A Table of Induced Radioactivities

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A TABLE of all the radioactive isotopes known to date (covering publications received prior to December 1, 1939) is presented together with a number of important features associated with them. (The natural radioactivities are not included.) Radioactive isotopes have now been reported for all elements with atomic number less than 85. Except for a few modifications the table follows the plan devised by Livingston and Bethe (L25). The references to the literature are designated each with a letter and a number (e.g., A1, A2, B1, B2, etc.) and the relevant references are listed beside each item. The list of references is given at the end of the paper.

The degree of certainty of each assignment is indicated, in the column headed "class," with a letter according to the following code:

A—Isotope certain (mass number and element certain)
B—Isotope probable, element certain
C—One of few isotopes, element certain
D—Element certain
E—Element probable
F—Insufficient evidence
G—Probably in error (e.g. impurity or inadequate half-life determination).

The fourth column lists the type of radiation, with the following meaning for the symbols:

β^-—Negative beta-particles
β^+—Positive beta-particles (positrons)
γ—Gamma-rays
e^-—Internal conversion electrons
K—*K*-electron capture
I.T.—Isomeric transition (transition from upper to lower isomeric state)

In the few cases where it is certain that no gamma-rays are emitted this fact is expressed explicitly by the symbol "no γ." Annihilation gamma-rays are not listed.

The half-life, followed by the relevant reference, is given in the fifth column. For the case where more than one value for the half-life has been reported an attempt has been made to list the best value (an experimental value near the mean or one determined with a strong sample).

In the column headed "Energy of Radiation," the energy value is followed by the corresponding reference and by a description of the method used for the energy determination. The beta-particle energies correspond to the observed upper limits of the spectra; in those cases where only the Konopinski-Uhlenbeck extrapolated value has been reported this is listed, followed by the designation "K.U." The methods used for the determination of the energy of the particles are described in each case with the aid of the following symbols:

abs.—absorption
cl. ch.—cloud chamber with magnetic field
spect.—electron magnetic spectrograph or spectrometer.

The symbols used to describe the methods employed for the determination of the gamma-ray energies have the following meaning:

abs.—absorption
cl. ch. recoil—secondary electrons in cloud chamber with magnetic field
cl. ch. pair—positron-electron pairs in cloud chamber with magnetic field
coincid. abs.—secondary electrons with coincidence counters and absorber
spect. conv.—internal conversion electrons with magnetic spectrograph
spect.—secondary electrons with magnetic spectrograph
abs. of e^-—absorption of internal conversion electrons.

When internal conversion electrons are emitted the energy listed is always that of the corresponding gamma-ray transition.

TABLE I. *Stable isotopes of the elements.*

Z	Element	A	Percent Abundance	Reference
1	H	1	99.98	H27
		2	.02	
2	He	3	$\sim 10^{-5}$	A11
		4	100	T8
3	Li	6	7.9	S24
		7	92.1	
4	Be	9	100	N8
5	B	10	18.4	O3
		11	81.6	
6	C	12	98.9	N16
		13	1.1	
7	N	14	99.62	V6
		15	0.38	
8	O	16	99.76	S27
		17	0.04	M20
		18	0.20	S27
9	F	19	100	A12
10	Ne	20	90.00	V6
		21	0.27	
		22	9.73	
11	Na	23	100	S24
12	Mg	24	77.4	A12
		25	11.5	
		26	11.1	
13	Al	27	100	A12
14	Si	28	89.6	M21
		29	6.2	
		30	4.2	
15	P	31	100	A12
16	S	32	95.0	N9
		33	0.74	
		34	4.2	
		36	0.016	
17	Cl	35	75.4	N17
		37	24.6	
18	A	36	0.307	N14
		38	0.061	
		40	99.632	
19	K	39	93.3	N14
		40†	0.012	N14, (†S25)
		41	6.7	N14
20	Ca	40	96.96	N9
		42	0.64	
		43	0.15	
		44	2.06	
		46	0.0033	
		48	0.19	
21	Sc	45	100	A12
22	Ti	46	7.95	N9
		47	7.75	
		48	73.45	
		49	5.51	
		50	5.34	
23	V	51	100	A12
24	Cr	50	4.49	N10
		52	83.77	
		53	9.43	
		54	2.30	
25	Mn	55	100	S26
26	Fe	54	6.04	N10
		56	91.57	
		57	2.11	
		58	0.28	
27	Co	57	0.17	S26
		59	99.83	
28	Ni	58	68.0	L30
		60	27.2	
		61	0.1	
		62	3.8	
		64	0.9	
29	Cu	63	68	A12
		65	32	
30	Zn	64	50.9	N14
		66	27.3	
		67	3.9	
		68	17.4	
		70	0.5	
31	Ga	69	61.2	S24
		71	38.8	
32	Ge	70	21.2	A12
		72	27.3	
		73	7.9	
		74	37.1	
		76	6.5	
33	As	75	100	N8
34	Se	74	0.9	A12
		76	9.5	
		77	8.3	
		78	24.0	
		80	48.0	
		82	9.3	
35	Br	79	50.6	B25
		81	49.4	
36	Kr	78	0.35	N8
		80	2.01	
		82	11.53	
		83	11.53	
		84	57.10	
		86	17.47	
37	Rb	85	72.3	B26
		87†	27.7	B26, (†H26)

† Natural radioactivity.

TABLE I.—*Continued.*

Z	Element	A	Percent Abundance	Reference
38	Sr	84	0.56	N13
		86	9.86	
		87	7.02	
		88	82.56	
39	Y	89	100	D11
40	Zr	90	48	A13
		91	11.5	
		92	22	
		94	17	
		96	1.5	
41	Cb	93	100	S26
42	Mo	92	15.5	M22
		94	8.7	
		95	16.3	
		96	16.8	
		97	8.7	
		98	25.4	
		100	8.6	
44	Ru	96	5	A12
		98	—?	
		99	12	
		100	14	
		101	22	
		102	30	
		104	17	
45	Rh	101	0.08	S26
		103	99.92	
46	Pd	102	0.8	S26
		104	9.3	
		105	22.6	
		106	27.2	
		108	26.8	
		110	13.5	
47	Ag	107	52.5	A13
		109	47.5	
48	Cd	106	1.4	N14
		108	1.0	
		110	12.8	
		111	13.0	
		112	24.2	
		113	12.3	
		114	28.0	
		116	7.3	
49	In	113	4.5	S24
		115	95.5	
50	Sn	112	1.1	A15
		114	0.8	
		115	0.4	
		116	15.5	
		117	9.1	
		118	22.5	
		119	9.8	
		120	28.5	
		122	5.5	
		124	6.8	
51	Sb	121	56	A12
		123	44	
52	Te	120	<0.1	D14
		122	2.9	A12
		123	1.6	
		124	4.5	
		125	6.0	
		126	19.0	
		128	32.8	
		130	33.1	
53	I	127	100	N8
54	Xe	124	0.094	N8
		126	0.088	
		128	1.90	
		129	26.23	
		130	4.07	
		131	21.17	
		132	26.96	
		134	10.54	
		136	8.95	
55	Cs	133	100	N8
56	Ba	130	0.101	N13
		132	0.097	
		134	2.42	
		135	6.59	
		136	7.81	
		137	11.32	
		138	71.66	
57	La	139	100	A12
58	Ce	136	<1	D15
		138	<1	D15
		140	90	A12
		142	10	A12
59	Pr	141	100	A12
60	Nd	142	25.95	M23
		143	13.0	
		144	22.6	
		145	9.2	
		146	16.5	
		148	6.8	
		150	5.95	
62	Sm	144	3	A14
		147	17	
		148†	14	(†W10)
		149	15	
		150	5	
		152	26	
		154	20	
63	Eu	151	49.1	L31
		153	50.9	
64	Gd	152	0.2	D12
		154	1.5	D12
		155	20.7	A14
		156	22.6	
		157	16.7	
		158	22.6	
		160	15.7	
65	Tb	159	100	A14

† Natural radioactivity.

TABLE I.—*Continued.*

Z	Element	A	Percent Abundance	Reference
66	Dy	158	0.1	D12
		160	1.5	D12
		161	21.6	A14
		162	24.6	
		163	24.6	
		164	27.6	
67	Ho	165	100	A14
68	Er	162	0.25	D12
		164	2.0	D12
		166	35.2	A14
		167	23.5	
		168	29.3	
		170	9.8	
69	Tm	169	100	A14
70	Yb	168	0.06	D12
		170	2	D12
		171	8.8	A14
		172	23.5	
		173	16.7	
		174	37.2	
		176	11.8	
71	Lu	175	97.5	M24
		176†	2.5	M24, (†H28)
72	Hf	172?	<0.1	D11
		174	0.3	D11
		176	5	A13
		177	19	
		178	28	
		179	18	
		180	30	
73	Ta	181	100	D11
74	W	180	~0.2	D13
		182	22.6	A12
		183	17.3	
		184	30.1	
		186	29.8	
75	Re	185	38.2	A12
		187	61.8	
76	Os	184	0.018	N11
		186	1.59	
		187	1.64	
		188	13.3	
		189	16.1	
		190	26.4	
		192	41.0	
77	Ir	191	38.5	S26
		193	61.5	
78	Pt	192	0.8	S26
		194	30.2	
		195	35.3	
		196	26.6	
		198	7.2	
79	Au	197	100	D16
80	Hg	196	0.15	N8
		198	10.1	
		199	17.0	
		200	23.3	
		201	13.2	
		202	29.6	
		204	6.7	
81	Tl	203	29.1	N13
		205	70.9	
82	Pb	204	1.48	N15
		206	23.59	
		207	22.64	
		208	52.29	
83	Bi	209	100	N13
90	Th	232†	100	D17
91	Pa	231†	—	G8
92	U	234†	0.006	N12
		235†	0.71	
		238†	99.28	

† Natural radioactivity.

The observed nuclear reactions (giving the target element, projectile and residue, in order) by which the radioactive isotopes are formed, and the corresponding references, are listed in the next to the last column (p=proton, n=neutron, α=alpha-particle, d=deuteron, γ=gamma-ray). The heavy element, neutron-induced, fission reactions are included and are designated by such symbols as U-n, Th-n, and Pa-n. In those cases where the radioactive fission product is known to be the second (or later) element in a chain decay its production is not designated by these symbols (U-n, etc.) but is listed as produced by the beta-decay of its immediate parent isotope.

No attempt has been made to list all of the publications connected with a given radioactivity since it has been the aim to keep the table as compact as possible. References to the original discoveries are not given when better data are available in more recent publications. The references which are listed usually give a key to the complete literature.

A list of the mass numbers and relative abundances of the known stable isotopes is included for convenience.

TABLE II. *Radioactive isotopes which have been produced by artificial means. The literature has been covered up to December 1, 1939.*

RADIO-ELEMENT Z	A	CLASS	TYPE OF RADIATION	HALF-LIFE	ENERGY OF RADIATION (MEV) PARTICLES	γ-RAYS	PRODUCED BY	OBSERVERS
1	H^3	*A*	β^-	~150 d.(A7)	~0.02(A7) abs.		D-*d*-*p*(A7)	A7
2	He^6	*A*	β^-	0.8 s.(B1)	3.7(B1, B2) cl. ch.		Be-*n*-α(B1, P1, B3) (Li-*n*-*p*)(K1, N1)	B1, N1, K1, P1, B2, B3
3	Li^8	*A*	β^-, α	0.88 s.(L1)	12(β^-)(B4) cl. ch.		Li-*d*-*p*(C1, L1, R14, D1) *B*-*n*-α(L24), (Li-*n*-*y*)(K1)	L1, B4, C1, D1, R14, K1, L24
4	Be^7	*A*	*K*, γ	43 d.(R1)		0.45(R1, M1) abs. Pb.	Li-*d*-*n*(R1, R13) B-*p*-α(R1, M1) Li-*p*-*n*(H1, H2)	R1, M1, H1, H2, R13
5	B^{12}	*A*	β^-	0.022 s.(C2, B22)	12(B4) cl. ch.		B-*d*-*p*(C2, F1, B5)	C2, F1, B4, B5, B22
6	C^{11}	*A*	β^+	21.0 m.(R11)	1.15(F1) cl. ch.		B-*d*-*n*(F1, C4, Y1) B-*p*-γ(C3, B23) B-*p*-*n*(B23) N-*p*-α(B23) C-*n*-2*n*(P2)	F1, C3, Y1, C4, P2, B23 R11
7	N^{13}	*A*	β^+, γ	9.93 m.(W12)	0.92, 1.20 (L22) spect.	0.28(R2) cl. ch. recoil	C-*d*-*n*(H3, Y1, C4, F1) C-*p*-γ(H3, C4) B-α-*n*(E1, R3) N-*n*-2*n*(P2)	H3, E1, Y1, R2, C4, F1, P2, B20, L22, W12
	N^{16}	*A*	β^-	8 s.(C5, N1)	6.0(F1) cl. ch.		N-*d*-*p*(F1) O-*n*-*p*(C5) F-*n*-α(N1, P1, N4)	F1, C5, P1, N1, N4
8	O^{15}	*A*	β^+	126 s.(M3, B20)	1.7(F1) cl. ch.		N-*d*-*n*(M3, F1) O-γ-*n*(B20) O-*n*-2*n*(P2) N-*p*-γ(D2) C-α-*n*(K3)	M3, F1, B20, P2, D2, K3
	O^{19}	*A*	β^-	31 s.(N1)			F-*n*-*p*(N1, A1)	N1, A1
9	F^{17}	*A*	β^+	70 s.(N2)	2.1(K4) cl. ch.		O-*d*-*n*(N2, F1) N-α-*n*(R3) O-*p*-γ(D2)	N2, K4, F1, R3, D2
	F^{18}	*A*	β^+	112 m.(S1)	0.7(Y2) cl. ch.		Ne-*d*-α(S1) O-*p*-*n*(D2) F-*n*-2*n*(P2) O-*d*-*n* or O-*d*-γ(Y2)	S1, D2, P2, Y2, B20
	F^{20}	*A*	β^-	12 s.(C1)	5.0(F1) cl. ch.		F-*d*-*p*(F1, C1) F-*n*-γ(N1) Na-*n*-α(N1)	F1, C1, N1
10	Ne^{19}	*A*	β^+	20.3 s.(W7)	2.20(W7) cl. ch.		F-*p*-*n*(W7)	W7
	Ne^{23}	*A*	β^-	40 s.(A1, B6)			Na-*n*-*p*(A1, N1, P1) Mg-*n*-α(A1, B6)	A1, N1, B6, P1
11	Na^{22}	*A*	β^+	3.0 y.(L3)	0.58(L3) cl. ch.	1.3(O2) spect.	Mg-*d*-α(L3) F-α-*n*(L3, M4) Ne-*d*-*n*(L3)	L3, M4, O2
	Na^{24}	*A*	β^-, γ	14.8 h. (V1)	1.4(L21) spect.	1.0, 2.0, 3.0(R4) cl. ch. recoil	Na-*d*-*p*(L4, V1) Na-*n*-γ(A1) Mg-*n*-*p*(A1) Al-*n*-α(A1) Mg-*d*-α(H4)	L4, A1, R4, H4, V1, L21
12	Mg^{23}	*A*	β^+	11.6 s.(W7)	2.82(W7) cl. ch.		Na-*p*-*n*(W7, D9)	W7, D9
	Mg^{27}	*A*	β^-, γ	10.2 m.(H4)	1.8(C13) cl. ch.	0.9(R4) cl. ch. recoil	Mg-*d*-*p*(H4) Mg-*n*-γ(A1) Al-*n*-*p*(A1)	H4, A1, R4, C13
13	Al^{26}	*A*	β^+	7.0 s.(W7, F2)	2.99(W7) cl. ch.		Na-α-*n*(M4, F2) Mg-*p*-*n*(W7, D9)	M4, F2, W7, D9
	Al^{28}	*A*	β^-, γ	2.4 m.(A1, M5, E2)	3.3(C6) cl. ch.	2.3(C6) cl. ch. recoil	Al-*d*-*p*(M5) Al-*n*-γ(A1) Si-*n*-*p*(A1) P-*n*-α(A1) Mg-α-*p*(E2, R3)	M5, C6, A1, E2, R3
	Al^{29}	*A*	β^-	6.7 m.(B27)	2.5(B27) cl. ch. and abs.		Mg-α-*n*(B27, H21, F3)	B27, H21, F3
14	Si^{27}	*A*		3.7 s.(K8)			Al-*p*-*n*(K8)	K8
	Si^{31}	*A*	β^-	170 m.(N3)	1.8(K4) cl. ch.	No γ(N3)	Si-*d*-*p*(N3) Si-*n*-γ(A1) P-*n*-*p*(A1, P2) S-*n*-α(S2, C9)	N3, K4, A1, P2, S2, C9

TABLE II.—*Continued.*

Radio-element		Class	Type of Radiation	Half-Life	Energy of Radiation (Mev)		Produced by	Observers
Z	*A*				Particles	γ-rays		
15	P^{30}	*A*	β^+	2.55 m.(R3)	3.6(A2) spect.		Al-α-*n*(R3, C7) S-*d*-α(S2) P-*n*-2*n*(P2) P-γ-*n*(B20) Si-*p*-*n*(B23) Si-He^3-*p*(A7)	C7, R3, A2, S2, P2, B20, A7, B23
	P^{32}	*A*	β^-	14.30 d.(C8)	1.69(L5) spect.	No γ (K4)	P-*d*-*p*(N3) P-*n*-γ(A1) S-*n*-*p*(A1) Cl-*n*-α(A1) S-*d*-α(S2) Si-α-*p*(F3)	N3, L5, C8, A1, K4, S2, F3
16	S^{31}	*F*	β^+	26 m.(P2)			S-*n*-2*n*(P2)	P2
	S^{35}	*A*	β^-	88 d.(L6)	0.107(L6) spect.		Cl-*n*-*p*(A3, L6)	A3, L6
17	Cl^{34}	*A*	β^+	33 m.(S2, B21)	2.5(B21) abs.		P-α-*n*(F2, R3, B21) S-*d*-*n*(S2) Cl-*n*-2*n*(P2) Cl-γ-*n*(B20)	F2, R3, S2, P2, B20, B21
	Cl^{36}	*A*	β^+, *K*, β^-	>1 y.(G9)	0.7(β^-)(G9) abs.		Cl-*n*-γ(G9) Cl-*d*-*p*(G9)	G9
	Cl^{38}	*B*	β^-, γ	37 m.(VI)	4.8(K4) cl. ch.	2.0, 2.5(R7) cl. ch. recoil	Cl-*d*-*p*(K4, VI) Cl-*n*-γ(A1) K-*n*-α(H5)	K4, R7, VI, H5, A1
18	A^{39}	*G*	β^-	4 m.(P2)			K-*n*-*p*(P2)	P2
	A^{41}	*A*	β^-, γ	110 m.(S3)	2.7(K4) cl. ch.	1.37(R8) cl. ch. recoil	A-*d*-*p*(S3) K-*n*-*p*(H5) A-*n*-γ(S3)	S3, K4, R8, H5
	$A^{35, 37}$	*F*		1.1 hr.(K3)			S-α-*n*(?)(K3)	K3
19	K^{38}	*A*	β^+, γ	7.7 m.(H5, R3)	2.3(R3) abs.		Cl-α-*n*(H5, R3) Ca-*d*-α(H5) K-*n*-2*n*(P2)	H5, R3, P2
	K^{42}	*A*	β^-	12.4 h.(H5)	3.5(K4) cl. ch.		K-*d*-*p*(H5) K-*n*-γ(H5, A1) Ca-*n*-*p*(H5) Sc-*n*-α(H5)	H5, K4, A1
	$K^{43, 44}$	*C*	β^-	18 m.(W1, W8)			Ca-*n*-*p*(W1, W8)	W1, W8
20	Ca^{39}	*F*	β^+	4.5 m.(P2, W8)			Ca-*n*-2*n*(?)(P2, W8)	P2, W8
	Ca^{41}	*B*	*K*, γ(W8)	8.5 d.(W8)		1.1(W8) abs. Pb	Ca-*d*-*p*(W8) Ca-*n*-2*n*(W8)	W8
	Ca^{45}	*A*	β^-, γ	180 d.(W8)	0.2, 0.9(W8) abs.	0.7(W8) abs.	Ca-*n*-γ(W8) Ca-*d*-*p*(W8, W5) Sc-*n*-*p*(W8)	W8, W5
	Ca^{47}	*A*	β^-, γ	2.5 h.(W8)	2.3(W8) abs.	0.8(W8) abs.	Ca-*d*-*p*(W8) Ca-*n*-γ(W8)	W8
	Ca^{49}	*B*	β^-	30 m.(W8)			Ca-*d*-*p*(W8) Ca-*n*-γ(W8)	W8
21	Sc^{42}	*A*	β^+	13.4 d.(W8)	1.4(W8) abs.		K-α-*n*(W8)	W8
	Sc^{43}	*A*	β^+	4 h.(W3)	1.3(W3) cl. ch.	1.0(W8) abs. Pb	Ca-α-*p*(F4, W3) Ca-*d*-*n*(W3) Ca-*p*-*n*(D2, D9)	F4, W3, D2, D9, W8
	Sc^{44}	*A*	*I.T.*, e^-(W8)	52 h.(W3)		0.25(W8) abs. of e^-	Sc-*n*-2*n*(B9) K-α-*n*(W3) Ca-*d*-*n*(W3) Ca-*p*-*n*(D2, D9) Ti-*d*-α(W4)	B9, W3, D2, W4, D9, W8
	Sc^{44}	*A*	β^+	4 h.(B9)	1.6(W3) cl. ch.		Sc-*n*-2*n*(B9) K-α-*n*(W3) Ca-*d*-*n*(W3) Ca-*p*-*n*(D2, D9) Sc-γ-*n*(B20) Sc^{44}(52h.)*I.T.*(W8)	B9, W3, D2, D9, B20, W8
	Sc^{46}	*A*	β^-, γ; *K*(W5)	85 d.(W5)	0.26, 1.5(β^-) (W8) abs.	1.25(W8) abs. Pb	Sc-*d*-*p*(W1, W5) Sc-*n*-γ(W1) Ti-*d*-α(W1) Ca-α-*p*(W8) Ti-*n*-*p*(W4)	W1, W5, W8, W4
	Sc^{47}	*B*	β^-, γ	63 h.(W8)	1.1(W8) abs.		Ca-α-*p*(W8), Ti-*n*-*p*(W8)	W8
	Sc^{48}	*A*	β^-, γ(W8)	44 h.(W8)	0.5, 1.4(W8) abs.	0.9(W8) abs.	Ti-*n*-*p*(W4, P2, W8) V-*n*-α(W4, P2, W8)	W4, P2, W8
	Sc^{49}	*A*	β^-	57 m.(W8)	1.8(W8) abs.	No γ(W8)	Ca-*d*-*n*(W8) Ti-*n*-*p*(W8) Ca^{49}(2.5 h.)β^- decay (W8)	W8
22	Ti^{51}	*A*	β^-, γ(W4)	2.9 m.(W4)			Ti-*d*-*p*(W4) Ti-*n*-γ(W4, A1)	W4, A1
	Ti^{51}	*A*	β^-, γ	72 d.(W5)	0.36(W5) abs.	1.0(W5) coincid. abs.	Ti-*d*-*p*(W5) Ti-*n*-γ(W8)	W5, W8
23	V^{47}	*B*	*K*	600 d.(W5)	No β^+ or e^-(W5)	No γ(W5)	Ti-*d*-*n*(W5)	W5

TABLE II.—*Continued.*

Radio-element Z	A	Class	Type of Radiation	Half-Life	Energy of Radiation (Mev) Particles	γ-rays	Produced by	Observers
23	V^{48}	*A*	β^+; *K*, γ(W5)	16 d.(W4)	1.0(W4) cl. ch.	1.05(R4) cl. ch. recoil	Ti-*d*-*n*(W4) Sc-α-*n*(W6) Cr-*d*-α(W4) Ti-*p*-*n*(D9)	W4, R4, W6, W5, D9
	V^{49}	*B*	β^+	33 m.(W4)	1.9(W4) abs.		Ti-*d*-*n*(W4) Ti-α-*p*(W4) Ti-*p*-*n*(D9)	W4, D9
	V^{50}	*A*	β^+	3.7 h.(W4)			V-*n*-2*n*(W4) Ti-*d*-*n*(W4) Ti-α-*p*(W4)	W4
	V^{52}	*A*	β^-	3.9 m.(W4)			V-*n*-γ(W4, P2, A1) V-*d*-*p*(W4) Cr-*n*-*p*(W4, P2) Mn-*n*-α(W4, P2, A1)	A1, W4, P2
24	Cr^{51}	*B*	*K*, e^-, γ; β^+(?)(W8)	26.5 d.(W8)		0.5(?), 1(W8) coincid. abs.	Ti-α-*n*(W8) Cr-*d*-*p*(W8) Cr-*n*-γ(W8)	W8
25	Mn^{51}	*A*	β^+	46 m.(L7)	2.0(L7) abs.		Cr-*d*-*n*(L7) Cr-*p*-γ(D2, D4)	D2, L7, D4
	Mn^{52}	*A*	β^+, γ	21 m.(L7)	2.2(H6)	1.2(H6)	Fe-*d*-α(D5, L7) Cr-*p*-*n*(H6)	L7, H6, D5
	Mn^{52}	*A*	β^+, γ; *K*(H6)	6.5 d.(L7)	0.77(H6)	1.0(H6)	Fe-*d*-α(L7) Cr-*p*-*n*(H6)	L7, H6
	Mn^{54}	*A*	*K*, γ(L7)	310 d.(L7)		0.85(L7) abs. Pb	Fe-*d*-α(L7) Cr-*d*-*n*(L7) V-α-*n*(L7) Cr-*p*-*n*(D9)	L7, D9
	Mn^{56}	*A*	β^-, γ	2.59 h.(L7)	1.2, 2.9(B10) cl. ch. K. U.	1.65(M6, L29) coincid. abs.	Mn-*n*-γ(A1) Mn-*d*-*p*(L7) Fe-*d*-α(L7) Fe-*n*-*p*(A1) Co-*n*-α(A1) Cr-α-*p*(R3)	A1, L7, B10, M6, R3, L29
26	Fe^{53}	*A*	β^+	8.9 m.(R3)			Cr-α-*n*(R3) Fe-*n*-2*n*(L20)	R3, L20
	Fe^{55}	*A*	*K*, e^-	~4 y.(V4)			Fe-*d*-*p*(L23) Mn-*p*-*n*(V4)	L23, V4
	Fe^{59}	*A*	β^-, γ	47 d.(L20)	0.4, 0.9(L20) abs.	1.0(L20) abs. Pb	Fe-*d*-*p*(L20) Co-*n*-*p*(L20)	L20
27	Co^{55}	*A*	β^+, γ	18.2 h.(D5)	1.50(L21) spect.	0.16, 0.21, 0.8, 1.2(C20) cl. ch. recoil	Fe-*d*-*n*(D5, L8) Fe-*p*-γ(L9)	D5, L8, L21, L9, C20
	Co^{56}	*B*	*K*, γ, e^-(L10)	270 d.(L10)			Fe-*d*-2*n*(L9, B24, P4) Ni-*d*-α(L11) Fe-*p*-*n*(L9)	L10, B24, P4, L9, L11
	Co^{58}	*A*	β^+	70 d.(L10)			Fe-*d*-*n*(L9, B24, P4) Mn-α-*n*(L9) Ni-*d*-α(L11) Fe-*p*-*n*(L9)	L10, B24, P4, L9, L11
	Co^{60}	*A*	β^-, γ	7 y.(L10)	0.16, 1.5(R9) abs.	1.3(L9) abs. Pb	Co-*d*-*p*(L9, B24) Co-*n*-γ(R9, L9) Ni-*n*-*p*(V5)	R9, L9, L10, B24, V5
	$Co^{58, 60}$	*C*	β^-	11 m.(H7)			Co-*n*-γ(H7, L8) Ni-*n*-*p*(H8)	H7, H8, L8
28	Ni^{57}	*A*	β^+	36 h.(L11)	0.67(L11) abs.		Fe-α-*n*(L11) Ni-*n*-2*n*(?)(L11)	L11
	Ni^{63}	*A*	β^-, γ	2.6 h.(L11)	1.9(L11) abs.	1.1(L11) abs. Pb	Ni-*d*-*p*(L11) Ni-*n*-γ(H8) Cu-*n*-*p*(H8) Zn-*n*-α(H8) Ni-*n*-2*n*(H8)	L11, H8
29	$Cu^{58, 60}$	*C*	β^+	81 s.(D4)			Ni-*p*-*n*(D4)	D4
	$Cu^{58, 60}$	*C*	β^+	7.9 m.(D4)			Ni-*p*-*n*(D4)	D4
	Cu^{61}	*B*	β^+; *K*(A4)	3.4 h.(T1, R3)	0.9(R3) abs.	No γ(G2)	Ni-*d*-*n*(T1) Ni-*p*-*n*(D4) Ni-*p*-γ(D4) Ni-α-*p*(R3)	T1, D4, R3, G2, A4
	Cu^{62}	*A*	β^+	10.5 m.(H8)	2.6(C13) cl. ch.		Cu-*n*-2*n*(H8) Cu-γ-*n*(B20) Co-α-*n*(R3) Ni-*p*-*n*(S18) Ni-*p*-γ(S18)	H8, B20, R3, S18, C13
	Cu^{64}	*A*	β^-; β^+; *K*(A4)	12.8 h.(V2)	0.58(β^-), 0.66(β^+)(T6) spect.	No γ(T6)	Cu-*d*-*p*(V2) Cu-*n*-γ(H8) Cu-*n*-2*n*(H8) Ni-*p*-*n*(S18, D4) Zn-*n*-*p*(H8)	V2, H8, T6, S18, D4, A4
	Cu^{66}	*A*	β^-	5 m.(A1)	2.9(S5) cl. ch. K. U.		Cu-*n*-γ(A1) Zn-*n*-*p*(H8) Ga-*n*-α(C5)	A1, H8, C5, S5
30	Zn^{63}	*A*	β^+	38 m.(D4, B20)	2.3(S18) abs.		Zn-*n*-2*n*(H8, P2) Zn-γ-*n*(B20), Cu-*d*-2*n*(L33) Cu-*p*-*n*(S18, D4) Ni-α-*n*(R3)	H8, B20, P2 D4, R3, S18 L33

TABLE II.—*Continued.*

Radio-element		Class	Type of Radiation	Half-Life	Energy of Radiation (Mev)		Produced by	Observers
Z	*A*				Particles	γ-rays		
30	Zn^{65}	*A*	β^+; *K*, γ, e^-	250 d.(L12)	0.4(β^+)(D9) cl. ch.	1.0(L12) abs. Pb	Zn-*d*-*p*(L12) Cu-*d*-2*n*(P4) Cu-*p*-*n*(B12) Zn-*n*-γ(S6) Ga^{65} *K* decay (L10)	L12, P4, B12, S6, D9, L10
	Zn^{69}	*A*	*I.T.*, γ(K11)	13.8 h.(L12)		0.47(K11) abs. Pb	Zn-*d*-*p*(L12, K11, V7) Zn-*n*-γ(T2, L12) Ga-*d*-α(L12) Ga-*n*-*p*(L12)	L12, T2, K11, V7
	Zn^{69}	*A*	β^-	57 m.(L12)	1.0(L12) abs.	No γ(L12)	Zn-*d*-*p*(L12, K11, V7) Zn-*n*-γ(T2) Ga-*d*-α(L12) Ga-*n*-*p*(L12) Zn^{69}(13.8 h.) *I.T.* (K11)	L12, H8, T2, K11, V7
31	Ga^{64}	*B*	β^+	48 m.(B13)			Zn-*p*-*n*(B13)	B13
	Ga^{65}	*A*	*K*, e^-	15 m.(A4, L10)			Zn-*d*-*n*(A4, L10)	A4, L10
	Ga^{66}	*A*	β^+	9.4 h.(B13, R3)	3.1(M7) abs.		Cu-α-*n*(M7, R3) Zn-*p*-*n*(B13)	M7, B13, R3,
	Ga^{67}	*A*	*K*, γ, e^-	83 h.(A4)		0.0925(V7, H25) spect. conv.; 0.1, 0.25(A4) abs. Cu, Pb	Zn-*d*-*n*(A4, G6, V7) Zn-α-*p*(M8) Zn-*p*-*n*(B13, V7)	A4, M8, B13, G6, V7, H25
	Ga^{68}	*A*	β^+	68 m.(R3)	1.9(R3, M7) abs.		Cu-α-*n*(R3, M7) Ga-*n*-2*n*(P2) Ga-γ-*n*(B20) Zn-*p*-*n*(D2, B13) Zn-*p*-γ(?)(D2) Zn-*d*-*n*(G6, V7)	R3, P2, B20, D2, M7, B13, G6, V7
	Ga^{70}	*A*	β^-, e^-, γ	20 m.(B20, A1)	5.0(β^-)(M8) abs.	0.054, 0.117(V7) spect. conv.	Ga-*n*-γ(A1) Ga-*n*-2*n*(P2) Ga-γ-*n*(B20) Zn-*p*-*n*(D2, V7) Zn-α-*p*(M8)	A1, P2, B20, D2, M8, B13, V7
	Ga^{72}	*A*	β^-, γ	14 h.(S6, L20)	2.6(L28) abs.	1.0(S7) abs. Pb	Ga-*d*-*p*(L20) Ga-*n*-γ(S6)	S6, S7, L20, L28
32	Ge^{69}	*E*	β^+	29 m.(S6)			Ge-*n*-2*n*(S6)	S6
	Ge^{71}	*B*	β^+	37 h.(M8)	1.0(M8) abs.		Zn-α-*n*(M8) Ge-*n*-γ(S6) Ge-*d*-*p*(S6) Ga-*d*-2*n*(L28)	M8, S6, L28
	$Ge^{67, 69, 71}$	*E*		195 d.(M8)			Zn-α-*n*(M8)	M8
	$Ge^{75, 77}$	*E*	β^-	81 m.(S6)			Ge-*n*-γ(S6) Ge-*d*-*p*(S6)	S6
	$Ge^{75, 77}$	*E*	β^-	8 h.(S6)			Ge-*n*-γ(S6)	S6
	$Ge^{69, 71}$	*C*		6–10 d.(S6, L28)			Ge-*n*-?(S6) Ga-*d*-2*n*(L28)	S6, L28
33	$As^{71, 73}$	*F*	β^+	50 h.(S6)			Ge-*d*-*n*(S6)	S6
	$As^{71, 73}$	*F*	β^+	88 m.(S6)			Ge-*d*-*n*(S6)	S6
	As^{72}	*E*	β^+	26 h.(V4)			Ge-*p*-*n*(V4)	V4
	As^{74}	*A*	β^-, β^+	17 d.(S8)	1.2(β^-), 0.9(β^+)(S8) cl. ch. K. U.		As-*n*-2*n*(S8, C11) Ge-*d*-*n*(S8) Se-*d*-α(F8)	S8, C11, F8
	As^{76}	*A*	β^-, γ; β^+; *K*, γ(?) (S23)	26.8 h.(W9)	1.1, 1.7, 2.7 (β^-)(S23, W9); 0.7, 2.6(β^+) (S23) cl. ch.	3.2, 2.2, 1.5 (S23) cl. ch. pair	As-*d*-*p*(C11, T3) As-*n*-γ(C11) Br-*n*-α(C11) Ge-*p*-*n*(V4) Se-*d*-α(F8)	C11, T3, S23, W9, V4, F8
	As^{77}	*D*	β^-, γ(S6)	55 d.(S6)			Ge-*d*-*n*(S6, S8)	S8, S6
	As^{78}	*A*	β^-	65 m.(S9)			Br-*n*-α(S9, C11)	S9, C11
34	Se^{75}	*A*		48 d.(D9)			As-*p*-*n*(D9)	D9
	$Se^{79, 81}$	*C*	*I.T.*, e^-(L32)	57 m.(S9, L32)		0.093 (L32) spect. conv.	Se-*d*-*p*(S9, L32) Se-*n*-γ(S9, H10) Br-*n*-*p*(S9, L32) Se-γ-*n*(B20)	S9, H10, B20, L32
	$Se^{79, 81}$	*C*	β^-	19 m.(L32)	1.5(L32) abs.		Se-*d*-*p*(S9, L32) Se-*n*-γ(S9, H10) Se-γ-*n*(B20) Br-*n*-*p*(L32) $Se^{79, 81}$(57 m.) *I.T.*(L32)	B20, S9, H10, L32
	Se^{83}	*A*	β^-	30 m.(L32)			Se-*d*-*p*(L32) Se-*n*-γ(L32)	L32
	Se	*D*		sev. h.(B15)			Th-*n*(B15)	B15
	Se	*D*		sev. d.(B15)			Th-*n*(B15)	B15
35	Br^{78}	*A*	β^+, e^-, γ	6.4 m.(S9)	2.3(β^+)(S9) abs	0.046, 0.108 (V7) spect. conv.	Se-*d*-*n*(S9) As-α-*n*(S9) Br-γ-*n*(B20, C5) Br-*n*-2*n*(H10) Se-*p*-*n*(B13, V7)	S9, C5, B20, H10, B13, V7
	Br^{80}	*A*	*I.T.*, e^- (S10, V3, V7)	4.4 h.(B13)		0.049; 0.037 or 0.025(V7) spect. conv.	Br-*n*-γ(S9, S10, A2) Br-*d*-*p*(S9) Se-*p*-*n*(B13, V7) Br-γ-*n*(B20) Br-*n*-2*n*(P2)	S9, S10, A2, B13, B20, P2, V7, D19

TABLE II.—*Continued.*

Radio-element Z	A	Class	Type of Radiation	Half-Life	Energy of Radiation (Mev) Particles	γ-rays	Produced by	Observers
35	Br^{80}	*A*	β^-, γ	18 m.(S9, S10)	2.0(A2) spect.	<0.5 (B13, S9) abs.	Br-*n*-γ(S9) Br-*d*-*p*(S9) Se-*p*-*n*(B13) Br-γ-*n*(B20) Br-*n*-2*n*(P2) Br^{80}(4.4 h.) *I.T.*(S10)	S9, S10, V3, A2, B13, B20, P2
	Br^{82}	*A*	β^-, γ	34 h.(S9)	0.7(B13)	0.65(K5) cl. ch. recoil and abs.	Br-*n*-γ(K5, S9) Br-*d*-*p*(S9) Se-*p*-*n*(B13) Se-*d*-2*n*(S9) Rb-*n*-α(S9, P2)	S9, K5, B13, P2
	Br^{83}	*A*	β^-	140 m.(L32)	1.05(L32) abs.	No γ(S9)	Se-*d*-*n*(S9) Se^{83} β^- decay (S9, L32) Th-*n*(B15, L32) U-*n*(L32)	S9, B15, L32
	$Br^{>82}$	*D*		40 m.(D6)			U-*n*(D6, H22)	D6, H22
	$Br^{>82}$	*F*		22 h.(B15)			Th-*n*(B15)	B15
	$Br^{>82}$	*D*		3.8 h.(H22)			U-*n*(H22)	H22
36	$Kr^{79, 81}$	*E*		18 h.(S9)			Kr-*d*-*p*(S9)	S9
	Kr^{83*}	*A*	*I.T.*, e^-	113 m.(L32)		0.049(L32) abs. of e^-	Br^{83} β^- decay (L32)	L32
	$Kr^{85, 87}$	*E*	β^-	74 m.(S9)			Kr-*d*-*p*(S9) Se-α-*n*(?)(K3)	S9, K3
	$Kr^{85, 87}$	*E*	β^-	4.5 h.(S9)			Kr-*d*-*p*(S9) Se-α-*n*(?)(K3)	S9, K3
	Kr(?)	*F*		1–2 m.(K3)			Se-α-*n*(?)(K3)	K3
	Kr^{88}	*A*	β^-	3 h.(L27)			Th-*n*(A5, L27) U-*n*(H22, H11)	H22, H11, A5, L27
37	$Rb^{82, 84}$	*F*	β^+	1.5 m.(R3)			Br-α-*n*(?)(R3)	R3
	$Rb^{82, 84}$	*F*	β^+	9.8 m.(R3)			Br-α-*n*(?)(R3)	R3
	Rb^{88}	*A*	β^-	18 m.(S9)			Rb-*n*-γ(S9, P2) Pa-*n*(G7) Kr^{88} β^- decay (L27, H11, A5)	S9, P2, H11, A5, L27, G7
	$Rb^{86, 88}$	*C*	β^-	18 d.(S9)			Rb-*n*-γ(S9)	S9
38	Sr^{85}	*B*	*K*, γ(D9)	~60 d.(D18)			Rb-*p*-*n*(D18)	D18, D9
	Sr^{85}	*B*	*K*, γ(D9)	70 m.(D9)			Rb-*p*-*n*(D9)	D9
	Sr^{87*}	*A*	*I.T.*, e^-, γ(D18)	2.7 h.(D18)		0.37(D18) spect. conv.	Rb-*p*-*n*(D18) Sr-*d*-*p*(D18) Sr-*n*-γ(D18) Y^{87} (85 h.) *K* decay	D18
	Sr^{89}	*A*	β^-	55 d.(S28)	1.50(S28) cl. ch.	No γ(S28)	Sr-*d*-*p*(S11, S28) Sr-*n*-γ(S11, S28) Y-*n*-*p*(S12) U-*n*(L26)	S11, S12, L26, S28
	$Sr^{>90}$	*D*	β^-	7 m.(L26)			U-*n*(L26)	L26
	$Sr^{>90}$	*D*	β^-	6 h.(L26)			U-*n*(L26)	L26
39	Y^{86}	*B*	*K*(D9)	80 d.(D9)			Sr-*p*-*n*(D9)	D9
	Y^{87}	*B*	*K*(D9)	14 h.(S28, D9)			Sr-*d*-*n*(S28, D9) Sr-*p*-*n*(D9)	S28, D9
	Y^{87}	*A*	*K*, γ, e^-(D18)	85 h.(D18)			Sr-*p*-*n*(D18) Sr-*d*-*n*(D18, S28)	D18, S28
	Y^{88}	*A*	β^+	2.0 h.(S28)	1.2(S11) cl. ch. K. U.		Sr-*d*-*n*(S11, S28) Y-*n*-2*n*(S11)	S11, S28
	Y^{90}	*A*	β^-	60 h.(S11)	2.6(S11) cl. ch. K. U.		Y-*d*-*p*(S11) Y-*n*-γ(S11, S12) Cb-*n*-α(S13)	S11, S12, S13
	Y	*D*	β^-	70 h.(S12)	1.3(S12) cl. ch. K. U.		Zr-*n*-*p*(S12) Zr-*d*-α(?)(S12)	S12
	$Y^{>90}$	*D*		3.5 h.(L26)			$Sr^{>90}$ (6 h.) β^- decay (L26)	L26
	Y	*E*		80 d.(D9)			Sr-*p*-*n*(?)(D9)	D9
40	Zr^{89}	*A*	β^+(S12, D9)	70 h.(S12, D9)	1.0(β^+)(S12) cl. ch. K. U.		Zr-*n*-2*n*(S12) Y-*p*-*n*(D9)	S12, D9
	Zr^{89}	*A*	γ; *I.T.* or *K*(D9)	4 m.(D9)			Y-*p*-*n*(D9)	D9
	Zr	*D*	β^-	17–40 h. (S12, H13)	1.25(S12) cl. ch. K. U.		Zr-*n*-γ(H13, S12)	S12, H13
	Zr	*F*		10–30 m.(P2, S12)			Zr-*n*-?(P2, S12)	S12, P2
	Zr	*F*	β^-	2.5–5 h.(S12, P2)			Zr-*n*-?(S12, P2) Zr-*d*-?(S12)	S12, P2
	Zr	*F*	β^-	90 m.(S12)			Zr-*d*-?(S12)	S12
41	Cb	*E*		4 m.(D9)			Zr-*p*-*n*(?)(D9)	D9
	Cb	*E*		12 m.(D9)			Zr-*p*-*n*(?)(D9)	D9
	Cb	*E*		38 m.(D9)			Zr-*p*-*n*(?)(D9)	D9
	Cb	*E*		21 h.(D9)			Zr-*p*-*n*(?)(D9)	D9
	Cb	*E*		96 h.(D9)			Zr-*p*-*n*(?)(D9)	D9
	Cb^{92}	*B*	β^-	11 d.(S13)	1.0(S13) cl. ch. K. U.		Cb-*n*-2*n*(S13)	S13
	Cb^{94}	*E*	β^-	7.5 m.(S13)			Cb-*n*-γ(S13, P2)	S13, P2
42	Mo^{93}	*F*		7 h.(D9)			Cb-*p*-*n*(?)(D9)	D9
	$Mo^{91, 93}$	*C*	β^+	17 m.(B20, S12)	1.8(S12) cl. ch. K. U.		Mo-*n*-2*n*(H10, S12) Mo-γ-*n*(B20)	S12, B20, H10

* Radioactive isomer of stable nucleus.

TABLE II.—*Continued.*

Radio-element		Class	Type of Radiation	Half-Life	Energy of Radiation (Mev)		Produced by	Observers
Z	*A*				Particles	γ-rays		
42	$Mo^{99, 101}$	*C*	β^-, γ	67 h.(S14)	1.5(S14) abs.	0.4(S14). abs.	Mo-*d*-*p*(S14) Mo-*n*-γ(S14, S12) U-*n*(H23) Th-*n*(H24)	S14, S12, H23, H24
	Mo^{101}	*B*	β^-	24 m.(S12)	1.3(S12) cl. ch. K. U.		Mo-*n*-γ(H10, S12)	S12, H10
43	43^{96}	*B*	β^+(?)	2.7 h.(D4)			Cb-α-*n*(K3) Mo-*p*-*n*(D4) Mo-*d*-*n*(S14)	K3, D4, S14
	$43^{99, 101}$	*C*	*I.T.*, e^-, γ(S14)	6.6 h.(S14)		~0.136(S14) spect. conv. ~0.18(S14) abs.	$Mo^{99, 101}$ (67 h.) β^- decay (S14)	S14
	43	*D*	*K*, e^-	90 d.(C12)			Mo-*d*-*n*(C12, C24)	C12, C24
	43	*D*	*K*, γ	62 d.(C12)			Mo-*d*-*n*(C12, C24)	C12, C24
	43	*D*	*K*(?), e^-, γ(E5)	110 h.(E3)	0.6(E3)	0.05, 0.5(E5)	Mo-*p*-*n*(E3, E5)	E3, E5
	43	*E*	β^-, γ(E3)	55 m.(E5)	2.5(E5) abs.		Mo-*p*-*n*(E3, D4, E5)	E3, D4, E5
	43	*E*	β^-	36.5 h.(D4)			Mo-*p*-*n*(D4)	D4
	43	*E*	β^-	18 s.(D9)			Mo-*p*-*n*(D3, D9)	D3, D9
	43	*D*	*K*	~2 d.(S14)			Mo-*d*-*n*(S14)	S14
44	Ru^{95}	*F*		20 m.(D7)			Ru-*n*-2*n*(?)(D7, P2)	D7, P2
	Ru^{103}	*B*	β^-	4 h.(D7, L13)			Ru-*n*-γ(D7) Ru-*n*-2*n*(D7, P2) Ru-*d*-*p*(L13)	D7, P2, L13
	Ru^{105}	*B*	β^-	20 h.(D7)			Ru-*n*-γ(D7)	D7
	Ru	*F*	β^-	39 h.(L13)			Ru-*d*-?(L13)	L13
	Ru	*G*		11 d.(L13)			Ru-*d*-?(L13)	L13
	Ru	*E*		90 m.(K3)			Mo-α-*n*(K3)	K3
45	Rh^{104}	*A*	*I.T.*, e^-(P5)	4.2 m.(S29)		0.055–0.080(P5) abs. of e^-	Rh-*n*-γ(P5, A1, P2) Ru-*p*-*n*(D9)	P5, C13, A1, P2, D9, S29
	Rh^{104}	*A*	β^-	44 s.(P5, A1)	2.3(C13) cl. ch.		Rh-*n*-γ(P5, A1) Rh^{104} (4.2 m.) *I.T.*(P5) Ru-*p*-*n*(D9) Ag-*n*-α(G3)	P5, C13, G3, A1, D9
	Rh^{105}	*B*	β^-	46 d.(L13)			Ru^{105} β^- decay (D7) Ru-*d*-*n*(L13)	D7, L13
	Rh	*G*	β^-	1.1 h.(P2)			Rh-*n*-?(P2)	P2
	Rh	*E*		3 h.(D9)			Ru-*p*-*n*(?)(D9)	D9
	Rh	*E*		10.7 h.(D9)			Ru-*p*-*n*(?)(D9)	D9
	Rh	*E*		3 d.(D9)			Ru-*p*-*n*(?)(D9)	D9
46	$Pd^{107, 109}$	*C*	β^-	13 h.(K6)	1.03(K6) cl. ch.		Pd-*d*-*p*(K6) Pd-*n*-γ(A1, K6) Ag-*n*-*p*(F5)	K6, A1, F5
	Pd^{111}	*A*	β^-	17 m.(K6)			Pd-*d*-*p*(K6, A1) Pd-*n*-γ(K6, A1)	K6, A1
47	Ag^{102}	*E*		73 m.(E6)			Pd-*p*-*n*(E6)	E6
	Ag^{104}	*E*		16.3 m.(E6)			Pd-*p*-*n*(E6)	E6
	Ag^{105}	*E*	*K*	45 d.(E6)		0.29, 0.42, 0.50, 0.62 (E6) spect.	Pd-*p*-*n*(E6)	E6
	Ag^{106}	*A*	β^+	24.5 m.(P6, D2)	2.04(F5) abs.	No γ(F5)	Ag-*n*-2*n*(P6) Pd-*d*-*n*(P6) Cd-*n*-*p*(P6) Rh-α-*n*(P6, K3) Ag-γ-*n*(B20) Pd-*p*-γ(D2) Pd-*p*-*n*(D2, E6)	P6, B20, D2, F5, K3, E6
	Ag^{106}	*A*	*K*(?), e^-, γ (P6, A4, F5)	8.2 d.(P6, K6)	1.2(e^-), (F5) abs.	1.06, 0.69 E(6) spect.	Ag-*n*-2*n*(P6, K6) Pd-*d*-*n*(P6, K6) Rh-α-*n*(P6) Pd-*p*-*n*(D2, E6) Cd-*n*-*p*(P6)	P6, R2, D2, F5, K6, A4, E6
	Ag^{109}	*A*	β^-	2.3 m.(A1, B20)	2.8(N4) cl. ch.		Ag-*n*-γ(A1) Ag-γ-*n*(B20) Pd-*p*-*n*(D2, E6) Cd-*n*-*p*(P6) Ag-*d*-*p*(K12)	A1, B20, N4, D2, P6, E6, K12
	Ag^{110}	*A*	β^- γ(P6)	22 s.(A1, P6)	2.8(G4) cl. ch. K. U.		Ag-*n*-γ(A1) Cd-*n*-*p*(P6)	A1, G4, P6
	$Ag^{108, 110}$	*C*	β^-	225 d.(L14, R10)			Ag-*n*-γ(R10, L14, A8, M12) Ag-*d*-*p*(K12)	R10, L14, A8, M12, K12
	Ag^{111}	*A*	β^-	7.5 d.(K6, P6)		No γ (K6, P6)	Pd-*d*-*n*(K6, P6) Pd-α-*p*(P6) Cd-*n*-*p*(P6) Pd^{111} β^- decay (K6)	K6, P6
	Ag^{112}	*A*	β^-, γ	3.2 h.(P6)	2.2(P6) cl. ch.		Cd-*n*-*p*(P6) In-*n*-α(P6)	P6
48	$Cd^{107, 109}$	*C*	*K*, e^-, γ(D4, V7, W11)	6.7 h.(D4, R5)		0.093(V7) spect. conv. 0.53(V7) abs. Pb	Ag-*p*-*n*(D4, R5, V7, W11) Ag-*d*-*n*(K12)	D4, R5, V7, K12, W11

TABLE II.—*Continued.*

Radio-element Z	A	Class	Type of Radiation	Half-Life	Energy of Radiation (Mev) Particles	γ-rays	Produced by	Observers
48	Cd^{109}	*E*	β^+	33 m.(P2)			Cd-*n*-2*n*(P2)	P2
	Cd^{115}	*A*	β^-, γ	2.5 d.(G5)	1.11(C14) spect.	0.8(C14) cl. ch. recoil	Cd-*d*-*p*(C14) Cd-*n*-γ(G5, M10) Cd-*n*-2*n*(G5)	G5, C14, M10
	Cd^{117}	*A*	β^-	3.75 h.(C14)			Cd-*d*-*p*(C14) Cd-*n*-γ(M10, G5)	G5, C14, M10
	Cd*	*D*	*I.T.*, e^-	50 m.(D8)			Cd-*n*-*n*(D8)	D8
49	In^{110}	*D*	β^+	65 m.(B17)	1.6(B17) spect.		Cd-*p*-*n*(B17) Ag-α-*n*(K9)	B17, K9
	In^{110}	*D*	β^+, γ, e^-	20 m.(B17, L15)	2.15(β^+) (C14) cl. ch.	0.16(B17) spect. conv.	Cd-*d*-2*n*(?)(L15) Cd-*p*-*n*(B17) Ag-α-*n*(K3, K9)	L15, B17, K3, C14, K9
	In^{112}	*B*	β^-	72 s.(L15, B17)			In-*n*-2*n*(L15, P2) In-γ-*n*(B11, C5) Cd-*p*-*n*(B17)	C5, B11, P2, L15, B17, K9
	In^{112}	*D*	β^-, γ, e^-(B17)	2.7 d.(B17, C14)	1.73(β^-)(D9)	0.17, 0.25 (B17, C14) spect. conv.	Cd-*p*-*n*(B17) In-*n*-2*n*(?)(C14)	B17, C14, D9
	In^{113}*	*A*	*I.T.*, γ, e^-(B17)	105 m.(B17)		0.39(B17) spect. conv.	Cd-*p*-*n*(B17) Sn^{113} *K* decay (B17, S22)	B17, S22
	In^{114}	*B*	β^-, γ, e^-	48 d.(B17)	1.75(β^-) (C14) cl. ch.	0.19(B17) spect. conv.	In-*n*-γ(L15, M12) Cd-*p*-*n*(B17)	M12, L15, B17, C14
	In^{115}*	*A*	*I.T.*, e^-, γ(C14)	4.1 h.(G5, B18)		0.34(C14) spect. conv.	In-*n*-*n*(G5) In-*p*-*p*(B18) In-α-α(L16) In-*x*-rays (P7, C10) Cd^{115} β^- decay (G5)	G5, B18, L16, C14, P7, C10
	In^{116}	*B*	β^-	13 s.(A1, C14)	2.8(C14) cl. ch.	No γ(M11)	In-*n*-γ(A1, L15) In-*d*-*p*(L15) Cd-*p*-*n*(D9)	A1, C14, M11, L15, D9
	In^{116}	*B*	β^-, γ	54 m.(A1, L15)	0.85(C14) spect.	1.8, 1.3, 1.0, 0.4, 0.2(C15) cl. ch. recoil	In-*n*-γ(A1, M11) Cd-*p*-*n*(B17) In-*d*-*p*(L15)	A1, M11, L15, C15, B17, C14
	In^{117}	*A*	β^-, γ, e^-	2.1 h.(C14)	1.73(β^-) (C14) spect.	0.388(C14) spect. conv.	Cd^{117} β^- decay (G5) Cd-*d*-*n*(C14)	G5, C14
50	Sn^{113}	*A*	*K*, e^-, γ	70–105 d.(L17, B17)		0.085(B17) spect. conv.	In-*p*-*n*(B17) Sn-*d*-*p*(L17) Cd-α-*n*(L17)	B17, L17
	$Sn^{<119}$	*E*	β^-	25 m.(L17)			Cd-α-*n*(L17)	L17
	$Sn^{<119}$	*E*	β^-	3 h.(L17)			Cd-α-*n*(L17)	L17
	$Sn^{<119}$	*E*	β^-	13 d.(L17)			Cd-α-*n*(L17)	L17
	$Sn^{<126}$	*D*	β^-	40 m.(L17)			Sn-*d*-*p*(L17) Sn-*n*-γ(L17) Sn-*n*-2*n*(P2)	L17, P2
	$Sn^{<126}$	*D*	β^-	26 h.(L17)			Sn-*d*-*p*(L17) Sn-*n*-γ(L17)	L17
	$Sn^{<126}$	*D*	β^-	10 d.(L17)			Sn-*d*-*p*(L17) Sn-*n*-γ(L17)	L17
	$Sn^{<126}$	*D*		~400 d.(L17)			Sn-*d*-*p*(L17)	L17
	Sn^{125}	*B*	β^-	9 m.(L17)			Sn-*d*-*p*(L17) Sn-*n*-γ(L17)	L17
51	Sb	*E*	β^-	3.5 m.(D9)			Sn-*p*-*n*(D9)	D9
	$Sb^{116, 118}$	*E*	β^+	5 m.(L16)			In-α-*n*(L16)	L16
	Sb^{120}	*A*	β^+	17 m.(H10, L18)	1.53(A10) cl. ch.		Sb-*n*-2*n*(P2, H10) Sb-γ-*n*(B20) Sn-*d*-*n*(L18) Sn-*p*-*n*(D9)	H10, B20, P2, L18, A10, D9
	Sb^{122}	*A*	β^-	2.8 d.(L28)	1.64(A10) cl. ch.	0.5(L28) abs. Pb	Sb-*d*-*p*(L18) Sb-*n*-γ(A1, L18) Sn-*d*-2*n*(L18) Sn-*p*-*n*(D9)	L18, A1, A10, D9, L28
	Sb^{124}	*A*	β^-	60 d.(L18)	1.8(L28) abs.	0.8(L28) abs. Pb	Sb-*d*-*p*(L18) Sb-*n*-γ(L18) I-*n*-α(L18)	L18, L28
	$Sb^{<126}$	*D*	β^-	3 h.(L18)			Sn-*d*-*n*(L18)	L18
	$Sb^{<126}$	*D*		~45 d.(L18)			Sn-*d*-*n*(L18)	L18
	$Sb^{<126}$	*D*		~2 y.(L18)			Sn-*d*-*n*(L18)	L18
	Sb^{127}	*A*	β^-	80 h.(A6)			U-*n*(A6)	A6
	Sb^{129}	*A*	β^-	4.2 h.(A6)			U-*n*(A6)	A6
	$Sb^{>131}$	*D*	β^-	<10 m.(A6)			U-*n*(A6)	A6
	$Sb^{>131}$	*D*	β^-	<10 m.(A6)			U-*n*(A6)	A6
	$Sb^{>131}$	*D*	β^-	5 m.(A6)			U-*n*(A6)	A6
52	Te^{121}	*A*	*K*, e^-	120 d.(S15)			Sb-*d*-2*n*(S15), Sn-α-*n*(L10) Sb-*p*-*n*(S15)	S15, L10
	Te^{127}	*A*	*I.T.*(S15)	90 d.(S15)			Te-*d*-*p*(S15) I-*n*-*p*(S15)	S15
	Te^{127}	*A*	β^-	10 h.(S15, T4)			Te-*d*-*p*(S15, T4) I-*n*-*p*(S15) Te-*n*-2*n*(T4) Te^{127} (90 d.) *I.T.* (S15) Sb^{127} β^- decay (A6)	S15, A6, T4
	Te^{129}	*A*	*I.T.*(S15)	30 d.(S15, T4)			Te-*d*-*p*(S15, T4) Te-*n*-2*n*(T4)	S15, T4

* Radioactive isomer of stable nucleus.

TABLE II.—*Continued.*

Radio-element		Class	Type of Radiation	Half-Life	Energy of Radiation (Mev)		Produced by	Observers
Z	*A*				Particles	γ-rays		
52	Te^{129}	*A*	β^-	70 m.(S15, A6)			Te-*d*-*p*(S15, T4) Te-γ-*n*(B20) Te-*n*-2*n*(H10, T4) Te^{129} (30 d.) *I.T.* (S15) Sb^{129} β^- decay (A6)	S15, B20, H10, A6, T4
	Te^{131}	*A*	*I.T.*(S15)	30 h.(S15, A6)			Te-*d*-*p*(S15) U-*n*(A6, H22)	S15, A6, H22
	Te^{131}	*A*	β^-	25 m.(S15)			Te-*d*-*p*(S15) Te-*n*-γ(S15) U-*n*(A6) Te^{131} (30 h.) *I.T.* (S15)	S15, A6
	$Te^{>131}$	*D*	β^-	43 m.(A6)			$Sb^{>131}$ (<10 m.) β^- decay (A6, H22)	A6, H22
	$Te^{>131}$	*D*	β^-	60 m.(A6)			$Sb^{>131}$ (<10 m.) β^- decay (A6, H22)	A6, H22
	$Te^{>131}$	*D*	β^-	77 h.(A6)			$Sb^{>131}$ (5 m.) β^- decay (A6, H22) Th-*n*(H24)	A6, H22, H24
	$Te^{>131}$	*D*	β^-	~0.5 h.(S21)			U-*n*(S21)	S21
53	I^{124}	*A*	β^+	4.0 d.(L19, D9)			Sb-α-*n*(L19) Te-*p*-*n*(D9)	L19, D9
	I^{126}	*A*	β^-, γ	13.0 d.(L19, T4)	1.1(L19) abs.	0.5(L19) abs. Pb	Sb-α-*n*(L19) I-*n*-2*n*(T4, L19) Te-*d*-*n*(L19) Te-*p*-*n*(D9)	L19, T4, D9
	I^{128}	*A*	β^-, γ	25 m.(A1)	1.2, 2.1(B19) cl. ch.	0.4(L19) abs. Pb	I-*n*-γ(A1, T4) Te-*d*-2*n*(L19) Te-*p*-*n*(D9)	A1, L19, B19, D9, T4
	I^{130}	*A*	β^-, γ	12.6 h.(L19)	0.83(T7) cl. ch.	0.6(L19) abs. Pb	Te-*d*-2*n*(L19) Te-*p*-*n*(D9)	L19, D9, T7
	I^{131}	*A*	β^-, γ	8.0 d.(L19)	0.687(T7) cl. ch.	0.4(L19) abs. Pb	Te-*d*-*n*(L19) Te^{131} β^- decay (S15, A6, H22)	L19, S15, T7, A6, H22
	$I^{>131}$	*D*	β^-	2.4 h.(A6)			$Te^{>131}$ (77 h.) β^- decay (A6, H22)	A6, H22
	$I^{>131}$	*D*	β^-	54 m.(A6)			$Te^{>131}$ (43 m.) β^- decay (H22, A6) Th-*n*(D6)	H22, D6, A6
	$I^{>131}$	*D*	β^-	6.6 h.(S21)			$Te^{>131}$(~0.5 h.) β^- decay(S21)	S21
	$I^{>131}$	*D*	β^-	22 h.(A6)			$Te^{>131}$ (60 m.) β^- decay (H22, A6, S21)	A6, H22, S21
54	Xe^{127}	*E*		~100 s.(W11)			I-*p*-*n*(W11)	W11
	Xe^{139}	*A*	β^-	<0.5 m.(H11, H12)			U-*n*(H22, H11) Th-*n*(A5)	H11, H22, A5, H12
	$Xe^{>139}$	*D*	β^-	~15 m.(H22)			U-*n*(H22, H11) Th-*n*(A5)	H11, A5, H22
	$Xe^{>131}$	*D*		4.5 d.(S21)			$I^{>131}$ (22 h.) β^- decay (S21)	S21
	$Xe^{>131}$	*D*		9.4 h.(S21)			$I^{>131}$ (6 h.) β^- decay (S21)	S21
55	Cs^{134}	*A*		1.5 h.(A1)			Cs-*n*-γ(A1, M16)	A1, M16
	Cs^{134}	*A*		~1 y.(A8)			Cs-*n*-γ(A8, S20)	A8, S20
	Cs^{139}	*A*	β^-	6 m.(H22)			Xe^{139} β^- decay (H22, H12, H11, A5)	H22, H11, A5, H12
	$Cs^{>139}$	*D*	β^-	33 m.(H22)			$Xe^{>139}$ (~15 m.) β^- decay (H22, H11, H12, A5) Pa-*n*(G7)	H22, H11, H12, A5, G7
56	Ba	*D*	e^-, γ	30 h.(K10)		0.23(K10) abs.	Ba-*n*-γ(K10)	K10
	Ba^{139}	*A*	β^-	86 m.(P8, H22)			Ba-*d*-*p*(P8) Ba-*n*-γ(A1, P2) La-*n*-*p*(P8) Cs^{139} β^- decay (H22, H11, A5, H12)	P8, A1, P2, H22, H12, H11, A5
	Ba	*F*		3 m.(A1, P2)			Ba-*n*-?(A1, P2)	A1, P2
	$Ba^{>139}$	*D*	β^-	300 h.(H22)			$Cs^{>139}$ (33 m.) β^- decay (H22, H11, H12, A5) Th-*n*(H24)	H22, H14, H12, H11, A5, H24
	$Ba^{>140}$	*D*	β^-	14 m.(H22)			U-*n*(H22, H12, H14) Th-*n*(H15, H14)	H22, H14, H12, H15
	$Ba^{>140}$	*E*	β^-	<1 m.(H14)			U-*n*(H14)	H14
57	La^{138}	*F*		2.2 h.(P2)			La-*n*-2*n*(?)(P2)	P2
	La^{140}	*A*	β^-	31 h.(P9)	0.8(P9) cl. ch.		La-*d*-*p*(P8) La-*n*-γ(P9, M13)	P8, P9, M13
	$La^{>140}$	*D*	β^-	~2.5 h.(H22)			$Ba^{>140}$ (14 m.) β^- decay (H22, H14, H15) U-*n*(B15) Th-*n*(C16)	H22, H14, H15, C16, B15
	$La^{>140}$	*E*	β^-	<30 m.(H14, H15)			$Ba^{>140}$ (<1 m.) β^- decay (H14, H15)	H14, H15
	$La^{>139}$	*D*	β^-	36 h.(H22)			$Ba^{>139}$ (300 h.) β^- decay (H22, H14, B15)	H22, H14, B15

TABLE II.—*Continued.*

Radio-element Z	A	Class	Type of Radiation	Half-Life	Energy of Radiation (Mev) Particles	γ-rays	Produced by	Observers
58	Ce^{139}	*F*	β^+	2.1 m.(P9)			Ce-*n*-2*n*(?)(P9)	P9
	$Ce^{141, 143}$	*C*		15 d.(R11)	0.12(R11) spect.		Ce-*n*-γ(R11)	R11
59	$Pr^{140, 142}$	*C*	β^+	3.5 m.(P9)			Pr-*n*-2*n* or Pr-*n*-γ(P9, A1)	P9, A1
	Pr^{142}	*A*	β^-	18.7 h.(P9)			Pr-*n*-γ(P9, P2, M13, A1)	P9, P2, M13,
							Nd-*n*-*p*(P9, P2)	A1
60	Nd^{147}	*E*	β^-	84 h.(P9)			Nd-*d*-*p*(P9)	P9
							Nd-*n*-γ(P9)	
							Nd-*n*-2*n*(?)(P9)	
	Nd^{149}	*E*	β^-	2.0 h.(P9)			Nd-*d*-*p*(P9)	P9
							Nd-*n*-γ(P9)	
							Nd-*n*-2*n*(?)(P9)	
	Nd^{151}	*E*	β^-	21 m.(P9)			Nd-*n*-γ(P9, M18)	P9, M18
61	61	*F*	β^-	12.5 h.(P9)			Nd-*d*-*n*(P9)	P9
62	Sm	*D*	β^-	21 m.(P9)			Sm-*n*-γ(P9, A1, M13, H17)	P9, A1, H17, M13
							Sm-*n*-2*n*(?)(P9)	
	Sm	*D*	β^-	46 h.(P9)			Sm-*n*-γ(P9, H20, R11, H17)	P9, H20, H17, R11
							Sm-*n*-2*n*(?)(P9)	
63	Eu^{150}	*E*	β^+	27 h.(P9)			Eu-*n*-2*n*(?)(P9, R11)	P9, R11
	$Eu^{152, 154}$	*C*	β^-, γ, e^-(T6); *K*(?)(R2)	9.2 h.(P9)	1.88(β^-)(T6) spect.	0.123, 0.163, 0.725(T6) spect. conv.	Eu-*n*-γ(P9, M13, H17, H20)	P9, R2, H17, T6, M13, H20,
							Eu-*n*-2*n*(?)(P9)	F7
							Eu-*d*-*p*(F7)	
	$Eu^{152, 154}$	*C*	β^-, γ(R11, F7)	>1 y.(F7, S20)	0.8(R11) spect.		Eu-*n*-γ(S20, R11, F7)	S20, R11, F7
	$Eu^{152, 154}$	*E*		12 m.(F7)			Eu-*d*-*p*(F7)	F7
	$Eu^{152, 154}$	*E*		105 m.(F7)			Eu-*d*-*p*(F7)	F7
64	$Gd^{159, 161}$	*E*		8 h.(A1, H17)			Gd-*n*-γ(A1, H20, H17)	A1, H17, H20
65	Tb^{160}	*A*	β^-	3.9 h.(H16, M13)			Tb-*n*-γ(H17, P9, M13, H20)	H17, P9, M13, H20
66	Dy^{165}	*A*	β^-	2.5 h.(H17, P9, M13)	1.9(N4) cl. ch.		Dy-*n*-γ(H17, H20, P9, M13)	H17, H20, P9, M13, N4
	Dy(?)	*F*	β^+	2.2 m.(P9)			Dy-*n*-?(P9)	P9
67	Ho^{164}	*F*	β^-	47 m.(P9)			Ho-*n*-2*n*(?)(P9)	P9
	Ho^{166}	*B*	β^-	35 h.(H17)	1.6(H20) abs.		Ho-*n*-γ(H17, H20, P9)	H17, H20, P9
68	Er^{165}	*F*	β^+	1.1 m.(P9)			Er-*n*-2*n*(?)(P9)	P9
	$Er^{169, 171}$	*C*		7 m.(M13)			Er-*n*-γ(M13, M18)	M13, M18
	$Er^{169, 171}$	*C*	β^-	12 h.(H17, P9)			Er-*n*-γ(H17, H20, P9, R12)	H17, P9, R12, H20
69	Tm^{170}	*A*		105 d.(H20)			Tm-*n*-γ(H20, N7)	H20, N7
70	$Yb^{175, 177}$	*C*		3.5 h.(H17, M13)			Yb-*n*-γ(H20, H17, M13, P9)	H20, H17, M13, P9
	Yb(?)	*G*		41 h.(P9)			Yb-*n*-γ(?)(P9)	P9
71	$Lu^{176, 177}$	*C*		4 h.(H17, H20, M13)			Lu-*n*-γ(H20, H17, M13, M18)	H20, H17, M13, M18
	$Lu^{176, 177}$	*C*		6 d. (H17, H20, F6)			Lu-*n*-γ(H17, H20, F6)	H20, H17, F6
	Rare Earth	*F*		2.3 d.(S4)			U-*n*(M19, S4)	M19, S4
72	Hf^{181}	*A*	β^-	55 d.(H19)			Hf-*n*-γ(H19)	H19
73	Ta^{180}	*A*		14–21 m. (B11, O1)			Ta-γ-*n*(B11) (Ta-*n*-2*n*)(?)(O1)	B11, O1
	Ta^{180}	*A*	*K*, e^-, γ(O1); β^-(?)	8.2 h.(O1)	<0.5(e^-)? (O1) abs.		Ta-*n*-2*n*(O1, P2)	O1, P2
	Ta^{182}	*A*	β^-	97 d.(O1)			Ta-*n*-γ(O1, F6)	O1, F6
							Ta-*d*-*p*(O1)	
74	$W^{185, 187}$	*C*		23 h.(M14)			W-*n*-γ(M14, A1)	A1, M14
75	Re	*E*		55 m.(D9)			W-*p*-*n*(D9)	D9
	Re	*E*		14 d.(D9)			W-*p*-*n*(D9)	D9
	Re^{186}	*B*	β^-	90 h.(S16)	1.2(S16) cl. ch. K. U.		Re-*n*-γ(S16, K7)	S16, K7, D9*
							Re-*n*-2*n*(S16)	
							W-*p*-*n*(D9)	
	Re^{188}	*B*	β^-	18 h.(P2)	2.5(S16) cl. ch. K. U.		Re-*n*-γ(P2, K7, S16)	S16, K7, P2
76	$Os^{191, 193}$	*C*	β^-	40 h.(K7)			Os-*n*-γ(K7)	K7
77	$Ir^{192, 194}$	*C*	β^-	1.5 m.(M15)			Ir-*n*-γ(M15)	M15
	$Ir^{192, 194}$	*C*	β^-	19 h.(M15, A1)	2.2(A2) spect.		Ir-*n*-γ(M15, A1, P2, J1)	M15, A1, P2,
							Au-*d*-α, *p*(?)(C18)	C18, A2, J1
	$Ir^{192, 194}$	*C*	β^-	60 d.(M15, F6)			Ir-*n*-γ(M15, F6, J1)	M15, F6, J1

TABLE II.—*Continued.*

Radio-element Z	A	Class	Type of Radiation	Half-Life	Energy of Radiation (Mev) Particles	γ-rays	Produced by	Observers
78	Pt^{197}	*B*	β^-	18 h.(M15)			Pt-*n*-γ(M15) Pt-*d*-*p*(C19)	M15, C19
	Pt^{197}	*B*	β^-	3.3 d.(M15)			Pt-*n*-γ(M15, P2)	M15, P2
	Pt^{199}	*A*	β^-	31 m.(M15)			Pt-*n*-γ(M15, A1, M14) Pt-*d*-*p*(C19)	M15, A1, C19, M14
79	Au^{198}	*B*	β^-	13 h.(M15)			Au-*n*-2*n*(M15)	M15
	Au^{196}	*B*	β^-	4–5 d.(M15)			Au-*n*-2*n*(M15)	M15
	Au^{198}	*A*	β^-, γ	2.7 d.(M15, A1)	0.8(M15, R2) abs. and cl. ch.	0.28, 0.44, 2.5(R2, S17) cl. ch. recoil	Au-*n*-γ(M15, A1, P2) Au-*d*-*p*(C18)	M15, A1, C18, R2, S17, P2
	Au^{199}	*A*	β^-	3.3 d.(M15)			Pt^{199} β^- decay (M15)	M15
	Au	*G*		17 m.(P2)			Pt-*n*-γ(?)(P2)	P2
80	Hg^{197}	*B*	*K*, e^-, γ (R11, A4)	43 m.(H10, M15)	<0.4(M15) abs.	<0.25(M15) abs.	Hg-*n*-2*n*(M15, H10, P2)	M15, H10, P2, R11, A4
	$Hg^{203, 205}$	*C*		25 h.(M15)			Hg-*n*-γ(M15, A9)	M15, A9
81	Tl^{200}	*F*		4 m.(K3)			Au-*α*-*n*(?)(K3)	K3
	Tl^{200}	*F*		3.8 h.(K3)			Au-*α*-*n*(?)(K3)	K3
	$Tl^{204, 206}$	*C*	β^-	4 m.(P10, H10)			Tl-*n*-γ(P10, P2, H10)	P10, H10, P2
	$Tl^{204, 206}$	*C*	β^-	97 m.(P10, M16)			Tl-*n*-γ(P10, M16, P2)	P10, M16, P2
82	Pb^{205}	*B*		80 m.(D10)			Pb-*n*-2*n*(D10)	D10
	Pb^{209}	*B*	β^-	3.0 h.(T5)			Pb-*d*-*p*(T5)	T5
83	Bi^{210}	*A*	β^-	5 d.(L13)			Bi-*d*-*p*(L13)	L13
84	Po^{210}	*A*	α	136 d.(L13)			Bi^{210} β^- decay (L13) Bi-*d*-*n*(V4)	L13, V4
	Po	*F*	α	7.5 h.(C23)	6, 7.5(C23) abs.		Bi-α(32 Mev)	C23
90	UY^{231}	*B*	β^-	24.5 h.(N5)			Th-*n*-2*n*(N5)	N5
	Th^{233}	*A*	β^-	26 m.(M17)			Th-*n*-γ(M17)	M17
91	Pa^{233}	*F*	β^-	25 d.(M17)			Th^{233} β^- decay (?)(M17)	M17
92	U^{239}	*B*	β^-	23 m.(I1, S4)			U-*n*-γ(H18, H14, I1, S4, M19)	H18, H14, I1, M19, S4

REFERENCES

A1. Amaldi, D'Agostino, Fermi, Pontecorvo, Rasetti and Segrè, Proc. Roy. Soc. **A149**, 522 (1935).
A2. Alichanian, Alichanow and Dzelepow, Physik. Zeits. d. Sowjetunion **10**, 78 (1936).
A3. Andersen, Zeits. f. physik. Chemie **B32**, 237 (1936).
A4. Alvarez, Phys. Rev. **54**, 486 (1938).
A5. Aten, Jr., Bakker and Heyn, Nature **143**, 679 (1939).
A6. Abelson, Phys. Rev. **56**, 1 (1939).
A7. Alvarez and Cornog, Phys. Rev. **56**, 613 (1939), and private communication.
A8. Alexeeva, Comptes rendus U.S.S.R. **18**, 553 (1938).
A9. Anderson, Nature **137**, 457 (1936).
A10. Amaki and Sugimoto, Inst. Phys. Chem. Research, Tokyo, Sci. Papers No. 853, 1650 (1938).
A11. Alvarez and Cornog, Phys. Rev. **56**, 379 (1939).
A12. Aston, *Mass Spectra and Isotopes* (E. Arnold and Co., London, 1933).
A13. Aston, Proc. Roy. Soc. **A149**, 396 (1935).
A14. Aston, Proc. Roy. Soc. **A146**, 46 (1934).
A15. Aston, Nature **137**, 613 (1936).

B1. Bjerge and Broström, Det. Kgl. Danske Vid. Selskab. **16**, No. 8 (1938).
B2. Bjerge and Broström, Nature **138**, 400 (1936).
B3. Bjerge, Nature **138**, 400 (1936).
B4. Bayley and Crane, Phys. Rev. **52**, 604 (1937).
B5. Bethe, Hoyle and Peierls, Nature **143**, 200 (1939).
B6. Bjerge, Nature **139**, 757 (1937).
B7. Bothe and Gentner, Naturwiss. **25**, 90 (1937).
B8. Barnes, Dubridge, Wiig, Buck and Strain, Phys. Rev. **51**, 775 (1937).
B9. Burcham, Goldhaber and Hill, Nature **141**, 510 (1938).
B10. Brown and Mitchell, Phys. Rev. **50**, 593 (1936).
B11. Bothe and Gentner, Naturwiss. **25**, 191 (1937).
B12. Barnes and Valley, Phys. Rev. **53**, 946 (1938).
B13. Buck, Phys. Rev. **54**, 1025 (1938).
B14. Bothe and Gentner, Naturwiss. **31**, 517 (1938).
B15. Bretscher and Cook, Nature **143**, 560 (1939).
B16. Bothe and Gentner, Naturwiss. **25**, 126 (1937).
B17. Barnes, Phys. Rev. **56**, 414 (1939).
B18. Barnes and Aradine, Phys. Rev. **55**, 50 (1939).
B19. Bacon, Grisewood and van der Merwe, Phys. Rev. **54**, 315 (1938).
B20. Bothe and Gentner, Zeits. f. Physik **112**, 45 (1939).
B21. Brandt, Zeits. f. Physik **108**, 726 (1938).
B22. Becker and Gaerttner, Phys. Rev. **56**, 854 (1939).
B23. Barkas, Phys. Rev. **56**, 287 (1939).
B24. Barresi and Cacciapuoti, Ricerca Scient. **10**, 464 (1939).
B25. Blewett, Phys. Rev. **49**, 900 (1936).
B26. Brewer, J. Am. Chem. Soc. **60**, 691 (1938).
B27. Bethe and Henderson, Phys. Rev. **56**, 1060 (1939).

C1. Crane, Delsasso, Fowler and Lauritsen, Phys. Rev. **47**, 971 (1935).

C2. Crane, Delsasso, Fowler and Lauritsen, Phys. Rev. **47**, 887 (1935).
C3. Crane and Lauritsen, Phys. Rev. **45**, 497 (1934).
C4. Crockcroft, Gilbert and Walton, Proc. Roy. Soc. **A148**, 225 (1935).
C5. Chang, Goldhaber and Sagane, Nature **139**, 962 (1937).
C6. Cork, Richardson and Kurie, Phys. Rev. **49**, 208 (1936).
C7. Curie and Joliot, Comptes rendus **198**, 254 (1934).
C8. Cacciapuoti, N. Cimento **15**, 213 (1938).
C9. Chichoki and Soltan, Comptes rendus **207**, 423 (1938).
C10. Collins, Waldman and Stubblefield, Phys. Rev. **55**, 507 (1939).
C11. Curtis and Cork, Phys. Rev. **53**, 681 (1938).
C12. Cacciapuoti, Phys. Rev. **55**, 110 (1939).
C13. Crittenden, Jr., Phys. Rev. **56**, 709 (1939).
C14. Cork and Lawson, Phys. Rev. **56**, 291 (1939).
C15. Curtis and Richardson, Phys. Rev. **53**, 942 (1938).
C16. Curie and Savitch, Comptes rendus **208**, 343 (1939).
C17. Curie and Preiswerk, Comptes rendus **203**, 787 (1936).
C18. Cork and Thornton, Phys. Rev. **51**, 59 (1937).
C19. Cork and Lawrence, Phys. Rev. **49**, 788 (1936).
C20. Curtis, Phys. Rev. **55**, 1136 (1939).
C21. Cork and Thornton, Phys. Rev. **53**, 866 (1938).
C22. Curie and Joliot, J. de phys. et rad. **5**, 153 (1934).
C23. Corson, Private communication.
C24. Cacciapuoti and Segrè, Phys. Rev. **52**, 1252 (1937).

D1. Delsasso, Fowler and Lauritsen, Phys. Rev. **48**, 848 (1935).
D2. DuBridge, Barnes, Buck and Strain, Phys. Rev. **53**, 447 (1938).
D3. DuBridge, Barnes, Wiig, Buck and Strain, Phys. Rev. **53**, 326 (1938).
D4. Delsasso, Ridenour, Sherr and White, Phys. Rev. **55**, 113 (1939).
D5. Darling, Curtis and Cork, Phys. Rev. **51**, 1010 (1937).
D6. Dodson and Fowler, Phys. Rev. **55**, 880 (1939).
D7. De Vries and Veldkamp, Physica **5**, 249 (1938).
D8. Dodé and Pontecorvo, Comptes rendus **207**, 287 (1938).
D9. DuBridge, Private communication. Includes work of entire Rochester group.
D10. DeVries and Diemer, Physica **6**, 599 (1939).
D11. Dempster, Phys. Rev. **55**, 794 (1939).
D12. Dempster, Phys. Rev. **53**, 727 (1938).
D13. Dempster, Phys. Rev. **52**, 1074 (1937).
D14. Dempster, Phys. Rev. **50**, 186 (1936).
D15. Dempster, Phys. Rev. **49**, 947 (1936).
D16. Dempster, Nature **136**, 65 (1935).
D17. Dempster, Nature **138**, 120 (1936).
D18. DuBridge and Marshall, Phys. Rev. **56**, 706 (1939).
D19. DeVault and Libby, Phys. Rev. **55**, 322 (1939).

E1. Ellis and Henderson, Nature **135**, 429 (1935).
E2. Ellis and Henderson, Proc. Roy. Soc. **A156**, 358 (1936).
E3. Ewing, Perry and McCreary, Phys. Rev. **55**, 1136 (1936).
E4. Enns, Phys. Rev. **55**, 1118 (1939).
E5. Ewing, Private communication from Barnes.
E6. Enns, Phys. Rev. **56**, 872 (1939).

F1. Fowler, Delsasso and Lauritsen, Phys. Rev. **49**, 561 (1936).
F2. Frisch, Nature **133**, 721 (1934).
F3. Fahlenbrach, Zeits. f. Physik **96**, 503 (1935).
F4. Frisch, Nature **136**, 220 (1935).
F5. Feather and Dunworth, Proc. Roy. Soc. **A168**, 566 (1938).
F6. Fomin and Houtermans, Physik. Zeits. d. Sowjetunion **9**, 273 (1936).
F7. Fajans and Stewart, Phys. Rev. **56**, 625 (1939).
F8. Friedlaender, Private communication.

G1. Gentner, Naturwiss. **26**, 109 (1938).
G2. Gentner and Segrè, Phys. Rev. **55**, 814 (1939).
G3. Guében, Nature **138**, 1095 (1936).
G4. Gaerttner, Turin and Crane, Phys. Rev. **49**, 793 (1936).
G5. Goldhaber, Hill and Szilard, Phys. Rev. **55**, 47 (1939) and Nature **142**, 521 (1938).
G6. Grahame and Seaborg, Phys. Rev. **54**, 240 (1938).
G7. v. Grosse, Booth and Dunning, Phys. Rev. **56**, 382 (1939).
G8. A. v. Grosse, J. Am. Chem. Soc. **56**, 2501 (1934).
G9. Grahame and Walke, Private communication.

H1. Hill, Phys. Rev. **55**, 1117 (1939).
H2. Hill and Valley, Phys. Rev. **55**, 678 (1939).
H3. Hafstad and Tuve, Phys. Rev. **48**, 306 (1935).
H4. Henderson, M. C., Phys. Rev. **48**, 855 (1935).
H5. Hurst and Walke, Phys. Rev. **51**, 1033 (1937).
H6. Hemmendinger, Phys. Rev. **55**, 604 (1939).
H7. Heyn, Physica **4**, 160 (1937).
H8. Heyn, Physica **4**, 1224 (1937).
H9. Harteck, Knauer and Schaeffer, Zeits. f. Physik **109**, 153 (1938).
H10 Heyn, Nature **139**, 842 (1937).
H11. Heyn, Aten, Jr. and Bakker, Nature **143**, 516 (1939).
H12. Hahn and Strassmann, Naturwiss. **27**, 163 (1939).
H13. Hevesy and Levi, Nature **135**, 580 (1935).
H14. Hahn and Strassmann, Naturwiss. **27**, 11 (1939).
H15. Hahn and Strassmann, Naturwiss. **27**, 89 (1939).
H16. Hevesy and Levi, Nature **136**, 103 (1935).
H17. Hevesy and Levi, Nature **137**, 185 (1936).
H18. Hahn, Meitner and Strassmann, Zeits. f. Physik, **106**, 249 (1937).
H19. Hevesy and Levi, Det. Kgl. Danske Videnskabernes Selskab. **15**, No. 11 (1938).
H20. Hevesy and Levi, Det. Kgl. Danske Videnskabernes Selskab. **14**, No. 5 (1936).
H21. Henderson and Doran, Phys. Rev. **56**, 123 (1939).
H22. Hahn and Strassmann, Naturwiss. **27**, 529 (1939).
H23. Hahn and Strassmann, Naturwiss. **27**, 451 (1939).
H24. Hahn, Strassmann and Flügge, Naturwiss **27**, 544 (1939).

H25. Helmholz, Private communication.
H26. Hemmendinger and Smythe, Phys. Rev. **51**, 1052 (1937).
H27. Hall and Jones, J. Am. Chem. Soc. **58**, 1915 (1936).
H28. Heyden and Wefelmeier, Naturwiss. **26**, 612 (1938).

I1. Irvine, Jr., Phys. Rev. **55**, 1105 (1939).

J1. Jaeckel, Zeits. f. Physik, **110**, 330 (1938).

K1. Knol and Veldkamf, Physica **3**, 145 (1936).
K2. Kittel, Phys. Rev. **55**, 515 (1939).
K3. King, Henderson and Risser, Phys. Rev. **55**, 1118 (1939).
K4. Kurie, Richardson and Paxton, Phys. Rev. **49**, 368 (1936).
K5. Kurtchatow, Kurtchatow, Myssowsky and Roussinow, Comptes rendus **200**, 1201 (1935).
K6. Kraus and Cork, Phys. Rev. **52**, 763 (1937).
K7. Kurtchatow, Latyschew, Nemenow and Selinow, Physik. Zeits. d. Sowjetunion **8**, 589 (1935).
K8. Kuerti and Van Voorhis, Phys. Rev. **56**, 614 (1939).
K9. King and Henderson, W. J., Bull. Am. Phys. Soc. **14**, No. 5, 11 (1939).
K10. Kalbfell, Phys. Rev. **54**, 543 (1938), and private communication.
K11. Kennedy, Seaborg and Segrè, Phys. Rev. **56**, 1095 (1939).
K12. Krishnan and Gant, Nature **144**, 547 (1939).

L1. Lewis, Burcham and Chang, Nature **139**, 24 (1937).
L2. Lyman, Phys. Rev. **55**, 234 (1939).
L3. Laslett, Phys. Rev. **52**, 529 (1937).
L4. Lawrence, Phys. Rev. **47**, 17 (1935).
L5. Lyman, Phys. Rev. **51**, 1 (1937).
L6. Libby and Lee, Phys. Rev. **55**, 245 (1939).
L7. Livingood and Seaborg, Phys. Rev. **54**, 391 (1938).
L8. Livingood, Seaborg and Fairbrother, Phys. Rev. **52**, 135 (1937).
L9. Livingood and Seaborg, Phys. Rev. **53**, 847 (1938).
L10. Livingood and Seaborg, to be published in Phys. Rev.
L11. Livingood and Seaborg, Phys. Rev. **53**, 765 (1938).
L12. Livingood and Seaborg, Phys. Rev. **55**, 457 (1939).
L13. Livingood, Phys. Rev. **50**, 425 (1936).
L14. Livingood and Seaborg, Phys. Rev. **54**, 88 (1938).
L15. Lawson and Cork, Phys. Rev. **52**, 531 (1937).
L16. Lark-Horovitz, Risser and Smith, Phys. Rev. **55**, 878 (1939).
L17. Livingood and Seaborg, Phys. Rev. **55**, 667 (1939).
L18. Livingood and Seaborg, Phys. Rev. **55**, 414 (1939).
L19. Livingood and Seaborg, Phys. Rev. **54**, 775 (1938).
L20. Livingood and Seaborg, Phys. Rev. **54**, 51 (1938).
L21. Lawson, Phys. Rev. **56**, 131 (1939).
L22. Lyman, Phys. Rev. **55**, 1123 (1939).
L23. Livingood and Seaborg, Phys. Rev. **55**, 1268 (1939).
L24. Lawrance, Proc. Camb. Phil. Soc. **35**, 304 (1939).
L25. Livingston and Bethe, Rev. Mod. Phys. **9**, 359 (1937).
L26. Lieber, Naturwiss. **27**, 421 (1939).
L27. Langsdorf, Jr., Phys. Rev. **56**, 205 (1939).
L28. Livingood and Seaborg, Unpublished work.
L29. Langer, Mitchell and McDaniel, Phys. Rev. **56**, 422 (1939).
L30. Lub, K. Akad. Amst. Proc. **42**, 253 (1939).
L31. Lichtblau, Naturwiss. **27**, 260 (1939).
L32. Langsdorf, Jr. and Segrè, Phys. Rev., in print.
L33. Livingston and Wright, Private communication.

M1. Maier-Leibnitz, Naturwiss. **26**, 614 (1939).
M2. Meitner, Naturwiss. **22**, 420 (1934).
M3. McMillan and Livingston, Phys. Rev. **47**, 452 (1935).
M4. Magnan, Comptes rendus **205**, 1147 (1937).
M5. McMillan and Lawrence, Phys. Rev. **47**, 343 (1935).
M6. Mitchell and Langer, Phys. Rev. **52**, 137 (1937).
M7. Mann, Phys. Rev. **52**, 405 (1937).
M8. Mann, Phys. Rev. **54**, 649 (1938).
M9. Mann, Phys. Rev. **53**, 212 (1938).
M10. Mitchell, Phys. Rev. **51**, 995 (1937).
M11. Mitchell and Langer, Phys. Rev. **53**, 505 (1938).
M12. Mitchell, Phys. Rev. **53**, 269 (1938).
M13. Marsh and Sugden, Nature **136**, 102 (1935).
M14. McLennan, Grimmet and Read, Nature **135**, 147 (1935).
M15. McMillan, Kamen and Ruben, Phys. Rev. **52**, 375 (1937).
M16. McLennan, Grimmet and Read, Nature **135**, 505 (1935).
M17. Meitner, Strassmann and Hahn, Zeits. f. Physik **109**, 538 (1938).
M18. McLennan and Rann, Nature **136**, 831 (1935).
M19 McMillan, Phys. Rev. **55**, 510 (1939).
M20. Mecke and Childs, Zeits. f. Physik **68**, 362 (1931).
M21. McKellar, Phys. Rev. **45**, 761 (1934).
M22. Mattauch and Lichtblau, Zeits. f. physik. Chemie **B42**, 288 (1939).
M23. Mattauch and Hauk, Naturwiss. **25**, 781 (1937).
M24. Mattauch, Lichtblau, Schüler and Gollnow, Zeits. f. Physik **111**, 514 (1939).

N1. Nahmias and Walen, Comptes rendus **203**, 71 (1936).
N2. Newson, Phys. Rev. **48**, 790 (1935).
N3. Newson, Phys. Rev. **51**, 624 (1937).
N4. Naidu and Siday, Proc. Phys. Soc. London, **48**, 332 (1936).
N5. Nishina, Yasaki, Kimura and Ikawa, Nature **142**, 874 (1938).
N6. Nahmias and Shiff, J. de phys. et rad. 140 (1938).
N7. Neuninger and Rona, Wiener Akad. Anzeiger **73**, 159 (1936).
N8. Nier, Phys. Rev. **52**, 933 (1937).
N9. Nier, Phys. Rev. **53**, 282 (1938).
N10. Nier, Phys. Rev. **55**, 1143 (1939).
N11. Nier, Phys. Rev. **52**, 885 (1937).
N12. Nier, Phys. Rev. **55**, 150 (1939).
N13. Nier, Phys. Rev. **54**, 275 (1938).
N14. Nier, Phys. Rev. **50**, 1041 (1936).
N15. Nier, J. Am. Chem. Soc. **60**, 1571 (1938).
N16. Nier and Gulbransen, J. Am. Chem. Soc. **61**, 697 (1939).
N17. Nier and Hanson, Phys. Rev. **50**, 722 (1936).

O1. Oldenberg, Phys. Rev. **53**, 35 (1938).
O2. Oppenheimer and Tomlinson, Phys. Rev. **56**, 858 (1939).
O3. Ornstein and Vreeswijk, Zeits. f. Physik **80**, 57 (1933).

P1. Polessitsky Physik. Zeits. de Sowjetunion **12**, 339 (1937).
P2. Pool, Cork and Thornton, Phys. Rev. **52**, 239 (1937).
P3. Pool, Cork and Thornton, Phys. Rev. **52**, 41 (1937).
P4. Perrier, Santangelo and Segrè, Phys. Rev. **53**, 104 (1938).
P5. Pontecorvo, Phys. Rev. **54**, 542 (1938).
P6. Pool, Phys. Rev. **53**, 116 (1938).
P7. Pontecorvo and Lazard, Comptes rendus **208**, 99 (1938).
P8. Pool and Cork, Phys. Rev. **51**, 1010 (1937).
P9. Pool and Quill, Phys. Rev. **53**, 437 (1938).
P10. Preiswerk and von Halban, Comptes rendus **201**, 722 (1935).

R1. Roberts, Heydenburg and Locher, Phys. Rev. **53**, 1016 (1938).
R2. Richardson, Phys. Rev. **55**, 609 (1939).
R3. Ridenour and Henderson, Phys. Rev. **52**, 889 (1937).
R4. Richardson, Phys. Rev. **53**, 124 (1938).
R5. Ridenour, Delsasso, White and Sherr, Phys. Rev. **53**, 770 (1938).
R6. Ridenour, Henderson, Henderson and White, Phys. Rev. **51**, 1012 (1937).
R7. Richardson, Phys. Rev. **49**, 203 (1936).
R8. Richardson and Kurie, Phys. Rev. **50**, 999 (1936).
R9. Risser, Phys. Rev. **52**, 768 (1937).
R10. Reddemann and Strassmann, Naturwiss. **26**, 187 (1938).
R11. Ruben and Kamen, Private communication.
R12. Rona, Wiener Akad. Anzeiger **73**, 159 (1936).
R13. Rumbaugh, Roberts and Hafstad, Phys. Rev. **54**, 657 (1938).
R14. Rumbaugh and Hafstad, Phys. Rev. **50**, 681 (1936).

S1. Snell, Phys. Rev. **51**, 143 (1937).
S2. Sagane, Phys. Rev. **50**, 1141 (1936).
S3. Snell, Phys. Rev. **49**, 555 (1936).
S4. Segrè, Phys. Rev. **55**, 1104 (1939).
S5. Sinma and Yamasaki, Sci. Papers Inst. Phys. Chem. Research (Tokyo) **35**, 16 (1938).
S6. Sagane, Phys. Rev. **55**, 31 (1939).
S7. Sagane, Phys. Rev. **53**, 212 (1938).
S8. Sagane, Kojima and Ikawa, Phys. Rev. **54**, 149 (1938).
S9. Snell, Phys. Rev. **52**, 1007 (1937).
S10. Segrè, Halford and Seaborg, Phys. Rev. **55**, 321 (1939).
S11. Stewart, Lawson and Cork, Phys. Rev. **52**, 901 (1937).
S12. Sagane, Kojima, Miyamoto and Ikawa, Phys. Rev. **54**, 543 (1938).
S13. Sagane, Kojima, Miyamoto and Ikawa, Phys. Rev. **54**, 970 (1938).
S14. Seaborg and Segrè, Phys. Rev. **55**, 808 (1939).
S15. Seaborg, Livingood and Kennedy, Phys. Rev. **55**, 794 (1939).
S16. Sinma and Yamasaki, Phys. Rev. **55**, 320 (1939).
S17. Sizoo and Eijkman, Physica **6**, 332 (1939).
S18. Strain, Phys. Rev. **54**, 1021 (1938).
S19. Stewart, Phys. Rev. **55**, 674 (1939).
S20. Scheichenberger, Anz. Akad. Wien, Nr. **17**, 108 (1938).
S21. Segrè, Langsdorf, Jr., and Wu, Private communication.
S22. Segrè, Kennedy and Seaborg, unpublished work.
S23. Shaeffer and Harteck, Zeits. f. Physik **113**, 287 (1939).
S24. Sampson and Bleakney, Phys. Rev. **50**, 456 (1936).
S25. Smythe and Hemmendinger, Phys. Rev. **51**, 178 (1937).
S26. Sampson and Bleakney, Phys. Rev. **50**, 732 (1936).
S27. Smythe, Phys. Rev. **45**, 299 (1934).
S28. Stewart, Phys. Rev. **56**, 629 (1939).
S29. Segrè, Ricerca Scient. **7**, 389 (1936).

T1. Thornton, Phys. Rev. **51**, 893 (1937).
T2. Thornton, Phys. Rev. **53**, 326 (1938).
T3. Thornton, Phys. Rev. **49**, 207 (1936).
T4. Tape and Cork, Phys. Rev. **53**, 676 (1938).
T5. Thornton and Cork, Phys. Rev. **51**, 383 (1937).
T6. Tyler, Phys. Rev. **56**, 125 (1939).
T7. Tape, Phys. Rev. **56**, 965 (1939).
T8. Tate and Smith, Phys. Rev. **43**, 672 (1933).

V1. Van Voorhis, Phys. Rev. **49**, 889 (1936).
V2. Van Voohis, Phys. Rev. **50**, 895 (1936).
V3. Valley and McCreary, Phys. Rev. **55**, 666 (1939).
V4. Van Voorhis, private communication.
V5. Victorin, Proc. Camb. Phil. Soc. **34**, 612 (1938).
V6. Vaughan, Williams and Tate, Phys. Rev. **46**, 327 (1934).
V7. Valley and McCreary, Phys. Rev. **56**, 863 (1939).

W1. Walke, Phys. Rev. **52**, 663 (1937).
W2. Walke, Phys. Rev. **51**, 439 (1937).
W3. Walke, Phys. Rev. **52**, 400 (1937).
W4. Walke, Phys. Rev. **52**, 777 (1937).
W5. Walke, Williams and Evans, Proc. Roy. Soc. **A171**, 360 (1939).
W6. Walke, Phys. Rev. **52**, 669 (1937).
W7. White, Delsasso, Fox and Creutz, Phys. Rev. **56**, 512 (1939).
W8. Walke, Private communication.
W9. Weil and Barkas, Phys. Rev. **56**, 485 (1939).
W10. Wilkins and Dempster, Phys. Rev. **54**, 315 (1938).
W11. White, Private communication.
W12. Ward, Proc. Camb. Phil. Soc. **35**, 523 (1939).

Y1. Yost, Ridenour and Shinohara, J. Chem. Phys. **3**, 133 (1935).
Y2. Yasaki and Watanabe, Nature **141**, 787 (1938).