

Appendix C

TABLE OF NUCLEAR PROPERTIES

The following table shows some properties of a selection of isotopes. For each element only the stable and relatively long-lived radioactive isotopes are included. Ground-state atomic masses and spin-parity assignments are shown for all isotopes; uncertain spin-parity assignments are in parentheses. Abundances are given for stable isotopes, and for radioactive isotopes the half-life and principal decay mode are shown (ϵ —electron capture, possibly including positron emission; β^- —negative beta decay; α —alpha decay; f—spontaneous fission). The masses are those of the corresponding neutral atoms and were taken from the 1983 atomic mass evaluation: A. H. Wapstra and G. Audi, *Nucl. Phys.* **A432**, 1 (1985). In the half-life entries, My = 10^6 y. Uncertainties in the masses are typically 10^{-5} u (10^{-4} u for some cases far from stability); uncertainties in the abundances and half-lives are typically at or below the level of the last digit tabulated.

		Atomic		<i>Abundance</i>				Atomic		<i>Abundance</i>	
<i>Z</i>	<i>A</i>	mass (u)	<i>I</i> ^π	or		<i>Z</i>	<i>A</i>	mass (u)	<i>I</i> ^π	or	
Half-life						Half-life					
H	1	1	1.007825	$\frac{1}{2}^{+}$	99.985%			10	10.012937	3^{+}	19.8%
		2	2.014102	1^{+}	0.015%			11	11.009305	$\frac{3}{2}^{-}$	80.2%
		3	3.016049	$\frac{1}{2}^{+}$	12.3 y (β^{-})			12	12.014353	1^{+}	20.4 ms (β^{-})
He	2	3	3.016029	$\frac{1}{2}^{+}$	$1.38 \times 10^{-4}\%$			13	13.017780	$\frac{3}{2}^{-}$	17.4 ms (β^{-})
		4	4.002603	0^{+}	99.99986%	C	6	9	9.031039	$\frac{3}{2}^{-}$	0.13 s (ϵ)
Li	3	6	6.015121	1^{+}	7.5%			10	10.016856	0^{+}	19.2 s (ϵ)
		7	7.016003	$\frac{3}{2}^{-}$	92.5%			11	11.011433	$\frac{3}{2}^{-}$	20.4 m (ϵ)
		8	8.022486	2^{+}	0.84 s (β^{-})		12	12.000000	0^{+}	98.89%	
Be	4	7	7.016928	$\frac{3}{2}^{-}$	53.3 d (ϵ)			13	13.003355	$\frac{1}{2}^{-}$	1.11%
		8	8.005305	0^{+}	0.07 fs (α)			14	14.003242	0^{+}	5730 y (β^{-})
		9	9.012182	$\frac{3}{2}^{-}$	100%			15	15.010599	$\frac{1}{2}^{+}$	2.45 s (β^{-})
		10	10.013534	0^{+}	1.6 My (β^{-})	N	7	12	12.018613	1^{+}	11 ms (ϵ)
		11	11.021658	$\frac{1}{2}^{+}$	13.8 s (β^{-})			13	13.005739	$\frac{1}{2}^{-}$	9.96 m (ϵ)
B	5	8	8.024606	2^{+}	0.77 s (ϵ)			14	14.003074	1^{+}	99.63%
		9	9.013329	$\frac{3}{2}^{-}$	0.85 as (α)		15	15.000109	$\frac{1}{2}^{-}$	0.366%	
							16	16.006100	2^{-}	7.13 s (β^{-})	

	<i>Z</i>	<i>A</i>	Atomic mass (u)	<i>I</i> ^π <i>Abundance</i> or Half-life		<i>Z</i>	<i>A</i>	Atomic mass (u)	<i>I</i> ^π <i>Abundance</i> or Half-life		
O	8	17	17.008450	$\frac{1}{2}^-$	4.17 s (β^-)	Si	26	25.986892	5^+	0.72 My (ϵ)	
		18	18.014081	1^-	0.63 s (β^-)		27	26.981539	$\frac{5}{2}^+$	100 %	
		14	14.008595	0^+	71 s (ϵ)		28	27.981910	3^+	2.24 m (β^-)	
		15	15.003065	$\frac{1}{2}^-$	122 s (ϵ)		29	28.980446	$\frac{5}{2}^+$	6.6 m (β^-)	
		16	15.994915	0^+	99.76 %		30	29.982940	3^+	3.7 s (β^-)	
		17	16.999131	$\frac{5}{2}^+$	0.038 %		26	25.992330	0^+	2.21 s (ϵ)	
		18	17.999160	0^+	0.204 %		27	26.986704	$\frac{5}{2}^+$	4.13 s (ϵ)	
		19	19.003577	$\frac{5}{2}^+$	26.9 s (β^-)		28	27.976927	0^+	92.23 %	
F	9	20	20.004076	0^+	13.5 s (β^-)	29	28.976495	$\frac{1}{2}^+$	4.67 %		
		17	17.002095	$\frac{5}{2}^+$	64.5 s (ϵ)	30	29.973770	0^+	3.10 %		
		18	18.000937	1^+	110 m (ϵ)	31	30.975362	$\frac{3}{2}^+$	2.62 h (β^-)		
		19	18.998403	$\frac{1}{2}^+$	100 %	32	31.974148	0^+	105 y (β^-)		
		20	19.999981	2^+	11 s (β^-)	33	32.997920	$(\frac{3}{2}^+)$	6.2 s (β^-)		
		21	20.999948	$\frac{5}{2}^+$	4.3 s (β^-)	P	29	28.981803	$\frac{1}{2}^+$	4.1 s (ϵ)	
		22	22.003030	$(3, 4)^+$	4.2 s (β^-)		30	29.978307	1^+	2.50 m (ϵ)	
		23	23.003600	$(\frac{3}{2}, \frac{5}{2})^+$	2.2 s (β^-)		31	30.973762	$\frac{1}{2}^+$	100 %	
Ne	10	17	17.017690	$\frac{1}{2}^-$	0.11 s (ϵ)		32	31.973907	1^+	14.3 d (β^-)	
		18	18.005710	0^+	1.7 s (ϵ)		33	32.971725	$\frac{1}{2}^+$	25.3 d (β^-)	
		19	19.001880	$\frac{1}{2}^+$	17.3 s (ϵ)		34	33.973636	1^+	12.4 s (β^-)	
		20	19.992436	0^+	90.51 %		S	30	29.984903	0^+	1.2 s (ϵ)
		21	20.993843	$\frac{3}{2}^+$	0.27 %			31	30.979554	$\frac{1}{2}^+$	2.6 s (ϵ)
		22	21.991383	0^+	9.22 %	32		31.972071	0^+	95.02 %	
		23	22.994465	$\frac{5}{2}^+$	37.6 s (β^-)	33		32.971458	$\frac{3}{2}^+$	0.75 %	
		24	23.993613	0^+	3.4 m (β^-)	34		33.967867	0^+	4.21 %	
		25	24.997690	$(\frac{1}{2}, \frac{3}{2})^+$	0.60 s (β^-)	35		34.969032	$\frac{3}{2}^+$	87.4 d (β^-)	
Na	11	20	20.007344	2^+	0.45 s (ϵ)	36		35.967081	0^+	0.017 %	
		21	20.997651	$\frac{3}{2}^+$	22.5 s (ϵ)	37		36.971126	$\frac{7}{2}^-$	5.0 m (β^-)	
		22	21.994434	3^+	2.60 y (ϵ)	38		37.971162	0^+	170 m (β^-)	
		23	22.989768	$\frac{3}{2}^+$	100 %	Cl	33	32.977452	$\frac{3}{2}^+$	2.51 s (ϵ)	
		24	23.990961	4^+	15.0 h (β^-)		34	33.973763	0^+	1.53 s (ϵ)	
		25	24.989953	$\frac{5}{2}^+$	60 s (β^-)		35	34.968853	$\frac{3}{2}^+$	75.77 %	
		26	25.992586	3^+	1.1 s (β^-)		36	35.968307	2^+	0.30 My (β^-)	
		27	26.993940	$\frac{5}{2}^+$	0.30 s (β^-)		37	36.965903	$\frac{3}{2}^+$	24.23 %	
Mg	12	21	21.011716	$(\frac{3}{2}, \frac{5}{2})^+$	0.123 s (ϵ)		38	37.968011	2^-	37.3 m (β^-)	
		22	21.999574	0^+	3.86 s (ϵ)		39	38.968005	$\frac{3}{2}^+$	56 m (β^-)	
		23	22.994124	$\frac{3}{2}^+$	11.3 s (ϵ)		40	39.970440	2^-	1.35 m (β^-)	
		24	23.985042	0^+	78.99 %	41	40.970590	$(\frac{1}{2}, \frac{3}{2})^+$	31 s (β^-)		
		25	24.985837	$\frac{5}{2}^+$	10.00 %	Ar	34	33.980269	0^+	0.844 s (ϵ)	
		26	25.982594	0^+	11.01 %		35	34.975256	$\frac{3}{2}^+$	1.78 s (ϵ)	
		27	26.984341	$\frac{1}{2}^+$	9.46 m (β^-)		36	35.967546	0^+	0.337 %	
		28	27.983877	0^+	21.0 h (β^-)		37	36.966776	$\frac{3}{2}^+$	35.0 d (ϵ)	
		29	28.988480	$\frac{3}{2}^+$	1.4 s (β^-)		38	37.962732	0^+	0.063 %	
Al	13	24	23.999941	4^+	2.07 s (ϵ)		39	38.964314	$\frac{7}{2}^-$	269 y (β^-)	
		25	24.990429	$\frac{5}{2}^+$	7.18 s (ϵ)		40	39.962384	0^+	99.60 %	
							41	40.964501	$\frac{7}{2}^-$	1.83 h (β^-)	

Z	A	Atomic mass (u)	I^π	<i>Abundance</i> or Half-life	Z	A	Atomic mass (u)	I^π	<i>Abundance</i> or Half-life	
		55	54.942001	$\frac{7}{2}^-$	Ga	31	64	63.936836	0^+	2.6 m (ϵ)
		56	55.939841	4^+			65	64.932738	$\frac{3}{2}^-$	15.2 m (ϵ)
		57	56.936294	$\frac{7}{2}^-$			66	65.931590	0^+	9.4 h (ϵ)
		58	57.935755	2^+			67	66.928204	$\frac{3}{2}^-$	78.3 h (ϵ)
		59	58.933198	$\frac{7}{2}^-$			68	67.927982	1^+	68.1 m (ϵ)
		60	59.933820	5^+			69	68.925580	$\frac{3}{2}^-$	60.1 %
		61	60.932478	$\frac{7}{2}^-$			70	69.926028	1^+	21.1 m (β^-)
		62	61.934060	2^+			71	70.924701	$\frac{3}{2}^-$	39.9 %
		63	62.933614	$(\frac{7}{2})^-$			72	71.926365	3^-	14.1 h (β^-)
	Ni	28	55	54.951336		$\frac{7}{2}^-$		73	72.925169	$\frac{3}{2}^-$
		56	55.942134	0^+		74	73.926940	$(4)^-$	8.1 m (β^-)	
		57	56.939799	$\frac{3}{2}^-$		75	74.926499	$\frac{3}{2}^-$	2.1 m (β^-)	
		58	57.935346	0^+	Ge	32	66	65.933847	0^+	2.3 h (ϵ)
		59	58.934349	$\frac{3}{2}^-$			67	66.932737	$(\frac{1}{2})^-$	19.0 m (ϵ)
		60	59.930788	0^+			68	67.928096	0^+	271 d (ϵ)
		61	60.931058	$\frac{3}{2}^-$			69	68.927969	$\frac{5}{2}^-$	39.0 h (ϵ)
		62	61.928346	0^+			70	69.924250	0^+	20.5 %
		63	62.929670	$\frac{1}{2}^-$			71	70.924954	$\frac{1}{2}^-$	11.2 d (ϵ)
		64	63.927968	0^+			72	71.922079	0^+	27.4 %
	65	64.930086	$\frac{5}{2}^-$			73	72.923463	$\frac{9}{2}^+$	7.8 %	
	66	65.929116	0^+			74	73.921177	0^+	36.5 %	
	67	66.931570	?			75	74.922858	$\frac{1}{2}^-$	82.8 m (β^-)	
Cu	29	59	58.939503	$\frac{3}{2}^-$		76	75.921402	0^+	7.8 %	
		60	59.937366	2^+		77	76.923548	$\frac{7}{2}^+$	11.3 h (β^-)	
		61	60.933461	$\frac{3}{2}^-$		78	77.922853	0^+	1.45 h (β^-)	
		62	61.932586	1^+		79	78.925360	$(\frac{1}{2})^-$	19 s (β^-)	
		63	62.929599	$\frac{3}{2}^-$	As	33	70	69.930929	4^+	53 m (ϵ)
		64	63.292766	1^+			71	70.927114	$\frac{5}{2}^-$	61 h (ϵ)
		65	64.927793	$\frac{3}{2}^-$			72	71.926755	2^-	26.0 h (ϵ)
		66	65.928872	1^+			73	72.923827	$\frac{3}{2}^-$	80.3 d (ϵ)
		67	66.927747	$\frac{3}{2}^-$			74	73.923928	2^-	17.8 d (ϵ)
		68	67.929620	1^+			75	74.921594	$\frac{3}{2}^-$	100 %
						76	75.922393	2^-	26.3 h (β^-)	
Zn	30	61	60.939514	$\frac{3}{2}^-$			77	76.920646	$\frac{3}{2}^-$	38.8 h (β^-)
		62	61.934332	0^+			78	77.921830	(2^-)	91 m (β^-)
		63	62.933214	$\frac{3}{2}^-$			79	78.920946	$\frac{3}{2}^-$	9.0 m (β^-)
		64	63.929145	0^+	Se	34	71	70.932270	$\frac{5}{2}^-$	4.7 m (ϵ)
		65	64.929243	$\frac{5}{2}^-$			72	71.927110	0^+	8.4 d (ϵ)
		66	65.926035	0^+			73	72.926768	$\frac{9}{2}^+$	7.1 h (ϵ)
		67	66.927129	$\frac{5}{2}^-$			74	73.922475	0^+	0.87 %
		68	67.924846	0^+			75	74.922522	$\frac{5}{2}^+$	119.8 d (ϵ)
		69	68.926552	$\frac{1}{2}^-$			76	75.919212	0^+	9.0 %
		70	69.925325	0^+			77	76.919913	$\frac{1}{2}^-$	7.6 %
	71	70.927727	$\frac{1}{2}^-$			78	77.917308	0^+	23.5 %	
	72	71.926856	0^+			79	78.918498	$\frac{7}{2}^+$	< 0.065 My (β^-)	
	73	72.929780	$(\frac{3}{2})^-$							

		Atomic			Abundance or Half-life			Atomic			Abundance or Half-life
Z	A	mass (u)		I^π		Z	A	mass (u)		I^π	
		80	79.916520	0^+	49.8%			87	86.908884	$\frac{9}{2}^+$	7.0%
		81	80.917991	$(\frac{1}{2})^-$	18.5 m (β^-)			88	87.905619	0^+	82.6%
		82	81.916698	0^+	9.2%			89	88.907450	$\frac{5}{2}^+$	50.5 d (β^-)
		83	82.919117	$(\frac{9}{2})^+$	22.5 m (β^-)			90	89.907738	0^+	28.8 y (β^-)
		84	83.918463	0^+	3.3 m (β^-)			91	90.910187	$(\frac{5}{2})^+$	9.5 h (β^-)
Br	35	76	75.924528	1^-	16.1 h (ϵ)			92	91.910944	0^+	2.7 h (β^-)
		77	76.921378	$\frac{3}{2}^-$	57.0 h (ϵ)			93	92.913987	$(\frac{7}{2})^+$	7.4 m (β^-)
		78	77.921144	1^+	6.46 m (ϵ)	Y	39	84	83.920310	(5^-)	39 m (ϵ)
		79	78.918336	$\frac{3}{2}^-$	50.69%			85	84.916437	$(\frac{1}{2})^-$	2.7 h (ϵ)
		80	79.918528	1^+	17.6 m (β^-)			86	85.914893	4^-	14.7 h (ϵ)
		81	80.916289	$\frac{3}{2}^-$	49.31%			87	86.910882	$\frac{1}{2}^-$	80.3 h (ϵ)
		82	81.916802	5^-	35.3 h (β^-)			88	87.909508	4^-	106.6 d (ϵ)
		83	82.915179	$(\frac{3}{2})^-$	2.39 h (β^-)			89	88.905849	$\frac{1}{2}^-$	100%
		84	83.916503	2^-	31.8 m (β^-)			90	89.907152	2^-	64.1 h (β^-)
		85	84.915612	$(\frac{3}{2})^-$	2.9 m (β^-)			91	90.907303	$\frac{1}{2}^-$	58.5 d (β^-)
								92	91.908917	2^-	3.54 h (β^-)
								93	92.909571	$\frac{1}{2}^-$	10.2 h (β^-)
Kr	36	75	74.931029	?	4.3 m (ϵ)			94	93.911597	2^-	18.7 m (β^-)
		76	75.925959	0^+	14.8 h (ϵ)	Zr	40	87	86.914817	$(\frac{9}{2})^+$	1.6 h (ϵ)
		77	76.924610	$\frac{5}{2}^+$	75 m (ϵ)			88	87.910225	0^+	83.4 d (ϵ)
		78	77.920396	0^+	0.356%			89	88.908890	$\frac{9}{2}^+$	78.4 h (ϵ)
		79	78.920084	$\frac{1}{2}^-$	35.0 h (ϵ)			90	89.904703	0^+	51.5%
		80	79.916380	0^+	2.27%			91	90.905644	$\frac{5}{2}^+$	11.2%
		81	80.916590	$\frac{7}{2}^+$	0.21 My (ϵ)			92	91.905039	0^+	17.1%
		82	81.913482	0^+	11.6%			93	92.906474	$\frac{5}{2}^+$	1.5 My (β^-)
		83	82.914135	$\frac{9}{2}^+$	11.5%			94	93.906315	0^+	17.4%
		84	83.911507	0^+	57.0%			95	94.908042	$\frac{5}{2}^+$	64.0 d (β^-)
		85	84.912531	$\frac{9}{2}^+$	10.7 y (β^-)			96	95.908275	0^+	2.80%
		86	85.910616	0^+	17.3%			97	96.910950	$\frac{1}{2}^+$	16.9 h (β^-)
		87	86.913360	$\frac{5}{2}^+$	76 m (β^-)			98	97.912735	0^+	31 s (β^-)
		88	87.914453	0^+	2.84 h (β^-)						
		89	88.917640	$(\frac{5}{2})^+$	3.18 m (β^-)						
Rb	37	82	81.918195	1^+	1.25 m (ϵ)	Nb	41	89	88.913449	$(\frac{1}{2})^-$	2.0 h (ϵ)
		83	82.915144	$\frac{5}{2}^-$	86.2 d (ϵ)			90	89.911263	8^+	14.6 h (ϵ)
		84	83.914390	2^-	32.9 d (ϵ)			91	90.906991	$(\frac{9}{2})^+$	700 y (ϵ)
		85	84.911794	$\frac{5}{2}^-$	72.17%			92	91.907192	$(7)^+$	35 My (ϵ)
		86	85.911172	2^-	18.8 d (β^-)			93	92.906377	$\frac{9}{2}^+$	100%
		87	86.909187	$\frac{3}{2}^-$	27.83%			94	93.907281	6^+	0.020 My (β^-)
		88	87.911326	2^-	17.8 m (β^-)			95	94.906835	$\frac{9}{2}^+$	35.0 d (β^-)
		89	88.912278	$(\frac{3}{2})^-$	15.2 m (β^-)			96	95.908100	6^+	23.4 h (β^-)
		90	89.914811	(1^-)	153 s (β^-)			97	96.908097	$\frac{9}{2}^+$	72 m (β^-)
Sr	38	81	80.923270	$(\frac{1}{2})^-$	22 m (ϵ)	Mo	42	90	89.913933	0^+	5.67 h (ϵ)
		82	81.918414	0^+	25.0 d (ϵ)			91	90.911755	$\frac{9}{2}^+$	15.5 m (ϵ)
		83	82.917566	$\frac{7}{2}^+$	32.4 d (ϵ)			92	91.906808	0^+	14.8%
		84	83.913430	0^+	0.56%			93	92.906813	$\frac{5}{2}^+$	3500 y (ϵ)
		85	84.912937	$\frac{9}{2}^+$	64.8 d (ϵ)			94	93.905085	0^+	9.3%
		86	85.909267	0^+	9.8%			95	94.905841	$\frac{5}{2}^+$	15.9%

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		96 95.904679	0^+	16.7%			108 107.903895	0^+	26.7%
		97 96.906021	$\frac{5}{2}^+$	9.6%			109 108.905954	$\frac{5}{2}^+$	13.4 h (β^-)
		98 97.905407	0^+	24.1%			110 109.905167	0^+	11.8%
		99 98.907711	$\frac{1}{2}^+$	66.0 h (β^-)			111 110.907660	$\frac{5}{2}^+$	23 m (β^-)
		100 99.907477	0^+	9.6%			112 111.907323	0^+	21.0 h (β^-)
		101 100.910345	$\frac{1}{2}^+$	14.6 m (β^-)					
Tc	43	94 93.909654	7^+	293 m (ϵ)	Ag	47	103 102.908980	$\frac{7}{2}^+$	65.7 m (ϵ)
		95 94.907657	$\frac{9}{2}^+$	20.0 h (ϵ)			104 103.908623	5^+	69.2 m (ϵ)
		96 95.907870	7^+	4.3 d (ϵ)			105 104.906520	$\frac{1}{2}^-$	41.3 d (ϵ)
		97 96.906364	$\frac{9}{2}^+$	2.6 My (ϵ)			106 105.906662	1^+	24.0 m (ϵ)
		98 97.907215	$(6)^+$	4.2 My (β^-)			107 106.905092	$\frac{1}{2}^-$	51.83%
		99 98.906254	$\frac{9}{2}^+$	0.214 My (β^-)			108 107.905952	1^+	2.4 m (β^-)
		100 99.907657	1^+	15.8 s (β^-)			109 108.904756	$\frac{1}{2}^-$	48.17%
							110 109.906111	1^+	24.4 s (β^-)
							111 110.905295	$\frac{1}{2}^-$	7.45 d (β^-)
							112 111.907010	2^-	3.14 h (β^-)
Ru	44	94 93.911361	0^+	52 m (ϵ)	Cd	48	104 103.909851	0^+	58 m (ϵ)
		95 94.910414	$\frac{5}{2}^+$	1.65 h (ϵ)			105 104.909459	$\frac{5}{2}^+$	56.0 m (ϵ)
		96 95.907599	0^+	5.5%			106 105.906461	0^+	1.25%
		97 96.907556	$\frac{5}{2}^+$	2.88 d (ϵ)			107 106.906613	$\frac{5}{2}^+$	6.50 h (ϵ)
		98 97.905287	0^+	1.86%			108 107.904176	0^+	0.89%
		99 98.905939	$\frac{5}{2}^+$	12.7%			109 108.904953	$\frac{5}{2}^+$	463 d (ϵ)
		100 99.904219	0^+	12.6%			110 109.903005	0^+	12.5%
		101 100.905582	$\frac{5}{2}^+$	17.0%			111 110.904182	$\frac{1}{2}^+$	12.8%
		102 101.904348	0^+	31.6%			112 111.902757	0^+	24.1%
		103 102.906323	$\frac{3}{2}^+$	39.4 d (β^-)			113 112.904400	$\frac{1}{2}^+$	12.2%
		104 103.905424	0^+	18.7%			114 113.903357	0^+	28.7%
		105 104.907744	$\frac{3}{2}^+$	4.44 h (β^-)			115 114.905430	$\frac{1}{2}^+$	53.4 h (β^-)
		106 105.907321	0^+	372 d (β^-)			116 115.904755	0^+	7.5%
		107 106.910130	$(\frac{5}{2}^+)$	3.8 m (β^-)			117 116.907228	$\frac{1}{2}^+$	2.4 h (β^-)
							118 117.911700	0^+	50.3 m (β^-)
Rh	45	98 97.910716	$(2)^+$	8.7 m (ϵ)	In	49	110 109.907230	2^+	69.1 m (ϵ)
		99 98.908192	$(\frac{1}{2}^-)$	16.1 d (ϵ)			111 110.905109	$\frac{9}{2}^+$	2.83 d (ϵ)
		100 99.908116	1^-	20.8 h (ϵ)			112 111.905536	1^+	14.4 m (ϵ)
		101 100.906159	$\frac{1}{2}^-$	3.3 y (ϵ)			113 112.904061	$\frac{9}{2}^+$	4.3%
		102 101.906814	6^+	2.9 y (ϵ)			114 113.904916	1^+	71.9 s (β^-)
		103 102.905500	$\frac{1}{2}^-$	100%			115 114.903882	$\frac{9}{2}^+$	95.7%
		104 103.906651	1^+	42.3 s (β^-)			116 115.905264	1^+	14.1 s (β^-)
		105 104.905686	$\frac{7}{2}^+$	35.4 h (β^-)			117 116.904517	$\frac{9}{2}^+$	43.8 m (β^-)
		106 105.907279	1^+	29.8 s (β^-)					
Pd	46	99 98.911763	$(\frac{5}{2}^+)$	21.4 m (ϵ)	Sn	50	109 108.911294	$\frac{7}{2}^+$	18.0 m (ϵ)
		100 99.908527	0^+	3.6 d (ϵ)			110 109.907858	0^+	4.1 h (ϵ)
		101 100.908287	$\frac{5}{2}^+$	8.5 h (ϵ)			111 110.907741	$\frac{7}{2}^+$	35 m (ϵ)
		102 101.905634	0^+	1.0%			112 111.904826	0^+	1.01%
		103 102.906114	$\frac{5}{2}^+$	17.0 d (ϵ)			113 112.905176	$\frac{1}{2}^+$	115.1 d (ϵ)
		104 103.904029	0^+	11.0%			114 113.902784	0^+	0.67%
		105 104.905079	$\frac{5}{2}^+$	22.2%			115 114.903348	$\frac{1}{2}^+$	0.38%
		106 105.903478	0^+	27.3%					
		107 106.905127	$\frac{5}{2}^+$	6.5 My (β^-)					

		Atomic		Abundance			Atomic		Abundance
Z	A	mass (u)	I^π	or Half-life	Z	A	mass (u)	I^π	or Half-life
		116	115.901747	0^+			129	128.904986	$\frac{7}{2}^+$
		117	116.902956	$\frac{1}{2}^+$			130	129.906713	5^+
		118	117.901609	0^+			131	130.906114	$\frac{7}{2}^+$
		119	118.903311	$\frac{1}{2}^+$			132	131.907987	4^+
		120	119.902199	0^+					
		121	120.904239	$\frac{3}{2}^+$					
		122	121.903440	0^+					
		123	122.905722	$\frac{11}{2}^-$					
		124	123.905274	0^+					
		125	124.907785	$\frac{11}{2}^-$					
		126	125.907654	0^+					
		127	126.910355	$(\frac{11}{2}^-)$					

			Atomic	Abundance			Atomic	Abundance	
	Z	A	mass (u)	or Half-life		Z	A	or Half-life	
				I^π				I^π	
La 57	135	134.906953	$\frac{5}{2}^+$	19.5 h (ϵ)		145	144.912743	$\frac{5}{2}^+$	17.7 y (ϵ)
	136	135.907630	1^+	9.87 m (ϵ)		146	145.914708	3^-	5.5 y (ϵ)
	137	136.906460	$\frac{7}{2}^+$	0.06 My (ϵ)		147	146.915135	$\frac{7}{2}^+$	2.62 y (β^-)
	138	137.907105	5^+	0.089%		148	147.917473	1^-	5.37 d (β^-)
	139	138.906347	$\frac{7}{2}^+$	99.911%		149	148.918332	$\frac{7}{2}^+$	53.1 h (β^-)
	140	139.909471	3^-	40.3 h (β^-)		150	149.920981	(1^-)	2.68 h (β^-)
	141	140.910896	$\frac{7}{2}^+$	3.90 h (β^-)	Sm 62	142	141.915206	0^+	72.5 m (ϵ)
	142	141.914090	2^-	91.1 m (β^-)		143	142.914626	$\frac{3}{2}^+$	8.83 m (ϵ)
Ce 58	133	132.911360	$\frac{1}{2}^+$	5.4 h (ϵ)		144	143.911998	0^+	3.1%
	134	133.908890	0^+	76 h (ϵ)		145	144.913409	$\frac{7}{2}^-$	340 d (ϵ)
	135	134.909117	$\frac{1}{2}^+$	17.6 h (ϵ)		146	145.913053	0^+	103 My (α)
	136	135.907140	0^+	0.190%		147	146.914894	$\frac{7}{2}^-$	15.1%
	137	136.907780	$\frac{3}{2}^+$	9.0 h (ϵ)		148	147.914819	0^+	11.3%
	138	137.905985	0^+	0.254%		149	148.917180	$\frac{7}{2}^-$	13.9%
	139	138.906631	$\frac{3}{2}^+$	137.2 d (ϵ)		150	149.917273	0^+	7.4%
	140	139.905433	0^+	88.5%		151	150.919929	$\frac{5}{2}^-$	90 y (β^-)
	141	140.908271	$\frac{7}{2}^-$	32.5 d (β^-)		152	151.919728	0^+	26.6%
	142	141.909241	0^+	11.1%		153	152.922094	$\frac{3}{2}^+$	46.8 h (β^-)
	143	142.912383	$\frac{3}{2}^-$	33.0 h (β^-)		154	153.922205	0^+	22.6%
	144	143.913643	0^+	284 d (β^-)		155	154.924636	$\frac{3}{2}^-$	22.4 m (β^-)
	145	144.917230	$\frac{5}{2}^+$	2.98 m (β^-)	Eu 63	148	147.918125	5^-	54.5 d (ϵ)
Pr 59	138	137.910748	1^+	1.45 m (ϵ)		149	148.917926	$\frac{5}{2}^+$	93.1 d (ϵ)
	139	138.908917	$\frac{5}{2}^+$	4.4 h (ϵ)		150	149.919702	0^-	36 y (ϵ)
	140	139.909071	1^+	3.39 m (ϵ)		151	150.919847	$\frac{5}{2}^+$	47.9%
	141	140.907647	$\frac{5}{2}^+$	100%		152	151.921742	3^-	13 y (ϵ)
	142	141.910039	2^-	19.2 h (β^-)		153	152.921225	$\frac{5}{2}^+$	52.1%
	143	142.910814	$\frac{7}{2}^+$	13.6 d (β^-)		154	153.922975	3^-	8.5 y (β^-)
	144	143.913301	0^-	17.3 m (β^-)		155	154.922889	$\frac{5}{2}^+$	4.9 y (β^-)
						156	155.924752	0^+	15 d (β^-)
Nd 60	139	138.911920	$\frac{3}{2}^+$	29.7 m (ϵ)		157	156.925418	$\frac{5}{2}^+$	15 h (β^-)
	140	139.909306	0^+	3.37 d (ϵ)	Gd 64	149	148.919344	$\frac{7}{2}^-$	9.4 d (ϵ)
	141	140.909594	$\frac{3}{2}^+$	2.5 h (ϵ)		150	149.918662	0^+	1.8 My (α)
	142	141.907719	0^+	27.2%		151	150.920346	$\frac{7}{2}^-$	120 d (ϵ)
	143	142.909810	$\frac{7}{2}^-$	12.2%		152	151.919786	0^+	0.20%
	144	143.910083	0^+	23.8%		153	152.921745	$\frac{3}{2}^-$	242 d (ϵ)
	145	144.912570	$\frac{7}{2}^-$	8.3%		154	153.920861	0^+	2.1%
	146	145.913113	0^+	17.2%		155	154.922618	$\frac{3}{2}^-$	14.8%
	147	146.916097	$\frac{5}{2}^-$	11.0 d (β^-)		156	155.922118	0^+	20.6%
	148	147.916889	0^+	5.7%		157	156.923956	$\frac{3}{2}^-$	15.7%
	149	148.920145	$\frac{5}{2}^-$	1.73 h (β^-)		158	157.924099	0^+	24.8%
	150	149.920887	0^+	5.6%		159	158.926384	$\frac{3}{2}^-$	18.6 h (β^-)
	151	150.923825	$(\frac{3}{2}^+)$	12.4 m (β^-)		160	159.927049	0^+	21.8%
	152	151.924680	0^+	11.4 m (β^-)		161	160.929664	$\frac{5}{2}^-$	3.7 m (β^-)
Pm 61	142	141.912970	1^+	40.5 s (ϵ)	Tb 65	156	155.924742	3^-	5.34 d (ϵ)
	143	142.910930	$\frac{5}{2}^+$	265 d (ϵ)		157	156.924023	$\frac{3}{2}^+$	150 y (ϵ)
	144	143.912588	5^-	349 d (ϵ)					

Z	A	Atomic mass (u)	I^π	Abundance or Half-life	Z	A	Atomic mass (u)	I^π	Abundance or Half-life
	184	183.950928	0^+	30.7%		198	197.967869	0^+	7.2%
	185	184.953416	$\frac{3}{2}^-$	75.1 d (β^-)		199	198.970552	$(\frac{5}{2}^-)$	30.8 m (β^-)
	186	185.954357	0^+	28.6%		200	199.971417	0^+	12.5 h (β^-)
	187	186.957153	$\frac{3}{2}^-$	23.9 h (β^-)	Au 79	194	193.965348	1^-	39.5 h (ϵ)
	188	187.958480	0^+	69.4 d (β^-)		195	194.965013	$\frac{3}{2}^+$	186 d (ϵ)
Re 75	182	181.951210	2^+	12.7 h (ϵ)		196	195.966544	2^-	6.18 d (ϵ)
	183	182.950817	$(\frac{5}{2})^+$	71 d (ϵ)		197	196.966543	$\frac{3}{2}^+$	100%
	184	183.952530	3^-	38 d (ϵ)		198	197.968217	2^-	2.696 d (β^-)
	185	184.952951	$\frac{5}{2}^+$	37.40%		199	198.968740	$\frac{3}{2}^+$	3.14 d (β^-)
	186	185.954984	1^-	90.6 h (β^-)		200	199.970670	1^-	48.4 m (β^-)
	187	186.955744	$\frac{5}{2}^+$	62.60%	Hg 80	193	192.966560	$\frac{3}{2}^-$	3.8 h (ϵ)
	188	187.958106	1^-	16.9 h (β^-)		194	193.965391	0^+	520 y (ϵ)
	189	188.959219	$(\frac{5}{2})^+$	24.3 h (β^-)		195	194.966640	$\frac{1}{2}^-$	9.5 h (ϵ)
Os 76	182	181.952120	0^+	21.5 h (ϵ)		196	195.965807	0^+	0.15%
	183	182.953290	$(\frac{9}{2})^+$	13.0 h (ϵ)		197	196.967187	$\frac{1}{2}^-$	64.1 h (ϵ)
	184	183.952488	0^+	0.018%		198	197.966743	0^+	10.0%
	185	184.954041	$\frac{1}{2}^-$	93.6 d (ϵ)		199	198.968254	$\frac{1}{2}^-$	16.8%
	186	185.953830	0^+	1.6%		200	199.968300	0^+	23.1%
	187	186.955741	$\frac{1}{2}^-$	1.6%		201	200.970277	$\frac{3}{2}^-$	13.2%
	188	187.955830	0^+	13.3%		202	201.970617	0^+	29.8%
	189	188.958137	$\frac{3}{2}^-$	16.1%		203	202.972848	$\frac{5}{2}^-$	46.6 d (β^-)
	190	189.958436	0^+	26.4%		204	203.973467	0^+	6.9%
	191	190.960920	$\frac{9}{2}^-$	15.4 d (β^-)		205	204.976047	$\frac{1}{2}^-$	5.2 m (β^-)
	192	191.961467	0^+	41.0%	Tl 81	200	199.970934	2^-	26.1 h (ϵ)
	193	192.964138	$\frac{3}{2}^-$	30.6 h (β^-)		201	200.970794	$\frac{1}{2}^+$	73 h (ϵ)
	194	193.965173	0^+	6.0 y (β^-)		202	201.972085	2^-	12.2 d (ϵ)
Ir 77	188	187.958830	(2^-)	41.5 h (ϵ)		203	202.972320	$\frac{1}{2}^+$	29.5%
	189	188.958712	$\frac{3}{2}^+$	13.1 d (ϵ)		204	203.973839	2^-	3.77 y (β^-)
	190	189.960580	(4^+)	11.8 d (ϵ)		205	204.974401	$\frac{1}{2}^+$	70.5%
	191	190.960584	$\frac{3}{2}^+$	37.3%		206	205.976084	0^-	4.20 m (β^-)
	192	191.962580	4^-	74.2 d (β^-)	Pb 82	201	200.972830	$\frac{5}{2}^-$	9.3 h (ϵ)
	193	192.962917	$\frac{3}{2}^+$	62.7%		202	201.972134	0^+	0.05 My (ϵ)
	194	193.965069	1^-	19.2 h (β^-)		203	202.973365	$\frac{5}{2}^-$	51.9 h (ϵ)
	195	194.965966	$(\frac{3}{2})^+$	2.8 h (β^-)		204	203.973020	0^+	1.42%
Pt 78	187	186.960470	$\frac{3}{2}^-$	2.35 h (ϵ)		205	204.974458	$\frac{5}{2}^-$	15 My (ϵ)
	188	187.959386	0^+	10.2 d (ϵ)		206	205.974440	0^+	24.1%
	189	188.960817	$\frac{3}{2}^-$	10.9 h (ϵ)		207	206.975872	$\frac{1}{2}^-$	22.1%
	190	189.959917	0^+	0.013%		208	207.976627	0^+	52.3%
	191	190.961665	$\frac{3}{2}^-$	2.9 d (ϵ)		209	208.981065	$\frac{9}{2}^+$	3.25 h (β^-)
	192	191.961019	0^+	0.78%		210	209.984163	0^+	22.3 y (β^-)
	193	192.962977	$(\frac{1}{2}^-)$	50 y (ϵ)		211	210.988735	$(\frac{9}{2}^+)$	36.1 m (β^-)
	194	193.962655	0^+	32.9%		212	211.991871	0^+	10.6 h (β^-)
	195	194.964766	$\frac{1}{2}^-$	33.8%	Bi 83	206	205.978478	6^+	6.24 d (ϵ)
	196	195.964926	0^+	25.3%		207	206.978446	$\frac{9}{2}^-$	32 y (ϵ)
	197	196.967315	$\frac{1}{2}^-$	18.3 h (β^-)					

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		Atomic		Abundance			Atomic		Abundance	
Z	A	mass (u)	I^π	or Half-life	Z	A	mass (u)	I^π	or Half-life	
	208	207.979717	(5 ⁺)	0.368 My (ϵ)		232	232.038051	0 ⁺	100 %	
	209	208.980374	$\frac{9}{2}^-$	100 %		233	233.041577	($\frac{1}{2}^+$)	22.3 m (β^-)	
	210	209.984095	1 ⁻	5.01 d (β^-)						
	211	210.987255	$\frac{9}{2}^-$	2.15 m (α)	Pa	91	229.032073	($\frac{5}{2}^+$)	1.4 d (ϵ)	
	212	211.991255	1 ⁻	60.6 m (β^-)		230	230.034527	(2 ⁻)	17.7 d (ϵ)	
Po	84	206	205.980456	0 ⁺		231	231.035880	$\frac{3}{2}^-$	32,800 y (α)	
	207	206.981570	$\frac{5}{2}^-$	5.8 h (ϵ)		232	232.038565	(2 ⁻)	1.31 d (β^-)	
	208	207.981222	0 ⁺	2.90 y (α)		233	233.040243	$\frac{3}{2}^-$	27.0 d (β^-)	
	209	208.982404	$\frac{1}{2}^-$	102 y (α)	U	92	233	233.039628	$\frac{5}{2}^+$	0.1592 My (α)
	210	209.982848	0 ⁺	138.4 d (α)		234	234.040947	0 ⁺	0.245 My (α)	
	211	210.986627	$\frac{9}{2}^+$	0.52 s (α)		235	235.043924	$\frac{7}{2}^-$	0.720 %	
At	85	208	207.986510	6 ⁺		236	236.045563	0 ⁺	23.42 My (α)	
	209	208.986149	$\frac{9}{2}^-$	5.4 h (ϵ)		237	237.048725	$\frac{1}{2}^+$	6.75 d (β^-)	
	210	209.987126	5 ⁺	8.3 h (ϵ)		238	238.050785	0 ⁺	99.275 %	
	211	210.987469	$\frac{9}{2}^-$	7.21 h (ϵ)		239	239.054290	$\frac{5}{2}^+$	23.5 m (β^-)	
	212	211.990725	(1 ⁻)	0.31 s (α)						
	213	212.992911	$\frac{9}{2}^-$	0.11 μ s (α)	Np	93	236	236.046550	(6 ⁻)	0.11 My (ϵ)
Rn	86	207	206.990690	$\frac{5}{2}^-$		237	237.048168	$\frac{5}{2}^+$	2.14 My (α)	
	210	209.989669	0 ⁺	2.4 h (α)		238	238.050941	2 ⁺	2.117 d (β^-)	
	211	210.990576	$\frac{1}{2}^-$	14.6 h (ϵ)		239	239.052933	$\frac{5}{2}^+$	2.36 d (β^-)	
	212	211.990697	0 ⁺	24 m (α)	Pu	94	237	237.048401	$\frac{7}{2}^-$	45.3 d (ϵ)
	218	218.005580	0 ⁺	35 ms (α)		238	238.049555	0 ⁺	87.74 y (α)	
	222	222.017571	0 ⁺	3.82 d (α)		239	239.052158	$\frac{1}{2}^+$	24,100 y (α)	
	224		0 ⁺	107 m (β^-)		240	240.053808	0 ⁺	6570 y (α)	
Fr	87	209	208.995870	$\frac{9}{2}^-$		241	241.056846	$\frac{5}{2}^+$	14.4 y (β^-)	
	212	211.996130	5 ⁺	20 m (ϵ)		242	242.058737	0 ⁺	0.376 My (α)	
	215	215.000310	$\frac{9}{2}^-$	0.12 μ s (α)		243	243.061998	$\frac{7}{2}^+$	4.96 h (β^-)	
	220	220.012293	1	27.4 s (α)	Am	95	240	240.055278	(3 ⁻)	50.9 h (ϵ)
	223	223.019733	($\frac{3}{2}$)	21.8 m (β^-)		241	241.056824	$\frac{5}{2}^-$	433 y (α)	
Ra	88	222	222.015353	0 ⁺		242	242.059542	1 ⁻	16.0 h (β^-)	
	223	223.018501	$\frac{1}{2}^+$	11.4 d (α)		243	243.061375	$\frac{5}{2}^-$	7370 y (α)	
	224	224.020186	0 ⁺	3.66 d (α)		244	244.064279	(6 ⁻)	10.1 h (β^-)	
	225	225.023604	($\frac{3}{2}$) ⁺	14.8 d (β^-)	Cm	96	246	246.067218	0 ⁺	4700 y (α)
	226	226.025403	0 ⁺	1602 y (α)		247	247.070347	$\frac{9}{2}^-$	16 My (α)	
	227	227.029171	($\frac{3}{2}^+$)	42 m (β^-)		248	248.072343	0 ⁺	0.34 My (α)	
Ac	89	224	224.021685	(0 ⁻)		249	249.075948	$\frac{1}{2}^+$	64 m (β^-)	
	225	225.023205	($\frac{3}{2}^-$)	10.0 d (α)	Bk	97	246	246.068720	2 ⁻	1.8 d (ϵ)
	226	226.026084	(1 ⁻)	29 h (β^-)		247	247.070300	($\frac{3}{2}^-$)	1380 y (α)	
	227	227.027750	$\frac{3}{2}^-$	21.77 y (β^-)	Cf	98	251	251.079580	$\frac{1}{2}^+$	898 y (α)
	228	228.031015	(3 ⁺)	6.1 h (β^-)		252	252.081621	0 ⁺	2.64 y (α)	
Th	90	228	228.028715	0 ⁺						
	229	229.031755	$\frac{5}{2}^+$	7300 y (α)	Es	99	252	252.082944	(4 ⁺ , 5 ⁻)	472 d (α)
	230	230.033128	0 ⁺	75,400 y (α)		253	253.084818	$\frac{7}{2}^+$	20.5 d (α)	
	231	231.036299	$\frac{5}{2}^+$	25.52 h (β^-)						

	<i>Z</i>	<i>A</i>	Atomic mass (u)	<i>I</i> ^π	Abundance or Half-life		<i>Z</i>	<i>A</i>	Atomic mass (u)	<i>I</i> ^π	Abundance or Half-life
Fm	100	256	256.091767	0 ⁺	2.63 h (f)	Lr	103	260	260.105320		180 s (α)
		257	257.095099	($\frac{9}{2}^{+}$)	100 d (α)	Rf	104	261	261.108690		65 s (α)
Md	101	257	257.095580	($\frac{7}{2}^{-}$)	5.2 h (ε)	Ha	105	261	261.111820		1.8 s (α)
		258	258.098570	(8 ⁻)	55 d (α)			262	262.113760		34 s (f)
							106	263	263.118220		0.8 s (f)
No	102	258	258.098150	0 ⁺	1.2 ms (f)		107	262	262.122930		115 ms (α)
		259	259.100931	($\frac{9}{2}^{+}$)	60 m (α)						

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