Brinell, Vickers and Knoop Hardness from Indentations

Brinell hardness from ball diameter and impression diameter, Vickers hardness from the mean diagonal and Knoop hardness from the long diagonal, with the test loads.

Method: Indentation hardness definitions

Input parameters

Unit system: SI

Parameter	Value	Unit
Brinell load	3,000.0	kgf
Brinell ball diameter	10.000	mm
Brinell impression diameter	4.2000	mm
Vickers load	30.000	kgf
Vickers mean diagonal	0.42000	mm
Knoop load	0.50000	kgf
Knoop long diagonal	0.10500	mm

Calculated results

Parameter	Value	Unit
Brinell hardness	206.53	
Meyer hardness (load/projected area)	2,123.5	MPa
Vickers hardness	315.37	
Knoop hardness	645.31	
Brinell d/D (valid 0.24–0.6)	0.42000	

Notes for this case

• Hardness numbers are load in kgf over indentation area in mm². Brinell: HB = 2F/[πD(D − √(D² − d²))] over the spherical cap; Meyer hardness uses the projected area. Vickers (136° pyramid): HV = 1.8544F/d². Knoop (elongated pyramid): HK = 14.229F/L². Valid Brinell tests need d/D between about 0.24 and 0.6 and thick enough specimens; converting between scales needs material-specific relations, not these formulas.

Formula and method

$$HB = \frac{2F}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}, \quad HV = \frac{1.8544F}{d_V^2}, \quad HK = \frac{14.229F}{L_K^2}$$

Variables

F_B	Brinell load	N
D	Brinell ball diameter	m
d	Brinell impression diameter	m
F_V	Vickers load	N
d_V	Vickers mean diagonal	m
F_K	Knoop load	N
L_K	Knoop long diagonal	m
HB	Brinell hardness	-
HM	Meyer hardness (load/projected area)	Pa
HV	Vickers hardness	-
HK	Knoop hardness	-

d/D	Brinell d/D (valid 0.24–0.6)	-

Method and standards

Indentation hardness.

Assumptions and limits

- Loads in kgf, lengths in mm inside the formulas.

References

Indentation hardness definitions

Report details

Report reference	FCC-CW7C-04SR (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Brinell, Vickers and Knoop Hardness from Indentations
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/indentation-hardness

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.