ATOMIC VOLUME AS A PERIODIC FUNCTION.

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IN a communication to the *Chemical News* (April 7, 1898),[1] the author showed that between each halogen and the next succeeding alkali metal there is a point of atomic weight that may be assumed to indicate the commencement of a cycle. This point, on the hypothesis of atomic condensation from cooling protyle, marks the temperature, expressed in terms of atomic weight, at which the tide of evolution turned and the conditions began again to necessitate the appearance of the positive atoms inaugurating a new cycle. It was shown that if the size of the cycles be reckoned from the "critical" points, the measurements are regular, and that each cycle corresponds exactly to an increment of atomic weight equal to $15.044 \times x$, x being one of the integers[2] 1, 1; 3, 3; 6, 6, taken consecutively. The apparent irregularity in the cyclic dimensions thus disappears, but the sequence of the individual elements remains unchanged and the increments of atomic weight between each atom and its next neighbor still appear to be quite irregular. But in saying that the elements occur irregularly, we merely assert that they do not appear at equal intervals, and the absence of this empirical regularity does not imply the absence of law. The study of atomic volume, on the contrary, discloses some interesting relations between the elements and suggests a definite influence ruling their occurrence. The atomic volume of an element is the result of the action of one of the fundamental forces with which the atom is endowed; this force is the attraction of cohesion between atoms of like kind. Atomic volume is thus a very important property of the elements, and if any general relations exist between atomic volumes it is desirable that they should be shown. The accompanying chart of atomic volume has been prepared and abscissae have been drawn through the "critical" points, marking the cyclic boundaries. These "critical lines" are, for the sake of easy reference, marked with letters, the lines through atomic weight 7.01 being called *A*; the line through atomic weight 22.05, *B*; through 37.09, *C*; through 82.21, *D*;

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[1] See the preceding paper.

[2] The series 1, 3, 6, ..., is such that each term is made up of the sums of the natural numbers 1, 2, 3, 4, 5, 6, etc.

through 127.33, E; through 217.57, F; and the line through 307.83, G. Points corresponding to atomic volumes 30, 60, 90, 120, 150, etc., have been marked off on the line A, and lines parallel to the ordinate have been drawn through these points cutting the critical lines at right angles. The "critical intersections" of these horizontal lines with the critical lines are referred to as A_{30}, B_{30}, C_{30}, D_{30}, etc. It is possible to draw through various critical intersections a series of straight lines, each of which passes also through the points of atomic volume of two elements on the chart. The lines that can be so drawn are given below under the heading I. It will be seen that they are "analogous lines," that is, they pass through atom analogues in every instance. The coincidences of lines and points although not mathematically exact are very close approximations, even when the scale of the chart is so large as one-tenth inch per unit of atomic weight and atomic volume. This is a notable fact when one considers that the determinations of density have been made at different temperatures, and compared with water at different temperatures, and that even if the determinations had been made at a standard temperature this would still have lain at varying distances from their respective melting-points, and that a certain influence upon atomic volume must be credited to the forces of crystallization, to allotropy, etc. In addition to the lines through the "critical intersections" a large number of analogous lines can be drawn through *three* elements. These are given under the second heading (II). In a number of instances the lines cross in an element, thus locating it both as regards atomic weight and atomic volume; and by following out the system of analogous lines it is possible to tentatively assign atomic volume where this is not known, as has been done with scandium (atomic weight 44), yttrium (atomic weight 89.6), and fluorine, and furthermore to tentatively fix both the atomic weight and atomic volume of unknown elements, such as eka-tellurium (atomic weight *c*212), VII$^{\text{I}}$, VII$^{\text{II}}$, VII$^{\text{III}}$, etc. It has proved possible to construct a portion of an assumed eight cycle of dimensions 15.044 × 6, although elements of so high atomic weight have never been discovered, and to locate elements along the "rare earth slope" in cycle VI. It is not necessary, however, either to assert or deny the actual existence of elements having the positives thus assigned, although some of them, such as eka-tellurium, $\mathrm{VII}^{\mathrm{I}}$, $\mathrm{VII}^{\mathrm{II}}$, $\mathrm{VII}^{\mathrm{III}}$, all of lower atomic weight than thorium, probably occur somewhere in nature. It is enough to recognize a general relationship between the elements, as revealed in a geometrical form by the particular method herein described. Of the elements on the "rare earth slope" it may be said that if they should be found to occur as they are placed they would be in lineal analogy with the known elements, and that although it will probably ultimately be possible to classify them in the usual groups their properties will be found to be so greatly dominated by their position in the earth region of cycle VI that the structural resemblance between their compounds and the compounds of their analogues in the lower cycles will be obscure.

The atomic volumes of hydrogen, nitrogen, and oxygen have been published while this investigation was in progress, and these elements have been found to fall into the system of lines. The accompanying table shows the atomic weights and atomic volumes which have been used in setting out the chart.

The existence of a series of points positionally interrelated by lines such as those here described appears to be of mathematical interest independently of reference to any special chemical significance.

I.

THROUGH AN INTERSECTION AND TWO ELEMENTS.

	Intersection.	Group I.	Group II.	Group III.	Group IV.
	B_{30}	Na	Mg		
	C_{90}	K	Ca		
	D_{90}	Rb	Sr		
	E_{120}	Cs	Ba	La	
	F_{120}	$\mathrm{VII}^{\mathrm{I}}$(223.7)	$\mathrm{VII}^{\mathrm{II}}$(228.2)	$\mathrm{VII}^{\mathrm{III}}$(230.8.)	Th
	G_{120}	$\mathrm{VIII}^{\mathrm{I}}$( )	$\mathrm{VIII}^{\mathrm{II}}$( )	$\mathrm{VIII}^{\mathrm{III}}$( )	$\mathrm{VIII}^{\mathrm{IV}}$
	E_{60}	Li	Ca		
	G_{60}	Na	Ca		
	F_{30}	K	Ba		
Same line	A_{60}	Rb	$\mathrm{VII}^{\mathrm{II}}$		
	A_{60}	Rb	$\mathrm{VIII}^{\mathrm{II}}$		
	F_{180}	Cu	Sr		
	D_{30}	$\mathrm{VII}^{\mathrm{I}}$	Be		
	G_{150}	$\mathrm{VII}^{\mathrm{I}}$	(154.5^{II})		
	B_{60}	(151.7^{I})	(154.5^{II})		
Same line	C_{210}	Cs	(179.3^{II})		
	C_{210}	(169.4^{I})	(179.3^{II})		

Intersection.	Group I.	Group II.	Group III.	Group IV.
C_{150}	Cs	Hg		
G_{60}	H	$\mathrm{VII}^{\mathrm{II}}$		
A_{30}	(169.4^{I})	Hg		
E_{30}	Cr(291.1)	Sr		

In addition to those above:

	Intersection.	Group II.	Group III.	Group IV.
	B_{60}	Ca	Sc	
	D_{60}	Sr	Yt	Zr
Same line	E_{30}	Mg	Sc	
	E_{30}	Mg	Yt	
	D_{30}	Be	Sc	
	A_{30}	Ca	In	
	F_{90}	Zn	Ga	
	F_{150}	Cd	In	
Same line	G_{30}	(154.5^{II})	(159.4^{III})	
	G_{30}	(154.5^{II})	Al	
	A_{30}	(171.3^{II})	(173.7^{III})	
	D_{30}	Hg	(159.4^{III})	
	G_{150}	$\mathrm{VII}^{\mathrm{II}}$	Tl	

In addition to the above:

Intersection.	Group III.	Group IV.
A_{60}	Sc	Ti
C_{120}	La	Ce
C_{210}	(173.7^{III})	(175.6^{IV})
G_{60}	Al	Zr
G_{30}	B	(161.3^{IV})
B_{90}	(159.4^{III})	(175.6^{IV})
B_{30}	Yt	(161.3^{IV})
G_{30}	(173.7^{III})	Th
F_{30}	$\mathrm{VII}^{\mathrm{III}}$	$\mathrm{VIII}^{\mathrm{IV}}$
B_{30}	La	Pb
F_{90}	Ga	Ge
G_{60}	Tl	Pb

Intersection.	Group V.	Group VI.
A_{60}	V	Cr
C_{90}	Nb	Mo
B_{60}	pr Di	W
D_{120}	(166^{V})	(167^{VI})
C_{240}	$\mathrm{VII}^{\mathrm{V}}$	U
C_{90}	pr Di	ne Di
B_{30}	Sb	W
B_{30}	Nb	Mo
D_{30}	$\mathrm{VII}^{\mathrm{V}}$	(212^{VI})
G_{30}	(166^{V})	(212^{VI})

Intersection.	Group V.	Group VI.
F_{30}	V	pr Di
C_{60}	Ta	(167^{VI})
A_{120}	Ta	W

Intersection.	Group II.	Group VI.
E_{120}	Ca	S
E_{120}	Sr	Se
B_{60}	Sr	Te
B_{60}	Ba	(212^{VI})
B_{60}	(154.5^{II})	(167^{VI})
D_{150}	Ba	ne Di
B_{30}	Ca	Mo
B_{210}	Sr	Mo
G_{180}	VII^{II}	(212^{VI})
E_{30}	Sr	(212^{VI})
C_{60}	$(154.5)^{II}$	W
F_{150}	Ba	Te
G_{90}	VII^{II}	(167^{VI})
G_{30}	Mg	O
G_{30}	Cd	Cr
F_{30}	Zn	Cr

Intersection.	Group VII.	Group IV.
A_{30}	F ?	Ti
A_{30}	Cl	Sn
A_{30}	Br	Ce
A_{30}	(147.5^{VII})	Pb
A_{60}	(214.8^{VII})	Th
C_{30}	I	Th
G_{30}	(214.8^{VII})	Ti
B_{30}	Br	(161.3^{IV})

	Intersection.	Group IV.	Group VII.
	G_0	Sn	F ?
	G_0	Zr	Cl
	F_{30}	Sn	Mn (approx.)
	G_{60}	Sn	(99.9^{VII})
	A_{30}	Zr	(168.8^{VII})
Same line	G_{30}	Th	(168.8^{VII})
	G_{30}	Pb	(168.8^{VII})
	B_{60}	(161.3^{IV})	(186.7^{VII})

Intersection.	Group I.	Group I.
F_{120}	H	Rb
A_{30}	Na	Cu
A_{60}	Cs	VII^{I}
B_{90}	Rb	(151.7^{I})
C_{210}	Cs	(169.4^{I})
D_{90}	K	Li
G_{180}	Rb	Li
C_{90}	VII^{I}	$VIII^{I}$

Intersection.	Intersection.	Group I.
D_{180}	C_{60}	Na
G_{90}	E_{60}	K
A_{240}	B_{150}	K
C_{120}	D_{60}	Rb
C_{150}	D_{60}	Ag
G_{210}	E_{60}	Cu
C_{60}	G_{90}	Cs
A_{240}	E_{150}	VII^{I}
A_{180}	C_{150}	(169.4^{I})
B_{150}	D_{90}	(151.7^{I})
B_{60}	E_{30}	Au
G_0F_{60}	E_{120} (D_{150}) (C_{180})	Cr
A_{150}	E_{120}	VIII^{I}

II.

THROUGH THREE ELEMENTS.

Group I.	Group III.	Group I.
Li	Al	Cu
H	Ga	Ag
Cu	Tl	Ag
Ag	Al	Au
Li	Ga	Cr(291.1^{I})
(151.7^{I})	Tl	Cr
(151.7^{I})	La	(169.4^{I}) (approx.)
Li	In	(169.4^{I})

NOTE.—In this group of lines Li is the only element of Group I having alkali-metal properties, the other elements of Group I being, for the most part, members of the subfamily.

	Group I.	Group II.	Group II.
	H	Mg	Cd
	Li	(171.3^{II})	Hg
	Rb	Ca	Be
Same line approx.	Na	Ca	Ba
	Na	Ca	VII^{II}
	K	Sr	(154.5^{II})
	Rb	VII^{II}	VIII^{II}
	VIII^{I}	Ba	Mg
	Cu	(154.5^{II})	VIII^{II}
	Cr	Cd	Mg
	Au	(154.5^{II})	Sr
	(151.7^{I})	Zn	VIII^{II}
Same line	(169.4^{I})	Cd	Zn
	(169.4^{I})	Cd	Be
	(169.4^{I})	Zn	Be
	(169.4^{I})	Ca	Hg (approx.)

	Group I.	Group V.	Group II.
	H	P (amorph.)	(171.3^{II})
	Li	P	VIII^{II}
	Cu	V	Mg
	Li	Nb	Hg
	Li	Sb	(154.5^{II})
	Na	Sb	(171.3^{II})
Same line[1]	K	(166^{V})	(154.5^{II})
	K	pr Di	Sr
	K	pr Di	(154.5^{II})
	K	(166^{V})	Sr
Same line[1]	Au	(166^{V})	Sr
	Au	pr Di	Sr
	Au	Sb	Ca
	Ag	Nb	Ca
	Au	As	Mg
	Au	VII^{V}	VIII^{II}
	Cr	Nb	Mg
	Cr	Bi	Sr
	(151.7^{I})	P	Mg

	Group II.	Group III.	Group III.
	Mg	Sc	Yt
Same line	Sr	Sc	Al
	Sr	Al	B
	Sr	Sc	B
	Cd	Ga	Al
	Mg	La	VII^{III}
Nearly coincident	Be	(159.4^{III})	VIII^{III}
	(154.5^{II})	(159.4^{III})	VIII^{III}
	Cd	(159.4^{III})	VII^{III}
	Be	Ga	VII^{III}
	Sr	La	(173.7^{III})
Same line	Hg	(173.7^{III})	Al
	Hg	(173.7^{III})	Ga
	Hg	Ga	Al
	Cd	Ga	Al
	Cd	Al	(173.7^{III})
	(171.3^{II})	(173.7^{III})	Yt
	Hg	La	(159.4^{III})
	Ca	Yt	La
	VII^{II}	In	La
	Zn	In	VII^{III}
	Be	In	VIII^{III}

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[1] This line passes through K, Sr, I, pr Di (154.5^{II}), (166^{V}), Au, and forms several combinations besides these four; *e. g.*, K, Sr, (154.5^{II}); K, I, Au; Au 154.5, Sr; Au (166^{V}), pr Di, etc. Several similar lines exist.

	Group II.	Group III.	Group III.
	VIII^{II}	La	Al
	VIII^{II}	VII^{III}	(159.4^{III})
	(154.5^{II})	In	B
	(171.3^{II})	Ga	Al

	Group IV.	Group V.	Group III.
	Ti	Sb	(159.4^{III})
	[1]Si	As	(173.7^{III})
	[1]Si	Nb	(173.7^{III})
	C	Nb	VII^{III}
	Ge	Sb	VIII^{III}
	Ce	V	B
Same line	C	V	La
	C	As	La
	(161.3^{IV})	(166^{V})	Tl (approx.)
	Pb	Sb	Sc
	Pb	Nb	Al
	Th	pr Di	Yt
Same line	Th	As	Al
	(161.3^{IV})	As	Al
	(161.3^{IV})	Nb	Ga
	Th	(166^{V})	Ga
	Sn	Nb	B
Same line	VIII^{IV}	VII^{V}	(173.7^{III})
	VIII^{IV}	VII^{V}	Tl
	VIII^{IV}	Sb	(159.4^{III})
	VIII^{IV}	Bi	In

	Group II.	Group IV.	Group II.
Same line	Mg	Ge	Cd
	Mg	(175.6^{IV})	Cd
	VIII^{II}	Sn	Zn
	Ca	Zr	(171.3^{II})
	Hg	(161.3^{IV})	Ca
	Be	Zn	VIII^{IV}

Group II.	Group IV.	Group VI.
Be	Ge	Te
Be	(161.3^{IV})	(212^{VI})
Ca	Zr	(167^{VI})
Ca	Ce	ne Di
Sr	(175.6^{IV})	W
Cd	Ti	O
Zn	(175.6^{IV})	U
VIII^{II}	Th	W

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[1] The position of silicon necessary for this line is higher than shown on the chart. The specific gravity of silicon is variously stated.

Group I.	Group V.	Group V.
H	As	Ta
Li	As	Nb
K	pr Di	(166^{V})
Cu	(166^{V})	Bi
Cu	V	N
Au	Ta	P (red)
Au	(166^{V})	pr Di

Several approximate lines are not given; *e. g.*, Cr, Ta, and V. The coincidences are less perfect with the elements of Group V than with all other elements.

	Group II.	Group II.	Group III.
	Be	(154.5^{II})	$\mathrm{VIII}^{\mathrm{III}}$
	Ca	(154.5^{II})	Tl
Same line	Be	(154.5^{II})	In
	Be	(154.5^{II})	$\mathrm{VIII}^{\mathrm{III}}$
	Hg	Cd	Ga

Group II.	Group II.	Group II.
Cd	Ba	$\mathrm{VII}^{\mathrm{II}}$
Be	Zn	Cd
Mg	(171.3^{II})	Hg

	Group II.	Group V.	Group IV.
	Be	As	Ce
	Be	V	Sn
	Mg	As	(175.6^{IV})
	Mg	(166^{V})	Pb
	Hg	(166^{V})	Zr
Same line	Hg	Nb	[1]Si
	Hg	As	[1]Si
	(171.3^{II})	As	[1]Si
	(171.3^{II})	Nb	[1]Si
	(154.5^{II})	Sb	[1]Si

	Group II.	Group VI.	Group IV.
Same line	Zn	Mo	Th
	Zn	Mo	$\mathrm{VIII}^{\mathrm{IV}}$
Same line	Cd	Mo	(161.3^{IV})
	Cd	Mo	C
	Be	(212^{VI})	(161.3^{IV})
Same line	Be	Cr	Pb
	Be	(167^{VI})	Pb
	Be	Mo	Pb
Same line	Mg	O	$\mathrm{VIII}^{\mathrm{IV}}$
	Mg	Se	$\mathrm{VIII}^{\mathrm{IV}}$
	Ca	(212^{VI})	Th
	Ca	ne Di	Pb

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[1] See previous note on position of silicon.

	Group II.	Group VI.	Group IV.
	Zn, Ti, S, Ca	Te	(161.3^{IV})
	Be, Ge, Te, Ca	$(167^{VI}$	Zr
	Sr	W	Ce
	Sr	W	(175.6^{IV})
	Hg	(167^{VI})	Sn
	Hg	Te	(161.3^{IV})
	Zn	U	(175.6^{IV})
Same line	Zn	Cr	Sn
	VIII^{II}	Cr	Sn
Approx.	Cd	U	Ti
Same line	Cd	O	[1]Ge
	Cd	O	Ti
	Cd	Cr	(161.3^{IV})
Same line	VIII^{II}	Se	Si
	VIII^{II}	Se	Ti
	VIII^{II}	Cr	Sn
Approx.	VIII^{II}	S	Zr

	Group II.	Group IV.	Group IV.
	Be	Th	VIII^{IV}
Same line	Mg	Sn	Pb
	Mg	Sn	(161.3^{IV})
	Mg	Ge	175.6
	Ca	Ce	Pb
	Ba	Ti	C
	Sr	Ce	(175.6^{IV})
	Cd	Ge	(175.6^{IV})
	Cd	Th	VIII^{IV}
Same line Approx.	Hg	Ge	Si
	(171.3^{II})	Ge	Si
	Hg	Ge	Ti
	(171.3^{II})	Ge	Ti
	Hg	(161.3^{IV})	Zr
	VIII^{II}	Ce	Ge
	VII^{II}	Zr	Ti
	(171.3^{II})	Pb	Th

	Group II.	Group VI.	Group VI.
	Ba	S	O
	Ba	Se	Cr
	Ca	Te	U
	Sr	167^{VI}	W
	(171.3^{II})	Se	U
	Cd	S	W
Approx.	Be	Cr	Mo
Approx. only.	Mg	Se	ne Di
	Mg	Te	ne Di

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[1] Point a little high.

	Group II.	Group VI.	Group III.
	171.3^{II}	Te	Yt
	171.3^{II}	Se	Sc
	171.3^{II}	S	In
	Group IV.	**Group V.**	**Group V.**
Same line	C	V	As
	C	V	pr Di
Same line	Ti	As	Nb
	Zr	Sb	Ta
	Ge	P	Ta
	Si	As	Nb
	[1]Sn	P	(166^{V})
	Pb	Sb	N
Same line	Ge	(166^{V})	VII^{V}
	Si	(166^{V})	VII^{V}
	Ce	[2]Sb	Nb
	Pb	[2]Sb	N
	$(VIII^{IV})$	Bi	As
	$VIII^{IV}$	(166^{V})	V
Approx.	(161.3^{IV})	(166^{V})	Sb
	(175.6^{IV})	Nb	P
	Group I.	**Group VII.**	**Group I.**
	Na	Cl	VII^{I}
	Li	99^{VII}	Cr
	Li	(151.7^{I})	(214.8^{VII})
	K	I	Au
	K	(147.5^{VII})	(169.4^{I})
	Cu	Mn	Au
Approx.	Li	(186.7^{VII})	Ag
Approx.	Cu	168.8^{VII}	Ag
	Cu	F?	Na
	Cu	(186.7^{VII})	Cr
	Rb	(186.7^{VII})	(169.4^{I})
	Cr	F?	(169.4^{I})
	Au	I	(151.7^{I})
	Cr	B	(151.7^{I})

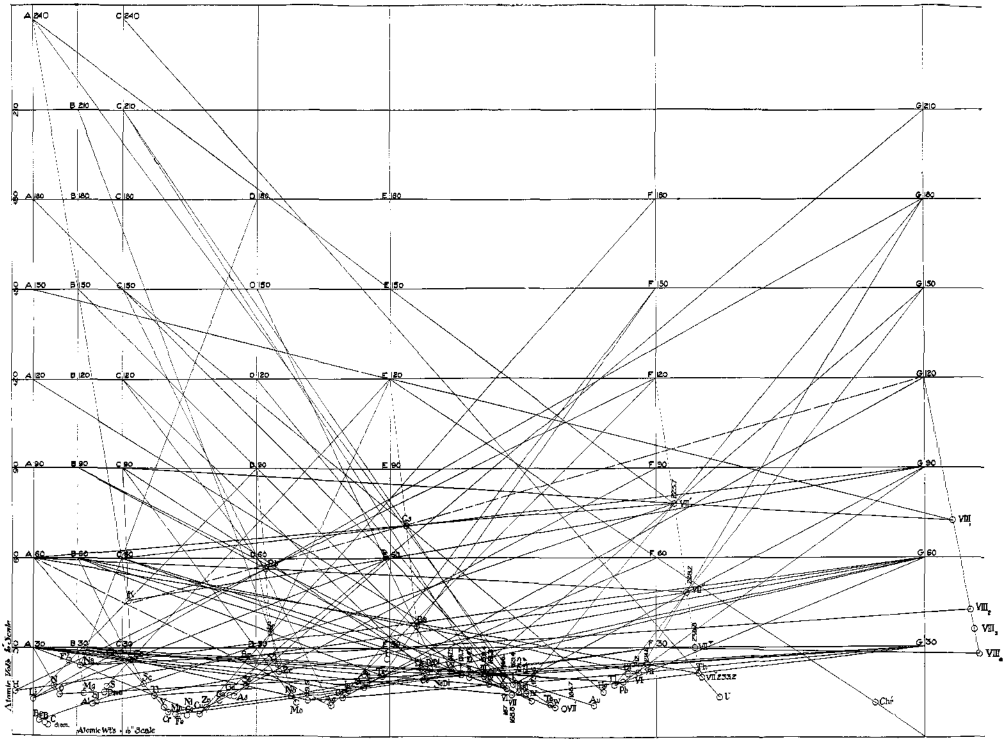
LIST OF ELEMENTS WITH SPECIFIC GRAVITIES AND ATOMIC WEIGHTS USED IN PREPARATION OF CHART OF ATOMIC VOLUMES.

Element.	Atomic weight.	Atomic volume.	D.
Aluminum	27.02	10.4	2.583
Antimony	120.0	17.9	6.697
Arsenic	74.9	13.1	5.725
Barium	136.8	(36.5)	(3.74)
Beryllium	9.08	4.9	1.85

[1] This and several other lines point to a slightly lower atomic volume for Sn.

[2] This and several other lines point to a slightly lower atomic volume for Sb.

Element.	Atomic weight.	Atomic volume.	D.
Bismuth	208.0	20.8	10.00
Boron	10.97	4.1	2.68
Bromine	79.75	25.0	3.188
Cadmium	111.7	13.08	8.546
Cadmium	111.7	12.91	8.65
Caesium	132.7	70.6	1.88
Calcium	39.91	(*c* 25.3)	(1.557)
Carbon (dia.)	11.97	3.4	3.518
Cerium	139.9	20.8	6.73
Chlorine	35.37	26.6	1.33
Chromium	52.45	7.71	6.8
Cobalt	58.8	....	....
Copper	63.2	7.06	8.945
n-Didymium	....	....	....
pr-Didymium	....	....	....
Fluorine	....	....	....
Gallium	69.9	11.7	5.96
Germanium	72.32	13.2	5.469
Gold	196.7	10.2	19.3
Hydrogen	....	....	....
Indium	113.4	15.3	7.42
Iodine	126.53	25.8	4.917
Iridium	192.5	8.6	22.42
Iron	55.9	....	....
Lanthanum	138.2	22.4	6.163
Lead	206.4	18.2	11.35
Lithium	7.01	11.9	5.89
Magnesium	24.0	14.0	1.71
Manganese	55.0	6.86	8.01
Mercury	199.8	14.7	13.596
Molybdenum	95.9	11.1	8.64
Nickel	58.6	6.5	8.97
Niobium	94.0	13.3	7.06
Nitrogen	....	....	....
Osmium	190.3	8.5	22.447
Oxygen	15.96	....	
Phosphorus (red)	30.96	14.7	2.106
Platinum	194.3	9.0	21.5
Potassium	39.04	45.1	8.65
Rhodium	102.7	8.48	12.1
Rubidium	85.2	56.0	1.52
Ruthenium	101.4	8.03	12.63
Scandium	....	....	....
Selenium	78.8	16.7	4.7
Silicon	28.3	11.4	2.49



A 240
C 240
B 210
C 210
G 210
A 180
B 180
C 180
D 180
E 180
F 180
G 180
A 150
B 150
C 150
D 150
E 150
F 150
G 150
A 120
B 120
C 120
D 120
E 120
F 120
G 120
A 90
B 90
C 90
D 90
E 90
F 90
G 90
A 60
B 60
C 60
D 60
E 60
F 60
G 60
A 30
B 30
C 30
D 30
E 30
F 30
G 30
210
180
150
120
90
60
30
Atomic Vols 1/8" Scale
Atomic Wt's - 1/8" Scale
H
Li
Be
B
C diam.
N
O
F
Na
Mg
Al
Si
S
P
K
Sc
Ti
V
Cr
Mn
Fe
Ni
Co
Cu
Zn
Ga
Ge
As
Se
Br
Rb
Zr
Nb
Mo
Cs
Ba
NeDi
VI
VII
187
168.5
Ta
W
O VII
184.7
Au
Hg
Tl
Pb
VI
VII
Th
VII 233.2
U
223.7
VII
232.2
VII
230.6
VII
VIII1
VIII2
VIII3
VIII4
Chr

Element.	Atomic weight.	Atomic volume.	D.
Silver	107.66	10.18	10.57
Sodium	22.995	23.3	0.985
Strontium	87.3	35.0	2.5
Sulphur	31.98	16.4	1.958
Tantalum	*c* 182.0	....	....
Tellurium	*c* 125.0	20.0	6.255
Thallium	203.64	....	11.81
Thallium	203.64	....	11.91
Thorium	232.0	20.9	11.1
Tin	118.8	16.3	7.3
Titanium	47.9	13.3	3.59
Tungsten	183.6	9.6	19.13
Uranium	239.0	12.8	18.685
Vanadium	51.2	9.3	5.5
Zinc	65.3	9.4	6.9
Zirconium	90.0	21.2	4.25

REMARKS ON LIST OF ELEMENTS.

Barium.—The lines cross at an atomic volume of 36.5, equal to 3.74 specific gravity. This is between the values recorded for the element, which vary from 3.5 to 4 (mean 3.75).

Bismuth.—The specific gravity of liquid bismuth at the melting-point is taken; this is the highest specific gravity of the element.[1]

Calcium.—The point taken in the chart was found by the crossing of the lines. It corresponds to an atomic volume of 25.3, equal to 1.577 specific gravity. Matthiessen gives 1.57, and this apparently is the only published result.

Germanium.—The point taken is *c* 15.34, which is a little too high. 15.3 would be better, and this corresponds to a specific gravity of 5.44. Winkler gives 5.469.

Hydrogen.—An atomic volume of 14.6 is assigned in the chart. This is about two-tenths higher than the figure recently given by Dewar. The lines drawn through this element place it in atom-analogy with Group I. It is sometimes placed in Group VII.

Silicon.—The lines indicate an atomic volume of 12.5, equal to 2.26 specific gravity. This value is between the values given by Wöhler (2.49 at 10° C.) and Winkler (2.149–2.197).

Strontium.—The point at which the lines intersect is 34.5,

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[1] Vincentini: *J. Chem. Soc.*, *1891*, II, 518.

equal to 2.53 specific gravity. The determinations made with doubtfully pure specimens vary from 2.4 to 2.58.

Sulphur.—Deville's results for monoclinic sulphur.

Thallium.—The chart indicates a somewhat higher gravity (11.98) than Crookes obtained from the metal in the form of wire (11.91).

Zirconium.—The atomic volume apparently should be a little greater than 21.2.

THE OIL OF CORN.[1]

BY C. G. HOPKINS.

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THE presence of oil in the corn kernel was discovered by Bizio[2] in 1823. A partial analysis by Hoppe-Seyler[3] gave the following as the percentage composition[4] of the oil:

Cholesterol	2.65
Protogon	3.95
Saponifiable fats, etc	93.40

The statement is made that the oil contains stearin, palmitin, and much olein, and the melting-point of the fatty acids is given as 51° to 54° F. (11° to 12° C.).

Some of the so-called physical and chemical "constants," which have been determined by several investigators are given below:

	Specific gravity of oil at 15° C.	Unsaponifiable substance. Per cent.	Iodine absorption. Per cent.
Spüller[5]	......	1.35	119.7
Smith[6]	0.9244	....	122.9
Hart[7]	0.9239	1.55	117.0
Rokitianski[8]	0.8360	....	75.8

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[1] From advance sheets of the author's thesis "The Chemistry of the Corn Kernel," for the degree of Doctor of Philosophy, Cornell University, 1898, which will be published as Bulletin No. 53 of the University of Illinois Agricultural Experiment Station.

[2] *J. Chem. u. Phys.*, *1823*, 37, 377.

[3] *Med. Chem. Untersuchungen*, 1, 162; *Bull. Soc. Chim.*, *1866*, [2], 6, 342; *Jsb. Fortschritte der Chem.*, *1866*, 698.

[4] I have not been able to see Hoppe-Seyler's original paper. Presumably the protogon is the substance now termed lecithin, and the methods employed in estimating it and cholesterol were similar to those which are discussed herein.

[5] Dingler's *poly. J.*, *1887*, 264, 626.

[6] *J. Soc. Chem. Ind.*, *1892*, 11, 504.

[7] *Ibid.*, 1894, 13, 257, from *Chem. Ztg.*, 17, 1522.

[8] Inaugural Dissertation, St. Petersburg, *1894*; *Pharm. Ztschr. Russland*, *1894*, 33, 712; *Chem. Centrbl.*, *1895*, [4], 7, I, 22.