# Heat Transfer Units Conversion Chart

Thermal conductivity, U-value, R-value and RSI, heat transfer coefficient, heat flux and specific heat

For: Building services, HVAC and mechanical engineers, energy assessors and students

**allunitconversions.com/heat-transfer-conversion-chart**
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| EXACT DEFINITION | FORMULA | REVERSE | WORKED EXAMPLE |
|---|---|---|---|
| 1 BTU = 1055.055 852 62 J (IT), 1 ft = 0.3048 m, 1 °F interval = 5/9 K | RSI = R × 0.1761102; U (W/m²·K) = U (IP) × 5.678263 | R = RSI × 5.678263; U-value = 1 ÷ total R-value | R-19 insulation = 19 × 0.17611 = 3.35 m²·K/W (RSI 3.35), U = 0.299 W/m²·K |

Factors to 7 significant figures; tables to 5. All factors follow from the exact definitions above.

## Multiply-by factors

| Quantity | From | To | Multiply by |
|---|---|---|---|
| Thermal conductivity k | BTU/(h·ft·°F) | W/(m·K) | 1.730735 |
| Thermal conductivity k | W/(m·K) | BTU/(h·ft·°F) | 0.5777893 |
| Thermal conductivity k | BTU·in/(h·ft²·°F) | W/(m·K) | 0.1442279 |
| Thermal conductivity k | W/(m·K) | BTU·in/(h·ft²·°F) | 6.933472 |
| Thermal conductivity k | kcal/(h·m·°C) | W/(m·K) | 1.163 |
| U-value, heat transfer coefficient | BTU/(h·ft²·°F) | W/(m²·K) | 5.678263 |
| U-value, heat transfer coefficient | W/(m²·K) | BTU/(h·ft²·°F) | 0.1761102 |
| U-value, heat transfer coefficient | kcal/(h·m²·°C) | W/(m²·K) | 1.163 |
| Thermal resistance R | h·ft²·°F/BTU (R-value) | m²·K/W (RSI) | 0.1761102 |
| Thermal resistance R | m²·K/W (RSI) | h·ft²·°F/BTU (R-value) | 5.678263 |
| Heat flux | BTU/(h·ft²) | W/m² | 3.154591 |
| Heat flux | W/m² | BTU/(h·ft²) | 0.3169983 |
| Specific heat capacity | BTU/(lb·°F) | kJ/(kg·K) | 4.1868 |
| Specific heat capacity | kcal/(kg·°C) | kJ/(kg·K) | 4.1868 |
| Specific heat capacity | kJ/(kg·K) | BTU/(lb·°F) | 0.2388459 |

## Insulation R-value to RSI and U-value

| R-value (h·ft²·°F/BTU) | RSI (m²·K/W) | U (W/m²·K) | U (BTU/h·ft²·°F) |
|---|---|---|---|
| **1** | 0.18 | 5.678 | 1.0000 |
| **2** | 0.35 | 2.839 | 0.5000 |
| **3** | 0.53 | 1.893 | 0.3333 |
| **4** | 0.70 | 1.420 | 0.2500 |
| **5** | 0.88 | 1.136 | 0.2000 |
| **6** | 1.06 | 0.946 | 0.1667 |
| **8** | 1.41 | 0.710 | 0.1250 |
| **10** | 1.76 | 0.568 | 0.1000 |
| **11** | 1.94 | 0.516 | 0.0909 |
| **13** | 2.29 | 0.437 | 0.0769 |

| R-value (h·ft²·°F/BTU) | RSI (m²·K/W) | U (W/m²·K) | U (BTU/h·ft²·°F) |
|---|---|---|---|
| **15** | 2.64 | 0.379 | 0.0667 |
| **19** | 3.35 | 0.299 | 0.0526 |
| **21** | 3.70 | 0.270 | 0.0476 |
| **25** | 4.40 | 0.227 | 0.0400 |
| **30** | 5.28 | 0.189 | 0.0333 |
| **38** | 6.69 | 0.149 | 0.0263 |
| **40** | 7.04 | 0.142 | 0.0250 |
| **49** | 8.63 | 0.116 | 0.0204 |
| **50** | 8.81 | 0.114 | 0.0200 |
| **60** | 10.57 | 0.095 | 0.0167 |

## U-value (W/m²·K) to imperial U and R-value

| U (W/m²·K) | U (BTU/h·ft²·°F) | R-value (IP) | RSI (m²·K/W) |
|---|---|---|---|
| **0.1** | 0.0176 | 56.8 | 10.00 |
| **0.11** | 0.0194 | 51.6 | 9.09 |
| **0.13** | 0.0229 | 43.7 | 7.69 |

| U (W/m²·K) | U (BTU/h·ft²·°F) | R-value (IP) | RSI (m²·K/W) |
|---|---|---|---|
| **0.45** | 0.0792 | 12.6 | 2.22 |
| **0.5** | 0.0881 | 11.4 | 2.00 |
| **0.7** | 0.1233 | 8.1 | 1.43 |

| U (W/m²·K) | U (BTU/h·ft²·°F) | R-value (IP) | RSI (m²·K/W) |
|---|---|---|---|
| **0.15** | 0.0264 | 37.9 | 6.67 |
| **0.16** | 0.0282 | 35.5 | 6.25 |
| **0.18** | 0.0317 | 31.5 | 5.56 |
| **0.2** | 0.0352 | 28.4 | 5.00 |
| **0.25** | 0.0440 | 22.7 | 4.00 |
| **0.28** | 0.0493 | 20.3 | 3.57 |
| **0.3** | 0.0528 | 18.9 | 3.33 |
| **0.35** | 0.0616 | 16.2 | 2.86 |

| U (W/m²·K) | U (BTU/h·ft²·°F) | R-value (IP) | RSI (m²·K/W) |
|---|---|---|---|
| **1** | 0.1761 | 5.7 | 1.00 |
| **1.4** | 0.2466 | 4.1 | 0.71 |
| **1.6** | 0.2818 | 3.5 | 0.63 |
| **2** | 0.3522 | 2.8 | 0.50 |
| **2.8** | 0.4931 | 2.0 | 0.36 |
| **4.8** | 0.8453 | 1.2 | 0.21 |
| **5.7** | 1.0038 | 1.0 | 0.18 |

## Thermal conductivity

| k (W/m·K) | BTU/(h·ft·°F) | BTU·in/(h·ft²·°F) | kcal/(h·m·°C) |
|---|---|---|---|
| **0.02** | 0.011556 | 0.13867 | 0.017197 |
| **0.025** | 0.014445 | 0.17334 | 0.021496 |
| **0.03** | 0.017334 | 0.208 | 0.025795 |
| **0.035** | 0.020223 | 0.24267 | 0.030095 |
| **0.04** | 0.023112 | 0.27734 | 0.034394 |
| **0.05** | 0.028889 | 0.34667 | 0.042992 |
| **0.1** | 0.057779 | 0.69335 | 0.085985 |
| **0.15** | 0.086668 | 1.04 | 0.12898 |
| **0.2** | 0.11556 | 1.3867 | 0.17197 |
| **0.5** | 0.28889 | 3.4667 | 0.42992 |

| k (W/m·K) | BTU/(h·ft·°F) | BTU·in/(h·ft²·°F) | kcal/(h·m·°C) |
|---|---|---|---|
| **1** | 0.57779 | 6.9335 | 0.85985 |
| **2** | 1.1556 | 13.867 | 1.7197 |
| **5** | 2.8889 | 34.667 | 4.2992 |
| **10** | 5.7779 | 69.335 | 8.5985 |
| **16** | 9.2446 | 110.94 | 13.758 |
| **50** | 28.889 | 346.67 | 42.992 |
| **100** | 57.779 | 693.35 | 85.985 |
| **200** | 115.56 | 1,386.7 | 171.97 |
| **237** | 136.94 | 1,643.2 | 203.78 |
| **401** | 231.69 | 2,780.3 | 344.8 |

## Heat transfer coefficient h

| h (W/m²·K) | BTU/(h·ft²·°F) | kcal/(h·m²·°C) |
|---|---|---|
| **2** | 0.35222 | 1.7197 |
| **5** | 0.88055 | 4.2992 |
| **10** | 1.7611 | 8.5985 |
| **25** | 4.4028 | 21.496 |
| **50** | 8.8055 | 42.992 |
| **100** | 17.611 | 85.985 |
| **250** | 44.028 | 214.96 |

| h (W/m²·K) | BTU/(h·ft²·°F) | kcal/(h·m²·°C) |
|---|---|---|
| **500** | 88.055 | 429.92 |
| **1,000** | 176.11 | 859.85 |
| **2,500** | 440.28 | 2,149.6 |
| **5,000** | 880.55 | 4,299.2 |
| **10,000** | 1,761.1 | 8,598.5 |
| **20,000** | 3,522.2 | 17,197 |
| **100,000** | 17,611 | 85,985 |

## Typical convection heat transfer coefficients

| Process | h (W/m²·K) | h (BTU/h·ft²·°F) |
|---|---|---|
| Free convection, gases | 2–25 | 0.35–4.4 |
| Free convection, liquids | 50–1,000 | 8.8–176 |
| Forced convection, gases | 25–250 | 4.4–44 |
| Forced convection, liquids | 100–20,000 | 17.6–3,522 |
| Boiling or condensation | 2,500–100,000 | 440–17,611 |

## Heat flux

| W/m² | BTU/(h·ft²) | kW/m² |
|---|---|---|
| **1** | 0.317 | 0.001 |
| **10** | 3.17 | 0.01 |
| **50** | 15.85 | 0.05 |
| **100** | 31.7 | 0.1 |
| **500** | 158.5 | 0.5 |

| W/m² | BTU/(h·ft²) | kW/m² |
|---|---|---|
| **1,000** | 317 | 1 |
| **1,361** | 431.43 | 1.361 |
| **5,000** | 1,585 | 5 |
| **10,000** | 3,170 | 10 |
| **100,000** | 31,700 | 100 |

## Specific heat of liquid water at 1 atm (IAPWS-IF97)

| T (°C) | T (°F) | cp (kJ/kg·K) | cp (BTU/lb·°F) | T (°C) | T (°F) | cp (kJ/kg·K) | cp (BTU/lb·°F) |
|---|---|---|---|---|---|---|---|
| **0.01** | 32.02 | 4.2194 | 1.0078 | **50** | 122 | 4.1796 | 0.9983 |
| **10** | 50 | 4.1954 | 1.0021 | **60** | 140 | 4.1828 | 0.9990 |
| **20** | 68 | 4.1848 | 0.9995 | **70** | 158 | 4.1881 | 1.0003 |
| **25** | 77 | 4.1819 | 0.9988 | **80** | 176 | 4.1955 | 1.0021 |
| **30** | 86 | 4.1800 | 0.9984 | **90** | 194 | 4.2050 | 1.0043 |
| **40** | 104 | 4.1786 | 0.9980 | **99** | 210.2 | 4.2154 | 1.0068 |

## Heat transfer formulas

| Formula | Meaning | Worked example |
|---|---|---|
| **Q = m × c × ΔT** | Heat to change the temperature of a mass | Heating 10 kg of water by 50 K: 10 × 4.18 × 50 = 2,090 kJ (0.58 kWh) |
| **q = k × A × ΔT ÷ L** | Conduction through a slab | k 0.04, 10 $m^2$, 20 K, 0.1 m: q = 80 W |
| **q = U × A × ΔT** | Heat loss through a wall or window | U 0.3, 50 $m^2$, 20 K: q = 300 W |
| **U = 1 ÷ ΣR** | U-value from the layer resistances (including surfaces) | R total 3.33 $m^2$·K/W: U = 0.30 W/$m^2$·K |
| **R = L ÷ k** | Resistance of one layer | 100 mm at k 0.035: R = 2.86 $m^2$·K/W |

## Sources and method

- **NIST Special Publication 811** — Conversion factors; BTU is the International Table BTU (1055.055 852 62 J) (www.nist.gov/pml/special-publication-811)
- **IAPWS-IF97 (IAPWS R7-97, 2012 revision)** — Industrial formulation for the thermodynamic properties of water and steam; reference state u = s = 0 for saturated liquid at the triple point (iapws.org/relguide/IF97-Rev.html)
- **Incropera et al., Fundamentals of Heat and Mass Transfer** — Table 1.1, typical convection heat transfer coefficients

Every factor is calculated from the exact definitions of the BTU, foot, pound and degree Fahrenheit; specific heat of water is calculated with IAPWS-IF97. Interactive version, corrections and more charts: **allunitconversions.com/heat-transfer-conversion-chart**