Thermal Effusivity and Contact Temperature

Thermal effusivity of two materials and the interface temperature when they touch, which explains why metal feels colder than wood at the same temperature.

Method: Contact of two semi-infinite solids

Input parameters

Unit system: SI

Parameter	Value	Unit
Body 1 thermal conductivity	0.37000	W/(m·K)
Body 1 density	1,000.0	kg/m³
Body 1 specific heat	3.5000	kJ/(kg·K)
Body 1 temperature	34.000	°C
Body 2 thermal conductivity	50.000	W/(m·K)
Body 2 density	7,850.0	kg/m³
Body 2 specific heat	0.46000	kJ/(kg·K)
Body 2 temperature	20.000	°C

Calculated results

Parameter	Value	Unit
Effusivity of body 1 (W·s½/m²·K)	1,138.0	
Effusivity of body 2 (W·s½/m²·K)	13,437	
Contact (interface) temperature	21.093	°C
Weight of body 1's temperature	7.8078	%

Notes for this case

• Two semi-infinite bodies brought into perfect contact jump at once to a constant interface temperature T_c = (e₁T₁ + e₂T₂)/(e₁ + e₂), where e = √(kρc) is the thermal effusivity. Skin (e ≈ 1,000–1,800) touching steel (e ≈ 13,000) ends up near the steel's temperature, so steel feels cold; touching wood (e ≈ 400) the interface stays near skin temperature. The result holds for short contacts before heat reaches the far side of either body.

Formula and method

$$e = \sqrt{k\rho c}, \quad T_c = \frac{e_1 T_1 + e_2 T_2}{e_1 + e_2}$$

Variables

k_1	Body 1 thermal conductivity	W/(m·K)
ρ_1	Body 1 density	kg/m³
c_1	Body 1 specific heat	J/(kg·K)
T_1	Body 1 temperature	K
k_2	Body 2 thermal conductivity	W/(m·K)
ρ_2	Body 2 density	kg/m³
c_2	Body 2 specific heat	J/(kg·K)
T_2	Body 2 temperature	K
e_1	Effusivity of body 1 (W·s½/m²·K)	-
e_2	Effusivity of body 2 (W·s½/m²·K)	-
T_c	Contact (interface) temperature	K

w_1	Weight of body 1's temperature	-

Method and standards

Contact temperature.

Assumptions and limits

- Semi-infinite bodies; perfect contact; constant properties.

References

Contact of two semi-infinite solids

Report details

Report reference	FCC-24XR-YMZ5 (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Thermal Effusivity and Contact Temperature
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/thermal-effusivity-contact-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.