

# **NUCLEAR WALLET CARDS**

April 2005

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(Seventh edition)

April 2005

**JAGDISH K. TULI**

**NATIONAL NUCLEAR DATA CENTER**

*(www.nndc.bnl.gov)*

for

*The U.S. Nuclear Data Program*

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*Centerfold: NNDC Web Page*

## **U.S. Nuclear Data Program**

*(<http://www.nndc.bnl.gov/usndp/>)*

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## INTRODUCTION

This is an updated edition of the 2000 booklet of the same name<sup>†</sup>.

This booklet presents selected properties of all known nuclides and their known isomeric states. Properties of ionized atoms are not included.

The data given here are taken mostly from the adopted properties of the various nuclides as given in the *Evaluated Nuclear Structure Data File* (ENSDF)[1]. The data in ENSDF are based on experimental results and are published in *Nuclear Data Sheets*[2] for  $A > 20$  and in *Nuclear Physics*[3] for  $A \leq 20$ . For nuclides for which either there are no data in ENSDF or those data have since been superseded, the half-life and the decay modes are taken either from recent literature[4] or from other sources[*e.g.*, 5]. The ground-state mass excesses are from the mass adjustments by G. Audi, A. H. Wapstra, and C. Thibault[6]. The isotopic abundances are those of N.Holden[7].

For other references, experimental data, and information on the data measurements, please refer to the original evaluations [1–3]. The data were updated to **January 15, 2005**.

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<sup>†</sup>The first *Nuclear Wallet Cards* was produced by F. Ajzenberg-Selove and C.L. Busch in 1971. The Isotopes Project, Lawrence Berkeley National Laboratory, produced the next edition in 1979 based upon the *Table of Isotopes*, 7<sup>th</sup> edition (1978)[9]. The subsequent editions, the third in 1985, the fourth in 1990, the fifth in 1995, and the sixth edition in 2000 were produced by J.K. Tuli, NNDC.

## Explanation of Table

### Column 1, Nuclide (Z, El, A):

Nuclides are listed in order of increasing atomic number (Z), and are subordered by increasing mass number (A). All isotopic species are included as well as all isomers with half-life  $\geq 0.1$  s, and some with half-life  $\geq 1$  ms which decay by SF,  $\alpha$  or p emissions. A nuclide is included even if only its mass estimate or its production cross section is available. For the latter nuclides half-life limit or an approximate value is given as estimated from systematics [5].

Isomeric states are denoted by the symbol "m" after the mass number and are given in the order of increasing excitation energy.

The  $^{235}\text{U}$  thermal fission products, with fractional cumulative yields  $\geq 10^{-6}$ , are *italicized* in the table. The information on fission products is taken from the ENDF/B-VI fission products file [8].

The names (El) for elements Z=104–111 are those adopted by the International Union of Pure and Applied Chemistry (2004).

### Column 2, J $\pi$ :

Spin and parity assignments, without and with parentheses, are based upon strong and weak arguments, respectively. See the introductory pages of any issue of *Nuclear Data Sheets*[2] for description of strong and weak arguments for J $\pi$  assignments.



## Explanation of Table (cont.)

### Column 3, Mass Excess, $\Delta$ :

Mass excesses,  $M-A$ , are given in MeV with  $\Delta(^{12}\text{C})=0$ , by definition. For isomers the values are obtained by adding the excitation energy to the  $\Delta(\text{g.s.})$  values. Wherever the excitation energy is not known, the mass excess for the next lower isomer (or the g.s.) is given. The values are given to the accuracy determined by uncertainty in  $\Delta(\text{g.s.})$  (maximum of three figures after the decimal). The uncertainty is  $\leq 9$  in the last significant figure. An appended "s" denotes that the value is obtained from systematics [6].

### Column 4, $T_{1/2}$ , $\Gamma$ or Abundance:

The half-life and the abundance (in **bold face**) are shown followed by their units ("% symbol in the case of abundance) which are followed by the uncertainty, in *italics*, in the last significant figures. For example,  $8.1 \text{ s } 10$  means  $8.1 \pm 1.0 \text{ s}$ . For some very short-lived nuclei, level widths rather than half-lives are given. There also, the width is followed by units (*e.g.*, eV, keV, or MeV) which are followed by the uncertainty in *italics*, if known. As stated above when a limit or an approximate value is given it is based on systematics, mostly from [5]. A '?' in this field indicates that  $T_{1/2}$  is not known.

For  $2\beta^-$  and  $2\varepsilon$  decay only the lowest value of their several limits (*e.g.*, for  $0\nu$  or  $2\nu$ , etc.) is given.

If a new measurement of half-life, has since become available it is presented in place of the evaluated value in ENSDF.

## Explanation of Table (cont.)

### Column 5, Decay Mode:

Decay modes are given in decreasing strength from left to right, followed by the percentage branching, if known ("w" indicates a weak branch). The percentage branching is omitted where there is no competing mode of decay or no other mode has been observed. A "?" indicates an expected but not observed mode of decay[5]. The various modes of decay are given below:

$\beta^-$	$\beta^-$ decay
$\epsilon$	$\epsilon$ (electron capture), or $\epsilon+\beta^+$ , or $\beta^+$ decay
IT	isomeric transition (through $\gamma$ or conversion-electron decay)
n, p, $\alpha$ , ...	neutron, proton, alpha, ... decay
SF	spontaneous fission
$2\beta^-$ , $3\alpha$ , ...	double $\beta^-$ decay ( $\beta^-\beta^-$ ), decay through emission of 3 $\alpha$ 's, ...
$\beta^-n$ , $\beta^-p$ , $\beta^- \alpha$ , ...	delayed n, p, $\alpha$ , ... (emission following $\beta^-$ decay)
$\epsilon p$ , $\epsilon \alpha$ , $\epsilon SF$ , ...	delayed p, $\alpha$ , SF, ... (emission following $\epsilon$ or $\beta^+$ decay)

## **NNDC Web Services**

The centerfold presents the NNDC home page on the web (*nndc.bnl.gov*). The greatly expanded NNDC web service offers a wealth of Nuclear Physics information which includes, analysis programs, reference data, and custom-tailored retrievals from its many databases. The content of this booklet, and its archival editions, are available on the web.

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## Nuclear Wallet Cards

Nuclide			$J^{\pi}$	$\Delta$ (MeV)	$T_{1/2}$ , $\Gamma$ , or Abundance	Decay Mode		
Z	El	A						
0	n	1	1/2+	8.071	10.15 m 1	$\beta^-$		
1	H	1	1/2+	7.289	<b>99.985% 1</b>			
		2	1+	13.136	<b>0.015% 1</b>			
		3	1/2+	14.950	12.32 y 2	$\beta^-$		
		4	2-	25.9	4.6 MeV 9	n		
		5		32.9	5.7 MeV 21	n		
		6	(2-)	41.9	1.6 MeV 4	n		
		7		49.s	$29 \times 10^{-23}$ y 7			
2	He	3	1/2+	14.931	<b>0.000137% 3</b>			
		4	0+	2.425	<b>99.999863% 3</b>			
		5	3/2-	11.39	0.60 MeV 2	$\alpha$ , n		
		6	0+	17.595	806.7 ms 15	$\beta^-$		
		7	(3/2)-	26.10	150 keV 20	n		
		8	0+	31.598	119.0 ms 15	$\beta^-$ , $\beta^-n$ 16%		
		9	(1/2-)	40.94	65 keV 37	n		
		10	0+	48.81	0.17 MeV 11	2n?		
		3	Li	3		29.s	unstable	p?
				4	2-	25.3	6.03 MeV	p
5	3/2-			11.68	$\approx 1.5$ MeV	$\alpha$ , p		
6	1+			14.087	<b>7.59% 4</b>			
7	3/2-			14.908	<b>92.41% 4</b>			
8	2+			20.947	838 ms 6	$\beta^-$ , $\beta^- \alpha$		
9	3/2-			24.954	178.3 ms 4	$\beta^-$ , $\beta^-n$ 50.8%		
10	(1-,2-)			33.05	1.2 MeV 3	n		
11	3/2-			40.80	8.59 ms 14	$\beta^-$ , $\beta^-n\alpha$ 0.027%, $\beta^-n$		
				50.1s	<10 ns	n?		
4	Be			5	(1/2+)	38.s	?	p
		6	0+	18.375	92 keV 6	p, $\alpha$		
		7	3/2-	15.770	53.22 d 6	$\epsilon$		
		8	0+	4.942	6.8 eV 17	$\alpha$		
		9	3/2-	11.348	<b>100.%</b>			
		10	0+	12.607	$1.51 \times 10^6$ y 6	$\beta^-$		
		11	1/2+	20.174	13.81 s 8	$\beta^-$ , $\beta^- \alpha$ 3.1%		
		12	0+	25.08	21.49 ms 3	$\beta^-$ , $\beta^-n \leq 1\%$		
		13	(1/2-)	33.25	$2.7 \times 10^{-21}$ s 18	n		
		14	0+	40.0	4.84 ms 10	$\beta^-$ , $\beta^-n$ 94%, $\beta^-2n$ 6%		
		15		49.8s	<200 ns	n?		
		16	0+	57.7s	<200 ns	2n?		
		5	B	6		43.6s	unstable	2p?
				7	(3/2-)	27.87	1.4 MeV 2	p, $\alpha$
8	2+			22.921	770 ms 3	$\epsilon$ , $\epsilon\alpha$		
9	3/2-			12.416	0.54 keV 21	p,		
10	3+			12.051	<b>19.8% 3</b>			
11	3/2-			8.668	<b>80.2% 3</b>			
12	1+			13.369	20.20 ms 2	$\beta^-$ , $\beta^-3\alpha$ 1.58%		
13	3/2-			16.562	17.33 ms 17	$\beta^-$		
14	2-			23.66	12.5 ms 5	$\beta^-$ , $\beta^-n$ 6.04%		
15				28.97	9.93 ms 7	$\beta^-$ , $\beta^-n$ 93.6%, $\beta^-2n$ 0.4%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
5	B	16	0-	37.08	<190 ps	n
		17	(3/2-)	43.8	5.08 ms	5 $\beta^-$ , $\beta^-$ -n 63%, $\beta^-$ -2n 11%, $\beta^-$ -3n 3.5%, $\beta^-$ -4n 0.4%
		18	(4-)	52.3s	<26 ns	n?
		19	(3/2-)	59.4s	2.92 ms	13 $\beta^-$ , $\beta^-$ -n 72%, $\beta^-$ -2n 16%
		20	0+	35.09	230 keV	50 p, $\alpha$
6	C	9	(3/2-)	28.910	126.5 ms	9 $\epsilon$ , $\epsilon$ p 23%, $\epsilon\alpha$ 17%
		10	0+	15.699	19.26 s	5 $\epsilon$
		11	3/2-	10.650	20.334 m	24 $\epsilon$
		12	0+	0.000		<b>98.89% 1</b>
		13	1/2-	3.125		<b>1.11% 1</b>
		14	0+	3.020	5700 y	30 $\beta^-$
		15	1/2+	9.873	2.449 s	5 $\beta^-$
		16	0+	13.694	0.747 s	8 $\beta^-$ , $\beta^-$ -n 99%
		17		21.04	193 ms	13 $\beta^-$ , $\beta^-$ -n 32%
		18	0+	24.93	92 ms	2 $\beta^-$ , $\beta^-$ -n 31.5%
		19		32.42	49 ms	4 $\beta^-$ -n 61%, $\beta^-$
		20	0+	37.6	14 ms	+6-5 $\beta^-$ , $\beta^-$ -n 72%
		21	(1/2+)	46.0s	<30 ns	n?
22	0+	53.3s	6.1 ms	+14-12 $\beta^-$ , $\beta^-$ -n 61%, $\beta^-$ -2n >0%		
7	N	10	(1-)	38.8	$20 \times 10^{-23}$ y	14 p?
		11m	1/2+	24.62	1.58 MeV	+75-52 p
		12	1+	17.338	11.000 ms	16 $\epsilon$
		13	1/2-	5.345	9.965 m	4 $\epsilon$
		14	1+	2.863		<b>99.634% 20</b>
		14m	4-	11.353	13.2 Fs	21 p 79%, IT 21%
		14m	5+	11.827	73 Fs	12 p 81%, IT 19%
		14m	3+	11.992	9 Fs	4 p 80%, IT 20%
		15	1/2-	0.101		<b>0.366% 20</b>
		15m	9/2+	10.795	12 Fs	6 IT, p
		16	2-	5.684	7.13 s	2 $\beta^-$ , $\beta^-$ - $\alpha$ $1.2 \times 10^{-3}\%$
		17	1/2-	7.87	4.173 s	4 $\beta^-$ , $\beta^-$ -n 95.1%
		18	1-	13.11	624 ms	12 $\beta^-$ , $\beta^-$ -n 14.3%, $\beta^-$ - $\alpha$ 12.2%
		19		15.86	271 ms	8 $\beta^-$ , $\beta^-$ -n 54.6%
		20		21.77	130 ms	7 $\beta^-$ , $\beta^-$ -n 57%
		21	(1/2-)	25.25	85 ms	7 $\beta^-$ , $\beta^-$ -n 81%
		22		32.0	18 ms	4 $\beta^-$ , $\beta^-$ -n 36%, $\beta^-$ -2n <13%
23		38.4s	14.1 ms	+12-15 $\beta^-$ , $\beta^-$ -n 42%, $\beta^-$ -2n 8%		
24		47.5s	<52 ns	n?		
25		56.5s	<260 ns	n?		
8	O	12	0+	32.05	0.40 MeV	25 p
		13	(3/2-)	23.112	8.58 ms	5 $\epsilon$ , $\epsilon$ p = 100%
		14	0+	8.007	70.641 s	20 $\epsilon$
		15	1/2-	2.856	122.24 s	16 $\epsilon$
		16	0+	-4.737		<b>99.762% 16</b>



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>8 O</b>	17	5/2+	-0.809	<b>0.038% 1</b>	
	18	0+	-0.781	<b>0.200% 14</b>	
	19	5/2+	3.335	26.88 s 5	$\beta^-$
	20	0+	3.797	13.51 s 5	$\beta^-$
	21	(5/2+)	8.06	3.42 s 10	$\beta^-$
	22	0+	9.28	2.25 s 15	$\beta^-$ , $\beta^-n < 22\%$
	23		14.6	82 ms 37	$\beta^-$ , $\beta^-n 31\%$
	24	0+	19.1	65 ms 5	$\beta^-$ , $\beta^-n 18\%$
	25	(3/2+)	27.4s	<50 ns	n
	26	0+	35.7s	<40 ns	n
	27		45.0s	<260 ns	n?
	28	0+	53.8s	<100 ns	n?
	<b>9 F</b>	14	(2-)	32.7s	?
15		(1/2+)	16.8	1.0 MeV 2	p
16		0-	10.680	40 keV 20	p
17		5/2+	1.952	64.49 s 16	$\epsilon$
18		1+	0.874	1.8291 h 4	$\epsilon$
19		1/2+	-1.487	<b>100%</b>	
20		2+	-0.017	11.07 s 6	$\beta^-$
21		5/2+	-0.048	4.158 s 20	$\beta^-$
22		(4+)	2.79	4.23 s 4	$\beta^-$ , $\beta^-n < 11\%$
23		(3/2,5/2)+	3.33	2.23 s 14	$\beta^-$
24		(1,2,3)+	7.56	400 ms 50	$\beta^-$ , $\beta^-n < 5.9\%$
25		(5/2+)	11.27	50 ms 6	$\beta^-$ , $\beta^-n 14\%$
26		1+	18.3	9.6 ms 8	$\beta^-$ , $\beta^-n 11\%$
27		(5/2+)	24.9	5.0 ms 2	$\beta^-$ , $\beta^-n 77\%$
28			33.2s	<40 ns	n
29	(5/2+)	40.3s	2.5 ms 4	$\beta^-$ , $\beta^-n$ , $\beta^-$	
30		48.9s	<260 ns	n?	
31		56.3s	>260 ns	$\beta^-?$ , $\beta^-n?$	
<b>10 Ne</b>	16	0+	24.00	122 keV 37	p
	17	1/2-	16.46	109.2 ms 6	$\epsilon$ , $\epsilon p = 100\%$ , $\epsilon\alpha$
	18	0+	5.317	1672 ms 8	$\epsilon$
	19	1/2+	1.751	17.22 s 2	$\epsilon$
	20	0+	-7.042	<b>90.48% 3</b>	
	21	3/2+	-5.732	<b>0.27% 1</b>	
	22	0+	-8.025	<b>9.25% 3</b>	
	23	5/2+	-5.154	37.24 s 12	$\beta^-$
	24	0+	-5.951	3.38 m 2	$\beta^-$
	25	(3/2)+	-2.11	602 ms 8	$\beta^-$
	26	0+	0.43	192 ms 6	$\beta^-$ , $\beta^-n < 0.2\%$
	27	(3/2+)	7.1	32 ms 2	$\beta^-$ , $\beta^-n 2\%$
	28	0+	11.2	19 ms 3	$\beta^-$ , $\beta^-n 16\%$
	29	(3/2+)	18.1	15.6 ms 5	$\beta^-$ , $\beta^-n 17\%$ , $\beta^-2n < 2.9\%$
	30	0+	23.1	5.8 ms 2	$\beta^-$ , $\beta^-n < 26\%$
31		30.8s	3.4 ms 8	$\beta^-$	
32	0+	37.3s	3.5 ms 9	$\beta^-$	
33		46.0s	<260 ns	n?	
34	0+	53.1s	>1.5 $\mu$ s	$\beta^-?$ , $\beta^-n?$	
<b>11 Na</b>	18	(1-)	24.19	$1.3 \times 10^{-21}$ s 4	p?, $\epsilon?$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>11 Na</b>	19	(5/2+)	12.93	<40 ns	p
	20	2+	6.848	447.9 ms 23	$\epsilon$ , $\epsilon\alpha$ 20.05%
	21	3/2+	-2.184	22.49 s 4	$\epsilon$
	22	3+	-5.182	2.6027 y 10	$\epsilon$
	23	3/2+	-9.530	<b>100%</b>	
	24	4+	-8.418	14.951 h 3	$\beta^-$
	24m	1+	-7.946	20.20 ms 7	IT 99.95%, $\beta^-$ 0.05%
	25	5/2+	-9.358	59.1 s 6	$\beta^-$
	26	3+	-6.862	1.077 s 5	$\beta^-$
	27	5/2+	-5.517	301 ms 6	$\beta^-$ , $\beta^-n$ 0.13%
	28	1+	-0.99	30.5 ms 4	$\beta^-$ , $\beta^-n$ 0.58%
	29	3/2+	2.66	44.9 ms 12	$\beta^-$ , $\beta^-n$ 21.5%
	30	2+	8.36	48 ms 2	$\beta^-$ , $\beta^-n$ 30%, $\beta^-$ 1.17%, $\beta^-n$ 5.5 $\times$ 10 <sup>-5</sup> %
	31	3/2+	12.7	17.0 ms 4	$\beta^-$ , $\beta^-n$ 37%, $\beta^-$ 0.9%
	32		19.1	13.2 ms 4	$\beta^-$ , $\beta^-n$ 24%, $\beta^-$ 8%
	33		24.9	8.1 ms 4	$\beta^-$ , $\beta^-n$ 47%, $\beta^-2n$ 13%
	34		32.8s	5.5 ms 10	$\beta^-$ , $\beta^-n$ $\leq$ 100%, $\beta^-$
	35		39.6s	1.5 ms 5	$\beta^-$ , $\beta^-n$
	36		48.0s	<260 ns	n?
	37		55.3s	>1.5 $\mu$ s	$\beta^-?$ , $\beta^-n?$
<b>12 Mg</b>	19		33.0	?	2p?
	20	0+	17.57	90.8 ms 24	$\epsilon$ , $\epsilon p$ $\approx$ 27%
	21	5/2+	10.91	122 ms 3	$\epsilon$ , $\epsilon p$ 32.6%, $\epsilon\alpha$ <0.5%
	22	0+	-0.397	3.8755 s 12	$\epsilon$
	23	3/2+	-5.474	11.317 s 11	$\epsilon$
	24	0+	-13.934	<b>78.99% 4</b>	
	25	5/2+	-13.193	<b>10.00% 1</b>	
	26	0+	-16.215	<b>11.01% 3</b>	
	27	1/2+	-14.587	9.458 m 12	$\beta^-$
	28	0+	-15.019	20.915 h 9	$\beta^-$
	29	3/2+	-10.62	1.30 s 12	$\beta^-$
	30	0+	-8.911	335 ms 17	$\beta^-$
	31		-3.22	230 ms 20	$\beta^-$ , $\beta^-n$ 1.7%
	32	0+	-0.95	86 ms 5	$\beta^-$
	32	0+	-0.95	65 ms 5	$\beta^-n$ 5.5%
	33		4.89	90.5 ms 16	$\beta^-$ , $\beta^-n$ 17%
	34	0+	8.8	20 ms 10	$\beta^-$ , $\beta^-n$
	35	(7/2-)	16.2s	70 ms 40	$\beta^-$ , $\beta^-n$ 52%
	36	0+	21.4s	3.9 ms 13	$\beta^-$
	37	(7/2-)	29.2s	>260 ns	$\beta^-$ , $\beta^-n$
38	0+	35.0s	>260 ns	$\beta^-?$	
39		43.6s	>260 ns	n?	
40	0+	50.2s	1 ms SY	$\beta^-?$ , $\beta^-n?$	
<b>13 Al</b>	21	(5/2+)	26.1s	<35 ns	p
	22	(3+)	18.18s	59 ms 3	$\epsilon$ , $\epsilon p$ = 60%, $\epsilon$ 0.9%, $\epsilon\alpha$ 0.31%
	23	3/2+	6.77	0.47 s 3	$\epsilon$ , $\epsilon p$ = 1.1%

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or		Decay Mode	
Z	El	A	(MeV)	Abundance			
13	Al	24	4+	-0.057	2.053 s 4	$\epsilon$ , $\epsilon\alpha$ 0.04%, $\epsilon p$ $1.6 \times 10^{-3}\%$	
		24m	1+	0.369	131.3 ms 25	IT 82%, $\epsilon$ 18%, $\epsilon\alpha$ 0.03%	
			25	5/2+	-8.916	7.183 s 12	$\epsilon$
			26	5+	-12.210	$7.17 \times 10^5$ y 24	$\epsilon$
			26m	0+	-11.982	6.3452 s 19	$\epsilon$
			27	5/2+	-17.197	<b>100%</b>	
			28	3+	-16.850	2.2414 m 12	$\beta^-$
			29	5/2+	-18.215	6.56 m 6	$\beta^-$
			30	3+	-15.87	3.60 s 6	$\beta^-$
			31	(3/2,5/2)+	-14.95	644 ms 25	$\beta^-$
			32	1+	-11.06	33 ms 4	$\beta^-$
			33	(5/2+)	-8.53	41.7 ms 2	$\beta^-$ , $\beta^-n$ 8.5%
			34		-2.9	42 ms 6	$\beta^-$ , $\beta^-n$ 27%
			35		-0.1	38.6 ms 4	$\beta^-$ , $\beta^-n$ 41%
			36		5.8	90 ms 40	$\beta^-$ , $\beta^-n < 31\%$
			37		9.9	10.7 ms 13	$\beta^-$
			38		16.1	7.6 ms 6	$\beta^-$
			39	(3/2+)	21.	7.6 ms 16	$\beta^-$
			40		29.3s	>260 ns	$\beta^-$ , $\beta^-n$
			41		35.7s	>260 ns	$\beta^-$
			42		43.7s	1 ms SY	$\beta^-?$ , $\beta^-n?$
		14	Si	22	0+	32.2s	29 ms 2
23				23.8s	42.3 ms 4	$\epsilon$ , $\epsilon p = 73\%$ , $\epsilon 2p < 4\%$	
24	0+			10.75	140 ms 8	$\epsilon$ , $\epsilon p$ 38%	
25	5/2+			3.82	220 ms 3	$\epsilon$ , $\epsilon p$	
26	0+			-7.145	2.234 s 13	$\epsilon$	
27	5/2+			-12.384	4.16 s 2	$\epsilon$	
28	0+			-21.493	<b>92.230% 19</b>		
29	1/2+			-21.895	<b>4.683% 8</b>		
30	0+			-24.433	<b>3.087% 5</b>		
31	3/2+			-22.949	157.3 m 3	$\beta^-$	
32	0+			-24.081	132 y 13	$\beta^-$	
33	(3/2+)			-20.49	6.18 s 18	$\beta^-$	
34	0+			-19.96	2.77 s 20	$\beta^-$	
35				-14.36	0.78 s 12	$\beta^-$	
36	0+			-12.5	0.45 s 6	$\beta^-$ , $\beta^-n < 10\%$	
37	(7/2-)			-6.6	90 ms 60	$\beta^-$ , $\beta^-n$ 17%	
38	0+			-4.1	>1 $\mu$ s	$\beta^-$ , $\beta^-n$	
39	(7/2-)			1.9	47.5 ms 20	$\beta^-$	
40	0+			5.5	33.0 ms 10	$\beta^-$ , $\beta^-n$	
41				14.	20.0 ms 25		
42	0+	18.4s	13 ms 4	$\beta^-$			
43		26.7s	>260 ns	$\beta^-?$ , $\beta^-n?$			
44	0+	32.8s	10 ms SY	$\beta^-?$ , $\beta^-n?$			
15	P	24	(1+)	32.0s	?	$p?$ , $\epsilon?$	
		25	(1/2+)	18.9s	<30 ns	$p$	
		26	(3+)	11.0s	43.7 ms 6	$\epsilon$ , $\epsilon p$	
		27	1/2+	-0.72	260 ms 80	$\epsilon$ , $\epsilon p$ 0.07%	
		28	3+	-7.159	270.3 ms 5	$\epsilon$ , $\epsilon p$ $1.3 \times 10^{-3}\%$ , $\epsilon\alpha$ $8.6 \times 10^{-4}\%$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>15 P</b>	29	1/2+	-16.953	4.142 s 15	$\epsilon$
	30	1+	-20.201	2.498 m 4	$\epsilon$
	31	1/2+	-24.441	<b>100%</b>	
	32	1+	-24.305	14.262 d 14	$\beta^-$
	33	1/2+	-26.337	25.34 d 12	$\beta^-$
	34	1+	-24.558	12.43 s 8	$\beta^-$
	35	1/2+	-24.858	47.3 s 7	$\beta^-$
	36	4-	-20.25	5.6 s 3	$\beta^-$
	37		-18.99	2.31 s 13	$\beta^-$
	38		-14.8	0.64 s 14	$\beta^-$ , $\beta^-n < 10\%$
	39		-12.9	0.25 s 8	$\beta^-$ , $\beta^-n 26\%$
	40	(2-,3-)	-8.1	125 ms 25	$\beta^-$ , $\beta^-n 15.8\%$
	41		-5.3	100 ms 5	$\beta^-$ , $\beta^-n 30\%$
	42		0.9	48.5 ms 15	$\beta^-$ , $\beta^-n 50\%$
	43		5.8	36.5 ms 15	$\beta^-$ , $\beta^-n$
	44		12.1s	18.5 ms 25	$\beta^-$
45		17.9s	>200 ns	$\beta^-?$	
46		25.5s	>200 ns	$\beta^-$	
<b>16 S</b>	26	0+	26.0s	$\approx 10$ ms	2p?
	27	(5/2+)	17.5s	15.5 ms 15	$\epsilon$ , $\epsilon p 2.3\%$ , $\epsilon 2p 1.1\%$
	28	0+	4.1	125 ms 10	$\epsilon$ , $\epsilon p 21\%$
	29	5/2+	-3.16	187 ms 4	$\epsilon$ , $\epsilon p 47\%$
	30	0+	-14.063	1.178 s 5	$\epsilon$
	31	1/2+	-19.045	2.572 s 13	$\epsilon$
	32	0+	-26.016	<b>95.02% 9</b>	
	33	3/2+	-26.586	<b>0.75% 1</b>	
	34	0+	-29.932	<b>4.21% 8</b>	
	35	3/2+	-28.846	87.51 d 12	$\beta^-$
	36	0+	-30.664	<b>0.02% 1</b>	
	37	7/2-	-26.896	5.05 m 2	$\beta^-$
	38	0+	-26.861	170.3 m 7	$\beta^-$
	39	(3/2,5/2,7/2)-	-23.16	11.5 s 5	$\beta^-$
	40	0+	-22.9	8.8 s 22	$\beta^-$
	41	(7/2-)	-19.0	1.99 s 5	$\beta^-$ , $\beta^-n$
42	0+	-17.7	1.013 s 15	$\beta^-$	
43		-12.0	0.28 s 3	$\beta^-$ , $\beta^-n 40\%$	
44	0+	-9.1	100 ms 1	$\beta^-$ , $\beta^-n 18\%$	
45		-3.	68 ms 2	$\beta^-$ , $\beta^-n 54\%$	
46	0+	0.7s	50 ms 8	$\beta^-$	
47		8.0s	>200 ns	$\beta^-?$	
48	0+	13.2s	$\geq 200$ ns	$\beta^-$	
49		22.0s	<200 ns	n	
<b>17 Cl</b>	28	(1+)	26.6s	?	p?
	29	(3/2+)	13.1s	<20 ns	p
	30	(3+)	4.4s	<30 ns	p
	31		-7.07	150 ms 25	$\epsilon$ , $\epsilon p 0.7\%$
	32	1+	-13.330	298 ms 1	$\epsilon$ , $\epsilon \alpha 0.05\%$ , $\epsilon p 0.03\%$
	33	3/2+	-21.003	2.511 s 3	$\epsilon$
	34	0+	-24.440	1.5264 s 14	$\epsilon$
34m	3+	-24.293	32.00 m 4	$\epsilon 55.4\%$ , IT 44.6%	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
17	Cl	35	3/2+	-29.014	<b>75.77% 4</b>	
		36	2+	-29.522	3.01×10 <sup>5</sup> y 2	$\beta^-$ 98.1%, $\epsilon$ 1.9%
		37	3/2+	-31.761	<b>24.23% 4</b>	
		38	2-	-29.798	37.24 m 5	$\beta^-$
		38m	5-	-29.127	715 ms 3	IT
		39	3/2+	-29.800	55.6 m 2	$\beta^-$
		40	2-	-27.56	1.35 m 2	$\beta^-$
		41	(1/2+,3/2+)	-27.31	38.4 s 8	$\beta^-$
		42		-24.9	6.8 s 3	$\beta^-$
		43		-24.2	3.07 s 7	$\beta^-$
		44		-20.2	0.56 s 11	$\beta^-$ , $\beta^-$ -n<8%
		45		-18.4	400 ms 43	$\beta^-$ , $\beta^-$ -n 24%
		46		-14.7	232 ms 2	$\beta^-$ , $\beta^-$ -n 60%
		47		-10.5s	101 ms 6	$\beta^-$ , $\beta^-$ -n>0%
		48		-4.7s	≥200 ns	$\beta^-$
		49		0.3s	≥170 ns	
50		7.3s	20 ms SY	$\beta^-$ ?		
51	(3/2+)	13.5s	>200 ns	$\beta^-$		
18	Ar	30	0+	20.1s	<20 ns	p?
		31	5/2+	11.3s	15.1 ms 13	$\epsilon$ , $\epsilon$ p 69%, $\epsilon$ 7.6%
		32	0+	-2.200	98 ms 2	$\epsilon$ , $\epsilon$ p 43%
		33	1/2+	-9.384	173.0 ms 20	$\epsilon$ , $\epsilon$ p 38.7%
		34	0+	-18.377	844.5 ms 34	$\epsilon$
		35	3/2+	-23.047	1.775 s 4	$\epsilon$
		36	0+	-30.232	<b>0.3365% 30</b>	
		37	3/2+	-30.948	34.95 d 4	$\epsilon$
		38	0+	-34.715	<b>0.0632% 5</b>	
		39	7/2-	-33.242	269 y 3	$\beta^-$
		40	0+	-35.040	<b>99.6003% 30</b>	
		41	7/2-	-33.068	109.61 m 4	$\beta^-$
		42	0+	-34.423	32.9 y 11	$\beta^-$
		43	(5/2-)	-32.010	5.37 m 6	$\beta^-$
		44	0+	-32.673	11.87 m 5	$\beta^-$
		45		-29.771	21.48 s 15	$\beta^-$
46	0+	-29.72	8.4 s 6	$\beta^-$		
47	(3/2-)	-25.9	1.23 s 3	$\beta^-$ , $\beta^-$ -n<0.002%		
48	0+	-23.7s	0.48 s 40	$\beta^-$		
49		-18.1s	≥170 ns			
50	0+	-14.5s	≥170 ns			
51		-7.8s	>200 ns	$\beta^-$ ?		
52	0+	-3.0s	10 ms	$\beta^-$		
53	(5/2-)	4.6s	3 ms SY	$\beta^-$ , $\beta^-$ -n		
19	K	32		20.4s	?	p?
		33	(3/2+)	6.8s	<25 ns	p
		34	(1+)	-1.5s	<25 ns	p
		35	3/2+	-11.17	178 ms 8	$\epsilon$ , $\epsilon$ p 0.37%
		36	2+	-17.426	342 ms 2	$\epsilon$ , $\epsilon$ p 0.05%, $\epsilon\alpha$ 3.4×10 <sup>-3%</sup>
		37	3/2+	-24.800	1.226 s 7	$\epsilon$
		38	3+	-28.801	7.636 m 18	$\epsilon$
		38m	0+	-28.670	924.2 ms 3	$\epsilon$
		39	3/2+	-33.807	<b>93.2581% 44</b>	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$				
Z	El	A	(MeV)	Abundance	Decay Mode			
19	K	40	4-	-33.535	1.248×10 <sup>9</sup> y 3 <b>0.0117% 1</b>	$\beta^-$ 89.28%, $\epsilon$ 10.72%		
		41	3/2+	-35.559	<b>6.7302% 44</b>			
		42	2-	-35.022	12.321 h 25	$\beta^-$		
		43	3/2+	-36.593	22.3 h 1	$\beta^-$		
		44	2-	-35.81	22.13 m 19	$\beta^-$		
		45	3/2+	-36.61	17.3 m 6	$\beta^-$		
		46	(2-)	-35.42	105 s 10	$\beta^-$		
		47	1/2+	-35.696	17.50 s 24	$\beta^-$		
		48	(2-)	-32.12	6.8 s 2	$\beta^-$ , $\beta^-n$ 1.14%		
		49	(3/2+)	-30.32	1.26 s 5	$\beta^-$ , $\beta^-n$ 86%		
		50	(0-,1,2-)	-25.4	472 ms 4	$\beta^-$ , $\beta^-n$ 29%		
		51	(1/2+,3/2+)	-22.0s	365 ms 5	$\beta^-$ , $\beta^-n$ 47%		
		52	(2-)	-16.2s	105 ms 5	$\beta^-$ , $\beta^-n \approx 64%$ , $\beta^-$		
		53	(3/2+)	-12.0s	30 ms 5	$\beta^-$ , $\beta^-n \approx 67%$ , $\beta^-2n \approx 17%$		
		54		-5.4s	10 ms 5	$\beta^-$ , $\beta^-n > 0%$		
		55		-0.3s	3 ms SY	$\beta^-?$ , $\beta^-n?$		
		20	Ca	34	0+	13.2s	<35 ns	p
				35		4.6s	25.7 ms 2	$\epsilon$ , $\epsilon p$ 95.7%, $\epsilon 2p$ 4.2%
36	0+			-6.44	102 ms 2	$\epsilon$ , $\epsilon p$ 57%		
37	3/2+			-13.16	181.1 ms 10	$\epsilon$ , $\epsilon p$ 82.1%		
38	0+			-22.059	440 ms 8	$\epsilon$		
39	3/2+			-27.274	859.6 ms 14	$\epsilon$		
40	0+			-34.846	>3.0×10 <sup>21</sup> y <b>96.94% 16</b>	2 $\epsilon$		
41	7/2-			-35.138	1.02×10 <sup>5</sup> y 7	$\epsilon$		
42	0+			-38.547	<b>0.647% 23</b>			
43	7/2-			-38.409	<b>0.135% 10</b>			
44	0+			-41.468	<b>2.09% 11</b>			
45	7/2-			-40.812	162.61 d 9	$\beta^-$		
46	0+			-43.135	>0.28×10 <sup>16</sup> y <b>0.004% 3</b>	2 $\beta^-$		
47	7/2-			-42.340	4.536 d 3	$\beta^-$		
48	0+			-44.214	>4.5×10 <sup>22</sup> y <b>0.187% 21</b>	2 $\beta^-$ 84%, $\beta^- < 15%$		
49	3/2-			-41.289	8.718 m 6	$\beta^-$		
50	0+			-39.571	13.9 s 6	$\beta^-$		
51	(3/2-)			-35.86	10.0 s 8	$\beta^-$ , $\beta^-n$		
52	0+	-32.5	4.6 s 3	$\beta^-$ , $\beta^-n \leq 2%$				
53	(3/2-,5/2-)	-27.9s	90 ms 15	$\beta^-$ , $\beta^-n > 30%$				
54	0+	-23.9s	>300 ns	$\beta^-$				
55		-18.1s	>300 ns	$\beta^-?$				
56	0+	-13.4s	10 ms SY	$\beta^-?$				
57		-7.s	5 ms SY	$\beta^-?$ , $\beta^-n?$				
21	Sc	36		13.9s	?	p?		
		37		2.8s	?	p?		
		38	(2-)	-4.9s	<300 ns	p		
		39	(7/2-)	-14.17	<300 ns	p		
		40	4-	-20.523	182.3 ms 7	$\epsilon$ , $\epsilon p$ 0.44%, $\epsilon \alpha$ 0.02%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode			
Z	El	A	(MeV)	Abundance				
21	Sc	41	7/2-	-28.642	596.3 ms 17	$\epsilon$		
		42	0+	-32.121	681.3 ms 7	$\epsilon$		
		42m	(7)+	-31.505	61.7 s 4	$\epsilon$		
		43	7/2-	-36.188	3.891 h 12	$\epsilon$		
		43m	3/2+	-36.036	438 $\mu$ s 7	IT		
		44	2+	-37.816	3.97 h 4	$\epsilon$		
		44m	6+	-37.545	58.61 h 10	IT 98.8%, $\epsilon$ 1.2%		
		45	7/2-	-41.068	<b>100%</b>			
		45m	3/2+	-41.056	318 ms 7	IT		
		46	4+	-41.757	83.79 d 4	$\beta^-$		
		46m	1-	-41.615	18.75 s 4	IT		
		47	7/2-	-44.332	3.3492 d 6	$\beta^-$		
		48	6+	-44.496	43.67 h 9	$\beta^-$		
		49	7/2-	-46.552	57.2 m 2	$\beta^-$		
		50	5+	-44.54	102.5 s 5	$\beta^-$		
		50m	(2,3)+	-44.28	0.35 s 4	IT > 97.5%, $\beta^-$ < 2.5%		
		51	(7/2)-	-43.22	12.4 s 1	$\beta^-$		
		52	3(+)	-40.4	8.2 s 2	$\beta^-$		
		53	(7/2)-	-37.6s	> 3 s	$\beta^-$ , $\beta^-n$		
		54	(3,4+)	-34.2	0.36 s 6	$\beta^-$		
		55	(7/2)-	-29.6	0.115 s 15	$\beta^-$ , $\beta^-n$		
		56	(1+)	-25.3s	35 ms 5	$\beta^-$ , $\beta^-n$		
		56	(6+,7+)	-25.3s	60 ms 7	$\beta^-$ , $\beta^-n$		
		57		-20.7s	13 ms 4	$\beta^-$		
		57	(7/2)-	-20.7s	13 ms 4	$\beta^-n$		
		58	(3+)	-15.2s	12 ms 5	$\beta^-$		
		59		-10.0s	10 ms SY	$\beta^-?$ , $\beta^-n?$		
		60		-4.0s	3 ms SY	$\beta^-$		
		22	Ti	38	0+	9.1s	< 120 ns	2p?
				39	(3/2+)	1.5s	31 ms +6-4	$\epsilon$ , $\epsilon p$ 14%
40	0+			-8.9	53.3 ms 15	$\epsilon$ , $\epsilon p$		
41	3/2+			-15.7s	80.4 ms 9	$\epsilon$ , $\epsilon p = 100%$		
42	0+			-25.122	199 ms 6	$\epsilon$		
43	7/2-			-29.321	509 ms 5	$\epsilon$		
44	0+			-37.549	60.0 y 11	$\epsilon$		
45	7/2-			-39.006	184.8 m 5	$\epsilon$		
46	0+			-44.123	<b>8.25% 3</b>			
47	5/2-			-44.932	<b>7.44% 2</b>			
48	0+			-48.488	<b>73.72% 3</b>			
49	7/2-			-48.559	<b>5.41% 2</b>			
50	0+			-51.427	<b>5.18% 2</b>			
51	3/2-			-49.728	5.76 m 1	$\beta^-$		
52	0+			-49.465	1.7 m 1	$\beta^-$		
53	(3/2)-	-46.8	32.7 s 9	$\beta^-$				
54	0+	-45.6	1.5 s 4	$\beta^-$				
55	(3/2)-	-41.7	1.3 s 1	$\beta^-$				
56	0+	-38.9	200 ms 5	$\beta^-$ , $\beta^-n$				
57		-33.5	60 ms 16	$\beta^-$ , $\beta^-n$				
58	0+	-30.8s	59 ms 9	$\beta^-$				
59	(5/2-)	-25.2s	30 ms 3	$\beta^-$				
60	0+	-21.6s	22 ms 2	$\beta^-$				
61		-15.6s	> 300 ns	$\beta^-?$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	$J^\pi$	(MeV)	Abundance	
22	Ti	62	0+	-11.7s	10 ms SY	$\beta^-?$
		63		-5.2s	3 ms SY	$\beta^-?, \beta^-n?$
23	V	40		10.3s	?	p?
		41		-0.2s	?	p?
		42		-8.2s	<55 ns	p
		43		-18.0s	>800 ms	$\epsilon$
		44	(2+)	-24.1	111 ms 7	$\epsilon, \epsilon\alpha$
		44m	(6+)	-24.1	150 ms 3	$\epsilon$
		45	7/2-	-31.88	547 ms 6	$\epsilon$
		46	0+	-37.073	422.50 ms 11	$\epsilon$
		46m	3+	-36.271	1.02 ms 7	IT
		47	3/2-	-42.002	32.6 m 3	$\epsilon$
		48	4+	-44.475	15.9735 d 25	$\epsilon$
		49	7/2-	-47.957	329 d 3	$\epsilon$
		50	6+	-49.222	$1.4 \times 10^{17}$ y 4	$\epsilon$ 83%, $\beta^-$ 17%
		51	7/2-	-52.201	<b>0.250% 2</b> <b>99.750% 2</b>	
		52	3+	-51.441	3.743 m 5	$\beta^-$
		53	7/2-	-51.849	1.60 m 4	$\beta^-$
		54	3+	-49.89	49.8 s 5	$\beta^-$
		55	(7/2-)	-49.2	6.54 s 15	$\beta^-$
		56	(1+)	-46.1	216 ms 4	$\beta^-$
		56	1+	-46.1	216 ms 4	$\beta^-n$ 0.06%
57	(3/2-)	-44.2	0.35 s 1	$\beta^-$ , $\beta^-n$ 0.04%		
58	(1+)	-40.2	185 ms 10	$\beta^-$		
59	(5/2-, 3/2-)	-37.1	75 ms 7	$\beta^-$		
60		-32.6	68 ms 5	$\beta^-$		
60m		-32.6	40 ms 15	$\beta^-$ , $\beta^-n$		
60m		-32.6	122 ms 18	$\beta^-$ , $\beta^-n$		
61	(3/2-)	-29.4s	47 ms 1	$\beta^-$		
62		-24.4s	33.5 ms 2	$\beta^-$		
63	(7/2-)	-20.9s	17 ms 3	$\beta^-$		
64		-15.4s	>150 ns	$\beta^-$		
65		-11.3s	10 ms SY	$\beta^-?, \beta^-n?$		
24	Cr	42	0+	6.0s	13 ms +4-2	$\epsilon$
		43	(3/2+)	-2.1s	21.6 ms 7	$\epsilon, \epsilon p$ 23%, $\epsilon$ 6%
		44	0+	-13.46s	53 ms +4-3	$\epsilon, \epsilon p > 7%$
		45		-19.0	50 ms 6	$\epsilon, \epsilon p > 27%$
		46	0+	-29.47	0.26 s 6	$\epsilon$
		47	3/2-	-34.56	500 ms 15	$\epsilon$
		48	0+	-42.819	21.56 h 3	$\epsilon$
		49	5/2-	-45.331	42.3 m 1	$\epsilon$
		50	0+	-50.259	$>1.3 \times 10^{18}$ y	2 $\epsilon$
		51	7/2-	-51.449	<b>4.345% 13</b> 27.7025 d 24	$\epsilon$
		52	0+	-55.417	<b>83.789% 18</b>	
		53	3/2-	-55.285	<b>9.501% 17</b>	
		54	0+	-56.932	<b>2.365% 7</b>	
		55	3/2-	-55.107	3.497 m 3	$\beta^-$
		56	0+	-55.281	5.94 m 10	$\beta^-$
		57	3/2-, 5/2-, 7/2-	-52.524	21.1 s 10	$\beta^-$
		58	0+	-51.8	7.0 s 3	$\beta^-$



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>24 Cr</b>	59	(1/2-)	-47.9	0.46 s 5	$\beta^-$
	60	0+	-46.5	0.57 s 6	$\beta^-$
	61		-42.2	0.27 s 2	$\beta^-$
	62	0+	-40.4	209 ms 12	$\beta^-$ , $\beta^-n$
	63	(1/2-)	-35.5s	129 ms 2	$\beta^-$ , $\beta^-n$
	64	0+	-33.2s	43 ms 1	$\beta^-$
	65	(1/2-)	-27.8s	27 ms 3	$\beta^-$ , $\beta^-n?$
	66	0+	-24.8s	10 ms 6	$\beta^-$
	67		-19.0s	$\approx 50$ ms	$\beta^-?$
<b>25 Mn</b>	44	(2-)	6.4s	<105 ns	$\epsilon$ , p
	45	(7/2-)	-5.1s	<70 ns	p
	46	[4+]	-12.4s	34 ms +5-4	$\epsilon$ , $\epsilon p$ 22%
	47		-22.3s	100 ms 50	$\epsilon$ , $\epsilon p > 3.4\%$
	48	4+	-29.3	158.1 ms 22	$\epsilon$ , $\epsilon p$ 0.28%, $\epsilon \alpha < 6.0 \times 10^{-4}\%$
	49	5/2-	-37.62	382 ms 7	$\epsilon$
	50	0+	-42.627	283.29 ms 8	$\epsilon$
	50m	5+	-42.398	1.75 m 3	$\epsilon$
	51	5/2-	-48.241	46.2 m 1	$\epsilon$
	52	6+	-50.705	5.591 d 3	$\epsilon$
	52m	2+	-50.328	21.1 m 2	$\epsilon$ 98.25%, IT 1.75%
	53	7/2-	-54.688	$3.74 \times 10^6$ y 4	$\epsilon$
	54	3+	-55.555	312.12 d 6	$\epsilon$ , $\beta^- < 2.9 \times 10^{-4}\%$
	55	5/2-	-57.711	<b>100%</b>	
	56	3+	-56.910	2.5789 h 1	$\beta^-$
	57	5/2-	-57.487	85.4 s 18	$\beta^-$
	58	1+	-55.91	3.0 s 1	$\beta^-$
	58m	(4)+	-55.83	65.2 s 5	$\beta^- \approx 80\%$ , IT=20%
	59	(5/2)-	-55.48	4.59 s 5	$\beta^-$
	60	0+	-53.18	51 s 6	$\beta^-$
	60m	3+	-52.91	1.77 s 2	$\beta^-$ 88.5%, IT 11.5%
	61	(5/2)-	-51.6	0.67 s 4	$\beta^-$
	62	(3+,4+)	-48.0	671 ms 5	$\beta^-$
	62	1+	-48.0	92 ms 13	$\beta^-$
	62	(3+,4+)	-48.0	671 ms 5	$\beta^-n$
	63	(5/2-)	-46.4	0.29 s 2	$\beta^-$
	64		-42.6	89 ms 4	$\beta^-$ , $\beta^-n$ 1.42%
	65		-40.7	92 ms 1	$\beta^-$ , $\beta^-n$ 6.92%
	66		-36.3s	64 ms 2	$\beta^-$ , $\beta^-n$ 10.88%
67	(5/2-)	-33.4s	47 ms 4	$\beta^-$ , $\beta^-n$	
68m		-28.6s	28 ms 4	$\beta^- > 0\%$ , $\beta^-n > 0\%$	
69	5/2-	-25.3s	14 ms 4	$\beta^-$	
<b>26 Fe</b>	45	(3/2+)	13.6s	3.8 ms +20-8	2p
	46	0+	0.8s	12 ms +4-3	
	47		-6.6s	21.8 ms 7	$\epsilon$ , $\epsilon p$
	48	0+	-18.16s	44 ms 7	$\epsilon$ , $\epsilon p > 3.6\%$
	49	(7/2-)	-24.6s	70 ms 3	$\epsilon$ , $\epsilon p \geq 52\%$
	50	0+	-34.48	155 ms 11	$\epsilon$ , $\epsilon p = 0\%$
	51	5/2-	-40.22	305 ms 5	$\epsilon$
	52	0+	-48.332	8.275 h 8	$\epsilon$
	52m	(12+)	-41.512	45.9 s 6	$\epsilon$
	53	7/2-	-50.945	8.51 m 2	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>26 Fe</b>	53m	19/2-	-47.905	2.526 m 24	IT
	54	0+	-56.252	<b>5.845% 35</b>	
	55	3/2-	-57.479	2.737 y 11	$\epsilon$
	56	0+	-60.605	<b>91.754% 36</b>	
	57	1/2-	-60.180	<b>2.119% 10</b>	
	58	0+	-62.153	<b>0.282% 4</b>	
	59	3/2-	-60.663	44.495 d 9	$\beta^-$
	60	0+	-61.412	$1.5 \times 10^6$ y 3	$\beta^-$
	61	3/2-, 5/2-	-58.92	5.98 m 6	$\beta^-$
	62	0+	-58.90	68 s 2	$\beta^-$
	63	(5/2)-	-55.5	6.1 s 6	$\beta^-$
	64	0+	-54.8	2.0 s 2	$\beta^-$
	65		-50.9	1.3 s 3	$\beta^-$
	66	0+	-49.6	0.44 s 6	$\beta^-$
	67		-45.7	0.47 s 5	$\beta^-$ , $\beta^-$ -n 1.13%
	68	0+	-43.1	187 ms 6	$\beta^-$
	69	1/2-	-38.4s	109 ms 9	$\beta^-$
	70	0+	-35.9s	94 ms 17	$\beta^-$
71	(7/2+)	-31.0s	>150 ns	$\beta^-$	
72	0+	-28.3s	>150 ns	$\beta^-$	
<b>27 Co</b>	47		10.7s	?	p?
	49		-9.6s	<35 ns	$\epsilon$ , p
	50	(6+)	-17.2s	44 ms 4	$\epsilon$ , $\epsilon$ p > 54%
	51	(7/2-)	-27.3s	>200 ns	$\epsilon$
	52	(6+)	-33.92s	115 ms 23	$\epsilon$
	53	(7/2-)	-42.64	240 ms 9	$\epsilon$
	53m	(19/2-)	-39.45	247 ms 12	$\epsilon \approx 98.5\%$ , p = 1.5%
	54	0+	-48.009	193.28 ms 7	$\epsilon$
	54m	(7+)	-47.812	1.48 m 2	$\epsilon$
	55	7/2-	-54.028	17.53 h 3	$\epsilon$
	56	4+	-56.039	77.233 d 27	$\epsilon$
	57	7/2-	-59.344	271.74 d 6	$\epsilon$
	58	2+	-59.846	70.86 d 6	$\epsilon$
	58m	5+	-59.821	9.04 h 11	IT
	59	7/2-	-62.228	<b>100%</b>	
	60	5+	-61.649	1925.28 d 14	$\beta^-$
	60m	2+	-61.590	10.467 m 6	IT 99.76%, $\beta^-$ 0.24%
	61	7/2-	-62.898	1.650 h 5	$\beta^-$
	62	2+	-61.43	1.50 m 4	$\beta^-$
	62m	5+	-61.41	13.91 m 5	$\beta^-$ > 99%, IT < 1%
	63	7/2-	-61.84	27.4 s 5	$\beta^-$
	64	1+	-59.79	0.30 s 3	$\beta^-$
65	(7/2)-	-59.17	1.20 s 6	$\beta^-$	
66	(3+)	-56.1	0.18 s 1	$\beta^-$	
67	(7/2-)	-55.1	0.425 s 20	$\beta^-$	
68	(7-)	-51.4	0.199 s 21	$\beta^-$	
68m	(3+)	-51.4	1.6 s 3	$\beta^-$	
69	7/2-	-50.0	0.22 s 2	$\beta^-$	
70	(6-)	-45.6	119 ms 6	$\beta^-$	
70m	(3+)	-45.6	0.50 s 18	$\beta^-$	
71		-43.9	79 ms 5	$\beta^-$ , $\beta^-$ -n 2.61%	
72	(6-, 7-)	-39.3s	62 ms 3	$\beta^-$ , $\beta^-$ -n 4.8%	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode	
Z	El	A	(MeV)	Abundance		
27	Co	73	-37.0s	41 ms 4	$\beta^-$	
		74	0+	>150 ns	$\beta^-$	
		75	(7/2-)	-29.5s	>150 ns	$\beta^-$
28	Ni	48	0+	>0.5 $\mu$ s	$\epsilon$	
		49		9.0s	12 ms +5-3	$\epsilon$
		49		9.0s	>350 ns	p
		50	0+	-3.8s	12 ms 3	$\epsilon$ , $\epsilon$ p 70%
		51	(7/2-)	-11.4s	>200 ns	$\epsilon$
		52	0+	-22.65s	38 ms 5	$\epsilon$ , $\epsilon$ p 17%
		53	(7/2-)	-29.4s	45 ms 15	$\epsilon$ , $\epsilon$ p = 45%
		54	0+	-39.21	104 ms 7	$\epsilon$
		55	7/2-	-45.34	202 ms 3	$\epsilon$
		56	0+	-53.90	6.075 d 10	$\epsilon$
		57	3/2-	-56.082	35.60 h 6	$\epsilon$
		58	0+	-60.228	<b>68.077% 9</b>	
		59	3/2-	-61.156	$7.6 \times 10^4$ y 5	$\epsilon$
		60	0+	-64.472	<b>26.223% 8</b>	
		61	3/2-	-64.221	<b>1.140% 1</b>	
		62	0+	-66.746	<b>3.634% 2</b>	
		63	1/2-	-65.513	100.1 y 20	$\beta^-$
		64	0+	-67.099	<b>0.926% 1</b>	
		65	5/2-	-65.126	2.5172 h 3	$\beta^-$
		66	0+	-66.006	54.6 h 3	$\beta^-$
		67	(1/2)-	-63.743	21 s 1	$\beta^-$
		68	0+	-63.464	29 s 2	$\beta^-$
		68m	5-	-60.615	0.86 ms 5	IT
		69	9/2+	-59.979	11.4 s 3	$\beta^-$
		69m	1/2-	-59.658	3.5 s 5	$\beta^-$
		70	0+	-59.1	6.0 s 3	$\beta^-$
		71		-55.2	2.56 s 3	$\beta^-$
		72	0+	-53.9	1.57 s 5	$\beta^-$ , $\beta^-$ n
		73	(9/2+)	-49.9s	0.84 s 3	$\beta^-$
		74	0+	-48.4s	0.68 s 18	$\beta^-$ , $\beta^-$ n
75	(7/2+)	-43.9s	0.6 s 2	$\beta^-$ , $\beta^-$ n 8.43%		
76	0+	-41.6s	0.24 s +55-24	$\beta^-$ , $\beta^-$ n		
77		-36.7s	>150 ns	$\beta^-$ ?		
78	0+	-34.s	>150 ns	$\beta^-$		
29	Cu	52	(3+)	?	p	
		53	(3/2-)	-13.5s	<300 ns	$\epsilon$ , p
		54	(3+)	-21.7s	<75 ns	p
		55	3/2-	-31.6s	>200 ns	$\epsilon$
		56	4+	-38.6s	94 ms 3	$\epsilon$
		57	3/2-	-47.31	196.3 ms 7	$\epsilon$
		58	1+	-51.662	3.204 s 7	$\epsilon$
		59	3/2-	-56.357	81.5 s 5	$\epsilon$
		60	2+	-58.344	23.7 m 4	$\epsilon$
		61	3/2-	-61.984	3.333 h 5	$\epsilon$
		62	1+	-62.798	9.67 m 3	$\epsilon$
		63	3/2-	-65.579	<b>69.17% 3</b>	
		64	1+	-65.424	12.700 h 2	$\epsilon$ 61%, $\beta^-$ 39%
		65	3/2-	-67.264	<b>30.83% 3</b>	
66	1+	-66.258	5.120 m 14	$\beta^-$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>29 Cu</b>	67	3/2-	-67.319	61.83 h 12	$\beta^-$
	68	1+	-65.567	31.1 s 15	$\beta^-$
	68m	(6-)	-64.845	3.75 m 5	IT 84%, $\beta^-$ 16%
	69	3/2-	-65.736	2.85 m 15	$\beta^-$
	70	(6-)	-62.976	44.5 s 2	$\beta^-$
	70m	(3-)	-62.875	33 s 2	$\beta^-$ 52%, IT 48%
	70m	1+	-62.734	6.6 s 2	$\beta^-$ 93.2%, IT 6.8%
	71	(3/2-)	-62.711	19.5 s 16	$\beta^-$
	72	(1+)	-59.783	6.6 s 1	$\beta^-$
	73	(3/2-)	-58.987	4.2 s 3	$\beta^-$
	74	(1+,3+)	-56.006	1.594 s 10	$\beta^-$
	75	(3/2-)	-54.1	1.224 s 3	$\beta^-$ , $\beta^-n$ 3.5%
	76m		-50.976	0.641 s 6	$\beta^-$ , $\beta^-n$ 3%
	76m		-50.976	1.27 s 30	$\beta^-$
	77		-48.6s	0.469 s 8	$\beta^-$
	78		-44.7s	342 ms 11	$\beta^-$
	79		-42.3s	188 ms 25	$\beta^-$ , $\beta^-n$ 55%
80		-36.4s	>300 ns	$\beta^-$	
<b>30 Zn</b>	54	0+	-6.6s	?	2p?
	55m		-14.9s	>0.5 $\mu$ s	$\epsilon$ , p
	56	0+	-25.7s	>0.5 $\mu$ s	$\epsilon$ , p
	57	(7/2-)	-32.8s	38 ms 4	$\epsilon$ , $\epsilon p \geq 65\%$
	58	0+	-42.30	84 ms 9	$\epsilon$
	59	3/2-	-47.26	182.0 ms 18	$\epsilon$ , $\epsilon p$ 0.1%
	60	0+	-54.19	2.38 m 5	$\epsilon$
	61	3/2-	-56.35	89.1 s 2	$\epsilon$
	61m	1/2-	-56.26	<430 ms	IT
	61m	3/2-	-55.93	0.14 s 7	IT
	61m	5/2-	-55.59	<0.13 s	IT
	62	0+	-61.17	9.186 h 13	$\epsilon$
	63	3/2-	-62.213	38.47 m 5	$\epsilon$
	64	0+	-66.004	>2.8 $\times 10^{16}$ y	2 $\epsilon$
				<b>48.63% 60</b>	
	65	5/2-	-65.912	243.66 d 9	$\epsilon$
	66	0+	-68.899	<b>27.90% 27</b>	
	67	5/2-	-67.880	<b>4.10% 13</b>	
	68	0+	-70.007	<b>18.75% 51</b>	
	69	1/2-	-68.418	56.4 m 9	$\beta^-$
	69m	9/2+	-67.979	13.76 h 2	IT 99.97%, $\beta^-$ 0.03%
	70	0+	-69.565	>1.3 $\times 10^{16}$ y	2 $\beta^-$
				<b>0.62% 3</b>	
71	1/2-	-67.33	2.45 m 10	$\beta^-$	
71m	9/2+	-67.17	3.96 h 5	$\beta^-$ , IT $\leq 0.05\%$	
72	0+	-68.131	46.5 h 1	$\beta^-$	
73	(1/2)-	-65.41	23.5 s 10	$\beta^-$	
73m		-65.41	5.8 s 8	IT, $\beta^-$	
73m	(5/2+)	-65.21	13.0 ms 2	IT	
74	0+	-65.71	95.6 s 12	$\beta^-$	
75	(7/2+)	-62.47	10.2 s 2	$\beta^-$	
76	0+	-62.14	5.7 s 3	$\beta^-$	
77	(7/2+)	-58.7	2.08 s 5	$\beta^-$	
77m	(1/2-)	-57.9	1.05 s 10	IT > 50%, $\beta^-$ < 50%	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>30 Zn</b>	78	0+	-57.34	1.47 s 15	$\beta^-$
	79	(9/2+)	-53.4s	0.995 s 19	$\beta^-$ , $\beta^-n$ 1.3%
	80	0+	-51.8	0.54 s 2	$\beta^-$ , $\beta^-n$ 1%
	81		-46.1s	0.29 s 5	$\beta^-$ , $\beta^-n$ 7.5%
	82	0+	-42.5s	>150 ns	$\beta^-$
	83	(5/2+)	-36.3s	>150 ns	$\beta^-$
<b>31 Ga</b>	56		-4.7s	?	p?
	57		-15.9s	?	p?
	58		-24.0s	?	p?
	59		-34.1s	?	p?
	60	(2+)	-40.0s	70 ms 13	$\epsilon$ 98.4%, $\epsilon p$ 1.6%, $\epsilon\alpha < 0.02\%$
	61	3/2-	-47.09	168 ms 3	$\epsilon$
	62	0+	-52.00	116.18 ms 4	$\epsilon$
	63	(3/2-)	-56.547	32.4 s 5	$\epsilon$
	64	0+	-58.834	2.627 m 12	$\epsilon$
	65	3/2-	-62.657	15.2 m 2	$\epsilon$
	66	0+	-63.724	9.49 h 7	$\epsilon$
	67	3/2-	-66.880	3.2623 d 15	$\epsilon$
	68	1+	-67.086	67.71 m 9	$\epsilon$
	69	3/2-	-69.328	<b>60.108% 9</b>	
	70	1+	-68.910	21.14 m 3	$\beta^-$ 99.59%, $\epsilon$ 0.41%
	71	3/2-	-70.140	<b>39.892% 9</b>	
	72	3-	-68.589	14.095 h 3	$\beta^-$
	72m	(0+)	-68.470	39.68 ms 13	IT
	73	3/2-	-69.699	4.86 h 3	$\beta^-$
	74	(3-)	-68.050	8.12 m 12	$\beta^-$
	74m	(0)	-67.990	9.5 s 10	IT 75%, $\beta^- < 50\%$
	75	(3/2)-	-68.465	126 s 2	$\beta^-$
	76	(2+,3+)	-66.297	32.6 s 6	$\beta^-$
	77	(3/2-)	-65.992	13.2 s 2	$\beta^-$
	78	(3+)	-63.707	5.09 s 5	$\beta^-$
	79	(3/2-)	-62.51	2.847 s 3	$\beta^-$ , $\beta^-n$ 0.09%
	80	(3)	-59.1	1.676 s 14	$\beta^-$ , $\beta^-n$ 0.86%
	81	(5/2-)	-58.0	1.217 s 5	$\beta^-$ , $\beta^-n$ 11.9%
	82	(1,2,3)	-53.1s	0.599 s 2	$\beta^-$ , $\beta^-n$ 19.8%
	83		-49.4s	0.308 s 1	$\beta^-$ , $\beta^-n$ 37%
	84		-44.1s	0.085 s 10	$\beta^-$ , $\beta^-n$ 70%
	85	(3/2-)	-40.1s	>150 ns	$\beta^-$
86		-34.4s	>150 ns	$\beta^-$	
<b>32 Ge</b>	58	0+	-8.4s	?	2p?
	59		-17.0s	?	2p?
	60	0+	-27.8s	$\approx 30$ ms	$\epsilon?$ , 2p?
	61	(3/2-)	-33.7s	39 ms 12	$\epsilon$ , $\epsilon p \approx 80\%$
	62	0+	-42.2s	129 ns 35	$\epsilon$
	63	(3/2-)	-46.9s	142 ms 8	$\epsilon$
	64	0+	-54.35	63.7 s 25	$\epsilon$
	65	(3/2)-	-56.4	30.9 s 5	$\epsilon$
	66	0+	-61.62	2.26 h 5	$\epsilon$
	67	1/2-	-62.658	18.9 m 3	$\epsilon$
	68	0+	-66.980	270.95 d 16	$\epsilon$
	69	5/2-	-67.101	39.05 h 10	$\epsilon$

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Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
32	Ge	69m	1/2-	-67.014	5.1 $\mu$ s 2	IT
		69m	9/2+	-66.703	2.81 $\mu$ s 5	IT
		70	0+	-70.563	<b>20.37% 18</b>	
		71	1/2-	-69.908	11.43 d 3	$\epsilon$
		72	0+	-72.586	<b>27.31% 26</b>	
		73	9/2+	-71.298	<b>7.76% 8</b>	
		73m	1/2-	-71.231	0.499 s 11	IT
		74	0+	-73.422	<b>36.73% 15</b>	
		75	1/2-	-71.856	82.78 m 4	$\beta^-$
		75m	7/2+	-71.717	47.7 s 5	IT 99.97%, $\beta^-$ 0.03%
		76	0+	-73.213	1.2 $\times$ 10 <sup>25</sup> y 14	2 $\beta^-$
					<b>7.83% 7</b>	
			7/2+	-71.214	11.30 h 1	$\beta^-$
		77m	1/2-	-71.054	52.9 s 6	$\beta^-$ 81%, IT 19%
		78	0+	-71.862	88.0 m 10	$\beta^-$
		79	(1/2)-	-69.49	18.98 s 3	$\beta^-$
		79m	(7/2+)	-69.30	39.0 s 10	$\beta^-$ 96%, IT 4%
		80	0+	-69.52	29.5 s 4	$\beta^-$
		81	(9/2+)	-66.3	7.6 s 6	$\beta^-$
		81m	(1/2+)	-65.6	7.6 s 6	$\beta^-$
		82	0+	-65.6	4.55 s 5	$\beta^-$
		83	(5/2+)	-60.9s	1.85 s 6	$\beta^-$
		84	0+	-58.2s	0.947 s 11	$\beta^-$ , $\beta^-$ -n 10.8%
		85		-53.1s	535 ms 47	$\beta^-$ , $\beta^-$ -n 14%
		86	0+	-49.8s	>150 ns	$\beta^-$
		87	(5/2+)	-44.2s	$\approx$ 0.14 s	$\beta^-$ , $\beta^-$ -n
		88	0+	-40.1s	$\geq$ 300 ns	$\beta^-$ ?
		89		-33.7s	>150 ns	$\beta^-$
		33	As	60		-6.4s
61				-18.1s	?	p?
62				-25.0s	?	p
63	(3/2-)			-33.8s	?	p
64				-39.5s	18 ms +43-7	$\epsilon$ ?
65				-47.0s	128 ms 16	$\epsilon$
66				-51.5	95.79 ms 22	$\epsilon$
67	(5/2-)			-56.6	42.5 s 12	$\epsilon$
68	3+			-58.90	151.6 s 8	$\epsilon$
69	5/2-			-63.09	15.2 m 2	$\epsilon$
70	4+			-64.34	52.6 m 3	$\epsilon$
71	5/2-			-67.894	65.28 h 15	$\epsilon$
72	2-			-68.230	26.0 h 1	$\epsilon$
73	3/2-			-70.957	80.30 d 6	$\epsilon$
74	2-	-70.860	17.77 d 2	$\epsilon$ 66%, $\beta^-$ 34%		
75	3/2-	-73.032	<b>100%</b>			
76	2-	-72.289	1.0942 d 7	$\beta^-$		
77	3/2-	-73.917	38.83 h 5	$\beta^-$		
78	2-	-72.817	90.7 m 2	$\beta^-$		
79	3/2-	-73.636	9.01 m 15	$\beta^-$		
79m	(9/2+)	-72.864	0.87 $\mu$ s 6	IT		
80	1+	-72.16	15.2 s 2	$\beta^-$		
81	3/2-	-72.533	33.3 s 8	$\beta^-$		
82	(1+)	-70.3	19.1 s 5	$\beta^-$		

## Nuclear Wallet Cards

Nuclide		$\Delta$	$T_{1/2}$ , $\Gamma$ , or		
Z	El A	(MeV)	Abundance	Decay Mode	
<b>33 As</b>	82m	(5-)	-70.3	13.6 s 4	$\beta^-$
	83	(5/2-, 3/2-)	-69.9	13.4 s 3	$\beta^-$
	84	(3-)	-66.1s	3.24 s 26	$\beta^-$ , $\beta^-$ -n 0.28%
	85	(3/2-)	-63.3s	2.021 s 10	$\beta^-$ , $\beta^-$ -n 59.4%
	86		-59.2s	0.945 s 8	$\beta^-$ , $\beta^-$ -n 33%
	87	(3/2-)	-56.0s	0.56 s 8	$\beta^-$ , $\beta^-$ -n 15.4%
	88		-51.3s	$\geq 300$ ns	$\beta^-?$ , $\beta^-$ -n?
	89		-47.1s	$\geq 300$ ns	$\beta^-?$
	90		-41.5s	>150 ns	$\beta^-?$
	91		-36.9s	>150 ns	$\beta^-$
	92		-30.9s	>300 ns	$\beta^-$
	<b>34 Se</b>	65		-32.9s	<50 ms
66		0+	-41.7s	33 ms 12	$\epsilon$
67			-46.5s	133 ms 11	$\epsilon$ , $\epsilon$ p 0.5%
68		0+	-54.21	35.5 s 7	$\epsilon$
69		(1/2-, 3/2-)	-56.30	27.4 s 2	$\epsilon$ , $\epsilon$ p 0.05%
70		0+	-62.05	41.1 m 3	$\epsilon$
71		5/2-	-63.12	4.74 m 5	$\epsilon$
72		0+	-67.89	8.40 d 8	$\epsilon$
73		9/2+	-68.22	7.15 h 8	$\epsilon$
73m		3/2-	-68.19	39.8 m 13	IT 72.6%, $\epsilon$ 27.4%
74		0+	-72.213	<b>0.89% 4</b>	
75		5/2+	-72.169	119.779 d 4	$\epsilon$
76		0+	-75.252	<b>9.37% 29</b>	
77		1/2-	-74.600	<b>7.63% 16</b>	
77m		7/2+	-74.438	17.36 s 5	IT
78		0+	-77.026	<b>23.77% 28</b>	
79		7/2+	-75.918	$2.95 \times 10^5$ y 38	$\beta^-$
79m		1/2-	-75.822	3.92 m 1	IT 99.94%, $\beta^-$ 0.06%
80		0+	-77.760	<b>49.61% 41</b>	
81		1/2-	-76.390	18.45 m 12	$\beta^-$
81m		7/2+	-76.286	57.28 m 2	IT 99.95%, $\beta^-$ 0.05%
82		0+	-77.594	$9.1 \times 10^{19}$ y 9	2 $\beta^-$
			<b>8.73% 22</b>		
	83	9/2+	-75.341	22.3 m 3	$\beta^-$
	83m	1/2-	-75.112	70.1 s 4	$\beta^-$
	84	0+	-75.95	3.10 m 10	$\beta^-$
	85	(5/2+)	-72.43	31.7 s 9	$\beta^-$
	86	0+	-70.54	15.3 s 9	$\beta^-$
	87	(5/2+)	-66.58	5.50 s 12	$\beta^-$ , $\beta^-$ -n 0.2%
	88	0+	-63.88	1.53 s 6	$\beta^-$ , $\beta^-$ -n 0.99%
	89	(5/2+)	-59.2s	0.41 s 4	$\beta^-$ , $\beta^-$ -n 7.8%
	90	0+	-55.9s	>150 ns	$\beta^-?$
	91		-50.3s	0.27 s 5	$\beta^-$ , $\beta^-$ -n 21%
	92	0+	-46.6s	>300 ns	$\beta^-$
	93	(1/2+)	-40.7s	>150 ns	$\beta^-$
	94	0+	-36.8s	>150 ns	$\beta^-$
<b>35 Br</b>	67		-32.8s	?	p?
	68		-38.6s	<1.2 $\mu$ s	p?
	69		-46.5s	<24 ns	p
	70	0+	-51.4s	79.1 ms 8	$\epsilon$
	70m	9+	-49.1s	2.2 s 2	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
35	Br	71	(5/2)-	-57.1	21.4 s 6	$\epsilon$
		72	1+	-59.02	78.6 s 24	$\epsilon$
		72m	1-	-58.91	10.6 s 3	IT=100%, $\epsilon$
		73	1/2-	-63.63	3.4 m 2	$\epsilon$
		74	(0-)	-65.31	25.4 m 3	$\epsilon$
		74m	4(+)	-65.29	46 m 2	$\epsilon$
		75	3/2-	-69.14	96.7 m 13	$\epsilon$
		76	1-	-70.289	16.2 h 2	$\epsilon$
		76m	(4+)	-70.186	1.31 s 2	IT>99.4%, $\epsilon$ <0.6%
		77	3/2-	-73.235	57.036 h 6	$\epsilon$
		77m	9/2+	-73.129	4.28 m 10	IT
		78	1+	-73.452	6.46 m 4	$\epsilon$ ≥99.99%, $\beta$ -≤0.01%
		79	3/2-	-76.068	<b>50.69% 7</b>	
		79m	9/2+	-75.861	4.86 s 4	IT
		80	1+	-75.890	17.68 m 2	$\beta$ - 91.7%, $\epsilon$ 8.3%
		80m	5-	-75.804	4.4205 h 8	IT
		81	3/2-	-77.975	<b>49.31% 7</b>	
		82	5-	-77.496	35.282 h 7	$\beta$ -
		82m	2-	-77.451	6.13 m 5	IT 97.6%, $\beta$ - 2.4%
		83	3/2-	-79.009	2.40 h 2	$\beta$ -
		84	2-	-77.80	31.80 m 8	$\beta$ -
		84m	6-	-77.48	6.0 m 2	$\beta$ -
		85	3/2-	-78.61	2.90 m 6	$\beta$ -
		86	(2-)	-75.64	55.1 s 4	$\beta$ -
		87	3/2-	-73.86	55.65 s 13	$\beta$ -, $\beta$ -n 2.6%
		88	(2-)	-70.73	16.29 s 6	$\beta$ -, $\beta$ -n 6.58%
		88m	(4-,5-)	-70.46	5.3 $\mu$ s 4	IT
		89	(3/2-,5/2-)	-68.57	4.40 s 3	$\beta$ -, $\beta$ -n 13.8%
		90		-64.62	1.91 s 1	$\beta$ -, $\beta$ -n 25.2%
		91		-61.51	0.541 s 5	$\beta$ -, $\beta$ -n 20%
		92	(2-)	-56.58	0.343 s 15	$\beta$ -, $\beta$ -n 33.1%
93	(5/2-)	-53.0s	102 ms 10	$\beta$ -, $\beta$ -n 68%		
94		-47.8s	70 ms 20	$\beta$ -, $\beta$ -n 70%		
95	(3/2-)	-43.9s	>150 ns	$\beta$ -		
96		-38.6s	>150 ns	$\beta$ -		
97	(3/2-)	-34.7s	>150 ns	$\beta$ -		
36	Kr	69		-32.4s	32 ms 10	$\epsilon$
		70	0+	-41.7s	52 ms 17	$\epsilon$ , $\epsilon$ p≤1.3%
		71	(5/2)-	-46.9	100 ms 3	$\epsilon$ , $\epsilon$ p 5.2%
		72	0+	-53.941	17.1 s 2	$\epsilon$
		73	3/2-	-56.552	27.3 s 10	$\epsilon$ , $\epsilon$ p 0.25%
		74	0+	-62.332	11.50 m 11	$\epsilon$
		75	5/2+	-64.324	4.29 m 17	$\epsilon$
		76	0+	-69.014	14.8 h 1	$\epsilon$
		77	5/2+	-70.169	74.4 m 6	$\epsilon$
		78	0+	-74.180	≥2.3×10 <sup>20</sup> y	2 $\epsilon$
					<b>0.35% 1</b>	
79	1/2-	-74.443	35.04 h 10	$\epsilon$		
79m	7/2+	-74.313	50 s 3	IT		
80	0+	-77.893	<b>2.28% 6</b>			
81	7/2+	-77.694	2.29×10 <sup>5</sup> y 11	$\epsilon$		



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>36 Kr</b>	81m	1/2-	-77.503	13.10 s 3	IT, $\epsilon$ $2.5 \times 10^{-3}\%$
	82	0+	-80.590	<b>11.58% 14</b>	
	83	9/2+	-79.982	<b>11.49% 6</b>	
	83m	1/2-	-79.940	1.83 h 2	IT
	84	0+	-82.431	<b>57.00% 4</b>	
	85	9/2+	-81.480	3916.8 d 25	$\beta^-$
	85m	1/2-	-81.175	4.480 h 8	$\beta^-$ 78.6%, IT 21.4%
	86	0+	-83.266	<b>17.30% 22</b>	
	87	5/2+	-80.709	76.3 m 5	$\beta^-$
	88	0+	-79.69	2.84 h 3	$\beta^-$
	89	3/2(+)	-76.73	3.15 m 4	$\beta^-$
	90	0+	-74.97	32.32 s 9	$\beta^-$
	91	5/2(+)	-71.31	8.57 s 4	$\beta^-$
	92	0+	-68.79	1.840 s 8	$\beta^-$ , $\beta^-$ n 0.03%
	93	1/2+	-64.0	1.286 s 10	$\beta^-$ , $\beta^-$ n 1.95%
	94	0+	-61.1s	212 ms 5	$\beta^-$ , $\beta^-$ n 1.26%
	95	1/2	-56.0s	114 ms 3	$\beta^-$ , $\beta^-$ n 2.87%
	96	0+	-53.0s	80 ms 8	$\beta^-$ , $\beta^-$ n 3.8%
	97		-47.9s	63 ms 4	$\beta^-$ , $\beta^-$ n 8.2%
	98	0+	-44.8s	46 ms 8	$\beta^-$ , $\beta^-$ n 7%
99	(3/2+)	-39.5s	40 ms 11	$\beta^-$ , $\beta^-$ n 11%	
100	0+	-36.2s	>150 ns	$\beta^-$	
<b>37 Rb</b>	71		-32.3s	?	p?
	72	(3+)	-38.1s	<1.2 $\mu$ s	p
	73		-46.1s	>30 ns	$\epsilon$ , p>0%
	74	(0+)	-51.917	64.9 ms 5	$\epsilon$
	75	(3/2-)	-57.222	19.0 s 12	$\epsilon$
	76	1(-)	-60.480	36.5 s 6	$\epsilon$ , $\epsilon\alpha$ $3.8 \times 10^{-7}\%$
	77	3/2-	-64.825	3.77 m 4	$\epsilon$
	78	0(+)	-66.936	17.66 m 8	$\epsilon$
	78m	4(-)	-66.833	5.74 m 5	$\epsilon$ 90%, IT 10%
	79	5/2+	-70.803	22.9 m 5	$\epsilon$
	80	1+	-72.173	33.4 s 7	$\epsilon$
	81	3/2-	-75.455	4.570 h 4	$\epsilon$
	81m	9/2+	-75.368	30.5 m 3	IT 97.6%, $\epsilon$ 2.4%
	82	1+	-76.188	1.273 m 2	$\epsilon$
	82m	5-	-76.119	6.472 h 5	$\epsilon$ , IT <0.33%
	83	5/2-	-79.075	86.2 d 1	$\epsilon$
	84	2-	-79.750	33.1 d 1	$\epsilon$ 96.2%
	84	2-	-79.750	32.1 d 1	$\beta^-$ 3.8%
	84m	6-	-79.286	20.26 m 4	IT
	85	5/2-	-82.167	<b>72.17% 2</b>	
86	2-	-82.747	18.642 d 18	$\beta^-$ 99.99%, $\epsilon$ $5.2 \times 10^{-3}\%$	
86m	6-	-82.191	1.017 m 3	IT, $\beta^-$ <0.3%	
87	3/2-	-84.598	$4.97 \times 10^{10}$ y 3 <b>27.83% 2</b>	$\beta^-$	
88	2-	-82.609	17.773 m 11	$\beta^-$	
89	3/2-	-81.713	15.15 m 12	$\beta^-$	
90	0-	-79.362	158 s 5	$\beta^-$	
90m	3-	-79.255	258 s 4	$\beta^-$ 97.4%, IT 2.6%	
91	3/2(-)	-77.745	58.4 s 4	$\beta^-$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode			
Z	El	A	(MeV)	Abundance				
37	Rb	92	0-	-74.772	4.492 s 20	$\beta^-$ , $\beta^-n$ 0.01%		
		93	5/2-	-72.618	5.84 s 2	$\beta^-$ , $\beta^-n$ 1.39%		
		94	3(-)	-68.553	2.702 s 5	$\beta^-$ , $\beta^-n$ 10.01%		
		95	5/2-	-65.85	377.5 ms 8	$\beta^-$ , $\beta^-n$ 8.73%		
		96	2+	-61.22	202.8 ms 33	$\beta^-$ , $\beta^-n$ 14%		
		97	3/2+	-58.36	169.9 ms 7	$\beta^-$ , $\beta^-n$ 25.1%		
		98	(0,1)	-54.22	114 ms 5	$\beta^-$ , $\beta^-n$ 13.8%, $\beta^-$ 0.05%		
		98m	(3,4)	-53.95	96 ms 3	$\beta^-$		
		99	(5/2+)	-50.9	50.3 ms 7	$\beta^-$ , $\beta^-n$ 15.9%		
		100		-46.7s	51 ms 8	$\beta^-$ , $\beta^-n$ 6%, $\beta^-2n$ 0.16%		
		101	(3/2+)	-43.6	32 ms 5	$\beta^-$ , $\beta^-n$ 28%		
		38	Sr	73		-31.7s	>25 ms	$\epsilon$ , $\epsilon p$ > 0%
				74	0+	-40.7s	>1.2 $\mu$ s	$\epsilon$
75	(3/2-)			-46.6	88 ms 3	$\epsilon$ , $\epsilon p$ 5.2%		
76	0+			-54.24	7.89 s 7	$\epsilon$ , $\epsilon p$ 0.34%		
77	5/2+			-57.804	9.0 s 2	$\epsilon$ , $\epsilon p$ < 0.25%		
78	0+			-63.174	2.5 m 3	$\epsilon$		
79	3/2(-)			-65.477	2.25 m 10	$\epsilon$		
80	0+			-70.308	106.3 m 15	$\epsilon$		
81	1/2-			-71.528	22.3 m 4	$\epsilon$		
82	0+			-76.008	25.55 d 15	$\epsilon$		
83	7/2+			-76.80	32.41 h 3	$\epsilon$		
83m	1/2-			-76.54	4.95 s 12	IT		
84	0+			-80.644	<b>0.56% I</b>			
85	9/2+			-81.103	64.84 d 2	$\epsilon$		
85m	1/2-			-80.864	67.63 m 4	IT 86.6%, $\epsilon$ 13.4%		
86	0+			-84.524	<b>9.86% I</b>			
87	9/2+			-84.880	<b>7.00% I</b>			
87m	1/2-			-84.492	2.815 h 12	IT 99.7%, $\epsilon$ 0.3%		
88	0+			-87.922	<b>82.58% I</b>			
89	5/2+			-86.209	50.57 d 3	$\beta^-$		
90	0+			-85.942	28.90 y 3	$\beta^-$		
91	5/2+			-83.645	9.63 h 5	$\beta^-$		
92	0+			-82.868	2.66 h 4	$\beta^-$		
93	5/2+			-80.085	7.423 m 24	$\beta^-$		
94	0+			-78.840	75.3 s 2	$\beta^-$		
95	1/2+	-75.117	23.90 s 14	$\beta^-$				
96	0+	-72.94	1.07 s 1	$\beta^-$				
97	1/2+	-68.79	429 ms 5	$\beta^-$ , $\beta^-n$ $\leq$ 0.05%				
98	0+	-66.65	0.653 s 2	$\beta^-$ , $\beta^-n$ 0.25%				
99	3/2+	-62.19	0.269 s 1	$\beta^-$ , $\beta^-n$ 0.1%				
100	0+	-60.2	202 ms 3	$\beta^-$ , $\beta^-n$ 0.78%				
101	(5/2-)	-55.4	118 ms 3	$\beta^-$ , $\beta^-n$ 2.37%				
102	0+	-53.1	69 ms 6	$\beta^-$ , $\beta^-n$ 4.8%				
103		-47.6s	>150 ns	$\beta^-$				
104	0+	-44.4s	>300 ns					
105		-38.6s	>150 ns	$\beta^-$				
39	Y	76		-38.7s	>200 ns	$\epsilon?$ , $p?$		
		77		-46.90s	$\approx$ 0.06 s	$\epsilon$ , $\epsilon p$		
		78	(0+)	-52.5s	50 ms 8	$\epsilon$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
39	Y	78m	(5+)	-52.5s	5.7 s 7	$\epsilon$
		79	(5/2+)	-58.4	14.8 s 6	$\epsilon, \epsilon p$
		80	(4-)	-61.2	30.1 s 5	$\epsilon, \epsilon p$
		80m	(1-)	-61.0	4.8 s 3	IT 81%, $\epsilon$ 19%
		80m	(2+)	-60.9	4.7 $\mu$ s 3	IT
		81	(5/2+)	-66.02	70.4 s 10	$\epsilon$
		82	1+	-68.2	8.30 s 20	$\epsilon$
		83	9/2+	-72.33	7.08 m 6	$\epsilon$
		83m	3/2-	-72.26	2.85 m 2	$\epsilon$ 60%, IT 40%
		84	1+	-74.16	4.6 s 2	$\epsilon$
		84m	(5-)	-74.16	39.5 m 8	$\epsilon$
		85	(1/2)-	-77.84	2.68 h 5	$\epsilon$
		85m	9/2+	-77.82	4.86 h 13	$\epsilon, \text{ IT} < 2.0 \times 10^{-3}\%$
		86	4-	-79.28	14.74 h 2	$\epsilon$
		86m	(8+)	-79.07	48 m 1	IT 99.31%, $\epsilon$ 0.69%
		87	1/2-	-83.019	79.8 h 3	$\epsilon$
		87m	9/2+	-82.638	13.37 h 3	IT 98.43%, $\epsilon$ 1.57%
		88	4-	-84.299	106.616 d 13	$\epsilon$
		88m	(8+)	-83.625	13.97 ms 18	IT
		89	1/2-	-87.702	100%	
		89m	9/2+	-86.793	15.28 s 17	IT
		90	2-	-86.488	64.053 h 20	$\beta^-$
		90m	7+	-85.806	3.19 h 6	IT, $\beta^-$ 1.8 $\times$ 10 <sup>-3</sup> %
		91	1/2-	-86.345	58.51 d 6	$\beta^-$
		91m	9/2+	-85.789	49.71 m 4	IT, $\beta^-$ < 1.5%
		92	2-	-84.813	3.54 h 1	$\beta^-$
		93	1/2-	-84.22	10.18 h 8	$\beta^-$
		93m	7/2+	-83.46	0.82 s 4	IT
		94	2-	-82.349	18.7 m 1	$\beta^-$
		95	1/2-	-81.207	10.3 m 1	$\beta^-$
		96	0-	-78.35	5.34 s 5	$\beta^-$
		96m	(8+)	-78.35	9.6 s 2	$\beta^-$
		97	(1/2)-	-76.26	3.75 s 3	$\beta^-$ , $\beta^-$ -n 0.058%
		97m	(9/2)+	-75.59	1.17 s 3	$\beta^-$ > 99.3%, IT < 0.7%, $\beta^-$ -n < 0.08%
		97m	(27/2-)	-72.73	142 ms 8	IT > 80%, $\beta^-$ < 20%
		98	(0)-	-72.47	0.548 s 2	$\beta^-$ , $\beta^-$ -n 0.33%
		98m	(4,5)	-72.06	2.0 s 2	$\beta^-$ > 80%, IT < 20%, $\beta^-$ -n 3.4%
		99	(5/2+)	-70.20	1.470 s 7	$\beta^-$ , $\beta^-$ -n 1.9%
		99m	(17/2+)	-68.06	8.6 $\mu$ s 8	IT
100	1-, 2-	-67.29	735 ms 7	$\beta^-$ , $\beta^-$ -n 0.92%		
100m	(3,4,5)	-67.29	0.94 s 3	$\beta^-$		
101	(5/2+)	-64.91	0.45 s 2	$\beta^-$ , $\beta^-$ -n 1.5%		
102m		-61.89	0.30 s 1	$\beta^-$ , $\beta^-$ -n 4%		
102m		-61.89	0.36 s 4	$\beta^-$ , $\beta^-$ -n 4%		
103	(5/2+)	-58.9s	0.23 s 2	$\beta^-$ , $\beta^-$ -n 8%		
104		-54.9s	180 ms 60	$\beta^-$ , $\beta^-$ -n?		
105		-51.4s	>300 ns	$\beta^-$ ?		
106		-46.8s	>150 ns	$\beta^-$		
107	(5/2+)	-42.7s	$\approx$ 30 ms	$\beta^-$		
108		-37.7s	20 ms SY	$\beta^-$ , $\beta^-$ -n		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
40	Zr	78	0+	-41.7s	>200 ns	$\epsilon?$ , $\epsilon p?$
		79		-47.4s	56 ms 30	$\epsilon$ , $\epsilon p$
		80	0+	-56.	4.6 s 6	$\epsilon$ , $\epsilon p$
		81	(3/2-)	-58.5	5.5 s 4	$\epsilon$ , $\epsilon p$ 0.12%
		82	0+	-64.2s	32 s 5	$\epsilon$
		83	(1/2-)	-66.46	41.6 s 24	$\epsilon$ , $\epsilon p$
		84	0+	-71.5s	25.9 m 7	$\epsilon$
		85	7/2+	-73.1	7.86 m 4	$\epsilon$
		85m	(1/2-)	-72.9	10.9 s 3	IT $\leq 92\%$ , $\epsilon > 8\%$
		86	0+	-77.80	16.5 h 1	$\epsilon$
		87	(9/2)+	-79.348	1.68 h 1	$\epsilon$
		87m	(1/2)-	-79.012	14.0 s 2	IT
		88	0+	-83.62	83.4 d 3	$\epsilon$
		89	9/2+	-84.869	78.41 h 12	$\epsilon$
		89m	1/2-	-84.281	4.161 m 17	IT 93.77%, $\epsilon$ 6.23%
		90	0+	-88.767	<b>51.45% 40</b>	
		90m	5-	-86.448	809.2 ms 20	IT
		91	5/2+	-87.890	<b>11.22% 5</b>	
		91m	(21/2+)	-84.723	4.35 $\mu$ s 14	IT
		92	0+	-88.454	<b>17.15% 8</b>	
		93	5/2+	-87.117	$1.53 \times 10^6$ y 10	$\beta^-$
		94	0+	-87.267	<b>17.38% 28</b>	
		95	5/2+	-85.658	64.032 d 6	$\beta^-$
		96	0+	-85.443	$> 3.9 \times 10^{20}$ y	$2\beta^-$
					<b>2.80% 9</b>	
					16.744 h 11	$\beta^-$
					30.7 s 4	$\beta^-$
					2.1 s 1	$\beta^-$
			7.1 s 4	$\beta^-$		
			2.3 s 1	$\beta^-$		
			2.9 s 2	$\beta^-$		
			1.3 s 1	$\beta^-$		
			1.2 s 3	$\beta^-$		
			0.6 s 1	$\beta^-$		
			>150 ns	$\beta^-?$		
			$\approx 150$ ms	$\beta^-$		
			80 ms SY	$\beta^-$ , $\beta^-n$		
			>150 ns	$\beta^-$ , $\beta^-n$		
			>150 ns	$\beta^-$		
41	Nb	81		-47.s	$\approx 0.8$ s	$\epsilon?$ , $\epsilon p?$ , p?
		82	0+	-53.0s	50 ms 5	$\epsilon$
		83	(5/2+)	-59.0	4.1 s 3	$\epsilon$
		84	3+	-61.9s	9.5 s 10	$\epsilon$ , $\epsilon p$
		85	(9/2+)	-67.1	20.9 s 7	$\epsilon$
		86?		-69.83	56 s 8	$\epsilon$
		86m	(6+)	-69.83	88 s 1	$\epsilon$
		87	(1/2-)	-74.18	3.75 m 9	$\epsilon$
		87m	(9/2+)	-74.18	2.6 m 1	$\epsilon$
		88	(8+)	-76.1	14.55 m 6	$\epsilon$
		88m	(4-)	-76.1	7.78 m 5	$\epsilon$
		89	(9/2+)	-80.65	2.03 h 7	$\epsilon$
89m	(1/2)-	-80.62	66 m 2	$\epsilon$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
41	Nb	90	8+	-82.656	14.60 h 5	$\epsilon$
		90m	4-	-82.532	18.81 s 6	IT
		91	9/2+	-86.632	6.8×10 <sup>2</sup> y 13	$\epsilon$
		91m	1/2-	-86.528	60.86 d 22	IT 96.6%, $\epsilon$ 3.4%
		92	(7)+	-86.448	3.47×10 <sup>7</sup> y 24	$\epsilon$ , $\beta$ -<0.05%
		92m	(2)+	-86.313	10.15 d 2	$\epsilon$
		93	9/2+	-87.208	<b>100%</b>	
		93m	1/2-	-87.177	16.13 y 14	IT
		94	(6)+	-86.365	2.03×10 <sup>4</sup> y 16	$\beta$ -
		94m	3+	-86.324	6.263 m 4	IT 99.5%, $\beta$ - 0.5%
		95	9/2+	-86.782	34.991 d 6	$\beta$ -
		95m	1/2-	-86.546	3.61 d 3	IT 94.4%, $\beta$ - 5.6%
		96	6+	-85.604	23.35 h 5	$\beta$ -
		97	9/2+	-85.606	72.1 m 7	$\beta$ -
		97m	1/2-	-84.863	58.7 s 18	IT
		98	1+	-83.529	2.86 s 6	$\beta$ -
		98m	(5+)	-83.445	51.3 m 4	$\beta$ - 99.9%, IT<0.2%
		99	9/2+	-82.33	15.0 s 2	$\beta$ -
		99m	1/2-	-81.96	2.6 m 2	$\beta$ ->96.2%, IT<3.8%
		100	1+	-79.94	1.5 s 2	$\beta$ -
		100m	(4+,5+)	-79.44	2.99 s 11	$\beta$ -
		101	(5/2+)	-78.94	7.1 s 3	$\beta$ -
		102m	1+	-76.35	1.3 s 2	$\beta$ -
		102m		-76.35	4.3 s 4	$\beta$ -
		103	(5/2+)	-75.32	1.5 s 2	$\beta$ -
		104	(1+)	-72.2	4.9 s 3	$\beta$ -, $\beta$ -n 0.06%
		104m		-72.0	0.94 s 4	$\beta$ -, $\beta$ -n 0.05%
105	(5/2+)	-70.85	2.95 s 6	$\beta$ -, $\beta$ -n 1.7%		
106		-67.1s	1.02 s 5	$\beta$ -, $\beta$ -n 4.5%		
107		-64.9s	330 ms 50	$\beta$ -		
108	(2+)	-60.7s	0.193 s 17	$\beta$ -, $\beta$ -n 6.2%		
109	(5/2)	-58.1s	0.19 s 3	$\beta$ -, $\beta$ -n 31%		
110		-53.6s	0.17 s 2	$\beta$ -, $\beta$ -n 40%		
111	(5/2+)	-50.6s	80. ms SY	$\beta$ -		
112	(2+)	-45.8s	>150 ns	$\beta$ -		
113		-42.2s	30 ms SY	$\beta$ -		
42	Mo	83		-47.7s	6 ms +30-3	$\epsilon$
		84	0+	-55.8s	3.7 s +10-8	$\epsilon$
		85	(1/2-)	-59.1s	3.2 s 2	$\epsilon$ p 0.14%, $\epsilon$
		86	0+	-64.6	19.6 s 11	$\epsilon$
		87	7/2+	-67.7	14.02 s 26	$\epsilon$ , $\epsilon$ p 15%
		88	0+	-72.70	8.0 m 2	$\epsilon$
		89	(9/2+)	-75.00	2.11 m 10	$\epsilon$
		89m	(1/2-)	-74.62	190 ms 15	IT
		90	0+	-80.167	5.56 h 9	$\epsilon$
		91	9/2+	-82.20	15.49 m 1	$\epsilon$
		91m	1/2-	-81.55	64.6 s 6	$\epsilon$ 50%, IT 50%
		92	0+	-86.805	<b>14.84% 35</b>	
		93	5/2+	-86.803	4.0×10 <sup>3</sup> y 8	$\epsilon$
		93m	21/2+	-84.379	6.85 h 7	IT 99.88%, $\epsilon$ 0.12%
94	0+	-88.410	<b>9.25% 12</b>			
95	5/2+	-87.707	<b>15.92% 13</b>			

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>42 Mo</b>	96	0+	-88.790	<b>16.68% 2</b>	
	97	5/2+	-87.540	<b>9.55% 8</b>	
	98	0+	-88.112	<b>24.13% 31</b>	
	99	1/2+	-85.966	2.7489 d 6	$\beta^-$
	100	0+	-86.184	$0.78 \times 10^{19}$ y 8	$2\beta^-$
				<b>9.63% 23</b>	
	101	1/2+	-83.511	14.61 m 3	$\beta^-$
	102	0+	-83.56	11.3 m 2	$\beta^-$
	103	(3/2+)	-80.85	67.5 s 15	$\beta^-$
	104	0+	-80.33	60 s 2	$\beta^-$
	105	(5/2-)	-77.34	35.6 s 16	$\beta^-$
	106	0+	-76.26	8.4 s 5	$\beta^-$
	107	(7/2-)	-72.9	3.5 s 5	$\beta^-$
	108	0+	-71.3s	1.09 s 2	$\beta^-$
	109	(7/2-)	-67.2s	0.53 s 6	$\beta^-$
110	0+	-65.5s	0.27 s 1	$\beta^-$	
111		-61.1s	200. ms SY	$\beta^-$	
112	0+	-58.8s	>150 ns	$\beta^-?$	
113		-54.1s	100 ms SY	$\beta^-$	
114	0+	-51.3s	80 ms SY	$\beta^-$	
115		-46.3s	60 ms SY	$\beta^-$ , $\beta^-n$	
<b>43 Tc</b>	85		-47.7s	$\approx 0.5$ s	$\epsilon?$
	86	(0+)	-53.2s	54 ms 7	$\epsilon$
	87	(9/2+)	-59.1s	2.2 s 2	$\epsilon$
	88	(3+)	-62.7s	5.8 s 2	$\epsilon$
	88m	(6+)	-62.7s	6.4 s 8	$\epsilon$
	89	(9/2+)	-67.8s	12.8 s 9	$\epsilon$
	89m	(1/2-)	-67.8s	12.9 s 8	$\epsilon$ , IT<0.01%
	90m	1+	-71.2	8.7 s 2	$\epsilon$
	90m	(6+)	-70.7	49.2 s 4	$\epsilon$
	91	(9/2+)	-76.0	3.14 m 2	$\epsilon$
	91m	(1/2-)	-75.8	3.3 m 1	$\epsilon$ , IT<1%
	92	(8+)	-78.93	4.25 m 15	$\epsilon$
	93	9/2+	-83.603	2.75 h 5	$\epsilon$
	93m	1/2-	-83.211	43.5 m 10	IT 76.6%, $\epsilon$ 23.4%
	93m	(17/2)-	-81.417	10.2 $\mu$ s 3	IT
	94	7+	-84.154	293 m 1	$\epsilon$
	94m	(2)+	-84.079	52.0 m 10	$\epsilon$ , IT<0.1%
	95	9/2+	-86.017	20.0 h 1	$\epsilon$
	95m	1/2-	-85.978	61 d 2	$\epsilon$ 96.12%, IT 3.88%
	96	7+	-85.817	4.28 d 7	$\epsilon$
96m	4+	-85.783	51.5 m 10	IT 98%, $\epsilon$ 2%	
97	9/2+	-87.220	$4.21 \times 10^6$ y 16	$\epsilon$	
97m	1/2-	-87.123	91.4 d 8	IT, $\epsilon$ 3.94%	
98	(6+)	-86.428	$4.2 \times 10^6$ y 3	$\beta^-$	
99	9/2+	-87.323	$2.111 \times 10^5$ y 12	$\beta^-$	
99m	1/2-	-87.180	6.0058 h 12	IT, $\beta^- 3.7 \times 10^{-3}\%$	
100	1+	-86.016	15.8 s 1	$\beta^-$ , $\epsilon 1.8 \times 10^{-3}\%$	
101	9/2+	-86.34	14.22 m 1	$\beta^-$	
102	1+	-84.566	5.28 s 15	$\beta^-$	
102m	(4,5)	-84.566	4.35 m 7	$\beta^- 98\%$ , IT 2%	
103	5/2+	-84.60	54.2 s 8	$\beta^-$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode			
Z	El	A	(MeV)	Abundance				
43	Tc	104	(3+)	-82.49	18.3 m 3	$\beta^-$		
		105	(3/2-)	-82.29	7.6 m 1	$\beta^-$		
		106	(1,2)	-79.78	35.6 s 6	$\beta^-$		
		107	(3/2-)	-79.1	21.2 s 2	$\beta^-$		
		108	(2+)	-76.0	5.17 s 7	$\beta^-$		
		109	(5/2+)	-74.54	0.86 s 4	$\beta^-$ , $\beta^-n$ 0.08%		
		110	(2+)	-70.96	0.92 s 3	$\beta^-$ 99.96%, $\beta^-n$ 0.04%		
		111	(7/2+,9/2+)	-69.2	290 ms 20	$\beta^-$ , $\beta^-n$ 0.85%		
		112		-66.0	0.29 s 2	$\beta^-$ , $\beta^-n$ 1.5%		
		113		-63.7s	170 ms 20	$\beta^-$ , $\beta^-n$ 2.1%		
		114		-59.7s	150 ms 30	$\beta^-$ , $\beta^-n$		
		115		-57.1s	100 ms SY	$\beta^-$ , $\beta^-n$		
		116		-52.8s	90 ms SY	$\beta^-$		
		117		-49.9s	40 ms SY	$\beta^-$		
		118		-45.2s	>150 ns	$\beta^-$		
		44	Ru	87		-47.3s	>1.5 $\mu$ s	$\epsilon$ ?
				88	0+	-55.6s	1.2 s +3-2	$\epsilon$ , $\epsilon p$
				89		-59.5s	1.5 s 2	$\epsilon$ , $\epsilon p$ < 0.15%
90	0+			-65.3s	11.7 s 9	$\epsilon$		
91	(9/2+)			-68.7s	7.9 s 4	$\epsilon$		
91m	(1/2-)			-68.7s	7.6 s 8	$\epsilon$ > 0%, $\epsilon p$ > 0%, IT		
92	0+			-74.4s	3.65 m 5	$\epsilon$		
93	(9/2+)			-77.27	59.7 s 6	$\epsilon$		
93m	(1/2-)			-76.53	10.8 s 3	$\epsilon$ 78%, IT 22%, $\epsilon p$ 0.03%		
94	0+			-82.57	51.8 m 6	$\epsilon$		
95	5/2+			-83.45	1.643 h 14	$\epsilon$		
96	0+			-86.072	<b>5.54% 14</b>			
97	5/2+			-86.112	2.791 d 4	$\epsilon$		
98	0+			-88.225	<b>1.87% 3</b>			
99	5/2+			-87.617	<b>12.76% 14</b>			
100	0+			-89.219	<b>12.60% 7</b>			
101	5/2+			-87.950	<b>17.06% 2</b>			
102	0+			-89.098	<b>31.55% 14</b>			
103	3/2+			-87.259	39.26 d 2	$\beta^-$		
103m	11/2-			-87.021	1.69 ms 7	IT		
104	0+			-88.089	<b>18.62% 27</b>			
105	3/2+			-85.928	4.44 h 2	$\beta^-$		
106	0+			-86.322	373.59 d 15	$\beta^-$		
107	(5/2+)			-83.9	3.75 m 5	$\beta^-$		
108	0+			-83.7	4.55 m 5	$\beta^-$		
109	(5/2+)			-80.85	34.5 s 10	$\beta^-$		
110	0+			-79.98	11.6 s 6	$\beta^-$		
111	(5/2+)	-76.67	2.12 s 7	$\beta^-$				
112	0+	-75.48	1.75 s 7	$\beta^-$				
113	(5/2+)	-72.20	0.80 s 5	$\beta^-$				
113m	(11/2-)	-72.07	510 ms 30	$\beta^-$ 92%, IT 8%				
114	0+	-70.5s	0.53 s 6	$\beta^-$				
115		-66.4	740 ms 80	$\beta^-$ , $\beta^-n$				
116	0+	-64.4s	400 ms SY	$\beta^-$ ?				
117		-60.0s	300 ms SY	$\beta^-$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
44	Ru	118	0+	-57.9s	>150 ns	$\beta^-$ ?
		119		-53.2s	>150 ns	$\beta^-$
		120	0+	-50.9s	>150 ns	$\beta^-$
45	Rh	89		-47.7s	>1.5 $\mu$ s	$\epsilon$
		90		-53.2s	12 ms +9-4	$\epsilon$ ?
		90m		-53.2s	1.0 s +3-2	$\epsilon$ ?
		91	(9/2+)	-59.1s	1.47 s 22	$\epsilon$
		91m	(1/2-)	-59.1s	1.46 s 11	$\epsilon$
		92	(2+)	-63.4s	0.5 s 4	$\epsilon$
		92	(GE 6+)	-63.4s	4.66 s 25	$\epsilon$
		93	(9/2+)	-69.2s	11.9 s 7	$\epsilon$
		94m	(8+)	-72.9s	25.8 s 2	$\epsilon$
		94m	(3+)	-72.9s	70.6 s 6	$\epsilon$
		95	(9/2+)	-78.3	5.02 m 10	$\epsilon$
		95m	(1/2-)	-77.8	1.96 m 4	IT 88%, $\epsilon$ 12%
		96	(6+)	-79.68	9.90 m 10	$\epsilon$
		96m	(3+)	-79.63	1.51 m 2	IT 60%, $\epsilon$ 40%
		97	9/2+	-82.59	30.7 m 6	$\epsilon$
		97m	1/2-	-82.33	46.2 m 16	$\epsilon$ 94.4%, IT 5.6%
		98	(2+)	-83.17	8.72 m 12	$\epsilon$
		98m	(5+)	-83.17	3.6 m 2	IT 89%, $\epsilon$ 11%
		99	1/2-	-85.574	16.1 d 2	$\epsilon$
		99m	9/2+	-85.510	4.7 h 1	$\epsilon$ >99.84%, IT <0.16%
		100	1-	-85.58	20.8 h 1	$\epsilon$
		100m	(5+)	-85.58	4.6 m 2	IT=98.3%, $\epsilon$ ≈ 1.7%
		101	1/2-	-87.41	3.3 y 3	$\epsilon$
		101m	9/2+	-87.25	4.34 d 1	$\epsilon$ 92.8%, IT 7.2%
		102	(1-,2-)	-86.775	207 d 3	$\epsilon$ 78%, $\beta^-$ 22%
		102m	6(+)	-86.634	≈2.9 y	$\epsilon$ 99.77%, IT 0.23%
		103	1/2-	-88.022	<b>100%</b>	
		103m	7/2+	-87.982	56.114 m 9	IT
		104	1+	-86.950	42.3 s 4	$\beta^-$ 99.55%, $\epsilon$ 0.45%
		104m	5+	-86.821	4.34 m 3	IT 99.87%, $\beta^-$ 0.13%
		105	7/2+	-87.846	35.36 h 6	$\beta^-$
105m	1/2-	-87.716	42.9 s 3	IT		
106	1+	-86.362	29.80 s 8	$\beta^-$		
106m	(6+)	-86.225	131 m 2	$\beta^-$		
107	7/2+	-86.86	21.7 m 4	$\beta^-$		
108	1+	-85.0	16.8 s 5	$\beta^-$		
108m	(5+)	-85.0	6.0 m 3	$\beta^-$		
109	7/2+	-85.01	80 s 2	$\beta^-$		
110m	1+	-82.78	3.2 s 2	$\beta^-$		
110m	(GE4)	-82.78	28.5 s 15	$\beta^-$		
111	(7/2+)	-82.36	11 s 1	$\beta^-$		
112m	1+	-79.74	3.45 s 37	$\beta^-$		
112m	(4,5,6)	-79.74	6.73 s 15	$\beta^-$		
113	(7/2+)	-78.68	2.80 s 12	$\beta^-$		
114	1+	-75.6	1.85 s 5	$\beta^-$		
114m	(4,5)	-75.6	1.85 s 5	$\beta^-$		
115	(7/2+)	-74.21	0.99 s 5	$\beta^-$		
116	1+	-70.7	0.68 s 6	$\beta^-$		



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>45 Rh</b>	116m	(6-)	-70.6	0.57 s 5	$\beta^-$
	117	(7/2+)	-68.9s	0.44 s 4	$\beta^-$
	118	0+	-65.1s	0.30 s 6	$\beta^-$
	119		-63.2s	>150 ns	$\beta^-$
	120		-59.2s	>150 ns	$\beta^-?$
	121		-57.1s	>150 ns	$\beta^-?$
	122		-52.9s	$\approx$ 50 ms	$\beta^-?$
<b>46 Pd</b>	91		-47.4s	>1 $\mu$ s	$\epsilon?$
	92	0+	-55.5s	0.7 s +4-2	$\epsilon$
	93	(7/2+,9/2+)	-59.7s	1.3 s 2	$\epsilon, \epsilon p$ 1.5%
	93m		-59.7s	9.3 s +25-17	$\epsilon, IT$
	94	0+	-66.3s	9.0 s 5	$\epsilon$
	95		-70.2s	10 s SY	$\epsilon$
	95m	(21/2+)	-68.2s	13.3 s 3	$\epsilon \geq 91.3\%, IT \leq 9.7\%, \epsilon p$ 0.9%
	96	0+	-76.2	122 s 2	$\epsilon$
	97	5/2+	-77.8	3.10 m 9	$\epsilon$
	98	0+	-81.30	17.7 m 3	$\epsilon$
	99	(5/2+)	-82.19	21.4 m 2	$\epsilon$
	100	0+	-85.23	3.63 d 9	$\epsilon$
	101	5/2+	-85.43	8.47 h 6	$\epsilon$
	102	0+	-87.925	<b>1.02% 1</b>	
	103	5/2+	-87.479	16.991 d 19	$\epsilon$
	104	0+	-89.390	<b>11.14% 8</b>	
	105	5/2+	-88.413	<b>22.33% 8</b>	
	106	0+	-89.902	<b>27.33% 3</b>	
	107	5/2+	-88.368	$6.5 \times 10^6$ y 3	$\beta^-$
	107m	11/2-	-88.153	21.3 s 5	IT
	108	0+	-89.524	<b>26.46% 9</b>	
	109	5/2+	-87.607	13.7012 h 24	$\beta^-$
	109m	11/2-	-87.418	4.696 m 3	IT
	110	0+	-88.35	<b>11.72% 9</b>	
111	5/2+	-86.00	23.4 m 2	$\beta^-$	
111m	11/2-	-85.83	5.5 h 1	IT 73%, $\beta^-$ 27%	
112	0+	-86.34	21.03 h 5	$\beta^-$	
113	(5/2+)	-83.69	93 s 5	$\beta^-$	
113m	(9/2-)	-83.61	0.3 s 1	IT	
113m		-83.69	$\geq$ 100 s		
114	0+	-83.50	2.42 m 6	$\beta^-$	
115	(5/2+)	-80.40	25 s 2	$\beta^-$	
115m	(11/2-)	-80.31	50 s 3	$\beta^-$ 92%, IT 8%	
116	0+	-79.96	11.8 s 4	$\beta^-$	
117	(5/2+)	-76.53	4.3 s 3	$\beta^-$	
117m	(11/2-)	-76.33	19.1 ms 7	IT	
118	0+	-75.5	1.9 s 1	$\beta^-$	
119		-71.6s	0.92 s 13	$\beta^-$	
120	0+	-70.1	0.5 s 1	$\beta^-$	
121		-66.3s	>150 ns	$\beta^-?$	
122	0+	-64.7s	>150 ns	$\beta^-, \beta^-n$	
123		-60.6s	>150 ns	$\beta^-$	
124	0+	-58.8s	$\approx$ 0.2 s	$\beta^-?$	
<b>47 Ag</b>	93		-46.8s	>1.5 $\mu$ s	$\epsilon?, p?$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	$J\pi$	(MeV)	Abundance	Decay Mode
47	Ag	94	(0+)	-53.3s	26 ms +26-9	$\epsilon, \epsilon p$
		94m	(21+)	-53.3s	0.47 s 8	$\epsilon, \epsilon p$
		94m	(7+)	-53.3s	0.59 s 2	$\epsilon, \epsilon p > 0\%$
		95		-60.1s	2.0 s 1	$\epsilon, \epsilon p$
		96	(8+)	-64.6s	4.40 s 6	$\epsilon, \epsilon p$ 8.15%
		96	(2+)	-64.6s	6.9 s 6	$\epsilon, \epsilon p$ 18%
		97	9/2+	-70.8	25.9 s 4	$\epsilon$
		98	(6+)	-73.06	47.5 s 3	$\epsilon, \epsilon p$ 1.1×10 <sup>-3%</sup>
		99	(9/2)+	-76.8	124 s 3	$\epsilon$
		99m	(1/2-)	-76.3	10.5 s 5	IT
		100	(5+)	-78.15	2.01 m 9	$\epsilon$
		100m	(2+)	-78.13	2.24 m 13	$\epsilon, \text{ IT}$
		101	9/2+	-81.2	11.1 m 3	$\epsilon$
		101m	(1/2-)	-81.0	3.10 s 10	IT
		102	5+	-82.26	12.9 m 3	$\epsilon$
		102m	2+	-82.26	7.7 m 5	$\epsilon$ 51%, IT 49%
		103	7/2+	-84.79	65.7 m 7	$\epsilon$
		103m	1/2-	-84.66	5.7 s 3	IT
		104	5+	-85.111	69.2 m 10	$\epsilon$
		104m	2+	-85.104	33.5 m 20	$\epsilon$ 99.93%, IT < 0.07%
		105	1/2-	-87.07	41.29 d 7	$\epsilon$
		105m	7/2+	-87.04	7.23 m 16	IT 99.66%
		106	1+	-86.937	23.96 m 4	$\epsilon$ 99.5%, $\beta^-$ < 1%
		106m	6+	-86.847	8.28 d 2	$\epsilon$
		107	1/2-	-88.402	<b>51.839% 8</b>	
		107m	7/2+	-88.309	44.5 s 8	IT
		108	1+	-87.602	2.37 m 1	$\beta^-$ 97.15%, $\epsilon$ 2.85%
108m	6+	-87.492	438 y 9	$\epsilon$ 91.3%, IT 8.7%		
109	1/2-	-88.723	<b>48.161% 8</b>			
109m	7/2+	-88.635	38.0 s 12	IT		
110	1+	-87.461	24.6 s 2	$\beta^-$ 99.7%, $\epsilon$ 0.3%		
110m	6+	-87.343	249.76 d 4	$\beta^-$ 98.64%, IT 1.36%		
111	1/2-	-88.221	7.45 d 1	$\beta^-$		
111m	7/2+	-88.161	64.8 s 8	IT 99.3%, $\beta^-$ 0.7%		
112	2(-)	-86.62	3.130 h 9	$\beta^-$		
113	1/2-	-87.03	5.37 h 5	$\beta^-$		
113m	7/2+	-86.99	68.7 s 16	IT 64%, $\beta^-$ 36%		
114	1+	-84.95	4.6 s 1	$\beta^-$		
114m (LE6+)		-84.75	1.50 ms 5	IT		
115	1/2-	-84.99	20.0 m 5	$\beta^-$		
115m	7/2+	-84.95	18.0 s 7	$\beta^-$ 79%, IT 21%		
116	(2)-	-82.57	2.68 m 10	$\beta^-$		
116m	(5+)	-82.49	8.6 s 3	$\beta^-$ 94%, IT 6%		
117	(1/2-)	-82.27	72.8 s +20-7	$\beta^- \approx 100\%$		
117m	(7/2+)	-82.24	5.34 s 5	$\beta^-$ 94%, IT 6%		
118	1(-)	-79.57	3.76 s 15	$\beta^-$		
118m	4(+)	-79.44	2.0 s 2	$\beta^-$ 59%, IT 41%		
119m	(7/2+)	-78.56	2.1 s 1	$\beta^-$		
119m	(1/2-)	-78.56	6.0 s 5	$\beta^-$		
120	3(+)	-75.65	1.23 s 4	$\beta^-$ , $\beta^-$ -n < 3.0×10 <sup>-3%</sup>		
120m	6(-)	-75.45	0.40 s 3	$\beta^- \approx 63\%$ , IT $\approx 37\%$		
121	(7/2+)	-74.7	0.79 s 2	$\beta^-$ , $\beta^-$ -n 0.08%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$				
Z	El	A	(MeV)	Abundance	Decay Mode			
47	Ag	122	(3+)	-71.2s	0.529 s 13	$\beta^-$ , $\beta^-n$ 0.19%		
		122m	(8-)	-71.2s	1.5 s 5	$\beta^-$ , $\beta^-n$		
		123	(7/2+)	-70.0s	0.300 s 5	$\beta^-$ , $\beta^-n$ 0.55%		
		124		-66.5s	0.172 s 5	$\beta^-$ , $\beta^-n > 0.1\%$		
		125	(7/2+)	-64.8s	166 ms 7	$\beta^-$ , $\beta^-n$		
		126		-61.0s	107 ms 12	$\beta^-$ , $\beta^-n$		
		127	(1/2-)	-58.9s	79 ms 3	$\beta^-$		
		128		-54.8s	58 ms 5	$\beta^-$ , $\beta^-n$		
		129	(9/2+)	-52.5s	46 ms +5-9	$\beta^-$ , $\beta^-n$		
		129m	(1/2-)	-52.5s	$\approx 160$ ms	$\beta^-$ , $\beta^-n$		
		130		-46.2s	$\approx 50$ ms	$\beta^-$		
		48	Cd	95		-46.7s	5 ms SY	$\epsilon?$ , $\epsilon p?$
				96	0+	-56.1s	$\approx 1$ s	$\epsilon?$
97				-60.6s	2.8 s 6	$\epsilon$ , $\epsilon p$		
98	0+			-67.63	9.2 s 3	$\epsilon$ , $\epsilon p < 0.03\%$		
99	(5/2+)			-69.9s	16 s 3	$\epsilon$ , $\epsilon p$ 0.17%, $\epsilon\alpha < 1.0 \times 10^{-4}\%$		
100	0+			-74.25	49.1 s 5	$\epsilon$		
101	(5/2+)			-75.7	1.36 m 5	$\epsilon$		
102	0+			-79.68	5.5 m 5	$\epsilon$		
103	5/2+			-80.65	7.3 m 1	$\epsilon$		
104	0+			-83.975	57.7 m 10	$\epsilon$		
105	5/2+			-84.33	55.5 m 4	$\epsilon$		
106	0+			-87.132	$\geq 2.6 \times 10^{17}$ y	2 $\epsilon$		
					<b>1.25% 6</b>			
107	5/2+			-86.985	6.50 h 2	$\epsilon$		
108	0+			-89.252	$> 1.0 \times 10^{18}$ y	2 $\epsilon$		
					<b>0.89% 3</b>			
109	5/2+			-88.508	461.4 d 12	$\epsilon$		
110	0+			-90.353	<b>12.49% 18</b>			
111	1/2+			-89.257	<b>12.80% 12</b>			
111m	11/2-			-88.861	48.50 m 9	IT		
112	0+			-90.580	<b>24.13% 21</b>			
113	1/2+			-89.049	$7.7 \times 10^{15}$ y 3	$\beta^-$		
					<b>12.22% 12</b>			
113m	11/2-	-88.786	14.1 y 5	$\beta^-$ 99.86%, IT 0.14%				
114	0+	-90.021	$> 6.4 \times 10^{18}$ y	2 $\beta^-$				
			<b>28.73% 42</b>					
115	1/2+	-88.090	53.46 h 5	$\beta^-$				
115m	(11/2)-	-87.910	44.56 d 24	$\beta^-$				
116	0+	-88.719	$3.1 \times 10^{19}$ y 4	2 $\beta^-$				
			<b>7.49% 18</b>					
117	1/2+	-86.425	2.49 h 4	$\beta^-$				
117m	(11/2)-	-86.289	3.36 h 5	$\beta^-$				
118	0+	-86.71	50.3 m 2	$\beta^-$				
119	3/2+	-83.91	2.69 m 2	$\beta^-$				
119m	(11/2-)	-83.76	2.20 m 2	$\beta^-$				
120	0+	-83.97	50.80 s 21	$\beta^-$				
121	(3/2+)	-81.06	13.5 s 3	$\beta^-$				
121m	(11/2-)	-80.85	8.3 s 8	$\beta^-$				
122	0+	-80.73	5.24 s 3	$\beta^-$				
123	(3/2+)	-77.31	2.10 s 2	$\beta^-$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode		
Z	El	A	(MeV)	Abundance			
48	Cd	123m (11/2-)	-76.99	1.82 s 3	$\beta^- \leq 100\%$ , IT		
		124	0+	-76.71	1.25 s 2	$\beta^-$	
		125	(3/2+)	-73.36	0.65 s 2	$\beta^-$	
		125m (11/2-)	-73.31	0.48 s 3	$\beta^-$		
		126	0+	-72.33	0.515 s 17	$\beta^-$	
		127	(3/2+)	-68.52	0.37 s 7	$\beta^-$	
		128	0+	-67.3	0.28 s 4	$\beta^-$	
		129	(3/2+)	-63.2s	0.27 s 4	$\beta^-$	
		130	0+	-61.6	162 ms 7	$\beta^-$ , $\beta^-n \approx 3.5\%$	
		131		-55.3s	68 ms 3	$\beta^-$ , $\beta^-n 3.5\%$	
		132	0+	-50.7s	97 ms 10	$\beta^-$ , $\beta^-n 60\%$	
		49	In	97	-47.0s	5 ms SY	$p^?$ , $\epsilon^?$
				98	-53.9s	32 ms +32-11	$\epsilon$
98m	-53.9s			1.2 s +12-4	$\epsilon$		
99	(9/2+)			-61.3s	3.0 s +8-7	$\epsilon$	
100	(6,7)+			-64.2	5.9 s 2	$\epsilon$ , $\epsilon p 1.6\%$	
101				-68.6s	15.1 s 3	$\epsilon \approx 100\%$ , $\epsilon p$	
102	(6+)			-70.7	23.3 s 1	$\epsilon$ , $\epsilon p 9.3 \times 10^{-3}\%$	
103	(9/2+)			-74.60	65 s 7	$\epsilon$	
103m (1/2-)	-73.97			34 s 2	$\epsilon 67\%$ , IT 33%		
104	5,6(+)			-76.11	1.80 m 3	$\epsilon$	
104m (3+)	-76.01			15.7 s 5	IT 80%, $\epsilon 20\%$		
105	9/2+			-79.48	5.07 m 7	$\epsilon$	
105m (1/2-)	-78.81			48 s 6	IT		
106	7+			-80.61	6.2 m 1	$\epsilon$	
106m (3+)	-80.58			5.2 m 1	$\epsilon$		
107	9/2+			-83.56	32.4 m 3	$\epsilon$	
107m 1/2-	-82.88			50.4 s 6	IT		
108	7+			-84.116	58.0 m 12	$\epsilon$	
108m 2+	-84.086			39.6 m 7	$\epsilon$		
109	9/2+			-86.489	4.2 h 1	$\epsilon$	
109m 1/2-	-85.839			1.34 m 7	IT		
109m (19/2+)	-84.387			0.209 s 6	IT		
110	7+			-86.47	4.9 h 1	$\epsilon$	
110m 2+	-86.41			69.1 m 5	$\epsilon$		
111	9/2+			-88.396	2.8047 d 5	$\epsilon$	
111m 1/2-	-87.859			7.7 m 2	IT		
112	1+			-87.996	14.97 m 10	$\epsilon 56\%$ , $\beta^- 44\%$	
112m 4+	-87.840	20.56 m 6	IT				
113	9/2+	-89.370	<b>4.29% 5</b>				
113m 1/2-	-88.978	99.476 m 23	IT				
114	1+	-88.572	71.9 s 1	$\beta^- 99.5\%$ , $\epsilon 0.5\%$			
114m 5+	-88.382	49.51 d 1	IT 96.75%, $\epsilon 3.25\%$				
114m 8-	-88.070	43.1 ms 6	IT				
115	9/2+	-89.537	4.41 $\times 10^{14}$ y 25	$\beta^-$			
			<b>95.71% 5</b>				
115m 1/2-	-89.200	4.486 h 4	IT 95%, $\beta^- 5\%$				
116	1+	-88.250	14.10 s 3	$\beta^- 99.98\%$ , $\epsilon 0.02\%$			
116m 5+	-88.123	54.29 m 17	$\beta^-$				
116m 8-	-87.960	2.18 s 4	IT				
117	9/2+	-88.945	43.2 m 3	$\beta^-$			
117m 1/2-	-88.630	116.2 m 3	$\beta^- 52.9\%$ , IT 47.1%				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
49	In	118	1+	-87.230	5.0 s 5	$\beta^-$
		118m	5+	-87.170	4.45 m 5	$\beta^-$
		118m	8-	-87.030	8.5 s 3	IT 98.6%, $\beta^-$ 1.4%
		119	9/2+	-87.704	2.4 m 1	$\beta^-$
		119m	1/2-	-87.393	18.0 m 3	$\beta^-$ 94.4%, IT 5.6%
		120	1+	-85.74	3.08 s 8	$\beta^-$
		120m	(8-)	-85.74	47.3 s 5	$\beta^-$
		120m	(5+)	-85.67	46.2 s 8	$\beta^-$
		121	9/2+	-85.84	23.1 s 6	$\beta^-$
		121m	1/2-	-85.53	3.88 m 10	$\beta^-$ 98.8%, IT 1.2%
		122	1+	-83.58	1.5 s 3	$\beta^-$
		122m	5+	-83.54	10.3 s 6	$\beta^-$
		122m	8-	-83.29	10.8 s 4	$\beta^-$
		123	(9/2)+	-83.43	6.17 s 5	$\beta^-$
		123m	(1/2)-	-83.10	47.4 s 4	$\beta^-$
		124	3+	-80.88	3.11 s 10	$\beta^-$
		124m	(8-)	-80.83	3.7 s 2	$\beta^-$
		125	9/2+	-80.48	2.36 s 4	$\beta^-$
		125m	1/2(-)	-80.12	12.2 s 2	$\beta^-$
		126	3(+)	-77.81	1.53 s 1	$\beta^-$
		126m	(8-)	-77.71	1.64 s 5	$\beta^-$
		127	(9/2+)	-76.99	1.09 s 1	$\beta^-$ , $\beta^-$ -n $\leq$ 0.03%
		127m	(1/2-)	-76.52	3.67 s 4	$\beta^-$ , $\beta^-$ -n 0.69%
		128	(3+)	-74.36	0.84 s 6	$\beta^-$ , $\beta^-$ -n $<$ 0.05%
		128m	(8-)	-74.02	0.72 s 10	$\beta^-$ , $\beta^-$ -n $<$ 0.05%
		129	(9/2+)	-72.94	0.61 s 1	$\beta^-$ , $\beta^-$ -n 0.25%
		129m	(1/2-)	-72.56	1.23 s 3	$\beta^-$ $>$ 99.7%, $\beta^-$ -n 2.5%, IT $<$ 0.3%
		130	1(-)	-69.89	0.29 s 2	$\beta^-$ , $\beta^-$ -n 0.93%
		130m	(10-)	-69.84	0.54 s 1	$\beta^-$ , $\beta^-$ -n 1.65%
		130m	(5+)	-69.49	0.54 s 1	$\beta^-$ , $\beta^-$ -n 1.65%
		131	(9/2+)	-68.14	0.28 s 3	$\beta^-$ , $\beta^-$ -n $\leq$ 2%
131m	(1/2-)	-67.77	0.35 s 5	$\beta^-$ $\geq$ 99.98%, $\beta^-$ -n $\leq$ 2%, IT $\leq$ 0.02%		
131m		-63.87	0.32 s 6	$\beta^-$ $>$ 99%, IT $<$ 1%, $\beta^-$ -n 0.03%		
132	(7-)	-62.42	0.207 s 6	$\beta^-$ , $\beta^-$ -n 6.3%		
133	(9/2+)	-57.9s	165 ms 3	$\beta^-$ , $\beta^-$ -n 85%		
134	(4-T07-)	-52.0s	140 ms 4	$\beta^-$ , $\beta^-$ -n 65%		
135		-47.2s	92 ms 10	$\beta^-$ , $\beta^-$ -n $>$ 0%		
50	Sn	99		-47.2s	5 ms SY	$\epsilon?$ , $\epsilon p?$
		100	0+	-56.8	0.94 s +54-27	$\epsilon$ , $\epsilon p$ $<$ 17%
		101		-59.6s	3 s 1	$\epsilon$ , $\epsilon p$
		102	0+	-64.9	4.5 s 7	$\epsilon$
		103		-67.0s	7.0 s 6	$\epsilon$ , $\epsilon p$
		104	0+	-71.6	20.8 s 5	$\epsilon$
		105	(5/2+)	-73.26	34 s 1	$\epsilon$ , $\epsilon p$
		106	0+	-77.43	115 s 5	$\epsilon$
		107	(5/2+)	-78.58	2.90 m 5	$\epsilon$
		108	0+	-82.04	10.30 m 8	$\epsilon$
		109	5/2(+)	-82.64	18.0 m 2	$\epsilon$
		110	0+	-85.84	4.11 h 10	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>50 Sn</b>	111	7/2+	-85.945	35.3 m 6	$\epsilon$
	111m	1/2+	-85.690	12.5 $\mu$ s 10	IT
	112	0+	-88.661	<b>0.97% 1</b>	
	113	1/2+	-88.333	115.09 d 3	$\epsilon$
	113m	7/2+	-88.256	21.4 m 4	IT 91.1%, $\epsilon$ 8.9%
	114	0+	-90.561	<b>0.66% 1</b>	
	115	1/2+	-90.036	<b>0.34% 1</b>	
	115m	7/2+	-89.423	3.26 $\mu$ s 8	IT
	115m	11/2-	-89.322	159 $\mu$ s 1	IT
	116	0+	-91.528	<b>14.54% 9</b>	
	117	1/2+	-90.400	<b>7.68% 7</b>	
	117m	11/2-	-90.085	13.76 d 4	IT
	118	0+	-91.656	<b>24.22% 9</b>	
	119	1/2+	-90.068	<b>8.59% 4</b>	
	119m	11/2-	-89.979	293.1 d 7	IT
	120	0+	-91.105	<b>32.58% 9</b>	
	121	3/2+	-89.204	27.03 h 4	$\beta^-$
	121m	11/2-	-89.198	43.9 y 5	IT 77.6%, $\beta^-$ 22.4%
	122	0+	-89.946	<b>4.63% 3</b>	
	123	11/2-	-87.821	129.2 d 4	$\beta^-$
	123m	3/2+	-87.796	40.06 m 1	$\beta^-$
	124	0+	-88.237	<b>5.79% 5</b>	
	125	11/2-	-85.898	9.64 d 3	$\beta^-$
	125m	3/2+	-85.871	9.52 m 5	$\beta^-$
	126	0+	-86.02	$2.30 \times 10^5$ y 14	$\beta^-$
	127	(11/2-)	-83.50	2.10 h 4	$\beta^-$
	127m	(3/2+)	-83.49	4.13 m 3	$\beta^-$
	128	0+	-83.33	59.07 m 14	$\beta^-$
	128m	(7-)	-81.24	6.5 s 5	IT
	129	(3/2+)	-80.59	2.23 m 4	$\beta^-$
	129m	(11/2-)	-80.56	6.9 m 1	$\beta^-$ , IT < $2.0 \times 10^{-3}\%$
	130	0+	-80.14	3.72 m 7	$\beta^-$
	130m	(7-)	-78.19	1.7 m 1	$\beta^-$
	131	(3/2+)	-77.31	56.0 s 5	$\beta^-$
	131m	(11/2-)	-77.07	58.4 s 5	$\beta^-$ , IT $\leq 4.0 \times 10^{-4}\%$
	132	0+	-76.55	39.7 s 8	$\beta^-$
	132m	(8+)	-71.71	2.03 $\mu$ s 4	IT
133	(7/2-)	-70.95	1.45 s 3	$\beta^-$ , $\beta^-$ -n 0.08%	
134	0+	-66.80	1.050 s 11	$\beta^-$ , $\beta^-$ -n 17%	
135	(7/2-)	-60.8s	530 ms 20	$\beta^-$ , $\beta^-$ -n 21%	
136	0+	-56.5s	0.25 s 3	$\beta^-$ , $\beta^-$ -n 30%	
137		-50.3s	190 ms 60	$\beta^-$ , $\beta^-$ -n 58%	
<b>51 Sb</b>	103		-56.2s	>1.5 $\mu$ s	$\epsilon$ ?
	104		-59.2s	0.44 s +15-11	$\epsilon$ , $\epsilon$ p < 7%, p < 1%
	105	(5/2+)	-63.8	1.12 s 16	$\epsilon$ 99%, p 1%
	106	(4+)	-66.3s	0.6 s 2	$\epsilon$
	107	(5/2+)	-70.7s	4.0 s 2	$\epsilon$
	108	(4+)	-72.5s	7.4 s 3	$\epsilon$
	109	(5/2+)	-76.26	17.3 s 5	$\epsilon$
	110	(3+,4+)	-77.5s	23.0 s 4	$\epsilon$
	111	(5/2+)	-80.89	75 s 1	$\epsilon$
	112	3+	-81.60	51.4 s 10	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
51	Sb	113	5/2+	-84.42	6.67 m 7	$\epsilon$
		114	3+	-84.52	3.49 m 3	$\epsilon$
		115	5/2+	-87.00	32.1 m 3	$\epsilon$
		115m	11/2-	-85.70	6.2 ns 3	IT
		115m	(19/2)-	-84.21	159 ns 3	IT
		115m	(25/2)+	-83.34	4.1 ns 2	IT
		116	3+	-86.821	15.8 m 8	$\epsilon$
		116m	8-	-86.438	60.3 m 6	$\epsilon$
		117	5/2+	-88.645	2.80 h 1	$\epsilon, \epsilon$ 1.7%
		117m	(25/2)+	-85.514	355 $\mu$ s 17	IT
		118	1+	-87.999	3.6 m 1	$\epsilon$
		118m	8-	-87.749	5.00 h 2	$\epsilon$
		119	5/2+	-89.477	38.19 h 22	$\epsilon$
		119m	(27/2+)	-86.636	0.85 s 9	IT
		120	1+	-88.424	15.89 m 4	$\epsilon$
		120m	8-	-88.424	5.76 d 2	$\epsilon$
		121	5/2+	-89.595	<b>57.21% 5</b>	
		122	2-	-88.330	2.7238 d 2	$\beta$ - 97.59%, $\epsilon$ 2.41%
		122m	5+	-88.193	0.53 ms 3	IT
		122m	(8)-	-88.167	4.191 m 3	IT
		123	7/2+	-89.224	<b>42.79% 5</b>	
		124	3-	-87.620	60.11 d 7	$\beta$ -
		124m	5+	-87.609	93 s 5	IT 75%, $\beta$ - 25%
		124m	(8)-	-87.584	20.2 m 2	IT
		125	7/2+	-88.256	2.7586 y 3	$\beta$ -
		126	(8-)	-86.40	12.35 d 6	$\beta$ -
		126m	(5+)	-86.38	19.15 m 8	$\beta$ - 86%, IT 14%
		126m	(3-)	-86.36	$\approx$ 11 s	IT
		127	7/2+	-86.700	3.85 d 5	$\beta$ -
		128	8-	-84.61	9.01 h 4	$\beta$ -
		128m	5+	-84.61	10.4 m 2	$\beta$ - 96.4%, IT 3.6%
		129	7/2+	-84.63	4.40 h 1	$\beta$ -
		129m	(19/2-)	-82.78	17.7 m 1	$\beta$ - 85%, IT 15%
130	(8-)	-82.29	39.5 m 8	$\beta$ -		
130m	(4,5)+	-82.29	6.3 m 2	$\beta$ -		
131	(7/2+)	-81.99	23.03 m 4	$\beta$ -		
132	(4+)	-79.67	2.79 m 7	$\beta$ -		
132m	(8-)	-79.67	4.10 m 5	$\beta$ -		
133	(7/2+)	-78.94	2.5 m 1	$\beta$ -		
134	(0-)	-74.17	0.78 s 6	$\beta$ -		
134m	(7-)	-74.17	10.07 s 5	$\beta$ -, $\beta$ -n 0.09%		
134m	(1+)	-70.39	<1 ns	n		
135	(7/2+)	-69.7	1.68 s 2	$\beta$ -, $\beta$ -n 22%		
136	1-	-64.9s	0.923 s 14	$\beta$ -, $\beta$ -n 16.3%		
136m	(6-)	-64.9s	0.57 $\mu$ s 5	IT		
137		-60.3s	>150 ns	$\beta$ -?, $\beta$ -n?		
138		-55.2s	>300 ns	$\beta$ -?, $\beta$ -n?		
139		-50.3s	>150 ns	$\beta$ -?		
52	Te	105		-52.5s	1 $\mu$ s SY	$\alpha$ ?, $\epsilon$ ?
		106	0+	-58.2	70 $\mu$ s +20-10	$\alpha$
		107		-60.5s	3.1 ms 1	$\alpha$ 70%, $\epsilon$ 30%
		108	0+	-65.7	2.1 s 1	$\epsilon$ 51%, $\alpha$ 49%, $\epsilon$ p 2.4%

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
52	Te	109	-67.61	4.6 s 3	$\epsilon$ 96.1%, $\epsilon p$ 9.4%, $\alpha$ 3.9%, $\epsilon\alpha < 5.0 \times 10^{-3}\%$
		110	-72.28	18.6 s 8	$\epsilon \approx 100\%$ , $\alpha \approx 3.0 \times 10^{-3}\%$
		111	-73.48	19.3 s 4	$\epsilon$ , $\epsilon p$
		112	-77.3	2.0 m 2	$\epsilon$
		113	-78.35	1.7 m 2	$\epsilon$
		114	-81.89	15.2 m 7	$\epsilon$
		115	-82.06	5.8 m 2	$\epsilon$
		115m	-82.04	6.7 m 4	$\epsilon \leq 100\%$ , IT
		115m	-81.78	7.5 $\mu$ s 2	IT
		116	-85.27	2.49 h 4	$\epsilon$
		117	-85.10	62 m 2	$\epsilon$ , $\epsilon$ 25%
		117m	-84.80	103 ms 3	IT
		118	-87.72	6.00 d 2	$\epsilon$
		119	-87.184	16.05 h 5	$\epsilon$ , $\epsilon$ 2.06%
		119m	-86.923	4.70 d 4	$\epsilon$ , $\epsilon$ 0.41%, IT $< 8.0 \times 10^{-3}\%$
		120	-89.405	$> 2.2 \times 10^{16}$ y <b>0.09% 1</b>	2 $\epsilon$
		121	-88.55	19.16 d 5	$\epsilon$
		121m	-88.26	154 d 7	IT 88.6%, $\epsilon$ 11.4%
		122	-90.314	<b>2.55% 12</b>	
		123	-89.172	$> 9.2 \times 10^{16}$ y <b>0.89% 3</b>	$\epsilon$
		123m	-88.924	119.2 d 1	IT
		124	-90.524	<b>4.74% 14</b>	
		125	-89.022	<b>7.07% 15</b>	
		125m	-88.877	57.40 d 15	IT
		126	-90.065	<b>18.84% 25</b>	
		127	-88.281	9.35 h 7	$\beta^-$
		127m	-88.193	109 d 2	IT 97.6%, $\beta^-$ 2.4%
		128	-88.992	$8.8 \times 10^{18}$ y 4 <b>31.74% 8</b>	2 $\beta^-$
		129	-87.003	69.6 m 3	$\beta^-$
		129m	-86.898	33.6 d 1	IT 63%, $\beta^-$ 37%
		130	-87.351	$> 5 \times 10^{23}$ y <b>34.08% 62</b>	2 $\beta^-$
		131	-85.210	25.0 m 1	$\beta^-$
		131m	-85.027	30 h 2	$\beta^-$ 77.8%, IT 22.2%
		132	-85.182	3.204 d 13	$\beta^-$
		132m	-83.257	28.1 $\mu$ s 15	IT
		132m	-82.459	3.70 $\mu$ s 9	IT
		133	-82.94	12.5 m 3	$\beta^-$
		133m	-82.61	55.4 m 4	$\beta^-$ 82.5%, IT 17.5%
		134	-82.56	41.8 m 8	$\beta^-$
		134m	-80.87	164.1 ns 9	IT
		135	-77.83	19.0 s 2	$\beta^-$
		136	-74.43	17.63 s 8	$\beta^-$ , $\beta^-$ -n 1.31%
		137	-69.6	2.49 s 5	$\beta^-$ , $\beta^-$ -n 2.69%
		138	-65.9s	1.4 s 4	$\beta^-$ , $\beta^-$ -n 6.3%



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
52	Te	139	(7/2-)	-60.8s	>150 ns	$\beta^-$ , $\beta^-n$
		140	0+	-57.0s	>150 ns	$\beta^-?$ , $\beta^-n?$
		141		-51.6s	>150 ns	$\beta^-?$ , $\beta^-n?$
		142	0+	-47.4s	>150 ns	$\beta^-?$
53	I	108	(1)	-52.7s	36 ms 6	$\alpha$ 91%, $\epsilon$ 9%, $p < 1\%$
		109	1/2+	-57.6	103 $\mu$ s 5	p
		110		-60.3s	0.65 s 2	$\epsilon$ 83%, $\alpha$ 17%, $\epsilon p$ 11%, $\epsilon\alpha$ 1.1%
		111	(5/2+)	-64.9s	2.5 s 2	$\epsilon$ 99.9%, $\alpha \approx 0.1\%$
		112		-67.1s	3.42 s 11	$\epsilon$ , $\alpha \approx 1.2 \times 10^{-3}\%$
		113	5/2+	-71.13	6.6 s 2	$\epsilon$ , $\alpha$ 3.3 $\times 10^{-7}\%$
		114	1+	-72.8s	2.1 s 2	$\epsilon$ , $\epsilon p$
		114m	(7)	-72.5s	6.2 s 5	$\epsilon$ 91%, IT 9%
		115	(5/2+)	-76.34	1.3 m 2	$\epsilon$
		116	1+	-77.49	2.91 s 15	$\epsilon$
		117	(5/2+)	-80.43	2.22 m 4	$\epsilon$
		118	2-	-80.97	13.7 m 5	$\epsilon$
		118m	(7-)	-80.87	8.5 m 5	$\epsilon < 100\%$ , IT > 0%
		119	5/2+	-83.77	19.1 m 4	$\epsilon$
		120	2-	-83.79	81.6 m 2	$\epsilon$
		120m	(7-)	-83.47	53 m 4	$\epsilon$
		121	5/2+	-86.29	2.12 h 1	$\epsilon$
		122	1+	-86.080	3.63 m 6	$\epsilon$
		123	5/2+	-87.943	13.232 h 6	$\epsilon$
		124	2-	-87.365	4.1760 d 3	$\epsilon$
		125	5/2+	-88.836	59.400 d 10	$\epsilon$
		126	2-	-87.910	12.93 d 5	$\epsilon$ 52.7%, $\beta^-$ 47.3%
		127	5/2+	-88.983	<b>100%</b>	
		128	1+	-87.738	24.99 m 2	$\beta^-$ 93.1%, $\epsilon$ 6.9%
		129	7/2+	-88.503	$1.57 \times 10^7$ y 4	$\beta^-$
		130	5+	-86.932	12.36 h 1	$\beta^-$
		130m	2+	-86.892	8.84 m 6	IT 84%, $\beta^-$ 16%
		131	7/2+	-87.444	8.02070 d 11	$\beta^-$
		132	4+	-85.700	2.295 h 13	$\beta^-$
		132m	(8-)	-85.580	1.387 h 15	IT 86%, $\beta^-$ 14%
		133	7/2+	-85.887	20.8 h 1	$\beta^-$
		133m	(19/2-)	-84.252	9 s 2	IT
134	(4)+	-84.073	52.5 m 2	$\beta^-$		
134m	(8)-	-83.756	3.52 m 4	IT 97.7%, $\beta^-$ 2.3%		
135	7/2+	-83.790	6.57 h 2	$\beta^-$		
136	(1-)	-79.50	83.4 s 10	$\beta^-$		
136m	(6-)	-78.86	46.9 s 10	$\beta^-$		
137	(7/2+)	-76.50	24.5 s 2	$\beta^-$ , $\beta^-n$ 6.97%		
138	(2-)	-72.33	6.23 s 3	$\beta^-$ , $\beta^-n$ 5.56%		
139	(7/2+)	-68.84	2.280 s 11	$\beta^-$ , $\beta^-n$ 10%		
140	(3)	-64.3s	0.86 s 4	$\beta^-$ , $\beta^-n$ 9.3%		
141		-60.5s	0.43 s 2	$\beta^-$ , $\beta^-n$ 21.2%		
142		-55.7s	$\approx 0.2$ s	$\beta^-$		
143		-51.6s	>150 ns	$\beta^-?$		
144		-46.6s	>300 ns	$\beta^-?$		
54	Xe	110	0+	-51.9	105 ms +35-25	$\alpha \approx 64\%$
		110	0+	-51.9	$\approx 0.2$ s	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
54	Xe	111	-54.4s	0.74 s 20	$\alpha$ 8%, $\epsilon$	
		112	0+	2.7 s 8	$\epsilon$ 99.16%, $\alpha$ 0.84%	
		113	(5/2+)	-62.09	2.74 s 8	$\epsilon \approx 100\%$ , $\epsilon p$ 7%, $\alpha \approx 0.01\%$ , $\epsilon \alpha \approx 7.0 \times 10^{-3}\%$
		114	0+	-67.09	10.0 s 4	$\epsilon$
		115	(5/2+)	-68.66	18 s 4	$\epsilon$ , $\epsilon p$ 0.34%, $\alpha$ $3.0 \times 10^{-4}\%$
		116	0+	-73.05	59 s 2	$\epsilon$
		117	5/2(+)	-74.19	61 s 2	$\epsilon$ , $\epsilon p$ $2.9 \times 10^{-3}\%$
		118	0+	-78.08	3.8 m 9	$\epsilon$
		119	(5/2+)	-78.79	5.8 m 3	$\epsilon$
		120	0+	-82.17	40 m 1	$\epsilon$
		121	(5/2+)	-82.47	40.1 m 20	$\epsilon$
		122	0+	-85.36	20.1 h 1	$\epsilon$
		123	(1/2)+	-85.249	2.08 h 2	$\epsilon$
		124	0+	-87.660	$\geq 1.1 \times 10^{17}$ y <b>0.095% 3</b>	2 $\epsilon$
		125	1/2(+)	-87.192	16.9 h 2	$\epsilon$
		125m	9/2(-)	-86.939	56.9 s 9	IT
		126	0+	-89.169	<b>0.089% 1</b>	
		127	1/2+	-88.321	36.4 d 1	$\epsilon$
		127m	9/2-	-88.024	69.2 s 9	IT
		128	0+	-89.860	<b>1.910% 22</b>	
		129	1/2+	-88.697	<b>26.40% 18</b>	
		129m	11/2-	-88.461	8.88 d 2	IT
		130	0+	-89.882	<b>4.071% 53</b>	
		131	3/2+	-88.415	<b>21.232% 62</b>	
		131m	11/2-	-88.251	11.934 d 21	IT
		132	0+	-89.281	<b>26.909% 68</b>	
		132m	(10+)	-86.528	8.39 ms 11	IT
		133	3/2+	-87.644	5.243 d 1	$\beta^-$
		133m	11/2-	-87.410	2.19 d 1	IT
		134	0+	-88.124	$> 5.8 \times 10^{22}$ y <b>10.436% 29</b>	2 $\beta^- \geq 0\%$
134m	7-	-86.159	290 ms 17	IT		
135	3/2+	-86.417	9.14 h 2	$\beta^-$		
135m	11/2-	-85.890	15.29 m 5	IT $> 99.4\%$ , $\beta^- < 0.6\%$		
136	0+	-86.425	$> 2.4 \times 10^{21}$ y <b>8.857% 33</b>	2 $\beta^-$		
137	7/2-	-82.379	3.818 m 13	$\beta^-$		
138	0+	-80.15	14.08 m 8	$\beta^-$		
139	3/2-	-75.64	39.68 s 14	$\beta^-$		
140	0+	-72.99	13.60 s 10	$\beta^-$		
141	5/2(-)	-68.33	1.73 s 1	$\beta^-$ , $\beta^- n$ 0.04%		
142	0+	-65.5	1.250 s 25	$\beta^-$ , $\beta^- n$ 0.21%		
143	5/2-	-60.4s	0.511 s 6	$\beta^-$ , $\beta^- n$ 1%		
144	0+	-57.3s	0.388 s 7	$\beta^-$ , $\beta^- n$ 3%		
145	(3/2-)	-52.1s	188 ms 4	$\beta^-$		
145		-52.1s	188 ms 4	$\beta^- n$ 5%		
146	0+	-48.7s	146 ms 6	$\beta^-$ , $\beta^- n$ 6.9%		
147		-43.3s	100 ms +100-50	$\beta^-$ , $\beta^- n < 8\%$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
55	Cs	112	(0+,3+)	-46.3s	0.5 ms 1	p
		113	(3/2+)	-51.7	16.7 $\mu$ s 7	p, $\alpha$
		114	(1+)	-54.5s	0.57 s 2	$\epsilon \approx 100\%$ , $\epsilon p$ 8.7%, $\epsilon \alpha$ 0.19%, $\alpha$ 0.02%
		115		-59.7s	1.4 s 8	$\epsilon$ , $\epsilon p = 0.07\%$
		116	(1+)	-62.1s	0.70 s 4	$\epsilon$ , $\epsilon p > 0\%$ , $\epsilon \alpha > 0\%$
		116m	4+,5,6	-62.0s	3.85 s 13	$\epsilon$ , $\epsilon p > 0\%$ , $\epsilon \alpha > 0\%$
		117	(9/2+)	-66.44	8.4 s 6	$\epsilon$
		117m	(3/2+)	-66.29	6.5 s 4	$\epsilon$
		118	2	-68.41	14 s 2	$\epsilon$ , $\epsilon p < 0.04\%$ , $\epsilon \alpha < 2.4 \times 10^{-3}\%$
		118m	6,7,8	-68.41	17 s 3	$\epsilon$ , $\epsilon p < 0.04\%$ , $\epsilon \alpha < 2.4 \times 10^{-3}\%$
		119	9/2+	-72.31	43.0 s 2	$\epsilon$
		119m	3/2(+)	-72.31	30.4 s 1	$\epsilon$
		120	2(+)	-73.89	61.3 s 11	$\epsilon$ , $\epsilon \alpha$ $2.0 \times 10^{-5}\%$ , $\epsilon p$ $7.0 \times 10^{-6}\%$
		120m	(7-)	-73.89	57 s 6	$\epsilon$
		121	3/2(+)	-77.10	155 s 4	$\epsilon$
		121m	9/2(+)	-77.03	122 s 3	$\epsilon$ 83%, IT 17%
		122	1+	-78.14	21.18 s 19	$\epsilon$
		122m	8-	-78.02	3.70 m 11	$\epsilon$
		122m	(5)-	-78.01	0.36 s 2	IT
		123	1/2+	-81.04	5.88 m 3	$\epsilon$
		123m	(11/2)-	-80.89	1.64 s 12	IT
		124	1+	-81.731	30.8 s 5	$\epsilon$
		124m	(7)+	-81.269	6.3 s 2	IT
		125	1/2(+)	-84.088	46.7 m 1	$\epsilon$
		126	1+	-84.34	1.64 m 2	$\epsilon$
		127	1/2+	-86.240	6.25 h 10	$\epsilon$
		128	1+	-85.931	3.66 m 2	$\epsilon$
		129	1/2+	-87.500	32.06 h 6	$\epsilon$
		130	1+	-86.900	29.21 m 4	$\epsilon$ 98.4%, $\beta^-$ 1.6%
		130m	5-	-86.737	3.46 m 6	IT 99.84%, $\epsilon$ 0.16%
		131	5/2+	-88.060	9.689 d 16	$\epsilon$
		132	2+	-87.156	6.480 d 6	$\epsilon$ 98.13%, $\beta^-$ 1.87%
		133	7/2+	-88.071	<b>100%</b>	
		134	4+	-86.891	2.0652 y 4	$\beta^-$ , $\epsilon$ $3.0 \times 10^{-4}\%$
134m	8-	-86.753	2.912 h 2	IT		
135	7/2+	-87.582	$2.3 \times 10^6$ y 3	$\beta^-$		
135m	19/2-	-85.949	53 m 2	IT		
136	5+	-86.339	13.04 d 3	$\beta^-$		
136m	8-	-86.339	19 s 2	IT > 0%, $\beta^-$		
137	7/2+	-86.546	30.03 y 5	$\beta^-$		
138	3-	-82.887	33.41 m 18	$\beta^-$		
138m	6-	-82.808	2.91 m 8	IT 81%, $\beta^-$ 19%		
139	7/2+	-80.701	9.27 m 5	$\beta^-$		
140	1-	-77.051	63.7 s 3	$\beta^-$		
141	7/2+	-74.48	24.84 s 16	$\beta^-$ , $\beta^- n$ 0.04%		
142	0-	-70.52	1.684 s 14	$\beta^-$ , $\beta^- n$ 0.09%		
143	3/2+	-67.67	1.791 s 7	$\beta^-$ , $\beta^- n$ 1.64%		
144	1	-63.27	0.994 s 4	$\beta^-$ , $\beta^- n$ 3.2%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or		
Z	El	A	(MeV)	Abundance	Decay Mode	
55	Cs	144m	(GE4)	-63.27	<1 s	$\beta^-$
		145	3/2+	-60.06	0.594 s 13	$\beta^-$ , $\beta^-n$ 14.3%
		146	1-	-55.62	0.321 s 2	$\beta^-$ , $\beta^-n$ 14.2%
		147	(3/2+)	-52.02	0.235 s 3	$\beta^-$ , $\beta^-n$ 43%
		148		-47.3	146 ms 6	$\beta^-$ , $\beta^-n$ 25.1%
		149		-43.8s	>50 ms	$\beta^-$ , $\beta^-n$
		150		-39.0s	>50 ms	$\beta^-$ , $\beta^-n$
		151		-35.2s	>50 ms	$\beta^-$ ?, $\beta^-n$ ?
56	Ba	114	0+	-45.9	0.43 s +30-15	$\epsilon \approx 100\%$ , $\epsilon p$ 20%, $\alpha$ 9.0 $\times 10^{-5}\%$ , $12 = 3.0 \times 10^{-5}\%$
		115	(5/2+)	-49.0s	0.45 s 5	$\epsilon$ , $\epsilon p$ >15%
		116	0+	-54.6s	1.3 s 2	$\epsilon$ , $\epsilon p$ 3%
		117	(3/2)	-57.3s	1.75 s 7	$\epsilon$ , $\epsilon p$ >0%, $\epsilon \alpha$ >0%
		118	0+	-62.4s	5.2 s 2	$\epsilon$
		119	(5/2+)	-64.6	5.4 s 3	$\epsilon$ , $\epsilon p$ <25%
		120	0+	-68.9	24 s 2	$\epsilon$
		121	5/2(+)	-70.7	29.7 s 15	$\epsilon$
		122	0+	-74.61	1.95 m 15	$\epsilon$
		123	5/2(+)	-75.65	2.7 m 4	$\epsilon$
		124	0+	-79.09	11.0 m 5	$\epsilon$
		125	1/2(+)	-79.67	3.5 m 4	$\epsilon$
		126	0+	-82.67	100 m 2	$\epsilon$
		127	1/2+	-82.82	12.7 m 4	$\epsilon$
		127m	7/2-	-82.74	1.9 s 2	IT
		128	0+	-85.40	2.43 d 5	$\epsilon$
		129	1/2+	-85.06	2.23 h 11	$\epsilon$
		129m	7/2+	-85.06	2.16 h 2	$\epsilon \leq 100\%$ , IT
		130	0+	-87.262	$\geq 3.5 \times 10^{14}$ y	2 $\epsilon$
					<b>0.106% I</b>	
		130m	8-	-84.786	9.54 ms 14	IT
		131	1/2+	-86.684	11.50 d 6	$\epsilon$
		131m	9/2-	-86.497	14.6 m 2	IT
		132	0+	-88.435	$> 3.0 \times 10^{21}$ y	
					<b>0.101% I</b>	
		133	1/2+	-87.553	3841 d 7	$\epsilon$
		133m	11/2-	-87.265	38.9 h 1	IT 99.99%, $\epsilon$ 9.6 $\times 10^{-3}\%$
134	0+	-88.950	<b>2.417% 18</b>			
134m	(10+)	-85.993	2.63 $\mu$ s 14	IT		
135	3/2+	-87.851	<b>6.592% 12</b>			
135m	11/2-	-87.582	28.7 h 2	IT		
136	0+	-88.887	<b>7.854% 24</b>			
136m	7-	-86.856	0.3084 s 19	IT		
137	3/2+	-87.721	<b>11.232% 24</b>			
137m	11/2-	-87.060	2.552 m 1	IT		
138	0+	-88.262	<b>71.698% 42</b>			
139	7/2-	-84.914	83.06 m 28	$\beta^-$		
140	0+	-83.271	12.752 d 3	$\beta^-$		
141	3/2-	-79.726	18.27 m 7	$\beta^-$		
142	0+	-77.823	10.6 m 2	$\beta^-$ , $\beta^-n$ 0.09%		
143	5/2-	-73.94	14.5 s 3	$\beta^-$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode			
Z	El	A	(MeV)	Abundance				
56	Ba	144	0+	-71.77	11.5 s 2	$\beta^-$ , $\beta^-$ -n 3.6%		
		145	5/2-	-67.42	4.31 s 16	$\beta^-$		
		146	0+	-65.00	2.22 s 7	$\beta^-$		
		147	(3/2+)	-60.6s	0.893 s 1	$\beta^-$ , $\beta^-$ -n 0.06%		
		148	0+	-58.01	0.612 s 17	$\beta^-$ , $\beta^-$ -n 0.4%		
		149		-53.5s	0.344 s 7	$\beta^-$ , $\beta^-$ -n 0.43%		
		150	0+	-50.6s	0.3 s	$\beta^-$		
		151		-45.8s	>150 ms	$\beta^-$ ?		
		152	0+	-42.6s	$\approx$ 0.1 s	$\beta^-$ ?		
		153		-37.6s	$\approx$ 0.08 s	$\beta^-$ ?		
		57	La	117	(3/2+,3/2-)	-46.5s	23.5 ms 26	p 93.9%, $\epsilon$ 6.1%
				117m	(9/2+)	-46.4s	10 ms 5	p 97.4%, $\epsilon$ 2.6%
				118		-49.6s	$\approx$ 1 s	$\epsilon$ ?
119				-55.0s	$\approx$ 2 s	$\epsilon$ ?		
120m				-57.7s	2.8 s 2	$\epsilon$ , $\epsilon$ p>0%		
121				-62.4s	5.3 s 2	$\epsilon$		
122				-64.5s	8.6 s 5	$\epsilon$ , $\epsilon$ p		
123				-68.7s	17 s 3	$\epsilon$		
124m	low			-70.26	<1 s	$\epsilon$		
124m	(7,8-)			-70.26	29 s 1	$\epsilon$		
125				-73.76	64.8 s 12	$\epsilon$		
125m				-73.65	0.4 s 2	IT		
126m(0-,1,2-)				-74.97	<50 s	$\epsilon$ , IT		
126m	(5+)			-74.97	54 s 2	$\epsilon$ >0%		
127	(11/2-)			-77.90	5.1 m 1	$\epsilon$		
127m	(3/2+)			-77.88	3.7 m 4	$\epsilon$ , IT		
128	(5+)			-78.63	5.18 m 14	$\epsilon$		
128m	(1+,2-)			-78.63	<1.4 m	$\epsilon$		
129	3/2+			-81.33	11.6 m 2	$\epsilon$		
129m	11/2-			-81.15	0.56 s 5	IT		
130	3(+)			-81.63	8.7 m 1	$\epsilon$		
131	3/2+			-83.77	59 m 2	$\epsilon$		
132	2-			-83.74	4.8 h 2	$\epsilon$		
132m	6-			-83.55	24.3 m 5	IT 76%, $\epsilon$ 24%		
133	5/2+			-85.49	3.912 h 8	$\epsilon$		
134	1+			-85.22	6.45 m 16	$\epsilon$		
134m				-84.88	29 $\mu$ s 4	IT		
135	5/2+			-86.65	19.5 h 2	$\epsilon$		
136	1+			-86.04	9.87 m 3	$\epsilon$		
136m	(8+)			-85.81	114 ms 3	IT		
137	7/2+			-87.10	$6 \times 10^4$ y 2	$\epsilon$		
138	5+	-86.525	$1.02 \times 10^{11}$ y 1	$\epsilon$ 65.6%, $\beta^-$ 34.4%				
			<b>0.090% I</b>					
			<b>0.090% I</b>					
139	7/2+	-87.231	<b>99.910% I</b>					
140	3-	-84.321	1.6781 d 3	$\beta^-$				
141	(7/2+)	-82.938	3.92 h 3	$\beta^-$				
142	2-	-80.035	91.1 m 5	$\beta^-$				
143	(7/2+)	-78.19	14.2 m 1	$\beta^-$				
144	(3-)	-74.89	40.8 s 4	$\beta^-$				
145	(5/2+)	-72.99	24.8 s 20	$\beta^-$				
146	2-	-69.12	6.27 s 10	$\beta^-$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$				
Z	El	A	(MeV)	Abundance	Decay Mode			
57	La	146m	(6-)	-69.12	10.0 s 1	$\beta^-$		
		147	(5/2+)	-66.85	4.015 s 8	$\beta^-$ , $\beta^-n$ 0.04%		
		148	(2-)	-63.13	1.26 s 8	$\beta^-$ , $\beta^-n$ 0.15%		
		149	(3/2,5/2)	-60.8s	1.05 s 3	$\beta^-$ , $\beta^-n$ 1.43%		
		150	(3-)	-57.0s	0.51 s 3	$\beta^-$ , $\beta^-n$ 2.7%		
		151		-54.3s	>150 ns	$\beta^-?$		
		152		-50.1s	>150 ns	$\beta^-?$		
		153		-46.9s	>100 ns			
		154		-42.4s	$\approx 0.1$ s	$\beta^-?$		
		155		-38.8s	$\approx 0.06$ s	$\beta^-?$		
		58	Ce	119		-44.0s	$\approx 0.2$ s	$\epsilon?$
				120	0+	-49.7s	$\approx 0.25$ s	$\epsilon?$
121				-52.7s	1.1 s 1	$\epsilon$ , $\epsilon p \approx 1\%$		
122	0+			-57.8s	$\approx 2$ s	$\epsilon?$ , $\epsilon p?$		
123	(5/2)			-60.2s	3.8 s 2	$\epsilon$ , $\epsilon p > 0\%$		
124	0+			-64.8s	6 s 2	$\epsilon$		
125	(5/2+)			-66.7s	10.2 s 4	$\epsilon$ , $\epsilon p$		
126	0+			-70.82	51.0 s 3	$\epsilon$		
127	(5/2+)			-71.98	31 s 2	$\epsilon$		
128	0+			-75.53	3.93 m 2	$\epsilon$		
129	5/2+			-76.29	3.5 m 5	$\epsilon > 0\%$		
130	0+			-79.42	22.9 m 5	$\epsilon$		
131	(7/2+)			-79.72	10.2 m 3	$\epsilon$		
131m	(1/2+)			-79.72	5.0 m 10	$\epsilon$		
132	0+			-82.47	3.51 h 11	$\epsilon$		
132m	(8-)			-80.13	9.4 ms 3	IT		
133	1/2+			-82.42	97 m 4	$\epsilon$		
133m	9/2-			-82.39	4.9 h 4	$\epsilon$		
134	0+			-84.84	3.16 d 4	$\epsilon$		
135	1/2(+)			-84.62	17.7 h 3	$\epsilon$		
135m	(11/2-)			-84.18	20 s 1	IT		
136	0+			-86.47	$> 0.7 \times 10^{14}$ y	2 $\epsilon$		
					<b>0.185% 2</b>			
137	3/2+			-85.88	9.0 h 3	$\epsilon$		
137m	11/2-			-85.62	34.4 h 3	IT 99.22%, $\epsilon$ 0.78%		
138	0+			-87.57	$\geq 0.9 \times 10^{14}$ y	2 $\epsilon$		
					<b>0.251% 2</b>			
138m	7-	-85.44	8.65 ms 20	IT				
138m	10+	-84.03	81 ns 2	IT				
139	3/2+	-86.952	137.641 d 20	$\epsilon$				
139m	11/2-	-86.198	54.8 s 10	IT				
140	0+	-88.083	<b>88.450% 18</b>					
141	7/2-	-85.440	32.508 d 13	$\beta^-$				
142	0+	-84.538	$> 2.6 \times 10^{17}$ y	2 $\beta^-$				
			<b>11.114% 17</b>					
143	3/2-	-81.612	33.039 h 6	$\beta^-$				
144	0+	-80.437	284.91 d 5	$\beta^-$				
145	(3/2-)	-77.10	3.01 m 6	$\beta^-$				
146	0+	-75.68	13.52 m 13	$\beta^-$				
147	(5/2-)	-72.03	56.4 s 10	$\beta^-$				
148	0+	-70.39	56 s 1	$\beta^-$				
149	(3/2-)	-66.70	5.3 s 2	$\beta^-$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
58	Ce	150	0+	-64.82	4.0 s 6	$\beta^-$
		151		-61.5	1.02 s 6	$\beta^-$
		152	0+	-59.1s	1.4 s 2	$\beta^-$
		153		-55.3s	>100 ns	$\beta^-?$
		154	0+	-52.7s	>150 ns	$\beta^-?$
		155		-48.4s	>300 ns	$\beta^-?$
		156	0+	-45.4s	$\approx 0.15$ s	$\beta^-?$
		157		-40.7s	$\approx 0.05$ s	$\beta^-?$
59	Pr	121	(3/2-)	-41.6s	1.4 s 8	p
		122		-44.9s	$\approx 0.5$ s	$\epsilon?$
		123		-50.3s	$\approx 0.8$ s	$\epsilon?$
		124		-53.1s	1.2 s 2	$\epsilon, \epsilon p$
		125		-57.9s	3.3 s 7	$\epsilon, \epsilon p$
		126	GE4	-60.3s	3.14 s 22	$\epsilon, \epsilon p$
		127		-64.4s	4.2 s 3	$\epsilon$
		128	4,5,6	-66.33	2.84 s 9	$\epsilon$
		129	(11/2-)	-69.77	32 s 3	$\epsilon > 0\%$
		130m	(2+)	-71.18	40 s 4	$\epsilon$
		130m	(4,5)+	-71.18	40 s 4	$\epsilon$
		130m	(7,8)	-71.18	40 s 4	$\epsilon$
		131	(3/2+)	-74.28	94 s 4	$\epsilon$
		131m	(11/2-)	-74.13	5.7 s 2	IT 96.4%, $\epsilon$ 3.6%
		132	(2+)	-75.21	1.6 m 3	$\epsilon$
		133	(3/2+)	-77.94	6.5 m 3	$\epsilon$
		134m	(6-)	-78.51	$\approx 11$ m	$\epsilon$
		134m	2-	-78.51	17 m 2	$\epsilon$
		135	3/2(+)	-80.94	24 m 2	$\epsilon$
		136	2+	-81.33	13.1 m 1	$\epsilon$
		137	5/2+	-83.18	1.28 h 3	$\epsilon$
		138	1+	-83.13	1.45 m 5	$\epsilon$
		138m	7-	-82.77	2.12 h 4	$\epsilon$
		139	5/2+	-84.823	4.41 h 4	$\epsilon$
		140	1+	-84.695	3.39 m 1	$\epsilon$
		141	5/2+	-86.021	<b>100%</b>	
		142	2-	-83.793	19.12 h 4	$\beta^-$ 99.98%, $\epsilon$ 0.02%
		142m	5-	-83.789	14.6 m 5	IT
		143	7/2+	-83.074	13.57 d 2	$\beta^-$
		144	0-	-80.756	17.28 m 5	$\beta^-$
		144m	3-	-80.697	7.2 m 3	IT 99.93%, $\beta^-$ 0.07%
		145	7/2+	-79.632	5.984 h 10	$\beta^-$
146	(2)-	-76.71	24.15 m 18	$\beta^-$		
147	(3/2+)	-75.45	13.4 m 4	$\beta^-$		
148	1-	-72.53	2.29 m 2	$\beta^-$		
148m	(4)	-72.44	2.01 m 7	$\beta^-$		
149	(5/2+)	-71.06	2.26 m 7	$\beta^-$		
150	(1)-	-68.30	6.19 s 16	$\beta^-$		
151	(3/2-)	-66.77	18.90 s 7	$\beta^-$		
152	(4-)	-63.8	3.63 s 12	$\beta^-$		
153		-61.6	4.28 s 11	$\beta^-$		
154	(3+,2+)	-58.2	2.3 s 1	$\beta^-$		
155		-55.8s	>300 ns	$\beta^-?$		
156		-51.9s	>300 ns	$\beta^-?$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
59	Pr	157	-49.0s	$\approx 0.3$ s	$\beta^-?$	
		158	-44.7s	$\approx 0.2$ s	$\beta^-?$	
		159	-41.5s	$\approx 0.1$ s	$\beta^-?$	
60	Nd	124	0+	0.5 s SY	$\epsilon?$	
		125	(5/2)	-47.6s	0.60 s 15	$\epsilon, \epsilon p > 0\%$
		126	0+	-52.9s	>200 ns	$\epsilon, \epsilon p$
		127		-55.4s	1.8 s 4	$\epsilon, \epsilon p$
		128	0+	-60.2s	5 s	$\epsilon, \epsilon p$
		129	(5/2+)	-62.2s	7 s 1	$\epsilon, \epsilon p$
		130	0+	-66.60	21 s 3	$\epsilon$
		131	(5/2)	-67.77	33 s 3	$\epsilon, \epsilon p$
		132	0+	-71.43	94 s 8	$\epsilon$
		133	(7/2+)	-72.33	70 s 10	$\epsilon$
		133m	(1/2)+	-72.20	$\approx 70$ s	$\epsilon, IT$
		134	0+	-75.65	8.5 m 15	$\epsilon$
		134m	(8)-	-73.35	410 $\mu$ s 30	IT
		135	9/2(-)	-76.21	12.4 m 6	$\epsilon$
		135m	(1/2+)	-76.15	5.5 m 5	$\epsilon > 99.97\%$ , IT < 0.03%
		136	0+	-79.20	50.65 m 33	$\epsilon$
		137	1/2+	-79.58	38.5 m 15	$\epsilon$
		137m	11/2-	-79.06	1.60 s 15	IT
		138	0+	-82.02	5.04 h 9	$\epsilon$
		139	3/2+	-81.99	29.7 m 5	$\epsilon$
		139m	11/2-	-81.76	5.50 h 20	$\epsilon$ 88.2%, IT 11.8%
		140	0+	-84.25	3.37 d 2	$\epsilon$
		140m	7-	-82.03	0.60 ms 5	IT
		141	3/2+	-84.198	2.49 h 3	$\epsilon$
		141m	11/2-	-83.441	62.0 s 8	IT, $\epsilon < 0.05\%$
		142	0+	-85.955	<b>27.2% 5</b>	
		143	7/2-	-84.007	<b>12.2% 2</b>	
		144	0+	-83.753	2.29 $\times 10^{15}$ y 16	$\alpha$
					<b>23.8% 3</b>	
		145	7/2-	-81.437	<b>8.3% 1</b>	
		146	0+	-80.931	<b>17.2% 3</b>	
		147	5/2-	-78.152	10.98 d 1	$\beta^-$
		148	0+	-77.413	<b>5.7% 1</b>	
149	5/2-	-74.381	1.728 h 1	$\beta^-$		
150	0+	-73.690	0.79 $\times 10^{19}$ y 7	2 $\beta^-$		
			<b>5.6% 2</b>			
151	3/2+	-70.953	12.44 m 7	$\beta^-$		
152	0+	-70.16	11.4 m 2	$\beta^-$		
153	(3/2)-	-67.35	31.6 s 10	$\beta^-$		
154	0+	-65.7	25.9 s 2	$\beta^-$		
155		-62.5s	8.9 s 2	$\beta^-$		
156	0+	-60.5	5.49 s 7	$\beta^-$		
157		-56.8s	>100 ns	$\beta^-?$		
158	0+	-54.4s	>50 ns	$\beta^-$		
159		-50.2s	$\approx 0.7$ s	$\beta^-?$		
160	0+	-47.4s	$\approx 0.3$ s	$\beta^-?$		
161		-43.0s	$\approx 0.2$ s	$\beta^-?$		
61	Pm	126	-39.6s	0.5 s SY	$\epsilon?$	



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>61 Pm</b>	127		-45.1s	1 s SY	$\epsilon?$ , p?
	128		-48.0s	1.0 s 3	$\epsilon$ , $\alpha$ , $\epsilon p$
	129	5/2-	-52.9s	2.4 s 9	$\epsilon$
	130	(4,5,6)	-55.5s	2.6 s 2	$\epsilon$ , $\epsilon p$
	131	(11/2)	-59.7s	6.3 s 8	$\epsilon$
	132	(3+)	-61.7s	6.2 s 6	$\epsilon$ , $\epsilon p \approx 5.0 \times 10^{-5}\%$
	133	(11/2-)	-65.41	15 s 3	$\epsilon$
	134	(2+)	-66.74	$\approx 5$ s	$\epsilon$
	134m	(5+)	-66.74	22 s 1	$\epsilon$
	135m	(11/2-)	-69.98	45 s 4	$\epsilon$
	135m	(3/2+, 5/2+)	-69.98	49 s 3	$\epsilon$
	136m	(2+)	-71.20	47 s 2	$\epsilon$
	136m	(5-)	-71.20	107 s 6	$\epsilon$
	137	11/2-	-74.07	2.4 m 1	$\epsilon$
	138		-74.94	10 s 2	$\epsilon$
	138m		-74.92	3.24 m 5	$\epsilon$
	139	(5/2)+	-77.50	4.15 m 5	$\epsilon$
	139m	(11/2)-	-77.31	180 ms 20	IT 99.94%, $\epsilon$ 0.06%
	140	1+	-78.21	9.2 s 2	$\epsilon$
	140m	8-	-78.21	5.95 m 5	$\epsilon$
	141	5/2+	-80.52	20.90 m 5	$\epsilon$
	142	1+	-81.16	40.5 s 5	$\epsilon$
	142m	(8)-	-80.27	2.0 ms 2	IT
	143	5/2+	-82.966	265 d 7	$\epsilon$ , $\epsilon < 5.7 \times 10^{-6}\%$
	144	5-	-81.421	363 d 14	$\epsilon$
	145	5/2+	-81.274	17.7 y 4	$\epsilon$ , $\alpha 3 \times 10^{-7}\%$
	146	3-	-79.460	5.53 y 5	$\epsilon$ 66%, $\beta$ - 34%
	147	7/2+	-79.048	2.6234 y 2	$\beta$ -
	148	1-	-76.872	5.368 d 2	$\beta$ -
	148m	5-, 6-	-76.734	41.29 d 11	$\beta$ - 95.8%, IT 4.2%
	149	7/2+	-76.071	53.08 h 5	$\beta$ -
	150	(1-)	-73.60	2.68 h 2	$\beta$ -
151	5/2+	-73.395	28.40 h 4	$\beta$ -	
152	1+	-71.26	4.12 m 8	$\beta$ -	
152m	4-	-71.11	7.52 m 8	$\beta$ -	
152m	(8)	-71.11	13.8 m 2	$\beta$ - $\leq 100\%$ , IT $\geq 0\%$	
153	5/2-	-70.68	5.25 m 2	$\beta$ -	
154	(3,4)	-68.50	2.68 m 7	$\beta$ -	
154m	(0,1)	-68.50	1.73 m 10	$\beta$ -	
155	5/2-	-66.97	41.5 s 2	$\beta$ -	
156m	4-	-64.22	26.70 s 10	$\beta$ -	
157	(5/2-)	-62.4	10.56 s 10	$\beta$ -	
158		-59.1	4.8 s 5	$\beta$ -	
159		-56.8s	1.47 s 15	$\beta$ -	
160		-53.1s	$\approx 2$ s	$\beta$ -?	
161		-50.4s	$\approx 0.7$ s	$\beta$ -?	
162		-46.3s	$\approx 0.5$ s	$\beta$ -?	
163		-43.1s	$\approx 0.2$ s	$\beta$ -?	
<b>62 Sm</b>	128	0+	-39.0s	0.5 s SY	$\epsilon?$ , p?
	129	(1/2+)	-42.3s	0.55 10	$\epsilon$ , $\epsilon p$
	130	0+	-47.6s	1 s SY	$\epsilon$
	131		-50.2s	1.2 s 2	$\epsilon$ , $\epsilon p > 0\%$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>62 Sm</b>	132	0+	-55.2s	4.0 s 3	$\epsilon, \epsilon p$
	133	(5/2+)	-57.1s	3.7 s 7	$\epsilon, \epsilon p > 0\%$
	134	0+	-61.5s	9.5 s 8	$\epsilon$
	135	(3/2+, 5/2+)	-62.9	10.3 s 5	$\epsilon, \epsilon p 0.02\%$
	136	0+	-66.81	47 s 2	$\epsilon$
	137	(9/2-)	-68.03	45 s 1	$\epsilon$
	138	0+	-71.50	3.1 m 2	$\epsilon$
	139	1/2+	-72.38	2.57 m 10	$\epsilon$
	139m	11/2-	-71.92	10.7 s 6	IT 93.7%, $\epsilon 6.3\%$
	140	0+	-75.46	14.82 m 12	$\epsilon$
	141	1/2+	-75.939	10.2 m 2	$\epsilon$
	141m	11/2-	-75.763	22.6 m 2	$\epsilon 99.69\%, \text{ IT } 0.31\%$
	142	0+	-78.993	72.49 m 5	$\epsilon$
	143	3/2+	-79.523	8.75 m 8	$\epsilon$
	143m	11/2-	-78.769	66 s 2	IT 99.76%, $\epsilon 0.24\%$
	143m	23/2(-)	-76.729	30 ms 3	IT
	144	0+	-81.972	<b>3.07% 7</b>	
	145	7/2-	-80.658	340 d 3	$\epsilon$
	145m	(49/2+)	-71.871	0.96 $\mu\text{s}$ +19-15	IT
	146	0+	-81.002	10.3 $\times 10^7$ y 5	$\alpha$
	147	7/2-	-79.272	1.06 $\times 10^{11}$ y 2	$\alpha$
				<b>14.99% 18</b>	
	148	0+	-79.342	7 $\times 10^{15}$ y 3	$\alpha$
				<b>11.24% 10</b>	
	149	7/2-	-77.142	<b>13.82% 7</b>	
	150	0+	-77.057	<b>7.38% 1</b>	
	151	5/2-	-74.582	90 y 8	$\beta^-$
	152	0+	-74.769	<b>26.75% 16</b>	
	153	3/2+	-72.566	46.284 h 4	$\beta^-$
	153m	11/2-	-72.467	10.6 ms 3	IT
154	0+	-72.462	<b>22.75% 29</b>		
155	3/2-	-70.197	22.3 m 2	$\beta^-$	
156	0+	-69.370	9.4 h 2	$\beta^-$	
157	(3/2-)	-66.73	8.03 m 7	$\beta^-$	
158	0+	-65.21	5.30 m 3	$\beta^-$	
159	5/2-	-62.2	11.37 s 15	$\beta^-$	
160	0+	-60.4s	9.6 s 3	$\beta^-$	
161		-57.0s	4.8 s 8	$\beta^-$	
162	0+	-54.8s	$\approx 2$ s	$\beta^-?$	
163		-50.9s	$\approx 1$ s	$\beta^-?$	
164	0+	-48.2s	$\approx 0.5$ s	$\beta^-?$	
165		-43.8s	$\approx 0.2$ s	$\beta^-$	
<b>63 Eu</b>	130	(1+)	-33.9s	0.9 ms +5-3	p
	131	3/2+	-39.4s	17.8 ms 19	p 87.9%, $\epsilon 12.1\%$
	132		-42.5s	200 ms SY	$\epsilon$
	133		-47.3s	$\approx 1$ s	$\epsilon?$
	134		-49.8s	0.5 s 2	$\epsilon, \epsilon p > 0\%$
	135		-54.2s	1.5 s 2	$\epsilon, \epsilon p$
	136m	(7+)	-56.3s	3.3 s 3	$\epsilon, \epsilon p 0.09\%$
	136m	(3+)	-56.3s	3.8 s 3	$\epsilon, \epsilon p 0.09\%$
	137	(11/2-)	-60.0s	11 s 2	$\epsilon$
	138	(6-)	-61.75	12.1 s 6	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>63 Eu</b>	139	(11/2)-	-65.40	17.9 s 6	$\epsilon$
	140	1+	-66.99	1.51 s 2	$\epsilon$
	140m	(5-)	-66.80	125 ms 2	IT, $\epsilon < 1\%$
	141	5/2+	-69.93	40.7 s 7	$\epsilon$
	141m	11/2-	-69.83	2.7 s 3	IT 87%, $\epsilon$ 13%
	142	1+	-71.32	2.34 s 12	$\epsilon$
	142m	8-	-71.32	1.223 m 8	$\epsilon$
	143	5/2+	-74.24	2.59 m 2	$\epsilon$
	144	1+	-75.62	10.2 s 1	$\epsilon$
	145	5/2+	-77.998	5.93 d 4	$\epsilon$
	146	4-	-77.122	4.61 d 3	$\epsilon$
	147	5/2+	-77.550	24.1 d 6	$\epsilon$ , $\alpha$ $2.2 \times 10^{-3}\%$
	148	5-	-76.30	54.5 d 5	$\epsilon$ , $\alpha$ $9.4 \times 10^{-7}\%$
	149	5/2+	-76.447	93.1 d 4	$\epsilon$
	150	5(-)	-74.797	36.9 y 9	$\epsilon$
	150m	0-	-74.755	12.8 h 1	$\beta^-$ 89%, $\epsilon$ 11%, IT $\leq 5.0 \times 10^{-8}\%$
	151	5/2+	-74.659	<b>47.81% 3</b>	
	152	3-	-72.895	13.506 y 6	$\epsilon$ 72.1%, $\beta^-$ 27.9%
	152m	0-	-72.849	9.3116 h 13	$\beta^-$ 72%, $\epsilon$ 28%
	152m	8-	-72.747	96 m 1	IT
	153	5/2+	-73.373	<b>52.19% 3</b>	
	154	3-	-71.744	8.590 y 3	$\beta^-$ 99.98%, $\epsilon$ 0.02%
	154m	(8-)	-71.599	46.3 m 4	IT
	155	5/2+	-71.825	4.753 y 14	$\beta^-$
	156	0+	-70.093	15.19 d 8	$\beta^-$
	157	5/2+	-69.467	15.18 h 3	$\beta^-$
	158	(1-)	-67.21	45.9 m 2	$\beta^-$
	159	5/2+	-66.053	18.1 m 1	$\beta^-$
	160	1	-63.4s	38 s 4	$\beta^-$
	161		-61.8s	26 s 3	$\beta^-$
	162		-58.6s	10.6 s 10	$\beta^-$
163		-56.6s	6 s SY	$\beta^-$ ?	
164		-53.1s	$\approx 2$ s	$\beta^-$ ?	
165		-50.6s	$\approx 1$ s	$\beta^-$ ?	
166		-46.6s	$\approx 0.4$ s	$\beta^-$	
167		-43.6s	$\approx 0.2$ s	$\beta^-$ ?	
<b>64 Gd</b>	134	0+	-41.6s	0.4 s SY	$\epsilon$ ?
	135		-44.2s	1.1 s 2	$\epsilon$ , $\epsilon p \approx 2\%$
	136	0+	-49.1s	$\geq 200$ ns	
	137	(7/2)	-51.2s	2.2 s 2	$\epsilon$ , $\epsilon p$
	138	0+	-55.8s	4.7 s 9	$\epsilon$
	139	(9/2-)	-57.5s	5.8 s 9	$\epsilon > 0\%$ , $\epsilon p > 0\%$
	139m		-57.5s	4.8 s 9	$\epsilon > 0\%$ , $\epsilon p > 0\%$
	140	0+	-61.78	15.8 s 4	$\epsilon$
	141	1/2+	-63.22	14 s 4	$\epsilon$ , $\epsilon p$ 0.03%
	141m	11/2-	-62.85	24.5 s 5	$\epsilon$ 89%, IT 11%
	142	0+	-66.96	70.2 s 6	$\epsilon$
	143	(1/2)+	-68.2	39 s 2	$\epsilon$
	143m	(11/2-)	-68.1	110.0 s 14	$\epsilon$
	144	0+	-71.76	4.47 m 6	$\epsilon$
145	1/2+	-72.93	23.0 m 4	$\epsilon$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode		
Z	El	A	(MeV)	Abundance			
64	Gd	145m	11/2-	-72.18	85 s 3	IT 94.3%, $\epsilon$ 5.7%	
		146	0+	-76.093	48.27 d 10	$\epsilon$	
		147	7/2-	-75.363	38.06 h 12	$\epsilon$	
		148	0+	-76.276	70.9 y 10	$\alpha$	
		149	7/2-	-75.133	9.28 d 10	$\epsilon, \alpha 4.3 \times 10^{-4}\%$	
		150	0+	-75.769	$1.79 \times 10^6$ y 8	$\alpha$	
		151	7/2-	-74.195	124 d 1	$\epsilon, \alpha = 8.0 \times 10^{-7}\%$	
		152	0+	-74.714	$1.08 \times 10^{14}$ y 8	$\alpha$	
						<b>0.20% 1</b>	
						240.4 d 10	$\epsilon$
						3.5 $\mu$ s 4	IT
						76.0 $\mu$ s 14	IT
						<b>2.18% 3</b>	
						<b>14.80% 12</b>	
						31.97 ms 27	IT
						<b>20.47% 9</b>	
						<b>15.65% 2</b>	
						18.5 $\mu$ s 23	IT
						<b>24.84% 7</b>	
						18.479 h 4	$\beta^-$
						26.2 ns 8	IT
						$> 3.1 \times 10^{19}$ y	$2\beta^-$
						<b>21.86% 19</b>	
						3.66 m 5	$\beta^-$
						8.4 m 2	$\beta^-$
						68 s 3	$\beta^-$
						45 s 3	$\beta^-$
						10.3 s 16	$\beta^-$
						$\approx 7$ s	$\beta^-$
						$\approx 3$ s	$\beta^-?$
						$\approx 0.3$ s	$\beta^-?$
						$\approx 1$ s	$\beta^-?$
		65	Tb	135	(7/2-)		0.94 ms +33-22
136				-36.0s	0.2 s SY	$\epsilon?$	
137				-41.0s	0.6 s SY	p?, $\epsilon?$	
138m				-43.6s	$\geq 200$ ns	$\epsilon, p$	
139				-48.2s	1.6 s 2		
140	(7+)			-50.5	2.1 s 4	$\epsilon, \epsilon p 0.26\%$	
141	(5/2-)			-54.5	3.5 s 2	$\epsilon$	
141m				-54.5	7.9 s 6	$\epsilon$	
142	1+			-57.1s	597 ms 17	$\epsilon, \epsilon p 2.2 \times 10^{-3}\%$	
142m	(5-)			-56.8s	303 ms 17	IT	
142m				-56.4s	15 $\mu$ s 4	IT	
143	(11/2-)			-60.43	12 s 1	$\epsilon$	
143m				-60.43	$< 21$ s	$\epsilon$	
144	1+			-62.37	$\approx 1$ s	$\epsilon$	
144m	(6-)			-61.97	4.25 s 15	IT 66%, $\epsilon$ 34%	
145	(3/2+)			-65.88	$\approx 20$ m	$\epsilon?$	
145m	(11/2-)			-65.88	30.9 s 7	$\epsilon$	
146	1+	-67.77	8 s 4	$\epsilon$			
146m	5-	-67.77	23 s 2	$\epsilon$			
147	(1/2+)	-70.75	1.7 h 1	$\epsilon$			

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>65 Tb</b>	147m	(11/2)-	-70.70	1.83 m 6	$\epsilon$
	148	2-	-70.54	60 m 1	$\epsilon$
	148m	(9)+	-70.45	2.20 m 5	$\epsilon$
	149	1/2+	-71.496	4.118 h 25	$\epsilon$ 83.3%, $\alpha$ 16.7%
	149m	11/2-	-71.460	4.16 m 4	$\epsilon$ 99.98%, $\alpha$ 0.02%
	150	(2-)	-71.110	3.48 h 16	$\epsilon$ , $\alpha$ < 0.05%
	150m	9+	-70.637	5.8 m 2	$\epsilon$
	151	1/2(+)	-71.630	17.609 h 1	$\epsilon$ , $\alpha$ $9.5 \times 10^{-3}\%$
	151m	(11/2-)	-71.530	25 s 3	IT 93.8%, $\epsilon$ 6.2%
	152	2-	-70.72	17.5 h 1	$\epsilon$ , $\alpha$ < $7.0 \times 10^{-7}\%$
	152m	8+	-70.22	4.2 m 1	IT 78.8%, $\epsilon$ 21.2%
	153	5/2+	-71.320	2.34 d 1	$\epsilon$
	153m	11/2-	-71.157	186 $\mu$ s 4	IT
	154	0	-70.16	21.5 h 4	$\epsilon$ , $\beta$ - < 0.1%
	154m	3-	-70.16	9.4 h 4	$\epsilon$ 78.2%, IT 21.8%, $\beta$ - < 0.1%
	154m	7-	-70.16	22.7 h 5	$\epsilon$ 98.2%, IT 1.8%
	155	3/2+	-71.25	5.32 d 6	$\epsilon$
	156	3-	-70.098	5.35 d 10	$\epsilon$
	156m	(7-)	-70.048	24.4 h 10	IT
	156m	(0+)	-70.009	5.3 h 2	IT < 100%, $\epsilon$ > 0%
	157	3/2+	-70.771	71 y 7	$\epsilon$
	158	3-	-69.477	180 y 11	$\epsilon$ 83.4%, $\beta$ - 16.6%
	158m	0-	-69.367	10.70 s 17	IT, $\beta$ - < 0.6%, $\epsilon$ < 0.01%
	158m	7-	-69.089	0.40 ms 4	IT
	159	3/2+	-69.539	<b>100%</b>	
	160	3-	-67.843	72.3 d 2	$\beta$ -
	161	3/2+	-67.468	6.906 d 19	$\beta$ -
	162	1-	-65.68	7.60 m 15	$\beta$ -
	163	3/2+	-64.601	19.5 m 3	$\beta$ -
	164	(5+)	-62.1	3.0 m 1	$\beta$ -
	165	(3/2+)	-60.7s	2.11 m 10	$\beta$ -
166		-57.8	21 s 6	$\beta$ -	
167	(3/2+)	-55.8s	19.4 s 27	$\beta$ -	
168	(4-)	-52.5s	8.2 s 13	$\beta$ -	
169		-50.1s	$\approx$ 2 s	$\beta$ -?	
170		-46.3s	$\approx$ 3 s	$\beta$ -?	
171		-43.5s	$\approx$ 0.5 s	$\beta$ -	
<b>66 Dy</b>	138	0+	-34.9s	200 ms SY	$\epsilon$ ?
	139	(7/2+)	-37.7s	0.6 s 2	$\epsilon$ , $\epsilon$ p
	141	(9/2-)	-45.3s	0.9 s 2	$\epsilon$ , $\epsilon$ p
	142	0+	-50.0s	2.3 s 3	$\epsilon$ , $\epsilon$ p 0.06%
	143	(1/2+)	-52.3s	5.6 s 10	$\epsilon$ , $\epsilon$ p
	143m	(11/2-)	-52.3s	3.0 s 3	$\epsilon$ , $\epsilon$ p
	144	0+	-56.58	9.1 s 4	$\epsilon$ , $\epsilon$ p
	145	(1/2+)	-58.29	10.5 s 15	$\epsilon$
	145m	(11/2-)	-58.29	13.6 s 10	$\epsilon$
	146	0+	-62.55	29 s 3	$\epsilon$
	146m	(10+)	-59.62	150 ms 20	IT
	147	1/2+	-64.19	40 s 10	$\epsilon$ , $\epsilon$ p > 0%
	147m	11/2-	-63.44	55.7 s 7	$\epsilon$ 65%, IT 35%

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>66 Dy</b>	148	0+	-67.86	3.3 m 2	$\epsilon$	
	149	(7/2-)	-67.715	4.20 m 14	$\epsilon$	
	149m	(27/2-)	-65.054	0.490 s 15	IT 99.3%, $\epsilon$ 0.7%	
	150	0+	-69.317	7.17 m 5	$\epsilon$ 64%, $\alpha$ 36%	
	151	7/2(-)	-68.759	17.9 m 3	$\epsilon$ 94.4%, $\alpha$ 5.6%	
	152	0+	-70.124	2.38 h 2	$\epsilon$ 99.9%, $\alpha$ 0.1%	
	153	7/2(-)	-69.150	6.4 h 1	$\epsilon$ 99.99%, $\alpha$ 9.4×10 <sup>-3</sup> %	
	154	0+	-70.398	3.0×10 <sup>6</sup> y 15	$\alpha$	
	155	3/2-	-69.16	9.9 h 2	$\epsilon$	
	155m	11/2-	-68.93	6 $\mu$ s 1	IT	
	156	0+	-70.530	<b>0.06% 1</b>		
	157	3/2-	-69.428	8.14 h 4	$\epsilon$	
	157m	11/2-	-69.229	21.6 ms 16	IT	
	158	0+	-70.412	<b>0.10% 1</b>		
	159	3/2-	-69.174	144.4 d 2	$\epsilon$	
	159m	11/2-	-68.821	122 $\mu$ s 3	IT	
	160	0+	-69.678	<b>2.34% 8</b>		
	161	5/2+	-68.061	<b>18.91% 24</b>		
	162	0+	-68.187	<b>25.51% 26</b>		
	163	5/2-	-66.386	<b>24.90% 16</b>		
	164	0+	-65.973	<b>28.18% 37</b>		
	165	7/2+	-63.618	2.334 h 1	$\beta^-$	
	165m	1/2-	-63.510	1.257 m 6	IT 97.76%, $\beta^-$ 2.24%	
	166	0+	-62.590	81.6 h 1	$\beta^-$	
	167	(1/2-)	-59.94	6.20 m 8	$\beta^-$	
	168	0+	-58.6	8.7 m 3	$\beta^-$	
	169	(5/2-)	-55.6	39 s 8	$\beta^-$	
	170	0+	-53.7s	$\approx$ 30 s	$\beta^-$ ?	
	171		-50.1s	$\approx$ 6 s	$\beta^-$	
	172	0+	-47.7s	$\approx$ 3 s	$\beta^-$	
	173		-43.8s	$\approx$ 2 s	$\beta^-$ ?	
	<b>67 Ho</b>	140	(6-,0-,8+)	-29.3s	6 ms 3	p
		141	7/2-	-34.4s	4.1 ms 3	p
141m		1/2+	-34.3s	6.6 $\mu$ s 8	p	
142			-37.5s	$\approx$ 0.3 s	$\epsilon$ , $\epsilon$ p	
143			-42.3s	>200 ns	$\epsilon$ ?%, $\epsilon$ p ?%	
144			-45.2s	0.7 s 1	$\epsilon$ , $\epsilon$ p	
145			-49.2s	2.4 s 1	$\epsilon$	
146		(10+)	-51.6s	3.6 s 3	$\epsilon$	
147		(11/2-)	-55.84	5.8 s 4	$\epsilon$	
148		(1+)	-58.0	2.2 s 11	$\epsilon$	
148m		(6)-	-58.0	9.59 s 15	$\epsilon$ , $\epsilon$ p 0.08%	
148m		(10+)	-57.3	2.35 ms 4	IT	
149		(11/2-)	-61.69	21.1 s 2	$\epsilon$	
149m		(1/2+)	-61.64	56 s 3	$\epsilon$	
150		2-	-61.95	72 s 4	$\epsilon$	
150m		(9)+	-61.15	23.3 s 3	$\epsilon$	
151		(11/2-)	-63.63	35.2 s 1	$\epsilon$ 78%, $\alpha$ 22%	
151m		(1/2+)	-63.59	47.2 s 10	$\alpha$ 80%, $\epsilon$ 20%	
152		2-	-63.61	161.8 s 3	$\epsilon$ 88%, $\alpha$ 12%	
152m	9+	-63.45	50.0 s 4	$\epsilon$ 89.2%, $\alpha$ 10.8%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>67 Ho</b>	153	11/2-	-65.019	2.01 m 3	$\epsilon$ 99.95%, $\alpha$ 0.05%
	153m	1/2+	-64.951	9.3 m 5	$\epsilon$ 99.82%, $\alpha$ 0.18%
	154	2-	-64.644	11.76 m 19	$\epsilon$ 99.98%, $\alpha$ 0.02%
	154m	8+	-64.644	3.10 m 14	$\epsilon$ , $\alpha < 1.0 \times 10^{-3}\%$ , IT?
	155	5/2+	-66.04	48 m 1	$\epsilon$
	155m	11/2-	-65.90	0.88 ms 8	IT
	156	4-	-65.35	56 m 1	$\epsilon$
	156m	1-	-65.30	9.5 s 15	IT
	156m	9+	-65.30	7.8 m 3	$\epsilon$ 75%, IT 25%
	157	7/2-	-66.83	12.6 m 2	$\epsilon$
	158	5+	-66.19	11.3 m 4	$\epsilon$
	158m	2-	-66.12	28 m 2	IT > 81%, $\epsilon < 19\%$
	158m	(9+)	-66.01	21.3 m 23	$\epsilon \geq 93\%$ , IT $\leq 7\%$
	159	7/2-	-67.336	33.05 m 11	$\epsilon$
	159m	1/2+	-67.130	8.30 s 8	IT
	160	5+	-66.39	25.6 m 3	$\epsilon$
	160m	2-	-66.33	5.02 h 5	IT 73%, $\epsilon$ 27%
	160m	(9+)	-66.22	3 s	IT
	161	7/2-	-67.203	2.48 h 5	$\epsilon$
	161m	1/2+	-66.992	6.76 s 7	IT
	162	1+	-66.047	15.0 m 10	$\epsilon$
	162m	6-	-65.941	67.0 m 7	IT 62%, $\epsilon$ 38%
	163	7/2-	-66.384	4570 y 25	$\epsilon$
	163m	1/2+	-66.086	1.09 s 3	IT
	164	1+	-64.987	29 m 1	$\epsilon$ 60%, $\beta$ - 40%
	164m	6-	-64.847	37.5 m +15-5	IT
	165	7/2-	-64.905	100%	
	166	0-	-63.077	26.83 h 2	$\beta$ -
	166m	(7)-	-63.071	$1.20 \times 10^3$ y 18	$\beta$ -
	167	7/2-	-62.287	3.003 h 18	$\beta$ -
	168	3+	-60.07	2.99 m 7	$\beta$ -
	168m	(6+)	-60.01	132 s 4	IT $\geq 99.5\%$ , $\beta$ - $\leq 0.5\%$
169	7/2-	-58.80	4.72 m 10	$\beta$ -	
170	(6+)	-56.24	2.76 m 5	$\beta$ -	
170m	(1+)	-56.12	43 s 2	$\beta$ -	
171	(7/2-)	-54.5	53 s 2	$\beta$ -	
172		-51.4s	25 s 3	$\beta$ -	
173		-49.1s	$\approx 10$ s	$\beta$ -?	
174		-45.5s	$\approx 8$ s	$\beta$ -?	
175		-42.8s	$\approx 5$ s	$\beta$ -?	
<b>68 Er</b>	143		-31.4s	0.2 s SY	$\epsilon$ ?
	144	0+	-36.9s	$\geq 200$ ns	$\epsilon$
	145	(11/2-)	-39.7s	0.9 s 3	$\epsilon$ , $\epsilon p$
	146	0+	-44.7s	1.7 s 6	$\epsilon$ , $\epsilon p$
	147	(11/2-)	-47.0s	2.5 s 2	$\epsilon$ , $\epsilon p > 0\%$
	147m	(1/2+)	-47.0s	$\approx 2.5$ s	$\epsilon$ , $\epsilon p > 0\%$
	148	0+	-51.7s	4.6 s 2	$\epsilon$
	149	(1/2+)	-53.74	4 s 2	$\epsilon$ , $\epsilon p$ 7%
	149m	(11/2-)	-53.00	8.9 s 2	$\epsilon$ 96.5%, IT 3.5%, $\epsilon p$ 0.18%
	150	0+	-57.83	18.5 s 7	$\epsilon$

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Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>68 Er</b>	151	(7/2-)	-58.27	23.5 s 13	$\epsilon$
	151m	(27/2-)	-55.68	0.58 s 2	IT 95.3%, $\epsilon$ 4.7%
	152	0+	-60.50	10.3 s 1	$\alpha$ 90%, $\epsilon$ 10%
	153	(7/2-)	-60.488	37.1 s 2	$\alpha$ 53%, $\epsilon$ 47%
	154	0+	-62.612	3.73 m 9	$\epsilon$ 99.53%, $\alpha$ 0.47%
	154m	11-	-59.587	39 ns 4	IT=100%, $\alpha=0\%$
	155	7/2-	-62.215	5.3 m 3	$\epsilon$ 99.98%, $\alpha$ 0.02%
	156	0+	-64.21	19.5 m 10	$\epsilon \approx 100\%$ , $\alpha 1.7 \times 10^{-5}\%$
	157	3/2-	-63.42	18.65 m 10	$\epsilon \approx 100\%$
	157m	(9/2+)	-63.26	76 ms 6	IT
	158	0+	-65.30	2.29 h 6	$\epsilon$
	159	3/2-	-64.567	36 m 1	$\epsilon$
	160	0+	-66.06	28.58 h 9	$\epsilon$
	161	3/2-	-65.209	3.21 h 3	$\epsilon$
	161m	11/2-	-64.813	7.5 $\mu$ s 7	IT
	162	0+	-66.343	<b>0.139% 5</b>	
	163	5/2-	-65.174	75.0 m 4	$\epsilon$
	164	0+	-65.950	<b>1.601% 3</b>	
	165	5/2-	-64.528	10.36 h 4	$\epsilon$
	166	0+	-64.932	<b>33.503% 36</b>	
	167	7/2+	-63.297	<b>22.869% 9</b>	
	167m	1/2-	-63.089	2.269 s 6	IT
	168	0+	-62.997	<b>26.978% 18</b>	
	169	1/2-	-60.929	9.392 d 18	$\beta^-$
	170	0+	-60.115	<b>14.910% 36</b>	
	171	5/2-	-57.725	7.516 h 2	$\beta^-$
	172	0+	-56.489	49.3 h 3	$\beta^-$
173	(7/2-)	-53.7s	1.4 m 1	$\beta^-$	
174	0+	-51.9s	3.2 m 2	$\beta^-$	
175	(9/2+)	-48.7s	1.2 m 3	$\beta^-$	
176	0+	-46.5s	$\approx 20$ s	$\beta^-?$	
177		-42.8s	$\approx 3$ s	$\beta^-?$	
<b>69 Tm</b>	145	(11/2-)	-27.9s	3.1 $\mu$ s 3	p
	146	(5-)	-31.3s	80 ms 10	p, $\epsilon$
	146m	(8+)	-31.1s	200 ms 10	p, $\epsilon$
	147	11/2-	-36.4s	0.58 s 3	$\epsilon$ 85%, p 15%
	147m	3/2+	-36.3s	0.36 ms 4	p
	148m	(10+)	-39.3s	0.7 s 2	$\epsilon$
	149	(11/2-)	-44.0s	0.9 s 2	$\epsilon$ , $\epsilon$ p 0.2%
	150	(6-)	-46.6s	2.2 s 2	$\epsilon$
	151	(11/2-)	-50.78	4.17 s 10	$\epsilon$
	151m	(1/2+)	-50.78	6.6 s 14	$\epsilon$
	152	(2-)	-51.77	8.0 s 10	$\epsilon$
	152m	(9+)	-51.77	5.2 s 6	$\epsilon$
	153	(11/2-)	-54.02	1.48 s 1	$\alpha$ 91%, $\epsilon$ 9%
	153m	(1/2+)	-53.97	2.5 s 2	$\alpha$ 92%, $\epsilon$ 8%
	154	(2-)	-54.43	8.1 s 3	$\alpha$ 54%, $\epsilon$ 46%
	154m	(9+)	-54.43	3.30 s 7	$\alpha$ 58%, $\epsilon$ 42%, IT
	155	11/2-	-56.64	21.6 s 2	$\epsilon$ 99.11%, $\alpha$ 0.89%
155m	1/2+	-56.59	45 s 3	$\epsilon > 98\%$ , $\alpha < 2\%$	
156	2-	-56.84	83.8 s 18	$\epsilon$ 99.94%, $\alpha$ 0.06%	



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Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>69 Tm</b>	157	1/2+	-58.71	3.63 m 9	$\epsilon$
	158	2-	-58.70	3.98 m 6	$\epsilon$
	158m	(5+)	-58.70	$\approx 20$ s	IT?
	159	5/2+	-60.57	9.13 m 16	$\epsilon$
	160	1-	-60.30	9.4 m 3	$\epsilon$
	160m	5	-60.23	74.5 s 15	IT 85%, $\epsilon$ 15%
	161	7/2+	-61.90	30.2 m 8	$\epsilon$
	162	1-	-61.48	21.70 m 19	$\epsilon$
	162m	5+	-61.48	24.3 s 17	IT 82%, $\epsilon$ 18%
	163	1/2+	-62.735	1.810 h 5	$\epsilon$
	164	1+	-61.89	2.0 m 1	$\epsilon$ , $\epsilon$ 39%
	164m	6-	-61.89	5.1 m 1	IT=80%, $\epsilon \approx 20\%$
	165	1/2+	-62.936	30.06 h 3	$\epsilon$
	166	2+	-61.89	7.70 h 3	$\epsilon$
	167	1/2+	-62.548	9.25 d 2	$\epsilon$
	168	3+	-61.318	93.1 d 2	$\epsilon$ 99.99%, $\beta$ - 0.01%
	169	1/2+	-61.280	<b>100%</b>	
	170	1-	-59.801	128.6 d 3	$\beta$ - 99.87%, $\epsilon$ 0.13%
	171	1/2+	-59.216	1.92 y 1	$\beta$ -
	172	2-	-57.380	63.6 h 2	$\beta$ -
	173	(1/2+)	-56.259	8.24 h 8	$\beta$ -
	174	(4)-	-53.87	5.4 m 1	$\beta$ -
	175	(1/2+)	-52.32	15.2 m 5	$\beta$ -
176	(4+)	-49.4	1.9 m 1	$\beta$ -	
177m	(7/2-)	-47.5s	90 s 6	$\beta$ - $\leq 100\%$	
178		-44.1s	$\approx 30$ s	$\beta$ -?	
179		-41.6s	$\approx 20$ s	$\beta$ -?	
<b>70 Yb</b>	148	0+	-30.3s	$\approx 0.25$ s	$\epsilon$ ?
	149	(1/2+, 3/2+)	-33.5s	0.7 s 2	$\epsilon$ , $\epsilon p = 100\%$
	150	0+	-38.7s	>200 ns	$\epsilon$ ?
	151	(1/2+)	-41.5	1.6 s 1	$\epsilon$ , $\epsilon p$
	151m	(11/2-)	-41.5	1.6 s 1	$\epsilon \approx 100\%$ , $\epsilon p$ , IT?
	152	0+	-46.3	3.04 s 6	$\epsilon$ , $\epsilon p$
	153	7/2-	-47.1s	4.2 s 2	$\alpha$ 60%, $\epsilon$ 40%
	154	0+	-49.93	0.409 s 2	$\alpha$ 92.6%, $\epsilon$ 7.4%
	155	(7/2-)	-50.50	1.793 s 19	$\alpha$ 89%, $\epsilon$ 11%
	156	0+	-53.26	26.1 s 7	$\epsilon$ 90%, $\alpha$ 10%
	157	7/2-	-53.44	38.6 s 10	$\epsilon$ 99.5%, $\alpha$ 0.5%
	158	0+	-56.015	1.49 m 13	$\epsilon$ , $\alpha \approx 2.1 \times 10^{-3}\%$
	159	5/2(-)	-55.84	1.67 m 9	$\epsilon$
	160	0+	-58.17	4.8 m 2	$\epsilon$
	161	3/2-	-57.84	4.2 m 2	$\epsilon$
	162	0+	-59.83	18.87 m 19	$\epsilon$
	163	3/2-	-59.30	11.05 m 35	$\epsilon$
	164	0+	-61.02	75.8 m 17	$\epsilon$
	165	5/2-	-60.29	9.9 m 3	$\epsilon$
	166	0+	-61.589	56.7 h 1	$\epsilon$
167	5/2-	-60.594	17.5 m 2	$\epsilon$	
168	0+	-61.575	<b>0.13% 1</b>		
169	7/2+	-60.370	32.018 d 5	$\epsilon$	
169m	1/2-	-60.346	46 s 2	IT	
170	0+	-60.769	<b>3.04% 15</b>		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>70 Yb</b>	171	1/2-	-59.312	<b>14.28% 57</b>		
	171m	7/2+	-59.217	5.25 ms 24	IT	
	172	0+	-59.260	<b>21.83% 67</b>		
	173	5/2-	-57.556	<b>16.13% 27</b>		
	174	0+	-56.950	<b>31.83% 92</b>		
	175	(7/2-)	-54.701	4.185 d 1	$\beta^-$	
	175m	1/2-	-54.186	68.2 ms 3	IT	
	176	0+	-53.494	$\geq 1.6 \times 10^{17}$ y	2 $\beta^-$	
				<b>12.76% 41</b>		
	176m	(8)-	-52.444	11.4 s 3	IT $\geq 90\%$ , $\beta^- \leq 10\%$	
	177	(9/2+)	-50.989	1.911 h 3	$\beta^-$	
	177m	(1/2-)	-50.658	6.41 s 2	IT	
	178	0+	-49.70	74 m 3	$\beta^-$	
	179	(1/2-)	-46.4s	8.0 m 4	$\beta^-$	
	180	0+	-44.4s	2.4 m 5	$\beta^-$	
	181		-40.8s	1 m SY	$\beta^- ?$	
	<b>71 Lu</b>	150	(2+)	-24.9s	43 ms 5	p 68%, $\epsilon$ 32%
		150m	(1-, 2-)	-24.9s	39 $\mu$ s 7	p
151		11/2-	-30.2s	80.6 ms 19	p 63.4%, $\epsilon$ 36.6%	
151m		3/2+	-30.1s	16 $\mu$ s 1	p	
152		(5-, 6-)	-33.4s	0.7 s 1	$\epsilon$ , $\epsilon$ p 15%	
153		11/2-	-38.4	0.9 s 2	$\alpha \approx 70\%$ , $\epsilon \approx 30\%$	
154		(2-)	-39.6s	$\approx 2$ s	$\epsilon ?$	
154m		(9+)	-39.6s	1.12 s 8	$\epsilon \approx 100\%$	
155		11/2-	-42.55	68 ms 1	$\alpha$ 90%, $\epsilon$ 10%	
155m		1/2+	-42.53	138 ms 8	$\alpha$ 76%, $\epsilon$ 24%	
155m		(25/2-)	-40.77	2.69 ms 3	$\alpha \approx 100\%$	
156		(2-)	-43.75	494 ms 12	$\alpha \approx 95\%$ , $\epsilon \approx 5\%$	
156m		9+	-43.75	198 ms 2	$\alpha$	
157		(1/2+, 3/2+)	-46.48	6.8 s 18	$\alpha > 0\%$	
157m		(11/2-)	-46.46	4.79 s 12	$\epsilon$ 94%, $\alpha$ 6%	
158			-47.21	10.6 s 3	$\epsilon$ 99.09%, $\alpha$ 0.91%	
159			-49.72	12.1 s 10	$\epsilon$ , $\alpha$ 0.1%	
160			-50.27	36.1 s 3	$\epsilon$ , $\alpha \leq 1.0 \times 10^{-4}\%$	
160m			-50.27	40 s 1	$\epsilon \leq 100\%$ , $\alpha$	
161		1/2+	-52.56	77 s 2	$\epsilon$	
161m		(9/2-)	-52.43	7.3 ms 4	IT	
162		(1-)	-52.84	1.37 m 2	$\epsilon \leq 100\%$	
162m		(4-)	-52.84	1.5 m	$\epsilon \leq 100\%$	
162m			-52.84	1.9 m	$\epsilon \leq 100\%$	
163		1/2(+)	-54.79	3.97 m 13	$\epsilon$	
164		1	-54.64	3.14 m 3	$\epsilon$	
165		1/2+	-56.44	10.74 m 10	$\epsilon$	
166		(6-)	-56.02	2.65 m 10	$\epsilon$	
166m	(3-)	-55.99	1.41 m 10	$\epsilon$ 58%, IT 42%		
166m	(0-)	-55.98	2.12 m 10	$\epsilon > 80\%$ , IT < 20%		
167	7/2+	-57.50	51.5 m 10	$\epsilon$		
167m	1/2+	-57.50	$\geq 1$ m	$\epsilon$ , IT		
168	(6-)	-57.06	5.5 m 1	$\epsilon$		
168m	3+	-56.84	6.7 m 4	$\epsilon > 95\%$ , IT < 5%		
169	7/2+	-58.077	34.06 h 5	$\epsilon$		
169m	1/2-	-58.048	160 s 10	IT		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>71 Lu</b>	170	0+	-57.31	2.012 d 20	$\epsilon$
	170m	(4)-	-57.22	0.67 s 10	IT
	171	7/2+	-57.833	8.24 d 3	$\epsilon$
	171m	1/2-	-57.762	79 s 2	IT
	172	4-	-56.741	6.70 d 3	$\epsilon$
	172m	1-	-56.699	3.7 m 5	IT
	173	7/2+	-56.886	1.37 y 1	$\epsilon$
	174	(1)-	-55.575	3.31 y 5	$\epsilon$
	174m	(6)-	-55.404	142 d 2	IT 99.38%, $\epsilon$ 0.62%
	175	7/2+	-55.171	<b>97.41% 2</b>	
	176	7-	-53.387	4.08 $\times$ 10 <sup>10</sup> 3 8	$\beta$ -
				<b>2.59% 2</b>	
	176m	1-	-53.264	3.664 h 19	$\beta$ - 99.91%, $\epsilon$ 0.1%
	177	7/2+	-52.389	6.6475 d 20	$\beta$ -
	177m	23/2-	-51.419	160.44 d 6	$\beta$ - 78.6%, IT 21.4%
	177m	(39/2-)	-49.689	6 m +3-2	$\beta$ - $\leq$ 100%, IT
	178	1(+)	-50.343	28.4 m 2	$\beta$ -
	178m	(9-)	-50.223	23.1 m 3	$\beta$ -
	179	7/2(+)	-49.064	4.59 h 6	$\beta$ -
	179m	1/2(+)	-48.472	3.1 ms 9	IT
	180	5+	-46.69	5.7 m 1	$\beta$ -
	180m	(9-)	-46.06	$\geq$ 1 ms	IT
	181	(7/2+)	-44.7s	3.5 m 3	$\beta$ -
	182	(0,1,2)	-41.9s	2.0 m 2	$\beta$ -
	183	(7/2+)	-39.5s	58 s 4	$\beta$ -
	184	(3+)	-36.4s	20 s 3	$\beta$ -
	<b>72 Hf</b>	153		-27.3s	>60 ns
154		0+	-32.7s	2 s 1	$\epsilon \approx$ 100%, $\alpha \approx$ 0%
154m		(10+)	-30.1s	9 $\mu$ s 4	IT
155			-34.1s	0.89 s 12	$\epsilon$
156		0+	-37.9	23 ms 1	$\alpha$
156m		8+	-35.9	0.52 ms 1	$\alpha$
157		7/2-	-38.8s	110 ms 6	$\alpha$ 86%, $\epsilon$ 14%
158		0+	-42.10	2.85 s 7	$\epsilon$ 55.7%, $\alpha$ 44.3%
159		7/2-	-42.85	5.6 s 4	$\epsilon$ 65%, $\alpha$ 35%
160		0+	-45.94	13.6 s 2	$\epsilon$ 99.3%, $\alpha$ 0.7%
161			-46.32	18.2 s 5	$\epsilon >$ 99.87%, $\alpha <$ 0.13%
162		0+	-49.173	39.4 s 9	$\epsilon$ 99.99%, $\alpha$ 8.0 $\times$ 10 <sup>-3%</sup>
163			-49.29	40.0 s 6	$\epsilon$ , $\alpha <$ 1.0 $\times$ 10 <sup>-4%</sup>
164		0+	-51.82	111 s 8	$\epsilon$
165		(5/2-)	-51.64	76 s 4	$\epsilon$
166		0+	-53.86	6.77 m 30	$\epsilon$
167		(5/2)-	-53.47	2.05 m 5	$\epsilon$
168		0+	-55.36	25.95 m 20	$\epsilon$
169		(5/2)-	-54.72	3.24 m 4	$\epsilon$
170		0+	-56.25	16.01 h 13	$\epsilon$
171		7/2(+)	-55.43	12.1 h 4	$\epsilon$
171m		1/2(-)	-55.41	29.5 s 9	IT $\leq$ 100%, $\epsilon$
172		0+	-56.40	1.87 y 3	$\epsilon$
173	1/2-	-55.41	23.6 h 1	$\epsilon$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
<b>72</b>	<b>Hf</b>	174	0+	-55.847	$2.0 \times 10^{15}$ y 4 <b>0.16% 1</b>	$\alpha$
		175	5/2(-)	-54.484	70 d 2	$\epsilon$
		176	0+	-54.577	<b>5.26% 7</b>	
		177	7/2-	-52.890	<b>18.60% 9</b>	
		177m	23/2+	-51.574	1.09 s 5	IT
		177m	37/2-	-50.150	51.4 m 5	IT
		178	0+	-52.444	<b>27.28% 7</b>	
		178m	8-	-51.297	4.0 s 2	IT
		178m	16+	-49.998	31 y 1	IT
		179	9/2+	-50.472	<b>13.62% 2</b>	
		179m	1/2-	-50.097	18.67 s 4	IT
		179m	25/2-	-49.366	25.05 d 25	IT
		180	0+	-49.788	<b>35.08% 16</b>	
		180m	8-	-48.647	5.47 h 4	IT 99.7%, $\beta$ - 0.3%
		181	1/2-	-47.412	42.39 d 6	$\beta$ -
		181m	(25/2-)	-45.670	1.5 ms 5	IT
		182	0+	-46.059	$8.90 \times 10^6$ y 9	$\beta$ -
		182m	8-	-44.886	61.5 m 15	$\beta$ - 58%, IT 42%
		183	(3/2-)	-43.29	1.067 h 17	$\beta$ -
		184	0+	-41.50	4.12 h 5	$\beta$ -
		184m	8-	-41.50	48 s 10	$\beta$ -
		185		-38.4s	3.5 m 6	$\beta$ -
		186	0+	-36.4s	2.6 m 12	$\beta$ -
		187		-33.0s	30 s SY	$\beta$ -?
		188	0+	-30.9s	20 s SY	$\beta$ -
<b>73</b>	<b>Ta</b>	155m	11/2-	-23.7s	12 $\mu$ s +4-3	p
		156	(2-)	-25.8s	144 ms 24	p $\approx$ 100%, $\epsilon$
		156m	9+	-25.7s	0.36 s 4	$\epsilon$ 95.8%, p 4.2%
		157	1/2+	-29.6	10.1 ms 4	$\alpha$ 96.6%, p 3.4%
		157m	11/2-	-29.6	4.3 ms 1	$\alpha$
		157m	(25/2-)	-28.0	1.7 ms 1	$\alpha$
		158	(2-)	-31.0s	55 ms 15	$\alpha$ $\approx$ 91%, $\epsilon$ $\approx$ 9%
		158m	(9+)	-30.9s	36.7 ms 15	$\alpha$ 95%, $\epsilon$ 5%
		159	(1/2-)	-34.45	0.83 s 18	$\epsilon$ 66%, $\alpha$ 34%
		159m	(11/2-)	-34.38	515 ms 20	$\alpha$ 55%, $\epsilon$ 45%
		160		-35.88	1.55 s 4	$\epsilon$ 66%, $\alpha$ 34%
		160m		-35.88	1.7 s 2	$\alpha$ ?
		161		-38.73s	2.89 s 12	$\epsilon$ 95%, $\alpha$ ?
		162		-39.78	3.57 s 12	$\epsilon$ 99.93%, $\alpha$ 0.07%
		163		-42.54	10.6 s 18	$\epsilon$ $\approx$ 99.8%, $\alpha$ = 0.2%
		164	(3+)	-43.28	14.2 s 3	$\epsilon$
		165		-45.86	31.0 s 15	$\epsilon$
		166	(2+)	-46.10	34.4 s 5	$\epsilon$
		167	(3/2+)	-48.35	80 s 4	$\epsilon$
		168	(2-, 3+)	-48.39	2.0 m 1	$\epsilon$
		169	(5/2+)	-50.29	4.9 m 4	$\epsilon$
		170	(3+)	-50.14	6.76 m 6	$\epsilon$
		171	(5/2-)	-51.72	23.3 m 3	$\epsilon$
		172	(3+)	-51.33	36.8 m 3	$\epsilon$
		173	5/2-	-52.40	3.14 h 13	$\epsilon$
		174	3+	-51.74	1.14 h 8	$\epsilon$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>73 Ta</b>	175	7/2+	-52.41	10.5 h 2	$\epsilon$
	176	(1)-	-51.37	8.09 h 5	$\epsilon$
	176m	(+)	-51.26	1.1 ms 1	IT
	176m	(20-)	-48.59	0.97 ms 7	IT
	177	7/2+	-51.724	56.56 h 6	$\epsilon$
	178	1+	-50.51	9.31 m 3	$\epsilon$
	178	(7)-	-50.51	2.36 h 8	$\epsilon$
	179	7/2+	-50.366	1.82 y 3	$\epsilon$
	179m	(25/2+)	-49.049	9.0 ms 2	IT
	179m	(37/2+)	-47.727	54.1 ms 17	IT
	180	1+	-48.936	8.154 h 6	$\epsilon$ 86%, $\beta$ - 14%
	180m	9-	-48.859	$>1.2 \times 10^{15}$ y	2 $\epsilon$ ?
	181	7/2+	-48.442	<b>99.988% 2</b>	
	182	3-	-46.433	114.43 d 3	$\beta$ -
	182m	5+	-46.417	283 ms 3	IT
	182m	10-	-45.913	15.84 m 10	IT
	183	7/2+	-45.296	5.1 d 1	$\beta$ -
	184	(5-)	-42.84	8.7 h 1	$\beta$ -
	185	(7/2+)	-41.40	49.4 m 15	$\beta$ -
	185m	(21/2)	-40.14	$>1$ ms	IT
186	(2-,3-)	-38.61	10.5 m 3	$\beta$ -	
186m		-38.61	1.54 m 5	$\beta$ -	
187		-36.8s	$\approx 2$ m	$\beta$ - ?	
188		-33.8s	$\approx 20$ s	$\beta$ -	
189	(7/2+)	-31.8s	3 s SY	$\beta$ - ?	
190		-28.7s	0.3 s SY	$\beta$ - ?	
<b>74 W</b>	158	0+	-23.7s	1.25 ms 21	$\alpha$
	158m	(8+)	-21.8s	0.143 ms 19	$\alpha$ , IT
	159		-25.2s	7.3 ms 27	$\alpha \approx 99.9\%$ , $\epsilon = 0.1\%$
	160	0+	-29.4	91 ms 5	$\alpha$ 87%
	161		-30.4s	409 ms 18	$\alpha$ 73%
	162	0+	-34.00	1.36 s 7	$\epsilon$ 54.8%, $\alpha$ 45.2%
	163		-34.91	2.8 s 2	$\epsilon$ 87%, $\alpha$ 13%
	164	0+	-38.23	6.3 s 2	$\epsilon$ 96.2%, $\alpha$ 3.8%
	165	(5/2-)	-38.86	5.1 s 5	$\epsilon$ , $\alpha < 0.2\%$
	166	0+	-41.89	19.2 s 6	$\epsilon$ 99.97%, $\alpha$ 0.04%
	167	(+)	-42.09	19.9 s 5	$\epsilon$ 99.96%, $\alpha$ 0.04%
	168	0+	-44.89	53 s 2	$\epsilon \approx 100\%$ , $\alpha$ $3.2 \times 10^{-3}\%$
	169	(5/2-)	-44.92	74 s 6	$\epsilon$
	170	0+	-47.29	2.42 m 4	$\epsilon$
	171	(5/2-)	-47.09	2.38 m 4	$\epsilon$
	172	0+	-49.10	6.6 m 9	$\epsilon$
	173	5/2-	-48.73	7.6 m 2	$\epsilon$
	174	0+	-50.23	33.2 m 21	$\epsilon$
	175	(1/2-)	-49.63	35.2 m 6	$\epsilon$
	176	0+	-50.64	2.5 h 1	$\epsilon$
177	1/2-	-49.70	132 m 2	$\epsilon$	
178	0+	-50.42	21.6 d 3	$\epsilon$	
179	(7/2)-	-49.30	37.05 m 16	$\epsilon$	
179m	(1/2)-	-49.08	6.40 m 7	IT 99.72%, $\epsilon$ 0.28%	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
<b>74 W</b>	180	0+	-49.645	$1.8 \times 10^{18}$ y 2 <b>0.12% 1</b>	$\alpha$	
	181	9/2+	-48.254	121.2 d 2	$\epsilon$	
	182	0+	-48.248	$>8.3 \times 10^{18}$ y <b>26.50% 16</b>	$\alpha$	
	183	1/2-	-46.367	$>1.3 \times 10^{19}$ y <b>14.31% 4</b>	$\alpha$	
	183m	11/2+	-46.057	5.2 s 3	IT	
	184	0+	-45.707	$>2.9 \times 10^{19}$ y <b>30.64% 2</b>	$\alpha$	
	185	3/2-	-43.390	75.1 d 3	$\beta^-$	
	185m	11/2+	-43.192	1.67 m 3	IT	
	186	0+	-42.509	$>2.7 \times 10^{19}$ y <b>28.43% 19</b>	$\alpha$	
	186m	(16+)	-38.967	$>3$ ms	IT	
	187	3/2-	-39.905	23.72 h 6	$\beta^-$	
	188	0+	-38.667	69.78 d 5	$\beta^-$	
	189	(3/2-)	-35.5	10.7 m 5	$\beta^-$	
	190	0+	-34.3	30.0 m 15	$\beta^-$	
	190m	(10-)	-31.9	$\leq 3.1$ ms	IT	
	191		-31.1s	$>300$ ns	$\beta^-?$	
	192	0+	-29.6s	$>300$ ns	$\beta^-?$	
	<b>75 Re</b>	160	(2-)	-16.7s	0.82 ms +15-9	p 91%, $\alpha$ 9%
		161	1/2+	-20.9	0.37 ms 4	p
		161m	11/2-	-20.8	15.6 ms 9	$\alpha$ 95.2%, p 4.8%
162		(2-)	-22.4s	107 ms 13	$\alpha$ 94%, $\epsilon$ 6%	
162m		(9+)	-22.2s	77 ms 9	$\alpha$ 91%, $\epsilon$ 9%	
163		(1/2+)	-26.01	390 ms 72	$\epsilon$ 68%, $\alpha$ 32%	
163m		(11/2-)	-25.89	214 ms 5	$\alpha$ 66%, $\epsilon$ 34%	
164			-27.6s	0.53 s 23	$\alpha \approx 58%$ , $\epsilon \approx 42%$	
165		(1/2+)	-30.66	$\approx 1$ s	$\epsilon$ , $\alpha$	
165m		(11/2-)	-30.61	2.1 s 3	$\epsilon$ 87%, $\alpha$ 13%	
166			-31.85s	2.8 s 3	$\alpha \geq 8%$	
167		(9/2-)	-34.84s	5.9 s 3	$\epsilon \approx 99%$ , $\alpha \approx 1%$	
167m			-34.84s	3.4 s 4	$\alpha \approx 100%$	
168		(5+,6+,7+)	-35.79	4.4 s 1	$\epsilon \approx 100%$ , $\alpha \approx 5.0 \times 10^{-3}\%$	
169		(9/2-)	-38.39	8.1 s 5	$\epsilon$ , $\alpha < 0.01%$	
169m			-38.39	15.1 s 15	$\alpha \approx 0.2%$	
170		(5+)	-38.92	9.2 s 2	$\epsilon$	
171		(9/2-)	-41.25	15.2 s 4	$\epsilon$	
172m		(5)	-41.52	15 s 3	$\epsilon$	
172m		(2)	-41.52	55 s 5	$\epsilon$	
173		(5/2-)	-43.55	1.98 m 26	$\epsilon$	
174			-43.67	2.40 m 4	$\epsilon$	
175		(5/2-)	-45.29	5.89 m 5	$\epsilon$	
176		3+	-45.06	5.3 m 3	$\epsilon$	
177		5/2-	-46.27	14 m 1	$\epsilon$	
178	(3+)	-45.65	13.2 m 2	$\epsilon$		
179	(5/2+)	-46.59	19.5 m 1	$\epsilon$		
180	(1-)	-45.84	2.44 m 6	$\epsilon$		
181	5/2+	-46.51	19.9 h 7	$\epsilon$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>75 Re</b>	182	7+	-45.4	64.0 h 5	$\epsilon$
	182m	2+	-45.4	12.7 h 2	$\epsilon$
	183	5/2+	-45.811	70.0 d 14	$\epsilon$
	184	3(-)	-44.227	38.0 d 5	$\epsilon$
	184m	8(+)	-44.039	169 d 8	IT 75.4%, $\epsilon$ 24.6%
	185	5/2+	-43.822	<b>37.40% 2</b>	
	186	1-	-41.930	3.7186 d 5	$\beta^-$ 92.53%, $\epsilon$ 7.47%
	186m	(8+)	-41.781	$2.0 \times 10^5$ y	IT
	187	5/2+	-41.216	$4.12 \times 10^{10}$ y 11	$\beta^-$ , $\alpha < 1.0 \times 10^{-4}\%$
				<b>62.60% 2</b>	
	188	1-	-39.016	17.003 h 3	$\beta^-$
	188m	(6)-	-38.844	18.59 m 4	IT
	189	5/2+	-37.978	24.3 h 4	$\beta^-$
	190	(2)-	-35.6	3.1 m 3	$\beta^-$
	190m	(6-)	-35.4	3.2 h 2	$\beta^-$ 54.4%, IT 45.6%
	191	(3/2+, 1/2+)	-34.35	9.8 m 5	$\beta^-$
	192		-31.7s	16 s 1	$\beta^-$
	193		-30.3s	30 s SY	$\beta^-$ ?
	194		-27.6s	>300 ns	$\beta^-$
<b>76 Os</b>	162	0+	-14.5s	1.9 ms 2	$\alpha$
	163		-16.1s	5.5 ms 6	$\alpha \approx 100\%$ , $\epsilon$
	164	0+	-20.5	21 ms 1	$\alpha$ 98%, $\epsilon$ 2%
	165	(7/2-)	-21.6s	71 ms 3	$\alpha > 60\%$ , $\epsilon < 40\%$
	166	0+	-25.44	181 ms 38	$\alpha$ 72%, $\epsilon$ 18%
	167		-26.50	0.81 s 6	$\alpha$ 57%, $\epsilon$ 43%
	168	0+	-29.99	2.1 s 1	$\alpha$ 40%, $\epsilon$
	169		-30.72	3.40 s 9	$\epsilon$ 88.8%, $\alpha$ 11.2%
	170	0+	-33.93	7.46 s 23	$\epsilon$ 91.4%, $\alpha$ 8.6%
	171	(5/2-)	-34.29	8.3 s 2	$\epsilon$ 98.2%, $\alpha$ 1.8%
	172	0+	-37.24	19.2 s 5	$\alpha$ 1.1%, $\epsilon$
	173	(5/2-)	-37.44	22.4 s 9	$\alpha$ 0.4%, $\epsilon$
	174	0+	-40.00	44 s 4	$\epsilon$ 99.98%, $\alpha$ 0.02%
	175	(5/2-)	-40.10	1.4 m 1	$\epsilon$
	176	0+	-42.10	3.6 m 5	$\epsilon$
	177	1/2-	-41.95	3.0 m 2	$\epsilon$
	178	0+	-43.55	5.0 m 4	$\epsilon$
	179	(1/2-)	-43.02	6.5 m 3	$\epsilon$
	180	0+	-44.36	21.5 m 4	$\epsilon$
	181	1/2-	-43.55	105 m 3	$\epsilon$
	181m	7/2-	-43.50	2.7 m 1	$\epsilon \approx 100\%$ , IT $\leq 3\%$
	182	0+	-44.61	22.10 h 25	$\epsilon$
	183	9/2+	-43.66	13.0 h 5	$\epsilon$
183m	1/2-	-43.49	9.9 h 3	$\epsilon$ 85%, IT 15%	
184	0+	-44.256	$> 5.6 \times 10^{13}$ y	$\alpha$	
			<b>0.02% 1</b>		
185	1/2-	-42.809	93.6 d 5	$\epsilon$	
186	0+	-43.000	$2.0 \times 10^{15}$ y 11	$\alpha$	
			<b>1.59% 3</b>		
187	1/2-	-41.218	<b>1.6% 3</b>		
188	0+	-41.136	<b>13.29% 8</b>		
189	3/2-	-38.985	<b>16.21% 5</b>		
189m	9/2-	-38.955	5.81 h 6	IT	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>76 Os</b>	190	0+	-38.706	<b>26.36% 2</b>	
	190m	(10)-	-37.001	9.9 m 1	IT
	191	9/2-	-36.394	15.4 d 1	$\beta^-$
	191m	3/2-	-36.320	13.10 h 5	IT
	192	0+	-35.881	<b>40.93% 19</b>	
	192m	(10)-	-33.865	5.9 s 1	IT>87%, $\beta^-$ <13%
	193	3/2-	-33.393	30.11 h 1	$\beta^-$
	194	0+	-32.433	6.0 y 2	$\beta^-$
	195		-29.7	$\approx$ 9 m	$\beta^-?$
	196	0+	-28.28	34.9 m 2	$\beta^-$
	197			2.8 m 6	$\beta^-$
	<b>77 Ir</b>	164	(9+)	-7.3s	0.11 ms +6-3
164m			-7.3s	58 $\mu$ s +46-18	p
165		(1/2+)	-11.6s	<1 $\mu$ s	p?, $\alpha?$
165m		11/2-	-11.4s	0.30 ms 6	p 87%, $\alpha$ 13%
166		(2-)	-13.2s	10.5 ms 22	$\alpha$ 93.1%, p 6.9%
166m		(9+)	-13.0s	15.1 ms 9	$\alpha$ 98.2%, p 1.8%
167		1/2+	-17.08	35.2 ms 20	$\alpha$ 48%, p 32%, $\epsilon$ 20%
167m		11/2-	-16.90	25.7 ms 8	$\alpha$ 80%, $\epsilon$ 20%, p 0.4%
168			-18.7s	0.161 ms 21	$\alpha$ 82%
169		(1/2+)	-22.08	0.64 s +46-24	$\alpha$ 50%, $\epsilon$ , p
169m		(11/2-)	-21.93	0.308 s 22	$\alpha$ 81%
170			-23.3s	0.87 s +18-12	$\alpha$ 5.2%, $\epsilon$ 94.8%
170m			-23.3s	0.44 s 6	$\alpha$ 36%, $\epsilon \leq 64%$ , IT $\leq 64%$
171		(1/2+)	-26.43	3.2 s +13-7	$\epsilon$ , $\alpha > 0%$ , p
171m		(11/2-)	-26.43	1.40 s 10	$\alpha$ 58%, $\epsilon \leq 42%$ , p $\leq 42%$
172		(3+)	-27.5s	4.4 s 3	$\epsilon$ 98%, $\alpha \approx 2%$
172m		(7+)	-27.4s	2.0 s 1	$\epsilon$ 77%, $\alpha$ 23%
173m		(11/2-)	-30.27	2.4 s 9	$\alpha$ 7%, $\epsilon$
173m		(3/2+, 5/2+)	-30.27	9.0 s 8	$\epsilon > 93%$ , $\alpha < 7%$
174		(3+)	-30.87	7.9 s 6	$\epsilon$ 99.5%, $\alpha$ 0.5%
174m		(7+)	-30.68	4.9 s 3	$\epsilon$ 97.5%, $\alpha$ 2.5%
175		(5/2-)	-33.43	9 s 2	$\epsilon$ 99.15%, $\alpha$ 0.85%
176			-33.86	8.3 s 6	$\epsilon$ 96.9%, $\alpha$ 3.1%
177		5/2-	-36.05	30 s 2	$\epsilon$ 99.94%, $\alpha$ 0.06%
178			-36.25	12 s 2	$\epsilon$
179		(5/2-)	-38.08	79 s 1	$\epsilon$
180		(4,5)	-37.98	1.5 m 1	$\epsilon$
181		5/2-	-39.47	4.90 m 15	$\epsilon$
182		(5+)	-39.05	15 m 1	$\epsilon$
183		5/2-	-40.20	57 m 4	$\epsilon$
184		5-	-39.61	3.09 h 3	$\epsilon$
185		5/2-	-40.34	14.4 h 1	$\epsilon$
186		5+	-39.17	16.64 h 3	$\epsilon$
186m	2-	-39.17	1.90 h 5	$\epsilon \approx 75%$ , IT $\approx 25%$	
187	3/2+	-39.716	10.5 h 3	$\epsilon$	
188	1-	-38.328	41.5 h 5	$\epsilon$	
188m		-37.405	4.2 ms 2	IT, $\epsilon?$	
189	3/2+	-38.45	13.2 d 1	$\epsilon$	
189m	11/2-	-38.08	13.3 ms 3	IT	



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
<b>77</b>	<b>Ir</b>	189m	(25/2)+	-36.12	3.7 ms 2	IT
		190	4-	-36.751	11.78 d 10	$\epsilon, \epsilon < 2.0 \times 10^{-3}\%$
		190m	(1-)	-36.725	1.120 h 3	IT
		190m	(11)-	-36.375	3.087 h 12	$\epsilon$ 91.4%, IT 8.6%
		191	3/2+	-36.706	<b>37.3% 2</b>	
		191m	11/2-	-36.535	4.94 s 3	IT
		191m		-34.659	5.5 s 7	IT
		192	4+	-34.833	73.827 d 13	$\beta$ - 95.13%, $\epsilon$ 4.87%
		192m	1-	-34.777	1.45 m 5	IT 99.98%, $\beta$ - 0.02%
		192m	(11-)	-34.665	241 y 9	IT
		193	3/2+	-34.534	<b>62.7% 2</b>	
		193m	11/2-	-34.454	10.53 d 4	IT
		194	1-	-32.529	19.28 h 13	$\beta$ -
		194m	4+	-32.382	31.85 ms 24	IT
		194m	(10,11)	-32.339	171 d 11	$\beta$ -
		195	3/2+	-31.690	2.5 h 2	$\beta$ -
		195m	11/2-	-31.590	3.8 h 2	$\beta$ - 95%, IT 5%
		196	(0-)	-29.44	52 s 1	$\beta$ -
		196m	(10,11-)	-29.03	1.40 h 2	$\beta$ - $\approx$ 100%, IT < 0.3%
		197	3/2+	-28.27	5.8 m 5	$\beta$ -
197m	11/2-	-28.15	8.9 m 3	$\beta$ - 99.75%, IT 0.25%		
198		-25.8s	8 s 1	$\beta$ -		
199		-24.40	20 s SY	$\beta$ -		
<b>78</b>	<b>Pt</b>	166	0+	-4.8s	300 $\mu$ s 100	$\alpha$
		167		-6.5s	0.9 ms 3	$\alpha$
		168	0+	-11.0	2.1 ms 2	$\alpha \leq 100\%$
		169		-12.4s	7.0 ms 2	$\alpha \approx 100\%$
		170	0+	-16.31	14.0 ms 2	$\alpha$
		171		-17.47	51 ms 2	$\alpha \approx 98\%, \epsilon$ 2%
		172	0+	-21.10	104 ms 7	$\alpha$ 94%, $\epsilon$ 6%
		173		-21.94	370 ms 13	$\alpha$ 83%, $\epsilon$
		174	0+	-25.32	0.889 s 17	$\alpha$ 76%, $\epsilon$ 24%
		175	(7/2-)	-25.69	2.53 s 6	$\alpha$ 64%, $\epsilon$ 36%
		176	0+	-28.93	6.33 s 15	$\epsilon$ 62%, $\alpha$ 38%
		177	5/2-	-29.37	10.6 s 4	$\epsilon$ 94.3%, $\alpha$ 5.7%
		178	0+	-32.00	21.1 s 6	$\epsilon$ 92.3%, $\alpha$ 7.7%
		179	1/2-	-32.264	21.2 s 4	$\epsilon$ 99.76%, $\alpha$ 0.24%
		180	0+	-34.44	56 s 2	$\epsilon, \alpha \approx 0.3\%$
		181	1/2-	-34.37	52.0 s 22	$\epsilon, \alpha \approx 0.08\%$
		182	0+	-36.17	3.0 m 2	$\epsilon$ 99.96%, $\alpha$ 0.04%
		183	1/2-	-35.77	6.5 m 10	$\epsilon, \alpha \approx 1.3 \times 10^{-3}\%$
		183m	(7/2)-	-35.74	43 s 5	$\epsilon \approx 100\%,$ $\alpha < 4.0 \times 10^{-4}\%,$ IT
		184	0+	-37.33	17.3 m 2	$\epsilon, \alpha \approx 0.001\%$
185	9/2+	-36.68	70.9 m 24	$\epsilon$		
185m	1/2-	-36.58	33.0 m 8	$\epsilon$ 99%, IT < 2%		
186	0+	-37.86	2.08 h 5	$\epsilon, \alpha \approx 1.4 \times 10^{-4}\%$		
187	3/2-	-36.71	2.35 h 3	$\epsilon$		
188	0+	-37.823	10.2 d 3	$\epsilon, \alpha \approx 2.6 \times 10^{-5}\%$		
189	3/2-	-36.48	10.87 h 12	$\epsilon$		
190	0+	-37.323	$6.5 \times 10^{11}$ y 3	$\alpha$		
			<b>0.014% 1</b>			

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Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
78	Pt	191	3/2-	-35.698	2.862 d 7	$\epsilon$
		192	0+	-36.293	<b>0.782% 7</b>	
		193	1/2-	-34.477	50 y 6	$\epsilon$
		193m	13/2+	-34.327	4.33 d 3	IT
		194	0+	-34.763	<b>32.967% 99</b>	
		195	1/2-	-32.797	<b>33.832% 10</b>	
		195m	13/2+	-32.537	4.010 d 5	IT
		196	0+	-32.647	<b>25.242% 41</b>	
		197	1/2-	-30.422	19.8915 h 19	$\beta^-$
		197m	13/2+	-30.023	95.41 m 18	IT 96.7%, $\beta^-$ 3.3%
		198	0+	-29.908	<b>7.163% 55</b>	
		199	5/2-	-27.392	30.80 m 21	$\beta^-$
		199m	(13/2)+	-26.968	13.6 s 4	IT
		200	0+	-26.60	12.5 h 3	$\beta^-$
201	(5/2-)	-23.74	2.5 m 1	$\beta^-$		
202	0+	-22.6s	44 h 15	$\beta^-$		
79	Au	169		-1.8s	150 $\mu$ s SY	$\alpha?$ , $\epsilon?$
		170	(2-)	-3.6s	286 $\mu$ s +50-40	p 89%, $\alpha$ 11%
		170m	(9+)	-3.6s	617 $\mu$ s +50-40	p 58%, $\alpha$ 42%
		171	(1/2+)	-7.56	22 $\mu$ s +3-2	p $\approx$ 100%
		171m	(11/2-)	-7.31	1.09 ms 3	$\alpha$ 66%, p 36%
		172		-9.3s	6.3 ms 15	$\alpha \leq 100\%$ , p < 2%
		173	(1/2+)	-12.82	25 ms 1	$\alpha$ 94%, $\epsilon$ , p
		173m	(11/2-)	-12.61	14.0 ms 9	$\alpha$ 92%, $\epsilon$ , p
		174		-14.2s	139 ms 3	$\alpha > 0\%$
		175	(1/2+)	-17.44	0.1 s SY	$\alpha?$ , $\epsilon?$
		175m	(11/2-)	-17.44	156 ms 5	$\alpha$ 94%, $\epsilon$ 6%
		176		-18.5s	0.84 s +17-14	$\alpha$ , $\epsilon$
		177	(1/2+, 3/2+)	-21.55	1462 ms 32	$\alpha \leq 100\%$ , $\epsilon$
		177m	11/2-	-21.39	1180 ms 12	$\alpha \leq 100\%$ , $\epsilon$
		178		-22.33	2.6 s 5	$\epsilon \leq 60\%$ , $\alpha \geq 40\%$
		179		-24.95	3.3 s 13	$\epsilon$ 78%, $\alpha$ 22%
		180		-25.60	8.1 s 3	$\epsilon \leq 98.2\%$ , $\alpha \geq 1.8\%$
		181	(3/2-)	-27.87	13.7 s 14	$\epsilon$ 97.3%, $\alpha$ 2.7%
		182		-28.30	15.6 s 4	$\epsilon$ 99.87%, $\alpha$ 0.13%
		183	(5/2-)	-30.19	42.8 s 10	$\epsilon$ 99.45%, $\alpha$ 0.55%
		184	5+	-30.32	20.6 s 9	$\alpha \leq 0.02\%$ , $\epsilon$
		184m	2+	-30.25	47.6 s 14	$\epsilon$ 70%, IT 30%, $\alpha \leq 0.02\%$
		185	5/2-	-31.87	4.25 m 6	$\epsilon$ 99.74%, $\alpha$ 0.26%
		185m		-31.87	6.8 m 3	$\epsilon < 100\%$ , IT
		186	3-	-31.71	10.7 m 5	$\epsilon$ , $\alpha$ $8.0 \times 10^{-4}\%$
		187	1/2+	-33.01	8.4 m 3	$\epsilon$ , $\alpha$ $3.0 \times 10^{-3}\%$
		187m	9/2-	-32.88	2.3 s 1	IT
		188	1(-)	-32.30	8.84 m 6	$\epsilon$
189	1/2+	-33.58	28.7 m 3	$\epsilon$ , $\alpha < 3.0 \times 10^{-5}\%$		
189m	11/2-	-33.33	4.59 m 11	$\epsilon$		
190	1-	-32.88	42.8 m 10	$\epsilon$ , $\alpha < 1.0 \times 10^{-6}\%$		
190m	(11-)	-32.88	125 ms 20	IT = 100%		
191	3/2+	-33.81	3.18 h 8	$\epsilon$		
191m	(11/2-)	-33.54	0.92 s 11	IT		
192	1-	-32.78	4.94 h 9	$\epsilon$		

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Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>79 Au</b>	192m	(5)+	-32.64	29 ms	IT
	192m	(11-)	-32.34	160 ms	20 IT
	193	3/2+	-33.39	17.65 h	15 $\epsilon$
	193m	11/2-	-33.10	3.9 s	3 IT 99.97%, $\epsilon \approx 0.03\%$
	194	1-	-32.26	38.02 h	10 $\epsilon$
	194m	(5+)	-32.15	600 ms	8 IT
	194m	(11-)	-31.79	420 ms	10 IT
	195	3/2+	-32.570	186.098 d	47 $\epsilon$
	195m	11/2-	-32.251	30.5 s	2 IT
	196	2-	-31.140	6.1669 d	6 $\epsilon$ 92.8%, $\beta$ - 7.2%
	196m	5+	-31.055	8.1 s	2 IT
	196m	12-	-30.544	9.6 h	1 IT
	197	3/2+	-31.141		100%
	197m	11/2-	-30.732	7.73 s	6 IT
	198	2-	-29.582	2.6956 d	3 $\beta$ -
	198m	(12-)	-28.770	2.27 d	2 IT
	199	3/2+	-29.095	3.139 d	7 $\beta$ -
	200	1(-)	-27.27	48.4 m	3 $\beta$ -
	200m	12-	-26.31	18.7 h	5 $\beta$ - 82%, IT 18%
	201	3/2+	-26.401	26 m	1 $\beta$ -
	202	(1-)	-24.4	28.8 s	19 $\beta$ -
	203	(3/2+)	-23.143	60 s	6 $\beta$ -
	204	(2-)	-20.8s	39.8 s	9 $\beta$ -
	205	(3/2+)	-18.8s	31 s	2 $\beta$ -
	<b>80 Hg</b>	171		3.5s	59 $\mu$ s +36-16
172		0+	-1.1	0.25 ms +35-9	$\alpha$
173			-2.6s	0.6 ms +5-2	$\alpha \approx 100\%$
174		0+	-6.65	2.1 ms +18-7	$\alpha$ 99.6%
175		(7/2-, 9/2-)	-8.0	10.8 ms	4 $\alpha$
176		0+	-11.78	20 ms	2 $\alpha \approx 100\%$
177		(13/2+)	-12.78	127.3 ms	18 $\alpha$ 85%, $\epsilon$ 15%
178		0+	-16.32	0.269 s	3 $\alpha \approx 70\%$ , $\epsilon \approx 30\%$
179			-16.92	1.08 s	9 $\alpha \approx 53\%$ , $\epsilon \approx 47\%$ , $\epsilon p = 0.15\%$
180		0+	-20.24	2.58 s	1 $\epsilon$ 52%, $\alpha$ 48%
181		1/2-	-20.66	3.6 s	1 $\epsilon$ 73%, $\alpha$ 27%, $\epsilon p$ 0.01%, $\epsilon \alpha$ $9.0 \times 10^{-6}\%$
182		0+	-23.576	10.83 s	6 $\epsilon$ 84.8%, $\alpha$ 15.2%
183		1/2-	-23.800	9.4 s	7 $\epsilon$ 88.3%, $\alpha$ 11.7%, $\epsilon p$ $2.6 \times 10^{-4}\%$
184		0+	-26.35	30.9 s	3 $\epsilon$ 98.89%, $\alpha$ 1.11%
185		1/2-	-26.18	49.1 s	10 $\epsilon$ 94%, $\alpha$ 6%
185m		13/2+	-26.08	21.6 s	15 IT 54%, $\epsilon$ 46%, $\alpha \approx 0.03\%$
186		0+	-28.54	1.38 m	6 $\epsilon$ 99.98%, $\alpha$ 0.02%
187		13/2+	-28.12	2.4 m	3 $\epsilon$ , $\alpha > 1.2 \times 10^{-4}\%$
187m		3/2-	-28.12	1.9 m	3 $\epsilon$ , $\alpha > 2.5 \times 10^{-4}\%$
188		0+	-30.20	3.25 m	15 $\epsilon$ , $\alpha$ $3.7 \times 10^{-5}\%$
189	3/2-	-29.63	7.6 m	1 $\epsilon$ , $\alpha < 3.0 \times 10^{-5}\%$	
189m	13/2+	-29.63	8.6 m	1 $\epsilon$ , $\alpha < 3.0 \times 10^{-5}\%$	
190	0+	-31.37	20.0 m	5 $\epsilon$ , $\alpha < 3.4 \times 10^{-7}\%$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>80 Hg</b>	191	(3/2-)	-30.59	49 m 10	$\epsilon$
	191m	13/2+	-30.59	50.8 m 15	$\epsilon$
	192	0+	-32.01	4.85 h 20	$\epsilon$
	193	3/2-	-31.05	3.80 h 15	$\epsilon$
	193m	13/2+	-30.91	11.8 h 2	$\epsilon$ 92.8%, IT 7.2%
	194	0+	-32.19	444 y 77	$\epsilon$
	195	1/2-	-31.00	10.53 h 3	$\epsilon$
	195m	13/2+	-30.82	41.6 h 8	IT 54.2%, $\epsilon$ 45.8%
	196	0+	-31.827	<b>0.15% 1</b>	
	197	1/2-	-30.541	64.14 h 5	$\epsilon$
	197m	13/2+	-30.242	23.8 h 1	IT 91.4%, $\epsilon$ 8.6%
	198	0+	-30.954	<b>9.97% 20</b>	
	199	1/2-	-29.547	<b>16.87% 22</b>	
	199m	13/2+	-29.015	42.67 m 9	IT
	200	0+	-29.504	<b>23.10% 19</b>	
	201	3/2-	-27.663	<b>13.18% 9</b>	
	202	0+	-27.346	<b>29.86% 26</b>	
	203	5/2-	-25.269	46.595 d 6	$\beta^-$
	204	0+	-24.690	<b>6.87% 15</b>	
	205	1/2-	-22.288	5.14 m 9	$\beta^-$
205m	13/2+	-20.731	1.09 ms 4	IT	
206	0+	-20.95	8.15 m 10	$\beta^-$	
207	(9/2+)	-16.2	2.9 m 2	$\beta^-$	
208	0+	-13.1s	41 m +5-4	$\beta^-$	
209		-8.3s	37 s 8	$\beta^-$	
210	0+	-5.1s	>300 ns	$\beta^-?$	
<b>81 Tl</b>	176	(3-,4-,5-)	1.4s	5.2 ms +30-14	p = 100%
	177	(1/2+)	-3.33	18 ms 5	$\alpha$ 73%, p 27%
	177m	(11/2-)	-2.52	230 $\mu$ s +70-40	p 55%
	177m	(11/2-)	-2.52	160 $\mu$ s +70-40	$\alpha$ 45%
	178		-4.8s	$\approx$ 60 ms	$\alpha?$ , $\epsilon?$
	179	(1/2+)	-8.30	0.42 s 6	$\alpha < 100%$ , $\epsilon$
	179m	(11/2-)	-8.30	1.7 ms 2	$\alpha \leq 100%$ , IT, $\epsilon$
	180		-9.4s	1.5 s 2	$\alpha$ 7%, $\epsilon$ SF $\approx 1.0 \times 10^{-4}\%$ , $\epsilon$
	181	1/2+	-12.801	1.4 ms 5	$\epsilon$ , $\alpha \leq 10%$
	181m	9/2-	-11.951	3.2 s 3	$\alpha$
	182	(7+)	-13.35	3.1 s 10	$\epsilon > 96%$ , $\alpha < 4%$
	183	(1/2+)	-16.587	6.9 s 7	$\epsilon > 0%$ , $\alpha$
	183m	(9/2-)	-15.957	53.3 ms 3	$\alpha$ 2%, $\epsilon$ , IT
	184	(2+)	-16.89	11 s 1	$\epsilon$ 97.9%, $\alpha$ 2.1%
	185	(1/2+)	-19.76	19.5 s 5	$\epsilon$
	185m	(9/2-)	-19.30	1.93 s 8	IT, $\alpha$
	186m	(7+)	-20.2	27.5 s 10	$\epsilon$ , $\alpha = 6.0 \times 10^{-3}\%$
	186m	(10-)	-19.8	2.9 s 2	IT
	187	(1/2+)	-22.444	$\approx$ 51 s	$\epsilon < 100%$ , $\alpha > 0%$
	187m	(9/2-)	-22.108	15.60 s 12	$\epsilon < 99.9%$ , IT < 99.9%, $\alpha$ 0.15%
188m	(2-)	-22.35	71 s 2	$\epsilon$	
188m	(7+)	-22.35	71 s 1	$\epsilon$	
188m	(9-)	-22.08	41 ms 4	IT = 100%, $\epsilon$	
189	(1/2+)	-24.60	2.3 m 2	$\epsilon$	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>81</b>	<b>Tl</b>	189m	(9/2-)	-24.34	1.4 m 1	$\epsilon < 100\%$ , IT < 4%
		190m	2(-)	-24.33	2.6 m 3	$\epsilon$
		190m	7(+)	-24.33	3.7 m 3	$\epsilon$
		190m	(8-)	-24.17	0.75 ms 4	IT
		191	(1/2+)	-26.281	?	$\epsilon$ ?
		191m	9/2(-)	-25.982	5.22 m 16	$\epsilon$
		192	(2-)	-25.87	9.6 m 4	$\epsilon$
		192m	(7+)	-25.72	10.8 m 2	$\epsilon$
		193	1/2+	-27.3	21.6 m 8	$\epsilon$
		193m	9/2-	-27.0	2.11 m 15	IT $\leq 75\%$ , $\epsilon \leq 25\%$
		194	2-	-26.8	33.0 m 5	$\epsilon$ , $\alpha < 1.0 \times 10^{-7}\%$
		194m	(7+)	-26.8	32.8 m 2	$\epsilon$
		195	1/2+	-28.16	1.16 h 5	$\epsilon$
		195m	9/2-	-27.67	3.6 s 4	IT
		196	2-	-27.50	1.84 h 3	$\epsilon$
		196m	(7+)	-27.10	1.41 h 2	$\epsilon$ 95.5%, IT 4.5%
		197	1/2+	-28.34	2.84 h 4	$\epsilon$
		197m	9/2-	-27.73	0.54 s 1	IT
		198	2-	-27.49	5.3 h 5	$\epsilon$
		198m	7+	-26.95	1.87 h 3	$\epsilon$ 54%, IT 46%
		198m	(10-)	-26.75	32.1 ms 10	IT
		199	1/2+	-28.06	7.42 h 8	$\epsilon$
		200	2-	-27.048	26.1 h 1	$\epsilon$
		201	1/2+	-27.18	72.912 h 17	$\epsilon$
		202	2-	-25.98	12.23 d 2	$\epsilon$
		203	1/2+	-25.761	<b>29.524% 14</b>	
		204	2-	-24.346	3.78 y 2	$\beta^-$ 97.1%, $\epsilon$ 2.9%
		205	1/2+	-23.821	<b>70.476% 14</b>	
206	0-	-22.253	4.200 m 17	$\beta^-$		
206m	(12-)	-19.610	3.74 m 3	IT		
207	1/2+	-21.034	4.77 m 2	$\beta^-$		
207m	11/2-	-19.686	1.33 s 11	IT		
208	5(+)	-16.750	3.053 m 4	$\beta^-$		
209	(1/2+)	-13.638	2.161 m 7	$\beta^-$		
210	(5+)	-9.25	1.30 m 3	$\beta^-$ , $\beta^-n$ $7.0 \times 10^{-3}\%$		
211		-6.1s	>300 ns	$\beta^-$ ?		
212		-1.7s	>300 ns	$\beta^-$ ?		
<b>82</b>	<b>Pb</b>	178	0+	3.57	0.23 ms 15	$\alpha$ , $\epsilon$ ?
		179		2.0s	3 ms SY	$\alpha$ ?
		180	0+	-1.94	4.5 ms 11	$\alpha \leq 100\%$
		181m	(13/2+)	-3.14	45 ms 20	$\alpha < 100\%$
		182	0+	-6.83	55 ms +40-35	$\alpha \leq 100\%$
		183	(3/2-)	-7.57	535 ms 30	$\alpha = 90\%$
		183m	(13/2+)	-7.47	415 ms 20	$\alpha = 100\%$
		184	0+	-11.05	490 ms 25	$\epsilon$ 77%, $\alpha$ 23%
		185m	13/2+	-11.54	4.24 s 17	$\alpha = 50\%$ , $\epsilon$ ?
		185m	3/2-	-11.54	6.3 s 4	$\alpha = 50\%$ , $\epsilon$ ?
		186	0+	-14.68	4.82 s 3	$\epsilon$ 60%, $\alpha$ 40%
		187	(3/2-)	-14.980	15.2 s 3	$\epsilon$ 93%, $\alpha$ 7%
		187m	(13/2+)	-14.899	18.3 s 3	$\epsilon$ 88%, $\alpha$ 12%
		188	0+	-17.82	25.1 s 1	$\epsilon$ 90.7%, $\alpha$ 9.3%
		189	(3/2-)	-17.88	51 s 3	$\epsilon > 99\%$ , $\alpha = 0.4\%$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>82 Pb</b>	190	0+	-20.42	71 s 1	$\epsilon$ 99.6%, $\alpha$ 0.4%
	191	(3/2-)	-20.25	1.33 m 8	$\epsilon$ 99.99%, $\alpha$ 0.01%
	191m	(13/2+)	-20.11	2.18 m 8	$\epsilon$ , $\alpha \approx 0.02\%$
	192	0+	-22.56	3.5 m 1	$\epsilon$ 99.99%, $\alpha$ $5.9 \times 10^{-3}\%$
	193	(3/2-)	-22.19	5 m SY	$\epsilon$
	193m	(13/2+)	-22.19	5.8 m 2	$\epsilon$
	194	0+	-24.21	10.7 m 6	$\epsilon$ , $\alpha$ $7.3 \times 10^{-6}\%$
	195	3/2-	-23.71	$\approx 15$ m	$\epsilon$
	195m	13/2+	-23.51	15.0 m 12	$\epsilon$
	196	0+	-25.36	37 m 3	$\epsilon \approx 100\%$ , $\alpha \leq 3.0 \times 10^{-5}\%$
	197	3/2-	-24.749	8.1 m 17	$\epsilon$
	197m	13/2+	-24.429	42.9 m 9	$\epsilon$ 81%, IT 19%
	198	0+	-26.05	2.4 h 1	$\epsilon$
	199	3/2-	-25.23	90 m 10	$\epsilon$
	199m	(13/2+)	-24.80	12.2 m 3	IT < 100%, $\epsilon > 0\%$
	200	0+	-26.24	21.5 h 4	$\epsilon$
	201	5/2-	-25.26	9.33 h 3	$\epsilon$
	201m	13/2+	-24.63	61 s 2	IT > 99%, $\epsilon < 1\%$
	202	0+	-25.934	$52.5 \times 10^3$ y 28	$\epsilon$ , $\alpha < 1\%$
	202m	9-	-23.764	3.53 h 1	IT 90.5%, $\epsilon$ 9.5%
	203	5/2-	-24.787	51.92 h 3	$\epsilon$
	203m	13/2+	-23.961	6.21 s 8	IT
	203m	29/2-	-21.837	480 ms 7	IT
	204	0+	-25.110	$\geq 1.4 \times 10^{17}$ y	$\alpha?$
	204m	9-	-22.924	1.14 h 4	IT
	205	5/2-	-23.770	$1.73 \times 10^7$ y 7	$\epsilon$
	205m	13/2+	-22.756	5.55 ms 2	IT
	206	0+	-23.785	<b>24.1% I</b>	
	207	1/2-	-22.452	<b>22.1% I</b>	
	207m	13/2+	-20.819	0.806 s 6	IT
208	0+	-21.749	<b>52.4% I</b>		
209	9/2+	-17.614	3.253 h 14	$\beta^-$	
210	0+	-14.728	22.20 y 22	$\beta^-$ , $\alpha$ $1.9 \times 10^{-6}\%$	
211	9/2+	-10.491	36.1 m 2	$\beta^-$	
212	0+	-7.547	10.64 h 1	$\beta^-$	
213	(9/2+)	-3.184	10.2 m 3	$\beta^-$	
214	0+	-0.181	26.8 m 9	$\beta^-$	
215		4.5s	36 s 1	$\beta^-$	
<b>83 Bi</b>	184m		1.0s	6.6 ms 15	$\alpha \approx 100\%$
	184m		1.0s	13 ms 2	$\alpha \approx 100\%$
	185	1/2+	-2.21s	63 $\mu$ s 3	p 90%, $\alpha$ 10%
	186	(3+)	-3.17	15.0 ms 17	$\alpha \approx 100\%$
	186m	(10-)	-3.17	9.8 ms 13	$\alpha \approx 100\%$
	187	(9/2-)	-6.37	32 ms 3	$\alpha$
	187m	(1/2+)	-6.26	0.29 ms +9-5	$\alpha$
	188m	(3+)	-7.20	60 ms 3	$\alpha$ , $\epsilon?$
	188m	(10-)	-7.20	265 ms 15	$\alpha$ , $\epsilon?$
	189	(9/2-)	-10.06	674 ms 11	$\alpha > 50\%$ , $\epsilon < 50\%$
	189m	(1/2+)	-9.88	5.0 ms 1	$\alpha > 50\%$ , $\epsilon < 50\%$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode	
Z	El	A	(MeV)	Abundance		
83	Bi	190m	(10-)	-10.9	6.2 s 1	$\alpha$ 70%, $\epsilon$ 30%
		190m	(3+)	-10.9	6.3 s 1	$\alpha$ 90%, $\epsilon$ 10%
		191	(9/2-)	-13.240	12.4 s 4	$\alpha$ 51%, $\epsilon$ 49%
		191m	(1/2+)	-13.000	121 ms 8	$\alpha$ 68%, $\epsilon$ 32%
		192	(3+)	-13.55	34.6 s 9	$\epsilon$ 88%, $\alpha$ 12%
		192m	(10-)	-13.55	39.6 s 4	$\epsilon$ 90%, $\alpha$ 10%
		193	(9/2-)	-15.873	63 s 3	$\epsilon$ 96.2%, $\alpha$ 3.8%
		193m	(1/2+)	-15.566	3.2 s 6	$\alpha$ 84%, $\epsilon$ 16%
		194	(3+)	-15.99	95 s 3	$\epsilon$ 99.54%, $\alpha$ 0.46%
		194m	(10-)	-15.99	115 s 4	$\epsilon$ 99.8%, $\alpha$ 0.2%
		194m	(6+,7+)	-15.99	125 s 2	$\epsilon$
		195	(9/2-)	-18.024	183 s 4	$\epsilon$ 99.97%, $\alpha$ 0.03%
		195m	(1/2+)	-17.623	87 s 1	$\epsilon$ 67%, $\alpha$ 33%
		196	(3+)	-18.01	308 s 12	$\epsilon$ = 100%, $\alpha$ $1.2 \times 10^{-3}\%$
		196m	(7+)	-17.84	0.6 s 5	IT, $\epsilon$
		196m	(10-)	-17.74	240 s 3	$\epsilon$ 74.2%, IT 25.8%, $\alpha$ $3.8 \times 10^{-4}\%$
		197	(9/2-)	-19.688	9.33 m 50	$\epsilon$ , $\alpha$ $1.0 \times 10^{-4}\%$
		197m	(1/2+)	-19.188	5.04 m 16	$\alpha$ 55%, $\epsilon$ 45%, IT < 0.3%
		198	(2+,3+)	-19.37	10.3 m 3	$\epsilon$
		198m	(7+)	-19.37	11.6 m 3	$\epsilon$
		198m	10-	-19.12	7.7 s 5	IT
		199	9/2-	-20.80	27 m 1	$\epsilon$
		199m	(1/2+)	-20.12	24.70 m 15	$\epsilon$ $\geq$ 98%, IT $\leq$ 2%, $\alpha$ = 0.01%
		200	7+	-20.37	36.4 m 5	$\epsilon$
		200m	(2+)	-20.37	31 m 2	$\epsilon$ > 90%, IT < 10%
		200m	(10-)	-19.94	0.40 s 5	IT
		201	9/2-	-21.42	108 m 3	$\epsilon$ , $\alpha$ < $1.0 \times 10^{-4}\%$
		201m	1/2+	-20.57	59.1 m 6	$\epsilon$ > 93%, IT $\leq$ 6.8%, $\alpha$ = 0.3%
		202	5+	-20.73	1.72 h 5	$\epsilon$ , $\alpha$ < $1.0 \times 10^{-5}\%$
		203	9/2-	-21.54	11.76 h 5	$\epsilon$
		203m	1/2+	-20.44	305 ms 5	IT
		204	6+	-20.67	11.22 h 10	$\epsilon$
		205	9/2-	-21.062	15.31 d 4	$\epsilon$
206	6(+)	-20.028	6.243 d 3	$\epsilon$		
207	9/2-	-20.054	32.9 y 14	$\epsilon$		
207m	21/2+	-17.953	182 $\mu$ s 6	IT		
208	(5)+	-18.870	$3.68 \times 10^5$ y 4	$\epsilon$		
209	9/2-	-18.258	$1.9 \times 10^{19}$ y 2	$\alpha$		
<b>100%</b>						
210	1-	-14.792	5.012 d 5	$\beta^-$ , $\alpha$ $1.3 \times 10^{-4}\%$		
210m	9-	-14.521	$3.04 \times 10^6$ y 6	$\alpha$		
211	9/2-	-11.858	2.14 m 2	$\alpha$ 99.72%, $\beta^-$ 0.28%		
212	1(-)	-8.117	60.55 m 6	$\beta^-$ 64.06%, $\alpha$ 35.94%		
212m	(8-,9-)	-7.867	25.0 m 2	$\alpha$ 67%, $\beta^-$ 33%, $\beta^-$ $\alpha$ 30%		
212m	$\geq$ 16	-6.207	7.0 m 3	$\beta^-$ = 100%		
213	9/2-	-5.231	45.59 m 6	$\beta^-$ 97.91%, $\alpha$ 2.09%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
83	Bi	214	1-	-1.20	19.9 m 4	$\beta^-$ 99.98%, $\alpha$ 0.02%
		215	(9/2-)	1.65	7.6 m 2	$\beta^-$
		215m	(25/2-)	3.00	36.4 s	IT, $\beta^-$
		216	(1-)	5.87	2.17 m 5	$\beta^- \leq 100\%$
		217		8.8s	98.5 s 8	$\beta^-$
		218		13.3s	33 s 1	$\beta^-$
84	Po	188	0+	-0.54	0.40 ms +20-15	$\epsilon < 100\%$ , $\alpha > 0\%$
		189		-1.42	5 ms 1	$\alpha$
		190	0+	-4.56	2.46 ms 5	$\alpha$
		191	(3/2-)	-5.05	22 ms 1	$\alpha$
		191m	(13/2+)	-4.92	93 ms 3	$\alpha$
		192	0+	-8.07	33.2 ms 14	$\alpha \approx 99.5\%$ , $\epsilon \approx 0.5\%$
		193m	(13/2+)	-8.36	243 ms +11-10	$\alpha \leq 100\%$
		193m	(3/2-)	-8.36	370 ms +46-40	$\alpha \leq 100\%$
		194	0+	-11.01	0.392 s 4	$\alpha \approx 100\%$ , $\epsilon$
		195	(3/2-)	-11.07	4.64 s 9	$\alpha$ 75%, $\epsilon$ 25%
		195m	(13/2+)	-10.84	1.92 s 2	$\alpha \approx 90\%$ , $\epsilon \approx 10\%$ , IT < 0.01%
		196	0+	-13.47	5.8 s 2	$\alpha \approx 98\%$ , $\epsilon \approx 2\%$
		197	(3/2-)	-13.36	84 s 16	$\epsilon$ 56%, $\alpha$ 44%
		197m	(13/2+)	-13.15	32 s 2	$\alpha$ 84%, $\epsilon$ 16%, IT 0.01%
		198	0+	-15.47	1.77 m 3	$\alpha$ 57%, $\epsilon$ 43%
		199	(3/2-)	-15.22	4.58 m 52	$\epsilon$ 92.5%, $\alpha$ 7.5%
		199m	13/2+	-14.90	4.13 m 43	$\epsilon$ 73.5%, $\alpha$ 24%, IT 2.5%
		200	0+	-16.95	10.9 m 11	$\epsilon$ 88.9%, $\alpha$ 11.1%
		201	3/2-	-16.525	15.3 m 2	$\epsilon$ 98.4%, $\alpha$ 1.6%
		201m	13/2+	-16.101	8.9 m 2	IT 56%, $\epsilon$ 41%, $\alpha \approx 2.9\%$
		202	0+	-17.92	44.7 m 5	$\epsilon$ 98.08%, $\alpha$ 1.92%
		203	5/2-	-17.31	36.7 m 5	$\epsilon$ 99.89%, $\alpha$ 0.11%
		203m	13/2+	-16.67	45 s 2	IT
		204	0+	-18.33	3.53 h 2	$\epsilon$ 99.34%, $\alpha$ 0.66%
		205	5/2-	-17.51	1.74 h 8	$\epsilon$ 99.96%, $\alpha$ 0.04%
		205m	13/2+	-16.63	0.645 ms 20	IT
		205m	19/2-	-16.05	57.4 ms 9	IT
		206	0+	-18.182	8.8 d 1	$\epsilon$ 94.55%, $\alpha$ 5.45%
		207	5/2-	-17.146	5.80 h 2	$\epsilon$ 99.98%, $\alpha$ 0.02%
		207m	19/2-	-15.763	2.79 s 8	IT
		208	0+	-17.469	2.898 y 2	$\alpha, \epsilon$
		209	1/2-	-16.366	102 y 5	$\alpha$ 99.52%, $\epsilon$ 0.48%
210	0+	-15.953	138.376 d 2	$\alpha$		
211	9/2+	-12.432	0.516 s 3	$\alpha$		
211m	(25/2+)	-10.970	25.2 s 6	$\alpha$ 99.98%, IT 0.02%		
212	0+	-10.369	0.299 $\mu$ s 2	$\alpha$		
212m	6+	-9.014	0.76 ns 21	$\alpha \approx 71\%$		
212m	8+	-8.893	17.1 ns 2	$\alpha \approx 42\%$		
212m	(18+)	-7.447	45.1 s 6	$\alpha$ 99.93%		
213	9/2+	-6.653	3.65 $\mu$ s 4	$\alpha$		
214	0+	-4.470	164.3 $\mu$ s 20	$\alpha$		
215	9/2+	-0.540	1.781 ms 4	$\alpha, \beta^-$ 2.3 $\times$ 10 <sup>-4</sup> %		



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
84	Po	216	0+	1.784	0.145 s 2	$\alpha$
		217	(9/2+)	5.901	1.53 s 5	$\alpha$
		218	0+	8.358	3.10 m 2	$\alpha$ 99.98%, $\beta^-$ 0.02%
		219		12.8s	$\approx$ 2 m	$\alpha?$ , $\beta^-?$
		220	0+	15.5s	>300 ns	$\beta^-?$
85	At	191	(1/2+)		1.7 ms +11-5	$\alpha$
		191m	(7/2-)		2.1 ms +4-3	$\alpha$
		193	(1/2+)	-0.15	28 ms +5-4	$\alpha \approx$ 100%
		193m	(7/2-)	-0.14	21 ms 5	$\alpha \approx$ 100%
		193m	(13/2+)	-0.11	27 ms +4-5	$\alpha$ 24%
		194m		-1.2	$\approx$ 40 ms	$\alpha, \epsilon$
		194m		-1.2	$\approx$ 250 ms	$\alpha, \epsilon, \text{ IT}$
		195	(1/2+)	-3.476	328 ms +20	$\alpha$
		195m	(7/2-)	-3.439	147 ms +5	$\alpha$
		196		-3.92	0.39 s 5	$\alpha$ 94%, $\epsilon$
		197	(9/2-)	-6.34	0.390 s 16	$\alpha$ 96.1%, $\epsilon$ 3.9%
		197m	(1/2+)	-6.29	2.0 s 2	$\alpha \leq$ 100%, IT $\leq$ 4.0 $\times$ 10 <sup>-3</sup> %, $\epsilon$
		198	(3+)	-6.67	4.2 s 3	$\alpha$ 90%, $\epsilon$ 10%
		198m	(10-)	-6.57	1.0 s 2	$\alpha$ 84%, $\epsilon$ 16%
		199	(9/2-)	-8.82	6.92 s 13	$\alpha$ 90%, $\epsilon$ 10%
		200	(3+)	-8.99	43 s 1	$\alpha$ 57%, $\epsilon$ 43%
		200m	(7+)	-8.88	47 s 1	$\epsilon \leq$ 57%, $\alpha$ 43%
		200m	(10-)	-8.65	3.5 s 2	IT $\approx$ 84%, $\alpha \approx$ 10.5%, $\epsilon \approx$ 4.5%
		201	(9/2-)	-10.790	89 s 3	$\alpha$ 71%, $\epsilon$ 29%
		202	(2,3)+	-10.59	184 s 1	$\epsilon$ 82%, $\alpha$ 18%
		202m	(7+)	-10.59	182 s 2	$\epsilon$ 91.3%, $\alpha$ 8.7%
		202m	(10-)	-10.20	0.46 s 5	IT 99.7%, $\epsilon$ 0.25%, $\alpha$ 0.1%
		203	9/2-	-12.16	7.37 m 13	$\epsilon$ 69%, $\alpha$ 31%
		204	7+	-11.88	9.2 m 2	$\epsilon$ 96.2%, $\alpha$ 3.8%
		204m	(10-)	-11.29	108 ms 10	IT
		205	9/2-	-12.97	26.9 m 8	$\epsilon$ 90%, $\alpha$ 10%
		206	(5)+	-12.42	30.6 m 13	$\epsilon$ 99.11%, $\alpha$ 0.89%
		207	9/2-	-13.24	1.80 h 4	$\epsilon$ 91.4%, $\alpha$ 8.6%
		208	6+	-12.49	1.63 h 3	$\epsilon$ 99.45%, $\alpha$ 0.55%
		209	9/2-	-12.880	5.41 h 5	$\epsilon$ 95.9%, $\alpha$ 4.1%
		210	(5)+	-11.972	8.1 h 4	$\epsilon$ 99.82%, $\alpha$ 0.18%
		211	9/2-	-11.647	7.214 h 7	$\epsilon$ 58.2%, $\alpha$ 41.8%
212	(1-)	-8.621	0.314 s 2	$\alpha, \epsilon <$ 0.03%, $\beta^- <$ 2.0 $\times$ 10 <sup>-6</sup> %		
212m	(9-)	-8.398	0.119 s 3	$\alpha >$ 99%, IT < 1%		
213	9/2-	-6.580	125 ns 6	$\alpha$		
214	1-	-3.380	558 ns 10	$\alpha$		
215	9/2-	-1.255	0.10 ms 2	$\alpha$		
216	1-	2.257	0.30 ms 3	$\alpha, \beta^- <$ 6.0 $\times$ 10 <sup>-3</sup> %, $\epsilon <$ 3.0 $\times$ 10 <sup>-7</sup> %		
217	9/2-	4.396	32.3 ms 4	$\alpha$ 99.99%, $\beta^-$ 7.0 $\times$ 10 <sup>-3</sup> %		
218		8.10	1.5 s 3	$\alpha$ 99.9%, $\beta^-$ 0.1%		
219		10.397	56 s 3	$\alpha \approx$ 97%, $\beta^- \approx$ 3%		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
85	At	220	3	14.35	3.71 m 4	$\beta^-$ 92%, $\alpha$ 8%
		221		16.8s	2.3 m 2	$\beta^-$
		222		20.8s	54 s 10	$\beta^-$
		223		23.5s	50 s 7	$\beta^-$
86	Rn	195		5.07	6 ms +3-2	$\alpha$
		195m		5.12	5 ms +3-2	$\alpha$
		196	0+	1.97	4.4 ms +13-9	$\alpha$
		197	(3/2-)	1.48	65 ms +25-14	$\alpha \approx 100\%$
		197m	(13/2+)	1.48	19 ms +8-4	$\alpha \approx 100\%$
		198	0+	-1.23	65 ms 3	$\alpha, \epsilon$
		199	(3/2-)	-1.52	0.62 s 3	$\alpha$ 94%, $\epsilon$ 6%
		199m	(13/2+)	-1.52	0.32 s 2	$\alpha$ 97%, $\epsilon$ 3%
		200	0+	-4.01	0.96 s 3	$\alpha \approx 98\%$ , $\epsilon \approx 2\%$
		201	(3/2-)	-4.07	7.1 s 8	$\alpha \approx 80\%$ , $\epsilon \approx 20\%$
		201m	(13/2+)	-3.79	3.8 s 1	$\alpha \approx 90\%$ , $\epsilon \approx 10\%$ , IT = 0%
		202	0+	-6.28	10.0 s 3	$\alpha$ 86%, $\epsilon$ 14%
		203	(3/2-)	-6.16	44.2 s 16	$\alpha$ 66%, $\epsilon$ 34%
		203m	(13/2+)	-5.80	26.9 s 5	$\alpha$ 75%, $\epsilon$ 25%
		204	0+	-7.98	1.17 m 18	$\alpha$ 73%, $\epsilon$ 27%
		205	5/2-	-7.71	170 s 4	$\epsilon$ 75.4%, $\alpha$ 24.6%
		206	0+	-9.12	5.67 m 17	$\alpha$ 62%, $\epsilon$ 38%
		207	5/2-	-8.63	9.25 m 17	$\epsilon$ 79%, $\alpha$ 21%
		208	0+	-9.65	24.35 m 14	$\alpha$ 62%, $\epsilon$ 38%
		209	5/2-	-8.93	28.5 m 10	$\epsilon$ 83%, $\alpha$ 17%
		210	0+	-9.598	2.4 h 1	$\alpha$ 96%, $\epsilon$ 4%
		211	1/2-	-8.756	14.6 h 2	$\epsilon$ 72.6%, $\alpha$ 27.4%
		212	0+	-8.660	23.9 m 12	$\alpha$
		213	(9/2+)	-5.698	19.4 ms 1	$\alpha$
		214	0+	-4.320	0.27 $\mu$ s 2	$\alpha$
		215	9/2+	-1.169	2.30 $\mu$ s 10	$\alpha$
		216	0+	0.256	45 $\mu$ s 5	$\alpha$
		217	9/2+	3.659	0.54 ms 5	$\alpha$
		218	0+	5.218	35 ms 5	$\alpha$
		219	5/2+	8.831	3.96 s 1	$\alpha$
		220	0+	10.613	55.6 s 1	$\alpha$
		221	7/2(+)	14.472	25.7 m 5	$\beta^-$ 78%, $\alpha$ 22%
222	0+	16.374	3.8235 d 4	$\alpha$		
223	7/2	20.3s	24.3 m 4	$\beta^-$		
224	0+	22.4s	107 m 3	$\beta^-$		
225	7/2-	26.5s	4.66 m 4	$\beta^-$		
226	0+	28.8s	7.4 m 1	$\beta^-$		
227		33.0s	20.8 s 7	$\beta^-$		
228	0+	35.4s	65 s 2	$\beta^-$		
87	Fr	199		6.76	12 ms +10-4	$\alpha > 0\%$ , $\epsilon$
		200	(3+)	6.12	49 ms 4	$\alpha$
		200m	(10-)	6.32	0.57 s +27-14	$\alpha$
		201	(9/2-)	3.60	67 ms 3	$\alpha, \epsilon < 1\%$
		201m		3.60	19 ms +19-6	$\alpha$
		202	(3+)	3.14	0.23 s +8-4	$\alpha \approx 97\%$ , $\epsilon \approx 3\%$
		202m	(10-)	3.24	0.23 s +14-5	$\alpha \approx 97\%$ , $\epsilon \approx 3\%$
203	(9/2-)	0.86	0.55 s 2	$\alpha \leq 100\%$		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
87	Fr	204	(3+)	0.61	1.7 s 3	$\alpha \approx 80\%$ , $\epsilon \approx 20\%$
		204m	(7+)	0.65	2.6 s 3	$\alpha \leq 100\%$
		204m	(10-)	0.92	$\approx 1$ s	$\alpha \leq 100\%$ , IT
		205	(9/2-)	-1.310	3.80 s 3	$\alpha \leq 100\%$
		206	(2+, 3+)	-1.24	$\approx 16$ s	$\alpha \approx 84\%$ , $\epsilon \approx 16\%$
		206m	(7+)	-1.24	15.9 s 1	$\alpha 84\%$ , $\epsilon 16\%$
		206m	(10-)	-0.71	0.7 s 1	$\alpha \approx 12\%$ , IT
		207	9/2-	-2.84	14.8 s 1	$\alpha 95\%$ , $\epsilon 5\%$
		208	7+	-2.67	59.1 s 3	$\alpha 90\%$ , $\epsilon 10\%$
		209	9/2-	-3.77	50.0 s 3	$\alpha 89\%$ , $\epsilon 11\%$
		210	6+	-3.35	3.18 m 6	$\alpha 60\%$ , $\epsilon 40\%$
		211	9/2-	-4.16	3.10 m 2	$\alpha > 80\%$ , $\epsilon < 20\%$
		212	5+	-3.54	20.0 m 6	$\epsilon 57\%$ , $\alpha 43\%$
		213	9/2-	-3.550	34.6 s 3	$\alpha 99.45\%$ , $\epsilon 0.55\%$
		214	(1-)	-0.958	5.0 ms 2	$\alpha$
		214m	(8-)	-0.836	3.35 ms 5	$\alpha$
		215	9/2-	0.318	86 ns 5	$\alpha$
		216	(1-)	2.98	0.70 $\mu$ s 2	$\alpha$ , $\epsilon < 2.0 \times 10^{-7}\%$
		217	9/2-	4.315	19 $\mu$ s 3	$\alpha$
		218	1-	7.059	1.0 ms 6	$\alpha$
		218m		7.145	22.0 ms 5	$\alpha \leq 100\%$ , IT
		219	9/2-	8.618	20 ms 2	$\alpha$
		220	1+	11.483	27.4 s 3	$\alpha 99.65\%$ , $\beta - 0.35\%$
		221	5/2-	13.278	4.9 m 2	$\alpha$ , $\beta - < 0.1\%$ , $^{14}\text{C} 9 \times 10^{-13}\%$
		222	2-	16.35	14.2 m 3	$\beta -$
		223	3/2(-)	18.384	22.00 m 7	$\beta - 99.99\%$ , $\alpha 6.0 \times 10^{-3}\%$
		224	1-	21.66	3.33 m 10	$\beta -$
225	3/2-	23.81	4.0 m 2	$\beta -$		
226	1-	27.4	49 s 1	$\beta -$		
227	1/2+	29.7	2.47 m 3	$\beta -$		
228	2-	33.3s	38 s 1	$\beta - \leq 100\%$		
229	(1/2+)	35.82	50.2 s 4	$\beta -$		
230		39.6s	19.1 s 5	$\beta -$		
231	(1/2+)	42.3s	17.6 s 6	$\beta -$		
232		46.4s	5 s 1	$\beta -$		
88	Ra	202	0+	9.21	0.7 ms +33-3	$\alpha$
		203	(3/2-)	8.64	1.0 ms +50-5	$\alpha \approx 100\%$
		203m	(13/2+)	8.64	33 ms +22-10	$\alpha \approx 100\%$
		204	0+	6.05	59 ms +12-9	$\alpha$
		205	(3/2-)	5.84	210 ms +60-40	$\alpha \leq 100\%$ , $\epsilon$
		205m	(13/2+)	5.84	170 ms +60-40	$\alpha \leq 100\%$ , $\epsilon$
		206	0+	3.57	0.24 s 2	$\alpha$
		207	(5/2-, 3/2-)	3.54	1.3 s 2	$\alpha \approx 90\%$ , $\epsilon \approx 10\%$
		207m	(13/2+)	4.01	55 ms 10	IT 85%, $\alpha 15\%$ , $\epsilon \approx 0.35\%$
		208	0+	1.71	1.3 s 2	$\alpha 95\%$ , $\epsilon 5\%$
		209	5/2-	1.86	4.6 s 2	$\alpha \approx 90\%$ , $\epsilon \approx 10\%$
		210	0+	0.46	3.7 s 2	$\alpha \approx 96\%$ , $\epsilon \approx 4\%$
		211	5/2(-)	0.84	13 s 2	$\alpha > 93\%$ , $\epsilon < 7\%$
		212	0+	-0.19	13.0 s 2	$\alpha \approx 85\%$ , $\epsilon \approx 15\%$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
88	Ra	213	1/2-	0.36	2.74 m 6	$\alpha$ 80%, $\epsilon$ 20%
		213m		2.13	2.1 ms 1	IT=99%, $\alpha$ ≈1%
		214	0+	0.101	2.46 s 3	$\alpha$ 99.94%, $\epsilon$ 0.06%
		215	(9/2+)	2.533	1.55 ms 7	$\alpha$
		216	0+	3.291	182 ns 10	$\alpha$ , $\epsilon$ < 1.0×10 <sup>-8</sup> %
		217	(9/2+)	5.887	1.6 $\mu$ s 2	$\alpha$ ≈100%
		218	0+	6.65	25.2 $\mu$ s 3	$\alpha$
		219	(7/2+)	9.394	10 ms 3	$\alpha$
		220	0+	10.273	18 ms 2	$\alpha$
		221	5/2+	12.964	28 s 2	$\alpha$ , <sup>14</sup> C 1×10 <sup>-12</sup> %
		222	0+	14.321	38.0 s 5	$\alpha$ , <sup>14</sup> C 3.0×10 <sup>-8</sup> %
		223	3/2+	17.235	11.43 d 5	$\alpha$ , <sup>14</sup> C 8.9×10 <sup>-8</sup> %
		224	0+	18.827	3.6319 d 23	$\alpha$ , <sup>14</sup> C 4.0×10 <sup>-9</sup> %
		225	1/2+	21.994	14.9 d 2	$\beta$ -
		226	0+	23.669	1600 y 7	$\alpha$ , <sup>14</sup> C 3.2×10 <sup>-9</sup> %
		227	3/2+	27.179	42.2 m 5	$\beta$ -
		228	0+	28.942	5.75 y 3	$\beta$ -
		229	5/2(+)	32.56	4.0 m 2	$\beta$ -
		230	0+	34.52	93 m 2	$\beta$ -
		231	(5/2+)	38.4s	103 s 3	$\beta$ -
		232	0+	40.6s	250 s 50	$\beta$ -
		233		44.8s	30 s 5	$\beta$ -
		234	0+	47.2s	30 s 10	$\beta$ -
89	Ac	206m		13.51	11 ms +9-3	$\alpha$
		206m	(3+)	13.51	22 ms +9-5	$\alpha$
		206m	(10-)	13.51	33 ms +22-9	$\alpha$
		207	(9/2-)	11.13	27 ms +11-6	$\alpha$
		208	(3+)	10.76	95 ms +24-16	$\epsilon$ 1%, $\alpha$
		208m	(10-)	11.27	25 ms +9-5	IT<10%, $\epsilon$ 1%, $\alpha$
		209	(9/2-)	8.84	0.10 s 5	$\alpha$ ≈99%, $\epsilon$ ≈1%
		210		8.79	0.35 s 5	$\alpha$ 91%, $\epsilon$ ≈9%
		211		7.20	0.21 s 3	$\alpha$ ≈100%
		212		7.28	0.93 s 5	$\alpha$ ≈57%, $\epsilon$ ≈43%
		213		6.16	0.731 s 17	$\alpha$ ≤100%
		214		6.43	8.2 s 2	$\alpha$ ≥89%, $\epsilon$ ≤11%
		215	9/2-	6.01	0.17 s 1	$\alpha$ 99.91%, $\epsilon$ 0.09%
		216	(1-)	8.12	0.440 ms 16	$\alpha$
		217	9/2-	8.71	69 ns 4	$\alpha$ ≈100%, $\epsilon$ ≤2%
		217m	21/2-	10.24	<10 ns	IT≥99.6%, $\alpha$ ≤0.48%
		217m	(29/2)+	10.72	740 ns 40	IT 95.7%, $\alpha$ 4.3%
		218	(1-)	10.84	1.08 $\mu$ s 9	$\alpha$
		219	9/2-	11.57	11.8 $\mu$ s 15	$\alpha$
		220	(3-)	13.75	26.4 ms 2	$\alpha$ , $\epsilon$ 5.0×10 <sup>-4</sup> %
		221		14.52	52 ms 2	$\alpha$
		222	1-	16.621	5.0 s 5	$\alpha$ 99%, $\epsilon$ 1%
		222m		16.621	63 s 3	$\alpha$ ≥88%, IT≤10%, $\epsilon$ ≥0.7%
		223	(5/2-)	17.826	2.10 m 5	$\alpha$ 99%, $\epsilon$ 1%
		224	0-	20.235	2.78 h 17	$\epsilon$ 90.9%, $\alpha$ 9.1%, $\beta$ -<1.6%
		225	(3/2-)	21.638	10.0 d 1	$\alpha$ , <sup>14</sup> C 5×10 <sup>-10</sup> %
226	(1)	24.310	29.37 h 12	$\beta$ - 83%, $\epsilon$ 17%, $\alpha$ 6.0×10 <sup>-3</sup> %		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>89</b>	<b>Ac</b>	227	3/2-	25.851	21.772 y 3	$\beta^-$ 98.62%, $\alpha$ 1.38%
		228	3+	28.896	6.15 h 2	$\beta^-$
		229	(3/2+)	30.75	62.7 m 5	$\beta^-$
		230	(1+)	33.8	122 s 3	$\beta^-$
		231	(1/2+)	35.9	7.5 m 1	$\beta^-$
		232	(1+)	39.1	119 s 5	$\beta^-$
		233	(1/2+)	41.5s	145 s 10	$\beta^-$
		234		45.1s	44 s 7	$\beta^-$
		235		47.7s	$\approx$ 40 s	$\beta^-$ ?
		236		51.5s	$\approx$ 2 m	$\beta^-$ ?
<b>90</b>	<b>Th</b>	209	(5/2-)	16.50	3.8 ms +69-15	$\alpha$
		210	0+	14.04	9 ms +17-4	$\alpha$ 99%, $\epsilon \approx$ 1%
		211		13.91	0.04 s +3-1	$\alpha$
		212	0+	12.09	30 ms +20-10	$\alpha$ , $\epsilon \approx$ 0.3%
		213		12.12	140 ms 25	$\alpha \leq$ 100%
		214	0+	10.71	100 ms 25	$\alpha$
		215	(1/2-)	10.93	1.2 s 2	$\alpha$
		216	0+	10.30	0.028 s 2	$\alpha$ , $\epsilon \approx$ 0.01%
		217	(9/2+)	12.22	0.241 ms 5	$\alpha$
		217m	(15/2-)	12.89	141 ns 50	IT
		218	0+	12.37	109 ns 13	$\alpha$
		219		14.47	1.05 $\mu$ s 3	$\alpha$
		220	0+	14.67	9.7 $\mu$ s 6	$\alpha$ , $\epsilon \approx 2.0 \times 10^{-7}\%$
		221	(7/2+)	16.938	1.73 ms 3	$\alpha$
		222	0+	17.20	2.237 ms 13	$\alpha$
		223	(5/2+)	19.386	0.60 s 2	$\alpha$
		224	0+	20.00	0.81 s 10	$\alpha$
		225	(3/2+)	22.310	8.72 m 4	$\alpha \approx$ 90%, $\epsilon \approx$ 10%
		226	0+	23.197	30.57 m 10	$\alpha$
		227	1/2+	25.806	18.68 d 9	$\alpha$
		228	0+	26.772	1.9116 y 16	$\alpha$ , $^{20}\text{O} 1 \times 10^{-11}\%$
		229	5/2+	29.587	7340 y 160	$\alpha$
		229m		29.590	13.9 h 30	$\alpha$
230	0+	30.864	$7.538 \times 10^4$ y 30	$\alpha$ , SF $< 4. \times 10^{-11}\%$		
231	5/2+	33.817	25.52 h 1	$\beta^-$ , $\alpha \approx 4 \times 10^{-11}\%$		
232	0+	35.448	$1.405 \times 10^{10}$ y 6	$\alpha$ , SF $1.2 \times 10^{-8}\%$ , Ne		
			<b>100%</b>			
	233	1/2+	38.733	21.83 m 4	$\beta^-$	
	233m		40.583	50 ns +50-49	IT $\approx$ 100%	
	234	0+	40.614	24.10 d 3	$\beta^-$	
	235	(1/2+)	44.26	7.2 m 1	$\beta^-$	
	236	0+	46.5s	37.5 m 2	$\beta^-$	
	237	(5/2+)	50.2s	4.7 m 6	$\beta^-$	
	238	0+	52.6s	9.4 m 20	$\beta^-$	
<b>91</b>	<b>Pa</b>	212		21.61	5.1 ms +61-19	$\alpha \approx$ 100%
		213	(9/2-)	19.66	5.3 ms +40-16	$\alpha$
		214		19.49	17 ms 3	$\alpha$
		215		17.87	14 ms 2	$\alpha$
		216		17.80	105 ms 12	$\alpha \approx$ 98%, $\epsilon \approx$ 2%
		217		17.07	3.6 ms 8	$\alpha$
		217m		18.92	1.2 ms 2	$\alpha$ 73%, IT 27%
		218		18.67	0.113 ms 1	$\alpha$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>91 Pa</b>	219m	9/2-	18.52	53 ns 10	$\alpha$	
	221	9/2-	20.38	4.9 $\mu$ s 8	$\alpha$	
	222		22.12s	3.3 ms 3	$\alpha$	
	223		22.32	5.1 ms 6	$\alpha$	
	224		23.87	0.85 s 2	$\alpha$	
	225		24.34	1.7 s 2	$\alpha$	
	226		26.03	1.8 m 2	$\alpha$ 74%, $\epsilon$ 26%	
	227	(5/2-)	26.832	38.3 m 3	$\alpha$ 85%, $\epsilon$ 15%	
	228	3+	28.924	22 h 1	$\epsilon$ 98%, $\alpha$ 2%	
	229	(5/2+)	29.898	1.50 d 5	$\epsilon$ 99.52%, $\alpha$ 0.48%	
	230	(2-)	32.174	17.4 d 5	$\epsilon$ 91.6%, $\beta$ - 8.4%, $\alpha$ $3.2 \times 10^{-3}\%$	
	231	3/2-	33.426	$3.276 \times 10^4$ y 11	$\alpha$ , SF $\leq 3 \times 10^{-10}\%$	
	232	(2-)	35.948	1.31 d 2	$\beta$ -, $\epsilon$ $3.0 \times 10^{-3}\%$	
	233	3/2-	37.490	26.975 d 13	$\beta$ -	
	234	4+	40.341	6.70 h 5	$\beta$ -	
	234m	(0-)	40.415	1.17 m 3	$\beta$ - 99.84%, IT 0.16%	
	235	(3/2-)	42.33	24.44 m 11	$\beta$ -	
	236	1(-)	45.3	9.1 m 1	$\beta$ -	
	237	(1/2+)	47.6	8.7 m 2	$\beta$ -	
	238	(3-)	50.77	2.27 m 9	$\beta$ -, SF $< 2.6 \times 10^{-6}\%$	
	239	(3/2)	53.3s	1.8 h 5	$\beta$ -	
	240		56.8s	$\approx 2$ m	$\beta$ - ?	
	<b>92 U</b>	217		22.70	16 ms +21-6	$\alpha \leq 100\%$
		218	0+	21.92	1.5 ms +73-7	$\alpha$
219			23.21	42 $\mu$ s +34-13	$\alpha$	
220		0+	23.0s	$\approx 60$ ns	$\alpha?$ , $\epsilon?$	
221			24.6s	$\approx 0.7$ $\mu$ s	$\alpha?$ , $\epsilon?$	
222		0+	24.3s	1.0 $\mu$ s +10-4	$\alpha$	
223			25.84	18 $\mu$ s +10-5	$\alpha$ , $\epsilon$ 0.2%	
224		0+	25.71	0.9 ms 3	$\alpha$	
225			27.38	84 ms 4	$\alpha$	
226		0+	27.33	0.26 s 2	$\alpha$	
227		(3/2+)	29.02	1.1 m 1	$\alpha$	
228		0+	29.22	9.1 m 2	$\alpha > 95\%$ , $\epsilon < 5\%$	
229		(3/2+)	31.211	58 m 3	$\epsilon \approx 80\%$ , $\alpha \approx 20\%$	
230		0+	31.615	20.8 d	$\alpha$ , SF $< 1 \times 10^{-10}\%$	
231		(5/2-)	33.807	4.2 d 1	$\epsilon$ , $\alpha \approx 4.0 \times 10^{-3}\%$	
232		0+	34.611	68.9 y 4	$\alpha$ , Ne $9 \times 10^{-10}\%$ , Mg $< 5 \times 10^{-12}\%$ , SF $3 \times 10^{-12}\%$	
233		5/2+	36.920	$1.592 \times 10^5$ y 2	$\alpha$ , SF $< 6.0 \times 10^{-9}\%$	
234		0+	38.147	$2.455 \times 10^5$ y 6	$\alpha$ , SF $1.6 \times 10^{-9}\%$ , Mg $1 \times 10^{-11}\%$ , Ne $9 \times 10^{-12}\%$	
235	7/2-	40.921	$7.04 \times 10^8$ y 1	$\alpha$ , SF $7.0 \times 10^{-9}\%$ , Ne $\approx 8. \times 10^{-10}\%$ , 28 $8. \times 10^{-10}\%$		
235m	1/2+	40.921	$\approx 26$ m	IT		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	Decay Mode		
Z	El	A	(MeV)	Abundance			
92	U	236	0+	42.446	$2.342 \times 10^7$ y 3 $\alpha$ , SF $9.4 \times 10^{-8}\%$ , $^{30}\text{Mg}$		
		237	1/2+	45.392	6.75 d 1 $\beta^-$		
		238	0+	47.309	$4.468 \times 10^9$ y 3 <b>99.2742% 10</b> SF $5.5 \times 10^{-5}\%$		
		239	5/2+	50.574	23.45 m 2 $\beta^-$		
		240	0+	52.715	14.1 h 1 $\beta^-$		
		241		56.2s	$\approx 5$ m $\beta^-?$		
		242	0+	58.6s	16.8 m 5 $\beta^-$		
		93	Np	225	(9/2-)	31.59	$> 2$ $\mu$ s $\alpha$
				226		32.74s	35 ms 10 $\alpha$
				227		32.56	0.51 s 6 $\alpha$
				228		33.7s	61.4 s 14 $\epsilon$ 60%, $\alpha$ 40%
229				33.78	4.0 m 4 $\alpha$ 68%, $\epsilon$ 32%		
230				35.24	4.6 m 3 $\epsilon \leq 97\%$ , $\alpha \geq 3\%$		
231	(5/2)			35.63	48.8 m 2 $\epsilon$ 98%, $\alpha$ 2%		
232	(4+)			37.4s	14.7 m 3 $\epsilon$		
233	(5/2+)			37.95	36.2 m 1 $\epsilon$ , $\alpha \leq 1.0 \times 10^{-3}\%$		
234	(0+)			39.957	4.4 d 1 $\epsilon$		
235	5/2+			41.045	396.1 d 12 $\epsilon$ , $\alpha$ $2.6 \times 10^{-3}\%$		
236	(6-)			43.38	$154 \times 10^3$ y 6 $\epsilon$ 87.3%, $\beta^-$ 12.5%, $\alpha$ 0.16%		
236m	1			43.44	22.5 h 4 $\epsilon$ 52%, $\beta^-$ 48%		
237	5/2+			44.873	$2.144 \times 10^6$ y 7 $\alpha$ , SF $\leq 2 \times 10^{-10}\%$		
238	2+			47.456	2.117 d 2 $\beta^-$		
239	5/2+			49.312	2.356 d 3 $\beta^-$		
240	(5+)			52.31	61.9 m 2 $\beta^-$		
240m	(1+)	52.31	7.22 m 2 $\beta^-$ 99.88%, IT 0.12%				
241	(5/2+)	54.26	13.9 m 2 $\beta^-$				
242	(1+)	57.4	2.2 m 2 $\beta^-$				
242m	(6+)	57.4	5.5 m 1 $\beta^-$				
243	(5/2-)	59.88s	1.85 m 15 $\beta^-$				
244	(7-)	63.2s	2.29 m 16 $\beta^-$				
94	Pu	228	0+	36.09	1.1 s +20-5 $\alpha$		
		229	(3/2+)	37.40	$> 2$ $\mu$ s $\alpha$		
		230	0+	36.93	1.70 m 17 $\alpha$ 84%, $\epsilon$ 16%		
		231	(3/2+)	38.29	8.6 m 5 $\epsilon \leq 99.8\%$ , $\alpha > 0.2\%$		
		232	0+	38.37	33.1 m 8 $\epsilon$ 80%, $\alpha$ 20%		
		233		40.05	20.9 m 4 $\epsilon$ 99.88%, $\alpha$ 0.12%		
		234	0+	40.350	8.8 h 1 $\epsilon \approx 94\%$ , $\alpha \approx 6\%$		
		235	(5/2+)	42.18	25.3 m 5 $\epsilon$ , $\alpha$ $2.8 \times 10^{-3}\%$		
		235m		45.18	25 ns 5 SF $\leq 100\%$		
		236	0+	42.903	2.858 y 8 $\alpha$ , SF $1.9 \times 10^{-7}\%$		
		237	7/2-	45.093	45.2 d 1 $\epsilon$ , $\alpha$ $4.2 \times 10^{-3}\%$		
		237m	1/2+	45.239	0.18 s 2 IT		
		238	0+	46.165	87.7 y 1 $\alpha$ , SF $1.9 \times 10^{-7}\%$		
		239	1/2+	48.590	24110 y 30 $\alpha$ , SF $3. \times 10^{-10}\%$		
		239m	(5/2+)	51.690	7.5 $\mu$ s 10 SF $\leq 100\%$		
		239m	(9/2-)	51.893	2.6 ns +40-12 SF $\leq 100\%$		
		240	0+	50.127	6561 y 7 $\alpha$ , SF $5.7 \times 10^{-6}\%$		
240m	(0+)	50.127	3.6 ns 2 SF $> 0\%$				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode	
Z	El	A	(MeV)	Abundance		
<b>94 Pu</b>	241	5/2+	52.957	14.290 y 6	$\beta^-$ , $\alpha$ 2.5×10 <sup>-3%</sup> , SF>2.×10 <sup>-14%</sup>	
	242	0+	54.718	3.75×10 <sup>5</sup> y 2	$\alpha$ , SF 5.5×10 <sup>-4%</sup>	
	242m		56.718	3.5 ns 6	SF≤100%	
	242m		56.718	28 ns	SF≤100%	
	243	7/2+	57.756	4.956 h 3	$\beta^-$	
	243m		59.456	45 ns 15	SF	
	244	0+	59.806	8.00×10 <sup>7</sup> y 9	$\alpha$ 99.88%, SF 0.12%	
	244m		62.206	380 ps 80	SF≤100%	
	245	(9/2-)	63.11	10.5 h 1	$\beta^-$	
	246	0+	65.40	10.84 d 2	$\beta^-$	
	247		69.0s	2.27 d 23	$\beta^-$	
	<b>95 Am</b>	231		42.4s	≈10 s	$\epsilon$ ?, $\alpha$ ?
		232		43.4s	79 s 2	$\epsilon$ ≈98%, $\alpha$ ≈2%
		233		43.2s	3.2 m 8	$\alpha$ >3%, $\epsilon$
234			44.5s	2.32 m 8	$\epsilon$ >99.96%, $\alpha$ <0.04%	
235m			44.7s	10.3 m 6	$\epsilon$ 99.6%, $\alpha$ 0.4%	
236?			46.2s	3.6 m 1	$\alpha$ 0.004%, $\epsilon$	
236m			46.2s	0.6 y 2	$\epsilon$	
236m			46.2s	≥30 d	$\epsilon$	
237		5/2(-)	46.57s	73.0 m 10	$\epsilon$ 99.98%, $\alpha$ 0.03%	
238		1+	48.42	98 m 2	$\epsilon$ , $\alpha$ 1.0×10 <sup>-4%</sup>	
238m			48.42	3.8 y	$\alpha$	
239		(5/2)-	49.392	11.9 h 1	$\epsilon$ 99.99%, $\alpha$ 0.01%	
239m		(7/2+)	51.892	163 ns 12	SF≤100%	
240		(3-)	51.51	50.8 h 3	$\epsilon$ , $\alpha$ 1.9×10 <sup>-4%</sup>	
240m			54.51	0.94 ms 4	SF≤100%	
241		5/2-	52.936	432.2 y 7	$\alpha$ , SF 4×10 <sup>-10%</sup>	
242		1-	55.470	16.02 h 2	$\beta^-$ 82.7%, $\epsilon$ 17.3%	
242m		5-	55.518	141 y 2	IT 99.55%, $\alpha$ 0.45%, SF<4.7×10 <sup>-9%</sup>	
242m		(2+,3-)	57.670	14.0 ms 10	SF=100%, $\alpha$ <5.0×10 <sup>-3%</sup> , IT	
243		5/2-	57.176	7370 y 40	$\alpha$ , SF 3.7×10 <sup>-9%</sup>	
243m			59.476	5.5 $\mu$ s 5	SF≤100%	
244		(6-)	59.881	10.1 h 1	$\beta^-$	
244m			59.881	≈6.5 $\mu$ s	SF≤100%	
244m			59.881	0.90 ms 15	SF≤100%	
244m	1+	59.967	26 m 1	$\beta^-$ 99.96%, $\epsilon$ 0.04%		
245	(5/2)+	61.900	2.05 h 1	$\beta^-$		
246	(7-)	64.99	39 m 3	$\beta^-$		
246m	2(-)	64.99	25.0 m 2	$\beta^-$ , IT<0.02%		
246m		66.99	73 $\mu$ s 10	SF≤100%		
247	(5/2)	67.2s	23.0 m 13	$\beta^-$		
248		70.6s	≈10 m	$\beta^-$		
249		73.1s	≈2 m	$\beta^-$ ?		
<b>96 Cm</b>	232	0+		1 m ?	SF<30.3%	
	233		47.29		$\alpha$ , $\epsilon$	
	234	0+	46.72	≈2 m	$\epsilon$ ?, $\alpha$ ?	
	235		47.9s	5 m SY	$\epsilon$ ?, $\alpha$ ?	
	236	0+	47.9s	≈10 m	$\epsilon$ , $\alpha$	
	237		49.3s	≈20 m	$\epsilon$ ?, $\alpha$ ?	



## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>96 Cm</b>	238	0+	49.40	2.4 h 1	$\epsilon \geq 90\%$ , $\alpha \leq 10\%$	
	239	(7/2-)	51.2s	$\approx 2.9$ h	$\epsilon$ , $\alpha < 0.1\%$	
	240	0+	51.725	27 d 1	$\alpha > 99.5\%$ , $\epsilon < 0.5\%$ , SF $3.9 \times 10^{-6}\%$	
	240m		53.725	10 ps 3	SF $\leq 100\%$	
	240m		54.725	55 ns 12	SF $\approx 100\%$	
	241	1/2+	53.703	32.8 d 2	$\epsilon$ 99%, $\alpha$ 1%	
	242	0+	54.805	162.8 d 2	$\alpha$ , SF $6.2 \times 10^{-6}\%$ , $34.1 \times 10^{-14}\%$	
	242m	0+	54.805	40 ps 15	SF $\leq 100\%$	
	242m		57.605	180 ns 70	SF, IT	
	243	5/2+	57.184	29.1 y 1	$\alpha$ 99.71%, $\epsilon$ 0.29%, SF $5.3 \times 10^{-9}\%$	
	243m		59.084	42 ns 6	SF $\leq 100\%$	
	244	0+	58.454	18.1 y 1	$\alpha$ , SF $1.4 \times 10^{-4}\%$	
	244m	0+	58.454	>500 ns	SF $\leq 100\%$	
	244m	6+	59.494	34 ms 2	IT	
	245	7/2+	61.005	8500 y 100	$\alpha$ , SF $6.1 \times 10^{-7}\%$	
	246	0+	62.618	4760 y 40	$\alpha$ 99.97%, SF 0.03%	
	247	9/2-	65.534	$1.56 \times 10^7$ y 5	$\alpha$	
	248	0+	67.392	$3.48 \times 10^5$ y 6	$\alpha$ 91.61%, SF 8.39%	
	249	1/2(+)	70.750	64.15 m 3	$\beta^-$	
	250	0+	72.99	$\approx 8.3 \times 10^3$ y	SF = 74%, $\alpha \approx 18\%$ , $\beta^- \approx 8\%$	
	251	(1/2+)	76.65	16.8 m 2	$\beta^-$	
	252	0+	79.1s	<2 d	$\beta^-$	
	<b>97 Bk</b>	235		52.7s	$\approx 20$ s	$\epsilon$ ?, $\alpha$ ?
		236		53.4s	$\approx 42$ s	$\alpha$ ?, $\epsilon$ ?
		237		53.1s	$\approx 1$ m	$\epsilon$ ?, $\alpha$ ?
238			54.3s	144 s 5	$\epsilon$ , $\epsilon$ SF 0.048%	
240			55.7s	4.8 m 8	$\epsilon$ SF $2.0 \times 10^{-3}\%$ , $\epsilon$	
241		(7/2+)	56.1s	$\approx 3$ m	$\alpha$ ?, $\epsilon$ ?	
242			57.7s	7.0 m 13	$\epsilon \leq 100\%$	
242m			57.7s	9.5 ns 20	SF $\leq 100\%$	
242m			57.7s	600 ns 100	SF $\leq 100\%$	
243		(3/2-)	58.691	4.5 h 2	$\epsilon \approx 99.85\%$ , $\alpha \approx 0.15\%$	
243m			60.891	5 ns	SF $\leq 100\%$	
244		(4-)	60.72	4.35 h 15	$\epsilon$ 99.99%, $\alpha$ $6.0 \times 10^{-3}\%$	
244m			60.72	820 ns 60	SF $\leq 100\%$	
245		3/2-	61.815	4.94 d 3	$\epsilon$ 99.88%, $\alpha$ 0.12%	
246m		2(-)	63.97	1.80 d 2	$\epsilon$ , $\alpha < 0.2\%$	
247		(3/2-)	65.491	1380 y 250	$\alpha \leq 100\%$	
248			68.08s	>9 y	$\alpha$	
248m		1(-)	68.08s	23.7 h 2	$\beta^-$ 70%, $\epsilon$ 30%	
249		7/2+	69.850	330 d 4	$\beta^-$ , $\alpha$ $1.4 \times 10^{-3}\%$ , SF $4.7 \times 10^{-8}\%$	
250		2-	72.951	3.212 h 5	$\beta^-$	
251	(3/2-)	75.23	55.6 m 11	$\beta^-$		
252		78.5s	$\approx 2$ m	$\beta^-$ ?, $\alpha$ ?		
253		80.9s	$\approx 10$ m	$\beta^-$ ?		
254		84.4s	$\approx 2$ m	$\beta^-$ ?		

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$				
Z	El	A	(MeV)	Abundance	Decay Mode			
98	Cf	237	57.8s	2.1 s 3	SF ≈ 10%, $\alpha$ ?			
		238	57.2s	21 ms 2	SF ≈ 100%			
		239	58.1s	39 s +37-12	$\epsilon, \alpha$			
		240	58.0s	0.96 m 15	$\alpha$ ≈ 98%, SF ≈ 2%, $\epsilon$			
		241	59.4s	3.78 m 70	$\epsilon$ ≈ 75%, $\alpha$ ≈ 25%			
		242	0+	59.34	3.7 m 5	$\alpha$ 80%, $\epsilon$ 20%, SF ≤ 0.01%		
		243	(1/2+)	60.9s	10.7 m 5	$\epsilon$ ≈ 86%, $\alpha$ ≈ 14%		
		244	0+	61.479	19.4 m 6	$\alpha$ ≤ 100%		
		245	(1/2+,5/2+)	63.387	45.0 m 15	$\epsilon$ 64%, $\alpha$ 36%		
		246	0+	64.092	35.7 h 5	$\alpha, \epsilon$ < 4.0 × 10 <sup>-3</sup> %, SF 2.5 × 10 <sup>-4</sup> %		
		246m		66.592	45 ns 10	SF ≤ 100%		
		247	(7/2+)	66.137	3.11 h 3	$\epsilon$ 99.97%, $\alpha$ 0.04%		
		248	0+	67.240	333.5 d 28	$\alpha, \text{ SF } 2.9 \times 10^{-3}\%$		
		249	9/2-	69.726	351 y 2	$\alpha, \text{ SF } 5.0 \times 10^{-7}\%$		
		250	0+	71.172	13.08 y 9	$\alpha$ 99.92%, SF 0.08%		
		251	1/2+	74.135	898 y 44	$\alpha, \text{ SF}$		
		252	0+	76.034	2.645 y 8	$\alpha$ 96.91%, SF 3.09%		
		253	(7/2+)	79.301	17.81 d 8	$\beta$ - 99.69%, $\alpha$ 0.31%		
		254	0+	81.34	60.5 d 2	SF 99.69%, $\alpha$ 0.31%		
		255	(7/2+)	84.8s	85 m 18	$\beta$ -		
		256	0+	87.0s	12.3 m 12	SF, $\beta$ - < 1%, $\alpha$ ≈ 1.0 × 10 <sup>-6</sup> %		
		99	Es	240	64.2s	1 s SY	$\alpha?, \epsilon?$	
				241	(3/2-)	63.8s	8 s +6-5	$\alpha$
				242		65.0s	13.5 s 25	$\alpha > 0\%, \epsilon > 0\%$
				243		64.8s	21 s 2	$\epsilon \leq 70\%, \alpha \geq 30\%$
244				66.0s	37 s 4	$\epsilon$ 96%, $\alpha$ 4%		
245	(3/2-)			66.4s	1.1 m 1	$\epsilon$ 60%, $\alpha$ 40%		
246m				67.9s	7.7 m 5	$\epsilon$ 90.1%, $\alpha$ 9.9%, $\epsilon$ 3.0 × 10 <sup>-3</sup> %		
247	(7/2+)			68.61s	4.55 m 26	$\epsilon$ ≈ 93%, $\alpha$ ≈ 7%		
247m				68.61s	625 d 84	$\alpha$		
248	(2-,0+)			70.30s	27 m 5	$\epsilon$ 99.7%, $\alpha$ ≈ 0.25%		
249	7/2+			71.18s	102.2 m 6	$\epsilon$ 99.43%, $\alpha$ 0.57%		
250	(6+)			73.2s	8.6 h 1	$\epsilon > 97\%, \alpha < 3\%$		
250m	1(-)			73.2s	2.22 h 5	$\epsilon \leq 100\%$		
251	(3/2-)			74.512	33 h 1	$\epsilon$ 99.5%, $\alpha$ 0.5%		
252	(5-)			77.29	471.7 d 19	$\alpha$ 78%, $\epsilon$ 22%, $\beta$ - ≈ 0.01%		
253	7/2+			79.014	20.47 d 3	$\alpha, \text{ SF } 8.7 \times 10^{-6}\%$		
254	(7+)			81.992	275.7 d 5	$\alpha$ ≈ 100%, $\beta$ - 1.7 × 10 <sup>-4</sup> %, SF < 3.0 × 10 <sup>-6</sup> %, $\epsilon$		
254m	2+			82.072	39.3 h 2	$\beta$ - 98%, IT < 3%, $\alpha$ 0.32%, $\epsilon$ 0.08%, SF < 0.05%		
255	(7/2+)			84.09	39.8 d 12	$\beta$ - 92%, $\alpha$ 8%, SF 4.1 × 10 <sup>-3</sup> %		
256	(1+,0-)			87.2s	25.4 m 24	$\beta$ -		
256m	(8+)	87.2s	7.6 h	$\beta$ -				

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>99 Es</b>	257		89.4s	7.7 d 2	$\beta^-$ , SF
	258		92.7s	3 m SY	$\epsilon?$ , $\alpha?$
<b>100 Fm</b>	242	0+	68.4s	0.8 ms 2	SF $\leq 100\%$
	243	(7/2+)	69.3s	0.18 s +8-4	$\alpha \leq 100\%$
	244	0+	69.0s	3.3 ms 5	SF $\leq 100\%$
	245		70.2s	4.2 s 13	$\alpha \leq 100\%$ , SF $\leq 0.1\%$
	246	0+	70.14	1.1 s 2	$\alpha 92\%$ , SF 8%, $\epsilon \leq 1\%$
	247	(7/2+)	71.6s	29 s 1	$\alpha \geq 50\%$ , $\epsilon \leq 50\%$
	247m	(1/2+)	71.6s	4.3 s 4	$\alpha \leq 100\%$
	248	0+	71.91	36 s 2	$\alpha 93\%$ , $\epsilon 7\%$ , SF 0.1%
	249	(7/2+)	73.6s	2.6 m 7	$\epsilon 67\%$ , $\alpha 33\%$
	250	0+	74.07	30 m 3	$\alpha > 90\%$ , $\epsilon < 10\%$ , SF $6.9 \times 10^{-3}\%$
	250m	0+	74.07	1.8 s 1	IT $\geq 80\%$ , $\alpha < 20\%$ , SF $\leq 8.2 \times 10^{-5}\%$ , $\epsilon$
	251	(9/2-)	75.987	5.30 h 8	$\epsilon 98.2\%$ , $\alpha 1.8\%$
	252	0+	76.817	25.39 h 4	$\alpha$ , SF $2.3 \times 10^{-3}\%$
	253	(1/2)+	79.350	3.00 d 12	$\epsilon 88\%$ , $\alpha 12\%$
	254	0+	80.904	3.240 h 2	$\alpha 99.94\%$ , SF 0.06%
	255	7/2+	83.799	20.07 h 7	$\alpha$ , SF $2.4 \times 10^{-5}\%$
	256	0+	85.486	157.6 m 13	SF 91.9%, $\alpha 8.1\%$
	257	(9/2+)	88.590	100.5 d 2	$\alpha 99.79\%$ , SF 0.21%
	258	0+	90.4s	370 $\mu$ s 43	SF $\leq 100\%$
	259		93.7s	1.5 s 3	SF
260	0+	95.6s	$\approx 4$ ms	SF	
<b>101 Md</b>	245	(1/2-)	75.3s	0.90 ms 25	$\alpha$ , SF
	245m		75.6s	0.35 s +23-16	$\alpha$ , $\epsilon$
	246m		76.3s	1.0 s 4	SF, $\alpha > 0\%$ , $\epsilon > 0\%$
	247		76.0s	1.12 s 22	$\alpha \leq 100\%$
	248		77.1s	7 s 3	$\epsilon 80\%$ , $\alpha 20\%$ , SF $\leq 0.05\%$
	249		77.3s	24 s 4	$\alpha > 60\%$ , $\epsilon \leq 40\%$
	250		78.6s	52 s 6	$\epsilon 93\%$ , $\alpha 7\%$
	251		79.0s	4.0 m 5	$\epsilon \geq 90\%$ , $\alpha \leq 10\%$
	252		80.6s	2.3 m 8	$\epsilon \leq 100\%$
	253	(1/2-)	81.3s	6 m +12-3	$\epsilon \leq 100\%$ , $\alpha$
	254m		83.5s	10 m 3	$\epsilon \leq 100\%$
	254m		83.5s	28 m 8	$\epsilon \leq 100\%$
	255	(7/2-)	84.843	27 m 2	$\epsilon 92\%$ , $\alpha 8\%$ , SF $< 0.15\%$
	256	(1-)	87.62	77 m 2	$\epsilon 90.8\%$ , $\alpha 9.2\%$ , SF $< 3\%$
	257	(7/2-)	88.996	5.52 h 5	$\epsilon 85\%$ , $\alpha 15\%$ , SF $< 1\%$
	258		91.688	51.5 d 3	$\alpha$ , SF
	258m		91.688	57.0 m 9	$\epsilon \geq 70\%$ , SF
	259		93.6s	96 m 3	SF $\approx 100\%$ , $\alpha < 1.3\%$
	260		96.6s	31.8 d 5	SF $\geq 42\%$ , $\alpha \leq 25\%$ , $\epsilon \leq 23\%$ , $\beta^- \leq 10\%$
	261		98.5s	40 m SY	$\alpha?$
262		101.4s	3 m SY	SF?, $\alpha?$	
<b>102 No</b>	248	0+	80.7s	$< 2$ $\mu$ s	SF?

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$	Decay Mode
Z	El	A	(MeV)	Abundance	
<b>102 No</b>	249		81.8s	54 $\mu$ s +15-10	SF
	250	0+	81.5s	6 $\mu$ s 1	SF $\leq 100\%$ , $\alpha$ 0.1%, $\epsilon$ 1.0 $\times 10^{-3}\%$
	251	(7/2+)	82.9s	0.78 s 2	$\alpha \leq 100\%$ , SF $\leq 8\%$ , $\epsilon$
	251m	(1/2+)	83.0s	0.93 s 6	$\alpha \leq 100\%$
	252	0+	82.88	2.27 s 14	$\alpha$ 58%, $\epsilon$ 23%, SF 19%
	252m		82.88	26 d 7	$\alpha$
	253	(9/2-)	84.5s	1.62 m 15	$\alpha \leq 100\%$ , $\epsilon$
	254	0+	84.72	51 s 10	$\alpha$ 90%, $\epsilon$ 10%, SF 0.17%
	254m	0+	84.72	0.28 s 4	IT > 80%
	255	(1/2+)	86.85	3.1 m 2	$\alpha$ 61%, $\epsilon$ 39%
	256	0+	87.824	2.91 s 5	$\alpha$ 99.47%, SF 0.53%
	257	(7/2+)	90.24	25 s 3	$\alpha \leq 100\%$ , SF $\leq 1.5\%$
	258	0+	91.5s	1.2 ms 2	SF $\leq 100\%$
	259		94.1s	58 m 5	$\alpha$ 75%, $\epsilon$ 25%, SF < 10%
	260	0+	95.6s	106 ms 8	SF
	261		98.5s		$\beta^-$ , $\alpha$
	262	0+	100.0s	$\approx 5$ ms	SF
	263		103.0s	20 m SY	$\alpha?$ , SF?
	264	0+	104.6s	1 m SY	$\alpha?$
	<b>103 Lr</b>	251		87.9s	
252			88.8s	0.36 s +11-7	$\alpha \approx 90\%$ , $\epsilon \approx 10\%$ , SF < 1%
253			88.7s	0.57 s +7-6	$\alpha$ , SF < 2%
253m			88.7s	1.5 s +3-2	$\alpha$ 90%, SF < 2%
254			89.8s	13 s 3	$\alpha$ 76%, $\epsilon$ 24%
255			90.1s	22 s 4	$\alpha$ 85%, $\epsilon$ < 30%, SF $\leq 0.1\%$
256			91.9s	27 s 3	$\alpha$ 85%, $\epsilon$ 15%, SF < 0.03%
257			92.7s	0.646 s 25	$\alpha \leq 100\%$ , SF $\leq 0.03\%$
258			94.8s	4.1 s 3	$\alpha > 95\%$ , SF < 5%
259			95.85s	6.2 s 3	$\alpha$ 78%, SF 22%
260			98.3s	180 s 30	$\alpha$ 80%, $\epsilon$ < 40%, SF < 10%
261			99.6s	39 m 12	SF
262			102.1s	$\approx 4$ h	SF < 10%, $\epsilon$ , $\alpha$
263			103.7s	5 h SY	$\alpha?$
264			106.2s	10 h SY	$\alpha?$ , SF?
265		107.9s	10 h SY	$\alpha?$ , SF?	
266		111.1s	1 h SY	$\alpha?$ , SF?	
<b>104 Rf</b>	253m		93.8s	48 $\mu$ s +17-10	SF $\leq 100\%$ , $\alpha$
	253m		93.8s	$\approx 1.8$ s	SF $\approx 50\%$ , $\alpha \approx 50\%$
	254	0+	93.3s	23 $\mu$ s 3	SF $\leq 100\%$
	255	(9/2-)	94.4s	1.64 s 11	SF 52%, $\alpha$ 48%
	255m		94.4s	0.8 s +5-2	$\alpha \leq 100\%$
	256	0+	94.24	6.4 ms 2	SF 99.68%, $\alpha$ 0.32%
	257	(1/2+)	95.9s	4.7 s 3	$\alpha$ < 100%, SF $\leq 1.4\%$ , $\epsilon > 0\%$
	257m		95.9s	3.9 s 4	$\alpha$ < 100%, SF $\leq 1.4\%$ , $\epsilon > 0\%$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}, \Gamma, \text{ or}$			
Z	El	A	(MeV)	Abundance	Decay Mode		
104	Rf	258	0+	96.4s	12 ms 2	SF 87%, $\alpha$ 13%	
		259		98.40s	3.2 s 6	$\alpha$ 92%, SF 8%	
		260	0+	99.1s	21 ms 1	SF $\leq$ 100%, $\alpha$ ?	
		261		101.32	65 s 10	$\alpha$ > 80%, $\epsilon$ < 15%, SF < 10%	
		262	0+	102.4s	2.3 s 4	SF $\leq$ 100%, $\alpha$ < 3%	
		263		104.8s	10 m 2	SF $\approx$ 100%, $\alpha$	
		264	0+	106.2s	1 h SY	$\alpha$ ?	
		265		108.7s	$\approx$ 13 h	$\alpha$ ?	
		266	0+	109.9s	10 h SY	$\alpha$ ?, SF ?	
		267		113.2s	2.3 h +980-17	SF	
		268	0+	115.2s	6 h SY	$\alpha$ ?, SF ?	
	105	Db	255		100.0s	1.6 s +6-4	$\alpha$ $\approx$ 80%, SF $\approx$ 20%
			256		100.7s	1.6 s +5-3	$\alpha$ $\approx$ 64%, $\epsilon$ $\approx$ 36%, SF = 0.02%
			257		100.3s	1.50 s +19-15	$\alpha$ > 94%, SF < 6%
		257m		100.3s	0.76 s +15-11	$\alpha$ $\geq$ 87%, SF $\leq$ 13%	
		258		101.7s	4.0 s 10	$\alpha$ 67%, $\epsilon$ 33%, SF < 1%	
		258m		101.7s	20 s 10	$\epsilon$ $\approx$ 100%	
		259		102.1s	0.51 s 16	$\alpha$	
		260		103.7s	1.52 s 13	$\alpha$ $\geq$ 90.4%, SF $\leq$ 9.6%, $\epsilon$ < 2.5%	
		261		104.4s	1.8 s 4	$\alpha$ $\geq$ 82%, SF $\leq$ 18%	
		262		106.3s	35 s 5	$\alpha$ $\approx$ 67%, SF	
		263		107.1s	27 s +10-7	SF 55%, $\alpha$ 41%, $\epsilon$ 3%	
		264		109.4s	3 m SY	$\alpha$ ?	
		265		110.5s	15 m SY	$\alpha$ ?	
		266		112.7s	20 m SY	$\alpha$ ?, SF ?	
		267		114.0s	73 m +350-33	SF	
		268		116.9s	16 h +19-6	SF, $\alpha$ ?, $\epsilon$ ?	
		269		118.7s	3 h SY	$\alpha$ ?, SF ?	
106		Sg	258	0+	105.4s	2.9 ms +13-7	SF $\leq$ 100%, $\alpha$ ?
	259		(1/2+)	106.7s	0.48 s +28-13	$\alpha$ 90%, SF < 20%	
		260	0+	106.58	3.6 ms 9	$\alpha$ 50%, SF 50%	
		261		108.2s	0.23 s 6	$\alpha$ $\approx$ 100%, SF < 1%	
		262	0+	108.4s	6.9 ms +38-18	SF $\geq$ 78%, $\alpha$ $\leq$ 22%	
		263		110.2s	1.0 s 2	$\alpha$ > 70%, SF < 30%	
		263m		110.2s	0.12 s	$\alpha$ , IT	
		264	0+	110.8s	0.4 s SY	$\alpha$ ?	
		265	(9/2+)	112.82	8 s 3	SF $\leq$ 57%, $\alpha$ $\geq$ 43%	
		266	0+	113.7s	21 s +20-12	SF > 50%, $\alpha$ > 18%	
		269m		119.9s	22 s +32-11	$\alpha$ < 100%, SF	
		271		124.3s	2.4 s +43-10	SF 50%, $\alpha$ 50%	
		272	0+	125.9s	1 h SY	$\alpha$ ?, SF ?	
		273		128.8s	1 m SY	SF ?	
107	Bh	260		113.6s	0.3 ms SY	$\alpha$ $\leq$ 100%	
		261		113.3s	12 ms +5-3	$\alpha$ 95%, SF < 10%	
		262m		114.5s	8.0 ms 21	$\alpha$ $\leq$ 100%	
		262m		114.5s	102 ms 26	$\alpha$ $\leq$ 100%	
		263		114.6s	0.2 ms SY	$\alpha$ ?	
		264		116.1s	0.44 s +60-16	$\alpha$ $\leq$ 100%	

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or	
Z	El	A	(MeV)	Abundance	Decay Mode
<b>107 Bh</b>	265		116.6s	0.9 s +7-3	$\alpha$
	266		118.2s	<10 s	$\alpha \leq 100\%$
	267		118.9s	17 s +14-6	$\alpha$
	271		125.9s	40 s SY	$\alpha$
	272		128.6s	9.8 s +117-35	$\alpha$
	273		130.1s	90 m SY	$\alpha?$ , SF?
	274		132.7s	90 m SY	$\alpha?$ , SF?
	275		134.4s	40 m SY	SF?
<b>108 Hs</b>	263		119.8s		$\alpha \leq 100\%$
	264	0+	119.60	$\approx 0.8$ ms	$\alpha \approx 50\%$ , SF $\approx 50\%$
	265		121.2s	2.0 ms +3-2	$\alpha \approx 100\%$ , SF $\leq 1\%$
	266	0+	121.2s	2.3 ms +13-6	$\alpha \leq 100\%$
	267m		122.8s	26 ms +20-10	$\alpha$
	269m		124.9s	9 s 4	$\alpha \approx 100\%$
	273m		132.3s	1.2 s +17-6	$\alpha$ , SF
	274	0+	133.3s	1 m SY	$\alpha?$ , SF?
	275		136.0s	0.15 s +27-6	$\alpha$
	276	0+	137.1s	1 h SY	$\alpha?$ , SF?
277m		139.6s	12 m +54-6	SF, $\alpha$	
<b>109 Mt</b>	265		126.8s	2 m SY	$\alpha?$
	266		127.9s	1.7 ms +18-16	$\alpha \leq 100\%$
	267		127.9s	10 ms SY	$\alpha?$
	268m		129.2s	0.07 s +10-3	$\alpha$
	274		137.4s	20 s SY	$\alpha?$ , SF?
	275		138.5s	9.7 ms +46-44	$\alpha$
	276		140.8s	0.72 s +87-27	$\alpha$
	279		145.5s	6 m SY	$\alpha?$ , SF?
<b>110 Ds</b>	267m		134.5s	3 $\mu$ s +6-2	$\alpha$
	268	0+	133.9s	100 $\mu$ s SY	
	269m		135.2s	0.17 ms +17-6	$\alpha$
	271m		136.1s	0.06 s +27-3	$\alpha$
	271m		136.1s	1.1 ms +6-3	$\alpha$
	272	0+	136.3s	$\approx 8.6$ ms	SF
	273m		138.7s	0.18 ms +40-12	$\alpha$
	273m		138.9s	$\approx 120$ ms	$\alpha$
	274	0+	139.3s	2 s SY	$\alpha?$ , SF?
	275		141.8s	2 s SY	$\alpha?$
	276	0+	142.6s	5 s SY	$\alpha?$ , SF?
	277m		145.0s	3.0 ms +47-15	$\alpha$ , SF
	279		148.0s	0.28 s +5-3	SF 90%, $\alpha$ 10%
280	0+	148.8s	11 s 6	SF	
281		151.0s	9.6 s +50-25	SF	
281m		151.0s	1.1 m +50-6	$\alpha$	
<b>111 Rg</b>	272m		143.1s	1.5 ms +20-5	$\alpha$
	273		143.2s	5 ms SY	$\alpha?$
	274		145.1s	5 ms SY	$\alpha?$ , SF?
	275		145.4s	10 ms SY	$\alpha?$
	276		147.6s	100 ms SY	$\alpha?$ , SF?
	277		148.6s	1 s SY	$\alpha?$ , SF?
	278		150.5s	1 s SY	$\alpha?$ , SF?
	279		151.3s	0.17 s +81-8	$\alpha$

## Nuclear Wallet Cards

Nuclide			$\Delta$	$T_{1/2}$ , $\Gamma$ , or		
Z	El	A	(MeV)	Abundance	Decay Mode	
<b>111</b>	<b>Rg</b>	280	153.2s	3.6 s +43-13	$\alpha$	
		281	154.0s	1 m SY	$\alpha?$ , SF?	
		282	156.0s	4 m SY	$\alpha?$ , SF?	
		283	156.9s	10 m SY	$\alpha?$ , SF?	
<b>112</b>		277	152.7s	1.1 ms 7	$\alpha$	
		278	0+	153.1s	10 ms SY	$\alpha?$ , SF?
		279		155.1s	0.1 s SY	$\alpha?$ , SF?
		280	0+	155.6s	1 s SY	$\alpha?$ , SF?
		281		157.7s	10 s SY	$\alpha?$
		282	0+	158.1s	0.50 ms +33-14	SF
		283		160.0s	4.0 s +13-7	SF $\leq$ 10%
		283	RG	160.0s	4.0 s +13-7	$\alpha$
		284	0+	160.6s	101 ms +41-22	SF
		285		162.2s	34 s +17-9	$\alpha$
<b>113</b>		283		164.4s	0.10 s +49-5	$\alpha$
		284		165.9s	0.48 s +58-17	$\alpha$
		285		166.5s	2 m SY	$\alpha?$ , SF?
		286		168.1s	5 m SY	$\alpha?$ , SF?
		287		168.6s	20 m SY	$\alpha?$ , SF?
<b>114</b>		285		171.s	5 s SY	$\alpha?$
		286	0+	171.3s	0.16 s +7-3	SF 60%, $\alpha$ 40%
		287		172.9s	0.51 s +18-10	$\alpha$
		288	0+	173.0s	0.80 s +32-18	$\alpha$
		289		174.4s	2.7 s +14-7	$\alpha$
<b>115</b>		287		178.1s	32 ms +155-14	$\alpha$
		288		179.3s	87 ms +105-30	$\alpha$
		289		180.s	10 s SY	$\alpha?$ , SF?
		290		180.8s	10 s SY	$\alpha?$ , SF?
		291		181.1s	1 m SY	$\alpha?$ , SF?
<b>116</b>		289		185.s	10 ms SY	$\alpha?$
		290	0+	185.0s	15 ms +26-6	$\alpha$
		291		186.3s	6.3 ms +116-25	$\alpha$
		292	0+	186.1s	18 ms +16-6	$\alpha$
		293			53 ms +62-19	$\alpha$
<b>117</b>		291		192.4s	10 ms SY	$\alpha?$ , SF?
		292		193.3s	50 ms SY	$\alpha?$ , SF?
<b>118</b>		293		200.	5 ms SY	$\alpha?$
		294	0+		1.8 ms +750-13	$\alpha$





### Appendix-I Table of Elemental Properties

Z	El	Atomic Weight <sup>a</sup>	Density (g/cc) <sup>b</sup>	Melting Pt. (°C) <sup>b</sup>	Boiling Pt. (°C) <sup>b</sup>	Valence <sup>b</sup>
1	H	1.00794 7	8.988×10 <sup>-5d</sup>	-259.34	-252.87	1
2	He	4.002602 2	1.785×10 <sup>-4f</sup>	<-272.2 (26 atm)	-268.93	0
3	Li	6.941 2	0.534 <sup>c</sup>	180.5	1342	1
4	Be	9.012182 3	1.848 <sup>c</sup>	1287	2471 (5 mm)	2
5	B	10.811 7	2.34 <sup>h</sup>	2075	4000 (subl.)	3
6	C	12.0107 8	1.8 to 2.1 <sup>i</sup>	≈3550	4827	2,3,4
7	N	14.0067 2	0.0012506 <sup>j</sup>	-210.00	-198.79	3,5
8	O	15.9994 3	0.001308 <sup>k</sup>	-218.79	-182.953	2
9	F	18.9984032 5	0.001696	-219.62 <sup>g</sup>	-188.12 <sup>g</sup>	1
10	Ne	20.1797 6	8.9990×10 <sup>-4</sup>	-248.59	-246.08 <sup>g</sup>	0
11	Na	22.989770 2	0.971 <sup>c</sup>	97.80	883	1
12	Mg	24.3050 6	1.738 <sup>c</sup>	650	1090	2
13	Al	26.981538 2	2.6989 <sup>c</sup>	660.32	2519	3
14	Si	28.0855 3	2.33 <sup>e</sup>	1414	3265	4
15	P	30.973761 2	1.82 <sup>l</sup>	44.15 <sup>l</sup>	280.5 <sup>l</sup>	3,5
16	S	32.065 5	2.07 <sup>cm</sup>	115.21 <sup>m</sup>	444.60	2,4,6
17	Cl	35.453 2	0.003214	-101.5	-34.04	1,3,5,7
18	Ar	39.948	0.0017837	-189.35	-185.85	0
19	K	39.0983	0.862 <sup>c</sup>	63.38	759	1
20	Ca	40.078 4	1.55 <sup>c</sup>	842	1484	2
21	Sc	44.955910 8	2.989 <sup>e</sup>	1541	2836	3
22	Ti	47.867	4.54	1668	3287	2 to 4
23	V	50.9415	6.11 (18.7°C)	1910	3407	2 to 5
24	Cr	51.9961 6	7.18 to 7.20 <sup>c</sup>	1907	2671	2,3,6
25	Mn	54.938049 9	7.21 to 7.44 <sup>n</sup>	1246	2061	1 to 4,6,7
26	Fe	55.845 2	7.874 <sup>c</sup>	1538	2861	2,3,4,6
27	Co	58.933200 9	8.9 <sup>c</sup>	1495	2927	2,3
28	Ni	58.6934 2	8.902 <sup>e</sup>	1455	2913	0 to 3
29	Cu	63.546 3	8.96 <sup>c</sup>	1084.62	2562	1,2
30	Zn	65.39 2	7.133 <sup>e</sup>	419.53	907	2
31	Ga	69.723	5.904 (29.6°C)	29.76	2204	2,3
32	Ge	72.64	5.323 <sup>e</sup>	938.25	2833	2,4
33	As	74.92160 2	5.73 <sup>o</sup>	817 <sup>o</sup> (28 atm)	614 <sup>o</sup> (subl.)	0,±3,5
34	Se	78.96 3	4.79 <sup>p</sup>	221 <sup>p</sup>	685 <sup>p</sup>	-2,4,6
35	Br	79.904	3.12 <sup>u</sup>	-7.2	58.8	1,3,5,7
36	Kr	83.80	0.003733	-157.36	-153.22	0
37	Rb	85.4678 3	1.532 <sup>c</sup>	39.31	688	1
38	Sr	87.62	2.54	777	1382	2
39	Y	88.90585 2	4.469 <sup>e</sup>	1522	3345	3
40	Zr	91.224 2	6.506 <sup>c</sup>	1855	4409	2 to 4
41	Nb	92.90638 2	8.57 <sup>c</sup>	2477	4744	2,3,4?,5
42	Mo	95.94	10.22 <sup>c</sup>	2623	4639	2 to 6
43	Tc	(98)	11.50 <sup>t</sup>	2157	4265	0,2,4 to 7
44	Ru	101.07 2	12.41 <sup>c</sup>	2334	4150	0 to 8
45	Rh	102.90550 2	12.41 <sup>c</sup>	1964	3695	3

### Appendix-I Table of Elemental Properties

Z	El	Atomic Weight <sup>a</sup>	Density (g/cc) <sup>b</sup>	Melting Pt. (°C) <sup>b</sup>	Boiling Pt. (°C) <sup>b</sup>	Valence <sup>b</sup>
46	Pd	106.42	12.02 <sup>c</sup>	1554.9	2963	2 to 4
47	Ag	107.8682 2	10.50 <sup>c</sup>	961.78	2162	1
48	Cd	112.411 8	8.65 <sup>c</sup>	321.07	767	2
49	In	114.818 3	7.31 <sup>c</sup>	156.60	2072	1 to 3
50	Sn	118.710 7	5.75 <sup>q</sup>	231.93	2602	2,4
51	Sb	121.760	6.691 <sup>c</sup>	630.63	1587	0,±3,5
52	Te	127.60 3	6.24 <sup>c</sup>	449.51	988	2,4,6
53	I	126.90447 3	4.93 <sup>v</sup>	113.7	184.4	1,3,5,7
54	Xe	131.293 6	0.005887	-111.79	-108.12	0
55	Cs	132.90545 2	1.873 <sup>c</sup>	28.44	671	1
56	Ba	137.327 7	3.5 <sup>c</sup>	727	1897	2
57	La	138.9055 2	6.145 <sup>e</sup>	918	3464	3
58	Ce	140.116	6.770 <sup>e</sup>	798	3424	3,4
59	Pr	140.90765 2	6.773 <sup>r</sup>	931	3520	3
			6.64 <sup>s</sup>			
60	Nd	144.24 3	7.008	1021	3074	3
61	Pm	(145)	7.264 <sup>e</sup>	1042	3000	3
62	Sm	150.36 3	7.520 <sup>r</sup>	1072	1790	2,3
			7.40 <sup>s</sup>			
63	Eu	151.964	5.244 <sup>e</sup>	822	1596	2,3
64	Gd	157.25 3	7.901 <sup>e</sup>	1313	3273	3
65	Tb	158.92534 2	8.230	1356	3230	3,4
66	Dy	162.50 3	8.551 <sup>e</sup>	1412	2567	3
67	Ho	164.93032 2	8.795 <sup>e</sup>	1474	2700	3
68	Er	167.259 3	9.066 <sup>e</sup>	1529	2868	3
69	Tm	168.93421 2	9.321 <sup>e</sup>	1545	1950	3
70	Yb	173.04 3	6.903 <sup>r</sup>	819	1196	2,3
			6.966 <sup>s</sup>			
71	Lu	174.967	9.841 <sup>e</sup>	1663	3402	3
72	Hf	178.49 2	13.31 <sup>c</sup>	2233	4603	4
73	Ta	180.9479	16.654	3017	5458	2?,3,4?,5
74	W	183.84	19.3 <sup>c</sup>	3422	5555	2 to 6
75	Re	186.207	21.02 <sup>c</sup>	3186	5596	4,6,7
					(est.)	
76	Os	190.23 3	22.57	3033	5012	0 to 8
77	Ir	192.217 3	22.42	2446	4428	3,4
			(17°C)			
78	Pt	195.078 2	21.45 <sup>c</sup>	1768.4	3825	1?,2,3
79	Au	196.96655 2	≈19.3 <sup>c</sup>	1064.18	2856	1,3
80	Hg	200.59 2	13.546 <sup>c</sup>	-38.83	356.73	1,2
81	Tl	204.3833 2	11.85 <sup>c</sup>	304	1473	1,3
82	Pb	207.2	11.35 <sup>c</sup>	327.46	1749	2,4
83	Bi	208.98038 2	9.747 <sup>c</sup>	271.40	1564	3,5
84	Po	(209)	9.32 <sup>r</sup>	254	962	0,±2,3?,4,6
85	At	(210)		300 <sup>t</sup>		1,3,5,7
86	Rn	(222)	0.00973	-71	-61.7	0
87	Fr	(223)		27		1
88	Ra	(226)	5	700		2
89	Ac	(227)	10.07 <sup>t</sup>	1051	3198	3
90	Th	232.03801	11.72	1750	4788	2?,3?,4
91	Pa	(231)	15.37 <sup>t</sup>	1572		4,5

## Appendix-I Table of Elemental Properties

Z	El	Atomic Weight <sup>a</sup>	Density (g/cc) <sup>b</sup>	Melting Pt. (°C) <sup>b</sup>	Boiling Pt. (°C) <sup>b</sup>	Valence <sup>b</sup>
92	U	238.02891 3	≈18.95	1135	4131	2 to 6
93	Np	(237)	20.25 <sup>c</sup>	644		3 to 6
94	Pu	(244)	19.84 <sup>e</sup>	640	3228	3, to 6
95	Am	(243)	13.67 <sup>c</sup>	1176	2011	2 to 6
96	Cm	(247)	13.51 <sup>t</sup>	1345		3,4
97	Bk	(247)	14 <sup>t</sup>	1050		3,4
98	Cf	(251)		900		3
99	Es	(252)		860 <sup>t</sup>		3
100	Fm	(257)		1527		3
101	Md	(258)		827		2,3
102	No	(259)		827		2,3

### Footnotes and References

a) Atomic weights of many elements are not invariant and depend on the origin and treatment of the material. The values given here apply to elements as they exist naturally on earth and are from N. E. Holden, *Handbook of Chemistry and Physics* (2002). Uncertainty is 1 in last significant figure, unless expressly given.

Masses are scaled to 12 for <sup>12</sup>C.

Parenthetical whole numbers represent the mass numbers (A) of the longest lived isotopes for radioactive elements.

Isotopic masses (and more precise atomic weights for some mono-isotopic elements) may be calculated as  $A + (\Delta/931.494)$ , where A is the mass number and  $\Delta$  is the mass excess as given in the *Nuclear Wallet Cards*.

b) C.R. Hammond, in *CRC Handbook of Chemistry and Physics, 85th edition, 2004*, 4-1, 4-121. Where specified, exact temperature and pressure conditions are given; the conditions for all gases have been inferred to be 0°C and 1 atm. The densities for the following gaseous elements are for diatomic molecules: H, N, O, F, Cl. In general, densities for gases (in g/cc) may be approximated by the formula:  $\text{density} = MP/82.05T$ , where M is the molecular weight in g, P the pressure in atm, and T the temperature in °K. The reported oxidation states do not include some uncommon states, or those states predicted by periodicity, but not confirmed chemically.

c) At 20°C.

d) For gas; density (liquid)=0.0708 g/cc at b.p.; density (solid)=0.0706 g/cc at -262°C.

f) For gas; density (liquid)=0.1221 g/cc at b.p.

e) At 25°C.

f) For gas; density (liquid)=1.221 g/cc at b.p.

g) At 1 atm.

## Appendix-I Table of Elemental Properties

- h) For crystal form; density (amorphous)=2.37 g/cc.
- i) For amorphous carbon; density (graphite)=1.9 to 2.3 g/cc; density (gem diamond)=3.513 g/cc at 25°C; density (other diamond)=3.15 to 3.53 g/cc.
- j) For gas; density (liquid)=0.808 g/cc at b.p.; density (solid)=1.026 g/cc at -252°C.
- k) For gas; density (liquid)=1.14 g/cc at b.p.
- l) For white phosphorus; density (red)=2.20 g/cc; density (black)=2.25 to 2.69 g/cc.
- m) For rhombic sulfur; melting point (monoclinic)=119.0°C; density (monoclinic)=1.957 g/cc at 20°C.
- n) Depending on allotropic form.
- o) For gray arsenic; density (yellow)=1.97 g/cc.
- p) For gray selenium; density (vitreous)=4.28 g/cc.
- q) For gray tin; density (white)=7.13 g/cc.
- r) For  $\alpha$  modification.
- s) For  $\beta$  modification.
- t) Calculated.
- u) For liquid at 20°C; 0.00759 g/cc for gas.
- v) For solid at 20°C; 0.01127 g/cc for gas.

## Appendix-II Frequently-Used Constants

The frequently used constants are given below in familiar units. Only approximate values are given, see App-III for values to current known precision.

Symbol	Constant	Value
$1/\alpha = \hbar c/e^2$	Fine structure constant	137.0
$c$	Speed of light in vacuum	$2.998 \times 10^{10}$ cm/s
$h$	Planck constant	$6.626 \times 10^{-27}$ erg s
$\hbar = h/2\pi$		$6.582 \times 10^{-22}$ MeV s
$\hbar c$		197.3 MeV fm
$k = R/N_A$	Boltzmann constant	$8.617 \times 10^{-11}$ MeV/K
$r_e = e^2/m_e c^2$	Classical $e^-$ radius	2.818 fm
$\lambda_{C,e} = \hbar/m_e c$	Compton wavelength of $e^-$	386.2 fm
$\lambda_{C,p} = \hbar/m_p c$	Compton wavelength of p	0.210 fm
$\lambda_{C,\pi} = \hbar/m_\pi c$	Compton wavelength of $\pi$	1.414 fm
$u$	Atomic mass unit	931.5 MeV/c <sup>2</sup>
$m_e$	Electron mass	0.511 MeV/c <sup>2</sup>
$m_n$	Neutron mass	939.6 MeV/c <sup>2</sup>
$m_p$	Proton mass	938.3 MeV/c <sup>2</sup>
$m_d$	Deuteron mass	1875.6 MeV/c <sup>2</sup>
$m_{\pi^\pm}$	$\pi^\pm$ mass	139.6 MeV/c <sup>2</sup>
$m_{\pi^0}$	$\pi^0$ mass	135.0 MeV/c <sup>2</sup>
$m_W$	$W^\pm$ boson mass	80.2 GeV/c <sup>2</sup>
$m_Z$	$Z^0$ boson mass	91.2 GeV/c <sup>2</sup>
$\mu_N = \hbar e/2m_p c$	Nuclear magneton	$3.152 \times 10^{-18}$ MeV/Gauss
$\mu_p$	Proton magnetic moment	2.793 $\mu_N$
$\mu_n$	Neutron magnetic moment	-1.913 $\mu_N$
<hr/>		
1 fm = $10^{-13}$ cm	1 Å = $10^{-8}$ cm	$\pi = 3.1416$
1 barn = $10^{-24}$ cm <sup>2</sup>	1 eV/c <sup>2</sup> = $1.783 \times 10^{-33}$ g	
1 joule = $10^7$ erg	1 coulomb = $2.998 \times 10^9$ esu	
1 newton = $10^5$ dyne	1 tesla = $10^4$ gauss	

## Appendix-IIa Fundamental Constants

Unless otherwise noted, the information presented in this table is from *CODATA Values of Fundamental Physical Constants: 1998*.<sup>a</sup> The constants are arranged alphabetically according to the symbols by which they are denoted. The numbers in *italics* are the one-standard-deviation uncertainty in the last digits of the values given. The unified atomic mass scale ( $^{12}\text{C}\equiv 12$ ) has been used throughout. Values are given for both SI and cgs units. In cgs units "permittivity of vacuum"  $\mu_0$  and "permeability of vacuum"  $\epsilon_0$  are dimensionless unit quantities; in SI units they have the values<sup>f</sup>

$$\begin{aligned}\mu_0 &= 4\pi \times 10^{-7} \text{ m}\cdot\text{kg}\cdot\text{s}^{-2}\cdot\text{A}^{-2} = 4\pi \times 10^{-7} \text{ N}\cdot\text{A}^{-2} = 4\pi \times 10^{-7} \text{ T}\cdot\text{A}^{-1} \\ \epsilon_0 &= 1/\mu_0 c^2\end{aligned}$$

The factor in square brackets given in the definition of a quantity is to be omitted to obtain the expression in cgs units<sup>f</sup>.

The following abbreviations are used:

A = ampere  
C = coulomb  
cm = centimeter  
emu = electromagnetic unit  
esu = electrostatic unit  
G = gauss  
g = gram  
Hz = hertz = cycles/sec  
J = joule  
K = degree Kelvin  
kg = kilogram  
m = meter  
mol = mole  
N = newton  
s = second  
T = tesla  
u = atomic mass unit (unified scale)  
V = volt  
W = watt  
Wb = Weber

### Appendix-IIa Fundamental Constants

Symbol	Constant	Value	Units (SI) <sup>b</sup>	Units (cgs) <sup>b</sup>
$a_0=r_e/\alpha^2$	Bohr radius	5.291772083 19	$10^{-11}$ m	$10^{-9}$ cm
$\alpha=e^2/\hbar c[4\pi\epsilon_0]$ $1/\alpha$	Fine structure constant	0.007297352533 27 137.03599976 50		
c	Speed of light in vacuum	2.99792458 <sup>(e)</sup>	$10^8$ m s <sup>-1</sup>	$10^{10}$ cm s <sup>-1</sup>
$c_1=2\pi\hbar c^2$	First radiation constant	3.74177107 29	$10^{-16}$ W m <sup>2</sup>	$10^{-5}$ erg cm <sup>2</sup> s <sup>-1</sup>
$c_2=\hbar c/k$	Second radiation constant	1.4387752 25	$10^{-2}$ m K	cm K
e	Elementary charge	4.80320420 19 1.602176462 63	$10^{-10}$ esu $10^{-19}$ C	$10^{-20}$ emu
2e/h	Josephson frequency-voltage ratio	4.83597898 19	$10^{14}$ Hz V <sup>-1</sup>	
-e/m <sub>e</sub>	Electron specific charge	-1.758820174 71	$10^{11}$ C kg <sup>-1</sup>	$10^7$ emu g <sup>-1</sup>
F=N <sub>A</sub> e	Faraday constant	9.64853415 39	$10^4$ C mol <sup>-1</sup>	$10^3$ emu mol <sup>-1</sup>
$\gamma_p$	Gyromagnetic ratio of proton	2.67522212 11	$10^8$ s <sup>-1</sup> T <sup>-1</sup>	$10^4$ s <sup>-1</sup> G <sup>-1</sup>
$\gamma_p'$	Gyromagnetic ratio of proton (uncorrected for diamagnetism of H <sub>2</sub> O)	2.67515341 11	$10^8$ s <sup>-1</sup> T <sup>-1</sup>	$10^4$ s <sup>-1</sup> G <sup>-1</sup>
G	Gravitational constant	6.673 10	$10^{-11}$ m <sup>3</sup> kg <sup>-1</sup> s <sup>-2</sup>	$10^{-8}$ cm <sup>3</sup> g <sup>-1</sup> s <sup>-2</sup>

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## Appendix-IIa Fundamental Constants

Symbol	Constant	Value	Units (SI) <sup>b</sup>	Units (cgs) <sup>b</sup>
$h$	Planck constant	6.62606876 52	$10^{-34}$ J s	$10^{-27}$ erg s
$\hbar=h/2\pi$		1.054571596 82	$10^{-34}$ J s	$10^{-27}$ erg s
$h/2e$	Quantum of magnetic flux	2.067833636 81	$10^{-15}$ Wb	$10^{-7}$ G cm <sup>2</sup>
$k=R/N_A$	Boltzmann constant	1.3806503 24	$10^{-23}$ J K <sup>-1</sup>	$10^{-16}$ erg K <sup>-1</sup>
$\lambda_{C,e}=h/m_e c$	Compton wavelength of electron	2.426310215 18	$10^{-12}$ m	$10^{-10}$ cm
$\lambda_{C,p}=h/m_p c$	Compton wavelength of proton	1.321409847 10	$10^{-15}$ m	$10^{-13}$ cm
$\lambda_{C,n}=h/m_n c$	Compton wavelength of neutron	1.319590898 10	$10^{-15}$ m	$10^{-13}$ cm
$m_e$	Electron mass	5.485799110 12	$10^{-4}$ u	$10^{-4}$ u
$m_H$	Mass of hydrogen atom	1.007825032 1 <sup>(c)</sup>	u	u
$m_\mu$	Muon mass	0.1134289168 34	u	u
$m_n$	Neutron mass	1.00866491578 55	u	u
$m_p$	Proton mass	1.00727646688 13	u	u
$m_{\pi^\pm}$	$\pi^\pm$ mass	0.1498348 4 <sup>(d)</sup>	u	u

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## Appendix-IIa Fundamental Constants

Symbol	Constant	Value	Units (SI) <sup>b</sup>	Units (cgs) <sup>b</sup>
$m_{\pi^0}$	$\pi^0$ mass	0.1449034 6 <sup>(d)</sup>	u	u
$\mu_B = [c]e\hbar/2m_e c$	Bohr magneton	9.27400899 37	$10^{-24}$ J T <sup>-1</sup>	$10^{-21}$ erg G <sup>-1</sup>
$\mu_e/\mu_B$	Magnetic moment of electron in units of $\mu_B$	-1.0011596521869 41		
$\mu_\mu$	Muon magnetic moment	-4.49044813 22	$10^{-26}$ J T <sup>-1</sup>	$10^{-23}$ erg Gs <sup>-1</sup>
$\mu_N = [c]e\hbar/2m_p c$	Nuclear magneton	5.05078317 20	$10^{-27}$ J T <sup>-1</sup>	$10^{-24}$ erg G <sup>-1</sup>
$N_A$	Avogadro constant	6.02214199 47	$10^{23}$ mol <sup>-1</sup>	$10^{23}$ mol <sup>-1</sup>
R	Molar gas constant	8.314472 15	J mol <sup>-1</sup> K <sup>-1</sup>	$10^7$ erg mol <sup>-1</sup> K <sup>-1</sup>
$R_\infty = m_e c \alpha^2 / 2\hbar$	Rydberg constant for infinite mass	1.0973731568549 83	$10^7$ m <sup>-1</sup>	$10^5$ cm <sup>-1</sup>
$r_e = \hbar\alpha/m_e c$	Classical e <sup>-</sup> radius	2.817940285 31	$10^{-15}$ m	$10^{-13}$ cm
$\sigma = (\pi^2/60)k^4/\hbar^3 c^2$	Stefan-Boltzmann constant	5.670400 40	$10^{-8}$ W m <sup>-2</sup> K <sup>-4</sup> erg cm <sup>-2</sup> s <sup>-1</sup> K <sup>-4</sup>	$10^{-5}$
$u = 1/N_A$	Atomic mass unit	1.66053873 13 931.494013 37	$10^{-27}$ kg MeV	$10^{-24}$ g

1 year (sidereal) = 365.25636 days =  $3.1558150 \times 10^7$  s, 1 year (tropical) = 365.242 days =  $3.15569 \times 10^7$  s

## Appendix-IIa Fundamental Constants

- a) P.J. Mohr and B.N. Taylor, *Jl. of Phys. and Chem. Ref. Data* 28, 1713 (1999); *Rev. Mod. Phys.* 72, 351 (2000). Data taken from *Physics Today* 56, BG6 (2003); <http://physics.nist.gov/constants>
- b) Quantities are given in the International System of Units (SI) except for the atomic mass unit; this unit is not part of the SI.
- c) The AME2003 atomic mass evaluation, G. Audi, A.H. Wapstra, and C. Thibault, *Nuclear Physics A* 729, 337 (2003)
- d) Review of Particle Physics, S. Eidelman, *et al.*, *Physics Letters B* 592, 1 (2004); <http://pdg.lbl.gov/>
- e) Speed of light in vacuum is an exact constant as a result of redefinition of meter [P. Giacomo, *Metrologia* 20, 25 (1984)].
- f) General Section by H.L. Anderson and E.R. Cohen in *A Physicist's Desk Reference*, H.L. Anderson, Editor-in-Chief, AIP, New York (1989)

### Appendix-IIIa Energy-Equivalent Factors†

units	erg	eV	s <sup>-1</sup>	cm <sup>-1</sup>
erg	1.0	1.602176462 63×10 <sup>-12</sup>	6.6260876 52×10 <sup>-27</sup>	1.98644544 16×10 <sup>-16</sup>
eV	6.24150974 24×10 <sup>11</sup>	1.0	4.13566727 16×10 <sup>-15</sup>	1.239841857 49×10 <sup>-4</sup>
s <sup>-1</sup>	1.50919050 12×10 <sup>26</sup>	2.417989491 95×10 <sup>14</sup>	1.0	2.99792458 ×10 <sup>10</sup>
cm <sup>-1</sup>	5.03411762 39×10 <sup>15</sup>	8.06554477 32×10 <sup>3</sup>	3.335640952×10 <sup>-11</sup>	1.0
K	7.242964 13×10 <sup>15</sup>	1.1604506 20×10 <sup>4</sup>	4.7992374 84×10 <sup>-11</sup>	1.4387752 25
g	1.112650056×10 <sup>-21</sup>	1.782661731 70×10 <sup>-33</sup>	7.37249578 58×10 <sup>-48</sup>	2.21021863 17×10 <sup>-37</sup>
u	6.70053662 53×10 <sup>2</sup>	1.073544206 43×10 <sup>-9</sup>	4.439821637 34×10 <sup>-24</sup>	1.331025042 10×10 <sup>-13</sup>
(1 cal = 4.1840 J, 1 J = 10 <sup>7</sup> erg)				

App-III-i

Note: In the above table all entries in the same column are equivalent. The various units of energy are connected as follows:

$$1 \text{ erg} = 1/c^2 \text{ g} = 1/(mc^2) \text{ u} = 1/(hc) \text{ cm}^{-1} = 1/h \text{ s}^{-1} = 1/k \text{ }^0\text{K} = 1/e \text{ eV}$$

Examples: 1 eV = 1.602..×10<sup>-12</sup> erg = 1.073..×10<sup>-9</sup> u = 3.829..×10<sup>-20</sup> cal

$$e/h = 2.417..×10<sup>14</sup> \text{ s}^{-1}, e/(hc) = 8.0654..×10^3 \text{ cm}^{-1}$$

$$e/c^2 = 1.782..×10^{-33} \text{ g}, e/mc^2 = 1.073..×10^{-9} \text{ u}$$

$$e/k = 1.160..×10^4 \text{ K}$$

### Appendix-IIIa Energy-Equivalent Factors†

units	deg K	g	u
erg	1.3806503 24×10 <sup>-16</sup>	8.987551787×10 <sup>20</sup>	1.49241778 12×10 <sup>-3</sup>
eV	8.617342 15×10 <sup>-5</sup>	5.60958921 22×10 <sup>32</sup>	9.31494013 37×10 <sup>8</sup>
s <sup>-1</sup>	2.0836644 36×10 <sup>10</sup>	1.35639277 11×10 <sup>47</sup>	2.252342733 17×10 <sup>23</sup>
cm <sup>-1</sup>	6.950356 12×10 <sup>-1</sup>	4.52443929 35×10 <sup>36</sup>	7.513006658 57×10 <sup>12</sup>
K	1.0	6.509651 11×10 <sup>36</sup>	1.0809528 19×10 <sup>13</sup>
g	1.5361807 27×10 <sup>-37</sup>	1.0	1.66053873 13×10 <sup>-24</sup>
u	9.251098 16×10 <sup>-14</sup>	6.02214199 47×10 <sup>23</sup>	1.0

Note: In the above table all entries in the same column are equivalent.

Example: 1u = 1.492..×10<sup>-3</sup> erg = 9.314..×10<sup>8</sup> eV = 3.567..×10<sup>-11</sup> cal, etc.

† From CODATA Values of Fundamental Physical Constants:1998, P.J. Mohr and B.N. Taylor, *Jour. of Phys. and Chem. Ref. Data* 28, 1713 (1999), *Rev. Mod. Phys.* 72, 351 (2000), *Physics Today* 56, BG6 (2003); <http://physics.nist.gov/constants>.

### Appendix-IV Observed $\Lambda$ Hypernuclides†

El	A	J(g.s.)	$B_{\Lambda}$ (g.s.)*	Excited (bound) states (MeV)
<b>H</b>	3	1/2	0.13 5	
	4	0	2.04 4	E=1.05 4
<b>He</b>	4	0	2.39 3	E=1.15 4
	5	1/2	3.12 2	
	6	(1)	4.18 10	
	8		7.16 70	
<b>Li</b>	6		4.50	E=8.3,18.3
	7	1/2+	5.58 3	E=0.692 4 3/2+ <sup>a</sup> ,2.050 2 5/2+ <sup>a</sup> ,8.3,20.2
	8	1	6.80 3	E=0.442? <sup>b</sup> ,1.22 4
	9		8.50 12	
<b>Be</b>	7	1/2	5.16 8	
	8		6.84 5	
	9	1/2	6.71 4	E <sup>b</sup> =3.079 4 <sup>#</sup> ,5.98 84,10.59 72, 16.55 69,22.93 71,27.90 72
	10		9.11 22	
<b>B</b>	9		8.29 18	
	10		8.89 12	E <sup>c</sup> =2.5 2,6.2 2,9.5 3
	11	5/2	10.24 5	
	12	1	11.37 6 <sup>d</sup>	
<b>C</b>	12	1	10.80 18 <sup>d</sup>	E <sup>e</sup> =2.71 13 1-,6.05 18 1-,8.10 38, 10.97 5 2+,12.0 3 <sup>b</sup> ,16.2 2 <sup>b</sup>
	13	1/2+	11.69 12	E <sup>e</sup> =4.9 1 3/2+,9.6 3 3/2-,11.6 2 1/2+, 15.4 1 <sup>#</sup>
	14		12.17 33	
<b>N</b>	14		12.17	E=10.5,19,22
	15		13.59 15	
<b>O</b>	16	1- <sup>e</sup>	12.5	E <sup>e</sup> =6.3 1 1-,10.6 1 2+,0-,16.7 1 2+,0+, 20.0 4 <sup>b</sup> ,23.3 5 <sup>b</sup>
	18			E=13,20,24,30
<b>Al</b>	27			E=7,18 <sup>b</sup>
<b>Si</b>	28		16.6 <sup>c</sup>	E <sup>c</sup> =4.7 4,9.6 3,12.3 3,17.6 8,23.2 5 <sup>b</sup>
<b>S</b>	32		17.5 5	E=11.5,22.5
<b>Ca</b>	40		20.0 5	E <sup>b</sup> =2.9 13,6.1 13,8.3 11,13.9 11, 16.7 11,19.8 11,22.9 13
<b>V</b>	51		19.5 <sup>f</sup>	E <sup>b</sup> =3.5 16,5.7 10,8.4 10,12.1 11, 15.0 10,18.3 11,21.8 10,26.0 10
<b>Fe</b>	56		21	
<b>Y</b>	89		23 2	E <sup>b,c</sup> =6.9 16,13.4 16,19.8 16,27.2 16
<b>La</b>	139		23.8 10 <sup>c</sup>	E <sup>c</sup> =3.8 11
<b>Pb</b>	208		26.5 5 <sup>c</sup>	E <sup>c</sup> =5.2 9
<b>Bi</b>	209			E=32,40

## Appendix-IV Observed $\Lambda$ Hypernuclides†

### Footnotes and References

† This table has been prepared by R. Chrien (BNL). The data are mostly from D. Davis and J. Pniewski, *Contemp. Phys.* 27, 91 (1986), and H. Bando, T. Motoba, and J. Zofka, *Int. J. Mod. Phys. A*5, 4021 (1990), except where indicated otherwise.

Almost all recent data have come from ( $\pi^+$ , $K^+$ ) reactions using magnetic spectrometers and Ge detectors at BNL and KFK. The early work is emulsion data while the later work is derived from magnetic spectrometers using ( $K^\pm$ , $\pi^\pm$ ) data.

The only confirmed example of a bound  $\Sigma$  hypernuclide is the T=1/2 isospin state in  $^4\text{He}$  reported by Nagae et al., *Phys. Rev. Lett.* 80, 1605 (1998).

\*  $\Lambda$  binding energy.

# Possibly complex.

a K. Tanida et al. Proc. of APCTP workshop (1999), to be published.

b R. Chrien, BNL, priv. comm. and results of BNL-AGS 798.

c T. Hasegawa et al., *Phys. Rev C*53, 1210 (1996).

d P. Dluzewski et al., *Nucl. Phys.* A484 520 (1988).

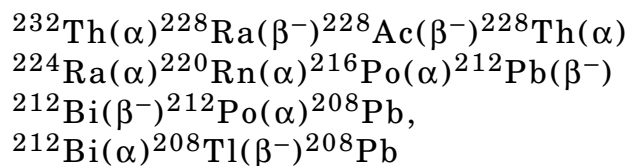
e O. Hashimoto, Proc. of APCTP workshop (1999), to be published.

f Calculated.

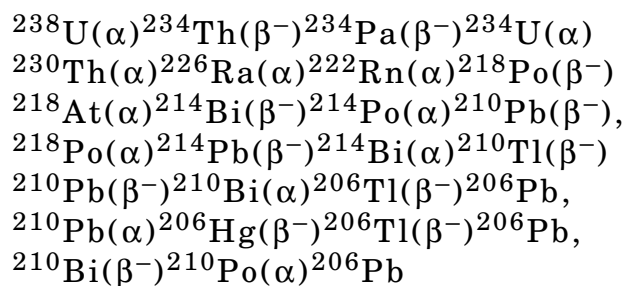
## Radioactive Decay Chains in Nature

The following three radioactive decay chains occur in nature:

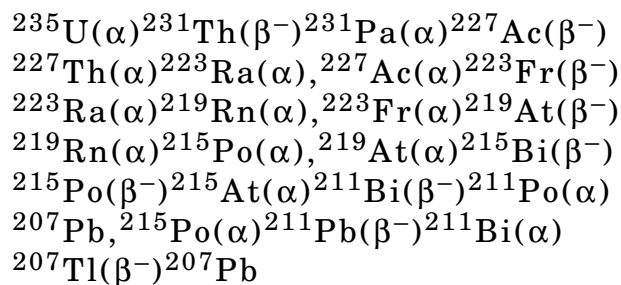
### The Thorium Series:



### The Uranium Series:



### The Actinium Series



## Radioactive Nuclides in Nature

Nuclide	Half-life	Major Radiations	Major $\gamma$ -rays (keV) $I_{\gamma} > 2\%$
<b>1 H 3</b>	12.32 y	$\beta^-$	
<b>6 C 14</b>	5700 y	$\beta^-$	
<b>19 K 40</b>	$1.265 \times 10^9$ y	$\beta^-, \gamma$	1461
<b>23 V 50</b>	$1.4 \times 10^{17}$ y	$\gamma$	1554, 783
<b>37 Rb 87</b>	$4.81 \times 10^{10}$ y	$\beta^-$	
<b>48 Cd 113</b>	$7.7 \times 10^{15}$ y	$\beta^-$	
<b>49 In 115</b>	$4.41 \times 10^{14}$ y	$\beta^-$	
<b>57 La 138</b>	$1.02 \times 10^{11}$ y	$\gamma$	1436, 789
<b>60 Nd 144</b>	$2.29 \times 10^{15}$ y	$\alpha$	
<b>62 Sm 147</b>	$1.06 \times 10^{11}$ y	$\alpha$	
<b>148</b>	$7 \times 10^{15}$ y	$\alpha$	
<b>64 Gd 152</b>	$1.08 \times 10^{14}$ y	$\alpha$	
<b>71 Lu 176</b>	$4.00 \times 10^{10}$ y	$\beta^-, \gamma$	307, 202, 56
<b>72 Hf 174</b>	$2.0 \times 10^{15}$ y	$\alpha$	
<b>73 Ta 180m</b>	$> 1.2 \times 10^{15}$ y	$\beta^-$	
<b>75 Re 187</b>	$4.35 \times 10^{10}$ y	$\beta^-$	
<b>76 Os 186</b>	$2.0 \times 10^{15}$ y	$\alpha$	
<b>78 Pt 190</b>	$6.5 \times 10^{11}$ y	$\alpha$	
<b>90 Th 232</b>	$1.405 \times 10^{10}$ y	$\alpha$	
<b>92 U 235</b>	$7.04 \times 10^8$ y	$\alpha, \gamma$	186, 144, 93
<b>238</b>	$4.468 \times 10^9$ y	$\alpha$	



## Some Well-known Radionuclides

Nuclide	Half-life	Major Radiations	Major $\gamma$ -rays (keV) $I_{\gamma} > 2\%$	
<b>11 Na</b> 22	2.602 y	$\gamma$	511, 1275	
<b>24 Cr</b> 51	27.7 d	$\gamma$	320	
<b>25 Mn</b> 56	2.579 h	$\beta^{-}, \gamma$	847, 1811, 2113	
<b>26 Fe</b> 59	44.5 d	$\beta^{-}, \gamma$	1099, 1292	
<b>27 Co</b> 57	271.7 d	$\gamma$	122, 136	
	60	5.271 y	$\beta^{-}, \gamma$	1332, 1173
<b>29 Cu</b> 64	12.7 h	$\gamma$	511	
<b>31 Ga</b> 66	9.49 h	$\gamma$	511, 1039, 2752	
	67	3.261 d	$\gamma$	93, 185, 300
	68	1.127 h	$\gamma$	511, 1077
<b>34 Se</b> 75	119.8 d	$\gamma$	265, 136, 280	
<b>38 Sr</b> 85	64.84 d	$\gamma$	514	
	85m	1.127 h	$\gamma$	232, 151
	90	28.79 y	$\beta^{-}$	
<b>43 Tc</b> 99m	6.015 h	$\gamma$	141	
<b>44 Ru</b> 103	39.26 d	$\beta^{-}, \gamma$	497, 610	
	106	1.023 y	$\beta^{-}$	
<b>45 Rh</b> 106m	2.183 h	$\beta^{-}, \gamma$	512, 1047, 717	
<b>47 Ag</b> 110m	249.8 d	$\beta^{-}, \gamma$	658, 885, 937	
<b>49 In</b> 111	2.805 d	$\gamma$	245, 171	
<b>53 I</b> 123	13.27 h	$\gamma$	159	
	131	8.021 d	$\beta^{-}, \gamma$	364, 637, 284
<b>55 Cs</b> 137	30.07 y	$\beta^{-}, \gamma$	662	
<b>56 Ba</b> 133	10.54 y	$\gamma$	356, 81, 303	
	133m	1.621 d	$\gamma$	276
<b>58 Ce</b> 144	284.9 d	$\beta^{-}, \gamma$	134	
<b>62 Sm</b> 153	1.929 d	$\beta^{-}, \gamma$	103, 70	
<b>67 Ho</b> 166	1.118 d	$\beta^{-}, \gamma$	81, 56	
	166m	$1.20 \times 10^3$ y	$\beta^{-}, \gamma$	184, 810, 712
<b>70 Yb</b> 169	32.03 d	$\gamma$	51, 63, 57	
<b>77 Ir</b> 192	73.83 d	$\beta^{-}, \gamma$	317, 468, 308	
	192m	1.45 m	$\gamma$	
	192m	241 y	$\gamma$	
<b>81 Tl</b> 201	3.038 d	$\gamma$	71, 69, 80	
<b>83 Bi</b> 207	32.9 y	$\gamma$	570, 1064, 75	
<b>95 Am</b> 241	432.2 y	$\alpha, \gamma$	60	

### Appendix-VIa Periodic Table of Elements

Appendix-VIa

IA	IIA	IIIB	IVB	VB	VIB	VIIIB	---	VIII---	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA		
H 1																He 2		
Li 3	Be 4										B 5	C 6	N 7	O 8	F 9	Ne 10		
Na 11	Mg 12										Al 13	Si 14	P 15	S 16	Cl 17	Ar 18		
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36	
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54	
Cs 55	Ba 56	* 57-	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86	
Fr 87	Ra 88	** 89-	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111		112	113	114	115	116	117	118
*	La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71	Lanthanides		
**	Ac 89	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103	Actinides		

### Appendix-VIb List of Elements - Alphabetical

<b>Name</b>	<b>Symbol</b>	<b>Z</b>	<b>Name</b>	<b>Symbol</b>	<b>Z</b>
Actinium	Ac	89	Mendelevium	Md	101
Aluminum	Al	13	Mercury	Hg	80
Americium	Am	95	Molybdenum	Mo	42
Antimony	Sb	51	Neodymium	Nd	60
Argon	Ar	18	Neon	Ne	10
Arsenic	As	33	Neptunium	Np	93
Astatine	At	85	Nickel	Ni	28
Barium	Ba	56	Niobium	Nb	41
Berkelium	Bk	97	Nitrogen	N	7
Beryllium	Be	4	Nobelium	No	102
Bismuth	Bi	83	Osmium	Os	76
Bohrium	Bh	107	Oxygen	O	8
Boron	B	5	Palladium	Pd	46
Bromine	Br	35	Phosphorus	P	15
Cadmium	Cd	48	Platinum	Pt	78
Calcium	Ca	20	Plutonium	Pu	94
Californium	Cf	98	Polonium	Po	84
Carbon	C	6	Potassium	K	19
Cerium	Ce	58	Praseodymium	Pr	59
Cesium	Cs	55	Promethium	Pm	61
Chlorine	Cl	17	Protactinium	Pa	91
Chromium	Cr	24	Radium	Ra	88
Cobalt	Co	27	Radon	Rn	86
Copper	Cu	29	Roentgenium	Rg	111
Curium	Cm	96	Rhenium	Re	75
Darmstadtium	Ds	110	Rhodium	Rh	45
Dubnium	Db	105	Rubidium	Rb	37
Dysprosium	Dy	66	Ruthenium	Ru	44
Einsteinium	Es	99	Rutherfordium	Rf	104
Erbium	Er	68	Samarium	Sm	62
Europium	Eu	63	Scandium	Sc	21
Fermium	Fm	100	Selenium	Se	34
Fluorine	F	9	Seaborgium	Sg	106
Francium	Fr	87	Silicon	Si	14
Gadolinium	Gd	64	Silver	Ag	47
Gallium	Ga	31	Sodium	Na	11
Germanium	Ge	32	Strontium	Sr	38
Gold	Au	79	Sulfur	S	16
Hafnium	Hf	72	Tantalum	Ta	73
Hassium	Hs	108	Technetium	Tc	43
Helium	He	2	Tellurium	Te	52
Holmium	Ho	67	Terbium	Tb	65
Hydrogen	H	1	Thallium	Tl	81
Indium	In	49	Thorium	Th	90
Iodine	I	53	Thulium	Tm	69
Iridium	Ir	77	Tin	Sn	50
Iron	Fe	26	Titanium	Ti	22
Krypton	Kr	36	Tungsten	W	74
Lanthanum	La	57	Uranium	U	92
Lawrencium	Lr	103	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lithium	Li	3	Ytterbium	Yb	70
Lutetium	Lu	71	Yttrium	Y	39
Magnesium	Mg	12	Zinc	Zn	30
Manganese	Mn	25	Zirconium	Zr	40
Meitnerium	Mt	109			

### Appendix-VIc List of Elements - by Z

Z	Symbol	Name	Z	Symbol	Name
1	H	Hydrogen	57	La	Lanthanum
2	He	Helium	58	Ce	Cerium
3	Li	Lithium	59	Pr	Praseodymium
4	Be	Beryllium	60	Nd	Neodymium
5	B	Boron	61	Pm	Promethium
6	C	Carbon	62	Sm	Samarium
7	N	Nitrogen	63	Eu	Europium
8	O	Oxygen	64	Gd	Gadolinium
9	F	Fluorine	65	Tb	Terbium
10	Ne	Neon	66	Dy	Dysprosium
11	Na	Sodium	67	Ho	Holmium
12	Mg	Magnesium	68	Er	Erbium
13	Al	Aluminum	69	Tm	Thulium
14	Si	Silicon	70	Yb	Ytterbium
15	P	Phosphorus	71	Lu	Lutetium
16	S	Sulfur	72	Hf	Hafnium
17	Cl	Chlorine	73	Ta	Tantalum
18	Ar	Argon	74	W	Tungsten
19	K	Potassium	75	Re	Rhenium
20	Ca	Calcium	76	Os	Osmium
21	Sc	Scandium	77	Ir	Iridium
22	Ti	Titanium	78	Pt	Platinum
23	V	Vanadium	79	Au	Gold
24	Cr	Chromium	80	Hg	Mercury
25	Mn	Manganese	81	Tl	Thallium
26	Fe	Iron	82	Pb	Lead
27	Co	Cobalt	83	Bi	Bismuth
28	Ni	Nickel	84	Po	Polonium
29	Cu	Copper	85	At	Astatine
30	Zn	Zinc	86	Rn	Radon
31	Ga	Gallium	87	Fr	Francium
32	Ge	Germanium	88	Ra	Radium
33	As	Arsenic	89	Ac	Actinium
34	Se	Selenium	90	Th	Thorium
35	Br	Bromine	91	Pa	Protactinium
36	Kr	Krypton	92	U	Uranium
37	Rb	Rubidium	93	Np	Neptunium
38	Sr	Strontium	94	Pu	Plutonium
39	Y	Yttrium	95	Am	Americium
40	Zr	Zirconium	96	Cm	Curium
41	Nb	Niobium	97	Bk	Berkelium
42	Mo	Molybdenum	98	Cf	Californium
43	Tc	Technetium	99	Es	Einsteinium
44	Ru	Ruthenium	100	Fm	Fermium
45	Rh	Rhodium	101	Md	Mendelevium
46	Pd	Palladium	102	No	Nobelium
47	Ag	Silver	103	Lr	Lawrencium
48	Cd	Cadmium	104	Rf	Rutherfordium
49	In	Indium	105	Db	Dubnium
50	Sn	Tin	106	Sg	Seaborgium
51	Sb	Antimony	107	Bh	Bohrium
52	Te	Tellurium	108	Hs	Hassium
53	I	Iodine	109	Mt	Meitnerium
54	Xe	Xenon	110	Ds	Darmstadtium
55	Cs	Cesium	111	Rg	Roentgenium
56	Ba	Barium			

