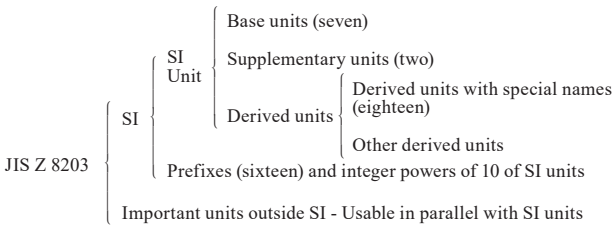
International System of Units (SI units)

■ SI units

The International System of Units, or SI, comprises seven base units, prefixes to represent integer powers of 10 in the range from 10^{18} to -10^{-18}, supplementary units of radians and steradians, and twenty-seven derived units defined according to the resolution by the International Committee of Weights and Measures.
It is often abbreviated as SI from its French expression "Systeme International d'Unites".
Its use in ISO standards started in 1971. In Japan, the Conference on Standardization of the Japanese Industrial Standards Committee decided in 1972 to introduce the SI units to JIS in a stepwise manner. And in 1974, JIS Z 8203 International System of Units (SI) (established based on ISO1000) and the guide for its use were enacted and promulgated, and their dissemination is in progress.

■ Structure of SI and JIS Z 8203



Appendix table 1 SI base units

Quantity	Name	Symbol	Quantity	Name	Symbol
length	meter	m	thermodynamic temperature	kelvin	K
mass	kilogram	kg	luminous intensity	candela	cd
time	second	s	amount of substance	mole	mol
current	ampere	A			

Appendix table 2 SI supplementary units

Quantity	Name	Symbol
Plane related angle	radian	rad
solid angle	steradian	sr

Appendix table 3 SI derived units with special names

Quantity	Name	Symbol	Definition
frequency	hertz	Hz	s^{-1}
force	newton	N	$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2
energy, work, heat	joule	J	N·m
power, radiant flux	watt	W	J/s
quantity of electricity, electric charge	coulomb	C	A·s
voltage, electrical potential	volt	V	W/A
electrical capacitance	farad	F	C/V
electrical resistance	ohm	Ω	V/A
conductance	siemens	S	A/V
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m^2
inductance	henry	H	Wb/A
celsius' temperature scale	degree Celsius	°C	t°C = (t + 273.15) K
luminous flux	lumen	lm	cd·sr
illuminance	lux	lx	1
radioactivity	becquerel	Bq	
absorbed dose	gray	Gy	

Appendix table 4 Example of SI derived units that are expressed with special names

Quantity	Name	Symbol
viscosity	pascal second	Pa·s
moment of force	newton meter	N·m
surface tension	newton per meter	N/m
heat flux density, irradiation	watt per square meter	W/m^2
heat capacity, entropy	joule per kelvin	J/K
specific heat capacity, specific entropy *	joule per kilogram kelvin	J/(kg·K)
thermal conductivity	watt per meter kelvin	W/(m·K)
permittivity	farad per meter	F/m
permeability	henry per meter	H/m

* It is also referred to as mass entropy.

Table 5 SI prefixes

Multiplication	Prefix	Symbol	Multiplication	Prefix	Symbol
10^{18}	exa	E	10^{-1}	deci	d
10^{15}	peta	P	10^{-2}	centi	c
10^{12}	tera	T	10^{-3}	milli	m
10^{9}	giga	G	10^{-6}	micro	μ
10^{6}	mega	M	10^{-9}	nano	n
10^{3}	kilo	k	10^{-12}	pico	p
10^{2}	hecto	h	10^{-15}	femto	f
10^{1}	deca	da	10^{-18}	atto	a

Multiplications of 10^6 (M: mega) and larger are expressed with capital letters.

Appendix table 6 Units used in parallel with SI units

Name	Symbol	Value in SI units
minute	min	1 min = 60 s
hour	h	1 h = 60 min = 3,600 s
day	d	1 d = 24 h = 86,400 s
degree	°	1° = (π/180) rad
minute	'	1' = (1/60)" = (π/10,800) rad
second	"	1" = (1/60)' = (π/648,000) rad
liter	L	1 L = 1 dm^3 = 10^{-3} m^3
ton	t	1 t = 10^3 kg

Appendix table 7.1 Conversion table from conventional gravitation units to SI units

Quantity	Unit name	Symbol	Conversion factor for SI units	SI unit name	Symbol
angle	degree minute second	° ' "	π/180 π/10800 π/648000	radian	rad
length	meter micron angstrom	m μm Å	1 10^{-6} 10^{-10}	meter	m
area	square meter are	m^2 a	1 10^2	square meter	m^2
volume	cubic meter liter	m^3 L	1 10^{-3}	cubic meter	m^3

International System of Units (SI units)

Appendix table 7.2 Conversion table from conventional gravitation units to SI units

Quantity	Unit name	Symbol	Conversion factor	SI unit name	Symbol
angle	degree minute second	° ' "	π/180 π/10800 π/648000	radian	rad
length	meter micron angstrom	m μ Å	1 10^{-6} 10^{-10}	meter	m
area	square meter are	m^2 a	1 10^2	square meter	m^2
volume	cubic meter liter	m^3 l, L	1 10^{-3}	cubic meter	m^3
mass	kilogram ton atomic mass unit	kg t u	1 10^3 1.6606×10^{-27}	kilogram	kg
time	second minute hour day	s min h d	1 60 3600 86400	second	s
speed, velocity	meter per second	m/s	1	meter per second	m/s
frequency	cycle	s^{-1}	1	hertz	Hz
rotational speed	times per minute	min^{-1}	1/60	revolutions per second	s^{-1}
angular velocity	radian per second	rad/s	1	radian per second	rad/s
acceleration	meter per second squared g	m/s^2 G	1 9.8067	meter per second squared	m/s^2
force	weight kilogram weight ton dyne	kgf tf dyn	9.8067 9806.7 10^{-5}	newton	N
moment of force	weight kilogram meter	kgf·m	9.8067	newton meter	N·m
stress	weight kilogram per square meter weight kilogram per square centimeter weight kilogram per square millimeter	kgf/m^2 kgf/cm^2 kgf/mm^2	9.8067 9.8067×10^4 9.8067×10^6	pascal	Pa
pressure	weight kilogram per square meter meter of water millimeter mercury column bar	kgf/m^2 mH_2O mmHg bar	9.8067 9806.7 101325/760 10^5	pascal	Pa
energy	erg International Steam Table calorie weight kilogram meter kilowatt hour metric horse power hour	erg cal_{IT} kgf·m kW·h PS·h	10^{-7} 4.1868 9.8067 3.600×10^6 2.6478×10^6	joule	J
work rate and power	watt metric horse power kilocalorie per hour	W PS kcal/h	1 735.5 1.163	watt	W
viscosity and viscosity coefficient	poise centipoise weight kilogram second per square meter	P cP $kgf·s/m^2$	10^{-1} 10^{-3} 9.8067	pascal second	Pa·s
dynamic viscosity and dynamic viscosity coefficient	stokes centistokes	St mm^2/S, cSt	10^{-4} 10^{-6}	square meter per second	m^2/s
temperature	degree	°C	+273.15	kelvin	K
magnetic flux	maxwell	M_X	10^{-8}	weber	Wb
magnetic flux density	gamma gauss	γ G_S	10^{-9} 10^{-4}	tesla	T
magnetic field strength	oersted	O_e	$10^3/4\ \pi$	ampere per meter	A/m
quantity of electricity	coulomb	C	1	coulomb	C
electrical potential difference	volt	V	1	volt	V
electrical capacitance	farad	F	1	farad	F
electrical resistance	ohm	Ω	1	ohm	Ω
conductance	siemens	S	1	siemens	S
inductance	henry	H	1	henry	H
current	ampere	A	1	ampere	A

International System of Units (SI units)

Appendix table 8 Comparison table between SI and CGS/system of gravitational units

Representative quantity	SI units	Absolute system of units		Gravity unit system	
		m - kg	ft - lb	m - kgf	ft - lbf
length	m	m	ft	m	ft
mass	kg	kg	lb	$kgf \cdot s^2/m$	$lbf \cdot s^2/ft$
time	s	s	s	s	s
gravity (force)	N	$kg \cdot m/s^2$	$lb \cdot ft/s^2$	kgf	lbf
acceleration	m/s^2	m/s^2	ft/s^2	kgf/s^2	lbf/s^2
pressure (stress)	Pa	$kg/m \cdot s^2$	$lb/ft \cdot s^2$	kgf/m^2	lbf/ft^2
energy	J	$kg \cdot m^2/s^2$	$lb \cdot ft^2/s^2$	kgf·m	lbf/ft
work rate	W	$kg \cdot m^2/s^3$	$lb \cdot ft^2/s^3$	kgf·m/s	lbf·ft/s
density	kg/m^3	kg/m^3	lb/ft^3	$kgf \cdot s^2/m^4$	$lbf \cdot s^2/ft^4$
viscosity	Pa·s	kg/m·s	lb/ft·s	$kgf \cdot s/m^2$	$lbf \cdot s/ft^2$
temperature	K	°C	°C	°C	°C

Note: 1 N = 10^5 $g \cdot cm/s^2$, 1 Pa = IN/m^2, 1J = 1 N·m, 1 W = 1 N·m/s
1 dyn = 1 $g \cdot cm/s^2$, 1 Poundal = 1 $lb \cdot ft/s^2$, 1 slug = 1 $lb \cdot s^2/ft$
1 Poise = 1 g/cm·s

International System of Units (SI units)

■ Conversion tables for frequently used units to SI units

● Force

N newton	dyn	kgf
1	1×10^{5}	$1.019\ 72 \times 10^{-1}$
1×10^{-5}	1	$1.019\ 72 \times 10^{-6}$
9.806 65	$9.806\ 65 \times 10^{5}$	1

● Pressure

Pa	bar	kgf/cm^2	atm	mmH_2O	mmHg or Torr
1	1×10^{-5}	$1.019\ 72 \times 10^{-5}$	$9.869\ 23 \times 10^{-6}$	$1.019\ 72 \times 10^{-1}$	$7.500\ 62 \times 10^{-3}$
1×10^{5}	1	1.019 72	$9.869\ 23 \times 10^{-1}$	$1.019\ 72 \times 10^{4}$	$7.500\ 62 \times 10^{2}$
$9.806\ 65 \times 10^{4}$	$9.806\ 65 \times 10^{-1}$	1	$9.678\ 41 \times 10^{-1}$	1×10^{4}	$7.355\ 59 \times 10^{2}$
$1.013\ 25 \times 10^{5}$	1.013 25	1.033 23	1	$1.033\ 23 \times 10^{4}$	$7.600\ 00 \times 10^{2}$
9.806 65	$9.806\ 65 \times 10^{-5}$	1×10^{-4}	$9.678\ 41 \times 10^{-5}$	1	$7.355\ 59 \times 10^{-2}$
$1.333\ 22 \times 10^{2}$	$1.333\ 22 \times 10^{-3}$	$1.359\ 51 \times 10^{-3}$	$1.315\ 79 \times 10^{-3}$	$1.359\ 51 \times 10$	1

Note: 1 Pa = 1 N/m^2

● Stress

Pa	MPa or N/mm^2	kgf/mm^2	kgf/cm^2
1	1×10^{-6}	$1.019\ 72 \times 10^{-7}$	$1.019\ 72 \times 10^{-5}$
1×10^{6}	1	$1.019\ 72 \times 10^{-1}$	$1.019\ 72 \times 10$
$9.806\ 65 \times 10^{6}$	9.806 65	1	1×10^{2}
$9.806\ 65 \times 10^{4}$	$9.806\ 65 \times 10^{-2}$	1×10^{-2}	1

● Work, Energy, Heat

J	kW·h	kgf·m	kcal
1	$2.777\ 78 \times 10^{-7}$	$1.019\ 72 \times 10^{-1}$	$2.388\ 89 \times 10^{-4}$
3.600×10^{6}	1	$3.670\ 98 \times 10^{5}$	$8.600\ 0 \times 10^{2}$
9.806 65	$2.724\ 07 \times 10^{-6}$	1	$2.342\ 70 \times 10^{-3}$
$4.186\ 05 \times 10^{3}$	$1.162\ 79 \times 10^{-3}$	$4.268\ 58 \times 10^{2}$	1

Note: 1 J = 1 W·s, 1 W·h3 600 W·s
1 cal = 4.186 05 J

● Power

kW	kgf·m/s	PS	kcal/h
1	$1.019\ 72 \times 10^{2}$	1.359 62	$8.600\ 0 \times 10^{2}$
$9.806\ 65 \times 10^{-3}$	1	$1.333\ 33 \times 10^{-2}$	8.433 71
7.355×10^{-1}	7.5×10	1	$6.325\ 29 \times 10^{2}$
$1.162\ 79 \times 10^{-3}$	$1.185\ 72 \times 10^{-1}$	$1.580\ 95 \times 10^{-3}$	1

Note: 1 W = 1 J/s, PS: metric horsepower
1 PS = 0.735 5 kW
1 cal = 4.186 05 J

● Temperature

$T_1 = T_2 + 273.15$

$T_3 = 1.8T_2 + 32$

T_1: thermodynamic temperature K (kelvin)
T_2: Celsius' temperature scale °C (degree Celsius)
T_3: °F

● Moment of force

N·m newton meter	kgf·m
1	0.102 0
9.807	1

Note: 1 N·m = 1 kg·m^2/S_2

● Viscosity

Pa·s pascal second	cP	P (poise)
1	1×10^{3}	1×10
1×10^{-3}	1	1×10^{-2}
1×10^{-1}	1×10^{2}	1

Note: 1 P = 1 dyn·s/cm^2 = 1 g/cm·s
1 Pa·s = 1 N·s/m^2, 1 cP = 1 mPa·s

● Dynamic viscosity

m^2/S	mm^2/S	St
1	1×10^{6}	1×10^{4}
1×10^{-6}	1	1×10^{-2}
1×10^{-4}	1×10^{2}	1

Note: 1 St = 1 cm^2/s

● Thermal conductivity

W/(m·K)	kcal/(h·m·°C)
1	$8.600\ 0 \times 10^{-1}$
1.162 79	1

Note: 1 cal = 4.186 05 J

● Heat transfer coefficient

W/(m^2·K)	kcal/(h·m^2·°C)
1	$8.600\ 0 \times 10^{-1}$
1.162 79	1

Note: 1 cal = 4.186 05 J

● Specific heat capacity

J/(kg·K)	kcal/(kg·°C) cal/(g·°C)
1	$2.388\ 89 \times 10^{-4}$
$4.186\ 05 \times 10^{3}$	1

Note: 1 cal = 4.186 05 J