〔Technical Data〕Quantity Symbols, Unit Symbols, Chemical Symbols and Element Symbols Excerpts from JIS Z 8202
Calculation of Cubic Volume and Weight/Physical Properties of Materials

■Greek Symbols

Uppercase	Lowercase	Pronunciation	Conventional Usage
Α	α	alpha	Angle, coefficient
Β	β	beta	Angle, coefficient
Γ	γ	gamma	Angle, weight per unit area, Relation (uppercase)
Δ	δ	delta	Fine difference, density, displacement
Ε	ε	epsilon	Fine quantity, distortion
Ζ	ζ	zeta	Variable
Η	η	eta	Variable
Θ	θ	theta	Angle, temperature, time
Ι	ι	iota	
Κ	κ	kappa	Rotational radius
Λ	λ	lambda	Wavelength, characteristic value
Μ	μ	mu	Friction coefficient 10^{-6} (Micro)
Ν	ν	nu	Frequency
Ξ	ξ	xi	Variable
Ο	ο	omicron	
Π	π	pi	Number π (3.14159…)、Angle
			volume (uppercase)
Ρ	ρ	rho	Radius, density
Σ	σ	sigma	Stress, standard deviation, summation (uppercase)
Τ	τ	tau	Time constant, time, torque
Υ	υ	upsilon	
Φ	φ, φ	phi	Angle, function, diameter
Χ	χ	chi	
Ψ	ψ	psi	Angle, function
Ω	ω	omega	Angular velocity : 2πf Ohm : Unit of electric resistivity (uppercase)

Note : Unless otherwise specified, lowercase letters are the norm.

■Characteristics of Metals

Materials	Specific Gravity	Thermal Expansion Coefficient ×10⁻⁶/℃	Young's Modulus GPa	Young's Modulus {Kgf/mm²}
Mild steel	7.85	11.7	214	21000
NAK80	7.8	12.5	209	20500
D2	7.85	11.7	214	21000
H13	7.75	10.8	214	21000
M2	8.2	10.1	227	22300
Carbide V30	14.1	6.0	571	56000
Carbide V40	13.9	6.0	551	54000
Cast iron	7.3	9.2~11.8	76~107	7500~10500
SUS304	8.0	17.3	201	19700
SUS440C	7.78	10.2	208	20400
C10200	8.9	17.6	119	11700
C28000	8.4	20.8	105	10300
C17200	8.3	17.1	133	13000
Aluminum 1100	2.7	23.6	70	6900
Duralumin 7075	2.8	23.6	73	7200
Titanium	4.5	8.4	108	10600

■Atomic Symbols

Atomic Number	Name	Symbol	Atomic Number	Name	Symbol
1	Hydrogen	H	53	Iodine	I
2	Helium	He	54	Xenon	Xe
3	Lithium	Li	55	Cesium	Cs
4	Beryllium	Be	56	Barium	Ba
5	Boron	B	57	Lanthanum	La
6	Carbon	C	58	Cerium	Ce
7	Nitrogen	N	59	Praseodymium	Pr
8	Oxygen	O	60	Neodymium	Nd
9	Fluorine	F	61	Promethium	Pm
10	Neon	Ne	62	Samarium	Sm
11	Sodium	Na	63	Europium	Eu
12	Magnesium	Mg	64	Gadolinium	Gd
13	Aluminum	Al	65	Terbium	Tb
14	Silicon	Si	66	Dysproium	Dy
15	Phosphorous	P	67	Holmium	Ho
16	Sulfur	S	68	Erbium	Er
17	Chlorine	Cl	69	Thulium	Tm
18	Argon	Ar	70	Ytterbium	Yb
19	Potassium	K	71	Lutetium	Lu
20	Calcium	Ca	72	Hafnium	Hf
21	Scandium	Sc	73	Tantalum	Ta
22	Titanium	Ti	74	Tungsten	W
23	Vanadium	V	75	Rhenium	Re
24	Chromium	Cr	76	Osmium	Os
25	Manganese	Mn	77	Iridium	Ir
26	Iron	Fe	78	Platinum	Pt
27	Cobalt	Co	79	Gold	Au
28	Nickel	Ni	80	Mercury	Hg
29	Brass	Cu	81	Thallium	Tl
30	Zinc	Zn	82	Lead	Pb
31	Gallium	Ga	83	Bismuth	Bi
32	Germanium	Ge	84	Polonium	Po
33	Arsenic	As	85	Astatine	At
34	Selenium	Se	86	Radon	Rn
35	Bromine	Br	87	Francium	Fr
36	Krypton	Kr	88	Radium	Ra
37	Rubidium	Rb	89	Actinium	Ac
38	Strontium	Sr	90	Thorium	Th
39	Yttrium	Y	91	Protactinium	Pa
40	Zirconium	Zr	92	Uranium	U
41	Niobium	Nb	93	Neptunium	Np
42	Molybdenum	Mo	94	Plutonium	Pu
43	Technetium	Tc	95	Americium	Am
44	Ruthenium	R	96	Curium	Cm
45	Rhodium	Rh	97	Berkelium	Bk
46	Palladium	Pd	98	Californium	Cf
47	Silver	Ag	99	Einsteinium	Es
48	Cadmium	Cd	100	Fermium	Fm
49	Indium	In	101	Mendelevium	Md
50	Tin	Sn	102	Nobelium	No
51	Antimony	Sb	103	Lawrencium	Lr
52	Tellurium	T			

Note This table was excerpt from Appendix A(Symbols and Atomic Numbers for Chemical Elements) of ISO 31/8-1980 (Quantities and Units of Physical Chemistry and Molecular Physics) and Appendix C (Names and Symbols for Radionuclide) of ISO 31/9-1980 (Quantities and Units of Atomic Physics and Nuclear Physics).

■How to Calculate the Volume

Solid	Volume V
Turncated cylinder	$V=\frac{\pi}{4}d^2h$ $=\frac{\pi}{4}d^2\left(\frac{h_1+h_2}{2}\right)$
Pyramid	$V=\frac{h}{3}A=\frac{h}{6}arn$ A = Area of base r = Radius of inscribed circle a = Length of a side of a regular polygon n = Number of the sides of a regular polygon
Spherical crown	$V=\frac{\pi h^2}{3}(3r-h)$ $=\frac{\pi h}{6}(3a^2+h^2)$ a is the radius.
Ellipsoid	$V=\frac{4}{3}\pi abc$ In case of a spheroid (b=c) $V=\frac{4}{3}\pi ab^2$

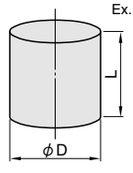
Solid	Volume V
Oval ring	$V=\frac{\pi^2}{4}d^2\frac{\sqrt{a^2+b^2}}{2}$
Cross cylinder	$V=\frac{\pi}{4}d^2\left(\ell+\ell'-\frac{d}{3}\right)$
Hollow cylinder	$V=\frac{\pi}{4}h(D^2-d^2)$ $=\pi th(D-t)$ $=\pi th(d+t)$
Turncated pyramid	$V=\frac{h}{3}(A+a+\sqrt{Aa})$ A,a=area of both ends

Three-dimensional object	Volume V
Spherical segment	$V=\frac{2}{3}\pi r^2h$ $=2.0944r^2h$
Torus	$V=2\pi^2Rr^2$ $=19.739Rr^2$ $=\frac{\pi^2}{3}Dd^2$ $=2.4674Dd^2$
Circular cone	$V=\frac{\pi}{3}r^2h$ $=1.0472r^2h$
Sphere	$V=\frac{4}{3}\pi r^3=4.1888r^3$ $=\frac{\pi}{6}d^3=0.5236d^3$

Solid	Volume V
Spherical belt	$V=\frac{\pi h}{6}(3a^2+3b^2+h^2)$
Barrel	When circumferance makes a curve equal to the circular arc, $V=\frac{\pi\ell}{12}(2D^2+d^2)$ When circumferance makes a curve equal to a parabolic line, $V=0.209\ell(2D^2d+1/4d^2)$

■How to Calculate the Weight

Weight W[g] = Volume[cm³] × Specific gravity



Ex. : Mild steel

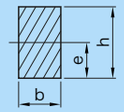
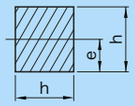
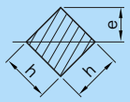
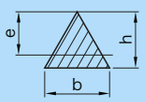
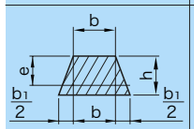
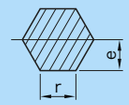
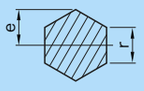
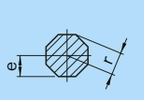
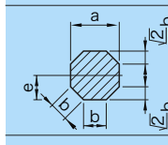
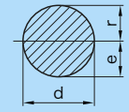
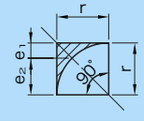
ϕD = 16 and L = 50mm, the weight is:

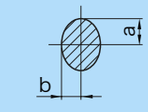
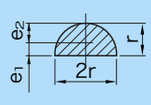
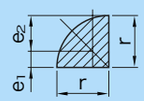
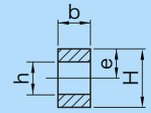
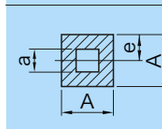
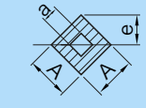
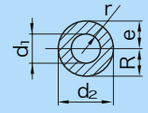
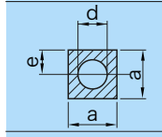
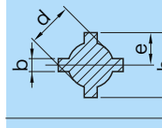
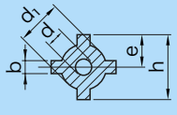
$W=\frac{\pi}{4}D^2\times L\times$ Specific gravity

$=\frac{\pi}{4}\times1.6^2\times5\times7.85$

≒79[g]

〔Technical Data〕
Calculation of Area, Center of Gravity and Sectional Secondary Moment

Section	A	e	I	Z=I/e
	bh	$\frac{h}{2}$	$\frac{bh^3}{12}$	$\frac{bh^2}{6}$
	h^2	$\frac{h}{2}$	$\frac{h^4}{12}$	$\frac{h^3}{6}$
	h^2	$\frac{h}{2}\sqrt{2}$	$\frac{h^4}{12}$	$0.1179h^3=\frac{\sqrt{2}}{12}h^3$
	$\frac{bh}{2}$	$\frac{2}{3}h$	$\frac{bh^3}{36}$	$\frac{bh^2}{24}$
	$(2b+b_1)\frac{h}{2}$	$\frac{1}{3}\times\frac{3b+2b_1}{2b+b_1}h$	$\frac{6b^2+6bb_1+b_1^2}{36(2b+b_1)}h^3$	$\frac{6b^2+6bb_1+b_1^2}{12(3b+2b_1)}h^2$
	$\frac{3\sqrt{3}}{2}r^2$ $=2.598r^2$	$\sqrt{\frac{3}{4}}r=0.866r$	$\frac{5\sqrt{3}}{16}r^4=0.5413r^4$	$\frac{5}{8}r^3$
		r		$\frac{5\sqrt{3}}{16}r^3=0.5413r^3$
	$2.828r^2$	$0.924r^2$	$\frac{1+2\sqrt{2}}{6}r^4$ $=0.6381r^4$	$0.6906r^3$
	$0.8284a^2$	$b=\frac{a}{1+\sqrt{2}}$ $=0.4142a$	$0.0547a^4$	$0.1095a^3$
	$\pi r^2=\frac{\pi d^2}{4}$	$\frac{d}{2}$	$\frac{\pi d^4}{64}=\frac{\pi r^4}{4}$ $=0.0491d^4$ ≒$0.05d^4$ $=0.7854r^4$	$\frac{\pi d^3}{32}=\frac{\pi r^3}{4}$ $=0.0982d^3$ ≒$0.1d^3$ $=0.7854r^3$
	$r^2\left(1-\frac{\pi}{4}\right)$ $=0.2146r^2$	e_1 $=0.2234r$ e_2 $=0.7766r$	$0.0075r^4$	$\frac{0.0075r^4}{e_2}$ $=0.00966r^3$ ≒$0.01r^3$

Section	A	e	I	Z=I/e
	πab	a	$\frac{\pi}{4}ba^3=0.7854ba^3$	$\frac{4}{\pi}ba^2=0.7854ba^2$
	$\frac{\pi}{2}r^2$	e_1 $=0.4244r$ e_2 $=0.5756r$	$\left(\frac{\pi}{8}-\frac{8}{9\pi}\right)r^4$ $=0.1098r^4$	$Z_1=0.2587r^3$ $Z_2=0.1908r^3$
	$\frac{\pi}{4}r^2$	e_1 $=0.4244r$ e_2 $=0.5756r$	$0.055r^4$	$Z_1=0.1296r^3$ $Z_2=0.0956r^3$
	b(H−h)	$\frac{H}{2}$	$\frac{b}{12}(H^3-h^3)$	$\frac{b}{6H}(H^3-h^3)$
	A^2-a^2	$\frac{A}{2}$	$\frac{A^4-a^4}{12}$	$\frac{1}{6}\frac{A^4-a^4}{A}$
	A^2-a^2	$\frac{A}{2}\sqrt{2}$	$\frac{A^4-a^4}{12}$	$\frac{A^4-a^4}{12A\sqrt{2}}$ $=\frac{0.1179(A^4-a^4)}{A}$
	$\frac{\pi}{4}(d_2^2-d_1^2)$	$\frac{d_2}{2}$	$\frac{\pi}{64}(d_2^4-d_1^4)$ $=\frac{\pi}{4}(R^4-r^4)$	$\frac{\pi}{32}\left(\frac{d_2^4-d_1^4}{d_2}\right)$ $=\frac{\pi}{4}\times\frac{R^4-r^4}{R}$
	$a^2-\frac{\pi d^2}{4}$	$\frac{a}{2}$	$\frac{1}{12}\left(a^4-\frac{3\pi}{16}d^4\right)$	$\frac{1}{6a}\left(a^4-\frac{3\pi}{16}d^4\right)$
	2b(h−d) $+\frac{\pi}{4}d^2$	$\frac{h}{2}$	$\frac{1}{12}\left\{\frac{3\pi}{16}d^4+b(h^3-d^3)+b^3(h-d)\right\}$	$\frac{1}{6h}\left\{\frac{3\pi}{16}d^4+b(h^3-d^3)+b^3(h-d)\right\}$
	2b(h−d)+ $\frac{\pi}{4}(d_1^2-d_2^2)$	$\frac{h}{2}$	$\frac{1}{12}\left\{\frac{3\pi}{16}(d_1^4-d_2^4)+b(h^3-d_1^3)\right\}$ $+b^3(h-d_1)\}$	$\frac{1}{6h}\left\{\frac{3\pi}{16}(d_1^4-d_2^4)+b(h^3-d_1^3)\right\}$ $+b^3(h-d_1)\}$

A : Sectional Area
e : Distance of Gravitational Center
I : Sectional Secondary Moment
Z=I/e : Sectional Coefficient