JOURNAL
OF THE AMERICAN CHEMICAL SOCIETY

VOLUME 93, NUMBER 11 JUNE 2, 1971

Physical and Inorganic Chemistry

Tables of Atomic Weights, Selected Radioactive Isotopes, and Atomic Masses of Selected Isotopes, 1969

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TABLE OF ATOMIC WEIGHTS, 1969

Based on the Assigned Relative Atomic Mass of $^{12}C = 12$

The following values apply to elements as they exist in materials of terrestrial origin and to certain artificial elements. When used with due regard to the footnotes, they are considered reliable to ±1 in the last digit, or ±3 if that digit is in small type, as a subscript.

Order of Atomic Number

Atomic no.	Name	Symbol	Atomic wt	Atomic no.	Name	Symbol	Atomic wt
1	Hydrogen	H	1.008_0[b,d]	28	Nickel	Ni	58.7_1
2	Helium	He	4.00260[b,c]	29	Copper	Cu	63.54_6[c,d]
3	Lithium	Li	6.941[c–e]	30	Zinc	Zn	65.3_7
4	Beryllium	Be	9.01218[a]	31	Gallium	Ga	69.72
5	Boron	B	10.81[c–e]	32	Germanium	Ge	72.5_9
6	Carbon	C	12.011[b,d]	33	Arsenic	As	74.9216[a]
7	Nitrogen	N	14.0067[b,c]	34	Selenium	Se	78.9_6
8	Oxygen	O	15.999_4[b–d]	35	Bromine	Br	79.904[c]
9	Fluorine	F	18.9984[a]	36	Krypton	Kr	83.80
10	Neon	Ne	20.17_9[c]	37	Rubidium	Rb	85.467_8[c]
11	Sodium	Na	22.9898[a]	38	Strontium	Sr	87.62[g]
12	Magnesium	Mg	24.305[c]	39	Yttrium	Y	88.9059[a]
13	Aluminum	Al	26.9815[a]	40	Zirconium	Zr	91.22
14	Silicon	Si	28.08_6[d]	41	Niobium	Nb	92.9064[a]
15	Phosphorus	P	30.9738[a]	42	Molybdenum	Mo	95.9_4
16	Sulfur	S	32.06[d]	43	Technetium	Tc	98.9062[f]
17	Chlorine	Cl	35.453[c]	44	Ruthenium	Ru	101.0_7
18	Argon	Ar	39.94_6[b–d,g]	45	Rhodium	Rh	102.9055[a]
19	Potassium	K	39.10_2	46	Palladium	Pd	106.4
20	Calcium	Ca	40.08	47	Silver	Ag	107.868[c]
21	Scandium	Sc	44.9559[a]	48	Cadmium	Cd	112.40
22	Titanium	Ti	47.9_0	49	Indium	In	114.82
23	Vanadium	V	50.941_4[b,c]	50	Tin	Sn	118.6_9
24	Chromium	Cr	51.996[c]	51	Antimony	Sb	121.7_5
25	Manganese	Mn	54.9380[a]	52	Tellurium	Te	127.6_0
26	Iron	Fe	55.84_7	53	Iodine	I	126.9045[a]
27	Cobalt	Co	58.9332[a]	54	Xenon	Xe	131.30

TABLE OF ATOMIC WEIGHTS (*Continued*)

Atomic no.	Name	Symbol	Atomic wt	Atomic no.	Name	Symbol	Atomic wt
55	Cesium	Cs	132.9055[a]	79	Gold	Au	196.9665[a]
56	Barium	Ba	137.3$_4$	80	Mercury	Hg	200.5$_9$
57	Lanthanum	La	138.905$_0$[b]	81	Thallium	Tl	204.3$_7$
58	Cerium	Ce	140.12	82	Lead	Pb	207.2[d,g]
59	Praseodymium	Pr	140.9077[a]	83	Bismuth	Bi	208.9806[a]
60	Neodymium	Nd	144.2$_4$	84	Polonium	Po	
61	Promethium	Pm		85	Astatine	At	
62	Samarium	Sm	150.4	86	Radon	Rn	
63	Europium	Eu	151.96	87	Francium	Fr	
64	Gadolinium	Gd	157.2$_5$	88	Radium	Ra	226.0254[a,f,g]
65	Terbium	Tb	158.9254[a]	89	Actinium	Ac	
66	Dysprosium	Dy	162.5$_0$	90	Thorium	Th	232.0381[c,f]
67	Holmium	Ho	164.9303[a]	91	Protactinium	Pa	231.0359[a,f]
68	Erbium	Er	167.2$_6$	92	Uranium	U	238.029[b,e,g]
69	Thulium	Tm	168.9342[a]	93	Neptunium	Np	237.0482[b,f]
70	Ytterbium	Yb	173.0$_4$	94	Plutonium	Pu	
71	Lutetium	Lu	174.97	95	Americium	Am	
72	Hafnium	Hf	178.4$_9$	96	Curium	Cm	
73	Tantalum	Ta	180.947$_9$[b]	97	Berkelium	Bk	
74	Wolfram (tungsten)	W	183.8$_5$	98	Californium	Cf	
				99	Einsteinium	Es	
75	Rhenium	Re	186.2	100	Fermium	Fm	
76	Osmium	Os	190.2	101	Mendelevium	Md	
77	Iridium	Ir	192.2$_2$	102	Nobelium	No	
78	Platinum	Pt	195.0$_9$	103	Lawrencium	Lr	

[a] Mononuclidic element. [b] Element with one predominant isotope (about 99–100% abundance). [c] Element for which the atomic weight is based on calibrated measurements. [d] Element for which variation in isotopic abundance in terrestrial samples limits the precision of the atomic weight given. [e] Element for which users are cautioned against the possibility of large variations in atomic weight due to inadvertent or undisclosed artificial isotopic separation in commercially available materials. [f] Most commonly available long-lived isotope; see "Table of Selected Radioactive Isotopes." [g] In some geological specimens this element has a highly anomalous isotopic composition, corresponding to an atomic weight significantly different from that given.

TABLE OF SELECTED RADIOACTIVE ISOTOPES

Order of Atomic Number

This table lists selected isotopes of the chemical elements, whether occurring in nature or known only through synthesis, that are commonly classed as radioactive. The listed isotopes include the one of longest known half-life and others of recognized interest. Decay modes with intensities below 0.01% are not mentioned.

Atomic no.	Name	Symbol	Isotope	Half-life	Decay mode	Atomic no.	Name	Symbol	Isotope	Half-life	Decay mode[a]
43	Technetium	Tc	97	2.6×10^6 y	EC	94	Plutonium	Pu	244	8.2×10^7 y	α, SF
43	Technetium	Tc	99	$2.1_4 \times 10^5$ y	β^-	95	Americium	Am	241	43_5 y	α
61	Promethium	Pm	145	18.0 y	EC	95	Americium	Am	243	7.4×10^3 y	α
61	Promethium	Pm	147	2.6$_2$ y	β^-	96	Curium	Cm	242	16_4 d	α
84	Polonium	Po	209	1.0×10^2 y	α, EC	96	Curium	Cm	243	3_2 y	α, EC
84	Polonium	Po	210	138.$_4$ d	α	96	Curium	Cm	244	18.$_1$ y	α
85	Astatine	At	210	8.3 h	EC, α	96	Curium	Cm	245	8.3×10^3 y	α
86	Radon	Rn	222	3.8$_2$ d	α	96	Curium	Cm	246	4.7×10^3 y	α, SF
87	Francium	Fr	223	22 m	β^-	96	Curium	Cm	247	1.6×10^7 y	α
88	Radium	Ra	226	1.60×10^3 y	α	96	Curium	Cm	248	3.5×10^5 y	α, SF
89	Actinium	Ac	227	21.8 y	β^-, α	96	Curium	Cm	250	1.1×10^4 y	SF
90	Thorium	Th	232	$1.4_1 \times 10^{10}$ y	α	97	Berkelium	Bk	247	1.4×10^3 y	α
91	Protactinium	Pa	231	3.26×10^4 y	α	97	Berkelium	Bk	249	3.1×10^2 d	β^-
92	Uranium	U	233	$1.6_0 \times 10^5$ y	α	98	Californium	Cf	251	90_0 y	α
92	Uranium	U	234	$2.4_7 \times 10^5$ y	α	98	Californium	Cf	252	2.64 y	α, SF
92	Uranium	U	235	7.0×10^8 y	α	98	Californium	Cf	254	60.$_5$ d	SF, α
92	Uranium	U	238	4.5×10^9 y	α	99	Einsteinium	Es	253	20 d	α
93	Neptunium	Np	237	$2.1_4 \times 10^6$ y	α	99	Einsteinium	Es	254	2.7×10^2 d	α
94	Plutonium	Pu	238	87 y	α	100	Fermium	Fm	257	8_0 d	α, SF
94	Plutonium	Pu	239	24.3×10^3 y	α	101	Mendelevium	Md	257	3.$_0$ h	EC, α, SF
94	Plutonium	Pu	240	6.6×10^3 y	α	101	Mendelevium	Md	258	5_4 d	EC, α, SF
94	Plutonium	Pu	241	14.$_2$ y	β^-	102	Nobelium	No	255	18_5 s	α, EC
94	Plutonium	Pu	242	$3.8_6 \times 10^5$ y	α	103	Lawrencium	Lr	256	3_5 s	α

[a] SF, spontaneous fission; EC, electron capture.

TABLE OF ATOMIC MASSES OF SELECTED ISOTOPES

Name	Symbol	Atomic no.	Mass no.	Atomic mass	Name	Symbol	Atomic no.	Mass no.	Atomic mass
Hydrogen	H	1	1	1.00782	Promethium	Pm	61	143	142.9110
Deuterium	D	1	2	2.01410				145	144.9128
Tritium	T	1	3	3.01605				147	146.9152
Helium	He	2	3	3.01603	Lead	Pb	82	204	203.9731
			4	4.00260				206	205.9745
Lithium	Li	3	6	6.01512				207	206.9759
			7	7.01600				208	207.9766
Boron	B	5	10	10.0129	Uranium	U	92	233	233.0396
			11	11.0093				234	234.0410
Carbon	C	6	12	12 exactly				235	235.0439
			13	13.0034				236	236.0456
			14	14.0032				238	238.0508
Nitrogen	N	7	14	14.0031	Plutonium	Pu	94	238	238.0496
			15	15.0001				239	239.0522
Oxygen	O	8	16	15.9949				240	240.0538
			17	16.9991				241	241.0569
			18	17.9992				242	242.0588
Sulfur	S	16	32	31.9721				244	244.0642
			33	32.9715	Curium	Cm	96	242	242.0589
			34	33.9679				244	244.0628
			36	35.9671				246	246.0672
								247	247.0704
								248	248.0724

Decay Mechanism of Triplet Sulfur Dioxide Molecules Formed by Intersystem Crossing in the Flash Photolysis of Sulfur Dioxide (2400–3200 Å)

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Abstract: The lifetimes of sulfur dioxide triplet-state molecules ($^3SO_2$) have been measured through phosphorescence intensity–time studies in pure SO_2 at a series of temperatures (25–100°) and pressures (13–366 μ). The $^3SO_2$ species were generated by intersystem crossing from excited singlet molecules ($^1SO_2$) formed in the flash photolysis of SO_2 (2400–3200 Å). The data from runs at pressures above 70 μ give the following rate constant estimates: $^3SO_2 + SO_2 \rightarrow SO + SO_3$ (8a) and $^3SO_2 + SO_2 \rightarrow 2SO_2$ (8b), $\log[k_{8a} + k_{8b}, \text{l./(mol sec)}] = 10.60 \pm 0.47 - (2.79 \pm 0.68 \text{ kcal/mol})/2.303RT$; $^3SO_2 \rightarrow SO_2 + h\nu_p$ (6) and $^3SO_2 \rightarrow SO_2$ (7), $k_6 + k_7 = (1.13 \pm 0.18) \times 10^3$ sec^{-1}, independent of the temperature (25–100°). The existing rate data confirm the inequalities $k_{8a} > k_{8b}$ and $k_7 > k_6$. The Stern–Volmer plot of the $^3SO_2$ lifetime data shows an upward curvature at pressures below about 60 μ. The difference between the reciprocals of the measured lifetime at low pressure and those estimated by the extrapolation of the high-pressure data is found to be proportional to the reciprocal of the SO_2 concentration. It is concluded that a significant fraction of the $^3SO_2$ molecules diffuse to the wall and are deactivated heterogeneously in runs at low pressures.

The demonstrated importance of the excited triplet sulfur dioxide molecule ($^3SO_2$) in the photochemistry of sulfur dioxide[1-4] has stimulated an increased interest in the further characterization of this species. Some reactions of $^3SO_2$ have been deduced recently from phosphorescence lifetime measurements in sulfur dioxide excited by a 3828.8-Å laser pulse which lies within the "forbidden" $SO_2(^1A_1) \rightarrow SO_2(^3B_1)$ absorption band.[5,6] Morikawa has studied the reactions of the $^3SO_2$ species formed in very different experiments.[5] He excited singlet sulfur dioxide molecules ($^1SO_2$) by the flash photolysis of sulfur dioxide within the first allowed absorption band (2400–3200 Å). He followed the phosphorescence decay of triplets created by intersystem crossing from the excited molecules. Morikawa found that the $^3SO_2$ molecules formed by this method showed similar reactivity to those

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