Table of Isotopes

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THE table on pages 476–612 represents a complete list of all the radioactive and stable isotopes of the elements, together with a number of their salient features, as recorded in the literature or by private communication by approximately December, 1952.

A primary objective has been to retain as much of the compactness of the previous editions as is consistent with an adequate coverage of the multitudes of nuclear data presently available.

A new system of references has been employed. Each paper is represented by the code symbol of the first author, followed by the year in which the paper was published. If two or more papers by one author have appeared during a single year, these are distinguished by the small letters *a*, *b*, *c*, etc., following the main reference. For example, 16H is the code symbol given to O. Hahn; thus, the references 16H41, 16H41a, and 16H41b represent three papers published in 1941 of which O. Hahn is the first author. The code symbols given to the authors are arranged alphabetically only with respect to the first letter of their names.

A description of the entries in the various columns is given below, followed by a table listing some frequently used abbreviations.

ISOTOPE

The first column lists the atomic numbers, chemical symbols, and mass numbers of the nuclear species. Separate entries have been made for each nuclear state whose half-life has been experimentally determined. Metastable excited states are denoted by the superscript "m" following the mass number, and for those cases in which two or more isomeric states are known, they are distinguished by the use of the superscripts "m_1," "m_2," etc.

CLASS AND IDENTIFICATION

The degree of certainty of each isotopic assignment is indicated by a letter, according to the following code:

A Element and mass number certain
B Element certain and mass number probable
C Element probable and mass number certain or probable
D Element certain and mass number not well established
E Element probable and mass number not well established or unknown (mass number not listed means that it is unknown)
F Insufficient evidence
G Assignment probably in error

Data which have been shown to be in error have in general been eliminated from the table. A few isotopes have been quoted so widely in the literature, however, that it was felt some reference should be made to them. For these cases the G rating has been adopted, and reference made both to the original work and to that which has supplanted it.

The means by which the mass assignments were made are next tabulated. In general, several references are given here, the first of which denotes the probable discoverer of the isotope (except in the cases of the old natural radioactivities). Following this, references are given to the paper or papers which contributed most significantly toward giving the isotope its best or present rating. Some indication of the experimental methods used in making the various assignments may be had from the following symbolism:

chem	Chemical separations, establishing uniquely the chemical identity (atomic number) of the isotope
genet	Proven genetic relationships (by chemical or other means) with other isotopes whose mass assignments are presumably known
genet energy levels	Proof of isobaric relationship with an identified nuclide by observation of identical energy levels following decay of both, implying decay to the same product
excit	Loosely refers to energetic considerations which have aided in making the mass assignment. Some of these might be (1) excitation or yield experiments to establish the nuclear reaction which produces the isotope (2) bombardments with low energy particles, in which possible products are few (3) mass calculations, or other estimates or measurements of Q values (4) in a few cases, use of fission yield data in making assignments
cross bomb	Studies of yields of the isotope in several different types of bombardments, in which the target elements as well as the projectiles have been varied
n-capt	Cases where bombardments with slow neutrons ($n-\gamma$ reactions) have provided key evidence in the mass assignments

sep isotopes — The use of target elements enriched or depleted in a certain isotope

mass spect — Identification of the mass number by means of a mass spectrograph

resonance neutron activation — Identification of a nuclear isomer by observing both isomers upon irradiation with filtered neutrons

decay charac — Identification of expected or predicted decay characteristics

sp act — Determination by weighing a long-lived isotope of known purity

delay coinc — Measurement of the time interval between two successive nuclear events (such as β^- and γ-emission) thus establishing the lifetime of the state responsible for the second event. By this method, half-lives between 10^{-3} sec and 10^{-10} sec have been determined.

yield — Estimation of half-life from the amount of activity resulting from a nuclear reaction whose cross section (or yield) is known or estimated

genet — Measurement of the half-life of a parent activity by determining the yield of a daughter activity as a function of time, where periodic chemical separations of daughter from parent have been performed

PERCENT ABUNDANCE

The relative isotopic abundances for the elements are given in accordance with the "best values" listed in the report (1B50) by K. T. Bainbridge and A. O. Nier. In some of the light elements, reference is made also to papers which discuss source variations in isotope abundances.

TYPE OF DECAY

The observed modes of decay have been listed for all radioactive nuclei. In cases of branched decay between two or more modes, the branching ratios are listed wherever they are known. Symbols used are

β^- Negative beta-particle (negatron) emission

β^+ Positive beta-particle (positron) emission

α Alpha-particle emission

EC Orbital electron capture. It may be assumed that x-rays have been observed or actually identified in virtually all cases of orbital electron capture listed. If the ratio of L electron capture to K electron capture has been determined, it is given here as L/K

IT Isomeric transition (transition from upper to lower isomeric state of same nucleus)

n Neutron emission

When experimenters have searched for and failed to find a particular mode of decay, this is indicated, for example, as "no β^+." Experimental upper limits are frequently given, but no theoretically predicted limits have been quoted.

Among the heavy alpha-emitting isotopes, calculations by means of closed radioactive decay cycles have shown that many of these isotopes are thermodynamically stable against β^-, β^+, or EC decay. This has been indicated by the term "β-stable," followed by an abbreviation for the principle of conservation of energy, which is used in the calculations.

HALF-LIFE

Half-life values are listed without qualification where the determination has been a direct measurement of decay rate. In other cases, the experimental methods have been described with the aid of the following symbols:

An attempt has been made to list the best value or values first. However, in a few cases where many values of comparable precision have been reported, and no choice seemed obvious, an average value for the half-life has been listed; this is explicitly stated, and references are given to all the papers whose values contributed to that average. Also, among the natural radioactivities an average value is often used which was taken from an international committee summary report (1C31).

PARTICLE ENERGIES

The particle energies are followed by other relevant information pertaining to the decay scheme, and by a description of the experimental methods used in obtaining the data. In cases of complex alpha-structure or several partial beta-spectra, the relative abundances of the various groups within that mode of decay are given in parentheses.

Beta-particle energies correspond to the upper limits of the spectra.

Alpha-particle energies have been quoted only where the investigator has actually measured them. Where he has determined only the relative abundances of alpha-groups or the energy differences between groups, this has been indicated as in the following example:

$$\alpha_0(10 \text{ percent}),\ \alpha_{50}(75 \text{ percent}),\ \alpha_{80}(15 \text{ percent}),$$

meaning that 75 percent of the alpha-particles lead to a state 50 kev above the ground state, and that 15 percent of the alpha-particles lead to a state 80 kev above the ground state.

The term "long-range α" is the classical designation for alpha-particle groups emitted from excited states of the listed nuclide, and the energies therefore are not included in the Q_α value, which applies to the ground state to ground-state transition. These alpha-groups

occur in competition with gamma-ray emission, following the beta-decay of the parent nuclide.

Conversion electron energies are listed only when it is not known in which shell internal conversion takes place or when no attempt was made by the experimenter to relate the electrons with observed or unobservable gamma-rays; in all other cases, entries are made in the column for gamma-transitions.

Experimental methods are described as follows:

abs	Absorption
spect	Magnetic deflection (magnetic spectrograph or spectrometer or counter with magnetic field)
scint spect	Measurement of pulses produced by a scintillating crystal or solution
ion ch	Measurement of pulse sizes in ionization chamber or proportional counter
cl ch	Cloud chamber (with magnetic field in case of beta-particles)
coinc abs	Beta- and gamma-coincidence counters with absorbers
coinc spect	Coincidence counters arranged with a spectrometer or spectrometers

GAMMA-TRANSITIONS

Gamma-transitions are described by the following information, in so far as reliable data permit:

Energy of the gamma-quantum. When internal conversion electrons form the basis for the energy determination, the energy listed in this column is always that of the corresponding gamma-ray transition.

Abundances of gamma-rays. This may be given as the number of unconverted gamma-rays emitted per 100 disintegrations. Where an absolute abundance has not been determined, often the relative unconverted gamma-ray abundances have been measured. These are tabulated as $\gamma_1/\gamma_2/\gamma_3 \approx 2/1/5$, for example.

Internal conversion coefficients. These are given for each gamma-transition as the ratio of the number of conversion electrons emitted to the number of unconverted gamma-quanta emitted, and are expressed as e/γ. Where conversion coefficients for individual electron shells have been determined, they are denoted as e_K/γ, e_L/γ, etc.

Conversion coefficient ratios. Where the ratios of internal conversion coefficients in several electron shells have been measured, they are listed as K/L, L/M, $K/L+M$, $K/L/M$, $L_{\mathrm{I}}/L_{\mathrm{II}}/L_{\mathrm{III}}$, etc.

Gamma-rays associated with short-lived isomers have been listed as entries both of the isomer and of its parent.

When an author states that gamma-radiation is present, but reports no energy determination, this is indicated by the symbol "γ." Conversely, when attempts to find gamma-radiation have failed, this has been indicated by "no γ."

X-rays have been mentioned only when they are the prominent radiation observed in measuring an activity, or when the observation and identification of x-rays has been crucial in the characterization of an isotope.

The symbols used to describe the methods employed for the determination of gamma-ray energies or for the elucidation of decay schemes are as follows:

spect	Secondary electrons observed with magnetic spectrograph or spectrometer
spect conv	Internal conversion electrons observed with magnetic spectrograph or spectrometer
scint spect	Measurement of pulses produced by a scintillating crystal or solution
cryst spect	Direct measurement by diffraction of gamma-rays with a bent crystal spectrometer
abs	Absorption of the gamma-rays
abs conv	Absorption of internal conversion electrons
abs sec	Absorption of secondary electrons
coinc	Studies of coincidences or lack of coincidences ($\gamma-\gamma$, γ-conv, conv-conv, $\beta-\gamma$, etc.) with coincidence counters, and, in some cases, spectrometers
coinc abs	Coincidence studies using absorber techniques
cl ch recoil	Secondary electrons observed in cloud chamber with magnetic field
pair spect	Magnetic analysis of positron-electron pairs produced by gamma-rays in a thin radiator
Be$-\gamma-n$, $D-\gamma-n$, or $D-\gamma-p$ reactions	Measurements of neutron or proton energies from these reactions

DISINTEGRATION ENERGY AND SCHEME

The disintegration energy, or Q value, of a nuclear transformation is defined as the mass difference (expressed in Mev) between the initial and final systems under consideration. For radioactive decay processes, Q is equal to the sum of the particle kinetic energy, nuclear recoil energy, and the energy of any gamma-rays necessary to de-excite the final nucleus to its ground state. For positron decay, the energy equivalent to $2m_0c^2$ has been included in the Q value. Where Q values have been estimated or calculated by the authors of this compilation, the special reference "HPS" is used; otherwise, reference is made to the paper from which the quoted value is taken. In most instances Q values have been obtained from decay data; where this is not the case, the method is indicated.

Energy level diagrams have been drawn in many cases; these are not necessarily complete representations of the data, but sometimes include only those features which are reasonably well established and unambiguous. Heights of the various energy levels above the ground state are indicated at the side of the drawing. Similarly,

the total angular momentum (spin) and parity of the states have been included in some cases, where these quantum numbers could be inferred with some confidence from determinations of conversion coefficients, K/L ratios, ft values, etc. We have relied heavily on the interpretation of decay data by Goldhaber and Hill (18G52).

For β^-, β^+, α or EC decay, the percentage figures given in the decay drawings total 100 percent for *each* mode of decay, thus expressing only the relative abundances of various groups within that mode of decay. (Branching ratios between the several modes of decay are found in the "Type of Decay" column.) In the case of gamma-radiation, however, the percentages given refer to the fraction of the total disintegrations of that isotope which give rise to the gamma-ray and its conversion electron. This has been done because of the difficulty of assigning a gamma-ray to a particular mode of decay.

Measured values for the mechanical or spin moment I of stable or long-lived isotopes have also been given in this column. Except as supplemented by more recent data, the values given here are taken from the compilation by Mack (87M50).

METHOD OF PRODUCTION AND GENETIC RELATIONSHIPS

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 (p-proton, n-neutron, α-alpha-particle, d-deuteron, t-triton, γ-gamma-ray or x-ray, e-electron, π-pi-meson, C-carbon ion). In cases in which the target material is not the naturally occurring element, but one enriched or depleted in a particular isotope, the isotope responsible for the reaction is indicated. No means for identifying the source or energy of the projectile is given.

In nuclear reactions with high energy projectiles, multiple particle ejection is common. Rather than attempt to state definitely the path by which the product nucleus was reached, these spallation reactions are briefly represented by the abbreviation "spall" followed by the symbol of the target element. High energy fission reactions are similarly represented by the words "spall-fission," and thermal or low energy neutron fission simply by "fission."

The criterion for listing genetic relationships has been with few exceptions that these relationships be demonstrated experimentally; for example, by chemical "milking" of daughter activities, analysis of growth-decay curves, or in the case of short-lived isomers, by delayed coincidence experiments. The listing of these parent-daughter relationships gives some warning to the reader as to what he may expect in the way of radiation from a given isotope, since a sufficiently short-lived daughter's radiation will usually be observed with that of the parent.

A few further abbreviations are listed below:

NNES–PPR	Volumes of the National Nuclear Energy Series, Plutonium Project Record, McGraw-Hill Book Company, Inc., New York
[ ]	Properties listed in brackets have not been observed directly, but have been inferred from other experimental data
est, calc	Estimated or calculated from theoretical or empirical considerations
HPS	Refers to the authors of this compilation
lim	Experimental upper limit
emuls	Photographic emulsion

A considerable fraction of the effort necessary to produce this table consisted of abstracting the literature and organizing the data over the past few years. We are greatly indebted to Marjorie Hollander for her efficacious handling of this work, and in addition for her preparation of the drawings.

It is a pleasure to acknowledge the generous help and constructive criticism which we have received from our friends and colleagues, and to thank many of the authors whose measurements are cited for their aid in evaluating data familiar to them. We are especially grateful to Dr. Gerhart Friedlander for his invaluable assistance in checking the entire draft.

We would also like to express our appreciation to Mildred Davis for the speed and accuracy with which she prepared the manuscript.

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Rapid Method for Calculating Log(ft) Values

[From S. A. Moszkowski, Phys. Rev. **82**, 35 (1951).]

Figures 1–5 permit the rapid calculation of log(ft) for a given type of decay, given energy, half-life, etc. The notation is: E_0 for $\beta^{\pm}$ emission is the maximum kinetic energy of the particles in Mev; E_0 for K-electron capture is the disintegration energy in Mev. When a β^+ emission and K-electron capture go from and to the same level, E_0 for K capture $=E_0$ for β^+ emission $+1.02$ Mev. Z is the atomic number of the initial nucleus, t is the total half-life, and p is the percentage of decay occurring in the mode under consideration. When no branching occurs, $p=100$.

PROCEDURE FOR OBTAINING LOG(FT)

(1) First obtain log(f_0t), using Fig. 1. E_0 is read off the left-hand side of the E_0 column for K-electron capture, and off the right-hand side for $\beta^{\pm}$ emission. Put a straight edge over the given values of E_0 and t and note where it crosses the column of log(f_0t) values.

(2) Then read off log(C) from Figs. 2, 3, and 4 for β^-, β^+, and K-electron capture, respectively.

(3) Get Δ log(ft) from Fig. 5 if $p<100$. When $p=100$, Δ log(ft) $=0$.

(4) Log(ft) $=$ log(f_0t) $+$ log(C) $+\Delta$ log(ft).

These graphs have been reproduced with the kind permission of Dr. Moszkowski. For details concerning their construction, significance, and range of usefulness, reference should be made to the original paper.

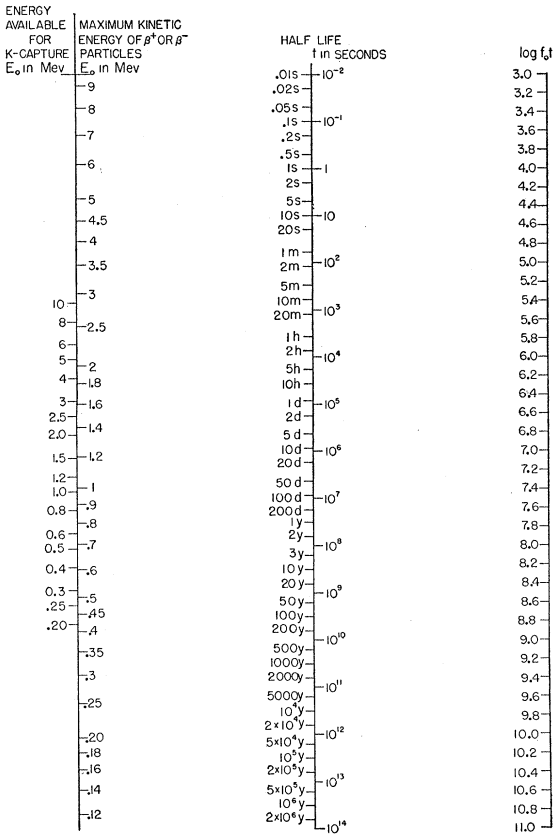


FIG. 1. Log(f_0t) as a function of E_0 and t.

(Figures 2–5 are on pages 474 and 475.)

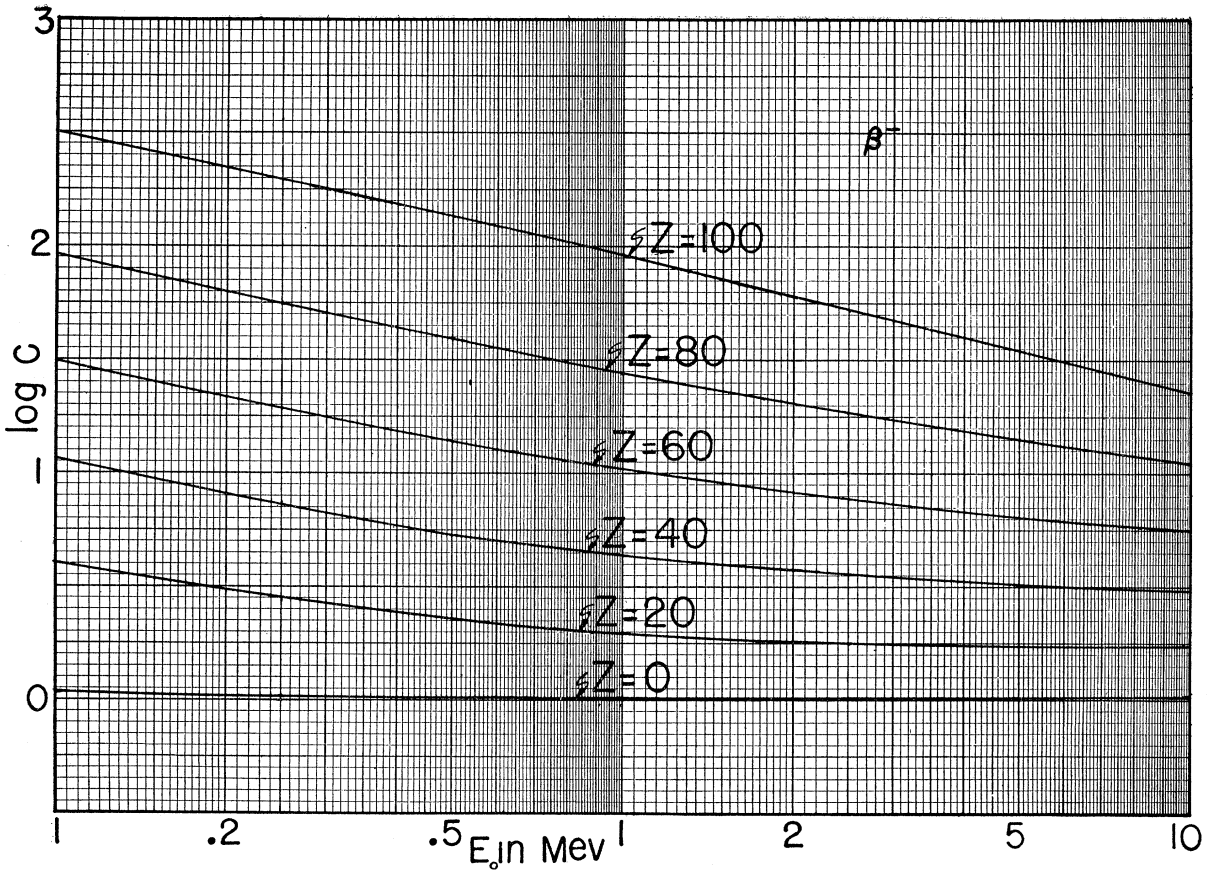


FIG. 2. Log(C) as a function of E_0 and Z for β^- emission.

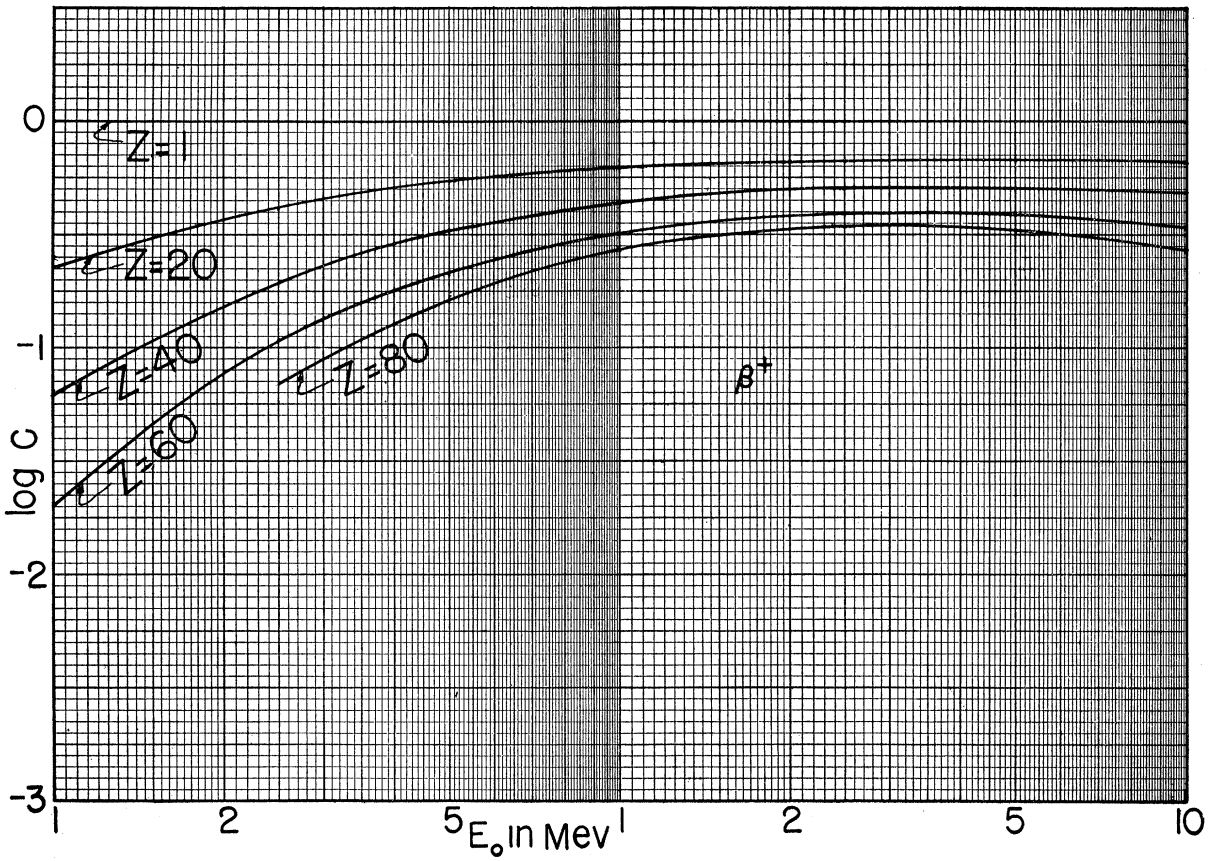


FIG. 3. Log(C) as a function of E_0 and Z for β^+ emission.

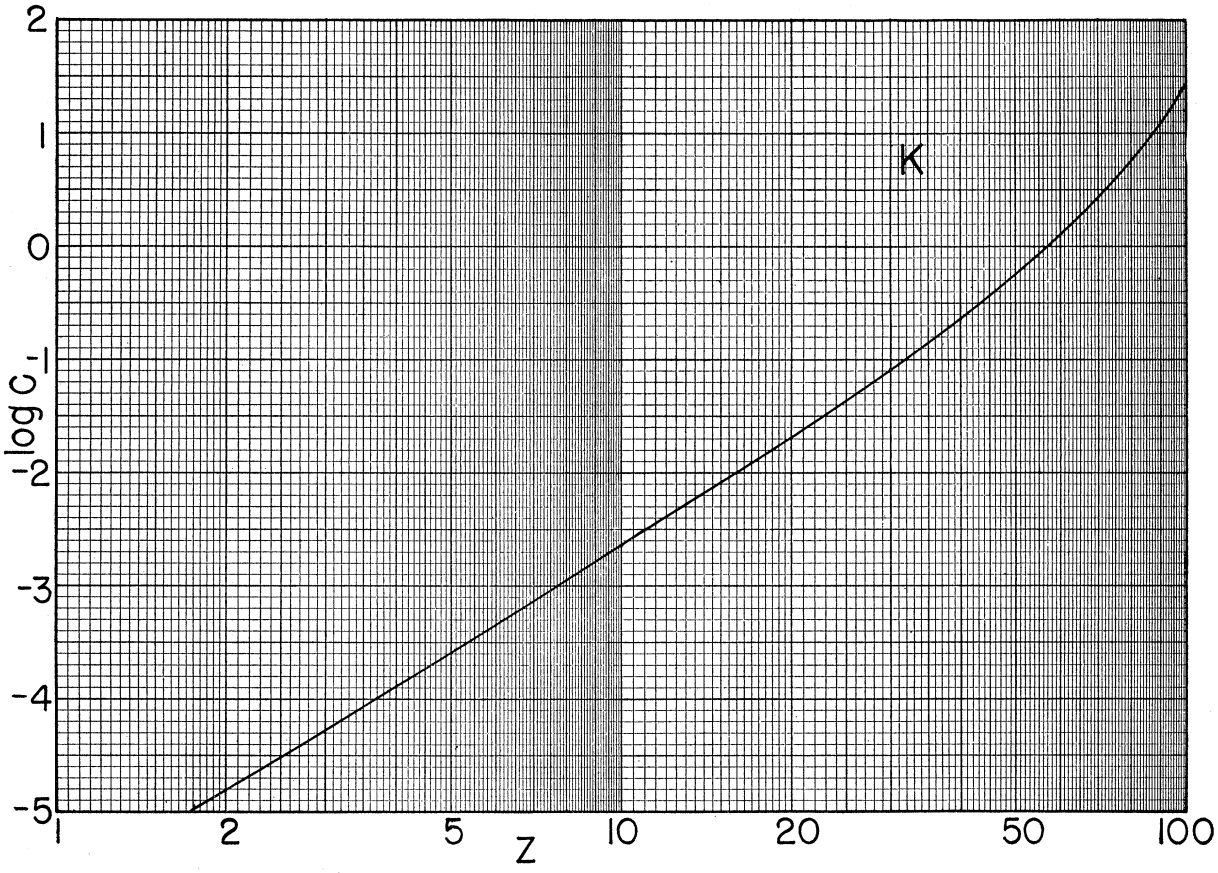


FIG. 4. Log(C) as a function of Z for K-electron capture.

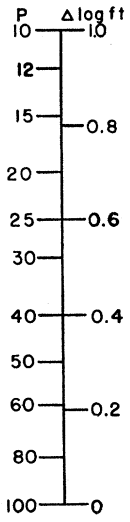
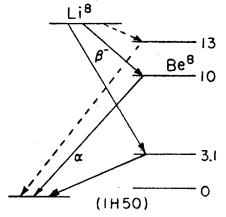
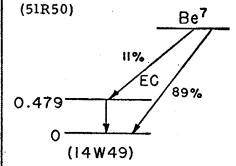
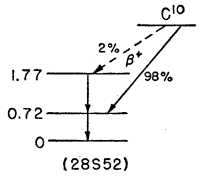
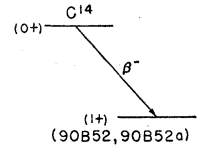
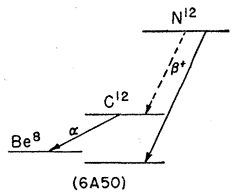


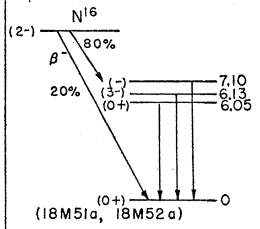
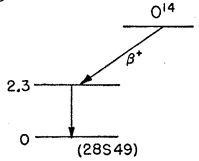
FIG. 5. $\Delta \log(ft)$ as a function of p.

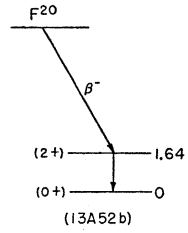
(Table of Isotopes begins on next page.)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_0n^1$	A recoil nuclei, conservation of momentum (18C32); observation of n-α reaction (4F32, 87H33)		β^- (18C35, 26S50)	12.8 m (2R51); 10-30 m (26S50)	0.78 p-β^- spect coinc (2R51)		Q^-_β 0.7823 (16L51) n^1, I = 1/2 (87M50)	Be-α-n (18C32); spall reactions in general; fission (92H39, 27A39, 118S39); parent H^1 (26S50, 2R50)
$_1H^1$		99.9849 - 99.9861 (diff sources) (52K51); 99.9851 (1V38)					H^1, I = 1/2 (87M50)	
H^2		0.0139-0.0151 (diff sources) (52K51); 0.0149 (1V38)					H^2, I = 1 (87M50)	
H^3	A chem, sep isotopes, excit (6A39, 6A40a)		β^- (6A39, 6A40a)	12.46 y genet (12J50); 12.4 y sp act (11J51); 12.1 y genet (8N47)	0.01795 spect (10L52b); 0.0183 ion ch (21C49); 0.0194 spect (26H51); 0.0189 ion ch (24H49); 0.0186 (72S49a, calc from 12J49); 0.0180 abs bremsstrahlung Zr, Ta (17G49); others (22B49, 21C48, 35K51b, 5I51)	no γ (18G46)	Q^-_β 0.019 (HPS) H^3, I = 1/2 (87M50)	D-d-p (6A39, 6A40a); D-n-γ (3Z43); He^3-n-p (19C48, 28H48); Li-n-t (4O40); Be-d-t (4O40a, 6A40a); B-n-t, N-n-t (20C41); spall reactions (33B52)
$_2He^3$		1.3×10^{-4} (atmos), 1.7×10^{-5} (wells) (7A46, 19C49)					He^3, I = 1/2 (87M50)	
He^4		~100					He^4, I = 0 (87M50)	
He^6	A chem (23B36, 23B36a), cross bomb, excit, chem (27S46)		β^- (23B36b)	0.823 s (9A50); 0.82 s (27H49); 0.84 s (12R49); 0.85 s (27S46)	3.50 spect (16W52); 3.2 abs (12R49); 3.5 abs (27S46); others (23B36b, 16K48, 2P50, 35A50)	no γ (16K48, 27S46)	Q^-_β 3.50 (16W52); Q^-_β 3.55 (36D52)	Be-n-α (23B36, 9P37, 27S46, 16K48, 2P50); Li-γ-p (25B47, 44S52a)
$_3Li^6$		7.52 (17L38)					Li^6, I = 1 (87M50)	
Li^{7m}	A excit (4E49)		IT (4E49)	5.2×10^{-14} s Doppler broadening (4E49)		~0.48 spect (4E49)		B-n-α (4E49)
Li^7		92.48 (17L38)					Li^7, I = 3/2 (87M50)	
Li^8	A excit (22C35, 11L37); n-capt, sep isotopes, genet (28H47)		β^-, 2α (11L37)	0.825 s (11R51); 0.88 s (26B37, 3O47, 10B49); 0.85 s (44S52a); 0.89 s (28H47)	β^-: 13 (~90%), ~6 (~5%), ~3 (~5%) spect (1H50); <13 (~2%) β-γ coinc abs (5V51a); 12.0 cl ch (26B37); abs (3C47); two α's: total energy 3.2, 7-9 cl ch (27B48)	no γ (13R37, 26B37); γ (very weak) β-γ coinc (5V51a)	Q^-_β 15.99 (9V52) 	Li-n-γ (15K36, 10P46, 28H47); Li^7-n-γ (28H47); Li-d-p (22C35, 5D35, 1F37, 26B37, 11L37, 1H50, 1Y50); spall C, N, Ne, A, Kr, Xe (13W50), Be-γ-p (3C47, 44S52a, 40T52); B-n-α (18L39); B-γ-2p, B-γ-2pn (44S52a)
Li^9	B excit, cross bomb (20G51)		β^-, n (20G51, 78H52)	0.168 s (20G51); 0.170 s (78H52); 0.19 s (44S52a)				Be-d-2p (20G51); B-p-3p, B-d-3pn (20G51), B-γ-2p (44S52a); C-d-4pn, C-p-4p (20G51); C-p-4p (78H52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_4Be^7$	A chem, cross bomb, excit (13R38)		EC (13R38)	52.93 d (24S49); 53.61 d (58K52); 54.3 d (55B47); 54.5 d (29B49)		0.479 spect (4E48, 11T49); 0.478 spect (1H49); 0.485 spect (17K48); coinc abs (4Z42); 0.474 spect (5Z48a); γ (11%) (14W49), (10-13%) (10T49) (Be^7 formation yield - γ ratio); others (15R46, 7S47b)	Q_{EC} 0.864 p-n-threshold (51R50) 	Li-d-n (13R38, 14R38, 14R38a, 4Z42); Li-p-n (39H39, 39H40); B-p-α (14R38a, 17M39); B-d-αn (12M46); spall C (4D50, 74M51), Al, Cu, Ag, Au (74M51)
Be^8	A observation of Be-γ-n reaction (18C35)		2α	$<2 \times 10^{-14}$ s photo-dis O^{16} emuls (26W51); $<5 \times 10^{-14}$ s photo-dis O^{16} emuls (18M52); 10^{-15} - 10^{-17} s calc (15W41)	energy of each α in center of mass system: 0.039 spect (41C51); 0.045 spect (12T49); 0.051 ion ch (40H49); 0.043 range emuls (23C50)		$Q_α$ 0.078 (41C51); $Q_α$ 0.089 (12T49); $Q_α$ 0.103 (40H49); $Q_α$ 0.085 (23C50)	Be-p-d (12T49); Be-γ-n (18C35, 40H49); O-γ-2α (18M51, 53L52)
Be^9		100 (6N37)					Be^9, I = 3/2 (100S51, 77H51)	
Be^{10}	A chem (12M46a); chem, mass spect (11P46)		β^- (12M46a)	2.5×10^6 y sp act + mass spect (12M47); 2.9×10^6 y yield (28H47a)	0.555 spect (15F52); 0.560 spect (13A50); abs (12M46a, 12M47); 0.553 ion ch (11F49a); others (28H49, 16W49, 41H49, 11B50a)	no γ (12M47, 19L47, 28H49)	$Q^-_β$ 0.56 (HPS)	Be-d-p (12M46a, 19L47); Be-n-γ (28H47a, 13A50, 11B50a); B-n-p (9E48); C-n-α (28H46)
$_5B^8$	A excit, cross bomb (6A50)		β^+, 2α (6A50)	0.46 s (102B52a); 0.61 s (44S52a)	β^+: 13.7 abs (6A50); spect (44S52a)		$Q^+_β$ 18 (calc from 6A50)	B-γ-2n, B-γ-3n (44S52a); B-p-t (6A50); Be-p-2n (6A50); C-p-nα (6A50); C-γ-p3n (44S52a); spall reactions (33B52)
B^{10}		18.45 - 18.98 (13T48)					B^{10}, I = 3 (87M50)	
B^{11}		81.02 - 81.55 (13T48)					B^{11}, I = 3/2 (87M50)	
B^{12}	A excit (22C35a, 1F36)		β^- (22C35a)	0.027 s delay coinc (3J48a, 30B51); 0.022 s delay coinc (25B39)	13.43 spect (1H50); 13.3 abs (30H48); 12 cl ch (26B37); ~9 (~4%) coinc abs (5V51a)	~4.5 β-γ coinc abs (5V51)		B-d-p (22C35a, 1F36, 30B51); C^{14}-d-α (32H50b); N^{15}-n-α (3J48a)
$_6C^{10}$	A chem, sep isotopes (28S48, 28S49)		β^+ (28S49)	19.1 s (28S49)	2.2 abs (28S49)	0.72 (~100%), 1.05 (~2%) scint spect (28S52)		B-p-n, B^{10}-p-n (28S48, 28S49, 28S52); C-γ-2n (44S52a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_6C^{11}$	A excit (22C34, 35H34); chem, excit (33B39)		β^+ (22C34)	20.4 m (30S41); 20.5 m (29S41, 12P48, 25C50); 20.0 m (7S44a, 4D51)	0.99 spect (7S44a); 0.981 spect (14T41); 0.95 cl ch (5D40)	no γ, β-γ coinc (7S46a)	Q_β^+ 2.0 (HPS)	Be-a-2n (12M46b); Be-He^3-n (1P52); B-d-n (26C35, 2Y35, 1F36); B-p-γ (22C34a, 33B39); B-p-n (33B39); C-γ-n (10B46, 12P48, 25C50, 55S51, 22E52, 44S52a); C-n-2n (1P37, 110S51, 30B52); C-d-dn (6T47); C-p-pn (27C47, 82H52); C-He^3-a (1P52); C-a-an (12M46b, 6T47); N-p-a (33B39); N-n-p3n (16K47); N-γ-p2n (10B46); N-π^--3n (21T51a); O-γ-an (10B46, 85H52); O-n-a2n (12M47a); O-π^--p4n (21T51a); spall Cu (57G51)
C^{12}		98.892 (limestone CO_2)(6N50)					C^{12}, I = 0 (87M50)	
C^{13}		1.108 (limestone CO_2)(6N50)					C^{13}, I = 1/2 (87M50)	
C^{14}	A chem, cross bomb, excit (16R41)		β^- (1K40)	5568 y weighted average of 3E50, 11J49, 21M50, and 20M51, all by sp act + mass spect (3L51); others (31H49, 17R46, 31H48, 10N48, 1Y48, 17W48)	0.155 spect (15F49, 18W50); 0.156 spect (28C48); 0.154 spect (2L47a), abs (29S47); 0.155 ion ch (10A49); no conv, spect (2L47a); E (average) 0.045 calorimetric (12J52)	no γ (16R41)	Q_β^- 0.155 (HPS) C^{14}, I = 0 (87M50) 	C-d-p (16R40, 16R41); C-n-γ (20L45); N-n-p (16R41, 20L45); O-n-a (19M47)
C^{15}	C excit, sep isotopes (32H50)		β^- (32H50)	2.4 s (32H50a)	8.8 abs (32H50a)	5.5 β-γ coinc abs (32H52)		C^{14}-d-p (32H50, 32H50a, 32H52); not found by: C^{14}-n-γ (1Y50)
$_7N^{12}$	A excit, sep isotopes (6A49)		β^+, $\beta^+3\alpha$ (6A50)	0.0125 s delay coinc (6A49)	β^+: 16.6 abs (6A49); a: ~4 total energy of three a's (6A50)			C-p-n, C^{12}-p-n (6A49, 6A50); N-γ-2n (33P52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_7N^{13}$	A excit (4C34, 22C34)		β^+ (22C34)	9.93 m (5W39a); 10.1 m (7S45); 10.2 m (28C48a)	1.24 spect (7S45); 1.25 spect (28C48a); 1.20 spect (1H48); 1.22 spect (14T41); others (21L39, 53K43)	no γ >0.135, <0.700 (10L47, 7S46a)	Q^+_β 2.26 (HPS)	B-a-n (4C34, 8E35, 18R37); C-d-n (22C34, 33H35, 2Y35, 26C35, 1F36); C-p-γ (33H35, 26C35); C^{13}-p-n (11A50); N-n-2n (1P37, 34H43); N-d-t (34B42); N-γ-n (10B46, 12P48, 22E52, 44S52a); O-n-p3n (16K47); O-γ-p2n (85H52); spall Al (74M52)
N^{14}		99.635 (6N50)					N^{14}, I = 1 (87M50)	
N^{15}		0.365 (6N50)					N^{15}, I = 1/2 (87M50)	
N^{16}	A excit (22L34, 16F34)		β^- (22L34, 16F34)	7.35 s (35B47); 7.5 s (28H46a); 7.3 s (27S46)	~10.3 (~20%), ~4.3 (~40%), ~3.8 (~40%) cl ch (35B47); 10, 3.5 abs (27S46); 10 cl ch (28H46a)	γ_1 6.13, γ_2 7.10 (γ_2/γ_1 0.08) pair spect (18M51a); 6.2, 6.7 abs sec, cl ch pair (35B46)	Q^-_β 10.3 (35B47)  (18M51a, 18M52a)	N-n-γ (28H46a, 41F52); N-d-p (1F36); O-n-p (7C37, 26S43, 35B47, 18M51a); F-n-a (22L34, 16F34, 3N36, 2N36, 9P37)
N^{17}	A chem, cross bomb (6A49a, 18K48, 27C48)		β^-, n (18K48)	4.14 s (18K48); 4.15 s (32S51)	β^-: 3.7 β-recoil coinc abs (6A49a); n: 0.9 (mean) O^{16} recoil in ion ch (6A49a); 1.0 (mean) p recoil in cl ch (36H49)		Q^-_β 8.7 (6A49a)	spall O, F, Na, Mg, Al, Si, P, S, Cl, K (27C48, 18K48); C^{14}-a-p (31S51); O-n-p (83C49); O^{18}-γ-p (32S51); F-γ-2p (44S52a)
$_8O^{14}$	B chem, excit (28S49)		β^+ (28S49)	76.5 s (28S49)	1.8 abs (28S49)	2.3 coinc abs sec (28S49)	Q^-_β 5.1 (28S49)  (28S49)	N-p-n (28S49); O-γ-2n (44S52a)
O^{15}	A chem, excit (22L34a, 12M35); excit (1F36, 19K39)		β^+ (22L34a)	118.0 s (2P49); 126 s (12M35, 37B39); 127 s (35D51)	1.683 spect (36B50); 1.68 abs (28S49)	no γ (2P50b)	Q^+_β 2.70 (HPS)	C-a-n (19K39); N-d-n (22L34a, 12M35, 1F36, 36B50); N-p-γ (2D38, 35D51); O-γ-n (37B39, 34H43, 10B46, 12P48, 22E52, 44S52a); O-n-2n (1P37); O-He^3-a (1P52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_8O^{16}$		99.759 (air O_2) (6N50); O^{16}/O^{18} variation $\lesssim$ ~4% (13T49, 1K46)					O^{16}, I = 0 (87M50)	
O^{17}		0.037 (air O_2) (6N50)					O^{17}, I = 5/2 (3A51)	
O^{18}		0.204 (air O_2) (6N50)					O^{18}, I = 0 (91M51)	
O^{19}	A excit (3N36); n-capt (22M43)		β^- (22M43)	29.4 s (11F44a); 29.5 s (28H46a); 27.0 s (35B47a)	4.5 (30%), 2.9 (70%) abs (35B47a); 4.1 abs (11F44a); ~3.2 abs (34H45)	1.6 abs (11F44a)		O-n-γ (22M43, 2S46, 2S47); F-n-p (12A35, 3N36)
$_9F^{17}$	A cross bomb (19W34, 8E34a); chem, excit (12N35, 37H35, 2D38)		β^+ (12N35)	70 s (12N35, 2P50c); 60 s (86H52); 66 s (46L51); 72 s (12P48); 74 s (2D38)	1.72 spect (2P50c); 1.7 abs (46L51); 2.1 cl ch (17K36)	no γ (2P51, 51R51)	Q^+_β 2.74 (HPS)	N-α-n (19W34, 8E34a, 18R37); O-d-n (12N35, 1F36, 2P50c); O-p-γ (2D38); F-γ-2n (10B46, 12P48, 86H52)
F^{18}	A chem (26S37); chem, sep isotopes, excit (2D38)		β^+ (26S37)	112 m (26S37, 12P48, 47B49); 115 m (34H43); 107 m (2D38)	0.649 spect (19R51); 0.635 spect (47B49); others (3Y38, 9K41, 20K45, 38H48)	no γ (16K48, 47B49)	Q^+_β 1.67 (19R51)	O-α-pn (2T47a); O^{18}-p-n (2D38); O-d-n (3Y38, 3D40, 20W41); O-He^3-p (1P52); O-t-n (20K45); F-n-2n (1P37); F-d-t (9K41, 34B42); F-γ-n (34H43, 10B46, 12P48, 22E52, 86H52); F-p-pn (19R51); Ne-d-α (26S37); Na-γ-an (10B46, 85H52); spall Al (74M52, 74M52a), Cu (57G51, 74M52a), Cl, Ag, Au (74M52a)
F^{19}		100 (1A20)					F^{19}, I = 1/2 (87M50)	
F^{20}	A excit (22C35, 1F36, 3N36)		β^- (22C35)	10.7 s (33S50); 12 s (22C35)	5.41, no ~7 β^- (lim 1%) spect (13A52b); 5.33 (97%), 6.7 (3%) spect (47L50); 5.0 spect, abs (3J50); others (38B40)	1.631, no 2.5 γ (lim 0.2%) spect, Be-γ-n reaction (13A52b); 1.64, no 2.5 γ spect, γ-γ coinc (47L50); 1.64, 2.5 (weak) spect, abs sec (3J50); 2.2 cl ch recoil (38B40); γ (coinc with 5.0 β^-) β-γ coinc (21C40, 3J50).	Q^-_β 7.04 (13A52b)  (13A52b)	F-d-p (22C35, 1F36, 33S50, 3J50, 13N50, 13A52c); F-n-γ (3N36, 2S47, 21K50); Na-n-α (3N36)

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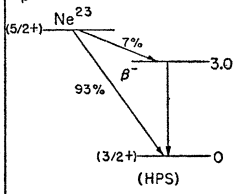
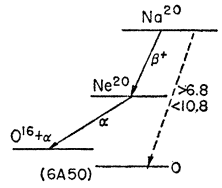
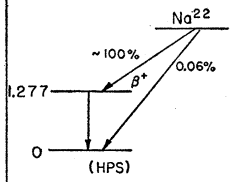
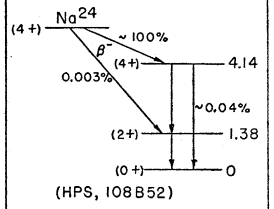
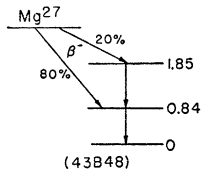
$_{10}Ne^{19}$	A cross bomb, excit (21W39)		β^+ (21W39)	18.2 s (28S49); 18.5 s (34S52); 20.3 s (21W39)	2.18 spect (34S52); 2.2 cl ch (21W39); 2.3 abs (28S49)	no γ (21W39, 34S52)	Q^+_β 3.20 (HPS)	F-p-n (21W39, 47B51a, 34S52)
Ne^{20}		90.92 (6N50a)					Ne^{20}, I = 0 (87M50)	
Ne^{21}		0.257 (6N50a)					Ne^{21}, I = 3/2 (87M50)	
Ne^{22}		8.82 (6N50a)					Ne^{22}, I = 0 (87M50)	
Ne^{23}	A excit (12A35); chem (23B37, 9P37)		β^- (14P40)	40.2 s (36B50a); 40.7 s (34H44a); 40 s (12A35, 23B37)	4.21 (~93%), 1.18 (~7%) spect (36B50a); 4.3 abs (35B46a, calc from 14P40); 4.1 abs (14P40)	~3 abs (2P50a)	Q^-_β 4.21 (2P50a) 	Ne-n-γ (41F52); Ne-d-p (22W40); Ne^{22}-d-p (14P40, 36B50a, 2P50a); Na-n-p (12A35, 3N36, 9P37, 23B37); Mg-n-α (12A35)
$_{11}Na^{20}$	A excit (6A50)		β^+, α (6A50, 44S51a)	0.385 s (102B52a); 0.23 s (44S51a)	$3.5 < \beta^+ < 7.3$ est (44S51a)			Ne-p-n (6A50); Na-γ-3n (44S51a, 44S52a)
Na^{21}	A excit (29C40a)		β^+ (14P40)	22.8 s (34S52); 23 s (29C40a)	2.50 spect (34S52); 2.53 spect (52B51b)	no γ (34S52)		Ne^{20}-p-γ (40B47); Ne-p-n (29C40a); Ne-d-n (14P40); Mg-p-α (34S52); Mg^{24}-p-α (39B48)
Na^{22}	A chem, excit (17F35)		β^+ ~100%, no EC (21G46)	2.60 y (23L49); 2.8 y (36S39)	0.542 spect (23M50); 0.575 spect (21G46); ~1.8 (0.06%) spect (56W52); ~1.8 (0.004%) cl ch (25M49); others (23L37, 2O39)	1.277 spect (13A49); 1.30 (coinc with β^+) spect, β-γ coinc (21G46); 1.3 spect (2O39) others (85S51)	Q^+_β 2.84 (HPS) Na^{22}, I = 3 (87M50) 	F-α-n (17F35, 23L37, 24M37); Ne-d-n (23L37); Ne^{21}-p-γ (40B47); Na-n-2n (41B46, 35S47); Mg-d-α (23L37, 13A49); spall Mg, Mg^{25}, Mg^{26} (92M51), Fe (45R52), Cu (42B51a)
Na^{23}		100 (37S36a)					Na^{23}, I = 3/2 (87M50)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{11}Na^{24}$	A chem, excit (16F34, 1L35)		β^- (1L35)	15.06 h (39S51); 15.04 h (29S50); 15.10 h (31C50); 15.0 h (38S51, 23W49)	1.390 spect, coinc (7S46b, 7S47); 1.4 spect (24L39); 4.17 (0.003%), no 5.5 β^-, spect (15T51); lim 4.15 β^-, 0.01% spect (22G50); others (42H48)	γ_1 1.3679, γ_2 2.7535 spect (12H52); γ_1 1.380, γ_2 2.758 spect (7S46b); 1.380, 2.765 spect (20R49); γ_2 (e/γ 3 x 10^{-6}) (7S50b); 2.748 spect (21K50a); 2.755 spect (6W50); γ_1 (coinc with γ_2) spect, β-γ, γ-γ coinc (4E43); γ-γ coinc abs (28C46); 3.7 (0.04%) D-γ-p ion ch (101B51); ~4 (0.05%) spect (15T51); others (9B50, 4I41, 26M43, 41M50, 85B50a, 85S51, 55C50, 108B52)	Q^-_β 5.53 (HPS) Na^{24}, I = 4 (101S51)  (HPS, 108B52)	Na-d-p (1L35, 2V36a); Na-n-γ (12A35, 2S47); Mg-d-α (35H35); Mg-n-p (12A35); Mg-γ-p (10B46, 42H47, 22E52); Al-n-α (12A35, 74M52); Al-d-pα (30C46, 30C47); Al-γ-n2p (10B46, 22E52, 42S52); Al-p-3pn (82H52); Si-γ-n3p (?) (10B46); spall Al (39F52), Fe (45R52), Cu (42B51a, 57G51), Sn (42B51); spall-fission Cu (42B51), U (6F51)
Na^{25}	B excit (34H43a)		β^- (34H43a)	58 s (35B47a); 62 s (12P48, 10B46, 34H43a); 60 s (21R44)	3.7 (~55%), 2.7 (~45%) abs (35B47a); 3.4 abs (34H44a); 3.3 abs (21R44)	>0.5 (weak) abs (35B47a)	Q^-_β 3.7 (35B47a)	Mg-γ-p (34H44a, 10B46, 22E52); Mg-n-p (34H44a, 35B47a); Al-γ-2p (10B46, 12P48, 22E52, 42S52)
$_{12}Mg^{23}$	A excit, cross bomb (21W39)		β^+ (21W39)	11.9 s (34H43); 12.3 s (52B51a); 11.6 s (21W39)	2.99 scint spect (52B51a); 2.8 cl ch (21W39)	no γ (21W39)		Na-p-n (21W39, 2D40); Mg-γ-n (34H42, 34H43, 10B46, 25B47, 27M49, 22E52)
Mg^{24}		78.60 (24W48)					Mg^{24}, I = 0 (87M50)	
Mg^{25}		10.11 (24W48)					Mg^{25}, I = 5/2 (87M50, 3A51a)	
Mg^{26}		11.29 (24W48)					Mg^{26}, I = 0 (87M50)	
Mg^{27}	A chem, excit (12A35, 35H35)		β^- (35H35)	9.45 m (3S52); 9.6 m (10E43); 10.0 m (32C39); 10.2 m (35H35)	1.80 (80%), 0.9 (20%) spect (43B48); 1.8 cl ch (10E43, 32C39); 1.7 abs (28M40); ~1.8 (coinc with γ) β-γ coinc (35B47a)	γ_1 1.01, γ_2 0.84 (γ_1 coinc with γ_2) spect, γ-γ coinc (43B48); 1.02, 0.84, 0.64 spect (4I41); 1.05 cl ch recoil (10E43)	Q^-_β 2.64 (43B48)  (43B48)	Mg-d-p (35H35); Mg-n-γ (12A35, 2S47); Al-n-p (12A35, 16F34, 74M52)
Mg^{28}	A chem, genet (37L53, 44S53)		β^- (37L53, 44S53)	21.2 h (37L53); 21.3 h (44S53)	0.3-0.4 abs (37L53)	<0.1 abs (37L53)		Si-γ-2p, Mg-α-2p (44S53); spall Cl (37L53); parent Al^{28} (37L53, 44S53)
$_{13}Al^{24}$	A excit, decay charac (102B52)		β^+ or EC, α (p?) (102B52a)	2.3 s (102B52)				Mg-p-n (102B52)
Al^{25}	B excit, sep isotopes (39B48)		β^+ (39B48)	7.3 s (39B48)				Mg^{25}-p-n (39B48)

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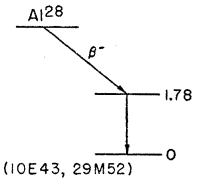
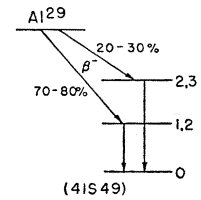
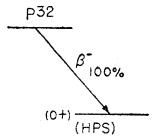
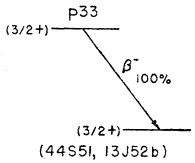
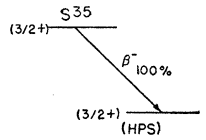
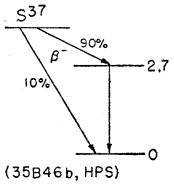
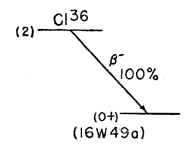
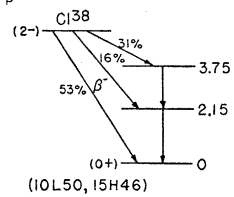
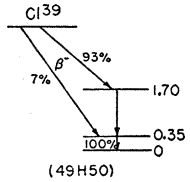
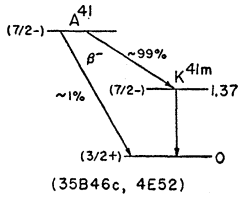
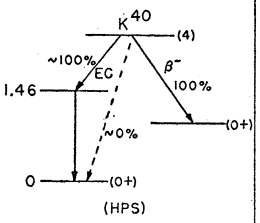
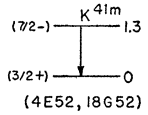
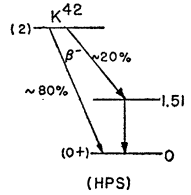
$_{13}Al^{26}$	A excit (17F34); cross bomb (34H43, 39B48)		β^+ (17F34)	6.5 s (30K51); 6.3 s (39B48); 7.0 s (21W39, 14A48, 12P48); 7.2 s (25W48)	2.8 abs (14A48); 3.0 cl ch (21W39); 3.4 abs (35B46a, calc from 17F34)			Na-α-n (17F34, 24M37); Mg-p-n (21W39); Mg^{26}-p-n (39B48); Mg-p-γ (21C39, 16T46); Al-γ-n (34H41, 34H42, 34H43, 10B46, 25B47, 12P48, 22E52)
Al^{27}		100 (1B50)					Al^{27}, I = 5/2 (87M50)	
Al^{28}	A chem, excit (4C34a, 4C34b, 16F34); chem, cross bomb (12A35)		β^- (12M35a)	2.27 m (106B52b); 2.07 m (40S48); 2.30 m (10E43)	2.865 spect (29M52); 2.75 (coinc with γ) coinc abs (35B47a); 3.01 spect (43B48); no 4.6 β^- (29M52)	1.782 spect (29M52); 1.80 spect (43B48); 1.80 abs sec (35B47a); 1.82 spect (4I41)	Q^-_β 4.65 (29M52)  (10E43, 29M52)	Mg-α-p (8E36, 18R37); Al-d-p (12M35a, 29M52); Al-n-γ (12A35, 2S47, 9O49, 50H51, 29M52); Si-n-p (12A35, 35B47a); Si-γ-p (10B46, 42H47); P-n-α (12A35); daughter Mg^{28} (37L53)
Al^{29}	A excit, cross bomb (32B39)		β^- (32B39)	6.56 m (41S49); 6.7 m (32B39)	2.5 (~70%), 1.4 (~30%) (both coinc with γ) β-γ coinc abs (41S49); ~2.5 cl ch, abs (32B39)	1.2 (~80%) (coinc with 2.5 β^-), 2.3 (~20%) coinc abs sec (41S49)	Q^-_β 3.8 (41S49)  (41S49)	Mg-α-p (8E36, 32B39, 14H39, 41S49); Al-α-2p (I12S51); Si-n-p (21F43); Si-γ-p (10B46, 42H47, 12P48); P-γ-2p (10B46, 12P48)
$_{14}Si^{27}$	A excit (22K39)		β^+ (30M40)	4.9 s (12E41, 29C40a); 4.5 s (25W48); 5.4 s (52B51a)	3.48 scint spect (52B51a); 3.5 cl ch (33B40); 3.7 cl ch (30M40)			Mg-α-n (12E41); Al-p-n (22K39, 30M40, 29C40a, 33B40, 76C51); Si-γ-n (34H44, 25B47, 25W48)
Si^{28}		92.27 (1B50)					Si^{28}, I = 0 (87M50)	
Si^{29}		4.68 (1B50)					Si^{29}, I = 1/2 (87M50)	
Si^{30}		3.05 (1B50)					Si^{30}, I = 0 (87M50)	
Si^{31}	A n-capt (12A35); chem, excit (12N35a)		β^- (12N35a)	2.62 h (33C38, 55W51); 2.65 h (29M52a); 2.6 h (48L50); 2.8 h (12N37, 15A40) 2.7 h (15P49)	1.471 spect (29M52a); 1.486 spect (47W52); 1.48 abs (55W51)	0.17, 0.52, ~1 (weak) (?) abs (80C52); no γ (12N37)	Q^-_β 1.47 (29M52a)	Si-d-p (12N35a, 12N37, 17K36); Si-n-γ (12A35, 2S47); Si-He^3-2p (1P52); P-n-p (12A35, 1P37); S-n-α (42S36, 33C38); spall Fe (45R52)
Si^{32}	B chem, genet (37L53)		β^- (37L53)	~100 y yield (37L53)	Soft β^- (37L53)			spall Cl, parent P^{32} (37L53)

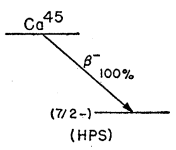
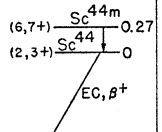
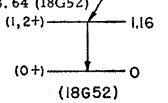
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{15}P^{29}$	B excit (21W41)		β^+ (21W41)	4.57 s (30R52); 4.6 s (21W41)	3.6 cl ch (21W41)	1.28 (2.5%), 2.42 (0.5%), scint spect, γ-γ coinc (30R52)		Si-p-n (21W41); Si-d-n (14D48); P-γ-2n (?) (10B46)
P^{30}	A excit (4C34, 17F34)		β^+ (4C34)	2.55 m (18R37); 2.18 m(33C38)	3.5 spect (24M41); 3.4 abs (35B46a, calc from 17F34); 3.0 cl ch (33B40)			Al-α-n (17F34, 4C34, 18R37); Si-p-n (33B39, 33B40); Si-He^3-p (6A39, 1P52); P-n-2n (1P37); P-γ-n (37B39, 10B46, 12P48); S-d-α (42S36); Cl-γ-an (85H52)
P^{31}		100 (1A20)					P^{31}, I = 1/2 (87M50)	
P^{32}	A chem, n-capt (12A35)		β^- (21L37)	14.30 d (12C38, 45B50); 14.35 d (23K48); 14.07 d (31M40); 14.60 d (38S51)	1.701 spect (average of 44S51, 29M52a, 13J52b, 8H51b, 16A50, 18W50a, 10L49, 7S46b); E (average) 0.70 ion ch (77C52)	no γ (17K36, 7S46b)	Q^-_β 1.702 (HPS) 	Si-d-γ (112S51); Si-α-p (18F35); Si-He^3-p (1P52); P-d-p (12N37); P-n-γ (2S47); S-n-p (12A35); S-d-α (42S36); Cl-n-α (12A35); Cl-γ-an, Cl-γ-t (85H52); Cl-d-pα (17T47); spall Fe (45R52), Cu (32M48, 42B51a)
P^{33}	A chem, cross bomb (44S51)		β^- (13J52b, 44S51)	25.4 d (58W52); 24.8 d (13J52b); 25 d (44S51)	0.27 spect (44S51); 0.26 spect (13J52b); 0.25 abs (58W52)	no γ (44S51, 58W52)	Q^-_β 0.27 (44S51)  (44S51, 13J52b)	S-n-p (44S51, 13J52b, 58W52); S-γ-p (44S51, 13J52b); Cl-γ-α, Cl-γ-2p (44S51, 13J52b)
P^{34}	B excit (10C40a); chem, excit, cross bomb (35B46b)		β^- (6Z45)	12.4 s (35B46b); 12.7 s (10C40a)	5.1 (75%), 3.2 (25%) abs (35B46b)			S-n-p (10C40a, 6Z45, 35B46b); Cl-n-α (6Z45, 34H45, 35B46b)
$_{16}S^{31}$	A excit, cross bomb (21W41, 12E41)		β^+ (21W41)	3.18 s (12E41); 3.2 s (21W41, 52B51a); 2.6 s (27M49)	3.85 cl ch (21W41); 3.87 cl ch (12E41a); 4.1 scint spect (52B51a)			Si-α-n (19K40, 12E41, 12E41a); P-p-n (21W41); S-γ-n (34H41, 34H42, 34H43, 25B47, 27M49)
S^{32}		95.018 (meteoritic sulfur) (76M50a); terrestrial S^{32}/S^{34} variation $\leq$5% (41T50)					S^{32}, I = 0 (87M50)	

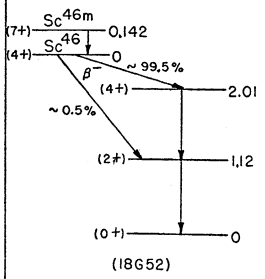
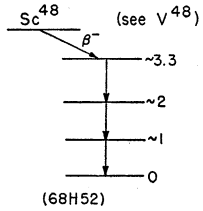
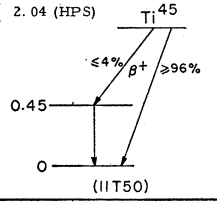
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{16}S^{33}$		0.750 (meteoritic sulfur) (76M50a)					S^{33}, I = 3/2 (87M50)	
S^{34}		4.215 (meteoritic sulfur) (76M50a)					S^{34} I = 0 (87M50)	
S^{35}	A chem, excit (17A36); chem, cross bomb, excit (1K41); sep isotopes (1K42)		β^- (3L39)	87.1 d (44H43) 88 d (26L40, 1K41)	0.1670 spect (10L50c); 0.167 spect (45H51), abs (29S47); 0.169 spect (46B48), abs (1Y48a); 0.168 spect (23G50); 0.166 spect (18A48); 0.168 ion ch (56C49)		Q^-_β 0.167 (HPS) S^{35}, I = 3/2 (87M50) 	S-n-γ (2S47); S-d-p (34C39, 1K41); Cl-n-p (17A36, 26L40, 1K41, 3M49); Cl^{35}-n-p (1K42); Cl-d-α (1K41); spall Fe (45R52)
S^{36}		0.017 (meteoritic sulfur) (76M50a)					S^{36}, I = 0 (87M50)	
S^{37}	B chem, excit cross bomb (6Z45, 35B46b)		β^- (6Z45)	5.04 m (35B46b); 5.0 m (28H46b)	4.3 (10%), 1.6 (90%) abs (6Z45, 35B46b); 1.4, ~4 abs (28H46b)	2.7 abs sec (35B46b); 2.75 abs sec (28H46b)	Q^-_β 4.3 (HPS)  (35B46b, HPS)	S-n-γ (28H46b); Cl-n-p (6Z45, 35B46b)
$_{17}Cl^{33}$	A excit (46H40); excit (21W41)		β^+ (21W41)	2.8 s (46H40, 45S48); 2.4 s (21W41); 1.8 s (52B51a)	4.13 cl ch (21W41); 4.4 scint spect (52B51a)			S-d-n (46H40, 45S48); S-p-n (21W41); Cl-γ-2n (52B51a)
Cl^{34}	A chem, excit (17F34); chem, excit (42S36)		β^+ (17F34; 44B38)	33.2 m (25W48); 33.0 m (12P48); 33 m (42S36, 44B38)	4.5 (46%), 2.6 (28%), 1.3 (26%) spect (19R51); 5.1 (~80%), 2.4 (~20%) cl ch (38H46)	3.22, 2.10, 1.16 scint spect (18T51); 3.3, 2.1, 0.145 spect, spect conv (19R51); 3.4 cl ch recoil (38H46)	Q^+_β 5.6 (19R51)	Al-C^{12}-αn (4M50); P-α-n (17F34, 18R37, 44B38); S-d-n (42S36, 38H46); S-α, pn (28S40); S-p-n (19R51); S-t-n (20K45); Cl-n-2n (1P37); Cl-p-pn (19R51); Cl-γ-n (37B39, 34H43, 12P48, 25W48, 22E52); spall Fe (45R52), Cu (42B51a)
Cl^{35}		75.4 (6N36)					Cl^{35}, I = 3/2 (87M50)	

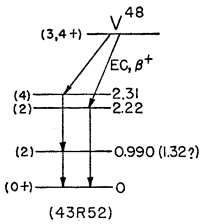
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{17}Cl^{36}$	A chem, n-capt (31G41)		β^- (31G41); no β^+ (lim 0.01%) (16W49a); (lim 0.03%) (14J49)	4.4×10^5 y sp act (16W49a); 3.6×10^5 y sp act (22R49); 2.0×10^5 y yield (22R49); 2×10^6 y yield (28H47b); $\sim 10^6$ y yield (10O47)	0.714 spect (15F52); 0.66 abs (10O47); 0.64 abs (31G41); others (16W49b, 16W51)	no γ (16W49a)	Q^-_β 0.714 (16W49b, 15F52) Cl^{36}, I = 2 (87M50, 27J51)  (16W49a)	Cl-n-γ (31G41, 10O47, 2S47); Cl-d-p (31G41)
Cl^{37}		24.6 (6N36)					Cl^{37}, I = 3/2 (87M50)	
Cl^{38}	A chem, n-capt (12A35); chem, sep isotopes (14K40)		β^- (17K36)	37.29 m (31C50); 37.5 m (47H37, 21C40a); 37.0 m (2V36a, 5S45); 38.5 m (15H46)	4.81 (53%), 2.77 (16%), 1.11 (31%) spect (10L50); 5.0, 2.8, 1.1 spect (27W39); spect, coinc abs (27W41); 5.2 (53%), 2.70 (11%), 1.19 (36%) spect (15H46)	γ_1 2.15, γ_2 1.60 (γ_1/γ_2 = 1.3) spect (15H46); γ_1 2.19, γ_2 1.64 (γ_1 coinc with γ_2) spect, coinc (4I41); 2.15, 1.65 spect (21C40a); no 3.75 γ (lim 0.03%) Be-γ-n reaction (33M49)	Q^-_β 4.81 (HPS)  (10L50, 15H46)	Cl-d-p (17K36, 2V36a); Cl-n-γ (12A35, 14K40, 19A41, 2S47); Cl^{37}-n-γ (14K40); K-n-α (47H37); spall Fe (45R52), Co (29W52), Cu (32M48, 42B51a); spall-fission Cu (42B51)
Cl^{39}	A chem (32M48a); chem, excit (49H49)		β^- (49H49)	55.5 m (49H49); ~1 h (32M48a, 48H49)	1.65 (93%), 2.96 (7%) abs (49H50)	1.35, 0.35 (coinc with 1.65 β^-) coinc abs sec (49H50)	Q^-_β 3.3 (49H50)  (49H50)	A-γ-p (49H49, 49H50); spall Fe (45R52), Co (29W52), Cu (32M48a, 42B51a), As (48H49)
$_{18}A^{35}$	A excit (21W41, 19K40)		β^+ (12E41a, 21W41)	1.88 s (12E41a); 1.84 s (45S48)	4.38 cl ch (21W41); 4.41 cl ch (12E41a)		Q^+_β 5.4 (HPS)	S-α-n (19K40, 45S48); Cl-p-n (21W41)
A^{36}		0.337 (6N50)					A^{36}, I = 0 (87M50)	
A^{37}	A chem, cross bomb (28W41)		EC (28W44, 46R52); EC (L/K 0.087) (17P49)	35.0 d (56M52); 34.1 d (28W44)		no γ, Cl K_α-x (28W44)	Q_{EC} ~0.8 continuous γ spectrum (38A52); Q_{EC} 0.816 p-n threshold (51R50)	S-α-n (28W41, 28W44); Cl-d-2n (28W41, 28W44); Cl-p-n (28W41, 28W44, 47B51a); K-d-α (28W41, 28W44); Ca-n-α (28W41, 28W44)
A^{38}		0.063 (6N50)						
A^{39}	B chem, excit (8Z52)		β^- (48B50)	~265 y sp act (8Z52)	0.565 spect (48B50)	no γ > 0.3 (lim 0.1%) (48B50)	Q^-_β 0.57 (HPS)	A-n-γ (32K52); K-n-p (48B50, 8Z52)

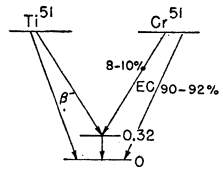
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{18}A^{40}$		99.600 (6N50)					A^{40}, I = 0 (87M50)	
A^{41}	A chem, excit (26S36)		β^- (26S36)	109 m (35B46c); 110 m (26S36)	1.245 (~100%) spect (36B50); 1.18 (99.3%), 2.5 (0.7%) abs, coinc abs (35B46c); others (26S36, 17K36)	1.37 cl ch recoil (23R36); 1.3 (coinc with 1.2 β^-) β-γ coinc, abs sec (35B46c); γ (e/γ ~0) spect conv (36B49)	Q^-_β 2.5 (35B46c)  (35B46c, 4E52)	A-d-p (26S36, 36B49, 36B50); A-n-γ (26S36); K-n-p (47H37, 35B46c); parent K^{41m} (4E52)
A^{42}	A chem, genet (32K52)		β^- (32K52)	$\geq$3.5 y (32K52)				A-n-γ (sec order reaction) (32K52); parent K^{42} (32K52)
$_{19}K^{37}$	C excit (27L48)		β^+ (52B51a)	1.3 s (27L48); 1.2 s (52B51a)	4.6 scint spect (52B51a)			K-γ-2n (27L48, 52B51a)
K^{38}	A chem, cross bomb (47H37, 14H37)		β^+ (47H37)	7.7 m (47H37, 18R37, 58G51); 7.5 m (24R47); 7.6 m (12P48)	2.8 spect (58G51); 2.5 abs (24R47); others (18R37)	2.16 scint spect (18T51); ~2.1 abs sec (24R47)	see Cl^{38}	Cl-a-n (47H37, 18R37, 14H37, 24R47); K-n-2n (1P37); K-p-pn (18T51, 58G51); K-γ-n (34H42, 34H43, 12P48, 22E52); Ca-d-a (47H37)
K^{39}		93.08 (6N50); K^{39}/K^{41} variations (81C43)					K^{39}, I = 3/2 (87M50)	

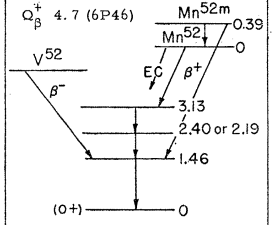
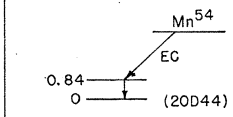
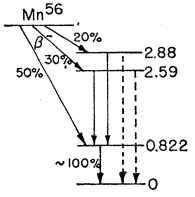
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{19}K^{40}$	A chem (1T05, 54C06); chem, mass spect (15S37)	0.0119 (6N50)	β^- 89%, EC 11% (3I50); β^- ~88%, EC (K) ~12% (46S50); β^- ~93%, EC (K) ~7% (36C50); assuming EC/γ = 1, β^- 90%, EC 10% (19F50, 76H50); β^- 91%, EC 9% (48S50); β^- 89%, EC 11% (27G51); β^- 94%, EC 6% (65M52); no β^+ (lim 0.06%) (37C51); no β^+ (lim 0.002%) (11B50b); $\beta^+ \leq 0.1\%$ (25G51b)	t_{β^-} sp act (uncorr. for EC): 1.32×10^9 y (47S49, 48S50); 1.26×10^9 y (17D51, 17D51a); 1.29×10^9 y (19F50); 1.49×10^9 y (27G50, 76H50, 25G51); 1.42×10^9 y (46S50); others (20A48, 20F49, 11IS50); $t_{1/2}$ 1.2×10^9 y calc from average t_{β^-} and EC/β^- (HPS)	1.33 spect (15F52); 1.36 spect (13A50a); 1.36 scint spect (11B50c); 1.35 spect coinc (16D46); 1.41 abs (42H46, 42H48); 1.28 scint spect (25G51)	1.46 scint spect (11B50b, 25G51a); 1.48 scint spect (55H50); 1.47 scint spect (18P50); 1.54 (with EC) abs, coinc (42H46); 1.55 abs (26G47); γ (with EC) (34M47, 16P52); γ/β^- 0.12 sp act (average of 19F50, 47S49, 48S50, 25G51, 20F49, 27G48, 46S49, 76H50); EC/γ ~1 (35M51, 46S50, 16P52)	Q_{β^-} 1.33 (HPS) Q_{EC} 1.63 (26R50, HPS) K^{40}, I = 4 (87M50)  (HPS)	natural source (1T05, 54C06)
K^{41m}	A genet (4E52)		IT (4E52)	6.7×10^{-9} s delay coinc (4E52)		~1.3 scint spect (4E52)	 (4E52, 18G52)	daughter A^{41} (4E52)
K^{41}		6.91 (6N50)					K^{41}, I = 3/2 (87M50)	
K^{42}	A chem, n-capt (12A35); chem, cross bomb (71H35, 71H36)		β^- (17K36)	12.44 h (7S47c); 12.5 h (38S51, 35L52a); 12.4 h (47H37)	3.58 (75%), 2.04 (25%) spect (7S47c); 3.60, 1.9 spect (6P47); 3.5 (~70%) (not coinc with γ), ~1.8 (~30%) abs, coinc (35B47a)	1.51 spect (7S47c); 1.50 spect (6P47); 1.5 (17%) scint spect (35L52a)	Q_{β^-} 3.6 (HPS)  (HPS)	A-α-pn (11O49); K-d-p (47H37); K-n-γ (12A35, 47H37, 2S47); Ca-n-p (71H35, 47H37); Sc-n-α (71H36, 47H37, 35B47a); spall Co (29W52), Cu (57G51); daughter A^{42} (32K52)
K^{43}	B chem, excit (11O49)		β^- (11O49)	22.4 h (11O49)	0.81, 0.24 spect, abs (11O49)	~0.4 abs (11O49)		A-α-p (11O49)
K^{44}	E chem, excit (30W37)		β^- (30W37)	18 m (30W37)				Ca-n-p (30W37, 30W40)
$_{20}Ca^{39}$	B excit (34H43, 27M49)		β^+ (34H43)	1.06 s (34H43) 1.1 s (52B51a)	5.1 scint spect (52B51a)			Ca-γ-n (34H43, 25W48, 27M49)
Ca^{40}		96.97 (6N38a)					Ca^{40}, I = 0 (87M50)	

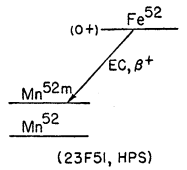
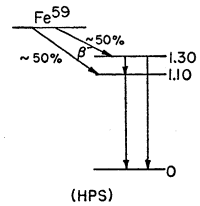
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{20}Ca^{41}$	B chem, n-capt sep isotopes (60B51)		EC (60B51)	1.1×10^5 y yield (60B52a)		K K_α-x (60B51)		Ca-n-γ (49S51, 60B51)
Ca^{42}		0.64 (6N38a)						
Ca^{43}		0.145 (6N38a)						
Ca^{44}		2.06 (6N38a)						
Ca^{45}	A chem, excit, cross bomb (30W40)		β^- (30W40)	152 d (36M47); 180 d (30W40)	0.254 spect (23M50a); 0.255 scint spect (24K50); 0.260 abs (29S48); 0.26 abs (50S50); E (average) 0.075 ion ch (77C52)	no γ (29S48, 37M49, 25K46); others (52M51)	Q^-_β 0.254 (HPS) 	Ca-d-p (30W40); Ca-n-γ (30W40, 2S47); Sc-n-p (30W40, 25K46); Sc-d-2p (51H48); Ti-n-α (38C48, 63H48); spall Fe (45R52), Cu (42B51a); spall-fission Bi (11G49)
Ca^{46}		0.0033 (6N38a)						
Ca^{47}	A (36M47); chem, genet (42B51a)		β^- (36M47)	4.8 d (42B51a); 5.8 d (36M47)	1.2 abs (42B51a); 1.1 abs (36M47)	1.3 abs (36M47)		Ca-d-p (36M47); spall Fe (45R52), Cu (42B51a); parent Sc^{47} (42B51a)
Ca^{48}		0.185 (6N38a)		$t_{\beta^-} > 2 \times 10^{16}$ y sp act (28J52)				
Ca^{49}	A chem, n-capt, sep isotopes (38M50)		β^- (38M50)	8.5 m (38M50)	~2.7 abs (38M50)	hard (38M50)		Ca^{48}-n-γ, Ca-n-γ (38M50)
$_{21}Sc^{41}$	A excit (12E41)		β^+ (12E41a)	0.873 s (98M52); 0.87 s (12E41)	4.94 cl ch (12E41)			Ca-d-n (12E41, 12E41a); Ca-p-γ (39T52)
Sc^{43}	A chem, excit (17F35)		β^+ (17F35)	3.92 h (53H45); 4 h (30W40a)	1.18 (72%), 0.77 (28%) spect (93H52); 1.12 abs, spect (53H45); 1.4 cl ch (30W37a); abs (30W40a)	0.375, no higher γ (lim 15%) spect (93H52); 1.65 abs (53H45); 1.0 abs (30W40a)		Ca-α-p (17F35, 30W40a); Ca-d-n (30W37a, 53H45); Ca-p-n (2D38, 53H45); spall Fe (45R52), Co (29W52), Cu (42B51a)
Sc^{44m}	A chem, excit cross bomb (30W37a)		IT (30W40a)	2.44 d (53H45); 2.4 d (49B50); 2.2 d (30W40a)		0.271 spect, spect conv (49B50); 0.269 spect conv (51S42); 0.26 spect conv (2H41); 0.28 abs conv (53H45)		K^{41}-α-n (49B50); K-α-n (30W40a, 53H43); Ca-d-n (30W37a, 51S42, 53H43); Ca-p-n (2D38); Sc-n-2n (31B38, 53H45); Ti-d-α (30W37b); spall Fe (45R52), Co (29W52), Cu (42B51a)
Sc^{44}	A chem, excit (10C38)		β^+, EC (53H45)	3.92 h (53H45); 4.0 h (49B50); 4.1 h (30W40a, 51S42)	1.463 spect (49B50); 1.45 spect (51S42); 1.5 abs (39C50, 30W40a)	1.16 spect spect conv (49B50); 1.18 coinc abs sec (39C50)	Q^+_β 3.64 (18G52) 	K^{41}-α-n (49B50); K-α-n (30W40a, 53H43); Ca-d-n (30W37a, 51S42, 53H43); Ca-p-n (2D38); Sc-n-2n (31B38, 53H43); Sc-γ-n (37B39); Ti-d-α (53H44); spall Co (29W52), Cu (42B51a); spall-fission Br (42B51)

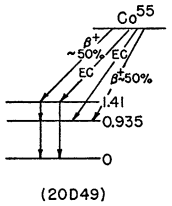
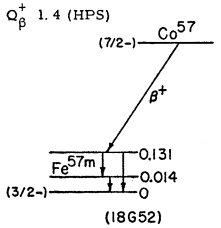
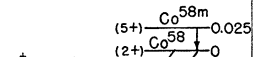
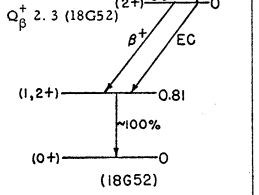
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{21}Sc^{45}$		100 (28L50)					Sc^{45}, I = 7/2 (87M50)	
Sc^{46m}	A n-capt, resonance neutron activation (18G48)		IT (18G48)	19.5 s (38M51)		0.142 (K/L ~10) spect conv (82B52); 0.135 scint spect (38M51)	 (18G52) Q_{β}^{-} 2.37 (18G52)	Sc-n-γ (18G48, 38M51)
Sc^{46}	A n-capt, chem (71H36); chem, excit, cross bomb (30W37c)		β^-, no EC (40M47); β^-, EC (weak) (30W39); no β^+ (lim 0.0016%) (41M51)	85 d (30W39); 84 d (19P51)	0.36 spect (22F47, 40M47, 20P48); 0.36 abs (52S50); 0.34 abs (14N50); 1.2 (~0.5%) spect (19P51); no 1.5 β^- (lim 0.05%) c1 ch (52S50); no 1.5 β^- (lim 0.06%) spect (39M50); 1.5 (~2%) spect (20P48); abs (14N50)	γ_1 0.89, γ_2 1.12 spect, spect conv (20P48); 0.88, 1.12 spect (22F47); 0.90, 1.12 spect (40M47); γ_1 (e/γ 1.7 x 10^{-4}), γ_2 (e/γ 0.98 x 10^{-4}) spect conv (39M50); γ_1 (e/γ 1.4 x 10^{-4}), γ_2 (e/γ 0.61 x 10^{-4}) spect conv (19P51a); γ_1 (coinc with 0.36 β^- and γ_2) β-γ, γ-γ coinc (15J48, 52S50, 26M48); γ_1 (coinc with 1.5 β^- and γ_2) delay coinc (14N50)		Ca-α-p (30W40a); Sc-d-p (30W37c, 30W39) Sc-n-γ (71H36, 30W37c, 2S47); Ti-d-α (30W37b); Ti-n-p (30W37b, 63H48); spall Fe (45R52), Cu (42B51a)
Sc^{47}	A chem, cross bomb (53H45a); sep isotopes (26K49)		β^- (53H45a)	3.43 d (26K49)	0.61 abs (26K49)	γ (26K49)		Ca-α-p (53H45a); Ca-d-n (53H45a); Ca-p-γ (53H45a); Ti-γ-p (22E52); Ti-n-p (63H48); Ti^{49}-d-α (26K49); spall Fe (45R52), Cu (42B51a); daughter Ca^{47} (42B51a)
Sc^{48}	A chem, excit (30W37b); sep isotopes (26K49)		β^- (30W37b)	44 h (30W40a, 26M42, 53H45a, 26K49)	0.64 spect (51S42); 0.57 abs (53H45a, 26K49)	γ_1 1.33, γ_2 0.98, γ_3 ~1.0 scint spect, γ-γ coinc (68H52); 1.32, 0.99, no 2.3 γ (lim 0.1%) scint spect (69M52); 1.33, 0.98 spect (6P46); 1.35 spect (26M42, 26M43a); 1.33 abs (53H45a)	Q_{β}^{-} 3.87 (74S51a)  (68H52)	Ca-p-n (53H43); Ca-d-2n (51S42, 26M42, 53H43, 26M43a); Ti-n-p (30W37b, 1P37, 30W40a, 26M43a); Ti^{50}-d-α (26K49); Ti-d-α (53H44); V-n-α (30W37b, 1P37, 30W40a); spall Fe (45R52)
Sc^{49}	B chem, excit, cross bomb (30W40a)		β^- (30W40a)	57 m (30W40a)	1.8 abs (30W40a)	no γ (30W40a)		Ca-d-n (30W40a); Ti-n-p (30W40a); Ti-γ-p (42H47, 22E52)
$_{22}Ti^{43}$	E excit (45S48)			0.6 s (45S48)				Ca-α-n (45S48)
Ti^{45}	A chem, cross bomb, excit (21A41)		β^+, EC (27K50)	3.09 h (27K50); 3.05 h (11T50); 3.08 h (21A41)	1.02 (≥96%), 0.57 (≤4%) spect (11T50); 1.00 spect (27K50); 1.2 c1 ch (21A41)	0.45 (weak), (no 0.8 γ) spect (11T50); 0.80 spect, abs (27K50)	Q_{β}^{+} 2.04 (HPS)  (11T50)	Ca-α-n (21A41); Sc-p-n (21A41, 11T50, 27K50), Sc-d-2n (21A41, 11T50); Ti-n-2n (21A41); Ti-γ-n (34H43b, 34H44, 25W48, 22E52); spall Fe (45R52), Cu (42B51a, 74M52)

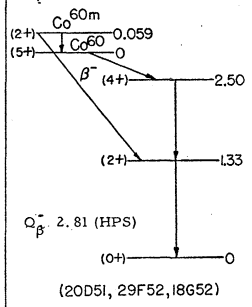
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{22}Ti^{46}$		7.95 (6N38a)						
Ti^{47}		7.75 (6N38a)						
Ti^{48}		73.45 (6N38a)						
Ti^{49}		5.51 (6N38a)					Ti^{49}, I = 7/2 (?) (29J52)	
Ti^{50}		5.34 (6N38a)						
Ti^{51}	B n-capt (2S47)		β^- (2S47)	5.82 m (3S52); 5.75 m (2B52); 6 m (24S49a, 38M50, 2S47)	1.7, 1.35 (coinc with 0.32 γ) scint spect (38M52); 2.2 (~30%), 1.9 (~70%) abs, spect (60K52); 1.6 abs (24S49a)	0.320, 0.910 (weak) scint spect (2B52); 0.32 scint spect (38M51a, 60K52)	see Cr^{51}	Ti-n-γ (2S47, 38M50)
$_{23}V^{46}$	E excit (98M52)		β^+ (98M52)	0.40 s (98M52)	>6.0 scint spect (98M52)			Ti-p-n (98M52)
V^{47}	A chem, excit, cross bomb (12O42); chem, sep isotopes (26K49)		β^+ (30W37b)	33 m (26K49, 12O42, 30W37b)	1.7 abs (26K49); 2.0 abs (35B46a, calc from 30W37b); ~1.9 abs (12O42, 30W37b)	γ (26K49)		Ti-d-n (30W37b, 12O42); Ti-p-n (12O42) Ti^{47}-p-n (26K49) spall Fe (45R52)
V^{48}	A chem, excit, cross bomb (30W37c, 30W37b)		β^+ 58%, EC 42% (21G46); β^+, EC (30W39, 53H44)	16.0 d (30W37b)	0.69 (~95%), ~0.8 (~5%) spect (43R52); 0.72 spect (6P46); 0.6 abs (53H44) 1.0 cl ch (30W37b)	γ_1 0.99, γ_2 1.32 (γ_2 coinc with γ_1), γ_3 2.29 (γ_3/γ_2 = 0.017) scint spect (69M52); γ_1 0.99, γ_2 1.32, γ_3 2.22 scint spect, β^+-γ, γ-γ coinc (43R52); γ_1 0.98, γ_2 1.33 (γ_2 coinc with γ_1, both coinc with β^+) spect, β-γ coinc (6P46); γ_1 (e/γ 2 x 10^{-4}), γ_2 (e/γ 8 x 10^{-5}) spect conv (7Z52); γ_3 2.22 (~2%), no 2.3 γ (lim 0.5%) scint spect (18T52); γ_1 0.99, γ_2 1.32 spect conv (20R49); γ_1 (coinc with γ_2) γ-γ coinc (34J52)	Q^+_β 4.02 (43R52)  (43R52)	Sc-α-n (30W37c); Ti-d-n (30W37b); Ti-p-n (2D40, 18T52); Cr-d-α (30W37b, 6P46); spall Fe (45R52), Cu (32M48, 42B51a); daughter Cr^{48} (45R52)
V^{49}	D chem (30W39, 29T40); excit (43H49, est from 10C49)		EC (30W39)	635 d (10C49) ~600 d (30W39)		0.119, 0.081 spect conv (10C49)		Ti-d-n (30W39); V-n-2n (?) (10C49)
V^{50}		0.24 (43H49, 28L49)					Q^-_β 1.18, Q^+_β 2.39 (23J52); V^{50}, I = 6 (56K52)	

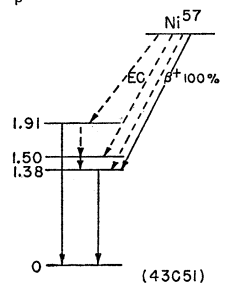
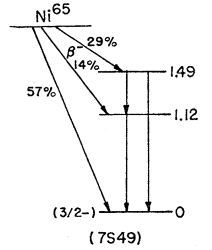
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{23}V^{51}$		99.76 (43H49, 28L49)					V^{51}, I = 7/2 (87M50, 97B51c)	
$V^{52(m?)}$	A chem, n-capt (12A35); cross bomb, excit (30W37b)		β^- (12A35); IT (25R50)	3.76 m (3S52); 3.74 m (42M47); 3.75 m (12A35)	2.1 abs (3D40a); 2.6 cl ch (4Y42); conv: 0.25, β^- with V^{52}, abs, β-γ, β-conv coinc (25R50)	1.5 abs (42M47); 1.3 abs (28G48); ~1.5 γ with V^{52} (25R50)		V-n-γ (12A35, 30W37b, 1P37, 2S47, 9O49, 25R50, 50H51); V-d-p (30W37b); Cr-n-p (30W37b, 1P37); Cr-γ-p (42H47); Cr^{54}-d-α (15N50); Mn-n-α (12A35, 30W37b, 1P37)
V^{52}	F n-capt (25R50)		β^- (25R50)	2.6 m (25R50)	2.7 cl ch (4Y42)	1.5 abs (42M47)		V-n-γ (25R50)
$V^{52,50m}$	F V^{52}: (10C49); V^{50m}: (43H49)			16 h (10C49)				V-n (10C49)
V^{53}	B chem, sep isotopes, excit (88H52)		β^- (88H52)	23 h (88H52)	~0.6 abs (88H52)			Cr^{54}-γ-p (88H52)
$_{24}Cr^{48}$	B chem, genet (45R52)		EC (45R52)	~23 h (45R52)				spall Fe, parent V^{48} (45R52)
Cr^{49}	A chem, excit, cross bomb (12O42)		β^+ (12O42)	41.9 m (12O42); 45 m (34H44)	1.45 abs, cl ch (12O42)	0.18, 1.55 abs (12O42)		Ti-α-n (12O42); Cr-n-2n (12O42); Cr-γ-n (34H44, 12P49); spall Fe (45R52), Co (29W52), Cu (32M48, 42B51a, 74M52), As (48H50)
Cr^{50}		4.31 (24W48)						
Cr^{51}	A chem, excit, cross bomb (30W40b); chem, genet (50B50)		EC (16B45a, 30W40b); no β^+ (16B45a, 28K49, 35L52)	27.8 d (35L52); 26.5 d (30W40b)		0.330 (~3%, e_K/γ ~0.02), spect spect conv (16B45a); 0.32 (8%, e/γ very small) scint spect, x-γ coinc (35L52); 0.323 spect, spect conv (28K49); 0.320 (single γ) spect (17K48); 0.32 spect conv (43M46); others (52M51, 28K49, 13A50b)	 (38M51a, 14S52a, 35L52)	Ti-α-n (30W40b); V-p-n (16B45a); Cr-d-p (30W40b, 22A40); Cr-n-γ (30W40b, 2S47); Cr-n-2n (22A40); spall Fe (45R52), Cu (32M48, 42B51a), As (48H50); daughter Mn^{51} (50B50)
Cr^{52}		83.76 (24W48)						
Cr^{53}		9.55 (24W48)					Cr^{53}, I = 3/2 (97B51)	
Cr^{54}		2.38 (24W48)						
Cr^{55}	G not found: sep isotopes, excit, cross bomb (15N50); chem, excit (32M50)			~2 h (18D40)				Cr-n (18D40, 22A40, 2S47); Cr-d (22A40)

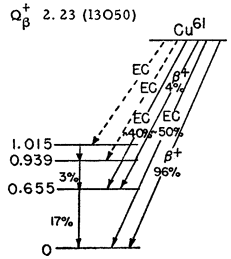
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{25}Mn^{49}$, Mn^{50}	E excit (39T52, 98M52)		β^+ (98M52)	0.28 s (98M52); ~0.5 s (39T52)	>6.3 scint spect (98M52)			Cr-p-2n (39T52); Cr-p-n (98M52)
Mn^{51}	A chem, cross bomb (12L37, 12L38); chem, genet (50B50)		β^+ (12L37)	44.3 m (50B50); 46 m (12L38)	2.4 abs (35B46a, calc from 12L38); 2.0 abs (12L38)			Cr-d-n (12L38, 50B50); Cr-p-γ (2D38, 5D39); Fe-γ-p2n (42S52); spall Fe (45R52), Cu (32M48, 42B51a, 74M52); parent Cr^{51} (50B50)
Mn^{52m}	A chem (19D37); chem, excit, cross bomb (12L37, 12L38)		β^+ 99+%, IT (?) ~0.05% (1O47)	21.3 m (40H40); 21 m (12L38, 19D37)	2.66 spect (1O47); 2.2 cl ch (40H40)	1.46 (coinc with β^+) spect, β-γ coinc (1O47); 0.392 (0.05%) (with IT?) spect conv (1O47)	Q^+_β 5.1 (1O47)	Cr-p-n (40H40); Fe-d-α (19D37, 12L38); Fe-γ-pn (22E52, 42S52); daughter Fe^{52} (32M48)
Mn^{52}	A chem, excit, cross bomb (12L37, 12L38)		EC 65%, β^+ 35% (21G46)	6.0 d (29H50); 6.2 d (84H51); 6.5 d (12L38); 6 d (32M48)	0.58 spect (6P46); 0.75 abs (19T48); 0.77 cl ch (40H40)	γ_1 0.73, γ_2 0.94, γ_3 1.46 (γ_1 coinc with γ_2 and γ_3, all coinc with β^+) spect, β-γ coinc (6P46)	Q^+_β 4.7 (6P46)  (18G52, HPS)	Cr-p-n (40H40); Cr-d-2n (6P46); Fe-d-α (12L38); spall Fe (45R52), Co (29W52), Cu (32M48, 42B51a, 74M52), As (48H50); spall-fission U (6F51)
Mn^{54m}	F sep isotopes (40C51)		β^- (40C51)	2.1 m (40C51)				Fe^{54}-n-p, Fe^{54}-d-2p (40C51)
Mn^{54}	A chem, excit, cross bomb (12L37, 12L38)		EC (6A38); no β^+, no β^- (12L38, 20D44)	310 d (12L38)		0.84 spect, x-γ coinc (20D44); 0.85 abs (12L38)	 (20D44)	V-α-n (12L38); Cr-d-n (12L38); Cr-p-n (2D40); Fe-d-α (12L38, 20D44); spall Fe (45R52). Cu (42B51a)
Mn^{55}		100 (37S36a)					Mn^{55}, I = 5/2 (97B51a)	
Mn^{56}	A chem, n-capt (12A35)		β^- (12A35)	2.576 h (106B52a); 2.59 h (12L38, 9B50)	2.81 (50%), 1.04 (30%), 0.65 (20%) spect (7S46c); 2.86 (60%), 1.05 (25%), 0.75 (15%) spect (4E43a); 2.88, 1.04 spect (14T41)	γ_1 0.822, γ_2 1.77, γ_3 2.06 ($\gamma_1/\gamma_2/\gamma_3$ ≈ 10/3/2) spect (7S46c); (γ_2/γ_3 = 1.0) spect (5S51); γ_1 0.85, γ_2 1.81, γ_3 2.13 ($\gamma_1/\gamma_2/\gamma_3$ ≈ 10/3/2) spect, β-γ coinc (4E43a); ~2.7 (~0.1%), ~3.0 (~0.2%) D-γ-p ion ch (9B50)	Q^-_β 3.63 (7S46c)  (7S46c, 4E43a)	Cr-α-p (18R37); Mn-n-γ (12A35, 2S47, 9O49, 50H51); Mn-d-p (12L38); Fe-d-α (12L38); Fe-n-p (12A35); Fe-γ-p (12P48, 22E52); Co-γ-2pn (22E52); Co-n-α (12A35); spall Fe (45R52), Co (29W52), Cu (32M48, 42B51a, 74M52), As (48H50)
Mn^{57}	B chem, cross bomb (112S51)		β^- (112S51)	7 d (112S51)	1.0 spect (112S51)			Mn-α-2p, Cr-α-p (112S51)

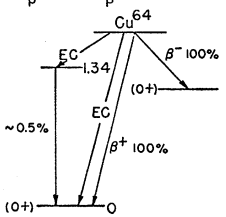
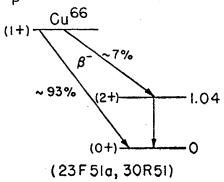
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{26}Fe^{52}$	A chem, genet (32M48)		EC 60%, β^+ 40% (23F51)	8.3 h (23F52b); 7.8 h (32M48)	~0.55 abs (32M48); ~0.6 abs (23F51)	no γ >0.5 scint spect (23F51)	 (23F51, HPS)	Cr-α-2n (23F51); Fe-γ-2n (42S52); spall Fe (45R52), Co (29W52), Cu (32M48, 51B50, 23F51, 42B51a, 74M52); parent Mn^{52m} (32M48); not parent Mn^{52} (lim 5%) (23F51)
Fe^{53}	A chem (18R37); chem, excit, cross bomb (12L38a)		β^+ (18R37)	8.9 m (18R37, 12L38a)	2.5 scint spect (52B51); 2.6 abs (15N50)	no γ (15N50)		Cr^{50}-α-n (15N50); Cr-α-n (18R37, 12L38a); Fe-n-2n (12L38a); Fe-γ-n (34H42, 34H44, 52B51, 22E52, 42S52); Fe^{54}-γ-n (12P49); spall Cu (32M48, 42B51a, 74M52)
Fe^{54}		5.84 (6V41)						
Fe^{55}	A chem, excit (12L39a)		EC, no β^+ (16B46b, 94M51)	2.94 y (53B50); 3.0 y (53S51)		no γ (6P46a); ~0.07 (0.002%), Mn K-x (16B46b)	Q_{EC} 0.21 continuous γ spectrum (94M51, 94M51a)	Mn-d-2n (51H48); Mn-p-n (2V40, 16B46b); Fe-d-p (12L39a); spall Co (93M51), Cu (42B51a, 93M51); daughter Co^{55} (12L41)
Fe^{56}		91.68 (6V41)						
Fe^{57m}	A genet (20D50)		IT (20D50)	1.1×10^{-7} s delay coinc (20D50)		0.014 spect (20D50)	see Co^{57}	daughter Co^{57} (20D50)
Fe^{57}		2.17 (6V41)						
Fe^{58}		0.31 (6V41)						
Fe^{59}	A chem, excit, cross bomb (12L38a)		β^- (12L38a)	45.1 d (53S51); 47.1 d (22T51); 45.5 d (29G43); 46 d (54S47)	0.460 (~50%), 0.257 (~50%) spect, β-γ coinc abs (20D42); 0.45, no 0.26 β^- spect (48M51)	γ_1 1.295, γ_2 1.097 spect (12H50); γ_1 1.29, γ_2 1.10 (not coinc with γ_1) spect, γ-γ coinc (48M51); 1.30, 1.10 spect (20D42); γ_1 (e_K/γ 0.84×10^{-4}), γ_2 (e_K/γ 1.45×10^{-4}) spect conv (93B52); 0.195 (2.5%, coinc with 1.1 γ) scint spect, γ-γ coinc (44M52); others (52M51)	 (HPS)	Fe-d-p (12L38a, 20D42); Fe-n-γ (26S42, 4W43, 2S47); Co-n-p (12L38a, 2I46); Co-d-2p (17T48); spall Cu (32M48, 51B50, 42B51a, 74M52), As (48H50); spall-fission Ta (22N52), Bi (11G49), U (6F51)
Fe^{60}	E chem (6F51)		β^- (6F51)	8.4 h (6F51)	~1.5 abs (6F51)			spall-fission U (6F51)

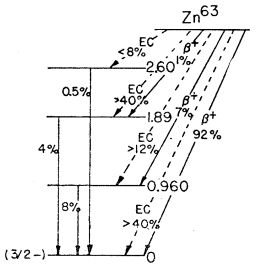
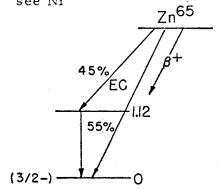
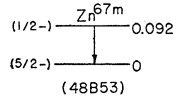
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{27}Co^{54}$	E excit (98M52)		β^+ (98M52)	0.18 s (98M52)	>7.4 scint spect (98M52)			Fe-p-n (98M52)
Co^{55}	A chem (19D37); chem, cross bomb, genet (12L41)		β^+ ~60%, EC ~40% (calc from 20D49)	18.2 h (19D37)	1.50 (~50%), 1.01 (~50%) spect (20D49); 1.50 spect (24L39)	γ_1 0.477 (γ/β^+ 0.3, e/γ 0.0007), γ_2 0.935 (γ/β^+ 1.4, e/γ 0.0005), γ_3 1.41 (γ/β^+ 0.3, e/γ 0.00004) spect, spect conv, β-γ coinc (20D49); others (85S51)	Q^+_β 3.45 (20D49)  (20D49)	Fe-d-n (19D37, 12L41, 20D49); Fe-p-γ (12L38b, 12L41); Ni-γ-p2n (42S52); spall Fe (45R52), Co (29W52), Cu (32M48, 42B51a, 74M52), As (48H50); parent Fe^{55} (12L41)
Co^{56}	A chem, excit, cross bomb (12L41)		EC, β^+ (4E43a, 28C42)	72 d (12L41); 80 d (28C42)	1.50 (coinc with γ_1 and γ_2) spect (4E43a); 1.2 abs (12L41, 28C42)	γ_1 0.845, γ_2 1.26 (coinc with γ_1), γ_3 1.74, γ_4 2.01, γ_5 2.55, γ_6 3.25 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ = 1.0/0.5/0.2/0.1/0.2/0.2) spect, β-γ coinc (4E43a); others (85S51)	Q^+_β 4.6 (4E43a)	Fe-d-2n (12L41, 16J41, 21P42, 4E43a); Fe-α-np (12L41); Co-p-p3n (29W52); Ni-d-α (12L41, 28C42, 4E43a); Ni-γ-pn (42S52); spall Fe (45R52), Cu (42B51a); daughter Ni^{56} (44S52, 32W52)
Co^{57}	A chem, excit, cross bomb (12L41)		β^+ (12L41)	270 d (12L41)	0.26 abs (12L41)	0.119, 0.131 spect (4E43a); 0.117 (e/γ large, K/L 7), 0.130 (e/γ large, K/L 7) spect, spect conv (21P42); with Fe^{57m}: 0.014 spect (20D50)	Q^+_β 1.4 (HPS)  (18G52)	Fe-d-n (12L38b, 22P38, 54B39, 12L41); Fe-p-γ (12L41); parent Fe^{57m} (20D50); daughter Ni^{57} (23F52)
Co^{58m}	A chem, excit (55S50)		IT, no β^+ (55S50)	9.2 h (25C50); 9.0 h (37A52); 8.8 h (55S50)		0.025 (e/γ large, K/L 1.9) spect conv (55S50)		Mn-α-n, Co-d-p2n, Co-n-2n, Ni-n-p, Ni-d-2p (55S50); Fe^{58}-p-n (37A52); Co-γ-n (25C50); spall Cu (55S50, 74M52)
Co^{58}	A chem, excit, cross bomb (12L41)		EC 85%, β^+ 15% (21G46)	72 d (12L41)	0.47 spect (20D44); 0.4 abs (12L41)	0.81 spect, β-γ coinc (20D44); ~0.81 (e/γ 0.0003) spect conv (55S50); 0.6 abs (12L41)	Q^+_β 2.3 (18G52)  (18G52)	Mn-α-n (12L38b, 12L41); Fe-d-n (12L38b, 22P38, 54B39, 12L41); Fe^{58}-p-n (37A52); Fe-p-n (12L38b); Fe-α-np (12L41); Fe-p-γ (12L41); Co-p-pn (29W52); Ni-n-p (7V38, 12L41, 20D44); spall Cu (51B50, 42B51a, 74M52), As (48H50)
Co^{59}		100 (45M41)					Co^{59}, I = 7/2 (87M50, 97B51d)	

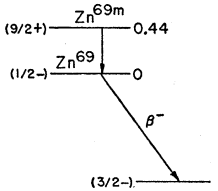
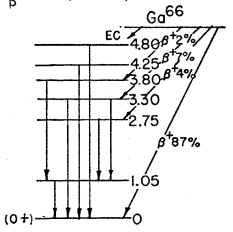
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{27}Co^{60m}$	A n-capt (6H37a); chem, excit, cross bomb (12L41)		IT 99+%, β^- 0.28% (20D51)	10.1 m (106B52b); 10.7 m (12L41)	1.56 spect (6P47); 1.35 spect (15N42); 1.28 spect (20D45)	0.0589 (K/L 4.6) spect conv (42C50); 0.059 scint spect (31K51); 0.055 spect conv (20D45)	Q_{β}^- 2.89 (HPS)  Q_{β}^- 2.81 (HPS) (20D51, 29F52, 18G52)	Co-n-γ (6H37a, 12L37, 12L41, 20D42a, 2S47); Co-d-p (15N42); Ni-n-p (6H37b, 12L41)
Co^{60}	A n-capt (37S36); chem, excit, cross bomb (12L41)		β^- (27R37)	5.27 y (22T51); 5.3 y (12L41, 53B50, 38S51)	0.306 spect (29F52); 0.318 spect (31W50a); 0.310 spect (43M47)	γ_1 1.3316, γ_2 1.1715 cryst spect (29L49); 1.3316, 1.1715 spect γ-γ coinc (16D51); γ_1 (e/γ 1.24×10^{-4}), γ_2 (e/γ 1.72×10^{-4}) spect conv (29F52); γ_1 (e/γ 1.29×10^{-4}), γ_2 (e/γ 1.73×10^{-4}) spect conv (31W50, 31W50a); γ_1 (e/γ 1.8×10^{-4}), γ_2 (e/γ 2.3×10^{-4}) spect conv (7S50); others (17B50, 44M50a, 13A49, 36A52, 37D51, 85B50a, 85S51)		Co-d-p (12L38b, 54B39, 12L41, 20D42a, 15N42); Co-n-γ (27R37, 12L38b, 12L41, 2S47, 1Y51); Ni-d-α (12L41); Cu-n-α (12M46c); spall-fission Bi (66B51)
Co^{61}	A chem, excit, cross bomb, sep isotopes, mass spect (23P47)		β^- (23P47)	99.0 m (56S51); 105 m (23P49); 110 m (48H50)	1.42 (~55%), 1.00 (~45%) abs (56S51); 1.3 abs (23P49)	~0.5 abs (56S51); no γ (23P49, 29K48)	Q_{β}^- 1.4 (HPS)	Co-α-2p (11ZS51); Co-t-p (29K48); Ni-γ-p (12P48, 56S51, 22E52); Ni^{64}-p-α (23P47, 23P49); Ni^{61}-n-p (23P47, 23P49); Ni-d-αn, Cu-n-αn (23P47, 23P49); Cu-γ-2p (12P48); Cu-γ-α (49H51); spall Cu (32M48, 42B51a, 74M52), As (48H50); spall-fission Ag (42B51), U (6F51)
Co^{62}	A chem, sep isotopes (23P49)		β^- (23P49)	13.9 m (23P49)	2.3 abs (23P49)	1.3 (coinc with β^-) abs, β-γ coinc (23P49)		Ni^{62}-n-p (23P49)
Co^{62}	E cross bomb, sep isotopes (23P49)		β^- (23P49)	1.6 m (23P49)		γ (23P49)		Ni^{62}-n-p, Ni^{64}-d-α (23P49)
Co^{64}	F cross bomb, sep isotopes (23P49)			~5 m (23P49)				Ni^{64}-n-p (23P49)
$_{28}Ni^{56}$	A chem (32W52); chem, sep isotopes, genet (44S52)		EC ~100%, no β^+ (lim 1%) (44S52)	6.4 d (44S52); 6.0 d (32W52)		γ_1 0.17, γ_2 0.28, γ_3 0.48, γ_4 0.81, γ_5 0.96, γ_6 1.33, γ_7 1.58, γ_8 1.75 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7/\gamma_8 \approx 1.0/0.3/0.4/0.8/0.1/0.05/0.15/0.02$) scint spect (44S52); 0.14, 0.77, >1.4 scint spect (32W52)		Fe-α-2n (32W52); Fe^{54}-α-2n (44S52); spall Zn (32W52); parent Co^{56} (44S52, 32W52)

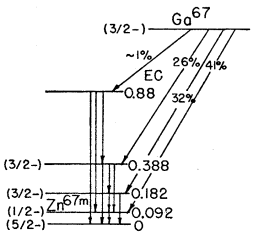
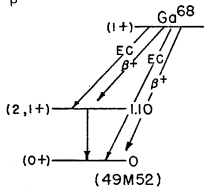
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{28}Ni^{57}$	A chem, excit, cross bomb (12L38c)		β^+ 50%, EC 50% (23F50)	36 h (46M49, 12L38c)	0.835 spect (43C51); 0.845 spect (23F50)	γ_1 1.91, γ_2 1.38 ($\gamma_2/\gamma_1 = 6$) spect (43C51); γ_1 1.90, γ_2 1.39 ($\gamma_2/\gamma_1 = 5$) scint spect (44S52); 0.128 spect, spect conv (43C51); 0.120, 1.9 scint spect, spect conv, β-γ coinc (23F50)	Q^+_β 3.24 (43C51) 	Fe-α-n (12L38c, 14D41, 15N42a, 46M49, 23F50, 43C51); Co-p-3n (29W52); Ni-n-2n (12L38c, 14D41, 15N42a, 80M52); Ni-He^3-α (1P52); Ni-γ-n (34H44, 12P48, 12P49, 22E52, 42S52); spall Cu (32M48, 42B51a, 74M52), As (48H50); parent Co^{57} (23F52)
Ni^{58}		67.76 (24W48)						
Ni^{59}	A chem, cross bomb, n-capt (44C45); chem, sep isotopes, n-capt (48B51)		EC (23F49)	8×10^4 y yield (48B51); 8×10^5 y yield (33W51); $\sim 3 \times 10^5$ y yield (23F49)		Co-K-x, no γ (33W50, 33W51); Co-K-x (48B51, 23F49)		Fe-α-n (44C45); Co-d-2n (48B51); Ni-n-γ (44C45, 33W50); Ni^{58}-n-γ (48B51); Ni-d-p (44C45)
Ni^{60}		26.16 (24W48)						
Ni^{61}		1.25 (24W48)						
Ni^{62}		3.66 (24W48)						
Ni^{63}	A chem, n-capt, sep isotopes (48B51)		β^- (23F49, 48B51)	85 y yield (48B51); 61 y yield (33W51)	0.067 ion ch (48B51); 0.063 ion ch (33W49)			Ni-n-γ (23F49, 33W49, 33W50, 48B51); Ni^{62}-n-γ (48B51)
Ni^{64}		1.16 (24W48)						
Ni^{65}	A n-capt (6R35); chem, sep isotopes, excit (54S46, 45C46)		β^- (6H37b)	2.564 h (57S49); 2.6 h (12L38c, 46M49)	2.10 (57%), 1.01 (14%), 0.60 (29%) spect (7S49)	1.49, 1.12, 0.37 spect, β-γ, γ-γ coinc (7S49); others (54W51)	Q^-_β 2.10 (7S49) 	Ni-d-p (12L38c, 15N42a); Ni-n-γ (6H37b, 14D41, 15N42a, 2S47, 46M49); Ni^{64}-n-γ (45C46); Cu-n-p (6H37b); Cu^{65}-n-p (54S46); Cu^{65}-t-He^3 (29K51); Cu-d-2p (32M48, 51B50); Zn-n-α (6H37b); spall Cu (74M52), As (48H50); spall-fission Ta (22N52), Bi (11G49), U (6O48, 6F51)
Ni^{66}	A chem, genet (11G49)		β^- (11G49)	56 h (11G49, 48H50)				spall As (48H50); spall-fission Ta (22N52), Bi (11G49), U (6F51); parent Cu^{66} (11G49)

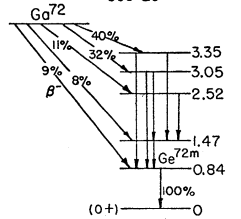
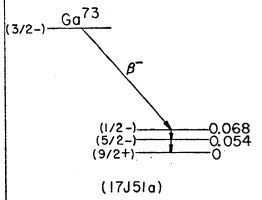
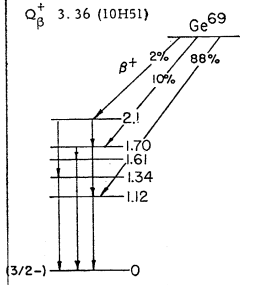
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{29}Cu^{58}$	B chem (5D39); chem, excit, sep isotopes (30L47)		β^+ (5D39)	7.9 m (5D39); 10 m (30L47)				Ni-p-n (5D39); Ni^{58}-p-n (30L47)
Cu^{58}	C excit (39T52, 98M51)		β^+ (98M51)	3.04 s (98M51); 2.6 s (39T52)	>7.5 scint spect (98M51)			Ni-p-n (39T52, 98M51)
Cu^{59}	E chem (5D39); excit, sep isotopes (30L47)		β^+ (5D39)	81 s (5D39, 30L47)				Ni-p-γ (5D39); Ni^{58}-p-γ (30L47)
Cu^{60}	A chem, excit, sep isotopes, mass spect (30L47)		β^+ (30L47)	24.6 m (30L47)	1.8, 3.3 (<5%) abs (30L47)	1.5 abs (30L47)		Ni-p-n (30L47); Ni^{60}-p-n, Ni^{60}-d-2n, Ni^{58}-α-pn (30L47); spall Cu (42B51a), As (48H48a)
Cu^{61}	A chem, excit (18R37a); chem, excit, sep isotopes (30L47, 29K50)		β^+ 68%, EC 32% (28C51); β^+ 72%, EC 28% (55B50); β^+ 75%, EC 25% (34H49)	3.33 h (28C48b); 3.4 h (6T37a, 18R37, 29K50); 3 3 h (48H50)	1.205 (96%), 0.55 (4%) spect (13O50); 1.23 spect (16B45b)	γ_1 0.655 (γ/β^+ 0.25, e/γ ~0), γ_2 0.284 (γ/β^+ 0.05, e/γ 0.015), γ_3 0.076 (γ/β^+ 0.01, e/γ large) spect, spect conv (13O50); γ_1 (17%), γ_2 (3%), γ_3 (~0.6%) (calc from 28C51, 13O50); 0.652, 0.279, 0.070 (K/L ~10) spect, spect conv (56B50)	Q^+_β 2.23 (13O50)  (13050, 28C51, HPS)	Ni-d-n (6T37a); Ni-p-n, Ni-p-γ (58S38, 5D39); Ni^{61}-p-n (30L47); Ni-He^3-d (1P52); Ni-α-p (18R37, 29K50); Cu-γ-2n (12P48, 22E52); Zn-γ-p2n (55S51, 42S52); spall Cu (32M48, 42B5la, 74M52), As (48H50); spall-fission Bi (66B51), U (6F51)
Cu^{62}	A excit (6H37a); excit, cross bomb (18R37, 58S38, 37B39); chem, sep isotopes (30L47)		β^+ (6H37a)	10.1 m (30L47); 10.0 m (18R37); 9.9 m (12P48); 10.5 m (6H37a)	2.92 spect (61H50); abs (30K50); 2.83 spect (25B49)	0.56 abs (19T47)		Co-α-n (18R37); Ni-p-n, Ni-p-γ (58S38); Ni^{60}-α-pn (48G50); Cu-n-2n (6H37b, 80M52, 30B52); Cu-p-pn (48G50); Cu-γ-n (37B39, 34H43, 34H43b, 55K52, 25B49, 12P48, 22J50, 55S51, 22E52); Cu-e^--e^-n (59S48); Cu-d-t (9K40a, 9K4la); Zn-γ-pn (55S51, 22E52, 42S52); spall Cu (32M48, 42B5la, 74M52), As (48H50); daughter Zn^{62} (32M48)
Cu^{63}		69.1 (57B47)					Cu^{63}, I = 3/2 (87M50)	

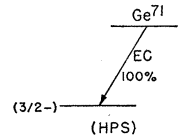
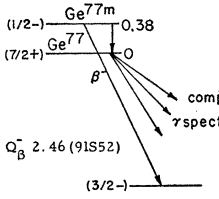
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{29}Cu^{64}$	A chem, n-capt (12A35); excit (2V36); chem, excit (5D39)		EC 42%, β^- 39%, β^+ 19% (HPS, calc from average of K/β^+ and β^-/β^+); K/β^+ 2.2 (24P51); K/β^+ 2.3 (28R50); K/β^+ 1.8 (34H49); K/β^+ 2.7 (55B50); β^-/β^+ 2.0 (55B49, 28C48c); β^-/β^+ 2.1 (16B46a); $\frac{\beta^+ + EC}{\beta^-}$ 1.62 (28R50)	12.80 h (29R50); 12.74 h (53S51); 12.88 h (57S49); 12.8 h (2V36, 48H50)	β^-: 0.571 spect (28C48c, 13O49); 0.570 spect (6P47); 0.58 spect (20T39, 14T41) β^+: 0.657 spect (28C48c, 13O49); 0.644 spect (6P47); 0.65 spect (14T41); 0.66 spect (20T39)	γ (with EC) coinc (16B46a); γ (1% of EC) (HPS, calc from 20D47, 27K50, 28R50); 1.34 (weak) spect (17K48); 1.35 (γ/β^+ 0.025) spect (20D47); 1.33 scint spect (11B50d); (γ/β^+ 0.023) abs (10V52); 1.38 (γ/β^+ 0.032) abs (27K50); ~1.34 (e_K/γ ~1.3 x 10^{-4}) spect conv (93B52); γ (e/γ <0.005) spect conv (47M48)	Q^-_β 0.57, Q^+_β 1.68 (HPS)  (HPS)	Ni-p-n (58S38, 5D39); Ni-He^3-p (1P52); Cu-d-p (2V36); Cu-n-γ (6H37b, 2S47); Cu-n-2n (6H37b, 74M52); Cu-p-pn (23R46, 42B51a); Cu-t-d (29K51); Cu-γ-n (34H43b, 34H44, 22J50, 12P49, 55S51, 22E52); Zn-n-p (12A35, 6H37b); Zn-γ-pn (55S51, 22E52); spall Cu (32M48, 42B51a), As (48H50); spall-fission Bi (66B51), U (6F51)
Cu^{65}		30.9 (57B47)					Cu^{65}, I = 3/2 (87M50)	
Cu^{66}	A n-capt (12A35); excit (7C37)		β^- (12A35)	5.10 m (3S52); 5.12 m (53S51); 5.17 m (30R51); 5.18 m (46C50); 5.2 m (23F51a)	2.63 (91%), 1.5 (9%) spect (23F51a); 2.7 (~94%), 1.65 (~6%) scint spect, β-γ coinc (30R51)	1.044 (γ/β^- 0.10, e/γ <3 x 10^{-3}) spect, spect conv (23F51a); 1.05 scint spect (30R51, 94M51a)	Q^-_β 2.63 (23F51a)  (23F51a, 30R51)	Cu-n-γ (12A35, 2S47, 9O49, 50H51); Cu-d-p (31L40); Zn-n-p (6H37b); Ga-n-α (7C37); daughter Ni^{66} (11G49)
Cu^{67}	A chem (11G49); chem, cross bomb, sep isotopes (29K50)		β^- (11G49)	58.5 h (29K50); 61.0 h (80S52); 56 h (11G49); 61 h (48H50)	0.38 (67%), 0.57 (33%) spect (80S52); 0.54 abs (29K50)	0.191 (e/γ 0.01, K/L ~8), 0.096 (e/γ 0.09, K/L 7.4) scint spect, spect conv, β-γ coinc (80S52)	see Ga^{67}	Ni^{64}-α-p (29K50); Cu-α-2p (11J51); Cu-t-p (29K51); Zn^{67}-n-p (29K50); Zn-γ-p (23D48, 55S51, 22E52) spall As (48H50); spall-fission Bi (11G49, 66B51), U (6F51)
$_{30}Zn^{62}$	A chem, genet (32M48); excit (48G50)		EC ~90%, β^+ ~10% (61H50)	9.33 h (61H50); 9.5 h (32M48)	0.66 spect (61H50)	0.0418 (K/L >6) spect conv (61H50)		Ni-He^3-n (1P52); Ni^{60}-α-2n (48G50); Cu-p-2n (48G50); Zn-γ-2n (55S51, 22E52, 42S52); spall Cu (32M48, 61H50, 51B50, 42B51a), As (48H50); parent Cu^{62} (32M48)

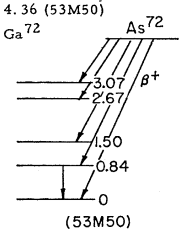
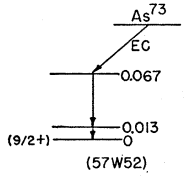
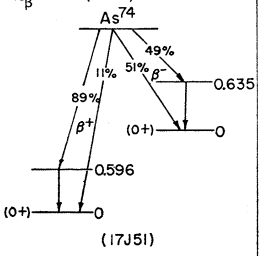
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{30}Zn^{63}$	A chem, excit (37B37, 6H37b, 18R37)		β^+ 93%, EC 7% (34H47)	38.3 m (34H47, 58S38); 38.5 m (5D39)	2.36 (92%), 1.40 (7%), 0.5 (~1%) spect (34H47); 2.32 spect (14T41)	0.960 (~8%, e/γ 2 x 10^{-4}), 1.89 (~4%, e/γ ~0), 2.60 (~0.5%, e/γ ~0) spect, spect conv, abs, γ-γ coinc (34H47)	Q^+_β 3.38 (34H47)  (34H47)	Ni-α-n (18R37); Ni^{60}-α-n (48G50); Cu-p-n (58S38, 5D39, 47B51b, 48G50); Cu-d-2n (31L40, 14T41); Zn-n-2n (6H37b, 1P37); Zn-γ-n (37B39, 12P49, 55S51, 22E52, 42S52); Zn-γ-3n (55S51); spall Cu (32M48, 51B50, 42B51a), As (48H50)
Zn^{64}		48.89 (1B50)					Zn^{64}, I = 0 (87M50)	
Zn^{65}	A chem (22P38); chem, excit, cross bomb (12L39)		EC (K) 97.5%, β^+ 2.5% (95M52, 4Y52) EC 99+%, β^+ 0.7% (calc from 30G51, 24F51, 21G46a)	250 d (12L39); 245 d (22P38)	0.325 spect (48M49); 0.32 spect (6P47)	1.120 spect conv (48M49); 1.125 spect, spect conv (12H50); 1.114 spect (48M49); 1.112 (e/γ 2.3 x 10^{-4}) spect conv (31W50); 1.127 scint spect (25G51a); 1.12 spect (13J49); γ (46% of EC) x-e coinc (21G46a); γ (44% of EC) x-γ coinc (24F51); $\gamma/\beta^+ \simeq 65$ γ-γ coinc (30G51); 0.21 (coinc with β^+, e/γ ~0.1) β-γ, β-conv coinc (47C50)	see Ni^{65}  (21G46a, 24F51, 95M52)	Cu-d-2n (22P38); Cu-p-n (58B38, 47B51b); Cu-t-n (29K51); Zn-d-p (12L39); Zn-n-γ (42S39, 2S47); spall Cu (42B51a), As (48H50); daughter Ga^{65} (12L39b)
Zn^{66}		27.81 (1B50)					Zn^{66}, I = 0 (87M50)	
Zn^{67m}	A genet (48B53, 47M52)		IT (47M52, 48B53)	8.5 x 10^{-6} s delay coinc (48B53); 9 x 10^{-6} s delay coinc (47M52)		0.092 (e_K/γ 0.63, K/L 7) scint spect (48B53); 0.092 (e/γ 0.6) scint spect (47M52)	see Ga^{67}  (48B53)	daughter Ga^{67} (48B53, 47M52)
Zn^{67}		4.11 (1B50)					Zn^{67}, I = 5/2 (87M50, 38D52)	
Zn^{68}		18.56 (1B50)					Zn^{68}, I = 0 (87M50)	

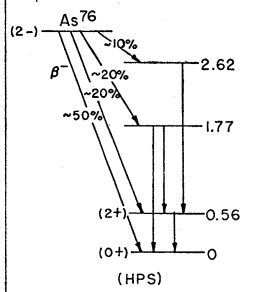
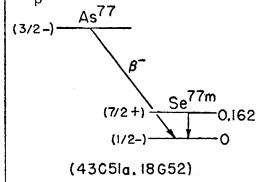
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{30}Zn^{69m}$	A chem, excit (6T38); chem, excit, cross bomb (12L39, 14K39)		IT (14K39)	13.8 h (12L39)		0.437 (e/γ 0.049) spect conv (91S52b); 0.436 (e/γ ~0.065) spect conv, scint spect (23D52); 0.439 (e/γ ~0.04) spect, spect conv (2H41); 0.440 spect (28G41); 0.450 (e/γ ~0.06) (16N44)	 (18G52) Q^-_β 0.90 (HPS, 12L39)	Zn-d-p (12L39, 14K39, 6V39); Zn-n-γ (6T38, 12L39, 2S47); Ga-d-α (12L39); Ga-n-p (12L39); spall As (48H50); parent Zn^{69} (14K39)
Zn^{69}	A chem, n-capt (6H37b); chem, excit, cross bomb (12L39, 14K39)		β^- (6H37b)	57 m (12L39); 51 m (48H48b); 52 m (7H49)	0.897 spect (23D52); 0.914 spect (91S52b); others (14K39, 12L39, 35B46a)	no γ (12L39)		Zn^{70}-γ-n (7H49); Zn-d-p (12L39, 14K39, 6V39); Zn-n-γ (6H36, 6T38, 2S47, 50H51, 42S39); Ga-d-α (12L39); Ga-n-p (12L39); spall As (48H48a); daughter Zn^{69m} (14K39)
Zn^{70}		0.62 (1B50)						
Zn^{71}	E n-capt, cross bomb (28H46b)		β^- (28H46b)	2.2 m (28H46b)	2.1 abs (28H46b)			Zn-n-γ, Ge-n-α (28H46b)
Zn^{72}	A chem, genet (60S46, 60S51)		β^- (60S51)	49.0 h (60S51)	~0.3 (95%), ~1.6 (5%) abs (60S51)	γ (60S51)		As-p-4p (11I2S51); spall As (48H50); spall-fission Bi (11G49), U (6F51); fission Th (21T51), U (60S51), Pu (61S51a); parent Ga^{72} (60S51)
$_{31}Ga^{65}$	A chem, genet (12L39b)		EC (6A38); β^+ >50% (25A52)	15 m (6A38, 12L39b)	2.2 (25A52)	0.054, 0.117 spect conv (6V39)		Cu-He^3-n (1P52); Zn-d-n (6A38, 12L39b); Zn-p-γ (2D40); parent Zn^{65} (12L39b)
Ga^{66}	A chem, excit (50M37, 18R37a)		β^+ 64%, EC 36% (49M52); β^+ 66%, EC 34% (10L50a)	9.45 h (10L50a); 9.4 h (18R37, 59B38); 9.2 h (49M50, 50M37)	4.144 (87%), 1.4 (4%), 0.88 (7%), 0.40 (2%) spect (10L50a); 4.15 (87%), 1.38 (4%), 0.90 (7%), 0.40 (2%) spect (49M52)	γ_1 1.05, γ_2 1.7, γ_3 2.2, γ_4 2.75 coinc with γ_1), γ_5 3.3, γ_6 4.25, γ_7 4.8 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7$ ≈ 3.7/0.3/0.5/2.9/0.5/0.2/0.2) spect, γ-γ coinc abs (49M52); γ_1 1.04, γ_2 1.38, γ_3 1.90, γ_4 2.17, γ_5 2.40, γ_6 2.75, γ_7 3.24, γ_8 3.41, γ_9 3.78, γ_{10} 4.12, γ_{11} 4.33, γ_{12} 4.83 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7/\gamma_8/\gamma_9/\gamma_{10}/\gamma_{11}/\gamma_{12}$ ≈ ~1.5/~0.2/0.14/0.24/0.10/1.00/0.09/0.14/0.08/0.07/0.21/0.09) scint spect, pair scint spect (58M52); 1.06, 2.75, 3.25, 4.27, 4.8 scint spect (55H50); 1.03, 2.75, 4.8 spect, spect conv (10L50a)	Q^+_β 5.16 (23F51a)  (49M52)	Cu-α-n (50M37, 18R37, 10L50a); Zn-p-n (59B38, 49M50); spall Cu (second order reaction) (42B51a, 29W52), spall As (48H50); spall-fission Sn, Ba (42B51); daughter Ge^{66} (48H49)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{31}Ga^{67}$	A chem, excit (50M38a, 50M38); chem, excit, cross bomb (6A38)		EC (6A38); no β^+ (lim 0.01%) (47M52); no β^+ (49M52, 48B53)	77.9 h (22T51); 78.2 h (51M48)		γ_1 0.090 (e_K/γ 0.074), γ_2 0.092 (with Zn^{67m}, e_K/γ 0.63, K/L 7), γ_3 0.182 (e_K/γ 0.011, K/L ~12.5), γ_4 0.206 (e_K/γ 0.029, K/L ~14), γ_5 0.296 (e_K/γ 0.0029), γ_6 0.388 (e_K/γ 0.0019), γ_7 0.496, γ_8 0.790, γ_9 0.880 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7/\gamma_8/\gamma_9$ = 0.073/1.00/0.81/0.021/0.54/0.13/0.004/0.002/0.004) spect conv, scint spect, conv-γ, γ-γ coinc (48B53); γ_2 0.092 (e/γ 0.28, K/L 6.5), γ_3 0.182 (e/γ 0.0091, K/L 9), γ_4 0.205 (e/γ 0.0055), γ_5 0.298 (e/γ 0.0025), γ_6 0.388 (e/γ 0.0017) ($\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ = 62/21/2/12/3) spect, spect conv, conv-γ coinc (49M52); γ_1 0.090 (4%), γ_2 0.092 (with Zn^{67m}, 46%, e/γ 0.6), γ_3 0.182 (21.5%), γ_4 0.20 (2%), γ_5 0.30 (12.5%), γ_6 0.39 (4.5%), γ_7 ~0.50 (<1%), γ_9 ~0.85 (≤1%), γ_{10} ~1.05 (<1%) scint spect, γ-γ coinc (47M52); others (2H41, 10C42, 28G41, 7S52)	 (48B53)	Cu-α-γ (112S51); Cu-He^3-n (1P52); Zn-d-n (6A38, 31G38, 6V39); Zn-α-p (50M38); Zn-p-n (59B38, 6V39); Ge-γ-p2n (42S52); spall Cu (second order reaction) (42B51a), As (48H50); daughter Ge^{67} (48H49); parent Zn^{67m} (48B53, 47M52)
Ga^{68}	A chem, excit (37B37); chem, excit (18R37)		β^+ ~85%, EC ~15% (49M52)	68 m (18R37, 12P48)	1.88 (~96%), 0.77 (~4%) spect (49M52); 2.0 abs (35B46a, calc from 50M37); 1.9 abs (18R37, 50M37); cl ch (50M37)	1.10 spect (49M52)	Q^+_β 2.90 (49M52)  (49M52)	Cu-α-n (18R37, 50M37); Zn-p-n (2D38, 59B38, 49M50); Zn-p-γ (?) (2D38); Zn-d-n (31G38, 6V39); Ga-n-2n (1P37); Ga-γ-n (37B37, 37B39, 12P48); Ge-γ-pn (12P49, 42S52); Ge-d-α (42S41); spall Cu (second order reaction) (42B51a, 29W52), spall As (48H50); daughter Ge^{68} (48H48a)
Ga^{69}		60.2 (3I48)					Ga^{69}, I = 3/2 (87M50)	
Ga^{70}	A chem, n-capt (12A35); chem, excit (2D38)		β^- (2D38)	20.3 m (61B47); 20 m (12A35)	1.65 spect (56H48); 1.62 abs (61B47); ~1.6 cl ch (42S39a)			Zn-p-n (2D38); Zn-α-p (50M38); Ga-n-γ (12A35, 2S47); Ga-n-2n (1P37); Ga-γ-n (37B39, 12P48); Ge-d-α (42S41); Ge-n-p (42S41); As-γ-αn (85H52); spall As (48H50)
Ga^{71}		39.8 (3I48)					Ga^{71}, I = 3/2 (87M50)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{31}Ga^{72}$	A chem, n-capt, excit (12L38a, 42S39)		β^- (42S39)	14.3 h (26M43a, 60S51); 14.1 h (42S39, 9B50)	3.15 (9%), 2.52 (8%), 1.5 (11%), 0.9 (32%), 0.6 (40%) spect (56H48); 3.17 (8%), 2.57 (8%), 1.7 (?) (3%), 1.5 (?) (7%), 1.00 (26%), 0.74 (23%), 0.6 (?) (25%) spect (14M48)	γ_1 2.491, γ_2 2.508 (γ_1/γ_2 0.63) spect (12H52); 2.51 (26%), 2.21 (33%), 1.87 (8%), 1.59 (5%), 1.20 (?) (<2%), 1.05 (5%), 0.84 (100%), 0.68 (<2%), 0.63 (24%) spect, spect conv (56H48); $\gamma_1\gamma_2$ 2.50 (15%), γ_3 2.18 (33%), γ_4 1.81 (10%), γ_5 1.57, γ_6 1.47, γ_7 1.30 ($\gamma_5 + \gamma_6 + \gamma_7$ 28%), γ_8 1.05 (15%), γ_9 0.835 (100%), γ_{10} 0.691 (5%), γ_{11} 0.631 (54%) spect, spect conv (14M48); 3.4 (~0.03%), 3.1 (~0.1%) D-γ-p ion ch (9B50)	Q^-_β 4.0 (56H48, 14M48) see Ge^{72m}  (56H48, HPS)	Ga-d-p (12L38a); Ga-n-γ (42S39, 2S47, 60S51); Ge-n-p (42S41, 60S51); As-d-αp (16C47); As-γ-He^3, As-γ-2pn (85H52); spall-fission Sn, Ba (42B51), Tl (2T47b), Bi (11G49, 13P47), U (6O47, 6F51); fission Th (21T51), U (60S51); daughter Zn^{72} (60S51); parent Ge^{72m} (28B48)
Ga^{73}	B chem, excit (60S46, 60S51)		β^- (60S51)	5.0 h (60S51)	1.4 abs (60S51)	0.0135, 0.054 spect conv (17J51a)	 (17J51a)	Ge-n-p (60S51); Ge-γ-p (12P49); As-γ-2p (85H52); As-α-α2p (112S51); spall-fission Bi (11G49); fission U (60S51)
$_{32}Ge^{66}$	A chem, genet (48H49)		β^+ (?) (48H50)	~150 m (48H50)				spall Cu (second order reaction) (42B51a), spall Ge (48H49), As (48H50); parent Ga^{66} (48H49)
Ge^{67}	A chem, genet (48H49)		β^+ (48H50)	21 m (48H50)				spall Cu (second order reaction) (42B51a), spall Ge (48H49), As (48H50); parent Ga^{67} (48H49)
Ge^{68}	A chem (50M38); chem, genet (48H48b)		EC (48H48b)	250 d (48H50)				spall Cu (second order reaction) (42B51a), spall As (48H48a, 48H50); Zn-α-2n (50M38); parent Ga^{68} (48H48a, 48H50)
Ge^{69}	A chem (50M38); chem, excit, cross bomb (51M48)		EC ~67%, β^+ ~33% (51M48); β^+ (50M38)	39.6 h (51M48); 39.7 h (12D42); 40 h (48H50); 37 h (50M38)	1.215 (88%), 0.610 (10%), 0.22 (2%) spect (10H51)	1.610, 1.340, 1.12, 0.870, 0.576, 0.388, 0.090 spect, β-γ coinc (10H51)	Q^+_β 3.36 (10H51)  (10H51)	Zn-α-n (50M38, 51M48); Ga-d-2n (13S41a, 51M48, 10H51); Ga-p-n (12D42); Ge-n-2n (42S41, 51M48); Ge-γ-n (34H44, 42S52); spall As (48H50)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{32}Ge^{70}$		20.55 (3I48a)					Ge^{70}, I = 0 (35T49)	
Ge^{71}	A chem, excit, cross bomb (13S41a); sep isotopes, n-capt (22R50)		EC, no β^+ (51M48, 26M49)	11.4 d (51M48); 11.3 d (12D42); 11 d (26M49, 13S41a)		no γ (13S41a, 26M49, 51M48); Ga K-x (2S47, 51M48, 26M49)		Ga-d-2n (13S41a, 51M48); Ga-p-n (12D42); Ge-d-p (13S41a, 51M48); Ge-n-γ (2S47, 51M48, 26M49); Ge^{70}-n-γ (22R50); spall As (48H50); daughter As^{71} (48H49)
Ge^{72m}	A genet (28B48)		IT (28B48)	2.9×10^{-7} s delay coinc (52M51); 5×10^{-7} s delay coinc (28B48)		0.7 (e/γ very high) coinc abs conv (28B48, 52M51)	see Ga^{72}	daughter Ga^{72} (28B48); daughter As^{72} (14S50b)
Ge^{72}		27.37 (3I48a)					Ge^{72}, I = 0 (35T49)	
Ge^{73}		7.67 (3I48a)					Ge^{73}, I = 9/2 (35T49)	
Ge^{74}		36.74 (3I48a)					Ge^{74}, I = 0 (35T49)	
Ge^{75m}	A excit (9F52); cross bomb, n-capt, sep isotopes (91S52c)		IT (9F52)	42 s (9F52); 48 s (91S52c)	conv: 0.14 abs (9F52)	0.175 scint spect (91S52c); ~0.150 scint spect (24C52)		Ge^{74}-n-γ (91S52c); Ge-n-γ (9F52, 24C52); As-n-p (9F52, 91S52c)
Ge^{75}	A chem, excit, cross bomb (13S41a); n-capt, sep isotopes (22R50)		β^- (13S41a)	82 m (51M48); 89 m (13S41a); 79 m (22R50)	1.137 (85%, not coinc with γ), 0.614 (15%) spect (91S52c); 1.2 abs (13S41a); 1.3 abs (22R50)	0.265 (e/γ very small), 0.418, 0.572, other γ's spect, spect conv, scint spect (91S52c); 0.25 (~10%) (22R50); no γ (51M48)	Q^-_β 1.14 (91S52c)	Ge^{74}-n-γ (22R50, 91S52c); Ge-n-γ (42S39, 42S41, 2S47); Ge-d-p (42S39, 42S41, 13S41a); Ge-n-2n (42S41, 13S41a); Ge-γ-n (34H44, 12P49); As-n-p (42S41, 13S41a, 51M48); Se-n-α (42S41, 13S41a)
Ge^{76}		7.67 (3I48a)					Ge^{76}, I = 0 (35T49)	
Ge^m	E n-capt (24C52)		IT (24C52)	~0.35 s (24C52)		~0.06 scint spect (24C52)		Ge-n-γ (24C52)
Ge^{77m}	A cross bomb, genet, n-capt (23A47); sep isotopes (22R50)		β ~50%, IT ~50% calc (42F52); β^-, IT (14M52)	59 s (23A47); 57 s (22R50)	2.8 abs (23A47)	0.38 scint spect (14M52)		Ge-n-γ, parent As^{77} (23A47, 22R50); Ge^{76}-n-γ (22R50)
Ge^{77}	A chem, excit, cross bomb (13S41a)		β^- (42S41)	12 h (13S41a, 61S51, 22R50)	2.196 (42%, coinc with γ), 1.379 (β5%), 0.71 (23%) spect (91S52); others (14M52, 61S51, 22R50, 26M49)	0.042, 0.073 (coinc with 0.213 and 0.264 γ), 0.213, 0.264, 0.368, 0.418, 0.564, 1.105, 1.75 spect, β-γ, γ-γ coinc (91S52); 0.209, 0.268, 0.300, 0.327, 0.366, 0.408, 0.425, 0.466 spect conv (91S52); 0.6, 0.3 (coinc with β^-) abs, β-γ coinc (22R50)		Ge^{76}-n-γ (22R50); Ge-n-γ (42S39, 42S41, 2S47); Ge-d-p (42S41, 13S41a, 88S52); Se-n-α (13S41a); fission Th (21T51), U (61S46, 61S51), U^{233} (61S48); parent As^{77} (61S46, 61S51)

Isotope Z A	Class and identification.	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{32}Ge^{78}$	B chem, genet (61S46, 61S51)		β^- (61S51)	2.1 h (61S51)	~0.9 abs (61S51)	γ (61S51)		fission U, parent As^{78} (61S51)
$_{33}As^{70}$	D chem (48H49, 48H50)		β^+ (48H50)	52 m (48H50)				As-d-p6n, daughter Se^{70} (48H50); not found: Ge^{70}-p (37A52)
As^{71}	A chem (42S41); chem, genet (48H49); mass spect (104B52)		EC (48H50); EC, β^+ (51M48a)	60 h (48H50); 50 h (51M48a)		0.162 spect conv (53M50)		Ga-α-2n (53M50); Ge-d-n (51M48a); As-d-p5n (48H50); parent Ge^{71} (48H49)
As^{72}	A chem, excit (14M47); chem, excit, sep isotopes (51M48a)		EC, β^+ (51M48a)	26 h (51M48a, 2V40); 27 h (48H50)	3.34 (19%), 2.50 (62%), 1.84 (12%), 0.67 (5%), 0.27 (2%) spect (53M50); 2.8 abs (14M47, 51M48a)	0.835, others up to 3.0 (weak) spect (53M50)	Q^+_β 4.36 (53M50) see Ga^{72}  (53M50)	Ga-α-n (14M47, 51M48a, 53M50); Ge-p-n (2V40); As-d-p4n (48H50); Se^{74}-d-α (51M48a); daughter Se^{72} (48H48a)
As^{73}	A chem (42S39b); chem, excit, cross bomb, sep isotopes (51M48a); mass spect (17J51a)		EC (4E43b); no β^+ (4E43b, 51M48a)	76 d (51M48a); 90 d (42S39b, 53M50)		0.0135 (L/M 5.4), 0.0539 (K/L+M 5.6) spect conv, conv-conv coinc (17J51a, 17J52); 0.052 spect conv (4E43b, 53M50)	 (57W52)	Ge-d-n (42S39b, 4E43b); Ge^{70}-α-p (51M48a); Ge-α-p (51M48a, 53M50); As-d-p3n (48H50); Se^{76}-p-α (25F51)
As^{74}	A excit (48C38); chem, excit (42S39b)		β^- 53%, β^+ 47% (17J51); β^- ~67%, β^+ ~33% (53M50)	17.5 d (51M48a); 19.0 d (48H50); 16 d (42S39b)	β^-: 1.36 (51%), 0.69 (49%) spect (17J51); 1.45 (47%), 0.82 (53%) spect (53M50) β^+: 1.53 (11%), 0.92 (89%) spect (17J51); 0.96 spect (53M50)	γ_1 0.596, γ_2 0.635 (γ_1/γ_2 = 4) spect, β-γ coinc (17J51); 0.593 spect (53M50); 0.582 spect (20D41)	Q^-_β 1.36 (17J51) Q^+_β 2.55 (17J51)  (17J51)	Ga-α-n (51M48a); Ge-d-n (42S39b, 42S41, 2I42); Ge-p-n (2D40); As-n-2n (48C38, 42S39b); As-d-p2n (48H50); Se-d-α (23F40); Br-γ-an (85H52); spall-fission Bi (11G49)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{33}As^{75}$		100 (6N37)					As^{75}, I = 3/2 (87M50, 29J52)	
As^{76}	A chem, n-capt (12A35)		β^-, no β^+: β^+ lim 0.03% (63B47); β^+ lim 0.07% (41M51); β^+ lim 0.1% (16W48)	26.8 h (34W42); 26.3 h (14M40); 26.1 h (3P48)	3.04 (60%), 2.49 (25%), 1.29 (15%) spect (7S47d); 3.15 (54%), 2.57 (21%), 1.4 (19%), 0.4 (7%) spect (54M51); 3.15 (~40%), 2.7 (~30%), 1.1 (~30%) spect, β-γ coinc (3P48)	0.55, 1.20, 1.70 spect (7S47d); 0.557, 1.22, 1.78 (weak) spect (16W48); 0.558 (e_K/γ 0.002) spect conv (7T52); γ_1 0.57, γ_2 1.25, γ_3 1.84, γ_4 2.15 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ = 1/0.4/weak/weak) spect (43M46); 0.58, 1.20, 1.76, 2.02, no 2.3-2.7 γ (lim 0.01%) scint spect, γ-γ coinc (62B51); γ_1 0.555, γ_2 0.648, γ_3 1.210, γ_4 1.410, γ_5 2.06 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5$ = 1/0.1/0.25/0.02/0.06) spect (57H51); 0.568 (e/γ ~0), 1.25 (e/γ ~0) spect, spect conv (54M49, 54M51); others (52M51)	Q^-_β 3.1 (HPS) 	Ge-p-n (2V40); As-d-p (6T36, 48C38); As-n-γ (12A35, 48C38, 9O49, 50H51); Se-n-p (42S39b); Se-γ-p (42H47); Se-d-α (23F40); Br-n-α (48C38); Br-γ-an, Br-γ-He^3 (85H52)
As^{77}	A chem, genet (61S46, 61S51)		β^- (61S51)	38 h (18H50, 21T51); 40 h (61S51)	0.700 spect (43C51a); 0.679 spect (13J51); no conv (43C51a, 13J51)	no γ (43C51a, 13J51)	Q^-_β 0.70 (43C51a) 	Br-γ-α (85H52); spall-fission Bi (11G49), Th (7N49a), U (6F51); fission Th (21T51), U (61S51), U^{233} (61S48); daughter Ge^{77} (61S51); daughter Ge^{77m} (23A47, 22R50); not parent Se^{77m} (lim 2%) (56M50a)
As^{78}	B chem (26S37a); excit (48C38)		β^- (26S37a)	90 m (61S51, 64B51); 80 m (48C38); 65 m (26S37a, 42S39b)	4.1 (~70%), 1.4 (~30%) abs (61S51); 1.4 cl ch (42S39b)	0.27 abs (42S39b); no γ coinc with 4.1 β^- (74S51a)	Q^-_β 4.1 (74S51a)	Br-n-α (26S37a, 48C38, 42S39b, 64B51); Br-γ-He^3 (85H52); Se-n-p (42S39b); fission U, daughter Ge^{78} (61S46, 61S51)
As^{78}	F chem (64B51)			~40 m (64B51)				fission U, daughter (?) Ge^{78} (64B51)
As^{79}	D chem (65B50)		β^- (11V52)	9 m (65B50); 10 m (11V52)	~2.1 abs (11V52)			Se-γ-p (65B50); Se-n-pn (11V52)
$_{34}Se^{70}$	D chem (48H49, 48H50)		β^+ (48H50)	~44 m (48H50)				As-d-7n, parent As^{70}? (48H50)
Se^{72}	A chem, genet (48H48a)		EC (48H50)	9.7 d (48H50)				As-d-5n, parent As^{72} (48H48a, 48H50)

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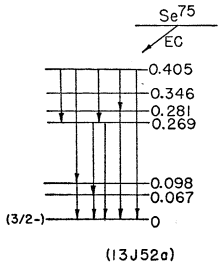
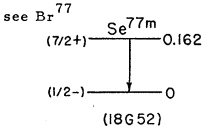
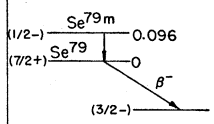
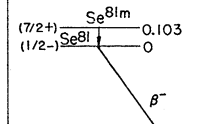
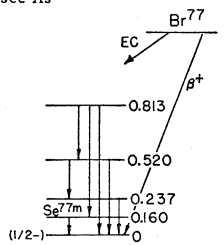
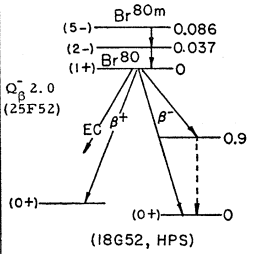
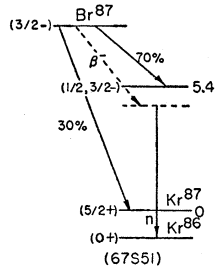
$Se^{73(m?)}$	A chem (48H48a); chem, excit, sep isotopes (49C48)		β^+, EC, IT 20% (?) (62S51)	7.1 h (49C48, 62S51); 6.7 h (48H50)	1.68 (1%), 1.318 (88%), 0.750 (10%), 0.25 (1%) spect (62S51)	γ_1 0.0671 (conv in Se, K/L 7.6), γ_2 0.361 (K/L 8.6), γ_3 0.860, γ_4 1.310 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ = 10/163/11/8) spect, spect conv (62S51)	Q^+_β 2.70 (62S51)	Ge-a-n (49C48, 62S51); Ge^{70}-a-n (49C48); As-d-4n (48H50); spall-fission Bi (66B51)
Se^{74}		0.87 (24W48)					Se^{74}, I = 0 (55G50)	
Se^{75}	A chem, excit (2D40, 4K42); sep isotopes, n-capt (10C50)		EC, no β^+ (26F47, 49C48, 10C50)	127 d (49C48); 128 d (10C50); 115 d (26F47); 120 d (48H50)		γ_1 0.067, γ_2 0.077, γ_3 0.098 (K/L ~11, e/γ ~8), γ_4 0.124 (e/γ ~0.3), γ_5 0.138 (e/γ ~0.1), γ_6 0.203, γ_7 0.269 (e/γ ~0.09), γ_8 0.281, γ_9 0.308, γ_{10} 0.405 (e/γ ~0.001) ($\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_7/\gamma_8/\gamma_{10}$ = 0.14/~0.007/~0.02/0.21/0.70/~0.05/0.14) spect, spect conv, γ-γ coinc (13J52a); 0.025, 0.066, 0.081, 0.097, 0.121, 0.136, 0.199, 0.265, 0.280, 0.305, 0.402 spect conv (10C50); 0.076, 0.099 (?), 0.123, 0.137, 0.267, 0.283, 0.405 spect (11T48); 0.098 (e/γ large), all other γ (e/γ very small) spect, spect conv (75M51); others (52M51)	 (13J52a)	As-p-n (2D40); As-d-2n (4K42, 26F47, 49C48, 48H50); Se-n-γ (2S47, 26F47, 11T48, 13J52a); Se^{74}-n-γ (10C50)
Se^{76}		9.02 (24W48)					Se^{76}, I = 0 (55G50)	
Se^{77m}	A n-capt (23A47); sep isotopes, n-capt (18G48a); genet (43C51b)		IT (23A47)	17.5 s (23A47, 32G49, 43C51b)		0.162 (K/L 4.6) spect conv (31R52); 0.160 (e/γ large) spect, spect conv (43C51b); 0.165 spect conv (19Q52); abs (9F50); others (38M51, 31K51, 32G49, 23A47)	see Br^{77}  (18G52)	Se-n-γ (23A47); Se^{76}-n-γ (18G48a); Se-x rays (32G49); daughter Br^{77} (43C51b, 43C51); not daughter As^{77} (lim 2%) (56M50a)
Se^{77}		7.58 (24W48)					Se^{77}, I = 1/2 (55G50, 32D51)	
Se^{78}		23.52 (24W48)					Se^{78}, I = 0 (55G50, 32D51)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{34}Se^{79m}$	A excit, n-capt (9F50, 9F50b); n-capt, sep isotopes (31R52)		IT (9F50b)	3.5 m (31R52); 3.9 m (9F50)		0.096 (K/L 2.9) spect conv (31R52)	 (18G52, HPS) Se^{79}, I = 7/2 (83H52)	Se^{78}-n-γ (31R52); Se-n-γ, Se-n-2n (9F50, 9F50b); Br-n-p (9F50b)
Se^{79}	B chem, spect (?) (26P49)		β^- (26P49)	$\leq 6.5 \times 10^4$ y sp act (est fission yield) (26P49)	0.160 abs (26P49); ~0.150 abs (32K50)	no γ (26P49)		fission U (26P49)
Se^{80}		49.82 (24W48)					Se^{80}, I = 0 (87M50)	
Se^{81m}	A chem, excit, cross bomb (26S37a); sep isotopes, n-capt (32L47); mass spect (67B49)		IT (20L40)	56.5 m (25W48); 57 m (26S37a, 20L40); 59 m (33G51)		0.103 (K/L 3.0) spect conv (31R52); 0.104 (e/γ very large, K/L ~3.9) spect conv (67B49); 0.099 (K/L ~4) spect conv (2H41)	 (18G52)	Se-d-p (26S37a, 20L40); Se-n-γ (26S37a, 6H37, 2S47); Se^{80}-n-γ (32L47); Br-n-p (26S37a, 20L40); fission U (33G51); parent Se^{81} (20L40)
Se^{81}	A chem, genet (20L40)		β^- (20L40)	17 m (33G51); 18 m (9F50); 19 m (20L40); 13.6 m (25W48)	1.38 spect (67B49); 1.5 abs (20L40, 33G51); no conv (31R52)	no γ (33G51)	Q^-_β 1.38 (67B49, 33G51)	Se-d-p (26S37a, 20L40); Se-n-γ (26S37a, 6H37, 2S47); Se-γ-n (37B39); Br-n-p (20L40); spall-fission Bi (66B51); fission U (33G51); daughter Se^{81m} (20L40)
Se^{82}		9.19 (24W48)					Se^{82}, I = 0 (55G50)	
Se^{83}	A chem, genet (23A47)		β^- (23A47)	67 s (23A47)	3.4 abs (23A47); no conv (31R52)			Se-n-γ (23A47); fission U (63S47); parent Br^{83} (23A47)
Se^{83}	A chem, excit, cross bomb (26S37a); chem, genet (20L40)		β^- (26S37a)	25 m (33G51a); 26 m (31R52); 30 m (20L40)	1.5 abs (33G51a, 31R52)	0.950, 0.176, 0.061 (?), 0.04 (?) spect conv, scint spect (31R52); 1.1, 0.37, 0.17 abs (33G51a)		Se-d-p (26S37a, 20L40); Se-n-γ (26S37a, 20L40, 2S47); fission Th (72B51), U (33G51a); parent Br^{83} (20L40, 33G51a)
Se^{84}	A chem, genet (33G46)		β^- (33G46)	~2 m (33G51b, 20E51)				fission U, parent Br^{84} (33G51b, 20E51)
$_{35}Br^{74}$	D chem (13H51)		β^+, EC (13H51)	~35 m (13H51)				Cu-C-3n (13H51)
Br^{75}	B chem, cross bomb, sep isotopes (35W48)		β^+, EC (35W48)	1.6 h (13H51); 1.7 h (35W48)	1.70 (46%), 0.8 (20%), 0.6 (15%), 0.3 (19%) spect (25F52); ~1.8 abs (13H51)	~0.6 abs (25F52)		Cu-C-2n (13H51); Se^{74}-d-n (35W48); Se^{74}-p-γ (35W48, 25F52)
Br^{76}	A chem (48H48); chem, excit (13H51); chem, sep isotopes (25F52)		β^+ (48H48)	17.2 h (25F52); 16.5 h (13H51); 15.7 h (48H48)	3.57 (46%), 1.7 (10%), 1.1 (11%), 0.8 (14%), 0.6 (19%) spect (25F52); 3.5 spect (13H51)	1.2, 0.96, 0.75, 0.68, 0.42, 0.37, 0.33, 0.25 spect, spect conv (25F52); ~2 abs (48H48)	Q^+_β 4.6 (25F52)	As-α-3n (48H48, 13H51); Se^{76}-p-n (25F52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{35}Br^{77}$	A chem, sep isotopes (35W48)		EC 95%, β^+ 5% (35W48)	57 h (48H48, 13H51); 58 h (35W48)	0.336 spect (43C51); 0.36 spect (48H48); abs, spect (35W48)	γ_1 0.160, γ_2 0.237, γ_3 0.284, γ_4 0.298, γ_5 0.520, γ_6 0.641, γ_7 0.813 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7$ = 0.6/20/0.2/0.2/100/8.6/25) spect, spect conv (43C51); 0.160, 0.234, 0.299, 0.521 spect conv, x-γ coinc (25F52)	see As^{77}  (43C51)	As-α-2n (48H48, 13H51, 43C51); Se^{74}-α-p (35W48); Se^{76}-d-n (35W48, 25F52); parent Se^{77m} (43C51, 43C51b)
Br^{78}	A chem, excit (26S37a)		β^+ (26S37a)	6.4 m (26S37a); 6.5 m (13H51)	2.4 abs (35B46a, calc from 26S37a); 2.3 abs (26S37a)	0.108, 0.046 spect conv (6V39)		As-α-n (26S37a, 13H51); Se-d-n (26S37a); Se-p-n (59B38, 6V39); Br-γ-n (7C37, 37B39); Br-n-2n (6H37)
Br^{79}		50.52 (9W46)					Br^{79}, I = 3/2 (87M50)	
Br^{80m}	A chem, n-capt (12A35); chem, excit, cross bomb (26S37a)		IT (24S39)	4.58 h (41M51); 4.5 h (26S37a); 4.4 h (59B38)		0.049, 0.037 (e/γ ~1.3) ion ch (32R50); 0.048, 0.036 spect conv (33L50); 0.049, 0.037 spect conv (6V39); 0.049 (L_I/L_{III} 1.0) spect conv (63M52a); 0.048 (e/γ very large), 0.037 (e/γ ~1) abs (35G40); others (52W51)		Se-d-2n (35W48, 25F52); Se-α-p (35W48); Se-p-n (59B38, 6V39, 25F52); Br-n-γ (24A36, 26S37a, 24S39, 34G46, 2S47); Br-d-p (26S37a); Br-γ-n (37B39); Br-n-2n (1P37); spall-fission Ta (22N52), Bi (66B51), U (6F51); fission Th (?) (9P40, 9P41)
Br^{80}	A chem, n-capt (12A35); chem, excit, cross bomb (26S37a); chem, genet (24S39)		β^- ~92%, β^+ ~3%, EC ~5% (calc from 41M51, 28R50); β^+/β^- 0.037 (41M51); $\frac{\beta^+ + EC}{\beta^-}$ 0.09 (28R50); β^+/β^- 0.028 (34L51); β^+/β^- 0.03 (63B47)	18 m (26S37a, 24S39)	β^-: 1.99 (85%), 1.1 (15%) spect (34L52); 1.97 (80%), 1.1 (11%), 0.7 (9%) spect (25F52); 1.99 spect (33L50); others (34L51, 50C48, 24A36) β^+: 0.87 spect (34L51); 1.0 spect (16D49); 0.73 abs (63B47)	>0.6 abs (21D40); <0.5 abs (26S37a, 59B38); no γ (34L52)	 (18G52, HPS)	Se-p-n (59B38); Br-n-γ (26S37a, 34G46, 2S47, 9O49); Br-d-p (26S37a); Br-γ-n (37B39); Br-n-2n (1P37); daughter Br^{80m} (24S39, 21D40, 64S41)
Br^{81}		49.48 (9W46)					Br^{81}, I = 3/2 (87M50)	
Br^{82}	A chem, n-capt (33K35); chem, excit, cross bomb (26S37a)		β^- (33K35); no EC or β^+ (lim 0.03%) (28R50); no β^+ (lim 0.02%) (41M51)	35.87 h (31C50); 36.0 h (68B50); 35.1 h (36W51); 35.7 h (38S51)	0.465 spect, β-γ coinc (33R41, 20D42b)	γ_1 0.547, γ_2 0.608, γ_3 0.692, γ_4 0.766, γ_5 0.823, γ_6 1.031, γ_7 1.312 spect conv, spect (7S49a); γ_1 0.535, γ_2 0.602, γ_4 0.750, γ_6 1.020, γ_7 1.292, γ_8 1.445 ($\gamma_1/\gamma_4/\gamma_6/\gamma_7/\gamma_8$ = 3.7/3.5/1.0/0.85/0.40) spect (16D52); 0.547, 0.615, 0.682, 0.752, 0.822, 1.026, 1.306, 1.453 spect (57H51a); 1.7-2.0 (0.14%) Be-γ-n reaction (33M49); 0.07, 0.05 abs conv (69B44); others (52M51)		Se-p-n (59B38, 6R41a); Se-d-2n (26S37a, 56M51); Br-n-γ (33K35, 26S37a, 2S47); Br-d-p (26S37a, 56M51); Rb-n-α (26S37a); spall-fission Ta (22N52), Hg (63S52), Tl (2T47b), Pb (13P47a), Bi (66B51, 13P47, 11G49), U (6O48, 6F51); fission U (2F51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{35}Br^{83}$	A chem, excit (26S37a)		β^- (26S37a)	2.33 h (20L40, 49H51a); 2.4 h (33G51a, 26S37a)	0.940 spect (23D51); 0.94 spect (25F52)	no γ (26S37a, 33G51a); -0.046 (?) cl ch (50W52)		Se-d-n (26S37a, 25F52); Rb-γ-α (49H51a); spall-fission Ta (22N52), Hg (63S52), Pb (13P47a), Bi (13P47, 11G49, 66B51), Th (7N49a), U (6O48); fission Th (6B39, 20L40, 21T51, 72B51), U (20L40, 65S40, 57M41, 33G51a), U^{233} (61S48), Pu (32K48, 61S51a); daughter Se^{83}, parent Kr^{83m} (20L40, 65S40, 57M41, 33G51a)
Br^{84}	A chem (22D39); chem, excit (70B43)		β^- (22D39)	30 m (65S40); 32 m (23D51); 33 m (32K51)	4.68 (40%), 3.56 (9%), 2.53 (16%), 1.72 (35%) spect (23D51)	0.89, 1.89 scint spect (10L52d)		Rb-n-α (70B43); spall-fission Bi (13P47a), U (6F51); fission Th (72B51), U (22D39, 16H39a, 16H39b, 65S40, 57M41, 70B43, 32K51); daughter Se^{84} (33G51b)
Br^{85}	A chem (65S40); chem, genet (66S43)		β^- (65S40)	3.00 m (63S49); 3.0 m (65S40, 70B43)	2.5 abs (63S49)	no γ (63S49)		fission U (65S40, 70B43, 66S43, 63S49); parent Kr^{85} (66S43, 63S49)
Br^{87}	A chem (65S40, 26S47); chem, genet (70B43, 63S49)		β^-, β^-n (~2% of disintegrations) (19L51a)	55.6 s (n) (28H48a); 55.0 s (n) (34R47); 56.1 s (β^-) (63S49)	β^-: 2.6 (70%), 8.0 (30%) abs (67S51); n (mean): 0.25 abs paraffin (28H48a); 0.30 p recoil in cl ch (71B46)	5.4, others ~3 abs, abs sec, γ-γ coinc (67S51)	Q^-_β ~8 (?) (67S51)  (67S51)	fission U (65S40, 26S47, 63S47a, 63S49), U^{235} (34R47, 28H48a), Pu (34R47); parent Kr^{87} (70B43, 66S43, 63S49); parent Kr^{86} (2% of dis) (26S47, 63S49)
Br^{88}	A chem, genet (63S49)		β^- (63S49)	15.5 s (63S49)				fission U, parent Kr^{88} (63S49)
Br^{89}	D chem (63S47a)		β^-, β^-n (26S47a, 28H48a)	4.51 s (n) (28H48a); 4.45 s (n) (34R47)	n (mean): 0.43 abs paraffin (28H48a); 0.65 p recoil in cl ch (71B46)			fission U (63S47a, 26S47a, 63S49), U^{235} (34R47, 28H48a); parent Kr^{89} (?), parent Kr^{88} (?) (51C51)
$_{36}Kr^{77}$	B chem, sep isotopes (35W48a)		EC 70%, β^+ 30% (35W48a)	1.1 h (35W48a)	1.7 abs (35W48a)	γ (35W48a)		Se-α-n, Se^{74}-α-n (35W48a)
Kr^{78}		0.354 (6N50a)						

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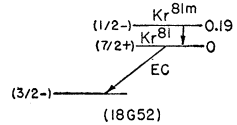
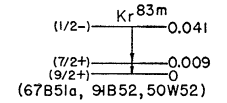
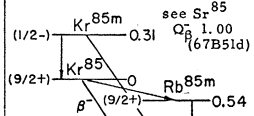
$_{36}Kr^{79m}$	D chem (29C40b)		IT (?), no β^+ (29C40b)	55 s (29C40b)		0.127 spect conv (29C40b)		Br-p-n (33B40a, 29C40b)
Kr^{79}	A chem (29C40b); chem, sep isotopes (35W48a); mass spect (104B52)		EC 95% (L/K 0.27), β^+ 5% (12R52a, 12R52b); EC (K) ~90%, β^+ ~10% (67B51); EC ~98%, β^+ ~2% (35W48a)	34.5 h (12R52); 34 h (33B40a, 35W48a, 29C40b)	0.595 spect (67B51); 0.6 abs (58H51)	0.263 (e/γ ~0.02), 0.044 spect conv (67B51); 0.2 abs (58H51)		Se-a-n (52C41); Se^{76}-a-n (35W48a); Br-d-2n (30C44); Br-p-n (33B40a, 29C40b); Kr-d-p (26S37a, 52C41); Kr-n-γ (58H51, 67B51)
Kr^{80}		2.27 (6N50a)						
Kr^{81m}	A chem (29C40b); genet (7K50)		IT, no β^+ (29C40b)	13 s (29C40b); ~10 s (7K50)		0.193 spect conv (7K50); 0.187 spect conv (29C40b)	 (18G52)	Br-p-n (33B40a, 29C40b); daughter Rb^{81} (7K50)
Kr^{81}	A chem, mass spect (28R50a)		EC (28R50a)	2.1×10^5 y sp act (28R50a)		0.012 abs, Br K-x (28R50a)		Kr-n-γ (28R50a)
Kr^{82}		11.56 (6N50a)					Kr^{82}, I = 0 (87M50)	
Kr^{83m}	A chem, genet (20L40); mass spect (67B50)		IT (20L40)	114 m (67B51a, 21R46); 113 m (20L40)		0.0322 (e/γ very large, K/L+M 0.35), 0.0093 (e/γ very large, L/M ~3) spect conv (67B51a); 0.032 (K/L 0.32), 0.009 (e/γ ~10) ion ch (91B52); 0.046, 0.029 spect conv (2H41)	 (67B51a, 91B52, 50W52)	Se-a-n (52C41); Kr-d-p (52C41); Kr-n-γ, Kr-x rays (37W45); fission U, daughter Br^{83} (20L40); daughter Rb^{83} (53C50)
Kr^{83}		11.55 (6N50a)					Kr^{83}, I = 9/2 (87M50)	fission U (mass spect) (13T47, 13T48a)
Kr^{84}		56.90 (6N50a)					Kr^{84}, I = 0 (87M50)	fission U (mass spect) (13T47, 13T48a)
Kr^{85m}	A chem (26S37a); chem, mass spect (34K49)		β^- 77%, IT 23% (67B51d)	4.36 h (34K49); 4.4 h (35W48a); 4.5 h (58H51, 26S37a); 4.6 h (21R46, 66S43)	0.855 spect (67B51d); 0.85 abs (70B43a); 0.95 abs (58H51); 0.75 abs (34K49)	0.150 (e/γ 0.057, coinc with β^-), 0.305 spect conv, β-γ coinc (67B50a, 67B51d); 0.17, 0.37 abs (58H51)	 (8Z50, 67B50a, 18G52)	Se-a-n (35W48a); Kr-d-p (26S37a, 52C41); Kr-n-γ (21R45, 58H51); Rb-n-p, Sr-n-a (70B43); fission U, daughter Br^{85} (66S43, 63S49)
Kr^{85}	A chem (58H51a); chem, mass spect (13T47)		β^- (58H51a)	9.4 y (13T48a); ~10 y (58H51a)	0.695 (99+%), 0.15 (0.65%) spect, β-γ coinc abs (8Z50); 0.74 abs (58H51a)	0.54 (coinc with 0.15 β^-) scint spect, abs, β-γ coinc (8Z50)		Kr-n-γ (58H51); fission U (13T47, 58H51a)
Kr^{86}		17.37 (6N50a)					Kr^{86}, I = 0 (87M50)	fission U (mass spect) (13T47, 13T48a); daughter Br^{87} (2% of dis) (26S47, 63S49)

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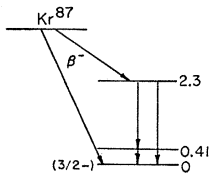
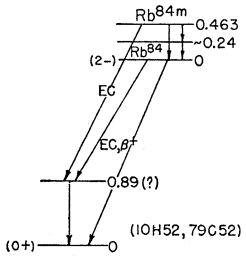
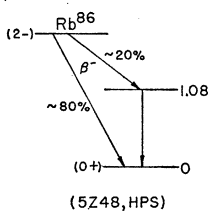
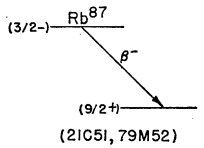
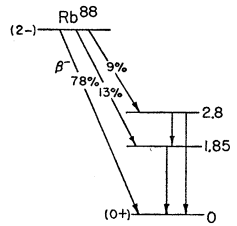
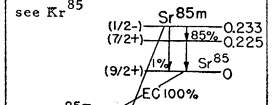
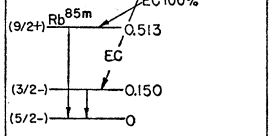
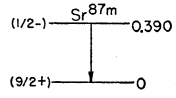
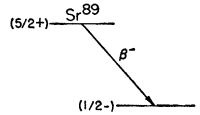
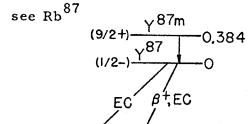
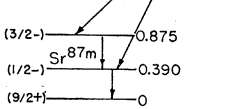
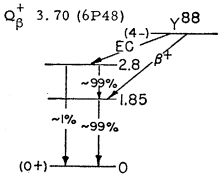
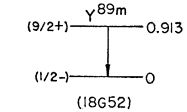
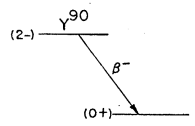
$_{36}Kr^{87}$	A chem, (26S37a); chem, mass spect (34K49)		β^- (26S37a)	78 m (34K49); 75 m (66S43, 63S49); 74 m (26S37a)	3.63 (75%), 1.27 (25%) spect (30T52a); others (34K49, 70B43a)	0.41, 1.89, ~2.3 scint spect (30T52a)	Q^-_β 3.6 (30T52a)  (30T52a)	Kr-n-γ (21R46, 58H51); Kr-d-p (26S37a); Rb-n-p (70B43); fission U (70B43, 66S43); daughter Br^{87} (66S43, 70B43, 63S49)
Kr^{88}	A chem (6H39); chem, genet (20L39); chem, mass spect (34K49)		β^- (20L39)	2.77 h (34K49); 2.8 h (36G40, 63S49)	2.8 (20%), 0.9 (12%), 0.52 (68%) spect (30T52b); 2.4 (weak), ~0.5 abs (4J48, 34K49)	0.028 (coinc with 0.5 β^-, e/γ ~0.1, K/L+M 8) spect conv, β-γ coinc (30T52b)		fission Th (20L39, 25A39), U (6H39, 16H40a, 36G40, 16H40b); parent Rb^{88} (20L39, 25A39, 6H39, 16H40a, 36G40, 16H40b); daughter Br^{88} (63S49)
Kr^{89}	A chem, genet (36G40, 66S40); mass spect (35K51a)		β^- (36G40)	3.18 m (35K51a); 2.6 m (24D51); 2.5 m (16H43a)	4.0 abs (35K51a); 3.9 calc from average recoil energy (35K51)			fission U, parent Rb^{89} (36G40, 66S40, 16H40b, 16H43, 17B51, 35K51a); spall-fission U (11O51); fission Pu (26A51)
Kr^{90}	A chem, genet (24D51a); mass spect (35K51a)		β^- (24D51a)	33 s (35K51a, 32K46)	3.2 abs (35K51a)			fission U, ancestor Sr^{90} (24D51a, 24D51); fission Pu (26A51); parent Rb^{90} (35K51a)
Kr^{91}	A chem, genet (16H40c); mass spect (35K51a)		β^- (16H40c)	9.8 s (24D51); 10 s (35K51a); ~6 s (11O51)	~3.6 abs (35K51a)			fission U, ancestor Y^{91} (16H40c, 17B51, 24D51a, 24D51); spall-fission U (11O51); fission Pu (26A51); parent Rb^{91}, parent Rb^{91m} (35K51a)
Kr^{92}	B chem, genet (16H40a, 24D51)		β^- (16H40a)	3.0 s (24D51)				fission Th (16H40), U (16H40a, 16H40b, 16H43), Pu (26A51); ancestor Y^{92} (24D51)
Kr^{93}	B chem, genet (16H42, 70S51)		β^- (16H42)	2.0 s (24D51)				fission U, ancestor Y^{93} (70S51); spall-fission U (11O51); fission Pu (26A51)
Kr^{94}	B chem, genet (16H43a, 24D51)		β^- (16H43a)	1.4 s (24D51)				fission U, ancestor Y^{94} (16H43a, 24D51)
Kr^{95}	A chem, genet (24D51a)		β^- (24D51a)	short (24D51a)				fission U, ancestor Zr^{95} (24D51a)
Kr^{97}	B chem, genet (26A51)		β^- (26A51)	~1 s (24D51)				fission U, ancestor Zr^{97} (26A51, 24D51); fission Pu (26A51)
$_{37}Rb^{81}$	A chem, mass spect (10R49)		EC 87%, β^+ 13% (7K50)	4.7 h (7K50)	0.990 spect (7K50)	0.95 abs (7K50)		Br-α-2n (10R49, 7K50); parent Kr^{81} (7K50)
Rb^{82m}	B chem, genet (54L52)		β^+ (54L52)	1.25 m (54L52)	~3 abs (54L52); see Sr^{82}			daughter Sr^{82} (54L52)
Rb^{82}	A chem (59H40); chem, mass spect (10R49)		EC 94%, β^+ 6% (7K50)	6.3 h (7K50)	0.775 (76%), 0.175 (24%) spect (10H52); 0.670 spect (7K50)	0.188, 0.248, 0.322, 0.390, 0.423, 0.465, 0.558, 0.610, 0.690, 0.768, 0.818, 1.020, 1.314, 1.464 spect conv, spect (10H52)		Br-α-n (59H40, 10R49, 7K50); Kr-d-2n (59H40); not daughter Sr^{82} (lim 0.01%) (54L52)

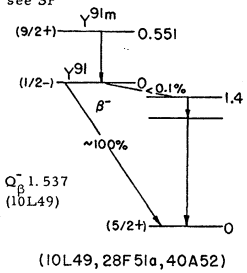
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{37}Rb^{83}$	A chem, mass spect (7K50)		EC (7K50)	83 d (53C50); 107 d (7K50)		~0.45, ~0.15 spect conv (53C50)		Br-α-2n (7K50); daughter Sr^{83} (53C50); parent Kr^{83m} (53C50)
Rb^{84m}	B chem (59H40); chem, excit (9F50a)		IT, EC (weak) (79C52); EC (9F50a)	23 m (9F50a); 20 m (59H40)		γ_1 0.463 (not coinc with γ_2 or γ_3), γ_2 0.239, γ_3 ~0.239 (coinc with γ_2), γ_4 0.890 (γ_1/γ_4 = 7) scint spect, γ-γ coinc (79C52)		Br-α-n (59H40); Rb-n-2n (9F50a, 79C52)
Rb^{84}	A chem, cross bomb (63B47); chem, mass spect (7K50)		EC, β^+, β^- (?) (7K50, 73B50); EC/β^+ ~13 (7K50); β^+/β^- ~6.2 (73B50)	34 d (7K50); 38 d (73B50)	β^+: 1.629 (39%), 0.822 (58%), 0.373 (?) (3%) spect (10H52); 1.5 spect (7K50); 1.3 abs (73B50)	0.890 scint spect, spect conv (10H52); 0.85 abs (7K50); 0.8 abs (73B50)		Br-α-n (7K50, 73B50); Kr-α-pn, Kr-d-2n (73B50); Rb-n-2n (63B47); Sr-d-α (63B47)
Rb^{85m}	A genet (14S52)		IT (14S52)	0.9×10^{-6} s delay coinc (14S52)		0.513 spect, spect conv (11T51, 14S52)	see Sr^{85} and Kr^{85}	daughter Sr^{85} (14S52)
Rb^{85}		72.15 (6N50a)					Rb^{85}, I = 5/2 (87M50)	fission U (mass spect) (38W52)
Rb^{86m}	B chem, excit, n-capt (9F51)		IT, no EC (12P52); EC (9F51)	0.99 m (12P52); 1.06 m (9F51)		0.57 scint spect (12P52); 0.78 abs (9F51)		Rb-n-γ, Rb-n-2n (9F51)
Rb^{86}	A chem, n-capt (26S37a); chem, excit (2H41a)		β^- (2H41a); no β^+ (lim 0.002%) (41M51); no EC (lim 0.04%) (12P52)	19.5 d (2H41a)	β_1 1.82 (80%), β_2 0.72 (20%) spect (5Z48); β_1 1.79 spect (96M52); β_1 1.76, β_2 0.670 (coinc with γ) β-γ coinc spect (23M51); β_1 1.82 (~67%), β_2 0.56 (~33%) abs (15J48); β_2 0.72 (coinc with γ) β-γ coinc spect (55M50); β_2 0.67 scint spect (27P51); β_2 (12%) β-γ coinc (26M50)	1.076 spect (55M50); 1.081 spect (5Z48); 1.12 (coinc with β_2) coinc abs sec, β-γ coinc (15J48); others (85S51)	Rb^{86}, I = 2 (98B51) Q^-_β 1.8 (5Z48)  (5Z48, HPS)	Rb-n-γ (26S37a, 69S38, 2S47); Rb-γ-n (34H44); Sr-d-α (2H4la); spall-fission Bi (11G49, 66B51), U (6F51); fission U (2F51a)
Rb^{87}	A chem (1T05, 54C06); chem, genet (16H37a, 8M37); chem, mass spect (40H37)	27.85 (6N50a)	β^- (1T05, 54C06)	6.0×10^{10} y sp act (37H48, 37H48a, 37K49, 50L52); 6.4×10^{10} y sp act (79M52); 6.2×10^{10} y sp act (21C51); 7.6×10^{10} y (55C51, calc from 21C51); 6.3×10^{10} y yield (65S38); 5.8×10^{10} y sp act (10E46)	0.275 spect (21C51); scint spect (50L52); 0.270 scint spect (11B50e); others (36K35, 34T52, 3L39, 14O41, 12S46)	no γ (21C51, 79M52, 50L52)	Rb^{87}, I = 3/2 (87M50) Q^-_β 0.27 (21C51)  (21C51, 79M52)	natural source (1T05, 54C06); fission U (mass spect) (38W52); parent Sr^{87} (mass spect) (16H37a, 8M37)

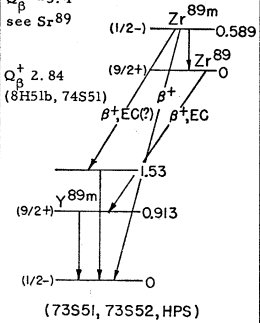
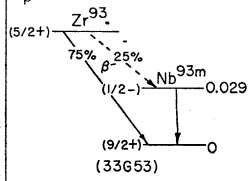
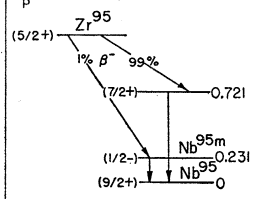
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev		Disintegration energy and scheme	Method of production and genetic relationships
					Particles	Gamma-transitions		
$_{37}Rb^{88}$	A chem (26S37a); chem, genet (20L39, 36G40, 16H39a)		β^- (16H39a)	17.8 m (36G40, 2B51); 17.7 m (30T52b); 17.5 m (34W42); 18 m (16H40b, 26S37a)	5.30 (78%), 3.6 (13%), 2.5 (9%) spect (30T52b); 5.13 (66%), 3.29 (19%), 2.0 (15%) spect (2B51); 5.20 (~66%), 3.6 (~17%), 1.8 (~17%) abs (37G51)	2.8, 1.86, 0.90 spect (2B51); γ_1 3.0, γ_2 1.7 (γ_1/γ_2 ~ 1/10) abs sec, β-γ coinc (37G51)	see Y^{88} Q^-_β 5.30 (30T52b)  (2B51, 30T52b, HPS)	Rb-n-γ (26S37a, 1P37, 69S38, 2S47); fission Th (25A39), Pa (2G39); fission U, daughter Kr^{88} (6H39, 20L39, 36G40, 16H40a, 16H40b)
Rb^{89}	A chem, genet (36G40, 66S40)		β^- (36G40)	15.4 m (36G40); 15.5 m (16H40b)	4.5 abs (35B46a, calc from 36G40); 3.8 abs (36G40)	γ (35B46a)		fission U, daughter Kr^{89} (36G40, 66S40, 16H40b, 16H43, 17B51); parent Sr^{89} (36G40, 16H40a, 16H40b, 16H43)
Rb^{90}	A chem, genet (35K51a)		β^- (35K51a)	2.74 m (35K51a)	5.7 abs (35K51a)	γ (35K51a)		fission U, daughter Kr^{90}, parent Sr^{90} (24D51a, 24D51, 35K51a)
Rb^{91}	A chem, genet (35K51a)		β^- (35K51a)	1.67 m (35K51a); [short] (24D51a, 17B51, 11O51, 24D51, 16H40c)	4.6 abs (35K51a)	γ (35K51a)		fission U, daughter Kr^{91}, parent Sr^{91} (35K51a); ancestor Y^{91} (24D51a, 16H40c)
Rb^{91}	A chem, genet (35K51a)		β^- (35K51a)	14 m (35K51a)	3.0 abs (35K51a)	γ (35K51a)		fission U, daughter Kr^{91}, parent Sr^{91} (35K51a)
Rb^{92}	D chem, genet (16H40a)		β^- (16H40a)	80 s (16H40a); [short] (17B51, 24D51)				fission U, daughter Kr^{92} (24D51); ancestor Y^{92} (16H40a, 16H40c, 16H40, 16H43, 24D51)
Rb^{93}	[B] genet (16H42, 17B51)		[β^-] (16H42)	[short] (17B51, 24D51, 24D51a, 16H42, 16H43)				fission U, daughter Kr^{93} (17B51, 24D51, 24D51a); ancestor Y^{93} (16H42, 16H43, 17B51)
Rb^{94}	[B] genet (16H43, 16H43a)		[β^-] (16H43, 16H43a)	[short] (24D51, 16H43, 16H43a)				fission U, daughter Kr^{94}, ancestor Y^{94} (16H43, 16H43a, 24D51)
Rb^{95}	[A] genet (24D51a)		[β^-] (24D51a)	[short] (24D51a)				fission U, daughter Kr^{95}, ancestor Zr^{95} (24D51a)
Rb^{97}	[A] genet (24D51)		[β^-] (24D51)	[short] (24D51)				fission U, daughter Kr^{97}, ancestor Zr^{97} (24D51); fission U^{235}, Pu (26A51)

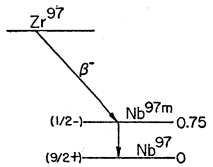
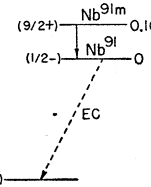
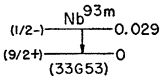
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{38}Sr^{81}$	B chem, genet (53C50)		EC, β^+ (53C50)	29 m (53C50)	conv (53C50)			spall Rb, parent Rb^{81} (53C50)
Sr^{82}	A chem, excit (53C50); mass spect (97M52)		EC, β^+ (?) (53C50)	27 d (97M52); 25 d (53C50)	β^+ with Rb^{82m} (54L52); 3.15 spect (53C50)	0.95, ~0.40, ~0.15 spect conv, abs (53C50)		spall Rb (53C50); daughter Y^{82} (78C52); parent Rb^{82m}, not parent Rb^{82} (lim 0.01%) (54L52)
Sr^{83}	A chem, genet (53C50); mass spect (97M52)		EC, β (53C50)	33 h (97M52); 38 h (53C50)	1.15 spect (53C50); 1.35 abs (97M52)	0.040, 0.074, 0.101, 0.151, 0.165 spect conv (53C50)		spall Rb, parent Rb^{83} (53C50); daughter Y^{83} (78C52)
Sr^{84}		0.56 (6N38b)						
Sr^{85m}	A chem, excit (2D40a)		IT 86%, EC 14% (14S52)	70 m (2D40a)		0.0075 (e/γ very large), 0.150 (with EC), 0.225 (e/γ 0.031, K/L ~5.5), 0.233 (e/γ ~0.04) scint spect, spect conv, x-γ coinc (14S52); 0.233, 0.152 spect conv (11T51)	see Kr^{85} 	Rb-p-n (2D40a); Rb-d-2n (11T51); Sr^{84}-n-γ (14S52)
Sr^{85}	A chem, excit (2D40a)		EC (35L51, 11T51); no β^+ (11T51)	65 d (11T51); 66 d (2D40a)		with Rb^{85m}: 0.513 spect, spect conv (11T51); 0.513 (~100%, e/γ 0.008) spect conv, x-γ coinc, scint spect (14S52); 0.514 (~100%, e/γ 0.007, K/L ~12) spect, spect conv, coinc abs (2E52)	 (14S52, 18G52)	Rb-p-n (2D40a); Rb-d-2n (11T51, 35L51, 2E52); parent Rb^{85m} (14S52); daughter Y^{85} (78C52)
Sr^{86}		9.86 (6N38b)					Sr^{86}, I = 0 (87M50)	
Sr^{87m}	A chem, excit (71S37); chem, excit, cross bomb, genet (2D40a)		IT (2D40a)	2.80 h (58M51, 8H51b); 2.75 h (2D40a)		0.388 (K/L+M 5.79) spect conv (59G52); 0.390 (e/γ 0.28, K/L+M 6.9) spect conv, x-conv coinc (58M51); 0.388 (K/L+M 5.5) spect conv (79B52); 0.388 spect conv (11T51); 0.394 (K/L 7.2) spect conv (8H51b); 0.386 spect conv (2H41)	 (18G52)	Rb-p-n (2D39); Sr-n-n (2D40a, 35R40, 35R40a); Sr-x rays, Sr-e-e (37W45a); Sr-d-p (71S37); Sr-n-γ (71S37, 2D39, 35R40, 2S47, 2S47a); Sr-p-p (?) (2D40a); daughter Y^{87} (2D39, 2D40a, 58M50, 18H51b, 58M51); Zr-n-α (42S40)
Sr^{87}		7.02 (6N38b)					Sr^{87}, I = 9/2 (87M50)	
Sr^{88}		82.56 (6N38b)					Sr^{88}, I = 0 (87M50)	
Sr^{89}	A chem, excit (71S37); chem, mass spect (60H48)		β^- (71S37)	53 d (1N51); 54 d (36L39); 55 d (71S39, 11G49)	1.463 spect (10L49); 1.48 spect (17N44); 1.5 spect (72S49, 4W44, 11R47); cl ch (71S39)	no γ (1N51, 71S39, 71S37); others (52M51)	see Zr^{89} Q^-_β 1.46 (10L49)  (18G52)	Sr-d-p (71S37, 71S39); Sr-n-γ (71S37, 71S39, 2S47); Y-n-p (42S38); Zr-n-α (?) (42S40); spall-fission Pt (2T47b), Pb (13P47a), Bi (2T47b, 11G49, 66B51), Th (7N49a), U (6O48, 11O51, 6F51); fission Th (72B51, 21T51), U^{233} (38G48, 61S48), U^{235} (38G46), Pu (28F51); fission U, daughter Rb^{89} (36G40, 16H40a, 16H40b, 16H43, 38G46)

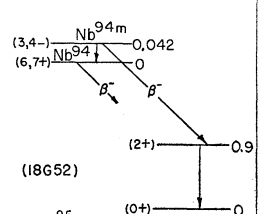
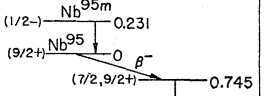
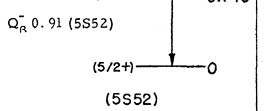
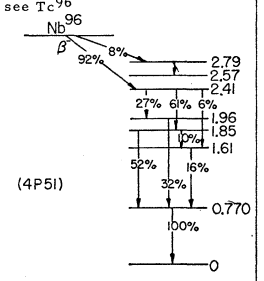
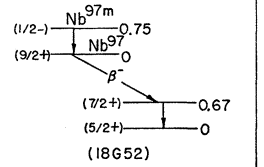
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
Sr^{90}	A chem, genet (16H42); chem, mass spect (60H48, 38W52)		β^- (18N51)	19.9 y (28P50)	0.61 spect (47M48a); 0.54 spect (23L50); 0.53 spect (74B49); 0.6 abs (38G46, 33G51c)	no γ (33G51c, 39G43)	Q^-_β 0.6 (HPS) Sr^{90} (0+) → β^- → (2-) (74B49)	spall-fission Bi (11G49), Th (7N49a); fission Th (21T51), U^{233} (38G48), U^{235} (38G46); fission U, daughter Rb^{90} (24D51a, 24D51, 35K51a, 38W52); parent Y^{90} (16H42, 16H43, 38G46, 18N51)
Sr^{91}	A chem, genet (40G41); chem, excit (66S43a)		β^- (40G41)	9.7 h (28F51a); 10 h (16H43)	2.665 (26%), 2.03 (4%), 1.36 (29%), 1.09 (33%), 0.62 (7%) spect (40A52); 3.2 (~60%), 1.3 (~40%) abs (28F51a)	0.551 (with Y^{91m}, K/L+M 6.0), 0.64, 0.66, 0.747, 1.025, 1.413 (coinc with 0.630 γ) spect, scint spect, γ-γ coinc (40A52)	Q^-_β 2.66 (40A52) Sr^{91} (5/2+) → β^- → 2.04, 1.58, 1.30, 0.64, 0.551, 0 Y^{91m} (9/2+) (1/2-) (40A52)	Zr-n-α (66S43a); spall-fission Pt (2T47b), Hg (π^-) (63S52), Pb (13P47a), Bi (13P47a, 13P47, 66B51), Th (7N49a), U (6F51), U (C) (13H51); fission Th (72B51, 21T51), Pu (32K48, 28F51); fission U, parent Y^{91m}, parent Y^{91} (40G41, 16H43, 28F51a); daughter 1.7 m Rb^{91}, 14 m Rb^{91} (35K51a)
Sr^{92}	B chem, genet (40G41)		β^- (40G41)	2.7 h (40G41)				spall-fission Th (7N49a); fission Th (72B51), U (16H40a, 16H43, 16H43a, 32K51a, 17B51), Pu (32K48); parent Y^{92} (40G41, 58H51b)
Sr^{93}	B chem (36L39); chem, genet (16H43)		β^- (36L39)	7 m (36L39)				fission U (36L39, 16H42, 16H43); parent Y^{93} (16H43, 16H43a)
Sr^{94}	B chem, genet (16H43, 16H43a)		β^- (16H43, 16H43a)	~2 m (16H43, 16H43a)				fission U (16H43, 16H43a, 24D51); parent Y^{94} (16H43, 16H43a)
Sr^{95}	[A] genet (24D51a)		β^- (24D51a)	short (24D51a)				fission U, ancestor Zr^{95}, descendent Kr^{95} (24D51a)
Sr^{97}	[A] genet (24D51)		β^- (24D51)	short (24D51)				fission U, ancestor Zr^{97}, descendent Kr^{97} (24D51, 26A51)
$_{39}Y^{82}$	B chem, genet (78C52)			70 m (78C52)				spall Y, parent Sr^{82} (78C52)
Y^{83}	B chem, genet (78C52)			3.5 h (78C52)				spall Y, parent Sr^{83} (78C52)
Y^{84}	B chem, excit, sep isotopes (36R49)		β^+, EC (36R49)	3.7 h (36R49)	2.0 abs (36R49)	γ (36R49)		Sr^{84}-d-2n, Sr^{84}-p-n (36R49)
Y^{85}	B chem, genet (78C52)			5 h (78C52)				spall Y, parent Sr^{85} (78C52)

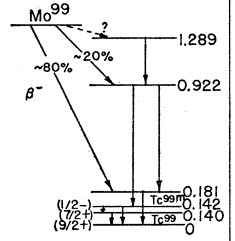
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{39}Y^{86}$	B chem, excit, sep isotopes (53C51)		β^+ (53C51)	14.6 h (53C51, 8H51b)	1.80 (~50%), 1.19 (~50%) spect (8H51b)	1.4 abs (8H51b); ~1.3 abs (53C51)		Sr-p-3n, Sr^{88}-p-3n (53C51); spall Nb, daughter Zr^{86} (8H51b)
Y^{87m}	A chem (71S39); chem, excit, cross bomb (2D40a)		IT (2D40a); no β^+ (8H51b)	14 h (2D40a, 8H51b, 58M51)		0.381 (K/L+M 5.41) spect conv (59G52); 0.384 (e/γ 0.28) spect conv, ion ch, conv-x coinc (58M51); 0.389 spect conv (8H51b); no γ >1 (58M51); conv >1 (8H51b)	see Rb^{87} 	Sr-d-n (71S39, 2D40a, 58M50, 58M51); Sr-p-n (2D40a, 58M51); spall Nb, daughter Zr^{87} (8H51b); parent Y^{87} (58M50, 8H51b, 58M51)
Y^{87}	A chem (71S39); chem, excit, cross bomb (2D40a)		EC 99+%, β^+ ~0.3% (58M51); EC, β^+ (weak) (36R50)	80.0 h (58M51); 80 h (2D40a, 8H51b)	0.7 spect (58M51, 36R50)	0.485 (e/γ 0.0035) spect conv, scint spect, γ-x coinc (58M51); 0.390 (with Sr^{87m})	 (58M51) Q^+_β 2.1 (58M51)	Sr-p-n (2D40a, 58M51); Sr-d-n (71S39, 2D40a, 58M51, 58M50); Sr^{84}-α-p (36R50); spall Nb (8H51b), Sb (37L50); daughter Y^{87m} (58M50, 8H51b, 58M51); parent Sr^{87m} (2D40a, 37L50, 58M50, 8H51b, 58M51)
Y^{88}	A chem (2D40a); chem, excit (2H42); mass spect (60H48)		EC (2D40a); EC 99+%, β^+ 0.19% (6P48)	104 d (10O46); 105 d (2D40a)	0.83 spect (6P48)	0.908 (e/γ 0.0003), 1.853 (e/γ 0.0001), 2.76 spect conv, spect (6P48); ~0.9 (e_K/γ 0.00034), ~1.85 (e_K/γ 0.00017) spect conv (44M52b); 0.908, 1.89 spect, γ-γ coinc (25D41); 1.87 Be-γ-n reaction (17S41); 2.8 (~1%) D-γ-n reaction (41G44)	see Rb^{88} Q^+_β 3.70 (6P48)  (6P48, HPS)	Sr-d-2n (29P40, 2H42, 41G44, 17B50); Sr-p-n (2D40a); Y-n-2n (2H42, 10O46); daughter Zr^{88} (8H51b)
Y^{88}	G not found: chem, cross bomb, sep isotopes (36R49)		β^+ (71S37)	2.0 h (71S39)				Sr-d (71S37, 71S39); Sr-p (2D40b, 2D40a); Y-n (71S37)
Y^{89m}	A chem, genet (18G51)		IT (18G51)	~14 s (18G51)		0.913 spect conv (73S51); 0.917 spect conv (8H51b); ~0.9 (K/L+M 7.0) spect conv (79B52); 0.92 (e/γ 0.01) spect conv, scint spect (74S51, 18G51)	 (18G52)	Y-n-n, daughter Zr^{89} (18G51)
Y^{89}		100 (1D39)					Y^{89}, I = 1/2 (87M50)	
Y^{90}	A chem, excit, cross bomb (71S37); chem, mass spect (60H48)		β^- (71S37)	61 h (37B46, 71S37); 62 h (11G49); 65 h (18N51)	2.18 spect (10L49); 2.24 spect (23L50); 2.25 spect (74B49); 2.27 spect (96M52); 2.2 spect, abs (33G51c); E (average) 0.90 ion ch (77C52)	no γ (33G51c, 74B49, 39G43); 1.4 (0.4%) abs (115S52); others (52M51)	Q^-_β 2.18 (10L49)  (74B49)	Y-d-p (71S37); Y-n-γ (71S37, 42S38, 2S47); Zr-n-p, Zr-d-α (42S40); Nb-n-α (42S38a, 42S40a); spall-fission Pt, Tl (2T47b), Bi (13P47, 11G49); fission Th (21T51); fission U, daughter Sr^{90} (16H42, 16H43, 38G46, 18N51)

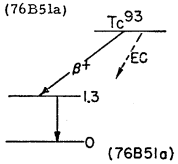
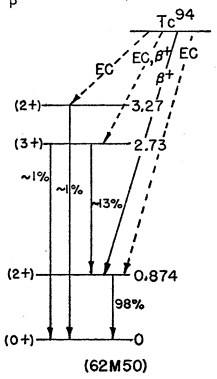
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{39}Y^{91m}$	A chem, genet (40G41)		IT (40G41)	51.0 m (28F51a); 50 m (40G41)		0.551 (K/L+M 6.00) scint spect (59G52); 0.61 (e/γ ~0.1) abs, abs conv (28F51a)	see Sr^{91}  (10L49, 28F51a, 40A52)	Zr-n-p (66S43a); fission U, daughter Sr^{91} (40G41, 16H43, 28F51a)
Y^{91}	A chem, genet (16H40c, 16H43); chem, mass spect (72B51a, 60H48)		β^- (16H40c)	61 d (38G46, 10L49); 57 d (40G41, 16H40c, 19J44)	1.537 spect (10L49); 1.54 spect (15O49); 1.55 spect (16W49c, 24K49); 1.56 spect (16A50, 96M52)	1.2, 0.2 (both <0.1%) abs, coinc abs sec, γ-γ coinc (10L49)		Zr-n-p (66S43a); spall Sb (37L50); spall-fission Bi (11G49), U (11O51); fission Th (72B51), U^{233} (38G48), Pu (28F51, 13E51); fission U, daughter (~60%) Sr^{91} (40G41, 16H43, 28F51a)
Y^{92}	B chem (36L39); fission fragment range (32K48)		β^- (36L39)	3.60 h (40A52a); 3.5 h (28A43, 16H43a, 36L39)	3.60, 2.7, 1.3 spect (40A52a); 3.5 abs (58H51b); 3.4 abs (40G41); 3.6 abs (70B43a)	0.6 abs (40G41); 0.7 - 1.1 abs (58H51b)		Zr-n-p (42S40, 66S43a, 28A43); fission Hg (π) (63S52); fission Th (72B51), Pu (32K48); fission U, daughter Sr^{92} (40G41, 58H51b)
Y^{93}	B chem (16H43, 72B46, 72B51b, 70S51); fission fragment range (32K48)		β^- (72B51b)	10.0 h (72B51b); 11.5 h (16H43)	3.1 abs (72B51b)	0.7 abs (72B51b)		spall-fission U (6O48); fission Th (72B51), Pu (32K48); fission U, daughter Sr^{93} (16H43, 16H43a, 72B51b)
Y^{94}	B chem (16H43, 16H43a); fission fragment range (32K48)		β^- (16H43, 16H43a)	16.5 m (75B49); 20 m (24D51b, 16H43)	5.4 abs (75B49)	1.4 abs (75B49)		Zr-n-p (66S43a); fission U (16H43, 16H43a, 24D51b), Pu (32K48); daughter Sr^{94} (16H43, 16H43a)
Y^{95}	B chem, sep isotopes, excit (20K49)		β^- (20K49)	10.5 m (20K49); <1.5 h (70S51)				Zr^{96}-γ-p (20K49)
Y^{97}	[A] genet (24D51)		β^- (24D51)	short (24D51)				fission U, descendent Kr^{97}, parent Zr^{97} (24D51, 26A51)
$_{40}Zr^{86}$	[B] chem, genet (8H51b)		EC (8H51b)	~17 h genet (8H51b)				spall Nb, parent Y^{86} (8H51b)
Zr^{87}	A chem, excit, sep isotopes (36R49); chem, genet (8H51b)		β^+, EC (36R49)	94 m (8H51b); 120 m (36R49)	2.10 spect (8H51b); 2.0 abs (36R49)	0.65, 0.35 abs (36R49)		Sr-α-n, Sr^{84}-α-n (36R49); spall Nb, parent Y^{87m} (8H51b); Mo-γ-an (85H52)
Zr^{88}	B chem, genet (8H51b)		EC (8H51b)	85 d (8H52)		0.406 spect conv (8H51b)		spall Nb, parent Y^{88} (8H51b)

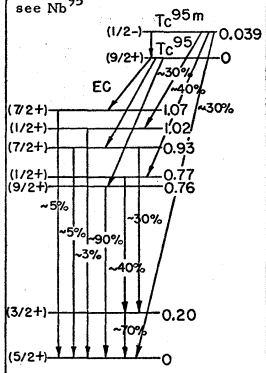
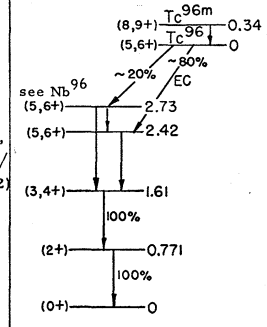
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{40}Zr^{89m}$	A chem, excit (2D40a)		IT, β^+ (weak) (73S51)	4.4 m (73S51); 4.5 m (2D40a)	2.5, ~0.85 (both weak) (β^+/0.59 γ ≈ 0.004) spect, scint spect, β-γ coinc abs (73S51, 73S52)	0.586 (e/γ 0.07, K/L+M 5.4) scint spect, spect conv (79B52, 73S51); 1.53 (~7%) scint spect (73S52)	Q^+_β ~3.4 see Sr^{89}  (73S51, 73S52, HPS)	Y-p-n (2D40a); Zr-n-2n (?) (28A43); Zr-γ-n (73S51)
Zr^{89}	A chem, excit (42S38, 2D40a)		EC ~75%, β^+ ~25% (18G51)	79.3 h (74S51); 77 h (8H51b); 78 h (2D40a); 80 h (11O43)	0.910 spect (8H51b); 0.905 spect (74S51); 0.890 spect (73S51)	γ (with Y^{89m}): 0.92 (e/γ 0.01) spect conv, scint spect (74S51, 18G51); 0.913 spect conv (73S51); 0.917 spect conv (8H51b); ~0.9 (K/L+M 7.0) spect conv (79B52)	Q^+_β 2.84 (8H51b, 74S51)	Y-d-2n (11O43, 18G51); Y-p-n (2D40a); Zr-n-2n (42S38, 42S40); Zr-γ-n (73S51); spall Nb (8H51b); Mo-n-α (42S40); parent Y^{89m} (18G51)
Zr^{90}		51.46 (24W48)						
Zr^{91}		11.23 (24W48)					Zr^{91}, I = 5/2 (87M50)	
Zr^{92}		17.11 (24W48)						
Zr^{93}	B chem (61S50)		β^- (61S50)	9.5×10^5 y sp act (33G53)	0.063 scint spect (33G53)	no γ (33G53)	Q^-_β 0.063 (33G53)  (33G53)	fission U (61S50, 76B50); parent Nb^{93m} (33G53)
Zr^{94}		17.40 (24W48)						
Zr^{95}	A chem (2G40, 42S40); chem, genet (39G51)		β^- (42S40)	65 d (17B51a, 38G46); 66 d (2G48); 63 d (42S40)	0.371 (99%), 0.84 (1%) spect (5S52); 0.39 (98%), ~1.0 (2%) spect (17N51); 0.365 (95%), ~0.60 (weak), ~1.1 (weak) spect (88S51b); ~0.4 (98%), ~1.0 (2%) abs (17B51a); 0.40 abs (26M48a); 0.40, 0.88 β-γ coinc abs, abs (14M51)	0.721 (e/γ 0.0024), no 0.92 γ spect, spect conv (5S52); 0.73, 0.92 (?) spect conv (17N51); 0.88 abs (17B51a); 0.91 coinc abs sec (26M48a); others (52M51)	Q^-_β 1.09 (5S52)  (5S52)	Zr-n-γ (42S40, 2S47); Zr-d-p (42S40, 20J51); Mo-n-α (42S40); spall-fission Bi (11G49, 66B51), Th (7N49a); fission U^{233} (38G48, 61S48), Pu (28F51); fission U, parent (~1%) Nb^{95m}, parent (~99%) Nb^{95} (62H49, 17B51a, 20J51. 61S51b)
Zr^{96}		2.80 (24W48)						

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{40}Zr^{97}$	A chem (2G40); chem, n-capt, sep isotopes (50B50a, 26M52)		β^- (2G40)	17.0 h (50B50a, 26M52, 32K51b, 2G40)	1.91 spect (50B50a); 1.9 abs (75S49); 2.2 abs (32K51b); 2.5 abs (26M52)	with Nb^{97m}: 0.747 (e/γ 0.015) spect, spect conv, β-γ coinc, γ-γ coinc, β-conv coinc (50B50a)	Q^-_β 2.66 (50B50a)  (18G52)	Zr^{96}-n-γ (50B50a, 26M52); Zr-n-γ (42S40, 2S47); Mo-n-α (42S40); spall-fission Bi (66B51), Th (7N49a), U (6O47); fission Th (21T51), U (2G40, 16H41a), Pu (32K48) parent Nb^{97m} (50B50a); descendent Kr^{97} (24D51)
Zr^m	E (24C52)		IT (24C52)	0.83 s (24C52)		~0.50 scint spect (24C52)		Zr-n (24C52)
$_{41}Nb^{90}$	A chem, excit, cross bomb (20J51); chem, sep isotopes, cross bomb (76B49b, 29K49)		β^+ (20J51)	15.0 h (29K49); 15 h (76B49b); 18 h (20J51)	1.2 abs (29K49); ~1.7 abs (76B49b)	0.14, 1.14, 2.23 scint spect (76B51d); 2.0 abs (29K49)		Zr-d-2n (20J51); Zr^{90}-d-2n (29K49); Mo-d-α (20J51); Mo^{92}-d-α (29K49, 76B49b); Mo-γ-pn (22E52); daughter Mo^{90} (43D52)
Nb^{91m}	A chem, excit (20J51); chem, sep isotopes (16O51)		IT (76B49b)	64 d (76B49b); 60 d (20J51)		0.1045 (e/γ ~50, K/L 2.1) spect conv, scint spect (16O51); 0.105 (K/L+M 2.1) spect conv (4P51); Nb x (76B49b, 16O51)	 (18G52)	Zr^{90}-d-n (16O51); Zr-d-n (20J51); Mo^{94}-d-αn (76B49b)
Nb^{91}	B genet (16O51)		[EC] (16O51)	long (16O51)		Zr x (16O51)		[Zr^{90}-d-n, daughter Nb^{91m}] (16O51)
Nb^{92}	B chem, excit (8J52a)		EC (8J52a)	~13 h (8J52a)		2.35 scint spect (8J52a)		Nb-p-pn (8J52a)
Nb^{92}	A chem, excit (42S38a)		EC, no β^- (lim 0.05%) (4P51); EC, no β^- (8J52a)	10.1 d (29K47); 9.8 d (60M48); 11 d (42S40a, 42S38a)	β^- (?): 1.3 cl ch (42S40a), abs (29K47); 0.6 abs (59M44)	0.930 (with EC) spect (4P51); 0.933, 1.84 (weak) scint spect (18T52); 1.0 abs (59M44, 29K47); 1.1 abs (1P45); Zr-x (1P45)		Y-α-n (1P45); Zr-p-n (59M44); Nb-γ-n (60M48, 22E52); Nb-n-2n (42S38a, 42S40a); Nb-d-t (37W46, 29K47); Mo-n-p (42S40); Mo^{94}-d-α (76B49b)
Nb^{92}	G not found: chem, excit (76B49b)		β^- (37W46)	21.6 h (37W46)				Nb-d (37W46)
Nb^{93m}	B genet (33G53)		IT (33G53)	3.65 y (33G53)		0.0292 (e/γ very large, K/L 0.14) spect conv (33G53)	 (33G53)	daughter Zr^{93} (33G53)
Nb^{93}		100 (37S36a)					Nb^{93}, I = 9/2 (87M50)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
41 Nb^{94m}	A n-capt, excit (1P37, 42S38a, 18G46b, 29K46)		IT 99+%, β^- ~0.1% (18G46b)	6.6 m (42S40a)	1.3 abs (18G46b)	0.0415 (e/γ large, K/L/M ≈ 0.31/1.00/0.36) spect conv (42C50); 0.056 (e/γ large) abs conv (18G46b); 0.9 (weak) scint spect (38M51a); Nb K-x (18G46a, 18G46b)		Nb-n-γ (1P37, 42S38a, 42S40a, 18G46a, 18G46b, 2S47); Nb-d-p (29K46, 37W46)
Nb^{94}	[A] n-capt (18G46b); chem, n-capt (63H52)		[β^-] (18G46b)	>5 x 10^4 y yield (63H52); >>100 y yield (18G46b, 18G48a)				Nb-n-γ (18G46b)
Nb^{95m}	A chem (13E46, 13E51a); chem, genet (61S51b)		IT (61S51b)	90 h (61S51b, 62H49); 84 h (5S52)		0.231 (e/γ very large) spect conv (5S52); 0.232 (K/L+M ~3.5) spect conv (4P51); 0.216 (e/γ very large) spect conv (62H49); Nb K-x (61S51b)	see Zr^{95} 	Mo^{97}-d-α (76B49b); fission U, daughter (~1%) Zr^{95} (62H49, 17B51a, 20J51, 61S51b); spall-fission U (6F51); parent Nb^{95} (61S51b, 19L51)
Nb^{95}	A chem (39G46, 39G51); chem, excit, cross bomb (20J51)		β^- (39G51)	35 d (13E51b); 37 d (20J51)	0.160 spect (29F52); 0.159 spect (5S52); 0.148 spect (88S51b); 0.146 spect (62H49); 0.15 spect (17N51a); others (26M48b)	0.745 (e/γ 0.0024) spect, spect conv (5S52); 0.758 (e/γ 0.002) spect, spect conv (62H49); 0.77 (e/γ 0.0016, K/L ≈ 4) spect conv (29F52); 0.77 spect, spect conv (17N51a); 0.75 spect conv (11R47)	Q_R^- 0.91 (5S52) 	Mo^{97}-d-α (76B49b); Mo-d-α (20J51); spall-fission Bi (66B51), U (6F51); fission U, daughter (~99%) Zr^{95} (62H49, 17B51a, 61S51b)
Nb^{96}	A chem, excit, sep isotopes (29K49a)		β^- (29K49a)	23.35 h (29K49a); 22.9 h (76B51)	0.750 (92%), 0.37 (8%) spect (4P51); 0.686 (92%), 0.37 (8%) spect (31J52); 0.75 spect (76B51)	0.216 (7%, e/γ <23 x 10^{-3}), 0.238 (10%, e/γ <16 x 10^{-3}), 0.451 (27%, e/γ 4 x 10^{-3}), 0.560 (61%, e/γ 1.7 x 10^{-3}), 0.770 (100%, e/γ 1.2 x 10^{-3}), 0.804 (6%, e/γ 1.3 x 10^{-3}), 0.840 (16%, e/γ 1.2 x 10^{-3}), 1.078 (52%, e/γ 0.5 x 10^{-3}), 1.187 (32%, e/γ 0.3 x 10^{-3}) spect conv, spect (4P51); 0.455, 0.545, 0.745, 0.9, 1.05, 1.1 spect, spect conv (31J52)	Q_β^- 3.16 (4P51, 74S51a) see Tc^{96} 	Zr^{96}-p-n (29K49a); Mo^{98}-d-α (76B51); spall-fission Bi (66B51); fission U (68C51a)
Nb^{97m}	A chem, excit, sep isotopes, genet (50B50a)		IT (50B50a)	60 s (50B50a)		0.747 (e/γ 0.015, K/L ≥4) spect, spect conv, β-γ coinc, γ-γ coinc, β-conv coinc (50B50a)		Mo^{98}-γ-p (50B50a); daughter Zr^{97} (50B50a)
Nb^{97}	A chem, genet (2G40)		β^- (2G40)	72.1 m (26M52); 74 m (50B50a); 75 m (2G40)	1.267 spect (50B50a); 1.35 abs (75S49); 1.4 abs (32K51b, 26M52)	0.665 (e/γ ~0.0015) spect, spect conv (50B50a); 0.7 abs, β-γ coinc (26M52)		Mo-n-p (42S40); Mo-γ-p (42H47, 12P48, 22E52); fission U (2G40, 32K51b), Pu (32K51b); spall-fission U (6F51)
Nb^{98}	E chem, sep isotopes (76B49b)		β^- (76B49b)	30 m (76B49b)				Mo^{100}-d-α (76B49b)
Nb^{99}	B chem, excit sep isotopes (23D50)		β^- (23D50)	2.5 m (23D50)	3.2 abs (23D50)			Mo^{100}-γ-p (23D50)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{42}Mo^{90}$	B chem, genet (43D52)		β^+, EC (43D52)	5.7 h genet (43D52)		~0.1, other γ's abs (43D52)		spall Nb (43D52); parent Nb^{90} (43D52)
Mo^{91}	A excit (37B37a); chem, excit (42S38); chem, sep isotopes, excit (29K49, 23D49)		β^+ (42S38)	15.5 m (23D49, 25W48); 17 m (29K49, 37B39, 42S38)	3.7 abs (23D49); 2.7 cl ch (42S40)	no γ (23D49)		Mo-γ-n (37B39, 25W48, 22E52); Mo-n-2n (6H37, 42S38, 42S40, 30B52); Mo^{92}-n-2n (29K49); Mo^{92}-γ-n (23D49)
Mo^{91}	B chem, sep isotopes (23D49)		β^+ (23D49)	75 s (23D49); 73 s (25W48)	2.6 abs (23D49)	0.3 abs (23D49)		Mo^{92}-γ-n (23D49); Mo-γ-n (25W48)
Mo^{92}		15.86 (9W46)					Mo^{92}, I = 0 (87M50)	
Mo^{93m}	D chem, excit (29K46); chem, excit, cross bomb, sep isotopes (29K50a); chem, excit (76B52b); possibly Mo^{92m} or Mo^{94m} (HPS)		IT (29K50a)	6.95 h (76B52b); 6.75 h (29K50a)		0.262 (K/L 2.9), 0.69, 1.51 spect, spect conv (19R51); 0.256 (K/L 2.8), 0.7, 1.5 spect conv, scint spect (13A50b); 0.30 (e/γ 9), 0.70 (e/γ 0.005), 1.7 (e/γ ~0) abs, abs conv, spect conv, conv-γ coinc (29K50a); γ_1 0.29, γ_2 0.69, γ_3 1.46 ($\gamma_1/\gamma_2/\gamma_3 \simeq 0.6/1/1$) scint spect (76B52b) others (85S51)		Zr^{90}-α-n (29K50a); Zr-α-n (29K46); Nb-p-n (29K46, 19R51, 76B52b); Nb-d-2n (29K46, 37W46, 29K50a); Mo^{94}-n-2n (29K50a); not found by: Mo^{92}-n-γ (76B50a); Mo^{94}-γ-n (23D49); Mo^{92}-d-p (29K50a); not daughter Tc^{93} (76B50a)
Mo^{93}	B chem, n-capt (76B49)		EC (76B49)	>2 y (76B49)		Nb K-x (76B49)		Mo-n-γ (76B49)
Mo^{94}		9.12 (9W46)					Mo^{94}, I = 0 (87M50)	
Mo^{95}		15.70 (9W46)					Mo^{95}, I = 5/2 (87M50)	
Mo^{96}		16.50 (9W46)					Mo^{96}, I = 0 (87M50)	
Mo^{97}		9.45 (9W46)					Mo^{97}, I = 5/2 (87M50)	
Mo^{98}		23.75 (9W46)					Mo^{98}, I = 0 (87M50)	
Mo^{99}	A chem, n-capt, excit (42S38, 42S40)		β^- (42S38)	67 h (13S39); 68.3 h (10C49); 63.5 h (25W48); 64 h (42S40)	1.23 (~80%), 0.45 (~20%), ~0.08 (weak) (?) spect (2B50a); 1.23 (87%), 0.54 (13%) spect (62M51); 1.25, others, spect (54M51); 1.2 abs (32K51c)	γ_1 0.040, γ_2 0.181 (K/L 5), γ_3 0.367, γ_4 0.741, γ_5 0.780 ($\gamma_3/\gamma_4/\gamma_5 \simeq 10/100/14$) spect, spect conv (2B50a); 0.728, 0.360 (weak), 0.182 (weak) spect, β-γ, γ-γ coinc (62M51); 0.179, 0.168 spect conv (10C49); γ_4 0.745, γ_5 0.780, γ_6 0.850 ($\gamma_4/\gamma_5/\gamma_6 \simeq 100/50/30$) spect (54M51); with Tc^{99m}: 0.0018, 0.140 (62M49, 62M51); 0.142 (63M51)	Q^-_β 1.37 (2B50a)  (18G52)	Zr-α-n (14E46); Mo-d-p (13S39); Mo-n-γ (42S38, 13S39, 61M47, 2S47, 26M48c, 62M49); Mo^{98}-n-γ (61M47a); Mo-n-2n (42S40); Mo-γ-n (25W48, 22E52); spall Sb (37L50); spall-fission Pt, Tl (2T47b), Bi (13P47, 11G49, 66B51), Th (7N49a); fission Th (16H39d, 72B51, 21T51), U^{233} (61S48), U (16H39e, 24S40, 32K51c), Pu (32K48, 28F51); parent Tc^{99m} (13S39, 24S40, 62M49, 33G51e)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{42}Mo^{100}$		9.62 (9W46)					Mo^{100}, I = 0 (87M50)	
Mo^{101}	A chem, n-capt (42S40); chem, n-capt, sep isotopes (61M47a)		β^- (42S40)	14.6 m (3M41); 14 m (16H41b)	1.2, 2.1 abs (31R52); ~1.0, 2.2 abs (3M41); 1.9 abs (42S40)	0.191 (K/L ~6), 0.960 (coinc with 1.2 β^-) spect conv, scint spect, β-γ, γ-γ coinc (31R52); 0.15 scint spect (38M51a)		Mo-n-γ (42S40b, 42S40, 24S40a, 3M41, 2S47, 50H51); Mo^{100}-n-γ (61M47a); parent Tc^{101} (42S40b); fission U, parent Tc^{101} (24S40a, 37B41, 16H41, 16H41b, 3M41)
Mo^{102}	D chem (16H41)		β^- (16H41)	12 m (16H41); 11 m (76B49a)				fission U, parent Tc^{102} (16H41, 16H41b, 76B49a)
Mo^{105}	B chem, genet (70B43b)		β^- (70B43b)	~5 m (66S47)				fission U, ancestor Ru^{105} (70B43b)
$_{43}Tc^{92}$	D chem, sep isotopes (61M48)		β^+, EC (76B52c)	4.3 m (76B52c)	4.1 abs (76B52c)	1.3 abs (61M48)		Mo^{92}-d-2n (61M48)
Tc^{92}	D chem, excit, sep isotopes (29K48a)		EC (29K48a)	43.5 m (62M50); 47 m (29K48a)		0.389 spect, spect conv (62M50); 1.50 abs conv (29K48a)		Mo^{92}-d-2n, p-n (29K48a); Mo-p-n (62M50)
Tc^{93}	A chem (13S39); chem, excit, sep isotopes (29K48a)		EC 93%, β^+ 7% (29K48a, 76B51d)	2.75 h (29K48a); 2.7 h (61M48, 5D39)	0.800 spect (76B51a); 0.83 abs (29K48a)	1.34 (coinc with β^+) scint spect, β-γ coinc abs (76B51d); 2.00 abs (29K48a); 2.4 abs (61M48)	Q^+_β 3.1 (76B51a)  (76B51a)	Mo^{92}-d-n (29K48a, 61M48); Mo-d-n (13S39); Mo-p-γ (5D39, 29K48a); not parent (7h) Mo^{93m} (76B50a)
Tc^{94}	B chem, excit (42G47); chem, excit, sep isotopes (61M48a)		β^+ ~75%, EC ~25% (62M50)	53 m (62M50); 50 m (61M48a)	2.41 (coinc with γ) spect, β-γ coinc (62M50); 2.5 abs (61M48a)	0.874 (e/γ ~10^{-3}), 1.85, 2.73, 3.27 spect, spect conv (62M50); 0.9 abs (61M48a)	Q^+_β 4.30 (62M50)  (62M50)	Mo-p-n (42G47, 34H48, 62M50); Mo^{94}-d-2n (61M48a); daughter Ru^{94} (12V52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{43}Tc^{95m}$	A chem (12C37, 12C39); chem, sep isotopes (61M48b)		EC 96+%, IT ~3%, β^+ 0.2-0.6% (62M50, 62M50a)	60 d (62M50); 52 d (14E47); 62 d (12C39)	0.4 cl ch (62M50)	γ_1 0.810 (e/γ 0.001), γ_2 0.201 (e/γ 0.036), γ_3 0.570 (e/γ 0.002), γ_4 1.02 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ = 0.3/0.7/0.4/0.03) spect, spect conv, γ-γ coinc (62M50); 0.0390 spect conv (62M50a); 0.80, 0.20, 0.58, 1.03 scint spect (76B51a); 0.8, 0.2 abs (14E47, 61M48b)	see Nb^{95}  (62M50, 62M50a, I8G52)	Mo-d-n (12C37, 12C39, 14E46); Mo-p-n (14E47); Mo^{95}-d-2n (61M48b)
Tc^{95}	A chem, sep isotopes (1E48, 61M48a)		EC (1E48); no β^+ (62M50)	20.0 h (1E48); 20 h (61M48a)		0.762 (~90%), 0.932 (~5%), 1.071 (~5%) spect conv, γ-γ coinc (62M50); 0.76, 1.07, no 0.93 γ scint spect (76B51d); 0.78 abs (1E48)		Mo-a-p, Mo-p-n, Mo^{92}-a-p (1E48); Mo^{95}-d-2n (61M48a); Mo-p-n (62M50)
Tc^{96m}	B chem, excit (62M50); chem, excit, sep isotopes (62M52)		IT (62M50)	51.5 m (62M50)		0.0344 (K/L 1.2) spect conv (62M50); Tc K-x (62M50)	 (62M50, 76B51a, 62M52, I8G52)	Mo^{96}-p-n (62M52); Mo-p-n (62M50)
Tc^{96}	A chem (15E39); chem, excit, cross bomb (14E47); chem, excit, sep isotopes (61M48b)		EC (61M48b); no β^+ (62M50)	4.20 d (3IC50); 4.35 d (62M50); 4.2 d (61M48b); 4.3 d (14E47)		γ_1 1.119 (e/γ 3 x 10^{-4}), γ_2 0.842 (e/γ 6 x 10^{-4}), γ_3 0.806 (e/γ 6 x 10^{-4}), γ_4 0.771 (e/γ 6 x 10^{-4}), γ_5 0.312 (K/L 6.4) ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5$ = 0.17/1.00/0.82/1.00/0.0052) spect, spect conv, γ-γ coinc (62M50); 1.65, 1.89, 2.39 (?) (all weak) scint spect (76B51a)		Nb-a-n (14E47); Mo-p-n (15E39, 14E47, 62M50); Mo-d-n (14E47, 13S39); Mo^{96}-d-2n (61M48b)
Tc^{97m}	A chem (22P37, 12C37); chem, genet (61M47b); excit, sep isotopes (61M48b)		IT (2H41, 14E47)	90 d (61M48b); 91 d (2H41); 95 d (14E47)		0.0958 (K/L+M 1.6) spect conv (62M50); 0.097 (K/L ~2) spect conv(2H41); 0.097 (e/γ very large) abs conv (61M48b); 0.108 (e/γ large) abs conv (14E47)		Mo^{97}-d-2n (61M48b); Mo-d-n (12C37, 22P37, 12C39); Mo-p-n (14E47); daughter Ru^{97} (61M47b)
Tc^{97}	[A] genet (76B51b)		[EC] (76B51b)	$>10^4$ y yield (76B51b)				[daughter Tc^{97m}] (76B51b)

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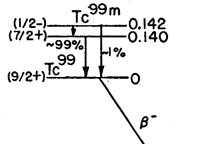
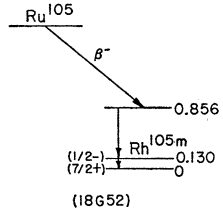
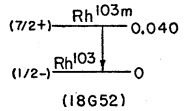
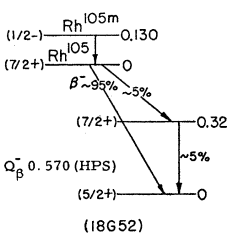
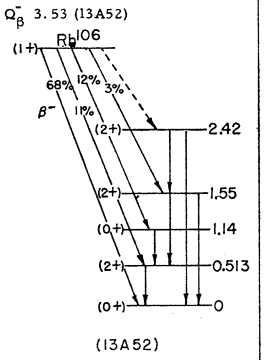
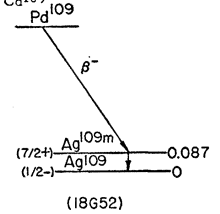
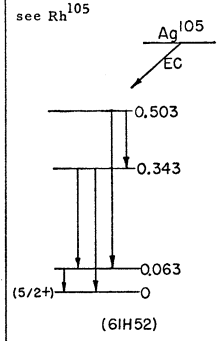
$_{43}Tc^{99m}$	A chem, genet (13S39)		IT (13S39)	6.04 h (1B52); 5.9 h (33G51e); 6.6 h (13S39)		0.1403 (K/L 7.7), 0.1423 (~1%, K/L ~2.5) spect conv (63M51); 0.1412 (e/γ 0.11, K/L/M+N = 7.9/1/0.3), 0.0018 (e/γ very large) spect conv (62M49, 62M51); 0.140 (K/L ~9) spect, spect conv (2B50a); 0.139 (K/L ~10) spect conv (54M51)		Ru-n-p (76B47); fission Th (72B51), U (24S40, 16H41, 33G51e); daughter Mo^{99} (13S39, 24S40, 62M49, 33G51e, 63M51); parent Tc^{99} (13S39, 16H41)
Tc^{99}	A chem (25L46, 53S46); chem, mass spect (3I47)		β^- (25L51, 53S51a)	2.12×10^5 y sp act (30F51); 2.2×10^5 y sp act (26P51)	0.290 spect (15F52); 0.292 spect (23T51); 0.296 spect (39W52); 0.30 spect (24K50a)	no γ (61M47, 53S51a, 30F51)	Q^-_β 0.29 (15F52, 23T51) (5/2+) (62M51, 63M51, 18G52) Tc^{99}, I = 9/2 (48K51)	fission U (3I47, 25L51, 53S51a); daughter Tc^{99m} (13S39, 16H41); descendent Mo^{99} (61M47)
Tc^{100}	A sep isotopes (64H52); sep isotopes, n-capt (76B52)		β^- (64H52)	15.8 s (76B52); 17.5 s (64H52)	2.8 abs (76B52); 2.4 abs (64H52)	0.55 scint spect (76B52c)		Mo^{100}-p-n (64H52); Mo-p-n (2D40); Tc^{99}-n-γ (76B52)
Tc^{101}	A chem, genet (42S40b)		β^- (42S40b)	14.0 m (3M41, 16H41b); 14.5 m (12P48); 16.5 m (60M48)	1.20 (>95%) abs; β-γ coinc (76B51d); 1.2 abs (42S40); 1.3 abs (3M41)	0.307 (coinc with β^-, K/L ~6) spect conv, β-γ coinc, scint spect (31R52); 0.30 (coinc with β^-), 0.56 (weak) scint spect, β-γ coinc (76B51a); 0.26 scint spect (38M51a); no 0.56 γ (31R52)		Mo^{100}-d-n (61M48); Ru-γ-p (12P48, 60M48); Rh-γ-2p (22E52); fission U, daughter Mo^{101} (24S40a, 37B41, 16H41, 16H41b, 3M41); daughter Mo^{101} (42S40b)
Tc^{102}	E genet (16H41)		β^- (16H41)	<25 s (76B49a); <1 m (16H41)				daughter Mo^{102} (16H41, 16H41b, 76B49a)
Tc^{105}	B chem, genet (70B43b)		β^- (70B43b)	short (70B43b)				fission U, daughter Mo^{105} parent Ru^{105} (70B43b)
Tc^{107}	[E] genet (70B43b)		[β^-] (70B43b)	<1.5 m (70B43b)				[fission U, parent Ru^{107}] (70B43b)
$_{44}Ru^{94}$	D chem, genet (12V52)		EC (12V52)	~57 m genet (12V52)				Mo-α-2n, parent Tc^{94} (12V52)
Ru^{95}	A chem, cross bomb, sep isotopes (1E48)		EC, β^+ (1E48)	1.65 h (1E48)	1.1 abs (1E48)	1.0, 0.5 abs (1E48)		Mo-α-n, Mo^{92}-α-n (1E48); Ru-n-2n (1E48); Ru-γ-n (60M48)
Ru^{96}		5.7 (16E43)						
Ru^{97}	A chem, excit (23S46); chem, cross bomb, sep isotopes (1E48)		EC (23S46)	2.8 d (23S46, 60M48)		0.217 spect (53M50a); 0.23 abs (23S46)		Mo^{94}-α-n (1E48); Ru-d-p (23S46); Ru-n-γ (23S46); Ru-n-2n (1E48); Ru-γ-n (60M48); spall Sb (37L50); parent Tc^{97m} (61M47b)
Ru^{98}		2.2 (16E43)						
Ru^{99}		12.8 (16E43)					Ru^{99}, I = 5/2 (19O52)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{44}Ru^{100}$		12.7 (16E43)						
Ru^{101}		17.0 (16E43)					Ru^{101}, I = 5/2 (19O52)	
Ru^{102}		31.3 (16E43)						
Ru^{103}	A excit (12L36); chem (5N42, 39G46); chem, excit (23S51, 23S51b)		β^- (5N42)	39.8 d (38K50); 42 d (23S51); 41 d (77B45, 15H48); 45 d (5N42, 60M48)	0.217 (~99%), 0.698 (~1%) spect (38K50, 38K51c); 0.222 (94%), 0.684 (6%) spect (53M50a); 0.205 (strong), 0.670 (weak) spect (79S50); 0.350 (50%), 0.665 (50%) spect (15H48); 0.2 (92%), 0.7 (8%) abs, β-γ coinc (26M50)	0.498 (coinc with 0.22 β^-, e/γ ~0.01) spect, spect conv, β-γ coinc (38K50, 38K51c); 0.498 spect (46K52); 0.494 (e_K/γ 0.006, K/L 6.5) spect, spect conv (53M50a); 0.499 (K/L 8.5), 0.611 (K/L 4), 0.295 (?), 0.053 (K/L 1.0) spect conv (10C52); others (26M50, 23E52, 52M51); with Rh^{103m}: 0.040 (38K50, 53M50a, 79S50, 37W45, 10C52)	Q^-_β 0.75 (38K51c)	Ru-d-p (12L36, 23S51); Ru-n-γ (23S51, 7D38); Ru-γ-n (60M48); spall Sb (37L50); spall-fission Pb (13P47a), Bi (11G49); fission Th (72B51, 21T51), U^{233} (38G48, 61S48), U (5N41, 5N42, 39G51a, 23S51f), Pu (28F51); parent Rh^{103m} (23S51b)
Ru^{104}		18.3 (16E43)						
Ru^{105}	A chem (24S41); chem, excit (23S51c)		β^- (5N41)	4.5 h (76S51, 23S51d, 23S51a); 4.4 h (77B45)	1.150 spect (23D51); 1.15 spect (90S52); 1.3 abs (23S51d, 23S51a, 77B45)	0.726 (coinc with β^-) spect, β-γ coinc (23D51); 0.75 abs (23S51d); 0.7 abs (77B45); with Rh^{105m}: 0.130 (29A51, 23D51a, 90S52)	Q^-_β 2.01 (23D51)  (18G52)	Ru-n-γ (7D38, 23S51c); Ru-d-p (12L36, 23S51c); spall Sb (37L50); spall-fission Pt (2T47b), Hg (π) (63S52), Tl (2T47b), Pb (13P47a), Bi (13P47, 11G49), U (6O48, 6F51); fission Th (24S41, 72B51), U (7D38, 5N41, 24S41, 70B43b, 77B45, 76S51, 23S51d); descendent Mo^{105} (70B43b), parent Rh^{105m} (23D51), ancestor Rh^{105} (5N41, 77B45, 76S51, 23S51c)
Ru^{106}	A chem (39G46, 33G46a); chem, mass spect (60H48)		β^- (39G51a, 33G51f)	1.0 y (33G51f, 66S46)	0.0392 spect (16A50); 0.038 spect (3F50b)	no γ (76S51a, 16A50)		spall Sb (37L50); spall-fission Bi (11G49), Th (7N49a), U (6F51); fission Th (72B51, 21T51), U^{233} (38G48, 61S48), U (33G51f), Pu (28F51); parent Rh^{106} (33G51f)
Ru^{107}	D chem (70B43b, 33G51g)		β^- (70B43b)	4 m (33G51g, 70B43b)	~4 abs (70B43b)			fission U, parent Rh^{107} (33G51g, 70B43b)
$_{45}Rh^{99}$	D chem (1E49)		β^+ (90S52)	4.5 h (90S52)	0.74 spect (90S52)			Ru-p-n (1E49, 90S52); Ru-d-n (1E49, 90S52)
Rh^{100}	B chem (23S51e); chem, genet (37L48)		EC ~95%, β^+ ~5% (37L48)	19.4 h (37L48); 21 h (23S51e)	3.0 spect (37L48)	1.2 abs (37L48); 1.8 abs (23S51e)		Ru-d-n (23S51e); daughter Pd^{100} (37L48)
Rh^{101}	B chem, excit (23S51g)		EC (23S51g)	4.3 d (37L48); 5.9 d (23S51g)		0.300, 0.148 spect conv (90S52); 0.35 spect conv, abs (37L48)		Ru-p-n (90S52); Ru-d-n (23S51g, 90S52); daughter Pd^{101} (37L48)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{45}Rh^{102}$	A chem, excit (64M41)		β^-, β^+ (64M41); EC (?) (23S51h)	210 d (64M41); 215 d (15H47)	β^-: 1.0 cl ch (15H45); 1.1 abs (64M41) β^+: 1.1 cl ch (15H45)			Ru-d-n (23S51h); Rh-n-2n (64M41, 15H45); Rh-γ-n (60M48, 22E52)
Rh^{103m}	A chem, excit (9F44); chem (33G46a, 33G51f); chem, genet (23S51b)		IT (9F44, 37W45)	57 m (33G51f); 56 m (53M50a); 52 m (9F47); 45 m (37W45)		0.0400 (K/L+M 0.2) spect conv, β-γ coinc (38K50, 38K51c); 0.0404 (e/γ very large) spect conv (53M50a); 0.0396 (K/L 0.1) spect conv (10C52); 0.040 spect conv (79S50); abs conv (37W45); 0.042 abs conv (9F47)		Rh-d-pn, Rh-p-p (15H48); Rh-n-n (9F44); Rh-e⁻-e⁻, Rh-x rays (37W45); fission U, daughter Ru^{103} (23S51b); daughter Pd^{103} (48B46, 53M50a)
Rh^{103}		100 (57C43)					Rh^{103}, I = 1/2 (49K50)	
Rh^{104m}	A n-capt (12A35)		IT (17P38, 28A43a)	4.4 m (32C39); 4.7 m (38M51, 58C47); 4.3 m (9F47)		0.052 scint spect (38M51); scint spect, ion ch (31K51); others (28A43a, 14O40, 15H47)		Ru-p-n (2D40); Rh-n-γ (12A35, 1P37, 17P38, 34G46, 2S47, 50H51); Pd-γ-p (42H47); parent Rh^{104} (17P38, 9F47)
Rh^{104}	A n-capt (12A35); genet (17P38)		β^- (17P38)	44 s (12A35, 17P38)	2.6 spect (15H47); 2.3 abs (18S43); cl ch (32C39); 2.5 abs (28M40)	0.04, 0.18, 0.95 abs, abs conv (58C47)		Rh-n-γ (12A35, 17P38, 34G46); daughter Rh^{104m} (17P38, 9F47)
Rh^{105m}	A chem, genet (23D51)		IT (23D51)	45 s (23D51)		0.130 (e/γ ~3, K/L 1.5) scint spect, spect conv (29A52); 0.127 spect conv (90S52)		daughter Ru^{105}, parent Rh^{105} (23D51)
Rh^{105}	A chem, genet (5N41); chem, genet (23S51c)		β^- (5N41)	36.5 h (23S51c); 37 h (77B45); 34 h (5N41)	0.570 (~96%), 0.25 (~4%) spect (23D51, 23D51a); 0.57 spect (90S52); 0.26 (~10%) β-γ coinc abs (76B52a)	0.322 (~10%, coinc with 0.26 β^-), 0.157 (very weak), 0.080 (?) scint spect, β-γ coinc abs (76B52a); 0.320 (~3%) scint spect (23D51a); ~0.3 (~8%, not coinc with 0.6 β^-) abs, β-γ coinc (26M51); 0.33 (weak) abs (23S51i)		Ru-d-n (23S51i, 90S52); Rh-t-p (29K48); Pd-γ-p (12P48); spall-fission U (6F51); fission Th (72B51, 21T51), U (5N41, 76S51), Pu (32K48); descendent Ru^{105} (5N41, 77B45, 76S51, 23S51c), daughter Rh^{105m} (23D51)
Rh^{106}	A chem, genet (33G46a, 33G51f)		β^- (33G51f)	30 s (33G51f); 40 s (66S46)	3.53 (68%), 3.1 (11%), 2.44 (12%), 2.0 (3%), others (6%) spect (13A52); 3.55 (82%), 2.30 (18%) spect (6P47a); 3.5, ~2.3 abs, β-γ coinc (15J49)	γ_1 0.513 (e_K/γ 0.004, K/L 8), γ_2 0.624 (e_K/γ 0.002), γ_3 0.87, γ_4 1.045, γ_5 1.55, γ_6 2.41 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ ≈ 100/53/3/8/2.5/1) spect, scint spect, spect conv (13A52); 0.510, 0.622 spect conv (10C52); 0.51 (17%), 0.73 (17%), 1.25 (~1%) spect, β-γ, γ-γ coinc (6P47a); ~0.5 (e_K/γ 0.005), ~0.7 (e_K/γ <0.003) spect conv (44M50); others (39A52)		fission U, daughter Ru^{106} (38G46, 33G51f); fission Pu (28F51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{45}Rh^{107}$	D chem, genet (70B43b)		β^- (70B43b)	26 m (33G51g); 24 m (70B43b)	1.2 abs (70B43b)			Pd-γ-p (22E52); fission U, daughter Ru^{107} (70B43b, 33G51g)
Rh^{109}	[A] genet (77S51)		[β^-] (77S51)	<1 h (77S51)				[fission U, parent Pd^{109}] (77S51)
$_{46}Pd^{100}$	B chem, excit (37L48)		EC (37L48)	4.0 d (37L48)		0.09, 1.8 abs (37L48)		Rh-d-5n (37L48); spall Sb (37L48, 37L50); parent Rh^{100} (37L48)
Pd^{101}	B chem, genet (37L48)		EC 90%, β^+ 10% (37L48, 1E49)	8 h (37L50); 9 h (1E49)	2.3 spect (37L48); 0.5 abs (1E49)	no γ (37L48)		Ru-α-n (1E49); Rh-d-4n (37L48); spall Sb (37L48, 37L50); parent Rh^{101} (37L48)
Pd^{102}		0.8 (37S36a)						
Pd^{103}	A chem, genet (48B46a); chem, excit (36M47)		EC (48B46a)	17.0 d (36M47, 48B46a)		Rh K-x (36M47, 53M50a); no γ (36M47, 53M50a); with Rh^{103m}: 0.040 (38K50, 53M50a, 79S50, 10C52)		Rh-α-p3n (53M50a); Rh-d-2n (36M47, 37L48); Rh-p-n (36M47); Pd-n-γ (48B46a, 78S50); spall Sb (37L50); parent Rh^{103m} (48B46a, 53M50a)
Pd^{104}		9.3 (37S36a)						
Pd^{105m}	E excit (9F52a)		IT (9F52a)	~23 s (9F52a)		0.20 (e/γ ~0.4) (9F52a)		Pd-n-2n, Pd-n-n (9F52a)
Pd^{105}		22.6 (37S36a)					Pd^{105}, I = 5/2 (99B51)	
Pd^{106}		27.2 (37S36a)						
Pd^{107}	B chem (26P49a)		β^- (26P49a)	~7×10^6 y sp act (26P49a)	~0.04 abs (26P49a)			fission U (26P49a)
Pd^{108}		26.8 (37S36a)						
Pd^{109m}	D n-capt (31K51); excit, cross bomb, n-capt (9F52a)		IT (31K51, 9F52a)	4.8 m (9F52a)		0.173 scint spect (31K51); 0.160 (e/γ ~0.6) (9F52a)		Pd-n-2n, Pd-n-γ (9F52a); Ag-n-p (9F52a)
Pd^{109}	A n-capt (12A35); chem, excit (39K37); chem, mass spect (37R46, 67B49a)		β^- (39K37)	13.6 h (11M53); 13.1 h (25W48); 13 h (39K37, 77S51); 14.1 h (60M48)	0.961 spect (20K52); 0.95 spect (7S49b, 38K51c); others (2H46, 39K37, 77S51)	with Ag^{109m}: 0.087 (e/γ ≥11, K/L+M 1.3) spect conv (7S49b); no γ (77S51); others (52M51)	Q^-_β 1.05 (HPS) see Cd^{109}  (18G52)	Pd-γ-n (12P48, 60M48, 25W48, 22E52); Pd-d-p (39K37); Pd-n-γ (12A35, 39K37, 2S47, 9O49, 50H51); Ag-d-2p (2H46, 112S51); Ag-n-p (4F38b); Ag-t-He^3 (29K47a); spall Sb (37L50), Ta (22N52); spall-fission Bi (11G49, 66B51), U (6F51); fission Th (21T51), U (77S51), U^{233} (61S48), Pu (32K48); parent Ag^{109m} (24S41, 7S49b, 77S51)
Pd^{110}		13.5 (37S36a)						

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{46}Pd^{111m}$	B chem, genet (66M52)		IT 75%, β^- 25% (66M52)	5.5 h (66M52)		0.16, 1.77 scint spect (66M52)		Pd-d-p, parent Ag^{111} (66M52)
Pd^{111}	A n-capt (12A35); chem, genet (24S41)		β^- (39K37)	22 m (66M52); 26 m (24S41)	2.13 spect (20K52); 2.15 spect (66M52); 3.5 abs (70B43b)	0.38, 0.56, 0.65, 0.73 scint spect (66M52)		Pd-d-p (12A35, 39K37); Pd-n-γ (12A35, 39K37, 2S47); spall Sb (37L50); spall-fission Bi (66B51); fission Th (24S41), U (24S41, 5N40a); parent Ag^{111} (39K37, 24S41)
Pd^{112}	A chem, genet (5N40a, 24S41)		β^- (5N40a)	21 h (77S51)	0.2 abs (77S51)	no γ (77S51)		In-p-4p, Pd-α-2p (112S51); spall Sb (37L50); spall-fission Bi (11G49, 66B51), Th (7N49a), U (6F51); fission Th (24S41, 21T51), U^{233} (61S48), Pu (32K48); fission U, parent Ag^{112} (5N40a, 5N40b, 24S41, 77S51)
$_{47}Ag^{102}$	E excit (17E39)			16 m (17E39)				Pd-p-n (17E39)
Ag^{104}	B excit (17E39); chem, excit, sep isotopes (11M52a)		β^+, EC (37L50)	1.2 h (17E39, 11M52a)				Pd-p-n (17E39); Cd^{106}-d-α (11M52a); spall Sb (37L50)
Ag^{104}	B chem, genet (32J52); chem, excit, sep isotopes (11M52a)		β^+ (32J52)	27 m (32J52)	2.70 spect (32J52)	0.118, 0.556, 0.148 (?), 0.179 (?) spect conv (32J52)		Cd^{106}-d-α (11M52a); daughter Cd^{104} (32J52)
Ag^{105}	A excit (17E39); chem, excit (16B47a)		EC (44G50)	40 d (44G50); 45 d (17E39)		0.0625 (e/γ very large, K/L >5), 0.280 (coinc with 0.063 γ, K/L 8), 0.343 (K/L 5.8), 0.440 (K/L 7), weak γ's: 0.154, 0.181, 0.391 spect conv, spect, γ-γ coinc (61H52); 0.064, 0.220 (weak), 0.278, 0.340, 0.437 (weak) spect (53M50b); 0.281, 0.319, 0.331, 0.345, 0.393, 0.443 spect conv (32J52); others (17E39, 20D42c)	see Rh^{105}  (61H52)	Rh-α-2n (16B47a, 44G50, 53M50b, 61H52); Pd-p-n (17E39, 44G50); Pd-d-2n (44G50, 53M50b, 61H52); Pd-α-p (44G50); spall Sb (37L50)

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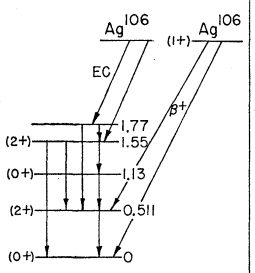
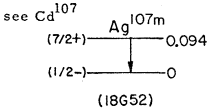
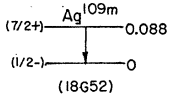
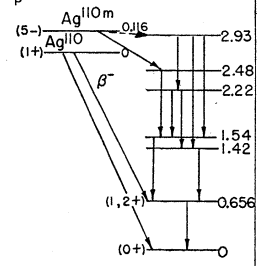
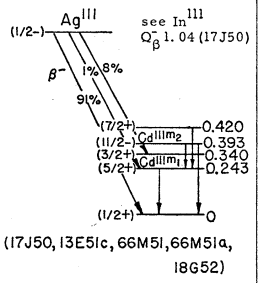
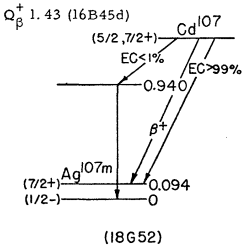
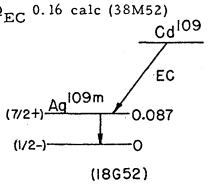
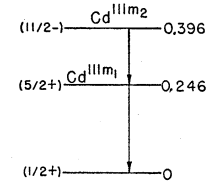
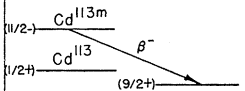
$_{47}Ag^{106}$	A excit (37B37a, 6H37); chem, excit, cross bomb (39K37, 1P38)		β^+ (39K37); β^- (?) ~2% (79B51)	24.0 m (79B51); 24.5 m (1P38); 24.4 m (2D38); 24.3 m (60M48)	β^+: 1.95, 1.5 spect (79B51); 2.0 abs (4F38b); 1.9 cl ch (1P38) β^- (?): 0.45 spect (79B51); conv: ~0.5 (weak) spect conv (79B51)	~0.5, >0.6 (weak) spect conv, scint spect, abs (79B51) no γ (4F38b, 1P38)	 see Rh^{106} (18G52)	Rh-α-n (1P38, 19K39, 16B47a); Pd-d-n (39K37, 1P38); Pd-p-γ (2D38); Pd-p-n (2D38, 17E39); Ag-n-2n (6H37, 1P38); Ag-d-t (29K47); Ag-γ-n (37B37a, 37B39, 60M48, 55S51, 22E52, 79B51); Ag-e^--e^-n (59S48); Ag-d-p2n (9K40b); Cd-n-p (1P38)
Ag^{106}	A chem, excit, cross bomb (39K37, 1P38)		EC (65H44)	8.2 d (1P38); 8.3 d (44G49); 7.5 d (39K37)		0.220, 0.409, 0.511 (K/L 8), 0.620, 0.717, 0.815, 1.04, 1.24, 1.55 spect conv (61H52); 0.515, 0.722, 1.04, 1.54 spect (53M50b); 0.72, 1.06, 1.63 spect (20D42c)		Rh-α-n (1P38, 16B47a, 53M50b, 61H52); Pd-d-n (39K37, 1P38, 61H52); Pd-p-n (2D38, 17E39); Ag-n-2n (1P38, 39K37, 36S51); Cd-n-p (1P38); spall Sb (37L50)
Ag^{107m}	A chem, genet (6A40, 2H41b)		IT (6A40)	44.3 s (16B45d, 16B47); 44 s (40W51)		0.094 (e/γ ~16, K/L 0.92) spect conv (16B47); 0.093 spect conv (6V39, 2H41)	see Cd^{107}  (18G52)	Ag-e^--e^- (37W45b); Ag-n-n (9F44); Ag-γ-γ (31F41, 37W45b, 24T45); Ag^{107}-γ-γ (40W51); daughter Cd^{107} (6A40, 2H41b, 16B45c, 2H46, 16B47)
Ag^{107}		51.35 (24W48)					Ag^{107}, I = 1/2 (87M50)	
Ag^{108}	A chem, n-capt (12A35); excit, cross bomb (1P38)		β^- 98.5%, EC 1.5% (12P52)	2.3 m (12A35, 12P48, 60M48, 37B39); 2.4 m (9F44)	1.5 scint spect (45G52)	0.45, 0.66 scint spect (12P52); 0.43, 0.60 scint spect (45G52)		Pd-p-n (2D38, 17E39); Ag-n-γ (12A35, 9F44, 2S47, 9O49, 50H51, 36S51); Ag-e^--e^-n (59S48); Ag^{107}-n-γ (9F44a); Ag-γ-n (37B39, 12P48, 60M48, 22E52); Ag-d-p (9K39, 9K40b); Cd-n-p (1P38)
Ag^{109m}	A chem, genet (2H41b)		IT (2H41b)	39.2 s (16B46c, 16B47); 40 s (40W51, 2H41b, 37W45b)		0.0875 spect conv (10C50b); 0.087 (e_K/γ ~6, K/L+M 0.75) spect conv (34H52); 0.087 (e/γ ≥11, K/L+M 1.3) spect conv (7S49b); 0.087 spect conv (2H46, 16B47)	 (18G52)	daughter Pd^{109} (24S41, 7S49b); Ag-n-n (9F44); Ag-γ-γ (31F41, 37W45b, 24T45); Ag^{109}-γ-γ (40W51); Ag-e^--e^- (37W45b); daughter Cd^{109} (2H41b, 16B45c, 2H46)
Ag^{109}		48.65 (24W48)					Ag^{109}, I = 1/2 (87M50)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{47}Ag^{110m}$	A chem, n-capt (35R38); resonance neutron activation (18G46c); chem, sep isotopes, n-capt (18G46d); chem, mass spect (67B49a)		β^-, IT (7S49c, 56M50, 10C50a); IT ≥3% (7S49c); no EC (lim 3%) (20D47a); no β^+: lim β^+/β^- 0.002% (2E49); lim β^+/β^- 0.05% (41M51)	270 d (44G50, 10C50a); 225 d (12L38d)	with Ag^{110m} and Ag^{110}: 0.087 (~58%), 0.530 (~35%), 2.12 (~3%), 2.86 (~3%), others (?) spect (7S49c); 0.088 (65%), 0.520 (33%), 2.89 (~2%) spect (31A51); 0.590, 2.24, 2.91 spect (88S51a); 0.09 (coinc with γ), 0.57 (coinc with γ), 0.19 (?) abs, β-γ coinc (46M49); 0.09, 0.59 cl ch (2E49); 0.59 spect (11R47)	0.116 (e/γ very large, K/L 1.3), 0.656 (e/γ 0.0025), 0.676, 0.706, 0.759, 0.814, 0.885, 0.935, 1.389, 1.516 spect conv, spect, β-γ coinc, γ-γ coinc (7S49c); 0.116 (conv in Ag), 0.438, 0.446, 0.471, 0.499, 0.542, 0.575, 0.619, 0.657, 0.677, 0.705, 0.723, 0.764, 0.817, 0.884, 0.937, 1.384, 1.504 spect, spect conv (10C50a); 0.116 (K/L+M 1.8), 0.447, 0.618, 0.655 (K/L+M 4.3), 0.687, 0.706 (K/L+M 6.6), 0.740, 0.759 (K/L+M 6.5), 0.815 (K/L+M 4.1), 0.883 (K/L+M 4.2), 0.932 (K/L+M 6.5), 1.386 (K/L+M 6.5), 1.480, 1.506 (K/L+M 4.5) spect conv (31A51); 0.656 (K/L+M 14) spect conv (40K52); 0.66, 0.90, 1.40 spect conv, spect (11R47); ~0.7, ~0.9 (coinc with 0.7 γ) γ-γ coinc abs (5Y49); 1.7 < γ < 2.2 Be-γ-n reaction (38M50a); others (52M51)	see In^{110} Q^-_β 3.02 (7S49c)  (7S49c, 18G52)	Pd-d-2n (44G50); Ag-n-γ (35R38, 12L38d, 30A38, 14M38, 2S47); Ag^{109}-n-γ (18G46d); Ag^{109}-d-p (44G50); Ag-d-p (9K39, 9K40b, 65H44a); spall Sb (37L50); parent Ag^{110} (56M50)
Ag^{110}	A n-capt (12A35); sep isotopes, n-capt (9F44a); chem, genet (56M50)		β^- (1P38)	24.2 s (42H46a); 22 s (12A35, 1P38)	2.24 (~60%), 2.82 (~40%) scint spect (45G51a)	0.66, ~0.9 (weak) scint spect (45G51a)	Q^-_β 2.90 (HPS)	Ag-n-γ (12A35,46G36,9F44,2S47); Ag^{109}-n-γ (9F44a); Cd-n-p (1P38); Cd-γ-p (42H46a, 42H47); daughter Ag^{110m} (56M50)
Ag^{111m}	F genet (80S52)			[<5 m] (80S52)				Pd-d-n, parent $Cd^{111m}2$ (80S52)
Ag^{111}	A chem, excit (39K37); chem, excit, cross bomb (1P38)		β^- (39K37)	7.6 d (61S51c); 7.5 d (17J50, 39K37, 1P38)	1.04 (91%), 0.80 (1%), 0.70 (8%) spect (17J50); 1.06 spect (66M51, 53M50b); 1.1 (93.5%), 0.7 (6.5%) abs (78S50)	γ_1 0.243 (e/γ <0.08), γ_2 0.340 (e/γ ~0.015) (γ_2/γ_1 ~ 8) spect, spect conv, β-γ coinc, γ-γ coinc (17J50); 0.33 (~6.5%) abs (78S50)	 (17J50, 13E51c, 66M51, 66M51a, 18G52)	Pd-d-n (39K37, 1P38, 9Z49); Pd-α-p (1P38); Ag-α-2p (66M51); Ag-t-p (29K47a); Cd-n-p (1P38); Cd-γ-p (42H47, 23D49a); spall Sb (37L50), Ta (22N52); spall-fission Bi (11G49, 66B51), Th (7N49a), U (6O48, 6F51), U (C) (13H51); fission Th (21T51), U (5N40a, 24S41, 61S51c), Pu (28F51); parent $Cd^{111m}1$ (13E51c), daughter Pd^{111} (39K37, 24S41, 17J50), daughter Pd^{111m} (66M52)
Ag^{112}	A chem, excit, cross bomb (1P38)		β^- (1P38)	3.20 h (74S51a); 3.2 h (1P38)	4.2 scint spect (27P51a); 3.6 abs (77S51); 3.5 abs (74S51a)	0.625, 1.40 (40A52b); 0.86 abs (77S51); no γ coinc with 3.5 β^- (74S51a)		Cd-n-p (1P38); Cd-γ-p (42H47); In-n-α (1P38); spall Sb (37L50); spall-fission Bi (66B51), U (6O47, 6F51); fission Th (21T51), U^{233} (61S48); fission U, daughter Pd^{112} (5N40a, 5N40b, 24S41, 77S51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{47}Ag^{113}$	A chem (21T47); chem, sep isotopes, excit (23D49a)		β^- (21T47)	5.3 h (21T47, 23D49a)	2.0 scint spect (27P51a); 2.1 abs (23D49a); 2.2 abs (21T47)	no γ (21T47, 23D49a)	Q^-_β 2.0 (HPS)	Cd^{114}-γ-p (23D49a); Cd-γ-p (23D49a); spall-fission Bi (66B51), U (6F51); fission U (21T47)
Ag^{114}	B chem (21T47, 66S47); chem, excit, sep isotopes (23D49a)		β^- (23D49a)	2 m (23D49a); 3 m (66S47)	hard β^- (23D49a)			Cd^{114}-n-p (23D49a); fission U (21T47, 66S47)
Ag^{115}	A chem (21T47, 66S47); chem, excit, sep isotopes (23D49a)		β^- (21T47)	20 m (23D49a, 66S47); 21 m genet (1W52); 22 m (21T47)	~3 abs (21T47, 23D49a)	no γ (23D49a)		Cd-γ-p (23D49a); Cd^{116}-γ-p (23D49a); fission U (21T47, 66S47); parent (91%) Cd^{115}, parent (9%) Cd^{115m} (1W52)
$_{48}Cd^{104}$	B chem, excit (32J52)		β^+ (32J52)	59 m (32J52)	0.93 spect (32J52)	0.0666 (K/L+M ~10), 0.0835 (K/L+M ~15), 0.124, 0.134, other γ's spect conv (32J52)		Ag-p-4n (32J52); parent (24 m) Ag^{104} (32J52)
Cd^{105}	B cross bomb (44G50); chem, excit (32J52)		EC, β^+ (44G50)	57 m (44G50); 55 m (32J52); 65 m (54K52)	1.68 spect (32J52); 1.5 abs (44G50)	0.0255, 0.0494, 0.0525, 0.262, 0.293, 0.308, 0.312, 0.317, 0.321, 0.341, 0.347, 0.433, 2.1 spect conv, scint spect (32J52)		Pd-a-n (44G50); Ag-p-3n (32J52, 54K52); Cd-n-2n (44G50)
Cd^{106}		1.215 (28L48)						
Cd^{107}	A chem (5D39); chem, n-capt, sep isotopes (2H46)		EC 99+%, β^+ 0.31% (16B45d, 55B50)	6.7 h (5D39)	0.32 spect (16B45d, 16B45e)	0.846 (0.4%, e/γ ~10^{-3}) spect, spect conv (16B45d, 16B45e); 0.7 abs (2H41); with Ag^{107m}: 0.094 (16B45c, 16B47, 6V39, 2H41)	Q^+_β 1.43 (16B45d)  (18G52)	Ag-p-n (5D39, 6V39); Ag-d-2n (9K39, 6A40, 9K40b, 2H41b); Ag-a-p3n (2H46); Cd^{106}-n-γ (2H46, 18G46d); spall Sb (37L50); spall-fission U (6F51); parent Ag^{107m} (6A40, 2H41b, 16B45c, 2H46, 16B47)
Cd^{108}		0.875 (28L48)						
Cd^{109}	A chem (9K40b); chem, n-capt, sep isotopes (2H46)		EC (L/K 0.28) (38M52); EC (16B46c); no β^+ (26D51)	470 d (44G50); 330 d (16B46c)		with Ag^{109m}: 0.0875 spect conv (10C50b); 0.087 (e_K/γ ~6, K/L+M 0.75) spect conv (34H52); 0.087 ($e/\gamma \geq 11$, K/L+M 1.3) spect conv (7S49b)	see Pd^{109} Q_{EC} 0.16 calc (38M52)  (18G52)	Pd-a-n (44G50); Ag-d-2n (9K40b, 2H41b, 44G50); Ag-a-pn (2H46); Cd^{108}-n-γ (2H46, 10C50b, 59C51); spall Sb (37L50); parent Ag^{109m} (2H41b, 16B45c, 2H46, 16B46c)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{48}Cd^{110}$		12.39 (28L48)					Cd^{110}, I = 0 (87M50)	
Cd^{111m_2}	A chem (27D38); chem, sep isotopes, n-capt (18G48a)		IT (31F41, 37W45b)	48.6 m (66M51); 48.7 m (37W45b)		γ_1 0.150 (e/γ ~3, K/L 2.0), γ_2 0.246 (e/γ 0.064, K/L 5.1) spect conv (66M51, 66M51a); γ_1 (e/γ 2.3) (calc from 14S51, 66M51); γ_1 0.149, γ_2 0.247 scint spect (14S51); γ_1 0.146, γ_2 0.235 spect conv (15H48a)	see Ag^{111} and In^{111}  (17J50, 13E51c, 66M51, 18G52)	Pd^{108}-α-n (2H48); Pd-α-n (66M51); Ag-α-pn (2H48, 66M51); Cd-n-n or Cd-n-γ (27D38, 15H48a); Cd-γ-γ (31F41, 37W45b, 24T45); Cd^{112}-n-2n (66M51); Cd-e^--e^- (37W45b); Cd^{110}-n-γ (18G48a, 52M51); fission U (5N40a, 5N40b); spall-fission U (6F51); parent Cd^{111m_1} (20D50, 52M51); daughter (0.01%) In^{111} (66M51a)
Cd^{111m_1}	A genet (20D49a)		IT (20D49a)	8×10^{-8} s delay coinc (20D50, 63B50, 52M51); 10×10^{-8} s delay coinc (13E51c)		0.247 scint spect (52M51)		daughter Cd^{111m_2} (20D50, 52M51); daughter In^{111} (20D49a, 63B50); daughter Ag^{111} (13E51c)
Cd^{111}		12.75 (28L48)					Cd^{111}, I = 1/2 (87M50)	
Cd^{112}		24.07 (28L48)					Cd^{112}, I = 0 (87M50)	
Cd^{113m}	A chem, excit (44G49); chem, excit, sep isotopes (60C50,59C51)		β^- (60C50)	5.1 y (60C50)	0.59 scint spect (59C51); 0.5 abs (60C50)		 (18G52)	Cd-d-p (60C50); Cd-n-γ or Cd-n-n (60C50); Cd^{112}-d-p (60C50); Cd^{112}-n-γ (59C51); fission U^{235} (1W52)
Cd^{113}		12.26 (28L48)					Cd^{113}, I = 1/2 (87M50)	
Cd^{114}		28.86 (28L48)					Cd^{114}, I = 0 (87M50)	

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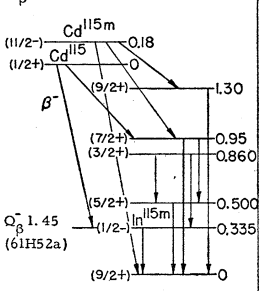
$_{48}Cd^{115m}$	A chem (10C39); chem, excit (2S47b); chem, sep isotopes, n-capt (10C50b)		β^- (10C39)	43 d (2S47b, 10C50b); 44 d (33G51h)	1.61 (~98%), 0.7 (~2%), ~0.3 (weak) spect (61H52a); 1.5 abs (2S47b, 10C50b, 1W52); 1.4 abs; 0.4 (coinc with γ, ~1%) β-γ coinc abs (47G50); 1.7 abs (33G51h); ~0.8 (~1.4%) abs (13E51d)	0.46, 0.50, 0.96, 1.28 scint spect, γ-γ coinc (61H52a); γ_1 0.48, γ_2 0.94 (coinc with γ_1), γ_3 1.30 (not coinc with γ_1 or γ_2) ($\gamma_1/\gamma_2/\gamma_3$ ≈ 13/100/40) scint spect, γ-γ coinc (13E52); others (56G49, 52M51)	Q^-_β 1.63 (61H52a)  (18G52)	Cd-d-p (10C39); Cd-n-γ (2S47, 2S47b); Cd^{114}-n-γ (10C50b); Cd^{116}-γ-n (1W52); In-n-p (2S47b); spall Sb (37L50); spall-fission Bi (11G49), Th (7N49a), U (6O48, 6F51); fission Th (21T51), U (67M51), U^{233} (61S48), U^{235} (1W52), Pu (33G51h, 28F51); daughter (9%) Ag^{115} (1W52)
Cd^{115}	A chem (10C37); chem, genet (18G38); chem, sep isotopes, n-capt (10C50b)		β^- (10C37)	53 h (1W52); 54 h (10C50b); 56 h (24L40, 67M51a)	1.11 (58%), 0.58 (42%) spect (10L52); 1.11 (~60%), 0.59 (~40%) spect (61H52a); ~1 (~85%), ~0.5 (~15%) β-γ coinc abs (1W52); others (26M49a, 10C50b, 67M51a)	0.335 (with In^{115m}), 0.360, 0.500, 0.525 scint spect, γ-γ coinc (61H52a); 0.522 spect (28D50); 0.336, 0.344, 0.349, 0.363 (?), 0.369, 0.424, 0.452, 0.525, 0.559, 0.713 spect conv (10C50b); with In^{115m}: 0.334 (10L52, 24L40, 61H49, 61H52a, 28D50, 20K51)	Q^-_β 1.45 (61H52a)	Cd-d-p (10C37, 10C39); Cd-n-γ (18G38, 14M37, 2S47); Cd^{114}-n-γ (10C50b); Cd-n-2n (18G38); Cd-γ-n (60M48); In-n-p (2S47b); spall Sb (37L50); spall-fission Th (7N49a), U (6O48, 6F51); fission Th (21T51), U^{233} (61S48), U^{235} (1W52), U (5N40a, 5N40b, 67M51a); parent In^{115m} (18G38, 10C39, 5N40b, 67M51a, 1W52, 10L52); daughter (91%) Ag^{115} (1W52)
Cd^{116}		7.58 (28L48)					Cd^{116}, I = 0 (87M50)	
Cd^{117m}	A chem, excit (10C39)		IT (51C52a)	3.0 h (51C52a); 2.9 h (25A52); 2.8 h (24L40); 2.7 h (67M51b)		with Cd^{117} (51C52a): ~1.2 abs (25A52)		Cd-d-p (10C39, 51C52a, 25A52); Cd-n-γ (14M37, 18G38, 2S47, 51C52a); spall-fission U (6F51); fission U (5N40a, 5N40b, 67M51b); parent In^{117} (18G38, 24L40, 67M51b), via Cd^{117} (51C52a)
Cd^{117}	A chem, genet (51C52a)		β^- (51C52a)	~50 m (51C52a)	~1.6, ~3.0 abs (51C52a)			Cd-n-γ, Cd-d-p, parent In^{117} parent In^{117m} (51C52a)
$_{49}In^{107}$	A chem, sep isotopes (68M49); mass spect (97M52)		β^+ (68M49)	30 m (97M52); 33 m (68M49)	~2 spect (68M49)			Cd^{106}-p-γ, Cd^{106}-d-n (68M49)
In^{108}	A chem, sep isotopes (68M49); mass spect (97M52)		β^+ (68M49)	50 m (97M52, 66M51); ~55 m (68M49)	2.31 spect (66M51); 2.2 abs (37L50); ~2 spect (68M49)	0.285 (<5%, K/L ≥3) spect conv (66M51)	Q^+_β 3.3 (66M51)	Cd^{108}-d-2n (68M49); daughter Sn^{108} (68M49, 37L50, 66M51)
In^{109}	A chem, excit (25T47); chem, mass spect (48G48); chem, excit, sep isotopes (68M49)		β^+, EC (25T47, 68M49)	4.3 h (68M49); 4.2 h (66M51); 6.5 h (25T47); 5.2 h (48G48)	0.75 abs (68M49); ~2 (weak) (25T47)	0.427, 0.347, 0.205 (K/L 3), 0.058 (K/L 0.9) spect conv (66M51)		Ag-α-2n (25T47, 48G48, 66M51); Cd^{106}-α-p, Cd^{108}-d-n, Cd^{108}-p-γ (68M49)

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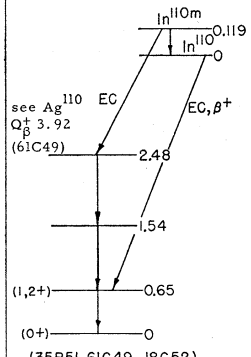
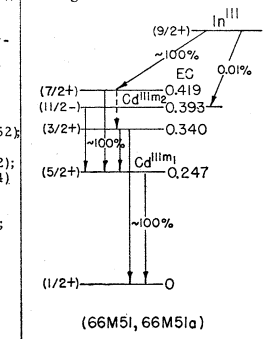
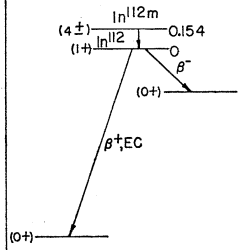
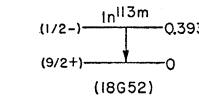
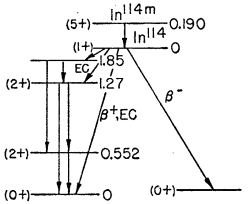
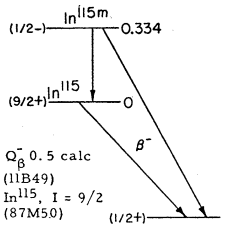
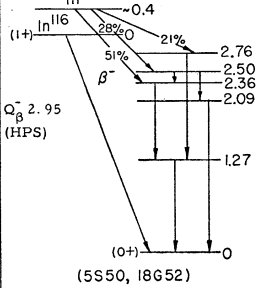
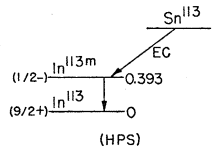
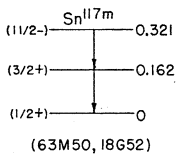
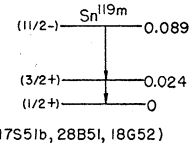
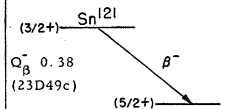
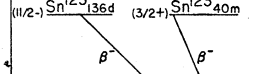
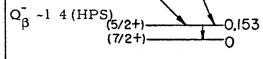
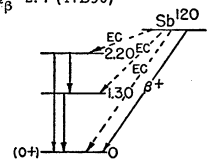
$_{49}In^{110m}$	A chem (48G48); chem, genet energy levels Ag^{110} (66M51a, 35B51)		EC 99+%, IT ~0.3% (66M51)	5.0 h (66M51); 4.9 h (35B51); ~5 h (48G48)		0.119 (with IT, K/L 4.5), 0.935, 0.885, 0.661 spect conv (66M51); 0.119 (weak), 0.937, 0.887, 0.654 spect conv (35B51)	 (35B51, 61C49, 18G52)	Ag-α-3n (48G48, 66M51)
In^{110}	A chem (58B39); chem, excit, mass spect (48G48)		β^+, EC (61C49)	66 m (58B39, 35B51); 65 m (48G48)	2.25 spect (61C49)	0.654 spect conv (35B51); 0.677 (e/γ 0.005) spect, spect conv (61C49)		Ag-α-n (19K39a, 25T47a, 48G48); Cd-p-n (58B39); Cd-d-2n (24L40)
In^{111}	A chem (10C39); chem, excit (25T47a, 48G48); mass spect (48G48)		EC (24L40); no β^+ (lim 0.06%) (66M51); no β^+ (48G48)	2.84 d (66M51); 2.7 d (58B39, 10C39)		0.172 (~100%, e/γ 0.12, K/L 6.6), 0.247 (~100%, e/γ 0.064, K/L 5.19), 0.330 (weak), 0.093 (weak) spect, spect conv, conv-conv coinc abs (66M51); 0.173 (e/γ 0.09, K/L ~8), 0.247 (e/γ 0.04, K/L ~5) γ-conv, conv-conv, γ-γ coinc (56B49); 0.171 (K/L+M 7.03), 0.246 (K/L+M 4.79) spect conv (59G52); 0.173 (K/L+M 6.6), 0.247 (K/L+M 5.3) spect conv (34H52); 0.173 (K/L 6.6), 0.247 (K/L 5.4) spect conv (24L40); 0.25 (coinc with 0.17 γ) scint spect, γ-γ delay coinc (69M51); others (36A51, 36A51a)	see Ag^{111}  (66M51, 66M51a)	Ag-α-γ (112S51); Ag-α-2n (24L40, 25T47a, 48G48, 66M51); Cd-p-n (58B39); Cd-α-p (66M51); Cd-d-n (24L40); In-n-3n (10C39); spall Sb (37L50); parent (0.01%) Cd^{111m_2} (66M51a); parent Cd^{111m_1} (20D49a, 63B50)
In^{112m}	A chem (58B39); chem, cross bomb, excit (81S42); chem, excit (25T47a)		IT (81S42, 25T47a)	20.9 m (35B52); 20 m (58B39); 23 m (25T47a)		0.154 (e/γ >4) spect conv (61C49); 0.16 spect conv (58B39); 0.16 (e/γ large) abs (25T47a)	 (18G52)	Ag-α-n (81S42, 25T47a); Cd-d-n (24L40); Cd-p-n (58B39); In-n-2n (81S42, 25T47a); parent In^{112} (81S42, 25T47a, 49G50)
In^{112}	A chem, cross bomb, excit (81S42); chem, excit (25T47a)		β^-, β^+, EC (25T47a, 61C49); β^-/β^+ 2.7 (61C49)	14.5 m (35B52)	β^+: 1.74 spect (61C49); 1.7 spect (24L40) β^-: 0.67 spect (61C49)			Ag-α-n (81S42, 25T47a); In-n-2n (81S42, 25T47a); daughter In^{112m} (81S42, 25T47a, 49G50)

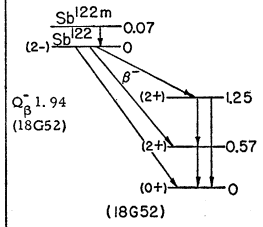
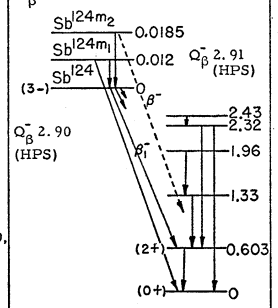
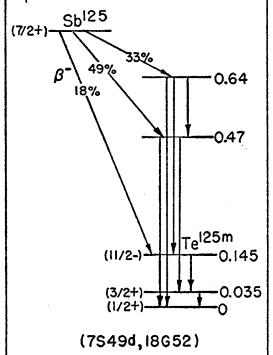
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{49}In^{m}$	E (31K52)		IT (31K52)	2.5 s (31K52)		0.153 scint spect (31K52)		In^{113}-n (31K52)
In^{113m}	A chem, excit, genet (58B39)		IT (58B39)	104 m (24L40) 105 m (58B39)		0.392 (K/L+M 4.21) spect conv (59G52); 0.393 spect conv (10C51a); 0.39 spect conv (58B39); 0.39 (K/L 5.4) spect conv (24L40); 0.39 (e/γ 0.55) scint spect (62C52); ~0.39 (e/γ 0.35, K/L 5.4) spect conv, ion ch (26T51)	 (18G52)	Cd-p-n (58B39); Cd-d-n (24L40); In-n-n (63C48); In-γ-γ (11D47); daughter Sn^{113} (58B39, 24S40a)
In^{113}		4.23 (24W48)					In^{113}, I = 9/2 (87M50)	
In^{114m}	A chem, n-capt, excit (24L37, 14M38)		IT, no EC (82S52)	49 d (58B39)		γ_1 with In^{114m}, γ_2, γ_3, γ_4, γ_5, γ_6 with In^{114}: γ_1 0.190, γ_2 0.552, γ_3 0.722, γ_4 1.27 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ ≈ 100/18.6/18.6/1.2) spect (53M49); γ_1 0.192 (e/γ 4.2, K/L 1.10) spect conv, scint spect (82S51); γ_1 0.190 (K/L/M ≈ 1.18/1.00/0.18) spect conv. (59G52); γ_1 0.191 spect conv (10C48); γ_1 (K/L 1.30) spect conv (40K52); γ_1 0.192 (e/γ 4, K/L 1.1), γ_2 0.55, γ_3 0.72 spect conv (56B49a); γ_1 (e/γ 4) spect conv (10L49a); γ_1 (K/L 1.16) spect conv (88S51a); γ_4/γ_2 ~0.06 scint spect, γ-γ coinc (23K52); γ_5 0.576, γ_6 1.30 (coinc with γ_2) spect, γ-γ coinc (25J52)	 (HPS, 18G52, 25J52)	Cd-p-n (58B39); Cd-d-n (24L40, 46M49); In-n-γ (24L37, 14M38, 46M49); In-d-p (24L40); In-γ-n (25W48, 22E52); In-n-2n (24L40); spall Sb (37L50); parent In^{114} (49G50)
In^{114}	A excit (7C37, 37B37a, 24L37); n-capt, sep isotopes (18G48a)		β^- ≤97%, EC ≥3%, β^+ ~0.01% (82S52); β^- 99+%, β^+ 0.015% (25J52); β^- 99+%, β^+ ~0.01% (56B49a)	72 s (24L37, 58B39)	β^-: 1.984 spect (25J52); 1.98 spect (24L40); 2.01 spect (88S51a); 2.05 abs (46M49) β^+: ~1 abs (25J52); 0.65 spect (56B49a)		Q^-_β 1.98 (25J52) Q^+_β 2.07 p-n threshold (66M51)	Cd-p-n (58B39); In-n-2n (24L37, 1P37); In-γ-n (37B37a, 7C37, 25W48, 22E52); In^{113}-n-γ (18G48a); daughter In^{114m} (49G50)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{49}In^{115m}$	A chem, excit (18G38)		IT (24L39), β^- (11B49); IT 95%, β^- 5% (10L52)	4.50 h (11D47); 4.53 h (24L40)	0.83 spect (11B49)	0.335 (e/γ 0.98, K/L+M 3.76) spect conv (10L52, 59G52); 0.338 (e/γ ~1, K/L 5.0, K/L+M 4.0) spect conv (24L40); 0.335 (K/L 5.3) spect conv (20K51); 0.337 spect, spect conv (61H49); 0.336 spect (28D50)	Q^-_β 0.83 (HPS)  	Cd-d-n (24L40); In-n-n (18G38, 63C48); In-p-p (58B39, 58B39a); In-α-α (38L39); In-e-e (64C40, 41W43, 41W49); In-γ-γ (17P38a, 64C39, 70M49, 83S51); fission Th (21T51), U (5N40a); daughter Cd^{115} (18G38, 10C39, 5N40b, 67M51a, 1W52, 10L52)
In^{115}	A chem, sep isotopes (71M50)	95.77 (24W48)	β^- (71M50, 63C51)	6 x 10^{14} y sp act (71M50); ~10^{14} y sp act (63C51)	0.63 abs (71M50)		Q^-_β 0.5 calc (11B49) In^{115}, I = 9/2 (87M50) (18G52)	natural source (71M50)
In^{116m}	A chem, n-capt (12A35); chem, excit, n-capt (24L37)		β^- (24L37)	53.93 m (57S49); 54.31 m (38R50); 54.05 m (50G47)	1.00 (51%), 0.87 (28%), 0.60 (21%) spect, β-γ coinc (5S50); 0.85 spect (10C39); cl ch (48C40); 0.7 β-γ coinc abs (26M48d)	2.090 (25%), 1.487 (21%), 1.274 (75%, e/γ 5.7 x 10^{-4}), 1.085 (54%, e/γ 8.4 x 10^{-4}), 0.406 (25%), 0.137 (3%) spect conv (5S50); 0.137, 0.171 spect conv (11K50a); others (20D42c, 48C40, 24L40, 18J45, 42W47)	Q^-_β 3.36 (5S50)  (5S50, 18G52)	Cd-p-n (58B39); In-n-γ (12A35, 14M38a, 34G46, 2S47, 50H51); In-d-p (24L37)
In^{116}	A n-capt (12A35); excit, n-capt (24L37)		β^- (24L37)	13 s (12A35, 10C39)	2.95 abs (35B46a, calc from 24L40); 2.8 cl ch (10C39)	no γ (14M38a)	Q^-_β 2.95 (HPS)	Cd-p-n (2D40); In-n-γ (12A35, 24L37, 34G46, 2S47); In-d-p (24L37); Sn-γ-p (42H47)
In^{117m}	A chem, genet (51C52a)		IT, β^- (51C52a)	~70 m (51C52a)	see In^{117}			daughter Cd^{117} (51C52a)
In^{117}	A chem, excit (10C39)		β^- (10C39)	~2.5 h (51C52a); 1.95 h (24L40); 1.90 h (67M51b)	with In^{117m} (?) (51C52a); 1.726 spect (20K51); 1.73 spect (10C39); 1.95 abs (67M51b) with In^{117}: 0.7 abs (51C52a)	0.161, 0.558 scint spect (20K51)		Cd-d-n (10C39, 24L40); Sn-γ-p (42H47); fission U (5N40a, 5N40b, 67M51b), Pu (32K48); daughter Cd^{117m} (18G38, 24L40, 67M51b); daughter Cd^{117} (51C52a)
In^{118}	B excit, sep isotopes (23D49b)		β^- (23D49b)	4.5 m (23D49b)	1.5 abs (23D49b)	γ (23D49b)		Sn^{119}-γ-p (23D49b)
In^{119}	B chem, excit, sep isotopes (23D49b)		β^- (23D49b)	17.5 m (23D49b)	2.7 abs (23D49b)	no γ (23D49b)		Sn^{120}-γ-p (23D49b)

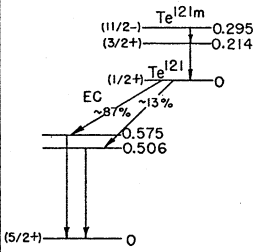
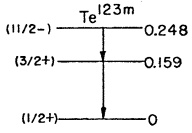
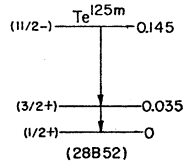
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{50}Sn^{108}$	B chem, sep isotopes (68M49)		EC (68M49)	4.0 h (66M51); 4.5 h (68M49)				Cd^{106}-α-2n (68M49); Cd-α-2n (66M51); parent In^{108} (68M49, 37L50, 66M51); spall Sb (37L50)
Sn^{111}	B chem, sep isotopes (66H49)		EC ~71%, β^+ ~29% (66M51)	35.0 m (66H49); 35 m (66M51)	1.51 spect (66M51); 1.5 abs (66H49)			Cd-α-3n (66M51); Cd^{108}-α-n (66H49)
Sn^{112}		0.95 (1B50)						
Sn^{113}	A chem, excit (58B39, 12L39c)		EC, no β^+ (58B39); EC (L/K ~0.8) (26T51)	112 d (19N50); 118 d (10C51a); 105 d (58B39)		with In^{113m}: 0.393 (10C51a, 58B39, 24L40, 62C52, 26T51); 0.401 (weak), 0.255 (weak) spect conv (10C51a); no 0.09 γ (65C47, 26T51, 10C51a, 63M51a, 28B51)	EC 0.43 calc (26T51)  (HPS)	Cd-α-n (12L39c); In-p-n (58B39); In-d-2n (65C47); Sn-d-p (12L39c); Sn-γ-n (60M48); Sn-n-γ (2S47, 28B51); Sn^{112}-n-γ (19N50, 63M51a, 10C51a); spall Sb (37L50); parent In^{113m} (58B39, 24S40a)
Sn^{114}		0.65 (1B50)						
Sn^{115}		0.34 (1B50)					Sn^{115}, I = 1/2 (87M50)	
Sn^{116}		14.24 (1B50)					Sn^{116}, I = 0 (87M50)	
Sn^{117m}	A chem (12L39c); chem, sep isotopes, cross bomb (68M50)		IT (68M50)	14.0 d (10C51a); 15 d (19N50)		0.159 (e/γ very large, K/L 2.2), 0.162 (e_K/γ 0.10) spect conv, e-γ coinc, x-γ coinc (63M50); 0.156 (e/γ large, K/L ~7), 0.159 spect conv (10C51a); 0.157 (K/L 2.2) spect conv (61H50a); 0.152 (K/L 2.4) spect conv (19N50)	 (63M50, 18G52)	Cd^{114}-α-n (68M50); Cd-α-n (12L39c); Sn^{116}-n-γ (63M50, 19N50); Sn^{116}-d-p, Sn^{118}-n-2n (68M50); Sn^{117}-n-n (68M50, 19N50); spall Sb (37L50)
Sn^{117}		7.57 (1B50)					Sn^{117}, I = 1/2 (87M50)	
Sn^{118}		24.01 (1B50)					Sn^{118}, I = 0 (87M50)	
Sn^{119m}	A chem, n-capt, sep isotopes (63M50)		IT (63M50)	~250 d (63M50); ~245 d (19N50)		γ_1 0.0653 (K/L 0.51, L/M ~4), γ_2 0.0242 (L/M ~4) spect conv (67H51); γ_2 0.0238 (e/γ ~7) scint spect, ion ch, γ-γ coinc (28B51); γ_1 0.065, γ_2 0.024 scint spect, ion ch conv (17S51b); γ_1 0.064 (K/L 0.82) spect conv (19N50)	 (17S51b, 28B51, 18G52)	Sn^{118}-n-γ (63M50, 19N50, 17S51b, 28B51)
Sn^{119}		8.58 (1B50)					Sn^{119}, I = 1/2 (87M50)	
Sn^{120}		32.97 (1B50)					Sn^{120}, I = 0 (87M50)	

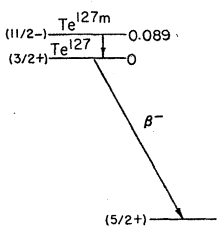
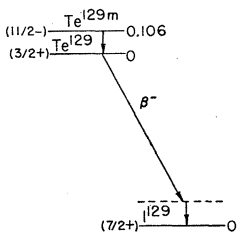
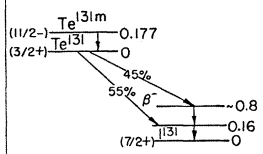
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{50}Sn^{121m}$	E sep isotopes, n-capt (19N50)		β^- (19N50)	>400 d (19N50)	0.42 spect (19N50)			Sn^{120}-n-γ (19N50)
Sn^{121}	A chem, excit (12L39c); chem, sep isotopes (37L48a)		β^- (12L39c)	27.5 h (19N50); 28 h (23D49c); ~27 h (6F51)	0.383 spect (23D49c); 0.4 abs (37L48a); 0.35 abs (39L49)	no γ (23D49c, 37L48a, 7N49b); others (52M51)	 (18G52)	Sn-d-p (12L39c); Sn-n-γ (12L39c, 2S47); Sn^{120}-d-p (37L48a, 39L49, 7N49b); Sn^{120}-n-γ (39L49, 23D49c, 19N50); Sn^{122}-n-2n (39L49); Sb-d-α (37L50); spall-fission Th (7N49a), U (6O48, 6F51)
Sn^{122}		4.71 (1B50)						
Sn^{123}	A chem (12L39c); chem, sep isotopes, excit (7N49b, 39L49, 19N50)		β^- (12L39c)	39.5 m (23D49c); 40 m (12L39c, 39L49, 19N50); 41.5 m (60M48); 39 m (7N49b)	1.26 spect (23D49c); 1.3 abs (39L49); 1.1 abs (19N50)	0.153 spect conv, β-e coinc (23D49c); 0.153 scint spect (76B51c); others (52M51)	Q^-_β ~1.4 (HPS) 	Sn-d-p (12L39c); Sn-n-γ (2S47); Sn-n-2n (1P37); Sn-γ-n (60M48, 7H49); Sn^{124}-d-t (7N49b); Sn^{122}-n-γ (23D49c, 39L49, 19N50); Sn^{124}-n-2n (39L49)
Sn^{123}	A chem (40L46, 40L51); chem, sep isotopes, cross bomb (39L49)		β^- (40L51)	136 d (38G51); 125 d (10C51a); 130 d (39L49, 7N49b, 40L51); 126 d (19N50)	1.42 spect (24K50b); 1.3 abs (39L49)	no γ (39L49, 7N49b, 19N50, 10C51a, 38G51)	Q^-_β ~1.4 (HPS)  (18G52)	Sn^{122}-n-γ (39L49, 19N50); Sn^{122}-d-p, Sn^{124}-n-2n (39L49); Sn^{124}-d-t (7N49b); Sb-n-p (7N49b); spall-fission Th (7N49a), U (6F51); fission U (38G46, 40L51), U^{233} (38G48, 38G51), U^{235} (38G51)
Sn^{124}		5.98 (1B50)		double β^- decay: (lower limit, by sp act) >2 x 10^{17} y (41K52, 32F52, 70H52); >10^{17} y (72M52); >10^{16} y (41L51, 25P52)				
Sn^{125}	A chem, excit, n-capt (12L39c); chem, sep isotopes (23D50a, 39L49, 19N50)		β^- (12L39c)	9.5 m (19N50); 9.8 m (39L49)	2.04, 1.17, 0.51 (?) spect (23D50a); 2.06, ~0.5 abs (19N50)	0.326, others >1 (weak) spect, spect conv (23D50a); 0.38 (coinc with 2.06 β) abs, β-γ coinc (19N50); 1.37 (weak) scint spect (76B51c)	Q^-_β ~2.4 (HPS)	Sn-d-p (12L39c); Sn-n-γ (12L39c, 23S47, 2S47); Sn^{124}-n-γ (39L49, 23D50a, 19N50)
Sn^{125}	A chem (12L39c); chem, excit, sep isotopes (39L49); chem, sep isotopes, n-capt, genet (19N50)		β^- (12L39c)	9.4 d (19N50); 10.0 d (39L49); 9.5 d (7N49b)	2.37 (~95%), 0.40 (~5%) spect (61H50b); 2.33 spect (24K50b); ~0.5 (10%) β-γ coinc abs (26M52a); others (65C47, 7N49b, 39L49, 77S51a)	1.90 scint spect, abs (76B51d); 1.67 coinc abs sec (26M52a)	Q^-_β ~2.4 (HPS)	Sn-n-γ (12L39c, 2S47); Sn-d-p (12L39c, 65C47); Sn^{124}-n-γ (39L49, 19N50); Sn^{124}-d-p (39L49); spall-fission Th (7N49a), U (6F51); fission U^{233} (61S48, 38G51), U (16H43b, 77S51a), U^{235} (38G51); parent Sb^{125} (19N50); not parent Sb^{125} (7N49b)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{50}Sn^{126}$	B chem, genet (80B51)		β^- (80B51)	~50 m yield (80B51)				fission U^{235}, parent Sb^{126} (80B51)
Sn^{127}	A chem, genet (80B51)		β^- (80B51)	1.5 h yield (80B51)				fission U^{235}, parent Sb^{127} (80B51)
$_{51}Sb^{116}$	A chem, excit, mass spect (27T49)		β^+ (27T49)	60 m (27T49)	~1.45 spect (27T49)			In-α-3n (27T49)
Sb^{117}	A chem (12L39d); chem, excit, mass spect. (27T49)		EC (65C47)	2.8 h (65C47, 27T49)		0.156 spect conv (27T49)		In-α-2n (27T49); Sn-d-n (12L39d, 65C47); Sn-p-n (65C47); spall I (π) (51W52)
Sb^{118}	B excit (27R40)		β^+ (37L48a)	3.5 m (37L48a); 3.6 m (27R40)	3.1 abs, spect (37L48a)			In-α-n (38L39, 27R40); Sn-p-n (2D40); daughter Te^{118} (37L48a)
Sb^{118}	A chem, cross bomb (65C47); chem, excit, mass spect (27T49)		EC (65C47)	5.1 h (65C47, 27T49)	e ~0.2 abs (65C47)	0.260 spect conv (27T49); 1.5 abs (65C47)		In-α-n (65C47, 27T49); Sn-d-n (65C47)
Sb^{119}	B chem, cross bomb (65C47)		EC (65C47)	39 h (65C47, 37L48a)		no γ (65C47); Sn K-x (65C47, 37L48a)		Sn-d-n, Sn-p-n (65C47); spall Sb (37L48a); daughter Te^{119} (37L48a)
Sb^{120}	D chem, sep isotopes (37L48a)		EC (37L48a)	6.0 d (37L48a)		~1.1 abs (37L48a)		Sb-d-p2n (37L48a); Sn^{120}-d-2n (37L48a); spall-fission Bi (11G49); not found: Sn-p, Sb-γ (47B51); Sb-x rays (30K51a)
Sb^{120}	A chem, excit (37B39, 6H37, 7C37); chem, excit, cross bomb (12L37a)		β^+, EC (47B50)	16.4 m (22J50); 16.6 m (12P48); 17 m (6H37, 12L39d)	1.70 spect (47B50)	γ_1 0.90, γ_2 1.30, γ_3 2.20 ($\gamma_1/\gamma_2/\gamma_3$ ~ 0.08/0.35/0.04) (e/γ very small) spect (47B50)	Q^+_β 2.7 (47B50)  (47B50)	Sn-d-n (12L39d); Sn-p-n (47B50); Sn^{120}-d-2n (37L48a); Sb-n-2n (1P37, 6H37, 21J44, 7C37); Sb-γ-n (37B39, 12P48, 27M49, 25W48, 22J50); Sb-d-t (9K41a); Sb-p-pn (23R46)
Sb^{121}		57.25 (24W48)					Sb^{121}, I = 5/2 (87M50)	

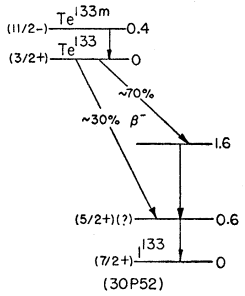
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{51}Sb^{122m}$	A chem, n-capt, sep isotopes (38M47)		IT (38M47)	3.5 m (38M47)		0.068 scint spect (38M51); 0.059, 0.074 ion ch (31K51)	 (18G52)	Sb-n-γ (38M47); Sb^{121}-n-γ (38M51, 31K51)
Sb^{122}	A chem (12A35); chem, cross bomb (12L39d)		β^- (12L39d)	2.80 d (47B51); 2.8 d (12L39b)	β_2 1.46 (coinc with γ) β-γ coinc spect (23M51); β_1 1.94, β_2 1.36 spect (43M46); β_1 1.8, β_2 1.2 abs, coinc abs (26M48d); β_1 1.8 abs (14M40)	0.568 spect (28C48d, 28K48); 0.57 spect conv (11R47); 0.56 (e_K/γ 0.0049), 0.68 (51G52)		Sn-d-2n (12L39d); Sn-p-n (47B51); Sb-d-p (12L39d); Sb-γ-n (22J50, 47B51); Sb-n-γ (12A35, 12L39d, 2S47, 50H51); spall Sb (37L50), I (π) (51W52); spall-fission Bi (11G49)
Sb^{123}		42.75 (24W48)					Sb^{123}, I = 7/2 (87M50)	
Sb^{124m_2}	A chem, n-capt, sep isotopes (38M47)		IT, β^- (38M47)	21 m (38M47)		0.0185 (e/γ very large) (18G50)	 (18G52, HPS)	Sb-n-γ, Sb^{123}-n-γ (38M47)
Sb^{124m_1}	A chem, n-capt, sep isotopes (38M47)		IT, β^- (38M47)	1.3 m (38M47)	3.2 abs (38M47)	0.012 (e/γ very large) (18G50)		Sb-n-γ, Sb^{123}-n-γ (38M47)
Sb^{124}	A chem (12L37a); chem, excit, cross bomb (12L39d)		β^- (12L39d); nσ β^+, no EC (10L50b)	60 d (12L39d)	β_1 2.291 (21%), β_2 1.69 (7%), β_3 0.95 (7%), β_4 0.68 (26%), β_5 0.50 (39%) spect (28C48d, 10L50b); β_1 2.37 (21%), β_2 1.62 (8%), β_3 1.00 (9%), β_4 0.65 (44%), β_5 0.48 (18%) spect (28K48); β_4 0.654 spect (7J47); others (54H43, 47M47, 43M46, 14M40, 37W47)	0.121, 0.607, 0.653, 0.730, 1.708, 2.04 spect, spect conv (28C48d, 10L50b); 0.61 γ (40-50%, e_K/γ 0.0043) spect, spect conv (44M52a); 0.61 γ (e_K/γ 0.0036) spect conv (94H52); 0.603 (~100%, e/γ ~0.002), 0.650, 0.714, 1.708, 2.06 spect, spect conv (28K48); 0.598, 0.645, 0.817, 1.67, 2.07 spect (13J49b); others (11R47, 14M40, 42W47, 52M51, 85S51, 89S52, 39D51, 39D51a, 42K45, 47M47)		Sn-p-n (47B51); Sn-d-2n (12L39d); Sb-d-p (12L39d, 54H43, 42K45); Sb-n-γ (12L39d, 2S47); spall Sb (37L50); Te-d-α (28T38); I-n-α (12L39d); spall-fission Bi (11G49)
Sb^{125}	A chem (12L39d); chem, n-capt (84S51)		β^- (67C51)	~2.7 y (40L51a)	0.616 (18%), 0.299 (49%), 0.128 (33%) spect (7S49d); 0.621, 0.288, others (?) spect (28K49); others (38G46, 15J49, 26M49b, 84S51)	0.637, 0.601, 0.465, 0.425, 0.175, 0.035 spect, spect conv, coinc (7S49d); 0.646 (weak, e/γ very small), 0.609 (strong), 0.466 (weak, e/γ very small), 0.431 (strong), 0.174 (strong), 0.125 (weak) spect, spect conv, coinc (28K49); with Te^{125m}: 0.110, 0.035 (28B52, 10C51a, 7S49d, 28K49, 67H49a)	 (7S49d, 18G52)	Sn-d-n (12L39d); Sn-n-γ, β^- decay (7S49d, 23F48, 84S51); spall-fission Th (7N49a); fission U^{233} (38G48), U (67C51, 40L51a, 84S51); parent Te^{125m} (23F48, 28K49); daughter (9.4 d) Sn^{125} (19N50); not daughter (9.4 d) Sn^{125} (7N49b)

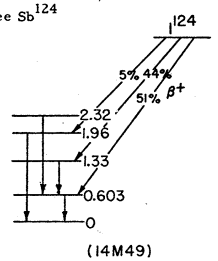
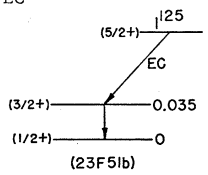
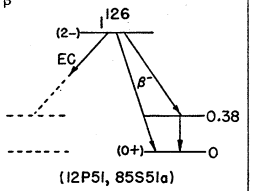
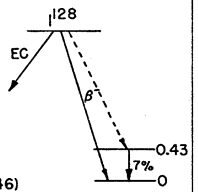
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{51}Sb^{126}$	B chem, excit (80B51)		β^- (80B51)	9 h (80B51)	~1 abs (80B51)	0.90, ~0.4 (both coinc with β^-) scint spect, β-γ-coinc (80B51)		fission U^{235} daughter Sn^{126} (80B51)
Sb	E chem (80B51)		β^- (80B51)	10 m (80B51)				fission U^{235} (80B51)
$Sb^{\sim 126}$	D chem (38G46)		β^- (38G46)	28 d (38G46); ~30 d (80B51)	1.9 (38G46)			fission U (38G46), U^{235} (80B51)
Sb^{127}	A chem, genet (32A39)		β^- (32A39)	93 h (76S51b); 95 h (38G46)	1.2 abs (76S51b); 0.8 abs (38G46)	0.72 abs (76S51b)		fission U^{233} (61S48), U^{235} (38G51, 80B51), U (32A39, 38G46, 76S51b), Pu (32K48); parent Te^{127} (32A39, 33G51i); parent (84%) Te^{127}, parent (16%) Te^{127m} (78B48); daughter Sn^{127} (80B51)
Sb^{129}	A chem, genet (32A39)		β^- (32A39)	4.2 h (32A39)				fission U (32A39), Pu (32K48); parent Te^{129} (32A39)
Sb^{130}	D chem, excit (fission yield) (80B52)		β^- (80B52)	40 m (80B52)				fission U^{235} (80B52)
Sb^{130}	D chem, excit (fission yield) (30P52a)		β^- (80B52)	12 m (30P52a); 10 m (80B52)				fission U (80B52, 30P52a)
Sb^{131}	A chem, genet (30P51, 68C51)		β^- (30P51)	23.1 m (30P51); ~20 m (68C51)				fission U, parent Te^{131}, parent Te^{131m} (30P51, 68C51)
Sb^{132}	B chem, genet (32A39)		β^- (32A39)	2 m (30P51); ~5 m (32A39); ~2 m (68C51)				fission U (32A39, 30P51, 68C51); parent Te^{132} (32A39, 30P52a)
Sb^{133}	B chem, genet (30P51)		β^- (30P51)	4.4 m (30P51); 4.2 m (68C51)				fission U (30P51, 68C51); parent Te^{133m} (30P51)
$Sb^{134,135}$	D chem (30P51)		β^- (30P51)	~50 s (30P51); 45 s (68C51)				fission U (30P51, 68C51)
$_{52}Te^{<118}$	D chem (37L48a)		β^+ (37L48b)	2.5 h (37L48a)				spall Sb (37L48a), I (π) (51W52)
Te^{118}	B chem, genet (37L48a)		EC (37L48a)	6.0 d (37L48a)		no γ (?) (37L48a)		Sb-d-5n, parent (4 m) Sb^{118} (37L48a, 37L50); spall I (π) (51W52); spall-fission Bi (11G49)
Te^{119}	B chem, genet (37L48a)		EC (37L48a)	4.5 d (37L48a)	conv: 0.2, 0.5 spect conv (37L48a)	1.6 abs (37L50)		Sb-d-4n, parent Sb^{119} (37L48a, 37L50); spall-fission Bi (11G49)
Te^{120}		0.089 (1B50)						

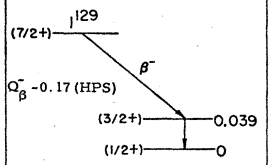
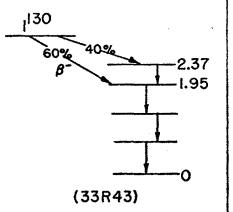
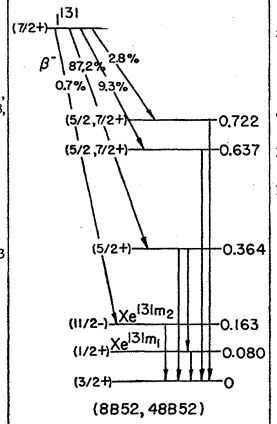
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{52}Te^{121m}$	A chem, excit, cross bomb (13S40); chem, n-capt, sep isotopes (10C51a)		IT (14E46a)	154 d (67H51d); 143 d (14E46a); 125 d (13S40); 140 d (10C51a)		γ_1 0.082 (e/γ very large, K/L 0.75), γ_2 0.213 (e_K/γ 0.09, K/L 7.3) (γ_2 coinc with γ_1) spect conv, conv-γ coinc, conv-conv coinc (43K50); γ_1 0.0818, γ_2 0.214 spect conv (10C51a); others (67H49, 81B46, 82B46, 6Y45, 20D50, 4K42a)	 (18G52, 67H52)	Sn-α-n (13S40); Sb-d-2n (13S40, 14E46a, 43K50); Sb-p-n (13S40, 14E46a); spall Sb (37L50); Te^{120}-n-γ (10C51a); parent Te^{121} (82B46)
Te^{121}	A chem, genet (14E46a, 82B46)		EC (14E46a)	17 d (14E46a); ~16 d (82B46)		γ_1 0.506 (13%, e/γ ~0.018, K/L+M 6), γ_2 0.573 (87%, not coinc with γ_1, e/γ 0.009, K/L+M 6) spect conv, scint spect (67H52); 0.575 spect conv (10C51a); ~0.61 (e_K/γ 0.004) spect conv (43K50); 0.6 abs (14E46a)		Sb-d-2n (14E46a); Sb-p-n (14E46a); daughter Te^{121m} (82B46); daughter I^{121} (74M50)
Te^{122}		2.46 (1B50)						
Te^{123m}	A chem, n-capt, sep isotopes (67H49)		IT (67H49)	104 d (67H51d); 121 d (10C51a)		γ_1 0.0885 (e/γ very large, K/L 0.68), γ_2 0.159 (e_K/γ 0.18, K/L 8.9) (γ_1 coinc with γ_2) spect conv, γ-conv coinc, conv-conv coinc, abs (43K50); γ_1 0.0887, γ_2 0.159 spect conv (10C51a); γ_1 (L_I/L_{III} 0.5) spect conv (63M52a); γ_2 (e_K/γ 0.19) scint spect (52M52e); no 0.25 γ (lim 0.5%) scint spect (68H51); others (4K42a, 67H49, 20D50, 52M52)	 (18G52)	Sb-d-2n (43K50); Te^{122}-n-γ (67H49, 43K50, 68H51, 10C51a)
Te^{123}		0.87 (1B50)					Te^{123}, I = 1/2 (87M50)	
Te^{124}		4.61 (1B50)						
Te^{125m}	A chem, genet (23F48)		IT (23F48)	58 d (67H49a, 67H51d)		0.110 (e_K/γ ~160, K/L+M 1.15), 0.0355 (e_K/γ ~11.7, K/L/M = 7.3/1.0/0.18) spect conv, ion ch, scint spect, x-γ coinc, x-x coinc (28B52); 0.110, 0.0353 spect conv (10C51a); 0.110 (K/L+M 1.1), 0.035 spect conv (7S49d); 0.110 (K/L 1.2) spect conv (28K49); 0.109 (e/γ >100, K/L ~1.5, L/M ~3.5) spect conv (67H49a); others (67H49, 23F50a, 52M51, 28B49)	see Sb^{125}  (28B52)	Te^{124}-n-γ (67H49); daughter Sb^{125} (23F48, 28K49); not daughter I^{125} (lim 0.05%) (23F51b)
Te^{125}		6.99 (1B50)					Te^{125}, I = 1/2 (87M50)	
Te^{126}		18.71 (1B50)					Te^{126}, I = 0 (87M50)	

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{52}Te^{127m}$	A chem, excit, genet (13S40)		IT (13S40)	115 d (10C51a); 90 d (13S40)		0.0885 (K/L 0.75) spect conv (67H49, 67H49a); 0.0887 spect conv (10C51a); 0.086 (e/γ very large, K/L 0.75) spect conv (2H41)	 (18G52)	Te-n-γ (13S40, 2S47); Te-d-p (13S40); Te^{126}-n-γ (67H49); I-n-p (13S40); fission U (38G46, 33G51i, 43W48), U^{233} (61S48, 38G48, 38G51), U^{235} (38G51); parent Te^{127} (13S40, 33G51i, 43W51); daughter (16%) Sb^{127} (78B48)
Te^{127}	A chem (28T38, 32A39); chem, excit, cross bomb (13S40)		β^- (32A39)	9.3 h (13S40)	0.7 abs (33G51i)	no γ (33G51i)		Te-n-γ (13S40, 2S47); Te-d-p (28T38, 13S40); Te-n-2n (28T38); I-n-p (13S40); fission U (32A39, 13S40, 43W48, 33G51i), U^{233}, U^{235} (38G51); daughter Te^{127m} (13S40, 33G51i, 43W51); daughter Sb^{127} (32A39, 33G51i), (84%) (78B48)
Te^{128}		31.79 (1B50)					Te^{128}, I = 0 (87M50)	
Te^{129m}	A chem, genet (13S40)		IT (13S40)	33.5 d (10C51a); 32 d (13S40, 1N51a)		0.1060 spect conv (10C51a); 0.106 (K/L ~1) spect conv (67H49); 0.102 (e/γ very large, K/L ~1) spect conv (2H41)	 (18G52, HPS)	Te^{128}-n-γ (67H49); Te-n-γ (13S40, 2S47); Te-d-p (13S40); Te-n-2n (28T38); Te-γ-n (25W48); fission U (16H43b, 38G46, 43W48, 1N51a, 30P51a), U^{233} (38G48, 38G51), U^{235} (38G51); parent Te^{129} (13S40, 38G46, 43W51)
Te^{129}	A chem, excit (37B39, 13S40)		β^- (13S40)	72 m (13S40); 70 m (32A39, 33G51i); 67 m (25W48)	1.8 spect (11R47); 1.7 abs (33G51i)	0.3, 0.8 abs (33G51i)		Te-n-γ (13S40, 2S47); Te-d-p (13S40, 28T38); Te-γ-n (37B39, 25W48); Te-n-2n (6H37, 28T38); fission Th (72B51), U (32A39, 16H43b, 38G46, 43W48, 1N51a); daughter Te^{129m} (13S40, 38G46, 43W51); daughter Sb^{129} (32A39)
Te^{130}		34.49 (1B50)		double beta decay: ~10^{21} y Xe ratios, mass spect (3I50b)			Te^{130}, I = 0 (87M50)	
Te^{131m}	A chem, genet (13S40)		IT (13S40)	30 h (32A39, 13S40)		0.177 (K/L 2) spect conv (2H41)	 (18G52, 37G52)	Te-n-γ (13S40, 2S47); Te-d-p (13S40); spall-fission U (6F51); fission U (32A39, 16H39a, 32K51d, 43W51, 30P51a); parent Te^{131} (32A39, 13S40, 43W51); daughter Sb^{131} (68C51)
Te^{131}	A chem, excit (13S40)		β^- (13S40)	24.8 m (37G52); 25 m (13S40)	2.0 (~55%), 1.4 (~45%) abs, β-γ coinc (37G52)	0.16, 0.7 abs (37G52)		Te-d-p (13S40); Te-n-γ (13S40, 2S47, 37G52); fission U (32A39); daughter Te^{131m} (32A39, 13S40, 43W51); parent I^{131} (32A39, 13S40, 30P51, 68C51); daughter Sb^{131} (30P51, 68C51)

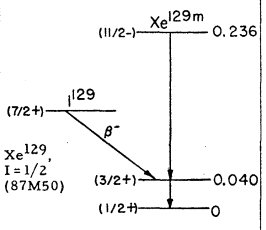
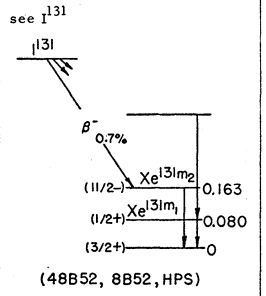
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{52}Te^{132}$	B chem (32A39); fission fragment range (32K48)		β^- (32A39)	77.7 h (30P51a); 77 h (32A39)	0.22 spect (10L51a); 0.3, ~0.1 (?) abs (1N51b); ~0.3 abs (70B43a)	0.231 scint spect (10L51a); 0.22 abs (1N51b)		Te-α-2p (112S51); spall-fission Th (7N49a); fission Th (16H39d, 72B51, 21T51), U (32A39, 16H39e, 16H39a, 1N51b, 30P51a), Pu (32K48); daughter Sb^{132} (32A39, 30P52a); parent I^{132} (32A39, 16H39e, 16H39a, 1N51b, 44W51)
Te^{133m}	A chem, genet (32A39)		IT (30P52)	63 m (30P52); 60 m (32A39, 16W40)		~0.4 scint spect (30P52); with Te^{133}: 0.6, 1.0 abs (30P52)		fission U (32A39, 16H39a, 24S40, 16W40, 30P51), Pu (32K48); parent Te^{133} (30P52); ancestor I^{133} (32A39, 16H39a, 24S40, 16W40, 16W45, 30P51); daughter Sb^{133} (30P51)
Te^{133}	A chem, genet (30P52)		β^- (30P52)	2 m (30P52)	2.4 (~30%), 1.3 (~70%) abs (30F52)	0.6, 1.0 abs (30P52)		daughter Te^{133m} (30P52); parent I^{133} (30P52a)
Te^{134}	B chem, genet (32A39)		β^- (32A39)	44 m (30P51a); 43 m (32A39)				fission Th (9P40), U (32A39, 16H39a, 30P51a), Pu (32K48); parent I^{134} (32A39, 16H39a, 30P51a)
Te^{135}	[A] genet (22D40)		β^- (22D40)	<2 m (33G51j, 32K51e, 22D40)				fission U, parent I^{135} (33G51j, 32K51e)
Te	E chem (16H43b)		β^- (16H43b)	~1 m (16H43b)				fission U (16H43b)
$_{53}I^{120}$	D chem (74M50)		β^+ (74M50)	30 m (74M50)	4.0 abs, spect (74M50)			spall Sn (second order reaction) (74M51); Sb-α-5n (74M50)
I^{121}	B chem, genet (74M50)		β^+ (74M50)	1.5 h (40D52); 1.8 h (74M50)	1.2 abs, spect (74M50); 1.2, 4.0 (weak) (40D52); conv: 0.185 spect (74M50)			spall Sn (second order reaction) (74M51); Sb-α-4n, parent Te^{121} (74M50); daughter Xe^{121} (37T52, 8H52b, 40D52)
I^{122}	A chem, excit (74M50); sep isotopes (7Y51)		β^+ (74M50)	3.6 m (7Y51); 3.4 m (40D52); 4 m (74M50)	2.9 abs (74M50); 3.1 abs (7Y51)			Sb-α-3n (74M50); Te^{122}-p-n (7Y51); daughter Xe^{122} (37T52, 8H52b, 40D52)
I^{123}	A chem, excit (74M50); chem, sep isotopes (14M49)		EC (74M50)	13.0 h (14M49); 13 h (74M50)		0.159 spect, spect conv (14M49)		spall Sn (second order reaction) (74M51); Sb-α-2n (74M50); Sb^{121}-α-2n (14M49); daughter Xe^{123} (37T52, 8H52b, 40D52)

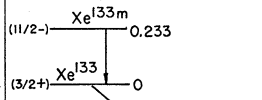
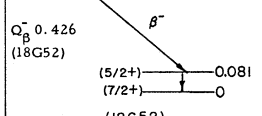
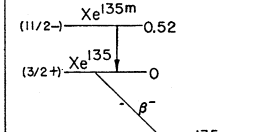


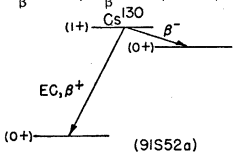
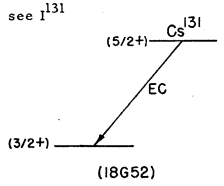
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{53}I^{124}$	A chem, excit, cross bomb (12L38e)		EC ~70%, β^+ ~30% (74M50)	4.5 d (74M50); 4.0 d (12L38e, 2D40)	2.20 (51%), 1.50 (44%), 0.7 (5%) spect (14M49); 2.1 spect, abs (74M50)	0.603, 0.73, 1.72, 1.95 spect, spect conv (14M49); no γ coinc with 2.2 β^+, β-γ coinc (85S51); γ-γ, β-γ coinc (37M49)	see Sb^{124}  (14M49)	spall Sn (second order reaction) (74M51); Sb-a-n (12L38e, 74M50); Sb-a-3n (74M50); Sb^{121}-a-n (74M50); Te-p-n (2D40); spall-fission Bi (11G49, 66B51)
I^{125}	A chem (17R46a); chem, excit (33G47); genet (67B51b)		EC (L/K 0.23) (38M52); EC (L/K 0.3) (23F51b); no β^+ (33G47)	60.0 d (23F51b); 56 d (17R46a)		0.035 ion ch (23F51b); 0.0355, no 0.109 γ spect conv (67B51b)	see Te^{125m} Q_{EC} ~0.13 calc (38M52)  (23F51b)	Sb-a-2n (74M50); Te-d-n (17R46a, 33G47); spall-fission Bi (11G49, 66B51); daughter Xe^{125} (67B51b); not parent Te^{125m} (lim 0.05%) (23F51b)
I^{126}	A excit (28T38); chem, excit, cross bomb (12L38e)		EC ~58%, β^- ~40%, β^+(?) ~2% (12P51)	13.0 d (12L38e); 13 d (28T38)	β^-: 1.268 (27%), 0.85 (73%) spect (14M49); 1.24 (~25%), 0.85 (~75%) spect (12P51); 0.865 spect (23M51a)	with β^-: 0.382 spect conv, β-γ coinc (12P51); 0.395 spect, spect conv (14M49); with EC: 0.64 (weak) scint spect, x-γ coinc, γ-γ coinc (12P51); others (85S51)	Q^-_β 1.27 (12P51)  (12P51, 85S51a)	spall Sn (second order reaction) (74M51); Sb-a-n (12L38e, 74M50); Te-d-n (12L38e); Te-p-n (2D40); I-n-2n (12L38e, 28T38, 12P51); I-γ-n (12P49, 27M49, 3O50); spall-fission Bi (11G49, 66B51)
I^{127}		100 (6N37)					I^{127}, I = 5/2 (87M50)	
I^{128}	A chem, n-capt (12A35)		β^- 95.0%, EC + β^+ 5.0% (28R50); EC/β^- 0.063 (41M51a)	24.99 m (69H41)	2.02 spect (7S46)	0.428 (7%) spect (7S46)	Q^-_β 2.0 (7S46)  (7S46)	I-n-γ (12A35, 28T38, 2S47, 7S46, 9O49, 50H51); Te-d-2n (12L38e); Te-p-n (2D40)

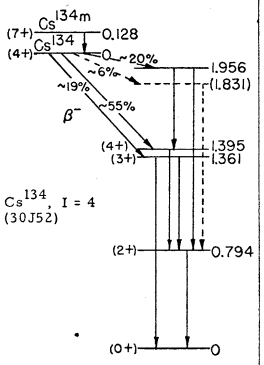
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{53}I^{129}$	A chem, n-capt (32K47)		β^- (32K47)	1.72 x 10^7 y sp act (32K51f); 3 x 10^7 y sp act (26P49b)	0.12 scint spect (38M52); 0.12 abs (26P49b); 0.12 ion ch (83B50); 0.13 abs (32K51f)	0.039 (coinc with β^-, e_K/γ ~6, K/L ~40) ion ch, β-γ coinc (83B50)	I^{129}, I = 7/2 (87M50)  (83B50, 30T52, 18G52)	fission U (32K47, 26P49b, 83B50)
I^{130}	A chem, cross bomb (12L38e)		β^- (12L38e)	12.6 h (12L38e)	1.03 (~60%), 0.61 (~40%) spect (33R43)	0.744 (e_K/γ 0.003), 0.667 (e_K/γ 0.004), 0.537 (e_K/γ 0.007), 0.417 (coinc with 0.6 β^-, e_K/γ 0.012) ($e_K >> e_L$ for all γ's) spect, spect conv, β-γ, γ-γ coinc (33R43)	 (33R43)	Te-d-2n (12L38e); Te-p-n (2D40); I^{129}-n-γ (32K47); Cs-n-α (16W40)
I^{131}	A chem (12L38e); chem, genet (13S40)		β^- (12L38e)	8.141 d (39S51a); 8.05 d (106B52); 8.16 d (17K51); 8.04 d (38S51)	0.815 (0.7%), 0.608 (87.2%), 0.335 (9.3%), 0.250 (2.8%) spect, β-γ coinc (8B52); 0.810, 0.606, 0.335, 0.250 spect, β-γ coinc (24K51); 0.807, 0.606, 0.339 spect (40R52); E (average) 0.189 ion ch (77C52); see also: (69C52, 11B52, 8V51, 20N51, 10C51b, 30T51, 11B51, 22F50, 28K49, 44M48, 25D42)	0.080 (2.2%, coinc with 0.284 γ, e_K/γ 1.73, K/L 7), 0.163 (coinc with Xe^{131m2}), 0.284 (5.3%, coinc with 0.608 β^-, e_K/γ 0.047, K/L 5), 0.364 (80%, coinc with 0.608 β^-, e_K/γ 0.018, K/L 8), 0.637 (9%, coinc with 0.335 β^-, e_K/γ 0.0037, K/L 9), 0.722 (3%, coinc with 0.250 β^-, e_K/γ 0.0028, K/L 8) spect, spect conv, β-γ delay coinc, scint spect (8B52, 8B52a); γ_1 0.080133, γ_2 0.28413, γ_3 0.36418 ($\gamma_1/\gamma_2/\gamma_3$ ≃ 5/9/100) cryst spect (29L49a); γ_2 0.284 (e_K/γ 0.052, K/L 3.3), γ_3 0.364 (e_K/γ 0.021, K/L 5.6), γ_4 0.638 (e_K/γ 0.0040), γ_5 0.723 (e_K/γ 0.0034) ($\gamma_2/\gamma_3/\gamma_4/\gamma_5$ ≃ 6/100/10/3) spect, spect conv (93H52a); 0.080 (4.3%, with 0.283 γ, e/γ 1.83) γ-γ, x-γ coinc, scint spect (69C52a); see also: (11B52, 48B52, 69C52, 86S52, 8V51, 30T51, 24K51, 10C51b, 22F50, 28K49, 48B49, 44M48, 13O48, 25D42, 40R52, 52W51, 24E51)	Q^-_β 0.972 (8B52)  (8B52, 48B52)	Te-d-n (12L38e, 33R41a); spall-fission Th (7N49a), U (16F41, 6O47, 6F51); fission Th (21T51), U (32A39, 16H39a, 38G46, 23S51j, 32K51g), U^{233} (1Y47, 38G48, 61S48, 38G51), U^{235} (1Y47, 38G51), Pu (28F51); daughter Te^{131} (12L38e, 32A39, 16H39a, 13S40, 30P51, 68C51); parent (~1%) Xe^{131m2} (48B49, 67B50b); parent Xe^{131m1} (14G51a)
I^{132}	B chem, genet (32A39)		β^- (32A39)	2.4 h (32A39); 2.3 h (16H39a)	2.2, 0.9 abs (1N51b); 1.5 abs (75S49); ~1.4 abs (70B43a)	γ_1 0.69, γ_2 1.41, γ_3 2.0 ($\gamma_1/\gamma_2/\gamma_3$ ≃ 37/4/1), γ_4 ~0.8 (very weak) scint spect, γ-γ coinc (46M51); 0.6, 1.4 abs (1N51b)		spall-fission U (16F41, 6O47); fission Th (72B51, 21T51), U (32A39, 16H39a, 9P40, 38G46, 1N51b), U^{233} (38G48); daughter Te^{132} (32A39, 16H39a, 16H39e, 1N51b, 44W51)

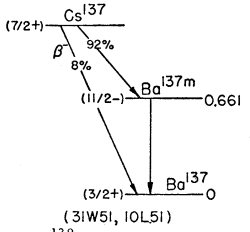
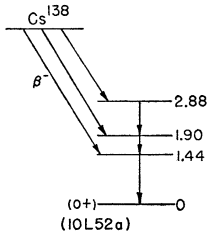
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{53}I^{133}$	A chem (32A39); chem, genet (16W40)		β^- (32A39, 16H39a)	20.5 h (106B52); 22.4 h (30P51a)	1.3 (~91%), 0.4 (~9%) abs (30P52a); 1.4 (~94%), 0.5 (~6%) abs, β-γ coinc (48B49a); 1.4 abs (23S51j)	0.53 (94%), 0.85 (5%), 1.4 (1%) scint spect, γ-γ coinc (48B49a); 0.53 spect (6P47b); 0.55 abs (23S51j)		spall-fission Pb (2T47b), U (16F41, 6O47); fission U (32A39, 16H39a, 24S40, 16W40, 30P51, 23S51k), Pu (28F51); daughter Te^{133} (32A39, 16H39a, 24S40, 16W40, 16W45, 30P51); parent Xe^{133} (24S40, 16W40, 16W45); parent (2.4%) Xe^{133m} (8Z51, 24K51a)
I^{134}	B chem (32A39); fission fragment range (32K48)		β^- (32A39)	52.5 m (30P51a); 51 m (32L49); 54 m (32A39)	1.6 (~70%), 2.8 (~30%), hard β (weak) abs (30P52a); 1.5-1.75, 3.5-4.2 abs (32L49)	>2.2 (weak) D-γ-n reaction (32L49); >1 abs (32K51h)		spall-fission U (16F41); fission Th (22D39), U^{235} (1Y47, 38G51), U (16H39a, 32A39, 9P40, 9P40a, 32L49, 32K51h, 30P51a), Pu (32K48, 28F51); daughter Te^{134} (16H39a, 32A39, 30P51a)
I^{135}	A chem, genet (22D40, 24S40)		β^- (22D40, 24S40)	6.68 h (6P47b); 6.7 h (33G51j, 32K51e)	0.5 (35%), 1.0 (40%), 1.4 (25%) spect (6P47b); 1.4 abs (32K51e); 1.5 abs (23S51j)	1.8, 1.27 spect (6P47b); 1.3 abs (23S51j); 1.6 abs (32K51e); 2.4 (1.1%) abs (32L49)		spall-fission U (6O47); fission Th (72B51), U (24S40, 16W40, 22D40, 16W45, 6P47b, 33G51j, 32K51e), Pu (28F51); daughter Te^{135} (33G51j, 32K51e); parent (~30%) Xe^{135m}, parent (~70%) Xe^{135} (6P47b); parent Xe^{135m} (40G40, 16W45); parent Xe^{135} (24S40, 22D40, 40G40, 16W45)
I^{136}	D chem (65S40)		β^- (65S40)	86 s (84S49)	6.5 abs (84S49)	1.4, 2.9 scint spect, abs (84S49, 99M52)		fission U (65S40, 66S43, 84S49), U^{233}, Pu (84S49)
I^{137}	A chem (65S40, 26S47); chem, genet (66S43, 63S49)		β^-, β^-n (~6% of disintegrations) (19L51a)	22.0 s (n) (28H48a); 22.5 s (n) (34R47); 19.3 s genet (63S49)	n (mean): 0.56 abs paraffin (28H48a); 0.67 p recoil in cl ch (71B46)			fission U (65S40, 66S43, 26S47, 34R47, 63S47a, 63S49), Pu (34R47); parent Xe^{137} (66S43, 63S49)
I^{138}	A chem, genet (63S49)		β^- (63S49)	5.9 s (63S49)				fission U, ancestor Cs^{138} (63S49)
I^{139}	A chem, genet (63S49)		β^- (63S49)	2.7 s (63S49)				fission U, parent Xe^{139}, ancestor Ba^{139} (63S49)
$_{54}Xe^{121}$	B chem, genet (37T52, 8H52b, 40D52)			40 m (40D52); 70 m (37T52); ~60 m (8H52b)				I-p-7n (37T52, 8H52b, 40D52); parent I^{121} (37T52, 8H52b, 40D52)
Xe^{122}	A chem, genet (37T52, 8H52b, 40D52)			19.5 h (37T52); 20.0 h (40D52); 19 h (8H52b)				I-p-6n (37T52, 8H52b, 40D52); parent I^{122} (37T52, 8H52b, 40D52)
Xe^{123}	A chem, genet (37T52, 8H52b, 40D52)		β^+ (40D52)	2.1 h (37T52); 1.7 h (40D52); ~2 h (8H52b)				I-p-5n (37T52, 8H52b, 40D52); parent I^{123} (37T52, 8H52b, 40D52)
Xe^{124}		0.096 (6N50a)						

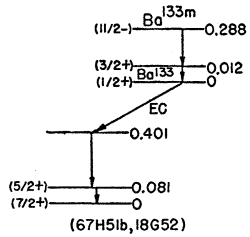
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{54}Xe^{125}$	A chem, sep isotopes (33A50); chem, mass spect (67B51b)		EC, no β^+ (67B51b, 33A50)	18 h (67B51b); 20 h (33A50)		0.054 (K/L ~4.3), 0.096, 0.106, 0.187 (K/L ~4.6), 0.243 spect conv; 0.460 scint spect (67B51b)		Te^{122}-α-n (33A50); Xe-n-γ (67B51b); parent I^{125} (67B51b)
Xe^{126}		0.090 (6N50a)						
Xe^{127}	D chem (29C40b)		IT (?) (29C40b)	75 s (29C40b)		0.125, 0.175 spect conv (29C40b)		I-p-n (29C40b)
Xe^{127}	A chem (29C40b); chem, sep isotopes (33A50); mass spect (67B51c)		EC (67B51c)	34 d (29C40b); 32 d (33A50); 25 d (67B51d)		0.057, 0.145, 0.170, 0.200, 0.365 spect conv, scint spect (67B51c)		Te^{124}-α-n (33A50); I-p-n (29C40b); I-d-2n (11O42); Xe-n-γ (44C44, 67B51c); daughter Cs^{127} (33F50)
Xe^{128}		1.919 (6N50a)						
Xe^{129m}	A chem, mass spect (67B51c)		IT (67B51c)	8.0 d (67B51c)		0.196 (K/L+M 2.1) spect conv (67B51c); 0.040 (K/L+M 4.3) spect conv (30T52, 30T52c)	 (30T52, 18652)	Xe-n-γ (67B51c)
Xe^{129}		26.44 (6N50a)						
Xe^{130}		4.08 (6N50a)						
Xe^{131m_2}	A chem (44C44); chem, genet (48B49); mass spect (67B50b)		IT (48B49, 44C44)	12.0 d (67B50b)		0.163 (K/L+M 1.9, L/M 3.4) spect conv (67B50b, 67B51c); 0.163 (K/L+M 1.7) spect conv (8V51); 0.165 (e/γ ~20) abs conv, abs (48B49)	see I^{131}  (48B52, 8B52, HPS)	Xe-n-n (44C44); daughter (~1%) I^{131} (48B49, 67B50b); not daughter Cs^{131} (43C51c); daughter Cs^{131} (70C50)
Xe^{131m_1}	A genet (14G51a)		IT (14G51a)	4.8×10^{-10} s delay coinc (14G51a, 8B52a)		0.080 scint spect (14G51a, 8B52a)		daughter I^{131} (14G51a, 8B52a)
Xe^{131}		21.18 (6N50a)					Xe^{131}, I = 3/2 (87M50)	fission U (mass spect) (13T47)
Xe^{132}		26.89 (6N50a)					Xe^{132}, I = 0 (87M50)	fission U (mass spect) (13T47)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{54}Xe^{133m}$	A chem (24K50c); mass spect (67B51a)		IT (24K50c)	2.3 d (67B51a); 2.1 d (24K51a)		0.233 (K/L 2.9) spect conv (67B51a); 0.235 (e_K/γ 4.2) spect conv, scint spect (24K51a)		Xe-n-γ (67B51a); fission U (24K50c, 67B50c); daughter (2.4%) I^{133} (8Z51, 24K51a)
Xe^{133}	A chem (20L39, 22D40, 24S40); chem, excit (16W40); mass spect (13T47, 30T49)		β^- (22D40)	5.270 d (76M50); 5.3 d (18E51)	0.345 spect (67B50c); 0.34 abs (18E51); 0.35 abs (13E51e)	with Cs^{133m}: 0.081 (K/L 5.9) spect conv (67B50c); 0.08 γ (e_K/γ 1.8, K/L+M 6.0) scint spect, β-γ delay coinc (14G53); ~0.085 abs (13E51e); 0.08 cl ch (84B51)		Te-α-n (52C41); Xe-d-p (52C41); Xe-n-γ (21R43, 44C44); Xe-n-2n (21R43); Cs-n-p (16W40, 44C44, 16W45); Ba-n-α (16W40, 66S43b, 44C44, 16W45); fission U (24S40, 22D40, 16W40, 70B43a, 16W45, 13T47, 18E51, 84B51, 13E51e); daughter I^{133} (24S40, 16W40, 16W45); parent Cs^{133} (8Z51); parent Cs^{133m} (14G53)
Xe^{134}		10.44 (6N50a)					Xe^{134}, I = 0 (87M50)	fission U (mass spect) (13T47)
Xe^{135m}	A chem, genet (40G40, 16W45)		IT (16W45)	15.6 m (21R43); 15.3 m (6P47b); 13 m (1N51c)		0.52 spect (6P47b); 0.5 (e/γ ~0.2) abs, abs conv (16W45, 1N51c)		Xe-n-2n (21R43); Xe-n-γ (21R43, 21R46); Ba-n-α (66S43b); fission U (40G40, 16W45, 13T47); daughter I^{135} (40G40, 16W45); daughter (~30%) I^{135} (6P47b); parent Xe^{135} (16W45)
Xe^{135}	A chem (24S40, 22D40); chem, excit (16W40); mass spect (30T49)		β^- (24S40)	9.13 h (60B52); 9.2 h (7N51, 58H51c); 9.1 h (30T49)	0.905 spect (67B51); 0.93 spect (6P47b); 0.95 abs (70B43a); 0.9 abs (16W45); 1.0 abs (7N51, 58H51c)	with Cs^{135m}: 0.250 (e_K/γ 0.05) spect conv, β^--conv coinc (67B51, 67B51d); 0.248 (K/L 7.0) spect conv, scint spect, β-γ delay coinc (14G53); 0.25 spect (6P47b)	Q^-_β 1.15 (67B51)	Xe-n-γ, Xe-n-2n (21R43); Xe-d-p (52C41); Ba-n-α (16W40, 66S43b, 16W45); fission U (24S40, 22D40, 84B51); daughter I^{135} (24S40, 22D40, 40G40, 16W45); daughter (~70%) I^{135} (6P47b); daughter Xe^{135m} (16W45); parent Cs^{135} (63S49a); parent Cs^{135m} (14G53)
Xe^{136}		8.87 (6N50a)					Xe^{136}, I = 0 (87M50)	fission U (mass spect) (13T47); daughter I^{137} (~6% of dis) (19L51a)
Xe^{137}	A chem (66S43); mass spect (30T49)		β^- (66S43)	3.9 m (63S49); 3.8 m (66S43); 3.4 m (21R43)	~4 abs (66S43, 70B43a)			Xe-n-γ (21R43, 66S43b, 63S49); fission U (66S43, 63S49, 33G51k); daughter I^{137} (66S43, 63S49); parent Cs^{137} (21T51b, 33G51k)
Xe^{138}	A chem (16H39a); mass spect (30T49)		β^- (16H39a)	17 m (36G40)				fission U (16H39a, 16H40a, 36G40, 66S43b); parent Cs^{138} (16H39a, 36G40, 66S43b)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{54}Xe^{139}$	A chem, genet (16H39a, 6H39)		β^- (16H39a, 6H39)	41 s (24D51)				fission Th (25A39, 16H40); fission U, parent Cs^{139} (16H39a, 6H39, 16H40a); ancestor Ba^{139} (16H39a, 6H39, 24D51); daughter I^{139} (63S49)
Xe^{140}	A chem, genet (16H40a)		β^- (16H40a)	16.0 s (24D51); 9.8 s (11O51)				fission Th (16H40); fission U, ancestor Ba^{140} (16H40a, 24D51a, 24D51, 11O51)
Xe^{141}	A chem, genet (17B51)		β^- (17B51)	1.7 s (32K46, 11O51); 3 s (24D51)				fission U, ancestor La^{141} (17B51); fission U, ancestor Ce^{141} (24D51a, 24D51, 11O51)
Xe^{143}	A chem, genet (17B51)		β^- (17B51)	1.0 s (24D51)				fission U, ancestor Ce^{143} (17B51, 24D51);
Xe^{144}	A chem, genet (24D51a)		β^- (24D51a)	~1 s (24D51)				fission U, ancestor Ce^{144} (24D51a, 24D51)
$_{55}Cs^{125}$	A chem, mass spect (73M52)		β^+ (73M52)	45 m (73M52)	2.03 spect (73M52)			I-α-6n (73M52)
Cs^{127}	A chem, mass spect (33F50)		β^+ (33F50)	5 5 h (33F50)	1.2 spect, abs (33F50)			I-α-4n (33F50); parent Xe^{127} (33F50); daughter Ba^{127} (37L52)
Cs^{128}	B chem, genet (33F51)		β^+, EC (37L52)	3.8 m (37L52); 3.1 m (33F51)	3.0 abs (33F50a, 32T50, 37L52)			daughter Ba^{128} (33F51, 37L52)
Cs^{129}	A chem, mass spect (33F50)		EC, no β^+ (33F50)	31 h (33F50)	conv: ~0.3 abs (33F50)	~0.5 abs (33F50)		I-α-2n (33F50); daughter Ba^{129} (33F50a, 32T50)
Cs^{130}	A chem (27R48); chem, excit (91S52a); chem, mass spect (73M52)		β^+, EC, β^- (β^+/β^- 27.5) (91S52a)	30 m (91S52a); ~30 m (27R48, 33F50)	β^+: 1.97 spect (91S52a); β^-: 0.442 spect (91S52a)	no γ (91S52a); Xe K-x (91S52a)	Q^-_β 0.442, Q^+_β 2.99 (91S52a)  (91S52a)	I-α-n (27R48, 33F50, 91S52a)
Cs^{131}	A chem, genet (32K47a); chem, mass spect (7K49)		EC, no β^+ (28F47, 43C51c, 38K51d)	9.6 d (1Y49); 10.2 d (32K47a); 10.0 d (5Y47)		no γ (43C51c, 32K47a, 38K51d, 113S52); Xe K-x (43C51c, 5Y47, 1Y49, 32K47a, 28F47); ~0.1 abs conv, abs (5Y47, 1Y49)	see I^{131}  (18G52)	I-α-γ (112S51); daughter Ba^{131} (32K47a, 5Y47, 1Y49, 43C51c); not parent Xe^{131m2} (43C51c); parent (?) Xe^{131m2} (70C50)
Cs^{132}	B chem, excit (44C44)		EC (44C44)	7 1 d (44C44)		0.668 scint spect (10L51a); 0.62 abs, abs conv (44C44)		Cs-n-2n (44C44, 10L51a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{55}Cs^{133m}$	A genet (14G53)		IT (14G53)	6.0×10^{-9} s delay coinc (14G53)		see Xe^{133}; ~0 081 (e_K/γ 1.8, K/L+M 6.0) scint spect, β-γ delay coinc (14G53)		daughter Xe^{133} (14G53)
Cs^{133}		100 (6N37)					Cs^{133}, I = 7/2 (87M50)	
Cs^{134m}	A chem, n-capt (12A35, 77M35); chem, excit, n-capt (45K40)		IT (6P47, 18G48a, 42C50)	3 2 h (5S45); 3 h (45K40)		0 128 (K/L/M ≈ 64. 3/100/18. 6) spect conv (42C50); 0. 128 (e_K/γ 2. 2) scint spect (14S51); 0. 128 (L_{II}/L_{III} ~1) spect conv (63M52a); others (6P47, 18G48a, 5S45)	 Cs^{134}, I = 4 (30J52) (87S52)	Cs-n-γ (12A35, 77M35, 45K40, 2S47); Cs-d-p (45K40)
Cs^{134}	A n-capt (30A38); chem, n-capt, excit (45K40)		β^- (45K40); no EC (lim 4%) (31W50); no EC (lim 5%) (7S48); no β^+ (lim 0. 009%) (41M51)	2 3 y (33G51l) 1. 7 y (45K40)	0. 648 (75%), 0. 09 (25%) spect (20P51); 0. 65 spect (31W50); 0. 66 (~72%), 0. 09 (~28%) spect (4E47); 0. 676, 0. 640, ~0. 08 (~24%) spect (87S52); 0. 60, 0. 09 abs, β-γ coinc abs (37M49); others (7S47e, 45K40, 6P47, 37W47)	0. 561 (e_K/γ 0. 005), 0. 567 (e_K/γ 0. 007), 0. 601 (e/γ 0. 005, K/L 6. 0), 0 794 (e/γ 0. 002, K/L 6. 0), 1. 037 (weak, K/L 4. 5), 1. 164 (weak, K/L 6. 2), 1. 365 (weak, K/L 6. 1) spect conv (87S52); 0 560 (e/γ 0. 008), 0. 602 (e/γ 0. 0053), 0. 799 (e/γ 0. 0025), 1. 037 (weak), 1. 170 (weak), 1. 363 (with 0. 09 β^-, e/γ 0. 00062) spect conv, β-γ coinc (31W50); 0. 040 crit abs (47R52); γ_1 0. 570, γ_2 0. 601, γ_3 0. 793, γ_4 1. 024, γ_5 1. 11, γ_6 1. 35 ($\gamma_1/\gamma_2/\gamma_3/\gamma_6$ ≈ 0. 35/0. 94/1. 0/0. 017) spect (88S51); γ_1 0. 57, γ_2 0. 60, γ_3 0. 79 ($\gamma_1/\gamma_2/\gamma_3$ ≈ 0. 26/1. 0/1. 0) spect (4E47); no 1. 96 γ (lim 10^{-4}%) Be-γ-n reaction (23W50); others (7S48, 20P51, 6P47, 20D50, 8B49, 45W50, 17B50, 44M50a, 85S51, 85B50, 39R51, 61K52)		Cs-n-γ (30A38, 69S38, 45K40, 2S47); Cs-d-p (45K40); Ba-d-α (51H43)
Cs^{135m}	A genet (14G53)		IT (14G53)	2.8×10^{-10} s delay coinc (14G53)		0. 248 (K/L 7. 0) spect conv, scint spect, β-γ delay coinc (14G53)	see Xe^{135}	daughter Xe^{135} (14G53)
Cs^{135}	A chem, genet (63S49a); chem, mass spect (3I49a)		β^- (63S49a)	3.0×10^6 y sp act (8Z49); 2.1×10^6 y yield (63S49a)	0. 21 abs (63S49a); ~0. 19 abs (8Z49)	no γ (63S49a, 8Z49)	Cs^{135}, I = 7/2 (87M50)	daughter Xe^{135} (63S49a); fission U (8Z49, 38W52)
Cs^{136}	A chem (33G46, 33G51m); chem, excit (33G49)		β^- (33G51m)	13. 7 d (33G49)	0. 35 abs (33G49); 0 28 β-γ coinc abs (28F51b)	~0. 9 abs (33G49); 1. 2 β-γ coinc abs (28F51b); two γ's (33G49)		La-n-α (44C44, 33G49); spall-fission Th (7N49a), U (6F51); fission Th (21T51), U^{233} (38G48, 38G51), U^{235} (38G51, 33G51m), Pu (28F51b, 33G51m)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{55}Cs^{137}$	A chem, genet (78M41); chem, mass spect (60H46a, 31I49a)		β^- (78M41)	33 y (33G51ln, 38W52)	β_1 0.523 spect (16A50); β_1 0.51 (92%), β_2 1.17 (8%) spect (10L51); β_1 0.521, β_2 ~1.2 spect (20P49); β_1 0.518, β_2 ~1.18 spect (15O49); others (31W51, 10L49, 31T48)	with Ba^{137m}: 0.6616 cryst spect (100M52); see Ba^{137m}: others (10L50d, 79B52, 31W51, 80H52, 40K52, 14M49a, 31T48, 20P49, 15O49)	Cs^{137}, I = 7/2 (87M50) Q^-_β 1.2 (HPS)  (31W51, 10L51)	spall-fission Th (7N49a); fission Th (21T51), U (60H48, 31I49a, 33G51ln, 38W52), U^{233} (38G48, 38G51), U^{235} (38G51), Pu (28F51); parent Ba^{137m} (13E48, 31T48); daughter Xe^{137} (21T51b, 33G51k)
Cs^{138}	A chem (16H39a, 6H39); chem, mass spect (30T49)		β^- (16H39a)	32.9 m (19E51); 33 m (25A39, 16H39a); 32 m (33G51k, 36G40)	3.40 (coinc with 1.4 γ), ~2.9, ~2.0 spect, β-γ coinc abs (10L52a); 2.68 spect (30T49); 2.65 abs (35B46a, calc from 36G40)	γ_1 0.463, γ_2 0.98, γ_3 1.44 (coinc with γ_1 and γ_2) spect conv, scint spect, β-γ, γ-γ coinc (10L52a); 1.2 abs (33G51k, 19E51)	see La^{138} Q^-_β 4.84 (10L52a)  (10L52a)	Ba-n-p (66S43b); fission Th (25A39, 16H40), Pa (2G39), U (6H39, 16H40a); daughter Xe^{138} (16H40a, 36G40, 66S43b); descendent I^{138} (63S49)
Cs^{139}	A chem, genet (16H39a, 6H39)		β^- (16H39a)	9.5 m (63S50); 10 m (25A39, 6H39); 7 m (16H40a)				fission Th (25A39), U (16H39a, 6H39, 16H40a); daughter Xe^{139} (16H39a, 6H39, 16H40, 16H40a); descendent I^{139} (63S49); parent Ba^{139} (16H39a, 6H39, 16H40, 16H40a, 63S50)
Cs^{140}	A chem (16H40a); chem, genet (63S50)		β^- (16H40a)	66 s (63S50)				fission U (16H40a, 63S50); parent Ba^{140} (63S50)
Cs^{141}	[A] genet (17B51)		[β^-] (17B51)	short (17B51, 24D51, 11O51)				[daughter Xe^{141}] (17B51, 24D51, 11O51); [ancestor La^{141}] (17B51)
Cs^{142}	D chem, genet (16H42a)		β^- (16H42a)	~1 m (16H42a)				fission U, parent Ba^{142} (16H42a)
Cs^{143}	[A] genet (17B51)		[β^-] (17B51)	short (17B51, 24D51, 11O51)				[daughter Xe^{143}] (17B51, 24D51); [ancestor Ce^{143}] (17B51, 24D51)
Cs^{144}	[A] genet (24D51a)		[β^-] (24D51a)	short (24D51a, 24D51)				[daughter Xe^{144}] (24D51); [ancestor Ce^{144}] (24D51a, 24D51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{56}Ba^{127}$	A chem, genet (37L52)			~12 m (37L52)				Cs-d-8n, Cs-p-7n (37L52); parent Cs^{127} (37L52)
Ba^{128}	B chem (33F50a, 32T50)		EC (37L52)	2.4 d (33F50a, 32T50)				Cs-d-7n (37L52); Cs-p-6n (33F50a, 32T50, 37L52); parent Cs^{128} (33F51, 37L52)
Ba^{129}	A chem, genet (32T50, 33F50a)		β^+ (33F50a, 32T50)	2.0 h (33F50a); 1.8 h (32T50)	hard β^+ (32T50)			Cs-p-5n (33F50a, 32T50); parent Cs^{129} (33F50a, 32T50)
Ba^{130}		0.101 (6N38b)						
Ba^{131}	A chem, n-capt, excit (32K47a)		EC (32K47a); no β^+ (5Y47, 28F47)	12.0 d (32K47a); 11.7 d (5Y47)		γ_1 0.122 (K/L 6.0), γ_3 0.214 (K/L 2.8, e_K/γ ~0.18), γ_4 0.241, γ_5 0.370 (e_K/γ ~0.01), γ_6 0.494 (K/L 2.5, e_K/γ ~0.005), ~0.043 (?), ~0.065 (?), ~0.108 (?) ($\gamma_3/\gamma_4/\gamma_5/\gamma_6$ = 10/4/7/100) spect, spect conv (25E52); γ_1 0.122, γ_2 0.196, γ_3 0.213, γ_4 0.241, γ_5 0.371, γ_6 0.497 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ = 1.3/4.4/5.3/1.4/12/100) spect (43C51c); 0.122 (e/γ 0.8, K/L ~3.5), 0.206 (e/γ 0.15), 0.372 (e/γ 0.03), 0.494 (e/γ 0.01) spect, spect conv, γ-γ, conv-conv coinc (38K50a); ~0.5 (coinc with ~0.2 γ) γ-γ coinc abs (39C51); γ_7 1.2 abs (32K47a, 39C51); (γ_6/γ_7 ~4) (39C51); others (28D50a, 10Z50)		Ba-n-γ (32K47a, 5Y47, 1Y49, 28D50a, 10Z50, 43C51c); parent Cs^{131} (32K47a, 5Y47, 1Y49, 43C51c); spall-fission Bi (11G49)
Ba^{132}		0.097 (6N38b)						
Ba^{133m}	A chem, excit (10C41, 2D40)		IT (10C41)	38.8 h (46W43a); 38.9 h (5Y48)		0.276 (e_K/γ ~3) spect conv, scint spect (67H51a); 0.0117 (e/γ ~130) γ-γ coinc, ion ch (67H51b); 0.276 (K/L 3.2) spect conv (10C41)	 (67H51b, 18G52)	Cs-p-n (2D40); Cs-d-2n (10C41, 67H51a, 67H51b); Ba-γ-n (60M48); Ba-n-γ (5Y48); spall-fission Pb (13P47a), Bi (13P47, 11G49); parent Ba^{133} (5Y48)
Ba^{133}	A chem, n-capt, excit (32K47a); chem, genet (5Y48)		EC (32K47a)	~9.5 y (32K52a)		0.320 (e/γ 0.02), 0.085 (e/γ 0.3, K/L ~10) abs, abs conv, cl ch (5Y48); 0.36 abs, abs conv (32K47a)		Ba-n-γ (32K47a); daughter Ba^{133m} (5Y48)
Ba^{134}		2.42 (6N38b)					Ba^{134}, I = 0 (87M50)	

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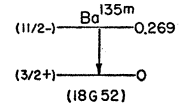
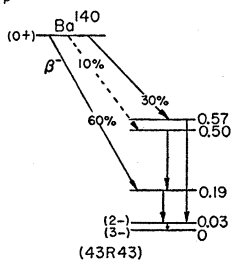
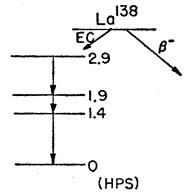
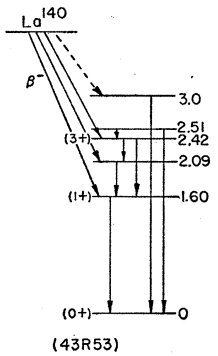
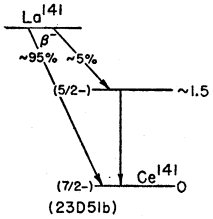
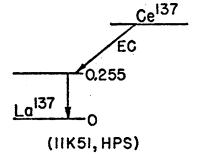
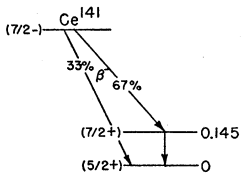
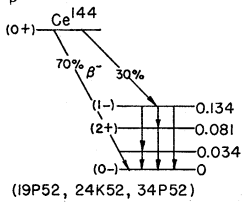
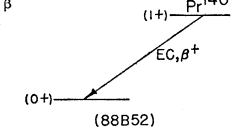
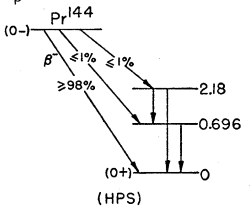
$_{56}Ba^{135m}$	A chem (45K40); chem, n-capt, sep isotopes (67H51a)		IT (46W43, 5Y48)	28.7 h (5Y48)		0.269 (e_K/γ ~3.5, K/L ~2) spect conv, scint spect (67H51a); 0.267 spect conv, spect, scint spect (39C51a)		Ba-n-γ, Ba-n-2n (45K40); Ba-d-p (46W43, 39C51a); Ba^{134}-n-γ (67H51a); spall-fission U (6O47)
Ba^{135}		6.59 (6N38b)					Ba^{135}, I = 3/2 (87M50)	
Ba^{136}		7.81 (6N38b)					Ba^{136}, I = 0 (87M50)	
Ba^{137m}	A n-capt (12A35); chem, genet (31T48, 13E48)		IT (31T48)	2.60 m (14M49a); 2.63 m (31T48); 2.5 m (13E48)		0.6616 cryst spect (100M52); γ_1 0.661 (K/L+M 4.64) spect conv (10L50d, 59G52); 0.661 (K/L/M+N = 5.5/1.0/0.27) spect conv (79B52); γ_1 (e_K/γ 0.097) spect, spect conv (31W51); γ_1 (e_K/γ 0.095) scint spect (80H52); 0.662 (K/L+M 4.57) spect conv (40K52); 0.663 (e_K/γ 0.13, K/L 4.8) spect conv (14M49a); γ_1 (e_K/γ 0.08, K/L 5.0) spect conv (15O49); 0.663 (e/γ 0.14) spect conv, x-conv coinc (31T48); 0.669 spect conv (20P49)	see Cs^{137}	Ba-n-2n (1P37, 45K40); Ba-n-γ (12A35); daughter Cs^{137} (13E48, 31T48)
Ba^{137}		11.32 (6N38b)					Ba^{137}, I = 3/2 (87M50)	
Ba^{138}		71.66 (6N38b)					Ba^{138}, I = 0 (87M50)	
Ba^{139}	A chem, n-capt (12A35); chem, excit (1P38a)		β^- (1P37a)	85.0 m (24D51c); 84 m (92S48); 86 m (1P37a, 16H40a)	2.27 spect (92S48); 2.3 abs (32K51i, 70B43a)	0.163 (26%, e/γ 0.20, K/L = 6), 1.05 (0.6%) spect conv, abs, coinc (92S48); ~0.163 (e_K/γ 0.28) scint spect (52M52e)		Ba-d-p (1P37a, 45K40, 92S48); Ba-n-γ (12A35, 1P37, 2S47, 1Y49a); La-n-p (1P38a); Ce-n-α (46W43); spall-fission U (γ) (42L40), U (6F51); fission Th (25A39, 16H40, 72B51), U (6H39, 16H39a, 24D51), U^{235} (38G51), Pu (32K48, 28F51); daughter Cs^{139} (16H39a, 6H39, 16H40, 16H40a, 63S50); descendent Xe^{139} (16H39a, 6H39, 24D51)

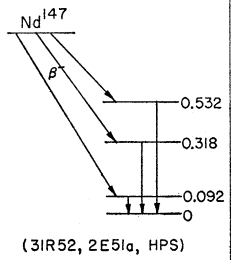
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{56}Ba^{140}$	A chem, genet (16H39, 16H39a)		β^- (16H39a)	12.80 d (13E51f, 77S47)	1.022 (60%), 0.480 spect (86B49, 43R53); 1.05 spect (4W51); 0.99, 0.47 spect (35L49); 1.0 (~75%), ~0.4 (~25%) abs (13E51g)	0.0296, 0.132, 0.162, 0.304, 0.537 spect conv (10C51c); 0.160, 0.310, 0.535 spect (35L49); 0.03, 0.16, 0.31, 0.54 spect, spect conv, scint spect, γ-γ coinc (86B49, 43R53); others (4W51, 26M49c)	Q^-_β 1.05 (43R53)  (43R43)	Ba-n-γ (second order reaction) (32K51k); spall-fission Th (6O47, 7N49a), U (6O48, 6F51); fission Th (72B51, 21T51), U (16H39, 6H39, 16H40a, 36G40, 38G46, 63S50, 24D51, 24D51a, 17B51, 11O51, 4W51, 13E51f, 13E51g), U^{233} (61S48, 38G51), U^{235} (38G51), Pu (32K48, 28F51) descendent Xe^{140} (16H40a, 17B51, 24D51, 24D51a, 11O51); parent La^{140} (16H39, 16H39a, 16H40a, 36G40, 16H42a, 38G46, 28F51c)
Ba^{141}	A chem, genet (16H42a)		β^- (16H42a)	18 m (16H42a, 52G51)	2.8 abs (32L48)	γ (52G51)		fission Th (16H39c, 16H39), U (16H42a, 52G51, 52G51a); photo-fission U (42L40); daughter Cs^{141} (16H42a); parent La^{141} (16H42a); descendent Xe^{141} (17B51, 11O51, 24D51)
Ba^{142}	D chem, genet (16H42a)		β^- (16H42a)	6 m (16H42a)				fission Th (16H39c, 16H39), U (16H42a); photo-fission U (42L40); daughter Cs^{142} (16H42a); parent La^{142} (16H42a)
Ba^{143}	B chem (16H39)		β^- (16H42a)	<0.5 m (16H42a)				fission Th (16H39c), U (16H39c, 16H39, 16H42a, 24D51, 17B51, 11O51); [descendent Xe^{143}] (17B51, 24D51)
Ba^{144}	[A] genet (24D51)		β^- (24D51)	short (24D51, 24D51a)				[fission U, descendent Xe^{144}, ancestor Ce^{144}] (24D51, 24D51a)
$_{57}La^{131}$	A chem, mass spect (53G51)		β^+ (53G51)	58 m (53G51)	1.6 abs (53G51)			spall Ba (53G51)
La^{132}	A chem, mass spect (53G51)		β^+ (53G51)	4.5 h (53G51)	3.5 abs (53G51)	1.0 abs (53G51)		spall Ba (53G51)
La^{133}	A chem, mass spect (21N50)		EC, β^+ (weak) (21N50)	4.0 h (21N50)	~1.2 abs, spect (21N50); conv: 0.26 spect conv (21N50)	0.8 abs (21N50)		Cs-α-4n (21N50); daughter Ce^{133} (93S51)
La^{134}	B chem, genet (93S51)		β^+ ~44%, EC ~56% (93S51)	6.5 m (93S51)	2.7 abs, spect (93S51)	no γ (93S51)		daughter Ce^{134} (93S51)
La^{135}	A chem (81M42); chem, excit (73C48); chem, mass spect (21N50)		EC (81M42, 73C48)	19 h (21N50); 19.5 h (73C48)		0.76 (weak) abs (73C48); 0.88 abs (46W43b)		Cs-α-2n (73C48, 21N50); Ba-d-n (81M42, 46W43b); Ba-p-n (46W43b); daughter Ce^{135} (73C48)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{57}La^{136}$	A chem (3M47); chem, excit, sep isotopes (36R50a)		EC ~67%, β^+ ~33% (21N50)	9.5 m (21N50); 9.0 m (36R50a); 10 m (3M47)	2.1 spect (21N50); abs (3M47); 1.8 abs (36R50a)			Cs-a-n (21N50, 36R50a); Ba-d-n (3M47); Ba^{135}-d-n, Ba^{136}-d-2n (36R50a)
La^{137}	C mass spect (3I48b)			>400 y yield (73C48); >30 y yield (3I48b)				[daughter Ce^{137}] (3I48b, 73C48)
La^{138}	A chem, mass spect (3I47a)	0.089 (3I47a)	EC (18P51); β^- ~6% (85M52a)	~2.0 x 10^{11} y sp act (18P51); ~7 x 10^{10} y sp act (85M52a)	1.0 abs (85M52a)	γ_1 1.39, γ_2 0.81, γ_3 0.54 ($\gamma_1/\gamma_2/\gamma_3$ ≈ 1/0.65/0.3) scint spect (18P51); 1.0, 0.54 scint spect (11B50f)	see Cs^{138} 	natural source (11B50f, 18P51)
La^{139}		99.911 (3I47a)					La^{139}, I = 7/2 (87M50)	
La^{140}	A n-capt (82M35); chem, excit, n-capt (1P38a); chem, mass spect (60H48)		β^- (1P38a)	40.0 h (72B51d, 9B50, 46W43b); 40.4 h (77S47); 39.5 h (37B46)	1.32 (~70%), 1.67 (~20%), 2.26 (~10%), others <1.3 (very weak) spect (86B49, 43R53); 0.90, 1.40, 2.12 spect (1O46); 1.45, 2.2 spect (4W51a); others (46W43b, 37B46)	γ_2 0.3286, γ_3 0.4867, γ_4 0.8151, γ_5 1.596 spect (12H52); γ_1 0.093, γ_2 0.335, γ_3 0.490, γ_4 0.820, γ_5 1.600, γ_6 2.50, γ_7 3.0 (weak) spect, spect conv, γ-γ coinc (86B49, 43R53); γ_1 0.093, γ_2 0.335, γ_3 0.49, γ_4 0.82, γ_5 1.62, γ_6 2.55 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ ≈ <1/3/22/16/56/3) scint spect (87B51); 0.069, 0.110, 0.131, 0.173, 0.241, 0.265, 0.329, 0.431, 0.486, 0.752, 0.816, 0.926, 1.597, 1.904 spect conv (10C51d); γ_2 0.335, γ_3 0.49, γ_4 0.87, γ_5 1.65, γ_6 2.3 ($\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ ≈ 2/5/10/77/6) spect (11R47); γ_2 0.335, γ_3 0.49, γ_4 0.83, γ_5 1.63, γ_6 ~2.3 ($\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6$ ≈ 1/10/20/100/5) spect (43M46); γ_5 (coinc with 2.3 β^- and γ_4) scint spect, β-γ, γ-γ coinc (39R51a); 2.55 (~4%), 2.9 (~0.1%) D-γ-p ion ch (9B50); 2.49 (~3%) D-γ-n, Be-γ-n reactions (42W47); others (26M48a)	Q^-_β 3.86 (39R51a, 43R53) 	Ba-d-γ (?) (46W43b); La-d-p (1P37a, 1P38a, 81M42, 46W43b); La-n-γ (82M35, 1P38a, 40G42, 81M42, 46W43b, 2S47); Ce-n-p (46W43b); fission Th (72B51, 21T51), U (16H39, 16H39a, 16H40a, 36G40, 16H42a, 38G46, 28F51c), U^{233} (38G48, 38G51), U^{235} (38G47), Pu (28F51); spall-fission U (6F51) daughter Ba^{140} (16H39, 16H39a, 16H40a, 36G40, 38G46, 28F51c)

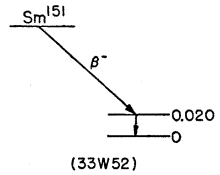
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{57}La^{141}$	A chem (16H42a); chem, genet (50B51, 23D51b)		β^- (16H42a)	3.7 h (32K51j); 3.5 h (16H42a)	2.43 (~95%), 0.9 (~5%) spect (23D51b)	1.3-1.6 (?, weak) scint spect, β-γ coinc (23D51b)	 (23D51b)	La-n-γ (second order reaction) (32K49); fission Th (4C39, 72B51), U (16H42a, 32K51j); daughter Ba^{141} (16H42a); descendent Xe^{141} (17B51); parent Ce^{141} (50B51, 23D51b)
La^{142}	D chem (16H42a)		β^- (32K51j)	74 m (16H42a); 77 m (32K51j)		γ (32K51j)		fission Th (16H39c), U (16H42a, 32K51j); daughter Ba^{142} (16H42a)
La^{143}	A chem, genet (54G51)		β^- (54G51)	~19 m genet (54G51); ~15 m (16H43b)				fission U (16H42a, 16H43b, 54G51); parent Ce^{143} (54G51)
La^{144}	[A] genet (24D51a)		[β^-] (24D51a)	short (24D51a)				[descendent Xe^{144}, parent Ce^{144}] (24D51a)
$_{58}Ce^{133}$	A chem, genet (93S51)		EC, β^+ (93S51)	6.30 h (93S51)	1.3 spect, abs (93S51)	1.8 abs (93S51)		La-p-7n (93S51); parent La^{133} (93S51)
Ce^{134}	B chem, excit (93S51)		EC (93S51)	72.0 h (93S51)		K-x, no γ (93S51)		La-p-6n (93S51); spall Ta (22N52); parent La^{134} (93S51)
Ce^{135}	A chem, genet (73C48)		EC, $\beta^+ \leqslant 1\%$ (93S51)	22 h (93S51)	0.81 spect (93S51)			La-d-6n (73C48); La-p-5n (93S51); spall Ta (22N52); parent La^{135} (73C48)
Ce^{136}		0.193 (3I47a)						
Ce^{137}	A chem, excit (73C48); n-capt, sep isotopes (67H51c)		EC, no β^+ (73C48)	36 h (73C48)		0.257 (K/L ~4) spect conv (67H51c); 0.253 (K/L ~10) spect conv (11K51)	 (11K51, HPS)	La-d-4n (73C48); La-p-3n (93S51); Ce^{136}-n-γ (67H51c, 11K51); [parent La^{137}] (3I48b, 73C48)
Ce^{138}		0.250 (3I47a)						
Ce^{139}	A chem (1P43); chem, excit, cross bomb (1P48, 36M47); n-capt, sep isotopes (67H51c)		EC (36M47)	140 d (1P43, 1P48)		0.166 (K/L ~10), 0.275 spect conv (11K51); 0.166 (K/L $\geqslant$4) spect conv (67H51c); ~0.8 abs (1P48)		Ba-α-n (1P43, 1P48); La-d-2n (1P43, 36M47, 1P48); Ce^{138}-n-γ (67H51c, 11K51); Ce-n-γ (83M50); spall-fission Bi (11G49); daughter Pr^{139} (93S51)
Ce^{140}		88.48 (3I47a)						

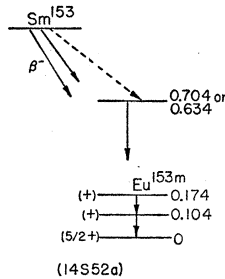
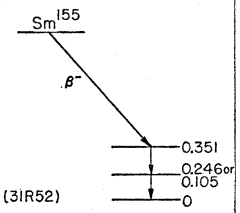
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{58}Ce^{141}$	A chem (16H40c); chem, excit, n-capt, cross bomb (1P43, 72B51e); chem, mass spect (60H48)		β^- (16H40c)	33.1 d (49W49); 32.5 d (3F50c); 30.6 d (1P48)	0.581 (33%), 0.442 (67%) spect (3F50c); 0.58 (29%), 0.44 (71%) spect (38K51c); 0.56 (30%), 0.41 (70%) spect (92S48a); 0.56 spect, β-γ coinc abs (11T49a); others (26M49e, 94S50, 1P48, 37B46)	0.145 (e_K/γ 0.25, K/L 5.5) spect conv, spect (3F50c); ~0.14 (e_K/γ 0.46) scint spect (80H52a); 0.142 (e_K/γ 0.48) scint spect (17J52a); 0.145 (K/L ~7) spect conv (67H51c); 0.144 (e/γ ~0.33, K/L 6.5) spect conv (38K51, 38K51c); 0.146 spect conv (11K51, 11T49a); 0.141 (coinc with β^-) spect conv, β-conv coinc (92S48a); 0.14 (coinc with β^-) scint spect, β-γ coinc (23D51b); others (94S50, 26M49e, 4B49, 42H47a, 52M51)	Q^-_β 0.58 (3F50c)  (3F50c, 38K51c)	Ba-α-n (1P43, 1P48); Ce-d-p (1P43, 1P48, 72B51e, 50B51); Ce-n-γ (1P43, 10C48a, 72B51e); Ce-n-2n (1P43, 1P48, 72B51e); Pr-n-p (1P43); spall Ta (22N52); spall-fission Bi (11G49), U (6F51); fission Th (72B51, 21T51), U (16H40c, 50B51), U^{235} (38G51), Pu (28F51) daughter La^{141} (50B51, 23D51b); descendent Xe^{141} (11O51, 24D51)
Ce^{142}		11.07 (3I47a)						
Ce^{143}	A chem (63S46, 1P43); chem, cross bomb (1P48); chem, genet (72B51e); mass spect (3I48b)		β^- (63S46)	33 h (72B51e, 95S50, 37B46); 34 h (38K51c); 36 h (4B49, 1P43)	β_1 1.39, β_2 1.09, β_3 0.71 ($\beta_1/\beta_2/\beta_3$ ≈ 1.0/1.3/1.0) spect (50B52); β_1 1.37, β_2 1.09, β_3 0.37 (?) (β_2/β_1 1.4) spect (38K51c)	0.035, 0.126, ~0.160, 0.289, 0.356, 0.660, 0.720 spect, spect conv, scint spect (50B52); γ_1 0.057 (K/L ~1), γ_2 0.283 (K/L ~6), γ_3 0.649, γ_4 0.705 ($\gamma_2/\gamma_3/\gamma_4$ ≈ 4.5/1/1) spect, spect conv, β-γ coinc (38K51, 38K51c); 0.0575 (K/L <1), 0.291 (K/L ~10), 0.348 spect conv (11K51); others (95S50)		Ce-d-p (1P43, 1P48, 72B51e); Ce-n-γ (1P43, 37B46, 1P48, 72B51e); Ce^{142}-n-γ (11K51); spall-fission Th (7N49a), U (6O48, 6F51); fission Th (72B51), U (17B51, 24D51, 63S51), Pu (32K48); daughter La^{143} (54G51); parent Pr^{143} (1P43, 37B46, 72B51e); descendent Xe^{143} (17B51, 24D51)
Ce^{144}	A chem (16H40c); chem, mass spect (60H48)		β^- (16H40c)	282 d (53S51); 275 d (50B51a); 290 d (19J44)	0.300 (70%), 0.170 (30%, coinc with 0.134 γ, with 0.080 γ) spect, β-γ coinc (34P52); 0.304 (70%) spect (19P52); 0.17 (coinc with 0.134 γ) β-γ coinc (24K52); others (70C52, 17N51b, 6P47, 26M50a)	0.0337, 0.054, 0.0807 (e/γ large, K/L ~4), 0.100, 0.134 (K/L ~9) spect conv, spect (19P52); 0.034, 0.041, 0.047, 0.054 (K/L <1), 0.081 (K/L ~5), 0.095, 0.101, 0.135 (K/L ~10) spect conv (11K51); 0.0547, 0.079 (K/L 6.3), 0.134 (K/L 8.3), 0.231 (K/L 1.7) spect conv (70C52); ~0.132 (K/L 5.3) spect conv (40K52); 0.695, 1.50, 2.18 spect (15T50); others (13A52a, 2E51)	Q^-_β 0.304 (19P52)  (19P52, 24K52, 34P52)	spall-fission Th (7N49a), U (6O48); fission Th (21T51), U (16H40c, 70B43a, 24D51, 7N51a, 50B51a), U^{233} (38G48, 61S48, 38G51), U^{235} (38G51), Pu (28F51); parent Pr^{144} (16H43b, 39G43, 7N51a); descendent Xe^{144} (24D51, 24D51a)
Ce^{145}	G not found: (78C52a)			~1.8 h (72B51f)				not found: fission U (78C52a); fission U (24D51, 72B51f); parent Pr^{145} (72B51f)
Ce^{146}	D chem, genet (40G43)		β^- (40G43)	14.6 m (53S45); 11 m (40G46)	~0.9 abs (78C52a)	soft γ (78C52a)		fission U, parent Pr^{146} (40G43, 16H43b, 53S45, 40G46)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{59}Pr^{137}$	B chem, mass spect (44D52)		β^+ (44D52)	1.4 h (44D52)	1.8 (44D52)			Ce-p-4n (44D52)
Pr^{138}	A chem, excit (93S51); chem, mass spect (44D52)		EC ~90%, β^+ ~10% (93S51)	2.0 h (93S51, 44D52)	1.4 abs, spect (93S51)	0.2, ~0.5, 1.3 abs (93S51)		Ce-p-3n (93S51, 44D52)
Pr^{139}	A chem, genet (93S51); chem, mass spect (44D52)		EC ~94%, β^+ ~6% (93S51)	4.2 h (44D52); 4.5 h (93S51)	1.0 abs spect (93S51)	1.0 abs (93S51)		Ce-p-2n (93S51, 44D52); parent Ce^{139} (93S51)
Pr^{140}	A excit (12A35); excit (1P38a)		β^+ 58%, EC 42% (88B52)	3.4 m (29D42); 3.5 m (1P38a)	2.23 spect (88B52)	no γ (88B52)	Q^+_β 3.25 (88B52)  (88B52)	Ce-p-n (93S51); Pr-n-2n (12A35, 1P38a, 29D42); Pr-γ-n (34H45, 12P49); daughter Nd^{140} (2W49, 88B52)
Pr^{141}		100 (3I48c)					Pr^{141}, I = 5/2 (87M50)	
Pr^{142}	A n-capt (12A35, 82M35)		β^- (29D42); no β^+ or EC (lim 0.5%) (28R50b)	19.2 h (37B46); 19.1 h (13J50); 19.3 h (29D42)	2.15 (~96%), 0.64 (~4%) spect (13J50); 2.23, 0.66 spect (41R50); 2.14 spect (96M52, 29D42); 2.23 spect (6P47); 2.22, 0.22 abs, β-γ coinc abs (26M49d); 2.5, ~0.4 abs, β-γ coinc abs (15J49)	γ_1 0.135, γ_2 1.59 (γ_1/γ_2 <0.2) spect, spect conv (41R50); 1.58 spect (13J50, 13J52); 0.134, 0.329, 0.490, 0.624 spect conv; 2.1 abs (10C48); 1.5 coinc abs sec (15J49)	Q^-_β 2.23 (13J50, 26M49d)	La-a-n (29D42); Ce-p-n (29D42); Pr-d-p (29D42); Pr-n-γ (12A35, 82M35, 1P37, 1P38a, 29D42, 2S47); Nd-n-p (1P37, 1P38a); spall-fission U (6F51)
Pr^{143}	A chem (72B51g, 19J44); mass spect (60H46a)		β^- (72B51g, 19J44)	13.7 d (15F49a); 13.8 d (72B51h); 13.5 d (1P48)	0.932 spect (15F49a); 0.922 spect (49B50a); 0.920 spect (11T49a); 0.92 spect (38K51); 0.84 abs (26M49e)	no γ (72B51g, 72B51h, 1P48)	Q^-_β 0.93 (HPS)	Ce-d-n (1P48); spall-fission U (6F51); fission U (16H43b, 19J44, 72B51g), Pu (28F51) daughter Ce^{143} (1P43, 37B46, 72B51e)
Pr^{144}	A chem, genet (7N51a, 16H43b, 39G43)		β^- (7N51a)	17.5 m (7N51a, 77S51b); 17 m (16H43b)	2.97 (>99%), other β's (<1%) spect (19P52); 2.32 (<1%, coinc with 0.69 γ), 0.81 (<1%) spect, β-γ coinc (24K52); 2.95 (~95%), 0.87 (~5%) spect (10L52c); 2.97 (~90%), 2.3 (~5%), 0.86 (~5%) spect (13A52a); 2.99 spect (6P47); others (17N51b, 19J44, 50B51a, 70B43a, 16H43b, 26M50a, 70C52)	γ_1 0.0603, γ_2 0.696, γ_3 1.5, γ_4 2.19 (γ_2, γ_3, γ_4 weak) scint spect, spect, spect conv (19P52); γ_2 0.695, γ_3 1.48, γ_4 2.19 ($\gamma_2/\gamma_3/\gamma_4$ ≈ 1/0.4/1.1) spect, β-γ, γ-γ coinc (13A52a); γ_1 0.061 (K/L <1) spect conv (11K51); others (17N51b, 77S51b)	Q^-_β 3.0 (13A52a, 19P52)  (HPS)	fission Th (21T51), Pu (28F51); spall-fission U (6F51); daughter Ce^{144} (16H43b, 39G43, 7N51a)
Pr^{145}	G not found: (78C52a)			4.5 h (72B51f)				not found: fission U (78C52a); fission U (72B51f); daughter Ce^{145} (72B51f)
Pr^{146}	D chem (40G43)		β^- (40G43)	24.0 m (20K51a); 24.6 m (53S45a); 25 m (40G46)	3.8 abs (78C52a); ~3 abs (53S45a)	0.490, 0.78 scint spect (20K51a); 1.4 abs (53S45a)		fission U, daughter Ce^{146} (40G43, 16H43b, 53S45, 40G46)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{60}Nd^{138}$	D chem, excit (93S51)		β^+ (93S51)	22 m (93S51)	~2.4 abs (93S51)			Pr-p-4n (93S51)
Nd^{139}	A chem, genet (93S51)		EC ~90%, β^+ ~10% (93S51)	5.50 h (93S51)	3.1 abs, spect (93S51)	1.3 abs (93S51)		Pr-p-3n (93S51); ancestor Ce^{139} (93S51)
Nd^{140}	A chem, excit, genet (2W49)		EC (88B52)	3.3 d (2W49)		Pr K-x (88B52)		Pr-p-2n (93S51); Pr-d-3n (2W49); parent Pr^{140} (2W49, 88B52); spall-fission U (6F51)
Nd^{141}	A excit (47K42); chem, excit (2W49)		EC ~98%, β^+ ~2% (2W49)	2.42 h (2W49); 2.5 h (47K42)	0.7 abs (2W49); 0.8 abs (47K42)	1.2 (weak) abs (2W49)		Pr-p-n (47K42, 2W49); Pr-d-2n (2W49); Nd-n-2n (1P38a, 47K42); Nd-γ-n (47K42)
Nd^{142}		27.13 (3I48c)						
Nd^{143}		12.20 (3I48c)					Nd^{143}, I = 7/2 (97B50, 88M51)	fission U^{235} (mass spect) (3I50a)
Nd^{144}		23.87 (3I48c)						fission U^{235} (mass spect) (3I50a)
Nd^{145}		8.30 (3I48c)					Nd^{145}, I = 7/2 (97B50, 88M51)	fission U^{235} (mass spect) (3I50a)
Nd^{146}		17.18 (3I48c)						fission U^{235} (mass spect) (3I50a)
Nd^{147}	A chem, genet (84M47, 84M51a)		β^- (84M47, 84M51)	11.3 d (average of 3IR52, 2E51a, 38K51a, 84M51, 37B46)	0.83 (~60%), 0.60 (~15%), 0.38 (~25%) spect (2E51a); 0.78 (~65%), 0.35 (~32%) spect (38K51a); 0.83, 0.60, 0.38 spect (3IR52)	0.0918 (K/L_I = 6.4) spect conv (63M52); γ_1 0.0918 (e/γ ~0.9, K/L+M 6.5), γ_2 0.309, γ_3 0.391, γ_4 0.520 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ = 66/1/2/32) spect (38K51a); γ_1 (K/L/M = 7.55/1/0.096) spect conv (91S52d); 0.0912 (K/L 4.9), 0.121, 0.197, 0.231, 0.260, 0.273, 0.301, 0.318, 0.398, 0.441, 0.532 (K/L ~6) (all weak except 0.091 γ) spect conv, γ-γ, β-γ coinc (3IR52); 0.0915 (coinc with 0.83 β^-), 0.320, 0.534 spect conv, β-conv coinc (2E51a); others (26M50b, 52M51)	Q^-_β 0.92 (3IR52)  (3IR52, 2E51a, HPS)	Nd-d-p (47K42); Nd-n-γ (37B46, 84M47, 10C48b, 84M51b); fission U (84M51); spall-fission U (6F51); parent Pm^{147} (84M47, 84M51a)
Nd^{148}		5.72 (3I48c)						U^{235}-n-fission (mass spect) (3I50a)
Nd^{149}	A excit (1P38a); chem, genet (84M51b)		β^- (1P38a)	2.0 h (37B46, 1P38a); 1.8 h (3IR52); 1.7 h (84M51b)	1.5, 1.1, 0.95 spect (3IR52); 1.5 abs (84M51b); 1.6 abs (37B46)	0.030, 0.097 (K/L 0.9), 0.112, 0.114 (K/L ~5), 0.124, 0.188, 0.198, 0.211 (K/L ~7), 0.226, 0.240, 0.266 (K/L ~10), 0.424, 0.538, 0.650 spect, spect conv, scint spect, coinc (3IR52); others (52M51)	Q^-_β 1.5 (3IR52)	Nd-n-2n (1P38a); Nd-d-p (1P38a); Nd-n-γ (1P38a, 37B46, 84M51b); parent Pm^{149} (42K52)
Nd^{150}		5.60 (3I48c)	β^- (?) (85M52, 3L34)	>2 x 10^{19} y sp act (85M52); >10^{13} y sp act (21C52)				fission U^{235} (mass spect) (3I50a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{60}Nd^{151}$	B n-capt (84M51b); sep isotopes, n-capt, Pm K-L-M difference (31R52)		β^- (31R52)	15 m (51C52); 12 m (31R52, 84M51b)	1.93 spect (31R52)	0.085, 0.110, 0.117 (K/L 4), 0.421, 0.73, 1.14 spect conv, scint spect, β-γ, γ-γ coinc (31R52); Pm K-x (31R52)		Nd-n-γ (84M51b); Nd^{150}-n-γ, parent Pm^{151} (31R52)
$_{61}Pm^{141}$	B chem, excit (34F52)		β^+ (34F52)	20 m (34F52)	2.4-2.8 spect (34F52)			Nd^{142}-p-2n (34F52)
$Pm^{142,143}$	D chem, excit (2W50a)		EC (2W50a)	250-280 d (43L52a); 285 d (2W50a)		0.95 abs (2W50a)		Pr-α-2n (2W50a, 34F52); Nd-p-n (43L52a)
$Pm^{143,144}$	D chem (34F52)		EC (34F52)	200-400 d (34F52); 300-350 d (43L52a)		0.65, 0.44, 0.17 scint spect (34F52)		Pr-α-n, Pr-α-2n (34F52); $Nd^{143,144}$-p-n (34F52); Nd-p-n (43L52a)
Pm^{145}	F sep isotopes (43L52a)		β^+ (43L52a)	14-18 d (43L52a)	0.45 (43L52a)			Nd-p-n (43L52a)
Pm^{145}	A chem, genet (65B51, 26P52)		EC (65B51)	~30 y yield (65B51)		Nd K, L-x (65B51, 26P52)		daughter Sm^{145} (65B51, 26P52)
Pm^{146}	B chem, excit (34F52)		β^- (?) (34F52)	~1 y (34F52); 1-2 y (43L52a)	0.7 abs (34F52); 0.75 (43L52a)			Nd^{146}-p-n (34F52); Nd-p-n (43L52a)
Pm^{147}	A chem (84M47, 84M51a); mass spect (60H48)		β^- (39G43, 72B51i)	2.6 y (53S51); 2.3 y yield (3I50a)	0.223 spect (10L50c); 0.227 spect (39W52a, 33L49); 0.229 spect (16A50)	no γ (84M47, 84M51a, 77S51c)	Q^-_β 0.223 (HPS)	fission U (39G43, 72B51i, 77S51c, 84M51a), U^{233} (38G48, 38G51), U^{235} (3I50a, 38G51); daughter Nd^{147} (84M47, 84M51a); parent Sm^{147} (42R50)
Pm^{148}	A chem, n-capt, mass spect (26P47)		β^- (47K43)	5.3 d (47K43, 26P47)	~2.5 abs (26P47); 2 abs (47K43)	~0.8 abs (26P47)		Nd-p-n (47K43); Nd^{148}-p-n (43L52, 34F52); Nd-d-2n (47K42, 47K43); Nd-α-p (47K42); Pm^{147}-n-γ (26P47); spall-fission U (6F51)
Pm^{148}	B excit, sep isotopes (43L52); chem (6F51)		β^- (43L52)	42 d (34F52); 43 d (6F51); 48 d (43L52)	2.4 (weak), 0.6 spect (6F51); 2.7 (weak), 0.7 abs (34F52); 1.7, 0.6 abs (43L52)	0.9 abs (6F51); 1.0 abs (34F52); 0.5 abs (43L52)		Nd^{148}-p-n (43L52, 34F52); spall-fission U (6F51)
Pm^{149}	A chem (84M47, 84M51c); chem, mass spect (3I47b)		β^- (84M47, 84M51c)	54 h (34F52); 55 h (3I47b); 50 h (31R52, 38K51c); 47.5 h (37B46); 47 h (84M51c, 16W42, 44L41)	1.05 spect (38K51a, 31R52, 34F52); others (26M49f, 37B46, 84M51c)	0.285 (coinc with β^-, K/L 8), ~1.3 (weak) spect conv, abs, β-γ coinc (31R52); no γ (38K51a); ~0.2 (coinc with β^-) β-γ coinc abs (26M49f); others (52M51)		Nd^{150}-p-2n (34F52); Nd-d-n, Sm-n-p, Sm-γ-p (44L41); fission U (84M47, 84M51c), Pu (32K48); spall-fission U (6F51); daughter Nd^{149} (42K52)
Pm^{150}	A excit, sep isotopes (43L52); chem, excit, sep isotopes (34F52)		β^- (43L52)	2.7 h (43L52, 34F52, 47K43)	2.01 (~70%), 3.00 (~30%) spect (34F52); 2.4 abs (43L52)	1.4, 0.3 abs (34F52)		Nd-p-n, Nd-d-2n (47K43); Nd^{150}-p-n (34F52, 43L52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{61}Pm^{151}$	B genet, Sm K-L-M differences (31R52)		β^- (31R52)	27.5 h (31R52)	1.1 abs (31R52)	0.065 (K/L 0.3), 0.066 (K/L 0.3), 0.070 (K/L 0.3), 0.100 (K/L ~5), 0.116, 0.144 (K/L ~9), 0.163 (K/L ~7), 0.168 (K/L ~3), 0.177 (K/L ~9), 0.208 (K/L ~4), 0.232, 0.240, 0.275 (K/L >10), 0.340 (K/L ~9), 0.715 spect conv, scint spect (31R52)		daughter Nd^{151} (31R52); fission U (51C52)
Pm	E (1P38a); chem (6F51)		β^- (1P38a)	12.5 h (6F51, 1P38a)				Nd-d- (1P38a); spall-fission U (6F51)
$_{62}Sm^{143}$	E chem (65B50)			8 m (65B50)				Sm-γ-n (65B50)
Sm^{144}		3.16 (3I48d)						
Sm^{145}	A mass spect (3I47c); chem (65B51); chem, sep isotopes, n-capt (26P52)		EC (65B51, 31R52)	~410 d (65B51); >150 d (10C48b); >72 d (3I47c)		0.061 (K/L 1.0) spect conv (31R52)		Sm^{144}-n-γ (26P52); Sm-n-γ (3I47c, 10C48b, 65B51); parent Pm^{145} (65B51, 26P52)
Sm^{147}	A chem (71H32); sep isotopes, mass spect (48W50); chem, genet, mass spect (42R50)	15.07 (3I48d)	α (71H32, 3L33)	$t_{1/2}$ corrected for abundance of Sm^{147} (HPS): 1.4×10^{11} y sp act (45L47); 1.5×10^{11} y sp act (72H35); 1×10^{11} y sp act (31P49)	2.18 ion ch (10J50); 2.14 range emuls (74C46); 2.1 range emuls (73H49); 2.0 cl ch (72H35); others (92B49)		Sm^{147}, I = 7/2 (105B52); Sm^{147}, I = 5/2 (88M51)	natural source (71H32, 3L33, 72B48, 1D48); daughter Pm^{147} (42R50); fission U^{235} (mass spect) (3I50a)
Sm^{148}		11.27 (3I48d)						
Sm^{149}		13.84 (3I48d)					Sm^{149}, I = 7/2 (105B52); Sm^{149}, I = 5/2 (88M51)	fission U^{235} (mass spect) (3I50a)
Sm^{150}		7.47 (3I48d)						
Sm^{151}	A mass spect (3I47c, 3I50a); chem (84M49)		β^- (3I47c)	73 y (7K52); ~120 y yield (3I50a)	0.076 spect (16A50, 39W52b); 0.079 spect (24K49e); 0.074 spect (84M49); no conv (31R52)	0.019 (coinc with β^-) ion ch, β-γ coinc (33W52); 0.021 ion ch (17S50); 0.021 scint spect (39W52b); no γ (84M49, 31R52); others (52M51)	 (33W52)	Sm-n-γ (3I47c); fission U (84M49); fission U^{235} (mass spect) (3I50a)
Sm^{152}		26.63 (3I48d)						fission U^{235} (mass spect) (3I50a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{62}Sm^{153}$	A n-capt, excit (1P38a); mass spect (60H46, 3I47b); chem (51W51)		β^- (47K42)	47 h (51W51, 37B46, 47K42, 31R52)	0.80, 0.70 (coinc with 0.101 γ) scint spect, β-γ coinc (87B52); 0.68 (~67%), 0.80 (~33%) spect (11H50); 0.70 spect (7S51); 0.82 spect (31R52); 0.78 abs (82B48); 0.73 abs (51W51)	γ_1 0.070 (e_K/γ 3.1), γ_2 0.104 (e_K/γ 1.2, coinc with γ_3 or γ_4), γ_3 0.530, γ_4 ~0.60 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4$ ≈ 100/425/1.0/0.3) scint spect, γ-γ coinc (14S52a); 0.069 (e_K/γ 3.8), 0.103 (e_K/γ 1.2, K/L+M 3.5) scint spect (52M52e); 0.070, 0.103 (coinc with 0.07 γ, e_K/γ 0.65, K/L ~6), 0.530 (weak) scint spect, spect conv, conv-conv coinc (7S51); 0.070 (weak, e/γ >10), 0.101 (e/γ ~3), no higher γ, scint spect, γ-γ coinc (87B52); 0.070 (K/L 3.5, $L_I/L_{II}/L_{III}$ ≈ 26/1.3/1.3), 0.104 (K/L 6.5, $L_I/L_{II}+L_{III}$ ≈ 43/2.3) spect conv (63M52a, 63M52b); 0.070 (coinc with 0.103 γ, K/L 0.29), 0.103 (K/L 3.5), 0.582 (weak) spect conv, γ-γ coinc (31R52); 0.069, 0.103 spect conv (67H48a); 0.102 (e/γ >2.5) spect conv, β-γ, β-conv coinc (11H50); others (43M46, 82B48)		Nd-α-n (47K42); Sm-n-γ (71H36, 1P38a, 44L41, 16W42, 60H46, 2S47, 51W51); Sm-n-2n (1P38a, 47K42); Sm-d-p (44L41, 47K42); Sm-γ-n (44L41); spall-fission Th (7N49a), U (6F51); fission U^{233} (61S48), U^{235}, Pu (51W51); parent Eu^{153m} (52M50)
Sm^{154}		22.53 (3I48d)						fission U^{235} (mass spect) (3I50a)
Sm^{155}	B n-capt (12A35, 82M35); chem (51W51a)		β^- (47K42)	23.5 m (31R52); 25 m (51W51a); 21 m (1P38a)	1.8 (coinc with both γ's) abs, β-γ coinc (31R52); 1.9 abs (51W51a); 1.8 abs (47K42)	γ_1 1.05 (K/L 3.6), γ_2 0.246 (coinc with γ_1, K/L ~8) (γ_1/γ_2 ~1) spect, spect conv, γ-γ coinc (31R52)	Q^-_β 2.2 (31R52) 	Sm-n-γ (12A35, 82M35, 71H36, 1P38a, 44L41, 2S47, 3I47c, 51W51a); Sm-d-p (44L41, 47K42); fission U^{235} (51W51a), Pu (51W51a); parent Eu^{155} (3I47c)
Sm^{156}	A chem, genet (51W51b)		β^- (51W51b)	~10 h (51W51b)	0.9 abs (51W51b)			fission U (51W51b); spall-fission U (6F51); parent Eu^{156} (51W51b)
$_{63}Eu^{144}$	C excit, sep isotopes (74H52)		β^+ (74H52)	18 m (74H52)	2.4 spect (74H52)			Sm^{144}-p-n (74H52)
Eu^{145}	A chem, genet, sep isotopes, excit (74H51)		EC (74H51)	5 d (74H51)	conv: 0.2 abs (74H51)			Sm^{147}-p-3n (74H51); daughter Tb^{149} (74H51)
Eu^{146}	C excit, sep isotopes (74H51)		EC (74H51)	38 h (74H51)	conv: 0.4 abs (74H51)			Sm^{144}-α-pn, Sm^{147}-d-3n (74H51)
Eu^{147}	B chem, excit, sep isotopes (74H51)		EC 99+%, α ~10^{-3}%, no β^+ (74H51)	24 d (74H51)	α: 2.88 ion ch (74H51) conv: 0.2 abs (74H51)			Sm^{147}-p-n (74H51); Sm-d-2n, 3n (42R52)

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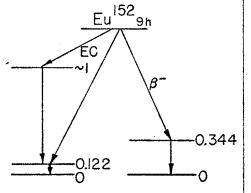
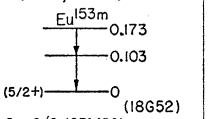
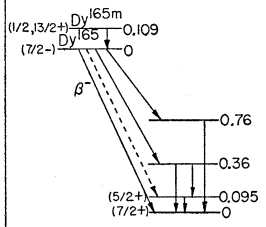
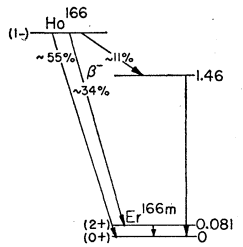
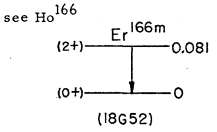
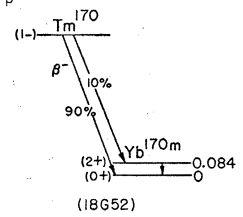
$_{63}Eu^{148}$	A chem (84M51d); excit, sep isotopes (74H51, 86M52)		EC, no β^+ (74H51)	59 d (86M52); 54 d (2W50b); 50 d (74H51); 53 d (84M51d)	conv: 0.4 abs (74H51, 2W50b)	0.57 scint spect (74H52); 1.0, 0.4 abs (84M51d, 2W50b); 0.7 abs (86M52)		Sm^{148}-p-n (74H51, 86M52); Sm-p-n (2W50b); Sm-d-n (47K43, 84M51d)
Eu^{149}	E sep isotopes, excit (74H52)			~120 d (74H52)		~0.4 scint spect (74H52)		Sm^{149}-p-n (74H52)
Eu^{150}	A chem, excit (65B50); chem, excit, sep isotopes (74H52); excit, sep isotopes (86M52)		β^- (86M52)	15.0 h (2W50b); 15 h (65B50); 13.1 h (86M52)	1.8 spect (2W50b); 0.8, other β's (86M52)			Sm^{150}-p-n (74H52, 86M52); Sm-p-n (2W50b); Eu-γ-n (65B50)
Eu^{151}		47.77 (43H48)					Eu^{151}, I = 5/2 (87M50)	fission U (mass spect) (3I50a)
Eu^{152}	A n-capt, mass spect (3I47d); chem (84M49a)		EC, β^- (60H49)	13 y (7K52); 5.3 y yield (60H49)	1.58, others spect (11H50); 1.58, 0.75 spect (68S48); 1.7 (~20%), 0.9 (~80%) abs (84M49a)	0.122 (conv in Sm), 0.123 (conv in Gd), 0.244, 0.344, 0.720, 0.964, 1.086 spect conv (11K51, 10C50c); 0.121, 0.244, 0.344 spect conv (43K52); 0.121 (coinc with 0.244 γ), 0.123 (coinc with 0.344 γ), 0.244, 0.344 (not coinc with 0.244 γ) conv-conv coinc spect (35F50); others (11H50, 68S48)		Eu-n-γ (3I47d, 2S47)
Eu^{152}	A n-capt (82M35); n-capt, excit (1P38a); mass spect (60H46, 60H49)		β^-, EC (60H49)	9.2 h (1P38a, 60H49); 9.3 h (37B46)	1.880, 0.55 (?) (weak) spect (11H50); 1.88 spect (20T39)	γ_1 0.122 (conv in Sm, K/L ~4), γ_2 0.344 (conv in Gd, K/L ~10) spect conv (11K51); 0.122, 0.336 (coinc with β) pair spect, β-γ coinc (107S51); 0.120 (coinc with 0.9 or 0.8 γ), 0.94, 0.82 (not coinc with 0.9 γ) spect, spect conv, β-conv, γ-γ coinc (11H50); others (52W51, 20T39, 10C50c, 35F50, 23R39)	 (11K51, 11H50)	Eu-n-γ (82M35, 1P38a, 71H36, 5F41b, 2S47, 60H49); Eu-n-2n (1P38a); Eu-d-p (5F39, 5F41b)
Eu^{153m}	A genet (52M50)		IT (52M50)	3.0×10^{-9} s delay coinc (52M50)		0.069 (e_K/γ 3.8), 0.103 (e_K/γ 1.2, K/L+M 3.5) scint spect (52M52e)	 (18G52)	daughter Sm^{153} (52M50)
Eu^{153}		52.23 (43H48)					Eu^{153}, I = 5/2 (87M50)	fission U (mass spect) (3I50a)
Eu^{154}	A n-capt (69S38); mass spect (3I47d, 60H49); chem (84M49a)		β^- (60H49)	16 y (7K52); 5.4 y yield (60H49)	1.9 (~10%), 0.7 (~40%), 0.3 (~50%) abs (84M49a, calc from 60H49); ~0.7 (coinc with hard γ), 0.3 abs, β-γ coinc abs (84M49a); with Eu^{154} and Eu^{155}: 1.88, 0.90, 0.59, 0.25, 0.14 spect, β-γ coinc abs (24K50d); others (37B46, 26K48, 11H50, 37W47)	0.336, 0.778, 1.116 spect conv (11K51); with Eu^{154} and Eu^{155}: 0.085, 0.101, 0.725, 1.005, 1.288 spect (24K50d); 0.122 spect conv (43K52); others (26K48, 10C48b)		Eu-n-γ (69S38, 5F39, 5F41b, 2S47); Eu-d-p (5F41b, 26K48); Eu^{153} (fission product)-n-γ (84M49a); fission U (24K50d)

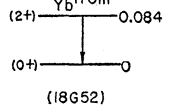
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{63}Eu^{155}$	A chem (51W51c); mass spect (60H49)		β^- (51W51c)	1.7 y (31R52); yield (60H49); 2.0 y (51W51c)	0.154 (80%), 0.243 (20%) spect, β-γ, γ-γ coinc (84M49a); see Eu^{154} β's (24K50d)	0.060 (weak), 0.087 (K/L ~8), 0.106 (K/L ~8), 0.132 (weak) spect conv (31R52); 0.085, 0.099 crit abs Pb, Pt (84M49a); 0.084 crit abs Tl, Hg (51W51c); 0.015 ion ch, β-γ coinc (33W52); see Eu^{154} γ's (24K50d)		Sm-d-n (47K43); Eu-n-γ (second order reaction) (60H49); spall-fission Th (7N49a); fission U (51W51c, 84M49a); daughter Sm^{155} (3I47c)
Eu^{156}	A chem (51W51b); mass spect (3I47b, 3I47c)		β^- (51W51b)	15.4 d (51W51b, 3I47c)	~0.5 (60%), 2.4 (40%) abs (51W51b)	2.0 abs (51W51b)		Eu-n-γ (second order reaction) (3I47c); spall-fission Th (7N49a), U (6O48, 6F51); fission U (51W51b), Pu (28F51); daughter Sm^{156} (51W51b)
Eu^{157}	D chem (51W51d)		β^- (51W51d)	15.4 h (51W51d)	~1.0 (~75%), ~1.7 (~25%) abs (51W51d)	0.6, 0.2 abs (51W51d)		spall-fission Th (7N49a); fission U (51W51d), Pu (32K48)
Eu^{158}	D chem (51W51d)		β^- (51W51d)	60 m (51W51d)	2.6 abs (51W51d)	γ (51W51d)		fission U (51W51d)
Eu^{159}	F excit (65B50)			20 m (65B50)				Gd-γ-p (?) (65B50)
$_{64}Gd^{148}$	B chem, excit, sep isotopes (42R52)		α, EC (?) (42R52)	>35 y (42R52)	α: 3.16 ion ch (42R52)			Sm-α-3n, Sm^{147}-α-3n (42R52); Eu-p-4n (42R52); spall Dy (42R52)
Gd^{149}	B chem, excit, sep isotopes, cross bomb (74H51)		EC 99+%, α ~10^{-3}% (42R52)	9 d (74H51)	α: 3.0 ion ch (74H51); conv: 0.35 abs (74H51)			Sm-α-2n, Sm^{147}-α-2n (74H51, 42R52); Eu-p-3n (74H51)
Gd^{150}	D chem (42R52)		α (42R52)	long (42R52)	α: 2.7 ion ch, range emuls (42R52)			Eu-d-3n (42R52)
Gd^{151}	B chem, excit (63H50)		EC, no β^+ (63H50)	150 d (63H50)		0.265 (e/γ large) abs (63H50)		Eu-d-2n (5F41b, 26K48, 63H50)
Gd^{152}		0.20 (1B50)						
Gd^{153}	A mass spect (3I47c); chem, n-capt (63H50)		EC, no β^+ (63H50)	236 d (63H50); 225 d (24K49a)		0.104 (K/L 5.2) spect conv (10C52c); 0.100 spect conv, abs (24K49a); 0.106 (e/γ >0.9) abs (63H50); others (10C48b)		Eu-d-2n (63H50); Gd-n-γ (3I47c, 10C48b, 24K49a, 63H50)
Gd^{154}		2.15 (1B50)						
Gd^{155}		14.73 (1B50)						
Gd^{156}		20.47 (1B50)						
Gd^{157}		15.68 (1B50)						
Gd^{158}		24.87 (1B50)						
Gd^{159}	B n-capt (2S47); chem (65B49, 63H50)		β^- (26K48)	18.0 h (65B49, 65B50, 26K48); 17.9 h (24K49b); ~24 h (63H50)	0.9 abs (26K48, 65B49)	0.055, 0.38 abs (65B49); ~0.3 abs (26K48); others (52M51)		Gd-n-γ (2S47, 24K49b, 65B49, 63H50); Gd-d-p (26K48); Gd-γ-n (65B50)
Gd^{160}		21.90 (1B50)						
Gd^{161}	C n-capt (3I46); n-capt, excit (65B49)		β^- (38M49)	3.6 m (65B49, 24K49b); 3.5 m (26K48); 3.3 m (38M49); 4.5 m (3I46)	1.5 abs (24K49c); ~2 (38M49)	0.37 abs (24K49c); ~0.07 (38M49)		Gd-n-γ (3I46, 26K48, 65B49, 38M49, 24K49b); parent Tb^{161} (24K49b, 24K49c)

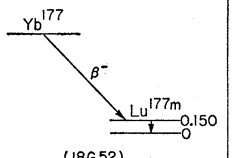
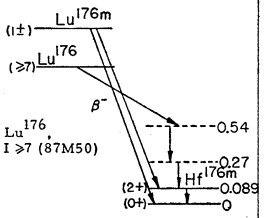
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{65}Tb^{149}$	A chem, mass spect (42R50)		α, EC (?) (42R52)	4.1 h (42R52)	α: 3.955 spect (42R52); 3.95 ion ch (42R52)			spall Gd, Dy (3T49, 42R52), Tb, Yb (42R52); parent Eu^{145} (74H51)
Tb^{151}	D chem, excit (42R52)		α, EC (?) (42R52)	19 h (42R52)	3.44 ion ch (42R52)			spall Eu (42R52), Gd, Tb, Dy (42R52)
Tb^{153}	B chem, excit (2W50c)		EC (2W50c)	5.1 d (2W50c)		1.2, 0.2 abs (2W50c)		Eu-α-2n (2W50c)
Tb^{154}	B chem, excit (2W50c)		EC 99+%, β^+ ~0.5% (2W50c)	17.2 h (2W50c)	2.6 spect (2W50c)	1.3 abs (2W50c)		Eu-α-n, Eu-α-3n (2W50c); Gd-p-n (2W50c)
Tb^{155}	D chem, excit (2W50c)		EC (2W50c)	190 d (2W50c)		1.4 abs (2W50c)		Eu-α-2n (2W50c)
Tb^{156}	B chem, excit (2W50c)		EC >75%, β^+ <25% (2W50c)	5.0 h (2W50c)	~1.3 abs (2W50c)			Eu-α-n (2W50c); Gd-p-n (2W50c)
Tb^{157}	B chem, excit, cross bomb (2W50c)		EC (2W50c)	4.7 d (2W50c)		1.4 abs (2W50c)		Gd-p-n (2W50c)
Tb^{159}		100 (43H48)					Tb^{159}, I = 3/2 (87M50)	
Tb^{160}	A n-capt (37B43); mass spect (3I47c); chem (6F51)		β^- (37B43); no β^+ (82B50)	73.5 d (37B46); 71 d (82B50); 76 d (10C50d)	0.860 (43%), 0.521 (41%), 0.396 (16%) spect (82B50); ~0.90 β^-(coinc with 0.085 γ) scint spect, β-γ coinc (52M52)	0.962, 0.876, 0.410, 0.391, 0.375, 0.298, 0.282, 0.215, 0.196, 0.176, 0.093, 0.087 spect, spect conv (10C50d); 0.970, 0.886, 0.300, 0.200, 0.085 spect conv (82B50); with Dy^{160m}: 0.085 (e_K/γ 1.7) scint spect (52M52a); others (10C48b)		Gd-d-2n (26K48); Tb-n-γ (37B43, 37B46, 2S47); spall-fission U (6F51); parent Dy^{160m} (52M52, 52M52a)
Tb^{161}	B excit (26K48); chem, excit (24K49c)		β^- (26K48)	6.75 d (65B49); 6.8 d (10C52c); 7.2 d (63H50); 7 d (24K49a)	0.5 abs (63H50, 65B49, 24K49a)	0.049 (L/M 3.7) spect conv (10C52c); 0.026 ion ch (17S50); 0.05 abs (65B49, 24K49a)		Gd-d-n (26K48, 65B49); spall-fission U (6F51); daughter Gd^{161} (24K49b, 24K49c)
$Tb^{162,163}$	E excit (65B50)			14 m (65B50)				Dy-γ-p (?) (65B50)
$_{66}Dy^{<153}$	E cross bomb (42R52)		α (42R52)	7 m (42R52)	4.21 ion ch (42R52)			Nd-C-spall, Tb-p (42R52)
$Dy^{<153}$	E cross bomb (42R52)		α (42R52)	19 m (42R52)	4.06 ion ch (42R52)			spall Tb, Dy (42R52)
$Dy^{<153}$	D chem (42R52)		α (42R52)	2.3 h (42R52)	3.61 ion ch (42R52)			Nd-C-spall, Tb-p (42R52)
Dy^{156}		0.0524 (3I49b)						
Dy^{158}		0.0902 (3I49b)						
Dy^{159}	B chem, n-capt (24K49d); chem, cross bomb (65B51a)		EC (24K49d)	134 d (65B51a); 140 d (24K49d)		Tb K, L-x (65B51a)		Tb-d-2n (65B51a); Dy-n-γ (24K49d, 65B51a)

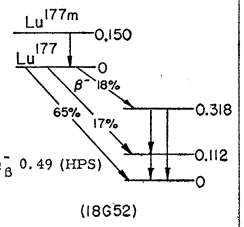
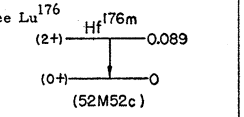
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{66}Dy^{160m}$	A genet (52M52)		IT (52M52a)	1.8×10^{-9} s delay coinc (52M52a)		0.085 (e_K/γ 1.7) scint spect (52M52a)		daughter Tb^{160} (52M52, 52M52a)
Dy^{160}		2.294 (3I49b)						
Dy^{161}		18.88 (3I49b)						
Dy^{162}		25.53 (3I49b)						
Dy^{163}		24.97 (3I49b)						
Dy^{164}		28.18 (3I49b)						
Dy^{165m}	A n-capt (9F44b); n-capt, sep isotopes (3I47e)		IT (9F44b)	1.25 m (9F46)		0.109 (K/L 0.08) spect conv (42C50); 0.102 scint spect (31K51); 0.102 spect conv (15H48)		Dy-n-γ (9F44b, 9F46, 2S47, 18G47, 42C50); Dy^{164}-n-γ (3I47e)
Dy^{165}	A n-capt (71H36, 82M35); n-capt, sep isotopes (3I47e); mass spect (3I47f)		β^- (1P38a)	139.2 m (109S52); 140 m (37B46); 145 m (5S46)	1.25, 0.88, 0.42 spect (5S46); others (72C42, 16D41, 10E41)	0.0951 (K/L_I 6.4) spect conv (63M52); 0.0878 spect conv (42C50); 0.091, 0.36, 0.76 spect, spect conv (5S46); others (43M46, 52M51, 52M52, 52W51)	 (18G52)	Dy-n-γ (82M35, 71H36, 1P38a, 1M40, 2S47, 24K49d); Dy^{164}-n-γ (3I47e)
Dy^{166}	A chem, genet (24K49d)		β^- (24K49d)	82 h (65B50a); 81 h (24K49d)	0.2 abs (65B50a); 0.4 abs (24K49d)			Dy-n-γ (second order reaction) (24K49d, 65B50a); spall-fission U (6F51); parent Ho^{166} (24K49d, 65B50a)
$_{67}Ho$	E excit (42R52)		α (42R52)	4 m (42R52)	α: 4.2 ion ch (42R52)			Dy-p (42R52)
Ho^{160}	C excit (2W50c)		EC 99+%, β^+ ~0.5% (2W50c)	22.5 m (2W50c)	~1.3 abs (2W50c); conv: 0.2 abs (2W50c)	~1.2 abs (2W50c)		Tb-α-3n (2W50c)
Ho^{161}	B chem, excit (2W50c)		EC (2W50c)	4.6 h (2W50c)	conv: 0.1 abs (2W50c)	1.1 abs (2W50c)		Tb-α-2n, Dy-p-n, Dy-d-n (2W50c)
Ho^{162}	B chem, excit (2W50c)		EC ~85%, β^- ~15% (2W50c)	65.0 d (2W50c)	β^-: 0.8 spect, abs (2W50c); conv: 0.1 abs (2W50c)	~1 abs (2W50c)		Tb-α-n, Dy-p-n, Dy-d-2n (2W50c)
Ho^{163}	B chem, excit, cross bomb (2W50c)		EC (2W50c)	5.20 d (2W50c)	conv: 0.4 abs (2W50c)	~0.5, 1.4 abs (2W50c)		Dy-p-n, Dy-d-n, Dy-d-2n (2W50c)
Ho^{164}	A excit (1P38a)		β^- (2W50c)	34.0 m (2W50c); 41.5 m (25W50)	0.95 spect (2W50c)	no γ (2W50c)		Dy-p-n (2W50c); Ho-n-2n (1P38a, 25W50); Ho-γ-n (25W48)

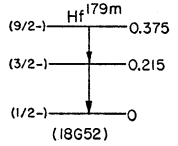
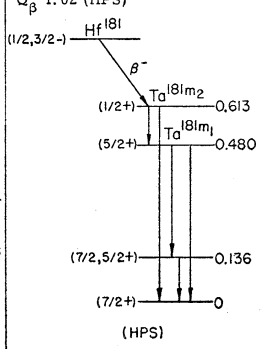
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{67}Ho^{165}$		100 (28L50)					Ho^{165}, I = 7/2 (87M50)	
Ho^{166}	A n-capt (71H36); mass spect (3I47d); chem (24K49b)		β^- (71H36)	27.3 h average of (24K49b, 3I47d, 37B46, 22G49, 10C49a, 31A50)	1.84 (~89%), 0.55 (~11%) spect (7S50a); 1.88 spect (22G49); 1.84 (86%), 0.66 (14%) spect (31A50); 1.85 spect (24K49); 1.90 cl ch, abs (97S50)	0.080 (e_K/γ 1.9, K/L+M 0.25), 1.38 (coinc with 0.08 γ) scint spect, γ-γ coinc (14S52a); 0.081 (K/L 0.07, $L_I/L_{II}/L_{III}$ = <0.1/0.72/1.00) spect conv (63M52); 0.080 (e_L/γ ~0.4, K/L <1), 1.36 (weak) spect, spect conv, β-conv coinc (7S50a); 0.081 (e_K/γ 1.9) scint spect (52M52a); 0.081, 0.9 spect conv, abs (10C49a); 0.081, ~1.5 (weak) spect conv, β-γ coinc (31A50); 0.080, 1.2 (weak) spect conv, abs (22G49)	 (14S52a)	Ho-n-γ (71H36, 1P38a, 1M40, 2S47); spall-fission U (6F51); daughter Dy^{166} (24K49d, 65B50a); parent Er^{166m} (52M50a, 52M52a, 63M52)
Ho^{166}	B chem, excit (65B52)		β^- (65B52)	>30 y (65B52)	1.1 (~8%), 0.28 (~46%), 0.18 (~46%) abs (65B52)	0.212 (coinc with 1.1 β), 0.280 (coinc with 0.73 and 0.83 γ), 0.725, 0.830, 0.095 (very weak) scint spect, γ-γ, β-γ coinc (65B52)		Ho-n-γ (65B52)
$Ho^{167,169}$	E excit (65B50)			96 m (65B50)				Er-γ-p (65B50)
$_{68}Er^{160,161}$	D chem (6F51)		β^+ (?) (6F51)	~17 h (6F51)				spall-fission U (6F51)
Er^{162}		0.136 (60H50)						
Er^{163}	D chem (6F51)		β^+ (?) (6F51)	~65 h (6F51)				spall-fission U (6F51)
Er^{164}		1.56 (60H50)						
Er^{165}	A chem, excit (65B50b); excit (29K52)		EC (65B50b)	10.0 h (65B50b); 9.9 h (29K52); 11.2 h (2W50d)	conv: ~0.2, 1.1 (weak) abs (29K52)	1.1 abs (2W50d); no γ (65B50b)		Dy-α-3n (2W50d); Ho-p-n (65B50b, 29K52); Ho-d-2n (29K52)
Er^{166m}	A genet (52M50a)		IT (52M50a)	1.7×10^{-9} s delay coinc (52M50a)		0.081 (e_K/γ 1.9) scint spect (52M52a); 0.081 (K/L 0.07) spect conv (63M52)	see Ho^{166}  (18G52)	daughter Ho^{166} (52M50a, 63M52, 52M52a)
Er^{166}		33.41 (60H50)						
Er^{167}		22.94 (60H50)					Er^{167}, I = 7/2 (97B51b)	
Er^{168}		27.07 (60H50)						
Er^{169}	B chem, n-capt (24K48)		β^- (24K48)	9.4 d (24K48); 9 d (65B50)	0.33 spect (24K48); 0.33 scint spect (11B49a)	no γ (24K48, 11K51)		Er-γ-n (65B50); Er-n-γ (24K48); spall-fission U (6F51)

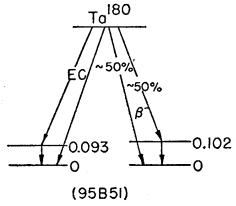
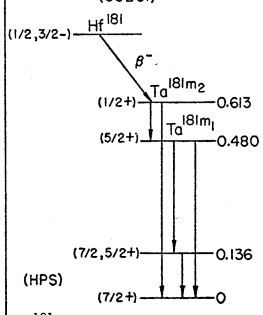
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev		Disintegration energy and scheme	Method of production and genetic relationships
					Particles	Gamma-transitions		
$_{68}Er^{170}$		14.88 (60H50)						
Er^{171}	B n-capt (71H36, 23N35); chem (24K48)		β^- (24K48)	7.5 h (24K48, 11K51)	1.49 (~6%), 1.05 (~72%), 0.67 (~22%) spect, β-γ coinc (24K48)	0.113 (K/L ~10), 0.118 (K/L ~0.5), 0.126 (K/L ~2), 0.176, 0.295 (K/L ~10), 0.308 (K/L ~10), 0.420, no 0.8 γ spect conv (11K51); 0.113 (e/γ large, coinc with 1.05 β and 0.31 γ), 0.31 (coinc with 1.05 β), 0.81 spect, spect conv, β-γ coinc (24K48); ~0.1 (e/γ 1.3) β-γ delay coinc (10D48)		Er-n-γ (71H36, 1P38a, 24K48, 37B46, 23N35); parent Tm^{171} (24K48); parent Tm^{171m} (10D48)
Er^{m}	E n-capt (38M49a)		IT (38M49a)	2.5 s (38M49a, 45G51)		0.210 (e_K/γ 0.55) scint spect (45G51, 24C51a)		Er-n-γ (38M49a, 45G51)
$_{69}Tm^{166}$	B chem, excit (2W49a)		EC 99+%, β^+ ~0.5% (2W49a)	7.7 h (2W49a)	β^+: 2.1 spect (2W49a); conv: 0.24, ~1 spect, abs (2W49a)	1.7 abs (2W49a)		Ho-α-3n (2W49a); Er-p-n (2W49a); daughter Yb^{166} (6F51)
Tm^{167}	B chem, excit (2W49a)		EC, no β^+ (2W49a)	9.6 d (2W49a)	conv: 0.21 abs (2W49a)	0.22, 0.95 abs (2W49a)		Ho-α-2n (2W49a); Er-p-n (2W49a); spall Ta (2W49a)
Tm^{168}	A chem, excit (2W49a)		EC, β^- (?) ~2% (2W49a)	85 d (2W49a)	conv: 0.16, 0.5 abs (2W49a)	0.21, 0.85 abs (2W49a)		Ho-α-n (2W49a); Er-p-n (2W49a); Tm-n-2n (2W49a)
Tm^{169m}	A genet (10D48)		IT (10D48)	all delay coinc: 0.658×10^{-6} s (27F50); 0.67×10^{-6} s (75M51a); 0.7×10^{-6} s (52M51); 0.60×10^{-6} s (14S51a)		see γ's of Yb^{169}		daughter Yb^{169} (10D48, 27F50, 52M51, 14S51a, 75M51a)
Tm^{169}		100 (7L50)					Tm^{169}, I = 1/2 (87M50)	
Tm^{170}	A n-capt (23N36, 71H36); chem (24K48a)		β^- (37B46a); no EC (lim 0.3%), no β^+ (lim 0.01%) (14G52)	129 d (24K49b); 120 d (42C50); 127 d (37B46a)	0.968 (76%), 0.884 (24%) spect (14G52); 0.970 (~90%), 0.886 (~10%) spect (36F49); 0.970, 0.88 spect, β-γ coinc (44R52); 0.990 spect (16A50); others (14G49, 22G49a, 97S50, 9S49a)	0.0841 (3%, e_K/γ 1.6, K/L/M ≈ 1/2.6/0.75) spect conv, β-γ coinc (14G52); γ (~3%, e/γ 9.4, K/L+M 0.22) x-γ coinc, scint spect (1N50); 0.085 (K/L 0.16, $L_I/L_{II}/L_{III}$ = <0.1/0.83/1.00) spect conv (63M52); 0.085 (e_K/γ 1.5) scint spect (52M52a); 0.084 (e/γ 4, K/L/M ~1/6.9/2.1) spect, spect conv, β-γ coinc (36F49); γ (e/γ >10, K/L+M 0.1) spect conv, scint spect (7S51); 0.085 spect conv (16A50, 42C50, 9S49a); others (22G50a, 4E50a, 1N50a, 10C49a, 52R52)	Q^-_β 0.970 (36F49)  (18G52)	Tm-n-γ (71H36, 23N36, 2S47); Tm-d-p (24K48a); parent Yb^{170m} (8B50, 52M52a, 14G52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{69}Tm^{171m}$	B genet (10D48)		IT (10D48)	2.5×10^{-6} s delay coinc (10D48)		0.113 (e/γ 1.3) spect conv, β-γ coinc (10D48); 0.113 (e/γ large) spect conv, β-γ coinc (24K48)		daughter Er^{171} (10D48)
Tm^{171}	B chem, genet (24K48)		β^- (24K48)	680 d (24K49b)	0.10 spect (24K48a)			daughter Er^{171} (24K48)
$Tm^{172(?)}$	E chem (6F51)		β^- (6F51)	2-3 d (6F51)				spall-fission U (6F51)
$Tm^{>171}$	E excit (65B50)			19 m (65B50)				Yb-γ-p (?) (65B50)
$_{70}Yb^{166}$	D chem, genet (6F51)		EC (6F51)	62 h (6F51)				spall-fission U, parent Tm^{166} (6F51)
Yb^{168}		0.140 (1B50)						
Yb^{169}	A n-capt (37B46a); chem, excit (24K48a)		EC (37B46a)	31.8 d (49W49); 32.4 d (10C50e); 33 d (37B46a, 75M51a)		γ_1 0.023, γ_2 0.064, γ_3 0.095, γ_4 0.110 (e/γ 1.6), γ_5 0.120, γ_6 0.133 (e/γ 0.2), γ_7 0.143, γ_8 0.160, γ_9 0.178 (e/γ 0.8), γ_{10} 0.198 (e/γ 0.4), γ_{11} 0.308 (e/γ 0.04); ($\gamma_2/\gamma_4/\gamma_6/\gamma_9/\gamma_{10}/\gamma_{11} \approx$ 1.3/2.1/2.0/1.0/1.7/0.6) spect, spect conv, delay coinc (75M51a); 0.063, 0.094, 0.110, 0.131, 0.177, 0.198, 0.308 spect conv (10C50e); 0.109, 0.130, 0.177, 0.198, 0.307 scint spect, delay coinc (14S51a)		Tm-d-2n (24K48a); Yb-n-γ (34A45, 37B46a, 3I48a); spall-fission U (6F51); parent Tm^{169m} (10D48, 27F50, 52M51, 14S51a, 75M51a)
Yb^{170m}	A genet (8B50)		IT (8B50)	1.57×10^{-9} s delay coinc (14G52); 1.6×10^{-9} s delay coinc (52M52a)		0.0841 (e_K/γ 1.6, K/L/M ≈ 1/2.6/0.75) spect conv, β-γ coinc (14G52); 0.085 (e_K/γ 1.5) scint spect (52M52a)	see Tm^{170}  (18G52)	daughter Tm^{170} (8B50, 14G52, 52M52a)
Yb^{170}		3.03 (1B50)						
Yb^{171}		14.31 (1B50)					Yb^{171}, I = 1/2 (87M50)	
Yb^{172}		21.82 (1B50)						
Yb^{173}		16.13 (1B50)					Yb^{173}, I = 5/2 (87M50)	
Yb^{174}		31.84 (1B50)						
Yb^{175}	A n-capt (37B46a, 34A45); mass spect (3I47f); chem (24K49b)		β^- (34A45)	102 h (3I47f); 99 h (37B46a); 101 h (34A45)	0.50, 0.13 abs (37B46a); 0.45 cl ch (34A45)	0.138, 0.259, 0.283, 0.396 spect conv (10C50e); others (52M51)		Yb-n-γ (34A45, 37B46a, 3I47f, 24K49b); Yb-γ-n (65B50)
Yb^{176}		12.73 (1B50)						

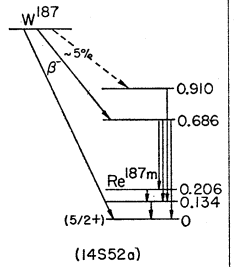
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{70}Yb^{177}$	B n-capt (82M35, 71H36); chem (24K49b)		β^- (37B46a)	1.8 h (52M51); 1.9 h (34A45); 2.4 h (37B46a)	1.3 abs (37B46a); 1.2 cl ch (34A45)	0.150 (K/L 3) spect conv, β-γ coinc (52M51)	 (18G52)	Yb-n-γ (82M35, 71H36, 1P38a, 37B46a, 3I47f); parent Lu^{177m} (52M49, 52M51)
Yb^m	E n-capt (38M49a)		IT (38M49a)	6 s (38M49a, 31K51)		0.212, 0.104 (?) scint spect (31K51); 0.200 abs (38M49a); Yb K-x (38M49)		Yb-n-γ (38M49a, 38M49, 31K51)
Yb^m	E n-capt (38M49a)		IT (38M49a)	50 s (38M49a)		~0.025, Yb L-x abs (38M49a)		Yb-n-γ (38M49a, 38M49)
Yb^m	E n-capt (31K51)			0.15 s (31K52)		0.455 scint spect (31K52)		Yb-n-γ (31K51)
$_{71}Lu^{170}$	B chem, excit (2W51)		EC (2W51)	1.7 d (2W51)		~2.5 abs (2W51)		Tm-α-3n, spall Ta (2W51)
Lu^{171}	B chem, excit (2W51)		EC (2W51)	8.5 d (2W51)		~1.2 abs (2W51)		Tm-α-2n, Yb-p-n, spall Ta (2W51); daughter Hf^{171} (2W51)
Lu^{171}	D chem, excit (2W51)		EC (2W51)	~600 d (2W51)		~1 abs (2W51)		Tm-α-2n (2W51)
Lu^{172}	B chem, excit (2W51)		EC (2W51)	6.70 d (2W51)		1.2 abs (2W51)		Tm-α-n, Yb-p-n (2W51); daughter Hf^{172} (2W51)
Lu^{172}	B chem, excit (2W51)		β^+, EC (?) (2W51)	4.0 h (2W51)	1.2 abs (2W51)			Tm-α-n, Yb-p-n, Lu-p-p3n (2W51)
Lu^{173}	B chem, excit (2W51)		EC (2W51)	~500 d (2W51)		~0.2, 0.8 abs (2W51)		Yb-p-n, Lu-p-p2n (2W51); daughter Hf^{173} (2W51)
Lu^{174}	A chem, excit (2W51)		EC ~80%, β^- ~20% (2W51)	165 d (2W51)	β^-: 0.6 abs (2W51)	~1 abs (2W51)		Lu-n-2n, Lu-d-p2n, Lu-p-pn, Hf-d-α (2W51)
Lu^{175}		97.40 (60H50)					Lu^{175}, I = 7/2 (87M50)	
Lu^{176m}	A n-capt (77M35a, 82M35); chem, excit (2W48)		β^-, no IT (17S52)	3.67 h (34A45); 3.7 h (37B46a)	1.1, 1.2 (17S52); 1.3 cl ch (34A45); 1.2 abs (9F43)	0.0889 ($K/L_{II}/L_{III}$ = 0.24/0.71/1.00) spect conv (63M52); 0.089 (e_K/γ 1.3) scint spect, β-γ delay coinc (52M52c); 0.089 (e/γ large, K/L 0.1) scint spect (17S52)		Lu-d-p (2W51, 2W48); Lu-n-γ (77M35a, 82M35, 71H36, 9F43, 37B46a, 34A45, 2S47, 24K49b, 31A50a); Lu-γ-γ (11D47a, 65B50); parent Hf^{176m} (52M52c)
Lu^{176}	A chem (52H38); mass spect (8M39)	2.60 (60H50)	β^-, no EC (17S52a)	7.5×10^{10} y sp act (3L39a)	0.40 abs (9F47a, 9F43)	0.089, 0.180, 0.270 scint spect (17S52a)	 (18G52)	natural source (52H38, 8M39)

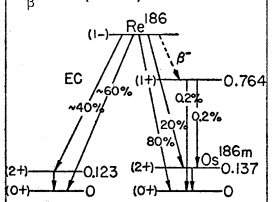
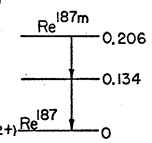
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{71}Lu^{177m}$	B genet (52M49)		IT (52M49)	1.3 x 10^{-7} s delay coinc (52M49, 52M51)		0.150 (K/L 3) scint spect, β-γ coinc (52M51, 52M49)	 (18G52)	daughter Yb^{177} (52M49, 52M51)
Lu^{177}	A n-capt (71H36); mass spect (3I47f); chem, excit (2W48)		β^- (37B46a)	6.8 d (37B46a, 2W48); 7.0 d (30D49); 6.6 d (9F43, 34A45)	0.495 (65%), 0.37 (17%), 0.17 (18%) spect (30D49); 0.475 spect (31A50a)	0.112 (e_K/γ 0.81), 0.206 (e_K/γ 0.04), 0.318 (~5%) scint spect, γ-γ coinc (52M52d); 0.112, 0.206, 0.317 (very weak) spect, spect conv (30D49); 0.112 (K/L/M ≈ 1/2/0.5), 0.205 spect conv (31A50a); 0.113, 0.209 spect conv (10C49a); others (52M51)		Lu-n-γ (71H36, 9F43, 34A45, 37B46a, 2S47, 24K49b, 31A50a); Lu-d-p (2W48)
$Lu^{178,179}$	D chem (65B50)			22 m (65B50)				Hf-γ-p (65B50)
$_{72}Hf^{170}$	D chem (2W51)		β^+ (2W51)	112 m (2W51)	2.4 spect (2W51)	no γ (2W51)		Lu-p-6n (2W51)
Hf^{171}	B chem, genet, excit (2W51)		EC (2W51)	16.0 h (2W51)		1.4 abs (2W51)		Yb-α-3n, Lu-p-5n (2W51); parent (8.5 d) Lu^{171} (2W51)
Hf^{172}	B chem, genet (2W51)		EC (2W51)	~5 y (2W51)		~0.28, 0.8 abs, spect conv (2W51)		Yb-α-2n, Yb-α-3n, Lu-p-4n, spall Ta (2W51); parent (6.7 d) Lu^{172} (2W51)
Hf^{173}	B chem, excit, genet (2W51)		EC (2W51)	23.6 h (2W51)		~1 abs (2W51)		Yb-α-n, Yb-α-2n, Yb-α-3n, Lu-p-3n (2W51); parent Lu^{173} (2W51)
Hf^{174}		0.18 (75H49)						
Hf^{175}	A chem, excit (2W49b); n-capt, sep isotopes (82B51); mass spect (12H51a)		EC (2W49b)	70 d (2W49b)		0.089, 0.113, 0.228, 0.318, 0.342 (K/L 4.9), 0.431 spect conv (82B52); 1.5 abs (2W49b)		Lu-d-2n, Lu-p-n (2W49b); Hf-n-γ (12H51a); Hf^{174}-n-γ (82B51)
Hf^{176m}	A genet (52M52c)		IT (52M52c)	1.35 x 10^{-9} s delay coinc (52M52c)		0.089 (e_K/γ 1.3) scint spect, β-γ coinc (52M52c)	see Lu^{176}  (52M52c)	daughter Lu^{176m} (52M52c)
Hf^{176}		5.15 (75H49)						
Hf^{177}		18.39 (75H49)					Hf^{177}, I = 1/2 or 3/2 (87M50)	
Hf^{178}		27.08 (75H49)					Hf^{178}, I = 0 (87M50)	

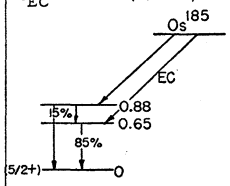
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{72}Hf^{179m}$	A n-capt (9F44b); n-capt, sep isotopes (82B51, 38M51b)		IT (9F46)	19 s (9F44b, 38M51b)		0.160, 0.217 scint spect, spect conv (82B51); ~0.150, 0.215 scint spect, conv-γ coinc (38M51b); 0.150 (e/γ very large, K/L 0.9) spect conv (15H48a); 0.220 scint spect (31K51)		Hf -n-γ (9F44b, 9F46, 38M51); Hf^{178}-n-γ (38M51b, 82B51)
Hf^{179}		13.78 (75H49)					Hf^{179}, I = 1/2 or 3/2 (87M50)	
Hf^{180m}	B chem, n-capt, sep isotopes (82B51)		IT (82B51)	5.5 h (82B51)		0.057, 0.093, 0.214, 0.330, 0.442 spect conv, γ-conv coinc (82B51)		Hf^{179}-n-γ (82B51)
Hf^{180}		35.44 (75H49)					Hf^{180}, I = 0 (87M50)	
Hf^{181}	A chem, n-capt (71H38); mass spect (12H51a); sep isotopes, n-capt (82B51)		β^- (71H38)	45 d (10C50f, 22R50); 47 d (43B48a)	0.408 spect (29F52); 0.420 spect (82B51); 0.410 spect (4E50); 0.404 spect (71C49); 0.460 spect (43B48a)	γ_1 0.133, γ_2 0.136, γ_3 0.344, γ_4 0.481, γ_5 0.611 spect conv, β-conv, conv-conv, β-γ coinc (82B51); γ_1 0.133, γ_2 0.136, γ_3 0.345, γ_4 0.481, γ_5 0.615 spect conv (4E50); γ_1 0.133 (K/L ~1), γ_2 0.136 (K/L ~0.2), γ_3 0.345, γ_4 0.481, γ_5 0.612 (γ_1 and γ_2 coinc with γ_3, γ_1 coinc with γ_4, γ_4 not coinc with γ_3) spect conv, conv-conv coinc (10C50f); γ_1 (e_K/γ 0.51), γ_4 (e_K/γ 0.034) scint spect, γ-γ coinc (52M52e); γ_1 0.130 (e/γ 0.90, K/L+M 0.6), γ_2 0.134 (e/γ ~3, K/L+M ~8), γ_3 0.340 (e/γ ~0.1), γ_4 0.474 (e/γ 0.030, K/L+M 4.0) spect conv (29F52); γ_1 0.132, γ_2 0.135 (K/L ~8), γ_3 0.345, γ_4 0.481 (γ_1/γ_2 ~5, γ_4/γ_3 ~8) spect, spect conv (12H51a); γ_1 0.130 (e_K/γ ~1.3), γ_2 0.134, γ_3 0.337 (K/L ~3.6), γ_4 0.471 (K/L ~3) (γ_3/γ_4 ~2.5) spect conv, β-γ, conv-conv coinc (71C49); γ_3 0.347 (K/L ~5.0), γ_4 0.485 (K/L ~5.2) spect, spect conv (13J49a); others (43B48a, 10C47, 24N47, 3V48, 26M49a, 49W49a, 63B50, 20D50a, 32P50, 27F50a, 35F50, 52M51, 4B48, 4B49, 14L49)	Q^-_β 1.02 (HPS) 	Hf-n-γ (71H38, 2S47); Hf^{180}-n-γ (82B51); Ta-n-p (24N47); spall-fission U (6F51); parent Ta^{181m_1} (4E50, 63B50, 52M51); parent Ta^{181m_2} (10D48, 4B48, 4E50, 63B50, 52M51)
Hf^m	E (24C52)		IT (24C52)	~3.5 s (24C52)				Hf-n (24C52)

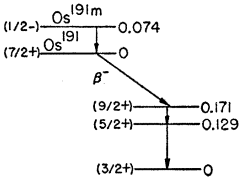
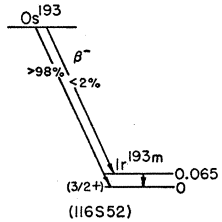
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{73}Ta^{176}$	B chem, excit (2W48, 2W50e)		EC (2W50e)	8.0 h (2W50e)	conv: 0.1, 0.2, ~1 abs (2W50e)	~2 abs (2W50e)		Lu-α-3n (2W50e); spall Ta (2W48); daughter W^{176} (2W50e)
Ta^{177}	B chem, excit (2W48, 2W50e)		EC (2W50e)	53 h (2W50e)	conv: 0.1 abs (2W50e)	~1.4 (weak) abs (2W50e)		Lu-α-2n, Lu-α-3n, Hf-p-n (2W50e); spall Ta (2W48); daughter W^{177} (2W50e)
Ta^{178}	B chem, excit (2W50e)		EC ~97%, β^+ ~3% (2W50e)	2.1 h (2W50e)	β^+: ~1 abs (2W50e); conv: ~0.1 abs (2W50e)	1.3-1.5 abs (2W50e)		Lu-α-n, Hf-p-n, Ta-p-p3n (2W50e)
Ta^{178}	B chem, genet (2W50e)		EC ~94%, β^+ ~6% (2W50e)	9.35 m (2W50e)	β^+: 1.06 spect (2W50e); conv: 0.08 spect conv (2W50e)	~1.5 abs (2W50e)		Hf-p-n (2W50e); daughter W^{178} (2W50e)
Ta^{179}	D chem, excit (2W50e)		EC (2W50e)	~600 d (2W50e)	conv: ~0.1 abs (2W50e)	~0.7 (weak) abs (2W50e)		Lu-α-n, Hf-p-n, Ta-p-p2n (2W50e)
Ta^{180}	A chem, excit (17O38)		EC ~79%, β^- ~21%, no β^+ (lim 0.005%) (95B51)	8.15 h (95B51); 8.00 h (2W50e); 8.2 h (17O38)	0.71 (~50%), ~0.61 (~50%) spect (95B51); 0.7 spect (2W50e); abs (83M51)	γ_1 0.093 (K/L ~0.15), γ_2 0.102 ($\gamma_1 + \gamma_2$: e/γ ~5), γ_3 0.2, γ_4 0.4 (γ_3 and γ_4 very weak) spect conv, scint spect, β-γ, x-γ coinc (95B51); 1.3 abs (2W50e)	 (95B51)	Ta-n-2n (1P37, 17O38, 2W50e); Ta-γ-n (27M49, 55S51, 95B51); Ta-p-pn (96B49, 2W50e); W^{182}-γ-pn (83M51)
Ta^{181m_2}	A genet (10D48)		IT (10D48)	2.2×10^{-5} s delay coinc (10D48, 4E50, 63B50); 2.0×10^{-5} s delay coinc (4B48)		see γ's of Hf^{181}		daughter Hf^{181} (10D48, 4B48, 4E50, 63B50, 52M51)
Ta^{181m_1}	A genet (63B50)		IT (63B50)	1.2×10^{-8} s delay coinc (4E50); 1.1×10^{-8} s delay coinc (63B50); 1×10^{-8} s delay coinc (52M51)		see γ's of Hf^{181}		daughter Hf^{181} (4E50, 63B50, 52M51)
Ta^{181}		100 (24W48)					Ta^{181}, I = 7/2 (87M50)	
Ta^m	E n-excit (24C49, 24C52)		IT (45G50)	0.33 s (24C49, 45G50, 31K51)		Ta L-x (45G50, 31K51)		Ta-n (24C49, 45G50, 31K51)

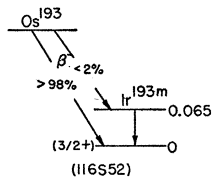
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{73}Ta^{182m}$	A chem, n-capt (2S47, 15H48a)		IT (15H48a); IT ~95%, β^- ~5% (2W50e)	16.5 m (15H48a); 16.2 m (2S47)	β^-: 0.6 abs (2W50e)	0.180 (K/L 0.25) spect conv (15H48a); 0.180 (e_K/γ 0.8) scint spect (14S51)		Ta-n-γ (2S47, 15H48a, 2W50e)
Ta^{182}	A chem, n-capt (37F36, 17O38)		β^- (76H40)	111 d (21E52, 38S51); 113 d (9S49c); 117 d (2S47, 11Z43)	0.525, other β's, spect (7J49); 0.53 spect (86B49a); others (11R47, 7J47, 24N47)	γ_1 0.065714, γ_2 0.067736, γ_3 0.084667, γ_4 0.10009, γ_5 0.11366, γ_6 0.11640, γ_7 0.15241, γ_8 0.15637, γ_9 0.17936, γ_{10} 0.19831, γ_{11} 0.22205, γ_{12} 0.22927, γ_{13} 0.26409, γ_{14} 1.121, γ_{15} 1.188, γ_{16} 1.223 (rel intens: γ_1 9, γ_2 100, γ_3 6, γ_4 46, γ_5 9, γ_6 2, γ_7 43, γ_8 14, γ_9 19, γ_{10} 9, γ_{11} 45, γ_{12} 24, γ_{13} 27, γ_{14} 352, γ_{15} 157, γ_{16} 334) cryst spect (100M52); 0.046, 0.058, 0.065, 0.067, 0.075, 0.077, 0.084, 0.100, 0.113, 0.134, 0.143, 0.152, 0.178, 0.198, 0.221, 0.228, 0.245, 0.262 spect conv (10C50e); 1.121, 1.189, 1.219 spect, spect conv (10C51e); 0.082, 0.098, 0.112, 0.122, 0.132, 0.141, 0.157, 0.165, 0.172, 0.198, 0.222, 0.243, 0.255, 0.264, 0.290 (?), 0.299 (?), 0.324, 1.133, 1.219, 1.237 spect, spect conv (86B49a); 0.224, 0.232, 0.260, 0.268, 0.280, 0.320, 0.342, 0.362, 0.392, 0.412, 0.421, 0.526, 0.565, 0.607, 0.624, 0.728, 0.763, 0.780, 0.892, 0.935, 0.993, 1.133, 1.215, 1.231 spect (18O50); others (4G49, 11R47, 10C49b, 13E50, 94S50, 98S48, 4B49, 52M51, 52W51)		Ta-n-γ (37F36, 17O38, 76H40, 2S47, 1M48); Ta-d-p (17O38, 11Z43, 31S50); W-d-α, W-n-p (33T51)
Ta^{183}	B chem, excit (65B50)		β^- (2W50f)	5.2 d (65B52c); 6.0 d (83M51); 6.1 d (2W50f)	0.65 scint spect (65B52c); 0.6 abs (2W50f, 83M51)	0.24 scint spect (65B52c); γ (2W50f)		W-n-p (2W50f, 65B52c); W-γ-p (65B50, 83M51)
Ta^{184}	B chem, excit (65B52c)		β^- (65B52c)	9.3 h (65B52c)	1.4 abs (65B52c)	0.410, 0.86, 1.10 scint spect (65B52c)		W-n-p, W^{184}-n-p (65B52c)
Ta^{185}	A chem, excit (65B50); excit, sep isotopes (23D50)		β^- (23D50)	48 m (83M51, 65B50)	1.6, 0.15 (conv?) abs (83M51); 1.7 abs (23D50)			W-γ-p (65B50, 83M51); W^{186}-γ-p (23D50)
$_{74}W^{176}$	B chem, genet (2W50e)		EC 99+%, β^+ ~0.5% (2W50e)	80 m (2W50e)	β^+: ~2 abs (2W50e); conv: ~0.1, ~0.2 abs (2W50e)	~1.3 abs (2W50e)		Ta-p-6n (2W50e, 22N52); parent Ta^{176} (2W50e)
W^{177}	B chem, genet (2W50e)		EC (2W50e)	130 m (2W50e)	conv: 0.13, ~0.4 abs (2W50e)	~0.5, 1.2 abs (2W50e)		Ta-p-5n (2W50e, 22N52); parent Ta^{177} (2W50e)

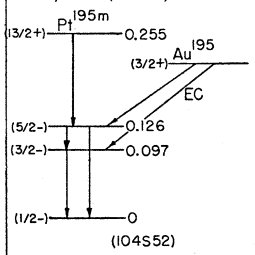
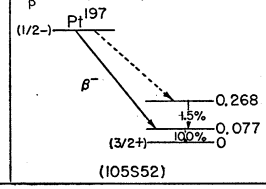
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{74}W^{178}$	B chem, genet (2W50e)		EC (2W50e)	21.5 d (2W50e)		~0.3 (weak) abs (2W50e)		Ta-p-4n (2W50e, 22N52); parent 9.4 m Ta^{178} (2W50e)
W^{179}	D chem, excit (2W50e)		EC (2W50e)	30 m (2W50e)				Ta-p-3n (2W50e)
W^{179}	D chem, excit (2W50e)		EC or IT (2W50e)	5.2 m (2W50e)				Ta-p-3n (2W50e)
W^{180}		0.135 (9W46)						
W^{181}	A chem, excit (2W47); chem, n-capt (37L51)		EC (2W47)	140 d (2W47)		0.030, 0.600, 0.800 scint spect (13A50b); 1.8 (weak) abs (2W47)		Ta-d-2n (2W47); Ta-p-n (96B49); W-n-γ (13A50b, 37L51); not parent Ta^{181m3} (38M51c)
W^{182}		26.4 (9W46)					W^{182}, I = 0 (87M50)	
W^{183m}	B sep isotopes, n-capt (38M49)		IT (38M49)	5.5 s (38M49, 24C52a)	conv: 0.08 abs (38M49a)	0.12, 0.17 scint spect (24C52a)		W^{182}-n-γ (38M49); W-n-γ (38M49, 31K51)
W^{183}		14.4 (9W46)					W^{183}, I = 1/2 (87M50)	
W^{184}		30.6 (9W46)					W^{184}, I = 0 (87M50)	
W^{185m}	C excit, sep isotopes (23D50)		IT (23D50)	1.85 m (23D50)	conv: 0.075 scint spect (23D50)			W^{186}-γ-n (23D50)
W^{185}	A chem, excit, n-capt (64M40)		β^- (64M40)	73.2 d (9S48a); 75 d (5F40a)	0.428 spect (68S48); 0.43 spect (20P48, 9S48a); others (23S45a)	0.134 spect conv (10C49); others (23S45a, 65C47a, 4B49, 52M51)		W-n-γ (64M40, 5F40a, 2S47, 10C49); W-n-2n (64M40, 5F40a); W-d-p (5F40a); Re-d-α (5F40a)
W^{186}		28.4 (9W46)					W^{186}, I = 0 (87M50)	
W^{187}	A chem, n-capt (12A35); chem, n-capt, excit (64M40)		β^- (64M40)	24.1 h (5F40a); 24.0 h (64M40)	1.33 (30%), 0.63 (70%) spect (20P48); 1.32 (≥12%), 0.63 (≥65%), ~0.38 (≤23%) spect (2L49); 1.34, ~0.65 spect (15H48b); others (23S45a, 43M46)	0.07200, 0.13425, 0.4795, 0.6189, 0.6861 cryst spect (100M52); γ_1 0.072 (coinc with γ_2, delay coinc with γ_3), γ_2 0.134 (coinc with γ_1, γ_4, and γ_7, delay coinc with γ_3), γ_3 0.480 (e_K/γ 0.022, delay coinc with γ_1 and γ_2, not coinc with γ_4 or γ_6), γ_4 0.552 (coinc with γ_2), γ_5 0.618 (not coinc with other γ's), γ_6 0.69, γ_7 0.775 (coinc with γ_2) ($\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7$ ≈ 0.45/1.00/0.31/0.42/1.48/0.23) scint spect (14S52a); 0.133, 0.204, 0.478, 0.615, 0.680, 0.767 spect conv (2L49); 0.129, 0.462, 0.652 spect conv, β-γ, γ-γ coinc (15H48b); 0.078, 0.138 spect conv (86B49b); others (6V4la, 72C42, 20P48, 9J51)	Q_{β}^- 1.33 (HPS)  (14S52a)	W-n-γ (12A35, 77M35b, 64M40, 5F40a, 2S47, 10C49); W-d-p (5F40a, 20P48); spall U (6O48); parent Re^{187m} (10D48, 4B49, 52M51)
W^{188}	A chem, genet (37L51)		β^- (37L51)	65 d genet (37L51)				W-n-γ (second order reaction) (13A50c, 37L51, 37L51a); parent Re^{188} (37L51, 37L51a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{75}Re^{182}$	B chem, excit (2W50g); chem, sep isotopes (31D50)		EC (2W50g)	12.7 h (2W50g); 14 h (31D50)		0.110, 0.127, 0.222, 0.250, 0.346 spect conv, spect (2W50g)		Ta-α-3n (2W50g); W-p-n (2W50g); W^{182}-d-2n (31D50); daughter Os^{182} (93S50)
Re^{182}	D (182) chem, excit (2W50g); (183) chem, sep isotopes (31D50)		EC (2W50g)	64.0 h (2W50g); 67 h (31D50)		0.110, 0.127, 0.222, 0.250, 0.346 spect conv, spect (2W50g)		Ta-α-3n, W-p-n (2W50g); W^{182}-d (31D50)
Re^{183}	B chem, excit (2W50g)		EC (2W50g)	155 d (33T51); 120 d (93S50)		0.081, 0.252 spect conv (2W50g)		Ta-α-2n, W-p-n (2W50g); W-d-n, W-α-p (33T51); daughter Os^{183} (93S50)
Re^{184}	A chem, excit (5F40a); chem, excit (2W50g)		EC (2W50g)	50 d (2W50g, 33T51)		0.159, 0.206, 0.244, 0.784, 0.89 spect conv (4W52); 0.043, 0.159, 0.205, 0.285 spect, spect conv (2W50g); 1.0 abs (33T51, 29C40)		Ta-α-n (2W50g); W-α-pn (33T51); W-p-n (2W50g); W-d-n (29C40, 5F40a, 33T51); Re-n-2n (2W50g, 5F40a)
Re^{184}	B chem, excit (2W50g)		EC or IT (2W50g)	2.2 d (2W50g)		0.043, 0.159 spect, spect conv (2W50g)		Ta-α-n (2W50g); W-p-n (2W50g)
Re^{185}		37.07 (24W48)					Re^{185}, I = 5/2 (87M50)	
Re^{186}	A n-capt (8K35); n-capt, excit (99S39); chem, n-capt, excit (5F40a); mass spect (43H47)		β^- ~95%, EC ~5%, no β^+ (lim 10^{-5}%) (44M51); β^- ~91%, EC ~9% (82S51a)	92.8 h (24G47); 91 h (10C48); 90 h (99S39)	1.07 (80%), 0.93 (20%) spect (44M51); 1.070 (73%), 0.942 (27%) spect (82S51a); 1.090 (67%), 0.95 (30%), 0.64 (3%) spect (22G49a); 1.063 spect (10L49); 1.07 spect (86B49a)	with β^-: γ_1 0.137 (e_K/γ ~0.35, K/L/M = 0.6/1/0.2), 0.627, 0.764 spect, spect conv, β-γ, γ-γ coinc (44M51); γ_1 0.136 (e_K/γ 0.37, K/L/M = 0.6/1/0.2) spect, spect conv, β-conv, γ-γ coinc (82S51a); with EC: γ_2 0.123 (~2%), γ_1/γ_2 = 9 (44M51); γ_2 0.122 (3%, e_K/γ 0.45, K/L 0.6) (82S51a); others (22G49a, 10C48, 86B49a)	Q_β^- 1.07 (44M51)  (44M51)	W-d-2n (5F40a); W-p-n (29C40); Re-γ-n (12P48); Re-n-γ (8K35, 99S39, 5F40a, 8Y40, 2S47); Re-n-2n (99S39, 8Y40, 5F40a); Re-d-p (5F40a, 66C50); spall Re (66C50); parent Os^{186m} (52M51a)
Re^{187m}	A genet (10D48)		IT (10D48)	5.3×10^{-7} s delay coinc (4B49); 5.5×10^{-7} s delay coinc (52M51)		0.133 ($e_K/\gamma \leq 3.2$, K/L ~5) scint spect (52M52b); see γ's of W^{187}	see W^{187}  (14S52a) Re^{187}, I = 5/2 (87M50)	daughter W^{187} (10D48, 4B49, 52M51)
Re^{187}	A chem (25N48)	62.93 (24W48)	β^- (25N48)	4×10^{12} y sp act (25N48, 63S48)	0.400 ion ch (42D52); 0.043 abs (25N48)	no γ, no x (42D52)		natural source (25N48, 63S48)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{75}Re^{188m}$	C n-capt, sep isotopes (63M52d, 63M52b)		IT (63M52d)	22 m (63M52d); 17 m (65B50)		0.0635, 0.092, 0.106 spect conv, scint spect (63M52b)		Re^{187}-n-γ (63M52b); Os-γ-p (?) (65B50)
Re^{188}	A chem, n-capt (12A35); n-capt, excit (99S39); chem, n-capt, excit (5F40a); mass spect (43H47)		β^- (99S39)	16.9 h (37L51); 18.9 h (24G47); 18 h (1P37)	2.07 (coinc with 0.152 γ) spect, β-γ coinc (44R52a); 2.10 spect (86B49a); 2.05 abs (24G47); others (26M48b, 99S39)	0.152 (70%, e_K/γ 0.05, K/L 0.42), 0.476 (3%), 0.638 (6%), 0.933 (5%), 1.3 (5%) spect, abs, spect conv (44R52a); 0.15, 0.48, 0.64, 0.95, 1.40 spect (86B49a); 0.16, 0.48, 0.64, 0 94, 1.43 spect (43M46); 1.39 coinc abs (26M48b); 0.154 spect conv (10C48)		Re-n-γ (8K35, 12A35, 1P37, 99S39, 5F40a, 8Y40, 2S47); Re-d-p (5F40a, 24G47, 66C50); spall U (6O48); spall Re (66C50); daughter W^{188} (37L51, 37L51a)
Re^{189}	D chem (37L51, 33T51)		β^- (37L51, 33T51)	150 d (37L51); 250-300 d (33T51)	0.2 abs (37L51, 33T51)	1.0 abs (33T51)		W-α-p (33T51); Re-n-γ (second order reaction) (37L51)
Re	E chem (37L51)		β^- (37L51)	≥5 y (37L51)	0.75 abs (37L51)			Re-n-γ (second order reaction) (?) (37L51)
$_{76}Os^{182}$	B chem, genet (93S50)		EC, no β^+ (93S50)	24.0 h (93S50)				Re-p-4n (93S50); parent Re^{182} (93S50)
Os^{183}	B chem, genet (93S50)		EC (93S50)	12.0 h (93S50)	conv: 0.15, 0.42 spect conv (93S50)	0.3, 1.6 abs (93S50)		Re-p-3n (93S50); parent Re^{183} (93S50)
Os^{184}		0.018 (6N37a)						
Os^{185}	B chem, cross bomb (24G47, 50K48)		EC (L/K ~0.35) (69M51a); no β^+ (2B50b)	97 d (50K48, 33T51); 95 d (24G47)		γ_1 0.648, γ_2 0.878 (γ_1/γ_2 ~6) spect, γ-γ coinc (2B50b); γ_1 0.65, γ_2 0.88 (γ_1/γ_2 6.1) scint spect (69M51b); 0.235, 0.653 spect conv (116S52)	Q_{EC} ~1.0 calc (69M51a)  (2B50b, 69M51b, HPS)	Re-d-2n (24G47, 66C50); Re-p-n (93S50); Os-n-γ (50K48)
Os^{186m}	A genet (52M51a)		IT (52M51a)	8×10^{-10} s delay coinc (52M51a)		0.137 scint spect (52M51a)	see Re^{186}	daughter Re^{186} (52M51a)
Os^{186}		1.59 (6N37a)						
$Os^{187m(?)}$	E chem (66C50)			35 h (66C50)				daughter Ir^{187} (?) (66C50)
Os^{187}		1.64 (6N37a)						
Os^{188}		13.3 (6N37a)						

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{76}Os^{189}$		16.1 (6N37a)					Os^{189}, I = 1/2 (87M50)	
$Os^{190m(?)}$	E chem (66C50)			6 h (66C50)				daughter 12 d Ir^{190} (?) (66C50)
Os^{190m}	D chem, genet (66C50)			9.5 m (66C50)				daughter 3 h Ir^{190} (66C50)
Os^{190}		26.4 (6N37a)						
Os^{191m}	A chem, genet (116S52)		IT, no β^- (lim 5%) (116S52)	14 h (116S52)		0.0742 ($L_I/L_{II}/L_{III}$ = 42/24/100) spect conv (116S52)	 (116S52, 67H53) Q^-_β 0.313 (38K51b)	Os-n-γ, Os-γ-n, parent Os^{191} (116S52)
Os^{191}	A n-capt (12Z40); chem, n-capt (13S41b); chem, excit (23F48a, 116S52)		β^- (13S41b)	16.0 d (66C50); 16.1 d (9S48a); 15.0 d (50K48)	0.143 spect (38K51b); 0.142 spect (9S48a); others (50K48, 13S41b, 37W47, 26M48b, 2B50b)	γ_1 0.0417 (L_{II}/L_{III} = 32/40, e/γ large), γ_2 0.129 (coinc with γ_1, $K/L_I/L_{II}/L_{III}$ = 100/30/11/6) spect conv, conv-conv coinc (116S52); γ_1 (e_K/γ 1.36) (116S52, calc from 38K51b); 0.042 (L/M 1.8), 0.128 (e_K/γ ~0.5, K/L 2.1) spect conv (38K51b, 38K51c); 0.041, 0.128 spect conv, spect (2B50b); 0.039, 0.127 spect conv (9S48a); 0.129 spect conv (10C47)		Os-n-γ (13S41b, 12Z40, 2S47, 116S52); Os-d-p (66C50); Os-γ-n (23F48a, 116S52); spall U (6O48); daughter Os^{191m} (116S52)
Os^{192}		41.0 (6N37a)						
Os^{193}	A n-capt (8K35, 12Z40); chem, n-capt (13S41b); chem, excit (23F48a, 116S52)		β^- (13S41b)	30.6 h (66C50); 31.9 h (24G47); 32 h (13S41b); 30 h (12Z40)	1.10 spect (2B50b); 1.05 scint spect (52M50b); 1.15 abs (66C50, 26M48b)	with Ir^{193m}: 0.066 spect conv (116S52); 0.065 scint spect, β-γ delay coinc (52M50b); no γ (2B50b); others (24G47, 26M48b)	Q^-_β 1.17 (HPS)  (116S52)	Os-n-γ (8K35, 12Z40, 13S41b, 2S47); Os-d-p (24G47, 66C50); Ir-d-2p (24G47); spall U (6F51); parent Ir^{193m} (52M50b, 52M51); not found: Os-γ-n (23F48a, 116S52)
Os^{194}	A chem, genet (37L50a)		[β^-] (37L50a)	~700 d (37L51)				Os-n-γ (second order reaction) (37L50a, 37L51); parent Ir^{194} (37L50a, 37L51)
$_{77}Ir^{187}$	B chem, excit, sep isotopes (66C50)		EC 99+%, β^+ ~0.2% (66C50)	11.8 h (66C50)	β^+: 2.2 spect (66C50); conv: 0.3, 1.2 spect conv (66C50)	~1.3 abs (66C50)		Re-α-2n, Re^{185}-α-2n (66C50); Os-d-3n (66C50); parent Os^{187m} (?) (66C50)
Ir^{188}	B chem, excit, sep isotopes (66C50)		EC 99+%, β^+ ~0.3% (66C50)	41.5 h (66C50)	β^+: 2.0 spect (66C50); conv: 0.2, 0.9 spect conv (66C50)	~1.8 abs (66C50)		Re-α-n, Re-α-3n, Re^{187}-α-3n (66C50); Os-d-2n, Os-d-3n (66C50)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{77}Ir^{190}$	D chem, excit, sep isotopes (66C50)		β^+, EC (?) (66C50)	3.2 h (66C50)	β^+: 1.7 spect (66C50); conv: 0.2, 0.8 spect conv (66C50)			Re-a-n, Re^{187}-a-n (66C50); Os-d-n, Os-d-2n (66C50); parent 9.5 m Os^{190m} (66C50)
Ir^{190}	B chem, excit (24G47); chem, excit, sep isotopes (66C50)		EC (24G47)	12.6 d (66C50); 10.7 d (24G47)		0.2, 0.6 abs (66C50); 0.3 abs (24G47)		Re-a-n, Re^{187}-a-n (66C50); Os-d-n (24G47, 66C50); Ir-n-2n (24G47); parent 6 h Os^{190m} (?) (66C50)
Ir^{191}		38.5 (37S36a)					Ir^{191}, I = 3/2 (99B50); Ir^{191}, I = 1/2 (94B49)	
Ir^{192m}	A n-capt (12M37); resonance neutron activation (18G47a)		IT (18G47a)	1.42 m (15H48a); 1.5 m (12M37)		0.057 spect conv (42C50); 0.056 spect conv (15H48a); γ (continuum) scint spect (38M51); γ (e_L/γ >400) ion ch (31K51)		Ir-n-γ (12M37, 18G47a, 2S47)
Ir^{192}	A n-capt (12A36); mass spect (37R46); chem (2W48a)		EC, β^- (10C51f); no β^+ (lim 0.008%) (41M51)	74.37 d (51K51); 74.5 d (38S51); 74.7 d (66C50)	0.66 spect (88S51a); 0.67 spect (2L47); 0.68 coinc abs (37W47); 0.6 abs (26M48a, 24G47)	γ_1 0.13633, γ_2 0.20131, γ_3 0.20574, γ_4 0.29594, γ_5 0.30845, γ_6 0.31646, γ_7 0.46798, γ_8 0.4848, γ_9 0.5884, γ_{10} 0.6045, γ_{11} 0.6129 (rel abund γ_1 4, γ_2 10, γ_3 75, γ_4 380, γ_5 370, γ_6 990, γ_7 300, γ_8 11, γ_9 11, γ_{10} 14, γ_{11} 5) cryst spect (100M52); 0.136, 0.151 (or 0.156), 0.169 (or 0.173), 0.201, 0.206, 0.283, 0.295, 0.308, 0.316, 0.396 (or 0.400), 0.415, 0.434 (or 0.438), 0.467, 0.484, 0.589, 0.604, 0.611 spect conv (10C51f); 0.775, 0.870 scint spect (50R52); others (103S51, 2L47, 20D50, 4B49, 67H48b, 52W51, 98S48, 56G49, 88S51a, 52M51)	Q^-_β 1.58 (50R52)	Os-d-2n (24G47, 66C50); Ir-n-γ (12A36, 12M37, 24J38, 2S47); Ir-n-2n (24G47); Ir-d-p (24G47, 2W48a); Pt-d-a (2W48a); Pt-γ-pn (25C52)
Ir^{193m}	B genet (52M50b)		IT (52M50b)	5.7×10^{-9} s delay coinc (52M50b)		0.065 scint spect, β-γ delay coinc (52M50b)	 (116S52)	daughter Os^{193} (52M50b, 52M51)
Ir^{193}		61.5 (37S36a)					Ir^{193}, I = 3/2 (99B50, 94B49)	
Ir^{194}	A n-capt (12A35); mass spect (37R46); chem (2W48a)		β^- (12M37)	19.0 h (24G47); 19.5 h (53W41); 19 h (12A35, 12M37)	2.18 spect (53W41); 2.2 spect (24A36); 2.1 abs (53W41, 24G47); 0.5 β-γ coinc abs (26M48a)	γ_1 0.290, γ_2 0.326, γ_3 1.51 ($\gamma_1/\gamma_2/\gamma_3$ = 1/5/1) spect (89B52); 0.328 spect conv (10C51f); 1.7-2.2 (0.14%) Be, D-γ-n reaction (23W50); others (4B49, 26M48a, 42C50, 37L51)		Ir-n-γ (12A35, 1P37, 2S47, 12M37, 24J38); Ir-d-p (24G47, 2W48a); Pt-γ-p, Pt-γ-pn (25C52)
Ir^{195}	D chem, excit (25C52)		β^- (25C52)	140 m (25C52, 65B52b)	1.8 abs (65B52b); ~1 abs (25C52)	0.49, 0.84 scint spect (65B52b)		Pt-γ-p (25C52); Pt-n-p (65B52b)
Ir^{196}	D chem, excit (65B52b)		β^- (65B52b)	9 d (65B52b)	~0.08 abs (65B52b)	γ (65B52b)		Pt-n-p (65B52b)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{77}Ir^{197}$	D chem, excit (25C52, 65B52b)		β^- (65B52b)	7 m (25C52, 65B52b)	1.65, 0.6 abs (65B52b)	γ (65B52b)		Pt-γ-p (25C52); Pt-n-pn (65B52b)
Ir^{198}	E excit (65B52b)		β^- (65B52b)	45 s (65B52b)	3.6 abs (65B52b)	0.78 scint spect (65B52b)		Pt-n-p (65B52b)
$_{78}Pt^{190}$		0.012 (28L49a)						
Pt^{191}	B chem, excit (2W48a, 90M52)		EC (2W48a)	3.00 d (2W49c, 90M52)		0.083, 0.096, 0.173 spect (116S52a); 0.6, 1.5 abs, abs conv (2W49c)		Ir-d-2n (2W48a, 2W49c); Pt-n-2n (2W48a, 2W49c); daughter Au^{191} (2W48a, 2W49c, 90M52)
Pt^{192}		0.78 (3I47g)						
Pt^{193m}	B chem, excit (2W48a, 90M52)		IT (116S52a); EC (2W48a)	4.33 d (2W49c); 4.6 d (90M52)		0.135 (K/L 0.28, $L_I/L_{II}/L_{III}$ 1/0/2) spect conv (116S52a); 0.2, 1.5 abs (2W49c)		Ir-d-2n (2W49c); Pt-n-γ, Pt-n-2n, Pt-d-p (2W49c); Pt-γ-n (116S52a); daughter Au^{193} (2W49c, 90M52)
Pt^{194}		32.8 (3I47g)					Pt^{194}, I = 0 (87M50)	
Pt^{195m}	B chem (12M37); chem, genet (104S52)		IT (104S52)	3.5 d (15H48a); 3.8 d (104S52); 4.4 d (79H52); 3.3 d (12M37)		0.029 (e/γ >7.5), 0.097 (e/γ 9.0, K/L 5.7), 0.126, 0.129 (e/γ very large, K/L 0.26) spect, spect conv, γ-conv coinc (104S52); 0.099, 0.130 (K/L 0.1) spect conv (10C52a); 0.126 (K/L 0.23) spect conv (15H48a)		Pt-n-γ (26M48e, 79H52, 104S52, 12M37, 1P37, 2S47, 34H51); Pt-d-p (9K41b); Pt-γ-n (25C52); daughter Au^{195} (180 d) (104S52)
Pt^{195}		33.7 (3I47g)					Pt^{195}, I = 1/2 (87M50)	
Pt^{196}		25.4 (3I47g)					Pt^{196}, I = 0 (87M50)	
Pt^{197m}	B chem (28S41); chem, excit, cross bomb (25C52)		IT (15H48a)	78 m (15H48a); 80 m (28S41); 88 m (25C52)		0.337 (e/γ very large, K/L 1.3) spect conv (15H48a)		Pt-d-p (28S41); Pt-n-2n (28S41); Pt-γ-n (60M48, 25C52); Hg-n-α (28S41); Au-n-p (?) (2W50f)
Pt^{197}	A chem (10C36); chem, excit (12M37)		β^- (12M37)	18 h (12M37); 17.4 h (10C52a)	0.670 spect (105S52, 34H51); 0.7 abs (9K41b, 28S41)	0.077, 0.191 (K/L 6.0) spect conv (10C52a); 0.077, 0.191 spect, spect conv (105S52); others (4B49)	see Au^{197m}, Hg^{197} Q^-_β 0.75 (105S52) 	Pt-n-γ (12M37, 28S41, 2S47, 79H52); Pt-d-p (10C36, 9K41b, 28S41, 9K42, 2W48a); Pt-γ-n (25C52, 25W48); Pt-n-2n (28S41); Hg-n-α (28S41)

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$_{78}Pt^{198}$		7.23 (3I47g)						
Pt^{199}	A n-capt (77M35b, 12A35); chem, n-capt, excit (28S41)		β^- (12M37)	31 m (12M37)	1.8 abs (9K41b, 28S41)			Pt-n-γ (12A35, 77M35b, 12M37, 28S41, 2S47, 50H51); Pt-d-p (28S41, 9K41b, 10C36); Hg-n-α (28S41)
Pt	F n-capt (10C50g)		β^- (10C50g)	82 d (10C50g)	0.5 abs (10C50g)	0.6 abs (10C50g)		Pt-n-γ (10C50g)
$_{79}Au^{183-187}$	D chem, excit (3T49)		EC, β^+, α ~0.01% (3T49)	4.3 m (42R52)	α: 5.07 ion ch (42R52)			spall Pt (42R52), Au (3T49, 42R52)
Au^{191}	B chem, genet (2W49c, 90M52)		EC (2W49c)	18 h (90M52); ~1 d (2W49c)		0.053, 0.064, 0.111, 0.123, 0.166, 0.250, 0.405 spect conv (90M52)		Ir-α-4n (2W49c); Pt-d-3n (2W49c); parent Pt^{191} (2W48a, 2W49c, 90M52); daughter Hg^{191} (90M52)
Au^{192}	B chem, excit (2W49c); chem, genet (42T52, 33F52)		EC, β^+ (2W49c)	5.0 h (42T52); 4.7 h (2W49c); 4.1 h (33F52)	β^+: ~1.9 abs (2W49c); conv: ~0.4 abs (2W49c)	2-3 abs (2W49c)		Ir-α-3n (2W49c); Pt-d-2n (2W49c); daughter Hg^{192} (33F52, 42T52)
Au^{193}	B chem, genet (2W49c, 90M52)		EC (2W49c)	15.8 h (2W49c, 90M52); 15.3 h (33F52)		0.051, 0.060, 0.084, 0.093, 0.109, 0.165, 0.177, 0.235 spect conv (90M52)		Ir-α-2n (2W49c); Pt-d-n, Pt-d-3n (2W49c); parent Pt^{193} (2W49c, 90M52); daughter Hg^{193} (33F52, 90M52)
Au^{194}	B chem, excit (2W49c)		EC ~97%, β^+ ~3% (2W49c)	39.5 h (2W49c); 39 h (82S49)	1.8 abs (2W49c)	0.291 (e/γ 0.054, K/L 2), 0.328 (e/γ 0.19, K/L 2), 0.466 (weak), 1.48 (e/γ 0.0026), 2.1 spect, spect conv (82S49)		Ir-α-3n (2W49c); Pt-d-2n, Pt-d-3n (2W49c); Pt-p-n (82S49)
Au^{195m}	B chem, genet (34H52a)		IT (34H52a)	0.5 m (34H52a)		0.056, 0.259 spect conv (34H52a)		daughter Hg^{195m} (34H52a)
Au^{195}	B chem, excit (2W49c); chem, genet (30D52)		EC (2W49c)	180 d (82S49, 30D52); 185 d (2W49c)		0.0308, 0.0990, 0.130 spect conv (30D52); 0.029 (L/M 4.6), 0.097 (K/L 5.8), 0.126 spect, spect conv, γ-conv coinc (104S52); others (34H51, 82S49)	see Pt^{195m}	Ir-α-2n (2W49c); Pt-d-n, Pt-d-2n, Pt-d-3n (2W49c); Pt-p-n (82S49); daughter Hg^{195m} (30D52)

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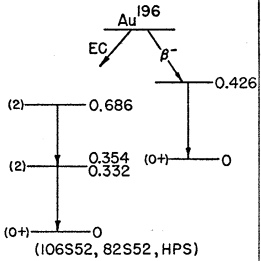
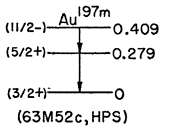
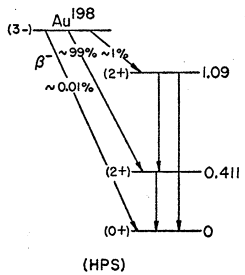
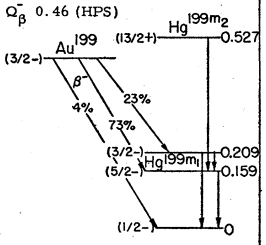
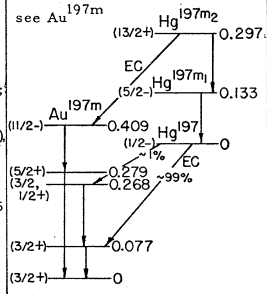
$_{79}Au^{196}$	B chem, excit (12M37)		EC or IT (2W49c)	14.0 h (2W49c); 13 h (12M37)				Au-n-2n (12M37, 2W49c); spall U (?) (6F51)
Au^{196}	A chem, excit (12M37)		EC ~95%, β^- ~5% (82S49); EC ~80%, β^- ~20% (2W49c)	5.55 d (2W49c); 5.60 d (82S49)	β^-: 0.27 spect (106S52); 0.30 spect (82S49); 0.34 abs (2W49c)	with EC: 0.332, 0.354 spect conv (106S52); 0.330 (K/L 1.7), 0.358 (K/L 1.7) spect conv (82S49); with β^-: 0.426 (e_L/γ 0.007, L/M+N 3.5), no 0.175 γ spect conv, β-conv coinc (106S52); 0.175 spect conv (82S49)	 (106S52, 82S52, HPS)	Pt-d-n (9K41b, 2W49c, 106S52); Pt-p-n (82S49); Au-n-2n (12M37, 2W49c); Au-γ-n (25W48); spall U (?) (6F51)
Au^{197m}	A excit (37W45a)		IT (37W45a)	7.4 s (40F47); 7.5 s (37W45a)		0.130 ($e_K/\gamma \leq 2.0$, K/L/M ≈ 1/7.5/3.6), 0.279 (e_K/γ ~0.3) spect conv (63M52c); 0.273 spect conv, conv-conv coinc (34H48a); 0.275 scint spect (24C52); 0.25 abs conv (37W45a)	 (63M52c, HPS)	Au-γ-γ (37W45a); Au-n-n (37W45a, 40F47); daughter 25 h Hg^{197} (40F47)
Au^{197}		100 (1D35a)					Au^{197}, I = 3/2 (87M50)	
Au^{198}	A chem, n-capt (12A35, 12M37)		β^- (12M37); no EC (lim 0.2%) (38M52); no EC (lim 0.4%) (25R49); no β^+ (lim 0.003%) (41M51)	2.69 d (57S49, 9S49b); 2.73 d (38S51, 33D46); 2.66 d (69C51)	β_1 0.963 spect (average of 9S48, 2L49a, 10L49, 82S49, 107S49, 4E51); β_2 0.290 (coinc with 0.680 γ) β-γ coinc spect (48B51a); β_3 1.37 (0.01%) spect (4E51)	γ_1 0.41177 cryst spect (100M52, 34D48); γ_1 0.4116 spect (29L51); γ_1 (e_K/γ 0.031, K/L 3.1, L/M 3.3) spect conv (50S52); γ_1 (e_K/γ 0.03, K/L 3, L/M 3.3) spect, spect conv (7S49e); γ_1 (e_K/γ 0.029, K/L 2.1, L/M 4.3) spect conv (82S49); γ_1 (e_K/γ 0.026, K/L 2.2, L/M 4) spect conv (107S49); γ_1 (e_K/γ 0.03, K/L+M 2.3) spect conv (29F52); γ_1 (L_{II}/L_{III} 2.5) spect conv (63M52a); γ_2 0.676 (0.5%, e_K/γ 0.034, K/L 5.7), γ_3 1.088 (0.1%, e_K/γ 0.005, K/L 6.3) spect, spect conv (4E51, 4E51a, 6W52); γ_2 0.680 (1%, coinc with 0.411 γ and 0.29 β^-), γ_3 1.09 (~0.2%) scint spect, β-γ coinc (48B51a); γ_2 0.673 (1.4%), γ_3 1.08 (0.3%) spect (57H51b); γ_2 0.67 (1.4%, coinc with 0.411 γ), γ_3 1.09 (0.3%) scint spect, γ-γ coinc (69C51a, 69C51); others (18P50a, 2L48, 2L49a, 9S49b, 31A50a, 12H50, 38T49, 4F44, 72C42, 7S47g, 15J48, 25R48, 52M51)	Q_β^- 1.374 (HPS)  (HPS)	Au-n-γ (12A35, 12M37, 1P37, 16D41, 2S47, 50H51); Au-d-p (9K41c); Hg-n-p (28S41); Pt-p-n (82S49, 82S48); spall U (6O48)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{79}Au^{199}$	A chem, genet (12M37)		β^- (9K41b)	3.15 d (8B52b); 3.2 d (104S52); 3.3 d (12M37)	0.460, 0.297 (coinc with 0.158 γ), 0.250 (coinc with 0.207 γ) β-γ spect coinc (8B52a); ~0.47 β^- (not coinc with γ) β-γ coinc (1I53); 0.47 (~4%), 0.30, 0.25 spect (108S51); 0.443 (~7%), 0.291 spect (104S52); 0.32 spect (86B49a); abs (37M49); others (26M48e, 9K41b)	γ_1 0.050 (e_L/γ 6), γ_2 0.159 (e_K/γ 0.19, K/L 0.6), γ_3 0.209 (e_K/γ 0.54, K/L 5.4) ($\gamma_1/\gamma_2/\gamma_3 \approx$ 0.84/100/23.8) spect, spect conv, γ-γ coinc (108S51); γ_1 (coinc with γ_2), γ_3 (not coinc with γ_1 or γ_2) scint spect, γ-γ coinc (1I53); 0.050, 0.158 (e_K/γ 0.24, K/L 0.73, L/M 3.3), 0.208 (e_K/γ 0.62, K/L ~5.6, L/M ~4) spect, spect conv, scint spect, γ-γ, β-γ coinc (7S51); 0.0498, 0.159 (K/L 0.56, L/M 3.6), 0.208 (K/L 4.5) spect conv (10C52a); others (104S52, 86B49a, 37M49, 26M48e, 67H50, 67H50a, 63M52a, 4B49, 34H51, 10C50g)	see Tl^{199}, Hg^{199} Q^-_β 0.46 (HPS)  (108S51, 104S52, 18G52)	Pt-d-n (9K41b); Au-n-γ (second order reaction) (67H50a); Hg-n-p (28S41); daughter Pt^{199} (12M37, 86B49a, 37M49, 67H50); parent Hg^{199m_1} (14G51a, 8B52a)
Au^{200}	B chem (28S41); chem, sep isotopes, excit (65B52a)		β^- (28S41)	48 m (65B52a, 28S41)	2.2 abs (65B52a); ~2.5 abs (28S41)	1.13, 0.39 scint spect (65B52a)		Hg-n-p (28S41, 3M42); Hg^{201}-γ-p (65B52a); Tl-n-α (3M42)
Au^{201}	B chem, excit, sep isotopes (65B50, 65B52a)		β^- (65B52a)	26 m (65B52a)	1.5 abs (65B52a)	0.55 scint spect (65B52a)		Hg-γ-p (65B50); Hg^{202}-γ-p (65B52a)
$Au^{202,204}$	E excit (65B52a)		β^- or IT (65B52a)	25 s (65B52a)				Hg-n-p (65B52a)
Au^{203}	B chem, excit, sep isotopes (65B52a)		β^- (65B52a)	55 s (65B52a)	1.9 abs (65B52a)	0.69 scint spect (65B52a)		Hg-n-pn (65B52a); Hg^{204}-γ-p (65B52a)
$_{80}Hg^{<195}$	E chem (3T49)		α (3T49)	0.7 m (42R52)	α: 5.60 ion ch (42R52)			spall Au (3T49)
Hg^{189}	D chem, excit (42T52)			30 m (42T52)				spall Au (42T52)
Hg^{190}	D chem, excit (42T52)			90 m (42T52)				spall Au (42T52)
Hg^{191}	D chem, excit (90M52)		EC (90M52)	12.4 h (90M52)				spall Au, parent Au^{191} (90M52)
Hg^{192}	D chem, excit (33F52, 90M52)		EC (90M52); β^+ (33F52)	5.7 h (33F52); 8.4 h (90M52)	1.18 spect (33F52)	1.4 abs (33F52)		spall Au (90M52, 33F52); parent Au^{192} (33F52, 42T52)
Hg^{193}	B chem, excit (33F52, 90M52)		EC (33F52)	10.0 h (33F52); 14.5 h (?), 29.0 h (?) (90M52)				Au-p-5n (33F52, 90M52); parent Au^{193} (33F52, 90M52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{80}Hg^{195m}$	B chem, excit (30D52, 33F52)		EC, IT (30D52)	38 h (30D52); ~31 h (33F52); 40 h (34H52a)		0.036, 0.056 (coinc with Au^{195m}), 0.122, 0.259 (coinc with Au^{195m}) spect conv (34H52a); 0.037, 0.056, 0.122 (conv in Hg), 0.206, 0.261, 0.318, 0.558 spect conv (30D52)		Au-d-4n (34H52a); Au-p-3n (30D52, 33F52); parent Au^{195} (30D52); parent Au^{195m} (34H52a)
Hg^{195}	B chem, excit (30D52)		EC (30D52)	9.5 h (30D52, 34H52a)		0.061, 0.179, 0.600, 0.780 spect conv (90M52); 0.061, 0.179 spect conv (34H52a)		Au-p-3n (30D52)
Hg^{196}		0.146 (6N50a)						
Hg^{197m_2}	A n-capt (17A36a); chem (12M37); chem, excit, cross bomb (16W41, 23F43)		IT 97%, EC 3% (104S52)	23 h (23F43, 34H51); 25 h (12M37)		with IT: 0.133 (e_K/γ 0.5, K/L/M+N ≈ 1.0/2.4/0.8), 0.164 (e_K/γ 4.6, K/L/M+N ≈ 1.0/2.3/1.2) spect conv, γ-γ coinc (40F50, 34H51); 0.134 (K/L <0.1), 0.165 (K/L ~0.25) spect conv (10C52b); 0.134 ($L_I/L_{II}/L_{III}$ ≈ 0.05/1.1/1.0), 0.165 ($L_I/L_{II}/L_{III}$ ≈ 1.0/<0.1/1.5) spect conv (63M52c); with EC: 0.191 (e_K/γ ~1.7, K/L ~6), 0.275 (weak, e_K/γ ~0.5, K/L ~5) spect conv, γ-γ coinc (40F50, 34H51); others (2H42a, 6V41b, 34H48a, 40F47, 40F50a)	see Au^{197m}  (63M52c, 104S52, HPS)	Pt-α-n (28S41); Au-d-2n (16W41, 9K41c, 23F43); Hg-n-2n (12M37, 23F43, 16W41); Hg-n-γ (17A36a, 16W41, 23F43); Hg-d-p (9K40); parent (3%) Au^{197m} (40F50, 104S52); parent Hg^{197m_1} (20D50, 52M50c)
Hg^{197m_1}	A genet (52M50c, 20D50)		IT (52M50c, 20D50)	7.0×10^{-9} s delay coinc (52M50c); 8×10^{-9} s delay coinc (20D50)		0.13 scint spect (20D50)		daughter Hg^{197m_2} (20D50, 52M50c)
Hg^{197}	A chem, excit, cross bomb (16W41, 23F43)		EC (23F43)	65 h (34H51); 66 h (10C52b); 64 h (23F43)		0.077 (e_L/γ 2.5, L/M 3.6), 0.191 (e_K/γ ~1.7, K/L ~6) spect conv, γ-γ coinc (34H51, 40F50); 0.077 ($L_I/L_{II}/L_{III}$ ≈ 1.0/0.45/0.34) spect conv (63M52c); 0.078 (L_I/M 4), 0.191 (K/L ~9) spect conv (10C52b); 0.077, 0.278 spect conv (30D52); others (2H42a, 40F47, 34H48a)		Au-d-2n (23F43, 16W41); Hg-n-2n (23F43, 16W41); Hg-n-γ (23F43, 16W41)
Hg^{198}		10.02 (6N50a)					Hg^{198}, I = 0 (87M50)	

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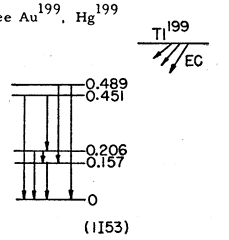
$_{80}Hg^{199m_2}$	A chem, excit (6H37, 12M37); mass spect (67B49b)		IT (23F43)	44 m (15H47a, 60M48); 43 m (12M37, 6H37)		0 155 (e/γ 0. 25, K/L <0. 4), 0. 368 (e/γ >11, K/L 1. 6) spect conv (15H48a); 0. 159 (L_{II}/L_{III} 1. 6) spect conv (63M52a); 0. 16 γ (coinc with 0. 37 γ) scint spect, γ-γ coinc (1I53); others (15H47a, 37M49)	see Au^{199}, Tl^{199}	Pt-α-n (28S41); Hg-n-2n (12M37, 1P37, 6H37, 67B49b); Hg-n-n (23F43, 16W41, 67B49b); Hg-d-p (9K40); Hg-γ-n (60M48, 37W45a); Hg-γ-γ (16W41)
Hg^{199m_1}	A genet (14G51a)		IT (14G51a)	2.4×10^{-9} s delay coinc (8B52a)		0. 158 spect conv, β-γ coinc (14G51a, 8B52a)		daughter Au^{199} (14G51a, 8B52a)
Hg^{199}		16. 84 (6N50a)					Hg^{199}, I = 1/2 (87M50)	
Hg^{200}		23. 13 (6N50a)					Hg^{200}, I = 0 (87M50)	
Hg^{201}		13 22 (6N50a)					Hg^{201}, I = 3/2 (87M50)	
Hg^{202}		29 80 (6N50a)					Hg^{202}, I = 0 (87M50)	
Hg^{203}	A excit (9K40); chem, excit, n-capt (16W41, 23F43); mass spect (5S49a, 67B49a)		β^- (23F43)	47. 9 d (10C52b); 45. 9 d (33W51a); 46. 5 d (35L51a); 43. 5 d (9S48b)	0. 208 β-γ coinc spect (5S49, 5S49a); 0. 210 spect (33W51a); 0. 205 spect (9S48b); others (37W47)	0. 279 (e/γ 0. 27, K/L 3) spect, spect conv, β-γ coinc (5S49, 5S49a, 12H50); 0. 278 (e_K/γ 0. 19, K/L+M 3. 7) spect, spect conv (33W51a); ~0. 28 (e_K/γ 0. 23) scint spect (80H52); 0. 279 (K/L ~10) spect conv (10C52b); 0. 286 (e/γ 0. 3, K/L 3) spect conv (9S48b); others (43M46, 11B50, 4B49, 100B50, 20D50, 52M51)	Q^-_β 0. 487 (5S49, 5S49a) see Pb^{203}	Hg-n-γ (23F43, 16W41, 3I47h, 2S47); Hg-n-2n (16W41, 28S41, 23F43); Hg-d-p (9K40); Hg^{202}-n-γ (35L51a); Tl-n-p (3M42)
Hg^{204}		6. 85 (6N50a)					Hg^{204}, I = 0 (87M50)	
Hg^{205}	A n-capt, excit (9K40, 9K42); sep isotopes, n-capt (35L51a)		β^- (9K40)	5. 5 m (3M42, 9K40); 5. 6 m (35L51a)	1. 8 abs (35L51a); 1. 6 abs (9K40)			Hg-d-p (9K40, 9K42); Hg-n-γ (23F43, 16W41, 2S47); Hg^{204}-n-γ (35L51a); Tl-n-p (3M42); Pb-n-α (3M42)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
81 Tl^{198}	B chem, excit (7O49)		EC (7O49)	1.8 h (7O49)	conv: ~0.4 abs (7O49)	several γ's, abs (7O49)		Au-α-3n (7O49); daughter Pb^{198} (4N50)
Tl^{199}	A chem (9K40); chem, excit (7O49); genet (energy levels Hg^{199}) (1I53)		EC (7O49); no β^+ (1I51)	7 h (7O49)		0.049, 0.078, 0.103, 0.157, 0.206, 0.245, 0.332, 0.454, 0.490 spect conv, γ-γ coinc (1I51, 1I53)	see Au^{199}, Hg^{199}  (1I53)	Au-α-2n (7O49, 1I51); Hg-d-2n (9K40); daughter Pb^{199} (4N50)
Tl^{200}	A chem, excit (7O49)		EC (7O49); no β^+ (1I51)	27 h (7O49)		0.365, 0.577, 0.622, 0.829, 1.210, 1.360 spect conv (1I51); ~0.4, 1.6 abs (4N50)		Au-α-n (7O49, 1I51); Hg-d-2n (9K40); daughter Pb^{200} (4N50)
Tl^{201}	B chem, excit, cross bomb (4N50)		EC (4N50)	72 h (4N50)		0.210 spect conv, abs (4N50)		Au-α-γ (1I2S51); Hg-d-2n (9K40); daughter Pb^{201} (4N50)
Tl^{202}	A chem, excit (9K40, 5F41)		EC (9K40, 3M42); EC (L/K ~1), no β^+ or β^- (2W50)	12.5 d (80M52); 11.5 d (2W50); 11.8 d (5F41)		0.435 spect conv, abs (2W50); 0.431 scint spect (80M52)		Hg-d-2n (9K40, 2W50); Tl-n-2n (9K40, 5F41, 3M42, 80M52)
Tl^{203}		29.50 (1B50)					Tl^{203}, I = 1/2 (87M50)	
Tl^{204}	B chem, n-capt (5F40)		β^- ~98%, EC ~2% (33L52); β^- ~98.5%, EC ~1.5% (38M52)	3.5 y (5F41); 2.7 y (3V45)	0.765 spect (33L52); 0.760 scint spect (38M52); 0.783 spect (9S49); 0.77 spect (6P47); others (4H47a, 5F41, 6E50)	no γ (lim 0.01%) (38M52a); no γ (lim 0.5%) (6E50); no γ (5F41); Hg K-x (33L52, 14M52a)	Q^-_β 0.77 (13S53)	Tl-n-γ (5F40, 2S47); Tl-γ-n (7H49); Tl-d-p (9K40, 5F41)
Tl^{205}		70.50 (1B50)					Tl^{205}, I = 1/2 (87M50)	
Tl^{206}	A n-capt (4P35); chem, genet (7B47); excit, sep isotopes (4N50a)		β^- (5F40, 9K42)	4.19 m (3S52); 4.23 m (5F40); 4.3 m (13A51)	1.51 spect (13A51); 1.65 abs (5F41); 1.8 abs (9K40); no conv (13A51)	no γ (5F40, 7B47, 13A51)	Q^-_β 1.51 (13A51)	Tl-n-γ (4P35, 1P37, 6H37); Tl^{205}-n-γ (4N50a); Tl-d-p (5F40, 9K40); daughter Bi^{210} (RaE) (7B47); daughter (long-lived) Bi^{210} (4N50a)
Tl^{207} (AcC'')	A chem, genet (1C31)		β^-	4.79 m (3S52); 4.77 m (5F40); 4.76 m (1C31, 3S39)	1.44 abs (6E50); 1.47 abs (3S39a); 1.6 abs (6L38)	0.870 (~0.5%) (11S41)	Q^-_β 1.44 (13S53)	Pb-n-p (6B40); Pb-γ-p (10B46); natural source, daughter Bi^{211} (AcC)

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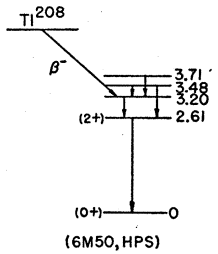
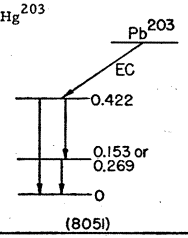
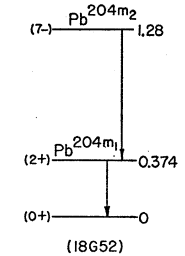
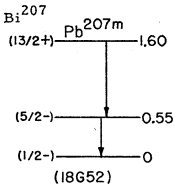
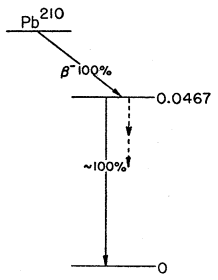
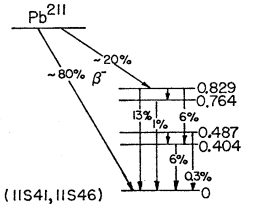
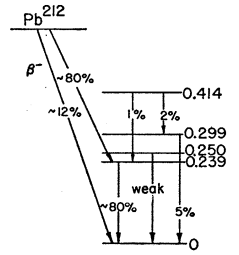
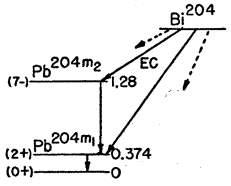
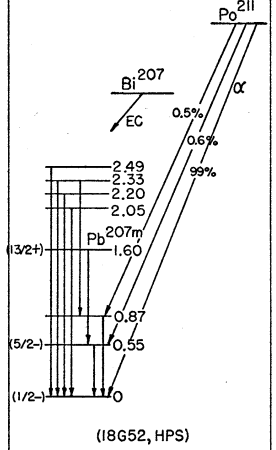
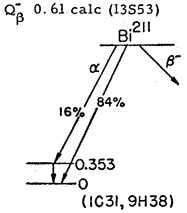
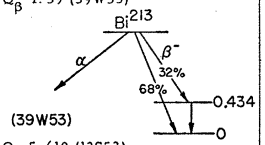
$_{81}Tl^{208}$ (ThC'')	A chem, genet (1C31)		β^-	3.1 m (1C31)	1.792 spect (6M48); 1.795 spect (14H34); 1.805 spect, β-γ coinc (4F48); 1.72 spect (7S47); 1.82 abs (3S33); β^- >1.792 (?) (<1%) spect (6M48)	2.62 (~100%, e/γ ~0.002), 0.859 (~15%, e/γ ~0.02), 0.582 (~80%, e/γ ~0.02), 0.510 (~25%, e/γ ~0.08), 0.277 (~10%, e/γ ~0.3) spect, spect conv (6M50); 2.6143 spect (49L52); 0.51085 spect (49L51); 2.6147 spect conv (110B51); 2.616, 0.510 spect (12H51); 2.615 spect (6W50); 2.58 (100%), 0.575 (100%), 0.51 (50%) spect (2J47); 2.62, 0.582, 0.510, 0.277 spect conv (8E32); 2.62, 0.868, 0.581, 0.502 spect (8B48); 2.62 scint spect (11B50); no 3.2 γ (8B48, 9B50)	Q^-_β 4.99 (13S53)  (6M50, HPS)	natural source, daughter Bi^{212} (ThC)
Tl^{209}	A chem, genet (4H50)		β^- (4H50)	2.2 m (4H50)	1.99 spect (39W53); 1.8 abs (4H50)	0.12 scint spect (39W53)	Q^-_β 3.92 calc (13S53)	daughter Bi^{213}, parent Pb^{209} (4H47, 11E47)
Tl^{210} (RaC'')	A chem, genet (1C31)		β^-	1.32 m (1C31); 1.5 m (9B50); ~1.3 m (8D37)	1.8 cl ch (6L38); 2.0 abs (8D37)	no γ >2.8, D-γ-p reaction (9B50)	Q^-_β 5.39 calc (13S53)	natural source, daughter Bi^{214} (RaC), parent Pb^{210} (RaD)
$_{82}Pb^{198}$	B chem, genet (7K51)		EC (7K51)	25 m (7K51)				Tl-p-6n (7K51); parent Tl^{198} (7K51, 4N50); daughter Bi^{198} (4N50)
Pb^{199}	B chem, genet (4N50)		EC (4N50)	~80 m (4N50)				daughter Bi^{199}, parent Tl^{199} (4N50)
Pb^{200}	A chem, genet (4N50)		EC (4N50)	18 h (4N50)		0.139, 0.320 spect conv (8O51)		daughter Bi^{200}, parent Tl^{200} (4N50)
Pb^{201m}	D chem, excit (89H52)		IT (89H52)	50 s (89H52)		0.25, 0.42, 0.67 scint spect (89H52)		Tl-p-3n (89H52)
Pb^{201}	B chem (5H46); chem, genet (4N50)		EC (4N50)	8 h (4N50)				Tl-d-4n (5H46); daughter Bi^{201}, parent Tl^{201} (4N50)
Pb^{202m}	E excit (89H52)		IT (89H52)	5.6 s (89H52)		0.89 scint spect (89H52)		Tl-p-2n (89H52)
Pb^{202}		$<4 \times 10^{-4}$ (9D49)		>500 y genet, yield (2T47, 4N50)				Tl-d (2T47)
Pb^{203}	B chem, excit (3M42); chem, excit, cross bomb (2T47)		EC (3M42, 8O51)	52 h (5F40, 2T47); 54 h (9K40, 12D42)		0.153, 0.269, 0.422 spect conv (8O51); 0.270, 0.420 abs conv (3M42); 0.270, ~0.470 spect, spect conv (9L44)	see Hg^{203}  (8O51)	Tl-d-2n (5F40, 9K40, 5F41, 2T47); Tl-p-n (12D42); Pb-n-2n (3M42); Pb^{204}-n-2n (2T47); Pb-γ-n (10B46)

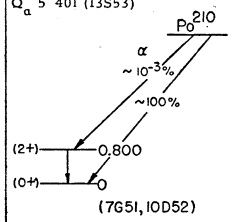
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{82}Pb^{204m_2}$	B chem (5F41); chem, excit, genet (2T47, 7K51)		IT (3M42)	68 m (3M42); 65 m (5F41)		0.905 (e/γ ~0.1, K/L 1.5), 0.374 (with Pb^{204m_1}, e/γ ~0.05, K/L 2.1) spect conv, abs conv, abs (14S50); 0.90 abs conv (3M42); 1.1 abs conv, abs (5F41)	see Bi^{204} 	Tl-d-n (5F41); Tl-d-3n (2T47); Pb-n-n (7D39, 3M42); Pb-γ-2n (10B46); daughter Bi^{204} (2T47, 14S50, 7K51), ~4% (2T47); parent Pb^{204m_1} (14S50)
Pb^{204m_1}	B genet (14S50)		IT (14S50)	3×10^{-7} s delay coinc (14S50)		0.374 (see γ's of Pb^{204m_2})		daughter Pb^{204m_2} (14S50); daughter Bi^{204} (14S52b)
Pb^{204}		1.48 (6N38)					Pb^{204}, I = 0 (87M50)	
Pb^{206}		23.6 (6N38)					Pb^{206}, I = 0 (87M50)	
Pb^{207m}	A excit, sep isotopes (24C51); chem, genet (23F52c)		IT (24C50)	0.84 s (24C52); 0.82 s (51L51); 0.80 s (89H52)		0.55, 1.05 scint spect (24C51); 0.5, 1.1 scint spect (23F52c)	see Bi^{207} 	Pb^{207}-n-n (24C51); Pb-n-n (51L51); daughter Bi^{207} (23F52c); not daughter Po^{211} (lim 0.005%) (23F52a)
Pb^{207}		22.6 (6N38)					Pb^{207}, I = 1/2 (87M50)	
Pb^{208}		52.3 (6N38)					Pb^{208}, I = 0 (87M50)	
Pb^{209}	A chem (6T37, 9K40); chem, sep isotopes (5F41a)		β^- (9K40, 5F41)	3.22 h (5F41); 2.75 h (9K40)	0.635 spect (47W52a); 0.620 spect (39W53); 0.68 spect (11R47); others (9K40, 5F41, 19L44)	no γ, no conv (4W44, 47W52a); no γ (19L44, 39W53)	Q^-_β 0.64 (13S53)	Pb-d-p (6T37, 9K40, 5F41, 5F41a, 9K42, 3H50); Pb-n-γ (3M42); Bi-d-2p (11ZS51); Bi-n-p (3M42); daughter Po^{213} (4H47, 11E47, 11M49); daughter Tl^{209} (11E47, 4H47)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev		Disintegration energy and scheme	Method of production and genetic relationships
					Particles	Gamma-transitions		
$_{82}Pb^{210}$ (RaD)	A chem, genet (1C31)		β^-	22 y (1C31)	0.018 ion ch (5I52); 0.018 scint spect, β-γ coinc (87B52a); 0.017 ($\lesssim$90%), 0.056 ($\gtrsim$10%) ion ch (33J52); others (8L39, 12S46)	γ_1 0.0465, no other γ between 0.016 and 0.060 (lim ~2% of γ_1) cryst spect (26E52); γ_1 0.0467, no other γ (lim 5% of γ_1) cryst spect (88B52a); 0.0467 (3.5%) spect conv, abs (24B30, 8S31, 19G32, 6D33); γ_1 (e_L/γ ~16, $L_I/L_{II}/L_{III}/M \approx 1.0/0.09/0.019/0.29$) spect conv (6C50); γ_1 (e/γ ~23) spect conv (33L51); γ_1 (e/γ ~17, using γ = 3.5%) spect conv (14B51); 0.032, 0.037, 0.0467 cryst spect (8F52); 0.065 (<0.2%), 0.0467 (2.8%), 0.043 (0.2%), 0.037 (0.2%), 0.032 (0.4%), 0.023 (~1%), 0.007 (~10%) cryst spect, cl ch, abs (9T46); others (9T43, 10C51, 4T52a, 63C52, 35C52)	Q^-_β 0.065 (5I52)  (26E52, HPS)	natural source, daughter Tl^{210} (RaC''), daughter Po^{214} (RaC'), parent Bi^{210} (RaE)
Pb^{211} (AcB)	A chem, genet (1C31)		β^-	36.1 m (3S39); 36.0 m (1C31)	1.39 (~80%), ~0.5 (~20%) abs (3S39a)	0.065, 0.083, 0.404, 0.425, 0.487, 0.764, 0.829 spect, spect conv, abs (11S42); 0.829 (5%) (54M44); 0.8 abs (3S39a)	Q^-_β 1.4 (13S53)  (11S41, 11S46)	natural source, daughter Po^{215} (AcA), parent Bi^{211} (AcC)
Pb^{212} (ThB)	A chem, genet (1C31)		β^-	10.6 h (1C31)	0.355, 0.589 spect, β-γ coinc (4F48); 0.331, 0.569 (~12%) spect (6M48a); 0.340 spect (6G49); 0.36 spect (3S33)	γ_3 0.2386 spect conv (49L51); γ_1 0.115, γ_2 0.176, γ_3 0.238, γ_4 0.249, γ_5 0.299 spect conv (8E32); γ_3 0.238 (~40%), γ_5 0.300 (~4%) spect (6M50); γ_3 (L_I/L_{II} ~18, M_I/M_{II} ~4.3) spect conv (117S52); γ_3 (e/γ ~1), γ_5 (e/γ ~0.3) (calc from 9F39, 6M48a, 6M50); γ_3 0.238 spect (7S44)	Q^-_β 0.58 (13S53)  (11S46, 4F48, 6M48a)	natural source, daughter Po^{216} (ThA), parent Bi^{212} (ThC)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{82}Pb^{214}$ (RaB)	A chem, genet (1C31)		β^- (3S33, 7R36)	26.8 m (1C31)	0.65 spect (3S33); 0.72 spect (8C41)	γ_1 0.05323, γ_2 0.24192, γ_4 0.29522, γ_5 0.35199 ($\gamma_2/\gamma_4/\gamma_5$ ≈ 0.2/0.55/1.0) cryst spect (100M52); γ_1 0.0528, γ_2 0.2410, γ_3 0.2578, γ_4 0.2942, γ_5 0.3509 spect (7S44); γ_1 (1.6%) crit abs (9T43a); γ_2 (K/L_I ~6.7), γ_4 (K/L_I ~6.7), γ_5 (K/L_I ~5.9) spect conv (59K51); 0.053, 0.241, 0.257, 0.294, 0.350 spect (8E34); 0.053, 0.242, 0.295, 0.351 spect conv (10C51)		natural source, daughter Po^{218} (RaA), parent Bi^{214} (RaC)
$_{83}Bi^{<198}$	E (2T48); chem (4N50)		α (2T48)	1.7 m (4N50)	6.2 ion ch (4N50)			spall Pb (2T48, 4N50)
Bi^{198}	B chem (2T48); chem, genet (4N50)		EC 99+%, α 5×10^{-2}% (4N50)	7 m genet (4N50)	5.83 ion ch (4N50)			spall Pb (2T48, 4N50); parent Pb^{198} (4N50)
Bi^{199}	B chem (2T48); chem, genet (4N50)		EC 99+%, α 10^{-2}% (4N50)	~25 m genet (4N50)	5.47 ion ch, abs mica (4N50)			spall Pb (4N50, 2T48); parent Pb^{199} (4N50)
Bi^{200}	B chem, genet (4N50)		EC (4N50)	35 m genet (4N50)				spall Pb, parent Pb^{200} (4N50)
Bi^{201}	B chem (2T48); chem, genet (4N50)		EC 99+%, α 3×10^{-3}% (4N50)	62 m (4N50)	5.15 ion ch (4N50)			spall Pb (2T48, 4N50); parent Pb^{201} (4N50)
Bi^{201}	B chem, genet (4N50)		EC (4N50)	~2 h genet (4N50)				spall Pb, parent Pb^{201} (4N50)
Bi^{202}	B chem, genet (7K51)		EC (7K51)	95 m (7K51)				daughter Po^{202} (7K51)
Bi^{203}	B chem, genet (4N50)		EC (4N50); α ~10^{-5}% (15D52a)	12 h genet (4N50)	α: 4.85 range emuls (15D52a)			spall Pb, parent Pb^{203} (4N50); daughter Po^{203} (7K51)
Bi^{204}	B chem, sep isotopes, cross bomb (2T47)		EC, no β^+ (2T47)	12 h (2T47)	conv: ~0.2, ~0.8 (weak), abs, spect (2T47)	0.217 spect conv (14S50a)	 (18G52, HPS)	Pb^{204}-d-2n (2T47); Pb-d-2n (14S50); daughter Po^{204} (7K51); Tl-α-3n, parent (~4%) Pb^{204m_2} (2T47); parent Pb^{204m_1} (14S52b)
Bi^{205}	B chem, genet, sep isotopes (7K51)		EC (7K51)	14.5 d (7K51)		0.431, 0.527, 0.550, 0.746, 1.84 spect conv (7K51)		daughter Po^{205} (7K51); daughter At^{209} (12B51)

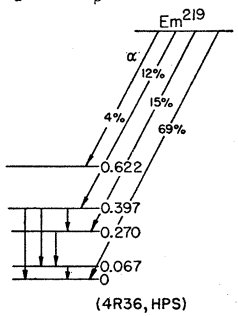
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{83}Bi^{206}$	B chem, sep isotopes (5F41a, 2T47)		EC (9L44); EC, no β^+ (13A51a)	6.4 d (9K40)		0.182, 0.234, 0.260, 0.341, 0.396, 0.470, 0.505, 0.536, 0.590, 0.803, 0.880, 0.889, 1.020, 1.097, 1.720 spect, spect conv, γ-γ coinc (13A51a); others (9K40, 5F41, 2T47a)		Tl-α-3n (2T47); Pb-d-2n (5F41, 5F41a, 9K40, 13A51a); Pb^{207}-d-3n (2T47); Pb^{206}-d-2n (5F41a); daughter Po^{206} (2T47a); daughter At^{210} (4N50b)
Bi^{207}	B chem, genet (4N51)		EC (5G50, 4N51)	~50 y genet (4N51)		0.56, 1.1 (coinc with 0.56 γ) scint spect, γ-γ coinc (7G51a); 0.064 or 0.137, 0.565, 1.063, 1.46, 2.05, 2.20, 2.33, 2.49 spect conv (4N51); with Pb^{207m}: 0.5, 1.1 scint spect (23F52c)	 (18G52, HPS)	Pb-d-3n (4N51); daughter At^{211} (4N51); parent Pb^{207m} (23F52c)
Bi^{208}	F chem (4N51)		EC (4N51)	long (4N51)		no γ (?) (4N51)	Q_α 3.2 calc (13S53)	Pb-d-2n (4N51)
Bi^{209}		100 (6N38b)					Bi^{209}, I = 9/2 (87M50) Q_α 3.2 calc (13S53)	
Bi^{209}	G α's not seen (91H52)		α (7F51)	>>10^{17} y sp act (91H52); 3 x 10^{17} y sp act (7F51)	~3.15 range emulsion (7F51)			
Bi^{210} (RaE)	A chem, genet (1C31)		β^- 99+%, α 5 x 10^{-5}% (7B47)	5.02 d (111B52); 4.85 d (7S47f); 5.0 d (1C31); 5.1 d (15H45a)	β^-: 1.17 spect (10L37, 9F39a, 9N40, 2Z49, 10L49)	no γ (19G36, 6L47, 10C51)	Q_β^- 1.17, Q_α 5.06 calc (13S53)	natural source, daughter Pb^{210} (RaD), parent Po^{210} (RaF); parent Tl^{206} (7B47); Pb-d-γ (112S51); Pb-α-pn (2T47); Bi-d-p (12L36, 10C40, 47H40); Bi-n-γ (7M48, 2S47)
Bi^{210}	A chem, genet (4N50a); chem, mass spect (52L52)		α, β^- or IT (~0.3%) (52L52)	~10^6 y yield (52L52)	4.93 ion ch (52L52)		Q_α 5.03 (52L52)	Bi-n-γ, parent Tl^{206} (4N50a); parent Po^{210} (52L52)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{83}Bi^{211}$ (AcC)	A chem, genet (1C31)		α 99.68%, β^- 0.32% (1C31)	2.16 m (1C31)	α: 6.618 (84%), 6.272 (16%) spect (9H38, 1R31); 6.621 (82.6%), 6.274 (17.4%) spect (13V52)	0.350 abs (3S39a); ~0.35 ($e_K/\gamma \simeq 0.18$, K/L 5.5) (4T52b, 10F52); 0.354 abs (16H25)	Q_α 6.746 (13S53); Q^-_β 0.61 calc (13S53) 	natural source, daughter Pb^{211} (AcB), parent Po^{211} (AcC'), parent Tl^{207} (AcC'')
Bi^{212} (ThC)	A chem, genet (1C31)		β^- 66.3%, α 33.7% (6K38)	60.5 m (1C31)	α: 6.086 (27.2%), 6.047 (69.9%), 5.765 (1.7%), 5.622 (0.15%), 5.603 (1.1%), 5.481 (0.016%). spect (48R51); 6.082 (27%), 6.042 (70%), 5.760 (1.8%), 5.618 (0.2%), 5.599 (1.1%) spect (11L34); β^-: 2.250 spect (6M48a); 2.256 spect, β-γ coinc (4F48); others (7C48, 3S33)	with α: 0.040 (strong), 0.144, 0.164, 0.288, 0.328, 0.432, 0.452, 0.472, other γ's, spect, spect conv (11S37, 11S46); 0.040 (~4%) coinc abs (21K47); (e/γ ≥14 calc from 21K47, 9F39, 14B49); 0.295 spect conv (11?S52); with β^-: 2.20, 1.81 (~7%), 1.61 (~7%), 1.34 (~5%), 1.03 (~6%), 0.83 (~19%), 0.72 (~19%) spect (2J47) (intensities calc from 2J47); 0.726 (~6%, e/γ 0.015) spect (6M50); others (5L47)	Q_α 6.203, Q^-_β 2.25 (13S53)	natural source, daughter Pb^{212} (ThB), parent Po^{212} (ThC') and Tl^{208} (ThC'')
Bi^{213}	A chem, genet (11E47, 4H47)		β^- 98%, α 2% (11E47, 4H50a, 39W53)	47 m (4H47); 46 m (11E47)	β^-: 1.39 (68%), 0.959 (32%) spect (39W53); ~1.3 abs (4H47, 11E47); α: 5.86 ion ch (11E47); 6.0 ion ch (4H47)	0.434 spect conv, scint spect (39W53)	Q_α 5.97 (13S53); Q^-_β 1.39 (39W53) 	daughter At^{217}, parent Po^{213} (4H47, 11E47, 4H50a); parent Tl^{209} (4H50)
Bi^{214} (RaC)	A chem, genet (1C31)		β^- 99+%, α 0.04% (1C31)	19.7 m (1C31)	α: 5.505 (45%), 5.444 (55%) spect (11L34); 5.52 (37%), 5.47 (46%), 5.33 (17%) spect (7C48a); β^-: 3.17 (~23%), 1.65 (~77%) spect (8C41, 5L47); 3 15 spect, abs (3S33)	with β^-: γ_1 0.6094 cryst spect (100M52); γ_1 0.606 (K/L 5.6), γ_2 0.766, γ_3 0.933, γ_4 1.120 (K/L 6.7), γ_5 1.238 (K/L 5.9), γ_6 1.379, γ_7 1.520, γ_8 1.761 (K/L 6.7), γ_9 1.820, γ_{10} 2.200, γ_{11} 2.420 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5/\gamma_6/\gamma_7/\gamma_8/\gamma_9/\gamma_{10}/\gamma_{11} \simeq 9/1.3/1.1/2.6/1.0/0.9/0.7/3.2/0.2/1.00/0.5$) spect, spect conv (59K52, 5M50); 0.426, 0.498, 0.607, 0.766, 0.933, 1.120, 1.238, 1.379, 1.414, 1.761, 2.193 spect conv (8E34); 0.609, 0.769, 0.935, 1.122, 1.241, 1.419, 1.766 spect conv (10C51); with α: 0.0625, 0.191 spect conv (10C51); others (8E30, 8C41)	Q_α 5.610 (13S53); Q^-_β 3.17 (8C41)	natural source, daughter Pb^{214} (RaB), daughter At^{218}, parent Po^{214} (RaC'), parent Tl^{210} (RaC''); descendent Fr^{222} (8H51a)
Bi^{215}	A chem, genet (8H53)		β^- (8H53)	8 m (8H53)			Q^-_β 2.01 est (60G53)	natural source, daughter At^{219}, parent Po^{215} (8H53)

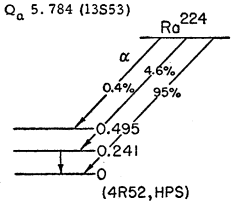
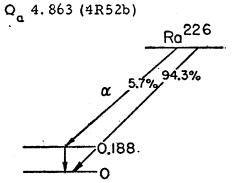
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{84}Po^{200}$	B chem, genet (7K51a)		EC, α (7K51a)	11 m (7K51a)	5.84 ion ch (7K51a)			Bi-p-10n, parent Bi^{200} (7K51a)
Po^{201}	B chem, genet (7K51a)		EC, α (7K51a)	18 m (7K51a)	5.70 ion ch (7K51a)			Bi-p-9n, parent Bi^{201} (7K51a)
Po^{202}	B chem, genet, excit (7K51)		EC, α (7K51)	52 m genet (7K51)	5 59 ion ch (7K51)			Bi-p-8n, Pb-α-spall, parent Bi^{202} (7K51)
Po^{203}	B chem, genet (7K51)		EC (7K51)	47 m genet (7K51)				Bi-p-7n, Pb-α-spall, parent Bi^{203} (7K51)
Po^{204}	B chem, genet (7K51)		EC ~99%, α ~1% (7K51)	3.8 h (7K51)	5 37 ion ch (7K51)			Bi-p-6n, Pb-α-spall, parent Bi^{204}, parent Pb^{200} (7K51)
Po^{205}	B chem, genet, sep isotopes, excit (7K51)		EC 99+%, α 0.074% (17H51a)	1 5 h genet (7K51)	5.2 ion ch (7K51a)			Pb^{204}-α-3n, parent Bi^{205} parent Pb^{201} (7K51)
Po^{206}	B chem, genet, sep isotopes (2T47a)		EC ~90%, α ~10% (2T47a)	9 d (2T47a)	5.218, 5.064 spect (4R52b); 5 21 ion ch (7K51a)	0.8 abs (2T47a)	$Q_α$ 5 321 (HPS)	Pb^{204}-α-2n, parent Bi^{206} (2T47a)
Po^{207}	B chem, excit, sep isotopes (2T47a)		EC 99+%, α ~10^{-2}% (2T47a)	5.7 h (2T47a)	5 10 ion ch (7K51a)	1 3 abs (2T47a)		Pb^{206}-α-3n (2T47a)
Po^{208}	A chem, excit, sep isotopes (2T47a)		α (2T47a)	2.93 y (2T50)	5.108 spect (4A52b); 5.109 spect (4R52b); 5.10 ion ch (7K51a)	no γ (2T47a, 18H51)	$Q_α$ 5.208, Q_{EC} 1.3 calc (13S53)	Pb^{206}-α-2n (2T47a); Pb^{207}-α-3n (2T47a); Bi-d-3n (2T47a, 10K49); Bi-p-2n (4L47); daughter Em^{212}, daughter 1.7 h At^{208} (8H50); daughter 7.0 h At^{208} (12B51)
Po^{209}	A chem, excit (10K49)		α ≥90%, EC ≤10% est (13P50)	~100 y yield (10K50)	4.877 spect (4A52b); 4 86 ion ch (7K51a)	0 87 (1%), 0.55 (0.5%), 0 2 (0.2%), 0 1 (0 07%) scint spect (18H51)	$Q_α$ 4 972 (13S53)	Bi-d-2n (10K49)
Po^{210}	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	138.3 d (5B49); 140 d (1C31)	5.298 spect (9H38, 16S51); 5.303 spect (7C46); ~4 5 (weak) α-γ coinc. scint spect (10D52)	$γ_1$ 0.800 (e/γ ~0.03, K/L 3 7) spect, spect conv (13A51a); $γ_1$ 0.804 scint spect (18P52); $γ_1$ 0 784 spect conv (10C51); $γ_1$ 0 773 spect (7S47a); $γ_1$ (1.8 x 10^{-3}%, e/γ ~0.07), no 0.08 γ ion ch, crit abs, γ-γ coinc (7G51); $γ_1$ (1.6 x 10^{-3}%) abs (3R52); 0.77 (~10^{-3}%), 0 084 (~10^{-3}%) abs (1Z48); others (10D47, 49R52, 63B52)	$Q_α$ 5 401 (13S53)  (7G51, 10D52)	natural source, daughter Bi^{210} (RaE); Pb^{208}-α-2n (2T47a); Bi-d-n (47H40, 10C40); Bi-p-γ (10K50); daughter At^{210} (10K49); daughter (long-lived) Bi^{210} (52L52)
Po^{211} (AcC')	A genet (1C31)		α; β stable (cons energy) (HPS)	0 52 s (13L51)	7.434 spect (11L34); 6.88 (0.50%), 6.56 (0.53%), no 6.34 α (lim 0 02%) spect (74H52a); 6 90 (0.6%), 6 57 (0.5%), 6.34 (0.1%) ion ch (4N51)		$Q_α$ 7.58 (13S53) see Bi^{207}	natural source, daughter Bi^{211} (AcC); daughter At^{211} (11C40, 11C40a); daughter Em^{215} (11M52); not parent Pb^{207m} (23F52a)
Po^{211}	D chem, excit, sep isotopes (114S51)		α (114S51)	25 s (114S51)	7.14 ion ch (114S51)			Pb^{208}-α-n (114S51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{84}Po^{212}$ (ThC')	A genet (1C31)		α	3.04 x 10^{-7} s delay coinc (4B49); 3.0 x 10^{-7} s delay coinc (11H48); others (3J48, 4V49, 11D39, 16B43)	8.776 spect (15B36, 9H38); long range α's: 10.536 (0.017%), 10.417 (0.002%), 9.489 (0.004%) spect (48R51)		$Q_α$ 8.946 (13S53)	natural source, daughter Bi^{212} (ThC); daughter Em^{216} (11M49)
Po^{213}	A genet (4H47, 11E47)		α (4H47, 11E47)	4.2 x 10^{-6} s delay coinc (3J48)	8.336 ion ch (11E47, 5C48); 8.34 ion ch (4H50a)		$Q_α$ 8.496 (13S53)	daughter Bi^{213}, parent Pb^{209} (4H47, 11E47); daughter Em^{217} (11M49)
Po^{214} (RaC')	A genet (1C31)		α; β stable (cons energy) (HPS)	1.637 x 10^{-4} s delay coinc (13D50); ~1.5 x 10^{-4} s delay coinc (11D39, 6R41, 5W42, 4J43, 14L47, 4B48); 1.4 x 10^{-4} s delay coinc (5R47)	7.680 spect (15B36, 9H38); 7.683 spect (16S51); long range α's: 9.069 (0.002%), others 8.280-10.509 spect (11L34)		$Q_α$ 7.826 (13S53)	natural source, daughter Bi^{214} (RaC), parent Pb^{210} (RaD); daughter Em^{218} (4S48)
Po^{215} (AcA)	A genet (1C31)		α 99+%, $β^-$ 5 x 10^{-4}% (5K44, 8A50)	1.83 x 10^{-3} s delay coinc (5W42)	7.365 spect (11L34)		$Q_α$ 7.505, $Q_{β^-}$ 0.8 calc (13S53)	natural source, daughter Em^{219} (An), parent Pb^{211} (AcB); parent At^{215} (5K44)
Po^{216} (ThA)	A genet (1C31)		α; β stable (cons energy) (HPS); α 99+%, $β^-$ 0.014% (5K43)	0.158 s (5W42)	α: 6.774 spect (15B36, 9H38)		$Q_α$ 6.902 (13S53)	natural source, daughter Em^{220} (Tn), parent Pb^{212} (ThB); parent At^{216} (5K43) (?)
Po^{217}	C genet (9M52b)		α (9M52b)		6.5 ion ch (9M52b)		$Q_α$ 6.7, $Q_{β^-}$ 1.3 est (13S53)	daughter Em^{221} (9M52b)
Po^{218} (RaA)	A chem, genet (1C31)		α 99+%, $β^-$ 0.03% (5K43a)	3.05 m (1C31)	α: 5.998 spect (15B36, 9H38)		$Q_α$ 6.110, $Q_{β^-}$ 0.33 calc (13S53)	natural source, daughter Em^{222} (Rn), parent Pb^{214} (RaB); parent At^{218} (5K43a)
$_{85}At^{<202}$	D chem, excit (12B51)		α, EC (12B51)	43 s (12B51)	6.50 ion ch (12B51)			Bi-α-spall (12B51)
$At^{<203}$	D chem, excit (12B51)		α, EC (12B51)	1.7 m (12B51)	6.35 ion ch (12B51)			Bi-α-spall (12B51)
At^{203}	D chem, excit (12B51)		α, EC (12B51)	7 m (12B51, 13H51)	6.10 ion ch (12B51)			Bi-α-10n (12B51); Au-C-6n (13H51, 4M50)
At^{204}	B chem, excit, genet (12B51)		EC (12B51)	~25 m genet (12B51)				Bi-α-9n, parent Po^{204} (12B51)
At^{205}	B chem, excit, genet (12B51)		α, EC (12B51)	25 m (12B51, 13H51)	5.90 ion ch (12B51)			Bi-α-8n, parent Po^{205} (12B51); Au-C-4n (4M50, 13H51)
At^{206}	B chem, excit, genet (12B51)		EC (12B51)	2.6 h genet (12B51)				Bi-α-7n, parent Po^{206} (12B51)

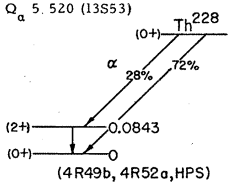
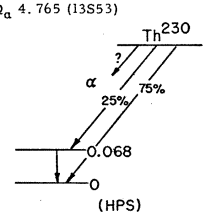
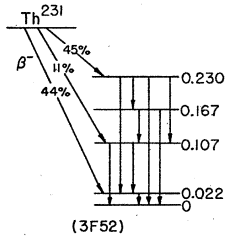
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{85}At^{207}$	B chem, excit, genet (2T48a, 12B51)		EC ~90%, α ~10% (2T48a, 12B51)	2.0 h (12B51)	5.75 ion ch (12B51)			Bi-α-6n (2T48a, 12B51); parent Po^{207}, parent Bi^{203} (12B51)
At^{208}	B chem, excit, genet (12B51)		EC (12B51)	6.3 h genet (12B51)				Bi-α-5n, parent Po^{208} (12B51)
At^{208}	A chem, genet (8H50)		EC 99+%, α 0.5%(8H50)	1.7 h (8H50)	5.65 ion ch (8H50)			daughter Fr^{212}, parent Po^{208} (8H50, 9M52a)
At^{209}	B chem, genet, excit (12B51)		EC ~95%, α ~5% (12B51)	5.5 h (12B51)	5.65 ion ch (12B51)	0.2, 0.8 scint spect (89M52)		Bi-α-4n, parent Po^{209}, parent Bi^{205} (12B51)
At^{210}	A chem, excit, genet (10K49)		EC 99+%, α 0.17% (74H52a); EC 99+%, α 0.1% (4N50b)	8.3 h (10K49)	5.519 (32%), 5.437 (31%), 5.355 (37%) spect (74H52a)	0.25, 1.15, 1.40 scint spect (74H52a); 1.0 abs, abs conv (10K49)		Bi-α-3n, parent Po^{210} (10K49, 12B51); parent Bi^{206} (4N50b)
At^{211}	A chem, excit, genet (11C40, 10K49)		α 40.9%, EC 59.1% (4N51)	7.5 h (11C40, 10K49); 7.3 h (17H51)	5.862 spect (74H52a); 5.89 ion ch (2T48a, 12B51)		Q_α 5.975, Q_{EC} 0.9 est (13S53)	Bi-α-2n (11C40, 11C40a, 10K49, 12B51); spall Th, U (20B52, 13S47)
At^{212}	E excit (7W48)		α (7W48)	0.25 s (7W48)				Bi-α-n (7W48)
At^{213}	E genet, decay charac (57K51)		α (57K51)		9.2 range emuls (57K51)			descendent Pa^{225} (57K51)
At^{214}	B genet (11M49)		α (11M49)	~2×10^{-6} s est (11M51)	8.78 ion ch (11M49, 11M51)		Q_α 8.95, Q_{EC} 1.05 calc (13S53)	daughter Fr^{218} (11M49, 11M51)
At^{215}	A genet (5K44, 13G48)		α (5K44, 13G48)	~10^{-4} s delay coinc (13G48, 11M51); short (5K44)	8.00 ion ch (13G48, 11M51); 8.4 ion ch (5K44)		Q_α 8.15, Q^-_β 0.0 calc (13S53)	daughter Fr^{219}, parent Bi^{211} (AcC) (13G48, 11M51); natural source, daughter Po^{215} (AcA), parent Bi^{211} (AcC) (5K44)
At^{216}	A genet (13G48)		α (5K43, 13G48)	~3×10^{-4} s delay coinc (11M49, 11M51); short (<54 s) (5K43)	7.79 ion ch (13G48, 11M51); 7.64 ion ch (5K43)		Q_α 7.94, Q^-_β 2.03 calc, Q_{EC} 0.46 calc (13S53)	daughter Fr^{220}, parent Bi^{212} (ThC) (13G48, 11M51); natural source, parent Bi^{212} (ThC) (5K43); daughter Po^{216} (ThA) (5K43); note Po^{216} β-stable (HPS)
At^{217}	A genet (11E47, 4H47)		α (11E47, 4H47)	0.018 s delay coinc (4H47, 4H50a); 0.021 s delay coinc (11E47)	7.02 ion ch (5C48); 7.00 ion ch (4H47)		Q_α 7.15, Q^-_β 0.65 calc (13S53)	daughter Fr^{221}, parent Bi^{213} (11E47, 4H47, 4H50a)
At^{218}	E genet (5K43a)		α (5K43a); α 99+%, β^- 0.1% (3W48)	1.5-2.0 s (3W48); several sec (?) (5K43a)	α: 6.63 range (5K43a); 6.7 ion ch (3W48)		Q_α 6.75, Q^-_β 2.67 calc (13S53)	natural source, daughter Po^{218} (RaA), parent Bi^{214} (RaC) (5K43a, 3W48)
At^{219}	A chem, genet (8H53)		α ~97%, β^- ~3% (8H53)	0.9 m (8H53)	α: 6.27 ion ch (8H53)		Q_α 6.39, Q^-_β 1.45 est (13S53)	natural source, daughter Fr^{223} (AcK), parent Em^{219} (An), parent Bi^{215} (8H53)

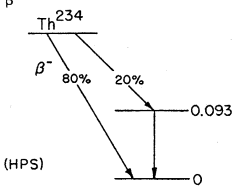
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{86}Em^{208}$	D chem (9M52b)		EC ~80%, α ~20% (9M52b)	23 m (9M52b)	6.138 spect (9M52)			spall Th (9M52b)
Em^{209}	B chem, genet (9M52a)		EC ~80%, α ~20% (9M52a)	30 m (9M52b)	6.02 ion ch (9M52a)			Pb-C-spall, spall Th (9M52a); daughter Ra^{213}, parent At^{209} (9M52a)
Em^{210}	B chem, genet (9M52a)		α >95%, EC <5% (9M52b)	2.7 h (9M52a); 2.1 h (13G49)	6.036 spect (9M52); 6.02 ion ch (9M52a)		$Q_α$ 6.153 (13S53)	spall Th (13G49, 9M52a); Pb-C-spall (9M52a); parent Po^{206} (9M52a)
Em^{211}	A chem, genet (9M52a)		EC 75%, α 25% (9M52a)	16 h (9M52a)	5.847 (33%), 5.778 (67%) spect (9M52); 5.82 ion ch (9M52a)			Pb-C-spall, parent At^{211} (9M52a)
Em^{212}	A chem, genet (8H50, 13G49)		α (8H50)	23 m (13G49, 8H50, 9M52a)	6.262 spect (9M52); 6.23 ion ch (9M52a)		$Q_α$ 6.382 (13S53)	spall Th (13G49); daughter Fr^{212}, parent Po^{208} (8H50, 9M52a)
Em^{215}	B genet (11M52)		α (11M52)	$\sim 10^{-6}$ s est (11M52)	8.6 ion ch (11M52)			daughter Ra^{219}, parent Po^{211} (AcC') (11M52)
Em^{216}	A genet (11M49, 11M51)		α (11M49, 11M51); β stable (cons energy) (HPS)	$\sim 10^{-4}$ s est (11M51)	8.01 ion ch (7O50)		$Q_α$ 8.16 (13S53)	daughter Ra^{220}, parent Po^{212} (ThC') (11M49, 11M51)
Em^{217}	A genet (11M49, 11M51)		α (11M51); β stable (cons energy) (HPS)	$\sim 10^{-3}$ s delay coinc (11M51)	7.74 ion ch (11M51)		$Q_α$ 7.89 (13S53)	daughter Ra^{221}, parent Po^{213} (11M49, 11M51)
Em^{218}	A genet (4S48)		α (4S48); β stable (cons energy) (HPS)	0.019 s delay coinc (4S48)	7.12 ion ch (1J48)		$Q_α$ 7.25 (13S53)	daughter Ra^{222}, parent Po^{214} (RaC') (4S48)
Em^{219} (An)	A chem, genet (1C31)		α	3.92 s (1C31)	6.824, 6.559, 6.434 spect (11L34); $α_0$ (69%), $α_{270}$ (15%), $α_{397}$ (12%), $α_{622}$ (4%) spect (4R36)	0.067, 0.124, 0.198 (strong), 0.267, 0.321, 0.392, 0.589 (weak) spect conv (11S37); 0.123, 0.270, 0.590 cryst spect (8F40)	$Q_α$ 6.951, $Q^-_β$ 0.26 calc (13S53)  (4R36, HPS)	natural source, daughter Ra^{223} (AcX), parent Po^{215} (AcA); daughter At^{219} (8H53)
Em^{220} (Tn)	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	54.5 s (1C31)	6.282 spect (15B36, 9H38)		$Q_α$ 6.398 (13S53)	natural source, daughter Ra^{224} (ThX), parent Po^{216} (ThA)
Em^{221}	A chem, genet (9M52a)		$β^-$ ~80%, α ~20% (9M52b)	25 m (9M52b)			$Q_α$ 6.0 est, $Q^-_β$ 0.9 est (13S53)	Th-p-spall, parent Fr^{221} (9M52a); parent Po^{217} (9M52b)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{86}Em^{222}$ (Rn)	A chem, genet (1C31)		α; no β^- (lim 10^{-4}%) (5K46)	3.825 d (22T51, 1C31)	5.486 spect (15B36, 9H38)		Q_α 5.587 (13S53)	natural source, daughter Ra^{226}, parent Po^{218} (RaA)
$_{87}Fr^{212}$	A chem, genet (8H50); chem, mass spect (9M52a)		EC 56%, α 44% (8H50)	19.3 m (8H50)	6.409 (37%), 6.387 (39%), 6.339 (24%) spect (8H52c); 6.36 ion ch (8H51)			spall Th (8H50), parent Em^{212} (8H50, 9M52a)
Fr^{217}	E genet, decay charac (57K51)		α (57K51)		8.3 range emuls (57K51)			descendent Pa^{225} (57K51)
Fr^{218}	B genet (11M49, 11M51)		α (11M51)	5×10^{-3} s est (11M51)	7.85 ion ch (11M51)		Q_α 8.00, Q_{EC} 1.8 calc (13S53)	daughter Ac^{222}, parent At^{214} (11M49, 11M51)
Fr^{219}	A genet (13G48)		α (13G48); β stable (cons energy) (HPS)	0.02 s delay coinc (11M51)	7.30 ion ch (11M51)		Q_α 7.44 (13S53)	daughter Ac^{223}, parent At^{215} (13G48, 11M49, 11M51)
Fr^{220}	A genet (13G48)		α (13G48)	27.5 s (11M51)	6.69 ion ch (11M51)		Q_α 6.81, Q_β^- 1.27 calc, Q_{EC} 0.87 calc (13S53)	daughter Ac^{224}, parent At^{216} (13G48, 11M49, 11M51)
Fr^{221}	A chem, genet (4H47, 11E47)		α (11E47, 4H47)	4.8 m (4H50a); 5 m (11E47)	6.30 ion ch (4H47, 5C48); 6.30 (~75%), 6.05 (~25%) ion ch (4H50a)	0.220 spect conv, scint spect (39W53)	Q_α 6.42, Q_β^- 0.24 calc (13S53)	daughter Ac^{225}, parent At^{217} (11E47, 4H47, 5C48, 4H50a); daughter Em^{221} (9M52a)
Fr^{222}	A chem, genet (8H50a)		β^- 99+%, α 0.01-0 1% (8H51a)	14.8 m (8H50a)			Q_α 6.00 est, Q_β^- 2.04 est, Q_{EC} 0.02 est (13S53)	spall Th, parent Ra^{222}, ancestor Bi^{214} (8H50a, 8H51a)
Fr^{223} (AcK)	A chem, genet (7P39, 7P39b)		β^- (7P39a, 8G47); α 4×10^{-3}% (8H53)	21 m (7P39)	β^-: 1.2 cl ch (7P39a, 7P39b, 6L50)	0.09 abs (6L44, 7P46); ~0.330 (6%) abs, 0.0486 (27%) crit abs (6L50)	Q_α 5.60 est, Q_β^- 1.19 calc (13S53)	natural source, daughter Ac^{227}, parent Ra^{223} (AcX) (7P39, 7P39a, 7P39b, 7P41, 7P46, 8G47, 6L50); parent At^{219} (8H53)
$_{88}Ra^{213}$	B chem, genet (9M52a)		α (9M52a)	2.7 m (9M52c)	6.90 ion ch (9M52c)			Pb-C-spall, spall Th, parent Em^{209} (9M52a)
Ra^{219}	B genet (11M52)		α (11M52)	~10^{-3} s est (11M52)	8.0 ion ch (11M52)		Q_α 8.1 (13S53)	daughter Th^{223}, parent Em^{215} (11M52)
Ra^{220}	A genet (11M49, 11M51)		α (11M51)	3×10^{-2} s est (11M51)	7.43 ion ch (7O50)		Q_α 7.57 (13S53)	daughter Th^{224}, parent Em^{216} (11M49, 11M51)
Ra^{221}	A chem, genet (11M49, 11M51)		α (11M51)	30 s (11M51)	6.71 ion ch (11M51)		Q_α 6.83 (13S53)	daughter Th^{225}, parent Em^{217} (11M49, 11M51)
Ra^{222}	A chem, genet (4S48)		α (4S48); β stable (cons energy) (HPS)	38 s (4S48)	6.51 ion ch (1J48)		Q_α 6.63 (13S53)	daughter Th^{226}, parent Em^{218} (4S48); daughter Fr^{222} (8H51a)

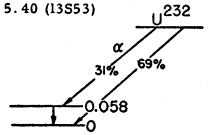
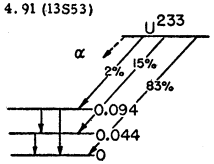
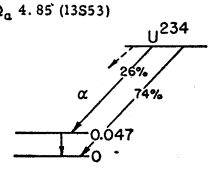
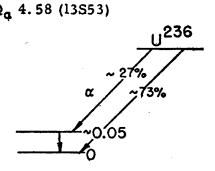
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{88}Ra^{223}$ (AcX)	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	11.2 d (1C31)	5.860 (weak), 5.730 (9%), 5.704 (53%), 5.596 (24%), 5.528 (9%), 5.487 (2%), 5.419 (3%) spect (4R52b); 5.750 (11%), 5.719 (53%), 5.607 (25%), 5.540 (9%), 5.433 (2%) spect (4A52a); no 6.0-6.1 α (lim 0.5%) (13H50); others (11L34, 4R36, 4R37)	0.144, 0.155, 0.180, 0.270, 0.340 cryst spect (8F40); 0.026, 0.064, 0.081, 0.099, 0.116, 0.154, 0.164, 0.180, 0.232, 0.268, 0.280, 0.322, 0.348, 0.444 spect conv (11S37)	$Q_α$ 5.855 (13S53)	natural source, daughter Th^{227} (RdAc), daughter Fr^{223} (AcK), parent Em^{219} (An); daughter Ac^{223} (11M51); spall U (13S47, 6O47, 6F51)
Ra^{224} (ThX)	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	3.64 d (1C31)	5.681 (95%), 5.448 (4.6%), 5.194 (0.4%) spect (4R49); 5.681 spect (15B36); 5.66 ion ch (2C45)	0.241 ($e_K/γ$ 0.1) spect conv (4R52); no γ (1M28, 4F49)	$Q_α$ 5.784 (13S53)  (4R52, HPS)	natural source, daughter Th^{228} (RdTh), parent Em^{220} (Tn); spall U (13S47, 6O47, 6F51)
Ra^{225}	A chem, genet (11E47, 4H47)		$β^-$ (11E47, 4H47); no α (lim 0.1%) (9M52c)	14.8 d (4H50a); 14 d (11E47)	~0.31 spect (3F52a); ~0.2 abs (4H50a); <0.05 abs (11E47)			daughter Th^{229} parent Ac^{225} (11E47, 4H47, 4H50a); spall U (6F51)
Ra^{226}	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	1622 y sp act (2K49a); 1631 y sp act (3C46); 1590 y sp act (1C31)	$α_0$ 4.777 spect (4R52b); $α_0$ (94.3%), $α_{188}$ (5.7%) spect (4A52c); $α_0$ (95.2%), $α_{186}$ (4.8%) ion ch (7K51a); $α_0$ (93.5%), $α_{187}$ (6.5%) spect (4R49a); others (109B51)	0.186 spect conv (10C51); ~0.19 (e/γ 0.88, K/L ~0.5) α-conv coinc abs (14V52); 0.188 (16H24, 7R36); (e/γ ~0.5) (8S43)	$Q_α$ 4.863 (4R52b)  (4A52a, HPS)	natural source, daughter Th^{230} (Io), parent Em^{222} (Rn)
Ra^{227}	A n-capt, genet (8P49)		$β^-$ (8P49, 6F50)	41.2 m (107B52)	1.30 spect (107B52)	0.291, 0.498 scint spect (107B52)		Ra-n-γ, parent Ac^{227} (8P49); spall U (6F50)
Ra^{228} ($MsTh_1$)	A chem, genet (1C31)		$β^-$	6.7 y (1C31)	~0.012 (?) cl ch. (6L48, 6L49a); 0.053 spect, abs (8L39)	~0.03 cl ch (6L48, 6L49)	$Q^-_β$ ~0.04 (13S53)	natural source, daughter Th^{232}, parent Ac^{228} ($MsTh_2$)
Ra^{229}	[B] n-capt, genet (41D52)		[$β^-$] (41D52)	[short] (41D52)				[Ra^{228}-n-γ, parent Ac^{229}] (41D52)
Ra^{230}	D chem (5J52)		$β^-$ (5J52)	1 h (5J52)	1.2 abs, spect (5J52)			spall Th, parent Ac^{230} (5J52)
$_{89}Ac^{221}$	E genet, decay charac (57K51)		α (57K51)		7.6 range emuls (57K51)			descendent Pa^{225} (57K51)
Ac^{222}	B genet (11M49, 11M51)		α (11M51)	5.5 s (11M52)	6.96 ion ch (11M51)		$Q_α$ 7.09, Q_{EC} 2.26 calc (13S53)	daughter Pa^{226}, parent Fr^{218} (11M49, 11M51)
Ac^{223}	A genet (13G48)		α 99%, EC 1% (11M51)	2.2 m (11M51)	6.64 ion ch (11M51)		$Q_α$ 6.76, Q_{EC} 0.64 calc (13S53)	daughter Pa^{227}, parent Fr^{219}, parent Ra^{223} (AcX) (13G48, 11M49, 11M51)
Ac^{224}	A chem, genet (13G48)		EC ~90%, α ~10% (11M51)	2.9 h (11M51)	6.17 ion ch (11M51)		$Q_α$ 6.28, Q_{EC} 1.37 calc, $Q^-_β$ 0.29 calc (13S53)	daughter Pa^{228}, parent Fr^{220}, parent Ra^{224} (ThX), (13G48, 11M49, 11M51)

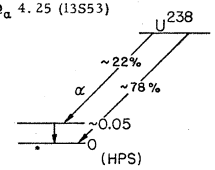
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{89}Ac^{225}$	A chem, genet (4H47, 11E47)		α (11E47, 4H47); β stable (cons energy) (HPS)	10.0 d (4H50a, 11E47)	5.80 ion ch (4H50a, 5C48)		$Q_α$ 5.90 (13S53)	daughter Ra^{225}, parent Fr^{221} (4H47, 11E47, 4H50a); daughter Pa^{229} (8H49a); daughter Th^{225} (11M49, 11M51); spall Th (17H50), U (6O47)
Ac^{226}	A chem, genet (6S48)		$β^-$ (6S48)	29 h (6S50)	1.17 abs (17H50)		$Q_α$ 5 44 est, Q_{EC} 0.6 est, $Q^-_β$ 1.07 est (13S53)	spall U, daughter Pa^{230}, parent Th^{226} (6S48, 6S50); spall Th (17H50, 11M50); daughter Pa^{230}, parent Th^{226} (11M50)
Ac^{227}	A chem, genet (1C31)		$β^-$ ~99% (7P39, 8P49a); α 1.2% (2M14, 7P39, 7P46, 8P49a)	22.0 y (13H50a); 21.7 y (4C44); 13.5 y (1C31)	α: 4.942 spect (4R52b); 4.94 (100%) ion ch (13G48a); others (3G47) $β^-$: 0.04 spect (3F50); ~0.02 cl ch (7P46); <0.03 abs (6L44)	0.037 (weak) abs (6L43, 6L44, 7P46); (0.2%) (6L50)	Ac^{227}, I = 3/2 (36T51) $Q_α$ 5.03, $Q^-_β$ ~0.08 calc (13S53)	natural source, daughter Pa^{231}, parent Th^{227} (RdAc); parent Fr^{223} (AcK) (7P39, 7P46); daughter Ra^{227} (8P49)
Ac^{228} ($MsTh_2$)	A chem, genet (1C31)		$β^-$	6.13 h (1C31)	2.18 (10%), 1.85 (9%), 1.72 (7%), 1.15 (53%), 0.66 (8%), 0.46 (13%) spect (82C52); 2.03, 1.74, 1.10 spect (5J51); others (4F38, 6L38, 3L39)	0.058, 0.129, 0.184, 0.338, 0.462, 0.914, 0.969 spect conv (13B24); 0.333, 0.462, 0.913, 0.968 spect (5T26); 0.063, 0.146, 0.186, 0.338, 0.533, 0.590, 0.905 spect conv (5J51)	$Q_α$ 4.66 est, $Q^-_β$ 2.18 (13S53)	natural source, daughter Ra^{228} ($MsTh_1$), parent Th^{228} (RdTh)
Ac^{229}	B chem, n-capt (41D52)		$β^-$ (41D52)	66 m (41D52)			$Q^-_β$ 1.0 est (13S53)	daughter Ra^{229} (41D52)
Ac^{230}	F genet (5J52)		$β^-$ (5J52)	<1 m genet (5J52)	~2.2 abs, spect (5J52)			daughter Ra^{230} (5J52)
$_{90}Th^{223}$	B genet (11M52)		α (11M52)	~0.1 s est (11M52)	7.55 ion ch (11M52)		$Q_α$ 7.69 (13S53)	daughter U^{227}, parent Ra^{219} (11M52)
Th^{224}	A genet (11M49, 11M51)		α (11M51); β stable (cons energy) (HPS)	~1 s est (11M51)	7.13 ion ch (7O50)		$Q_α$ 7.26 (13S53)	daughter U^{228}, parent Ra^{220} (11M49, 11M51)
Th^{225}	A chem, genet (11M49, 11M51)		α ~90%, EC ~10% (11M51)	8.0 m (11M51)	6.57 ion ch (11M51)		$Q_α$ 6.69, Q_{EC} 0.55 calc (13S53)	daughter U^{229}, parent Ra^{221}, parent Ac^{225} (11M49, 11M51)
Th^{226}	A chem, genet (4S48)		α (4S48); β stable (cons energy) (HPS)	30.9 m (4S48)	$α_0$ (78%), $α_{117}$ (22%) spect (21S52); 6.30 ion ch (1J48)		$Q_α$ 6.41 (13S53)	daughter U^{230}, parent Ra^{222} (4S48); daughter Ac^{226} (6S48, 6S50)

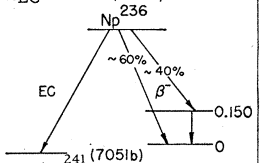
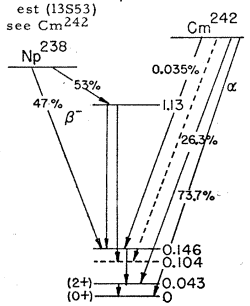
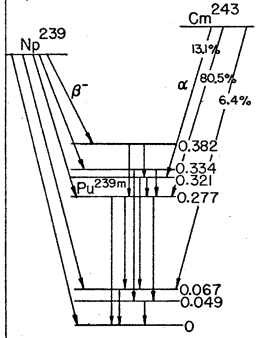
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{90}Th^{227}$ (RdAc)	A chem, genet (1C31)		α; β stable (cons energy (HPS)	18.6 d (8P49b); 18.9 d (1C31)	6.030 (19%), 6.001 (5%), 5.972 (21%), 5.952 (13%), 5.922 (~2%), 5.860 (4%), 5.796 (2%), 5.749 (17%), 5.728 (~1%), 5.704 (15%), 5 651 (~2%) spect (4R52b); 6.049 (20%), 6.017 (4%), 5.988 (25%), 5.966 (4%), 5.922 (~1%), 5.868 (2.5%), 5.815 (~1%), 5.764 (20%), 5.742 (4%), 5.717 (15%), 5.672 (2.5%) spect (11L34)	0.050, 0.057, 0.080, 0.101, 0.113, 0.129, 0.208, 0.240, 0.258 cryst spect (8F40); 0.050 (3%), 0.120 (13%), 0.280 (50%) abs (3R50); 0.050 (5%), 0.125 (10%), 0.270 (26%) abs (3B44); 0 050 (~3%), 0.125 (23%) abs (9T42)	Q_α 6.138 (13S53)	natural source, daughter Ac^{227}, parent Ra^{223} (AcX); daughter Pa^{227} (13G48, 11M51); spall U (6O47)
Th^{228} (RdTh)	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	1.90 y (1C31)	5.423 (72%), 5.338 (28%) spect (4R49b)	0.0843 spect conv (4R52a); 0.083 (e/γ 12) α-conv coinc abs (14V52); 0.083 (2.1%, e/γ = 10) crit abs (3R53); others (1M28, 11S41a, 3R50, 103B51)	Q_α 5.520 (13S53)  (4R49b, 4R52a, HPS)	natural source, daughter Ac^{228} ($MsTh_2$), parent Ra^{224} (ThX); daughter U^{232} (9G49); daughter Pa^{228} (13G48b, 11M51)
Th^{229}	A chem, genet (11E47, 4H47)		α; β stable (cons energy) (HPS)	7340 y genet (4H50a); ~10^4 y genet (11E47)	5.02 (~10%), 4.94 (~20%), 4.85 (~70%) ion ch (4H50a)		Q_α 5.11 (13S53)	daughter U^{233}, parent Ra^{225} (11E47, 4H47, 4H50a)
Th^{230} (Io)	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	8.0 x 10^4 y sp act (8H49b); 8.2 x 10^4 y genet (1C30)	4.682 (~75%), 4.613 (~25%), 4.51 (?) (weak) spect (4R48); 4.66 range air (1G22), ion ch (2C44, 2C45)	0.068, 0.228 (very weak) spect conv (4R51); 0.068 (0.85%), 0.140 (0.33%), 0.240 (0.05%) abs (4C48); ~0.07 (coinc with α, e/γ ~46) α-conv coinc abs (14V52, 10F51); ~0.068 (0.5%), 0.190 (0.3%) abs (3R50); ~0.07 (coinc with α), ~0.2 (coinc with α) α-γ, α-conv coinc abs (5P51); others (6J51, 5W39)	Q_α 4.765 (13S53)  (HPS)	natural source, daughter U^{234} (U_{II}), parent Ra^{226}; daughter Pa^{230} (4S48a)
Th^{231} (UY)	A chem, genet (1C31)			25.64 h (1J51); 25.5 h (3K49); 24.6 h (1C31); 24.0 h (12G32)	0.302 (44%), 0.216 (11%), 0.094 (45%) spect (3F52); 0.39 (~20%), 0.19 (~40%), 0.10 (~40%) spect (10S51); 0.2 abs (5E37, 1J51)	γ_1 0.022, γ_2 0.059, γ_3 0.063, γ_4 0.085, γ_5 0.107, γ_6 0.122, γ_7 0.167, γ_8 0.208, γ_9 0.230 (γ_2+γ_3/γ_4/γ_5/γ_6/γ_7/γ_8/γ_9 = 0.40/1.00/0.065/0.02/0.018/0.003/0.001) spect conv, scint spect (3F52); 0.059, 0.063, 0.082, 0.120 spect conv (10S51); 0.035 (>80%), 0.210 abs (3K49)	Q_α 4.19 calc (13S53) Q_{β^-} 0.324 (3F52)  (3F52)	natural source, daughter U^{235} (AcU), parent Pa^{231}; Th-n-2n (5N38, 13S52)
Th^{232}	A chem, genet (1C31)	100 (1A35, 1D36)	α; β stable (cons energy) (HPS)	1.39 x 10^{10} y sp act (6K38); spont fission: 1.4 x 10^{18} y (24S52)	3.98 ion ch (2C45); 3.98 range emuls (7F51a); 4.20 ion ch (1S37)	~0.055 (coinc with 24% of α) α-conv coinc emuls (15D52); ~0.075 (coinc with ~20% of α) α-conv coinc emuls (5A52)	Q_α 4.05 (13S53)	natural source, parent Ra^{228} ($MsTh_1$)

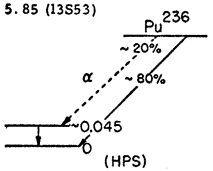
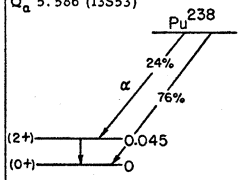
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{90}Th^{233}$	A chem, n-capt (1M38)		β^- (13S47a)	23.3 m (2B50); 23.5 m (13S47a); 23.6 m (31R52); 23 m (2G41)	1.23 spect (2B50, 31R52); 1.24 spect (3F53); 1.2 abs (13S52)	0.098 (0.25%), 0.172 (0.03%), 0.350 (0.004%), 0.448 (0.1%), 0.662 (0.05%) scint spect (3F53); no γ (2B50, 31R52)	Q_α 3.79 est, Q^-_β 1.23 (13S53)	Th-n-γ (1M38, 13S47a, 13S41, 2G41); Th-d-p (9G49); parent Pa^{233} (1M38)
Th^{234} (UX_1)	A chem, genet (1C31)		β^-	24.10 d (3K48); 24.1 d (3S39); 24.5 d (1C31)	0.205 (~80%), 0.111 (~20%) spect (16B46); 0.192 (56%), 0.104 (44%) spect (19H50); 0.190 spect (7J46); 0.20, 0.1 abs (4F38a)	0.090 (e/γ ~0.2) spect conv (19H50); 0.093 (~20%, e_L/γ ~0.34), 0.180 (4.5%) spect conv, abs (16B46); 0.092 (1M23)	Q^-_β 0.20 (13S53) 	natural source, daughter U^{238}, parent Pa^{234} (UX_2)
Th^{235}	[B] n-capt, genet (20H50)		[β^-] (20H50)	<<10 m genet (20H50)				[Th^{234}-n-γ, parent Pa^{235}] (20H50)
$_{91}Pa^{225}$	E excit, decay charac (57K51)		α (57K51)	2.0 s (57K51)				spall Th, ancestor Ac^{221} Fr^{217}, At^{213} (57K51)
Pa^{226}	B chem, genet (11M49, 11M51)		α (11M51)	1.8 m (11M51)	6.81 ion ch (11M51)		Q_α 6.93, Q_{EC} 2.8 calc (13S53)	spall Th, parent Ac^{222} (11M49, 11M51, 11M52)
Pa^{227}	A chem, genet (13G48)		α ~85%, EC ~15% (11M51)	38.3 m (11M51)	6.46 ion ch (11M51)		Q_α 6.58, Q_{EC} 1.08 calc (13S53)	spall Th, parent Ac^{223}, parent Th^{227} (RdAc) (13G48, 11M51); daughter Np^{231} (13G48b); spall U (6O48)
Pa^{228}	A chem, genet (13G48)		EC ~98%, α ~2% (11M51)	22 h (11M51)	6.09 (75%), 5.85 (25%) ion ch (11M51)		Q_α 6.20, Q_{EC} 2.05 calc (13S53)	spall Th, daughter U^{228}, parent Ac^{224}, parent Th^{228} (RdTh) (13G48, 11M49, 11M51)
Pa^{229}	A chem, genet (8H49a)		EC 99+%, α 0.25% (21S51); EC ~99%, α ~1% (11M51)	1.5 d (8H48)	5.69 ion ch (11M48); 5.66 ion ch (8H48)		Q_α 5.79, Q_{EC} 0.37 calc (13S53)	Th^{230}-d-3n, parent Ac^{225} (8H49a); daughter U^{229} (11M51)
Pa^{230}	A chem, genet, excit (4S48)		EC ~92%, β^- ~8% (4S49); α ~0.003% (11M50)	17.7 d (5O49); 17.0 d (4S48)	β^-: ~0.43 abs (5O49)	0.94 abs (5O49)	Q_α 5.45 est, Q^-_β 0.57 est, Q_{EC} 1.28 est (13S53)	Th-d-4n, Th-α-p5n, parent U^{230} (4S48); Th^{230}-d-2n (8H49a); Pa-d-p2n, Pa-α-an (5O49); U^{233}-d-an (8H49); parent Th^{230} (Io), parent Ac^{226} (11M50)
Pa^{231}	A chem, genet (1C31)		α; β stable (cons energy) (HPS)	3.43×10^4 y sp act (8W49); 3.2×10^4 y sp act (2G30)	5.042 (11%), 5.002 (47%), 4.938 (25%), 4.838 (3%), 4.720 (11%), 4.660 (1-3%) spect (4R49c, 13C51); ~5.0 (85%), ~4.7 (15%) ion ch (2C44, 9T46a, 13G48a)	0.034, 0.038, 0.057, 0.064, 0.082, 0.102, 0.198, 0.259, 0.301, 0.331, 0.357, 0.383 spect conv (10F52a); 0.095, 0.294, 0.323 spect conv (1M28a); 0.027 (9%), 0.087, 0.100, 0.30 (4%) abs, crit abs (3R52a); 0.044, 0.066 cl ch (4T52); 0.027 crit abs, ion ch (17S51); others (4S46, 4T49)	Pa^{231}, I = 3/2 (87M50) Q_α 5.131 (13S53)	natural source, daughter Th^{231} (UY), parent Ac^{227}; Th-d-3n (4S48); daughter U^{231} (14C50)

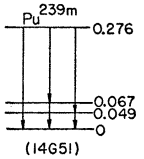
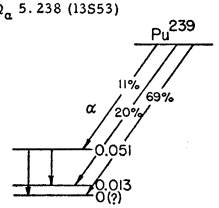
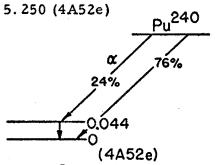
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{91}Pa^{232}$	A chem, genet (9G49)		β^- (9G49); no EC (lim 2%) (88B52a)	1.32 d (1J50); 1.4 d (5O49); 1.6 d (9G49)	0.99 (~30%), 0.64 (~10%), 0.28 (~60%) spect (35P52); ~0.28 abs (1J48b)	~0.23 (~30%), 1.05 (~100%) abs (1J48b); 0.21, 1.0 abs (5O49)	Q_α 4.70 est, Q^-_β 1.48, Q_{EC} 0.61 est (13S53)	Th-d-2n (9G49, 4S48, 1J50); Th-α-p3n (4S48); Pa-d-p (5O49); Pa-n-γ (1J50); parent U^{232} (9G49, 5O49)
Pa^{233}	A chem, genet (1M38, 2G41, 13S41)		β^- (1M38, 2G41, 13S41)	27.4 d (2G41)	0.530, 0.430 spect (3F51); 0.5 abs (13S52); ~0.2 spect, abs (21H41, 2L47; 11K50); ~0.7 spect (11F44)	0.029, 0.041, 0.058, 0.076, 0.087, 0.105, 0.273, 0.302, 0.313, 0.342, 0.377, 0.400, 0.416 spect conv (11K50); 0.028, 0.040, 0.058, 0.076, 0.087, 0.105, 0.302, 0.343, 0.417 spect conv (7K51b); 0.0287, 0.0405, 0.0754, 0.0870 (rel abund 100/75/3/3) cryst spect (88B52a); 0.084, 0.298, 0.309, 0.337 spect conv (2L47); no γ > ~0.4 abs (11K50)	Q_α 4.46 est, Q^-_β 0.53 (13S53)	daughter Th^{233} (1M38, 2G41, 13S41, 16H41a, 13S47a); parent U^{233} (13S47a); daughter Np^{237} (4H47); Th-d-n (4S48, 9G49); Th-α-p2n (4S48); daughter Np^{237} (15M47)
Pa^{234} (UX_2)	A chem, genet (1C31)		β^- 99+%, IT 0.15% (4F38a, 16B45)	1.175 m (112B51); 1.14 m (1C31)	2.32 (80%), 1.50 (13%), 0.60 (?) (~7%) spect (19H50); 2.32 (98%) spect (16B45)	0.817 (e_K/γ 0.04) spect conv (19H50); 0.394 (with IT, 0.15%, e/γ ~1), ~0.9 (~2%), ~1.5 (~0.2%) spect, spect conv (16B45); 0.822, 0.806, 0.782 (weak, e/γ large) spect conv (16B43a)	Q^-_β 2.32 (16B45)	natural source, daughter Th^{234} (UX_1), parent U^{234} (U_{II})
Pa^{234} (UZ)	A chem, genet (1C31)		β^-	6.7 h (1C31)	~1.2 (10%), 0.45 (90%) spect (16B45); 1.6, 0.6 abs (4F38a)	0.85 (two γ's) abs, β-γ coinc (16B45); ~0.7 (two γ's) abs, γ-γ coinc (4F38a, 4F38b)	Q^-_β 2.2 (?) est (13S53) Q^-_β 1.95 (4F49)	natural source, parent U^{234} (U_{II}); Pa^{233}-n-γ (50K52)
Pa^{235}	B chem, excit, sep isotopes (11M50); genet (20H50)		β^- (11M50, 20H50)	23.7 m (11M50); 23 m (20H50)	1.4 abs (11M50)	no γ, abs (11M50)		U^{238}-p-α, U^{238}-d-αn (11M50); daughter Th^{235} (20H50)
$_{92}U^{227}$	B chem, genet (11M52)		α (11M52)	1.3 m (11M52)	6.8 ion ch (11M52)		Q_α 7.14 est (13S53)	Th-α-9n, parent Th^{223} (11M52)
U^{228}	A chem, genet (11M49, 11M51)		α ~80%, EC ~20% (11M51)	9.3 m (11M51)	6.67 ion ch (7O50)		Q_α 6.79, Q_{EC} 0.30 calc (13S53)	Th-α-8n, parent Th^{224}, parent Pa^{228} (11M49, 11M51); daughter Pu^{232} (8J48)
U^{229}	A chem, genet (11M49, 11M51)		EC ~80%, α ~20% (11M51)	58 m (11M51)	6.42 ion ch (11M51)		Q_α 6.53, Q_{EC} 1.29 calc (13S53)	Th-α-7n, parent Th^{225}, parent Pa^{229} (11M49, 11M51)
U^{230}	A chem, genet (4S48)		α (4S48); β stable (cons energy) (HPS)	20.8 d (4S48)	5.85 ion ch (1J48); α_0 (77%), α_{70} (23%) spect (21S52)		Q_α 5.95 (13S53)	daughter Pa^{230}, parent Th^{226} Th-α-6n (4S48); daughter Pa^{230}, Pa-d-3n, Pa-α-p4n (5O49); daughter Pu^{234} (13P49); spall U (6O47)
U^{231}	A chem, sep isotopes, excit (5O49); genet (14C50)		EC 99+%, α 5.5×10^{-3} % (14C50)	4.3 d (14C50); 4.2 d (5O49)	5.45 ion ch (14C50)	0.051, 0.064, 0.076 spect conv (8O50)	Q_α 5.55, Q_{EC} 0.34 calc (13S53)	Pa^{231}-d-2n, Pa^{231}-α-p3n (5O49); Th-α-5n (14C50, 8O50); parent Th^{227}, parent Pa^{231} (14C50)

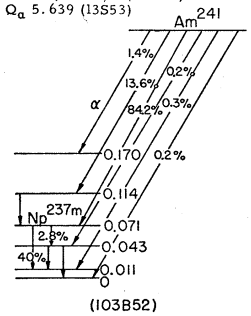
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{92}U^{232}$	A chem, genet (9G49)		α (9G49); β stable (cons energy) (HPS)	70 y yield (8J49); ~30 y yield (9G49)	5.31 range Al (1J48a); 5.27 range air (12K44); α_0 (69%), α_{58} (31%) spect (21S52)	~0.060 (coinc with 30% of α) α-conv coinc emuls (15D52)	Q_α 5.40 (13S53)  (HPS)	daughter Pa^{232}, parent Th^{228} (RdTh) (9G49); daughter Pu^{236} (8J49); daughter Pa^{232}, Pa^{231}-d-n, Pa^{231}-α-p2n (5O49); Th-α-4n (7N49)
U^{233}	A chem, genet (13S47a, 13S52)		α (13S52); β stable (cons energy) (HPS)	1.62×10^5 y sp act + mass spect (8H52a); 1.63×10^5 y sp act + mass spect (15L45); 1.2×10^5 y yield (13S52)	4.823 ion ch (5C48); α_0 (83%), α_{44} (15%), α_{94} (2%) spect (4A52a); 4.80 abs air (15C47); others (11E47)	0.0428 (0.05%), 0.0561 (0.01%) ion ch (12W52); ~0.043, ~0.056, 0.099 α-conv coinc emuls (113B52); 0.04, 0.08 (0.8%, e/γ ~8), 0.31 (0.1%, e/γ ~3) abs (4S52); 0.04, 0.09, 0.36 (all coinc with α) α-γ, α-conv coinc abs (5P51)	Q_α 4.91 (13S53)  (HPS)	daughter Pa^{233} (13S47a); parent Th^{229} (11E47, 4H47)
U^{234} (U_{II})	A chem, genet, mass spect (1C31)	0.0058 (1B50)	α; β stable (cons energy) (HPS)	2.48×10^5 y sp act (12F52); 2.52×10^5 y sp act, sp act + mass spect (13K52, 13K49); 2.67×10^5 y yield (10G49); 2.35×10^5 y sp act + mass spect (15C46); spont fission: 2×10^{16} y (13G52)	4.763 ion ch (2C44); α_0 (74%), α_{47} (26%) spect (4A52a); 4.76 ion ch (1S39, 13G51); 4.78 range air (18S37), ion ch (3A47)	0.050, 0.117 scint spect (17S51a); γ_1 0.053, γ_2 0.093, γ_3 0.118 ($\gamma_1/\gamma_2/\gamma_3$ = 1/~0.2/0.4) scint spect (11B52a); 0.055 (coinc with α, e/γ large) α-conv coinc emuls (4T52); 0.065 (coinc with α, e/γ large) α-γ coinc abs, α-conv coinc abs (5P51); others (10M47, 17S51)	Q_α 4.85 (13S53)  (HPS)	natural source, daughter Pa^{234} (UX_2 and UZ), parent Th^{230} (Io)
U^{235} (AcU)	A chem, mass spect (1C31)	0.715 (1B50)	α; β stable (cons energy) (HPS)	7.13×10^8 y sp act (12F52); 7.07×10^8 y radiogenic Pb ratios (6N39); spont fission: 1.9×10^{17} y (24S52)	4.58 (10%), 4.47 (?) (~3%), 4.40 (83%), 4.20 (4%) ion ch (13G51); 4.39 ion ch (15V52)	γ_1 0.094, γ_2 0.143, γ_3 0.184, γ_4 0.289, γ_5 0.386 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5$ = 0.9/0.2/1.0/0.1/0.05) scint spect (11B52a); 0.187 abs (20S52); 0.167 abs (10M49)	Q_α 4.66 (13S53) U^{235}, I = 5/2 (102S50)	natural source, parent Th^{231} (UY)
U^{236}	A chem, n-capt, mass spect (9W45, 13G51a)		α (13G51a); β stable (cons energy) (HPS)	2.39×10^7 y sp act (12F52); 2.46×10^7 y sp act (1J51a)	4.499 ion ch (1J51a); 4.5 ion ch (13G51a)	~0.050 (coinc with 27% of α) α-conv coinc emuls (15D52)	Q_α 4.58 (13S53)  (HPS)	U^{235}-n-γ (9W45, 13G51a, 1J51a)

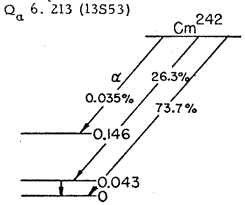
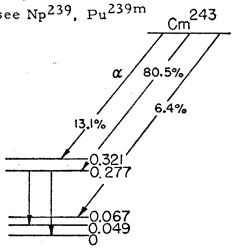
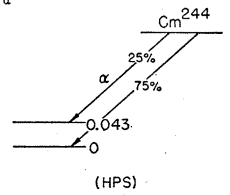
Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{92}U^{237}$	A chem, excit (5N40, 12M40)		β^- (5N40, 12M40)	6.75 d (81H52); 6.63 d (13M48); 6.8 d (1W48)	0.245, other β^- (weak) spect (3F53); ~0.23 spect (13M48)	γ_1 0.027, γ_2 0.043, γ_3 0.059, γ_4 0.165, γ_5 0.207 (e_K/γ 1.6, K/L 5.0), γ_6 0.269, γ_7 0.334, γ_8 0.370, γ_9 0.430 ($\gamma_3/\gamma_5/\gamma_7 \simeq$ 37/21/2.5) scint spect, spect conv (3F53); 0.0598 cryst spect (88B52a); 0.032, 0.057, 0.204, 0.260 abs, spect conv (13M48); 0.14, 0.23, 0.53 abs (17B43)	Q^-_β 0.514 (3F53)	U-n-2n (12M40, 5N40, 1W48, 2A44); parent Np^{237} (1W48); daughter Pu^{241} (2K45, 13S49); U-d-t (17B43, 2A44, 8J49); U-α-an (8J49)
U^{238} (U_I)	A chem, genet, mass spect (1C31)	99.28 (1B50)	α; β stable (cons energy) (HPS)	4.49×10^9 y sp act (13K49); 4.51×10^9 y sp act (6N39); spont fission: 8.0×10^{15} y (24S52, 17S46)	4.18 ion ch (3A47, 2C44); 4.21 range (1S39)	~0.045 (coinc with 22% of α) α-conv coinc emuls (15D52); 0.048 (coinc with 23% of α) α-conv coinc emuls (1Z52); ~0.050 (coinc with 24% of α) α-conv coinc emuls (5A52a)	Q_α 4.25 (13S53) 	natural source (18B96), parent Th^{234} (UX_1)
U^{239}	A n-capt (1M37)		β^- (12M39)	23.54 m (14M43); 23.5 m (4F47, 13M47)	1.21 spect (3F53); 1.20 abs (4F47, 4F47a); 1.2 abs (1W42, 14M42); 1.12 spect (5S47)	0.0736 spect conv, scint spect (3F53); 0.073 spect conv, abs (5S47); 0.076, >0.3 (≤10%) abs (4F47, 4F47a)	Q^-_β 1.28 (3F53) Q_α 4.12 est (13S53)	U-n-γ (1M37, 2I39, 12M39, 22S42); parent Np^{239} (12M40a, 22S42); U-d-p (13S49a)
U^{240}	A chem, n-capt (4S49a)		β^- (4S49a)	~~ 18 h genet (4S49a)				U-n-γ (second order reaction) (4S49a); parent Np^{240} (8H48b)
$_{93}Np^{231}$	A chem, genet, excit, sep isotopes (15M50)		α (15M50)	~50 m (15M50)	6.28 ion ch (15M50)		Q_α 6.39, Q_{EC} 1.92 calc (13S53)	U^{238}-d-9n, U^{233}-d-4n, U^{235}-d-6n, parent Pa^{227} (15M50)
Np^{232}	D chem (15M50)		EC (15M50)	~13 m (15M50)		hard γ (15M50)	Q_α 6.04 est, Q_{EC} 2.7 est (13S53)	U^{233}-d-3n (15M50)
Np^{233}	A chem, excit, sep isotopes (15M50, 7O51)		EC 99+%, α $\sim 10^{-3}$% (15M50)	35 m (15M50)	5.53 ion ch (15M50); conv: ~0.3 (15M50)		Q_α 5.63, Q_{EC} 1.09 calc (13S53)	U^{233}-d-2n, U^{235}-d-4n (15M50); U^{233}-p-n (7O51)
Np^{234}	A chem, excit, genet, sep isotopes (8J49)		EC (L/K ~1) (7O51a); no α (lim 0.01%) (8H49); no β^+ (8H49)	4.40 d (8H49); 4.4 d (5O49)		0.177, 0.442, 0.803, 1.42 spect conv (7O51a); 1.9 abs (8H49, 5O49)	Q_α 5.39 est, Q_{EC} 1.8 est (13S53)	U^{235}-d-3n, U^{235}-α-p4n (8J49); U^{235}-p-2n (11G46); U^{233}-d-n (8H49); U^{233}-α-p2n (8H49, 13P49); Pa^{231}-α-n (5O49); daughter Pu^{234} (13P49)
Np^{235}	A chem, excit, sep isotopes (8J49)		EC (L/K >9) (8J52); α $\sim 5 \times 10^{-3}$% (8J52)	410 d (8J52)	5.06 ion ch (8J52)		Q_α 5.15, Q_{EC} 0.17 calc (13S53)	U^{235}-d-2n (8J49, 8J52); U^{233}-α-pn (8H49)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{93}Np^{236}$	A chem, genet, sep isotopes, excit (8J49)		β^- ~33%, EC ~67% (L/K ~2) (7O51b)	22 h (8J49)	0.51 (~60%), 0.36 (~40%) spect (7O51b)	0.150 (e/γ large) spect conv (7O51b)	Q_α 5.00 est, Q_β^- 0.63 est, Q_{EC} 1.03 est (13S53) 	U^{235}-d-n, U^{235}-α-p2n, U-d-4n (8J49); Np^{237}-d-p2n (8J49a); U^{233}-α-p (8H49); Np^{237}-n-2n (13G45, 13F50); parent Pu^{236} (8J49, 8J49a, 8H49, 13G52)
Np^{237m}	A genet (103B52)		IT (103B52)	6.3×10^{-8} s delay coinc (103B52)		0.060 scint spect (103B52)	see Am^{241} (7O51b)	daughter Am^{241} (103B52)
Np^{237}	A chem, genet, excit (1W48)		α (1W48); β stable (cons energy) (HPS)	2.20×10^6 y sp act (15M48)	4.77 ion ch (13G48c)	soft γ's (coinc with 80% of α) α-conv coinc emuls (15D52); soft γ, spect conv (15M45)	Np^{237}, I = 5/2 (87M50) Q_α 4.97 est (13S53)	daughter U^{237} (1W48); parent Pa^{233} (15M47)
Np^{238}	A chem, genet, n-capt, sep isotopes (13S46)		β^- (13S46, 13S49a)	2.10 d (3F50a); 2.0 d (13S49a)	1.272 (47%), 0.258 (53%) spect, spect coinc (3F50a); 1.39, 0.22 abs (1J49)	0.043, 0.047, 0.103 (L/M 1.6), 0.983, 1.03 (1.03 γ/0.98 γ = 1) spect, spect conv, β-γ, β-x coinc (3F50a); no 0.047 γ (63M52a, 4A52a); 1.1 abs (13S49a); 0.075, 1.2 abs, abs conv (1J49)	Q_α 4.83 est, Q_β^- 1.42, Q_{EC} 0.38 est (13S53) see Cm^{242}  (4A52a)	U-d-2n (13S46, 13S49a, 14K49); U^{238}-d-2n (14K49); parent Pu^{238} (13S46, 14K49, 1J49, 8J49); daughter Am^{242} (13S49, 6S50a); U^{238}-α-p3n, U^{235}-α-p (8J49); Np^{237}-n-γ (1J49); Np^{237}-d-p (8J49a)
Np^{239}	A chem, n-capt, genet, excit (12M39, 12M40a)		β^- (12M40a)	2.33 d (1W42); 2.35 d (4F42); 2.3 d (3P46)	0.715, 0.654, 0.44, 0.33 spect (7T51); 0.718 (4.8%), 0.655 (1.7%), 0.441 (31%), 0.380 (10%), 0.329 (52%) spect (3F53); 0.705 (7%, not coinc with γ), 0.435 (46%), 0.310 (47%) spect (14G51); 1.179, 0.676, 0.403, 0.288 spect (5S47); others (22H45, 11F49)	0.049, 0.057, 0.061, 0.067 (coinc with 0.210 γ), 0.210, 0.227, 0.276 (last 3 γ's coinc with 0.435 β^-, 0.276 γ not coinc with 0.227 γ) spect conv, β-γ, γ-γ coinc (14G51); 0.013, 0.019, 0.044, 0.049, 0.057, 0.061, 0.067, 0.077, 0.105, 0.209, 0.228, 0.254, 0.277, 0.285, 0.316, 0.334 spect conv (3F53); 0.044, 0.049, 0.057, 0.061, 0.068, 0.105, 0.209, 0.228, 0.254, 0.277, 0.286 spect conv (7T51); 0.023, 0.049, 0.057, 0.061, 0.068, 0.106, 0.209, 0.228, 0.277 spect conv (11F49); 0.0576, 0.0618 cryst spect (26J52); 0.057, 0.061, 0.067, 0.206, 0.227, 0.275 spect conv (5S47); others (4F42, 22H45, 3P46)	Q_β^- 0.715 (3F53, 14G51)  (4A52a)	daughter U^{239} (12M40a, 22S42); parent Pu^{239} (14K46, 13S49a); U-d-n (13S46, 13S49a, 8J49); U-α-p2n (8J49); daughter Am^{243} (6S50a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{93}Np^{240}$	A chem, genet (8H48b)		β^- (8H48b)	7.3 m (8H48b)	~1.3 abs (8H48a)			daughter U^{240} (8H48b)
Np^{241}	B chem, cross bomb (7O51a)		β^- (7O51a)	60 m (7O51a)	0.89 spect (7O51a)	0.15, 0.20, 0.26, 0.58 spect conv (7O51a); ~0.7 abs (7O51a)		U^{238}-a-p (7O51a)
$_{94}Pu^{232}$	B chem, sep isotopes, excit, genet (7O51a)		a ≥2%, EC ≤98% (7O51a)	36 m (7O51a)	6.58 ion ch (7O51a)		Q_a 6.70, Q_{EC} 0.96 est (13S53)	U^{235}-a-7n, U^{233}-a-5n, parent U^{228} (7O51a)
Pu^{234}	A chem, genet, sep isotopes, excit (8H49, 13P49)		a ~4%, EC ~96% (7O51a, 23H52a)	9.0 h (7O51a); 8.5 h (13P49)	6.19 ion ch (7O51a); 6.2 ion ch (13P49)		Q_a 6.30, Q_{EC} 0.21 est (13S53)	U^{233}-a-3n (8H49, 13P49, 7O51a); U^{235}-a-5n (7O51a); parent U^{230}, parent Np^{234} (13P49, 7O51a); daughter Cm^{238} (23H52a)
Pu^{235}	B chem, excit, sep isotopes (7O51a)		EC 99+%, a ~0.002% (7O51a)	26 m (7O51a)	5.85 ion ch (7O51a)		Q_a 5.95, Q_{EC} 1.14 calc (13S53)	U^{233}-a-2n, U^{235}-a-4n (7O51a)
Pu^{236}	A chem, excit, sep isotopes, cross bomb, genet (8J49)		a (8J49); β stable (cons energy) (HPS)	2.7 y (8J49); spont fission: 3.5×10^9 y (13G52)	5.75 range air (8J49); 5.75 ion ch (13G53)	~0.045 (coinc with 20% of a) a-conv coinc emuls (15D52)	Q_a 5.85 (13S53)  (HPS)	U^{235}-a-3n, U^{238}-a-6n (8J49); Np^{237}-d-3n (8J49a); U^{233}-a-n (8H49, 13P49); daughter Cm^{240} (13S49b); daughter Np^{236} (8J49, 8J49a, 8H49, 13G52)
Pu^{237}	B chem, sep isotopes, cross bomb (8J49)		EC (8J49)	~40 d (8J49)		K, L-x, no γ (8J49)	Q_a 5.72 est, Q_{EC} 0.21 est (13S53)	U^{235}-a-2n, U-a-5n (8J49); Np^{237}-d-2n (8J49a)
Pu^{238}	A chem, sep isotopes, excit (13S46, 13S46a, 13S49a)		a (13S46); β stable (cons energy) (HPS)	89.6 y (1J50a); 92 y genet (13S49b); 77 y genet (1J49); spont fission: 3.8×10^{10} y (24S52)	5.492 (76%), 5.450 (24%) spect (4A52a); 5.47 range air (8T49); 5.51 range air (15C47)	0.045 spect conv (8O51); ~0.040 (coinc with 23% of a) a-conv coinc emuls (15D52); ~0.04 (e/γ ~700) a-γ coinc, scint spect (4A52d)	Q_a 5.586 (13S53)  (HPS)	U^{238}-d-2n (13S46, 13S49a, 14K49, 7E42, 8J49); U^{238}-a-4n, U^{235}-a-n (8J49); daughter Np^{238} (8J49, 1J49, 13S46a, 14K49); daughter Cm^{242} (13S49b)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{94}Pu^{239m}$	A genet (14G51)		IT (14G51)	1.1×10^{-9} s delay coinc (14G51)		0.049, 0.067, 0.210, 0.227, 0.276 spect conv, coinc (14G51)	see Np^{239}, Cm^{243}  (14G51)	daughter Np^{239}, parent Pu^{239} (14G51)
Pu^{239}	A chem, genet, mass spect (14K46)		α (14K46); β stable (cons energy) (HPS)	24,360 y sp act (10W51); 24,400 y sp act (11W46, 14F45); 24,300 y sp act (16C49); 24,100 y calorimetric (96S47); spont fission: 5.5×10^{15} y (24S52)	5.150 (69%), 5.137 (20%), 5.099 (11%) spect (4A52e); 5.147 (~70%), 5.097 (~30%) spect (4R50); 5.14 ion ch (10J48); 5.15 range air (15C47); 5.13 ion ch (17C51); 5.13 range air (8T49); conv: ~0.10 (weak) α-conv coinc emuls (15D52, 5A51)	γ_1 0.039, γ_2 0.0531, γ_3 0.100, γ_4 0.124, γ_5 0.384 ($\gamma_1/\gamma_2/\gamma_3/\gamma_4/\gamma_5 \approx 0.4/1.4/1.1/0.5/0.3$) spect conv, scint spect (3F52b); 0.0385 (2×10^{-3}%), 0.0520 (7×10^{-3}%) ion ch (12W51, 12W52); ~0.035, 0.05 α-conv coinc emuls (15D52); 0.05 α-conv coinc emuls (5A51); others (1I52)	Q_α 5.238 (13S53)  (4A52a, HPS)	daughter Np^{239} (14K46, 13S49a); U^{238}-α-3n (8J49); Pu^{238}-n-γ (9R48, 19B48)
Pu^{240}	A chem, n-capt, mass spect (15C44, 14F46, 21B44)		α (8J49); β stable (cons energy) (HPS)	6580 y genet (3I51); 6240 y sp act (11W51); 6760 y sp act (10W51)	5.162 (76%), 5.118 (24%) spect (4A52e)	0.0496 spect conv, scint spect (3F52b)	Q_α 5.250 (4A52e)  (4A52e)	Pu^{239}-n-γ (15C44, 14F46, 21B44); U^{238}-α-2n (8J49)
Pu^{241}	A chem, n-capt, mass spect, excit, genet (13S49, 13S49b, 13G50)		β^- 99+%, α ~10^{-3}% (13S49, 3T50e)	14 y genet (3T50e)	α: 4.91 ion ch (3T50e); β^-: 0.021 spect (3F52b); ~0.02 abs (13S49)	γ_1 0.100, γ_2 0.145 ($\gamma_1/\gamma_2 \simeq 5$) scint spect (3F52b)	Q_α 5.15, Q_β^- 0.021 (13S53)	Pu^{240}-n-γ (13G50, 3T50e); U^{238}-α-n (13S49); parent Am^{241} (13S49, 16C49a); parent U^{237} (2K45, 13S49)
Pu^{242}	A chem, mass spect, n-capt, genet (3T50e)		α (3T50e); β stable (cons energy) (HPS)	~5×10^5 y genet (3T50e)	4.88 ion ch (3T50e)		Q_α 4.96 (13S53)	Pu^{241}-n-γ (3T50e, 3I49); daughter Am^{242m} (8O50a)
Pu^{243}	B chem, n-capt, cross bomb (25S51)		β^- (25S51)	4.98 h (81H52a); 5.0 h (25S51, 3T51)	0.39 spect (3T51); ~0.45 abs (25S51)	0.095, 0.12 spect conv (3T51)	Q_α 4.82 est, Q_β^- 0.67 est (13S53)	Pu^{242}-n-γ (25S51, 3T51); parent Am^{243} (3T51)
$_{95}Am^{237}$	B chem, excit (23H52a)		EC 99+%, α 0.005% (23H52a)	~1.3 h (23H52a)	6.01 ion ch (23H52a)		Q_α 6.20 est, Q_{EC} 1.6 est (13S53)	Pu^{239}-d-4n, Pu^{239}-p-3n (23H52a)
Am^{238}	B chem, excit (6S50a)		EC (6S50a); no α (lim 3×10^{-4}%) (23H52a)	2.1 h (23H52a)	conv (6S50a)		Q_α 5.99 est, Q_{EC} 2.22 est (13S53)	Pu^{239}-d-3n (6S50a, 23H52a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{95}Am^{239}$	B chem, excit (13S49)		EC 99+%, α 0.003% (23H52a)	12 h (13S49)	5.75 ion ch (23H52a)	0.3 (10%) scint spect (23H52a); 0.3 abs conv (13S49)	$Q_α$ 5.85, Q_{EC} 0.78 calc (13S53)	Np^{237}-α-2n (13S49); Pu^{239}-p-n (6S50a); Pu^{239}-d-2n (13S49, 23H52a); Pu^{239}-α-p3n (23H52a)
Am^{240}	B chem, excit (13S49); chem, excit, cross bomb (6S50a)		EC (13S49); no α (lim 0.2%) (23H52a)	50 h (13S49); 53 h (23H52a)		no γ >0.7 (23H52a)	$Q_α$ 5.76 est, $Q^-_β$ 0.02 est, Q_{EC} 1.54 est (13S53)	Np^{237}-α-n (13S49); Pu^{239}-d-n (13S49, 6S50a, 23H52a); Pu^{239}-α-p2n (23H52a)
Am^{241}	A chem, n-capt, excit, mass spect (13S49)		α (13S49); β stable (cons energy) (HPS)	470 y sp act (20H52a); 475 y sp act (16C50)	5.546 (0.23%), 5.535 (0.34%), 5.503 (0.21%), 5.476 (84.2%), 5.433 (13.6%), 5.379 (1.4%) spect (4A52); 5.48 ion ch (13G48c); 5.47 range air (8T49)	$γ_1$ 0.0597 (40%, e/γ <1.5, with Np^{237m}), $γ_2$ 0.0263 (2.8%, e/γ ≤20), $γ_3$ 0.0209, $γ_4$ 0.0173, $γ_5$ 0.0135 ($γ_1/γ_2/γ_3/γ_4/γ_5$ ≈ 1/0.069/0.155/0.56/0.32) ion ch, α-γ delay coinc (103B52); $γ_1$ 0.0598, $γ_2$ 0.0264 ($γ_1/γ_2$ ≈ 1/0.30) cryst spect (88B52a); 0.0590, 0.0414, 0.0264 spect conv, scint spect (3F52b); others (13S49, 8O51, 5P51, 15D52)	Am^{241}, I = 5/2 (38F52) $Q_α$ 5.639 (13S53)  (103B52)	daughter Pu^{241} (13S49,16C49a); parent Np^{237m} (103B52)
Am^{242m}	A chem, n-capt, genet (16M49, 13S49b)		$β^-$ 60%, EC (L) 20%, IT 20% (8O51)	16.01 h (44K52); 15.7 h (20H49a); 16 h (16M49)	0.628 spect (8O50a); 0.63 abs (15G50)	0.035, 0.038, 0.053 spect conv (8O51)	$Q^-_β$ 0.68 (HPS) $Q_α$ 5.44 calc, $Q^-_β$ 0.65, Q_{EC} 0.86 est (13S53)	Am^{241}-n-γ (16M49, 13S49); parent Cm^{242} (16M49, 13S49b); parent Pu^{242} (8O50a)
Am^{242}	A chem, genet, mass spect, n-capt (13S49, 6S50a)		$β^-$, EC, α (8O51); (α/$β^-$ 0.01) (6S50a)	~100 y genet (6S50a)	$β^-$: 0.593 spect (8O51); ~0.5 abs (13S49)	0.038, 0.053 spect conv (8O51)		Am^{241}-n-γ, parent Cm^{242}, parent Np^{238} (13S49, 6S50a, 13S49b)
Am^{243}	A chem, mass spect (6S50a)		α (6S50a)	~10^4 y genet (6S50a)	5.267 (~90%), 5.226 (~10%) spect (4A52a); 5.27 ion ch (13G51b)	0.075 (coinc with 90% of α) α-γ coinc, scint spect (4A52a); 0.076 scint spect (89M52a)	$Q_α$ 5.430, $Q^-_β$ 0.00 calc (13S53)	Am^{242}-n-γ, parent Np^{239} (6S50a); daughter Pu^{243} (3T51)
Am^{244}	B chem, n-capt (6S50a)		$β^-$ (6S50a)	~25 m (6S50a)				Am^{243}-n-γ (6S50a)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{96}Cm^{238}$	B chem, (6S48a); chem, genet (23H52a)		EC <90%, α >10% (75C52)	2.5 h (6S48a)	6.50 ion ch (6S48a)		$Q_α$ 6.61, Q_{EC} 0.8 est (13S53)	Pu^{239}-α-5n (6S48a); parent Pu^{234} (23H52a)
Cm^{239}	D chem, excit (75C52)		EC ~100%, no α (lim 0.1%) (75C52)	~3 h (75C52)			$Q_α$ 6.50 est, Q_{EC} 1.8 est (13S53)	Pu^{239}-α-4n (75C52)
Cm^{240}	A chem, genet (13S49b)		α (13S49b); no EC (lim 0.5%) (23H52)	26.8 d (13S49b); spont fission: 7.9×10^5 y (13G52)	6.25 ion ch (23H52); 6.3 range air (13S49b)		$Q_α$ 6.37 (13S53)	Th-C-4n (23H52a); Pu^{239}-α-3n (13S49b, 23H52)
Cm^{241}	B chem, excit (13S49b, 23H52)		EC 99+%, α 0.2% (23H52a)	35 d (23H52)	5.90 ion ch (23H52a)		$Q_α$ 6.3 est, Q_{EC} 0.9 est (13S53)	Pu^{239}-α-2n, Am^{241}-p-n (23H52, 23H52a)
Cm^{242}	A chem, genet (13S49b); mass spect (10R50)		α (13S49b); β stable (cons energy) (HPS)	162.5 d (24H50); 162 d (8J48a); spont fission: 7.2×10^6 y (24H51)	6.110 (73.7%), 6.066 (26.3%), 5.965 (0.035%) spect (4A52, 4A52d); 6.118 ion ch (20H52); 6.08 ion ch (13G48c)	0.043 spect conv (8O51); ~0.04 (e/γ ~600) α-γ coinc, scint spect (4A52d); ~0.045 (coinc with 23% of α) α-conv coinc emuls (15D52); ~0.04 (coinc with α) α-conv coinc (5P51)	see Np^{238} $Q_α$ 6.213 (13S53)  (4A52a)	Pu^{239}-α-n (13S49b); daughter Am^{242} (13S49b, 13G50); Am^{241}-d-n (3T50a); daughter Cf^{246} (25H51)
Cm^{243}	A chem, mass spect, genet (10R50)		α (10R50)	~100 y genet (3T50b)	5.985 (6.4%), 5.777 (80.5%), 5.732 (13.1%) spect (4A52d); 5.89 (15%), 5.79 (85%) ion ch (3T50b)	0.226, 0.277 (both γ's coinc with 5.777 α) scint spect (4A52d)	$Q_α$ 6.15 (4A52a) Q_{EC} 0.00 calc (13S53) see Np^{239}, Pu^{239m}  (4A52a)	Cm^{242}-n-γ (10R50); daughter Bk^{243} (3T50b)
Cm^{244}	A chem, mass spect (10R50)		α (10R50); β stable (cons energy) (HPS)	19 y (3T52); spont fission: 1.4×10^7 y (13G52)	5.798 (75%), 5.755 (25%) spect (4A52d)		$Q_α$ 5.895 (13S53)  (HPS)	daughter Am^{244}, Cm^{243}-n-γ (10R50)
Cm^{245}	B chem, decay charac, genet (25H51)		α (25H51)	>500 y (25H51)	~5.6 ion ch (25H51)			daughter Bk^{245} (25H51)

Isotope Z A	Class and identification	Percent abundance	Type of decay	Half-life	Energy of radiation in Mev: Particles	Energy of radiation in Mev: Gamma-transitions	Disintegration energy and scheme	Method of production and genetic relationships
$_{97}Bk^{243}$	A chem, n-capt, genet (3T50, 3T50b)		EC 99+%, α ~0.1% (3T50b)	4.6 h (3T50b)	6.72 (30%), 6.55 (53%), 6.20 (17%) ion ch (3T50b)		$Q_α$ 6.83, Q_{EC} 1.46 calc (13S53)	Am^{241}-α-2n (3T50, 3T50b); Cm^{242}-d-n (25H51); parent Cm^{243} (3T50b)
Bk^{244}	D chem, decay charac (3T52)		EC (3T52)	~5 h (3T52)			$Q_α$ 6.63 est, Q_{EC} 2.27 est (13S53)	Am^{241}-α-n (3T52)
Bk^{245}	B chem, excit, decay charac (25H51)		EC 99+%, α ~0.1% (25H51)	4.95 d (25H51)	6.33 (18%), 6.15 (48%), 5.90 (34%) ion ch (25H51)		$Q_α$ 6.44, Q_{EC} 0.67 est (13S53)	Am^{243}-α-2n (3T52); Cm^{244}-d-n, Cm^{242}-α-p (25H51); parent Cm^{245} (25H51)
$_{98}Cf^{244}$	B chem, excit, decay charac (3T50c)		α, EC (?) (3T50d)	45 m (3T50d)	7.15 ion ch (3T50d)		$Q_α$ 7.27, Q_{EC} 0.7 est (13S53)	U-C-6n (13G51c); Cm^{242}-α-2n (3T50c, 3T50d)
Cf^{246}	A chem, genet (13G51c)		α (13G51c); β stable (cons energy) (HPS)	35.7 h (25H51); spont fission: ~2000 y (3T52)	6.75 ion ch (13G51c)		$Q_α$ 6.86 (13S53)	U-C-4n (13G51c); Cm^{243}-α-n, Cm^{244}-α-2n (25H51); parent Cm^{242} (25H51)

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