HELBING . BURKART

chemical

MATTER NUMBER PROCESS

TABLES

for Laboratory and Industry

CHEMICAL TABLES

for Laboratory and Industry

MATTER . NUMBER . PROCESS

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FOREWORD

Through a special way of describing and summarizing we have combined the information of the tabular work with that of a textbook. Colours have been used at certain places as methodical and didactical means. The use of technical words and comments has been made for a better understanding of the tabular and graphic matter. Therefore, this book also serves the purpose of a review course

In the beginning of the first part 'Matter' (135 pages) an introduction of the chemical elements and their properties have been put together followed by an illustrative wave-mechanical model of the atom and a description of the chemical compounds. The synopses and tables of the inorganic compounds (matter) have been compiled in special ways based on the periodic classification of elements and according to their common properties. In the case of the organic compounds the syntheses provided the structural framework of the molecules and the kind of functional groups present as the principle of classification. Through the use of screens the tabular matter has been made easy to understand and the grouping of the various classes of matter made clear. The re-location of information through the group numbers on the respective pages has also been simplified. The inorganic chemistry part of the tables consists of information about 1300 types of matter and their properties. The organic portion has just as many compounds. The choice of the compounds included in the tabular part has been based on the matter included in the textbooks on inorganic and organic chemistry.

The second part 'Number' (45 pages) does not only contain the important values of chemical and physiochemical quantities and constants, but also the rules of calculation and principles which are of importance for the chemical reactions and methods. Of special significance is the gas reduction table. This part is supplemented by the log tables included as appendix (36 pages) which contain apart from the 5-digit logarithm tables about 10,000 so-called decadic supplements, i.e., the logarithms of the reciprocal values of the numbers. In calculations the logarithm numbers need only to be added up. Finally, the lists also contain a large number of useful numerical figures: reciprocal values, square numbers, square roots, circumferences and areas of the circle.

The third part 'Process' (66 pages) contains principal methods for research laboratories and industry, and the numerical values used there. Graphic description of the essential apparatus and other vivid symbols are of great help for understanding the text matter that has been presented in a concise form here. Apart from the general methods qualitative as well as quantitative inorganic and organic analytical methods have also been described. In connection with the analytical tables of numerical value short notes have been inserted at places which considerably enhance the purely mathematical value of the tables. A well-compiled list of technical words with about 5,000 such key-words simplify the location of the required information about the concepts, definitions, rules, laws or methods as well as of the matter and its characteristics.

We would also like to thank all those who in the publishing house extended to us all the facility in bringing out this book. The composing and printing of the chemical formulae put the publishers to a number of difficulties.

Karlsruhe, Spring 1969

Wolfgang Helbing Adolf Burkart

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CHEMICAL TABLES

for Laboratory and Industry

MATTER . NUMBER . PROCESS

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and

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WILEY EASTERN LIMITED

New Delhi Bangalore Bombay Calcutta

FOREWORD

Through a special way of describing and summarizing we have combined the information of the tabular work with that of a textbook. Colours have been used at certain places as methodical and didactical means. The use of technical words and comments has been made for a better understanding of the tabular and graphic matter. Therefore, this book also serves the purpose of a review course.

In the beginning of the first part 'Matter' (135 pages) an introduction of the chemical elements and their properties have been put together followed by an illustrative wave-mechanical model of the atom and a description of the chemical compounds. The synopses and tables of the inorganic compounds (matter) have been compiled in special ways based on the periodic classification of elements and according to their common properties. In the case of the organic compounds the syntheses provided the structural framework of the molecules and the kind of functional groups present as the principle of classification. Through the use of screens the tabular matter has been made easy to understand and the grouping of the various classes of matter made clear. The re-location of information through the group numbers on the respective pages has also been simplified. The inorganic chemistry part of the tables consists of information about 1300 types of matter and their properties. The organic portion has just as many compounds. The choice of the compounds included in the tabular part has been based on the matter included in the textbooks on inorganic and organic chemistry.

The second part. Number: (45 pages) does not only contain the important values of chemical and physiochemical quantities and constants, but also the rules of calculation and principles which are of importance for the chemical reactions and methods. Of special significance is the gas reduction table. This part is supplemented by the log tables included as appendix (36 pages) which contain apart from the 5-digit logarithm tables about 10,000 so-called decadic supplements, i.e., the logarithms of the reciprocal values of the numbers. In calculations the logarithm numbers need only to be added up. Finally, the lists also contain a large number of useful numerical figures: reciprocal values, square numbers, square roots, circumferences and areas of the circle.

The third part 'Process' (66 pages) contains principal methods for research laboratories and industry, and the numerical values used there. Graphic description of the essential apparatus and other vivid symbols are of great help for understanding the text matter that has been presented in a concise form here. Apart from the general methods qualitative as well as 'quantitative' inorganic and organic analytical methods have also been described. In connection with the analytical tables of numerical value short notes have been inserted at places which considerably enhance the purely mathematical value of the tables. A well-compiled list of technical words with about 5.000 such key-words simplify the location of the required information about the concepts, definitions. rules, laws or methods as well as of the matter and its characteristics.

We would also like to thank all those who in the publishing house extended to us all the facility in bringing out this book. The composing and printing of the chemical formulae put the publishers to a number of difficulties.

Karlsruhe, Spring 1969

Wolfgang Helbing Adolf Burkart

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MATTER

Basic Materials or Elements.

Structure of basic materials

Basic materials or elements are substances which cannot be split into more other substances through chemical methods.

All fundamental matters are built up of atoms.

Atoms have spherical shape and consist of a nucleus and a sheath.

Diameter of the sheath nearly 2 to 5.10-8 cm

Diameter of the nucleus nearly 1 to 3.10-12 cm"

Mass of the atom nearly 2 to 500.10-24 g

Atomic particles

Name and	symbol	Mass in g	in me	in ME	Electrical charge in electrostatic units	
Proton	р	1,6725.10 -24	1836	1,0076	+ 4,80.10 -10	1.14.1
Neutron	n	1,6748.10 -24	1838	1,0090	nil	
Electron	е-	9,1089.10-28	1	5,5,10-4	- 4,80.10 - 10	

The atomic nucleus consists of neutrons and protons.

In conformity to law, the electrons are distributed in the atomic shell,

The number of electrons in the shell is equal to the number of protons in the nucleus and equals the atomic number of elements in the periodic system of elements.

The chemical properties of the elements depend on the structure of the shell.

A fundamental matter or an element is a substance in which all their shells have the structure and out of which atom is built.

Till now, we know 103 such elements.

The number of neutrons in the nucleus amounts to nearly 1.2 to 2.5 times the proton number and thus does not comprehend regularity.

Till now we know about 1,350 different atomic nuclei of which 324 occur in nature. The others are produced artificially and most undergo radioactive decay in short time.

Atoms whose nuclei have the same proton number but different neutron number, possess similarly built shells and have same atomic number, that is, they stand at the same place in the periodic system and are therefore called Isotopes (Greek, isos = equal, topos = place).

Isotopes have same chemical properties and distinguish themselves only in the mass, which by admission of a neutron. increases to about 1 ME.

A fundamental matter which possesses similarly built nucleus and shells, of which atom is built, is called pure

In nature 20 pure elements occur (see also pp. 14 and 15).

The percentage constituent of the isotope at the structure of a natural mixed element is (practically) constant (exception Pb. see pp. 16-19). Therefore, for the mixed element a constant atomic weight as weighed average value of isotopic weight results.

Trivial variations on account of local different mixtures of isotopes result in discrepancies in atomic weights of the following mixed elements.

Si

1,00797 ± 0,000 01 H -

0 15,999 4 ± 0,000 1*

10.811 ± 0.003

28,086 ± 0,001

12,01115 ± 0,000 05

S $32,064 \pm 0,003$

*Since 1961, the fundamental unit 'atomic weight' or better the 'atom mass' 1 ME = 1/12 of mass of Carbon isotope 12 C has been chosen.

In case of accuracy of measurement the usual practical determination methods for molecular weights (molecular mass) have no significance in these discrepancies.

Wave mechanical model of atom

One dimensional oscillator, e.g., vibrating chord.

Basic oscillator (fundamental tone)

- 1. Over oscillation (overtone) at K originates a nodal point.
- 2. Over oscillation (overtone) at K originates a nodal points.

The whole can superimpose at which the oscillating chord is always the minima.

Two dimensional oscillator, e.g., drumhead basic oscillation (primary tone)

- Over oscillation are three possible independent oscillations from one another. It results thereby a nodal line in the form of concentric circles or of diametrical nature.
- ii. Over oscillations are five possible independent oscillations. The nodal lines are, thereby, in part, superimposed.

The fundamental and over oscillations can superimpose.

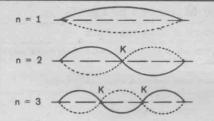
Through the nodal lines, the area in the region is so divided that either oscillations take place or they do not.

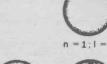
Three dimensional Oscillator

(Wave mechanic model)

By these oscillations originate nodal planes in the form of concentric spheres and sectional plane (circular area) through the oscillating sphere.

Thus the sphere in spatial region is distributed which are designated as ORBITALS.











0





0

3:1

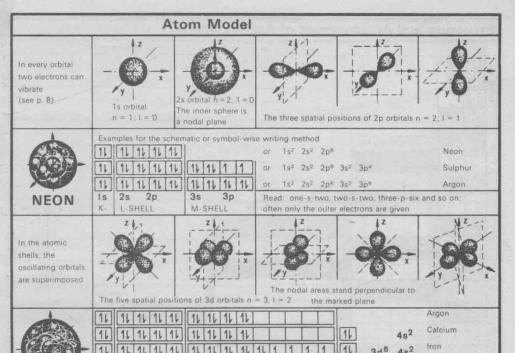


Such figures result when a vibrating drumhead is covered with powder.

Number and Type of Nodal Planes in the Atomic Shells

Shell	n	I = No. of flat planes	n - I - 1 = No. of sphere shaped planes	Designation of electron orbitals
к	1	0	0	1s
L	2	0	1 0	2s 2p
M	3	0 1 2	2 1 0	3s 3p 3d
N	4	0 1 2 3	3 2 1 0	4s 4p 4d 4f

The limitation of shells comes as there are no further "walls" (planes) (see p. 7).



Structure of Elements and the Chemical Formula

11

38

M-SHELL

11

25

L-SHELL

For writing various atoms, symbols are used, which are provided with indices.

Abbreviation of names of the elements are employed as 'symbols'. The abbreviation has not more than two letters and is employed internationally. A portion of the abbreviation has been derived not only from German names but also from Latin or Greek. (See pp. 11–12)

3d

48

N-SHELL

he Symbol s	stands for	Examples	Fe
1.	The substance as such	1.	Ferrum (Iron)
2.	An atom of the substance	2.	Iron atom
3,	One gram atom of the substance	3.	65.85 g

Mixed Elements

Krypton

In case of naturally occurring mixed elements the symbol is mostly given.

Pure Elements

In case of pure elements, through rounding off the isotope weight, it is made integral to the mass number and often the atomic number is attached as index to the symbol.

Mass Number Atomic Number	Symbol	Example	235 -92	or U 235	

Atomic lons

To write different atomic ions the element symbols are used and the charge is written on the top right hand side as index.

To indicate single charge of atomic ion often the sign + or - is used. However, multiple charge of atomic ion is indicated by number written before the sign + or -

In case of ions in aqueous solution (solvated ions) often the signs and are employed instead of + and - respectively. Examples are: H *, O2 * or O"; Fe3 * or Fe

Krypton

Further examples

(see pp. 26-29)

Structure and Arrangement of Atomic Shells Period No. Shell - Design Shell No. n orbitals p - orbitals (3) M 3 Ma Mg S CI Ar 16 17 18 d - orbitals (5) V Cr Mn Fa Co Ni Cu Zn 23 24 25 26 27 28 29 30 14 0 5 In Sn Sb Te I Xe 49 50 51 52 53 54 f - orbitals (7) Hf Ta W Re Os Ir Pt Au Hg 72 73 74 75 76 77 78 79 80 5 Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lw 90 91 92 93 94 95 96 97 98 99 100 101 102 103 AII 3a 4a 5a 6a 7a 0 3b 4b 5b 6b 7b Lanthanides and Actinides

Orbital sub-groups of equal (or nearly equal) energy are arranged in equal height.

The energy increases stepwise—in these representations from above to below. First of all, the orbitals of equal energy grades, i.e., first singlet, then doublet, are filled. Subsequently, the structure passes on to the next grade.

Fundamental Rules for the Structure and the Arrangement of Atomic Covers

The total number of electrons in an Atomic Cover is equal to the atomic number.	Z = A.N.
The atomic sheath is classified as shells. Instead of "Numbers" symbols are also used frequently.	n = 1, 2, 3, K. L. M,
The total number (maximum) of possible orbitals in a shell is:	z _{max} = 2n ²
The total number of possible orbitals in a shell is:	$z_n = n^2$
The orbitals in orbital sub-groups are compounded. Instead of "numbers" symbols are also used.	l = 0, 1, 2, s, p, d,
The "numbers" of orbital sub-groups are equal to:	l = n - 1
The number of orbital sub-group is equal to:	z = 21 + 1
Each orbital can take up two electrons, the spins of which must be (opposite) coupled.	Pauli - principle

Values of the first 4 Shells in an atomic cover

De	signation of	Nur	nber of	Maximum number of	Number of Orbitals							
Shell	Sub-groups	Shells	Sub-groups	Electrons	in the Shell	in the Orbital Sub-groups						
K	S	1	1	0	1 =	1						
L	s, p	2	0, 1	/8	4 =	1+3						
M	s, p, d	3	0, 1, 2	18	9 =	1+3+5						
N	s, p, d, f	4	0, 1, 2, 3	32	16 =	1+3+5+7						

The fifth Shell (O) contains these shell groups like the fourth Shell.

The sixth Shell (P) contains only s- and p-orbitals as well as a d-Orbital.

The seventh Shell (Q) contains only an s-Orbital

Arrangement of Elements Principle of Arrangement in the Periodic System of Elements Successive increase in nuclear charge number or electron IA.N. 1 ... 103 number gives the atomic number Arrangement according to the possible shells in the atomic cover gives the horizontal periods from VII 3. Arrangement according to the number of valency electrons in 0 ... 8 the outer most shell gives the vertical group from. The Splitting of groups into main and sub-groups as well as the insertion of 1a, 1b, Lanthanides and Actinides is a result of alternately installing the electrons in the Lanthanides Actinides orbital sub-groups of the shell (see pp. 26-31) Periodic system of Elements

	.,.	41.0	-7	0,10	-		20.00			_		_					-	-		-	_	_	_	_	_	_	_	_	_	_	_
1	1 H	2 He																													2 Ne
11,,)	3 Li	4 Be		ı	Ī												10					E				5	6 C	7	8	9 F	10 Ne
m	11 Na	12 Mg						10	į.																	13 Al	14 Si	15 P	18	17 CI	18 Ar
IV	19 K	20 Ca	21 Sc						H								22 Ti	23 V		25 M n		27 Co	28 Ni	29 Cu	30 Zn	31 6a	32 6e	Desired.	34 Se		36 Kr
٧	37 Rb		39 Y														40 Zr		42 Mo	43 Tc		45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te		54 Xe
VI		56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm		64 6d			67 Ho		69 Tm	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 0s	77 Ir	78 Pt	79 Au	80 Hg	81 TI	82 Pb	83 Bi	84 Po	85 At	86 Br
AII	87 Fr		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am		97 Bk	98 Cf	99 Es	100 Fm	101 Md	103 Lw															
	1a	2 a	3 b			La	nth	an	de	s a	nd	Ac	tini	ide:	S		4b	5b	6b	7 b		8		16	2 b	3a	4a	5a	6a	7a	8
		s -	d-												d-	- 0	rbi	tals	3				p-	Or	bit	als					

Except rare gases, all atoms are qualified to either take electrons in their shell or give them out of their shell. These electrons are called **valence electrons**.

Out of a shell 1 to 8 valence electrons can be given up. Thus ionic atoms which carry 1 to 8 positive charges are formed.

Those possessing an ionic valency of +1 to +8 are called cations. (see p. 23)

In an atomic cover 1 to 4 valence electrons can be taken up. Thus ionic atoms which carry 1 to 4 negative charges are formed.

Those possessing an ionic valency of -1 to -4 are called anions. (see p. 23)

(An inert gas structure mostly results by giving up or receiving of electrons.)

Atoms, in particular of non-metallic elements, can build with the other elements to form a common structure. Besides electrons in pair always go together.

The number of possible electron pairs is equal to their cohesiveness.

In the I period upto 1 electron pair equals to 1 cohesiveness.

In the II period upto 4 electron pairs equal to 4 cohesiveness.

From the III period upto 8 electron pairs equal to 8 cahesiveness.

(Formation of a common cover also results in inert gas structure.) (see pp. 22, 26-30)

Metals are substances which can form only positive ionic atoms

Non-metals are substances which preferably form negative ionic atoms.

A stable and permanent atomic structure can result

- with 2, 8, 18 or 32 electrons in the outermost shell.
 That in the above state rare gas is existing: it is designated as inert gas configuration (configuration = arrangement).
- those which do not have completely filled shells with 18 outer most electrons. Examples of this state are atoms of Ni, Pd and Pt.
- 3. those outside the completely filled 8- or 18-shell possessing a completely filled s-orbital (4s², 5s²).

Examples of this state are Sn +2 and other ions. (see pp. 26–29)

Group	Sym-	Name	A.N	Atomic	og AM	DE loc	MP	BP	D/DD	Ω-1. cm-1	cal/g
Group	bol	Teamo	7,51.5	mass	9			132			, 9
0	He	Helium	2	4,0026	60239	39761	-270.7	-268,94	0,17848	-	
	Ne	Neon	10	20,183	30499	69501	-248,60	-245,98	0,9004		
60	Ar	Argon	18	39,948	60108	39892	-189,3	-186,0	1,7839		
gas	Kr	Krypton	36	83,80	92324	07676	-157,2	-152,9	3,74		
Inert	Xe	Xenon	54	131,30	11826	88174	-111.9	-108,1	5,851		
=	Rn	Radon	86	222	34635	65365	-71	-61,9	9.730	- 4	
	Н	Hydrogen**	1	1,00797*	00346	99654	-259,14	-252,78	0,08987	-	
1a	Li	Lithium .	3	6,939	84136	15864	186	1330	0,534	1,2 - 105	0.79
	Na	Sodium	11	22,9898	36156	63844	97,7	883	0,971	2,3 - 105	0,295
6	K	Potassium	19	39,102	59218	40782	62,3	760	0,851	1.6 105	0,192
ali	Rb	Rubidium	37	8,547	93186	06814	39,0	700	1,532	8.6 - 104	0.080
Alkali- metals	Cs	Casium	55	132,905	12355	87645	28,5	670	1,90	4,5 · 104	0,052
	Fr	Frankium	87	(223)	34830	65170			cc = 1.88		-
2a	Be	Beryllium	4	9,0122	95521	04479	1280	2967	$\beta = 1.91$	1,5 · 105	0,425
50	Mg	Magnesium	12	14,312	38596	61404	650	1107	1,74	2,2 · 105	0,246
ili-	Ca	Calcium	20	40,08	60293	39707	850	1240	1,55	2,2 - 105	0,145
Alkali- earthmetal	Sr	Strontium	38	87,62	94265	05735	757	1150	2,60	2,3 · 10 ⁵	0,068
A	Ba	Barium	56	137,34	13786	86214	850	1140	3,61	3,3 - 104	0,066
	Ra	Radium	88	226,05	35421	64579	700	1140	~ 6		
За	В	Boron	5	10,811*	03423	96577	2300	~ 2550	Cryst:2.33 amorph. 1,73 2,70	1 · 10-12	8,307
	AI	Aluminium	13	26,9815	43104	58896	660,1			3,8 · 105	0,214
th-	Ga	Gallium	31	69,72		15664	29,78	1983	5,92	1,9 · 10 4	0.079
Earth	In	Indium	49	114,82	06002		156,17	The same of	0 7,31	1,2 · 105	0,057
	TI	Thallium	81	204,37		68954	302	1457	11,84	5,7 · 104	0,0326
4a	C	Carbon	6	12,01115	- F40.000.0		> 3550	4200	Graphite Diamond 3.51	3 - 10-14	0,147
c .	Si	Silicon	14	28,086*	44855	55145	1420	2355	2,33	8,3 - 10-8	0,181
Carbon	Ge	Germanium	32	72,59	86094		958,5	2700	5,35 cc = 5,75	1,1 - 10-5	0,074 cz 0,515
Gar	Sn	Stannum	50	118,69		92555	231,9	2270	$\beta = 7.28$	8,7 · 104	\$ 0.054
	Pb	Plumbum	82	207,19	31641	68359	327,4	1620	11,344	4,5 - 104	0,0306
5a	N	Nitrogen	7	14,0067	14638	85362	-210 white:44.1 red:59b	-195,8	1,2505 1,84 violet: 2,3 220 black: 2,7	6	
90	P	Phosphorus	15	30,9738	49101	50899	red:59b violet:593 817 b.36at.	280 _{red}	220 black: 2.7	05 · 10 · 6	0,190
Nitrogen group	As	Arsenic	33	74,9216					2,0 - 5,73	2,9 · 104	0,08
ditr	Sb	Stibum	51	121,75	08550	91450	630,5	1380	6,684	2,4 · 104	0,05
	Bi	Bismuth	83	208,980	32015		271,3	~ 1560	9,845	8.4 · 103	0,294
6a	0	Oxygen	8	15,9994	20412	79588	-218.7 \(\alpha = \frac{112 \text{ is}}{3} = \frac{119}{119}	-182,97	1,42897	5.3 - 10-18	0.176
Ë	S	Sulphur	16	32,064*		49396	3 = 119 7 = 120	= 444.6 = 444.6 = 444.6	= 2.07 = 1.90 = 1.92 α = 4.47	1,3 - 10-13	0.176
Oreforming	Se	Selenium	34	78,96		10259	7 = 129,220	688	α 1.92 γβ = 1.47 γβ = 1.40 γ 6,24	1,3 · 10-7	
efe	Te	Tellurium	52	127,60		89412	452	1390		5 · 103	0,0483
	Po	Polonium	84	(210)	32222	1 100 4 10 4 10 4 10 4 1			9,32	-	
_ 7a	F	Fluorine	9	18,9984	27875	72125	-218/-22		1,695 1,557h -34		
min	CI	Chlorine	17	35,453	54970	45030	-101	-34,1	1.557b -34 3,214	fl. 1 · 10 · 16	-
or	Br	Bromine	35	79,909	90263	09737	- 7,3	58,8	fl 3,14	11.3 - 10-15	0,107
Saltforming or Halogens	1	lodine	53	126,9044	10349	89651	113,7	184,35	11,72 Ré	1,3 - 10-11	0,0523
	At	Astatine	85	(211)	32428	67572	4000	8000			-
1b	Cu	Cupprum	29	63,54		19695	1083	2336	8,929	5,8 105	0.0921
	Ag	Argentine	47	107.870		96706	960,5	1950	10.50	6,1 105	0.0558
0.	Au	Aurum	79	196,967		70553	1063	2600	19,3	4,1 · 105	0,0312
2b	Zn	Zinc	30	65,37		18456	419,4	907	7.14	1,7 · 105	0.0925
	Cd	Cadmium	48	112.40		94920	320,9	765	8,642	1,3 · 105	0.0552
0.1	Hg	Hydrargyrum		200,59		69765	- 38,87	356,58	Charles and the second	1,1 104	0,03325
3b	Sc	Scandium	21	44,956		34717	1400	2400	3,02		
	Υ	Yttrium	39	88,905		05100	1490	2500	4,47		
	La	Lanthan	57	138,91		85724	920	4500/4230	6,15		8,8448
	Ac	Actinium	89	(227)	100000000000000000000000000000000000000	64397	(1600)				
46	Ti	Titanium	22	47,90		31966	1800	> 3000	4,50	3.3 · 10 ⁵	0.1125
	Zr	Zirconium	40	91,22		03991	1857	> 2900	6,52	2,5 104	0.068
	Hf	Hafnium	72	178.58		74817	2230	> 3200	13.3	3.0 - 104	0.033
5b	V	Ranadium	23	50,942		29286	1710	3000	6.07	5,0 - 104	0.1153
	Nb	Niobium	41	92,906	96806	03194	2415	3700	8.56	7.7 : 104	0.065
	Ta	Tantalum	73	180,948	25756	74244	~ 3000	~ 4100	16.6	7.2 - 104	0.033

	Behaviour towards				Further properties			es'	* Nomenclature	Sym
H ₂ O	HCI	H ₂ SU ₄	HNO3	OH		-	b			bal
0.009			- 8 7	ni e	t _k -267.9p _k 2.26atD _k 0.0693g/cm ³	4	2	-	gr. Helias = sun	H
0.012				-	2287 259 0484	7	3	-	gr. Neas = new	N
0.056	,	- F	-	-	122 48 0.531	8	3	-	gr. Argos = inert	A
0.06		-	-	-	63 54 0.78	25	6	-	gr. Kryptos = hidden	Ki
0.119			-		16.6 58.2 1.155	29	9	-	gr. Xenon = strange	X
0.224	0				104 62	16	-	3	from sodium	R
0.018	-		-	-	239.9 ,, 12.8 0.0310	3	2	4	gr. Hydrogenium = water forming	H
d	#	+	+	0	wH ₂ O → LiOH; w.alk. → alcoholate	5	2	-	gr. lithos = brick	Li
d	+	+	+	0	wH ₂ O → NaOH; walk. → alcoholate	8	1	-	Natron (saltpeter)	N
d	+	+	+	0	wH ₂ O → KOH, w.alk → alcoholate	10	2	1	Arabic alkali = soda	K
d	+	+	+	o	with H ₂ O → RbOH:	20	1	1	L. Rubidus = red	R
d	4	+	+	. 0	with H₂O → CsoH;	22	1	_	L Caesium = skyblue	C
0	- 0	0	0	0	properties like above				from France	Fi
	+	+	+	+	corrosion resistant (oxide film)	-	1	-	from Beryl (crystal)	В
	- 1	1	+		corrosion resistant (oxidefilm)		3		Magnesia city	N
d	- 4			0	w H ₂ O → Ca(OH) ₂	12			L calx = chalk	C
	7	7								
d	*			0	$WH_2O \rightarrow Sr(OH)_2$	18			Stranton city	S
d	+	-		0	$WH_2O \rightarrow Ba(OH)_2$	22			gr. Brayo = hard	В
d	+	+	+	0	w H ₂ O → Ra(OH) ₂ , Radioact crystal hardness ~ 10, semiconductor	13	_	_	L Radjús ray	B
		1	-	+					from Alvim Jona's	A
	16	- 10	-	*	corrosion resistant (oxide film)		1		from Alum (salt)	e
-	- +	+	+	- *	Thermometer packing		2		L. Gallien = France	
	+	+	+	0	soft like wax			1		- 0
-	(+)	+	+	0	similarity with lead		-	4		T
-22		-	-	-	Hardness of diamond = 10 Brittle n = 2-4173	3 7	2	-	L. carbo = coal	C
-		1		+	l in HF/HNO ₃ : see crystel hardness	7	3	**	L. silex = silica, sand	S
-		h+		-	"semiconductor": I in HCI/HNO ₃	16	5	-	L Germania = Germany	G
	+	+	k ox	h+	grey decom a 13.2" \$ 161" y brittle d	29	10	34	L. Stannum = tin	S
-	-	h+k	+0	-	very soft and malleable	27	3	5	L. Plumbum = lead	P
0.015		-		-	t _k =118.8° p _k 49.7 at D _k 0.430g/cm ³	6	2	9	gr Nitrogen = NaNO ₃ forming	N
					white P at 250-300° to red P					
				*	Ignition temperature ~ 50"		1		gr, Phosphorus = light carrier	P
-01		h+k			brittle crystal brittle crystal; I HCI/HNO ₃	14			L Stibium	A S
	-	h+	+		brittle crystal; I HCI/HNO				white mass	B
0.031	727	-	-	-	tx-118.8° px 47.7atm, Dx 0.430g/cm3		3		gr. Oxygenium = acid forming	0
-	-	-	-		a or rhomb 95.6 \$ monoclivellow, s. CS2	8	4	_	L. Sulphur	S
	-	+	+	14.	"Semi conductor", photoelectric				gr. Selene = moon goddess	S
-	100	+	+	+	little hardness, brittle				h. tellus = earth	- Te
0	0	0	0	0	"strong and noble like silver"				from Poland	P
_						_	-			È
3.1(d)	o I		-	4	weakly yellowish gas th144",pn76.1 atm Dh0.573g/cm3	D.	1		L Fluo = bleed	
2.1(4)					yellowish green gas	11	2	-	gr. Chloros = green	C
3.58×1		-	-	+	Brown liquid corrosive vapours	19			gr. Bromos = stench	В
0.02×1	-		-	+	s. in Kl, Hl and alcohol	23				- 1
0	0	0	0	0	marked metallic property		-	_	gr. Astos = unstable	Д
-	(+)	h+	+		pale red malleable and ductile	12	2	-	L Cuprium = copper 0	C
-	-	h+	+	-	s. KCN soln, "Noble metal"	24	2	=	L. Argentum = silver	A
-	- 7	(h+)		-	s. KCN soln "Noble metal"	19	1	à	L. Aurum = gold	Α
- 72	+	+	+	+	corrosion resistant (hydroxide film)	15	5	-		Z
	+	h+	+	+	corrosion resistant	27	8	3	gr. Kadmia = earth	C
	-22	-	k+	-	silvery gloss liquid; 🙎 vapours especially	23	7	-	gr. Hydrargyrum = active silver	H
d	+	+		+) hard and not easily accessible	13	1	-17	from Scandinavia	. \$
a	+	+		14	"rare earths" very closely	19	1	-	Yttorby, city in Sweden	Y
d	*	+	4-2	+	related metals		1		gr. Lanthanos = secret	L
0	0	0	0	0	radioactive, β-radiations	10		2	gr. Actis = rays	A
-3-	v±	v+	V+		very corrosion resistant. "light metal"		5		Titanen	T
-	((+))	((+))	((+))		s. in HF and HCI/HNO ₃ corrosion resistant	15	-		Arabic Zargon = golden	Z
	10,733	((-))	(1,1)							H
-		+	+		analogus to Zr. corrosion resistant very corrosion resistant, s. HF and HCI/HNO ₃	_	1	_	Hafnia = Copenhagen Vanadis = Venus goddess	V
-	-	((h+))		-	γ corrosion resistant solids		1		Niobe gr. goddess	N
				2.4.6	Insol, in HF and HCI/HNO ₃	4.0	16.7	34		
		- 10	100	(+)	steel like properties	1.13	-10		Tantalos = Goddess father	T

^{*}g in 100g H₂O **Isotopes, a total number; b stable and natural; c unstable and natural

		TIES OF						and the second		-				
Group	Symbol	Name	AN	Atomic mass	log	DElog	MP	BP	D/DD	2	2-1 cm-1	cal/g		
6b	Cr	Chromium	24	52.01	71609	28391	1890	2480	6.92	3.92 7.7-104		0.11		
	Mo	Molebdenum	42	95.95	98204	01796	2620	(4800)	10.21		1.8-106	0.065		
	W	Tungsten	74	183.86	26449	.73551	3380	~6000	19.32		1.8-10	0.034		
7b	Mn	Maganese	25	54.94	73989	26011	1260	1900	7.21-7.4	12	2.0-105	0.121		
	To	Technitium	43	(99)	99564	00436					-	_		
	Re	Rhenium	75	186.22	27003	72997	3170		21.0		5.0-104	0.035		
8	Fe	Ferrous	26	55.85	74702	25298	1535	3000	7.86		1.0-104 0.1			
	Co	Cobalt	27	58.94	77041	22959	1495	2900	$\alpha = 8.89$ $\beta = 8.64$		1.0-105	0.100		
	Ni	Nickel	28	58.71	78671	23129	1454.8	2900	8.90		1.5-105	0.105		
	Ru	Ruthenium	44	101.1	00475	99525	2450	2700	12.43	3	1.3 105	0.061		
	Rh	Rhodium	45	102.91	01246	98754	1966	>2500	12.5		2.1.105	0.058		
	Pd	Palladium	46	106.7	02816	97184	1549.4	2200	11.97	7	9.1-104	0.053		
	Os	Osmium	76	190.2	27921	72079	2700	>5300	22.48		1.7-104	0.031		
	lr lr	Iridium	77	192.2	28375	71625	2454	4400	22.421		1.6-105	0.031		
	Pt	7.55-5-5-1-7	78		29014	70986			21.45					
		Platin		195.09 Atomic			1773.5	4300			1.0-104 0.032			
Group	Symbol	Name	An	mass	log	DElog	MP	BP	D		Nomenclature			
	Ce	Cerium	58	140.13	14653	85347	1077	3200	6.768		Plenetoid ceres			
	Pr	Praesedium	59	140,92	14897	85103	1208	3290	6.76	9	ar dydimos = twi			
	Nd	Neodynium	60	£44.27	15918	84082	1297	3450	7.007		gr neos = new gr dydimos = tw			
	Pm	Promethium	61	(145)	16137	83863	1570	3000			gr. God Promethe			
	Sm	Samarium	62	150.35	17711	82289	1325	1900	7.540		Samarski, Russian o			
	Eu	Europium	63	152.0	18184	81816	~1200	1700	5.166		from Europe			
	Gd	Gadolinium	64	157.26	19662	80338	~1520	3000	7.86	88	Gadolina a chemi			
	Tb	Terbium	65	158.93	20120	79880	1638	2800	8.253		Ytterby a city in Swe			
	Dy	Dysprosium	66	162.51	21088	78912	~1670	2600	8.556		Gadolin, Finish chen			
	Но	Holmium	67	164.94	21723	78268	~1770	2600	8.70	00	Holmia = Stockh			
	Er	Erbium	68	167.27	22342	77658	~1800	2900	9.058		Ytterby a city in Swe			
	- Tm	Thulium	69	168.94	22773	77227	~1900	2400	9.318		Thule = island			
	Yb	Ytterbium	70	173.04	23815	76185					'tterby = a city in Swe			
	Lu	Lutetium	71	174.09	24302	75698	~2000	1800	9.84		Lutetia = F			
Group	Symbol	Name	AN	Atomic	MP	BP	D	Half-life	period	De-	Nomeno			
	Th		90	mass 232.05	1845	4500	11.2	1.4-1010		cay				
	Pa	Thorium	90	232.05	1840	4500	11.2	3.4-104	years	α	German			
		Protactinium			1100		40.7		years		gr. protos = firs			
	U	Uranium	92	238.07	~1133		18.7	4.5-10 ⁹	years	α	Uranus = 7th pla			
	Np	Neptiunium	93	237	640		20.5	2.2-106	years	α	Neptune = 8th pl			
	Pu	Plutonium	94	242	640	-	19.7	2.4-104	years	α	Pluto = 9th plan			
	Am	Americium	95	243	827	610	11.7	8.3-103	years	α	from An	nerica		
	Cm	Curium	96	248	_	_	~7	4.0-105	years	α	Curie discover			
	Bk	Berkelium	97	249	-	_		7.0-103	years	α	Berkeley (city in U			
	Cf	Californium	98	251			_	7.0-102	years	α	- Service Const.			
	Es	Einsteinium	99	254	_	-	-	38.5	hours	β	from Einstein			
	Fm	Fermium	100	253	-	-		3	days	K	Fermi, math.			
	Md	Mendelevium	101	256	-			1.5	hours	K	Mandeleef			
	Nb	Nobelium	102	253	-	_	-	10	min.	α	Nobel (of Nob			
	Lw	Lawrentium	103	257		_	-	8	see.	α	discoverer's na			
		THE RESERVE	CLASS	SIFICATI	ON OFM	ETALS A	CCORDIN	G TO DENS	ITY					
-	ight me				-10 01 19			vv metals						
Mg.	Be	Al Ti	Ge	Iv	Cr	Zn		e Cu	Ag	Pb	Au	Os		
1.74	1.90	2.70 4.50	5.35	_	6.92	7.14		86 8.93	10.5	11.4	19.3	22.5		
7.7	7.00		1111210					r industrial			10.0	22.0		
	us meta	ls		Non-ferrous metals					Noble metals					
F-Me		C [10]	36											
Fe	Mn	Cr Ni	V	Cu Zn Sn Pb Cd and few others which together with copper and among themselves form alloy.					Au Ag Pt Jr Pd and other platinum metals with which Pt is alloyed.					
	w others	7.4	_			2.4.6	7.1					-		