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Table of Isotopes

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THE following table presents a complete list of all the artificial and natural radioactive isotopes and stable isotopes known to date (covering publications received prior to June 1, 1944) together with a number of important features associated with them.

The first and second columns give the atomic numbers and the mass numbers associated with the isotopes. The degree of certainty of each assignment of a radioactive isotope 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 percent abundance of the stable isotopes is listed in column four.

The fifth 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,
α = alpha-particles,
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 sixth column. Usually for the cases 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 some cases of natural radioactivities an average value, taken from an international committee summary report (C60), is used.

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 (K32) extrapolated value has been reported, this is listed,

followed by the designation "K.U." For alpha-particles the mean-range-in-air *vs.* energy relationship of Holloway and Livingston (H81) was used. The methods used for the determination of the energy of the particles (alpha and beta) are described in each case with the aid of the following symbols: abs. = absorption; cl. ch. = cloud chamber (with magnetic field in case of beta-particles); spect. = magnetic deflection (magnetic spectrograph or spectrometer or counter in magnetic field); calor. = calorimetric measurements; ion. ch. = measurement of pulse sizes in ionization chamber; coincid. abs. = beta- and gamma-coincidence counters with absorbers; and coincid. = beta- and gamma-coincidence counters. The alpha-particle energies which are listed are those of the main group for each of the isotopes which have more than one group.

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 absorbers; spect. conv. = internal-conversion electrons with magnetic spectrograph; spect. = secondary electrons with magnetic spectrograph; abs. of e^- = absorption of internal-conversion electrons; coincid. = gamma-gamma-coincidence counters; Be-γ-n reaction = measurement of neutron energy from Be-γ-n reaction; and D-γ-n reaction = measurement of neutron energy from D-γ-n reaction. When internal-conversion electrons are emitted, the energy listed is always that of the corresponding gamma-ray transition. Only the main gamma-rays are listed for the natural radioactive isotopes.

When a semicolon is used, it means that the values listed on each side of it are independent determinations of the same item, e.g., independent determinations of the half-life or of the energy of the radiation of a radioactivity. In another usage the semicolon separates the symbols in the "type of radiation" column and the energy values and symbols in the "energy of radiation" columns when there is more than one type of decay (β^-, β^+, α, K, or I.T.) for the radioactivity.

The observed nuclear reactions (giving the target element, projectile, and outgoing particle, in order) by which the radioactive isotopes are formed, and the corresponding references are listed in the last column (p = proton, n = neutron, α = alpha-particle, d = deuteron, γ = gamma-ray). The neutron-induced fission reactions of the heavy elements 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. Similarly, the radioactivities of the three heavy natural families (except for the three parents of these families) are listed as produced by the decay of their immediate parent isotopes. The natural radioactivities without parents are listed as produced by a "natural source," followed by a reference to the original discovery.

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. As a rule 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.

The half-lives of H^3, Be^{10}, C^{14}, and Cl^{36} have been estimated from measured intensities of the radioactivities together with the corresponding values for the yields.

Table of Isotopes

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
1	H^1		99.98(H70)					
	H^2		0.02(H70)					
	H^3	*A*		β^-	31 yr.(O4)	0.015(O3,N6) abs., cl.ch.		D-*d*-*p*(A7,A16) Be-*d*-H^3(O6,A16) Li-*n*-H^3(O4) B-*n*-H^3(C15) N-*n*-H^3(C15)
2	He^3		$\sim10^{-5}$(A7, A30)					
	He^4		100(T20)					
	He^6	*A*		β^-	0.8 sec.(B1)	3.7(B1,B2) cl.ch.		Be-*n*-α(B1,P1,B3) (Li-*n*-*p*)(K1)
3	Li^6		7.5(H71)					
	Li^7		92.5(H71)					
	Li^8	*A*		β^-,α	0.88 sec.(L1)	12(β^-)(B4) cl.ch.		Li-*d*-*p*(C1,L1,R14,D1) B-*n*-α(L24) (Li-*n*-γ)(K1)
4	Be^7	*A*		K,γ	43 days(R13,A18)		0.485(Z1) coincid. abs.	Li-*d*-*n*(R1,R13,Z1) B-*p*-α(R1,M1) Li-*p*-*n*(H30,H2)
	Be^9		100(N30)					
	Be^{10}	*A*		β^-,γ	$\gg10^3$ yr.(M22)	$\sim$0.5(M22) abs.	<0.5(M22) abs.	Be-*d*-*p*(M22)
5	B^{10}		18.4(O20)					
	B^{11}		81.6(O20)					
	B^{12}	*A*		β^-	0.022 sec.(C2,B22)	12(B4) cl.ch.		B-*d*-*p*(C2,F1,B5)
6	C^{10}	*A*		β^+	8.8 sec.(B27,D26)	3.4(D26) cl.ch.		B-*p*-*n*(B27,D26)
	C^{11}	*A*		β^+	20.5 min.(S8,T8)	0.95(D26) 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)
	C^{12}		98.9(N31)					
	C^{13}		1.1(N31)					
	C^{14}	*A*		β^-	$>10^3$ yr.(K24)	0.145(R21) abs.	No γ(R21)	C-*d*-*p*(R17,R21) N-*n*-*p*(R21)
7	N^{13}	*A*		β^+,γ	9.93 min.(W14,T8)	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,H44) N-*d*-H^3(B7)
	N^{14}		99.62(V20)					
	N^{15}		0.38(V20)					
	N^{16}	*A*		β^-	8 sec.(C5,N1)	6.0(?)(F1) cl.ch.		N-*d*-*p*(F1) O-*n*-*p*(C5) F-*n*-α(N1,P1,N4)
8	O^{15}	*A*		β^+	126 sec.(M3,B20)	1.7(F1) cl.ch.		N-*d*-*n*(M3,F1) O-γ-*n*(B20,H44) O-*n*-2*n*(P2) N-*p*-γ(D2) C-α-*n*(K3)
	O^{16}		99.76(S60)					
	O^{17}		0.041(M50)					
	O^{18}		0.20(S60)					
	O^{19}	*A*		β^-	31 sec.(N1)			F-*n*-*p*(N1,A1)
9	F^{17}	*A*		β^+	70 sec.(N2)	2.1(K4) cl.ch.		O-*d*-*n*(N2,F1) N-α-*n*(R3) O-*p*-γ(D2)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
9	F^{18}	*A*		β^+	112 min.(S1)	0.7(Y2) cl.ch.		Ne-*d*-α(S1) O-*p*-*n*(D2) F-*n*-2*n*(P2) O-*d*-*n*(D22,Y2,W2) F-*d*-H^3(B7,K2) F-γ-*n*(H44)
	F^{19}		100(A30)					
	F^{20}	*A*		β^-,γ(B50, C47)	12 sec.(C1)	5.0(F1,B50) cl.ch.	2.2(B50) cl.ch. recoil	F-*d*-*p*(F1,C1) F-*n*-γ(N1) Na-*n*-α(N1)
10	Ne^{19}	*A*		β^+	20.3 sec.(W7)	2.20(W7) cl.ch.		F-*p*-*n*(W7)
	Ne^{20}		90.00(V20)					
	Ne^{21}		0.27(V20)					
	Ne^{22}		9.73(V20)					
	Ne^{23}	*A*		β^-	40 sec.(A1,B6)	4.1(P21) abs.		Na-*n*-*p*(A1,N1,P1) Mg-*n*-α(A1,B6) Ne-*d*-*p*(P21,W24)
11	Na^{21}	*B*			23 sec.(C27)			Ne-*p*-*n*(C27) Ne-*d*-*n*(P21)
	Na^{22}	*A*		β^+,γ	3.0 yr.(L3)	0.58(L3) cl.ch.	1.3(O2) spect.	Mg-*d*-α(L3) F-α-*n*(L3,M4) Ne-*d*-*n*(L3)
	Na^{23}		100(S61)					
	Na^{24}	*A*		β^-,γ	14.8 hr.(V1)	1.4(L21,S49) spect.	1.4, 2.8(E7,I2,E8) spect.; 2.87(G16) Be-γ-*n* reaction, D-γ-*n* reaction; 2.69, 3.22, 3.61(O10) cl.ch. pair	Na-*d*-*p*(L4,V1) Na-*n*-γ(A1) Mg-*n*-*p*(A1) Al-*n*-α(A1) Mg-*d*-α(H4)
	Na^{25}	*E*		β^-,γ	62 sec.(H54)	2.8(H54) abs. Al	0.035(H54) abs. Al	Mg-γ-*p*(H54)
12	Mg^{23}	*A*		β^+	11.6 sec.(W7)	2.82(W7) cl.ch.		Na-*p*-*n*(W7, D9) Mg-γ-*n*(H43,H44)
	Mg^{24}		77.4(A31)					
	Mg^{25}		11.5(A12)					
	Mg^{26}		11.1(A12)					
	Mg^{27}	*A*		β^-,γ	10.2 min.(H4)	1.8(C13) cl.ch.	0.64, 0.84, 1.02(I2) spect.	Mg-*d*-*p*(H4) Mg-*n*-γ(A1) Al-*n*-*p*(A1)
13	Al^{26}	*A*		β^+	7.0 sec.(W7,F2)	2.99(W7) cl.ch.		Na-α-*n*(M4,F2) Mg-*p*-*n*(W7,D9) Mg-*p*-γ(C29) Al-γ-*n*(H43,H44,H58)
	Al^{27}		100(A31)					
	Al^{28}	*A*		β^-,γ(W17)	2.4 min.(A1,M5, E2)	3.3(C6) cl.ch.	1.8(I2) spect.	Al-*d*-*p*(M5) Al-*n*-γ(A1) Si-*n*-*p*(A1) P-*n*-α(A1) Mg-α-*p*(E2,R3)
	Al^{29}	*A*		β^-	6.7 min.(B25)	2.5(B25) cl.ch. and abs.		Mg-α-*n*(B25,H21,F3)
14	Si^{27}	*A*		β^+	4.9 sec.(K10,C27)	3.74(M21) cl.ch.; 3.54(B8) cl.ch.		Al-*p*-*n*(K8,M21,C27,B8) Mg-α-*n*(K10)
	Si^{28}		89.6(M51)					
	Si^{29}		6.2(M51)					
	Si^{30}		4.2(M51)					
	Si^{31}	*A*		β^-	170 min.(N3,A13)	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)
15	P^{29}	*A*		β^+	4.6 sec.(W11)	3.63(W11) cl.ch.		Si-*p*-*n*(W11)
	P^{30}	*A*		β^+	2.55 min.(R3,B49)	3.0(B48,B49) cl.ch.; 3.5(M26) spect.		Al-α-*n*(R3,C7) S-*d*-α(S2) P-*n*-2*n*(P2) P-γ-*n*(B20)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
15								Si-p-n(B23,B49) Si-He^3-p(A7)
	P^{31}		100(A31)					
	P^{32}	*A*		β^-	14.30 days(C8)	1.69(L5) spect.; 1.75(W29) spect.; 1.71 (S49) 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)
16	S^{31}	*A*		β^+	3.2 sec.(W11,K10)	3.85(W11,E4) cl.ch.		P-p-n(W11,V4) Si-α-n(K10) S-γ-n(H43,H44,H58)
	S^{32}		95.1(N32)					
	S^{33}		0.74(N32)					
	S^{34}		4.2(N32)					
	S^{35}	*A*		β^-	87.1 days(H53)	0.107(L6) spect.; 0.120(K13) abs. Al		Cl-n-p(A3,L6,L58,K13) S-d-p(C25,K13) Cl-d-α(K13)
	S^{36}		0.016(N32)					
17	Cl^{33}	*A*		β^+	2.4 sec.(W11)	4.13(W11) cl.ch.		S-d-n(H31) S-p-n(W11)
	Cl^{34}	*A*		β^+	33 min.(S2,B21)	2.5(B21) abs.		P-α-n(F2,R3,B21) S-d-n(S2) Cl-n-2n(P2) Cl-γ-n(B20,H44) S-α-p,n or S-α-d(S45)
	Cl^{35}		75.4(N33)					
	Cl^{36}	*A*		β^+;K;β^- (G8)	$>10^3$ yr.(G8,O5)	0.64(β^-)(G8) abs.		Cl-n-γ(G8) Cl-d-p(G8)
	Cl^{37}		24.6(N33)					
	Cl^{38}	*A*		β^-,γ	37 min.(V1)	1.1, 2.8, 5.0(W16, W17) spect., (W17) coincid. abs.	1.65, 2.15(C28, I2) spect.	Cl-d-p(K4,V1) Cl-n-γ(A1,K18,A15) K-n-α(H5)
18	A^{35}	*A*		β^+	1.88 sec.(E4)	4.4(E4,W11) cl.ch.		Cl-p-n(W11) S-α-n(K10)
	A^{36}		0.307(N34)					
	A^{37}	*A*			34 days(W18)			Cl-d-2n(W18) Cl-p-n(W18) K-d-α(W18) Ca-n-α(W18) S-α-n(W18)
	A^{38}		0.061(N34)					
	A^{39}	*G*		β^-	4 min.(P2)			K-n-p(P2)
	A^{40}		99.632(N34)					
	A^{41}	*A*		β^-,γ	110 min.(S3)	1.5(K4) cl.ch. (K.U.)	1.37(R8) cl.ch. recoil	A-d-p(S3) K-n-p(H5) A-n-γ(S3)
19	K^{38}	*A*		β^+	7.7 min.(H5,R3)	2.3(R3) abs.		Cl-α-n(H5,R3) Ca-d-α(H5) K-n-2n(P2) K-γ-n(H43,H44)
	K^{39}		93.38(C51)					
	K^{40}(H88, S62)	*A*	0.012 (N34)	β^-(T31,C61), γ(K52); K(75%) (T30)	1.42×10^9 yr. (B71); 4×10^8 yr.(T30)	0.40(H83), 0.725 (L6) spect.; 1.3 (H87) abs.	2(K52) abs. Fe	Natural source(T31,C61)
	K^{41}		6.61(C51)					
	K^{42}	*A*		β^-	12.4 hr.(H5)	3.5(K4) cl.ch.		K-d-p(H5) K-n-γ(H5,A1) Ca-n-p(H5) Sc-n-α(H5)
	$K^{43,44}$	*C*		β^-	18 min.(W1,W12)			Ca-n-p(W1,W12)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
20	Ca^{39}	*F*		β^+	4.5 min.(P2,W12)			Ca-*n*-2*n*(?)(P2,W12)
	Ca^{39}	*E*			1.06 sec.(H44)			Ca-γ-*n*(H44)
	Ca^{40}		96.96(N32)					
	Ca^{41}	*B*		*K*,γ,e^- (W12)	8.5 days(W12)		1.1(W12) abs. Pb, abs. of e^-	Ca-*d*-*p*(W12) Ca-*n*-2*n*(W12)
	Ca^{42}		0.64(N32)					
	Ca^{43}		0.15(N32)					
	Ca^{44}		2.06(N32)					
	Ca^{45}	*A*		β^-,γ	180 days(W12)	0.2, 0.9(W12) abs.	0.7(W12) abs. Pb	Ca-*n*-γ(W12) Ca-*d*-*p*(W12,W5) Sc-*n*-*p*(W12)
	Ca^{46}		0.0033 (N32)					
	Ca^{48}		0.19(N32)					
	Ca^{49}	*A*		β^-,γ	2.5 hr.(W12)	2.3(W12) abs.	0.8(W12) abs. Pb	Ca-*d*-*p*(W12) Ca-*n*-γ(W12)
	Ca^{49}	*B*		β^-	30 min.(W12)			Ca-*d*-*p*(W12) Ca-*n*-γ(W12)
21	Sc^{41}	*A*		β^+	0.87 sec.(K10)	4.94(E4) cl.ch.		Ca-*d*-*n*(K10,E4)
	Sc^{42}	*F*		β^+	13.5 days(W10)	1.4(W10) abs.		K-α-*n*(W10)
	Sc^{43}	*A*		β^+,γ	4 hr.(W10)	0.4, 1.4(W10) abs.; 1.13(H1)	1.0(W10) abs. Pb; 1.65(H1)	Ca-α-*p*(F4,W10) Ca-*d*-*n*(W3) Ca-*p*-*n*(D2,D9,H1)
	Sc^{44}	*A*		I.T.,e^-,γ (W10)	52 hr.(W10)		0.27(H9,S19) spect. conv.; 0.28, 1.33 (H1)	Sc-*n*-2*n*(B9,H1) K-α-*n*(W10,H1) Ca-*d*-*n*(W3,S19,H1) Ca-*p*-*n*(D2,D9) Ti-*d*-α(W4)
	Sc^{44}	*A*		β^+,γ	4.1 hr.(W10)	1.5(W10) abs., (S19) spect.; 1.33(H1)	1.80(H1)	Sc-*n*-2*n*(B9,H1) K-α-*n*(W10,H1) Ca-*d*-*n*(W3,S19,H1) Ti-*d*-α(H60) Ca-*p*-*n*(D2,D9) Sc-γ-*n*(B20) Sc^{44} (52 hr.) I.T.(W10)
	Sc^{45}		100(A31)					
	Sc^{46}	*A*		β^-,γ,*K*(W5)	85 days(W5)	0.26, 1.5(β^-) (W10) abs.	1.25(W10) abs. Pb	Sc-*d*-*p*(W1,W5) Sc-*n*-γ(W1) Ti-*d*-α(W1) Ca-α-*p*(W10) Ti-*n*-*p*(W4)
	Sc^{47}	*F*		β^-,γ	63 hr.(W10)	1.1(W10) abs.		Ca-α-*p*(W10) Ti-*n*-*p*(W10)
	Sc^{48}	*A*		β^-,γ(W10)	44 hr.(W10,M2)	0.64(S19) spect.; 0.57(H1)	1.35(M2,M30) spect.; 1.33(H1) abs.	Ti-*n*-*p*(W4,P2,W10,M30) V-*n*-α(W4,P2,W10) Ca-*d*-2*n*(S19,M2,H1,M30) Ti-*d*-α(H60) Ca-*p*-*n*(H1)
	Sc^{49}	*A*		β^-	57 min.(W10)	1.8(W10) abs.	No γ(W10)	Ca-*d*-*n*(W10) Ca^{49} (2.5 hr) β^- decay (W10) Ti-*n*-*p*(W10)
	Sc	*F*		β^-	3.4 days(H1)	0.46(H1)	No γ(H1)	
22	Ti^{45}	*A*		β^+	3.08 hr.(A17)	1.2(A17) cl.ch.		Ca-α-*n*(A17) Sc-*p*-*n*(A17) Sc-*d*-2*n*(A17) Ti-*n*-2*n*(A17) Ti-γ-*n*(H45)
	Ti^{46}		7.95(N32)					
	Ti^{47}		7.75(N32)					
	Ti^{48}		73.45(N32)					
	Ti^{49}		5.51(N32)					
	Ti^{50}		5.34(N32)					
	Ti^{51}	*A*		β^-,γ(W4)	2.9 min.(W4)			Ti-*d*-*p*(W4) Ti-*n*-γ(W4,A1)
	Ti^{51}	*A*		β^-,γ	72 days(W5)	0.36(W5) abs.	1.0(W5) coincid. abs,	Ti-*d*-*p*(W5) Ti-*n*-γ(W8)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
23	V^{47}	*B*		β^+	33 min.(W4,O7)	1.9(W4,O7) abs.		Ti-*d*-*n*(W4,O7) Ti-*p*-*n*(D9,O7)
	V^{48}	*A*		β^+,*K*,γ (W5, H60)	16 days(W4)	1.0(W4) cl.ch.; 0.58(H60)	1.05(R4) cl.ch. recoil; 1.50(H60) abs. Pb	Ti-*d*-*n*(W4) Sc-α-*n*(W6) Cr-*d*-α(W4) Ti-*p*-*n*(D9)
	V^{49}	*B*		*K*	600 days(W5)	No β^+ or ϵ^-(W5)	No γ(W5)	Ti-*d*-*n*(W5)
	V^{50}	*A*		β^+	3.7 hr.(W4)			V-*n*-2*n*(W4) Ti-*d*-*n*(W4) Ti-α-*p*(W4)
	V^{51}		100(A31)					
	V^{52}	*A*		β^-	3.9 min.(W4)	2.05(D24) abs.		V-*n*-γ(W4,P2,A1) V-*d*-*p*(W4) Cr-*n*-*p*(W4,P2) Mn-*n*-α(W4,P2,A1)
24	Cr^{49}	*A*		β^+,γ	41.9 min.(O7)	1.45(O7) abs., cl.ch.	0.18, 1.55(O7) abs. Pb	Ti-α-*n*(O7) Cr-*n*-2*n*(O7)
	Cr^{50}		4.49(N35)					
	Cr^{51}	*B*		*K*,γ,ϵ^- (W13)	26.5 days(W13)		0.5, 1(W13) abs. Pb, abs. of ϵ^-	Ti-α-*n*(W13) Cr-*d*-*p*(W13,A14) Cr-*n*-γ(W13) Cr-*n*-2*n*(A14)
	Cr^{52}		83.78(N35)					
	Cr^{53}		9.43(N35)					
	Cr^{54}		2.30(N35)					
	Cr^{55}	*B*			1.6–2.3 hr.(A14, D14)			Cr-*n*-γ(D14,A14) Cr-*d*-*p*(A14)
25	Mn^{51}	*A*		β^+	46 min.(L7)	2.0(L7) abs.		Cr-*d*-*n*(L7) Cr-*p*-γ(D2,D4)
	Mn^{52}	*A*		β^+,γ	21 min.(L7)	2.2(H6,H12) cl.ch.	1.2(H6)	Fe-*d*-α(D5,L7) Cr-*p*-*n*(H6,H12)
	Mn^{52}	*A*		β^+,γ,*K*(H6, H12)	6.5 days(L7)	0.77(H6,H12) cl.ch.	1.0(H6)	Fe-*d*-α(L7) Cr-*p*-*n*(H6,H12)
	Mn^{54}	*A*		*K*,γ(L7)	310 days(L7)		0.85(L7) abs. Pb; 0.835(D35) spect., coincid.	Fe-*d*-α(L7) Cr-*d*-*n*(L7) V-α-*n*(L7) Cr-*p*-*n*(D9)
	Mn^{55}		100(S63)					
	Mn^{56}	*A*		β^-,γ	2.59 hr.(L7)	0.75, 1.05, 2.86 (E12) spect., coincid.; 1.04, 2.88(T8) spect.	0.7, 1.7(B26,B14) cl.ch. recoil; 0.845, 1.81, 2.13(E9,E12) spect.; 0.800(G3) spect.	Mn-*n*-γ(A1) Mn-*d*-*p*(L7) Fe-*d*-α(L7) Fe-*n*-*p*(A1) Co-*n*-α(A1) Cr-α-*p*(R3)
26	Fe^{53}	*A*		β^+	8.9 min.(R3)			Cr-α-*n*(R3) Fe-*n*-2*n*(L20) Fe-γ-*n*(H43)
	Fe^{54}		6.04(N35)					
	Fe^{55}	*A*		*K*,ϵ^-	~4 yr.(V4)			Fe-*d*-*p*(L23) Mn-*p*-*n*(V4) Co^{55} β^+ decay(L10)
	Fe^{56}		91.57(N35)					
	Fe^{57}		2.11(N35)					
	Fe^{58}		0.28(N35)					
	Fe^{59}	*A*		β^-,γ	47 days(L20)	0.26, 0.46(D16) spect., coincid. abs.	1.10, 1.30(D16) spect.	Fe-*d*-*p*(L20,D16) Co-*n*-*p*(L20)
27	Co^{55}	*A*		β^+,γ	18.2 hr.(D5)	1.50(L21) spect.	0.16, 0.21, 0.8, 1.2 (C20) cl.ch. recoil	Fe-*d*-*n*(L10) Fe-*p*-γ(L9,L10)
	Co^{56}	*A*		β^+,γ,*K*(E9)	72 days(L10)	1.2(L10) abs., (C17) cl.ch., coincid.; 1.50(E9, E12) spect., coincid.	1.7(C17) abs. Pb, coincid.; 1.05(L10) abs. Pb; 0.845, 1.26, 1.74, 2.01, 2.55, 3.25 (E12) spect., coincid.	Fe-*d*-2*n*(L10,P3,J1) Ni-*d*-α(L10,C17) Fe-α-*n*,*p*(L10)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
27	Co^{57}	*A*		K,γ,e^-; β^+(L10)	270 days(L10)	0.26(β^+)(L10)	0.117, 0.130, 0.202, 0.215(P3) spect.	Fe-*d*-*n*(L9,B24,P4,L10) Fe-*p*-γ(L10)
	Co^{58}	*A*		β^+,γ,(10%) (D35);K,γ (90%) (D35)	72 days(L10)	0.4(L10) abs.; 0.470(E13,D35) spect.; (E13), coincid.	0.6(L10) abs. Pb; 0.805(D35) spect., coincid.	Fe-*d*-*n*(L9,B24,P4,L10) Mn-α-*n*(L9,L10) Ni-*d*-α(L11) Fe-*p*-*n*(L9) Ni-*n*-*p*(V5,L10) Fe-α-*n*,*p*(L10) Fe-*p*-γ(L10)
	Co^{59}		100(M52)					
	Co^{60}	*A*		β^-,γ	5.3 yr.(L10)	0.300(D17) spect., coincid.abs.	1.10, 1.30(D17) spect., coincid.	Co-*d*-*p*(L9,B24,L10,D17, N10) Co-*n*-γ(R9,L9,L10) Ni-*d*-α(L10) Co^{60} (10.7 min.) I.T. (L10, D17)
	Co^{60}	*A*		I.T., γ,e^- (L10,D17); β^-,γ(D17, N10)	10.7 min.(L10)	1.35(β^-)(N10) spect.	0.056(I.T.)(D17) spect. conv.; 1.5 (with β^-)(N10) abs. Pb	Co-*n*-γ(H7,L8,L10,D17) Ni-*n*-*p*(H8,L10) Co-*d*-*p*(N10)
28	Ni^{57}	*A*		β^+	36 hr.(L11)	0.67(L11) abs.		Fe-α-*n*(L11,N11,D18) Ni-*n*-2*n*(L11,N11,D18) Ni-γ-*n*(H45)
	Ni^{58}		67.4(V21)					
	Ni^{60}		26.7(V21)					
	Ni^{61}		1.2(V21)					
	Ni^{62}		3.8(V21)					
	Ni^{63}	*A*		β^-,γ	2.6 hr.(L11)	1.9(L11) abs.	1.1(L11) abs. Pb; 0.280, 0.65, 0.93 (G3) spect.	Ni-*d*-*p*(L11,N11) Ni-*n*-γ(H8,N11) Cu-*n*-*p*(H8) Zn-*n*-α(H8) Ni-*n*-2*n*(H8,D18,N11)
	Ni^{64}		0.88(V21)					
29	$Cu^{58,60}$	*C*		β^+	81 sec.(D4)			Ni-*p*-*n*(D4)
	$Cu^{58,60}$	*C*		β^+	7.9 min.(D4)			Ni-*p*-*n*(D4)
	Cu^{61}	*B*		β^+;*K*(A4)	3.4 hr.(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)
	Cu^{62}	*A*		β^+	10.5 min.(H8)	2.6(C13) cl.ch.		Cu-*n*-2*n*(H8) Cu-γ-*n*(B20,H44,H45) Co-α-*n*(R3) Ni-*p*-*n*(S18) Ni-*p*-γ(S18) Cu-*d*-H^3(K22,K14)
	Cu^{63}		70.13(E20)					
	Cu^{64}	*A*		$\beta^-;\beta^+;K$ (A4)	12.8 hr.(V2)	0.58(β^-); 0.66(β^+) (T6,T11,T8) spect.	No γ(T6)	Cu-*d*-*p*(V2) Cu-*n*-γ(H8) Ni-*p*-*n*(S18,D4) Zn-*n*-*p*(H8) Cu-*n*-2*n*(H8) Cu-γ-*n*(H45)
	Cu^{65}		29.87(E20)					
	Cu^{66}	*A*		β^-	5 min.(A1)	2.9(S5) cl.ch. (K.U.); 2.58 (G15)		Cu-*n*-γ(A1) Zn-*n*-*p*(H8) Ga-*n*-α(C5) Cu-*d*-*p*(L31)
30	Zn^{63}	*A*		β^+	38 min.(D4,B20)	2.3(S18) abs., (T11,T8) spect.		Zn-*n*-2*n*(H8,P2) Zn-γ-*n*(B20) Cu-*p*-*n*(S18,D4) Ni-α-*n*(R3) Cu-*d*-2*n*(L31,T8)
	Zn^{64}		50.9(N34)					

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev Particles	γ-rays	Produced by
30	Zn^{65}	*A*		β^+,K,γ,e^-	250 days(L12)	0.4(β^+)(D9) cl.ch.	0.45, 0.65, 1.0(W15, I3) cl.ch. recoil; 1.14(D19,M34) spect.	Zn-*d*-*p*(L12) Cu-*d*-2*n*(P4) Cu-*p*-*n*(B12) Zn-*n*-γ(S6) Ga^{65} *K* decay(L10)
	Zn^{66}		27.3(N34)					
	Zn^{67}		3.9(N34)					
	Zn^{68}		17.4(N34)					
	Zn^{69}	*A*		I.T.,γ(K11)	13.8 hr.(L12)		0.439(H9,G3) spect. conv.	Zn-*d*-*p*(L12,K11,V7) Zn-*n*-γ(T2,L12) Ga-*d*-α(L12) Ga-*n*-*p*(L12)
	Zn^{69}	*A*		β^-	57 min.(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 hr.) I.T.(K11)
	Zn^{70}		0.5(N34)					
31	Ga^{64}	*B*		β^+	48 min.(B13)			Zn-*p*-*n*(B13)
	Ga^{65}	*A*		*K*,e^-	15 min.(A4,L10)		0.054, 0.117(D9) spect. conv.	Zn-*d*-*n*(A4,L10) Zn-*p*-γ(D9)
	Ga^{66}	*A*		β^+	9.4 hr.(B13,R3)	3.1(M7) abs.		Cu-α-*n*(M7,R3) Zn-*p*-*n*(B13)
	Ga^{67}	*A*		*K*,γ,e^-	83 hr.(A4)		0.0925, 0.180, 0.297 (H9) spect.conv., spect.; 0.292(G3) spect.; 0.094, 0.174, 0.187, 0.301(C21) spect.	Zn-*d*-*n*(A4,G6,V7) Zn-α-*p*(M8) Zn-*p*-*n*(B13,V7)
	Ga^{68}	*A*		β^+	68 min.(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) Ge-*d*-α(S29)
	Ga^{69}		61.2(S61)					
	Ga^{70}	*A*		β^-,γ	20 min.(B20,A1)	1.68(S25) cl.ch. (K.U.)		Ga-*n*-γ(A1) Ga-*n*-2*n*(P2) Ga-γ-*n*(B20) Zn-*p*-*n*(D2,V7) Zn-α-*p*(M8) Ge-*d*-α(S29) Ge-*n*-*p*(S29)
	Ga^{71}		38.8(S61)					
	Ga^{72}	*A*		β^-,γ	14.1 hr.(S6)	1.71(S25) cl.ch. (K.U.)	1.17, 2.65(M30) spect.	Ga-*d*-*p*(L20) Ga-*n*-γ(S6) Ge-*n*-*p*(S29)
	Ga^{74}	*D*		β^-	9 days(S29)	0.8(S29)		Ge-*d*-α(S29)
32	Ge^{69}	*E*			~195 days(M8)			Zn-α-*n*(M8)
	Ge^{70}		21.2(A31)					
	Ge^{71}	*A*		*K*,e^-(?) (S30)	11 days(S30)		0.6(S30) abs. of e^-	Ga-*d*-2*n*(S30) Ge-*d*-*p*(S30)
	Ge^{71}	*A*		β^+	40 hr.(S30)	1.2(S30) abs.		Zn-α-*n*(M8) Ge-*n*-γ(S6,S29) Ge-*d*-*p*(S6,S30,S29) Ga-*d*-2*n*(S30) Ge-*n*-2*n*(S25,S29) Se-*n*-α(S29)
	Ge^{72}		27.3(A31)					
	Ge^{73}		7.9(A31)					
	Ge^{74}		37.1(A31)					
	Ge^{75}	*A*		β^-,γ(S30)	89 min.(S30)	1.1(S25,S29) cl.ch. (K.U.); 1.2 (S30) abs.		Ge-*n*-γ(S6,S29) Ge-*d*-*p*(S6,S29,S30) Ge-*n*-2*n*(S29,S30) As-*n*-*p*(S29,S30) Se-*n*-α(S29,S30)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
32	Ge^{76}		6.5(A31)					
	Ge^{77}	*A*		β^-(S29)	12 hr.(S30)	1.9(S25,S29) cl.ch. (K.U.)		Ge-*n*-γ(S6,S29) Ge-*d*-*p*(S29,S30) Se-*n*-*α*(S30)
33	As^{72}	*E*		β^+	26 hr.(V4)			Ge-*p*-*n*(V4)
	$As^{72,73}$	*D*		K,e^-(E10)	90 days(S26)		0.052(E10) spect. conv.	Ge-*d*-*n*(S26, E10)
	As^{73}	*D*		β^+	50 hr.(S29)	0.6(S29)		Ge-*d*-*n*(S29)
	As^{74}	*A*		β^-,β^+,γ(S26)	16 days(S26)	1.3(β^-), 0.9(β^+) (S26) cl.ch. (K.U.)	0.582(D15) spect.	As-*n*-2*n*(S26,C11) Ge-*d*-*n*(S26,S29,I4) Se-*d*-*α*(F8) Ge-*p*-*n*(D9)
	A^{75}		100(N30)					
	As^{76}	*A*		$\beta^-,\gamma;\beta^+,K,\gamma$(?)(S23)	26.8 hr.(W9,W19)	1.1, 1.7, 2.7(β^-) (S23,W9,W19) cl.ch.; 0.7, 2.6 (β^+)(S23) cl.ch.; coincid.(M35)	3.2, 2.2, 1.5(S23) cl.ch. pair; 1.94, 0.83(M6) spect.; coincid. (M35)	As-*d*-*p*(C11,T3) As-*n*-γ(C11) Br-*n*-*α*(C11) Ge-*p*-*n*(V4) Se-*n*-*p*(S26) Se-*d*-*α*(F8)
	As^{78}	*A*		β^-,γ	65 min.(S9)	1.4(S26) cl.ch. (K.U.)	0.27(S26) abs. Pb	Br-*n*-*α*(S9,C11,S26) Se-*n*-*p*(S26)
34	Se^{74}		0.9(A31)					
	Se^{75}	*B*		K,γ,e^-	48 days(D9); 160 days(K30)		0.50(D9) spect.conv.; several <0.3(K30) spect.conv.	As-*p*-*n*(D9) As-*d*-2*n*(K30)
	Se^{76}		9.5(A31)					
	Se^{77}		8.3(A31)					
	Se^{78}		24.0(A31)					
	$Se^{79,81}$	*C*		I.T.,e^- (L30)	57 min.(S9,L30)		0.099(H9) spect.conv.	Se-*d*-*p*(S9,L30) Se-*n*-γ(S9,H10) Br-*n*-*p*(S9,L30) Se-γ-*n*(B20)
	$Se^{79,81}$	*C*		β^-	19 min.(L30)	1.5(L30) abs.		Se-*d*-*p*(S9,L30) Se-*n*-γ(S9,H10) Se-γ-*n*(B20) Br-*n*-*p*(L30) $Se^{79,81}$ (57 min.) I.T. (L30)
	Se^{80}		48.0(A31)					
	Se^{82}		9.3(A31)					
	Se^{83}	*A*		β^-	30 min.(L30)			Se-*d*-*p*(L30) Se-*n*-γ(L30)
	Se	*D*			Several hrs.(B15)			Th-*n*(B15)
	Se	*D*			Several days(B15)			Th-*n*(B15)
35	Br^{78}	*A*		β^+,e^-,γ	6.4 min.(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)
	Br^{79}		50.6(B60)					
	Br^{80}	*A*		I.T.,e^-,γ (S10,V3, V7,G22)	4.4 hr.(B13)		0.049, 0.037 or 0.025 (V7) spect. conv.; 0.037(G22) abs. Al	Br-*n*-γ(S9,S10,A2) Br-*d*-*p*(S9) Se-*p*-*n*(B13,V7) Br-γ-*n*(B20) Br-*n*-2*n*(P2) Th-*n*(?)(P12,P16)
	Br^{80}	*A*		β^-,γ	18 min.(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 hr). I.T. (S10,S31, D20)
	Br^{81}		49.4(B60)					
	Br^{82}	*A*		β^-,γ	34 hr.(S9)	0.465(R6,D21); (D23) coincid.	0.547, 0.787, 1.35(R6, D15) spect.; (D23) coincid.	Br-*n*-γ(K5,S9) Br-*d*-*p*(S9) Se-*p*-*n*(B13,R7) Se-*d*-2*n*(S9) Rb-*n*-*α*(S9,P2)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
	Br^{83}	*A*		β^-	140 min.(L30)	1.05(L30) abs.	No γ(S9)	Se-*d*-*n*(S9) Se^{83} β^- decay(S9,L30) Th-*n*(B15,L30) U-*n*(L30,M9,S35)
	Br^{84}	*A*		β^-	30 min.(S35)	4.5(B30) abs.		U-*n*(D6,H22,H57,M9,S35, B29) Th-*n*(P12) Rb-*n*-α(B29)
	Br^{85}	*A*			3.0 min.(S35,B29)			U-*n*(S35,B29,S43)
	Br^{87}	*B*			50 sec.(S35)			U-*n*(S35,B29,S43)
	$Br^{>82}$	*F*			22 hr.(B15)			Th-*n*(B15)
36	Kr^{78}		0.35(N30)					
	$Kr^{79,81}$	*C*		β^+(B41)	34 hr.(B41)	0.4(C41) cl.ch.		Kr-*d*-*p*(C45,S9,C22) Br-*p*-*n*(B41,C41) Se-α-*n*(C45,C22)
	$Kr^{79,81}$	*C*		I.T.(?),e^-, γ; no β^+ (C41)	13 sec.(C41)		0.187(C41) spect. conv.	Br-*p*-*n*(B41,C41)
	$Kr^{79,81}$	*C*		I.T.(?),e^-, γ; no β^+ (C41)	55 sec.(C41)		0.127(C41) spect. conv.	Br-*p*-*n*(B41,C41) Se-α-*n*(?)(K3)
	Kr^{80}		2.01(N30)					
	Kr^{82}		11.53(N30)					
	Kr^{83}		11.53(N30)					
	Kr^{83*}	*A*		I.T.,e^- (L30)	113 min.(L30)		0.029, 0.046(H9) spect. conv.	Br^{83} β^- decay(L30) Se-α-*n*(C45,C22) Kr-*d*-*p*(C45,C22)
	Kr^{84}		57.11(N30)					
	Kr^{85}	*A*		β^-	4.0 hr.(C22)	0.85(B30) abs.		Kr-*d*-*p*(S9,C45,C22) Br^{85} β^- decay (B29,S43) Sr-*n*-α(B29) Rb-*n*-*p*(B29)
	Kr^{86}		17.47(N30)					
	Kr^{87}	*B*		β^-	74 min.(S9)	4(B30) abs.		Kr-*d*-*p*(S9)
	Kr^{88}	*A*		β^-	3 hr.(L27,H28)	2.5(W19) cl.ch. (K.U.)		Br^{87} β^- decay(B29, S43) Th-*n*(H29,A5,L27) U-*n*(H28,H11,G9,G21,H46)
	Kr^{89}	*B*		β^-	2.5 min.(H56)			U-*n*(G9,G21,S41,H46,H47)
	$Kr^{>90}$	*D*		β^-	<0.5 min.(H28)			U-*n*(H28,H46,H47,H56) Th-*n*(H29)
37	Rb^{82}	*B*			20 min.(H51)			Br-α-*n*(H51)
	Rb^{84}	*B*			6.5 hr.(H51)			Br-α-*n*(H51) Kr-*d*-*n*(H51)
	Rb^{85}		72.8(N34)					
	Rb	*F*			42 min.(H51)			Kr-*d*-*n*(H51)
	Rb	*F*			200 hr.(H51)			Kr-*d*-*n*(H51)
	Rb^{86}	*A*		β^-	19.5 days(H13)	1.56(H13) abs.; 1.60(H32) spect.		Rb-*n*-γ(S9,S20) Sr-*d*-α(H13)
	Rb^{87} (H89, H84)	*A*	27.2(N34)	β^-(T31, C61), γ(O30)	6.3×10^{10} yr.(S74)	0.132(L6) spect.; 0.25(K53); 0.13 (O30) spect.	0.034, 0.053, 0.082, 0.102, 0.129(O30) spect. conv.	Natural source (T31,C61)
	Rb^{88}	*A*		β^-	17.5 min.(W19)	5.1(W19) cl.ch.		Rb-*n*-γ(S9,P2,S20) Pa-*n*(G7) Kr^{88} β^- decay(H28,L27, H11,G21,W19,H46)
	Rb^{89}	*B*		β^-,γ(G21)	15 min.(G9,G21)	3.8(G21) abs.		Kr^{89} β^- decay(G9,G21,S41, H46,H47)
	$Rb^{>90}$	*D*		β^-	80 sec.(H28)			$Kr^{>90}$ (<0.5 min.) β^- decay (H28,H46,H47,H56)
38	Sr^{84}		0.56(N36)					
	Sr^{85}	*A*		*K*,γ(D13)	65 days(D13)		0.8(D13,D25) abs. Pb	Rb-*p*-*n*(D13,D25)
	Sr^{85}	*A*		I.T.,e^-,γ (D25)	70 min.(D25)		0.170(D25) spect. conv.	Rb-*p*-*n*(D13,D25)
	Sr^{86}		9.86(N36)					
	Sr^{87}		7.02(N36)					

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
38	Sr^{87*}	*A*		I.T.,e^-,γ (D11)	2.7 hr.(D11)		0.37(D11) spect. conv.; 0.386(H9) spect.conv.	Sr-*n*-*n*(D13,R15,D25,R20) Rb-*p*-*n*(D11) Sr-*d*-*p*(D11) Sr-*n*-γ(D11,R15) Y^{87} (80 hr.) *K* decay(D11, D25) Sr-*p*-*p*(?)(D25) Zr-*n*-α(S46)
	Sr^{88}		82.56(N36)					
	Sr^{89}	*A*		β^-	55 days(S24)	1.50(S24) cl.ch.; 1.32(H32) spect.	No γ(S24)	Sr-*d*-*p*(S11,S24) Sr-*n*-γ(S11,S24) Y-*n*-*p*(S12) Rb^{89} β^- decay(G9,H28,G21, H46,H47) Zr-*n*-α(?)(S46)
	Sr^{90}	*B*			~5 yr.(H47)			U-*n*(H47)
	$Sr^{>90}$	*D*		β^-	2.7 hr.(G13)			$Rb^{>90}$ (80 sec.) β^- decay (G13,H47,H56) U-γ(L2)
	$Sr^{>90}$	*D*		β^-	7 min.(L26)			U-*n*(Kr parent)(H56,L26, H28,H47)
	Sr^{91}	*B*		β^-	10 hr.(H47)			U-*n*(Kr parent)(H56,H47, G13,S48) Zr-*n*-α(S48)
	$Sr^{>90}$	*D*			~2 min.(H47)			U-*n*(Kr parent)(H56,H47)
39	Y^{87}	*B*		I.T.,e^-,γ (D25)	14 hr.(S24,D13)		0.5(D25) abs.	Sr-*d*-*n*(S24,D13,D25) Sr-*p*-*n*(D13,D25)
	Y^{87}	*A*		*K*(D13)	80 hr.(D25)		No γ(?)(D25)	Sr-*p*-*n*(D13,D25) Sr-*d*-*n*(D13,S24,D25)
	Y^{88}	*A*		β^+	2.0 hr.(S24)	1.2(S11) cl.ch. (K.U.)		Sr-*d*-*n*(S11,S24) Y-*n*-2*n*(S11) Sr-*p*-*n*(D13,D25)
	Y^{88}	*B*		*K*,γ(D25)	87 days(H33)		0.95, 1.92(R12) cl.ch.; 0.908, 1.89(D28) spect., coincid.; 1.87 (S32) Be-γ-*n*; 1.9, 2.8(G10) D-γ-*n*	Sr-*p*-*n*(D13,D25) Sr-*d*-2*n*(P11,H33) Y-*n*-2*n*(H33)
	Y^{89}			100(D40)				
	Y^{90}	*A*		β^-	60 hr.(S11)	2.6(S11) cl.ch. (K.U.)		Y-*d*-*p*(S11) Y-*n*-γ(S11,S12) Cb-*n*-α(S42,S13) Zr-*n*-*p*(S46,S48) Zr-*d*-α(S46) Sr^{90} β^- decay(H47)
	$Y^{>90}$	*D*		β^-,γ(H56)	3.5 hr.(H56)	3.6(B30) abs.		$Sr^{>90}$ (2.7 hr.) β^- decay (G13,H47,H56) Zr-*n*-*p*(S46,S48)
	Y^{91}	*B*		β^-,γ(B30)	57 days(H42,G13)	1.6(B30) abs.		Sr^{91} β^- decay (H47,G13) Zr-*n*-*p*(S48)
	Y^{91}	*B*			50 min.(G13)			Sr^{91} β^- decay (H47,G13) Zr-*n*-*p*(S48)
	$Y^{>90}$	*D*			11.5 hr.(H47)			$Sr^{>90}$ (7 min.) β^- decay (H47,H56)
	$Y^{>90}$	*D*		β^-,γ(H56)	20 min.(H47)			$Sr^{>90}$ (2 min.) β^- decay (H47,H56) Zr-*n*-*p*(S48)
40	Zr^{89}	*A*		β^+(S12, D13)	78 hr.(D25)	1.0(β^+)(S12) cl.ch. (K.U.), (D25) abs.	No γ(D25)	Zr-*n*-2*n*(S12,S46) Y-*p*-*n*(D13,D25) Mo-*n*-α(S46)
	Zr^{89}	*A*		e^-,γ,I.T. or *K*(D13, D25)	4.5 min.(D25)			Y-*p*-*n*(D13,D25)
	Zr^{90}		48(A31)					
	Zr^{91}		11.5(A31)					
	Zr^{92}		22(A31)					

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
40	Zr^{93}	*D*		β^-,γ	63 days(S46)	0.25(S46) abs.; 0.57, 0.29(M33)	0.94(M33)	Zr-*n*-γ(S46) Zr-*d*-*p*(S46) Mo-*n*-α(?)(S46) U-*n*(H55,G18)
	Zr^{94}		17(A31)					
	Zr^{95}	*D*		β^-	17.0 hr.(G18)	1(G18) abs.		U-*n*(G18,H39) Zr-*n*-γ(S46) Mo-*n*-α(S46)
	Zr^{96}		1.5(A31)					
	Zr^{97}	*E*		β^-	6 min.(S46)	~1.9(S46) abs.		Zr-*n*-γ(S46)
	Zr	*E*		β^-	18 min.(S46)			Zr-*n*-γ(S46)
	Zr	*F*		β^-	90 min.(S12)	~1.5(S46) abs.		Zr-*d*-?(S12,S46)
	Zr	*E*		β^-	70 hr.(S46)	1.17(S46) cl.ch. (K.U.)		Zr-*n*-?(S46)
41	Cb	*E*			4 min.			Zr-*p*-*n*(?)(D9)
	Cb	*E*			12 min.			Zr-*p*-*n*(?)(D9)
	Cb	*E*			38 min.			Zr-*p*-*n*(?)(D9)
	Cb	*E*			21 hr.			Zr-*p*-*n*(?)(D9)
	Cb	*E*			96 hr.			Zr-*p*-*n*(?)(D9)
	Cb^{92}	*A*		β^-,γ	11 days(S42,S13)	1.38(S42) cl.ch. (K.U.); 0.59 (M33)	1.0(M33)	Cb-*n*-2*n*(S42,S13) Mo-*n*-*p*(S46) Zr-*p*-*n*(M33)
	Cb^{93}		100(S63)					
	Cb^{93*}	*D*		I.T.,e^-	~55 days(S46)		~0.15(S46,M33) abs. of e^-; 0.94(M33)	Zr^{93} β^- decay(S46,H55)
	Cb^{94}	*A*		β^-,γ(S42)	6.6 min.(S42)	1.4(S42) abs.	0.4(S42) abs. Pb	Cb-*n*-γ(S42,S13,P2)
	Cb^{95}	*D*		β^-	75 min.(G18)	1(G18) abs.		Zr^{95} β^- decay(G18,S46,H39) Mo-*n*-*p*(S46)
42	Mo^{92}		14.9(V22)					
	Mo^{93}	*F*			7 hr.(D9)			Cb-*p*-*n*(?)(D9)
	$Mo^{91,93}$	*C*		β^+	17 min.(B20,S12)	2.65(S46) cl.ch. (K.U.)		Mo-*n*-2*n*(H10,S12,S46) Mo-γ-*n*(B20)
	Mo^{94}		9.4(V22)					
	Mo^{95}		16.1(V22)					
	Mo^{96}		16.6(V22)					
	Mo^{97}		9.65(V22)					
	Mo^{98}		24.1(V22)					
	Mo^{99}	*B*		β^-,γ	67 hr.(S14)	1.5(S14) abs.	0.4(S14) abs.	Mo-*d*-*p*(S14) Mo-*n*-γ(S14,S12) U-*n*(H23,H41) Th-*n*(H24) Mo-*n*-2*n*(S46)
	Mo^{100}		9.25(V22)					
	Mo^{101}	*B*		β^-,γ	14.6 min.(M25)	1.8(S40) cl.ch. (K.U.); 1.0, 2.2(M38)	0.3, 0.9(M38)	Mo-*n*-γ(S40,S22,S46,M25) U-*n*(H41,B28)
	$Mo^{>101}$	*D*		β^-	12 min.(H41)			U-*n*(H41)
	Mo	*E*			~~60 days(H55)			U-*n*(H55)
43	43^{96}	*B*		β^+(?)	2.7 hr.(D4)			Cb-α-*n*(K3) Mo-*p*-*n*(D4) Mo-*d*-*n*(S14)
	43^{99}	*B*		I.T.,e^-,γ (S14)	6.6 hr.(S14)		0.136(S14) spect. conv.; ~0.18(S14) abs.	Mo^{99} β^- decay(S14,H41)
	43^{101}	*B*		β^-,γ	14.0 min.(M25)	1.1(S40) cl.ch. (K.U.); 1.3 (M38)	0.30(M38)	Mo^{101} β^- decay(S40,S22, S46,H41,M25)
	$43^{>101}$	*D*		β^-	<1 min.(H41)			$Mo^{>101}$ (12 min.) β^- decay (H41)
	43	*D*		K,e^-	90 days(C12)		0.097(H9) spect. conv.	Mo-*d*-*n*(C12,C24)
	43	*D*		K,γ	62 days(C12)			Mo-*d*-*n*(C12,C24)
	43	*D*		K(?)e^-,γ (E5)	110 hr.(E3)	0.6(E3)	0.05, 0.5(E5)	Mo-*p*-*n*(E3,E5)
	43	*E*		β^-,γ(E3)	55 min.(E5)	2.5(E5) abs.		Mo-*p*-*n*(E3,D4,E5)
	43	*E*		β^-	36.5 hr.(D4)			Mo-*p*-*n*(D4)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
43	43	*E*		β^-	18 sec.(D9)			Mo-*p*-*n*(D3,D9)
	43	*D*		*K*	~2 days(S14)			Mo-*d*-*n*(S14)
44	Ru^{95}	*F*			20 min.(D7)			Ru-*n*-2*n*(?)(D7,P2)
	Ru^{96}		5.68(E20)					
	Ru^{98}		2.22(E20)					
	Ru^{99}		12.81(E20)					
	Ru^{100}		12.70(E20)					
	Ru^{101}		16.98(E20)					
	Ru^{102}		31.34(E20)					
	Ru^{104}		18.27(E20)					
	Ru^{105}	*B*		β^-	4 hr.(D7,L13, N12)	1.5(B31) abs.		Ru-*n*-γ(D7) Ru-*d*-*p*(L13) U-*n*(S33,N12,N13) Th-*n*(S33)
	Ru	*G*			11 days(L13)			Ru-*d*-?(L13)
	Ru	*E*			90 min.(K3)			Mo-α-*n*(K3)
	Ru	*D*			45 days(N15)			U-*n*(N12,N15) Ru-*d*-*p*(L13)
	Ru	*D*		β^-	4 min.(B31)	4(B31) abs.		U-*n*(B31)
45	Rh^{102}	*A*		β^-,β^+,γ (M23)	210 days(M23)	1.1(β^-)(M23) abs.		Rh-*n*-2*n*(M23)
	Rh^{103}		100(C50)					
	Rh^{104}	*A*		I.T.,ϵ^-(P5)	4.2 min.(P5)		0.055–0.080(P5) abs. of ϵ^-; 0.069(O9) spect. conv.	Rh-*n*-γ(P5,A1,P2) Ru-*p*-*n*(D9)
	Rh^{104}	*A*		β^-	44 sec.(P5,A1)	2.3(C13) cl.ch.		Rh-*n*-γ(P5,A1) Rh^{104} (4.2 min.) I.T.(P5) Ru-*p*-*n*(L13)
	Rh	*E*			3 hr.(D9)			Ru-*p*-*n*(?)(D9)
	Rh	*E*			10.7 hr.(D9)			Ru-*p*-*n*(?)(D9)
	Rh	*E*			3 days(D9)			Ru-*p*-*n*(?)(D9)
	Rh^{105}	*B*		β^-	34 hr.(N12,N13)	0.5(N13) abs.		Ru^{105} β^- decay(N12,D7, L13)
	Rh	*D*		β^-	24 min.(B31)	1.2(B31) abs.		Ru (4 min.) β^- decay(B31)
46	Pd^{102}		0.8(S63)					
	Pd^{104}		9.3(S63)					
	Pd^{105}		22.6(S63)					
	Pd^{106}		27.2(S63)					
	$Pd^{107,109}$	*C*		β^-	13 hr.(K6)	1.03(K6) cl.ch.		Pd-*d*-*p*(K6) Pd-*n*-γ(A1,K6) Ag-*n*-*p*(F5)
	Pd^{108}		26.8(S63)					
	Pd^{110}		13.5(S63)					
	Pd^{111}	*A*		β^-	26 min.(S33)	3.5(B31) abs.		Pd-*d*-*p*(K6,A1) Pd-*n*-γ(K6,A1) U-*n*(S33,N14) Th-*n*(S33)
	Pd^{112}	*A*			17 hr.(S33,N14)			U-*n*(S33,N14) Th-*n*(S33)
47	Ag^{102}	*E*			73 min.(E6)			Pd-*p*-*n*(E6)
	Ag^{104}	*E*			16.3 min.(E6)			Pd-*p*-*n*(E6)
	Ag^{105}	*E*		*K*,γ	45 days(E6)		0.29, 0.42, 0.50, 0.62 (E6) spect.; 0.282, 0.345, 0.430, 0.650, >1.0(D19) spect.	Pd-*p*-*n*(E6)
	Ag^{106}	*A*		β^+	24.5 min.(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) Ag-*d*-*p*,2*n*(K15,K31)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
47	Ag^{106}	*A*		*K*,e^-,γ(H50, P6,F5, A4)	8.2 days(P6,K6)	1.2(e^-)(F5) abs.	1.06, 0.69(E6) spect.; 1.63, 1.06, 0.72(?) (D19) 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) Ag-*d*-*p*,2*n*(?)(K23)
	Ag^{107}		51.9(P44)					
	$Ag^{107*,109*}$	*C*		I.T.,e^-	40 sec.(A12)		0.093(V7,A12,H9) spect. conv.	$Cd^{107,109}$ (6.7 hr.) *K* decay (A12,H34) $Cd^{107,109}$ (158 days) *K* decay (H34) Ag-*n*-*n*(A12) $Pd^{107,109}$ β^- decay (S33) Ag-x-rays(F9)
	Ag^{108}	*A*		β^-	2.3 min.(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,K15)
	Ag^{109}		48.1(P44)					
	Ag^{110}	*A*		β^-,γ(P6)	22 sec.(A1,P6)	2.8(G4) cl.ch. (K.U.)		Ag-*n*-γ(A1) Cd-*n*-*p*(P6)
	$Ag^{108,110}$	*C*		*K*,γ,e^-(K15, H59)	225 days(L14, R10)		0.650, 0.925, 1.51 (D19) spect.; 0.6 (K15) abs. Al	Ag-*n*-γ(R10,L14,A8,M12) Ag-*d*-*p*(K12,K15,H59)
	Ag^{111}	*A*		β^-	7.5 days(K6,P6)	~0.8(B30) abs.	No γ(K6,P6)	Pd-*d*-*n*(K6,P6) Pd-α-*p*(P6) Cd-*n*-*p*(P6) Pd^{111} β^- decay(K6,S33,N14)
	Ag^{112}	*A*		β^-,γ	3.2 hr.(P6)	2.2(P6) cl.ch.		Cd-*n*-*p*(P6) In-*n*-α(P6) U-*n*(N9) Pd^{112} β^- decay(S33,N14)
48	Cd^{106}		1.4(N34)					
	$Cd^{107,109}$	*C*		*K*,γ(D4,V7, W11, A12)	6.7 hr.(D4,R5)		0.53(V7) abs. Pb	Ag-*p*-*n*(D4,R5,V7,W11) Ag-*d*-2*n*(K12,A12,H34,K15)
	$Cd^{107,109}$	*C*		*K*	158 days(H34)			Ag-*d*-2*n*(H34,K15)
	Cd^{108}		1.0(N34)					
	Cd^{109}	*E*		β^+	33 min.(P2)			Cd-*n*-2*n*(P2)
	Cd^{110}		12.8(N34)					
	Cd^{111}		13.0(N34)					
	Cd^{112}		24.2(N34)					
	Cd^{113}		12.3(N34)					
	Cd^{114}		28.0(N34)					
	Cd^{115}	*A*		β^-,γ	2.5 days(G5)	1.11(C14) spect.	0.55(L57) cl.ch. recoil; 0.65(M34) spect.	Cd-*d*-*p*(C14) Cd-*n*-γ(G5,M10) Cd-*n*-2*n*(G5) U-*n*(N9,N14)
	Cd	*E*		β^-,γ(C14)	40 days(C14)	095.(C14)cl.ch.		Cd-*d*-*p*(C14)
	Cd^{116}		7.3(N34)					
	Cd^{117}	*A*		β^-	3.75 hr.(C14)			Cd-*d*-*p*(C14) Cd-*n*-γ(M10,G5) U-*n*(N9,N14)
	Cd*	*D*		I.T.,e^-	48.7 min.(W30)		0.195(W30) abs. of e^-	Cd-*n*-*n*(D8) U-*n*(N9,N14) Cd-x-rays(F9,W30) Cd-e^-—e^-(W30)
49	In^{110}	*D*		β^+	65 min.(B17)	1.6(B17) spect.		Cd-*p*-*n*(B17) Ag-α-*n*(K9) Cd-*d*-2*n*(L57)
	In^{111}	*D*		β^+,γ,e^-	20 min.(B17)	1.7(β^+)(L57) cl.ch.	0.16(B17) spect. conv.	Cd-*d*-*n*(L57) Cd-*p*-*n*(B17)
	In^{112}	*D*		*K*,γ,e^- (L57)	2.7 days(B17,C14)		0.17, 0.25(B17,C14) spect.conv.	Cd-*p*-*n*(B17) In-*n*-2*n*(C14) Cd-*d*-*n*(L57) Ag-α-*n*(L57)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
49	In^{112}	*D*		I.T.,γ,e^-	16.5 min.(S34)		0.120(S34) abs. of e^-	Ag-α-n(S34) In-n-$2n$(S34)
	In^{112}	*D*		β^+,β^-(?),γ, e^-(S34)	17.5 min.(S34)	1.3(β^+)(S34) abs.; 0.47(β^-?)(S34) abs.	0.095(S34) abs. of e^-	Ag-α-n(S34) In-n-$2n$(S34) In^{112} (16.5 min.) I.T. (S34)
	In^{113}		4.5(S61)					
	In^{113*}	*A*		I.T.,γ,e^- (B17)	105 min.(B17)		0.39(B17,L57) spect. conv.	Cd-p-n(B17) Sn^{113} *K* decay(B17,S22) Cd-d-n(L57)
	In^{114}	*A*		I.T.,e^- (L57, L48)	48 days(B17)		0.19(B17,L57) spect. conv.	In-n-γ(L15,M12) Cd-p-n(B17) In-d-p(L57) Cd-d-n(L57) In-n-$2n$(L57)
	In^{114}	*A*		β^-	72 sec.(L15,B17)	1.98(L32) cl.ch.		In^{114} (48 days) I.T.(L48, L57) In-n-$2n$(L15,P2) In-γ-n(B11,C5) Cd-p-n(B17)
	In^{115}		95.5(S61)					
	In^{115*}	*A*		I.T.,e^-,γ (L57)	4.1 hr.(G5,B18)		0.34(O57) spect. conv.	In-n-n(G5) In-p-p(B18) In-α-α(L16) In-x-rays(P7,C10) Cd^{115} β^- decay(G5) Cd-d-n(L57) U-n(N14)
	In^{116}	*A*		β^-	13 sec.(A1,C14)	2.8(C14) cl.ch.	No γ(M11)	In-n-γ(A1,L15) In-d-p(L15) Cd-p-n(D9)
	In^{116}	*A*		β^-,γ	54 min.(A1,L15)	0.85(C14,C44) spect., cl.ch.	1.8,1.4, 1.0, 0.6, 0.4, 0.2(C44) cl.ch. recoil; 2.32, 1.31, 1.12, 0.428(D19) spect.	In-n-γ(A1,M11) Cd-p-n(B17) In-d-p(L15)
	In^{117}	*A*		β^-,γ,e^-	117 min.(L32)	1.73(β^-)(C14) spect.		Cd^{117} β^- decay (G5) Cd-d-n(C14,L57) U-n(N14)
50	Sn^{112}		1.1(A32)					
	Sn^{113}	*A*		K,e^-,γ	70–105 days(L17, B17)		0.085(B17) spect. conv.	In-p-n(B17) Sn-d-p(L17) Cd-α-n(L17)
	Sn^{114}		0.8(A32)					
	Sn^{115}		0.4(A32)					
	Sn^{116}		15.5(A32)					
	Sn^{117}		9.1(A32)					
	Sn^{118}		22.5(A32)					
	$Sn^{<119}$	*E*		β^-	25 min.(L17)			Cd-α-n(L17)
	$Sn^{<119}$	*E*		β^-	3 hr.(L17)			Cd-α-n(L17)
	$Sn^{<119}$	*E*		β^-	13 days(L17)			Cd-α-n(L17)
	Sn^{119}		9.8(A32)					
	Sn^{120}		28.5(A32)					
	Sn^{122}		5.5(A32)					
	Sn^{124}		6.8(A32)					
	Sn^{125}	*B*		β^-	9 min.(L17)			Sn-d-p(L17) Sn-n-γ(L17)
	$Sn^{<126}$	*D*		β^-	40 min.(L17)			Sn-d-p(L17) Sn-n-γ(L17) Sn-n-$2n$(P2)
	$Sn^{<126}$	*D*		β^-	26 hr.(L17)			Sn-d-p(L17) Sn-n-γ(L17)
	$Sn^{<126}$	*D*		β^-	10 days(L17)			Sn-d-p(L17) Sn-n-γ(L17)
	$Sn^{<126}$	*D*			~400 days(L17)			Sn-d-p(L17)
	$Sn^{>125}$	*D*		β^-	~20 min.(H55)			U-n(H55)
	$Sn^{>125}$	*D*		β^-	~80 hr.(H55); ~60 hr.(N15)			U-n(H55, N15)
	$Sn^{>125}$	*D*		β^-	~70 min.(N15, H55)			U-n(N15, H55)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
50	$Sn^{>125}$	*D*		β^-	~11 days(H55)			U-*n*(H55)
	$Sn^{>125}$	*F*		β^-	~4–5 hr.(H55)			U-*n*(H55)
51	Sb	*E*		β^-	3.5 min.(D9)			Sn-*p*-*n*(D9)
	$Sb^{116,118}$	*E*		β^+	3.6 min.(R16)			In-*α*-*n*(L16,R16)
	Sb^{120}	*A*		β^+	17 min.(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) Sb-*d*-H^3(K14)
	Sb^{121}		56(A31)					
	Sb^{122}	*A*		β^-,γ	2.8 days(L28)	0.81, 1.64(A10, M35) cl.ch., abs.	0.96(M35) coincid. abs.; 0.80(M34) spect.	Sb-*d*-*p*(L18) Sb-*n*-*γ*(A1,L18) Sn-*d*-2*n*(L18) Sn-*p*-*n*(D9)
	Sb^{123}		44(A31)					
	Sb^{124}	*A*		β^-,γ	60 days(L18)	1.53(M35) abs.; 0.74, 2.45(H35, H49) spect.	1.82(M35) coincid. abs.; 1.75(K16) Be-*γ*-*n* reaction	Sb-*d*-*p*(L18) Sb-*n*-*γ*(L18) I-*n*-*γ*(L18)
	$Sb^{<126}$	*D*		β^-	3 hr.(L18)			Sn-*d*-*n*(L18)
	$Sb^{<126}$	*D*			~45 days(L18)			Sn-*d*-*n*(L18)
	$Sb^{<126}$	*D*			~2 yr.(L18)			Sn-*d*-*n*(L18)
	$Sb^{>125}$	*D*		β^-	60 min.(N15)			$Sn^{>125}$ (70 min.) β^- decay (N15)
	Sb^{127}	*A*		β^-	80 hr.(A6)			U-*n*(A6)
	Sb^{129}	*A*		β^-	4.2 hr.(A6)			U-*n*(A6)
	$Sb^{>131}$	*D*		β^-	<10 min.(A6)			U-*n*(A6)
	$Sb^{>131}$	*D*		β^-	5 min.(A6)			U-*n*(A6)
	Sb^{133}	*A*		β^-	<10 min.(A6, W21)			U-*n*(A6,S21,W21) Th-*n*(S21,W21)
52	Te^{120}		<1(A31)					
	Te^{121}	*A*		*K*,e^-(S15, O8)	125 days(S15)		coincid. (Y3)	Sb-*d*-2*n*(S15) Sn-*α*-*n*(S15) Sb-*p*-*n*(S15)
	Te^{122}		2.9(A31)					
	$Te^{122,124}$	*E*		I.T.,e^-(?)	30 days(K17)		0.0820, 0.0883, 0.136, 0.1573, 0.2108, 0.615(K17) spect. conv.	Sb-*d*-*n*(?)(K17)
	Te^{123}		1.6(A31)					
	Te^{124}		4.5(A31)					
	Te^{125}		6.0(A31)					
	Te^{126}		19.0(A31)					
	Te^{127}	*A*		I.T.,e^- (S15)	90 days(S15)		0.086(H9) spect.conv.	Te-*d*-*p*(S15) I-*n*-*p*(S15)
	Te^{127}	*A*		β^-	9.3 hr.(S15)			Te-*d*-*p*(S15,T4) I-*n*-*p*(S15) Te-*n*-2*n*(T4) Te^{127} (90 days) I.T.(S15) Sb^{127} β^- decay(A6)
	Te^{128}		32.8(A31)					
	Te^{129}	*A*		I.T.,e^- (S15)	32 days(S15)		0.102(H9) spect.conv.	Te-*d*-*p*(S15,T4) Te-*n*-2*n*(T4) U-*n*(H55)
	Te^{129}	*A*		β^-	72 min.(S15,A6)			Te-*d*-*p*(S15,T4) Te-*γ*-*n*(B20) Te-*n*-2*n*(H10,T4) Te^{129} (32 days) I.T.(S15) Sb^{129} β^- decay(A6)
	Te^{130}		33.1(A31)					
	Te^{131}	*A*		I.T.,e^- (S15)	30 hr.(S15,A6)		0.177(H9) spect.conv.	Te-*d*-*p*(S15) U-*n*(A6,H22)
	Te^{131}	*A*		β^-	25 min.(S15)			Te-*d*-*p*(S15) Te-*n*-*γ*(S15) U-*n*(A6) Te^{131} (30 hr.) I.T.(S15)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
	$Te^{>131}$	*D*		β^-	43 min.(A6)			$Sb^{>131}$ (<10 min.) β^- decay (A6,H22) Th-*n*(P12)
	$Te^{>131}$	*D*		β^-	77 hr.(A6)	~0.3(B30) abs.		$Sb^{>131}$ (5 min.) β^- decay(A6, H22) Th-*n*(H24)
	Te^{133}	*A*		β^-	60 min.(A6,W21)			Sb^{133} β^- decay(A6,H22,S21, W21)
	Te^{135}	*A*		β^-	<1 min.–15 min. (W21,S21)			U-*n*(S21,W21) Th-*n*(S21,W21)
	Te	*D*		β^-	~1 min.(H55)			U-*n*(H55)
53	I^{124}	*A*		β^+	4.0 days(L19,D9)			Sb-α-*n*(L19) Te-*p*-*n*(D9)
	I^{126}	*A*		β^-,γ	13.0 days(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)
	I^{127}		100(N30)					
	I^{128}	*A*		β^-,γ	24.99 min.(H36)	1.85(B14) cl.ch. or 1.05, 2.10 (B14) cl.ch. (K.U.)	0.4(L19) abs. Pb	I-*n*-γ(A1,T4) Te-*d*-2*n*(L19) Te-*p*-*n*(D9)
	I^{130}	*A*		β^-,γ	12.6 hr.(L19)	0.61, 1.03(R23) spect., coincid.	0.417, 0.537, 0.667, 0.744(R23) spect. conv., spect., coincid.	Te-*d*-2*n*(L19) Te-*p*-*n*(D9) Cs-*n*-α(W21) Th-*n*(?)(P15)
	I^{131}	*A*		β^-,γ	8.0 days(L19)	0.687(T7) cl.ch.; 0.595(D29,D30, D31) spect., coincid.	0.4(L19) abs. Pb; 0.367, 0.080(D30, D31) spect., spect. conv., coincid.	Te-*d*-*n*(L19,R19) Te^{131} β^- decay(S15,A6,H22) U-α(F10)
	$I^{>131}$	*D*		β^-,γ	2.4 hr.(A6)	~1.35(B30) abs.	0.85(B30) abs.	$Te^{>131}$ (77 hr.) β^- decay(A6, H22,P12) U-α(F10)
	$I^{>131}$	*D*		β^-	54 min.(A6)			$Te^{>131}$ (43 min.) β^- decay (H22,A6,P12,P15) Th-*n*(D6) U-α(F10)
	I^{133}	*A*		β^-	22 hr.(A6,W21)	1.1(P13) cl.ch.		Te^{133} β^- decay (H22, A6, S21,W21) U-α(F10)
	I^{135}	*A*		β^-	6.6 hr.(S21,D27, W21)			Te^{135} β^- decay(S21,W21)
	I^{137}	*E*			30 sec.(S35)			U-*n*(S35,S43)
	I	*E*			1.8 min.(S35)			U-*n*(S35)
54	Xe^{124}		0.094(N30)					
	Xe^{126}		0.088(N30)					
	Xe^{127}	*B*		I.T.(?),e^-, γ(C41)	75 sec.(C41)		0.175, 0.125(C41) spect. conv.	I-*p*-*n*(B41,C41)
	Xe^{127}	*B*		$e^-\gamma$(C41)	34 days(C41)		0.9(C41) abs. of e^-	I-*p*-*n*(C41)
	Xe^{128}		1.90(N30)					
	Xe^{129}		26.23(N30)					
	Xe^{130}		4.07(N30)					
	Xe^{131}		21.17(N30)					
	Xe^{132}		26.96(N30)					
	Xe^{133}	*A*		I.T.,e^- (S27); β^-(S47) (?)	7.0 days(R22); 5.4 days (C22)	0.2–0.3(B30,S47) abs.	0.083(H25) spect. conv.	I^{133} β^- decay(S21,D27,W21) Xe-*d*-*p*(C22) Te-α-*n*(C22) Xe-*n*-γ(R22) Cs-*n*-*p*(W21) Ba-*n*-α(W21,S47)
	Xe^{134}		10.54(N30)					
	Xe^{135}	*A*		β^-,γ(B30)	9.4 hr.(S21,W21)	0.95(B30) abs.Al; 0.9(S47) abs. Al		I^{135} β^- decay(S21,D27,W21) Xe-*d*-*p*(C22) Ba-*n*-α(W21,S47)
	Xe^{135}	*A*		β^-,γ(B30)	15.6 min.(R22)	0.7(B30) abs. Al; 0.6(S47) abs. Al		I^{135} β^- decay(G11) Xe-*n*-γ(R22)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
54	Xe^{136}		8.95(N30)					
	Xe^{137}	*D*			68 min.(C22)			Xe-*d*-*p*(C22)
	Xe^{137}	*D*		β^-	3.4 min.(R22)	4(B30) abs. Al		I^{137} β^- decay (S43) Xe-*n*-γ(R22)
	Xe^{138}	*D*		β^-	17 min.(G21)			U-*n*(H28,H22,G9,G21,S47)
	Xe^{139}	*A*		β^-	<0.5 min.(H28)			U-*n*(H28,H22,H11) Th-*n*(H29,A5)
	Xe^{140}	*D*		β^-	<0.5 min.(H28)			U-*n*(H28) Th-*n*(H29)
55	Cs^{133}		100(N30)					
	Cs^{134}	*A*		β^-(K26)	3 hr.(K26)	1(K26) abs.		Cs-*n*-γ(A1,M16,K26) Cs-*d*-*p*(K26)
	Cs^{134}	*A*		β^-,γ(K26)	1.7 yr.(K26)	0.9(K26) abs.		Cs-*n*-γ(A8,S20,K26) Cs-*d*-*p*(K26)
	Cs^{138}	*D*		β^-	33 min.(H28)	2.6(G21) abs.		Xe^{138} β^- decay(H28,H22, G9,G21) Pa-*n*(G7) Ba-*n*-*p*(S47)
	Cs^{139}	*A*		β^-	7 min.(H28)			Xe^{139} β^- decay(H28,H22, H11)
	Cs^{140}	*D*		β^-	40 sec.(H28)			Xe^{140} β^- decay(H28)
56	Ba^{130}		0.101(N36)					
	Ba^{132}		0.097(N36)					
	Ba^{133}	*A*		I.T.,e^-,γ (C30)	38.8 hr.(W28)		0.30(D9) spect.conv.; 0.276(C30) spect. conv.	Ba-*n*-2*n*(K26,W22) Cs-*p*-*n*(D9,W28) Cs-*d*-2*n*(C30,W28) Ba-*d*-*p*(W22)
	Ba^{134}		2.42(N36)					
	Ba^{135}		6.59(N36)					
	Ba^{136}		7.81(N36)					
	Ba^{137}		11.32(N36)					
	Ba^{138}		71.66(N36)					
	Ba^{139}	*A*		β^-,γ	86 min.(P8,H28)	1(K26) abs.; 2.3 (B30) abs.	0.6(K26) abs. Pb, Cu	Ba-*d*-*p*(P8,K26) Ba-*n*-γ(A1,P2) La-*n*-*p*(P8) Cs^{139} β^- decay(H29,H22, H11) U-γ(L2) Ce-*n*-α(W22)
	Ba	*D*			3 min.(A1,P2)			Ba-*n*-?(A1,P2,K26)
	Ba^{140}	*A*		β^-	~300 hr.(H28, G21)	1.2(B30) abs.		Cs^{140} β^- decay(?)(G21)
	$Ba^{>140}$	*D*		β^-	6 min.(H48)			U-*n*(H48) Th-n(H15,H14) U-γ(L2)
	$Ba^{>140}$	*D*		β^-	18 min.(H48)			U-*n*(H48) Th-*n*(H15,H14) U-γ(L2)
	$Ba^{>140}$	*E*		β^-	<1 min.(H14)			U-*n*(H14)
57	La^{137}	*B*		*K*,γ(W23, M24)	17.5 hr.(W23)		0.88(W23) abs. Pb.	Ba-*d*-*n*(W23,M24) Ba-*p*-*n*(W23,W22)
	La^{138}	*F*			2.2 hr.(P2)			La-*n*-2*n*(?)(P2)
	La^{139}		100(A31)					
	La^{140}	*A*		β^-,γ	40.0 hr.(W23)	1.41(W23) abs. Al, spect.	2.00(W23,M24) abs. Pb; 2.04(M27) spect.	La-*d*-*p*(P8,W23,M24) La-*n*-γ(P9,M13,W23,M24, G14) Ce-*n*-*p*(W23) Ba-*d*-γ(?)(W23) Ba^{140} β^- decay(H48,H28, H22,G21)
	$La^{>140}$	*D*		β^-	74 min.(H48)			$Ba^{>140}$ (6 min.) β^- decay (H48)
	$La^{>140}$	*D*		β^-	3.5 hr.(H48)			$Ba^{>140}$ (18 min.) β^- decay (H48) Th-*n*(C16)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
57	$La^{>140}$	*E*		β^-	<30 min.(H14,H15)			$Ba^{>140}$ (<1 min.) β^- decay (H14,H15)
	$La^{>140}$	*F*		β^-	15 min.(H55)			U-*n*(H55)
	$La^{>140}$	*F*		β^-	13 days(H55)			U-*n*(H55)?
58	Ce^{136}		<1(D41)					
	Ce^{138}		<1(D41)					
	Ce^{139}	*F*		β^+	2.1 min.(P9)			Ce-*n*-2*n*(?)(P9)
	Ce^{140}		89(A31)					
	Ce^{140*}	*B*		I.T.,γ(P14)	140 days(P14)		0.21(P14)	La-*d*-*n*(P14) Ba-α-*n*(P14)
	Ce^{141}	*A*		β^-,γ	30 days(P14)	0.65(P14)	0.2(P14)	Ce-*d*-*p*(P14) Ce-*n*-γ(P14) Ce-*n*-2*n*(P14) Ba-α-*n*(P14) Pr-*n*-*p*(P14)
	$Ce^{141,143}$	*C*			15 days(R11)	0.12(R11) spect.		Ce-*n*-γ(R11)
	Ce^{142}		11(A31)					
	Ce^{143}	*B*		β^-	36 hr.(P14)			Ce-*d*-*p*(P14) Ce-*n*-γ(P14)
	Ce	*D*		β^-	310 days(B30, H55)			U-*n*(Xe parent)(B30,H55)
	Ce	*D*		β^-	≦20 days(H55)			U-*n*(Xe parent)(H55)
	Ce	*D*		β^-	~15 min.(G19)			U-*n*(H55,G19)
	Ce	*D*		β^-	~4–5 hr.(H55)			U-*n*(H55)
	Ce	*D*		β^-	~40 hr.(H55)			U-*n*(H55)
59	Pr^{140}	*A*		β^+	3.5 min.(P9)	2.40(D32) cl.ch.		Pr-*n*-2*n*(P9,A1,W25,D32)
	Pr^{141}		100(A31)					
	Pr^{142}	*A*		β^-,γ	19.3 hr.(D32)	2.14(D32) spect.	1.9(D32) abs. Pb	Pr-*n*-γ(P9,P2,M13,A1,W25, D32) Nd-*n*-*p*(P9,P2) Pr-*d*-*p*(D32) Ce-*p*-*n*(D32) La-α-*n*(D32)
	Pr^{143}	*B*		β^-	13.5 days(P14)	0.95(P14)		Ce^{143} β^- decay(P14) U-*n*(H55)?
	Pr	*B*		β^-	25 min.(G19)			Ce (~15 min.) β^- decay (G19)
	Pr	*D*		β^-	17 min.(H55)	3.1(B30,H55) abs.		Ce (310 days) β^- decay (H55)
60	Nd^{141}	*E*		β^+	2.5 hr.(K19)	0.78(K19)		Nd-*d*-H^3(?)(P9,K19) Nd-*n*-2*n*(P9,K19,L25) Pr-*p*-*n*(K19) Nd-γ-*n*(L25,K19)
	Nd^{142}		25.95(M53)					
	Nd^{143}		13.0(M53)					
	Nd^{144}		22.6(M53)					
	Nd^{145}		9.2(M53)					
	Nd^{146}		16.5(M53)					
	$Nd^{147,149}$	*E*		β^-	47 hr.(W25,L25)	0.95(W25) abs.		Nd-*d*-*p*(P9,L25) Nd-*n*-γ(P9,L25,W25) Nd-*n*-2*n*(?)(P9)
	Nd^{148}		6.8(M53)					
	Nd^{150}		5.95(M53)					
	Nd^{151}	*E*		β^-	21 min.(P9)			Nd-*n*-γ(P9,M18)
61	61	*F*		β^-	12.5 hr.(P9)			Nd-*d*-*n*(P9)
	61	*E*		*K* or I.T., γ(W25)	~200 days(W25)		0.67(W25) abs.	Pr-α-*n*(W25,K21) Nd-*d*-*n*(K20,K21)
	61	*E*		β^-,γ	5.3 days(K20)	2(K20)		Nd-*p*-*n*(K20) Nd-*d*-*n*(K20,K21,L25) Nd-α-*p*(K21,L25)
	61	*E*		β^-,γ	2.7 hr.(K20)	2(K20)		Nd-*p*-*n*(K20,L25) Nd-*d*-*n*(K20,L25) Nd-α-*p*(L25)
	61	*E*		β^-,γ	16 days(K20)	1.7(K20)		Nd-*d*-*n*(K20)

Table of Isotopes— *Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
62	Sm^{144}		3(A33)					
	Sm^{147}		17(A33)					
	Sm^{148}(W40)	*A*	14(A33)	α(H85,L74)	1.4×10^{11} yr.(H86); 1.7×10^{11} yr.(W40)	2.0(H86) cl.ch.		Natural source(H85,L74)
	Sm^{149}		15(A33)					
	Sm^{150}		5(A33)					
	Sm^{152}		26(A33)					
	Sm^{154}		20(A33)					
	Sm	*D*		β^-	21 min.(P9)	1.8(K19)		Sm-*n*-γ(P9,A1,M13,H17, (L25) Sm-*n*-2*n*(?)(P9,K19) Sm-γ-*n*(L25) Sm-*d*-*p*(L25,K19) Nd-α-*n*(K19)
	Sm	*D*		I.T.(W25)	46 hr.(P9)		~0.6(M31) abs. of e^-	Sm-*n*-γ(P9,H20,R11,H17, W25,L25) Sm-*n*-2*n*(?)(P9,K19) Sm-*d*-*p*(L25,K19) Sm-γ-*n*(L25) Nd-α-*n*(K19)
	Sm	*E*			60 days(K19)			Sm-*d*-*p*(K19,L25) Sm-*n*-γ(K19) Nd-α-*n*(K19)
63	Eu^{150}	*E*		β^+	27 hr.(P9)			Eu-*n*-2*n*(?)(P9,R11)
	Eu^{151}		49.1(L60)					
	Eu^{152}	*B*		β^-,γ,e^-(T6); *K*(?)(R2)	9.2 hr.(P9)	1.88(β^-)(T6) spect.	0.123, 0.163, 0.725 (T6) spect.conv.	Eu-*n*-γ(P9,M13,H17,H20, F11) Eu-*n*-2*n*(?)(P9) Eu-*d*-*p*(F7,F11)
	Eu^{153}		50.9(L60)					
	Eu^{154}	*B*		β^-,γ(R11, F7)	5–8 yr.(F11)	0.9(R11) spect.		Eu-*n*-γ(S20,R11,F7,F11) Sm-*d*–2*n*(?)(K20) Eu-*d*-*p*(F11)
	Eu	*E*			40 days(K20)			Sm-*d*-*n*(K20)
64	Gd^{152}		0.2(W41)					
	Gd^{154}		2.86(W41)					
	Gd^{155}		15.61(W41)					
	Gd^{156}		20.59(W41)					
	Gd^{157}		16.42(W41)					
	Gd^{158}		23.45(W41)					
	$Gd^{159,161}$	*E*			8 hr.(A1,H17)			Gd-*n*-γ(A1,H20,H17)
	Gd^{160}		20.87(W41)					
	Gd	*F*		β^-,γ(F11)	155–170 days (F11)			Eu-*d*-*n*(F11)
65	Tb^{159}		100(A33)					
	Tb^{160}	*A*		β^-	3.9 hr.(H16,M13)			Tb-*n*-γ(H17,P9,M13,H20)
	Tb^{160}	*A*		β^-,γ(B33)	72 days(B33)	0.70(B33) abs. Al		Tb-*n*-γ(B33)
66	Dy^{158}		0.1(D42)					
	Dy^{160}		1.5(D42)					
	Dy^{161}		22(A31)					
	Dy^{162}		24(A31)					
	Dy^{163}		24(A31)					
	Dy^{164}		28(A31)					
	Dy^{165}	*A*		β^-,γ	2.5 hr.(H17,P9, M13)	1.20(C31) abs., coincid.; 1.18 (D33) spect.; 1.40(E11) cl.ch.	1.1(C31) abs., coincid.	Dy-*n*-γ(H17,H20,P9,M13, M31)
	Dy(?)	*F*		β^+	2.2 min.(P9)			Dy-*n*-?(P9)
67	Ho^{164}	*F*		β^-	47 min.(P9)			Ho-*n*-2*n*(?)(P9)
	Ho^{165}		100(A33)					
	Ho^{166}	*B*		β^-	35 hr.(H17)	1.6(H20) abs.; 1.9 (M31) abs.		Ho-*n*-γ(H17,H20,P9,M31)
68	Er^{162}		0.1(W42)					
	Er^{164}		1.5(W42)					

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
68	Er^{165}	*F*		β^+	1.1 min.(P9)			Er-*n*-2*n*(?)(P9)
	Er^{166}		32.9(W42)					
	Er^{167}		24.4(W42a					
	Er^{168}		26.9(W42)					
	$Er^{169,171}$	*C*			7 min.(M13)			Er-*n*-γ(M13,M18)
	$Er^{169,171}$	*C*		β^-	12 hr.(H17,P9)			Er-*n*-γ(H17,H20,P9,R24)
	Er^{170}		14.2(W42)					
69	Tm^{169}		100(A33)					
	Tm^{170}	*A*			105 days(H20)			Tm-*n*-γ(H20,N7)
70	Yb^{168}		0.06(W43)					
	Yb^{170}		4.21(W43)					
	Yb^{171}		14.26(W43)					
	Yb^{172}		21.49(W43)					
	Yb^{173}		17.02(W43)					
	Yb^{174}		29.58(W43)					
	$Yb^{175,177}$	*C*			3.5 hr.(H17,M13)			Yb-*n*-γ(H20,H17,M13,P9)
	Yb^{176}		13.38(W43)					
	Yb(?)	*G*			41 hr.(P9)			Yb-*n*-γ(?)(P9)
71	Lu^{175}		97.5(M54)					
	Lu^{176}(H80, M54)	*A*	2.5(M54)	β^-(H80, L70), γ(F16)	7.3×10^{10} yr.(L70)	0.215(L70) abs. Al, spect.; 0.40 (F16)	0.260(F16)	Natural source(H80)
	$Lu^{176,177}$	*C*		β^-	3.4 hr.(F16)	1.150(F16) abs.		Lu-*n*-γ(H20,H17,M13,M18, F16)
	$Lu^{176,177}$	*C*		β^-	6.6 days(F16)	0.440(F16) abs.		Lu-*n*-γ(H17,H20,F6,F16)
72	Hf^{174}		0.18(M55)					
	Hf^{176}		5.30(M55)					
	Hf^{177}		18.47(M55)					
	Hf^{178}		27.13(M55)					
	Hf^{179}		13.85(M55)					
	Hf^{180}		35.14(M55)					
	Hf^{181}	*A*		β^-	55 days(H19)			Hf-*n*-γ(H19)
73	Ta^{180}	*A*			14–21 min.(B11, O1)			Ta-γ-*n*(B11) (Ta-*n*-2*n*)(?)(O1)
	Ta^{180}	*A*		*K*,*e*$^-$,γ(O1); β^-(?)	8.2 hr.(O1)	<0.5(*e*$^-$)(?)(O1) abs.		Ta-*n*-2*n*(O1,P2)
	Ta^{181}		100(D40)					
	Ta^{182}	*A*		β^-,γ	97 days(O1)	1.0(H37) abs.; 0.98, 0.32, 0.050 (Z2)	1.6(Z2)	Ta-*n*-γ(O1,F6,H37) Ta-*d*-*p*(O1,Z2)
74	W^{180}		~0.2(D43)					
	W^{182}		22.6(A31)					
	W^{183}		17.3(A31)					
	W^{184}		30.1(A31)					
	W^{185}	*B*		β^-,γ(M36)	77 days(M36)	0.55–0.65(F12) abs. Al; 0.64–0.72(F12) cl.ch.		W-*n*-γ(M36,F12) W-*n*-2*n*(M36,F12) W-*d*-*p*(F12) Re-*d*-α(F12)
	W^{186}		29.8(A31)					
	W^{187}	*B*		β^-,γ(M36)	24.1 hr.(F12)	1.4(F12) abs. A1, cl.ch., (C31) abs., coincid.	0.87(F12) abs. Pb; 0.90(C31) coincid. abs., coincid.; 0.94 (M30) spect.; 0.135, 0.101, 0.086(V6) spect.conv.	W-*n*-γ(M14,A1,M36,F12) W-*d*-*p*(F12)
75	Re	*E*		β^+(C42)	30–55 min.(C32, D9)			W-*p*-*n*(D9,C32)
	Re	*E*			13 min.(C42)			W-*p*-*n*(C42)
	Re^{184}	*B*		*K*(?),γ	52 days(F12)		0.85(F12)	W-*p*-*n*(D9,C42,F12,C32) W-*d*-*n*(F12) Re-*n*-2*n*(F12)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev Particles	γ-rays	Produced by
75	Re^{185}		38.2(A31)					
	Re^{186}	*B*		β^-	90 hr.(S16)	1.05(Y4) cl.ch.	No γ(C42)	Re-*n*-γ(S16,K7,Y4,F12) Re-*n*-2*n*(S16,Y4,F12) W-*p*-*n*(D9,C32) Re-*d*-*p*(F12) W-*d*-2*n*(F12)
	Re^{187}		61.8(A31)					
	Re^{188}	*B*		β^-,γ	18 hr.(P2)	2.5(S16) cl.ch. (K.U.)	0.8(M34) spect.	Re-*n*-γ(P2,K7,S16,Y4,F12) Re-*d*-*p*(F12)
76	Os^{184}		0.018(N37)					
	Os^{186}		1.59(N37)					
	Os^{187}		1.64(N37)					
	Os^{188}		13.3(N37)					
	Os^{189}		16.1(N37)					
	Os^{190}		26.4(N37)					
	Os^{191}	*B*		β^-,γ(S36)	32 hr.(S36)	1.5(S36) abs. Al		Os-*n*-γ(K7,S36,Z3) Os-*n*-2*n*(?)(S36)
	Os^{192}		41.0(N37)					
	Os^{193}	*B*		β^-,γ(S36)	17 days(S36)	0.35(S36) abs. Al		Os-*n*-γ(S36,Z3)
77	Ir^{191}		38.5(S63)					
	$Ir^{192,194}$	*C*		β^-	1.5 min.(M15)			Ir-*n*-γ(M15)
	$Ir^{192,194}$	*C*		β^-,γ(M34, W29)	19 hr.(M15,A1)	2.2(A2) spect.; 2.18(W29) spect.; 2.11 (W29) abs. Al	1.35(M34) spect.	Ir-*n*-γ(M15,A1,P2,J4) Au-*d*-α,*p*(?)(C18)
	$Ir^{192,194}$	*C*		β^-,γ	60 days(M15,F6)		0.63(M34) spect.; 0.307, 0.467, 0.603 (D34) spect.	Ir-*n*-γ(M15,F6,J4)
	Ir^{193}		61.5(S63)					
78	Pt^{192}		0.8(So3)					
	Pt^{194}		30.2(S63)					
	Pt^{195}		35.3(S63)					
	Pt^{196}		26.6(S63)					
	Pt^{196*}	*D*		I.T.,e^-(?) (S37)	80 min.(S37)			Hg-*n*-α(S37) Pt-*d*-*p*(S37)
	Pt^{197}	*B*		β^-	18 hr.(M15)	0.65(S37) abs.; 0.72(K27) abs.		Pt-*n*-γ(M15,S37) Pt-*d*-*p*(C19,S37,K27) Pt-*n*-2*n*(S37) Hg-*n*-α(S37)
	Pt^{197}	*B*		β^-,γ(K27)	3.3 days(M15)			Pt-*n*-γ(M15,P2) Pt-*d*-*p*(K27)
	Pt^{198}		7.2(S63)					
	Pt^{199}	*A*		β^-	31 min.(M15)	1.8(S37,K27) abs.		Pt-*n*-γ(M15,A1,M14,S37) Pt-*d*-*p*(C19,K27,S37) Hg-*n*-α(S37)
79	Au^{196}	*B*		β^-	13 hr.(M15)			Au-*n*-2*n*(M15)
	Au^{196}	*B*		β^-,γ,e^- (K27)	4–5 days(M15); 5.6 days(L29, K27)	0.36(C43)	0.41(C43)	Au-*n*-2*n*(M15) Pt-*d*-*n*(K27)
	Au^{197}		100(D44)					
	Au^{198}	*A*		β^-,γ	2.7 days(M15,A1)	0.8(M15,R2) abs. and cl.ch.; 0.78 (C31) abs., coincid.	0.28, 0.44, 2.5(R2,S17) cl.ch. recoil, (C31) coincid.	Au-*n*-γ(M15,A1,P2,D33) Au-*d*-*p*(C18,K28) Hg-*n*-*p*(S37)
	Au^{199}	*A*		β^-,γ(K27)	3.3 days(M15)	1.01(K27) abs.	0.45(K27) abs.	Pt^{199} β^- decay(M15,K27) Hg-*n*-*p*(S37) Pt-*d*-*n*(K27)
	$Au^{200,202}$	*D*		β^-	48 min.(S37,M32)	2.5(S37) abs.		Hg-*n*-*p*(S37,M32) Tl-*n*-α(M32)
80	Hg^{196}		0.15(N30)					
	Hg^{197}	*A*		*K*,γ,e^- (F13)	23 hr.(F13)		~0.20(F13) abs. of e^-; 0.161, 0.130 (H38) spect.conv.; 0.125, 0.157(V8) spect.conv.	Au-*d*-2*n*(F13,W26,K28) Hg-*n*-2*n*(F13,W26) Hg-*n*-γ(F13,W26,M15,A9) Pt-α-*n*(S37) Hg-*d*-*p*(K29)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
80	Hg^{197}	*A*		K,γ,e^- (F13)	64 hr.(F13)		~0.09(F13) abs. of e^-; 0.075(H38) spect. conv.	Au-*d*-2*n*(F13,W26) Hg-*n*-2*n*(F13,W26) Hg-*n*-γ(F13,W26)
	Hg^{198}		10.1(N30)					
	Hg^{199}		17.0(N30)					
	$Hg^{199*,201*,204*}$	*D*		I.T.,e^-, γ(F13)	43 min.(H10,M15)		~0.53(F13) abs. of e^-	Hg-*n*-2*n*(M15,H10,P2) Hg-*n*-*n*(?)(F13,W26) Hg-*d*-*p*(K29) Pt-α-*n*(?)(S37)
	Hg^{200}		23.3(N30)					
	Hg^{201}		13.2(N30)					
	Hg^{202}		29.6(N30)					
	$Hg^{203,205}$	*C*		β$^-$,γ(F13)	51.5 days(F13)	0.46(F13) abs. Al	0.30(F13) abs. Pb	Hg-*n*-γ(F13,W26,S37) Hg-*d*-*p*(K29) Tl-*n*-*p*(M32)
	Hg^{204}		6.7(N30)					
	Hg^{205}	*A*		β$^-$	5.5 min.(K29, M32)	1.62(K29) abs. Al		Hg-*d*-*p*(K29) Hg-*n*-γ(F13,W26) Tl-*n*-*p*(M32) Pb-*n*-α(M32)
81	Tl	*D*		*K*(?),e^-, γ(K29)	10.5 hr.(K29)		1.0(K29) abs. Pb	Hg-*d*-2*n*(K29)
	Tl	*D*		*K*(?),e^- (K29)	44 hr.(K29)			Hg-*d*-2*n*(K29)
	Tl^{200}	*F*			4 min.(K3)			Au-α-*n*(?)(K3)
	Tl^{200}	*F*			3.8 hr.(K3)			Au-α-*n*(?)(K3)
	Tl^{202}	*B*		*K*(?),γ,e^- (K29, M32)	11.8 days(F14); 13 days(M32)		0.40(M32)	Hg-*d*-2*n*(K29) Tl-*n*-2*n*(F14,M32)
	Tl^{203}		29.1(N36)					
	Tl^{204}	*B*		β$^-$	4.23 min.(F17)	1.6(F17) abs.; 1.77(K29) abs. Al	No γ(F17)	Tl-*n*-γ(P10,P2,H10) Tl-*d*-*p*(F17,K29) Tl-*n*-2*n*(F17,P2,H10)
	Tl^{205}		70.9(N36)					
	Tl^{206}	*B*		β$^-$	3.5 yr.(F14)	0.87(F14) cl.ch.	No γ(F14)	Tl-*n*-γ(F17,F14) Tl-*d*-*p*(F17,F14)
	AcC''^{207}	*A*		β$^-$,γ(C60)	4.76 min.(C60, S70)	1.47(S71) abs. Al		AcC^{211} α decay Pb-*n*-*p*(B16)
	ThC''^{208}	*A*		β$^-$,γ(C60)	3.1 min.(C60)	1.82(S72) abs. paper	2.62(R40)	ThC^{212} α decay
	RaC''^{210}	*A*		β$^-$	1.32 min.(C60)	1.80(L71) cl.ch.		RaC^{214} α decay
82	Pb^{203}	*B*		β$^+$	10.25 min.(K29)	1.66(K29) abs. Al		Tl-*d*-2*n*(K29)
	Pb^{203}	*B*		I.T(?) or *K*(?),e^- γ(F14, K29,L33, M32)	52 hr.(F17,F14)		~0.45(F17,F14,K29) abs. of e^-, (F14,M32, L33) abs. Pb, (L33) spect., (M32) spect. conv.,0.27(L33, M32) spect. conv., abs.Pb	Tl-*d*-2*n*(F14,K29,F17) Pb-*n*-2*n*(M32)
	Pb^{204}		1.5(N38)					
	$Pb^{204*,205}$	*C*		I.T.(?),γ,e^- (F14, M32)	68 min.(M32); 65 min.(F14)		1.1(F14) abs. of e^-, abs. Pb; 0.90(M32)	Pb-*n*-γ or Pb-*n*-*n*(D10,M32) Tl-*d*-*n*(F14)
	Pb^{206}		23.6(N38)					
	Pb^{207}		22.6(N38)					
	Pb^{208}		52.3(N38)					
	Pb^{209}	*A*		β$^-$	3.0 hr.(T5)	0.70(K29,F14) abs.; 0.750 (M32)		Pb-*d*-*p*(T5,K29,F14,F15) Pb-*n*-γ(M32) Bi-*n*-*p*(M32)
	RaD^{210}	*A*		β$^-$,γ(R40)	22 yr.(C60)	0.0255(L72) spect.	0.047(R40)	RaC''^{210} β$^-$ decay RaC'^{214} α decay
	AcB^{211}	*A*		β$^-$,γ(S71)	36.1 min.(S70)	0.5, 1.40(S71) abs. Al	0.8(S71) abs.	AcA^{215} α decay
	ThB^{212}	*A*		β$^-$,γ(R40)	10.6 hr.(C60)	0.36(S72) spect.		ThA^{216} α decay
	RaB^{214}	*A*		β$^-$,γ(R40)	26.8 min.(C60)	0.65(S72) spect.		RaA^{218} α decay
	Pb*	*D*		I.T.,e^-	1.6 min.(W27)		~0.3(W27) abs. of e^-	Pb-x-rays(W27)

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
83	Bi^{207}	*A*		*K*(?),e^-, γ(L33)	6.4 days(K29)		0.74(K29) abs. of e^-; 0.93(F14) abs. of e^-; 1.1(F14) abs. Pb	Pb-*d*-*n*(F15,F14,K29)
	Bi^{209}		100(N36)					
	RaE^{210}	*A*		β^-	5.0 days(C60)	1.17(F30,N40, L76) spect.		RaD^{210} β^- decay Bi-*d*-*p*(L13,C26,H27) Bi-*n*-γ(M29)
	AcC^{211}	*A*		α(99.68%) (C60),γ (R40);β^- (0.32%) (C60),γ (C60)	2.16 min.(C60)	6.619(α)(H81) spect.		AcB^{211} β^- decay
	ThC^{212}	*A*		α(33.7%) (K50),γ (R40);β^- (66.3%) (K50),γ (C60)	60.5 min.(C60)	6.054(α)(B70, H81) spect.;2.20 (β^-)(S72) spect.		ThB^{212} β^- decay
	RaC^{214}	*A*		α(0.04%) (C60);β^- (99.96%) (C60), γ(R40)	19.7 min.(C60)	5.502(α)(L73) spect.; 3.15(β^-) (S72) abs. Al, spect.	1.8(R40)	RaB^{214} β^- decay
84	Po^{210}	*A*		α,γ(R40)	140 days(C60)	5.298(H81) spect.		RaE^{210} β^- decay(L13,C26, H27) Bi-*d*-*n*(V4,C26,H27)
	AcC'^{211}	*A*		α	5×10^{-3} sec.(C60)	7.434(L73) spect.		AcC^{211} β^- decay 85^{211} *K* decay(C46,C23)
	ThC'^{212}	*A*		α	3×10^{-7} sec.(D50)	8.776(B70,H81) spect.		ThC^{212} β^- decay
	RaC'^{214}	*A*		α	1.5×10^{-4} sec. (D50,R41,W50)	7.680(B70,H81) spect.		RaC^{214} β^- decay
	AcA^{215}	*A*		α	1.83×10^{-3} sec. (W50)	7.365(L73) spect.		An^{219} α decay
	ThA^{216}	*A*		α(~100%); β^-(0.014%) (K33)	1.58×10^{-1} sec. (W50)	6.774(α)(B70, H81) spect.		Tn^{220} α decay
	RaA^{218}	*A*		α(99.96%); β^-(0.04%) (K51)	3.05 min.(C60)	5.998(α)(B70,H81) spect.		Rn^{222} α decay
85	85^{211}	*A*		α(60%) (C46); *K*(40%) (C46)	7.5 hr.(C46,C23)	5.94(α)(C46) abs.		Bi-α-2*n*(C46,C23)
	85^{216}	*I?*		α(K33)	Short (<54 sec.) (K33)	7.64(K33) ion.ch.		ThA^{216} β^- decay(K33)
	85^{218}	*I*		α(K51)	Several sec.(?) (K51)	6.63(K51) ion.ch.		RaA^{218} β^- decay(K51)
86	An^{219}	*A*		α	3.92 sec.(C60)	6.824(H81,L73) spect.		AcX^{223} α decay
	Tn^{220}	*A*		α	54.5 sec.(C60)	6.282(B70,H81) spect.		ThX^{224} α decay
	Rn^{222}	*A*		α	3.825 days(C60)	5.486(B70,H81) spect.		Ra^{226} α decay
87	87^{223} (AcK)	*E*		β^-,γ(P41, P43)	21 min.(P40,P43)	1.20(P42,P41) cl. ch.	>3(P41) cl.ch. pair	Ac^{227} α decay(P40)
88	AcX^{223}	*A*		α,γ(R40)	11.2 days(C60)	6.717(L73) spect.		$RdAc^{227}$ α decay
	ThX^{224}	*A*		α	3.64 days(L71)	5.681(B70) spect.		$RdTh^{228}$ α decay
	Ra^{226}	*A*		α,γ(C60)	1590 yr.(C60)	4.791(L73) spect.	0.19(R40)	Io^{230} α decay
	$MsTh_1^{228}$	*A*		β^-	6.7 yr.(C60)	0.053(L72) spect., abs. Al		Th^{232} α decay

Table of Isotopes—*Continued*

Z	Isotope A	Class	Percent abundance	Type of radiation	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: γ-rays	Produced by
89	Ac^{227}	A		α(1%) (P40); β^-(99%) (P40)	13.5 yr.(C60)	5.0(α)(P40) abs. air; 0.220(β^-) (H82) spect.	No γ(P43)	Pa^{231} α decay
	$MsTh_2^{228}$	A		β^-,γ(C60); α(G40)	6.13 hr.(C60)	1.55(β^-)(L6) spect.;4.5(α) (G40) abs. air		$MsTh_1^{228}$ β^- decay
90	$RdAc^{227}$	A		α,γ(C60)	18.9 days(C60)	6.049(L73) spect.		Ac^{227} β^- decay
	$RdTh^{228}$	A		α,γ(C60)	1.90 yr.(C60)	5.418(L73) spect.		$MsTh_2^{228}$ β^- decay
	Io^{230}	A		α,γ(W53)	8.3×10^4 yr.(C60)	4.66(G41) abs. air; 4.81(W51) calor.		UII^{234} α decay
	UY^{231}	A		β^-	24.6 hr.(C60); 24.0 hr.(G43)	~0.2(E30) abs.		AcU^{235} α decay Th-n-2n(N5)
	Th^{232}	A	100(D45)	α	1.39×10^{10} yr. (K50)	4.20(S73) ion.ch.		Natural source(C62,S76)
	Th^{233}	A		β^-	23 min.(G12)			Th-n-γ(M17)
	UX_1^{234}	A		β^-,γ(M60, F40)	24.5 days(C60); 24.1 days(S70)	0.130, 0.300(M61) cl.ch.; 0.11, 0.20 (F40) abs. Al; 0.13(S72) abs. Al, spect.	0.092(M60)(1%)(F40)	UI^{238} α decay
91	Pa^{231}	A		α,γ(C60)	3.2×10^4 yr.(G42)	5.049(R42) spect.		UY^{231} β^- decay
	Pa^{233}	A		β^-,γ,e^- (H40)	27.4 days(G12)	0.4(S38) abs. Al; 0.23(H40) spect.	e^- lines at 0.063, 0.077, 0.192, 0.293(H40) spect.	Th^{233} β^- decay(S38,G12, H39)
	UZ^{234}	A		β^-,γ(F40)	6.7 hr.(C60)	0.56, 1.55(F40) abs. Al	0.70(F40) abs. Pb, W	UX_2^{234} I.T.(F40)
	UX_2^{234}	A		β^-,γ(M61); I.T. (0.15%) (?)(F40)	1.14 min.(C60)	2.32(S72) abs. Al; 1.52(5%),2.32 (95%)(M61) spect.	0.802(5%)(M61) spect. conv.; 0.782, 0.822(B32) spect. conv.	UX_1^{234} β^- decay
92	UII^{234}	A	0.006(N39)	α	2.69×10^5 yr.(N41)	4.71(R43) cl.ch.; 4.78(S75) abs. air; 4.76(S77) ion.ch.		Pa^{234} β^- decay
	AcU^{235}	A	0.71(N39)	α	7.07×10^8 yr. (N41)	4.52(W52) cl.ch.		Natural source(D51)
	U^{237}	A		β^-,γ(M37)	~7 days(M37,N8)	0.26(M37) abs.		U-n-2n(M37,N8)
	UI^{238}	A	99.28(N39)	α	4.51×10^9 yr.(N41)	4.15(R43) cl.ch.; 4.23(S75) abs. air; 4.21(S77) ion.ch.		Natural source(B72)
	U^{239}	A		β^-	23 min.(I1,S4)			U-n-γ(H18,H14,I1,M19, S44)
93	93^{239}	A		β^-,γ	2.3 days(M28, M19)	0.47(M28) abs.	0.22, 0.27(H25) spect. conv., spect.	U^{239} β^- decay(M28,S39,S44)

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