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TABLE OF THE ISOTOPES

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Berkeley, California

August, 1948

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sponsored by the Atomic Energy Commission.

TABLE OF THE ISOTOPES

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The following table represents a complete list of all the artificial and natural radioactive isotopes and stable isotopes, together with a number of their important features covering information available by approximately July, 1948, through publications, private communications and almost all of the restricted distribution reports of the U. S. Atomic Energy Commission, the former "Manhattan District", U. S. Army Corps of Engineers and the corresponding offices of Great Britain and Canada. With very few exceptions the criterion for listing a radioactive isotope has been the actual observation of its radiation.

The first column lists the atomic numbers and mass numbers of the isotopes. The superscript "m" following the mass number denotes a metastable isomer of measured half-life of either a stable or unstable ground state but the isomeric transition need not have been observed.

In the second column headed "class" the degree of certainty of each isotopic assignment is indicated 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

In most cases the class is determined by evaluating the uniqueness of the assignment through chemical separation, reaction type and yield considerations, genetic relationships, and type of radiation. In a few cases newer techniques have been used. The term "m.s." in the second column refers to the identification of the mass number by means of a mass spectrograph, and "res.n.act." (resonance neutron activation) refers to the identification of a nuclear isomer by observing both isomers upon irradiation with filtered neutrons. With the mass spectrographic assignment of mass numbers there are some instances in which the mass number is known with greater certainty than the element. Such cases are assigned the appropriate code letter such as "E" followed by "m.s.".

The percent abundance of the stable isotopes is listed in column three.

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

β^- = negative beta-particles (negatrons)
β^+ = positive beta-particles (positrons)
γ = gamma-rays
α = alpha-particles
n = neutrons
e^- = internal-conversion electrons
K = K-electron capture (or in more general terms, orbital electron capture)
I.T.= isomeric transition (transition from upper to lower isomeric state)

In the cases where it is certain that no gamma-rays are emitted, this fact is expressed explicitly in column seven by the term "No γ". Annihilation gamma-rays and x-rays are not listed. It may be assumed that x-rays have been observed or actually identified in almost all cases of orbital electron capture listed.

The half-life, followed by the relevant reference, is given in the fifth column. In most cases the determination is direct, either by measuring the decay rate, by weighing a long-lived isotope of known purity, or by comparing the activity with that of a genetically related isotope of known half-life. A number of half-lives are known only from the yield of activity resulting from a nuclear reaction of known or estimated cross section. Half-lives estimated in this manner are indicated by the term "yield". 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 thought to be taken under the most favorable conditions) rather than a mean value; more than one value is listed where a choice does not seem obvious. Among the natural radioactivities an average value is often used which was taken from an international committee summary report (C60).

In the columns 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 reported only by a range 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 with magnetic field)
calor. = calorimetric measurements
ion. ch. = measurement of pulse sizes in ionization chamber

coinbid. abs. = beta- and gamma-coincidence counters with absorbers
coincid. = beta- and gamma-coincidence counters (for information on decay scheme; data not necessarily used in the table)
spect. coincid. = coincidence counters arranged with a magnetic field

The alpha-particle energies listed, where more than a single group exists in high abundance, include the group of highest energy and those groups with abundance greater than ten percent. Conversion electron energies are listed only when it is not known in which shell internal conversion takes place or when no attempt was made to relate the electrons with observed or unobservable gamma-rays; in all other cases reference is given in the column for gamma-rays.

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

abs. = absorption
cl. ch. recoil = secondary electrons in cloud chamber with magnetic field
cl. ch. pair = positive-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 or spectrometer
spect. = secondary electrons with magnetic spectrograph or spectrometer
cryst. spect. = direct measurement of gamma-ray energy by diffraction in a crystal
abs. of e^- = absorption of internal-conversion electrons
abs. sec. e^- = absorption of secondary electrons
coincid. = measurements with gamma-gamma coincidence counters (for information on decay scheme; data not necessarily used in the table)
Be-γ-n reaction = measurement of neutron energy from Be-γ-n reaction
D-γ-n reaction = measurement of neutron energy from D-γ-n reaction

When internal-conversion electrons are omitted, the energy listed in this column is always that of the corresponding gamma-ray transition. Only the main gamma-rays are listed for the natural radioactive isotopes. In a few instances in which a very short lived metastable state has been identified as the daughter of the isotope in question, the gamma-rays of the daughter may be listed for both parent and daughter.

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" 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, t = tritium or triton (H^3), γ = gamma-ray, e^- = electron). In cases in which the target material is not the naturally occurring element but one enriched or depleted in a particular isotope, that isotope is indicated. No means for identifying the source or energy of the projectile is given. For example, deuterons varying from low energies to 200 Mev have been used. In many cases, with high energy projectiles, multiple particles are ejected. A reaction such as (d-αp2n) is a formal presentation showing what the outgoing particles might be and does not mean that the order of leaving the nucleus was determined nor that the α, p and n were identified.

In some cases where the path for reaching the product nucleus can even less definitely be stated the reaction is presented in the form (d-3z10a) where "3z" indicates that the product nucleus is lower in atomic number than the compound nucleus by three units and "10a" means that it is lower in mass number by ten units. Where the same isotope has been made by spallation of various target elements with high energy particles this is indicated by the symbol "spal." followed by the symbols for the target elements.

Stable product nuclei which have been identified by means of the mass spectrograph are indicated by "m.s." following the reference. The neutron-induced fission reactions of the heavy elements are designated by such symbols as U-n, Th-n, Pu-n and Pa-n, while the gamma-ray, deuteron and alpha-particle-induced fission reactions are designated by symbols such as U-γ, U-d, and U-α. Usually, but not always, "U-n" will mean the slow neutron fission of U^{235} while "U-d" or "U-α" designated fission products arise from U^{238}. In this last column the method of production for each radioactive fission product is described by these symbols (U-n, etc.) together with the designation of its radioactive parent and its radioactive daughter when these are known. Similarly, for the radioactivities of the heavy natural and artificial families there are listed the immediate parent and daughter isotopes. The natural radioactivities without parents are listed as produced by a "natural source", followed by a reference to the discovery.

Some of the data entered in this table were taken from restricted distribution reports which are not generally available. These have reference numbers from 100-199. References to the open literature have numbers below 100 or over 200. No attempt has been made to list all of the publications or restricted distribution reports 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 papers 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.

Those references designated by "NNES-PPR" refer to papers which will appear in the forthcoming National Nuclear Energy Series - Plutonium Project Record. Similarly, the symbol "AECD" refers to a declassified U. S. Atomic Energy Commission Document bearing the indicated number. Since

it was not possible to check all papers for numbering changes, the paper title is being included in the bibliography to aid in identification.

It is a pleasure to acknowledge the assistance through helpful discussions of Dr. T. P. Kohman and Dr. W. H. Sullivan, and to thank many of the authors whose work is cited for their aid in evaluating data familiar to them. We are also grateful to Mrs. Lorraine Petch and Mrs. Jane Wulf for their painstaking work in the preparation of the manuscript.

Isotope Z	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		99.9844(H70)					
	H^2		0.0156(H70)					
	H^3	A		β^-	12.1 yr(N46); 10.7 yr (G60)	0.011(W60) abs. collodion; 0.015 (O3,N6) abs., cl.ch.	No γ(G133)	D-n-γ(Z101) D-d-p(A7,A16) He^3-n-p(C132,H135) Li-n-t(O4) Be-d-t(O6,A16) B-n-t(C15) N-n-t(C15)
2	He^3 (A7, A30)		1.3×10^{-4} (F35,A34)					
	He^4		~100(T20)					
	He^6	A		β^-	0.89 sec(H120); 0.8 sec(B1); 0.85 sec (S81)	3.7(B1,B2) cl.ch.; 3.5(S81) abs. Al	No γ(?)(S81)	Li-γ-p(B83) Li-n-p(K1) Be-n-α(B1,P1,B3)
3	Li^6		7.39(I104)					
	Li^7		92.61(I104)					
	Li^8	A		β^-,2α	0.89 sec(H78); 0.88 sec(L1,H107)	12(β^-)(B4) cl.ch.; 12 (β^-)(O13) abs. Al; distribution, mean at 2.0(α)(F18)	No γ(R25,B4)	Li-d-p(C1,L1,R14,D1) Li-n-γ(K1,H107) Li^7-n-γ(G142,H78) Be-γ-p(O13) B-n-α(L24)
4	Be^7	A		K,γ	43 days(R13,A18)		0.485(Z1)coincid.abs.; 0.476(R44)abs.Pb; 0.453(S95) spect.; 0.474(Z5) spect.	Li-d-n(R1,R13,Z1) Li-p-n(H30,H2) B-p-α(R1,M1) B-d-αn(M63)
	Be^8	A		2α	10^{-15}-10^{-17} sec(W61) calc.	0.058(H64) ion. ch.		Be-γ-n(C53,H64)
	Be^9		100(N30)					
	Be^{10}	A (P48)m.s.		β^-	2.5×10^6 yr(M85); 2.9×10^6 yr(H73) yield	0.560(M65,M85) abs.Al; 0.58(H73) abs.Al; 0.65(L78) abs.Al	No γ(M65,L78)	Be-d-p(M65,L78) Be-n-γ(B124,H73) B-n-p(E35) C-n-α(H119)
5	B^{10}		18.83(I5)					
	B^{11}		81.17(I5)					
	B^{12}	A		β^-	0.027 sec(J11); 0.022 sec(C2,B22)	12(B4) cl.ch.		B-d-p(C2,F1,B5) N^{15}-n-α(J11)
6	C^{10}	B		β^+	20 sec(S202)	~2(S202) abs.		B-p-n(S202) B^{10}-p-n(S202)
	C^{11}	A		β^+	20.5 min(S8,T8); 20.0 min(S83)	0.95(D26) cl.ch.; 0.99 (S82) spect.	No γ(S97) coincid.	Be-α-2n(M128) B-d-n(F1,C4,Y1) B-p-γ(C3,B23) B-p-n(B23) C-γ-n(B53) C-n-2n(P2) C-d-dn(T41) C-p-pn(C77) C-α-αn(M126,T41) N-p-α(S83) N-n-p3n(K63) N-γ-p2n(B23) O-γ-αn(?)(B53) O-n-α2n(M134,K63)
	C^{12}		98.9(N31)					
	C^{13}		1.1(N31)					
	C^{14}	A		β^-(K24)	5100 yr(L130,N45); 4700 yr(R50)	0.154(S200)abs.Al; 0.145(R21) abs.; 0.154(L89) spect.; 0.15(S96) spect.	No γ(R21)	C-d-p(R17,R21) C-n-γ(L110) N-n-p(R21,H108,L110) O-n-α(H129,M71)
7	N^{13}	A		β^+	9.93 min(W14,T8); 10.13 min(S98)	1.24(S98) spect.; 0.92,1.20(L22) spect.	No γ(S97) coincid.; No γ(L79) spect.	B-α-n(E1,R3) C-d-n(H3,Y1,C4,F1) C-p-γ(H3,C4) N-n-2n(P2,H44) N-d-t(B7) N-γ-n(B53) O-n-p3n(K63)
	N^{14}		99.62(V20)					
	N^{15}		0.38(V20)					

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
7	N^{16}	A		β^-, γ	7.36 sec(B74); 7.5 sec(H120); 7.3 sec (S81); 8 sec(C5,N1, N106)	3.5, 10(S81) abs.Al, Cu; 10(H120) cl.ch.; 4, 10.3(B74) cl.ch., abs.	6.2, 6.7(B73) abs.sec. e^-, cl.ch. pair; 4(S101) abs.Pb, Cu; ~6(S81) cl.ch. recoil	N-n-γ(H120) N-d-p(F1) O-n-p(C5,S101) F-n-α(N1,P1,N4)
	N^{17}	A (A36)		β^-, n(K65, A36)	4.14 sec(K65)	2.7(β^-)(A36) β^--n coincid. abs.		Spal.(O,F,N,Mg,Al,Si, P,S,Cl,K)(C75,K65)
8	O^{15}	A		β^+	126 sec(M5,B20)	1.7(F1) cl.ch.		C-α-n(K3) N-d-n(M5,F1) N-p-γ(D2) O-γ-n(B20,B53,H44) O-n-2n(P2)
	O^{16}		99.757(T101)					
	O^{17}		0.039(T101)					
	O^{18}		0.204(T101)					
	O^{19}	A		β^-, γ	29.4 sec(F101); 29.5 sec(H120); 27.0 sec(B75)	4.5(30%), 2.9(70%)(B75) abs.Al; 4.1(F101) abs.; 3.2(H90) abs.Al	1.6(F101) abs.	O-n-γ(M103) F-n-p(N1,Al)
9	F^{17}	A		β^+	70 sec(N2)	2.1(K4) cl.ch.		N-α-n(R3) O-d-n(N2,F1) O-p-γ(D2) F-γ-2n(B53)
	F^{18}	A		β^+, γ	112 min(S1)	0.7(Y2) cl.ch.; 0.7 (K110) abs.Al; 0.95(20%), 0.6(80%) (H203) cl.ch.	1.4(H203) cl.ch. recoil	O-α-pn(T36) O-p-n(D2) O-d-n(D22,Y2,W2) O-t-n(K110) F-n-2n(P2) F-d-t(B7,K2) F-γ-n(H44,B53) Ne-d-α(S1) Na-γ-αn(?)(B53)
	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); 40.7 sec(H61)	4.1(P21) abs.		Ne-d-p(P21,W24) Na-n-p(A1,N1,P1) Mg-n-α(A1,B6)
11	Na^{21}	B			23 sec(C27)			Ne-p-n(C27) Ne-d-n(P21)
	Na^{22}	A		β^+(~100%), no K(G44),γ	3.0 yr(L3)	0.58(L3) cl.ch.; 0.575(G44) spect.; coincid.(M72)	1.3(02) spect.; 1.30(G44) spect.	F-α-n(L3,M4) Ne-d-n(L3) Na-n-2n(B131,S180) Mg-d-α(L3)
	Na^{23}		100(S61)					
	Na^{24}	A		β^-, γ	14.8 hr(V1)	1.390(S88,S99) spect., coincid.; 1.4(L21, S49,S82) spect.	1.380, 2.758(S88) spect.; 1.4, 2.8(E7,I2,E8) spect.; 2.87(Q16), 2.74(W64) Be-γ-n reaction, D-γ-n reaction; 2.56, 2.68, 2.76,2.89 (K56) cl.ch. pair; coincid. abs.(C56,W65)	Na-d-p(L4,V1) Na-n-γ(A1) Mg-d-α(H4) Mg-n-p(A1) Mg-γ-p(B53,H74) Al-n-α(A1) Al-d-pα(C65,C67) Al-γ-n2p(B53) Si-γ-n3p(?)(B53)
	Na^{25}	E		β^-, γ(B75)	58.2 sec(B75); 60 sec (R47); 62 sec(H54)	3.4(B75) abs.Al; 2.8(H54) abs.Al		Mg-γ-p(H54,H61,B53) Mg-n-p(H61,B75) Al-γ-2p(B53)
12	Mg^{23}	A		β^+	11.6 sec(W7)	2.82(W7) cl.ch.		Na-p-n(W7,D9) Mg-γ-n(H43,H44,B53)
	Mg^{24}		78.60(C131)					
	Mg^{25}		10.11(C131)					
	Mg^{26}		11.29(C131)					
	Mg^{27}	A		β^-, γ	10.2 min(H4); 9.6 min(E31)	0.79(20%), 1.80(80%) (B86) spect.; 1.8(C13,E31) cl.ch.; coincid.(B75)	1.01, 0.84(B86) spect., coincid.; 0.64, 0.84, 1.02(I2) spect.; 1.05(single γ)(E31) cl.ch. recoil	Mg-d-p(H4) Mg-n-γ(A1) Al-n-p(A1)
13	Al^{25}	A			8 sec(B84)			Mg^{25}-p-n(B84)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Y rays	Produced by
13	Al^{26}	A		β^+	6 sec(B84); 7.0 sec (W7,F2)	2.99(W7) cl.ch.; 1.8 (F2) abs.		Na-α-n(M4,F2) Mg-p-n(W7,D9) Mg^{26}-p-n(B84) Mg-p-Y(C29) Al-Y-n(H43,H44,H58,B53)
	Al^{27}		100(A31)					
	Al^{28}	A		β^-,Y(W17)	2.30 min(E31); 2.4 min(A1,M5,E2)	2.75(B75) coincid.abs.; 3.3(C6) cl.ch.; 3.0 (E31) cl.ch.; 3.10 (D54) abs.Al, coincide 3.01(B86) spect.	1.80(B75) abs. sec.e$^-$; 1.8(I2) spect.; 2.1 (E31) cl.ch.recoil; 1.80(B86) spect.	Mg-α-p(E2,R3) Al-d-p(M5) Al-n-Y(A1) Si-n-p(A1,B75) Si-Y-p(B53,H74) P-n-α(A1)
	Al^{29}	A		β^-	6.7 min(B25)	2.5(B25) cl.ch. and abs.		Mg-α-p(B25,H21,F3) Si-n-p(F110) Si-Y-p(B53,H74) P-Y-2p(B53)
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-Y-n(H62)
	Si^{28}		92.28(I5)					
	Si^{29}		4.67(I5)					
	Si^{30}		3.05(I5)					
	Si^{31}	A		β^-	170 min(N3,A13)	1.8(K4) cl.ch.	No Y(N3)	Si-d-p(N3) Si-n-Y(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) Si-d-n(D12) P-Y-2n(?)(B53)
	P^{30}	A		β^+	2.55 min(R3,B49)	3.0(B48,B49) cl.ch.; 3.5(M26) spect.		Al-α-n(R3,C7) Si-p-n(B23,B49) Si-He^3-p(A7) P-n-2n(P2) P-Y-n(B20,B53) S-d-α(S2)
	P^{31}		100(A31)					
	P^{32}	A		β^-	14.30 days(C8); 14.07 days(M39)	1.712(S88) spect.; 1.69 (L5) spect.	No Y(K4)	Si-α-p(F3) P-d-p(N3) P-n-Y(A1) S-n-p(A1) S-d-α(S2) Cl-n-α(A1) Cl-d-pα(T107) Cu-d-15x33a(M87)
	P^{34}	B		β^-,Y(Z4)	12.4 sec(Z4)	5.1(75%), 3.2(25%)(B42) coincid. abs.; 4.9 (H90) abs. Al		S-n-p(Z4) Cl-n-α(Z4,H90)
16	S^{31}	A		β^+	2.6 sec(B57); 3.2 sec (W11,K10)	3.85(W11,E4) cl.ch.		Si-α-n(K10) P-p-n(W11,V4) S-Y-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)	0.167(S200) abs.Al; 0.169(B82,C78) spect.; 0.17(0110) abs.Al; 0.107(L6) spect.; 0.120(K13) abs.Al; 0.103(S64) spect.		S-n-Y(S102) S-d-p(C25,K13) Cl-n-p(A3,L6,L58,K13) Cl-d-α(K13)
	S^{36}		0.016(N32)					
	S^{37}	B		β^-,Y	5.04 min(Z4); 5.0 min (H130)	4.3(10%), 1.6(90%)(Z4); 4, 1.4(H130) abs.Al	2.6(B42) abs.; 2.75 (H130) abs. sec e$^-$	S-n-Y(H130) Cl-n-p(Z4,H130)
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^+,Y	33 min(S2,B21)	2.5(B21) abs.; 5.1,2.4 (H72) cl.ch.	3.4(H72) cl.ch.recoil	P-α-n(P2,R3,B21) S-d-n(S2) S-α-p,n or S-α-d(S45) S-$\bar{e}$-n(K110) Cl-n-2n(P2) Cl-Y-n(B20,H44)
	Cl^{35}		75.4(N33)					

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
17	Cl^{36}	A		β^+; K; β^- (G8)	2×10^6 yr(H135) yield β^-,β^+; $\sim10^8$ yr(O112) yield; $>10^8$ yr (G8,O5) yield	0.64(β^-)(G8) abs.		Cl-n-γ(G8) Cl-d-p(G8)
	Cl^{37}		24.6(N33)					
	Cl^{38}	A		β^-,γ	38.5 min(H75); 37 min(V1)	1.19(36%), 2.70(11%), 5.2(53%)(H75) spect.; 1.1, 2.8, 5.0 (W16,W17) spect.; (W17) coincid. abs.	1.60(43%), 2.12(57%) (H75) spect.; 1.65, 2.15 (C28,I2) spect.	Cl-d-p(K4,V1) Cl-n-γ(A1,K18,A16) K-n-α(H5) Cu-d-15±27a(M87)
18	A^{35}	A		β^+	1.88 sec(E4)	4.4(E4,W11) cl.ch.		S-α-n(K10) Cl-p-n(W11)
	A^{36}		0.307(N34)					
	A^{37}	A		K(H52,W54)	34.1 days(W54)		No γ(W54)	S-α-n(W18,W54) Cl-d-2n(W18,W54) Cl-p-n(W18,W54) K-d-α(W18,W54) Ca-n-α(W18,W54)
	A^{38}		0.061(N34)					
	A^{39}	F		β^-	4 min(P2)			K-n-p(P2)
	A^{40}		99.632(N34)					
	A^{41}	A		β^-,γ	110 min(S3); 109.4 min(B76)	1.18, 2.55(0.7%)(B76) abs. Al, coincid.; 1.5(K4) cl.ch.(K.U.)	1.37(R8) cl.ch.recoil; 1.3(B76) abs.of e^-	A-d-p(S3) A-n-γ(S8) K-n-p(H5)
19	K^{38}	A		β^+,γ	7.7 min(H5,R3); 7.5 min(R52)	2.53(R52) abs.Al; 2.3(R3) abs.	2.15(R52) coincid.abs.	Cl-α-n(H5,R3) K-n-2n(P2) K-γ-n(H43,H44) Ca-d-α(H5)
	K^{39}		93.3(N34)					
	K^{40} (H88, S62)	A	0.012(N34)	β^-(T31,C61), (~95%) (S204), (34%)(B80); K(~6%) (S204), (66%)(B80); γ(K52)	1.42×10^9 yr (uncorr. for K)(B71); 7×10^8 yr (uncorr. for K)(B80)	1.35(D37) spect. coincid.; 0.40(H83), 0.725(L6) spect.; 1.3(H87) abs. Cu; 1.7(weak)(F43) cl.ch.	1.54(with K) (H98) coincid.; 1.5(with K)(M73) abs. Cu, Pb, coincid.; 1.55(7% of β^-) (G59) abs.	Natural source(T31,C61)
	K^{41}		6.7(N34)					
	K^{42}	A		β^-, γ	12.4 hr(H5); 12.44 hr(S65)	~1.8, 3.50(B75) abs.Al, coincid.; 3.5(K4) cl.ch.; 2.04 (25%), 3.58(75%) (S65) spect.	1.4, 2.1(B75) abs. sec.e; 1.51(S65) spect., coincid.	A-α-pn(O109) K-d-p(H5) K-n-γ(H5,Al) Ca-n-p(H5) Sc-n-α(H5,B75)
	K^{43}	B		β^-,γ	22.4 hr(O116)	0.24,0.81(O116) spect.	0.4(O116) abs.Pb	A-α-p(O116)
	K^{43}	D		β^-	27 min(B138)			Ca-n-p(B138)
	$K^{43,44}$	C		β^-	18 min(W1,W12)			Ca-n-p(W1,W12)
20	Ca^{39}	F		β^+	4.5 min(P2,W12)			Ca-n-2n(?)(P2,W12)
	Ca^{39}	E			1.06 sec(H44)			Ca-γ-n(H44)
	Ca^{40}		96.96(N32)					
	Ca^{42}		0.64(N32)					
	Ca^{43}		0.15(N32)					
	Ca^{44}		2.06(N32)					
	Ca^{45}	A		β^-	152 days(M74); 180 days(W12)	0.260(S68) abs.Al; 0.25(P106) spect.; 0.21(M74)	No γ(K116,P106)	Ca-n-γ(W12) Ca-d-γ(W12,W5) Sc-n-p(W12,K116) Ti-n-α(C101) Bi-d(G62)
	Ca^{46}		0.0033(N32)					
	Ca^{47}	F		β^-,γ	5.8 days(M74)	1.1(M74)	1.3(M74)	Ca-d-p(M74)
	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)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	γ rays	Produced by
21	Sc^{41}	A		β^+	0.87 sec(K10)	4.94(E4) cl.ch.		Ca-d-n(K10,E4)
	Sc^{43}	A		β^+,γ	3.92 hr(H92); 4 hr(W10)	1.12(H92) abs.Al,spect.; 0.4, 1.4(W10) abs.	1.65(H92) abs.Pb, Cu; 1.0(W10) abs.Pb	Ca-α-p(F4,W10) Ca-d-n(W3) Ca-p-n(D2,D9,H92)
	Sc^{44m}	A		I.T.,e^-,γ (W10)	2.44 days(H92); 2.2 days(W10)		0.27(H9,S19) spect. conv.; 0.28(H92) abs.of e^-	K-α-n(W10,H1) Ca-d-n(W3,S19,H1) Ca-p-n(D2,D9) Sc-n-2n(B9,H92) Ti-d-α(W4)
	Sc^{44}	A		β^+,γ,K(H92)	3.92 hr(H92); 4.1 hr(W10)	1.8(W10) abs., (S19) spect.; 1.33(H92) abs.Al	1.33(H92) abs.Pb,Cu,Al	K-α-n(W10,H1) Ca-d-n(W3,S19,H1) Ca-p-n(D2,D9) Sc-n-2n(B9,H1) Sc-γ-n(B20) Sc^{44m} I.T.(W10) Ti-d-α(H60)
	Sc^{45}		100(A31)					
	Sc^{46}	A		β^-,γ,K(W5)	85 days(W5)	0.36(β^-)(F36,M76,P49) spect.; 0.26(β^-)(M75) abs.Al, coincid.; 0.4(β^-)(K116) abs.Al; 0.26, 1.5(β^-)(W10) abs.; 1.49(β^-)(weak) (P49) spect.	0.88, 1.12(F36,M76,P49) spect.; 1.25(W10) abs.Pb; 1.5(M42) abs.Pb; 1.4(K116) abs.Pb	Ca-α-p(W10) Sc-d-p(W1,W5) Sc-n-γ(W1) Ti-d-α(W1) Ti-n-p(W4)
	Sc^{46}	F		I.T.(?)	24 min(P106)			Sc-n-γ(P106)
	Sc^{47}	B		β^-	3.4 days(H1,H93)	0.46(H93) abs.Al	No γ(?)(H93)	Ca-α-p(H93) Ca-d-n(H93) Ca-p-γ(H93)
	Sc^{48}	A		β^-,γ(W10), K (?)(H93)	44 hr(W10,M2,H93)	0.64(S19) spect.; 0.57(H93) abs.Al	0.98, 1.33(P45) spect.; 1.35(M2,M30) spect.; 1.33(H93) abs.Pb	Ca-p-n(H1) Ca-d-2n(S19,M2,H1,M30) Ti-n-p(W4,P2,W10,M30) Ti-d-α(H60) V-n-α(W4,P2,W10)
	Sc^{49}	A		β^-	57 min(W10)	1.8(W10) abs.	No γ(W10)	Ca-d-n(W10) Ti-n-p(W10) Ti-γ-p(H74) Ca^{49}(2.5 hr) β^- decay (W10) Ca^{49}(30 min) β^- decay (S103)
22	Ti^{45}	A		β^+	3.08 hr(A17)	1.2(A17) cl.ch.		Ca-α-n(A17) Sc-p-n(A17) Sc-d-2n(A17) Ti-n-2n(A17) Ti-γ-n(H45,H62) Cu-d-8z20a(M97) Sc-p-n(D101)
	Ti^{46}	D			21 days(D101)			
	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^{51m}	A		β^-,γ(W4)	6 min(S28)	1.6(S28) abs.		Ti-d-p(W4) Ti-n-γ(W4,A1)
	Ti^{51}	A		β^-,γ	72 days(W5)	0.36(W5) abs.; 0.3(M77) abs.Al	1.0(W5) coincid.abs.; 1.02(M77) coincid. abs.	Ti-d-p(W5) Ti-n-γ(W8) Cu-d-8z14a(M97)
23	V^{48}	A		β^+,K,γ(W5, H60); β^+ (58%), K (42%)(G44)	16 days(W4)	0.72(P45) spect.; 1.0(W4) cl.ch.; 0.58(H60)	0.98,1.33(P45) spect.; 1.05(R4) cl.ch. recoil; 1.50(H60) abs.Pb	Sc-α-n(W6) Ti-d-n(W4) Ti-p-n(D9) Cr-d-α(W4,P45) Cu-d-7z17a(M97)
	$V^{49,47}$	C		β^+	33 min(W4,07)	1.9(W4,07) abs.		Ti-d-n(W4,07) Ti-p-n(D9,07) Cr^{49} β^+ decay(?)(H62)
	V^{49}	B		K	600 days(W5)	No β^+ or e^-(W5)	No γ(W5)	Ti-d-n(W5)
	V^{51}		100(A31)					
	V^{52}	A		β^-,γ	3.74 min(M40); 3.9 min(W4)	2.05(D24) abs.; 2.65(Y5) cl.ch.	1.46(M93) abs.Pb,Fe,Cu; 1.3(G1) abs.Pb	V-n-γ(W4,P2,Al) V-d-p(W4) Cr-n-p(W4,P2) Cr-γ-p(H74) Mn-n-α(W4,P2,Al)

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
24 Cr^{49}	A	•	β^+,γ	41.9 min(O7); 45 min(H62)	1.46(O7) abs., cl.ch.	0.18, 1.55(O7) abs.Pb	Ti-α-n(O7) Cr-n-2n(O7) Cr-γ-n(H62) Cu-d-6z16a or Cu-d-6z16a(M87)
Cr^{50}		4.31(W121)					
Cr^{51}	A		K,γ,e^-(W13); no β^+(B34)	26.5 days(W13)		0.32(single)(M120,M87) spect.conv.; 0.350, 0.237(B34) abs.of e^-	Ti-α-n(W13) V-p-n(B34) Cr-d-p(W13,A14) Cr-n-γ(W13,M120) Cr-n-2n(A14) Cu-d-6z14a(M87) As-d-10z26a(H66)
Cr^{52}		83.75(W121)					
Cr^{53}		9.55(W121)					
Cr^{54}		2.38(W121)					
Cr^{55}	B			1.3 hr(S104); 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) Cu-d-5z14a(M87)
Mn^{52m}	A		β^+,γ; I.T.(?) (0.05%) (O12)	21 min(L7)	2.66(O12) spect.; 2.2(H6,L12) cl.ch.	1.46(O12) spect., coincid.; 1.2(H6); 0.39(I.T.?)(O12) spect.conv.	Fe-d-α(D5,L7) Cr-p-n(H6,H12) Fe^{52} β^+ decay(M87)
Mn^{52}	A		β^+(35%), K (65%) (G44),γ	6.5 days(L7); 5.8 days(M97)	0.58(P45) spect.; 0.77(H6,H12) cl.ch.; 0.75(T108) abs.Al	1.0(H6); 0.73, 0.94, 1.46(P45) spect., coincid.abs.	Cr-p-n(H6,H12) Cr-d-2n(P45) Fe-d-α(L7) Cu-d-5z13a or Cu-d-5z15a(M87) As-d-9z25a(H66)
Mn^{54}	A		K,γ(L7)	310 days(L7)		0.835(D35) spect., coincid.; 0.85(L7) abs.Pb	V-α-n(L7) Cr-d-n(L7) Cr-p-n(D9) Fe-d-α(L7)
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.; 0.75(20%), 1.04(30%), 2.81(50%)(S66) spect.	2.06(20%), 1.77(30%), 0.822(≈100%)(S66) spect.; 0.345, 1.81, 2.13 (E9,E12) spect.; 2.7(≤1%)(W64,W124, L131) D-γ-n reaction	Cr-α-p(R3) Mn-n-γ(A1) Mn-d-p(L7) Fe-d-α(L7) Fe-n-p(A1) Co-n-α(A1) Cu-d-p2α or Cu-d-p2α2n(M87) As-d-9z21a(H66)
26 Fe^{52}	A		β^+	7.8 hr(M87)	0.55(M87) abs.Al		Cu-d-4z13a or Cu-d-4z15a, parent of Mn^{52m}(M87)
Fe^{53}	A		β^+	8.9 min(R3)			Cr-α-n(R3) Fe-n-2n(L20) Fe-γ-n(H43,H62) Cu-d-4z12a or Cu-d-4z14a(M87)
Fe^{54}		5.81(W121)					
Fe^{55}	A		K, no e^-, no β^+(B46)	~4 yr(V4)		No γ(P50)	Mn-d-2n(H127) Mn-p-n(V4) Fe-d-p(L23) Co^{55} β^+ decay(L10)
Fe^{56}		91.66(W121)					
Fe^{57}		2.20(W121)					
Fe^{58}		0.33(W121)					
Fe^{59}	A		β^-,γ	46.3 days(S174); 45.5 days(G45); 47 days(L20); 42.5 days(K103)	0.26, 0.46(D16) spect., coincid. abs.	1.10, 1.30(D16) spect.	Fe-d-p(L20,D16) Fe-n-γ(S105,W101) Co-n-p(L20,I100) Cu-d-α2p or Cu-d-2α(M87) As-d-8z18a(H66) Bi-d(G62)
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) Cu-d-3z10a or Cu-d-3z12a(M87) As-d-7z22a(H66)

Isotope Z	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^{56}	A		β^+, γ, K(E9)	72 days(L10)	1.50(E9,E12) spect., coincid.; 1.2(L10) abs., (C17) cl.ch.,coincid.	0.845, 1.26, 1.74, 2.01, 2.55, 3.25 (E12) spect., coincid.; 1.7(C17) abs.Pb, coincid.; 1.05(L10) abs.Pb	Fe-d-2n(L10,P3,J1) Fe-α-np(L10) Ni-d-α(L10,C17) Cu-d-3z9a or Cu-d-3z11a(T108)
	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(15%) (G44); K, γ (85%)(G44)	72 days(L10)	0.470(E13,D35) spect.; (E13) coincid.; 0.4(L10) abs.	0.835(D35) spect., coincid.; 0.6(L10) abs.Pb	Mn-α-n(L9,L10) Fe-d-n(L9,B24,P4,L10) Fe-p-n(L9) Fe-α-np(L10) Fe-p-γ(L10) Ni-d-α(L11) Ni-n-p(V5,L10) Cu-d-αp2n or Cu-d-αp4n(T108)
	Co^{59}		100(M52)					
	Co^{60}	A		β^-, γ	5.3 yr(L10)	0.31(D17,D36) spect. coincid. abs.; 0.23(D55) spect.; 0.310(M78) spect.	1.16, 1.32(M78,J8) spect.; 1.16, 1.30 (P106) spect.; 1.10, 1.30(D17,D36) spect., coincid.	Co-d-p(L9,B24,L10, D17,N10) Co-n-γ(R9,L9,L10) Co^{60m} I.T. (L10,D17) Ni-d-α(L10) Cu-n-α(M64)
	Co^{60m}	A		I.T., γ, e^- (>90%)(L10, D17,D36, S103); β^-,γ (<10%)(D17, D36,N10, S103)	10.7 min(L10)	1.35(β^-)(N10) spect.; 1.25(β^-)(D36) spect.; 1.56(β^-)(P106) spect.	0.056(I.T.)(D17,D36) spect. conv.; 1.5(with β^-) (N10,D36) abs.Pb; 1.32(with β^-) (P106) spect.	Co-n-γ(H7,L8,L10,D17) Co-d-p(N10) Ni-n-p(H8,L10)
	Co^{61}	A (P51) m.s.		β^-	1.75 hr(P51)	1.1(P51) abs.Al	No γ(P51)	Co-t-p(K64) Ni-d-αn(P51) Ni^{64}-p-α(P51) Ni^{61}-n-p(P51) Cu-n-nα(P51) Cu-d-αpn(M87) As-d-7z16a(H66)
	Co^{62}	B		β^-, γ(P52)	13.8 min(P52)	2.5(P52) abs.Al, coincid.	1.3(P52) abs.Pb	Ni^{62}-n-p(P52) Cu-n-α(P52) Cu-d-αp(P52)
28	Ni^{57}	A		β^+	36 hr(L11); 34 hr(H66)	0.67(L11) abs.		Fe-α-n(L11,N11,D18) Ni-n-2n(L11,N11,D18) Ni-γ-n(H45,H62) Cu-d-2z8a or Cu-d-2z10a(M87) As-d-6z20a(H66)
	Ni^{58}		67.76(W121)					
	Ni^{59}	B			12 yr(C124) yield	~0.05(C102,C124) abs.Al		Fe-α-n(C117) Ni-n-γ(C102) Ni-d-p(C102)
	Ni^{60}		26.16(W121)					
	Ni^{61}		1.21(W121)					
	Ni^{62}		3.66(W121)					
	Ni^{64}		1.16(W121)					
	Ni^{65}	A		β^-, γ	2.6 hr(L11)	1.9(L11,S161) abs.Al	1.1(L11) abs.Pb; 0.280, 0.65, 0.93 (G3) spect.	Ni-d-p(L11,N11) Ni^{64}-n-γ(H8,N11) Ni^{64}-n-γ(G134,C55) Ni-n-2n(H8,D18,N11) Cu-n-p(H8) Zn-n-α(H8) Cu^{65}-n-p(S87) Cu-d-2p(M87) As-d-6z12a(H66)
	Ni^{66}	A		β^-	56 hr(G62)			As-d-6z11a(H66) Bi-d_x parent of Cu^{66}(G62)
29	Cu^{58}	D		β^+	7.9 min(D4); 10 min(L83)			Ni-p-n(D4)
	Cu^{59}	E		β^+	81 sec(D4)			Ni-p-n(D4)
	Cu^{60}	A (L83) m.s.		β^+, γ	24.6 min(L83)	1.8, 3.3(<5%)(L83) abs.Al	1.5(L83) abs.Pb	Ni-p-n(L80) Ni^{60}-p-n(L83) Ni^{60}-d-2n(L83) Ni^{58}-α-pn(L83) Cu-d-p4n(M87) As-d-5z17a(H66)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
29	Cu^{61}	B		β^+; K(A4)	3.4 hr(T1,R3); 3.33 hr(C80)	1.205(C80) spect.; 0.9(R3) abs.; 1.23(B36)	No γ(G2,B36)	Ni-d-α(T1) Ni-p-n(D4) Ni^{61}-p-n(L83) Ni-p-γ(D4) Ni-α-p(R3) Cu-d-p3n or Cu-d-p5n(M87) As-d-5z16a(H66)
	Cu^{62}	A		β^+,γ	10.6 min(H8); 10.1 min(L83)	2.6(C13) cl.ch.; 2.5(T108) abs.Al	0.56(T108) abs.Pb	Co-α-n(R3) Ni-p-n(S18) Ni-p-γ(S18) Cu-n-2n(H8) Cu-γ-n(B20,H44,H45, H62) Cu-e^--e^-n(S59) Cu-d-t(K22,K14) Zn^{62} K decay(M87)
	Cu^{63}		69.09(I104)					
	Cu^{64}	A		β^-(65%), β^+(32%), K,γ(3%) (B44,A4)	12.8 hr(V2)	0.571(β^-), 0.657(β^+) (C73) spect.; 0.58(β^-), 0.66(β^+) (T6,T11,T8) spect.; 0.57(β^-), 0.64(β^+) (P106) spect.	1.20(weak)(B44) coincid. abs.; 1.35(2.5%)(D62) spect.	Ni-p-n(S18,D4) Cu-d-p(V2) Cu-n-γ(H8) Cu-n-2n(H8) Cu-p-pn(R45) Cu-γ-n(H45,H62) Zn-d-α(B51) Zn-n-p(H8) As-d-5z13a(H66)
	Cu^{65}		30.91(I104)					
	Cu^{66}	A		β^-,γ	5 min(A1)	2.9(S5) cl.ch.(K.U.); 2.58(G15)	1.32(M79) abs.Pb	Cu-n-γ(A1) Cu-d-p(L31) Zn-n-p(H8) Ga-n-α(C5) Ni^{66} β decay(G62)
	Cu^{67}	B		β^-	56 hr(G62); 61 hr(H66)	0.56(H204) abs.Al		As-d-5z10a(H66) Bi-d(G62)
30	Zn^{62}	A		K(?)(M87)	9.6 hr(M87)			Cu-d-3n or Cu-d-5n, parent of Cu^{62}(M87) As-d-4z15a(H204)
	Zn^{63}	A		β^+,γ, K(?) (H207)	38 min(D4,B20)	2.3(S18) abs., (T11,T8) spect.; 2.36(88%)(B45)	0.96(weak), 1.9(weak), 2.6(weak),(B45,H207)	Ni-α-n(R3) Cu-p-n(S18,D4) Cu-d-2n(L31,T8,M87) Cu-d-4n(M87) Zn-n-2n(H8,P2) Zn-γ-n(B20) As-d-4z14a(H204)
	Zn^{64}		48.89(L88)					
	Zn^{65}	A		β^+(1.3%), K (98.7%) (G46),γ,e^-	250 days(L12)	0.32(β^+)(P106) spect.; 0.4(β^+)(D9) cl.ch.	1.11(J8) spect.; 1.14(D19,M34) spect.; 1.14(46% of K), no γ (54% of K)(G46) x-ray-e^- coincid.; 0.45, 0.65, 1.0(W15, I3) cl.ch. recoil	Cu-d-2n(P4) Cu-p-n(B12) Zn-d-p(L12) Zn-n-γ(S6) Ga^{65} K decay(L10)
	Zn^{66}		27.81(L88)					
	Zn^{67}		4.07(L88)					
	Zn^{68}		18.61(L88)					
	Zn^{69m}	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) As-d-2α(H66)
	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) As-d-2α(H66) Zn^{69m} I.T. (K11)
	Zn^{70}		0.620(L88)					
	Zn^{71}	B		β^-,γ(H130)	2.2 min(H130)	2.1(H130)		Zn-n-γ(H130) Ge-n-α(H130)
	Zn^{72}	A		β^-,γ(S149, G120)	49 hr(S149)	~0.3(95%), ~1.6(5%) (S149) abs.Al		U-n, parent of Ga^{72} (G121) Bi-d(G62) As-d-4z5a(H66)
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)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev: Particles	Energy of Radiation in Mev: γ rays	Produced by
31	Ga^{66}	A		β^+	9.4 hr(B13,R3)	3.1(M7) abs.		Cu-α,n(M7,R3) Zn-p-n(B13) As-d-3z11a(H66) Ge^{66} decay(H147)
	Ga^{67}	A		K,γ,e^-	78.3 hr(M88); 83 hr(A4)		0.094, 0.174, 0.187, 0.301(C21) spect.; 0.0925, 0.180, 0.297(H9) spect. conv., spect.; 0.292(G3) spect.	Zn-d-n(A4,G6,V7) Zn-α-p(M8) Zn-p-n(B13,V7) As-d-3z10a(H66) Ge^{67} β^+ decay(H147)
	Ga^{68}	A		β^+	68 min(R3)	1.9(R3,M7) abs.		Cu-α-n(R3,M7) Zn-p-n(D2,B13) Zn-p-γ(?)(D2) Zn-d-n(G6,V7) Ga-n-2n(P2) Ga-γ-n(B20) Ge-d-α(S29) As-d-3z9a(H66) Ge^{68} K decay(H66)
	Ga^{69}		61.2(S61)					
	Ga^{70}	A		β^-,γ	20.3 min(B139); 20 min(B20,A1)	1.68(S25) cl.ch.(K.U.); 1.65(H136) spect.; 1.62(B139) abs.Al		Zn-p-n(D2,V7) Zn-α-p(M8) Ga-n-γ(A1) Ga-n-2n(P2) Ga-γ-n(B20) Ge-d-α(S29) Ge-n-p(S29,G121)
	Ga^{71}		38.8(S61)					
	Ga^{72}	A		β^-,γ	14.3 hr(M30,G121,S149); 14.1 hr(S6)	0.64(40%), 0.96(32%), 2.52(18%), 3.15(~10%)(H63) spect.; (M94) spect.; ~0.77, 2.3(M68) coincid. abs.; 0.8(~65%), ~3.1(~35%)(S149) abs.Al	0.63(18%), 0.84(100%), 1.87(8%), 2.21(32%), 2.51(26%)(H63) spect.; (M94) spect.; 0.64(~8%), 0.84(~46%), 2.25(~46%)(M67) spect.; 2.50(W64) D-γ-n reaction	Ga-d-p(L20) Ga-n-γ(S6,G121) Ge-n-p(S29,G121) As-d-αp(C130) U-n,Zn^{72} β^- decay(G121) Bi-α(P56) Tl-α(T109) U-α(O115)
	Ga^{73}	B		β^-(S150,G121)	5 hr(S150,G121)	1.4(S150) abs.Al	No γ(S150)	Ge-n-p(G121) U-n(S150,S149)
	Ga^{74}	D		β^-	9 days(S29)	0.8(S29)		Ge-d-α(S29)
32	Ge^{66}	A			~140 min(H147)			Ge-d-p5n, parent of Ga^{66}(H147)
	Ge^{67}	B		β^+(H147)	23 min(H147)			Ge-d-p4n, parent of Ga^{67}(H147)
	Ge^{68}	B		K(H66)	250 days(H66); ~195 days(M8)			Zn-α-2n(M8,M99) As-d-α5n(H66) Parent of Ga^{68}(H66)
	Ge^{70}		20.55(I105)					
	Ge^{71}	A		K,e^-(?)(S30); K, no β^- or e^-(S104); β^+(?)(M67)	11 days(S30); 11.3 days(D101); 11.4 days(H66)	~0.6(β^+?)(M67)	0.6(S30) abs. of e^-	Ga-d-2n(S30) Ga-p-n(D101) Ge-d-p(S30) Ge-n-γ(S104) As-d-α2n(H66)
	Ge^{71}	A		β^+	39.7 hr(D101); 40 hr(S30); 36 hr(H62); 38 hr(H66)	1.2(S30) abs.		Zn-α-n(M8) Ga-d-2n(S30) Ga-p-n(D101) Ge-n-γ(S6,S29) Ge-d-p(S6,S30,S29) Ge-n-2n(S25,S29) Ge-γ-n(H62) As-d-α2n(H66) Se-n-α(S29) As^{71} β^+ decay(H66)
	Ge^{72}		27.37(I105)					
	Ge^{73}		7.61(I105)					
	Ge^{74}		36.74(I105)					
	Ge^{75}	A		β^-,γ(S30)	89 min(S30)	1.1(S25,S29) cl.ch.(K.U.); 1.2(S30) abs. Al		Ge-n-α(S6,S29) Ge-d-p(S6,S29,S30) Ge-n-2n(S29,S30) Ge-γ-n(H62) As-n-p(S29,S30) Se-n-α(S29,S30)
	Ge^{76}		7.67(I105)					
	Ge^{77}	A		β^-(S29), γ(S152)	12 hr(S30,S106)	2.0(S106) abs.Al; 1.9(S25,S29) cl.ch.(K.U.); 1.8(S152) abs.Al		Ge-n-γ(S6,S29) Ge-d-p(S29,S30) Se-n-α(S30) U-n(S106) parent of As^{77}(S151,S152) U^{233}-n(S184)

Isotope Z	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^{77m}	B		β^-	59 sec(A37)	2.8(A37) abs.Al		Ge-n-γ(A37) Parent of As^{77}(A37)
	Ge^{78}	D		β^-,γ(S152)	2.1 hr(S152)	~0.9(S152) abs.Al		U-n, parent of As^{78} (S106,S152)
33	As^{71}	A		β^+(H66)	52 min(H66)			As-d-p5n(H66) Se^{71} β^+ decay, parent of Ge^{71}(40 hr)(H66)
	As^{72}	B		β^+,γ	26 hr(V4)	2.78(M80) abs.Al, coincid.	2.4(M80) coincid.abs.	Ga-α-n(M80) Ge-p-n(V4) As-d-p4n(H66) Se^{74}-d-α(M99) Se^{72} K decay(H66)
	As^{73}	B		K,e^-(E10)	90 days(S26)		0.052(E10) spect.conv.	Ge-d-n(S26,E10) Ge^{70}-α-p(?)(M88)
	As^{74}	A		β^-,β^+,γ(S26)	17.5 days(M88); 19.0 days(H66); 16 days(S26)	1.3(β^-), 0.9(β^+)(S26) cl.ch. (K.U.)	0.582(D15) spect.	Ga-α-n(M88) As-n-2n(S26,C11) As-d-p2n(H66) Ge-d-n(S26,S29,I4) Se-d-α(F8) Ge-p-n(D9) Bi-d(G62)
	As^{75}		100(N30)					
	As^{76}	A		β^-,γ; β^+, K,γ(S23)	26.8 hr(W9,W19)	1.29(15%),2.49(25%), 3.04(60%)(β^-)(S67) spect.; 1.1, 1.7, 2.7(β^-)(S23,W9,W19) cl.ch.; 0.7, 2.6 (β^+)(S23) cl.ch.; coincid.(M35)	0.55, 1.20, 1.70(S67) spect.; 0.557, 1.22, 1.78(weak)(W70) spect.; 1.94, 0.83 (M6) spect.; coincid. (M35); 2.15(weak), 1.84(weak), 1.25 (~30%), 0.57(~70%) (M120,M67) spect.; 3.2, 2.2, 1.5(S23) cl.ch. pair	Ge-p-n(V4) As-d-p(C11,T3) As-n-γ(C11) Se-n-p(S26) Se-γ-p(H74) Se-d-α(F8) Br-n-α(C11)
	As^{77}	B		β^-(S106)	40 hr(S151)	0.8(S152) abs.Al		U-n(S151), Ge^{77} β^- decay(S152) Th-α(N116) Bi-d(G62) Ge^{77}(59 sec) β^- decay(A37)
	As^{78}	A		β^-,γ	60 min(C11); 65 min(S9,S26)	1.4(S26) cl.ch.(K.U.)	0.27(S26) abs.Pb	Br-n-α(S9,C11,S26) Se-n-p(S26)
	As^{78}	D		β^-	90 min(S106,S152)	1.4(~30%), 4.1(~70%) (S152) abs.Al		U-n, Ge^{78} β^- decay (S106,S152)
34	Se^{71}	A		β^+(H66)	44 min(H66)			As-d-6n, parent of As^{71}(H66)
	Se^{72}	B		K(H66)	9.5 days(H66)			As-d-5n(H66) Parent of As^{72}(H66)
	Se^{73}	B		β^+(H66).	6.7 hr(H66); 7.1 hr(C79)			Ge-α-n(C79) Ge^{70}-α-n(C79) As-d-4n(H66)
	Se^{74}		0.87(W121)					
	Se^{75}	A		K,γ,e^-	127 days(C79); 125 days(G143); 115 days(F46); 120 days(H66)		0.097, 0.122, 0.137, 0.265, 0.400(J131) spect., spect. conv.; 0.50(D9) spect. conv.; several <0.3(K30) spect. conv.; 0.335, 0.18(B117); 0.22, 0.43(C79) abs.Pb	As-p-n(D9) As-d-2n(K30,S107) Se-n-γ(F46,B130)
	Se^{76}		9.02(W121)					
	Se^{77}		7.58(W121)					
	Se^{77m}	A		I.T.,γ (D122,A37)	17.5 sec(A37)		~0.15(A37)	Se-n-γ(A37) Se^{76}-n-γ(D122)
	Se^{78}		23.52(W121)					
	Se^{80}		49.82(W121)					
	Se^{81m}	B		I.T., e^-(L30)	59 min(G125); 57 min(S9,L30)		0.099(H9) spect. conv.	Se-d-p(S9,L30) Se-n-γ(S9,H10) Se^{80}-n-γ(L131) Se-γ-n(B20) Br-n-p(S9,L30) U-n, parent of Se^{81} (G125)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Y rays	Produced by
34	Se^{81}	B		β^-	17 min(G125); 19 min(L30)	1.5(L30,G125) abs.Al	No Y(G126)	Se-d-p(S9,L30) Se-n-Y(S9,H10) Se-Y-n(B20) Se^{81m} I.T.(L30) Br-n-p(L30) U-n, Se^{81m} I.T. (G125,G101)
	Se^{82}		9.19(W121)					
	Se^{83m}	A		β^-,Y(A37)	67 sec(A37)	3.4(A37) abs.Al		Se-n-Y(A37) U-n(S177)
	Se^{83}	A		β^-,Y(G120, G125)	25 min(M121,G125); 30 min(L30)	1.5(M121,G125) abs.Al	0.17, 0.37, 1.1 (E112,G125) abs.Pb	Se-d-p(L30) Se-n-Y(L30) U-n, parent of Br^{83} (G101) Th-n(G101)
	Se^{84}	A		β^-	~2.5 min(G125); <10 min(E111)			U-n, parent of Br^{84} (E111)
35	Br^{74}	B		β^+(W73)	106 min(W73)	1.5(W73)	No Y(W73)	Se^{74}-d-2n(W73) Se^{74}-p-n(W73)
	Br^{77}	B			48 hr(W73)			Se^{76}-α-p(W73) Se^{77}-d-n(W73)
	Br^{78}	A		β^+,e^-,Y	6.4 min(S9)	2.3(β^+)(S9) abs.	0.046, 0.108(V7) spect. conv.	As-α-n(S9) Se-d-n(S9) Se-p-n(B13,V7) Br-Y-n(B20,C5) Br-n-2n(H10)
	Br^{79}		50.5(W122)					
	Br^{80m}	A		I.T.,e^-, Y (S10,V3, V7,G22)	4.4 hr(B13)		0.049, 0.037 or 0.025 (V7) spect.conv.; 0.037(G22) abs.Al	Se-α-p(W73) Se-p-n(B13,V7) Br-n-Y(S9,S10,A2), (~30%)(G137) Br-d-p(S9) Br-Y-n(B20) Br-n-2n(P2) Th-n(?)(P12,P16)
	Br^{80}	A		β^-,Y; β^+ (3%)(B81)	18 min(S9,S10)	2.0(β^-)(A2) spect.; 0.73(β^+)(B81) spect., abs.	<0.5(B13,S9) abs.	Se-p-n(B13) Br-n-Y(S9), (~70%)(G137) Br-d-p(S9) Br-Y-n(B20) Br-n-2n(P2) Br^{80m} I.T.(S10,S31,D20)
	Br^{81}		49.5(W122)					
	Br^{82}	A		β^-,Y	34 hr(S9)	0.465(R6,D21) spect.; (D23) coincid.	0.547, 0.787, 1.35 (R6,D15) spect.; (D23) coincid.	Se-p-n(B13,R7) Se-d-2n(S9) Br-n-Y(K5,S9) Br-d-p(S9) Rb-n-α(S9,P2) U-n(F113) Pb-α(F104) Tl-α(T109) Bi-α(P56) Bi-d(P56) U-α(0115)
	Br^{83}	A		β^-	2.4 hr(G101); 140 min(L30)	1.05(L30) abs.; 0.9(G125) abs.Al	No Y(S9,G101)	Se-d-n(S9) Se^{83} β^- decay(S9,L30), parent of Kr^{83m}(L30) U-n, Se^{83} β^- decay, parent of Kr^{83m} (L30,M9,S35,G101) U^{235}-n(S184) Th-n(B15,L30,S108,G101) Th-α(W116) Pu-n(F102) Bi-d(P56) Pb-α(F104) Bi-α(P56) U-α(0115)
	Br^{84}	A		β^-	30 min(S35); 33 min(K104,K111)	5.3(K111) abs.Al; 4.5(B30) abs.; possibly weak 0.2 β^- or e^-(K104)		Rb-n-α(B29) U-n(D6,H22,H57,M9,S35, B29,K104), Se^{84} β^- decay(E111) Th-n(F12,B101) Bi-d(F104)
	Br^{85}	A		β^-	3.00 min(S205); 3.0 min(S35,B29)	2.5(S205) abs.Al	No Y(S205)	U-n, parent of Kr^{85} (S35,B29,S43)
	Br^{87}	B		β^-(S35); β^-,n(S60)	55.6 sec(H131); 55.0 sec(R51); 56 sec(S60)	0.3(mean)(n)(B134) p recoil in cl.ch.		U-n, parent of Kr^{87} (S35,B29,S43,S60,R51) Pu-n(R51)
	Br^{88}	B		β^-	16.0 sec(R107)			U-n, ancestor of Rb^{88}(R107)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
35	$Br^{(68)}$	D (S68)	•	β^-,n(L125, S68)	4.61 sec(H131); 4.6 sec(L125)	0.7(mean)(n)(B134) p recoil in cl.ch.		U-n(M125)
36	Kr^{78}		0.342(L75)					
	$Kr^{79,81}$	C		β^+(B41), - γ(H109)	34 hr(B41)	~0.9(30%),~0.6(70%) (H109) abs.Al; 0.4(C41) cl.ch.	0.2(H109) abs.Pb	Se-α-n(C45,C22) Br-d-2n(C64) Br-p-n(B41,C41) Kr-d-p(C45,S9,C22) Kr-n-γ(H109)
	$Kr^{79,81}$	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.	Se-α-n(?)(K3) Br-p-n(B41,C41)
	Kr^{80}		2.225(L75)					
	Kr^{82}		11.50(L75)					
	Kr^{83}		11.48(L75)					U-n(T43) m.s.
	Kr^{83m}	A		I.T., e^-(L30)	113 min(L30)		0.029, 0.046(no) spect. conv.	Se-α-n(C45,C22) Kr-d-p(C45,C22) Kr-n-γ(W57) Kr-x-rays(W57) U-n, Br^{83} β^- decay(L30)
	Kr^{84}		57.02(L75)					U-n(T43) m.s.
	Kr^{85}	A		β^-,γ(H109)	4.5 hr(H109); 4.0 hr(C22); 4.6 hr(S43)	1.0(H109) abs.Al; 0.85(B30) abs.	0.17, 0.37(H109) abs.Pb	Kr-d-p(S9,C45,C22) Kr-n-γ(H109) Rb-n-p(B29) Sr-n-α(B29) U-n, Br^{85} β^- decay (B29,S43)
	Kr^{86}	B (T43)m.s.		β^-(W113,H114)	9.4 yr(T110); ~10 yr(H114,T45); >2.5 yr(W113)	0.74(H114) abs.Al; ~0.8(W113) abs.Al	Mo γ(H114)	Kr-n-γ(H109) U-n(W113,H114)
	Kr^{86}		17.43(L75)					U-n(T43) m.s.
	Kr^{87}	B		β^-	74 min(S9)	~4(B30) abs.Al		Kr-d-p(S9) Rb-n-p(B29) U-n,Br^{87} β^- decay (B29,S43)
	Kr^{88}	A		β^-	3 hr(L27,H28)	2.5(W19) cl.ch.(K.U.)		Th-n(H29,A5,L27) ^{88} U-n, parent of Rb (H28,H11,G9,G21,H46)
	Kr^{89}	A		β^-	2.6 min(D114); 2.5 min(H56)			U-n, ancestor of Sr^{89} (G9,G21,S41,H46,B47) U-d(O101) Pu-n(A105)
	Kr^{90}	A		β^-	~33 sec(K124); short(D108)			U-n, ancestor of Sr^{90}(D108) Pu-n(A105)
	Kr^{91}	B		β^-	9.3 sec(D114); 5.7 sec(O101)			U-n, ancestor of Sr^{91} (S110,D114),ancestor of Y^{91}(S110,D108) U-d(O101) Pu-n(A105)
	Kr^{92}	D		β^-	2.5 sec(D114); <0.5 min(H28)			U-n(H28,H46,H47) ancestor of Y^{92}(D102) Th-n(H29) Pu-n(A105)
	Kr^{93}	D		β^-	2.2 sec(D114); 2.0 sec(A104)			U-n, ancestor of Y^{93} (S171) U-d(O101,H102) Pu-n(A105)
	Kr^{94}	D		β^-	1.4 sec(A104)			U-n, ancestor of Y^{94} (H56,A103)
	Kr^{97}	B		β^-	Short(A105)			U-n, ancestor of Zr^{97}(A105) Pu-n(A105)
37	Rb^{81}	A (R108)m.s.		β^+, K, γ, e^- (R108)	5.0 hr(R108)			Br-α-2n(R108)
	Rb^{82}	A (R108)m.s.		β^+,γ, e^- (R108)	6 hr(R108); 6.5 hr(H51)			Br-α-n(R108,H51) Kr-d-2n(H51)
	Rb^{82}	D			20 min(H51)			Br-α-n(H51)
	Rb^{84}	B		β^+(B81)	~40 days(B81)			Rb-n-2n(B81) Sr-d-α(B81)
	Rb^{85}		72.8(H34)					

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
37	Rb	F			42 min(H51)			Kr-d-n(H51)
	Rb	F			200 hr (H51)			Kr-d-n(H51)
	Rb^{86}	A		β^-,γ(H52)	19.5 days(H13); ~17 days(H62)	1.56(H13) abs.; 1.60(H32) spect.; 1.80(F117) abs.Al		Rb-n-γ(S9,S20) Rb-γ-n(H62) Sr-d-α(H13) Bi-d(G62) U-n(F114,F117)
	Rb^{87} (H89, H84)	A	27.2(N34)	β^-(T31,C61), γ, e^-(O30)	6.5×10^{10} yr(S74); 5.8×10^{10} yr(E33)	0.132(L6) spect.; 0.25(K53); 0.13(O30) spect.; 0.144(S64) 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)	4.6(G21) abs.Al; 5.1(W19) el.ch.		Rb-n-γ(S9,P2,S20) Pa-n(G7) U-n, Kr^{88} β^- decay (H28,L27,H11,G21, W19,H46) Th-n(A5)
	Rb^{89}	A		β^-, γ(G21)	15 min(G9,G21)	3.8(G21) abs.		U-n, Kr^{89} β^- decay (G9,G21,S41,H46,H47); parent of Sr^{89}(G21)
	Rb^{90}	A		β^-	Short(D108)			U-n, Kr^{90} β^- decay, parent of Sr^{90}(D108)
	Rb^{91}	A		β^-	Short(H42,S110)			U-n, Kr^{91} β^- decay, ancestor of Y^{91} (S110,D105)
	Rb^{90}	D		β^-	80 sec(H28)			U-n(H28,H46,H47,H56)
	Rb^{93}	D		β^-	Short(D105,D104)			U-n, Kr^{93} β^- decay, ancestor of Y^{93} (D105,D104)
	Rb^{94}	D		β^-	Short(H56)			U-n, Kr^{94} β^- decay, ancestor of Y^{94}(H56)
	Rb^{97}	B		β^-	Short(A105)			U-n, Kr^{97} β^- decay, ancestor of Zr^{97} (A105)
38	Sr^{84}		0.56(N36)					
	Sr^{85m}	A		I.T., e^-, γ (D25)	70 min(D25)		0.170(D25) spect.conv.	Rb-p-n(D13,D25)
	Sr^{85}	A		K, γ(D13)	65 days(D13)		0.8(D13,D25) abs.Pb	Rb-p-n(D13,D25) Rb-d-2n(M20,O102)
	Sr^{86}		9.86(N36)					
	Sr^{87m}	A		I.T., e^-, γ (D11)	2.7 hr(D11)		0.37(D11) spect. conv.; 0.386(H9) spect.conv.	Rb-p-n(D11) Sr-n-n(D13,R15, D25,R20) Sr-x-rays(W56) Sr-e^--e^-(W56) Sr-d-p(D11) Sr-n-γ(D11,R15,F103) Sr^{86}-n-γ(S69) Sr-p-p(?)(D25) Y^{87} K decay(D11,D25) Zr-n-α(S46)
	Sr^{87}		7.02(N36)					
	Sr^{88}		82.56(N36)					
	Sr^{89}	A (L112,H96) m.s.		β^-	55 days(S24)	1.50(S24) el.ch.; 1.48(N102) spect.; 1.5(W102,R49) spect.	No γ(G106,S24,W112)	Sr-d-p(S11,S24) Sr-n-γ(S11,S24) Y-n-p(S12) Zr-n-α(?)(S46) U-n, Rb^{89} β^- decay (G9,H28,O21,H46, H47,G51) U-d(O103) U^{238}-n(G65,S184) Th-n(B101) Th-α(N116) Pu-n(F102) Bi-α(T109) Bi-d(G62) Pb-α(P104) Pt-α(T109)
	Sr^{90}	A (H110,H96) m.s.		β^-(N112)	~30 yr(C113)	0.65(G102) abs.Al; 0.6(G51)	No γ(G102,G122)	U-n, Rb^{90} β^- decay, parent of Y^{90}(H47, N112,D103,G122,G51) U^{238}-n(S65) Th-α(N116)

Isotope Z	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^{91}	A		β^-,γ	9.7 hr(K117); 10 hr(H47)	1.3(40%), 3.2(60%)(K105, F111,K112) abs.Al	~1.3(K117) abs.Pb	Zr-n-d(S48) U-n,Rb^{91} β^- decay, parent of Y^{91}(~60%) (F111) and Y^{91m} (~40%)(F111),(H56, H47,G13,S48,K105) Th-n(B101) Th-α(N116) Pu-n(S111,F102) Bi-α(P56) Pt-α(T109) Pb-α(P104) Bi-d(P104)
	Sr^{92}	D		β^-	2.7 hr(G13)			U-n, parent of Y^{92} (G13,H47,H56, S110,K105) Th-n(B101) Th-α(N116) U-γ(L2)
	Sr^{93}	D		β^-	7 min(L26)			U-n,Rb^{93} β^- decay, parent of Y^{93} (H56, L26,H28,H47)
	Sr^{94}	D		β^-	~2 min(H47)			U-n, Rb^{94} β^- decay, parent of Y^{94} (H56,H47)
	Sr^{97}	B		β^-	Short(A105)			U-n, Rb^{97} β^- decay, ancestor of Zr^{97} (A105)
39	Y^{87m}	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)	Rb-α-n(R18) 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) Sr-p-n(D13,D25) Y-n-2n(S11)
	Y^{88}	A (H111)m.s.		K,γ(D25,H33); β^+(0.19%) (P111)	105 days(D25,O109)	0.83(β^+)(P111) spect.	0.91, 1.83, 2.75(P111) spect.; 0.908, 1.89 (D28) spect.coincid.; 0.95, 1.92(R12) cl.ch.; 1.87(S32) Be-γ-n; 2.8(1%) (G47) D-γ-n	Sr-p-n(D13,D25) Sr-d-2n(P11,H33, G47,O102) Y-n-2n(H33,O110)
	Y^{89}		100(D40)					
	Y^{90}	A (H110)m.s.		β^-(N112)	62 hr(G122); 60 hr(S11)	2.16(N102) spect.; 2.6(S11) cl.ch.(K.U.); 2.5(G103) abs.Al	No γ(G103,G122)	Y-d-p(S11) Y-n-γ(S11,S12) Zr-n-p(S46) Zr-d-α(S46) Cb-n-α(S42,S13) U-n, Sr^{90} β^- decay (H47,G122,G51) Bi-d(G62) Bi-α(P56) Pt-α(T109) Tl-α(T109)
	Y^{91m}	A		I.T., γ, e^- (~9%)(K112)	51.0 min(F111); 50 min(G13)		0.61(F111) abs.Pb, abs. Al of e^-	Zr-n-p(S48) U-n, Sr^{91} β^- decay (H47,G13)
	Y^{91}	A (L112,H96) m.s.		β^-	57 days(H42,G13); 61 days(G51)	1.53(L118) spect.; 1.6(B30) abs.	No γ(B102)	Zr-n-p(S48) U-n, Sr^{91} β^- decay (H47,G13); Y^{91m} I.T.(G13,F111) U^{233}-n(G65) U-d(O101) Th-n(B101) Pu-n(F102) Bi-d(G62)
	Y^{92}	D		β^-, γ(H56)	3.5 hr(H56)	3.5 (K105,H112) abs.Al; 3.6(B30) abs.Al	~1(K105) abs.Pb	Zr-n-p(S46,S48) U-n, Sr^{92} β^- decay (G13,H47,H56,K105) Th-n(B101)
	Y^{93}	D (S171)		β^-,γ(B121)	10.0 hr(B121); 11.5 hr(H47)	3.1(B121) abs.Al	0.7(B121) abs.Pb	U-n, Sr^{93} β^- decay (H47,H56,B104) Th-n(B101)
	Y^{94}	D		β^-,γ(H56)	20 min(H47)			Zr-n-p(S48) U-n, Sr^{94} β^- decay (H47,H56,D110)
	Y^{97}	B		β^-	Short(A105)			U-n,Sr^{97} β^- decay, parent of Zr^{97}(A105)

Isotope Z	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^{89}	A		e^-,γ,I.T. or K(D13,D25)	4.5 min(D25)			Y-p-n(D13,D25) Zr-n-2n(?)(A19)
	Zr^{89}	A		β^+ (S12,D13)	80.1 hr(O104); 78 hr(D25)	1.07(O104) abs.Al; 1.0(β^+)(S12) el.ch. (K.U.),(D25) abs.	No γ(D25)	Y-d-2n(O104) Y-p-n(D13,D25) Zr-n-2n(S12,S46) Mo-n-α(S46)
	Zr^{90}		51.51(W121)					
	Zr^{91}		11.27(W121)					
	Zr^{92}		17.14(W121)					
	Zr^{93}	F			2.5 min(N108)			Cb-n-p(?)(N108)
	Zr^{94}		17.30(W121)					
	Zr^{95}	A		β^-, γ, e^-	65 days(B105,G51); 65.5 days(P17); 63 days(S46)	0.394(98%), 1.0(2%) (N109) spect.; 0.42(95%), 1.0(5%) (E101) abs.Al	0.73(93%), 0.23(93%), 0.92(7%)(N109) spect. conv.; 0.80(E101) abs.Pb	Zr-n-γ(S46) Zr-d-p(S46,J105) Mo-n-α(S46) U-n, parent of Cb^{95} (35 days) and Cb^{95} (90 hr)(?)(H55,G18, B104,S112,G104,G51) U^{233}-n(G65,S185) Pu-n(F102) U-α(O115) Bi-d(G62) Th-α(N116)
	Zr^{96}		2.78(W121)					
	Zr^{97}	B		β^-, γ	17.0 hr(G18,K113)	2.2(K113) abs.Al; 1(G18) abs.	~0.8(K113) abs.Pb	Zr-n-γ(S46) Mo-n-α(S46) U-n, Sr^{97} β^- decay (A105), parent of Cb^{97} (G18,H39,C105) U-α(O115) Th-α(N116)
	Zr	E			5 sec(A19)			Zr-n-γ(?)(A19)
	Zr	E		β^-	18 min(S46)			Zr-n-γ(?)(S46,A19)
	Zr	F		β^-	90 min(S12)	~1.5(S46) abs.		Zr-d-?(S12,S46)
	Zr	E		β^-	70 hr(S46)	1.17(S46) el.ch.(K.U.)		Zr-n-?(S46)
41	Cb	E			4 min(D9)			Zr-p-n(?)(D9)
	Cb	E			12 min(D9)			Zr-p-n(?)(D9)
	Cb	E			38 min(D9)			Zr-p-n(?)(D9)
	Cb^{90}	B		β^+	18 hr(J121); 21 hr(D9)	~1(J121) abs.Al		Zr-p-n(?)(D9) Zr-d-2n(J121) Mo-d-α(J121)
	Cb^{91}	B		K, e^-(?) (J121), γ	60 days(J121); ~55 days(S46)		~0.15(S46,M33) abs. of e^-; 0.94(M33)	Zr-d-n(J121)
	Cb^{92}	A		β^-,γ	10.1 days(K58); 11 days(S42,S13)	1.38(S42) el.ch.(K.U.); 1.38(K58); 0.59(M33)	1.0(M33,K58)	Zr-p-n(M33) Cb-n-2n(S42,S13) Cb-d-t(K58,W62) Mo-n-p(S46)
	Cb^{92}	F		β^-,γ(W62)	21.6 hr(W62)	1.2(W62) abs.Al	0.6(W62) abs.Pb	Cb-d-?(W62)
	Cb^{93}		100(S63)					
	Cb^{93m}	E		I.T.(W56)	42 days(W56)			Cb-x-rays(W56)
	Cb^{94m}	A		I.T.,e^-(~100%), β^-(~0.01%) (G50,G138)	6.6 min(S42)	1.3(G138) coincid. abs.Al	0.058(G138) abs. of e^-; 1.0(C133) abs.Pb	Cb-n-γ(S42,S13,P2) Cb-d-p(K57,W62)
	Cb^{95m}	A		I.T., e^- (~100%) (L113,L114)	90 hr(L113); 80 hr(E101)		0.24(L113,L114) spect. conv.	U-n, Zr^{95} β^- decay(~2%) (E101,C103,S112), parent of Cb^{95} (S162,L114)
	Cb^{95}	A		β^-(L103,P104, E106),γ	35 days(E101); 37 days(J121)	0.15(G104,E101) absAl; 0.154(N109) spect.	0.75(W112,R49) spect.; 0.79(J101) spect.; 0.775(N109) spect. conv.	Zr^{95} β^- decay(J121) Mo-d-α(J121) U-n, Zr^{95} β^- decay (~98%)(G104,G51)
	Cb^{96}	B			3 days(J121); 4 days(D9)			Zr-p-n(?)(D9) Zr-d-2n(J121) Mo-d-α(J121)
	Cb^{97}	B		β^-,γ	75 min(G18)	1.4(K113) abs.Al	0.78(K113) abs.Pb	Mo-n-p(S46) Mo-γ-p(H74) U-n, Zr^{97} β^- decay (G18,S46,H39)
42	Mo^{92}		15.85(W122)					

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
42 Mo^{93}	B		β^+, γ	6.70 hr(K57); 7 hr(D9)	0.3, 0.7(K57)	1.6(K57)	Zr-α-n(K57) Cb-p-n(D9,K57) Cb-d-2n(K57,W62) Mo-d-p(W62)
Mo^{93}	B		β^+	17 min(B20,S12)	2.65(S46) cl.ch.(K.U.)		Cb-d-2n(W62) Mo-n-2n(H10,S12,S46) Mo-γ-n(B20) Mo-d-p(W62)
Mo^{94}		9.12(W122)					
Mo^{95}		15.7(W122)					
Mo^{96}		16.6(W122)					
Mo^{97}		9.45(W122)					
Mo^{98}		23.75(W122)					
Mo^{99}	A		β^-, γ	67 hr(S14,K118); 66.0 hr(S181)	1.3(K105) abs.Al; 1.5(S14) abs.; 0.24, 1.03(M90) coincid. abs.	0.4(S14) abs.Cu, Pb; 0.24(20%), 0.75(80%) (M120) spect.; 0.77, 0.815,0.84(S91) spect.; 0.71(M90) coincid. abs.	Zr-α-n(D12,E32) Mo-d-p(S14) Mo-n-γ(S14,S12) Mo^{98}-n-γ(M139) Mo-n-2n(S46) U-n, parent of Tc^{99m}(H23,H41, K105) U^{233}-n(S164) Th-n(H24,B101) Th-α(N116) Pu-n(F102) Bi-α(P56) Bi-d(G62) Tl-α(T109) Pt-α(T109)
Mo^{100}		9.63(W122)					
Mo^{101}	A		β^-, γ	14.6 min(M25)	1.0, 2.2(M38); 1.8(S40) cl.ch.(K.U.)	0.3, 0.9(M38)	Mo-n-γ(S40,S22,S46,M25) Mo^{100}-n-γ(M139) U-n, parent of Tc^{101} (H41,B28)
Mo^{102}	D		β^-	12 min(H41)			U-n, parent of Tc^{102} (H41)
Mo^{105}	B		β^-	Short(B31)			U-n, ancestor of Ru^{105} (B31)
43 $Tc^{92,93}$	C		β^+, γ	4.5 min(M95)	4.3(M95) abs.	1.3(M95) abs.	Mo^{92}-d-n or Mo^{92}-d-2n(M95)
Tc^{94m}	D		I.T., e^-(H67)	53 min(G54)		0.0334(H67) spect. conv.	Mo-p-n(G55)
Tc^{94}	D		β^+, K(65%), γ(G54)	<53 min(H67)	2.47(β^+)(G54) spect.; 2.5(β^+)(M96) abs.Al	0.380, 0.873, 1.48, 1.85, 2.74(H67) spect.	Mo-p-n(G55) Mo^{94}-d-2n(M96)
Tc^{95}	B		K, γ(E34); e^-, β^+(~1%) (H201)	52 days(E34); 62 days(C12)	0.4(β^+)(H201) cl.ch.	0.25, 0.84(E34) abs.Pb; 0.201, 0.57, 0.81, 1.01(H201) spect., spect. conv., coincid.	Mo-d-n(C12,C24,E32) Mo-p-n(E34) Mo^{95}-d-2n(M57)
Tc^{95}	A		K, γ, e^-(E39)	20.0 hr(E39)		0.78(E39) abs.Pb; 0.8(M96) abs.Pb	Mo-p-n(E39) Mo^{95}-d-2n(M96) Ru^{95} β^+ decay(E39)
Tc^{96}	D		β^+, γ(M95)	2.7 hr(D4)	1.2(M95) abs.	2.4(M95) abs.	Cb-α-n(K3) Mo-p-n(D4) Mo-d-n(S14)
Tc^{96}	B		K(E32),e^-, γ (E5)	4.30 days(E34); 4.33 days(G55)	0.64(e^-)(E34) abs.Al; no e^-(M57)	0.05, 0.5(E5); 0.92(E32) spect.; 0.8(M57)	Cb-α-n(E32) Mo-p-n(E3,E32) Mo-d-n(E32) Ru-n-p(B132) Mo^{96}-d-2n(M57)
Tc^{97m}	A		I.T., e^-(E34)	90 days(C12,M57); 93 days(M69); 95 days(E34)		0.097(H9) spect.conv.; 0.108(E34) abs. of e^-	Mo^{97}-d-2n(M57) Mo-d-n(C12,C24) Mo-p-n(E34,G55) Ru^{97} K decay(M130,M69)
Tc^{98}	B		β^-,K(?),γ (G127)	2.7 days(G127); 2.8 days(M96)	1.3(M96) abs.Al; 0.75(G127) abs.Al	0.9(M96) abs.Pb; 1.0(G127) abs.Pb	Mo^{98}-d-2n(M96) Ru-n-p(G127)
Tc^{99}	D		K	~2 days(S14)			Mo-d-n(S14)
Tc^{99m}	A		I.T., e^-, γ (S14)	6.0 hr(B127); 6.6 hr(S14); 6.1 hr(G109); 5.9 hr(M121)		0.136(S14) spect.conv.; ~0.18(S14) abs.Cu,Pb	Mo^{99} β^- decay(S14) Ru-n-p(B132) U-n, Mo^{99} β decay (H41,G110) Th-n(B101)
Tc^{99}	A (I9) m.s.		β^-	9.4×10^5 yr(M86); 4.7×10^6 yr(P107); ~3×10^6 yr(S154) yield	0.32(M86) abs.Al; ~0.4(L115) abs.Al; ~0.3(S154) abs.Al	No γ(S154,M86)	Tc^{99m} I.T.(S14) U-n(S154,L115)

Isotope Z	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	Tc^{101}	D		β^-, γ(E3)	55 min(E5)	2.5(E5) abs.		Mo-p-n(E3,D4,E5) Ru-n-p(B132)
	Tc^{101}	D		β^-	36.5 hr(D4)			Mo-p-n(D4,B127) Ru-n-p(B132)
	Tc^{101}	E		β^-	18 sec(D9)			Mo-p-n(D3,D9)
	Tc^{101}	B		β^-, γ	14.0 min(M25)	1.3(M38); 1.1(S40) cl.ch.(K.U.)	0.30(M38)	Mo^{101} β^- decay(S40, S46) U-n, Mo^{101} β^- decay (S22,H41,M26)
	$Tc^{101,100}$	C		β^-, γ	80 sec(M95)	2.3(M95) abs.	0.6(M95) abs.	Mo^{100}-d-n or Mo^{100}-d-2n(M95)
	Tc^{102}	D		β^-	<1 min(H41)			U-n, Mo^{102} β^- decay (H41)
	Tc^{104}	D		K(?), γ(G127)	60 days(G127)			Ru-n-p(G127)
	Tc^{105}	B		β^-	Short(B31)			U-n, Mo^{105} β^- decay, parent of Ru^{105}(B31)
44	Ru^{96}	F			20 min(D7)			Ru-n-2n(?)(D7,P2)
	Ru^{96}	A		β^+, K, γ (E39)	1.65 hr(E39)	1.1(β^+)(E39) abs.Al	0.95(E39) abs.Pb	Mo-α-n(E39) Mo^{92}-α-n(E39) Ru-n-2n(E39) Parent of Tc^{95}(E39)
	Ru^{96}		5.68(E20)					
	Ru^{97}	A		K, γ, e^- (S113,S90)	2.8 days(S113,S90); 3.0 days(M130)		0.23(S113,S90) abs.Pb	Mo^{94}-α-n(E39) Ru-d-p(S113,S90) Ru-n-γ(S113,M130,S90) Parent of Tc^{97m} (M130,M69)
	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^{103}	A		β^-, γ	42 days(S113,S90); 41 days(B87); 45 days(N15); 37 days(G51)	0.25(G51); 0.3, 0.8 (weak)(S113) abs.Al; 0.75(B87) abs.Al	0.56(G105,S113) abs.Pb; 0.4(B87) abs.Pb	Ru-d-p(L13,S113) Ru-n-γ(S113) U-n(N12,N15,G104, S113), parent of Rh^{103m}(S150) U^{233}-n(G65,S164) Th-n(B101) Pu-n(F102) Bi-d(G62) Pb-α(P104)
	Ru^{104}		18.27(E20)					
	Ru^{105}	B		β^-, γ	4.5 hr(S113); 4.4 hr(B87); 4 hr(D7,L13,N12)	1.4(S113) abs.Al; 1.5(B31) abs.; 1.3(B87) abs.Al	0.76(S113) abs.Pb; 0.7(B87) abs.Pb	Ru-n-γ(D7,S113) Ru-d-p(L13,S113) U-n, Tc^{105} β^- decay parent of Rh^{105} (B31,N12,D7,L13, S33,S113) Th-n(S33,B101) Bi-α(P56) Pb-α(P104) Tl-α(T109) Pt-α(T109)
	Ru^{106}	A (H96)m.s.		β^-	1.0 yr(G105); 290 days(G51)	Very soft(S133)	No γ(G105)	U-n, parent of Rh^{106} (G106,S113,G107, G108,G104) U^{233}-n(G65,S164) U-d(G107) Th-n(B101) Th-α(N116) Pu-n(F102) Bi-d(G62)
	Ru^{107}	D		β^-	4 min(B31)	~4(B31) abs.Al		U-n, parent of Rh^{107} (B31)
45	Rh^{100}	B		K, γ(S113), e^-,β^+(~5%) (L86)	19.4 hr(L86); 21 hr(S113)	0.6(e^-), 3.0(β^+) (L86) spect.	1.2(L86) abs.Pb; 1.8(S113) abs.Pb	Ru-d-n(S113) Pd^{100} K decay(L86)
	Rh^{101}	B		K, γ, e^- (S113)	4.3 days(L86); 5.9 days(S113)		0.55(L86) abs.Pb, spect. conv.	Ru-d-n(S113) Pd^{101} K and β^+ decay (L86)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Y rays	Produced by
45	Rh^{102}	A		β^-, β^+, γ(M23), K(S113)	210 days(M23); 215 days(H77)	1.04(β^-), 1.13(β^+)(H76) cl.ch.; 1.3(S113) abs.Al; 1.1(β^-)(M23) abs.	0.46(annih.?)(S113) abs.Pb	Ru-d-4n(S113) Rh-n-2n(M23,H76)
	Rh^{103}		100(C50)					
	Rh^{103m}	A		I.T., e^-(F31, S150,W57)	57 min(G108,G107); 52 min(F37); 48 min(F31); 45 min(W57,W58)	0.034(e^-)(H77) spect.	0.040(W57) abs. argon of e^-; 0.042(F37) abs. of e^-	Rh-n-n(F31) Rh-e^--e^-(W57) Rh-x-rays(W57) Pd^{103} K decay (B122,M81) U-n, Ru^{103} β^- decay (S150,G107)
	Rh^{104m}	A		I.T., γ, e^- (P5,A38)	4.2 min(P5); 4.4 min(F31); 4.7 min(C134)		0.069(09,H77) spect. conv.; 0.087(F37); 0.09(A38) abs.Al	Ru-p-n(D9) Rh-n-γ(P5,Al,P2), (~10%)(G137) Pd-γ-p(H74)
	Rh^{104}	A		β^-, γ(S50), e (C134)	44 sec(P5,Al)	2.3(C13) cl.ch.; 2.6(H77) spect.; 2.3(S50) abs.Al	0.041, 0.18, 0.95 (C134) abs., abs. of e^-	Ru-p-n(L13) Rh-n-γ(P5,Al), (~90%) (G137) Rh^{104m} I.T.(P5)
	Rh^{105}	A		β^-, γ, e^-	36.5 hr(S113); 37 hr(B87); 34 hr(N12,N13)	0.65(S113) abs.Al; 0.78(B87) abs.Al; 0.5(N13) abs.	0.33(weak)(S113) abs.Pb	Ru-d-n(S113) Ru^{105} β^- decay(S113) Rh-t-p(K64) U-n, Ru^{106} β^- decay (N12,D7,L13,S113) Th-n(B101)
	Rh^{106}	A		β^-, γ	30 sec(G108,G107)	3.55(82%), 2.30(18%) (P57) spect.,coincid. abs.; 4.5(S133) abs.Al; 4 (G108) abs.Al	1.25(1%), 0.73(17%), 0.51(17%)(P57) spect.	U-n, Ru^{106} β^- decay (G107,G108,G51) Pu-n(F102)
	Rh	E		β^-, γ	9 hr(B128)	~1.3(B128) abs.Al	0.8(B128) abs.Pb	U-n(B128)
	Rh^{107}	D		β^-	24 min(B31)	1.2(B31) abs.Al		U-n, Ru^{107} β^- decay (B31)
46	Pd^{100}	B		K, γ(L86)	4.0 days(L86)		0.090, 1.8(L86) abs.Al,Ag,Pb	Rh-d-5n(L86) Sb-d-6s23a(L86) Parent of Rh^{100}(L86)
	Pd^{101}	B		K(~90%), β^+ (~10%)(L86)	9 hr(L86)	2.3(β^+)(L86) spect.	No γ(L86)	Rh-d-4n(L86) Sb-d-6s22a(L86) Parent of Rh^{101}(L86)
	Pd^{102}		0.8(S63)					
	Pd^{103}	A		K(B129)	17 days(B129,MB1)			Rh-d-2n(M81) Rh-p-n(M81) Pd-n-γ, parent of Rh^{103m} (B129)
	Pd^{104}		9.3(S63)					
	Pd^{105}		22.6(S63)					
	Pd^{106}		27.2(S63)					
	Pd^{108}		26.8(S63)					
	Pd^{109}	A (R46)m.s.		β^-	13 hr(K6)	1.03(K6) cl.ch.; 1.0(S155,H95) abs.Al; 1.1(S156) abs.Al	No γ(S156)	Pd-γ-n(P55) Pd-d-p(K6) Pd-n-γ(Al,K6) Ag-n-p(P5) Ag-d-2p(H95) Ag-t-He^3(K60) U-n, parent of Ag^{109m} (S155) U^{235}-n(S184)
	Pd^{110}		13.5(S63)					
	Pd^{111}	A		β^-	26 min(S33)	3.5(B31) abs.		Pd-d-p(K6,Al) Pd-n-γ(K6,Al) U-n, parent of Ag^{111} (S33,N14) Th-n(S33)
	Pd^{112}	A		β^-(S33,N14)	21 hr(S155)	0.2(S156) abs.Al	No γ(S156)	U-n, parent of Ag^{112} (S33,N14,S155) Th-n(S33) Th-α(N116) Bi-d(G62)
47	Ag^{102}	E			73 min(E6)			Pd-p-n(E6)
	Ag^{104}	E			16.3 min(E6)			Pd-p-n(E6)

Isotope Z	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^{105}	E		K,γ	45 days(E6)		0.282, 0.345, 0.430, 0.650, >1.0(D19) spect.; 0.29, 0.42, 0.50, 0.62(E6) spect.	Pd-p-n(E6)
	Ag^{106}	A		β^+	24.5 min(P6,D2)	2.04(P5) abs.	No γ(P5)	Rh-α-n(P6,K3) Pd-d-n(P6) Pd-p-γ(D2) Pd-p-n(D2,E6) Ag-n-2n(P6) Ag-d-t(K58) Ag-γ-n(B20) Ag-e^--e^-n (S59) Ag-d-p2n(K15,K31) Cd-n-p(P6)
	Ag^{106}	A		K, e^-, γ(H50, P6,P5,A4)	8.2 days(P6,K6)	1.2(e^-)(P5) abs.	1.06, 0.69(E6) spect.; 1.63, 1.06, 0.72(?) (D19) spect.	Rh-α-n(P6) Pd-d-n(P6,K6) Pd-p-n(D2,E6) Ag-n-2n(P6,K6) Ag-d-p2n(?)(K23) Cd-n-p(P6) Sn-d-?(L123)
	Ag^{107}		51.35(W121)					
	Ag^{107m}	A		I.T., e^-	44.3(B38,B77); 40 sec(A12,H34)		0.093(V7,A12,H9) spect. conv.; 0.094 (B37,B77) spect.conv.	Ag-n-n(F31) Ag-x-rays(F9,W32,T35) Ag-e^--e^-(W32) Cd^{107} K decay(A12, H34,B37,H95)
	Ag^{108}	A		β^-	2.3 min(A1,B20); 2.4 min(F31)	2.8(N4) el.ch.		Pd-p-n(D2,E6) Ag-n-γ(A1,F31) Ag-γ-n(B20,P56) Ag-e^--e^-n(S59) Ag^{107}-n-γ(F33) Ag-d-p(K12,K15) Cd-n-p(P6)
	Ag^{109m}	A		I.T., e^-	40.4 sec(W32); 40 sec(H34); 39.2 sec(B45)		0.087(H34) spect.conv.; 0.088(B37) spect. conv.	Pd^{109} β^- decay(S33) Ag-n-n(F31) Ag-x-rays(F9,W32,T35) Ag-e^--e^-(W32) Cd^{109} K decay(H34, B37,H95)
	Ag^{109}		48.65(W121)					
	Ag^{110}	A		β^-,γ(P6)	24.2 sec(H97); 22 sec(A1,P6); 28 sec(F31)	2.6(H97) abs.; 2.8(G4) el.ch.(K.U.)		Ag-n-γ(A1,F31) Ag^{109}-n-γ(F33) Cd-n-p(P6) Cd-γ-p(H97,H74)
	Ag^{110}	A (G49) res. n.act.		K, γ, e^-(K15, H59); β^-(K15,D63)	225 days(L14,R10)	1.3(K15) abs.Al; 0.38(S115) abs.Al; 0.59(W112) spect.	1.40(9%), 0.90(47%), 0.66(44%)(R49) spect. conv., spect.; 0.650, 0.925,1.51(D19)spect; 0.6(K15) abs.Al	Ag-n-γ(R10,L14,A8,M12) Ag^{109}-n-γ(G134) Ag-d-p(K12,K15,H59)
	Ag^{111}	A		β^-	7.5 days(K6,P6,S116)	~0.24(?), 1.0(S116) abs.; ~0.8(B30) abs.	No γ(K6,P6,S116)	Pd-d-n(K6,P6) Pd-α-p(P6) Cd-n-p(P6) Cd-γ-p(H74) U-n, Pd^{111} β^- decay (K6,S33,N14,S116, G51) U^{233}-n(G65) U-α(O115) Th-α(N116) Pu-n(F102) Bi-d(G62)
	Ag^{112}	A		β^-,γ(S114)	3.2 hr(P6)	3.6(S155) abs.Al; 2.2(P6) el.ch.	0.86(S156) abs.Al	Cd-n-p(P6) Cd-γ-p(H74) In-n-α(P6) U-n, Pd^{112} β^- decay (N9,S33,N14,S155) U^{233}-n(S184) U-α(O115)
	Ag	D		β^-	5.3 hr(T113)	2.2(T113) abs.Al	No γ(?)(T113)	U-n(T113)
	Ag	E		β^-, γ	22 min(T113)	~3(T113) abs.Al		U-n(T113)
48	$Cd^{105,107}$	D		β^+	33 min(P2)			Cd-n-2n(P2)
	Cd^{106}		1.215(L88)					
	Cd^{107}	A		K(~100%), γ(4%), β^+ (0.3%)(B38)	6.7 hr(D4,R5)	0.32(β^+)(B38) spect.	0.84(weak)(B38) spect.; 0.53(V7) abs.Pb; 0.7(H9) abs.	Ag-p-n(D4,R5,V7,W11) Ag-d-2n(K12,A12, H34,K15) Ag-α-p3n(H95) Cd^{106}-n-γ(H95,G134) Sb-d-16a4s or Sb-d-18a4s(L123) Sn-d-?(L123)

Isotopes Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
48	Cd^{108}		0.875(L88)					
	Cd^{109}	A		K	330 days(B43)			Ag-d-2n(H34,K15) Ag-α-pn(H95) Cd^{108}-n-γ(H95,G134) Sn-d-?(L123) Sb-d-14a4z or Sb-d-16a4z(L123)
	Cd^{110}		12.39(L88)					
	Cd^{111m}	A		I.T., e^-	48.7 min(W30,W32)		0.148, 0.247(H144) spect. conv.; 0.195(W30,W32) abs. of e^-; 0.145, 0.230(H208) spect.conv., spect.	Pd-α-n(H206) Ag-α-pn(H206) Cd-n-n or Cd-n-γ(D8) Cd-x-rays(F9,W30, W32,T35) Cd-e^--e^-(W30,W32) Cd^{110}-n-γ(G144) U-n(N9,N14)
	Cd^{111}		12.75(L88)					
	Cd^{112}		24.07(L88)					
	Cd^{113}		12.26(L88)					
	Cd^{113m}	A		I.T.	2.3 min(H206)			Cd^{113}-n-n(H206)
	Cd^{114}		28.86(L88)					
	Cd^{115}	A		β^-,γ	2.33 days(L57,M123); 2.5 days(G5)	0.6, 1.13(L57) spect.; 0.55, 1.25(M122) abs. Al; 1.11(C14) spect.	0.65(M34) spect.; 0.55 (L57) cl.ch. recoil	Cd-d-p(C14) Cd-n-γ(G5,M10) Cd-n-2n(G5) In-n-p(S117) Sb-d-2α2n(L123) U-n, parent of In^{115m} (N9,N14,M104) U^{233}-n(S184) Th-α(N116)
	Cd^{115}	A		β^-,γ	43 days(S51); 40 days(C14)	1.85(M123) abs.Al; 1.5(S51) abs.Al	0.5(S51) abs.Pb	Cd-d-p(C14) Cd-n-γ(S61) In-n-p(S51) Sn-n-α(?)(S115) U-n(M123) U^{233}-n(S184) Pu-n(F102) Bi-d(G62) Th-α(N116)
	Cd^{116}		7.58(L88)					
	Cd^{117}	A		β^-	170 min(L57); 2.72 hr(M126)	1.3-1.7(L57) spect.		Cd-d-p(C14) Cd-n-γ(M10,G5) U-n, parent of In^{117} (N9,N14,M104)
49	In^{109}	D		K, β^+(T37)	6.5 hr(T37)	2(β^+)(T37)		Ag-α-2n(T39)
	In^{110}	B		β^+	65 min(B17)	1.6(B17) spect.		Ag-α-n(K9,T39) Cd-p-n(B17) Cd-d-2n(L57)
	In.	D		β^+(L87)	72 min(L87)	2.2(L85) abs.Be		Sn(4.5 hr) K decay (L87)
	In^{111}	D		K, γ, e^-(L57)	2.7 days(B17,C14)		0.17, 0.25(B17,C14) spect. conv.	Ag-α-2n(T39,L57) Cd-p-n(B17) Cd-d-n(L57) In-n-3n(C14)
	In^{112m}	B		I.T., γ, e^- (S34,T39)	20 min(B17); 23 min(T37); 16.5 min(S34)		0.16(B17) spect.conv.; 0.12(S44) abs. of e^-	Ag-α-n(T39) Cd-d-n(L57) Cd-p-n(B17) In-n-2n(S34,T39) Parent of In^{112} (T39,S34)
	In^{112}	B		β^+,β^-(?) (S34,T39)	9 min(T39); 17.6 min(S34)	1.5(β^+)(S34) abs.; 1.7(β^+)(L57) cl.ch.; 0.47(β^-?)(S34) abs.		Ag-α-n(S34,T39) In-n-2n S4,T39) In^{112m} I.T. (S34,T39, G64)
	In^{113m}	A		I.T., γ, e^- (B17)	105 min(B17)		0.39(B17,L57) spect. conv.	Cd-p-n(B17) Cd-d-n(L57) In-x-rays(D111) Sn^{113} K decay(B17,S22)
	In^{113}		4.23(W121)					
	In^{114m}	A		I.T., e^- (L57,L48)	48 days(B17)		0.19(B17,L57) spect. conv.; 0.186(L132) spect. conv.	Cd-p-n(B17) Cd-d-n(L57) In-n-γ(L15,M12) In-d-p(L57) In-n-2n(L57) Sn-d-α(?)(L123)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Y rays	Produced by
49	In^{114}	A		β^-	72 sec(L15,B17)	1.98(L32) cl.ch.; 1.98(L132) spect.		Cd-p-n(B17) In^{114m} I.T.(L48, L57,G64) In-n-2n(L15,P2) In-Y-n(B11,C5) In^{113}-n-Y(G144)
	In^{115m}	A		I.T., e^-, Y (L57)	4.50 hr(D56); 4.53 hr(L32); 4.1 hr(G5,B18)		0.34(L57) spect.conv.; 0.3(M122) abs.Al of e^-	Cd-d-n(L57) In-n-n(G5) In-p-p(B18) In-a-a(L16) In-x-rays(P7,C10) In-e^--e^-(W31) U-n, Cd^{115} (2.5 days) β^- decay(G5,N14, M104)
	In^{115}		95.77(W121)					
	In^{116}	A		β^-	13 sec(A1,C14)	2.8(C14) cl.ch.	No Y(M11)	Cd-p-n(D9) In-n-Y(A1,L15), (25%)(G137) In-d-p(L15)
	In^{116}	A		β^-, Y	54.31 min(R103); 54 min(A1,L15)	0.85(C14,C44) spect., cl.ch.	2.32, 1.31, 1.12, 0.428(D19) spect.; 1.8, 1.4, 1.0, 0.6, 0.4, 0.2(C44) cl.ch. recoil; 2.08(~60%), ~1.8(~40%)(J120) Be-Y-n reaction	Cd-p-n(B17) In-n-Y(A1,M11), (75%)(G137) In-d-p(L15) Sn-Y-p(H74)
	In^{117}	A		β^-	117 min(L32); 1.90 hr(M126)	1.73(C14) spect.; 1.95(M126) abs.Al	No Y(L57)	Cd-d-n(C14,L57) Sn-Y-p(H74) U-n, Cd^{117} β^- decay (G5,N14,M104)
50	Sn	D		K(L87)	4.5 hr(L87)			Sb-d-?, parent of In(70 min)(L87)
	Sn^{112}		0.90(W121)					
	Sn^{113}	A		K, e^-, Y	105 days(C71,B17); ~70 days(L17)		0.085(B17) spect.conv.; no Y(C71)	Cd-a-n(L17) In-p-n(B17) In-d-2n(C71) Sn-d-p(L17) Sn-n-Y(S103) Sb-d-10s2z or Sb-d-12a2z(L123) Parent of In^{113m} (B17,S22)
	Sn^{114}		0.61(W121)					
	Sn^{115}		0.35(W121)					
	Sn^{116}		14.07(W121)					
	Sn^{117}		7.64(W121)					
	Sn^{118}		23.98(W121)					
	Sn^{119}	E		β^-	25 min(L17)			Sn-n-Y(G121) Cd-a-n(L17)
	Sn^{119}	E		β^-	3 hr(L17)			Cd-a-n(L17)
	Sn^{119m}	D		I.T., Y, e^- (L87)	13 days(L17), 14 days(L87)	0.13(e^-)(L87) spect.	0.17(L87) abs.Pb	Cd-a-n(L17) Sb-d-a(L87)
	Sn^{119}		8.62(W121)					
	Sn^{120}		33.03(W121)					
	Sn^{121}	A		β^-	28 hr(L85); 26 hr(L17)	0.4(L85) abs.Al	No Y(L85)	Sn-d-p(L17) Sn-n-Y(L17) Sn^{120}-d-p(L85) Th-a(N116)
	$Sn^{121,123}$	C		β^-	130 days(L119); 136 days(G51)	1.5-1.6(L119) abs.Al; 1.2(G51)	No Y(L119)	U-n(L119,G51) U^{233}-n(G65) Th-a(N116)
	Sn^{122}		4.78(W121)					
	Sn^{120}	D		β^-	~80 hr(H55); 60 hr(N15)			U-n(H55,N15,S120) U-a(O115)
	Sn^{123}	D		β^-, Y(S120)	10 days(L17,S164); 11 days(H55,S120); 9 days(C71)	2.6(S164) abs.Al; 2.6(C71) abs.Al		Sn-d-p(L17) Sn-n-Y(L17) U-n(H55,S120) U^{233}-n(S164)
	Sn^{124}		6.11(W121)					
	Sn^{125}	B		β^-, Y	10 min(S173); 9 min(L17)	~2.2(S173) abs.Al	~0.74(S173) abs.Pb	Sn-d-p(L17) Sn-n-Y(L17,S173)

Isotope Z	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	$Sn^{(126}$	D		β^-	40 min(L17)			Sn-d-p(L17) Sn-n-γ(L17) Sn-n-2n(P2)
	$Sn^{(126}$	D		β^-	47 hr(G121)	0.8(G121) abs.Al		Sn-n-γ(G121)
	$Sn^{(126}$	D		β^-	~400 days(L17)			Sn-d-p(L17) Sn-n-γ(?)(S115)
	Sn^{120}	E		β^-	17.5 days(G51)	1.7(G51)		U-n(G51) U^{233}-n(G65)
	Sn^{120}	E		β^-	7.0 days(G51)	1.8(G51)		U-n(G51)
	Sn^{126}	D		β^-, γ	70 min(N15,H55,S120); 80 min(S164)	0.7 or 2.8(S164) abs. Al	1.2(S164) abs.Pb	U-n, parent of Sb^{126} (N15,H55,S120)
	Sn^{125}	D		β^-	~20 min(H55)			U-n(H55)
51	Sb^{117}	D		K, e^-(C71)	2.8 hr(C71)	0.46(e^-)(C71) abs.Al		Sn-d-n(C71) Sn-p-n(C71)
	Sb^{118}	D		K, γ, e^- (C71)	5.1 hr(C71)	0.20(e^-)(C71) abs.Al	1.5(C71) abs.Pb	In-α-n(C71) Sn-d-n(C71)
	Sb^{118}	B		β^+	3.3 min(L123); 3.6 min(R16)			In-α-n(L16,R16) Sn-p-n(D9) Te^{118} K decay(L85)
	Sb^{119}	B		K	39 hr(C71,L85)		No γ, no e^-(C71)	Sn-d-n(C71) Sn-p-n(C71) Sb-d-p3n(L85) Te^{119} K decay(L85)
	Sb^{120}	A		β^+	17 min(H10,L18)	1.55(A10) cl.ch.		Sn-d-n(L18) Sn-p-n(D9) Sn^{120}-d-2n(L85) Sb-n-2n(P2,H10) Sb-γ-n(B20,P55,M98) Sb-d-t(K14) Sb-p-pn(R45)
	Sb^{120}	B		K, γ, e^- (L85)	6.0 days(L85)		1.1(L85) abs.Pb	Sn^{120}-d-2n(L85) Sb-d-p2n(L85)
	Sb^{121}		57.25(W121)					
	Sb^{122m}	B		I.T., e^- (D59)	3.5 min(D59)		0.14(D59) abs. of e^-	Sb-n-γ(D54)
	Sb^{122}	A		β^-, γ, e^- (M120)	2.8 days(L28)	1.36, 1.94(M120,M67) spect.; 0.81, 1.64 (A10, M35) cl.ch., abs.; 1.19, 1.77(M84) coincid. abs., abs.Al	0.57(R49,M67) spect. conv.; 0.96(M35) coincid. abs.; 0.80(M54) spect.	Sn-d-2n(L18) Sn-p-n(D9) Sb-d-p(L18) Sb-n-γ(Al,L18) Bi-d(G62)
	Sb^{123}		42.75(W121)					
	Sb^{124}	A		β^-, γ	60 days(L18)	2.37, 1.62, 1.00, 0.65, 0.48(K67) spect.; (C76) spect.; (M91) coincid. abs.; 0.74, 2.45(H35,H49) spect.; 2.25, 0.53 (M120,M67) spect.; 1.55(M35) abs.; 0.654(J9) spect.; 0.67, 2.45(W68) coincid. abs.	2.04(weak), 1.708, 0.732, 0.654, 0.608, 0.121(C76) spect., spect. conv.; (K67) spect.; 1.72(W112,R49)spect.; 1.82(M35) coincid. abs.; 1.67(W64), 1.71(H138) Be-γ-n reaction; 1.70(K56) cl.ch.pair	Sb-d-p(L18) Sb-n-γ(L18) I-n-α(L18)
	Sb^{124m}	B		I.T.(?), β^-, γ(D59)	21 min(D59)		0.02(I.T.)(D59) abs. of e^-	Sb-n-γ(D59) Sb^{123}-n-γ(D59)
	Sb^{124m}	B		β^-, γ	1.3 min(D69)	3.2(D59) abs.Al		Sb-n-γ(D59) Sb^{123}-n-γ(D59)
	Sb^{125}	B		β^-, γ	2.7 yr(L120); several yr.(G51)	0.3, 0.7(S165) abs.Al; 0.56(G51)	0.55(L120) abs.Pb; 0.6(S165) abs.Pb	Sn-n-γ, β^- decay (S165) Sn-d-n(L18) U-n(S121,L120) U^{233}-n(G65) Th-α(N116)
	$Sb^{(126}$	D		β^-	3 hr(L18)			Sn-d-n(L18)
	$Sb^{(126}$	D			~45 days(L18)			Sn-d-n(L18)
	Sb^{125}	E		β^-	28 days(G51)	1.86(G51)		U-n(G51)
	Sb^{126}	D		β^-	60 min(N15)	2.8 or 0.7(S164) abs.Al		U-n, Sn^{126} β^- decay (N15)
	Sb^{127}	A		β^-, γ	93 hr(S121); 90 hr(G51)	1.2(S121) abs.Al; 0.8(G51)	0.72(S122) abs.Pb	U-n, parent of Te^{127} (A6,S121,G51) U^{233}-n(S184)
	Sb^{129}	A		β^-	4.2 hr(A6)			U-n, parent of Te^{129} (A6)

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
51 Sb^{132}	B		β^-	5 min(A6)			U-n, parent of Te^{132} (A6)
Sb^{133}	B		β^-	<10 min(A6,W21)			U-n, parent of Te^{133} (A6,S21,W21) Th-n(S21,W21)
Sb^{134}	B		β^-	<10 min(A6)			U-n, parent of Te^{134} (A6)
52 Te^{118}	B		K(L85)	6.0 days(L85)		No γ(?)(L85)	Sb-d-5n, parent of Sb^{118}(3.3 min)(L85)
Te^{119}	B		K, γ, e^- (L85)	4.5 days(L85)	0.2, 0.5(e^-)(L85) spect.	1.4(L85) abs.Pb	Sb-d-4n, parent of Sb^{119}(L85) Bi-d(G62)
Te^{120}		0.091(W121)					
Te^{121m}	A		I.T.(E40), e^- (S15,08), γ(Y6,E40)	143 days(E40); 125 days(S15)		0.05(B47,B56) spect. conv., abs.Ag; 0.23, 0.61(H49) spect. conv., (Y6) abs.; 0.22(E40) abs.Pb	Sn-α-n(S15) Sb-d-2n(S15) Sb-p-n(S15)
Te^{121m}	A		I.T., γ(B55)	$5x10^{-8}$ sec(B55)		0.23(B55) coincid. abs.	Te^{121m}(143 days) I.T., parent of Te^{121}(B55)
Te^{121}	A		K, γ(E40)	17 days(E40)		0.61(E40) abs.Pb	Sb-d-2n(E40) Sb-p-n(E40) Te^{121m}(143 days, $5x10^{-8}$ sec) I.T. (E40,B55)
Te^{122}		2.49(W121)					
$Te^{122,124}$	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}		0.89(W121)					
Te^{124}		4.63(W121)					
Te^{125}		7.01(W121)					
Te^{126}		18.72(W121)					
Te^{127m}	A		I.T., e^-(S15)	90 days(S15)		0.086(H9) spect. conv.	Te-n-γ(S15) Te-d-p(S15) I-n-p(S15) U-n, parent of Te^{127} (N104,G51) U^{233}-n(G65,S184)
Te^{127}	A		β^-	9.3 hr(S15,C106)	0.76(C106) abs.Al	No γ(C106)	Te-n-γ(S15) Te-d-p(S15,T4) Te-n-2n(T4) I-n-p(S15) U-n, Te^{127m} I.T. (S15,N104) U-n, Sb^{127} β^- decay (A6,C106)
Te^{128}		31.72(W121)					
Te^{129m}	A		I.T., e^-(S15)	32 days(S15,N103)		0.102(H9) spect. conv.; no hard γ(N103)	Te-n-γ(S15) Te-d-p(S15,T4) Te-n-2n(T4) U-n, parent of Te^{129} (H55,N103,G51) U^{233}-n(G65)
Te^{129}	A		β^-, γ	72 min(S15,A6)	1.8(W112,R49) spect.	0.3, 0.8(G139) abs.Pb	Te-n-γ(S15) Te-d-p(S15,T4) Te-γ-n(B20) Te-n-2n(H10,T4) U-n, Te^{129m} I.T. (S15,N104,G51) U-n, Sb^{129} β^- decay(A6) Th-n(B101)
Te^{130}		34.46(W121)					
Te^{131m}	A		I.T., e^-(S15)	30 hr(S15,A6)		0.177(H9) spect. conv.	Te-n-γ(S15) Te-d-p(S15) U-n, parent of Te^{131} (A6,H22,S15)
Te^{131}	A		β^-	25 min(S15)			Te-d-p(S15) Te-n-γ(S15) U-n, Te^{131m} I.T., parent of I^{131} (A6,S15)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
52	Te^{132}	B		β^-, γ	77 hr(A6,N110)	0.36(N110) abs.Al; ~0.3(B30) abs.	0.22(N110) abs.Pb	U-n, Sb^{132} β^- decay, parent of I^{132} (A6,H22,N110) Th-n(H24) Th-α(N116)
	Te^{133}	B		β^-	60 min(A6,W21)			U-n, parent of I^{133} (A6,H22,S21,W21)
	Te^{134}	B		β^-	43 min(A6)			U-n, Sb^{134} β^- decay, parent of I^{134} (A6,H22) Th-n(P12)
	Te^{135}	A		β^-	<2 min(S135)			U-n, parent of I^{135} (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) Bi-d(G62)
	I^{125}	B		K(R48,G56)	56 days(R48)	~0.1(weak)(e^-?)(R48)	No γ, no e^-(G56)	Te-d-n(R48). Bi-d(G62)
	I^{126}	A		β^-, γ	13.0 days(L19,T4)	1.1(L19) abs.	0.5(L19) abs.Pb	Sb-α-n(L19) Te-d-n(L19) Te-p-n(D9) I-n-2n(T4,L19) Bi-d(G62)
	I^{127}		100(N30)					
	I^{128}	A		β^-, γ	24.99 min(H36)	1.59(7%)(by diff.), 2.02(93%)(S89) spect.; 1.05, 2.10(B14) cl.ch.(K.U.)	0.428(7%)(S89) spect.; 0.4(L19) abs.Pb	I-n-γ(A1,T4) Te-d-2n(L19) Te-p-n(D9)
	I^{129}	A		β^-	long(K61)			U-n(K61)
	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-2n(L19) Te-p-n(D9) Cs-n-α(W21) Th-n(?)(P15) I^{129}-n-γ(K61)
	I^{131}	A		β^-, γ, e^-	8.0 days(L19)	0.595(D29,D30,D31) spect.,coincid.; 0.687(T7) cl.ch.	0.367, 0.080(D30,D31) spect., spect. conv., coincid.; 0.65(15%) (D60) abs.; 0.4(L19) abs.Pb	Te-d-n(L19,R19) U-n, Te^{131} β^- decay (S15,A6,H22,G104, S123,K106,G51) U^{233}-n(G65,S184) U-α(F10,O115) Th-α(N116) Pu-n(F102)
	I^{132}	B		β^-, γ	2.4 hr(A6)	0.9, 2.2(N110) abs.Al; ~1.35(B30) abs.	0.6, 1.4(N110) abs.Pb; 0.85(B30) abs.	U-n, Te^{132} β^- decay (A6,H22,P12,M106,G51), parent of Xe^{132} (T104,T102) U^{233}-n(G65) U-α(F10,O115) Th-n(B101)
	I^{133}	B		β^-, γ	22 hr(A6,W21); 20.5 hr(B118)	1.4(S123) abs.Al; 1.1(P13) cl.ch.	0.55(S123) abs.Pb; 0.528(P109) spect.	U-n, Te^{133} β^- decay, parent of Xe^{133} (H22,A6,S21,W21,K106) U-α(F10,O115) Pu-n(F102) Pb-α(T109)
	I^{134}	B		β^-, γ	54 min(A6)		>1(G123) abs.Pb	U-n, Te^{134} β^- decay (H22,A6,P12,P15,K107) Th-n(D6) U-α(F10) Pu-n(F102)
	I^{135}	A		β^-, γ	6.7 hr(G123,K119); 6.6 hr(S21,D27,W21)	1.40(25%), 1.00(40%), 0.47(35%)(P109) spect.; 1.4(K119) abs.Al; 1.6(S123) abs.	1.6(K119) abs.Pb; 1.3(S123) abs.; 1.27, 2.00(P109) spect	U-n, Te^{135} β^- decay, parent of Xe^{136}(S21, W21,K106), parent of Xe^{135m} (~10%), Xe^{135} (~90%)(W59) Th-n(B101) Pu-n(F102) U-α(O115)
	I^{136}	D		β^-, γ	1.8 min(S35); 86 sec(K126)	6.5(K126) abs.Al	2.9(K126) abs.Pb	U-n(S35), parent of Xe^{136}(T104,T102)
	I^{137}	D		β^-; β^-, n (S60)	22.0 sec(H131); 22.5 sec(R51); 18 sec(K107)	0.7(mean)(n)(B134) p recoil in cl.ch.		U-n, parent of Xe^{137} (S35,S43,S60,R51) Pu-n(R51)
	I^{138}	D		β^-	5.9 sec(S205)			U-n, ancestor of Cs^{138}(R107)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
53	I^{139}	D		β^-	2.6 sec(R107)			U-n, ancestor of Ba^{139}(R107)
	I	F			30 days(S124)			Xe-n-p(S124)
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^-, γ(C41)	34 days(C41)		0.9(C41) abs. of e^-	Xe-n-γ(C125) I-p-n(C41) I-d-2n(O102)
	Xe^{128}		1.90(N30)					
	Xe^{129}		26.23(N30)					
	Xe^{130}		4.07(N30)					
	Xe^{131}		21.17(N30)					U-n(T43) m.s.
	Xe^{132}		26.96(N30)					U-n(T43) m.s.
	Xe^{m}	F		I.T., e^- (C125)	11 days(C125)			Xe-n-α(C125)
	Xe^{133}	A		β^-, γ, e^-	5.3 days(E102,E103); 5.4 days(C22)	0.34(E102) abs.; 0.049(e^-)(E102) abs.; 0.260(W109,W59) abs. Al; 0.42(E109) abs.Al	0.085(E109) abs.Cu,Pb	Te-α-n(C22) Xe-d-p(C22) Xe-n-γ(R22,C125) Cs-n-p(W21,C125,W59) Ba-n-α(W21,C125,W59) U-n, I^{133} β^- decay (S21,D27,W21,B30, E102,W59)
	Xe^{134}		10.54(N30)					U-n(T43) m.s.
	Xe^{135}	A		β^-, γ(B30), e^- (10%)(M124)	9.2 hr(H114); 9.4 hr(S21,W21)	0.93(P109) spect.; 0.95(B30) abs.Al; 0.9(W109,W59) abs.Al; 1.0(H114) abs.Al	0.247(P109) spect.; 0.25(W109,W59) abs.Pb	Xe-d-p(C22) Ba-n-α(W21,S47,W59) U-n, I^{135} β^- decay (S21,D27,W21), Xe^{135m} I.T.(W59)
	Xe^{135m}	A		γ(B30); I.T., γ, e^-(W59)	15.6 min(R22); 10 min(W59)		0.52(P109) spect.; ~0.5(W109,W59)abs.Pb; 0.6(S47) abs.Al of e^-	Xe-n-γ(R22) U-n, I^{135} β^- decay (G11,W59), parent of Xe^{135}(W59)
	Xe^{136}		8.95(N30)					U-n(T43) m.s.
	Xe^{137}	D			68 min(C22)			Xe-d-p(C22)
	Xe^{137}	B		β^-	3.9 min(S205); 3.4 min(R22); 3.8 min(S43)	4(B30) abs.Al		Xe-n-γ(R22,S205) U-n, I^{137} β^- decay (S43), parent of Cs^{137}(G123)
	Xe^{138}	D		β^-	17 min(G21)			U-n, parent of Cs^{138} (H28,H22,G9,G21,S47)
	Xe^{139}	A		β^-	41 sec(D102,D117); ~0.5 min(H28)			U-n, parent of Cs^{139} (H28,H22,H11,D103) Th-n(H29,A5)
	Xe^{140}	A		β^-	16 sec(D117); <0.5 min(H28); 9.8 sec(O101)			U-n, ancestor of Ba^{140} (H28,S110,O101) Th-n(H29) U-d(O101)
	Xe^{141}	A		β^-	1.7 sec(O101)			U-n, ancestor of Ce^{141} (S110,O101) U-d(O101)
	Xe^{143}	A		β^-	~1.3 sec(D102)			U-n, ancestor of Pr^{143} (S110)
	Xe^{144}	A		β^-	Short(D108)			U-n, ancestor of Ce^{144} (D108)
	Xe^{145}	D		β^-	0.8 sec(D120); Short(S110)			U-n, ancestor of Pr^{145} (S110)
55	Cs^{130}	B			30 min(R18)			I-α-n(R18)
	Cs^{131}	B		K(K62); γ, e^-(Y7)	10.2 days(K62); 10.0 days(Y7)		No γ(K62); 0.145(Y7) abs. of e^-	Ba^{131} K decay(K62,Y7)
	Cs^{132}	B		K, γ, e^-(C125)	7.1 days(C125)	0.6(e^-)(C125) abs.Al	0.62(C125) abs.Pb	Cs-n-2n(C125)
	Cs^{133}		100(N30)					

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
55 Cs^{134m}	A		β^-(K26); γ(S92); I.T., e^- (P106,G63)	3.15 hr(S92); 3 hr(K26)	2.4(S92) abs.Al; 1(K26) abs.	0.7(S92) abs.Pb; 0.15 (I.T.)(P106) spect. conv.; 0.16(I.T.) (M140) abs. of e^-	Cs-n-γ(Al,M16,K26) Cs-d-p(K26)
Cs^{134}	A		β^-,γ(K26); e^-(2.5%) (W69)	2.3 yr(G136); 1.7 yr(K26)	0.09(25%), 0.66(75%) (E36) spect.; 0.65(S93) spect.; 0.75(G136) abs.Al; 0.64(P106) spect.; 0.9(K26) abs.; 0.8(W68) coincid. abs.	0.57(25%), 0.60(100%), 0.79(100%)(E36,S57) spect.; 0.58, 0.78, 1.35(weak)(S93) spect., coincid.; 0.61, 0.80(P106) spect.	Cs-n-γ(A8,S20,K26) Cs-d-p(K26) Ba-d-α(H103)
Cs^{136}	A		β^-, γ	13 days(F118); 12 days(G140); 10.2 days(C125)	~0.28(F118) abs.Al; ~0.35(G140) abs.Al	0.9(G140) abs.Pb; 1.2(F115) abs.Pb	Ba-n-p(C125) La-n-α(C125,G140) U^{233}-n(G65) Pu-n(F115) Th-α(N116)
Cs^{137}	A (H96) m.s.		β^-; γ, e^- (T42)	33 yr(G123) yield	0.550(single)(T42) spect.; 0.57(E115) abs.Al; 0.84(50%), 0.5(50%)(S137) abs.Al	0.663(T42) spect. conv., spect.	Xe-n-γ, Xe β^- decay (T106) Parent of Ba^{137m}(E115) U-n(G111) U^{233}-n(G65) Pu-n(F102) Th-α(N116)
Cs^{138}	D		β^-, γ	33 min(H28)	2.6(G21) abs.	1.2(G123) abs.Pb	Ba-n-p(S47) U-n, Xe^{138} β^- decay (H28) Pa-n(G7) Th-n(A5,H29)
Cs^{139}	A		β^-	7 min(H28); 10 min(A5)			U-n, Xe^{139} β^- decay, parent of Ba^{139} (H28,H22,H11,H29, D103) Th-n(A5)
Cs^{140}	D		β^-	40 sec(H28)			U-n(H28)
Cs^{141}	A		β^-	Short(S110)			U-n, Xe^{141} β^- decay, ancestor of Ce^{141} (S110)
Cs^{142}	D		β^-	Short(H48)			U-n, parent of Ba^{142} (H48)
Cs^{143}	A		β^-	Short(S110)			U-n, Xe^{143} β^- decay, ancestor of Pr^{143} (S110)
Cs^{144}	A		β^-	Short(D108)			U-n, Xe^{144} β^- decay, ancestor of Ce^{144} (D108)
Cs^{145}	D		β^-	Short(S110)			U-n, Xe^{145} β^- decay, ancestor of Pr^{145} (S110)
56 Ba^{130}		0.101(N36)					
Ba^{131}	B		K, γ(K62); no β^+, e^- (Y7)	12.0 days(K62); 11.7 days(Y7)		0.22, 0.50, 1.7(weak) (Y7); 0.26, 0.5, 1.2 (weak)(K62) abs.Pb, abs. of e^-	Ba-n-γ(K62,Y7) Parent of Cs^{131}(K62,Y7)
Ba^{132}		0.097(N36)					
Ba^{133m}	A		I.T., e^-, γ (C30)(?)	38.8 hr(W28); 37.8 hr(O103)		0.30(D9) spect. conv.; 0.276(C30) spect. conv.	Cs-p-n(D9) Cs-d-2n(C30) Ba-n-2n(K26,W22) Ba-d-p(W22) Bi-α(P56) Bi-d(G62) Pb-α(P104)
Ba^{133}	A		K, γ, e^-(K62)	>20 yr(K62)		0.36(K62) abs.Pb, abs. of e^-; 0.085, 0.320 (Y9) abs., abs. of e^-, cl.ch.	Ba-n-γ(K62) Ba^{133m} I.T.(Y9)
Ba^{134}		2.42(N36)					
Ba^{135}		6.59(N36)					
Ba^{136}		7.81(N36)					
Ba^{137m}	A		I.T., γ, e^- (E115)	2.5 min(E115)	0.7(e^-)(E115) abs.Al, coincid.	0.75(E115) abs.Pb	Cs^{137} β^- decay(E115) Ba-n-γ(Al,P2,K26)
Ba^{137}		11.32(N36)					
Ba^{138}		71.66(N36)					

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
56	Ba^{139}	A		β^-, γ	85 min(D115); 86 min(P8,H28)	2.3(B30) abs.	0.6(K26) abs.Pb,Cu	Ba-d-p(P8,K26) Ba-n-γ(A1,P2) La-n-p(P8) Ce-n-α(W22) U-n, Cs^{139} β^- decay (H29,H22,H11,D103) U-γ(L2) Th-n(B101,A5) Pu-n(S111,F102)
	Ba^{140}	A		β^-, γ, e^- (W112)	308 hr(S181); 12.8 days(E113); 12.5 days(G104)	1.05(R49) spect.; 0.4 (25%), 1.0(75%)(E104) abs.Al; 1.2(B30) abs.; 1.1(L104) abs.	0.529(N109) spect.; 0.54(R49) spect., spect. conv.; 0.5 (25%)(E104) abs.Pb	U-n, Xe^{140}(and Cs^{140}) β^- decay, parent of La^{140}(H28,H48,H22, G21,S110,O101,G51) U^{233}-n(S184) U-d(O101) U-α(O115) Th-n(B101) Th-α(O115,N116) Pu-n(S111,F102)
	Ba^{141}	A		β^-, γ(G124)	18 min(H48)			U-n, Cs^{141} β^- decay, parent of La^{141}(H48) Th-n(H15,H14) U-γ(L2)
	Ba^{142}	D		β^-	6 min(H48)			U-n, Cs^{142} β^- decay, parent of La^{142}(H48) Th-n(H15,H14) U-γ(L2)
	Ba^{143}	B		β^-	<1 min(H14)			U-n, parent of La^{143} (H14,H15) Th-n(H15)
	Ba^{144}	D		β^-	Short(D108)			U-n, descendant of Xe^{144}, ancestor of Ce^{144}(D108)
	Ba^{145}	D		β^-	Short(S110)			U-n, descendant of Xe^{145}, ancestor of Pr^{145}(S110)
57	La^{135}	B		K, γ(W23,M24)	19.5 hr(C74); 17.5 hr(W23)		0.88(W23)abs.Pb	Cs-α-2n(C74) Ba-d-n(W23,M24) Ba-p-n(W23,W22) Ce^{135} β^+ decay(C74)
	La^{136}	B		β^+(C74)	2.1 hr(C74)	0.84(C74) abs.Al	No γ(C74)	Cs-α-n(C74)
	La^{138}		0.089(I14)					
	La^{139}		99.911(I14)					
	La^{140}	A (H96) m.s.		β^-, γ	40.4 hr(S181); 40.0 hr(W23); 39.5 hr(B85)	0.90(20%), 1.40(70%), 2.12(10%)(O11) spect.; 1.41(W23) abs.Al, spect.; 1.45(W112) spect.; 1.8(L104) abs.	0.335(2%), 0.49(5%), 0.87(10%), 1.65(77%), 2.3(6%)(R49) spect.; 0.335(1%), 0.49(7%), 0.83(14%), 1.63(74%), 2.3(4%)(M120,M67) spect.; 2.49(weak) (W64) D-γ-n reaction	Ba-d-γ(?)(W23) La-d-p(P8,W23,M24) La-n-γ(P9,M13,W23, M24,G14) Ce-n-p(W23) U-n, Ba^{140} β^- decay (H28,H48,H22,G21, G104,G51) U^{233}-n(G65) Th-n(B101) Pu-n(S111,F102)
	La^{141}	A		β^-	3.7 hr(K120); 3.5 hr(H48)	2.9(K120) abs.Al	No γ(?)(K120)	U-n, Ba^{141} β^- decay, parent of Ce^{141}(H48) Th-n(C16,B101)
	La^{142}	D		β^-, γ(K120)	74 min(H48); 77 min(K120)			U-n, Ba^{142} β^- decay (H48) Th-n(H15)
	La^{143}	A		β^-	20 min(B123); 15 min(H55)			U-n, Ba^{143} β^- decay (H14,H15), parent of Ce^{143}(B123)
	La^{144}	A		β^-	Short(D108)			U-n, descendant of Xe^{144}, parent of Ce^{144}(D108)
	La^{145}	D		β^-	Short(S110)			U-n, descendant of Xe^{145}, ancestor of Pr^{145}(S110)
58	Ce^{135}	B		β^+(C74)	~16 hrs(C74)			La-d-6n, parent of La^{135}(C74)
	Ce^{136}		0.193(I14)					
	Ce^{137}	B		K, γ, e^-(C74)	36 hrs(C74)		0.28, 0.75(C74) abs.Pb	La-d-4n(C74)
	Ce^{138}		0.250(I14)					
	Ce^{139}	B		K, γ, e^-(M81)	140 days(P14)		0.18, 1.8(C74) abs.Fb; 0.18,~0.8(P58)abs.Pb	Ba-α-2n(P14) La-d-2n(P14) Bi-d(G62)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
58	Ce^{140}		88.48(I14)					
	Ce^{141}	A (H96) m.s.		β^-, γ	28 days(B106); 30.6 days(P58)	0.60(B108) abs.Al; 0.66(P58) abs.Al; 0.4(B85) abs.Al	0.21(B106) abs.Pb; 0.2(P14)	Ba-α-n(P14) Ce-d-p(P14) Ce-n-γ(P14) Ce-n-2n(P14) Pr-n-p(P14) U-n, La^{141} β^- decay (G104,B106,0101,B107) Th-n(B101) Pu-n(F102) U-d(0101)
	Ce^{142}		11.07(I14)					
	Ce^{143}	A		β^-, γ	33 hr(E105,B85,0103); 36 hr(P14)	1.36(B108) abs.Al; 1.3(B85) abs.Al	0.5(B108) abs.Pb; 0.6(P58) abs.Pb	Ce-d-p(P14,B108) Ce-n-γ(P14) U-n, La^{143} β^- decay, parent of Pr^{143}(E105, B123,B108,0103) U-d(0103) Th-n(B101) Th-α(N116) Pu-n(F102)
	Ce^{144}	A (H96) m.s.		β^-, e^-(P106)	275 days(B119); 300 days(B30)	0.348(N109) spect.; 0.25(N105) abs.; 0.30(P106) spect., .075, 0.12(e^-)(P106) spect.	No γ(S158)	U-n, descendant of Xe^{144}, parent of Pr^{144}(B30,H55,G104, N105,D103,W51) U^{233}-n(G65,S184) U-d(0106) Pu-n(F102) Th-α(N116)
	Ce^{145}	D		β^-	1.8 hr(B110)			U-n, descendant of Xe^{145}, parent of Pr^{145}(B110,S110)
	Ce^{146}	D		β^-	14.6 min(S157); 11 min(G57)			U-n, parent of Pr^{146} (H55,G57)
59	Pr^{140}	A		β^+	3.5 min(P9)	2.5(H90) abs.Al; 2.40(D32) cl.ch.		Pr-n-2n(P9,A1,W23,D32) Pr-γ-n(H90)
	Pr^{141}		100(A31)					
	Pr^{142}	A		β^-, γ	19.3 hr(D32); 19.2 hr(B85)	2.14(D32) spect.; 2.23(P106) spect.	1.9(D32) abs.Pb; ~1.3, ~1.65(P106) spect.	La-α-n(D32) Ce-p-n(D32) Pr-d-p(D32) Pr-n-γ(P9,P2,M13,A1, W23,D32) Nd-n-p(P9,P2)
	Pr^{143}	A (H96) m.s.		β^-	13.8 days(M127); 13.5 days(P14,P58); 14.2 days(0103); 12.7 days(J5)	0.83(P58) abs.Al; 0.95(B108) abs.Al	No γ(B108,M127)	Ce^{143} β^- decay(M125, B85) U-n, Ce^{143} β^- decay (H55,P14,B111) U-d(0103) Pu-n(F102)
	Pr^{144}	A		β^-, γ	17.5 min(N105); 17 min(H55); 18 min(G122)	3.07(N107) spect.; 3.1(B30,H55) abs.; 2.99(P106) spect.	0.135(N109) spect. conv.; 1.25, 0.22 (S159) abs.Pb	U-n, Ce^{144} β^- decay (H55,N105,W51) U-d(0106) Pu-n(F102)
	Pr^{145}	D		β^-	4.5 hr(B110)	3.2(K121) abs.Al	No γ(K121)	U-n, Ce^{145} β^- decay (B110)
	Pr^{146}	D		β^-, γ	24.6 min(S166); 25 min(G57)	~3(S166) abs.Al	1.4(S166) abs.Pb	U-n, Ce^{146} β^- decay (G57)
60	Nd^{141}	E		β^+	2.5 hr(K19)	0.78(K19)		Pr-p-n(K19) Nd-d-t(?)(P9,K19) Nd-n-2n(P9,K19,L25) Nd-γ-n(L25,K19)
	Nd^{142}		27.13(I16)					
	Nd^{143}		12.20(I16)					
	Nd^{144}		23.87(I16)					
	Nd^{145}		8.30(I16)					
	Nd^{146}		17.18(I16)					
	Nd^{147}	B		β^-, γ	12.1 days(M141); 11 days(G121,M127); 11.1 days(B85)	0.9, ~0.15(G121,M127) abs.Al; 0.76(M141) abs.	0.55(M127) abs.Pb; 0.45(M141) abs.	Nd-n-γ(G121,M127) U-n(G121,S160)
	Nd^{148}		5.72(I16)					
	Nd^{149}	D		β^-	1.8 hr(M132); 2.0 hr(B85)	1.6(B85) abs.Al		Nd-n-γ(M132,G121) Nd-d-p(P9) Nd-n-2n(P9)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
60	Nd^{150}		5.60(I16)					
	Nd^{150}	E		β^-(L34)	~5 x 10^{10} yr(L34)	0.011(L34) abs. air		Natural source(L34)
	Nd^{151}	E		β^-	21 min(P9)			Nd-n-γ(P9,M18)
	Nd	F		β^-	11 min(G121)			Nd-n-γ(G121)
61	Pm^{143}	B (W125)		K, e^-, γ (W26,W125)	~200 days(W25); ~1 yr(W125)		0.67(W26) abs.	Pr-α-2n(W26,W126) Nd-d-n(K20,K21)
	Pm	E		β^-, γ	2.7 hr(K20)	2(K20)		Nd-p-n(K20,L25) Nd-d-n(K20,L25) Nd-α-p(L25)
	Pm	E		β^-, γ	16 days(K20)	1.7(K20)		Nd-d-n(K20)
	Pm^{147}	A (L117,H96) m.s.		β^-(G121,B120)	~4 yr(B120); ~5 yr(S167); 2-3 yr(G121)	0.223(L124) spect.; ~0.2(B120) abs.Al; ~0.3(M127) abs.Al	No γ(M127)	U-n(S159,B120) U^{233}-n(G65)
	Pm^{148}	A (P53)m.s.		β^-, γ	5.3 days(K20,P53)	2.5(P53) abs.; 2(K20)	0.8(P53) abs.	Pm^{147}-n-γ(P53) Nd-p-n(K20) Nd-d-2n(K20,K21,L25) Nd-α-p(K21,L25)
	Pm^{149}	A (I11)m.s.		β^-, γ	55 hr(I11); 47 hr(W25,L25,M121); 47.5 hr(B85)	1.2(M121) abs.Al; 1.1(B85) abs.Al	0.25(weak)(M133) abs.Pb	Nd-n-γ, Nd β^- decay (M121,B85) U-n(M121)
	Pm	F		β^-	12.5 hr(P9)			Nd-d-n(P9)
62	Sm^{144}		3.16(I15)					
	Sm^{145}	F (I12)m.s.			>72 days(I12)			Sm-n-γ(I12)
	Sm^{147}		15.07(I15)					
	Sm^{148}		11.27(I15)					
	Sm^{149}		13.84(I15)					
	Sm^{150}		7.47(I15)					
	Sm^{151}	A (L117,H96) m.s.		β^-	~20 yr(I12)	0.06(P113) abs.Al	No γ(?)(P113)	Sm-n-γ(I12) U-n(L117)
	Sm^{152}		26.63(I15)					
	Sm^{152}	B (D61) m.s.		α(H85,L74)	1.0x10^{12} yr(total Sm) (H86); 1.2x10^{12}yr (total Sm)(W40)	2.0(H86) cl.oh.		Natural source(H85,L74, B89)
	Sm^{153}	A (H99) m.s.		β^-, γ(W115, W116); e^-(B140)	47 hr(W115); 46 hr(P9)	0.78(W116,B88) abs.Al	0.0695, 0.103(H202) spect. conv.; 0.57 (weak), 0.10(W116) abs.Pb, Cu; ~0.6, 0.11(M67) spect.; 0.61(weak), 0.11(B88) abs., coincid. abs.	Nd-α-n(K19) Sm-n-γ(P9,H20,R11,H17, W25,L25) Sm-n-2n(P9,K19) Sm-d-p(L25,K19) Sm-γ-n(L25) U-n(W116) U^{233}-n(S184) Pu-n(W115)
	Sm^{154}		22.53(I15)					
	Sm^{155}	B		β^-, γ	25 min(W123); 21 min(P9)	1.9(W123) abs.Al; 1.8(K19)	~0.3(W123) abs.Pb	Nd-α-n(K19) Sm-n-γ(P9,A1,M13,H17, L25) Sm-d-p(L25,K19) U-n(W123)
	Sm^{156}	A		β^-	~10 hr(W116)	~0.8(W119) abs.Al		U-n, parent of Eu^{156} (W114)
63	Eu	E			40 days(E20)			Sm-d-n(K20)
	Eu^{150}	E		β^+	27 hr(P9)			Eu-n-2n(?)(P9,R11)
	Eu^{151}		47.77(H149)					
	Eu^{152}	A (H99) m.s.		β^-, γ, e^-(T6); K(R2,M142, B85)	9.2 hr(P9); 9.3 hr(B85)	1.88(β^-)(T6) spect.; 0.36, 1.8(β^-)(M142) abs.Al	0.123, 0.163, 0.725(T6) spect. conv.; 1.0 (M142) abs.Pb	Eu-n-γ(P9,M13,H17, H20,F11) Eu-n-2n(P9) Eu-d-p(F7,F11)
	Eu^{152}	A (I6,I7) m.s.			Long(I7)			Eu-n-γ(I6)
	Eu^{153}		52.23(H149)					

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev: Particles	Energy of Radiation in Mev: γ rays	Produced by
63	Eu^{154}	A (I7) m.s.		β^-, γ(R11,F7), K(M142,B86)	>20 yr(K70); 6-8 yr(F11)	0.9(R11) spect.; 0.64, 0.84(M142) abs.Al; 0.62, 1.0(W68) coincid. abs.; 1.4(K70) abs.Al; 1.0(B86) abs.Al	1.1(M142) abs.Pb; 0.122, 0.248, 0.408, 1.25(072) spect.conv., abs.; 0.9(K70) abs.Pb	Sm-d-2n(?)(K20) Eu-n-γ(S20,R11,F7,F11) Eu-d-p(F11,K70)
	Eu^{155}	A (L117,H98) m.s.		β^-, γ	2-5 yr(W114)	0.18(P113) abs.Al; ~0.3(W104) abs.Al	0.086(W104) abs.Al, crit. abs.Tl, Hg	Sm-n-γ, Sm^{155} β^- decay(I12) U-n(W104) Th-α(N116)
	Eu^{156}	A (I12)m.s.		β^-, γ	15.4 days(W104)	0.5(60%), 2.5(40%) (W104) abs.Al	2.0(60%)(W104) abs.Pb	Eu^{155}-n-γ(I12) U-n(W105,W104), Sm^{156} β^- decay(W114,W116) Pu-n(F102) Th-α(N116)
	Eu^{157}	D		β^-, γ	15.4 hr(W106)	~1.0(~75%), ~1.8(~25%) (W106,W114) abs.Al	0.2, 0.6(W117) abs.Pb	U-n(W106) Th-α(N116)
	Eu^{154}	D		β^-	60 min(W106,W114)	~2.5(W106,W114) abs.Al		U-n(W106)
64	Gd^{152}		0.21(H149)					
	Gd^{153}	B (I12) m.s.		β^-(?), γ(F11)	155-170 days(F11); >72 days(I12); >75 days(K70)			Eu-d-2n(F11,K70) Gd-n-γ(I12)
	Gd^{154}		2.14(H149)					
	Gd^{155}		14.86(H149)					
	Gd^{156}		20.61(H149)					
	Gd^{157}		15.66(H149)					
	Gd^{158}		24.75(H149)					
	$Gd^{159,161}$	E			9.5 hr(S125); 8 hr(Al,H17)			Gd-n-γ(Al,H20,H17)
	Gd^{160}		21.77(H149)					
	Gd^{161}	F		β^-, γ(K66)	18.0 hr(K70); 20 hr(S153)	0.85(K66)	0.3(K66)	Gd-n-γ(S153,K66) Gd-d-p(K66)
	Gd	F			8.6 day(S153)			Gd-n-γ(S153)
65	Tb^{152}	D		K(?), e^-(W125)	4.5 hr(W125)			Eu-α-3n(W125)
	Tb^{153}	D		K, e^-(W125)	5.1 days(W125)	0.15, 0.4(e^-)(W125) abs.Al		Eu-α-2n(W125)
	Tb^{154}	D		β^+, K, γ, e^- (W125)	17.2 hr(W125)	2.6(β^+), 0.22(e^-)(W125) spect., abs.Al	1.4(W125) abs.Pb	Eu-α-3n(W125)
	Tb^{155}	D		K(?), e^-(W125)	~1 yr(W125)	0.1(e^-)(W125) abs.Al		Eu-α-2n(W125)
	Tb^{159}		100(A33)					
	Tb^{160}	A		β^-	3.9 hr(H16,M13)			Tb-n-γ(H17,P9,M13,H20)
	Tb^{160}	A (I12) m.s.		β^-, γ(B33)	73.5 days(B56); 77.3 days(C81)	0.546, 0.882(C81) spect.; 0.75(B56) abs.Al; 0.71(K70) abs.Al	0.086, 0.195, 0.212, 0.297, 1.15(C81) spect. conv., abs.Pb	Gd-d-2n(K70) Tb-n-γ(B33)
	Tb^{161}	F		β^-, γ	420 days(H139)	0.23(H139)	~0.1, 0.5(H139)	U-n(H139)
	Tb^{161}	F		β^-, γ	6.5 days(K70)	0.5(K70) abs.Al	1.28(K70) abs.Pb	Gd-d-n(K70)
66	Dy	F		β^+	2.2 min(P9)			Dy-n-γ(?)(P9)
	Dy^{158}		<0.1(W44)					
	Dy^{160}		0.1(W44)					
	Dy^{161}		21.1(W44)					
	Dy^{162}		26.8(W44)					
	Dy^{163}		24.8(W44)					
	Dy^{164}		27.3(W44)					
	$Dy^{165,165m}$	C		I.T., e^-(?) (F32,F34)	1.25 min(F34)	0.13(e^-)(F32) abs.Al		Dy-n-γ(F32) Dy^{164}-n-γ(I8)
	Dy^{165}	A (I13) m.s.		β^-, γ	145 min(S94); 140 min(S104,B56); 2.5 hr(H17,P9,M13)	0.42, 0.88, 1.25 (S94) spect.; 1.20 (C31) abs. coincid.; 1.18(D33) spect.; 1.40(E11) cl.ch.	0.091, 0.37, 0.78(S94) spect. conv., spect.; 1.1(C31) abs. coincid.; ~1, 0.37(M67) spect.	Dy-n-γ(H17,H20,P9, M13,M31) Dy^{164}-n-γ(I8)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	γ rays	Produced by
67	Ho^{160}	D			~20 min(W125)			Tb-α-3n(W125)
	Ho^{161}	B		β^+, K, γ(W125)	4.55 hr(W125)	2.0 (β^+), 0.3(e^-)(W125) spect., abs.Al	1.12(W125) abs.Pb	Tb-α-2n(W125)
	Ho^{162}	B		K, γ, e^-(W125)	65 days(W125)	0.6, 0.16(e^-)(W125) abs. Al		Tb-α-n(W125)
	Ho^{163}	D		K, γ, e^-(W125)	~4 days(W125)	0.4(e^-)(W125) abs.Al		Dy-p-n(W125)
	Ho^{164}	D		β^-	35 min(W125); 47 min(P9)	0.74(W125) abs.Al		Ho-n-2n(?)(P9) Dy-p-n(W125)
	Ho^{165}		100(A33)					
	Ho^{166}	A (I7) m.s.		β^-	27.0 hr(B135); 27.5 hr(I7); 27.3 hr(B56); 30 hr(S126)	1.8(B56) abs.Al; 1.9(M31) abs.; 1.6(H20) abs.		Ho-n-γ(H17,H20,P9, M31,S126)
68	Er^{162}		0.1(W42)					
	Er^{164}		1.5(W42)					
	Er^{165}	F		β^+	1.1 min(P9)			Er-n-2n(?)(P9)
	Er^{166}		32.9(W42)					
	Er^{167}		24.4(W42)					
	Er^{168}		26.9(W42)					
	$Er^{169,171}$	C		β^-	9.4 days(K127); ~10 days(B135)	0.33(K127) spect.	No γ(B135)	Er-n-γ(B135)
	$Er^{169,171}$	C			6 min(B56); 7 min(M13)			Er-n-γ(M13,M18)
	Er^{170}		14.2(W42)					
	Er^{171}	B		β^-, γ, e^- (K127)	7.5 hr(K127); 5.7-7.1 hr(B56); 12 hr(H17,P9)	1.49(6%), 1.05(71%), 0.67(22%)(K127) spect., coincid.	0.81(22%), 0.31(71%), 0.113(71%)(K127) spect., spect. conv.	Er-n-γ(H17,P9,R24, B135) Parent of Tm^{171} (500 days)(K127)
	Er^{171}	F		β^-, γ	20 hr(B85)	0.6(B85) abs.Al		Er-n-γ(B85)
69	Tm^{166}	B		β^+, γ, e^- (W125)	7.7 hr(W125)	2.1(β^+), 0.24, 1.0(e^-) (W125) spect., abs.Al	1.5(W125) abs.Pb	Ho-α-3n(W125)
	Tm^{167}	B		K(?), γ, e^- (W125)	9.6 days(W125)	0.21(e^-)(W125) abs.Al	0.22, 0.95(W125) abs.Pb	Ho-α-2n(W125) Ta-d-5z16a(W125)
	Tm^{168}	B		K(?)(W125)	~150 days(W125)			Ho-α-n(W125) Ta-d-5z15a(W125)
	Tm^{169m}	B		I.T., e^-(M143)	$1x10^{-6}$ sec(M143)		0.2(M143) coincid. abs. of e	Yb^{169} K decay(M143)
	Tm^{169}		100(A33)					
	Tm^{170}	A		β^-	127 days(B56); ~125 days(B135); 105 days(H20)	0.98(K133) spect.; 1.1(B56) abs.Al	No γ(B135,B56)	Tm-d-p(K133) Tm-n-γ(H20,N7)
	Tm^{171m}	B		I.T., e^-(M143)	$2.5x10^{-6}$ sec(M143)		0.1(M143) coincid. abs. of e^-	Er^{171}(7.5 hr) K decay(M143)
	Tm^{171}	B		β^-	500 days(K128)	0.1(K128) abs.Al; 0.100(K133) spect.		Er^{171}(7.5 hr) β^- decay(K128)
70	Yb^{168}		0.06(W43)					
	Yb^{169}	B		K, γ(B56), e^-(?)(B133)	33 days(B56); 33.5 days(I105); 32.5 days(K133)		0.2, 0.4(B56) abs.Pb, coincid.	Tm-d-2n(K133) Yb-n-γ(B56,B133)
	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}	A (I13) m.s.		β^-, γ(B56)	99 hr(I6,B56); 100 hr(A35); 102 hr(I13)	0.50, 0.13(B56) abs.Al; 0.45(A35) cl.ch.	0.35(B56) abs.Pb, coincid.	Yb-n-γ(I6)
	Yb^{176}		13.38(W43)					
	Yb^{177}	B		β^-	2.4 hr(B56); 2.7 hr (I13); 3.5 hr(H17, M13); 1.9 hr(A35)	1.3(B56); 1.15(A35)cl.ch.		Yb-n-γ(H20,H17,M13,P9)

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
71 Lu^{170}	B		K, γ, e^-, β^+(?)(W125)	2.15 days(W125)	1.7(β^+), 0.1(e^-)(W125) spect., abs.Al	1.5(W125) abs.Pb	Tm-α-3n(W125) Yb-d-2n(W125) Ta-d-3z13a(W125)
Lu^{171}	B		K, γ, e^- (W125)	9 days(W125)	0.17, 0.7(e^-)(W125) abs.Al		Tm-α-2n(W125) Ta-d-3z12a(W125)
Lu^{172}	B			>100 days(W125)			Tm-α-n(W125)
Lu^{175}		97.5(M54)					
Lu^{176} (H80, M54)	A	2.6(M54)	β^-(H80,L70), (67%)(F45); γ(F16); (33%)(F45)	$7.3x10^{10}$ yr(uncorr. for K)(L70)	0.215(L70) abs.Al, spect.; 0.40(F16) abs.Al	0.260(F16) abs.Pb	Natural source(H80)
Lu^{176m}	B		β^-	3.67 hr(A35); 3.75 hr(W125); 3.7 hr(B56); 3.4 hr(F16,D57)	1.04(W125) abs.Al; 1.15(F16) abs.Al; 1.25(A35) cl.ch.	No γ(B56,A35)	Lu-d-p(W125) Lu-n-γ(H20,H17,M13, M18,F16) Lu-x-rays(D57)
Lu^{177}	A (113) m.s.		β^-, γ(B56)	6.8 days(B56); 6.6 days(F16,A35); 6.9 days(W125)	0.440(F16) abs.Al; 0.52(B56) abs.Al; 0.47(A35) cl.ch.	0.2(B56) abs.Pb; 0.2, 1.3(weak)(W125) abs.Pb	Lu-n-γ(H17,H20,F6,F16) Lu-d-p(W125) Hf-d-α(W125)
72 Hf^{174}		0.18(M55)					
Hf^{176}		5.30(M55)					
Hf^{177}		18.47(M55)					
Hf^{178}		27.10(M55)					
Hf^{179}		13.84(M55)					
Hf^{180}		35.11(M55)					
Hf^{181}	A		β^-, γ(D52)	46 days(S118); 55 days(H19)	0.45(M83) abs.Al; 0.28(N47) abs.Al, coincid.; 0.63(V23) abs., coincid.; 0.8(D52) abs.Al	0.52, 0.30(M83) abs.Pb; 1.4(N47) coincid.abs.; 0.52, 0.13(V23) abs., coincid. abs.; 0.5(D52) abs.Al	Hf-n-γ(H19) Parent of Ta^{181m}(D52)
Hf^{m}	D		I.T., e^-(?) (F32,F34)	19 sec(F32)	0.19(e^-)(F32) abs.Al		Hf-n-γ(F32)
73 Ta^{176}	B		K, γ, e^- (W125)	8.0 hr(W125)	0.12, 0.18, 1.2(e^-) (W125) abs.Al	~2(W125) abs.Pb	Lu-α-3n(W125) Ta-d-p6n(W125)
Ta^{177}	B		K, γ, e^- (W125)	2.66 days(W125)	0.11(e^-)(W125) abs.Al		Lu-α-2n(W125) Ta-d-p5n(W125)
Ta^{178}	B		K, e^- or β^- (W125)	16 days(W125)	1.1(e^-?)(W125) abs.Al		Lu-α-n(W125)
Ta^{180}	B			14-21 min(B11,01)			Ta-γ-n(B11) Ta-n-2n (?)(01)
Ta^{180}	A		K, e^-, γ(01); β^-(?)	8.2 hr(01)	<0.5(e^-?)(01) abs.		Ta-n-2n(01,P2) Ta-γ-n(M98)
Ta^{181m}	A		I.T., γ, e^- (D113,D52)	$2x10^{-5}$ sec(D52,M83)		0.18(D52) coincid. abs.	Hf^{181} β^- decay (D113,D52)
Ta^{181}		100(D40)					
Ta^{182}	A		β^-, γ, e^-	117 days(Z2,S52)	1.0(H37) abs.; 0.98, 0.32, 0.050(Z2); 0.63(R49) spect.; 0.499(J9) spect.; 1.1(N47) abs.Al, coincid.	1.22(57%), 1.13(37%), 0.22(4%), 0.15(2%) (R49) spect., spect. conv.; 1.6(Z2); 0.23(N47) abs.Pb	Ta-n-γ(01,F6,H37) Ta-d-p(01,Z2)
Ta^{182}	B		β^-, γ(?)(S52)	16.2 min(S52)	0.2(S52) abs.Al		Ta-n-γ(S52)
74 W^{180}		0.122(I5)					
W^{181}	B		K, γ, e^-	140 days(W66)		~0.14, 1.85(weak)(W66) abs. of e^-, abs.Pb	Ta-d-2n(W66)
W^{182}		25.77(I5)					
W^{183}		14.24(I5)					
W^{184}		30.68(I5)					
W^{185}	A		β^-, γ(?)(M36)	73.2 days(S207); 74 days(F12); 77 days(M36)	0.430(S207,P59) spect.; 0.675(J9) spect.; 0.6(S84) abs.Al; 0.64-0.72(F12) cl.ch.	No γ(S84,C68)	W-n-γ(M36,F12) W-n-2n(M36,F12) W-d-p(F12) Re-d-α(F12)
W^{186}		29.17(I5)					

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Y rays	Produced by
74 W^{187}	A		β^-, Y(M36); e^-	24.1 hr(F12)	0.63(70%), 1.33(30%) (P59) spect.; 0.562, 1.35(L126) spect.; 1.3, 0.6(M67) spect.; 1.4, 0.6(S84) abs.Al	0.135, 0.101, 0.086(V6) spect. conv.; 0.135, 0.48, 0.69(M120) spect. conv.; 0.90 (C31) coincid. abs., coincid.; 0.14, 0.21, 0.48, 0.62, 0.69 (P59) spect. conv.	W-n-Y(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^{182}	B		K(?), Y, e^- (W125)	64.0 hr(W125)	0.11, 0.27, >0.6(e^-) (W125) abs.Al	0.22, 1.52(W125) abs. Pb	Ta-a-3n(W125) W-p-n(W125)
$Re^{183,184}$	C		K, Y, e^- (W125)	~60 days(W125)	0.1(e^-)(W125) abs.Al	1.0(W125) abs.Pb	Ta-a-2n or Ta-a-n(W125)
$Re^{184,183}$	C		K, Y, e^- (W125)	13 hr(W125)		1.6(W125) abs.Pb	W-p-n(W125)
Re^{184}	A		β^-, K, Y (S85)	50 days(S85); 52 days(F12)	0.22-0.26(S85); 0.1(e^-), 0.22, 0.86(e^-?) (C32) abs.Al	0.17, 1.05(S85); 0.85(F12); 0.17, 1(C32) spect. conv., abs.Pb	W-p-n(D9,C42,C32) W-d-n(F12) Re-n-2n(F12)
Re^{185}		37.07(W121)					
Re^{186}	A (H79) m.s.		β^-	92.8 hr(G52); 90 hr(S16)	1.07(G52) abs.Al; 1.05(Y4) el.ch.	No Y(C42,S85)	W-d-2n(F12) W-p-n(D9,C32) Re-Y-n(P55) Re-n-Y(S16,K7,Y4,F12) Re-n-2n(S16,Y4,F12) Re-d-p(F12)
Re^{187m}	A		I.T., Y(D58) e^-	$.65\times10^{-6}$ sec(D58)		0.13(D58) coincid. abs.	W^{187} β^- decay(D58)
Re^{187}		62.93(W121)	β^-(N44)	4×10^{12} yr(N44)	0.043(N44) abs.Al		Natural source(N44)
Re^{188}	A (H79) m.s.		β^-, Y	18.9 hr(G52); 18 hr(P2,S85)	2.05(G52) abs.Al; 2.5 (S16) el.ch.(K.U.); 2.5(S85) abs.	0.16, 0.46, 0.64, 0.94, 1.43(M67) spect.; 0.8(M34) spect.; 0.7(S85) abs.Pb	Re-n-Y(P2,K7,S16,Y4, F12) Re-d-p(F12)
76 Os^{184}		0.018(N37)					
Os^{185}	B		K, Y(G48)	97 days(K71); 94.7 days(G52)		0.75(K71) abs.Pb	Re-d-2n(G48,K71) Os-n-Y(K71)
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^-, Y(S36)	32 hr(S36); 31.9 hr(G52); 30 hr(Z3,S104)	1.5(S36) abs.Al; 0.95(G52) abs.Al	1.17(G52) abs.Pb	Os-n-Y(K7,S36,Z3) Os-n-2n(S36) Os-d-p(G48) Ir-d-a(G48)
Os^{192}		41.0(N37)					
Os^{193}	B		β^-, Y, e^-	15.0 days(K71); 16.1 days(S207); 17 days(S36)	0.142(S207) spect.; 0.16(K71) abs.Al; 0.35(S36) abs.Al; 0.64(W68) coincid.abs.	0.039, 0.127(S207) spect. conv.; 0.13(K71) abs.Pb; 0.129(C72) spect. conv.	Os-n-Y(S36,Z3)
77 Ir^{190}	B		K(?), e^-(?),Y	10.7 days(G52)	0.091(e^-?)(G52) abs.Al	0.25(G52) abs.Pb	Os-d-n(G52) Ir-n-2n(G52) Ir-Y-n(G48)
Ir^{191}		38.5(S63)					
Ir^{192m}	A (G135) res. n. act.		I.T., Y, e^- (G135,G58)	1.5 min(M15)	0.038(e^-)(G146) abs.Al	0.06(G58) abs.Al of e^-, abs.Pb	Ir-n-Y(M15)
Ir^{192}	A (D116,R46) m.s.		β^-, Y, e^- (~30%) (W69,S206)	70 days(F103); 60 days(M15,F6); 75 days(G52)	0.59(G52) abs.Al; 0.68(W68) coincid. abs; 0.56(M89) abs.Al	0.307, 0.467, 0.603(D34) spect.; 0.52(G52) abs.Pb; 0.137, 0.209, 0.295, 0.307, 0.316, 0.468(L81,H65) spect. conv.	Ir-n-Y(M15,F6,J4) Ir-n-2n(G52) Ir-d-p(G52) Ir-Y-n(G48)
Ir^{193}		61.5(S63)					

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
77 Ir^{194}	A (D116,R46) m.s.		β^-, γ	19.0 hr(G52); 19 hr(M15,A1); 20.7 hr(S104,S153)	2.2(A2) spect.; 2.18(W29) spect.; 2.11(W29) abs.Al; 2.07(G52) abs.Al; 0.48(M89) coincid.abs.	1.35(M34,M89) spect.; 1.65, 0.38(G52)abs.Pb; (M89) coincid.	Ir-n-γ(M15,A1,P2,J4) Au-d-αp(?)(C18) Ir-d-p(G52)
78 Pt^{191}	D		K, e^-, γ(W67)	3.00 days(W67)	0.5(e^-)(W67) abs.Al	0.57, 1.8(W67) abs.Pb	Pt-n-2n(W67) Ir-d-2n(W67) Au^{191} K or β^+ decay(W67)
Pt^{192}		0.78(I104)					
Pt^{193}	B		K, γ, e^-(W67)	4.33 days(W67)	0.10(e^-)(W67) abs.Al	0.17, 1.7(W67) abs. of e^-, abs. Pb	Ir-α-pn(W67) Ir-d-2n(W67) Pt-d-p(W67) Pt-n-2n(W67) Au^{193} K decay(W67)
Pt^{194}		32.8(I104)					
Pt^{195}		33.7(I104)					
Pt^{196}		25.4(I104)					
Pt^{196m}	D		I.T., e^-(?) (S37)	80 min(S37)			Pt-d-p(S37) Hg-n-α(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-2n(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}		7.23(I104)					
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^{191}	D		K or β^+(W67)	~1 day(W67)			Ir-α-4n(W67) Pt-d-3n(W67) Parent of Pt^{191}(W67)
Au^{192}	D		K, γ, e^-(W67)	4.7 hr(W67)	0.3(e^-)(W67) abs.Al	~3(W67) abs.Pb	Ir-α-3n(W67) Pt-d-2n(W67)
Au^{193}	B		K, e^-(W67)	15.8 hr(W67)			Ir-α-2n(W67) Pt-d-3n(W67) Parent of Pt^{193}(W67)
Au^{194}	D		K, γ, e^-(W67)	39.5 hr(W67)	0.31, 1.8(e^-)(W67) abs.Al	0.38, 1.9(W67) abs. of e^-, abs. Pb	Ir-α-3n(W67) Pt-d-2n(W67)
Au^{195}	B		K, γ, e^-(W67)	195 days(W67)	0.08(e^-)(W67) abs.Al	0.17, 1.7(W67) abs. of e^-, abs.Pb	Ir-α-2n(W67) Pt-d-2n(W67)
Au^{196}	B		β^-	13 hr(M15); 14 hr(W67)			Au-n-2n(M15)
Au^{196}	B		β^-, γ, e^- (K27)	5.55 days(W67); 5.6 days(L29,K27)	0.36(C43)	0.41(C43); 0.41, 1.7 (W67) abs.Pb	Au-n-2n(M15) Pt-d-n(K27)
Au^{197}		100(D44)					
Au^{197m}	A		I.T., e^-(W56)	7.5 sec(W56)	0.07(e^-), 0.25(e^-)(F38) abs. Al, coincid.	0.25(W56) abs. of e^-	Au-x-rays(W56) Au-n-n(W56,F38) Hg^{197}(25 hr) K decay (4%)(F38)
Au^{198}	A		β^-, γ, e^- (4.7%)(W69)	2.7 days(M15,A1); 65.6 hr(D38)	0.970(86%), 0.605(15%) (L84) spect.; 0.960(100%)(S201) spect; 0.97(100%)(P59) spect.; 0.985(F41) abs.Al. coincid.	0.408(100%), 0.167(15%), 0.208(15%)(L84)spect., spect. conv.; 0.4112 (D64) cryst. spect.; 0.065(F41) abs., coincid.; (C31,S53, R53) 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)	0.38(M56) abs.Al, coincid.; 1.01(K27) abs.	0.18(M56) abs.Pb, coincid.; 0.45(K27) abs.	Pt^{199} β^- decay(M15) Pt-d-n(K27) Hg-n-p(S37)
$Au^{200,202}$	D		β^-	48 min(S37,M32)	2.5(S37) abs.		Hg-n-p(S37,M32) Tl-n-α(M32)
80 Hg^{196}		0.15(W30)					
Hg^{197}	A		K, γ, e^-(F13)	23 hr(F13); 25 hr(D101)		0.161, 0.130(H38) spect. conv.; 0.125, 0.157 (V8) spect. conv.; 0.165, 0.135(F38) coincid. abs.	Pt-α-n(S37) Au-d-2n(F13,W26,K28) Au-p-n(D101) Hg-n-2n(F13,W26) Hg-n-γ(F13,W26,M15,A9) Hg-d-p(K29)

Isotope Z	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,D101)		0.075(H38) spect.conv.; 0.077(F38) abs.of e^-	Au-d-2n(F13,W26) Au-p-n(D101) Hg-n-2n(F13,W26) Hg-n-γ(F13,W26)
	Hg^{198}		10.1(N30)					
	Hg^{199}		17.0(N30)					
	Hg^{m}	D		I.T., e^-, γ (F13)	43 min(H10,M15); 43.5 min(H208)		~0.53(F13) abs. of e^-; 0.222, 0.362(H208) (spect. conv.)	Pt-α-n(?)(S37) Hg-n-2n(M15,H10,P2) Hg-n-n(?)(F13,W26) Hg-d-p(K29) Hg-x-rays(W36)
	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)	<0.3(M120,M67) spect.; 0.46(F13) abs.Al; 0.11, 0.44(W68) coincid. abs.	0.30(F13) abs.Pb; 0.28(M67) spect.	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-2n(K29)
	Tl	D		K(?), e^-(K29)	44 hr(K29)			Hg-d-2n(K29)
	Tl^{198}	D		K, γ, e^-(O31)	1.8 hr(O31)	0.4(e^-)(O31) abs.Al,Be	1.3(O31) abs.Pb	Au-α-3n(O31)
	Tl^{199}	D		K, γ, e^-(O31)	7 hr(O31)	0.5(e^-)(O31) abs.Al, Be	1.5(O31) abs.Pb	Au-α-2n(O31)
	Tl^{200}	B		K, γ, e^-(O31)	27 hr(O31)	0.4(e^-)(O31) abs.Al, Be		Au-α-n(O31)
	Tl^{200}	F			4 min(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-2n(K29) Tl-n-2n(F14,M32)
	Tl^{203}		29.1(N36)					
	Tl^{204}	B		β^-	2.7 yr(V110); 3.5 yr(F14)	0.80(H141) abs.Al; 0.87(F14) cl.ch.; 0.77(P106) spect.	No γ(F14)	Tl-n-γ(P10,P2,H10) Tl-d-p(F17,K29)
	Tl^{205}		70.9(N36)					
	Tl^{206}	A		β^-(B116)	4.23 min(F17)	1.65(F14) abs.; 1.77(K29) abs.Al	No γ(F17)	Tl-n-γ(P10,P2,H10) Tl-d-p(F17,K29) Pb-γ-p(B53) RaE^{210} α decay(B78)
	AcC"^{207}	A		β^-, γ(C60)	4.76 min(C60,S70)	1.47(S71) abs.Al		Pb-n-p(B16) Natural source, AcC^{211} α decay
	ThC"^{208}	A		β^-, γ(C60)	3.1 min(C60)	1.72(S99) spect.; 1.82(S72) abs. paper	2.62(R40)	Natural source, ThC^{212} α decay
	Tl^{209}	A		β^-	2.2 min(H146)		1.8(H146) abs.Al	Bi^{213} α decay, parent of Pb^{209}(S108,H143)
	RaC"^{210}	A		β^-	1.32 min(C60)	1.80(L71) cl.ch.		Natural source, RaC^{214} α decay, parent of RaD^{210}
82	Pb^{201}	D		K, e^-, γ(H118)	~5 hr(H118)			Tl-d-4n(H118)
	Pb^{203}	B		I.T.(?) or K(?), e^-, γ (F14,K29, L33,M32)	52 hr(F17,F14); 54 hr(D101)		~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-2n(F14,K29,F17, H118) Tl-p-n(D101) Pb-n-2n(M32) Pb^{204}-n-2n(T38) Pb-γ-n(B53)
	Pb^{204}		1.5(N38)					
	Pb^{204m}	B		I.T., γ, e^- (F14,M32. T38)	68 min(M32); 65 min(F14)		1.1(F14) abs. of e^-, abs.Pb; 0.90(M32)	Tl-d-n(F14) Tl-d-3n(T38) Pb-n-n(D10,M32) Pb-x-rays(B53) Bi^{204} K decay(T38)
	Pb^{206}		23.6(N38)					
	Pb^{207}		22.6(N38)					

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
82 Pb^{208}		52.3(N38)					
Pb^{209}	A		β^-	3.32 hr(L108)	0.70(K29,F14) abs.; 0.68(R49) spect.; 0.750(M32); 0.71(L108) abs.Al; 0.70(L108) spect.	No γ, no e^-(W102); no γ(L108)	Pb-d-p(T5,K29,F14,F15) Pb-n-γ(M32) Bi-n-p(M32) Po^{213} α decay(H69,E38)
RaD^{210}	A		β^-, γ(R40)	22 yr(C60)	0.0255(L72) spect.; 0.0292(S64) spect.	0.047(R40); 0.0472(T44) spect. conv.; several weak lines of lower energy(B35,F42,T32, T33)	Natural source, RaC''^{210} β^- decay, RaC'^{214} α decay, parent of RaE^{210}
AcB^{211}	A		β^-, γ(S71)	36.1 min(S70)	0.5, 1.40(S71) abs.Al	0.8(S71) abs.	Natural source, AcA^{215} α decay, parent of AcC^{211}
ThB^{212}	A		β^-, γ(R40)	10.6 hr(C60)	0.36(S72) spect.		Natural source, ThA^{216} α decay, parent of ThC^{212}
RaB^{214}	A		β^-, γ(R40)	26.8 min(C60)	0.65(S72) spect.		Natural source, RaA^{218} α decay, parent of RaC^{214}
83 Bi^{203}	F		α(T40)	2 min(T40)			Pb-d-?(T40)
Bi^{203}	D		α, K(?)(T40)	9 min(T40)	5.83(N117) ion.ch.; ~5.5(α)(T40) ion.ch.		Pb-d-?(T40)
Bi^{203}	D		α, K(?)(T40)	27 min(T40)	5.47(N117) ion.ch., abs. mica; ~5.5(α)(T40) ion.ch.		Pb-d-?(T40)
Bi^{203}	D		α, K(?)(T40)	55 min(N117); ~100 min(T40)	5.15(N117) ion.ch.; ~5.5(α)(T40) ion.ch.		Pb-d-?(T40)
Bi^{204}	B		K, e^-, γ(T38)	12 hr(T38)	0.2(e^-), ~0.8(e^-, weak) (T38) spect., abs.Al		Pb^{204}-d-2n(T38) Tl-α-3n(T38) Parent of Pb^{204m}(~4%) (T38)
Bi^{206}	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; ~0.4, 1.1(T38) abs.Pb	Tl-α-3n(T38) Pb-d-2n(F14,F15,K29) Pb^{207}-d-3n(T38) Po^{206} K decay(T38)
Bi^{209}		100(N36)					
RaE^{210}	A		β^-(~100%); α(10^{-4}-10^{-5} %)(B116)	5.0 days(C60)	1.17(β^-)(F30,N40,L76) spect.; 4.87(α)(B78) calc.	No γ(G23)	Natural source, RaD^{210} β^- decay, parent of Po^{210} and Tl^{206}(B78) 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,84%), 6.273 (α,16%)(H81) spect.		Natural source, AcB^{211} β^- decay, parent of AcC'^{211} and AcC''^{207} At^{215} α decay(G66)
ThC^{212}	A		α(33.7%)(K50), γ(R40); β^- (66.3%) (K50), γ (C60)	60.5 min(C60)	6.081(α, 27%), 6.042 (α,70%)(L73) spect.; 2.20(β^-)(S72) spect.		Natural source, ThB^{212} β^- decay, At^{216} α decay, parent of ThC'^{212} and ThC''^{208} At^{216} α decay(G66)
Bi^{213}	A		β^-; α(2%) (E38), (4%) (H69)	47 min(H69); 46 min(E38)	~1.3(β^-)(E38) abs.Al; ~1.2(β^-)(H69); 5.86(α)(E38) ion.ch.; 6.0(α)(H69) ion.ch.		At^{217} α decay, parent of Po^{213}(H69,E38)
RaC^{214}	A		α(0.04%)(C60) β^-(99.96%) (C60), γ (R40)	19.7 min(C60)	5.505(α,45%), 5.444 (α,55%)(L73) spect.; 3.15(β^-)(S72) abs.Al, spect.	1.8(R40)	Natural source, RaB^{214} β^- decay, At^{218} α decay, parent of RaC'^{214} and RaC''^{210}
84 Po^{206}	A		K(~90%), α (~10%), γ (T36)	9 days(T36)	5.2(α)(T36) ion.ch.		Pb^{204}-α-2n, parent of Bi^{206}(T36)
Po^{207}	A		K(~100%), α (0.01%) (T36)	5.7 hr(T36)	5.1(T36) ion.ch.		Pb^{206}-α-3n(T36)
Po^{208}	B		α(T36)	3 yr(T36)	5.14(T36) ion.ch.	No γ(T36)	Pb^{206}-α-2n(T36) Pb^{207}-α-3n(T36) Bi-d-3n(T36) Bi-p-2n(L111)
Po^{210}	A		α,γ(R40)	140 days(C60)	5.298(H81) spect.; 5.303(C66) spect.	0.8(weak)(D53) abs.Pb; 0.773(S54) spect. conv.	Natural source, RaE^{210} β^- decay(L13,C26, H27) Pb-α-2n(T36) Bi-d-n(V4,C26,H27) At^{210} K decay(K18)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
84	AcC'^{211}	A		α	5×10^{-3} sec(C60)	7.434(L73) spect.		Natural source, AcC^{211} β^- decay At^{211} K decay(C46,C23)
	ThC'^{212}	A		α	3.0×10^{-7} sec(H205); 2.6×10^{-7} sec(B51); 3×10^{-7} sec(D50)	8.776(B70,H81) spect.		Natural source, ThC^{212} β^- decay Em^{216} α decay(M145)
	Po^{213}	A		α(H69,E38)	3.2×10^{-6} sec(E38)	8.336(E38) ion.ch.; 8.30(H69) ion.ch.		Bi^{213} β^- decay, parent of Pb^{209}(H69,E38) Em^{217} α decay(M145)
	RaC'^{214}	A		α	1.5×10^{-4} sec (D50,R41,W50); 1.55×10^{-4} sec(J7)	7.680(B70,H81) spect.		Natural source, RaC^{214} β^- decay, parent of RaD^{210} Em^{218} α decay(S146)
	AcA^{215}	A		α(~100%), β^- (5×10^{-4}%) (K55)	1.83×10^{-3} sec(W50)	7.365(L73) spect.		Natural source, An^{219} α decay, parent of AcB^{211} and At^{215}
	ThA^{216}	A		α(~100%); β^-(0.014%) (K33)	0.158 sec(W50)	6.774(B70,H81)(α) spect.		Natural source, Th^{220} α decay, parent of ThB^{212} and At^{216}
	RaA^{218}	A		α(99.96%); β^-(0.04%) (K51)	3.05 min(C60)	5.998(α)(B70,H81) spect.		Natural source, Rn^{222} α decay, parent of RaB^{214} and At^{218}
85	At^{207}	D		α, K(?)(T115)	1.7 hr(T115)	5.76(α)(T115) ion.ch.		Bi-α-6n(T115)
	At^{209}	D		α, K(?)(T115)	4.5 hr(T115)	5.66(α)(T115) ion.ch.		Bi-α-4n(T115)
	At^{210}	A		K, γ(K132)	8.3 hr(K132)		1.0(K132)	Bi-α-3n, parent of Po^{210}(K132)
	At^{211}	A		α(40%)(C46); K(60%)(C46)	7.5 hr(C46,C23)	5.89(α)(T115) ion.ch.; 5.94(α)(C46) abs.		Bi-α-2n(C46,C23) Th-α-25a7z(O115) U-α-31a9z(O115)
	At^{212}	A		α(W74)	0.25 sec(W74)			Bi-α-n(W74)
	At^{214}	B		α(M145)	Very short(M145)	8.7(M145) ion.ch.		Fr^{218} α decay(M145)
	At^{215}	A (G66)		α(K55,G66)	~10^{-4} sec(G66); short(K55)	8.00(G66) ion.ch.; 8.4(K55) ion.ch.		Natural source, AcA^{215} β^- decay, parent of AcC^{211}(K55) Fr^{219} α decay, parent of AcC^{211}(G66)
	At^{216}	A (G66)		α(K33,G66)	~10^{-3} sec(G66); short(<54 sec)(K33)	7.79(G66) ion.ch.; 7.64(K33) ion.ch.		Natural source, ThA^{216} β^- decay, parent of ThC^{212}(K33) Fr^{220} α decay, parent of ThC^{212}(G66)
	At^{217}	A		α(E38,H69)	0.018 sec(H69); 0.021 sec(E38)	7.02(E38) ion.ch.; 7.00(H69) ion.ch.		Fr^{221} α decay, parent of Bi^{213}(E38,H69)
	At^{218}	F		α(K51)	Several sec(?)(K51)	6.63(K51) ion.ch.		Natural source, RaA^{218} β^- decay, parent of RaC^{214}(K51)
86	Em^{216}	B		α(M145)	Very short(M145)	8.0(M145) ion.ch.		Ra^{220} α decay, parent of ThC'^{212}(M145)
	Em^{217}	B		α(M145)	Very short(M145)	7.8(M145) ion.ch.		Ra^{221} α decay, parent of Po^{213}(M145)
	Em^{218}	A		α(S146)	0.019 sec(S169)	7.1(S146) ion.ch.		Ra^{222} α decay, parent of RaC'^{214}(S146)
	An^{219}	A		α	3.92 sec(C60)	6.824(82%)(H81,L73) spect.		Natural source, AcX^{223} α decay, parent of AcA^{215}
	Tn^{220}	A		α	54.5 sec(C60)	6.282(B70,H81) spect.		Natural source, ThX^{224} α decay, parent of ThA^{216}
	Rn^{222}	A		α	3.825 days(C60)	5.486(B70,H81) spect.		Natural source, Ra^{226} α decay, parent of RaA^{218}
87	Fr^{218}	B		α(M145)	Very short(M145)	7.8(M145)		Ac^{222} α decay, parent of At^{214}(M145)
	Fr^{219}	A		α(G66)	~10^{-4} sec(G66)	7.30(G66) ion.ch.		Ac^{223} α decay, parent of At^{215}(G66)
	Fr^{220}	A		α(G66)	~30 sec(G66)	6.69(G66) ion.ch.		Ac^{224} α decay, parent of At^{216}(G66)
	Fr^{221}	A		α(E38,H69)	4.8 min(H69); 5 min(E38)	6.30(H69) ion.ch.; 6.31(E38) ion.ch.		Ac^{225} α decay, parent of At^{217}(E38,H69)

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
87 Fr^{223} (AcK)	A		β^-, γ(P41,P43)	21 min(P40,P43)	1.20(P42,P41) cl.ch.	0.090(L82) abs.Al	Natural source, Ac^{227} α decay(P40), parent of AcX^{223}
88 Ra^{220}	A		α(M145)	Short(M145)	7.5(M145) ion.ch.		Th^{224} α decay, parent of Em^{216}(M145)
Ra^{221}	A		α(M145)	Short(M145)	6.7 (M145) ion.ch.		Th^{225} α decay, parent of Em^{217}(M145)
Ra^{222}	A		α(S146)	38 sec(S146)	6.5(S146) ion.ch.		Th^{226} α decay, parent of Em^{218}(S146)
AcX^{223}	A		α, γ(R40)	11.2 days(C60)	5.717(55%), 5.606(36%) (L73) spect.		Natural source, $RdAc^{227}$ α decay, AcK^{223} β^- decay, parent of An^{219} U-α-19a6s(O115) U-d-17a5s(O115)
ThX^{224}	A		α	3.64 days(L71)	5.681(B70) spect.; 5.66(C120) ion.ch.		Natural source, $RdTh^{228}$ α decay, parent of Th^{220} U-α-18a6s(O115) U-d-16a5s(O115) Ac^{224} K decay(G147)
Ra^{225}	A		β^-(E38,H69)	14.8 days(H69); 14 days(E38)	~0.2(H69) abs.Al; <0.05(E38) abs.		Th^{229} α decay, parent of Ac^{225}(E38,H69)
Ra^{226}	A		α, γ(C60)	1622 yr(A106,K125); 1631 yr(C128); 1590 yr(C60)	4.791(L73) spect.	0.19(R40)	Natural source, Io^{230} α decay, parent of Rn^{222}
Ra^{227}	A		β^-				Ra-n-γ, parent of Ac^{227}(P105)
$MsTh_1^{228}$	A		β^-	6.7 yr(C60)	0.053(L72) spect., abs.Al		Natural source, Th^{232} α decay, parent of $MsTh_2^{228}$
89 Ac^{222}	B		α(M145)	Short(M145)	6.9(M145) ion.ch.		Pa^{226} α decay, parent of Fr^{218}(M145)
Ac^{223}	A		α(G66)	~2 min(G66)	6.64(G66) ion.ch.		Pa^{227} α decay, parent of Fr^{219}(G66)
Ac^{224}	A		α(~10%), K (~90%)(G66)	2.5 hr(G66)	6.17(G66) ion.ch.		Pa^{228} α decay, parent of Fr^{220} and ThX^{224} (G66)
Ac^{225}	A		α(E38,H69)	10.0 days(H39,E38)	5.80(H69,E38) ion.ch.		Ra^{225} β^- decay(E38,H69) Pa^{229} α decay(H106) Parent of Fr^{221} (E38,H69) U-d-15a4s(O115)
Ac^{227}	A		α(1.2%)(P40, P54),(1.25%) (P112); β^- (99%)(P40, P112); γ,e^- (L82)	21.7 yr(C69); 13.5 yr(C60)	4.94(α)(100%)(H148) ion.ch.; 4.95(α)(85%), 4.6(α)(15%)(G61) ion ch.; 4.95(α)(P112) ion.ch.; very soft (β^-)(L82)	0.037(weak)(L82,P54) abs.Al	Natural source, Pa^{231} α decay, parent of $RdAc^{227}$ and AcK^{223} Ra^{227} β^- decay(P105)
$MsTh_2^{228}$	A		β^-, γ(C60); α(G40)	6.13 hr(C60)	1.55(β^-)(L6) spect.; 4.5(α)(G40) abs.air		Natural source, $MsTh_1^{228}$ β^- decay, parent of $RdTh^{228}$
90 Th^{224}	A		α(M145)	Short(M145)	7.2(M145) ion.ch.		U^{228} α decay, parent of Ra^{220}(M145)
Th^{225}	A		α(M145)	7.5 min(M145)	6.6(M145) ion.ch.		U^{229} α decay, parent of Ra^{221}(M145)
Th^{226}	A		α(S146)	30.9 min(S146)	6.3(S146) ion.ch.		U^{230} α decay, parent of Ra^{222}(S146)
$RdAc^{227}$	A		α, γ(C60)	18.6 days(P110); 18.9 days(C60)	6.049(20%), 5.988(25%), 5.764(20%), 5.717 (15%)(L73) spect.		Natural source, Ac^{227} β^- decay, parent of AcX^{223} U-d-13a3s(O115)
$RdTh^{228}$	A		α, γ(C60)	1.90 yr(C60)	5.418(83%), 5.333(17%) (L73) spect.; 5.38(C120) ion.ch.		Natural source, $MsTh_2^{228}$ β^- decay, parent of ThX^{224} U^{232} α decay(G112) Pa^{228} K decay(G147)
Th^{229}	A		α(H69,E38)	7000 yr(H69); ~10^4 yr(E38)	4.85(H69) ion.ch.; ~5(E38) ion.ch.		U^{233} α decay, parent of Ra^{225}(H69,E38)
Io^{230}	A		α, γ(W53)	8.0×10^4 yr(H124); 8.3×10^4 yr(C60)	4.66(G41) abs.air; 4.81(W51) calor.; 4.66(C119,C120) ion. ch.		Natural source, U_{II}^{234} α decay, parent of Ra^{226}

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
90	UY^{231}	A		β^-, γ	25.5 hr(K130); 24.0 hr(G43); 24.6 hr(C60)	0.055, 0.2(J108) abs.Al; ~0.2(E30) abs.; 0.21(K130)	0.036(K130)	Natural source, AcU^{235} α decay, parent of Pa^{231} Th-n-2n(N5,S128)
	Th^{232}	A	100(D45)	α	1.39×10^{10} yr(K50)	3.98(C120) ion.ch.; 4.20(S73) ion.ch.		Natural source(C62,S76), parent of $MsTh_1^{228}$
	Th^{233}	A		β^-	23.5 min(S128); 23 min(C12)	1.6(S128) abs.Al	No γ(S128)	Th-n-γ(M17,S128) Th-d-p(G112)
	UX_1^{234}	A		β^-, γ (M60,F40)	24.10 days(K131); 24.1 days(S70); 24.5 days(C60)	0.11, 0.20(F40) abs.Al; 0.13(S72) abs.Al, spect.; C.190(J6) spect.; 0.205(B79) spect.	0.092(M60)(1%)(F40); 0.092(J6) spect. conv.; 0.093(20%) (B52,B79) spect.conv.	Natural source, U_I^{238} α decay, parent of UX_2^{234m}
91	Pa^{226}	B		α(M145)	1.5 min(M145)	6.5(M145) ion.ch.		Th-d-8n, parent of Ac^{222}(M145)
	Pa^{227}	A		α(~80%), K (~20%)(G66)	38 min(G66)	6.46(G66) ion.ch.		Th-d-7n, parent of Ac^{223} and $RdAc^{227}$ (G66) Np^{231} α decay(G147)
	Pa^{228}	A		α(~2%), K (~98%)(G66)	22 hr(G66)	6.09(G66) ion.ch.		Th-d-6n, parent of Ac^{224} and $RdTh^{228}$ (G66)
	Pa^{229}	B		α(~0.1%), K(~100%) (H145)	1.5 days(H145); 1.4 days(H106)	5.66(H145) ion.ch.; 5.4(H106) ion.ch.		Th^{230}-d-3n(H106) Parent of Ac^{225}(H106)
	Pa^{230}	A		β^-(S146), γ (0108)	17.7 days(0108); 17 days(S146)	~1.1(0108) abs.Al	0.94(0108) abs.Pb	Parent of U^{230}(S146) Th-α-p5n(S146) Th^{230}-d-2n(H106) Th-d-4n(S146) Pa-d-p2n(0108) Pa-α-αn(0108) U^{233}-d-αn(H104)
	Pa^{231}	A		α(C60), γ(S152)	3.43×10^4 yr(V101); 3.2×10^4 yr(G42)	5.00(~85%), 4.69-4.72 (~15%)(T34) ion.ch.; 5.049(R42) spect.; 5.012(87%), 4.736 (13%)(C119) ion.ch.	0.095, 0.294, 0.323(M70) spect. conv.; 0.308(S179) abs.Pb	UY^{231} β^- decay(S128), parent of Ac^{227} Th-d-3n(S146)
	Pa^{232}	A		β^-, γ(G112)	1.32 days(J128); 1.4 days(0108,S146); 1.6 days(G112)	0.14, 0.4, 1.0(J106) abs. Al; 1.1(0108) abs.Al	1.2(J106) abs.Pb; 1.0(0108) abs.Pb	Th-d-2n(G112,S146) Th-α-p3n(S146) Pa-d-p(0108)
	Pa^{233}	A		β^-, γ, e^- (H40,S128, M108,F106)	27.4 days(G12)	0.4(S38) abs.Al; 0.23(H40) spect.; 0.5(S128) abs.Al; ~0.7(F106) spect.	0.084, 0.298, 0.309, 0.337(L81) spect. conv.; e^- lines at 0.063, 0.077, 0.192, 0.293(H40) spect.; 0.33(S147) abs.Pb	Th^{233} β^- decay(S38, G12,H39,S128) Np^{237} α decay(L106), parent of U^{233} (S128,S55) Th-d-n(G112,S146) Th-α-p2n(S146)
	UZ^{234}	A		β^-, γ(F40)	6.7 hr(C60)	0.56, 1.55(F40) abs.Al; 0.45(B39) spect.	0.70(F40) abs.Pb, W	Natural source, UX_2^{234m} I.T.(F40), parent of U_{II}^{234}
	UX_2^{234m}	A		β^-, γ(M61); I.T.(0.15%) (F40,B39)	1.14 min(C60); 1.22 min(H142)	1.52(5%), 2.32(95%)(M61) spect.; 2.32(S72) abs.Al	0.802(5%)(M61) spect. conv.; 0.782, 0.822 (B52) spect. conv.; 0.396(I.T.)(B39) spect. conv.	Natural source, UX_1^{234} β^- decay, parent of UZ^{234} and U_{II}^{234}
92	U^{228}	A		α(80%), K (20%)(M145)	7 min(M145)	6.7(M145) ion.ch.		Th-α-8n, parent of Th^{224}(M145) Pu^{232} α decay(J132)
	U^{229}	A		α(2%), K (98%)(M145)	1 hr(M145)	6.4(M145) ion.ch.		Th-α-7n, parent of Th^{225}(M145)
	U^{230}	A		α(S146)	20.8 days(S146)	5.86(S146) ion.ch.		Pa^{230} β^- decay(S146, 0108), parent of Th^{226}(S146) Th-α-6n(S146) Pa-d-3n(0108) Pa-α-p4n(0108) U-d-10az(0115)
	U^{231}	B		K(0108)	4.2 days(0108)			Pa-d-2n(0108) Pa-α-p3n(0108)
	U^{232}	A		α(G112)	70 yr(J109); 30 yr(G112)	5.31(J125) abs.Al; 5.27(K122)		Th-α-4n(N115) Pa^{232} β^- decay (G112,0108) Pu^{236} α decay(J109), parent of $RdTh^{228}$ (G112) Pa-d-n(0108) Pa-α-p2n(0108)

Isotope Z A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
92 U^{233}	A		α(S128,S55); γ, e^-(S168)	1.62×10^5 yr(H105); 1.63×10^5 yr(L121); 1.2×10^5 yr(S128)	4.825(E38) ion.ch.; 4.80(C110) abs.air	0.31, 0.080, 0.040 (weak)(S168) abs.Pb, Cu,Al	Pa^{233} β^- decay(S128, S55), parent of Th^{229}(H69, E38)
U_{II}^{234}	A	0.0051 (W118)	α	2.35×10^5 yr(C126,C54); 2.69×10^5 yr(N41)	4.763(C119) ion.ch.; 4.78(S75) abs.air; 4.76(S77) ion.ch.		Natural source, UX_2^{234m} and UZ^{234} β^- decay, parent of Io^{230}
AcU^{235}	A	0.71(N39)	α,γ(S178,M144)	8.91×10^8 yr(C119); 7.07×10^8 yr(N41); 8.52×10^8 yr(B113)	4.396(C119) ion.ch.; 4.35(B113); 4.34(B114) ion.ch.	0.187(S178) abs.Pb; 0.162(M144) abs.Pb	Natural source(D51), parent of UY^{231}
U^{237}	A		β^-, γ(M37); e^-(B115)	6.8 days(W107)	0.135, 0.35, (1.6?) (B115) abs.Al; 0.26(M37) abs.; 0.17, 0.22(A101) abs.Al, cellophane	0.14, 0.23, 0.53(B115) abs.Pb	U-n-2n(M37,N8,W107, A101), parent of Np^{237}(W72) U-d-t(B115,A101,J109) U-α-αn(J109) Pu^{241} α decay(K109, S144)
U_I^{238}	A	99.28(N39)	α	4.51×10^9 yr(N41); 4.498×10^9 yr(C119)	4.180(C119) ion.ch.; 4.23(S75) abs.air; 4.21(S77) ion.ch.		Natural source(B72), parent of UX_1^{234}
U^{239}	A		β^-, γ, e^- (F39)	23.5 min(F107,F39); 23 min(I1,S4); 23.2 min(W108); 23.54 min(M109)	1.20(F39,F44) abs.Al; 1.2(W108,M108) abs.Al; 1.12, 2.06(weak) (S203) spect.	0.076, >0.3(weak) (F107,F39,F44) abs.Pb; 0.073, 0.92(S203) spect. conv., abs.Pb	U-n-γ(H18,H14,I1,M19, S44), parent of Np^{239}(M28,S39,S44, S132) U-d-p(S131)
93 Np^{231}	A		α(~1%), K (~99%) (G147)	53 min(G147)	6.2(α)(G147) ion.ch.		U-d-9n, parent of Pa^{227}(G147)
Np^{234}	B		K, γ(J109)	4.40 days(H104); 4.4 days(O108)		1.9(H104) abs.Pb	Pu^{234} K decay(P102) U^{233}-d-n(H104) U^{235}-d-3n(J109) Pa-α-n(O108) U^{233}-α-p2n(H104,P102) U^{235}-α-p4n(J109) U^{235}-p-2n(G131)
Np^{235}	B		K(J109), α (~0.1%) (J130)	435 days(J130); 400 days(J109)	5.06(α)(J130) ion.ch.	No γ(?)(J109)	U^{235}-d-2n(J109) U^{233}-α-pn(H104) U^{235}-α-p3n(J109)
Np^{236}	A		β^-, γ(J109)	22 hr(J109)			Parent of Pu^{236}(J109) U^{235}-d-n(J109) U-d-4n(J109) U^{233}-α-p(H104) U^{235}-α-p2n(J109) Np-d-t(J110) Np-n-2n(G132) Np-α-αn(J110)
Np^{237}	A		α(W107,W72)	2.20×10^6 yr(M129,M92); 3×10^6 yr(W107,W72)	4.72(L122) abs. mica; 4.75(G113) abs.air; 4.73(J102) abs.Al		U^{237} β^- decay(W107,W72) parent of Pa^{233}(L106)
Np^{238}	A		β^-, γ(S79); β^-, γ, e^- (J107)	2.10(J126); 2.0 days(S131)	0.22, 1.39(J126) abs.Al; 1.0(S131) abs.Al	1.2, 0.075(J126) abs. Pb, abs. of e^-; 1.1(S131) abs.Pb	Parent of Pu^{238}(S80) U^{238}-d-2n(K108) U-d-2n(S79,S131,K108) Am^{242} α decay(S144) U-α-p3n(J109) U-α-p(J109) Np-n-γ(J107) Np-d-p(J110)
Np^{239}	A		β^-, γ, e^- (F107, W108, M108)	2.33 days(W108); 2.3 days(M28,M19); 2.35 days(F107)	0.68, 0.33, 0.090(H125) abs.; 0.47(M28) abs.; 0.14, 0.40, 0.63 (F107) abs.Al; 0.78(S131,W108) abs. Al; 0.288, 0.403, 0.673, 1.179(S203) spect.	0.057, 0.061, 0.067, 0.206, 0.227, 0.275 (S203) spect. conv.; 0.2094, 0.2280, 0.2774, numerous softer γ's(F108) spect. conv.; 0.22, 0.27(H25) spect. conv., spect.	U^{239} β^- decay(M28,S39, S44,S132), parent of Pu^{239}(S132) U-d-n(S79,S131,J109) U-α-p2n(J109)
94 Pu^{232}	B		α(J132)	22 min(J132)	6.6(J132) ion.ch.		U^{235}-α-7n, parent of U^{228}(J132)
Pu^{234}	A		K(H104)(~99%) (P102); α (H104)(~1%) (P102)	8 hr(H104); 8.5 hr(P102)	6.2(P102) ion.ch.; 6.0(H104) ion.ch.		U^{233}-α-3n(H104,P102) Parent of U^{230} and Np^{234}(P102)
Pu^{236}	A		α(J109)	2.7 yr(J109)	5.7(J109) ion.ch.		Np^{236} β^- decay(J109) Cm^{240} α decay(S142) Parent of U^{232}(J109) U^{235}-α-3n(J109) U^{233}-α-n(H104,P102) U-α-6n(J109) Np-α-p4n(J110) Np-d-3n(J110)

Isotope Z	A	Class	Percent Abundance	Type of Radiation	Half life	Energy of Radiation in Mev Particles	Energy of Radiation in Mev γ rays	Produced by
94	Pu^{237}	B		K(J109)	40 days(J109)		No γ(J109)	U^{235}-α-2n(J109) U-α-5n(J109) Np-d-2n(J110)
	Pu^{238}	A		α(S80)	92 yr(S142); 89 yr(J127); 40 yr(S131)	5.51(C110,C70) abs.air; 5.5(S131) abs.air,Al; 5.4(F109) abs.Al; 5.493(J10) ion.ch.		Np^{238} β⁻ decay(S80, S131,K108) Cm^{242} α decay(S142) Np-d-n(J110) U-α-4n(J109) U^{235}-α-n(J109)
	Pu^{239}	A		α(K69), γ, e⁻ (G114)	2.411×10^4 yr(S56) calor.; 2.44×10^4 yr(W110)	5.15(C110,C70) abs.air; 5.1(S132)abs.air; 5.16(P101) cl.ch.; 5.140(J10) ion.ch.	0.42, 0.2(weak)(S170) abs.Pb; 0.05, 0.3 (weak)(G114) abs. Pb,Al	Np^{239} β⁻ decay(K69) Natural source(S134) U-α-3n(J109)
	Pu^{240}	A		α(J109)	~6000 yr(J109) yield	5.1(J109) ion.ch.		U-α-2n(J109)
	Pu^{241}	A (B126) m.s.		β⁻(S144), α (K109,S144) (~.002%) (S145)	~10 yr(S144)	0.01-0.02(β⁻)(S144) abs. hydrocarbon		U-α-n(S144,J109) Parent of Am^{241}(S144) and U^{237}(K109,S144)
95	Am^{238}	D		K(?)(J129)	1.5 hr(J129)			Pu-d-3n(J129)
	Am^{239}	B		K(~100%), α (~0.1%), e⁻, γ(S144)	12 hr(S144)	5.77(α)(J129) ion.ch.	0.285(S144) abs.Pb, abs. of e⁻	Pu-d-2n(S144) Pu-p-n(J129) Np-α-2n(S144)
	Am^{240}	B		K, γ, e⁻ (S144)	50 hr(S144); 53 hr(J129)		1.3(S144) abs.Pb, abs. of e⁻	Pu-d-n(J129,S144) Np-α-n(S144)
	Am^{241}	A		α(S144)	510 yr(C129)	5.45(S144) ion.ch.		Pu^{241} β⁻ decay(S144)
	Am^{242m}	A		β⁻(A107)	16 hr(A107); 17 hr (S144)	1.0(A107) abs.Al		Am-n-γ(A107,S144) Parent of Cm^{242}(S142, A107)
	Am^{242}	A		α(~0.2%), β⁻ (S144)	~400 yr(T114,S144)	~0.5(β⁻)(S144) abs.Al		Am-n-γ, parent of Cm^{242} and Np^{238}(S144)
96	Cm^{240}	A		α(S142)	26.8 days(S142)	6.3(S142) ion.ch.		Pu-α-3n(S142) Parent of Pu^{236}(S142)
	Cm^{241}	E		K(S142)	55 days(S142)			Pu-α-2n(S142)
	Cm^{242}	A		α(S142)	150 days(S142)	6.1(S142) ion.ch.		Pu-α-n(S142) Am^{242} and Am^{242m} β⁻ decay(S142,A107) Parent of Pu^{238}(S142)

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