〔TECHNICAL DATA〕

GREEK SYMBOLS・ATOMIC SYMBOLS EXCERPT FROM JIS Z 8202

■Greek Symbols

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

Note Unless otherwise specified, lowercase letters are the norm.

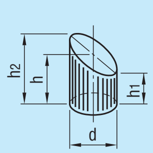
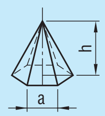
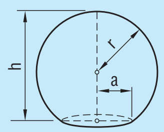
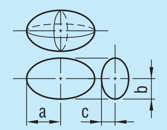
■Atomic Symbols

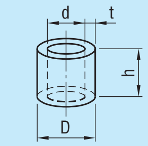
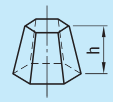
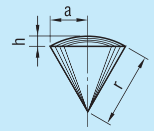
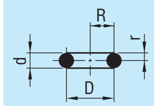
Atomic Number	Name	Symbol	Atomic Number	Name	Symbol	Atomic Number	Name	Symbol
1	Hydrogen	H	36	Krypton	Kr	71	Lutetium	Lu
2	Helium	He	37	Rubidium	Rb	72	Hafnium	Hf
3	Lithium	Li	38	Strontium	Sr	73	Tantalum	Ta
4	Beryllium	Be	39	Yttrium	Y	74	Tungsten	W
5	Boron	B	40	Zirconium	Zr	75	Rhenium	Re
6	Carbon	C	41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

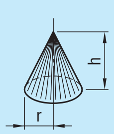
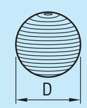
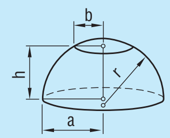
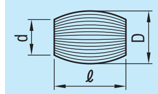
Note: This table was excerpt from Appendix **A** (Symbols and Atomic Numbers for Chemical Elements) of ISO 31/8-1980 (Quantities and Units of Physical Chemistry and Molecular Physics) and Appendix **C** (Names and Symbols for Radioactive Elements) of ISO 31/9-1980 (Quantities and Units of Atomic Physics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

〔TECHNICAL DATA〕

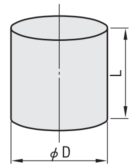
CALCULATION OF CUBIC VOLUME AND PHYSICAL CHARACTERISTICS OF METALS

Solid	Volume V
Truncated 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
Hollow cylinder 	$V=\frac{\pi}{4}h(D^2-d^2)$ $=\pi th(D-t)$ $=\pi th(d+t)$
Truncated pyramid 	$V=\frac{h}{3}(A+a+\sqrt{Aa})$ A,a=Area of both ends
Spherical segment 	$V=\frac{2}{3}\pi r^2h$ $=2.0944r^2h$
Torus 	$V=2\pi^2Rr^2$ $=19.739Rr^2$ $=\frac{\pi^2}{4}Dd^2$ $=2.4674Dd^2$

Solid	Volume V
Circular cone 	$V=\frac{\pi}{3}r^2h$ $=1.0472r^2h$
Sphere 	$V=\frac{4}{3}\pi r^3=4.1888r^3$ $=\frac{\pi}{6}d^3=0.5236d^3$
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 its periphery makes a curve equal to a parabolic line, $V=0.209\ell(2D^2Dd+1/4d^2)$

■How to Calculate The Weight



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

Example: Soft steel

ϕD=16 L=50mm, then the weight is:

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

$=\frac{\pi}{4}\times 1.6^2\times 5\times 7.85$

≒79[g]

■How to Calculate Dimensional Changes due to Thermal Expansion

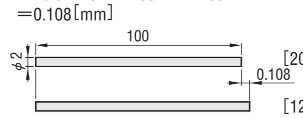
Example: SKD61

When the temperature of a pin whose ϕD=2 and L=100mm raises by 100℃, its dimensional change amount δ is:

δ=Thermal expansion coefficient×Overall length×Temperature change

$=10.8\times 10^{-6}\times$100mm×100℃

=0.108[mm]



■How to Calculate Distortion from Young's Modulus E

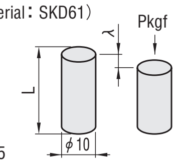
Example: The distortion obtained when a load of P=1000kgf is applied to a ϕ10×L60 pin (Material: SKD61)

$E=\frac{PL}{A}$

$\lambda=\frac{PL}{AE}=\frac{1000\times 60}{78.5\times 21000}$

≒0.036mm

Crossectional area $A=\frac{\pi}{4}D^2$≒78.5



■ Physical Characteristics of Metals

Materials	Specific gravity	Young's modulus	Thermal expansion coefficient	
		$X10^{-6}$/℃	GPa	{kgf/mm²}
Soft steel	7.85	11.7	214	21000
NAK80	7.8	12.5	209	20500
SKD61	7.75	10.8	214	21000
SKH51	8.2	10.1	227	22300
Carbide Alloy (JIS V40)	13.9	6.0	551	54000
Cast iron	7.3	9.2~11.8	76~107	7500~10500
SUS440C	7.78	10.2	208	20400
Oxygen free copper (C1020)	8.9	17.6	119	11700
6/4Brass (C2801)	8.4	20.8	105	10300
Beryllium steel C1720	8.3	17.1	133	13000
Aluminum A1100	2.7	23.6	70	6900
Duralumin A7075	2.8	23.6	73	7200
Titanium	4.5	8.4	108	10600

GENERAL DIMENSIONAL TOLERANCE

EXCERPT FROM JIS B 0405 (1991)
JIS B 0419 (1991)

1. General dimensional tolerance of cutting JIS B 0405 —1991

Length dimensional tolerance (excluding chamfered parts)

Unit: mm

Degree		Standard dimension							
Symbol	Explanation	0.5 (1) to 3 incl.	Over 3 to 6 incl.	Over 6 to 30 incl.	Over 30 to 120 incl.	Over 120 to 400 incl.	Over 400 to 1000 incl.	Over 1000 to 2000 incl.	Over 2000 to 4000 incl.
		Tolerance							
f	Fine	±0.05	±0.05	±0.1	±0.15	±0.2	±0.3	±0.5	—
m	Medium	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2
c	Coarse	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	±4
v	Very coarse	—	±0.5	±1	±1.5	±2.5	±4	±6	±8

Note(1): Tolerance for standard dimensions of less than 0.5mm shall be specified individually.

2. Length dimensional tolerance in chamfered parts (corner roundness or chamfer dimension)

Unit: mm

Degree		Standard dimension		
Symbol	Explanation	0.5 (1) to 3 incl.	Over 3 to 6 incl.	Over 6
		Tolerance		
f	Fine	±0.2	±0.5	±1
m	Medium			
C	Coarse	±0.4	±1	±2
V	Very coarse			

Note(1): Tolerance for standard dimensions of less than 0.5mm shall be specified individually.

3. Tolerance of angle dimension

Unit: mm

Degree		Shorter side of corner				
Symbol	Explanation	10 or less	Over 10 to 50 incl.	Over 50 to 120 incl.	Over 120 to 400 incl.	Over 400
		Tolerance				
f	Fine	±1°	±30′	±20′	±10′	± 5′
m	Medium					
c	Coarse	±1° 30′	± 1°	±30′	±15′	±10′
v	Very coarse	±3°	± 2°	± 1°	±30′	±20′

4. General tolerance of perpendicularity

JIS B 0419 —1991

Unit: mm

Degree	Nominal length on shorter side			
	100 or less	Over 100 to 300 incl.	Over 300 to 1000 incl.	Over 1000 to 3000 incl.
	Squareness tolerance			
H	0.2	0.3	0.4	0.5
K	0.4	0.6	0.8	1
L	0.6	1	1.5	2

5. General tolerance of straightness and flatness

JIS B 0419 —1991

Unit: mm

Degree	Nominal area					
	10 or less	Over 10 to 30 incl.	Over 30 to 100 incl.	Over 100 to 300 incl.	Over 300 to 1000 incl.	Over 1000 to 3000 incl.
	Straightness and flatness tolerance					
H	0.02	0.05	0.1	0.2	0.3	0.4
K	0.05	0.1	0.2	0.4	0.6	0.8
L	0.1	0.2	0.4	0.8	1.2	1.6