Thermal Conductivity from Electrical Conductivity (Wiedemann–Franz)

Electronic thermal conductivity of a metal from its electrical resistivity and temperature by the Wiedemann–Franz law, with the Sommerfeld Lorenz number.

Method: Wiedemann–Franz law with the Sommerfeld value

Input parameters

Unit system: SI

Parameter	Value	Unit
Electrical resistivity at T	1.7200	μΩ·cm
Temperature	20.000	°C
Lorenz number (0 = theoretical value)	0	

Calculated results

Parameter	Value	Unit
Sommerfeld Lorenz number π²k²/3e²	2.4430e-08	
Electronic thermal conductivity	416.38	W/(m·K)
Electrical conductivity	5.8140e+07	S/m

Notes for this case

• In metals the same free electrons carry charge and heat, so k/σ = LT with $L_0 = (\pi^2/3)(k_B/e)^2 = 2.44 \times 10^{-8}$ W·Ω/K². It holds well for pure metals near and above room temperature (copper: 1.72 μΩ·cm at 293 K gives about 416 W/m·K, measured 398). It fails at intermediate low temperatures, and for alloys and poorer conductors the lattice (phonon) part adds noticeably to k. Enter a measured Lorenz number to override L_0.

Formula and method

$$k_e = L_0 \sigma T, \quad L_0 = \frac{\pi^2}{3}\left(\frac{k_B}{e}\right)^2$$

Variables

ρ	Electrical resistivity at T	Ω·m
T	Temperature	K
L	Lorenz number (0 = theoretical value)	-
L_0	Sommerfeld Lorenz number π²k²/3e²	-
k_e	Electronic thermal conductivity	W/(m·K)
σ	Electrical conductivity	S/m

Method and standards

Wiedemann–Franz.

Assumptions and limits

- Free-electron metal; elastic scattering.

References

Wiedemann–Franz law with the Sommerfeld value

Report details

Report reference	FCC-Y7W1-HGE9 (the same inputs always give the same reference)
Generated	23 November 2026, 17:51 UTC
Calculator	Thermal Conductivity from Electrical Conductivity (Wiedemann–Franz)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/properties/wiedemann-franz-thermal-conductivity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.