

## Reference Data

### Physical & Thermodynamic Properties of Common Gases

#### Properties of Common Gases at Normal Temperatures

Substance	Density <sup>1</sup> (Lbs/Ft <sup>3</sup> )	Specific Ht. at Constant Press <sup>2</sup> (Btu/lb/°F)	Thermal Conductivity (Btu/in/hr/ft <sup>2</sup> /°F)	Melting Point (°F)	Latent Heat Fusion <sup>2</sup> (Btu/lb)	Boiling Point (°F)	Latent Heat Vaporization (Btu/lb)
Acetylene	0.068	0.3832	0.129	-114.34	—	-118.48	—
Air	0.75	0.2400	0.18	—	—	—	92
Ammonia	0.048	0.5202	0.154	-103	194.4	-28.3	589
Argon	0.1033	0.1233	0.113	-308.56	12.1	-302.26	67.9
Butane-iso	0.16	—	0.0948	-229	—	13.64	157.3
Butane-n	0.15	—	0.0876	-211	—	33.08	164.7
Carbon Dioxide	0.1144	0.2025	0.12	-109.3	81.5	Sublimates	245
Carbon Monoxide	0.0725	0.2425	0.18	-340.6	14.4	-312.7	90.7
Chlorine	0.1853	0.1125	0.058	-150.88	44.4	-30.46	145.8
Chlorodifluoromethane (F-22)	0.289	0.1510	—	-256	—	-41.36	—
Chloroform	—	0.1440	0.0972	—	—	143.1	—
Cyanogen	0.14	0.4095	—	-18.22	—	-6.106	—
Dichlorodifluoromethane (F-12)	0.329	0.1410	0.058	-252	—	-21.62	—
Ethane	0.084	0.3861	0.13	-277.6	—	-126.94	464.4
Ethyl Chloride	0.179	0.2750	0.0610	-217.7	—	53.96	166.5
Ethylene	0.078	0.3990	0.1230	-272.92	—	-154.84	—
Fluorine	0.1059	0.1820	0.1760	-369.4	—	-304.6	72.9
Helium	0.0103	1.2500	0.9880	-457.6	—	-452.092	10.7
Hydrogen	0.0056	3.4090	1.16	-434.45	25.2	-423.755	192
Hydrogen Bromide	0.2275	0.0820	—	-124.06	13.8	-91.66	87.7
Hydrogen Chloride	0.1023	0.1940	0.0910	-168.34	24.1	-117.58	190.6
Hydrogen Fluoride	0.0535	—	—	-134.14	—	-34.06	0.3
Hydrogen Iodide	0.355	0.0600	—	-60.34	10.2	-32.26	61
Hydrogen Sulfide	0.096	0.2451	0.091	-122.8	—	-79.6	237.4
Methane	0.0446	0.5929	0.214	-296.5	26.2	-258.52	248.4
Methyl Chloride	0.142	0.2400	0.0648	-154.48	—	-10.714	184.1
Methyl Ether	0.131	—	—	-216.4	—	-12.82	—
Methyl Fluoride	0.096	—	—	—	—	-108.4	—
Neon	0.056	—	0.322	-415.61	5.1	-410.62	—
Nitric Oxide	0.0777	0.2320	0.1656	-268.6	33.1	-243.4	—
Nitrogen	0.073	0.2438	0.186	-345.75	11	-320.44	86
Nitrous Oxide	0.123	0.2126	0.1056	-152.32	—	-129.64	—
Oxygen	0.083	0.2175	0.18	-361.12	6	-297.4	91.8
Phosphine	0.095	—	—	-208.3	—	-125.32	—
Propane	0.126	—	0.097	-309.82	—	-48.1	—
Silicone Tetrafluoride	0.292	—	—	—	—	-90.4	—
Sulfur Dioxide	0.166	0.1544	0.07	-104.8	—	14	170.6
Water Vapor	0.0372	0.4820	0.1700	32	143.6	212	972
Xenon	0.365	—	—	-220	6.71	-164.38	43.9

1. Weight in lbs/ft<sup>3</sup> at approximately 70°F and atmospheric pressure.
2. Where temperature is not given, 68°F (20°C) is understood.
3. All properties are at a pressure equivalent to 760 mm of mercury, unless otherwise indicated.

#### Properties of Common Gases at Cryogenic Temperatures

Properties / Gases	N <sub>2</sub>	O <sub>2</sub>	He	H <sub>2</sub>	CH <sub>4</sub>	NH <sub>3</sub>	A	Ne
Density @ 32°F Atm lb/ft <sup>3</sup>	0.0781	0.0892	0.01114	0.00561	0.0448	0.0481	0.1113	0.0562
Boiling Point @ 1 Atm - °F	-320.4	-297.4	-452	-423	-258.7	-28.03	-302.4	-410.6
Melting Point @ 1 Atm - °F	-345.8	-361.1	-458 (26 Atm)	-434.6	-299.2	-107.9	-308.7	-415.7
Vapor Density @ BP - lbs/ft <sup>3</sup>	0.288	0.296	0.999	0.083	0.1124	0.0556	0.368	0.593
Liquid Density @ BP - lbs/ft <sup>3</sup>	50.19	71.29	7.803	4.37	26.47	42.58	86.77	74.91
Vapor Pressure Solid @ MP in mm.	96.4	2.0	< .02	54	70.0	45.2	516	323
Heat of Vapor @ BP - Btu/lb	85.7	91.6	< .03	194.4	248.4	588.6	70.0	37.4
Heat of Fusion @ MP - Btu/lb	11.0	5.9	< 1.8	25.2	26.1	151.2	12.1	7.2
Cp @ 50°F @ 1 Atm - Btu/lb°F	0.248	0.218	1.25 (-292°F)	3.39	0.528	0.523	0.125	0.25 (Approx)
Cp/Cv @ 59 - 68°F @ 1 Atm	1.40	1.40	1.65 (292°F)	1.41	1.31	1.31	1.67	1.64
Critical Temperature - °F	-232.8	-181.1	-450.2	-399.8	-116.5	270.3	-188.5	-379.7
Critical Pressure @ 1 Atm	33.5	50.1	2.26	12.8	45.8	111.5	48.0	26.8

## Reference Data

### Physical & Thermodynamic Properties of Common Solids

#### Properties of Metals (Solid)

Substance	Density (Lb/Ft <sup>3</sup> )	Specific Heat (Btu/lb/°F)	Thermal Conductivity (Btu/in/hr/ft <sup>2</sup> /°F)	Melting Point (°F)	Latent Heat Fusion (Btu/lb)
Aluminum	169	0.226	1536	1220	167.4
Antimony	413	0.0504	127	1167	70.2
Babbitt - Tin	462	0.071	278	465	279
Barium	218	0.068	—	1562	—
Beryllium	113	0.425	960	2462	572.4
Bismuth	610	0.0294	62	520	22.5
Brass (Yellow)	529	0.092	768	~ 1680	—
Cadmium	540	0.0552	644	609	23
Calcium	97	0.168	910	1490	140
Carbon	165	0.165	165	> 6400	—
Chromium	432	0.111	480	2940	126
Cobalt	544	0.1001	336	2696	115.2
Copper	555	0.0928	2784	1981	88.7
Gold	1204	0.0312	2352	1945	28.6
INCOLOY® 800	495	0.108	80	2475	—
INCONEL® 600	525	0.106	103	2470	—
Iridium	1399	0.0323	448	4449	47
Iron (99.97%)	491	0.1075	498	2795	117
Lead	708	0.0306	243	621	10.8
Lithium	33	0.79	516	357	217
Magnesium	108	0.246	1188	1204	126
Manganese	449	0.1211	81	2300	116
Mercury	845	0.0333	58	-38	4.98
Molybdenum	636	0.065	948	4748	126
MONEL® 400	551	0.11	144	2370	—
Nickel	552	0.1032	432	2624	131.4
Platinum	1333	0.0319	492	3224	48.4
Potassium	54	0.177	720	146	26.3
Rhodium	776	0.058	666	3570	—
Silver	665	0.0557	2904	1761	46.6
Sodium	60	0.283	970	208	48.6
Solder 50%Sn - 50%Pb	550	0.04	340	~ 440	17
Steel, Carbon	487	0.12	315	2548	—
Steel, SS	501	0.12	113	2550	—
Tantalum	1035	0.036	384	5162	—
Tin	454	0.0548	432	449	25.9
Titanium	281	0.1125	108	3272	—
Type Metal 85%Pb - 15%Sb	625	0.04	180	~ 479	14
Tungsten	1204	0.032	1104	6119	79
Uranium	397	0.028	168	< 3362	—
Vanadium	349	0.1153	240	3110	—
Zinc	445	0.0931	780	787	47.9
Zirconium	408	0.066	132	3452	108

**Note** — Where temperature is not given, 68°F (20°C) temperature is understood.

#### Properties of Metals (Liquid)

Metal	Melting Point (°F)	Latent Ht. of Fusion (Btu/lb)	Liquid Temp. (°F)	Density (Lbs/ft <sup>3</sup> )	Specific Heat (Btu/Lb/°F)	Thermal Conductivity (Btu/in/hr/ft <sup>2</sup> /°F)
Aluminum	1220	173	1220	148.6	0.26	—
	—	—	1292	147.7	0.26	717
	—	—	1454	—	0.26	842
Bismuth	520	21.6	600	625	0.034	114
	—	—	1000	608	0.037	108
	—	—	1400	591	0.039	108
Cadmium	609	23.8	626	500	0.063	—
	—	—	660	499	0.063	308
	—	—	752	495	0.063	—
Gold	1945	26.9	2012	1,076	0.036	—
Lead	621	10.6	700	658	0.038	126
	—	—	900	650	0.037	137
	—	—	1300	633	—	—
Lithium	357	284	392	31.7	1	262
	—	—	752	31	1	—
Magnesium	1204	148	1204	98	0.317	—
	—	—	1328	94	—	—
	—	—	1341	—	0.321	—
Mercury	-38	5	50	847	0.033	56
	—	—	300	826	0.033	80
	—	—	600	802	0.032	97
Potassium	146	26.3	300	50.4	0.190	312
	—	—	800	46.3	0.183	274
	—	—	1300	42.1	0.180	229
Silver	1761	44.8	1761	581	0.069	—
	—	—	1832	578	0.069	—
	—	—	2000	574	0.069	—
Sodium	208	48.7	200	58	0.33	598
	—	—	400	56	0.32	557
	—	—	700	54	0.31	502
	—	—	1300	49	0.30	414
Solder 50%Sn - 50%	421	17	—	—	0.056	—
60%Sn - 40%	375	28	—	—	0.058	—
Tin	449	26.1	482	—	0.058	—
	—	—	768	427	—	—
	—	—	783	—	—	229
Zinc	787	43.9	787	432	0.12	—
	—	—	932	—	—	400
	—	—	1112	425	0.117	394

## Reference Data

### Physical & Thermodynamic Properties of Common Solids

#### Properties of Non-Metallic Solids

Substance	Density (Lbs/Ft <sup>3</sup> )	Specific Heat (Btu/lb/°F 20°C 68°F)	Thermal Conductivity (Btu/in/hr/ft <sup>2</sup> /°F)	Melting Point (°F)
Alumina	231	0.19	205	—
Aluminum Silicate (Lava)	130	0.25	9	—
Asbestos (Insul.)	36	0.2	1.1	—
Asbestos - Cement Board	120	0.24	4	—
Asphalt	81	0.4	5.2	250
Bakelite	81	0.35	116	—
Basalt	184	0.2	—	—
Beeswax	60	—	—	144
Boron Nitride (Comp.)	130	0.32	150	—
Brick, Building	123	0.22	4.8	—
Carbon, Powder	131	0.168	2.4	6400
Graphite, Solid	140	0.165	1044	—
Graphite, Powder	130	0.165	1.27	—
Diamond	219	0.16	15840	—
Cellulose (Pulp)	3.4	0.35	0.32	—
Chalk	143	0.215	5.76	—
Charcoal (Oak)	33	0.2	0.36	—
Clay	115	0.22	9	—
Coal (Anthracite)	97	0.3	1.18	—
Coke	75	0.36	6.6	—
Concrete, Sand	144	0.22	12.6	—
Concrete, Cinder	97	0.21	4.92	—
Cordierite	138	0.35	23	—
Cork (Granulated)	5.4	0.485	0.336	—
Earth (42% H <sub>2</sub> O)	108	0.9	7.44	—
Earth (Dry, Packed)	95	0.42	0.9	—
Earth (Dry, Stony)	127	0.44	3.6	—
Fiberglas® (Insul.)	0.75	—	0.29	—
Fiberglas® (Insul.)	3	—	0.22	—
Firebrick (Clay)	112	0.198	6.96	—
Fosterite	174	0.23	26	—
Fused Silica (Quartz)	137	0.31	9.96	—
Glass				
Normal	139	0.199	7.08	2200
Crown	154	0.161	7.08	—
Flint (Leaded)	200	0.117	9.48	—
Pyrex	139	0.20	7.08	—
Granite	159	0.192	13 - 28	—
Ice -0°C (32°F)	57.5	0.465	15.6	32
Limestone	153	0.217	6.48	—

#### Properties of Non-Metallic Solids

Substance	Density (Lbs/Ft <sup>3</sup> )	Specific Heat (Btu/lb/°F 20°C 68°F)	Thermal Conductivity (Btu/in/hr/ft <sup>2</sup> /°F)	Melting Point (°F)
Magnesia 85% (Insul.)	12	0.222	4.2	—
Magnesium Oxide	135	0.25	17.6	—
Marble	170	0.21	18	—
Mica	165	0.206	3	—
Paper	58	0.32	0.9	—
Plastics				
ABS	62.2	0.3 - 0.4	1.56	—
Cellulose Acetate	82.9	0.3 - 0.42	2.28	—
Epoxy (Resin)	71.8	0.4 - 0.5	1.2 - 3.5	—
Fluoroplastic (PTFE)	133	0.25	1.68	—
Nylon	69.1	0.4	1.2	—
Phenolic	82.9	0.35	0.097 - 0.3	—
Polyethylene	57	0.55	2.58	—
Polystyrene	64.8	0.32	0.7 - 1.08	—
Polystyrene (Exp.)	1.7	0.29	0.252	—
Polypropylene	56.7	0.45	1.21 - 1.36	—
Polyurethane (Exp.)	1.5	0.38	0.228	—
Polyvinyl	86.4	0.2 - 0.3	0.84 - 1.20	—
Paraffin	56	0.69	1.68	133
Porcelain	145	0.26	15.6	—
Pyroceram	163	0.233	23.4	—
Quartz	138	0.17	27.6	3150
Rigid Insulation				
Fiber Board	14.8	—	0.28	—
Inorganic Bonded	10 - 15	—	0.45	—
Rock Salt	136	0.21	—	1472
Rubber Soft	68.6	0.48	0.96	—
Rubber, Hard	74.3	0.48	1.104	—
Sand	94	0.195	2.25	—
Silicon	145	0.181	—	2577
Sodium Carbonate	135	0.30	—	1546
Sodium Chloride	135	0.22	—	1440
Sodium Cyanide	94	0.3	—	1015
Sodium Nitrate	141	0.29	—	555
Sodium Nitrite	135	0.3	—	490
Steatite	158	0.2	23.2	—
Sugar	105	0.3	—	160
Sulfur	129	0.181	1.8	—
Woods (Average)	23 - 70	0.45 - 0.67	0.78 - 1.78	—
Oak, Red	42	0.57	1.188	—
Pine, White	25	0.67	0.72	—