

# Appendix



## Appendix

Physical constants	
Quantity	Value
Elementary charge	$e = 4.80298 \times 10^{-10}$ esu $e = 1.60210 \times 10^{-19}$ coulombs
Speed of light in vacuum	$c = 2.997925 \times 10^{10}$ cm sec <sup>-1</sup>
Planck's constant,	$h = 6.6256 \times 10^{-27}$ ergs sec
$\hbar = h/2\pi$	$\hbar = 1.05450 \times 10^{-27}$ ergs sec
Electron rest mass	$m_e = 9.1091 \times 10^{-28}$ grams
Neutron rest mass	$m_n = 1.675 \times 10^{-24}$ grams
Proton rest mass	$m_p = 1.67252 \times 10^{-24}$ grams
Avogadro's number	$N_A = 6.02252 \times 10^{22}$ mole <sup>-1</sup>
Boltzmann's constant	$k_B = 1.38054 \times 10^{-16}$ ergs deg <sup>-1</sup>
Gas constant	$R = 8.3143 \times 10^7$ ergs deg <sup>-1</sup> mole <sup>-1</sup>
Stefan-Boltzmann constant	$\sigma = 5.6697 \times 10^{-3}$ ergs cm <sup>-2</sup> sec <sup>-1</sup> deg <sup>-4</sup>
Coulomb constant	$C_o = 8.988 \times 10^9$ Nm <sup>2</sup> c <sup>-2</sup>
Gravitational constant	$G = 6.673 \times 10^{-11}$ Nm <sup>2</sup> kg <sup>-2</sup>
Solar constant	1340 W m <sup>-2</sup>
Electron volt	eV = 1.60210 × 10 <sup>-19</sup> J
Velocity of sound in dry air	331.45 m cm <sup>-1</sup> (at 0°C)
Density of air at standard condition	1.293 kg m <sup>-3</sup>
Average density of earth	5.518 × 10 <sup>3</sup> kg m <sup>-3</sup>
Standard atmospheric pressure (1atm)	760 mmHg 1.01325 × 10 <sup>5</sup> pa 760 torr 1.013 bar
Mechanical equivalent of heat	4.186 J. cal <sup>-1</sup>
Permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ Wb A <sup>-1</sup> m <sup>-1</sup>
Permittivity of free space	$\epsilon_o = 8.854188 \times 10^{-12}$ c <sup>2</sup> .N <sup>-1</sup> .m <sup>-2</sup>
Atomic mass unit	1u = 1.66054 × 10 <sup>-27</sup> kg
Acceleration due to gravity	$g = 9.80665$ m. s <sup>-2</sup>

---

**The Greek Alphabet**

---

Name	Capital	letter
Alpha	<i>A</i>	<i>α</i>
Beta	<i>B</i>	<i>β</i>
Gamma	<i>Γ</i>	<i>γ</i>
Delta	<i>Δ</i>	<i>δ</i>
Epsilon	<i>E</i>	<i>ε</i>
Zeta	<i>Z</i>	<i>ζ</i>
Eta	<i>H</i>	<i>η</i>
Theta	<i>Θ</i>	<i>θ</i>
Iota	<i>I</i>	<i>ι</i>
Kappa	<i>K</i>	<i>κ</i>
Lambda	<i>Λ</i>	<i>λ</i>
Mu	<i>M</i>	<i>μ</i>
Nu	<i>N</i>	<i>ν</i>
Xi	<i>Ξ</i>	<i>ξ</i>
Omicron	<i>O</i>	<i>ο</i>
Pi	<i>Π</i>	<i>π</i>
Rho	<i>P</i>	<i>ρ</i>
Sigma	<i>Σ</i>	<i>σ</i> or <i>ς</i>
Tau	<i>T</i>	<i>τ</i>
Upsilon	<i>Υ</i>	<i>υ</i>
Phi	<i>Φ</i>	<i>φ</i>
Chi	<i>X</i>	<i>χ</i>
Psi	<i>Ψ</i>	<i>ψ</i>
Omega	<i>Ω</i>	<i>ω</i>

---

**Specific heat of solids and liquids**

Substance	$c \left( \frac{J}{gmK} \right)$	$c \left( \frac{cal}{gmK} \right)$	Molar $C \left( \frac{J}{molK} \right)$
Aluminum	0.900	0.215	24.3
Bismuth	0.123	0.0294	25.7
Copper	0.386	0.0923	24.5
Brass	0.380	0.092	...
Gold	0.126	0.0301	25.6
Lead	0.128	0.0305	26.4
Silver	0.233	0.0558	24.9
Tungsten	0.134	0.0321	24.8
Zinc	0.387	0.0925	25.2
Mercury	0.140	0.033	28.3
Alcohol (ethyl)	2.4	0.58	111
Water	4.186	1.00	75.2
Ice (-10°C)	2.05	0.49	36.9
Granite	.790	0.19	...
Glass	.84	0.20	...

**Change of pressure with altitude**

Altitude		Pressure			
(Feet)	(Meter)	(hg)	(torr)	(psia)	(kPa)
0	0	29.92	759.97	14.7	101.3
500	152	29.39	746.51	14.43	99.4
1000	305	28.86	733.04	14.17	97.6
1500	457	28.34	719.84	13.91	95.8
2000	610	27.82	706.63	13.66	94.1
2500	762	27.32	693.93	13.41	92.4
3000	914	26.82	681.23	13.17	90.7
3500	1067	26.33	668.78	12.93	89.1
4000	1219	25.84	656.34	12.69	87.4
4500	1372	25.37	644.4	12.46	85.8
5000	1524	24.9	632.46	12.23	84.3
5500	1676	24.44	620.78	12	82.7
6000	1829	23.98	609.09	11.77	81.1
6500	1981	23.53	597.66	11.55	79.6
7000	2134	23.09	586.49	11.34	78.1
7500	2286	22.66	575.56	11.13	76.7
8000	2438	22.23	564.64	10.91	75.2
8500	2591	21.81	553.97	10.71	73.8
9000	2743	21.39	543.31	10.5	72.3

---

9500	2896	20.98	532.89	10.3	71.0
10000	3048	20.58	522.73	10.1	69.6
10500	3200	20.19	512.83	9.91	68.3
11000	3353	19.8	502.92	9.72	67.0
11500	3505	19.41	493.01	9.53	65.7
12000	3658	19.03	483.36	9.34	64.4
12500	3810	18.66	473.96	9.16	63.1
13000	3962	18.3	464.82	8.99	61.9
13500	4115	17.94	455.68	8.81	60.7
14000	4267	17.58	446.53	8.63	59.5
14500	4420	17.24	437.9	8.46	58.3
15000	4572	16.89	429.01	8.29	57.1
15500	4724	16.56	420.62	8.13	56.0
16000	4877	16.22	411.99	7.96	54.8
16500	5029	15.9	403.86	7.81	53.8
17000	5182	15.58	395.73	7.65	52.7
17500	5334	15.26	387.6	7.47	51.5
18000	5486	14.95	379.73	7.34	50.6
18500	5639	14.65	372.11	7.19	49.5
19000	5791	14.35	364.49	7.05	48.6
19500	5944	14.05	356.87	6.9	47.5
20000	6096	13.76	349.5	6.76	46.6
20500	6248	13.48	342.39	6.62	45.6
21000	6401	13.2	335.28	6.48	44.6
21500	6553	12.92	328.17	6.34	43.7
22000	6706	12.65	321.31	6.21	42.8
22500	6858	12.38	314.45	6.08	41.9
23000	7010	12.12	307.85	5.95	41.0
23500	7163	11.86	301.24	5.82	40.1
24000	7315	11.61	294.89	5.7	39.3
24500	7468	11.36	288.54	5.58	38.4
25000	7620	11.12	282.45	5.46	37.6
25500	7772	10.88	276.35	5.34	36.8
26000	7925	10.64	270.26	5.22	36.0
26500	8077	10.41	264.41	5.11	35.2
27000	8230	10.18	258.57	5	34.5
27500	8382	9.96	252.98	4.89	33.7
28000	8534	9.74	247.4	4.78	32.9
28500	8687	9.53	242.06	4.68	32.2
29000	8839	9.31	236.47	4.57	31.5
29500	8992	9.11	231.39	4.47	30.8
30000	9144	8.9	226.06	4.37	30.1

---

**Properties of saturated liquid Mercury - Hg - density, specific heat capacity, kinematic viscosity and thermal conductivity**

Temperature $T$ (°C)	Density $\rho$ (kg/m <sup>3</sup> )	Specific heat capacity $c_p$ (10 <sup>3</sup> $\frac{J}{kgK}$ )	Thermal conductivity $k$ ( $\frac{W}{mK}$ )
0	13628	0.140	8.20
20	13579	0.139	8.69
50	13506	0.139	9.40
100	13385	0.137	10.51
150	13264	0.137	11.49
200	13145	0.157	12.34
250	13026	0.136	13.07
315.5	12847	0.134	14.02

**Thermal conductivity of some common materials**

Material/Substance	Thermal Conductivity $k$ ( $\frac{W}{m \cdot K}$ )		
	at Temperature		
	25(°C)	125(°C)	225(°C)
Acetone	0.16		
Acrylic	0.2		
Air (gas)	0.024		
Alcohol	0.17		
Aluminum	250	255	250
Aluminum Oxide	30		
Ammonia (gas)	0.022		
Antimony	18.5		
Argon (gas)	0.016		
Asbestos-cement board	0.744		
Asbestos-cement sheets	0.166		
Asbestos-cement	2.07		
Asbestos, loosely packed	0.15		
Asbestos mill board	0.14		
Asphalt	0.75		
Balsa	0.048		
Bitumen	0.17		
Benzene	0.16		
Beryllium	218		
Brass	109		
Brick dense	1.31		
Brick work	0.69		
Cadmium	92		
Carbon	1.7		

---

Carbon dioxide (gas)	0.0146		
Cement, portland	0.29		
Cement, mortar	1.73		
Chalk	0.09		
Chrome Nickel Steel (18% Cr, 8 % Ni)	16.3		
Clay, dry to moist	0.15 - 1.8		
Clay, saturated	0.6 - 2.5		
Cobalt	69		
Concrete, light	0.42		
Concrete, stone	1.7		
Constantan	22		
Copper	401	400	398
Corian (ceramic filled)	1.06		
Corkboard	0.043		
Cork, regranulated	0.044		
Cork	0.07		
Cotton	0.03		
Carbon Steel	54	51	47
Cotton Wool insulation	0.029		
Diatomaceous earth (Sil-o-cel)	0.06		
Earth, dry	1.5		
Engine Oil	0.15		
Ether	0.14		
Epoxy	0.35		
Ethylene glycol	0.25		
Felt insulation	0.04		
Fiberglass	0.04		
Fiber insulating board	0.048		
Fiber hardboard	0.2		
Fireclay brick 500°C	1.4		
Foam glass	0.045		
Freon 12 (gas)	0.073		
Freon (liquid)	0.07		
Gasoline	0.15		
Glass	1.05		
Glass, Pearls, dry	0.18		
Glass, Pearls, saturated	0.76		
Glass, window	0.96		
Glass, wool Insulation	0.04		
Glycerol	0.28		
Gold	310	312	310
Granite	1.7 - 4.0		
Gypsum or plaster board	0.17		
Hairfelt	0.05		
Hardboard high density	0.15		
Hardwoods (oak, maple..)	0.16		
Helium (gas)	0.142		
Hydrogen (gas)	0.168		

---



Ice (0°C, 32°F)	2.18		
Insulation materials	0.035 - 0.16		
Iridium	147		
Iron	80	68	60
Iron, wrought	59		
Iron, cast	55		
Kapok insulation	0.034		
Kerosene	0.15		
Lead Pb	35		
Leather, dry	0.14		
Limestone	1.26 - 1.33		
Magnesia insulation (85%)	0.07		
Magnesite	4.15		
Magnesium	156		
Marble	2.08 - 2.94		
Mercury	8		
Methane (gas)	0.03		
Methanol	0.21		
Mica	0.71		
Mineral insulation materials, wool blankets...	0.04		
Molybdenum	138		
Monel	26		
Nickel	91		
Nitrogen	0.024		
Nylon 6	0.25		
Oil, machine lubricating SAE 50	0.15		
Olive oil	0.17		
Oxygen	0.024		
Paper	0.05		
Paraffin Wax	0.25		
Perlite, atmospheric pressure	0.031		
Perlite, vacuum	0.00137		
Plaster, gypsum	0.48		
Plaster, metal lath	0.47		
Plaster, wood lath	0.28		
Plastics, foamed (insulation materials)	0.03		
Platinum	70	71	72
Plywood	0.13		
Polyethylene HD	0.42 - 0.51		
Polypropylene	0.1 - 0.22		
Polystyrene expanded	0.03		
Polyurethane foam	0.02		
Porcelain	1.5		
PTFE	0.25		
PVC	0.19		
Pyrex glass	1.005		
Quartz mineral	3		
Rock, solid	2-7		

Rock, porous volcanic (Tuff)	0.5 - 2.5		
Rock Wool insulation	0.045		
Sand, dry	0.15 - 0.25		
Sand, moist	0.25 - 2		
Sand, saturated	02-04		
Sandstone	1.7		
Sawdust	0.08		
Silica aerogel	0.02		
Silicone oil	0.1		
Silver	429		
Snow (temp < 0°C)	0.05 - 0.25		
Sodium	84		
Softwoods (fir, pine...)	0.12		
Soil, with organic matter	0.15 - 2		
Soil, saturated	0.6 - 4		
Steel, Carbon 1%	43		
Stainless Steel	16	17	19
Straw insulation	0.09		
Styrofoam	0.033		
Tin Sn	67		
Zinc Zn	116		
Urethane foam	0.021		
Vermiculite	0.058		
Vinyl ester	0.25		
Water	0.58		
Water, vapor (steam)		0.016	
Wood across the grain, white pine	0.12		
Wood across the grain, balsa	0.055		
Wood across the grain, yellow pine	0.147		
Wood, oak	0.17		
Wool, felt	0.07		

Note:  $1 \frac{W}{m \cdot K} = 1 \frac{W}{m \cdot ^\circ C} = 0.85984 \frac{kcal}{hr \cdot m \cdot ^\circ C} = 0.5779 \frac{Btu}{ft \cdot hr \cdot ^\circ F}$

### Linear Temperature Expansion Coefficients for some common materials

Product	Coefficient of Linear Expansion $\alpha$	
	$(10^{-6} \frac{m}{mK})$	$(10^{-6} \frac{in}{in^\circ F})$
ABS (Acrylonitrile butadiene styrene) thermoplastic	73.8	41
ABS -glass fiber-reinforced	30.4	17
Acetal	106.5	59.2
Acetal - glass fiber-reinforced	39.4	22
Acrylic, sheet, cast	81	45
Acrylic, extruded	234	130
Alumina	5.4	3

---

Aluminum	22.2	12.3
Antimony	10.4	5.8
Arsenic	4.7	2.6
Barium	20.6	11.4
Beryllium	11.5	6.4
Bismuth	13	7.3
Brass	18.7	10.4
Brick masonry	5.5	3.1
Bronze	18	10
Cadmium	30	16.8
Calcium	22.3	12.4
Carbon - diamond	1.2	0.67
Cast Iron Gray	10.8	6
Cellulose acetate (CA)	130	72.2
Cellulose acetate butynate (CAB)		80 - 95
Cellulose nitrate (CN)	100	55.6
Cement	10	6
Cerium	5.2	2.9
Chlorinated polyvinylchloride (CPVC)	66.6	37
Chromium	6.2	3.4
Clay tile structure	5.9	3.3
Cobalt	12	6.7
Concrete	14.5	8
Concrete structure	9.8	5.5
Constantan	18.8	10.4
Copper	16.6	9.3
Copper, Beryllium 25	17.8	9.9
Corundum, sintered	6.5	3.6
Cupronickel 30%	16.2	9
Diamond	1.1	0.6
Dysprosium	9.9	5.5
Ebonite	76.6	42.8
Epoxy, castings resins & compounds, unfilled	55	31
Erbium	12.2	6.8
Ethylene ethyl acrylate (EEA)	205	113.9
Ethylene vinyl acetate (EVA)	180	100
Europium	35	19.4
Fluoroethylene propylene (FEP)	135	75
Gadolinium	9	5
Germanium	6.1	3.4
Glass, hard	5.9	3.3
Glass, Pyrex	4	2.2
Glass, plate	9	5
Gold	14.2	8.2
Granite	7.9	4.4
Graphite, pure	7.9	4.4
Hafnium	5.9	3.3
Hard alloy K20	6	3.3

---

Hastelloy C	11.3	6.3
Holmium	11.2	6.2
Ice	51	28.3
Inconel	12.6	7
Indium	33	18.3
Invar	1.5	0.8
Iridium	6.4	3.6
Iron, pure	12	6.7
Iron, cast	10.4	5.9
Iron, forged	11.3	6.3
Lanthanum	12.1	6.7
Lead	28	15.1
Limestone	8	4.4
Lithium	46	25.6
Lutetium	9.9	5.5
Magnesium	25	14
Manganese	22	12.3
Marble	5.5 - 14.1	3.1 - 7.9
Masonry	4.7 - 9.0	2.6 - 5.0
Mica	3	1.7
Molybdenum	5	2.8
Monel	13.5	7.5
Mortar	7.3 - 13.5	4.1-7.5
Neodymium	9.6	5.3
Nickel	13	7.2
Niobium (Columbium)	7	3.9
Nylon, general purpose	72	40
Nylon, Type 11, molding and extruding compound	100	55.6
Nylon, Type 12, molding and extruding compound	80.5	44.7
Nylon, Type 6, cast	85	47.2
Nylon, Type 6/6, molding compound	80	44.4
Osmium	5	2.8
Palladium	11.8	6.6
Phenolic resin without fillers	80	44.4
Plaster	16.4	9.2
Platinum	9	5
Plutonium	54	30.2
Polyallomer	91.5	50.8
Polyamide (PA)	110	61.1
Polybutylene (PB)		72
Polycarbonate (PC)	70.2	39
Polycarbonate - glass fiber-reinforced	21.5	12
Polyester	123.5	69
Polyester - glass fiber-reinforced	25	14
Polyethylene (PE)	200	111
Polyethylene (PE) - High Molecular Weight		60
Polyethylene terephthalate (PET)	59.4	33

Polyphenylene - glass fiber-reinforced	35.8	20
Polypropylene (PP), unfilled	90.5	50.3
Polypropylene - glass fiber-reinforced	32	18
Polystyrene (PS)	70	38.9
Polysulfone (PSO)	55.8	31
Polyurethane (PUR), rigid	57.6	32
Porcelain	3.6	2
Polyvinyl chloride (PVC)	50.4	28
Polyvinylidene fluoride (PVDF)	127.8	71
Porcelain	4.5	2.5
Potassium	83	46.1
Praseodymium	6.7	3.7
Promethium	11	6.1
Quartz	0.77 - 1.4	0.43 - 0.79
Rhenium	6.7	3.7
Rhodium	8	4.5
Rubber, hard	77	42.8
Ruthenium	9.1	5.1
Samarium	12.7	7.1
Sandstone	11.6	6.5
Scandium	10.2	5.7
Selenium	3.8	2.1
Silicon	5.1	2.8
Silver	19.5	10.7
Slate	10.4	5.8
Sodium	70	39.1
Solder 50 - 50	24	13.4
Steatite	8.5	4.7
Steel	13	7.3
Steel Stainless Austenitic (304)	17.3	9.6
Steel Stainless Austenitic (310)	14.4	8
Steel Stainless Austenitic (316)	16	8.9
Steel Stainless Ferritic (410)	9.9	5.5
Strontium	22.5	12.5
Tantalum	6.5	3.6
Tellurium	36.9	20.5
Terbium	10.3	5.7
Terne	11.6	6.5
Thallium	29.9	16.6
Thorium	12	6.7
Thulium	13.3	7.4
Tin	23.4	13
Titanium	8.6	4.8
Tungsten	4.3	2.4
Uranium	13.9	7.7
Vanadium	8	4.5
Vinyl Ester	16 - 22	8.7 - 12
Wood, fir	3.7	2.1

Wood, oak parallel to grain	4.9	2.7
Wood, oak across to grain	5.4	3
Wood, pine	5	2.8
Ytterbium	26.3	14.6
Yttrium	10.6	5.9
Zinc	29.7	16.5
Zirconium	5.7	3.2

---

**Volumetric expansion coefficients of some common fluids**

---

Liquid	Volumetric Coefficient of Expansion	
	$\left(\frac{1}{K}, \frac{1}{^{\circ}\text{C}}\right)$	$\left(\frac{1}{^{\circ}\text{F}}\right)$
Acetic acid	0.0011	0.00061
Acetone	0.00143	0.00079
Alcohol, ethyl (ethanol)	0.00109	0.00061
Alcohol, methyl (methanol)	0.00118	0.00066
Ammonia	0.00245	0.00136
Aniline	0.00085	0.00047
Benzene	0.00125	0.00069
Bromine	0.0011	0.00061
Carbon disulfide	0.00119	0.00066
Carbon tetrachloride	0.00122	0.00068
Chloroform	0.00127	0.00071
Ether	0.0016	0.00089
Ethyl acetate	0.00138	0.00077
Ethylene glycol	0.00057	0.00032
Freon refrigerant R-12	0.0026	0.00144
n-Heptane	0.00124	0.00069
Isobutyl alcohol	0.00094	0.00052
Gasoline	0.001	0.00056
Glycerin (glycerol)	0.0005	0.00028
Kerosene	0.001	0.00056
Mercury	0.00018	0.0001
Methyl alcohol	0.00119	0.00066
Methyl iodide	0.0012	0.00067
n-Octane	0.00114	0.00063
Oil (unused engine oil)	0.0007	0.00039
Paraffin oil	0.000764	0.00042
Petroleum	0.001	0.00056
n-Pentane	0.00158	0.00088
Phenol	0.0009	0.0005
Sulphuric acid, concentrated	0.00055	0.00031
Toluene	0.00108	0.0006
Trichloroethylene	0.00117	0.00065
Turpentine	0.001	0.00056
Water	0.00018	0.0001

---

Base metal thermocouples		
Thermocouple	Maximum Temperature (°C)	
	Continuous	Spot
Copper-Constantan	400	500
Iron-Constantan	850	1,100
Chromel-Constantan	700	1,000
Chromel-Alumel	1,100	1,300
Nicrosil-Nisil	1,250	-
Tungsten-Molybdenum	2,600	2,650

### Semiconductor Properties: Band Gaps, Effective Masses, Dielectric Constants

Material	Energy gap (eV) at 273K	Effective mass $m^*/m$		Dielectric constant
		Electrons	Holes	
Ge	0.67	0.2	0.3	16
Si	1.14	0.33	0.5	12
InSb	0.16	0.013	0.6	18
InAs	0.33	0.02	0.4	14.5
InP	1.29	0.07	0.4	14
GaSb	0.67	0.047	0.5	15
GaAs	1.39	0.072	0.5	13

### Boiling points and heat of vaporization

Substance	Boiling point $K$	Boiling point $^{\circ}C$	Heat of vaporization ( $10^3 \frac{J}{kg}$ )
Helium	4.216	-268.93	20.9
Hydrogen	20.26	-252.89	452
Nitrogen	77.34	-195.81	201
Oxygen	90.18	-182.97	213
Ethyl alcohol	351	78	854
Mercury	630	357	272
Water	373.15	100.00	2256
Sulfur	717.75	444.60	326
Lead	2023	1750	871
Antimony	1713	1440	561
Silver	2466	2193	2336
Gold	2933	2660	1578
Copper	2840	2567	5069

---

**Temperature standard points**

---

Substance	State	Temperature <i>K</i>
Hydrogen	Triple point	13.81
Hydrogen	Boiling point	20.28
Neon	Boiling point	27.102
Oxygen	Triple point	54.361
Argon	Triple point	83.798
Oxygen	Boiling point	90.188
Water	Triple point	273.16
Water	Boiling point	373.125
Tin	Melting point	505.074
Zinc	Melting point	692.664
Silver	Melting point	1235.08
Gold	Melting point	1337.58

---



---

**Dielectric constants at 20°C**

---

Elements	Dielectric constant
Vacuum	1
Glass	5-10
Pyrex	4.7
Mica	3-6
Mylar	3.1
Neoprene	6.70
Plexiglas	3.40
Polyvinyl chloride	3.18
Teflon	2.1
Germanium	16
Strontium	310
Benzene	2.28
Paper	3.5
Polyethylene	2.25
Polypropylene	2.2-2.36
Polystyrene	2.4-2.7
Concrete	4.5
Diamond	5.5-10
Salt	3-15
Graphite	10-15
Silicon	11.68
Methanol	30
Glycerol	41.2 at 0°C 47 at 20°C 42.5 at 25°C

---



Boiling point of water at different atmospheric pressure (mmHg)										
mmHg	0	1	2	3	4	5	6	7	8	9
<b>700</b>	97.71	97.75	97.79	97.83	97.87	97.91	97.95	97.99	98.03	98.07
<b>710</b>	98.11	98.14	98.18	98.22	98.26	98.30	98.34	98.38	98.42	98.45
<b>720</b>	98.49	98.53	98.27	98.61	98.63	98.69	98.72	98.76	98.80	98.84
<b>730</b>	98.88	98.91	98.95	98.99	99.03	99.07	99.10	99.14	99.18	99.22
<b>740</b>	99.24	99.29	99.33	99.37	99.41	99.44	99.48	99.52	99.56	99.59
<b>750</b>	99.63	99.67	99.70	99.74	99.78	99.81	99.85	99.89	99.93	99.96
<b>760</b>	100	100.03	100.07	100.11	100.15	100.18	100.22	100.26	100.29	100.33

Metric (SI) Multipliers				
Exponential	Multiplier	in word	Prefix	Symbol
1,0E+24	1 000 000 000 000 000 000 000 000	septillion	yotta-	Y
1,0E+21	1 000 000 000 000 000 000 000 000	sextillion	zetta-	Z
1,0E+18	1 000 000 000 000 000 000 000	quintillion	exa-	E
1,0E+15	1 000 000 000 000 000 000	quadrillion	peta-	P
1,0E+12	1 000 000 000 000 000	trillion	tera-	T
1,0E+9	1 000 000 000	billion	giga-	G
1,0E+6	1 000 000	million	mega-	M
1,0E+3	1 000	thousand	kilo-	k
1,0E+2	100	hundred	hecto-	h
1,0E+1	10	ten	deca-	da
1,0E-1	0,1	tenth	deci-	d
1,0E-2	0,01	hundredth	centi-	c
1,0E-3	0,001	thousandth	milli-	m
1,0E-6	0,000 001	millionth	micro-	μ
1,0E-9	0,000 000 001	billionth	nano-	n
1,0E-12	0,000 000 000 001	Trillionth	pico-	p
1,0E-15	0,000 000 000 000 001	quadrillionth	femto-	f
1,0E-18	0,000 000 000 000 000 001	quintillionth	atto-	a
1,0E-21	0,000 000 000 000 000 000 001	Sextillionth	zepto-	z
1,0E-24	0,000 000 000 000 000 000 000 001	septillionth	yocto-	y

---

**Density and saturated vapour pressure of water at different temperature**

---

Temperature	Saturated vapour pressure <i>torr</i>	Density <i>kg. m<sup>-3</sup></i>
-8	2.3	0.00274
-4	3.3	0.00366
0	4.58	0.00485
4	6.1	0.00633
5	6.51	-
10	9.21	0.00941
12	10.5	0.0106
15	12.79	0.0128
16	13.6	0.0135
20	17.51	0.0173
24	22.3	0.0215
25	23.76	0.023
28	28.2	0.026
30	31.71	0.03035
32	35.5	0.03345
36	44.4	-
40	55.13	0.0511
50	92.3	0.0832
60	149.19	0.1305
70	233.53	0.1984
80	355.1	0.2938
90	525.8	0.4241
94	611	-
99	733	0.598
100	760	0.0418
110	1074.5	0.827
120	1488.9	1.122
130	2025.6	1.498
140	2709.5	1.968
150	3568.7	2.55
160	4630	-
180	7510	-
200	11650	-
220	17390	-

---

**Table of specific heat capacities at 25 °C unless otherwise noted**

Substance	Phase	$C_p$	$C_{p,m}$	$C_{v,m}$	volumetric heat capacity
		J/g.K	J/mol.K	J/mol.K	J/(cm <sup>3</sup> .K)
Air (Sea level, dry, 0 °C)	gas	1.0035	29.07	20.7643	0.001297
Air (typical room conditionsA)	gas	1.012	29.19	20.85	
Aluminium	solid	0.897	24.2		2.422
Ammonia	liquid	4.7	80.08		3.263
Animal (and human) tissue	mixed	3.5	—		3.7*
Antimony	solid	0.207	25.2		1.386
Argon	gas	0.5203	20.7862	12.4717	
Arsenic	solid	0.328	24.6		1.878
Beryllium	solid	1.82	16.4		3.367
Bismuth	solid	0.123	25.7		1.2
Cadmium	solid	0.231	—		—
Carbon dioxide CO <sub>2</sub>	gas	0.839	36.94	28.46	
Chromium	solid	0.449	—		—
Copper	solid	0.385	24.47		3.45
Diamond	solid	0.5091	6.115		1.782
Ethanol	liquid	2.44	112		1.925
Gasoline	liquid	2.22	228		1.64
Glass	solid	0.84			
Gold	solid	0.129	25.42		2.492
Granite	solid	0.79			2.17
Graphite	solid	0.71	8.53		1.534
Helium	gas	5.1932	20.7862	12.4717	
Hydrogen	gas	14.3	28.82		
Hydrogen sulfide H <sub>2</sub> S	gas	1.015	34.6		
Iron	solid	0.45	25.1		3.537
Lead	solid	0.129	26.4		1.44
Lithium	solid	3.58	24.8		1.912
Lithium at 181 °C	liquid	4.379	30.33		2.242
Magnesium	solid	1.02	24.9		1.773
Mercury	liquid	0.1395	27.98		1.888
Methane at 2 °C	gas	2.191			
Methanol	liquid	2.597	—		—
Nitrogen	gas	1.04	29.12	20.8	
Neon	gas	1.0301	20.7862	12.4717	
Oxygen	gas	0.918	29.38		
Paraffin wax	solid	2.5	900		2.325
Polyethylene (rotomolding grade)	solid	2.3027			
Polyethylene (rotomolding grade)	liquid	2.9308			
Silica (fused)	solid	0.703	42.2		1.547
Silver	solid	0.233	24.9		2.44
Sodium	solid	1.23	—		—

Tin	solid	0.227	—	—	—
Titanium	solid	0.523	—	—	—
Tungsten	solid	0.134	24.8		2.58
Uranium	solid	0.116	27.7		2.216
Water at 100 °C (steam)	gas	2.08	37.47	28.03	
Water at 25 °C	liquid	4.1813	75.327	74.53	4.1796
Water at 100 °C	liquid	4.1813	75.327	74.53	4.216
Water at -10 °C (ice)	solid	2.11	38.09		1.938
Zinc	solid	0.387	25.2		2.76

---

**Specific heat capacity of building materials**

---

Substance	Phase	$C_p$ J/g·K
Asphalt	solid	0.92
Brick	solid	0.84
Concrete	solid	0.88
Glass, silica	solid	0.84
Glass, crown	solid	0.67
Glass, flint	solid	0.503
Glass, pyrex	solid	0.753
Granite	solid	0.79
Gypsum	solid	1.09
Marble, mica	solid	0.88
Sand	solid	0.835
Soil	solid	0.8
Wood	solid	1.7 (1.2 to 2.3)

---

**Thermal properties of water**

Temperature $T$ (°C)	Absolute pressure $P$ ( $\frac{kN}{m^2}$ )	Density $\rho$ ( $\frac{kg}{m^3}$ )	Specific volume $V$ $10^3$ ( $\frac{m^3}{kg}$ )	Specific heat $C_p$ ( $\frac{kJ}{kgK}$ )	Specific entropy $e$ ( $\frac{kJ}{kgK}$ )	Dynamic viscosity $\mu$ (Centipoise)	Kinematic viscosity $10^{-6}$ ( $\frac{m^2}{s}$ )	Expansion coefficient $10^{-3}$ ( $\frac{1}{K}$ )	Specific enthalpy ( $\frac{kJ}{kg}$ )
0 (ice)	-	916.8	-	-	-	-	-	-	-
0.01	0.6	999.8	1.00	4.210	0	1.78	1.792	-0.07	0
4	0.9	1000.0	-	-	-	-	-	-	-
5	0.9	1000.0	1.00	4.204	0.075	1.52	-	0.160	21.0
10	1.2	999.8	1.00	4.193	0.150	1.31	1.304	0.088	41.9
15	1.7	999.2	1.00	4.186	0.223	1.14	-	0.151	62.9
20	2.3	998.3	1.00	4.183	0.296	1.00	1.004	0.207	83.8
25	3.2	997.1	1.00	4.181	0.367	0.890	-	0.257	104.8
30	4.3	995.7	1.00	4.179	0.438	0.798	0.801	0.303	125.7
35	5.6	994.1	1.01	4.178	0.505	0.719	-	0.345	146.7
40	7.7	992.3	1.01	4.179	0.581	0.653	0.658	0.385	167.6
45	9.6	990.2	1.01	4.181	0.637	0.596	-	0.420	188.6
50	12.5	988	1.01	4.182	0.707	0.547	0.553	0.457	209.6
55	15.7	986	1.01	4.183	0.767	0.504	-	0.486	230.5
60	20.0	983	1.02	4.185	0.832	0.467	0.474	0.523	251.5
65	25.0	980	1.02	4.188	0.893	0.434	-	0.544	272.4
70	31.3	978	1.02	4.191	0.966	0.404	0.413	0.585	293.4
75	38.6	975	1.03	4.194	1.016	0.378	-	0.596	314.3
80	47.5	972	1.03	4.198	1.076	0.355	0.365	0.643	335.3
85	57.8	968	1.03	4.203	1.134	0.334	-	0.644	356.2
90	70.0	965	1.04	4.208	1.192	0.314	0.326	0.665	377.2
95	84.5	962	1.04	4.213	1.250	0.297	-	0.687	398.1
100	101.33	958	1.04	4.219	1.307	0.281	0.295	0.752	419.1
105	121	954	1.05	4.226	1.382	0.267	-	-	440.2
110	143	951	1.05	4.233	1.418	0.253	-	-	461.3
115	169	947	1.06	4.240	1.473	0.241	-	-	482.5
120	199	943	1.06	4.248	1.527	0.230	0.249	0.860	503.7
125	228	939	1.06	4.26	1.565	0.221	-	-	524.3
130	270	935	1.07	4.27	1.635	0.212	-	-	546.3

Thermal properties of water (continued)

Temperature $T$ (°C)	Absolute pressure $P$ ( $\frac{kN}{m^2}$ )	Density $\rho$ ( $\frac{kg}{m^3}$ )	Specific volume $v$ $10^3$ ( $\frac{m^3}{kg}$ )	Specific heat $c_p$ ( $\frac{kJ}{kgK}$ )	Specific entropy $e$ ( $\frac{kJ}{kgK}$ )	Dynamic viscosity $\mu$ (Centipoise)	Kinematic viscosity $10^{-6}$ ( $\frac{m^2}{s}$ )	Expansion coefficient $10^{-3}$ ( $\frac{1}{K}$ )	Specific enthalpy ( $\frac{kJ}{kg}$ )
135	313	931	1.07	4.28	1.687	0.204			567.7
140	361	926	1.08	4.29	1.739	0.196	0.215	0.975	588.7
145	416	922	1.08	4.30	1.790	0.190			610.0
150	477	918	1.09	4.32	1.842	0.185			631.8
155	543	912	1.10	4.34	1.892	0.180			653.8
160	618	907	1.10	4.35	1.942	0.174	0.189	1.098	674.5
165	701	902	1.11	4.36	1.992	0.169			697.3
170	792	897	1.11	4.38	2.041	0.163			718.1
175	890	893	1.12	4.39	2.090	0.158			739.8
180	1000	887	1.13	4.42	2.138	0.153	0.170	1.233	763.1
185	1120	882	1.13	4.45	2.187	0.149			785.3
190	1260	876	1.14	4.46	2.236	0.145			807.5
195	1400	870	1.15		2.282	0.141			829.9
200	1550	864	1.16	4.51	2.329	0.138	0.158	1.392	851.7
220		840		4.63			0.149	1.597	
225	2550	834	1.20	4.65	2.569	0.121			966.8
240		814		4.78			0.142	1.862	
250	3990	799	125	4.87	2.797	0.110			1087
260		784		4.98			0.137	2.21	
275	5950	756	1.32	5.20	3.022	0.0972			1211
300	8600	714	1.40	5.65	3.256	0.0897			1345
325	12130	654	1.53	6.86	3.501	0.0790			1494
350	16540	575	1.74	10.1	3.781	0.0648			1672
360	18680	528	1.90	14.6	3.921	0.0582			1764

**Gases - Specific Heat Capacities and Individual Gas Constants**

Gas or Vapour	Formula	Specific Heat Capacity				Ratio of Specific Heats $\gamma \left( \frac{C_p}{C_v} \right)$	Individual gas constant <i>R</i>	
		$C_p \left( \frac{kJ}{kgK} \right)$	$C_v \left( \frac{kJ}{kgK} \right)$	$C_p \left( \frac{Btu}{lb_m \text{ } ^\circ F} \right)$	$C_v \left( \frac{Btu}{lb_m \text{ } ^\circ F} \right)$		$C_p - C_v \left( \frac{kJ}{kgK} \right)$	$C_p - C_v \left( \frac{Btu}{lb_m \text{ } ^\circ F} \right)$
Acetone		1.47	1.32	0.35	0.32	1.11	0.15	
Acetylene	C2H2	1.69	1.37	0.35	0.27	1.232	0.319	59.34
Air		1.01	0.718	0.24	0.17	1.4	0.287	53.34
Alcohol	C2H5OH	1.88	1.67	0.45	0.4	1.13	0.22	
Alcohol	CH3OH	1.93	1.53	0.46	0.37	1.26	0.39	
Ammonia	NH3	2.19	1.66	0.52	0.4	1.31	0.53	96.5
Argon	Ar	0.52	0.312	0.12	0.07	1.667	0.208	
Benzene	C6H6	1.09	0.99	0.26	0.24	1.12	0.1	
Blast furnace gas		1.03	0.73	0.25	0.17	1.41	0.3	55.05
Bromine		0.25	0.2	0.06	0.05	1.28	0.05	
Butadiene						1.12		
Butane	C4H10	1.67	1.53	0.395	0.356	1.094	0.143	26.5
Carbon dioxide	CO2	0.844	0.655	0.21	0.16	1.289	0.189	38.86
Carbon monoxide	CO	1.02	0.72	0.24	0.17	1.4	0.297	55.14
Carbon disulphide		0.67	0.55	0.16	0.13	1.21	0.12	
Chlorine	Cl2	0.48	0.36	0.12	0.09	1.34	0.12	
Chloroform		0.63	0.55	0.15	0.13	1.15	0.08	
Combustion products		1		0.24				
Ethane	C2H6	1.75	1.48	0.39	0.32	1.187	0.276	51.5
Ether		2.01	1.95	0.48	0.47	1.03	0.06	
Ethylene	C2H4	1.53	1.23	0.4	0.33	1.24	0.296	55.08
Freon 22						1.18		
Helium	He	5.19	3.12	1.25	0.75	1.667	2.08	386.3
Hexane						1.06		
Hydrogen	H2	14.32	10.16	3.42	2.43	1.405	4.12	765.9
Hydrogen Chloride	HCl	0.8	0.57	0.191	0.135	1.41	0.23	42.4
Hydrogen Sulfide	H2S			0.243	0.187	1.32		45.2
Hydroxyl	OH	1.76	1.27			1.384	0.489	

**Gases - Specific Heat Capacities and Individual Gas Constants (continued)**

Methane	CH4	2.22	1.7	0.59	0.45	1.304	0.518	96.4
Methyl Chloride	CH3Cl			0.24	0.2	1.2		30.6
Natural Gas		2.34	1.85	0.56	0.44	1.27	0.5	79.1
Neon		1.03	0.618			1.667	0.412	
Nitric Oxide	NO	0.995	0.718	0.23	0.17	1.386	0.277	
Nitrogen	N2	1.04	0.743	0.25	0.18	1.4	0.297	54.99
Nitrogen tetroxide		4.69	4.6	1.12	1.1	1.02	0.09	
Nitrous oxide	N2O	0.88	0.69	0.21	0.17	1.27	0.18	35.1
Oxygen	O2	0.919	0.659	0.22	0.16	1.395	0.26	48.24
Pentane						1.07		
Propane	C3H8	1.67	1.48	0.39	0.34	1.127	0.189	35
Propene (propylene)	C3H6	1.5	1.31	0.36	0.31	1.15	0.18	36.8
Water Vapor Steam (1psia. 120 – 600°F )		1.93	1.46	0.46	0.35	1.32	0.462	
Steam (14.7psia. 220 – 600°F)		1.97	1.5	0.47	0.36	1.31	0.46	
Steam (150psia. 360 – 600 °F)		2.26	1.76	0.54	0.42	1.28	0.5	
Sulfur dioxide (Sulphur dioxide)	SO2	0.64	0.51	0.15	0.12	1.29	0.13	24.1



# Periodic Table

1 IA																	18 VIIIA
1 <b>H</b> 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 <b>He</b> 4.00
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII B	10	11 IB	12 IIB	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <b>Rg</b> (272)							

* 58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.3	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0
^ 90 <b>Th</b> 232.0	91 <b>Pa</b> (231)	92 <b>U</b> 238.0	93 <b>Np</b> (237)	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)

## Tables of Element Properties

Z	Name	Aggregate state	Density	Melting Point [°C]	Boiling Point [°C]	Lattice constant (Å)	Crystal type	c/a	$\alpha$	b/a
1	Hydrogen	gas	0,084 g/l	-259.1	-252.9	3.75	HEX	n.n.	-	-
2	Helium	gas	0,17 g/l	-272.2	-268.9	3.57	HEX	n.n.	-	-
3	Lithium	solid	0,53 g/cm3	180.5	1317	3.49	BCC	-	-	-
4	Beryllium	solid	1,85 g/cm3	1278	2970	2.29	HEX	1.567	-	-
5	Boron	solid	2,46 g/cm3	2300	2550	8.73	TET	0.576	-	-
6	Carbon	solid	3,51 g/cm3	3550	4827	3.57	DIA	-	-	-
7	Nitrogen	gas	1,17 g/l	-209.9	-195.8	4.039	HEX	1.051	-	-
8	Oxygen	gas	1,33 g/l	-218.4	-182.9	6.83	CUB	-	-	-
9	Fluorine	gas	1,58 g/l	-219.6	-188.1	n.n.	MCL	-	-	-
10	Neon	gas	0,84 g/l	-248.7	-246.1	4.43	FCC	-	-	-
11	Sodium	solid	0,97 g/cm3	97.8	892	4.23	BCC	-	-	-
12	Magnesium	solid	1,74 g/cm3	648.8	1107	3.21	HEX	1.624	-	-
13	Aluminium	solid	2,70 g/cm3	660.5	2467	4.05	FCC	-	-	-
14	Silicon	solid	2,33 g/cm3	1410	2355	5.43	DIA	-	-	-
15	Phosphorus	solid	1,82 g/cm3	44 (P4)	280 (P4)	7.17	CUB	-	-	-
16	Sulfur	solid	2,06 g/cm3	113	444.7	10.47	ORC	2.339	-	1.229
17	Chlorine	gas	2,95 g/l	-101	-34.6	6.24	ORC	1.324	-	0.718
18	Argon	gas	1,66 g/l	-189.4	-185.9	5.26	FCC	-	-	-
19	Potassium	solid	0,86 g/cm3	63.7	774	5.23	BCC	-	-	-
20	Calcium	solid	1,54 g/cm3	839	1487	5.58	FCC	-	-	-
21	Scandium	solid	2,99 g/cm3	1539	2832	3.31	HEX	1.594	-	-
22	Titanium	solid	4,51 g/cm3	1660	3260	2.95	HEX	1.588	-	-
23	Vanadium	solid	6,09 g/cm3	1890	3380	3.02	BCC	-	-	-
24	Chromium	solid	7,14 g/cm3	1857	2482	2.88	BCC	-	-	-
25	Manganese	solid	7,44 g/cm3	1244	2097	8.89	CUB	-	-	-

Z	Name	Aggregate state	Density	Melting Point [°C]	Boiling Point [°C]	Lattice constant (Å)	Crystal type	c/a	$\alpha$	b/a
26	Iron	solid	7,87 g/cm <sup>3</sup>	1535	2750	2.87	BCC	-	-	-
27	Cobalt	solid	8,89 g/cm <sup>3</sup>	1495	2870	2.51	HEX	1.622	-	-
28	Nickel	solid	8,91 g/cm <sup>3</sup>	1453	2732	3.52	FCC	-	-	-
29	Copper	solid	8,92 g/cm <sup>3</sup>	1083.5	2595	3.61	FCC	-	-	-
30	Zinc	solid	7,14 g/cm <sup>3</sup>	419.6	907	2.66	HEX	1.856	-	-
31	Gallium	solid	5,91 g/cm <sup>3</sup>	29.8	2403	4.51	ORC	1.695	-	1.001
32	Germanium	solid	5,32 g/cm <sup>3</sup>	937.4	2830	5.66	DIA	-	-	-
33	Arsenic	solid	5,72 g/cm <sup>3</sup>	613	sublimation	4.13	RHL	-	54°10'	-
34	Selenium	solid	4,82 g/cm <sup>3</sup>	217	685	4.36	HEX	1.136	-	-
35	Bromine	liquid	3,14 g/cm <sup>3</sup>	-7.3	58.8	6.67	ORC	0.672	-	1.307
36	Krypton	gas	3,48 g/l	-156.6	-152.3	5.72	FCC	-	-	-
37	Rubidium	solid	1,53 g/cm <sup>3</sup>	39	688	5.59	BCC	-	-	-
38	Strontium	solid	2,63 g/cm <sup>3</sup>	769	1384	6.08	FCC	-	-	-
39	Yttrium	solid	4,47 g/cm <sup>3</sup>	1523	3337	3.65	HEX	1.571	-	-
40	Zirconium	solid	6,51 g/cm <sup>3</sup>	1852	4377	3.23	HEX	1.593	-	-
41	Niobium	solid	8,58 g/cm <sup>3</sup>	2468	4927	3.30	BCC	-	-	-
42	Molybdenum	solid	10,28 g/cm <sup>3</sup>	2617	5560	3.15	BCC	-	-	-
43	Technetium	radioactive	11,49 g/cm <sup>3</sup>	2172	5030	2.74	HEX	1.604	-	-
44	Ruthenium	solid	12,45 g/cm <sup>3</sup>	2310	3900	2.70	HEX	1.584	-	-
45	Rhodium	solid	12,41 g/cm <sup>3</sup>	1966	3727	3.90	FCC	-	-	-
46	Palladium	solid	12,02 g/cm <sup>3</sup>	1552	3140	3.89	FCC	-	-	-
47	Silver	solid	10,49 g/cm <sup>3</sup>	961.9	2212	4.09	FCC	-	-	-
48	Cadmium	solid	8,64 g/cm <sup>3</sup>	321	765	2.98	HEX	1.886	-	-
49	Indium	solid	7,31 g/cm <sup>3</sup>	156.2	2080	4.59	TET	1.076	-	-
50	Tin	solid	7,29 g/cm <sup>3</sup>	232	2270	5.82	TET	0.546	-	-
51	Antimony	solid	6,69 g/cm <sup>3</sup>	630.7	1750	4.51	RHL	-	57°6'	-
52	Tellurium	solid	6,25 g/cm <sup>3</sup>	449.6	990	4.45	HEX	1.33	-	-
53	Iodine	solid	4,94 g/cm <sup>3</sup>	113.5	184.4	7.27	ORC	0.659	-	1.347

Z	Name	Aggregate state	Density	Melting Point [°C]	Boiling Point [°C]	Lattice constant (Å)	Crystal type	c/a	$\alpha$	b/a
54	Xenon	gas	4,49 g/l	-111.9	-107	6.20	FCC	-	-	-
55	Caesium	solid	1,90 g/cm <sup>3</sup>	28.4	690	6.05	BCC	-	-	-
56	Barium	solid	3,65 g/cm <sup>3</sup>	725	1640	5.02	BCC	-	-	-
57	Lanthanum	solid	6,16 g/cm <sup>3</sup>	920	3454	3.75	HEX	1.619	-	-
58	Cerium	solid	6,77 g/cm <sup>3</sup>	798	3257	5.16	FCC	-	-	-
59	Praseodymium	solid	6,48 g/cm <sup>3</sup>	931	3212	3.67	HEX	1.614	-	-
60	Neodymium	solid	7,00 g/cm <sup>3</sup>	1010	3127	3.66	HEX	1.614	-	-
61	Promethium	radioactive	7,22 g/cm <sup>3</sup>	1080	2730	n.n.	n.n.	n.n.	n.n.	n.n.
62	Samarium	solid	7,54 g/cm <sup>3</sup>	1072	1778	9.00	RHL	-	23°13'	-
63	Europium	solid	5,25 g/cm <sup>3</sup>	822	1597	4.61	BCC	-	-	-
64	Gadolinium	solid	7,89 g/cm <sup>3</sup>	1311	3233	3.64	HEX	1.588	-	-
65	Terbium	solid	8,25 g/cm <sup>3</sup>	1360	3041	3.60	HEX	1.581	-	-
66	Dysprosium	solid	8,56 g/cm <sup>3</sup>	1409	2335	3.59	HEX	1.573	-	-
67	Holmium	solid	8,78 g/cm <sup>3</sup>	1470	2720	3.58	HEX	1.570	-	-
68	Erbium	solid	9,05 g/cm <sup>3</sup>	1522	2510	3.56	HEX	1.570	-	-
69	Thulium	solid	9,32 g/cm <sup>3</sup>	1545	1727	3.54	HEX	1.570	-	-
70	Ytterbium	solid	6,97 g/cm <sup>3</sup>	824	1193	5.49	FCC	-	-	-
71	Lutetium	solid	9,84 g/cm <sup>3</sup>	1656	3315	3.51	HEX	1.585	-	-
72	Hafnium	solid	13,31 g/cm <sup>3</sup>	2150	5400	3.20	HEX	1.582	-	-
73	Tantalum	solid	16,68 g/cm <sup>3</sup>	2996	5425	3.31	BCC	-	-	-
74	Tungsten	solid	19,26 g/cm <sup>3</sup>	3407	5927	3.16	BCC	-	-	-
75	Rhenium	solid	21,03 g/cm <sup>3</sup>	3180	5627	2.76	HEX	1.615	-	-
76	Osmium	solid	22,61 g/cm <sup>3</sup>	3045	5027	2.74	HEX	1.579	-	-
77	Iridium	solid	22,65 g/cm <sup>3</sup>	2410	4130	3.84	FCC	-	-	-
78	Platinum	solid	21,45 g/cm <sup>3</sup>	1772	3827	3.92	FCC	-	-	-
79	Gold	solid	19,32 g/cm <sup>3</sup>	1064.4	2940	4.08	FCC	-	-	-
80	Mercury	liquid	13,55 g/cm <sup>3</sup>	-38.9	356.6	2.99	RHL	-	70°45'	-
81	Thallium	solid	11,85 g/cm <sup>3</sup>	303.6	1457	3.46	HEX	1.599	-	-

Z	Name	Aggregate state	Density	Melting Point [°C]	Boiling Point [°C]	Lattice constant (Å)	Crystal type	c/a	$\alpha$	b/a
82	Lead	solid	11,34 g/cm <sup>3</sup>	327.5	1740	4.95	FCC	-	-	-
83	Bismuth	solid	9,80 g/cm <sup>3</sup>	271.4	1560	4.75	RHL	-	57°14'	-
84	Polonium	radioactive	9,20 g/cm <sup>3</sup>	254	962	3.35	SCB	-	-	-
85	Astatine	radioactive	n.n.	302	337	n.n.	n.n.	n.n.	n.n.	n.n.
86	Radon	gas	9,23 g/l	-71	-61.8	n.n.	FCC	-	-	-
87	Francium	radioactive	n.n.	27	677	n.n.	BCC	-	-	-
88	Radium	radioactive	5,50 g/cm <sup>3</sup>	700	1140	n.n.	n.n.	n.n.	n.n.	n.n.
89	Actinium	radioactive	10,07 g/cm <sup>3</sup>	1047	3197	5.31	FCC	-	-	-
90	Thorium	radioactive	11,72 g/cm <sup>3</sup>	1750	4787	5.08	FCC	-	-	-
91	Protactinium	radioactive	15,37 g/cm <sup>3</sup>	1554	4030	3.92	TET	0.825	-	-
92	Uranium	radioactive	18,97 g/cm <sup>3</sup>	1132.4	3818	2.85	ORC	1.736	-	2.056
93	Neptunium	radioactive	20,48 g/cm <sup>3</sup>	640	3902	4.72	ORC	1.035	-	1.411
94	Plutonium	radioactive	19,74 g/cm <sup>3</sup>	641	3327	n.n.	MCL	-	-	-
95	Americium	radioactive	13,67 g/cm <sup>3</sup>	994	2607	n.n.	n.n.	n.n.	n.n.	n.n.
96	Curium	radioactive	13,51 g/cm <sup>3</sup>	1340	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
97	Berkelium	radioactive	13,25 g/cm <sup>3</sup>	986	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
98	Californium	radioactive	15,1 g/cm <sup>3</sup>	900	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
99	Einsteinium	radioactive	n.n.	860	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
100	Fermium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
101	Mendelevium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
102	Nobelium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
103	Lawrencium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
104	Rutherfordium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
105	Dubnium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
106	Seaborgium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
107	Bohrium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
108	Hassium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
109	Meitnerium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Z	Name	Aggregate state	Density	Melting Point [°C]	Boiling Point [°C]	Lattice constant (Å)	Crystal type	<i>c/a</i>	$\alpha$	<i>b/a</i>
110	Ununnilium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
111	Unununium	radioactive	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

**Note:**

- 1- In this table the densities for solids and liquids are given in units of g/cm<sup>3</sup> at a temperature of 20°C. The densities of gases are given in units of g/l at a pressure of 1013hPa.
- 2- The state is given for normal conditions, i.e. a temperature of 20°C and a pressure of 1 atm
- 3- The melting point of an element is the temperature at which the transition from the solid phase to the liquid phase occurs.
- 4- The boiling point of an element is the temperature at which there is the transition from the liquid to the gas phase.
- 5- The lattice constant is given in Angstrom [Å].
- 6- The crystal type is abbreviated according to the table below:

<b>CUB</b>	cubic	<b>MCL</b>	monoclinic
<b>FCC</b>	face centered cubic	<b>DIA</b>	diamond
<b>BCC</b>	body centered cubic	<b>ORC</b>	orthorhombic
<b>HEX</b>	hexagonal	<b>RHL</b>	rhombohedral
<b>TET</b>	tetragonal	<b>SCB</b>	simple cubic
- 7- *c/a* ratio in the HEX, ORC, TET phases, or the angle  $\alpha$  in the RHL phase, or the *b/a* ratio in the ORC phase is given, respectively