,\text{m}^3 = \text{Pa} \cdot \text{m}^3$. In this case, the conversion from one unit system to another is given by

$$R = 8.3143 \left(\frac{E_{\text{unit}}}{\text{J}}\right)\left(\frac{\text{K}}{T_{\text{unit}}}\right)\left(\frac{\text{g}}{m_{\text{unit}}}\right). \quad \ldots\ldots\ldots\ldots\ldots \quad (3.26)$$