

► Appendix C REFERENCE

Table 1 Système International (SI) Base Units of Measurement

Quantity	Quantity Symbol	SI Base Unit	Unit Symbol
length	$L, l, h, d, w, r, \lambda, \Delta \vec{d}$	metre	m
mass	m	kilogram	kg
time	t	second	s
electric current	I	ampere	A
thermodynamic temperature	T	kelvin	K
amount of substance	n	mole	mol
luminous intensity	I_v	candela	cd

Table 2 Metric Prefixes and Their Origins

Prefix	Abbreviation	Meaning	Origin
exa	E	10^{18}	Greek <i>exa</i> – out of
peta	P	10^{15}	Greek <i>peta</i> – spread out
tera	T	10^{12}	Greek <i>teratos</i> – monster
giga	G	10^9	Greek <i>gigas</i> – giant
mega	M	10^6	Greek <i>mega</i> – great
kilo	k	10^3	Greek <i>khilioi</i> – thousand
hecto	h	10^2	Greek <i>hekatón</i> – hundred
deca	da	10^1	Greek <i>deka</i> – ten
standard unit		10^0	
deci	d	10^{-1}	Latin <i>decimus</i> – tenth
centi	c	10^{-2}	Latin <i>centum</i> – hundred
milli	m	10^{-3}	Latin <i>mille</i> – thousand
micro	μ	10^{-6}	Greek <i>mikros</i> – very small
nano	n	10^{-9}	Greek <i>nanos</i> – dwarf
pico	p	10^{-12}	Italian <i>piccolo</i> – small
femto	f	10^{-15}	Greek <i>femten</i> – fifteen
atto	a	10^{-18}	Danish <i>atten</i> – eighteen

Table 3 The Greek Alphabet

Upper Case	Lower Case	Name	Upper Case	Lower Case	Name
A	α	alpha	N	ν	nu
B	β	beta	Ξ	ξ	xi
Γ	γ	gamma	O	o	omicron
Δ	δ	delta	Π	π	pi
E	ϵ	epsilon	P	ρ	rho
Z	ζ	zeta	Σ	σ	sigma
H	η	eta	T	τ	tau
Θ	θ	theta	Υ	υ	upsilon
I	ι	iota	Φ	ϕ	phi
K	κ	kappa	X	χ	chi
Λ	λ	lambda	Ψ	ψ	psi
M	μ	mu	Ω	ω	omega

Table 4 Some SI Derived Units

Quantity	Symbol	Unit	Unit Symbol	SI Base Unit
acceleration	\vec{a}	metre per second per second	m/s ²	m/s ²
area	A	square metre	m ²	m ²
Celsius temperature	t	degrees Celsius	°C	°C
density	ρ, D	kilogram per cubic metre	kg/m ³	kg/m ³
electric charge	Q, q	coulomb	C	A·s
electric field	\vec{E}	volt per metre	V/m	kg·m/A·s ³
electric field intensity	$\vec{\epsilon}$	newton per coulomb	N/C	kg·m/A·s ³
electric potential	V	volt	V	kg·m ² /A·s ³
electric resistance	R	ohm	Ω	kg·m ² /A ² ·s ³
energy	E	joule	J	kg·m ² /s ²
force	\vec{F}	newton	N	kg·m/s ²
frequency	f	hertz	Hz	s ⁻¹
heat	Q	joule	J	kg·m ² /s ²
magnetic field	\vec{B}	weber per square metre (Tesla)	T	kg/A·s ²
gravitational field	\vec{g}	newton per kilogram	N/kg	m/s ²
momentum	\vec{p}	kilogram metre per second	kg·m/s	kg·m/s
period	T	second	s	s
power	P	watt	W	kg·m ² /s ³
pressure	P	newton per square metre	N/m ²	kg/m·s ²
radiation activity	A	becquerel	Bq	s ⁻¹
speed	v	metre per second	m/s	m/s
velocity	\vec{v}	metre per second	m/s	m/s
volume	V	cubic metre	m ³	m ³
weight	\vec{F}_w	newton	N	kg·m/s ²
work	W	joule	J	kg·m ² /s ²

Table 5 Physical Constants

Quantity	Symbol	Approximate Value
speed of light in a vacuum	c	3.00×10^8 m/s
universal gravitation constant	G	6.67×10^{-11} N·m ² /kg ²
Coulomb's constant	k	9.00×10^9 N·m ² /C ²
charge on electron	$-e$	-1.60×10^{-19} C
charge on proton	e	1.60×10^{-19} C
electron rest mass	m_e	9.11×10^{-31} kg
proton rest mass	m_p	1.673×10^{-27} kg
neutron rest mass	m_n	1.675×10^{-27} kg
atomic mass unit	u	1.660×10^{-27} kg
electron volt	eV	1.60×10^{-19} J
Planck's constant	h	6.63×10^{-34} J·s

Table 6 The Solar System

Object	Mass (kg)	Radius of Object (m)	Period of Rotation on Axis (s)	Mean Radius of Orbit (m)	Period of Revolution of Orbit (s)	Orbital Eccentricity
Sun	1.99×10^{30}	6.96×10^8	2.14×10^6	—	—	—
Mercury	3.28×10^{23}	2.44×10^6	5.05×10^6	5.79×10^{10}	7.60×10^6	0.206
Venus	4.83×10^{24}	6.05×10^6	2.1×10^7	1.08×10^{11}	1.94×10^7	0.007
Earth	5.98×10^{24}	6.38×10^6	8.64×10^4	1.49×10^{11}	3.16×10^7	0.017
Mars	6.37×10^{23}	3.40×10^6	8.86×10^4	2.28×10^{11}	5.94×10^7	0.093
Jupiter	1.90×10^{27}	7.15×10^7	3.58×10^4	7.78×10^{11}	3.75×10^8	0.048
Saturn	5.67×10^{26}	6.03×10^7	3.84×10^4	1.43×10^{12}	9.30×10^8	0.056
Uranus	8.80×10^{25}	2.56×10^7	6.20×10^4	2.87×10^{12}	2.65×10^9	0.046
Neptune	1.03×10^{26}	2.48×10^7	5.80×10^6	4.50×10^{12}	5.20×10^9	0.010
Pluto	1.3×10^{23}	1.15×10^6	5.51×10^5	5.91×10^{12}	7.82×10^9	0.248
Moon	7.35×10^{22}	1.74×10^6	2.36×10^6	3.84×10^8	2.36×10^6	0.055

Table 7 Atomic Masses of Selected Particles

Name	Symbol	Atomic Mass (u)
neutron	n	1.008 665
proton	p	1.007 276
deuteron	d	2.013 553
alpha particle	α	4.002 602

Table 8 Data for Some Radioisotopes

Atomic Number (Z)	Name	Symbol	Atomic Mass (u)	Decay Type	Half-Life
1	tritium hydrogen-3	${}^3_1\text{H}$	3.016 049	β^-	12.33 a
4	beryllium-7	${}^7_4\text{Be}$	7.016 928	γ	53.29 d
6	carbon-11	${}^{11}_6\text{C}$	11.011 433	β^+	20.385 min
6	carbon-14	${}^{14}_6\text{C}$	14.003 242	β^-	5730 a
8	oxygen-15	${}^{15}_8\text{O}$	15.003 065	β^+	122.24 s
11	sodium-22	${}^{22}_{11}\text{Na}$	21.994 434	β^+, γ	2.6088 a
14	silicon-31	${}^{31}_{14}\text{Si}$	30.975 362	β^-, γ	157.3 min
15	phosphorus-32	${}^{32}_{15}\text{P}$	31.973 908	β^-	14.262 d
16	sulfur-35	${}^{35}_{16}\text{S}$	34.969 033	β^-	87.51 d
19	potassium-40	${}^{40}_{19}\text{K}$	39.96 400	β^-, β^+	1.28×10^9 a
27	cobalt-60	${}^{60}_{27}\text{Co}$	59.933 820	β^-, γ	5.2714 a
38	strontium-90	${}^{90}_{38}\text{Sr}$	89.907 737	β^-	29.1 a
43	technetium-98	${}^{98}_{43}\text{Tc}$	97.907 215	β^-, γ	4.2×10^6 a
49	indium-115	${}^{115}_{49}\text{In}$	114.903 876	β^-, γ	4.41×10^{14} a
53	iodine-131	${}^{131}_{53}\text{I}$	130.906 111	β^-, γ	8.04 d
61	promethium-145	${}^{145}_{61}\text{Pm}$	144.912 745	γ, α	17.7 a

Table 8 continued

Atomic Number (Z)	Name	Symbol	Atomic Mass (u)	Decay Type	Half-Life
75	rhenium-187	$^{187}_{75}\text{Re}$	186.955 746	β^-	4.35×10^{10} a
76	osmium-191	$^{191}_{76}\text{Os}$	190.960 922	β^-, γ	15.4 d
82	lead-210	$^{210}_{82}\text{Pb}$	209.984 163	β^-, γ, α	22.3 a
82	lead-211	$^{211}_{82}\text{Pb}$	210.988 734	β^-, γ	36.1 min
82	lead-212	$^{212}_{82}\text{Pb}$	211.991 872	β^-, γ	10.64 h
82	lead-214	$^{214}_{82}\text{Pb}$	213.999 798	β^-, γ	26.8 min
83	bismuth-211	$^{211}_{83}\text{Bi}$	210.987 254	α, β, β^-	2.14 min
84	polonium-210	$^{210}_{84}\text{Po}$	209.982 848	α, γ	138.376 d
84	polonium-214	$^{214}_{84}\text{Po}$	213.995 177	α, γ	0.1643 s
85	astatine-218	$^{218}_{85}\text{At}$	218.008 68	α, β^-	1.6 s
86	radon-222	$^{222}_{86}\text{Rn}$	222.017 571	α, γ	3.8235 s
87	francium-223	$^{223}_{87}\text{Fr}$	223.019 733	β^-, γ, α	21.8 min
88	radium-226	$^{226}_{88}\text{Ra}$	226.025 402	α, γ	1600 a
89	actinium-227	$^{227}_{89}\text{Ac}$	227.027 749	α, β^-, γ	21.773 a
90	thorium-228	$^{228}_{90}\text{Th}$	228.028 716	α, γ	1.9131 a
90	thorium-232	$^{232}_{90}\text{Th}$	232.038 051	α, γ	1.405×10^{10} a
91	protactinium-231	$^{231}_{91}\text{Pa}$	231.035 880	α, γ	3.276×10^4 a
92	uranium-232	$^{232}_{92}\text{U}$	232.037 131	α, γ	68.9 a
92	uranium-233	$^{233}_{92}\text{U}$	233.039 630	α, γ	1.592×10^5 a
92	uranium-235	$^{235}_{92}\text{U}$	235.043 924	α, γ	7.038×10^8 a
92	uranium-236	$^{236}_{92}\text{U}$	236.045 562	α, γ	2.3415×10^7 a
92	uranium-238	$^{238}_{92}\text{U}$	238.050 784	α, γ	4.468×10^9 a
92	uranium-239	$^{239}_{92}\text{U}$	239.054 289	β^-, γ	23.50 min
93	neptunium-239	$^{239}_{93}\text{Np}$	239.052 932	β^-, γ	2.355 d
94	plutonium-239	$^{239}_{94}\text{Pu}$	239.052 157	α, γ	24 119 a
95	americium-243	$^{243}_{95}\text{Am}$	243.061 373	α, γ	7380 a
96	curium-245	$^{245}_{96}\text{Cm}$	245.065 484	α, γ	8500 a
97	berkelium-247	$^{247}_{97}\text{Bk}$	247.070 30	α, γ	1380 a
98	californium-249	$^{249}_{98}\text{Cf}$	249.074 844	α, γ	351 a
99	einsteinium-254	$^{254}_{99}\text{Es}$	254.088 02	α, β^-, γ	275.7 d
100	fermium-253	$^{253}_{100}\text{Fm}$	253.085 174	α, γ	3.00 d
101	mendelevium-255	$^{255}_{101}\text{Md}$	255.091 07	α, γ	27 min
102	nobelium-255	$^{255}_{102}\text{No}$	255.093 24	α, γ	3.1 min
103	lawrencium-257	$^{257}_{103}\text{Lr}$	257.099 5	α	0.646 s
104	rutherfordium-261	$^{261}_{104}\text{Rf}$	261.108 69	α	65 s
105	dubnium-262	$^{262}_{105}\text{Db}$	262.113 76	α	34 s
106	seaborgium-263	$^{263}_{106}\text{Sg}$	263.116 2	α	0.9 s
107	bohrium-262	$^{262}_{107}\text{Bh}$	262.123 1	α	0.10 s
108	hassium-264	$^{264}_{108}\text{Hs}$	264.128 5	α	0.00008 s
109	meitnerium-266	$^{266}_{109}\text{Mt}$	266.137 8	α	0.0034 s

Periodic Table

1 1A	1 -259 2.1 -253 0.0899 37 H hydrogen 1s ¹ 1.01		2 IIA															
2	3 1.0 181 1342 0.534 152 Li lithium [He] 2s ¹ 6.94		4 1.5 1278 2970 1.85 111 Be beryllium [He] 2s ² 9.01															
3	11 0.9 97.8 883 0.971 186 Na sodium [Ne] 3s ¹ 22.99		12 1.2 649 1107 1.74 160 Mg magnesium [Ne] 3s ² 24.31															
4	19 0.8 63.3 760 0.862 227 K potassium [Ar] 4s ¹ 39.10		20 1.0 839 1484 1.54 197 Ca calcium [Ar] 4s ² 40.08		3 IIIB		4 IVB		5 VB		6 VIB		7 VIIB		8		9	
5	37 0.8 38.9 686 1.53 248 Rb rubidium [Kr] 5s ¹ 85.47		38 1.0 769 1384 2.6 215 Sr strontium [Kr] 5s ² 87.62		21 1.3 1541 2836 3+ 161 Sc scandium [Ar] 4s ² 3d ¹ 44.96		22 1.5 1660 3287 4+ 145 Ti titanium [Ar] 4s ² 3d ² 47.88		23 1.6 1890 3380 5+ 132 V vanadium [Ar] 4s ² 3d ³ 50.94		24 1.6 1857 2672 3+ 125 Cr chromium [Ar] 4s ¹ 3d ⁵ 52.00		25 1.5 1244 1962 2+ 124 Mn manganese [Ar] 4s ² 3d ⁵ 54.94		26 1.8 1535 2750 3+ 124 Fe iron [Ar] 4s ² 3d ⁶ 55.85		27 1.8 1495 2870 2+ 125 Co cobalt [Ar] 4s ² 3d ⁷ 58.93	
6	55 0.7 28.4 669 1.88 265 Cs cesium [Xe] 6s ¹ 132.91		56 0.9 725 1640 3.5 217 Ba barium [Xe] 6s ² 137.33		39 1.3 1522 3338 3+ 181 Y yttrium [Kr] 5s ² 4d ¹ 88.91		40 1.4 1852 4377 4+ 160 Zr zirconium [Kr] 5s ² 4d ² 91.22		41 1.6 2468 5127 5+ 143 Nb niobium [Kr] 5s ¹ 4d ⁴ 92.91		42 1.8 2610 5560 6+ 136 Mo molybdenum [Kr] 5s ¹ 4d ⁵ 95.94		43 1.9 2172 4877 7+ 136 Tc technetium [Kr] 5s ² 4d ⁵ 98.91		44 2.2 2310 3900 3+ 133 Ru ruthenium [Kr] 5s ¹ 4d ⁷ 101.07		45 2.2 1966 3727 3+ 135 Rh rhodium [Kr] 5s ¹ 4d ⁸ 102.91	
7	87 0.7 27 677 — — Fr francium [Rn] 7s ¹ (223)		88 0.9 700 1140 5 215 Ra radium [Rn] 7s ² 226.03		71 1.2 1663 3402 3+ 188 Lu lutetium [Xe] 6s ² 4f ¹⁴ 5d ¹ 174.97		72 1.3 2227 4602 4+ 156 Hf hafnium [Xe] 6s ² 4f ¹⁴ 5d ² 178.49		73 1.5 2996 5425 5+ 143 Ta tantalum [Xe] 6s ² 4f ¹⁴ 5d ³ 180.95		74 1.7 3410 5660 6+ 137 W tungsten [Xe] 6s ² 4f ¹⁴ 5d ⁴ 183.85		75 1.9 3180 5627 7+ 137 Re rhenium [Xe] 6s ² 4f ¹⁴ 5d ⁵ 186.21		76 2.2 2700 5300 4+ 134 Os osmium [Xe] 6s ² 4f ¹⁴ 5d ⁶ 190.2		77 2.2 2410 4130 4+ 136 Ir iridium [Xe] 6s ² 4f ¹⁴ 5d ⁷ 192.22	
8	103 — 1627 — — 3+ Lr lawrencium [Rn] 7s ² 5f ¹⁴ 6d ¹ (260)		104 — — — — — Rf rutherfordium [Rn] 7s ² 5f ¹⁴ 6d ² (261)		105 — — — — — Db dubnium [Rn] 7s ² 5f ¹⁴ 6d ³ (262)		106 — — — — — Sg seaborgium [Rn] 7s ² 5f ¹⁴ 6d ⁴ (266)		107 — — — — — Bh borium [Rn] 7s ² 5f ¹⁴ 6d ⁵ (264)		108 — — — — — Hs hassium [Rn] 7s ² 5f ¹⁴ 6d ⁶ (269)		109 — — — — — Mt meitnerium [Rn] 7s ² 5f ¹⁴ 6d ⁷ (268)					

Key

atomic number → 26
 electronegativity → 1.8
 common ion charge → 3+
 other ion charge → 2+
 symbol of element → Fe
 name of element → iron
 electron configuration → [Ar] 4s² 3d⁶
 atomic mass (u) → 55.85
 atomic molar mass (g/mol) → 55.85

melting point (°C) → 1535
 boiling point (°C) → 2750
 density of solid (g/cm³) → 7.87
 density of liquid (g/mL) → 7.87
 density of gas at SATP (g/L) → 124
 atomic radius (pm) → 124

(solids in black, liquids in blue, gases in red)

VIII B

6	57 1.1 3464 3+ 195 La lanthanum [Xe] 6s ² 5d ¹ 138.90		58 1.1 3443 3+ 185 Ce cerium [Xe] 6s ² 4f ¹ 5d ¹ 140.12		59 1.1 3520 3+ 185 Pr praseodymium [Xe] 6s ² 4f ³ 140.91		60 1.2 3074 3+ 185 Nd neodymium [Xe] 6s ² 4f ⁴ 144.24		61 — 1042 3+ 185 Pm promethium [Xe] 6s ² 4f ⁵ (145)	
7	89 1.1 3200 3+ 195 Ac actinium [Rn] 7s ² 6d ¹ 227.03		90 1.3 4790 4+ 180 Th thorium [Rn] 7s ² 6d ² 232.04		91 1.5 — 5+ 180 Pa protactinium [Rn] 7s ² 5f ² 6d ¹ 231.04		92 1.7 3818 6+ 175 U uranium [Rn] 7s ² 5f ³ 6d ¹ 238.03		93 1.3 3902 5+ 175 Np neptunium [Rn] 7s ² 5f ⁴ 6d ¹ (237)	

of the Elements

18
VIII A

			13 IIIA		14 IVA		15 VA		16 VIA		17 VIIA		18 VIII A		1
			5 2300 2.0 2550 X 2.34 88 B boron [He] 2s ² 2p ¹ 10.81	6 3550 2.5 4827 X 2.26 77 C carbon [He] 2s ² 2p ² 12.01	7 -210 3.0 -196 1.25 70 N nitrogen [He] 2s ² 2p ³ 14.01	8 -218 3.5 -183 1.43 66 O oxygen [He] 2s ² 2p ⁴ 16.00	9 -220 4.0 -188 1.70 64 F fluorine [He] 2s ² 2p ⁵ 19.00	10 -249 — -246 X 0.900 62 Ne neon [He] 2s ² 2p ⁶ 20.18							2
			13 1.5 660 2467 2.70 143 Al aluminum [Ne] 3s ² 3p ¹ 26.98	14 1.8 1410 2355 X 2.33 117 Si silicon [Ne] 3s ² 3p ² 28.09	15 2.1 44.1 280 1.82 110 P phosphorus [Ne] 3s ² 3p ³ 30.97	16 2.5 113 445 2.07 104 S sulfur [Ne] 3s ² 3p ⁴ 32.06	17 3.0 -101 -34.6 3.21 99 Cl chlorine [Ne] 3s ² 3p ⁵ 35.45	18 -189 — -186 X 1.78 95 Ar argon [Ne] 3s ² 3p ⁶ 39.95							3
10	11 IB	12 IIB													
28 1.8 2+ 3+ Ni nickel [Ar] 4s ² 3d ⁸ 58.69	29 1.9 2+ 1+ Cu copper [Ar] 4s ¹ 3d ¹⁰ 63.55	30 1.6 2+ Zn zinc [Ar] 4s ² 3d ¹⁰ 65.38	31 1.6 3+ Ga gallium [Ar] 4s ² 3d ¹⁰ 4p ¹ 69.72	32 1.8 4+ Ge germanium [Ar] 4s ² 3d ¹⁰ 4p ² 72.61	33 2.0 3+ 5+ As arsenic [Ar] 4s ² 3d ¹⁰ 4p ³ 74.92	34 2.4 2+ 4+ Se selenium [Ar] 4s ² 3d ¹⁰ 4p ⁴ 78.96	35 2.8 3+ 4+ Br bromine [Ar] 4s ² 3d ¹⁰ 4p ⁵ 79.90	36 -157 — -152 X 3.74 112 Kr krypton [Ar] 4s ² 3d ¹⁰ 4p ⁶ 83.80							4
46 2.2 2+ 4+ Pd palladium [Kr] 4d ¹⁰ 106.42	47 1.9 1+ Ag silver [Kr] 5s ¹ 4d ¹⁰ 107.87	48 1.7 2+ Cd cadmium [Kr] 5s ² 4d ¹⁰ 112.41	49 1.7 3+ In indium [Kr] 5s ² 4d ¹⁰ 5p ¹ 114.82	50 1.8 4+ 2+ Sn tin [Kr] 5s ² 4d ¹⁰ 5p ² 118.69	51 1.9 3+ 5+ Sb antimony [Kr] 5s ² 4d ¹⁰ 5p ³ 121.75	52 2.1 2+ 4+ Te tellurium [Kr] 5s ² 4d ¹⁰ 5p ⁴ 127.60	53 2.5 1.8 4.93 133 I iodine [Kr] 5s ² 4d ¹⁰ 5p ⁵ 126.90	54 -112 — -107 X 5.89 130 Xe xenon [Kr] 5s ² 4d ¹⁰ 5p ⁶ 131.29							5
78 2.2 4+ 2+ Pt platinum [Xe] 6s ¹ 4f ¹⁴ 5d ⁹ 195.08	79 2.4 3+ 1+ Au gold [Xe] 6s ¹ 4f ¹⁴ 5d ¹⁰ 196.97	80 1.9 2+ 1+ Hg mercury [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 200.59	81 1.8 1+ 3+ Tl thallium [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ¹ 204.38	82 1.8 2+ 4+ Pb lead [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ² 207.20	83 1.9 3+ 5+ Bi bismuth [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ³ 209.98	84 2.0 2+ 4+ Po polonium [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁴ (209)	85 2.2 At astatine [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁵ (210)	86 -71 — -61.8 X 9.73 140 Rn radon [Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁶ (222)							6
110 — — — Uun ununilium [Rn] 7s ² 5f ¹⁴ 6d ⁸ (269, 271)	111 — — — Uuu unununium [Rn] 7s ² 5f ¹⁴ 6d ⁹ (272)	112 — — — Uub ununbium [Rn] 7s ² 5f ¹⁴ 6d ¹⁰ (277)	113	114 — — — Uuq ununquadium [Rn] 7s ² 5f ¹⁴ 6d ¹⁰ 7p ² (285)	115	116 — — — Uuh ununhexium [Rn] 7s ² 5f ¹⁴ 6d ¹⁰ 7p ⁴ (289)	117	118							7

62 1.2 3+ 2+ Sm samarium [Xe] 6s ² 4f ⁶ 150.36	63 — 3+ 2+ Eu europium [Xe] 6s ² 4f ⁷ 151.96	64 1.1 3+ Gd gadolinium [Xe] 6s ² 4f ⁷ 5d ¹ 157.25	65 1.2 3+ Tb terbium [Xe] 6s ² 4f ⁹ 158.92	66 — 3+ Dy dysprosium [Xe] 6s ² 4f ¹⁰ 162.50	67 1.2 3+ Ho holmium [Xe] 6s ² 4f ¹¹ 164.93	68 1.2 3+ Er erbium [Xe] 6s ² 4f ¹² 167.26	69 1.2 3+ Tm thulium [Xe] 6s ² 4f ¹³ 168.93	70 1.1 3+ 2+ Yb ytterbium [Xe] 6s ² 4f ¹⁴ 173.04							6
94 1.3 4+ 6+ Pu plutonium [Rn] 7s ² 5f ⁶ (244)	95 1.3 3+ 4+ Am americium [Rn] 7s ² 5f ⁷ (243)	96 — 3+ Cm curium [Rn] 7s ² 5f ⁷ 6d ¹ (247)	97 — 3+ 4+ Bk berkelium [Rn] 7s ² 5f ⁹ (247)	98 — 3+ Cf californium [Rn] 7s ² 5f ¹⁰ (251)	99 — 3+ Es einsteinium [Rn] 7s ² 5f ¹¹ (252)	100 — 3+ Fm fermium [Rn] 7s ² 5f ¹² (257)	101 — 2+ 3+ Md mendelevium [Rn] 7s ² 5f ¹³ (258)	102 — 2+ 3+ No nobelium [Rn] 7s ² 5f ¹⁴ (259)							7

C

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For more information on the physics Nobel Prize winners and their work, check out the official Nobel Foundation Web site at <http://www.nobel.se/physics/laureates>. Canadian citizens or those scientists doing their work primarily in Canada are indicated by a maple leaf.

- 2001 Eric A. Cornell (1961–), Wolfgang Ketterle (1957–), Carl E. Wieman (1951–)
2000 Zhores I. Alferov (1930–), Herbert Kroemer (1928–), Jack S. Kilby (1923–)
1999 Gerardus 't Hooft (1946–), Martinus J.G. Veltman (1931–)
1998 Robert B. Laughlin (1950–), Horst L. Störmer (1949–), Daniel C. Tsui (1939–)
1997 Steven Chu (1948–), Claude Cohen-Tannoudji (1933–), William D. Phillips (1948–)
1996 David M. Lee (1931–), Douglas D. Osheroff (1945–), Robert C. Richardson (1937–)
1995 Martin L. Perl (1927–), Frederick Reines (1918–1998)
1994 Bertram N. Brockhouse (1918–) , Clifford G. Shull (1915–2001)
1993 Russell A. Hulse (1950–), Joseph H. Taylor Jr. (1941–)
1992 Georges Charpak (1924–)
1991 Pierre-Gilles de Gennes (1932–)
1990 Jerome I. Friedman (1930–), Henry W. Kendall (1926–), Richard E. Taylor (1929–) 
1989 Norman F. Ramsey (1915–), Hans G. Dehmelt (1922–), Wolfgang Paul (1913–1993)
1988 Leon M. Lederman (1922–), Melvin Schwartz (1932–), Jack Steinberger (1921–)
1987 J. Georg Bednorz (1950–), K. Alexander Müller (1927–)
1986 Ernst Ruska (1906–1988), Gerd Binnig (1947–), Heinrich Rohrer (1933–)
1985 Klaus von Klitzing (1943–)
1984 Carlo Rubbia (1934–), Simon van der Meer (1925–)
1983 Subramanyan Chandrasekhar (1910–1995), William Alfred Fowler (1911–1995)
1982 Kenneth G. Wilson (1936–)
1981 Nicolaas Bloembergen (1920–), Arthur Leonard Schawlow (1921–1999), Kai M. Siegbahn (1918–)
1980 James Watson Cronin (1931–), Val Logsdon Fitch (1923–)
1979 Sheldon Lee Glashow (1932–), Abdus Salam (1926–1996), Steven Weinberg (1933–)
1978 Pyotr Leonidovich Kapitsa (1894–1984), Arno Allan Penzias (1933–), Robert Woodrow Wilson (1936–)
1977 Philip Warren Anderson (1923–), Sir Nevill Francis Mott (1905–1996), John Hasbrouck van Vleck (1899–1980)
1976 Burton Richter (1931–), Samuel Chao Chung Ting (1936–)
1975 Aage Niels Bohr (1922–), Ben Roy Mottelson (1926–), Leo James Rainwater (1917–1986)
1974 Sir Martin Ryle (1918–1984), Antony Hewish (1924–)
1973 Leo Esaki (1925–), Ivar Giaever (1929–), Brian David Josephson (1940–)
1972 John Bardeen (1908–1991), Leon Neil Cooper (1930–), John Robert Schrieffer (1931–)
1971 Dennis Gabor (1900–1979)
1970 Hannes Olof Gösta Alfvén (1908–1995), Louis Eugène Félix Néel (1904–2000)
1969 Murray Gell-Mann (1929–)
1968 Luis Walter Alvarez (1911–1988)
1967 Hans Albrecht Bethe (1906–)
1966 Alfred Kastler (1902–1984)
1965 Sin-Itiro Tomonaga (1906–1979), Julian Schwinger (1918–1994), Richard P. Feynman (1918–1988)
1964 Charles Hard Townes (1915–), Nicolay Gennadiyevich Basov (1922–), Aleksandr Mikhailovich Prokhorov (1916–2002)
1963 Eugene Paul Wigner (1902–1995), Maria Goeppert-Mayer (1906–1972), J. Hans D. Jensen (1907–1973)
1962 Lev Davidovich Landau (1908–1968)
1961 Robert Hofstadter (1915–1990), Rudolf Ludwig Mössbauer (1929–)
1960 Donald Arthur Glaser (1926–)
1959 Emilio Gino Segrè (1905–1989), Owen Chamberlain (1920–)
1958 Pavel Alekseyevich Cherenkov (1904–1990), Il'ja Mikhailovich Frank (1908–1990), Igor Yevgenyevich Tamm (1895–1971)
1957 Chen Ning Yang (1922–), Tsung-Dao Lee (1926–)
1956 William Bradford Shockley (1910–1989), John Bardeen (1908–1991), Walter Houser Brattain (1902–1987)
1955 Willis Eugene Lamb (1913–), Polykarp Kusch (1911–1993)
1954 Max Born (1882–1970), Walther Bothe (1891–1957)
1953 Frits (Frederik) Zernike (1888–1966)
1952 Felix Bloch (1905–1983), Edward Mills Purcell (1912–1997)
1951 Sir John Douglas Cockcroft (1897–1967), Ernest Thomas Sinton Walton (1903–1995)
1950 Cecil Frank Powell (1903–1969)
1949 Hideki Yukawa (1907–1981)
1948 Patrick Maynard Stuart Blackett (1897–1974)
1947 Sir Edward Victor Appleton (1892–1965)
1946 Percy Williams Bridgman (1882–1961)
1945 Wolfgang Pauli (1900–1958)
1944 Isidor Isaac Rabi (1898–1988)
1943 Otto Stern (1888–1969)
1939 Ernest Orlando Lawrence (1901–1958)
1938 Enrico Fermi (1901–1954)
1937 Clinton Joseph Davison (1881–1958), George Paget Thomson (1892–1975)
1936 Victor Franz Hess (1883–1964), Carl David Anderson (1905–1991)
1935 James Chadwick (1891–1974)
1933 Erwin Schrödinger (1887–1961), Paul Adrien Maurice Dirac (1902–1984)
1932 Werner Karl Heisenberg (1901–1976)
1930 Sir Chandrasekhara Venkata Raman (1888–1970)
1929 Prince Louis-Victor Pierre Raymond de Broglie (1892–1987)
1928 Owen Willans Richardson (1879–1959)
1927 Arthur Holly Compton (1892–1962), Charles Thomson Rees Wilson (1869–1959)
1926 Jean Baptiste Perrin (1870–1942)
1925 James Franck (1882–1964), Gustav Ludwig Hertz (1887–1975)
1924 Karl Manne Georg Siegbahn (1886–1978)
1923 Robert Andrews Millikan (1868–1953)
1922 Niels Henrik David Bohr (1885–1962)
1921 Albert Einstein (1879–1955)
1920 Charles-Edouard Guillaume (1861–1938)
1919 Johannes Stark (1874–1957)
1918 Max Karl Ernst Ludwig Planck (1858–1947)
1917 Charles Glover Barkla (1877–1944)
1915 Sir William Henry Bragg (1862–1942), William Lawrence Bragg (1890–1971)
1914 Max von Laue (1879–1960)
1913 Heike Kamerlingh Onnes (1853–1926)
1912 Nils Gustaf Dalén (1869–1937)
1911 Wilhelm Wien (1864–1928)
1910 Johannes Diderik van der Waals (1837–1923)
1909 Guglielmo Marconi (1874–1937), Carl Ferdinand Braun (1850–1918)
1908 Gabriel Lippmann (1845–1921)
1907 Albert Abraham Michelson (1852–1931)
1906 Sir Joseph John Thomson (1856–1940)
1905 Philipp Eduard Anton von Lenard (1862–1947)
1904 Lord (John William Strutt) Rayleigh (1842–1919)
1903 Antoine Henri Becquerel (1852–1908), Pierre Curie (1859–1906), Marie Curie (1867–1934)
1902 Hendrik Antoon Lorentz (1853–1928), Pieter Zeeman (1865–1943)
1901 Wilhelm Conrad Röntgen (1845–1923)

**No prizes were awarded in 1916, 1931, 1934, and from 1940–1942.*