6. ATOMIC AND NUCLEAR PROPERTIES OF MATERIALS

Table 6.1 Abridged from pdg.lbl.gov/AtomicNuclearProperties by D. E. Groom (2007). See web pages for more detail about entries in this table including chemical formulae, and for several hundred other entries. Quantities in parentheses are for NTP (20° C and 1 atm), and square brackets indicate quantities evaluated at STP. Boiling points are at 1 atm. Refractive indices n are evaluated at the sodium D line blend (589.2 nm); values $\gg 1$ in brackets are for $(n-1) \times 10^6$ (gases).

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Material	Z	A	$\langle Z/A\rangle$		Nucl.inter.				Melting	Boiling	Refract.
					length λ_I	X_0	{ MeV	$\{\mathrm{g}\ \mathrm{cm}^{-3}\}$	point	point	index
				$\{ {\rm g \ cm^{-2}} \}$	$\{\mathrm{g~cm}^{-2}\}$	$\{g \text{ cm}^{-2}\}$	$g^{-1}cm^{2}$	$\{(g\ell^{-1}\})$	(K)	(K)	(@ Na D)
$\overline{\mathrm{H}_2}$	1	1.00794(7)	0.99212	42.8	52.0	63.04	(4.103)	0.071(0.084)	13.81	20.28	1.11[132.]
D_2	1	2.01410177803(8)	0.49650	51.3	71.8	125.97	(2.053)	0.169(0.168)	18.7	23.65	1.11[138.]
Не	2	4.002602(2)	0.49967	51.8	71.0	94.32		0.125(0.166)		4.220	1.02[35.0]
Li	3	6.941(2)	0.43221	52.2	71.3	82.78	1.639	0.534	453.6	1615.	
Be	4	9.012182(3)	0.44384	55.3	77.8	65.19	1.595	1.848	1560.	2744.	2.42
C diamond	6	12.0107(8)	0.49955	59.2	85.8	42.70	1.725	3.520			2.42
C graphite	6	12.0107(8)	0.49955	59.2	85.8	42.70	1.742	2.210	C9 15	77.00	1 00[000]
$ \begin{array}{c} N_2 \\ O_2 \end{array} $	7 8	14.0067(2) 15.9994(3)	0.49976 0.50002	61.1 61.3	$89.7 \\ 90.2$	37.99 34.24		0.807(1.165) 1.141(1.332)	63.15 54.36	77.29 90.20	1.20[298.] 1.22[271.]
F_2	9	18.9984032(5)	0.30002 0.47372	65.0	97.4	32.93	,	1.507(1.580)	53.53	85.03	[195.]
Ne	10	20.1797(6)	0.47572 0.49555	65.7	99.0	28.93		1.204(0.839)	24.56	27.07	1.09[67.1]
Al	13	26.9815386(8)	0.48181	69.7	107.2	24.01	1.615	2.699	933.5	2792.	1.00[01.1]
Si	14	28.0855(3)	0.49848	70.2	108.4	21.82	1.664	2.329	1687.	3538.	3.95
Cl_2	17	35.453(2)	0.47951	73.8	115.7	19.28		1.574(2.980)	171.6	239.1	[773.]
Ar	18	39.948(1)	0.45059	75.7	119.7	19.55	(1.519)	1.396(1.662)	83.81	87.26	1.23[281.]
Ti	22	47.867(1)	0.45961	78.8	126.2	16.16	1.477	4.540	1941.	3560.	
Fe	26	55.845(2)	0.46557	81.7	132.1	13.84	1.451	7.874	1811.	3134.	
Cu	29	63.546(3)	0.45636	84.2	137.3	12.86	1.403	8.960	1358.	2835.	
Ge	32	72.64(1)	0.44053	86.9	143.0	12.25	1.370	5.323	1211.	3106.	
Sn	50	118.710(7)	0.42119	98.2	166.7	8.82	1.263	7.310	505.1	2875.	1 00[=01]
Xe	54	131.293(6)	0.41129	100.8	172.1	8.48		2.953(5.483)	161.4	165.1	1.39[701.]
W Pt	74 78	183.84(1) 195.084(9)	0.40252 0.39983	110.4 112.2	191.9 195.7	6.76	1.145	19.300 21.450	3695. 2042.	5828. 4098.	
Au	79	196.966569(4)	0.39963	112.2 112.5	196.3	$6.54 \\ 6.46$	1.128 1.134	19.320	2042. 1337.	4098. 3129.	
Pb	82	207.2(1)	0.40103 0.39575	114.1	199.6	6.37	1.134 1.122	11.350	600.6	2022.	
U	92	[238.02891(3)]	0.38651	118.6	209.0	6.00	1.081	18.950	1408.	4404.	
		[======================================									
Air (dry, 1 a Shielding con	,		0.49919 0.50274	61.3 65.1	$90.1 \\ 97.5$	36.62 26.57	(1.815) 1.711	(1.205) 2.300		78.80	
Borosilicate		vrex)	0.30274 0.49707	64.6	96.5	$\frac{20.37}{28.17}$	1.696	2.300 2.230			
Lead glass	51000 (1.)	(ION)	0.42101	95.9	158.0	7.87	1.255	6.220			
Standard roo	ek		0.50000	66.8	101.3	26.54	1.688	2.650			
Methane (CI	H_4)		0.62334	54.0	73.8	46.47	(2.417)	(0.667)	90.68	111.7	[444.]
Ethane (C_2 E			0.59861	55.0	75.9	45.66	(2.304)	(1.263)	90.36	184.5	
Propane (C_3	-,		0.58962	55.3	76.7	45.37	, ,	0.493(1.868)	85.52	231.0	
Butane (C ₄ F	,		0.59497	55.5	77.1	45.23	(2.278)	(2.489)	134.9	272.6	
Octane (C ₈ E		CII)	0.57778	55.8	77.8	45.00	2.123	0.703	214.4	398.8	
Paraffin (CH		1≈23CH ₃)	0.57275 0.54790	56.0	78.3	44.85	2.088	0.930			
Nylon (type		n)	0.54790 0.52697	$57.5 \\ 58.3$	81.6 83.6	41.92 41.50	1.973 1.886	1.18 1.20			
	Polycarbonate (Lexan) Polyethylene ([CH ₂ CH ₂] _n)			56.1	78.5	44.77	2.079	0.89			
		halate (Mylar)	0.57034 0.52037	58.9	84.9	39.95	1.848	1.40			
Polyimide fil			0.51264	59.2	85.5	40.58	1.820	1.42			
Polymethylm			0.53937	58.1	82.8	40.55	1.929	1.19			1.49
Polypropyler	ne	,	0.55998	56.1	78.5	44.77	2.041	0.90			
Polystyrene			0.53768	57.5	81.7	43.79	1.936	1.06			1.59
Polytetrafluc		ene (Teflon)	0.47992	63.5	94.4	34.84	1.671	2.20			4 70
Polyvinyltolu			0.54141	57.3	81.3	43.90	1.956	1.03			1.58
Aluminum o			0.49038	65.5	98.4	27.94	1.647	3.970	2327.	3273.	1.77
Barium flour			0.42207	90.8	149.0	9.91	1.303	4.893	1641.	2533.	1.47
Bismuth germanate (BGO)		0.42065	96.2	159.1	7.97	1.251	7.130	1317.		2.15	
Carbon dioxide gas (CO ₂) Solid carbon dioxide (dry ice)		0.49989 0.49989	60.7 60.7	88.9 88.9	$36.20 \\ 36.20$	1.819 1.787	(1.842) 1.563	Sublima	s at 194.7	[449.] K	
Cesium iodide (CsI)		0.49969 0.41569	100.6	171.5	8.39	1.243	4.510	894.2	1553.	1.79	
Lithium fluoride (LiF)		0.41309 0.46262	61.0	88.7	39.26	1.614	2.635	1121.	1946.	1.79	
Lithium hydride (LiH)			0.50321	50.8	68.1	79.62	1.897	0.820	965.	-0.101	1.00
Lead tungstate (PbWO ₄)			0.41315	100.6	168.3	7.39	1.229	8.300	1403.		2.20
		, fused quartz)	0.49930	65.2	97.8	27.05	1.699	2.200	1986.	3223.	1.46
Sodium chlor	ride (Na		0.55509	71.2	110.1	21.91	1.847	2.170	1075.	1738.	1.54
Sodium iodio			0.42697	93.1	154.6	9.49	1.305	3.667	933.2	1577.	1.77
Water (H ₂ O))		0.55509	58.5	83.3	36.08	1.992	1.000(0.756)	273.1	373.1	1.33
Silica aeroge	l		0.50093	65.0	97.3	27.25	1.740	0.200	(0.03 H_2)	O, 0.97 Si	O_2)

Material	Dielectric	Young's	Coeff. of	Specific	Electrical	Thermal
	constant $(\kappa = \epsilon/\epsilon_0)$	modulus	thermal	heat	resistivity	conductivity
	() is $(\kappa-1)\times 10^6$	$[10^6 \text{ psi}]$	expansion	[cal/g-°C]	$[\mu\Omega cm(@^{\circ}C)]$	[cal/cm-°C-sec]
	for gas		$[10^{-6} \mathrm{cm/cm}\text{-}^{\circ}\mathrm{C}]$			
$\overline{\mathrm{H}_2}$	(253.9)	_	_	_	_	_
He	(64)		_	_	_	_
Li	_		56	0.86	$8.55(0^{\circ})$	0.17
Be	_	37	12.4	0.436	$5.885(0^{\circ})$	0.38
C	_	0.7	0.6-4.3	0.165	1375(0°)	0.057
N_2	(548.5)		_	_		_
O_2	(495)	_	_	_	_	_
Ne	(127)	_	_	_	_	_
Al	_	10	23.9	0.215	$2.65(20^{\circ})$	0.53
Si	11.9	16	2.8 - 7.3	0.162	_	0.20
Ar	(517)	_	_	_	_	_
Ti	_	16.8	8.5	0.126	$50(0^{\circ})$	_
Fe	_	28.5	11.7	0.11	9.71(20°)	0.18
Cu	_	16	16.5	0.092	$1.67(20^{\circ})$	0.94
Ge	16.0		5.75	0.073	_	0.14
Sn	_	6	20	0.052	$11.5(20^{\circ})$	0.16
Xe	_	_	_	_	_	_
W	_	50	4.4	0.032	$5.5(20^{\circ})$	0.48
Pt	_	21	8.9	0.032	$9.83(0^{\circ})$	0.17
Pb	_	2.6	29.3	0.038	$20.65(20^{\circ})$	0.083
U	_	_	36.1	0.028	$29(20^{\circ})$	0.064