

## 6.3 Properties of Radioactive Nuclides

- Column 1* Z = atomic number = number of protons.
- Column 2* Symbol and mass number = number of protons + number of neutrons. A bold font indicates a nuclide naturally occurring or otherwise available.
- Column 4* Total atomic mass, including electrons. For some nuclides data is also given for a meta state. For these rows, the nucleus' excitation energy is given within parentheses.
- Column 5* s = seconds, m= minutes, h = hours, d = days, a = years. Boldface indicates an important product in nuclear power plants.
- Column 6* Types of decay:  $\alpha$  = alpha particle,  $\beta^-$  = negative electron,  $\beta^+$  = positron,  $\epsilon$  = electron capture,  $\gamma$  = gamma ray, n = neutron, p = proton, d = deuteron, IT = isomeric transition, D = delayed radiation, SF = spontaneous fission,  $e^-$  = conversion electron,  $\beta^-\beta^-$  = double beta-decay, and C14 and Ne24 = particle emission. A value within parenthesis means weak decay mode intensity (abundance < 1 %).

For nuclides not mentioned in this table, information can be found on the internet:  
<http://www.dne.bnl.gov/CoN/index.html>



1	2	3	4	5	6
Z	Nuclide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
1	<b>H 3</b>	1/2 +	3.016049	<b>12.33 a</b>	$\beta^-$ 0.0186 (no $\gamma$ )
2	He 6	0 +	6.018888	807 ms	$\beta^-$ 3.510 (no $\gamma$ )
	He 8	0 +	8.033922	119 ms	$\beta^-$ 9.7, $\gamma$ 980.7
3	Li 8	2 +	8.022486	0.84 s	$\beta^-$ 12.5, ( $2\alpha$ 1.57)
	Li 9	3/2 -	9.026789	178 ms	$\beta^-$ 13.5, 11.0
4	<b>Be 7</b>	3/2 -	7.016929	53.3 d	$\epsilon$ , $\gamma$ 477.8
	Be 8	0 +	8.005305	0.07 fs	$2\alpha$ 0.0461
	Be 10	0 +	10.013534	1.6 Ma	$\beta^-$ 0.556 (no $\gamma$ )
	Be 11	1/2 +	11.021658	13.8 s	$\beta^-$ 11.5,... $\gamma$ 2124.5, 6791,...
5	B 8	2 +	8.024607	0.77 s	$\beta^+$ 14.1,...
	B 9	3/2 -	9.013329	0.85 as	p + 2 $\alpha$
	B 12	1 +	12.014352	20.2 ms	$\beta^-$ 13.37, ..., $\gamma$ 4439, ...
	B 13	3/2 -	13.017780	17.4 ms	$\beta^-$ 13.4, ... $\gamma$ 3680, n 3.61, 2.40, ...
	B 14	2 -	14.025404	13.8 ms	$\beta^-$ 14, ... $\gamma$ 6094, 6730
6	C 10	0 +	10.016853	19.3 s	$\beta^+$ 1.87, ... $\gamma$ 718.3, 1022
	C 11	3/2 -	11.011433	20.3 m	$\beta^+$ 0.960 (no $\gamma$ )
	<b>C 14</b>	0 +	14.003242	5730 a	$\beta^-$ 0.157 (no $\gamma$ )
	C 15	1/2 +	15.010599	2.45 s	$\beta^-$ 4.51, 9.82, ... $\gamma$ 5297.8, ...
	C 16	0 +	16.014701	0.75 s	$\beta^-$ 4.7, 7.9, n 0.81, 1.71
	C 17		17.022584	193 ms	$\beta^-$ , n 1.62, $\gamma$ 1375, 1849, 1906

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7	N 12	1+	12.018613	11.00 ms	$\beta^+$ 16.3, ... $\gamma$ 4439, ...
	N 13	1/2-	13.005739	9.97 m	$\beta^+$ 1.190
	N 16	2-	16.006100	7.13 s	$\beta^-$ 4.27, 10.44, ... $\gamma$ 6129, 7115, ... ( $\alpha$ 1.85, ...)
	N 17	1/2-	17.008450	4.17 s	$\beta^-$ 3.77, ... n 1.17, 0.38, ... $\gamma$ 870.7, 2184
	N 18	1-	18.014081	0.62 s	$\beta^-$ 9.4, $\gamma$ 1981.9, 1651.5, 821.7, ...
	N 19		19.017027	0.329 s	$\beta^-$ , $\gamma$ 96, 3138, 709, ...
8	O 14	0+	14.008595	70.60 s	$\beta^+$ 1.81, ... $\gamma$ 2312.7, ...
	O 15	1/2-	15.003066	122.2 s	$\beta^+$ 1.72 (no $\gamma$ )
	O 19	5/2+	19.003577	26.9 s	$\beta^-$ 3.3, 4.60, ... $\gamma$ 197.1, 1356.8, ...
	O 20	0+	20.004076	13.5 s	$\beta^-$ 2.75, ... $\gamma$ 1056.8, ...
	O 21		21.008655	3.4 s	$\beta^-$ 6.4, $\gamma$ 1730.3, 3517.4, 280.1, 1787.2, ...
9	F 17	5/2+	17.002095	64.5 s	$\beta^+$ 1.74 (no $\gamma$ )
	F 18	1+	18.000938	109.8 m	$\beta^+$ 0.635, $\epsilon$ (no $\gamma$ )
	F 20	2+	19.999981	11.00 s	$\beta^-$ 5.40, ... $\gamma$ 1636, ...
	F 21	5/2+	20.999949	4.16 s	$\beta^-$ 5.4, ... $\gamma$ 350.7, 1395.1, ...
	F 22	4+	22.002999	4.23 s	$\beta^-$ 5.5, ... $\gamma$ 1274.5, 2082.5, 2166.0, ...
10	Ne 17	1/2-	17.017698	109 ms	$\beta^+$ , p 4.59, 3.77, 5.12, ... $\gamma$ 495
	Ne 18	0+	18.005710	1.67 s	$\beta^+$ 3.42, ... $\gamma$ 1041, ...
	Ne 19	1/2+	19.001880	17.22 s	$\beta^+$ 3.24, $\epsilon$ , $\gamma$ 109.9, 1356.8
	Ne 23	5/2+	22.994467	37.2 s	$\beta^-$ 4.38, 3.95, ... $\gamma$ 439.8, ...
	Ne 24	0+	23.993615	3.38 s	$\beta^-$ 1.98, ... $\gamma$ 472.3D, ...
	Ne 25	1/2+	24.997790	0.61 s	$\beta^-$ 7.2, 6.3, ... $\gamma$ 89.5, 979.8, ...
11	Na 20	2+	20.007348	447 ms	$\beta^+$ 11.25, $\gamma$ 1633.6, ( $\alpha$ 2.15, 4.44)
	Na 21	3/2+	20.997665	22.48 s	$\beta^+$ 2.51, ... $\gamma$ 350.7
	Na 22	3+	21.994437	2.605 a	$\beta^+$ 0.546, $\epsilon$ , $\gamma$ 1274.5
	Na 24	4+	23.990963	14.96 h	$\beta^-$ 1.391, $\gamma$ 1368.6, 2754.0, ...
	Na 25	5/2+	24.989954	60 s	$\beta^-$ 3.8, ... $\gamma$ 947.7, 585.0, 387.7, 1611.7, ...
	Na 26	3+	25.992590	1.07 s	$\beta^-$ 7.4, ... $\gamma$ 1808.6, ...
	Na 27	5/2+	26.994009	0.290 s	$\beta^-$ 8.0, ... $\gamma$ 984.7, 1698.0, ... (n 0.46)
12	Mg 22	0+	21.999574	3.86 s	$\beta^+$ 3.1, ... $\gamma$ 582, 72.9, ...
	Mg 23	3/2+	22.994125	11.32 s	$\beta^+$ 3.09, ... $\gamma$ 439.8, ...
	Mg 27	1/2+	26.984341	9.45 m	$\beta^-$ 1.75, 1.59, ... $\gamma$ 843.8, 1014.4, ...
	Mg 28	0+	27.983877	21.0 h	$\beta^-$ 0.459, ... $\gamma$ 30.6, 1342.3, ...
	Mg 29	3/2+	28.988555	1.30 s	$\beta^-$ 5.4, ... $\gamma$ 2224.0, 1398.0, 960.4, ...
13	Al 25	5/2+	24.990429	7.17 s	$\beta^+$ 3.26, ... $\gamma$ 1611.7, ...
	Al 26	5+	25.986892	0.73 Ma	$\beta^+$ 1.17, $\epsilon$ , $\gamma$ 1808.6, ...
	Al 28	3+	27.981910	2.25 m	$\beta^-$ 2.86, ... $\gamma$ 1779.0
	Al 29	5/2+	28.980445	6.56 m	$\beta^-$ 2.5, ... $\gamma$ 1273.4, 2426, 2028, ...
14	Si 26	0+	25.992330	2.23 s	$\beta^+$ 3.83, ... $\gamma$ 829, 1622, ...
	Si 27	5/2+	26.986704	4.15 s	$\beta^+$ 3.85, ... ( $\gamma$ 2210, ...)
	Si 31	3/2+	30.975363	2.62 h	$\beta^-$ 1.48, ... $\gamma$ 1266.2
	Si 32	0+	31.974148	172 a	$\beta^-$ 0.221 (no $\gamma$ )
15	P 29	1/2+	28.981801	4.14 s	$\beta^+$ 3.94, $\gamma$ 1273.4, ...
	P 30	1+	29.978314	2.50 m	$\beta^+$ 3.24, $\epsilon$ , ( $\gamma$ 2235.2, ...)
	P 32	1+	31.973907	14.28 d	$\beta^-$ 1.709 (no $\gamma$ )
	P 33	1/2+	32.971725	25.3 d	$\beta^-$ 0.249 (no $\gamma$ )

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16	S 30	0+	29.984903	1.18 s	$\beta^+$ 4.42, 5.09... $\gamma$ 677.2...
	S 31	1/2+	30.979555	2.57 s	$\beta^+$ 4.39... $\gamma$ 1266.2...
	S 35	3/2+	34.969032	87.3 d	$\beta^-$ 0.1674 (no $\gamma$ )
	S 37	7/2-	36.971126	5.05 m	$\beta^-$ 1.76... $\gamma$ 3104.0...
17	Cl 33	3/2+	32.977452	2.511 s	$\beta^+$ 4.5... $\gamma$ 1966.2, 2866.3...
	Cl 34	3+	(146 keV)	32.2 m	$\beta^+$ 2.5, 1.3... $\gamma$ 2127.7, 1176.0... IT 146.4
	Cl 34	0+	33.973762	1.528 s	$\beta^+$ 4.47 (no $\gamma$ )
	Cl 36	2+	35.968307	0.301 Ma	$\beta^-$ , 0.709, $\epsilon$ , ( $\beta^+$ 0.12) (no $\gamma$ )
	Cl 38	2-	37.968011	37.2 m	$\beta^-$ 4.91, 1.11... $\gamma$ 2167.7, 1642.4...
	Cl 39	3/2+	38.968009	55.6 m	$\beta^-$ 1.91... $\gamma$ 1267.2, 250.3, 1517.5...
18	Ar 34	0+	33.980270	844 ms	$\beta^+$ 5.037... $\gamma$ 666.5, 3129, 461.0, 2580
	Ar 35	3/2+	34.975257	1.77 s	$\beta^+$ 4.943... $\gamma$ 1219.2, (1763.0), 2693.6...
	Ar 37	3/2+	36.966776	35.0 d	$\epsilon$ (no $\gamma$ )
	Ar 39	7/2-	38.964313	269 a	$\beta^-$ 0.565 (no $\gamma$ )
	Ar 41	3/2+	40.964501	1.82 h	$\beta^-$ 1.198, 2.5... $\gamma$ 1293.6...
	Ar 42	2-	41.963035	32.9 a	$\beta^-$ 0.6, (no $\gamma$ )
19	K 37	3/2+	36.973377	1.23 s	$\beta^+$ 5.13... $\gamma$ 2796...
	K 38	3+	37.969080	7.63 m	$\beta^+$ 2.68... $\gamma$ 2167.7...
	<b>K 40</b>	4-	39.963999	1.28 Ga	$\beta^-$ 1.33, $\epsilon$ , $\gamma$ 1460.8, ( $\beta^+$ )
	K 42	2-	41.962403	12.36 h	$\beta^-$ 3.52... $\gamma$ 1524.6...
	K 43	3/2+	42.960716	22.3 h	$\beta^-$ 0.83, 1.8... $\gamma$ 372.8, 617.5...
20	Ca 38	0+	37.976319	0.44 s	$\beta^+$ 5.6, $\gamma$ 1568...
	Ca 39	3/2+	38.970718	861 ms	$\beta^+$ 5.49... ( $\gamma$ 2522)
	Ca 41	7/2-	40.962278	0.103 Ma	$\epsilon$ (no $\gamma$ )
	Ca 45	7/2-	44.956186	162.7 d	$\beta^-$ 0.258... ( $\gamma$ 12.4D)
	Ca 47	7/2-	46.954546	4.536 d	$\beta^-$ 0.694, 1.990... $\gamma$ 1297.1, 808, 489...
	Ca 49	3/2-	48.955673	8.72 m	$\beta^-$ 2.18, 2.9... $\gamma$ 3084.4, 4072...
21	Sc 43	7/2-	42.961151	3.89 h	$\beta^+$ 1.20, 0.82... $\epsilon$ , $\gamma$ 372.8...
	Sc 44	6+	(271 keV)	2.44 d	IT 271.2, $\epsilon$ , $\gamma$ 1001.8, 1226.1, 1157.0
	Sc 44	2+	43.959403	3.93 h	$\beta^+$ 1.47, $\epsilon$ , $\gamma$ 1157.0...
	Sc 46	1-	(143 keV)	18.7 s	IT 142.5
	Sc 46	4+	45.955170	83.8 d	$\beta^-$ 0.357... $\gamma$ 1120.5, 889.3...
	Sc 47	7/2-	46.952408	3.349 d	$\beta^-$ 0.439, 0.600... $\gamma$ 159.4
	Sc 48	6+	47.952235	43.7 h	$\beta^-$ 0.66... $\gamma$ 983.5, 1312.1, 1037.5...
22	Ti 44	0+	43.959690	49 a	$\epsilon$ , $\gamma$ 78.4D, 67.8D...
	Ti 45	7/2-	44.958124	3.078 h	$\beta^+$ 1.04... $\epsilon$ , $\gamma$ (719.4), 1407.8...
	Ti 51	3/2-	50.946616	5.76 m	$\beta^-$ 2.14... $\gamma$ 320.1, 928...
	Ti 52	0+	51.946898	1.7 m	$\beta^-$ 1.8... $\gamma$ 124.5, 17.0, $e^-$
23	V 47	3/2-	46.954907	32.6 m	$\beta^+$ 1.89... $\epsilon$ , $\gamma$ 1794.0...
	V 48	4+	47.952254	15.98 d	$\beta^+$ 0.694... $\epsilon$ , $\gamma$ 983.5, 1312.1, 944...
	V 49	7/2-	48.948517	337 d	$\epsilon$ (no $\gamma$ )
	<b>V 50</b>	6+	49.947163	144 Pa	$\epsilon$ , $\gamma$ 1553.8, ( $\beta^-$ , $\gamma$ 783)
	V 52	3+	51.944780	3.76 m	$\beta^-$ 2.47... $\gamma$ 1434.1...
	V 53	7/2-	52.944342	1.61 m	$\beta^-$ 2.5... $\gamma$ 1006.2, 1289...

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Z	Nu- clide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
24	Cr 48	0+	47.954036	21.6 h	$\epsilon, \beta^+, \gamma$ 308.3, 112.4,...
	Cr 49	5/2-	48.951341	42.3 m	$\beta^+$ 1.39, 1.45,.... $\gamma$ 90.6, 152.9, 62.3,....
	Cr 51	7/2-	50.944772	27.70 d	$\epsilon, \gamma$ 320.1
	Cr 55	3/2-	54.940844	3.497 m	$\beta^-$ 2.49,.... $\gamma$ 1528.1,....
	Cr 56	0+	55.940645	5.9 m	$\beta^-$ 1.5,.... $\gamma$ 83.9, 26.6,....
25	Mn 52	2+	(378 keV)	21.1 m	$\beta^+$ 2.63,.... $\epsilon, \gamma$ 1434.1,.... IT 377.7
	Mn 52	6+	51.945570	5.591 d	$\epsilon, \beta^+$ 0.575,.... $\gamma$ 1434.1, 935.5, 744.2,....
	Mn 53	7/2-	52.941294	3.7 Ma	$\epsilon$ (no $\gamma$ )
	Mn 54	3+	53.940363	312 d	$\epsilon, \gamma$ 834.8
	Mn 56	3+	55.938909	2.578 h	$\beta^-$ 2.84, 1.04,.... $\gamma$ 846.8, 1810.8, 2113.1,....
	Mn 57	5/2-	56.938287	1.45 m	$\beta^-$ 2.55,.... $\gamma$ 122.1, 14.4, 692.0,....
	26	Fe 52	12+	(6820 keV)	46 s
Fe 52		0+	51.948116	8.28 h	$\beta^+$ 0.80, $\epsilon, \gamma$ 168.7,....
Fe 53		19/2-	(3040 keV)	2.6 m	IT 701.2,.... $\gamma$ 1328.2, 1011.6, 2340,....
Fe 53		7/2-	52.945312	8.51 m	$\beta^+$ 2.8, 2.4,.... $\epsilon, \gamma$ 377.9,....
Fe 55		3/2-	54.938298	2.73 a	$\epsilon$ (no $\gamma$ )
Fe 59		3/2-	58.934880	44.51 d	$\beta^-$ 0.466, 0.271,.... $\gamma$ 1099.2, 1291.6,....
Fe 60		0+	59.934077	1.5 Ma	$\beta^-$ 0.147, $\gamma$ 58.6D, $e^-$
Fe 61			60.936749	6.0 m	$\beta^-$ 2.8, 2.6,.... $\gamma$ 1205.1, 1027.5, 297.9,....
27		Co 56	4+	55.939844	77.26 d
	Co 57	7/2-	56.936296	271.8 d	$\epsilon, \gamma$ 122.1, 136.5, 14.4,....
	Co 58	5+	(25 keV)	9.0 h	IT 24.9, $e^-$
	Co 58	2+	57.935757	70.88 d	$\epsilon, \beta^+$ 0.474,.... $\gamma$ 810.8,....
	Co 60	2+	(59 keV)	10.47 d	IT 58.6, $e^-$ ( $\beta^-$ 1.6,....), $\gamma$ (1332.5),....
	Co 60	5+	59.933822	5.271 a	$\beta^-$ 0.318, 1.5,.... $\gamma$ 1332.5, 1173.2,....
	Co 61	7/2-	60.932479	1.650 h	$\beta^-$ 1.22,.... $\gamma$ 67.4,....
	28	Ni 56	0+	55.942136	6.10 d
Ni 57		3/2-	56.939800	35.6 h	$\epsilon, \beta^+$ 0.85,.... $\gamma$ 1377.8, 1920,....
Ni 59		3/2-	58.934351	0.076 Ma	$\epsilon$ (no $\gamma$ )
Ni 63		1/2-	62.929673	100 a	$\beta^-$ 0.0669 (no $\gamma$ )
Ni 65		5/2-	64.930088	2.517 h	$\beta^-$ 2.14, 6.5,.... $\gamma$ 1481.9, 1115.5,....
29		Cu 61	3/2-	60.933462	3.35 h
	Cu 62	1+	61.932587	9.74 m	$\beta^+$ 2.93,.... $\epsilon, \gamma$ 1173.0, 875.7,....
	Cu 64	1+	63.292768	12.701 h	$\epsilon, \beta^-$ 0.578, $\beta^+$ 0.651, $\gamma$ 1345.8
	Cu 66	1+	65.928873	5.10 m	$\beta^-$ 2.63,.... $\gamma$ 1039.3,....
	Cu 67	3/2-	66.927750	2.580 d	$\beta^-$ 0.39, 0.48, 0.58,.... $\gamma$ 184.6, 93.3D,....
	30	Zn 62	0+	61.934334	9.22 h
Zn 63		3/2-	62.933215	38.5 m	$\beta^+$ 2.32,.... $\epsilon, \gamma$ 669.7, 962.1, 1412,....
Zn 65		5/2-	64.929245	243.8 d	$\epsilon, \gamma$ 1115.5,.... ( $\beta^+$ 0.325)
Zn 69		9/2+	(439 keV)	13.76 h	IT 438.6, $\beta^-$ , $\gamma$ 574.1
Zn 69		1/2-	68.926553	56 m	$\beta^-$ 0.90,.... $\gamma$ 318.5,....
Zn 72		0+	71.926861	46.5 h	$\beta^-$ 0.30,.... $\gamma$ 144.7,....

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31	Ga 67	3/2 -	66.928205	3.260 d	$\epsilon, \gamma$ 93.3D, 184.6, 300.2...
	Ga 68	1 +	67.927983	67.7 m	$\beta^+$ 1.899, ... $\epsilon, \gamma$ 1077.3, ...
	Ga 70	1 +	69.926027	21.1 m	$\beta^-$ 1.65, ... $\gamma$ 1039.3, 176.2, ... ( $\epsilon$ )
	Ga 72	3 -	71.926372	14.10 h	$\beta^-$ 0.96, 0.64, ... $\gamma$ 834.1, 2201.7, 630.0, ...
	Ga 73	3/2 -	72.925170	4.87 h	$\beta^-$ 1.2, ... $\gamma$ 297.3, 325.7, 53.4D, 13.3D, ... $e^-$
32	Ge 68	0 +	67.928097	270.8 d	$\epsilon$ (no $\gamma$ )
	Ge 69	5/2 -	68.927972	39.1 h	$\epsilon, \beta^+$ 1.21, ... $\gamma$ 1106.8, 574.1, 872.0, ...
	Ge 71	1 -	70.924954	11.4 d	$\epsilon$ (no $\gamma$ )
	Ge 75	7/2 +	(140 keV)	48 s	IT 139.6, ... $e^-, \beta^-$ ( $\gamma$ )
	Ge 75	1/2 -	74.922860	82.80 m	$\beta^-$ 1.19, ... $\gamma$ 264.7, ...
	<b>Ge 76</b>	0 +	75.921401	~ 1.5 Za	$\beta^- \beta^-$
	Ge 77	1/2 -	(160 keV)	53 s	$\beta^-$ 2.9, ... $\gamma$ 215.5, ... IT 159.7
	Ge 77	7/2 +	76.923549	11.30 h	$\beta^-$ 2.20, 1.38, ... $\gamma$ 264.4, 211.0, 215.5, ...
33	As 71	5/2 -	70.927115	2.72 d	$\epsilon, \beta^+$ 0.81, ... $\gamma$ 175.0, ...
	As 72	2 -	71.926753	26.0 h	$\beta^+$ 2.48, 3.3, ... $\epsilon, \gamma$ 834.1, 630, ...
	As 73	3/2 -	72.923825	80.3 d	$\epsilon, \gamma$ 53.4D, 13.3D, $e^-$
	As 74	2 -	73.923929	17.78 d	$\epsilon, \beta^+$ 0.941, ... $\gamma$ 595.9, ... $\beta^-$ 1.350, 0.717, $\gamma$ 634.8, ...
	As 76	2 -	75.922394	26.3 h	$\beta^-$ 2.97, 2.41, ... $\gamma$ 559.1, ...
	As 77	3/2 -	76.920648	38.8 h	$\beta^-$ 0.68, ... $\gamma$ 239.0, ...
	34	Se 72	0 +	71.927112	8.5 d
Se 73		3/2 -	(26 keV)	40 m	IT 25.7, $e^-, \beta^+$ 1.7, ... $\epsilon, \gamma$ 67.1, 253.9, 84.3, ...
Se 73		9/2 +	72.926767	7.1 h	$\beta^+$ 1.32, ... $\epsilon, \gamma$ 361.0, 67.1, ...
Se 75		5/2 +	74.922524	119.78 d	$\epsilon, \gamma$ 264.7, 136.0, 279.5, ...
Se 79		7/2 +	78.918500	$\leq$ 65 ka	$\beta^-$ 0.16 (no $\gamma$ )
Se 81		7/2 +	(103 keV)	57.3 m	IT 103.0, ( $\beta^-$ ), $\gamma$ (260), 276, ...
Se 81		1/2 -	80.917993	18.5 m	$\beta^-$ 1.58, ... $\gamma$ 276.0, 290.1, ...
<b>Se 82</b>		0 +	81.916700	~ 0.11 Za	$\beta^- \beta^-$
35		Br 77	3/2 -	76.921380	2.376 d
	Br 78	1 +	77.921146	6.45 m	$\beta^+$ 2.5, ... $\epsilon, \gamma$ 613.7, ... ( $\beta^-, \gamma$ )
	Br 80	5 -	(86 keV)	4.42 h	IT 48.8, $e^-, \gamma$ 37.1, ...
	Br 80	1 +	79.918530	17.66 m	$\beta^-$ 2.00, $\gamma$ 616.6, $\epsilon, \beta^+$ 0.85, $\gamma$ 665.9, ...
	Br 82	2 -	(46 keV)	6.1 m	IT 45.9, $e^-, \beta^-$ ( $\gamma$ 776.5, ...)
	Br 82	5 -	81.916805	35.31 h	$\beta^-$ 0.444, ... $\gamma$ 776.5, 554.3, 619.1, ...
	Br 83	3/2 -	82.915181	2.40 h	$\beta^-$ 0.93, ... $\gamma$ 9.4D( $e^-$ ), 32.2D( $e^-$ ), 526.6, ...
	36	Kr 76	0 +	75.925950	14.8 h
Kr 77		5/2 +	76.924669	74.4 m	$\beta^+$ 1.88, 1.70, ... $\epsilon, \gamma$ 129.7, 146.4, ...
Kr 79		1/2 -	78.920083	34.92 h	$\epsilon, \beta^+$ 0.60, ... $\gamma$ 261.3, 397.5, 606.1, ...
Kr 81		7/2 +	80.916593	0.213 Ma	$\epsilon, \gamma$ 276.0
Kr 85		1/2 -	(305 keV)	4.48 h	$\beta^-$ 0.839, $\gamma$ 151.2, IT 304.9
Kr 85		9/2 +	84.912530	<b>10.73 a</b>	$\beta^-$ 0.687, ... ( $\gamma$ 514.0D)
Kr 87		5/2 +	86.913359	76.2 m	$\beta^-$ 3.5, 3.9, ... $\gamma$ 402.6, 2555, ...

T-6.3 Properties of Radioactive Nuclides

1	2	3	4	5	6
Z	Nuclide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
					$\epsilon, \gamma$ 520.4, 529.6, 552.6,...
37	Rb 83	5/2-	82.915114 (464 keV)	82.2 d	IT 216.1, 464.3, $\gamma$ 248.2
	Rb 84	6-	83.914385	20.3 m	$\epsilon, \beta^+$ 1.66, 0.78, ... $\gamma$ 881.7, ... $\beta^-$ 0.892
	Rb 84	2-	85.911167	32.9 d	$\beta^-$ 1.775, ... $\gamma$ 1076.7, ( $\epsilon$ )
	Rb 86	2-	85.911167	18.65 d	$\beta^-$ 0.273 (no $\gamma$ )
	Rb 87	3/2-	86.909184	47.5 Ga	$\beta^-$ 5.31, ... $\gamma$ 1836.1, 898.1, ...
	Rb 88	2-	87.911319	17.7 m	$\beta^-$ 5.31, ... $\gamma$ 1836.1, 898.1, ...
					$\epsilon$ (no $\gamma$ )
38	Sr 82	0+	81.918401	25.36 d	$\epsilon, \beta^+$ 1.23, ... $\gamma$ 762.7, 381.5, ...
	Sr 83	7/2+	82.917555 (239 keV)	1.350 d	IT 238.7, ... $\gamma$ 231.7, $\epsilon, \gamma$ 151.2
	Sr 85	1/2-	84.912933	1.127 h	$\epsilon, \gamma$ 514.0D, ...
	Sr 85	9/2+	84.912933	64.84 d	$\beta^-$ 1.49, ... $\gamma$ 909.2D, ...
	Sr 89	5/2+	88.907453	50.52 d	$\beta^-$ 0.546 (no $\gamma$ )
	Sr 90	0+	89.907738	<b>29.1 a</b>	$\beta^-$ 0.546 (no $\gamma$ )
					$\epsilon, \beta^+$ (0.8), ... $\gamma$ 484.8, 388.5D, ...
39	Y 87	1/2-	86.910878	3.35 d	$\epsilon, \beta^+$ (0.76), $\gamma$ 1836.1, 898.1, ...
	Y 88	4-	87.909504	106.6 d	IT 479.5, $\gamma$ 202.5, ( $\beta^-$ ), $\gamma$ 2318.9D, ...
	Y 90	7+	(682 keV)	3.19 h	$\beta^-$ 2.281, ... $\gamma$ (2186.2)
	Y 90	2-	89.907151	2.67 d	$\beta^-$ 1.545, ... $\gamma$ 1205
	Y 91	1/2-	90.907303	58.5 d	$\beta^-$ 1.545, ... $\gamma$ 1205
					$\epsilon, \gamma$ 392.9D
40	Zr 88	0+	87.910226	83.4 d	$\epsilon, \beta^+$ 0.90, $\gamma$ 909.2D, ...
	Zr 89	9/2+	88.908889	3.27 d	$\beta^-$ 0.060, $\gamma$ 30.4D
	Zr 93	5/2+	92.906475	1.53 Ma	$\beta^-$ 0.366, 0.400, ... $\gamma$ 756.7, 724.2, ...
	Zr 95	5/2+	94.908043	64.02 d	$\beta^-$ 1.92, ... $\gamma$ 743.3D, ...
	Zr 97	1/2+	96.910951	16.8 h	$\beta^-$ 1.92, ... $\gamma$ 743.3D, ...
					IT 104.5, $e^-$ , $\epsilon, \gamma$ 1205
41	Nb 91	1/2-	(104 keV)	62 d	$\epsilon, (\beta^+)$
	Nb 91	9/2+	90.906990	680 a	$\epsilon, (\beta^+), \gamma$ 934.5
	Nb 92	2+	(135 keV)	10.13 d	$\epsilon, \gamma$ 561.1, 934.5
	Nb 92	7+	91.907193	35 Ma	IT 30.4, $e^-$
	Nb 93	1/2-	(031 keV)	16.1 a	$\beta^-$ 0.473, $\gamma$ 871.1, 702.6
	Nb 94	6+	93.907283	0.020 Ma	IT 235.7, $\beta^-$ 1.16, ... $\gamma$ 204.1, ...
	Nb 95	1/2-	(236 keV)	3.61 d	$\beta^-$ 0.160, ... $\gamma$ 765.8, ...
	Nb 95	9/2+	94.906835	34.97 d	$\beta^-$ 0.160, ... $\gamma$ 765.8, ...
42	Mo 90	0+	89.913936	5.7 h	$\epsilon, \beta^+$ 1.085, $\gamma$ 257.9, 122.9D, ...
	Mo 91	9/2+	90.911751	15.5 m	$\beta^+$ 3.44, ... $\epsilon, \gamma$ 1637.0, 1581.2, ...
	Mo 93	5/2+	92.906811	3.50 ka	$\epsilon, (\gamma$ 30.4D)
	Mo 99	1/2+	98.907712	2.7476 d	$\beta^-$ 1.214, ... $\gamma$ 140.5D, 739.5, ...
	Mo 101	1/2+	100.910347	14.6 m	$\beta^-$ 0.7, 2.23, ... $\gamma$ 191.9, 590.9, 1012.5, 506.0, ...
43	Tc 95	1/2-	(39 keV)	61 d	$\epsilon, \gamma$ 204.1, 582.1, 835.1, ... IT 38.9, $e^-$ , $\beta^+$ (0.71) 0.51
	Tc 95	9/2+	94.907657	20.0 h	$\epsilon, \gamma$ 765.8
	Tc 96	7+	95.907871	4.3 d	$\epsilon, \gamma$ 778.2, 849.9, 812.5, ...
	Tc 97	1/2-	(97 keV)	90 d	IT 96.5, $e^-$
	Tc 97	9/2+	96.906365	2.6 Ma	$\epsilon$ (no $\gamma$ )
	Tc 98	6+	97.907215	4.2 Ma	$\beta^-$ 0.40, $\gamma$ 745.4, 652.4
	Tc 99	9/2+	98.906254	<b>0.213 Ma</b>	$\beta^-$ 0.292, ( $\gamma$ 89.7)
	Tc 100	1+	99.907658	15.8 s	$\beta^-$ 3.4, 2.9, ... $\gamma$ 539.5, 590.8, ...

T-6.3 Properties of Radioactive Nuclides

1	2	3	4	5	6
Z	Nuclide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
					$\epsilon, \gamma$ 367, 892,...
					$\epsilon, \beta^+$ 1.20, 0.91, ..., $\gamma$ 336.4, 1096.9, 626.9,...
44	Ru 94	0+	93.911360	52 m	$\epsilon, \gamma$ 215.7, 324.5,...
	Ru 95	5/2+	94.910413	1.64 h	$\beta^-$ 0.223, ..., $\gamma$ 497.1,...
	Ru 97	5/2+	96.907555	2.89 d	$\beta^-$ 1.187, 1.11, 1.8, ..., $\gamma$ 724.3, 469.4, 676.3,...
	Ru 103	3/2+	102.906324	39.27 d	$\beta^-$ 0.0394 (no $\gamma$ )
	Ru 105	3/2+	104.907750	4.44 h	
	Ru 106	0+	105.907327	<b>372.6 d</b>	
					$\epsilon, \gamma$ 306.9, 545, ..., IT 157.3, $e^-$
					$\epsilon, \gamma$ 127.2, 198.0, ...
45	Rh 101	9/2+	(157 keV)	4.35 d	$\epsilon, \gamma$ 475.1, 631.3, 697.5, ..., IT 42, $e^-$
	Rh 101	1/2-	100.906163	3.3 a	$\epsilon, \beta^-$ 1.15, ..., $\beta^+$ 1.30, 0.82, ..., $\gamma$ 475.1, ...
	Rh 102	6+	(141 keV)	~ 2.9 a	IT 77.5( $e^-$ ), 31.8( $e^-$ ), $\gamma$ 51.4, 91.7, ( $\beta^-$ 1.3), $\gamma$ 555.8
	Rh 102	2-	101.906843	207 d	
	Rh 104	5+	(129 keV)	4.36 m	$\beta^-$ 2.44, ... ( $\epsilon$ ), $\gamma$ 555.8, ...
					IT 129.6
	Rh 104	1+	103.906655	42.3 s	$\beta^-$ 0.566, 0.248, ..., $\gamma$ 319.2, ...
	Rh 105	1/2-	(130 keV)	40 s	
	Rh 105	7/2+	104.905692	35.4 h	
					$\epsilon, \gamma$ 84.0, 74.7, ...
46	Pd 100	0+	99.908505	3.7d	$\epsilon, \beta^+$ 0.776, ..., $\gamma$ 296.3, 590.5, ...
	Pd 101	5/2+	100.908289	8.4 h	$\epsilon, \gamma$ 38.8D ( $e^-$ ) 357.5, ...
	Pd 103	5/2+	102.906087	16.99 d	$\beta^-$ 0.040 (no $\gamma$ )
	Pd 107	5/2+	106.905129	6.5 Ma	$\beta^-$ 1.028, ..., $\gamma$ 88.0D, ...
	Pd 109	5/2+	108.905954	13.5 h	IT 172.2, $\beta^-$ 0.35, 0.77, ..., $\gamma$ 70.4, 391.2, ...
	Pd 111	11/2-	(172 keV)	5.5 h	$\beta^-$ 2.2, ..., $\gamma$ (580.0), 70.4, ...
	Pd 111	5/2+	110.907644	23.4 m	
					$\epsilon, \gamma$ 344.5, 280.5, ... ( $\beta^+$ )
47	Ag 105	1/2-	104.906528	41.3 d	$\epsilon, \gamma$ 511.9, 1046, ...
	Ag 106	6+	(90 keV)	8.4 d	$\beta^+$ 1.96, ... $\epsilon, \gamma$ 51.9, ... $\beta^-$
	Ag 106	1+	105.906666	24.0 m	$\epsilon, \beta^+, \gamma$ 722.9, 433.9, 614.3, IT 30.4, $e^-$
	Ag 108	6+	(109 keV)	130 a	$\beta^-$ 1.65, $\gamma$ 633.0, $\epsilon, \beta^+$ 0.88, $\gamma$ (433.9), 618.8, ...
	Ag 108	1+	107.905954	2.39 m	$\beta^-$ 0.087, 0.530, ..., $\gamma$ 657.8, 884.7, ... IT 116.5 $e^-$
	Ag 110	6+	(117 keV)	249.8 d	$\beta^-$ 2.981, ..., $\gamma$ 657.8, ...
	Ag 110	1+	109.906111	24.6 s	
					$\epsilon, (\beta^+ 0.29), \gamma$ 83.5, 709.3, ...
48	Cd 104	0+	103.909848	58 m	$\epsilon, \beta^+$ 1.69, ..., $\gamma$ 961.8, 346.6, 1302.5, ...
	Cd 105	5/2+	104.909468	55.5 m	$\epsilon, \gamma$ 91.3D, 828.9, ... ( $\beta^+ 0.302$ )
	Cd 107	5/2+	106.906614	6.52 h	$\epsilon, \gamma$ 88.0D, $e^-$
	Cd 109	5/2+	108.904985	462.6 d	$\beta^-$ 0.59, (IT 263.7)
	Cd 113	11/2-	(264 keV)	14.1 a	$\beta^-$ 0.3
	<b>Cd 113</b>	1/2+	122.904402	9 Pa	$\beta^-$ 1.62, ..., $\gamma$ 933.8, 1290.6, ...
	Cd 115	11/2-	(181 keV)	44.6 d	$\beta^-$ 1.31, 0.593, ..., $\gamma$ 336.3D, 527.9, ...
	Cd 115	1/2+	114.905431	2.228 d	$\beta^-$ 0.67, 2.2, ..., $\gamma$ 315.3D, 273.3, 1303.3, ...
	Cd 117	1/2+	116.907218	2.49 h	
49	In 111	9/2+	110.905111	2.8049 d	$\epsilon, \gamma$ 245.4, 171.3, ...
	In 114	5+	(190 keV)	49.51 d	IT 190.3, $\epsilon, \gamma$ 558.4, 725.2
	In 114	1+	113.904917	1.198 m	$\beta^-$ 1.984, ..., $\gamma$ 1299.9, $\epsilon, (\beta^+ 0.40), \gamma$ 558.4, 576, ...
	<b>In 115</b>	9+	114.903878	0.44 Pa	$\beta^-$ 0.49 (no $\gamma$ )
50	Sn 110	0+	109.907853	4.1 h	$\epsilon, \gamma$ 283
	Sn 111	7/2+	110.907735	35 m	$\epsilon, \beta^+$ 1.5, ..., $\gamma$ 1153.0, 1915.0, 762.0, 1610.5, ...
	Sn 113	1/2+	112.905174	115.1 d	$\epsilon, \gamma$ 391.7D, ...

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1	2	3	4	5	6
Z	Nu- clide	Spin and parity $\pi$	Mass	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
	Sn 121	11/2 -	(6 keV)	55 a	IT 6.3, $e^-$ , $\beta^-$ 0.35, $\gamma$ 37.1, $e^-$
	Sn 121	3/2 +	120.904237	1.128 d	$\beta^-$ 0.383 (no $\gamma$ )
	Sn 123	11/2 -	122.905722	129.2 d	$\beta^-$ 1.42, ..., $\gamma$ 1088.6, ...
	Sn 125	11/2 -	124.907785	9.63 d	$\beta^-$ 2.35, ..., $\gamma$ 1067.0, 1089.2, 822.4, 915.5, ...
	Sn 126	0 +	125.907654	<b>0.1 Ma</b>	$\beta^-$ 0.25, $\gamma$ 87.6, ...
51	Sb 119	5/2 +	118.903947	38.1 h	$\epsilon$ , $\gamma$ 23.9, $e^-$
	Sb 120	8 -	(0 keV)	5.76 d	$\epsilon$ , $\gamma$ 1171.4, 1023.1, 197.3D, 89.8, ...
	Sb 120	1 +	119.902197	15.89 m	$\epsilon$ , $\beta^+$ 1.72, ..., $\gamma$ 1171.4, ...
	Sb 122	2 -	121.905175	2.70 d	$\beta^-$ 1.414, 1.980, ..., $\gamma$ 564.1, $\epsilon$ , $\beta^+$ 0.57
	Sb 124	3 -	123.905938	60.20 d	$\beta^-$ 0.61, 2.301, ..., $\gamma$ 602.7, 1691.0, ...
	Sb 125	7/2 +	124.905248	<b>2.758 a</b>	$\beta^-$ 0.302, 0.13, ..., $\gamma$ 427.9, 600.5, 635.9, 463.4, ...
52	Te 118	0 +	117.905825	6.00 d	$\epsilon$ (no $\gamma$ )
	Te 119	11/2 -	(261 keV)	4.69 d	$\epsilon$ , ( $\beta^+$ ), $\gamma$ 153.6, 1212.7, 270.5, ...
	Te 119	1/2 +	118.906408	16.0 h	$\epsilon$ , $\beta^+$ 0.627, ..., $\gamma$ 644.0, 700, ...
	Te 121	11/2 -	(294 keV)	154 d	IT 818.8, $e^-$ , $\gamma$ 212.2, $\epsilon$ , $\gamma$ 1102.2, 37.1 ( $e^-$ ), ...
	Te 121	1/2 +	120.904930	16.8 h	$\epsilon$ , $\gamma$ 573.1, 507.6, ...
	Te 123	11/2 -	(248 keV)	119.7 d	IT 88.5, $e^-$ , $\gamma$ 159.0
	<b>Te 123</b>	1/2 +	122.904273	12 Ta	$\epsilon$ (no $\gamma$ )
	Te 127	11/2 -	(88 keV)	109 d	IT 88.3, $e^-$ , $\beta^-$ 0.7, $\gamma$ 57.6, ...
	Te 127	3/2 +	126.905217	9.4 h	$\beta^-$ 0.69, ..., $\gamma$ 417.9, (360.3), ...
	Te 132	0 +	131.908524	<b>3.27 d</b>	$\beta^-$ 0.215, ..., $\gamma$ 228.3, 49.7, ...
53	I 124	2 -	123.906211	4.18 d	$\epsilon$ , $\beta^+$ 2.14, 1.53, ..., $\gamma$ 602.7, ...
	I 125	5/2 +	124.904624	60.1 d	$\epsilon$ , $\gamma$ 35.5, $e^-$
	I 126	2 -	125.905619	13.0 d	$\epsilon$ , $\beta^-$ 0.87, ..., $\gamma$ 388.6, ..., $\beta^+$ (1.13), ...
	I 128	1 +	127.905805	25.0 m	$\beta^-$ 2.13, ..., $\gamma$ 442.9, ..., $\epsilon$ , ( $\beta^+$ ), ( $\gamma$ 743.4)
	I 129	7/2 +	128.904988	15.7 Ma	$\beta^-$ 0.15, $\gamma$ 39.6, $e^-$
	I 130	5 +	129.906674	12.36 h	$\beta^-$ 1.04, 0.62, ..., $\gamma$ 536.1, 668.6, 739.5
	I 131	7/2 +	130.906124	8.040 d	$\beta^-$ 0.606, ..., $\gamma$ 264.5, ...
	I 132	4 +	131.907995	<b>2.28 h</b>	$\beta^-$ 1.22, 2.16, ..., $\gamma$ 667.7, 772.7, ...
54	Xe 127	1/2 +	126.905180	36.4 d	$\epsilon$ , $\gamma$ 202.9, 172.1, ...
	Xe 133	3/2 +	132.905906	5.243 d	$\beta^-$ 0.346, ..., $\gamma$ 81.0, ...
	Xe 135	3/2 +	134.907208	9.10 h	$\beta^-$ 0.91, ..., $\gamma$ 249.8, ...
55	Cs 131	5/2 +	130.905460	9.69 d	$\epsilon$ (no $\gamma$ )
	Cs 132	2 -	131.906430	6.48 d	$\epsilon$ , $\beta^+$ 0.40, ..., $\gamma$ 667.7, ..., $\beta^-$ 0.8, $\gamma$ 464.5, ...
	Cs 134	4 +	133.906714	<b>2.065 a</b>	$\beta^-$ 0.658, 0.089, ..., $\gamma$ 604.7, 795.8, ..., $\epsilon$ , ( $\beta^+$ )
	Cs 135	7/2 -	134.905972	2.3 Ma	$\beta^-$ 0.21 (no $\gamma$ )
	Cs 136	5 +	135.907306	13.16 d	$\beta^-$ 0.341, ..., $\gamma$ 818.5, 1048.1, 340.6, ...
	Cs 137	7/2 +	136.907084	<b>30.17 a</b>	$\beta^-$ 0.514, ..., $\gamma$ 661.65D
56	Ba 128	0 +	127.908309	2.43 d	$\epsilon$ , $\gamma$ 273.4, ...
	Ba 129	1/2 +	128.908674	2.2 h	$\beta^+$ 1.42, ..., $\gamma$ 214.3, 220.9, 129.1, ...
	Ba 131	1/2 +	130.906931	11.7 d	$\epsilon$ , ( $\beta^+$ ), ..., $\gamma$ 496.3, 123.8, 216.1, ...
	Ba 133	1/2 +	132.906002	10.53 a	$\epsilon$ , $\gamma$ 356.0, 81.0, 302.9, ...
	Ba 139	7/2 -	138.908835	1.40 h	$\beta^-$ 2.27, 2.14, ..., $\gamma$ 165.9, ...
	Ba 140	0 +	139.910599	<b>12.75 d</b>	$\beta^-$ 1.0, 0.48, 1.02, ..., $\gamma$ 537.3, 30.0, ...



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1	2	3	4	5	6
Z	Nuclide	Spin and parity u	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
57	La 136	1+	135.907651	9.87 m	$\epsilon, \beta^+ 1.8, \dots, \gamma 818.5, \dots$
	La 137	7/2+	136.906470	0.06 Ma	$\epsilon$ (no $\gamma$ )
	<b>La 138</b>	5+	137.907107	105 Ga	$\epsilon, \beta^- 0.25, \gamma 1435.8, 788.7, \dots$
	La 140	3-	139.909473	1.678 d	$\beta^- 1.35, 1.24, 1.67, \dots, \gamma 1596.5, 487.0, 815.8, \dots$
	La 141	7/2+	140.910957	3.90 h	$\beta^- 2.43, \dots, \gamma 1354.5, \dots$
58	Ce 134	0+	133.909026	75.9 h	$\epsilon, \gamma 162.3, 130.4, \dots$
	Ce 135	1/2+	134.909146	17.7 h	$\epsilon, \beta^+ 0.8, \dots, \gamma 265.6, 300.1, 606.8, \dots$
	Ce 137	11/2-	(254 keV)	34.3 h	IT 254.3, $\epsilon, \gamma 824.7, 169.2, 762.2, \dots$
	Ce 137	3/2+	136.907778	9 h	$\epsilon, \beta^+, \gamma 447.2, \dots$
	Ce 139	3/2+	138.906647	137.6 d	$\epsilon, \gamma 165.9, \dots$
	Ce 141	7/2-	140.908271	32.50 d	$\beta^- 0.436, 0581, \dots, \gamma 145.4, \dots$
	Ce 143	3/2-	142.912381	1.38 d	$\beta^- 1.110, 1.404, \dots, \gamma 293.3, 57.4, \dots$
	Ce 144	0+	143.913643	<b>284.6 d</b>	$\beta^- 0.318, 0.185, \dots, \gamma 133.5, 80.1, \dots$
59	Pr 140	1+	139.909071	3.39 m	$\epsilon, \beta^+ 2.37, \dots, (\gamma 1596.5, 306.9, \dots)$
	Pr 142	2-	141.910040	19.12 h	$\beta^- 2.162, \dots, \gamma 1575.5, \dots, \epsilon, \gamma 641.2$
	Pr 143	7/2+	142.910812	13.57 d	$\beta^- 0.933, \dots, \gamma (742.0)$
60	Nd 140	0+	139.909310	3.37 d	$\epsilon$ (no $\gamma$ )
	Nd 141	3/2+	140.909605	2.49 h	$\epsilon, \beta^+ 0.802, \dots, (\gamma 1127.0, 1292.7, 1147.3, \dots)$
	<b>Nd 144</b>	0+	143.910082	2.3 Pa	$\alpha 1.83$
	Nd 147	5/2-	146.916096	10.98 d	$\beta^- 0.805, \dots, \gamma 91.1, 531.0, \dots$
	Nd 149	5/2-	148.920144	1.72 h	$\beta^- 1.42, 1.13, 1.03, \dots, \gamma 211.3, 114.3, 270.2, \dots$
61	Pm 143	5/2+	142.910928	265 d	$\epsilon, \gamma 742.0, \dots$
	Pm 144	5-	143.912586	360 d	$\epsilon, \gamma 696.5, 618.0, 476.8, \dots$
	Pm 145	5/2+	144.912744	17.7 a	$\epsilon, \gamma 72.5, 67.2, (e^-), (\alpha 2.24)$
	Pm 146	3-	145.914692	5.53 a	$\epsilon, \gamma 453.9, 735.8, \dots, \beta^-, 0.795, \dots, \gamma 747.2$
	Pm 147	7/2+	146.915134	<b>2.6234 a</b>	$\beta^- 0.224, \dots, \gamma (121.3), \dots$
	Pm 148	1-	147.917468	5.37 d	$\beta^- 2.47, 1.02, \dots, \gamma 1465.1, 550.3, \dots$
	Pm 149	7/2+	148.918329	53.1 h	$\beta^- 1.072, \dots, \gamma 286.0, \dots$
62	Sm 145	7/2-	144.913406	340 d	$\epsilon, \gamma 61.2, (492), \dots$
	Sm 146	0+	145.913038	103 Ma	$\alpha 2.455$
	<b>Sm 147</b>	7/2-	146.914893	0.11 Ta	$\alpha 2.235$
	<b>Sm 148</b>	0+	147.914818	7 Pa	$\alpha 1.96$
	<b>Sm 149</b>	7/2-	148.917179	2 Pa	$\alpha 1.07$
	Sm 151	5/2-	150.919929	90 a	$\beta^- 0.076, \dots, \gamma (21.5), e^-$
	Sm 153	3/2+	152.922094	46.3 h	$\beta^- 0.69, 0.64, \dots, \gamma 103.2, 69.7, \dots$
	Sm 155	3/2-	154.924636	22.2 m	$\beta^- 1.52, \dots, \gamma 104.3, 246, 141, \dots$
63	Eu 147	5/2+	146.916741	24.4 d	$\epsilon, \beta^+ 0.701, 0.58, 0.505, \dots, \gamma 197.4, 121.3, \dots, (\alpha 2.91)$
	Eu 148	5-	147.918154	54.5 d	$\epsilon, \beta^+ (0.92), \dots, \gamma 550.3, 630.0, \dots, (\alpha 2.63)$
	Eu 149	5/2+	148.917926	93.1 d	$\epsilon, \gamma 327.5, 277.1, \dots$
	Eu 150	5-	149.919699	36.9 a	$\epsilon, \gamma 333.9, 439.4, 584.3, \dots$
	Eu 152	3-	151.921741	13.54 a	$\epsilon, \beta^+ 0.727, \dots, \gamma 121.8, 1408.0, \dots, \beta^- 0.696, \dots, \gamma 344.3, \dots$
	Eu 154	3-	153.922976	8.59 a	$\beta^- 0.58, 0.27, \dots, \gamma 123.1, 1274.5, \dots, \epsilon, (\gamma)$
	Eu 155	5/2+	154.922890	4.71 a	$\beta^- 0.15, \dots, \gamma 86.5, 105.3, \dots$
	Eu 156	0+	155.924751	15.2 a	$\beta^- 2.45, 0.49, \dots, \gamma 811.8, 89.0, 1230.7, \dots$

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1	2	3	4	5	6
Z	Nuclide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
64	Gd 148	0+	147.918110	75 a	$\alpha$ 3.1828
	Gd 149	7/2-	148.919336	9.3 d	$\epsilon$ , $\gamma$ 149.7, 298.6, 346.7D, ( $\alpha$ 3.016)
	Gd 150	0+	149.918656	1.79 Ma	$\alpha$ 2.726
	Gd 151	7/2-	150.920344	124 d	$\epsilon$ , $\gamma$ 153.6, 243.2, ... ( $\alpha$ 2.60)
	<b>Gd 152</b>	0+	151.919788	0.11 Pa	$\alpha$ 2.14
	Gd 153	3/2-	152.921746	241.6 d	$\epsilon$ , $\gamma$ 97.4, 103.2, ...
	Gd 159	3/2-	158.926385	18.6 h	$\beta^-$ 0.96, ... $\gamma$ 363.6, 58.0(e <sup>-</sup> ), ...
	Gd 161	5/2-	160.929666	3.66 m	$\beta^-$ 1.56, ... $\gamma$ 360.9, 314.9, 102.3, ...
65	Tb 157	3/2+	156.924021	99 a	$\epsilon$ , $\gamma$ 54.5, e <sup>-</sup>
	Tb 158	3-	157.925410	180 a	$\epsilon$ , $\gamma$ 944.2, 962.2, ... $\beta^-$ 0.85, ... $\gamma$ 99.0, ...
	Tb 160	3-	159.927164	72.3 d	$\beta^-$ 0.57, 0.86, ... $\gamma$ 879.4, 298.6, 966.2, ...
	Tb 161	3/2+	160.927566	6.90 d	$\beta^-$ 0.52, 0.46, ... $\gamma$ 25.7, 48.9, 74.6, ...
66	Dy 154	0+	153.924423	3.0 Ma	$\alpha$ 2.870
	Dy 155	3/2-	154.925749	9.9 h	$\epsilon$ , $\beta^+$ 0.845, ... $\gamma$ 226.9, ...
	Dy 157	3/2-	156.925461	8.1 h	$\epsilon$ , $\gamma$ 326.2, ...
	Dy 159	3/2-	158.925736	144.4 d	$\epsilon$ , $\gamma$ 58.0, e <sup>-</sup> , ...
	Dy 165	7/2+	164.931700	2.33 h	$\beta^-$ 1.29, ... $\gamma$ 94.7, 361.7D, ...
	Dy 166	7/2+	165.932803	3.400 d	$\beta^-$ 0.40, ... $\gamma$ 82.5, (426), ...
	67	Ho 163	7/2-	162.928730	4570 a
Ho 164		1+	163.930231	29 m	$\epsilon$ , $\gamma$ 73.4, ... $\beta^-$ 0.96, 0.88, ... $\gamma$ 91.4
Ho 166		7-	(6 keV)	1.2 ka	$\beta^-$ < 0.065, ... $\gamma$ 184.4, 810.3, 711.7, ...
Ho 166		0-	165.932281	26.80 h	$\beta^-$ 1.855, 1.773, ... $\gamma$ 80.6, 1379.4, ...
Ho 167		7/2-	166.933126	3.1 h	$\beta^-$ 0.32, 0.97, 0.61, ... $\gamma$ 346.5, 321.3, ...
68	Er 160	0+	159.929079	28.58 h	$\epsilon$ , $\gamma$ (60.0 (e <sup>-</sup> )), ...
	Er 161	3/2-	160.930001	3.21 h	$\epsilon$ , ( $\beta^+$ 0.82), ... $\gamma$ 826.5, 211.2D, ...
	Er 163	5/2-	162.930029	1.25 h	$\epsilon$ , ( $\beta^+$ 0.19), ... $\gamma$ (1113.5), 436.1, 439.9, ...
	Er 165	5/2-	164.930723	10.36 h	$\epsilon$ (no $\gamma$ )
	Er 169	1/2-	168.934588	9.40 d	$\beta^-$ 0.344, 0.34, ... $\gamma$ (8.4 (e <sup>-</sup> )), ...
	Er 171	5/2-	170.938026	7.52 h	$\beta^-$ 1.065, ... $\gamma$ 308.3D, 295.9, 111.6, ...
	69	Tm 167	1/2+	166.932849	9.24 d
Tm 168		3+	167.934170	93.1 d	$\epsilon$ , ( $\beta^+$ ), ( $\beta^-$ ), $\gamma$ 198.2, 816.0, 447.5, 184.3, ...
Tm 170		1-	169.935798	128.6 d	$\beta^-$ 0.968, 0.883, $\gamma$ 84.3, ( $\epsilon$ ), ( $\gamma$ 78.7)
Tm 171		1/2+	170.936426	1.92 a	$\beta^-$ 0.097, ... $\gamma$ 66.7, e <sup>-</sup>
Tm 172		2-	171.938396	2.65 d	$\beta^-$ 1.79, 1.87, ... $\gamma$ 78.8, 1093.6, 1387.1, 1529, ...
70	Yb 166	0+	165.933880	56.7 h	$\epsilon$ , $\gamma$ 82.3
	Yb 167	5/2-	166.934947	17.5 m	$\epsilon$ , ( $\beta^+$ 0.64), ... $\gamma$ 113.3D, 106.2, 176.2D, ...
	Yb 169	7/2+	168.935187	32.03 d	$\epsilon$ , $\gamma$ 63.1, 198.0, 177, ...
	Yb 175	7/2-	174.941273	4.19 d	$\beta^-$ 0.466, ... $\gamma$ 396.3, 282.5, 113.8, ...
71	Lu 173	7/2+	172.938927	1.37 a	$\epsilon$ , $\gamma$ 272.0, 78.7, 100.7, 171.4, ...
	Lu 174	1-	173.940334	3.3 a	$\epsilon$ , $\gamma$ 1241.8, 76.5, ... $\beta^+$ 0.38, ...
	<b>Lu 176</b>	7-	175.942682	37 Ga	$\beta^-$ 0.57, ... $\gamma$ 306.9, 201.8, ...
	Lu 177	23/2-	(970 keV)	160 d	$\beta^-$ 0.152, $\gamma$ 208.4, 228.5, (IT 115.8), e <sup>-</sup> , $\gamma$ 413.7, ...
	Lu 177	7/2+	176.943755	6.71 d	$\beta^-$ 0.497, ... $\gamma$ 208.4, 112.9, ...

T - 6.3 Properties of Radioactive Nuclides

1	2	3	4	5	6	
Z	Nuclide	Spin and parity $\pi$	Mass $u$	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)	
72	Hf 172	0+	171.939458	1.87 a	$\epsilon, \gamma$ 24.0, 125.8, 67.4, 81.8,...	
	Hf 173	1/2-	172.940650	23.6 h	$\epsilon, \gamma$ 123.7D, 297.0,...	
	<b>Hf 174</b>	0+	173.940040	2.0 Pa	$\alpha$ 2.50	
	Hf 175	5/2-	174.941503	70 d	$\epsilon, \gamma$ 343.4,...	
	Hf 178	16+	(2446 keV)	31 a	IT 12.7, $e^-$ , 426.4, 325.6,...	
	Hf 181	1/2-	180.949099	42.4 d	$\beta^-$ 0.405, ... $\gamma$ 482.1, 133.0, 345.9,...	
	Hf 182	0+	181.950553	9 Ma	$\beta^-$ , $\gamma$ 270.4,...	
73	Ta 179	7/2+	178.945934	1.8 a	$\epsilon$ (no $\gamma$ )	
	<b>Ta 180</b>	9-	(75 keV)	> 1.2 Pa	$\epsilon, \beta^+, \gamma$ 350, 332,...	
	Ta 180	1+	179.947466	8.15 h	$\epsilon, \gamma$ 93.3, $\beta^-$ 0.71, 0.61, $\gamma$ 103.4	
	Ta 182	3-	181.950152	114.43 d	$\beta^-$ 0.522, 0.25, ... $\gamma$ 67.8, 1121.3, 1221.4,...	
74	W 178	0+	177.945848	21.6 d	$\epsilon$ (no $\gamma$ )	
	W 181	9/2+	180.948198	121.2 d	$\epsilon, \gamma$ 6.2D ( $e^-$ ),...	
	W 185	3/2-	184.953421	74.8 d	$\beta^-$ 0.433, ... ( $\gamma$ 125.4)	
	W 187	3/2-	186.957158	23.9 h	$\beta^-$ 0.622, 1.312, ... $\gamma$ 685.7, 479.6,...	
	W 188	0+	187.958487	69.4 d	$\beta^-$ 0.349, ... ( $\gamma$ 290.7, 227.1, 63.6, ...)	
	75	Re 183	5/2+	182.950821	70 d	$\epsilon, \gamma$ 162.3, 46.5,...
Re 184		8+	(188 keV)	165 d	IT 83.3, $e^-$ , 104.7, $\epsilon, \gamma$ 252.8, 216.6, 920.9,...	
Re 184		3-	183.952524	38 d	$\epsilon, \gamma$ 902.3, 792.1,...	
Re 186		8+	(149 keV)	0.20 Ma	IT (~50), $e^-$ , $\gamma$ 59.0, 40.4, 99.4,...	
Re 186		1-	185.954987	3.777 d	$\beta^-$ 1.071, 0.933, ... $\gamma$ 137.1, ... $\epsilon, \gamma$ 122.4	
<b>Re 187</b>		5/2+	186.955751	41 Ga	$\beta^-$ 0.00264 (no $\gamma$ )	
Re 188		1-	187.958112	16.94 h	$\beta^-$ 2.118, 1.962, ... $\gamma$ 155.0,...	
Re 189		5/2+	188.959228	24 h	$\beta^-$ 1.01, ... $\gamma$ 216.7, 219.4, 245.1,...	
76		Os 185	1/2-	184.954043	93.6 d	$\epsilon, \gamma$ 646, 874.8, 880.4, 717.4,...
	<b>Os 186</b>	0+	185.953838	2 Pa	$\alpha$ 2.757	
	Os 191	9/2-	190.960928	15.4 d	$\beta^-$ 0.143, ... $\gamma$ 129.4D,...	
	Os 193	3/2-	192.964148	30.5 h	$\beta^-$ 1.13, ... $\gamma$ 138.9, 460.5, 73.0,...	
	Os 194	0+	193.965179	6.0 a	$\beta^-$ 0.096, 0.054, ... $\gamma$ 43 $e^-$ ,...	
	77	Ir 188	2-	187.958852	41.3 h	$\epsilon, \beta^+$ 1.65, 1.13, ... $\gamma$ 155.1, 2214.7, 633.1, 478.0,...
Ir 189		3/2+	188.958717	13.2 d	$\epsilon, \gamma$ 245.0, 69.5, 59.1,...	
Ir 190		4+	189.960592	11.8 d	$\epsilon, \gamma$ 186.7, 605.2, 518.5,...	
Ir 192		9+	(155 keV)	241 a	IT (155.2), $e^-$	
Ir 192		4-	191.962602	73.83 d	$\beta^-$ 0.672, 0.54, ... $\gamma$ 316.5, 468.1, ... $\epsilon, \gamma$ 205.8, 484.6,...	
Ir 194		11?	(190 keV)	170 d	$\beta^-$ , $\gamma$ 482.9, 328.5,...	
Ir 194		1-	193.965076	19.3 h	$\beta^-$ 2.24, ... $\gamma$ 328.5,...	
78		Pt 188	0+	187.959396	10.2 d	$\epsilon, \gamma$ 187.5, 195.0, ... ( $\alpha$ 3.92)
		Pt 189	3/2-	188.960832	10.9 h	$\epsilon, \beta^+$ 0.89, ... $\gamma$ 721.4, 607.6, 94.3, 568.8, 243.5,...
	<b>Pt 190</b>	0+	189.959930	0.65 Ta	$\alpha$ 3.18	
	Pt 191	3/2-	190.961685	2.96 d	$\epsilon, \gamma$ 538.9, 409.5, 359.9,...	
	Pt 193	1/2-	192.962984	50 a	$\epsilon$ (no $\gamma$ )	
	Pt 197	1/2-	196.967323	19.8 h	$\beta^-$ 0.642, 0.719, ... $\gamma$ 77.3, 191.4,...	

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1	2	3	4	5	6
Z	Nuclide	Spin and parity $u$	Mass	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
79	Au 194	1 -	193.965339	39.4 h	$\epsilon, \beta^+ 1.49, \dots, \gamma 328.5, 293.6, \dots$
	Au 195	3/2 +	194.965018	186.12 d	$\epsilon, \gamma 98.9, \dots$
	Au 196	2 -	195.966551	6.18 d	$\epsilon, \gamma 355.6, 332.9, \dots, \beta^- 0.259, \gamma 425.6, (\beta^+)$
	Au 198	2 -	197.968225	64.66 h	$\beta^- 0.962, \dots, \gamma 411.8, \dots$
	Au 199	3/2 +	198.968748	3.14 d	$\beta^- 0.292, 0.25, 0.453, \dots, \gamma 158.4, 208.2, \dots$
80	Hg 194	0 +	193.965382	520 a	$\epsilon$ (no $\gamma$ )
	Hg 195	13/2 + (176 keV)	(176 keV)	40.1 h	IT 122.8, $e^-, \gamma 37.1, e^-, \epsilon, \gamma 261.8D, 560.3, \dots$
	Hg 195	1/2 -	194.966639	9.5 h	$\epsilon, \gamma 779.8, 61.4, \dots$
	Hg 197	1/2 -	196.967195	64.13 h	$\epsilon, \gamma 77.3, \dots$
	Hg 203	5/2 -	202.972857	46.61 d	$\beta^- 0.213, \gamma 279.2$
	Hg 205	1/2 -	204.976056	5.2 m	$\beta^- 1.54, \dots, \gamma 203.7, \dots$
81	Tl 200	2 -	199.970945	26.1 h	$\epsilon, \beta^+ (1.07), 1.44, \dots, \gamma 368.0, 1205.7, \dots$
	Tl 201	1/2 +	200.970804	72.9 h	$\epsilon, \gamma 167.4, 135.3, \dots$
	Tl 202	2 -	201.972091	12.23 d	$\epsilon, (\beta^+), \gamma 439.6, \dots$
	Tl 204	2 -	203.973849	3.78 a	$\beta^- 0.7634, ,$ (no $\gamma$ )
	Tl 206	0 -	205.976095	4.20 m	$\beta^- 1.528, \dots$ ( $\gamma 803.1$ )
	Tl 207	1/2 +	206.977408	4.77 m	$\beta^- 1.44, \dots, \gamma (897.2), \dots$
	Tl 208	5 +	207.982005	3.053 m	$\beta^- 1.796, 1.28, 1.52, \dots, \gamma 2614.5, 583.2, 510.7, \dots$
	Tl 209	1/2 +	208.985349	2.2 m	$\beta^- 1.83, \gamma 1566, 117, 467$
	Tl 210	5 +	209.990066	1.30 m	$\beta^- 1.9, 1.3, 2.3, \dots, \gamma 799.7, 298, \dots$ (n)
	82	Pb 202	0 +	201.972144	53 ka
Pb 203		5/2 -	202.973376	51.88 h	$\epsilon, \gamma 279.2, \dots$
Pb 205		5/2 -	204.974467	15.2 Ma	$\epsilon$ (no $\gamma$ )
Pb 209		9/2 +	208.981075	3.25 h	$\beta^- 0.645$ (no $\gamma$ )
Pb 210		0 +	209.984173	22.3 a	$\beta^- 0.017, 0.061, \gamma 46.5, e^-, (\alpha 3.72)$
Pb 211		9/2 +	210.988731	36.1 m	$\beta^- 1.38, \dots, \gamma 404.9, 831.9, 427.0, \dots$
Pb 212		0 +	211.991887	10.64 h	$\beta^- 0.331, 0.569, \dots, \gamma 238.6, 300.0, \dots$
Pb 214		0 +	213.999798	27 m	$\beta^- 0.67, 0.73, \dots, \gamma 351.9, 295.2, 242.0, \dots$
83	Bi 205	9/2 -	204.977375	15.31 d	$\epsilon, (\beta^+ 0.985), \gamma 1764.3, 703.5, 987.6D, \dots$
	Bi 206	6 +	205.978483	6.243 d	$\epsilon, (\beta^+ 0.977), \gamma 803.1, 881.0, 516.2, \dots$
	Bi 207	9/2 -	206.978455	32.2 a	$\epsilon, (\beta^+ 0.808), \gamma 569.7D, 1063.7D, 1770.2, \dots$
	Bi 208	5 +	207.979727	0.368 Ma	$\epsilon, \gamma 2614.4$
	Bi 210	9 -	(271 keV)	3 Ma	$\alpha 4.946, 4.908, \dots, \gamma 266.2, 305.2, \dots$
	Bi 210	1 -	209.984105	5.01 d	$\beta^- 1.162, (\alpha 4.648, 4.687), \psi 305, 266$
	Bi 211	9/2 -	210.987258	2.14 m	$\alpha 6.623, 6.279, \gamma 350, (\beta^-)$
	Bi 212	1 -	211.991271	60.5 m	$\beta^- 0.2251, \dots, \gamma 727.2, \alpha 6.051, \dots, \gamma 39.8, \dots$
	Bi 213	9/2 -	212.994375	45.6 m	$\beta^- 1.42, 1.02, \dots, \gamma 440.4, \dots, \alpha 5.869, (5.549), \gamma (323.8)$
	Bi 214	1 -	213.998699	19.9 m	$\beta^- 3.27, 1.54, 1.51, \dots, \gamma 609.3, 1764.5, 1120.3, \dots, \alpha 5.450, 5.513, \gamma 63, \dots$

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1	2	3	4	5	6
Z	Nu- clide	Spin and parity $\pi$	Mass	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
84	Po 206	0+	205.980465	8.8 d	$\epsilon, \gamma$ 1032.3, 511.3, 286.4, 807.4, ... $\alpha$ 5.223
	Po 208	0+	207.981231	2.90 a	$\alpha$ 5.115, ... $\gamma$ 899, ( $\epsilon$ ), ( $\gamma$ 292, 571, 603, ...)
	Po 209	1/2-	208.982416	102 a	$\alpha$ 4.880, ... $\gamma$ (260.5), 262.8, $\epsilon, \gamma$ (896.4)
	Po 210	0+	209.982857	138.4 d	$\alpha$ 5.3044, $\gamma$ (803.1)
	Po 211	9/2+	210.986637	0.516 s	$\alpha$ 7.451, ... $\gamma$ (569.2D), 897.2
	Po 212	0+	211.988852	0.298 $\mu$ s	$\alpha$ 8.7844
	Po 214	0+	213.995186	163.7 $\mu$ s	$\alpha$ 7.6869, ... ( $\gamma$ 799, ...)
	Po 215	9/2+	214.999415	1.78 ms	$\alpha$ 7.386, ... ( $\gamma$ 439, ...), ( $\beta^-$ )
	Po 216	0+	216.001905	0.145 s	$\alpha$ 6.7785, ... $\gamma$ (805)
	Po 218	0+	218.008966	3.10 m	$\alpha$ 6.0024, ... ( $\gamma$ 510, ...), ( $\beta^-$ )
85	At 210	5+	209.98713	8.1 h	$\epsilon, \gamma$ 1181, 245.3, 1483.3, ... $\alpha$ 5.524, 5.442, 5.361, ... ( $\gamma$ 83, 106, ...)
	At 211	9/2-	210.987481	7.21 h	$\epsilon, \gamma$ (687), $\alpha$ 5.868, ... $\gamma$ (669.6), ...
	<b>At 215</b>	9/2-	214.998641	0.10 ms	$\alpha$ 8.026, $\gamma$ (404.9)
	At 217	9/2-	217.004710	32 ms	$\alpha$ 7.067, ... $\gamma$ 260, 440, 594, ... ( $\beta^-$ )
86	Rn 211	1/2-	210.990585	14.6 h	$\epsilon, \beta^+, \gamma$ 674.1, 1363.0, 678.4, ... $\alpha$ 5.784, 5.851, ... ( $\gamma$ 68.6), $e^-$ , ...
	Rn 219	5/2+	219.009475	3.96 s	$\alpha$ 6.8193, 6.553, 6.4254, ... $\gamma$ 271.1, 401.7, ...
	Rn 220	0+	220.011384	55.6 s	$\alpha$ 6.2882, ... $\gamma$ 549.7
	Rn 221	7/2+	221.01546	25 m	$\beta^-$ 0.83, ... $\gamma$ 186.4, ... $\alpha$ 6.037, 5.788, ... $\gamma$ 254, 265
	Rn 222	0+	222.017571	3.8235 d	$\alpha$ 5.4895, ... $\gamma$ 510
87	Fr 212	5+	211.99620	20 m	$\epsilon, \beta^+, \gamma$ 1275, 227.7, ... $\alpha$ 6.261, 6.383, 6.406, ... $\gamma$ 124.84, (84), 72, ...
	Fr 221	5/2-	221.014246	4.8 m	$\alpha$ 6.341, 6.127, ... $\gamma$ 218.0, ...
	Fr 223	3/2-	223.019731	21.8 m	$\beta^-$ 1.17, ... $\gamma$ 50, 79.8, 235, ... ( $\alpha$ 5.340)
88	Ra 223	1/2+	223.018497	11.435 d	$\alpha$ 5.7164, 5.607, ... $\gamma$ 269.4, 154.2, 323.9, ... (C14)
	Ra 224	0+	224.020202	3.66 d	$\alpha$ 5.685, 5.449, ... $\gamma$ 241.0, ... (C14)
	Ra 225	1/2+	225.023605	14.9 d	$\beta^-$ 0.32, ... $\gamma$ 40.3
	Ra 226	0+	226.025403	1.60 ka	$\alpha$ 4.7844, 4.602, ... $\gamma$ 186.1, ... (C14)
	Ra 227	3/2+	227.029171	42 m	$\beta^-$ 1.31, 1.03, ... $\gamma$ 27.4, 300.1, 302.7, 283.7, ...
	Ra 228	0+	228.031064	5.76 a	$\beta^-$ 0.039, 0.015, ( $\gamma$ 14, 16, 13, ...)
89	Ac 225	3/2-	225.023221	10.0 d	$\alpha$ 5.829, 5.793, 5.731, ... $\gamma$ 100, 150, 63, $e^-$ , (C14)
	Ac 226	1-	226.026090	29.4 h	$\beta^-$ 0.89, 1.11, ... $\gamma$ 230.3, 158.1, ... $\epsilon, \gamma$ 253.7, 186.0, ( $\alpha$ 5.399)
	Ac 227	3/2-	227.027747	21.77 a	$\beta^-$ 0.045, ... $\gamma$ (15.2 ( $e^-$ )), ... $\alpha$ 4.9534, (4.941), $\gamma$ (100), ...
	Ac 228	3+	228.031015	6.15 h	$\beta^-$ 1.2, 2.1, ... $\gamma$ 911.2, 969.0, 338.3, ... ( $\alpha$ 4.27)

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1	2	3	4	5	6	
Z	Nuclide	Spin and parity u	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)	
90	Th 227	3/2 +	227.027699	18.72 d	$\alpha$ 6.038, 5.978, 5.757, ... $\gamma$ 236.0, 50.2, ...	
	Th 228	0 +	228.028731	1.913 a	$\alpha$ 5.423, 5.340, ... $\gamma$ 84.4 e <sup>-</sup> , 216.0, 131.6, 166.4, ...	
	Th 229	5/2 +	229.031755	7880 a	$\alpha$ 4.845, 4.901, 4.815, ... $\gamma$ 193.6, 86.4, 210.9, 31.5, ... (Ne24)	
	Th 230	0 +	230.033127	75.4 ka	$\alpha$ 4.688, 4.621, ... $\gamma$ 67.7 e <sup>-</sup> , (SF), (Ne24)	
	Th 231	5/2 +	231.036297	25.5 h	$\beta^-$ 0.305, 0.138, ... $\gamma$ 25.6, 84.2, ...	
	<b>Th 232</b>	0 +	232.038050	14.0 Ga	$\alpha$ 4.013, 3.950, ... ( $\gamma$ 64), (e <sup>-</sup> )	
	Th 233	1/2 +	233.041577	22.3 m	$\beta^-$ 1.245, ... $\gamma$ 86.5, 29.4, 459.3, ...	
	Th 234	0 +	234.043596	24.10 d	$\beta^-$ 0.198, ... $\gamma$ 63.3, 92.4, 92.8, ...	
	91	Pa 230	2 -	230.034533	17.4 d	$\epsilon$ , $\gamma$ 952, ... $\beta^-$ 0.51, ... ( $\gamma$ 314.8, ...), ( $\alpha$ 5.345)
		Pa 231	3/2 -	231.035879	32.8 ka	$\alpha$ 5.013, 4.950, 5.028, ... $\gamma$ 27.4, 300.0, ... (Ne24)
Pa 232		2 -	232.038582	1.31 d	$\beta^-$ 0.314, 0.294, ... $\gamma$ 969.3, 894.3, ... $\epsilon$	
Pa 233		3/2 -	233.040240	27.0 d	$\beta^-$ 0.256, 0.15, ... $\gamma$ 312.0, ...	
Pa 234		0 -	(74 keV)	1.17 m	$\beta^-$ 2.29, ... $\gamma$ 1001.0, 766.4, ... (IT < 73.9 e <sup>-</sup> )	
<b>Pa 234</b>		4 +	234.043302	6.69 h	$\beta^-$ 0.48, 0.65, ... $\gamma$ 131.3, 881, 883, ...	
92		U 232	0 +	232.037146	70 a	$\alpha$ 5.3203, 5.2635, ... ( $\gamma$ 57.8, (e <sup>-</sup> )), (SF), (Ne24)
	U 233	5/2 +	233.039628	159.2 ka	$\alpha$ 4.824, 4.783, ... $\gamma$ (42.5, 97.1, 54.7, ...), (SF), (Ne24)	
	<b>U 234</b>	0 +	234.040946	246 ka	$\alpha$ 4.776, 4.725, ... $\gamma$ 53.2 (e <sup>-</sup> ), 120.9, ... (SF)	
	U235	1/2 +	(0.0 keV)	26 m	IT ~ 76.8 eV, e <sup>-</sup>	
	<b>U 235</b>	7/2 -	235.043923	704 Ma	$\alpha$ 4.400, 4.365, ... $\gamma$ 185.7, 143.8, ... (SF)	
	U 236	0 +	236.045562	23.42 Ma	$\alpha$ 4.494, 4.445, ... ( $\gamma$ 49.4 e <sup>-</sup> , 112.8, ...), (SF)	
	U 237	1/2 +	237.048724	6.75 d	$\beta^-$ 0.24, 0.25, ... $\gamma$ 59.5, 208.0, ...	
	<b>U 238</b>	0 +	238.050783	4.47 Ga	$\alpha$ 4.197, 4.147, ... ( $\gamma$ 49.6 e <sup>-</sup> , ...), (SF)	
	U 239	5/2 +	239.054288	23.5 m	$\beta^-$ 1.21, 1.28, ... $\gamma$ 74.7, 43.5, ...	
	93	Np 235	5/2 +	235.044056	1.085 a	$\alpha$ 5.021, 5.004, ... ( $\gamma$ 25.6-188.8)
Np 236		6 -	236.04656	0.115 Ma	$\epsilon$ , $\gamma$ 160.3, $\beta^-$ 0.2, $\gamma$ 44.6 e <sup>-</sup> , 104, ...	
Np 237		5/2 +	237.048167	<b>2.14 Ma</b>	$\alpha$ 4.788, 4.771, ... $\gamma$ 29.4, 86.5, ...	
Np 238		2 +	238.050941	2.117 d	$\beta^-$ 0.263, 1.248, ... $\gamma$ 984.5, 1028.5, ...	
Np 239		5/2 +	239.052931	<b>2.355 d</b>	$\beta^-$ 0.438, 0.341, ... $\gamma$ 106.1, 277.6, 228.2, ...	
94		Pu 236	0 +	236.046048	2.87 a	$\alpha$ 5.7677, 5.7210, ... ( $\gamma$ 47.6-643.7), (SF)
	Pu 237	7/2 -	237.048404	45.2 d	$\epsilon$ , $\gamma$ 59.5, ... $\alpha$ 5.344, ( $\gamma$ 280.4, 298.9, ...)	
	Pu 238	0 +	238.049553	87.74 a	$\alpha$ 5.4992, 5.4565, ... ( $\gamma$ 43.5 e <sup>-</sup> , 99.9e <sup>-</sup> , ...), (SF)	
	Pu 239	1/2 +	239.052156	<b>24.10 ka</b>	$\alpha$ 5.156, 5.143, 5.105, ... $\gamma$ 51.6 e <sup>-</sup> , (30.1-1057.3), (SF)	
	Pu 240	0 +	240.053807	6563 a	$\alpha$ 5.1683, 5.1237, ... ( $\gamma$ 45.2 e <sup>-</sup> , 104.2 e <sup>-</sup> ), (SF)	
	Pu 241	5/2 +	241.056845	14.4 a	$\beta^-$ 0.0208, ( $\alpha$ 4.897, 4.853, ...), ( $\gamma$ 148.6, 103.7, ...)	
	Pu 242	0 +	242.058736	0.373 Ma	$\alpha$ 4.901, 4.856, ... ( $\gamma$ 44.9 e <sup>-</sup> , ...), (SF)	
	Pu 243	7/2 +	243.061997	4.9656 h	$\beta^-$ 0.578, 0.485, ... $\gamma$ 84.0, ...	
	Pu 244	0 +	244.064198	80 Ma	$\alpha$ 4.589, 4.546, (SF)	

T - 6.3 Properties of Radioactive Nuclides

1	2	3	4	5	6
Z	Nuclide	Spin and parity	Mass u	Half life	Modes of decay and energy of radiation MeV for particles, keV for $\gamma$ (and IT)
95	Am 241	5/2 -	241.056823	432.7 a	$\alpha$ 5.4857, 5.4430, ... $\gamma$ 26.3-955, (SF)
	Am 242	5 -	(48 keV)	141 a	IT 48.6, $e^-$ , ( $\alpha$ 5.207, ...), ( $\gamma$ 49.2), (SF)
	Am 242	1 -	242.059543	16.02 h	$\beta^-$ 0.63, 0.67, $\gamma$ 42.2 $e^-$ , ... $\epsilon$ , $\gamma$ 44.5 $e^-$
	Am 243	5/2 -	243.061372	7380 a	$\alpha$ 5.276, 5.234, ... $\gamma$ 74.7, 31.1-662.2, (SF)
96	Cm 242	0 +	242.058829	162.8 d	$\alpha$ 6.1127, 6.0694, ... ( $\gamma$ 44.1 $e^-$ , ...), (SF)
	Cm 243	5/2 +	243.061382	29.1 a	$\alpha$ 5.785, 5.742, ... $\gamma$ 277.6, 228.2, ... $\epsilon$ , (SF)
	Cm 244	0 +	244.062747	18.1 a	$\alpha$ 5.8048, 5.7627, ... ( $\gamma$ 42.8 $e^-$ , ...), (SF)
	Cm 245	7/2 +	245.065486	8.5 ka	$\alpha$ 5.362, 5.304, ... $\gamma$ 174.9, 133.0, ... (SF)
	Cm 246	0 +	246.067218	4.76 ka	$\alpha$ 5.386, 5.343, ( $\gamma$ 44.5, $e^-$ , ...), (SF)
	Cm 247	9/2 -	247.070347	15.6 Ma	$\alpha$ 4.869, 5.266, ... $\gamma$ 403, 279, 289, ...
	Cm 248	0 +	248.072342	348 ka	$\alpha$ 5.078, 5.035, ... SF
97	Bk 247	3/2 -	247.070299	1.38 ka	$\alpha$ 5.532, 5.711, 5.687, ... $\gamma$ 84.0, 268, ...
98	Cf 249	9/2 -	249.074847	351 a	$\alpha$ 5.812, 5.945, ... $\gamma$ 388.3, 333.4, ... (SF)
	Cf 250	0 +	250.076400	13.1 a	$\alpha$ 6.0304, 5.989, ... ( $\gamma$ 42.9, $e^-$ , ...), (SF)
	Cf 251	1/2 +	251.079580	898 a	$\alpha$ 5.677, 5.852, 6.014, ... $\gamma$ 176.7, 226.8, 285, ...
	Cf 252	0 +	252.081620	2.64 a	$\alpha$ 6.118, 6.076, ... ( $\gamma$ 43.4, $e^-$ , 100, $e^-$ , ...), SF
99	Es 252	5 -	252.082972	472 d	$\alpha$ 6.632 6.562, ... ( $\gamma$ 52.3, 64.4, 418, ...)
100	Fm 257	9/2 +	257.095099	101 d	$\alpha$ 6.519, ... $\gamma$ 241.0, 179.4, ... (SF)
101	Md 258		258.098425	51.5 d	$\alpha$ 6.716, 6.763, ... $\gamma$ 369, 448, ...
102	No 259		259.10102	58 m	$\alpha$ 7.520, 7.551, 7.581, ,
103	Lr 260		260.10557	3.0 m	$\alpha$ 8.03, $\epsilon$ , (SF)
	Lr 262		262.10969	3.6 h	$\epsilon$ , (SF)
104	Rf 261		261.10875	65 s	$\alpha$ 8.28, $\epsilon$ , SF ?
105	Db 262		262.11415	34 s	$\alpha$ 8.45, 8.63, 8.53, $\epsilon$ , SF
106	Sg 261		261.1162	0.23 s	$\alpha$ 9.56, 9.52, SF?
	Sg 263		263.11831	0.9 s	$\alpha$ 9.06, 9.25, SF
107	Bh 262		262.1230	0.10 s	$\alpha$ 10.06, 9.91, 9.74, SF?
	Bh 264		264.1247	~ 440 ms	$\alpha$ 9.48, 9.62
108	Hs 267		267.13177	19 ms	$\alpha$ 9.83, SF?
109	Mt 268		268.1388	70 ms	$\alpha$ 10.10, 10.24, SF?
110	?? 271		271.1461	1.1 ms	$\alpha$ 10.74, 10.68
111	?? 272		272.1535	1.5 ms	$\alpha$ 10.82