SJH－ 3016	TITLE	Reference
SHEET No－ 1/3	SUB TITLE	Thermal data of substances

■各種物質の熱的性質

	Substances	Temperature ℃	Specific gravity g／cm^3	Specific heat kcal/kg℃	Thermal conductivity Kcal/mh℃	Temperature conductivity m^3/h	Remarks
Metals	Aluminum (pure)	20	2.71	0.214	196	0.340	
	Duralumin（94－96A1 3-5 Cu、	〃	2.79	0.211	141	0.240	
	Lead	〃	11.37	0.031	30	0.086	
	Cast iron (C4 %)	〃	7.27	0.10	45	0.062	
	Steel	〃	7.80	0.113	37	0.042	
	Stainless steel 18Cr, 8Ni	〃	7.82	0.11	14	0.016	
	Copper (pure)	〃	8.96	0.0915	332	0.404	
	Bronze 75Cu, 25Sn	〃	8.67	0.082	22	0.031	
	Bronze (red) 85Cu,9sn,6Zn	〃	8.71	0.092	52	0.065	
	7-3 brass 70Cu,30Zn	〃	8.52	0.092	95	0.123	
	German silver 62Cu,15Ni,22Zn	〃	8.62	0.094	21	0.027	
	Nickel (99.9 %)	〃	8.91	0.1005	77	0.082	
	Silver (pure)	〃	10.53	0.0559	360	0.613	
	Zinc	〃	7.14	0.0918	96	0.148	
	Tin	〃	7.31	0.0541	55	0.140	
	Gold	〃	19.29	0.0309	267	0.448	
	Platinum	0	21.45	0.0318	60	0.088	
	Mercury	0	13.628	0.0335	7.1	0.01548	
Non-metallic solid bodies	Bakelite	20	1.27	0.38	0.200	0.00041	
	Rubber	〃	0.92～1.23	0.27～0.48	0.204	－	
	Paper (plain)	〃	－	－	0.12	－	
	Paper (hard white)	〃	1.30	－	0.179	－	
	Glass	〃	2.59	0.186	0.83	0.00172	
	Celluloid	〃	1.40	－	0.185	－	
	Coal	〃	1.20－1.50	0.30	0.22	0.0005-0.0006	
	Mica	〃	1.90－2.30	0.21	0.7～1.2	0.0018-0.0025	
	Quartz glass	0	2.21	0.174	1.16	0.00301	
	Chamotte brick	200	1.83	0.210	0.77	0.0020	
	Asbestos	20	0.47	0.19	1.134	0.0015	
	Cork	〃	0.10	0.4～0.5	0.036	0.00090-0.00072	
	Rock wool	－	0.24	－	0.046	－	
	Diatomaceous earth (pale yellow)	80	0.439	－	0.084	－	
Liquid	Benzoyl	20	0.879	0.415	0.132	3.62	
	Spindle oil	〃	0.871	0.442	0.124	3.22	
	Transformer oil	〃	0.866	0.452	0.107	2.73	
	Ammonia	〃	0.612	1.146	0.448	6.39	
	Glycerin	〃	1.264	0.570	0.246	3.41	
	Lubricant	40	0.876	0.469	0.12	3.00	
	Dausam A	100	0.933	0.45	－	－	
	Dausam A	200	0.905	0.57	－	－	
	Water	20	0.9988	0.999	0.513	0.00143	
※ Gas	Air	20	1.164	0.242	0.022	0.213	The unit of the specific weight of gas is kilogram per cubic meter (kg/m3). The value is 760 mmHg.
		100	0.916	0.244	0.026	0.328	
		200	0.723	0.247	0.032	0.494	
		400	0.508	0.253	0.042	0.901	
		500	0.442	0.257	0.046	1.135	
		600	0.391	0.260	0.050	1.363	
	Superheated steam	100	0.578	0.486	0.020	0.0717	
		200	0.451	0.469	0.026	0.122	
		300	0.302	0.477	0.032	0.1776	
		400	0.316	0.490	0.037	0.2400	
		500	0.275	0.506	0.043	0.3080	
	Hydrogen (H_2)	0	0.087	3.39	0.144	0.486	
		200	0.050	3.47	0.221	1.28	
	Nitrogen (N_2)	0	1.211	0.249	0.021	0.0687	
		200	0.699	0.252	0.033	0.186	
	Carbonic acid gas (CO_2)	0	1.912	0.198	0.013	0.033	
		200	1.103	0.238	0.026	0.101	
	Oxygen (O_2)	0	1.382	0.219	0.020	0.065	
	Carbon monoxide (CO)	0	1.210	0.249	0.020	0.066	
		100	0.886	0.250	0.026	0.118	
	Ammonia (NH_2)	0	0.746	0.512	0.019	0.049	
		100	0.540	0.535	0.029	0.099	
	Sulfurous acid gas (SO_2)	0	2.83	0.149	0.007	0.017	
		100	2.06	0.161	0.010	0.031	

■Melting points (or freezing points) of substances（℃）

Asbestos	1,300	Rubber	125	Quartz glass	1,400	Turpentine oil	-10
Wood alloy	69	Shellac	150	Chamotte brick	1,700	Pottery	1,550
Olive oil	20	Fat (cow)	42	Iron (wrought)	1,400	Steel	1,400
Sea water	-2.5	Salt water	-18	Iron (cast, gray)	1,200	Solder (white solder)	210
Glass (soda)	550	Brass	900	Iron (cast, white)	1,130	Paraffin	54
Volatile oil	-150	Quartz	1,710	Delta metal	950	Gun metal	900

■Linear expansion coefficients of elements (at 20 degrees C) （$\times 10^{-6}$/℃）

Zinc	33	Gold	14.2	Tungsten	4	Platinum	8.9
Aluminum	23.03	Silver	18.9	Iron	11.7	Bismuth	13.3
Antimony	11.4	Chrome	8.2	Copper	16.6	Magnesium	25.6
Iridium	6.5	Cobalt	12.3	Lead	29.1	Manganese	23
Cadmium	29.8	Tin	20	Nickel	12.8	Molybdenum	4

■Linear expansion coefficients of elements （×10-6/degrees C）

——Alloys——							
		30％ Ni	12	German silver	18	Sandstone	10
Aluminum	19	36％ Ni(amber)	0.9	Phosphor bronze	17	Quartz glass	0.5
Brass	19	40％ Ni	6	——Miscellaneous——		Cement	10～14
Type metal	20	50％ Ni	10	Ebonite	84	Celluloid	10
Constantan	15	80％ Ni	13	Granite	8	Marble (white)	1～4
Bronze	18	Steel	13	Glass	9	Marble (black)	4
Ultra amber	-0.61	Platinized iridium	9	Concrete	14	Elastic rubber	77
Nickel steel		Solder (white	25	Ice(0～－10℃)	51	Wood (vertical)	3～4
10％ Ni	13	Gun metal	18			Wood (horizontal)	30～60
20％ Ni	20	Magnalium	24	Pottery	3	Brick	9

■Linear expansion coefficients of liquid (at 20 degrees C)（$\times 10^{-3}$/℃）

Acetone	1.487	Calcium chloride		Carbon	1.236	Pentane	1.608
Alcohol		（6％solution）	0.25	Table salt		Water	0.207
(ethyl)	1.12	（41％solution）	0.46	（21％solution）	0.41	Sulfuric acid	
(methyl)	1.199	Glycerin	0.505	Mercury	0.182	(11％solution)	0.39
Ether	1.656	Chloroform	1.273	Carbon disulfide	1.218	(100％)	0.56
Olive	0.721	Acetic acid	1.071	Benzoyl	1.237		

■Melting temperatures of substances（Kcal/kg）

Zinc	26	Chrome	32	Lead	5.4	Furnace slag	50
Aluminum	77	Cobalt	68	Nickel	74	Aniline	21
Antimony	38	Ice	79.7	Platinum	27	Glycerin	47
Ammonia	108	Bromine	16	Palladium	36	Chloroform	18
Sulfur	8.8	Table salt	124	Bismuth	12	Acetic acid	45
Wood alloy	8.4	Mercury	2.8	Magnesium	70	Stearic acid	48
Calcium	54	Tin	14	Manganese	47	Naphthalene	36
Potassium	15	Iron (electrolytic	64	Lithium	33	Paraffin	35
Cadmium	13	Copper	42	Phosphorus	5.0	Benzoyl	30
Silver	24	Sodium	27	Sulfuric acid	24		

■Evaporation heat at standard boiling point（Kcal/kg）

Ammonia	325	Carbonic acid gas (sublimation)	138	Ethyl alcohol	205	Naphthalene	75
Sulfur	81	Nitrogen	48	Ethyl ether	84	Butane	96
Chrome	829	Carbon disulfide	84	Octane	71	Hexane	87
Oxygen	51	Water	539	Chloroform	59	Heptane	78
Mercury	70	Acetone	125	Acetic acid	96	Benzoyl	94
Hydrogen	112	Aniline	104	Toluene	86	Methyl alcohol	264

■Melting and boiling points of substances（760^{mm}Hg）

Substances	Melting℃	Boiling ℃	Substances	Melting℃	Boiling ℃	Substances	Melting℃	Boiling ℃
Zinc	420	910	Neon	-249	-246	（Organic compounds）		
Argon	-189	-186	Platinum	1,773	3,800	Acetone	-96	56
Aluminum	659	2,270	Palladium	1,555	……	Aniline	-6.1	……
Antimony	631	1,640	Bismuth	271	1,560	Ethyl alcohol	-115	78
Sulfur (rhombic)	115	455	Fluorine	-223	-188	Ethyl ether	-116	35
Iridium	2,454	＞4,800	Helium	……	-269	Ethyl chloride	-139	13
Chlorine	-103	-34	Magnesium	651	1,097	Glycerin	18	290
Cadmium	321	766	Manganese	1,247	2,032	Chloroform	-63	61
Potassium	64	760	Iodine	114	1,184	Acetic acid (glacial acetic acid)	17	118
Calcium	845	1,439	Lithium	179	336	Stearic acid	69	……
Gold	1,063	2,710	Phosphorus (yellow)	44	281	Methyl alcohol	-97	-65
Silver	961	2,152	（Inorganic compound）			Methyl chloride	-92	-24
Chrome	1,777	2,660	Nitrogen	-91	-90	（Hydrocarbons）		
Silicon	1,410	2,355	Sulfurous acid	-73	-10	Acetylene	-84	-82
Cobalt	1,490	3,185	Ammonia	-78	-34	Ethan	-184	-89
Oxygen	-219	-183	Carbon monoxide	-205	-192	Ethylene	-169	-104
Bromine	-7.3	59	Calcium chloride	777	……	Octane	-57	126
Platinum	-39	357	Hydrogen	-114	-85	Decane	-95	111
Hydrogen	-259	-253	Nitrogen oxide	-164	-152	Toluene	-30	174
Tin	232	2,362	Carbon	-23	77	Naphthalene	80	218
Tungsten	3,380	4,830	Nitric acid	41	86	Butane	-135	0.5
Nitrogen	-210	-196	Table salt	803	1,445	Propane	-190	-45
Iron	1,535	3,235	Carbonic acid gas	……	-78.5 (sublimation)	Hexane	-95	69
Copper	1,083	2,336	Carbon disulfide	-112	46	Heptane	-91	98
Sodium	98	878	Water	0	100	Pentane	-130	36
Lead	327	1,755	Hydrogen sulfide	-86	-61	Benzoyl	5.5	80
Nickel	1,455	3,075	Sulfuric acid	11	338	Methane	-183	-164

■Thermal Transfer Unit Converter

The table below shows the various heat units expressed in the MKS, industrial and physical unit systems.

Unit system	Kcal system	Cal system	MKS system
Heat quantity	1 （Kcal） 10^{-3} 0.2389×10^{-3}	10^{-3} （cal） 1 0.2389	4.186×10^{3} （J） 4.186 1
Heat flow	1 （Kcal/h） 3.6 0.86	0.2778 （cal/s） 1 0.2389	1.163 （W） 4.186 1
Thermal conductivity	1 （Kcal/m-h-deg） 360 0.86	0.2778×10^{-2} （cal/cm-s-deg） 1 0.2389×10^{-2}	1.163 （W/m-deg） 4.186×10^{2} 1
Thermal resistivity	1 （m-h-deg/Kcal） 0.2778×10^{-2} 1.163	360 （cm-s-deg/cal） 1 4.186×10^{2}	0.86 （m-deg/W） 0.2389×10^{-2} 1
Heat transfer coefficient	1 （Kcal/m^2-h-deg） 3.6×10^{4} 0.86	0.2778×10^{-4} （cal/cm^2-s-deg） 1 0.2389×10^{-4}	1.163 （W/m^2-deg） 4.186×10^{4} 1
Superficial thermal resistivity	1 （m^2-h-deg /Kcal） 0.2778×10^{-4}	3.6×10^{4} （cm^2-s-deg/cal） 1 4.186×10^{4}	0.86 （m^2-deg/W） 0.2389×10^{-4} 1
Specific heat	1 （kcal/kg-deg） 0.2389×10^{-3}	1 （cal/g-deg） 0.2389×10^{-3}	4.186×10^{3} （J/kg-deg） 1
Concentration	1 （kg/m^2） 10^{3}	10^{-3} （g/cm^2） 1	1 （kg/m^2） 10^{3}
Volumetric specific heat	1 （Kcal/m^2-deg） 10^{3} 0.2389×10^{-3}	10^{-3} （cal/cm^2-deg） 1 0.2389×10^{-6}	4.186×10^{3} （J/m^2-deg） 4.186×10^{6} 1
Temperature conductivity	1 （m^2/h） 0.36 0.36×10^{4}	0.2778×10 （cm^2/s） 1 10^{4}	0.2778×10^{-3} （m^2/s） 10^{-4} 1

Examples
- When the thermal conductivity is expressed in (cal/cm-s-degrees C)
- Multiply the value by 360 to convert it into (Kcal/m-h-degrees C).
  Multiply it by 4,186 x 102 to convert it into (W/m-degrees C).

Thermal conductivity of silver is 1 (cal/cm-s-degrees C), 360 (Kcal/m-h-degrees C) or 418.6 (W/m-degrees C).