(3) It is pointed out that since these E_0's *are* fairly concordant for a definite range of concentration of electrolyte, the ferro-ferricyanide electrode can be used as a reference electrode for measuring activity products of many electrolytes.

(4) In addition to the measurements of activity products of simple electrolytes which are now in progress, an effort will be made also to measure the activity products of polyvalent electrolytes, with the hope of obtaining some definite knowledge concerning intermediate ions.

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A NOTE ON THE NUMERICAL RELATION OF ATOMIC WEIGHTS TO ATOMIC NUMBERS.

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W. D. Harkins and E. D. Wilson in their papers[1] have reviewed much recent work on the structure of atoms and have contributed some fresh ideas. Special attention is drawn to the fundamental importance of atomic numbers, and prominence is given to the idea that elements of odd and even atomic numbers form two distinct series. For the lighter elements they give the relation

$$W = 2n + \left\{{}^1/_2 + [(-1)^{n-1} \times {}^1/_2]\right\},$$

where W = atomic weight and n = atomic number. In the summary of the second paper they say:[2]

"In the case of the heavier elements another term enters so that the more general equation may be given

$$W = 2(n + n') + [{}^1/_2 + {}^1/_2(-1)^{n-1}]."$$

W. D. Harkins and R. E. Hall[3] refer to this latter equation and define n' as zero for the lighter elements. They also state: "The atomic weights are a linear function of the atomic numbers." The varying values of the term n' are not published in any of these papers but are given in the table appended to this note, and are compared to the quotients obtained when each atomic weight is divided by the corresponding atomic number.

The graph of n' values is more regular than the other; it approximates on the whole to four straight lines:

(i) A horizontal line along the zero from helium to chlorine,

(ii) A shorter horizontal—titanium to cobalt—when $n' = 2$,

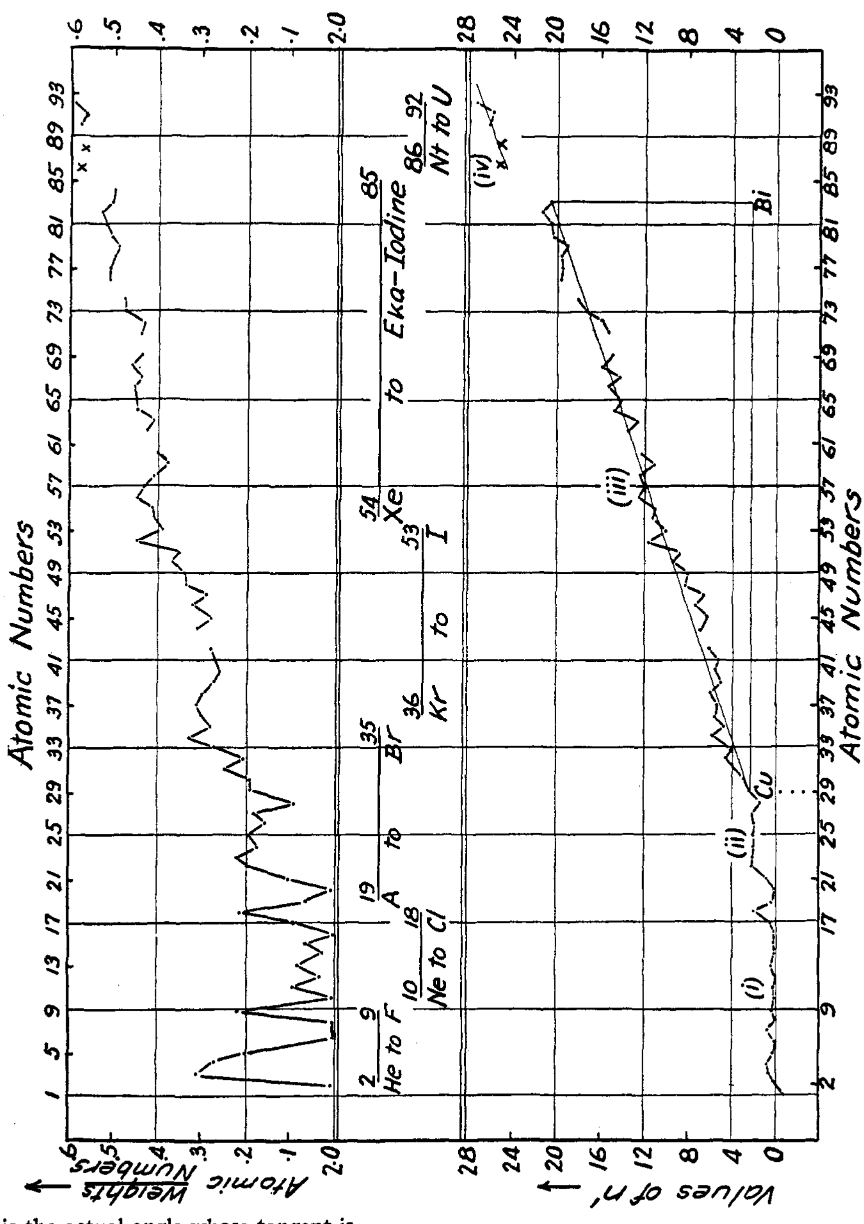
(iii) A very long line—copper to bismuth—which slopes at an angle whose tangent[4] is almost exactly $^1/_3$,

[1] THIS JOURNAL, 37, 6 (1915).

[2] *Ibid.*, 37, 1395 (1915).

[3] *Ibid.*, 38, 2 (1916).

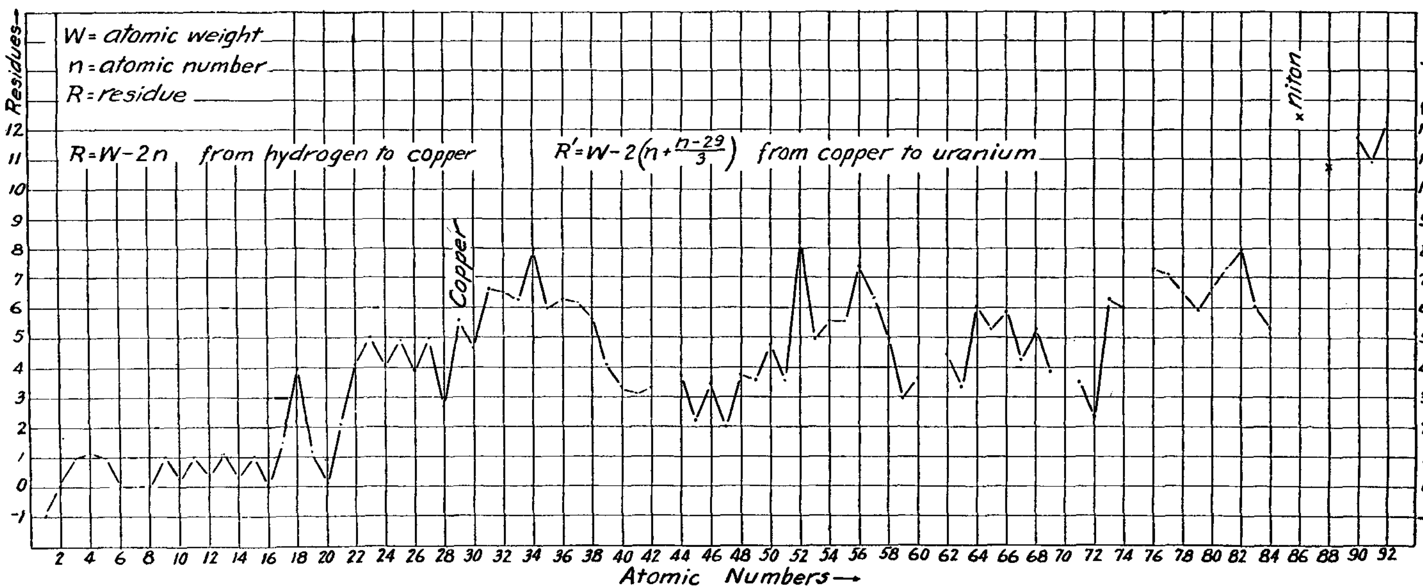
[4] The tangent of the angle, as given in the graph, is rather larger than $^1/_3$, so also



is the actual angle whose tangent is

$$\frac{20.50-2.28}{83-29} = \frac{1}{2.96}.$$

If the line is drawn from copper (on a rectified scale) to a point 0.22 *below* bismuth it gives the exact tangent ($^1/_3$), as used in the calculations in the last column of the table, and will be seen to run very evenly between the intermediate values of n'.



W = atomic weight
n = atomic number
R = residue
R = W − 2n from hydrogen to copper
R′ = W − 2(n + (n−29)/3) from copper to uranium
Residues
Copper
niton
Atomic Numbers

(iv) A short line, parallel to the last but raised above it, from niton to uranium.

Harkins and Wilson[1] give tables of deviation of the atomic weights from whole numbers and remark that a tendency towards large deviation begins at nickel—they say:

"The reason for this abrupt change at the atomic weight 59 is not apparent. It may be in some unknown way connected with the first appearance at this point of a new series, possibly formed by disintegration instead of aggregation; to a change in the effect of packing, or, if atoms exist which are lighter than hydrogen, it might possibly be due to their inclusion."

The main slope from copper to uranium (iii and iv above) would also be due to this unknown cause. This slope can be reduced to the horizontal by obtaining the values $2[n + (n - 29)/3]$ for each element,

	n. Atomic number.	W. Atomic weight.	n'. (from equation).	W/n.	$2n$. (as far as Ni).	R. (R = W — $2n$) as far as Ni.
Hydrogen	1	1.008	—0.996	1.008	2	—0.992
Helium	2	4.00	0.00	2.00	4	0
Lithium	3	6.94	+0.44	2.31	6	+0.94
Glucinum	4	9.1	0.55	2.27	8	1.1
Boron	5	11.0	0.00	2.20	10	1.0
Carbon	6	12.005	0.00	2.00	12	0.005
Nitrogen	7	14.01	—0.495	2.00	14	0.01
Oxygen	8	16.00	0.00	2.00	16	0.0
Fluorine	9	19.0	0.00	2.11	18	1.0
Neon	10	20.2	+0.10	2.02	20	0.2
Sodium	11	23.00	0.00	2.09	22	1.0
Magnesium	12	24.32	0.16	2.03	24	0.32
Aluminium	13	27.1	0.05	2.08	26	1.1
Silicon	14	28.3	0.15	2.02	28	0.3
Phosphorus	15	31.04	0.02	2.07	30	1.04
Sulfur	16	32.06	0.03	2.00	32	0.06
Chlorine	17	35.46	0.23	2.09	34	1.46
Argon	18	39.88	1.94	2.21	36	3.88
Potassium	19	39.10	0.05	2.06	38	1.10
Calcium	20	40.07	0.03	2.00	40	0.07
Scandium	21	44.1	0.55	2.10	42	2.1
Titanium	22	48.1	2.05	2.19	44	4.1
Vanadium	23	51.0	2.00	2.22	46	5.0
Chromium	24	52.0	2.00	2.17	48	4.0
Manganese	25	54.93	1.96	2.19	50	4.93
Iron	26	55.84	1.92	2.15	52	3.84
Cobalt	27	58.97	1.97	2.18	54	4.97
Nickel	28	58.68	1.34	2.09	56	2.68

[1] *Loc. cit.*

because the atomic number of copper is 29 and the tangent of the slope is $^1/_3$. This has been done and the results inserted in the table where also —in the last column—are given the residues ($W - 2n$) as far as nickel, and the residues $[W - 2(n + (n - 29)/3)]$ from copper to uranium. These last column numbers are plotted also in the form of a graph.

The question of deviation from whole numbers is not here considered. The object of the comparison is to see (now that the unknown factor

	n. Atomic number.	W. Atomic weight.	n'. (from equation).	W/n.	$2\left(n + \frac{n - 20}{3}\right)$. (from Co to U).	R'[1]. $R' = \left[W - 2\left(n + \frac{n-29}{3}\right)\right]$ from Co to U.
Copper............	29	63.57	2.28	2.19	58.0	5.57
Zinc...............	30	65.37	2.68	2.19	60.6	4.71
Gallium............	31	69.9	3.45	2.25	63.3	6.6
Germanium.........	32	72.5	4.25	2.20	66.0	6.5
Arsenic............	33	74.96	3.98	2.27	68.6	6.30
Selenium...........	34	79.2	5.60	2.33	71.3	7.9
Bromine...........	35	79.92	4.46	2.28	74.0	5.92
Krypton.............	36	82.92	5.46	2.30	76.6	6.26
Rubidium............	37	85.45	5.22	2.31	79.3	6.12
Strontium............	38	87.63	5.81	2.30	82.0	5.63
Yttrium..............	39	88.7	4.85	2.27	84.6	4.0
Zirconium............	40	90.6	5.30	2.26	87.3	3.3
Columbium...........	41	93.1	5.05	2.27	90.0	3.1
Molybdenum.........	42	96.0	6.00	2.28	92.6	3.3
Eka-Manganese I.....	43	..	...	..	...	..
Ruthenium...........	44	101.7	6.85	2.31	98.0	3.7
Rhodium.............	45	102.9	5.95	2.28	100.6	2.2
Palladium............	46	106.7	7.35	2.32	103.3	3.4
Silver................	47	107.88	6.44	2.29	106.0	1.88
Cadmium............	48	112.40	8.20	2.34	108.6	3.74
Indium..............	49	114.8	7.90	2.34	111.3	3.5
Tin..................	50	118.7	9.35	2.37	114.0	4.7
Antimony............	51	120.2	8.60	2.35	116.6	3.5
Tellurium............	52	127.5	11.50	2.45	119.3	8.2
Iodine...............	53	126.92	9.96	2.39	122.0	4.92
Xenon.............	54	130.2	11.10	2.41	124.6	5.5
Caesium...........	55	132.81	10.90	2.41	127.3	5.48
Barium............	56	137.37	12.68	2.45	130.0	7.37
Lanthanum.........	57	139.0	12.00	2.44	132.6	6.3
Cerium............	58	140.25	12.12	2.41	135.3	4.92

[1] For copper R' = R.

producing the slope has been removed) whether the deviations of the atomic weights from the doubled atomic numbers come within the limits which appear possible from our knowledge of the varying atomic weights of the isotopes of lead. It is seeen that, excepting tellurium, the maximum variations among elements coming before lead are *less* than those existing among the isotopes of lead.[1] The variations which follow after are greater.

	n.	W.	n'.	W/n.	$2\left(n + \frac{n - 29}{3}\right)$.	R'.
Praseodymium.........	59	140.9	10.95	2.38	138.0	2.9
Neodymium.........	60	144.3	12.15	2.40	140.6	3.6
Eka-neodymium.......	61	...	...	..	...	..
Samarium...........	62	150.4	13.20	2.42	146.0	4.4
Europium...........	63	152.0	12.50	2.41	148.6	3.3
Gadolinium..........	64	157.3	14.65	2.45	151.3	6.0
Terbium............	65	159.2	14.10	2.45	154.0	5.2
Dysprosium.........	66	162.5	15.25	2.46	156.6	5.8
Holmium............	67	163.5	14.25	2.44	159.3	4.2
Erbium.............	68	167.7	15.85	2.46	162.0	5.2
Thulium............	69	168.5	14.75	2.44	164.6	3.8
Thulium II..........	70	...	...	..	...	..
Ytterbium...........	71	173.5	15.25	2.44	170.0	3.5
Lutecium............	72	175.0	15.50	2.43	172.6	2.3
Tantalum............	73	181.5	17.25	2.48	175.3	6.2
Tungsten............	74	184.0	18.00	2.48	178.0	6.0
Eka-manganese II......	75	...	...	..	...	..
Osmium.............	76	190.9	19.45	2.51	183.3	7.3
Iridium.............	77	193.1	19.05	2.51	186.0	7.1
Platinum............	78	195.2	19.60	2.50	188.6	6.5
Gold................	79	197.2	19.10	2.49	191.3	5.9
Mercury............	80	200.6	20.30	2.51	194.0	6.6
Thallium............	81	204.0	20.50	2.52	196.6	7.3
Lead................	82	207.20	21.60	2.53	199.3	7.87
Bismuth............	83	208.0	20.5	2.51	202.0	6.0
Polonium............	84	210.0	21.00	2.50	204.6	5.3
Eka-iodine..........	85	...	...	..	...	..
Niton.................	86	222.4	25.20	2.58	210.0	12.4
Eka-caesium...........	87	...	...	..	...	..
Radium...............	88	226.0	25.00	2.57	215.3	10.7
Actinium..............	89	...	...	..	...	..
Thorium..............	90	232.4	26.20	2.58	220.6	11.7
Uranium X_2...........	91	234.2	25.60	2.57	223.3	10.9
Uranium..............	92	238.2	27.10	2.59	226.0	12.2

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[1] The maximum variation in atomic weight among the known isotopes of lead is 8, this being the difference between 214.1 (from thorium B) and 206.1 (from radium). It is seen from the table that R' for ordinary lead is 7.87, for selenium is 7.9 and for