Atomic Weights of the Elements 1987

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The International Union of Pure and Applied Chemistry Commission on Atomic Weights and Isotopic Abundances has reviewed recent literature and confirmed the atomic weight values published in 1985, with one minor change. The current table of standard atomic weights is presented.

Key words: atomic mass; isotopic abundance; IUPAC; trans-uranium elements.

1. Introduction

The Commission on Atomic Weights and Isotopic Abundances of the International Union of Pure and Applied Chemistry (IUPAC) met under the chairmanship of Professor R. L. Martin from August 22–25, 1987, during the XXXIV IUPAC General Assembly in Boston, Massachusetts. The Commission has monitored the literature since the last review in 1985 and evaluated the published data on atomic weights and isotopic compositions on an element by element basis. The atomic weight of an element can be determined from a knowledge of the isotopic abundances and corresponding atomic masses of the nuclides of that element. The latest compilation of atomic masses[1] was published in 1985, which resulted in a number of small changes in the atomic weights that were reported in the 1985 table.[2] Only one additional change is incorporated in the 1987 table.

Membership of the Commission for the period 1985–1987 was as follows: R. L. Martin (Australia, Chairman); J. R. De Laeter (Australia, Secretary); R. C. Barber (Canada, Titular); I. L. Barnes (USA, Associate); J. Cesario (France, Associate); T. L. Chang (China, Titular); T. B. Coplen (USA, Associate); J. W. Gramlich (USA, Associate); K. G. Heumann (FRG, Titular); N. E. Holden (USA, Associate); H. R. Krouse (Canada, Associate); I. A. Lebedev (USSR, Associate); T. J. Murphy (USA, Titular); K. J. R. Rosman (Australia, Associate); M. Shima (Japan, Titular); P. De Bièvre (Belgium, National Representative); N. N. Greenwood (UK, National Representative); H. S. Peiser (USA, National Representative).

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2. The Table of Standard Atomic Weights 1987

The 1987 Table of Standard Atomic Weights is presented in Table 1. The only change from the 1985 table is the reduction of the uncertainty in the atomic weight of gallium from 0.004 to 0.001.

The names and symbols for those elements with atomic numbers 104 to 107 referred to in the following tables are systematic and based on the atomic numbers of the elements as recommended by the IUPAC Commission of the Nomenclature of Inorganic Chemistry.[3] The names are composed of the following roots representing digits of the atomic number:

1 un,	2 bi,	3 tri,	4 quad,	5 pent,
6 hex,	7 sept,	8 oct,	9 enn,	10 nil.

The ending "ium" is then added to these three roots. The three-letter symbols are derived from the first letters of the corresponding roots.

The Commission again wishes to emphasize the need for new precise isotopic composition measurements in order to improve the accuracy of the atomic weight of a number of elements which are still not known to the desired level of accuracy.

TABLE 1. Standard atomic weights 1987 [scaled to $A_r(^{12}\mathrm{C}) = 12$]. The atomic weights of many elements are not invariant but depend on the origin and treatment of the material. The footnotes to this Table elaborate the types of variation to be expected for individual elements. The values of $A_r(\mathrm{E})$ and uncertainty $U_r(\mathrm{E})$ given here apply to elements as they exist naturally on earth.

Atomic number	Name	Symbol	Atomic weight	Atomic number	Name	Symbol	Atomic weight
1	Hydrogen	H^{g,m,r}	1.00794(7)	55	Cesium	Cs	132.90543(5)
2	Helium	He^{g,r}	4.002602(2)	56	Barium	Ba	137.327(7)
3	Lithium	Li^{g,m,r}	6.941(2)	57	Lanthanum	La^{g}	138.9055(2)
4	Beryllium	Be	9.012182(3)	58	Cerium	Ce^{g}	140.115(4)
5	Boron	B^{g,m,r}	10.811(5)	59	Praseodymium	Pr	140.90765(3)
6	Carbon	C^{r}	12.011(1)	60	Neodymium	Nd^{g}	144.24(3)
7	Nitrogen	N^{g,r}	14.00674(7)	61	Promethium*	Pm^{A}	
8	Oxygen	O^{g,r}	15.9994(3)	62	Samarium	Sm^{g}	150.36(3)
9	Fluorine	F	18.9984032(9)	63	Europium	Eu^{g}	151.965(9)
10	Neon	Ne^{g,m}	20.1797(6)	64	Gadolinium	Gd^{g}	157.25(3)
11	Sodium (Natrium)	Na	22.989768(6)	65	Terbium	Tb	158.92534(3)
12	Magnesium	Mg	24.3050(6)	66	Dysprosium	Dy^{g}	162.50(3)
13	Aluminum	Al	26.981539(5)	67	Holmium	Ho	164.93032(3)
14	Silicon	Si^{r}	28.0855(3)	68	Erbium	Er^{g}	167.26(3)
15	Phosphorus	P	30.973762(4)	69	Thulium	Tm	168.93421(3)
16	Sulfur	S^{r}	32.066(6)	70	Ytterbium	Yb^{g}	173.04(3)
17	Chlorine	Cl	35.4527(9)	71	Lutetium	Lu^{g}	174.967(1)
18	Argon	Ar^{g,r}	39.948(1)	72	Hafnium	Hf	178.49(2)
19	Potassium (Kalium)	K	39.0983(1)	73	Tantalum	Ta	180.9479(1)
20	Calcium	Ca^{g}	40.078(4)	74	Tungsten (Wolfram)	W	183.85(3)
21	Scandium	Sc	44.955910(9)	75	Rhenium	Re	186.207(1)
22	Titanium	Ti	47.88(3)	76	Osmium	Os^{g}	190.2(1)
23	Vanadium	V	50.9415(1)	77	Iridium	Ir	192.22(3)
24	Chromium	Cr	51.9961(6)	78	Platinum	Pt	195.08(3)
25	Manganese	Mn	54.93805(1)	79	Gold	Au	196.96654(3)
26	Iron	Fe	55.847(3)	80	Mercury	Hg	200.59(3)
27	Cobalt	Co	58.93320(1)	81	Thallium	Tl	204.3833(2)
28	Nickel	Ni	58.69(1)	82	Lead	Pb^{g,r}	207.2(1)
29	Copper	Cu^{r}	63.546(3)	83	Bismuth	Bi	208.98037(3)
30	Zinc	Zn	65.39(2)	84	Polonium*	Po^{A}	
31	Gallium	Ga	69.723(1)	85	Astatine*	At^{A}	
32	Germanium	Ge	72.61(2)	86	Radon*	Rn^{A}	
33	Arsenic	As	74.92159(2)	87	Francium*	Fr^{A}	
34	Selenium	Se	78.96(3)	88	Radium*	Ra^{A}	
35	Bromine	Br	79.904(1)	89	Actinium*	Ac^{A}	
36	Krypton	Kr^{g,m}	83.80(1)	90	Thorium*	Th^{g,Z}	232.0381(1)
37	Rubidium	Rb^{g}	85.4678(3)	91	Protactinium*	Pa	
38	Strontium	Sr^{g,r}	87.62(1)	92	Uranium*	U^{g,m,Z}	238.0289(1)
39	Yttrium	Y	88.90585(2)	93	Neptunium*	Np^{A}	
40	Zirconium	Zr^{g}	91.224(2)	94	Plutonium*	Pu^{A}	
41	Niobium	Nb	92.90638(2)	95	Americium*	Am^{A}	
42	Molybdenum	Mo	95.94(1)	96	Curium*	Cm^{A}	
43	Technetium*	Tc^{A}		97	Berkelium*	Bk^{A}	
44	Ruthenium	Ru^{g}	101.07(2)	98	Californium*	Cf^{A}	
45	Rhodium	Rh	102.90550(3)	99	Einsteinium*	Es^{A}	
46	Palladium	Pd^{g}	106.42(1)	100	Fermium*	Fm^{A}	
47	Silver	Ag^{g}	107.8682(2)	101	Mendelevium*	Md^{A}	
48	Cadmium	Cd^{g}	112.411(8)	102	Nobelium*	No^{A}	
49	Indium	In	114.82(1)	103	Lawrencium*	Lr^{A}	
50	Tin	Sn^{g}	118.710(7)	104	Unnilquadium	Unq^{A}	
51	Antimony (Stibium)	Sb	121.75(3)	105	Unnilpentium	Unp^{A}	
52	Tellurium	Te^{g}	127.60(3)	106	Unnilhexium	Unh^{A}	
53	Iodine	I	126.90447(3)	107	Unnilseptium	Uns^{A}	
54	Xenon	Xe^{g,m}	131.29(2)				

^{g} geological specimens are known in which the element has an isotopic composition outside the limits for normal material. The difference between the atomic weight of the element in such specimens and that given in the Table may exceed the implied uncertainty.

^{m} modified isotopic compositions may be found in commercially available material because it has been subjected to an undisclosed or inadvertent isotopic separation. Substantial deviations in atomic weight of the element from that given in the Table can occur.

^{r} range in isotopic composition of normal terrestrial material prevents a more precise $A_r(\mathrm{E})$ being given; the tabulated $A_r(\mathrm{E})$ value should be applicable to any normal material.

^{A} Radioactive element that lacks a characteristic terrestrial isotopic composition.

^{Z} An element, without stable nuclide(s), exhibiting a range of characteristic terrestrial compositions of long-lived radionuclide(s) such that a meaningful atomic weight can be given.

* Element has no stable nuclides.

3. Acknowledgments

This table is reprinted from the full report of the Commission,[4] which contains additional data on relative atomic masses of selected radionuclides, variations in the atomic weights of nonterrestrial sources, and comments on the atomic weights of boron, oxygen, and gallium. A table of atomic weights in alphabetical order is also included.

4. References

[1]A. H. Wapstra and G. Audi, Nucl. Phys. A **432**, 1 (1985).
[2]International Union of Pure and Applied Chemistry Commission, Atomic Weights of the Elements, Pure Appl. Chem. **58**, 1677 (1986).
[3]J. Chatt, Pure Appl. Chem. **51**, 381 (1979).
[4]International Union of Pure and Applied Chemistry Commission, Atomic Weights of the Elements, Pure Appl. Chem. **60**, 841 (1988).