APPENDIX B.1. Data Table of the Elements

Element	Symbol	At. No. Z	At. Wt. A	Z/A	$10^{-23}\ N_A Z/A$[a]	Density[b] (g/cm^3)	K-edge (keV)	$L1$-edge (keV)	I[c] (eV)
Hydrogen	H	1	1.008	.9922	5.975	8.374×10^{-5}	0.014	—	19.2
Helium	He	2	4.003	.4997	3.009	1.663×10^{-4}	0.025	—	41.8
Lithium	Li	3	6.941	.4322	2.603	0.533	0.055	—	40.0
Beryllium	Be	4	9.012	.4438	2.673	1.848	0.111	—	63.7
Boron	B	5	10.81	.4625	2.785	2.34–2.37	0.188	—	—
Carbon (graphite)	C	6	12.01	.4995	3.008	1.9–2.3	0.284	—	78.0
Nitrogen	N	7	14.01	.4998	3.010	1.165×10^{-3}	0.402	—	82.0
Oxygen	O	8	16.00	.5000	3.011	1.331×10^{-3}	0.532	0.024	95.0
Fluorine	F	9	19.00	.4737	2.853	1.580×10^{-3}	0.685	0.031	—
Neon	Ne	10	20.18	.4956	2.984	8.385×10^{-4}	0.867	0.045	137
Sodium	Na	11	22.99	.4785	2.881	0.969	1.07	0.063	149
Magnesium	Mg	12	24.30	.4937	2.973	1.735	1.30	0.089	156
Aluminum	Al	13	26.98	.4818	2.901	2.69	1.56	0.118	166
Silicon	Si	14	28.09	.4985	3.002	2.32	1.84	0.149	173
Phosphorus	P	15	30.97	.4843	2.916	1.82–2.69	2.15	0.189	—
Sulfur	S	16	32.06	.4991	3.005	1.954, 2.07	2.47	0.229	—
Chlorine	Cl	17	35.45	.4795	2.888	2.995×10^{-3}	2.82	0.270	—
Argon	Ar	18	39.95	.4506	2.713	1.662×10^{-3}	3.20	0.320	188
Potassium	K	19	39.10	.4860	2.926	0.860	3.61	0.377	190
Calcium	Ca	20	40.08	.4990	3.005	1.55	4.04	0.438	191
Scandium	Sc	21	44.96	.4671	2.813	2.980	4.49	0.500	—
Titanium	Ti	22	47.90	.4593	2.766	4.54	4.97	0.564	233
Vanadium	V	23	50.94	.4515	2.719	6.10	5.47	0.628	245
Chromium	Cr	24	52.00	.4616	2.780	7.18	5.99	0.695	—
Manganese	Mn	25	54.94	.4551	2.740	7.21–7.44	6.54	0.769	272
Iron	Fe	26	55.85	.4656	2.804	7.86	7.11	0.846	286
Cobalt	Co	27	58.93	.4581	2.759	8.9	7.71	0.926	297
Nickel	Ni	28	58.71	.4769	2.872	8.88	8.33	1.01	311

APPENDIX B.1. (*Continued*)

Element	Symbol	At. No. Z	At. Wt. A	Z/A	$10^{-23}\ N_A Z/A$[a]	Density[b] (g/cm^3)	K-edge (keV)	$L1$-edge (keV)	I[c] (eV)
Copper	Cu	29	63.55	.4564	2.748	8.94	8.98	1.10	322
Zinc	Zn	30	65.38	.4589	2.763	7.11	9.66	1.19	330
Gallium	Ga	31	69.72	.4446	2.678	5.88	10.38	1.30	—
Germanium	Ge	32	72.59	.4408	2.655	5.31	11.10	1.41	350
Arsenic	As	33	74.92	.4405	2.652	5.73	11.87	1.53	—
Selenium	Se	34	78.96	.4306	2.593	4.28, 4.79	12.66	1.65	348
Bromine	Br	35	79.90	.4380	2.638	7.07×10^{-3}	13.47	1.78	—
Krypton	Kr	36	83.80	.4296	2.587	3.478×10^{-3}	14.33	1.92	352
Rubidium	Rb	37	85.47	.4329	2.607	1.529	15.20	2.07	363
Strontium	Sr	38	87.62	.4337	2.612	2.54	16.10	2.22	—
Yttrium	Y	39	88.91	.4387	2.642	4.46	17.04	2.37	—
Zirconium	Zr	40	91.22	.4385	2.641	6.49	18.00	2.53	—
Niobium	Nb	41	92.91	.4413	2.658	8.55	18.99	2.70	—
Molybdenum	Mo	42	95.94	.4378	2.636	10.20	20.00	2.87	—
Technetium	Tc	43	98.91	.4348	2.618	11.50	21.04	3.04	—
Ruthenium	Ru	44	101.1	.4353	2.622	12.41	22.12	3.22	—
Rhodium	Rh	45	102.9	.4373	2.633	12.41	23.22	3.41	—
Palladium	Pd	46	106.4	.4323	2.604	12.00	24.35	3.60	—
Silver	Ag	47	107.9	.4357	2.624	10.48	25.51	3.81	470
Cadmium	Cd	48	112.4	.4270	2.571	8.65	26.71	4.02	469
Indium	In	49	114.8	.4268	2.570	7.30	27.94	4.24	487
Tin (white)	Sn	50	118.7	.4213	2.537	7.31	29.20	4.46	488
Antimony	Sb	51	121.7	.4191	2.524	6.68	30.5	4.70	—
Tellurium	Te	52	127.6	.4075	2.454	6.23	31.8	4.94	—
Iodine	I	53	126.9	.4176	2.515	4.92	33.2	5.19	—
Xenon	Xe	54	131.3	.4113	2.477	5.485×10^{-3}	34.6	5.45	482
Cesium	Cs	55	132.9	.4138	2.492	1.870	36.0	5.71	488
Barium	Ba	56	137.3	.4078	2.456	3.5	37.4	5.99	—

APPENDIX B.1. ***(Continued)***

Element	Symbol	At. No. Z	At. Wt. A	Z/A	$10^{-23}\ N_A Z/A^a$	Density[b] (g/cm^3)	K-edge (keV)	$L1$-edge (keV)	I^c (eV)
Lanthanum	La	57	138.9	.4104	2.471	6.13	38.9	6.27	—
Cerium	Ce	58	140.1	.4139	2.494	6.64	40.4	6.55	—
Praeseodymium	Pr	59	140.9	.4187	2.522	6.64, 6.77	42.0	6.83	—
Neodymium	Nd	60	144.2	.4160	2.505	6.80, 7.01	43.6	7.13	—
Promethium	Pm	61	(145)	.421	2.53	7.20	45.2	7.43	—
Samarium	Sm	62	150.4	.4122	2.482	7.40, 7.52	46.8	7.74	—
Europium	Eu	63	152.0	.4146	2.497	5.23	48.5	8.05	—
Gadolinium	Gd	64	157.2	.4070	2.451	7.88	50.2	8.38	591
Terbium	Tb	65	158.9	.4090	2.463	8.23	52.0	8.71	—
Dysprosium	Dy	66	162.5	.4062	2.446	8.52	53.8	9.05	—
Holmium	Ho	67	164.9	.4062	2.446	8.77	55.6	9.39	—
Erbium	Er	68	167.3	.4066	2.448	9.04	57.5	9.75	—
Thulium	Tm	69	168.9	.4084	2.460	9.29	59.4	10.1	—
Ytterbium	Yb	70	173.0	.4045	2.436	6.54, 6.96	61.3	10.5	—
Lutetium	Lu	71	175.0	.4058	2.444	9.81	63.3	10.9	—
Hafnium	Hf	72	178.5	.4034	2.429	13.29	65.4	11.3	—
Tantalum	Ta	73	180.9	.4034	2.429	16.65	67.4	11.7	718
Tungsten	W	74	183.8	.4025	2.424	19.3	69.5	12.1	727
Rhenium	Re	75	186.2	.4028	2.426	20.98	71.7	12.5	—
Osmium	Os	76	190.2	.3996	2.406	22.57	73.9	13.0	—
Iridium	Ir	77	192.2	.4006	2.412	22.39	76.1	13.4	—
Platinum	Pt	78	195.1	.3998	2.408	21.41	78.4	13.9	790
Gold	Au	79	197.0	.4011	2.415	19.29	80.7	14.4	790
Mercury	Hg	80	200.6	.3988	2.402	13.52	83.1	14.8	800
Thallium	Tl	81	204.4	.3963	2.387	11.83	85.5	15.3	—
Lead	Pb	82	207.2	.3958	2.383	11.33	88.0	15.9	823
Bismuth	Bi	83	209.0	.3972	2.392	9.73	90.5	16.4	—
Polonium	Po	84	(210)	.400	2.41	9.32	93.1	16.9	—

APPENDIX B.1. ***(Continued)***

Element	Symbol	At. No. Z	At. Wt. A	Z/A	$10^{-23}\,N_A Z/A^a$	Density[b] (g/cm^3)	K-edge (keV)	$L1$-edge (keV)	I^c (eV)
Astatine	At	85	(210)	.405	2.44	—	95.7	17.5	—
Radon	Rn	86	(222)	.387	2.33	9.07×10^{-3}	98.4	18.0	794
Francium	Fr	87	(223)	.390	2.35	—	101.1	18.6	—
Radium	Ra	88	226.0	.3893	2.345	—	103.9	19.2	—
Actinium	Ac	89	(227)	.392	2.36	10.07	106.8	19.8	—
Thorium	Th	90	232.0	.3879	2.336	11.72	109.7	20.5	—
Protactinium	Pa	91	231.0	.3939	2.372	15.37	112.6	21.1	—
Uranium	U	92	238.0	.3865	2.328	18.95	115.6	21.8	890
Neptunium	Np	93	237.0	.3923	2.363	20.21	118.7	22.4	—
Plutonium	Pu	94	(244)	.385	2.32	19.78	121.8	23.1	—
Americium	Am	95	(243)	.391	2.35	13.65	125.0	23.8	—
Curium	Cm	96	(247)	.389	2.34	13.51	128.2	24.5	—
Berkelium	Bk	97	(247)	.393	2.36	$\cong 14$	131.6	25.3	—
Californium	Cf	98	(251)	.390	2.35	—	136.0	26.1	—
Einsteinium	Es	99	(254)	.390	2.35	—	139.5	26.9	—
Fermium	Fm	100	(257)	.389	2.34	—	143.1	27.7	—
Mendelevium	Md	101	(258)	.391	2.36	—	146.8	28.5	—
Nobelium	No	102	(259)	.394	2.37	—	150.5	29.4	—
Lawrencium	Lr	103	(260)	.396	2.39	—	154.4	30.2	—

[a] Number of electrons per gram of element (in units of 10^{23}).
[b] Assuming $T = 20°C$ and $P = 1$ atm, and Charles's law for gases. Multiply by 10^3 to convert to kg m^{-3}.
[c] From Berger and Seltzer (1983). I is the mean excitation potential for stopping power; see Chapter 8.

Appendix B.2. Data Table for Compounds and Mixtures[a]

Material	Density (g/cm^3)[c]	Electron density (10^{23} e/g)	I (eV)[d]
A-150 plastic[b]	1.127	3.306	65.1
Adipose tissue (Fat, ICRP)[b]	0.92	3.363	63.2
Air[b]	1.205×10^{-3}	3.006	85.7
Bone, cortical (ICRP)[b]	1.85	3.139	106.4
Calcium fluoride, CaF_2	3.18	2.931	166
Carbon dioxide, CO_2	1.842×10^{-3}	3.010	85.0
Cesium iodide, CsI	4.51	2.503	553
Lithium fluoride, LiF	2.64	2.786	94.0
Lucite, $(C_5H_8O_2)_n$	1.19	3.248	74.0
Muscle, skeletal (ICRP)[b]	1.04	3.308	75.3
Mylar, $(C_{10}H_8O_4)_n$	1.40	3.134	78.7
Nylon, type 6 $(C_6H_{11}NO)_n$	1.14	3.299	63.9
Polycarbonate $(C_{16}H_{14}O_3)_n$	1.20	3.173	73.1
Polyethylene $(C_2H_4)_n$	0.94	3.435	57.4
Polyimide $(C_{22}H_{10}N_2O_5)$	1.42	3.087	79.6
Polypropylene $(C_3H_5)_n$	0.90	3.372	59.2
Polystyrene $(C_8H_8)_n$	1.06	3.238	68.7
Polyvinyl Chloride $(C_2H_3Cl)_n$	1.30	3.083	108.2
Pyrex (borosilicate glass)[b]	2.23	2.993	134
Silicon dioxide, SiO_2	2.32	3.007	139.2
Silver bromide, AgBr	6.47	2.629	487
Sodium iodide, NaI	3.67	2.571	452
Teflon, $(C_2F_4)_n$	2.20	2.890	99.1
TE gas (methane-based)[b]	1.064×10^{-3}	3.312	61.2
TE gas (propane-based)[b]	1.826×10^{-3}	3.314	59.5
TE liquid (no sucrose)[b]	1.070	3.313	74.2
Water, H_2O	0.9982	3.343	75.0

[a] Data from Berger and Seltzer (1983)

[b] See compositions in Appendix B.3

[c] Assuming $T = 20°C.$, $P = 1$ atm., and Charles' Law for gases applies.

[d] I is the mean excitation potential for stopping power, see Chapter 8.