# Energy Equivalents

| | J | kg | $m^{-1}$ | Hz |
|---|---|---|---|---|
| 1 J | $(1\ \text{J}) =$<br>1 J | $(1\ \text{J})/c^2 =$<br>$1.112\,650\,056 \times 10^{-17}$ kg | $(1\ \text{J})/hc =$<br>$5.034\,117\,62(39) \times 10^{24}\ \text{m}^{-1}$ | $(1\ \text{J})/h =$<br>$1.509\,190\,50(12) \times 10^{33}$ Hz |
| 1 kg | $(1\ \text{kg})c^2 =$<br>$8.987\,551\,787 \times 10^{16}$ J | $(1\ \text{kg}) =$<br>1 kg | $(1\ \text{kg})c/h =$<br>$4.524\,439\,29(35) \times 10^{41}\ \text{m}^{-1}$ | $(1\ \text{kg})c^2/h =$<br>$1.356\,392\,77(11) \times 10^{50}$ Hz |
| 1 $\text{m}^{-1}$ | $(1\ \text{m}^{-1})hc =$<br>$1.986\,445\,44(16) \times 10^{-25}$ J | $(1\ \text{m}^{-1})h/c =$<br>$2.210\,218\,63(17) \times 10^{-42}$ kg | $(1\ \text{m}^{-1}) =$<br>1 $\text{m}^{-1}$ | $(1\ \text{m}^{-1})c =$<br>299 792 458 Hz |
| 1 Hz | $(1\ \text{Hz})h =$<br>$6.626\,068\,76(52) \times 10^{-34}$ J | $(1\ \text{Hz})h/c^2 =$<br>$7.372\,495\,78(58) \times 10^{-51}$ kg | $(1\ \text{Hz})/c =$<br>$3.335\,640\,952 \times 10^{-9}\ \text{m}^{-1}$ | $(1\ \text{Hz}) =$<br>1 Hz |
| 1 K | $(1\ \text{K})k =$<br>$1.380\,6503(24) \times 10^{-23}$ J | $(1\ \text{K})k/c^2 =$<br>$1.536\,1807(27) \times 10^{-40}$ kg | $(1\ \text{K})k/hc =$<br>$69.503\,56(12)\ \text{m}^{-1}$ | $(1\ \text{K})k/h =$<br>$2.083\,6644(36) \times 10^{10}$ Hz |
| 1 eV | $(1\ \text{eV}) =$<br>$1.602\,176\,462(63) \times 10^{-19}$ J | $(1\ \text{eV})/c^2 =$<br>$1.782\,661\,731(70) \times 10^{-36}$ kg | $(1\ \text{eV})/hc =$<br>$8.065\,544\,77(32) \times 10^{5}\ \text{m}^{-1}$ | $(1\ \text{eV})/h =$<br>$2.417\,989\,491(95) \times 10^{14}$ Hz |
| 1 u | $(1\ \text{u})c^2 =$<br>$1.492\,417\,78(12) \times 10^{-10}$ J | $(1\ \text{u}) =$<br>$1.660\,538\,73(13) \times 10^{-27}$ kg | $(1\ \text{u})c/h =$<br>$7.513\,006\,658(57) \times 10^{14}\ \text{m}^{-1}$ | $(1\ \text{u})c^2/h =$<br>$2.252\,342\,733(17) \times 10^{23}$ Hz |
| 1 $E_\text{h}$ | $(1\ E_\text{h}) =$<br>$4.359\,743\,81(34) \times 10^{-18}$ J | $(1\ E_\text{h})/c^2 =$<br>$4.850\,869\,19(38) \times 10^{-35}$ kg | $(1\ E_\text{h})/hc =$<br>$2.194\,746\,313\,710(17) \times 10^{7}\ \text{m}^{-1}$ | $(1\ E_\text{h})/h =$<br>$6.579\,683\,920\,735(50) \times 10^{15}$ Hz |

Derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 1998 CODATA adjustment of the values of the constants;
1 eV $= (e/\text{C})$ J, 1 u $= m_\text{u} = \frac{1}{12}m(^{12}\text{C}) = 10^{-3}$ kg mol$^{-1}/N_\text{A}$, and $E_\text{h} = 2R_\infty hc = \alpha^2 m_\text{e} c^2$ is the Hartree energy (hartree).

Source: Peter J. Mohr and Barry N. Taylor, CODATA Recommended Values of the Fundamental Physical Constants: 1998, *Journal of Physical and Chemical Reference Data*, Vol. 28, No. 6, 1999 and *Reviews of Modern Physics*, Vol. 72, No. 2, 2000.

# Energy Equivalents

| | J | kg | $\mathrm{m}^{-1}$ | Hz |
|---|---|---|---|---|
| 1 J | $(1\ \mathrm{J})/k =$ $7.242\,964(13) \times 10^{22}$ K | $(1\ \mathrm{J}) =$ $6.241\,509\,74(24) \times 10^{18}$ eV | $(1\ \mathrm{J})/c^2 =$ $6.700\,536\,62(53) \times 10^{9}$ u | $(1\ \mathrm{J}) =$ $2.293\,712\,76(18) \times 10^{17}\ E_\mathrm{h}$ |
| 1 kg | $(1\ \mathrm{kg})c^2/k =$ $6.509\,651(11) \times 10^{39}$ K | $(1\ \mathrm{kg})c^2 =$ $5.609\,589\,21(22) \times 10^{35}$ eV | $(1\ \mathrm{kg}) =$ $6.022\,141\,99(47) \times 10^{26}$ u | $(1\ \mathrm{kg})c^2 =$ $2.061\,486\,22(16) \times 10^{34}\ E_\mathrm{h}$ |
| $1\ \mathrm{m}^{-1}$ | $(1\ \mathrm{m}^{-1})hc/k =$ $1.438\,7752(25) \times 10^{-2}$ K | $(1\ \mathrm{m}^{-1})hc =$ $1.239\,841\,857(49) \times 10^{-6}$ eV | $(1\ \mathrm{m}^{-1})h/c =$ $1.331\,025\,042(10) \times 10^{-15}$ u | $(1\ \mathrm{m}^{-1})hc =$ $4.556\,335\,252\,750(35) \times 10^{-8}\ E_\mathrm{h}$ |
| 1 Hz | $(1\ \mathrm{Hz})h/k =$ $4.799\,2374(84) \times 10^{-11}$ K | $(1\ \mathrm{Hz})h =$ $4.135\,667\,27(16) \times 10^{-15}$ eV | $(1\ \mathrm{Hz})h/c^2 =$ $4.439\,821\,637(34) \times 10^{-24}$ u | $(1\ \mathrm{Hz})h =$ $1.519\,829\,846\,003(12) \times 10^{-16}\ E_\mathrm{h}$ |
| 1 K | $(1\ \mathrm{K}) =$ 1 K | $(1\ \mathrm{K})k =$ $8.617\,342(15) \times 10^{-5}$ eV | $(1\ \mathrm{K})k/c^2 =$ $9.251\,098(16) \times 10^{-14}$ u | $(1\ \mathrm{K})k =$ $3.166\,8153(55) \times 10^{-6}\ E_\mathrm{h}$ |
| 1 eV | $(1\ \mathrm{eV})/k =$ $1.160\,4506(20) \times 10^{4}$ K | $(1\ \mathrm{eV}) =$ 1 eV | $(1\ \mathrm{eV})/c^2 =$ $1.073\,544\,206(43) \times 10^{-9}$ u | $(1\ \mathrm{eV}) =$ $3.674\,932\,60(14) \times 10^{-2}\ E_\mathrm{h}$ |
| 1 u | $(1\ \mathrm{u})c^2/k =$ $1.080\,9528(19) \times 10^{13}$ K | $(1\ \mathrm{u})c^2 =$ $931.494\,013(37) \times 10^{6}$ eV | $(1\ \mathrm{u}) =$ 1 u | $(1\ \mathrm{u})c^2 =$ $3.423\,177\,709(26) \times 10^{7}\ E_\mathrm{h}$ |
| $1\ E_\mathrm{h}$ | $(1\ E_\mathrm{h})/k =$ $3.157\,7465(55) \times 10^{5}$ K | $(1\ E_\mathrm{h}) =$ $27.211\,3834(11)$ eV | $(1\ E_\mathrm{h})/c^2 =$ $2.921\,262\,304(22) \times 10^{-8}$ u | $(1\ E_\mathrm{h}) =$ $1\ E_\mathrm{h}$ |

Derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 1998 CODATA adjustment of the values of the constants; 1 eV $= (e/\mathrm{C})$ J, 1 u $= m_\mathrm{u} = \frac{1}{12}m(^{12}\mathrm{C}) = 10^{-3}$ kg mol$^{-1}/N_\mathrm{A}$, and $E_\mathrm{h} = 2R_\infty hc = \alpha^2 m_\mathrm{e} c^2$ is the Hartree energy (hartree).

Source: Peter J. Mohr and Barry N. Taylor, CODATA Recommended Values of the Fundamental Physical Constants: 1998, *Journal of Physical and Chemical Reference Data*, Vol. 28, No. 6, 1999 and *Reviews of Modern Physics*, Vol. 72, No. 2, 2000.