NEUTRON SCATTERING AND ABSORPTION PROPERTIES*

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This Table presents an evaluated set of values for the experimental quantities, which characterize the properties for scattering and absorption of neutrons. The neutron cross section is given for room temperature neutrons, 20.43° C, corresponds to a thermal neutron energy of 0.0253 electron volts (eV) or a neutron velocity of 2200 meters/second. The neutron resonance integral is defined over the energy range from 0.5 eV to 0.1×10^6 eV, or 0.1 MeV. A list of the major references used is given below. The literature cutoff date is October 1993. Uncertainties are given in parentheses. Parentheses with two or more numbers indicate values to the excited state(s) and to the ground state of the product nucleus.

TABLE LAYOUT

Column No.	Column title	Description
1	Isotope or Element	For elements, the atomic number and chemical symbol are listed. For nuclides, the mass number and chemical symbol are listed. Isomers are indicated by the addition of m, m1, or m2.
2	Isotopic Abundance	in atom percent.
3	Half-life	Half-life in decimal notation. μ s = microseconds; ms = milliseconds; s = seconds; m = minutes; h = hours; d = days; and y = years.
4	Thermal Neutron Cross Section	Cross sections for neutron capture reactions in barns (10^{-24} cm ²) or in millibarns (mb). Proton, alpha production and fission reactions are designated by σ_p , σ_α , σ_f , respectively. Separate values are listed for isomeric production.
5	Neutron Resonance Integral	Resonance integrals for neutron capture reactions in barns (10^{-24} cm ²) or in millibarns (mb). Proton, alpha production and fission reactions are designated by RI_p , RI_α , RI_f , respectively. Separate values are listed for isomeric production.
6	Neutron Scattering Length	Bound Coherent scattering length for neutron scattering reactions in units of femtometer (fm), which is equal to fermis (10^{-13} cm).

GENERAL NUCLEAR DATA REFERENCES

The following references represent the major sources of the neutron data presented:

1. Mughabghab, S.F.; Divadeenam, M.; Holden, N.E.; *Neutron Cross Sections, Vol. I Neutron Resonance Parameters and Thermal Cross Sections Part A Z=1-80*. Academic Press Inc, New York, New York (1981); Mughabghab, S.F.; *Part B, Z=81-100*. Academic Press Inc, Orlando, Florida (1984).
2. Walker, F.W.; Parrington, J.R.; Feiner, P.; *Chart of the Nuclides, 14th Edition*. Knolls Atomic Power Laboratory (April 1988).
2. Holden, N.E.; *Total and Spontaneous Fission Half-lives for Uranium, Plutonium, Americium and Curium Nuclides*, *Pure & Applied Chemistry* **61**, 1483 (1989).
3. Holden, N.E.; *Fifty Years with Nuclear Fission* Conference, Wash., D.C., Gaithersburg, Md. April 26 - 29, 1989, p.946. American Nuclear Society, LaGrange Park, Illinois (1989).
4. Holden, N.E.; *Review of Thermal Neutron Cross Sections and Isotopic Composition of the Elements*, BNL-NCS-42224 (March 1989) and Holden, N.E.; *Thermal Neutron Cross Sections for the 1991 Table of the Isotopes*, BNL-45255 (Feb. 1991).
5. Tuli, J.K.; *Nuclear Wallet Cards*, Brookhaven National Laboratory (July 1990).
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7. Koester, L.; Rauch, H.; Seymann, E.; *Neutron Scattering Lengths: A Survey of Experimental Data and Methods*, *Atomic Data Nuclear Data Tables* **49**, 85 (1991).
8. Sears, V.F.; *Neutron Scattering Lengths and Cross Sections*, *Neutron News* **3**, (3), 26 (1992).

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NEUTRON SCATTERING AND ABSORPTION PROPERTIES

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^1H			0.332(2)	0.149(1)	- 3.739(1)
^1H	99.985(1)		0.332(2)	0.149(1)	- 3.741(1)
^2H	0.015(1)		0.52(1) mb	0.23(2) mb	6.671(4)
^3H		12.32 y	< 6. μb		4.79(3)
^4He			< 0.05		3.26(3)
^3He	1.37×10^{-6}		$\sigma_p = 5.33(1) \times 10^3$ 0.05(1) mb	$RI_p = 2.39(1) \times 10^3$	5.74(7)
^4He	$\approx 100.$				3.26(3)
^6Li			71.(2)	32.(1)	- 1.90(2)
^6Li	7.5(2)		$\sigma_\alpha = 9.4(1) \times 10^2$ 39.(5) mb	$RI_\alpha = 425.(4)$ 18.(2) mb	2.0(1)
^7Li	92.5(2)		45.(5) mb	20.(2) mb	- 2.22(2)
^9Be			8.(1) mb	3.6(5) mb	7.79(1)
^7Be		53.28 d	$\sigma_p = 3.9(1) \times 10^4$	$RI_p = 1.75(5) \times 10^4$	
^9Be	100.		8.(1) mb	3.6(5) mb	7.79(1)
^{10}Be		1.52×10^6 y	< 1. mb		
^{10}B			$7.6(1) \times 10^2$	344.(5)	5.30(4)
^{10}B	19.9(2)		$\sigma_\alpha = 38.4(1) \times 10^2$ 0.3(1) $\sigma_p = 7.(1)$ mb $\sigma_t = 8.(2)$ mb	$RI_\alpha = 17.3(1) \times 10^2$ 0.13(4)	- 0.2(4)
^{11}B	80.1(2)		5.(3) mb	2.5(1) mb	6.65(4)
^{12}C			3.5(1) mb	1.6(1) mb	6.646(1)
^{12}C	98.89(1)		3.5(1) mb	1.6(1) mb	6.651(2)
^{13}C	1.11(1)		1.4(1) mb	1.7(2) mb	6.19(9)
^{14}C		5715. y	< 1. μb		
^{14}N			1.9(1)	0.90(5)	9.36(2)
^{14}N	99.634(9)		$\sigma_p = 1.8(1)$ 0.080(1)	$RI_p = 0.87(3)$ 0.036(1)	9.37(2)
^{15}N	0.366(9)		0.04(1) mb	34.(3) mb	6.44(3)
^{16}O			0.29(1) mb	0.26(4) mb	5.805(4)
^{16}O	99.76(1)		0.19(1) mb	0.21(4) mb	5.805(5)
^{17}O	0.04		$\sigma_\alpha = 0.24(1)$ 0.54(7) mb	0.11(1) 0.39(5) mb	5.8(2)
^{18}O	0.20(1)		0.16(1) mb	0.81(4) mb	5.84(7)
^{19}F			9.5(7) mb	21.(3) mb	5.65(1)
^{19}F	100.		9.5(7) mb	21.(3) mb	5.65(1)
^{20}Ne			0.04(1)	0.02(1)	4.566(6)
^{20}Ne	90.48(3)		0.04(1)	0.02(1)	4.631(6)
^{21}Ne	0.27(1)		0.7(1)	0.3(1)	6.7(2)
^{22}Ne	9.25(3)		0.05(1)	0.02(1)	3.87(1)

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
¹¹ Na			0.525(5)	0.32(2)	3.63(2)
²² Na		2.605 y	$\sigma_p=2.8(3)\times 10^4$ $\sigma_\alpha=2.8(3)\times 10^2$ $\sigma_n=0.43(3)$	$< 2\times 10^5$	
²³ Na	100.			(0.28+0.04)	3.63(2)
¹² Mg			63.(3) mb	38.(4) mb	5.37(1)
²⁴ Mg	78.99(3)		0.053(6)	32.(4) mb	5.5(2)
²⁵ Mg	10.00(1)		0.17(5)	98.(15) mb	3.6(1)
²⁶ Mg	11.01(2)		0.037(2)	25.(2) mb	4.9(2)
²⁷ Mg		9.45 m	0.07(2)	0.03(1)	
¹³ Al			0.230(2)	0.17(1)	3.45(1)
²⁷ Al	100.		0.230(2)	0.17(1)	3.45(1)
¹⁴ Si			0.166(7)	0.09(2)	4.149(1)
²⁸ Si	92.23(2)		0.17(1)	76.(5) mb	4.107(6)
²⁹ Si	4.67(2)		0.12(1)	77.(15) mb	4.7(1)
³⁰ Si	3.10(1)		0.107(4)	0.71(6)	4.58(8)
³¹ Si		2.62 h	73.(6) mb	33.(3) mb	
¹⁵ P			0.16(2)	85.(10) mb	5.13(1)
³¹ P	100.		0.16(2)	85.(10) mb	5.13(1)
¹⁶ S			0.54(2)	0.25(2)	2.847(1)
³² S	95.02(9)		0.55(5)	0.26	2.804(2)
³³ S	0.75(4)		0.46(3)	0.23	4.7(2)
³⁴ S	4.21(8)		0.29(6)	0.13	3.48(3)
³⁶ S	0.02(1)		0.20(3)	0.17(4)	
¹⁷ Cl			33.6(3)	12.(2)	9.578(1)
³⁵ Cl	75.77(7)		43.7(4); $\sigma_p=0.5$	15.(2); $RI_p=0.6$	11.70(9)
³⁶ Cl		3.01x10 ⁵ y	$\sigma_p=46.(2)$ mb $< 10.$	$RI_p=0.02$	
³⁷ Cl	24.23(7)		(0.05+0.37)	(0.04+0.26)	3.1(1)
¹⁸ Ar			0.66(3)	0.42(5)	1.909(6)
³⁶ Ar	0.337(3)		5.6(5); $\sigma_p<1.5$ mb	2.(1)	24.90(7)
³⁷ Ar		35.0 d	$\sigma_\alpha=2.0(3)\times 10^3$		
³⁸ Ar	0.063(1)		0.8(2)	0.4(1)	
³⁹ Ar		268. y	6.(2)x10 ²		
⁴⁰ Ar	99.600(3)		0.64(3)	0.41(5)	1.7
⁴¹ Ar		1.82 h	0.5(1)	0.2(1)	
¹⁹ K			2.1(1)	1.0(1)	3.67(2)
³⁹ K	93.2581(44)		2.1(2)	0.9(1)	3.74(2)
⁴⁰ K	0.0117(1)	1.26x10 ⁹ y	30.(8)	13.(4)	
⁴¹ K	6.7302(44)		$\sigma_p=4.4(4)$ 1.46(3)	1.4(2)	2.69(8)

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{20}Ca			0.43(2)	0.20(2)	4.70(2)
^{40}Ca	98.941(18)	1.03×10^5 y	0.41(3)	0.22(7)	4.80(5)
^{41}Ca			≈ 4 .		
^{42}Ca	0.647(9)		0.85(10)	0.39(4)	3.4(1)
^{43}Ca	0.135(6)	162.7 d	6.(1)	3.9(2)	- 1.56(9)
^{44}Ca	2.086(12)		0.8(2)	0.56(1)	1.42(6)
^{45}Ca			≈ 15 .		
^{46}Ca	0.004(3)		0.70(2)	1.0(1)	
^{48}Ca	0.187(4)		1.1(1)	0.4(1)	0.39(9)
^{21}Sc			27.2(2)	12.(1)	12.3(1)
^{45}Sc	100.	83.81 d	(12.+15.)	(5.+7.)	12.3(1)
^{46}Sc			8.(1)	3.6(5)	
^{22}Ti			6.1(1)	2.8(2)	- 3.438(2)
^{46}Ti	8.25(3)		0.6(2)	0.4(1)	4.93(6)
^{47}Ti	7.44(2)		1.6(2)	1.6(2)	3.63(1)
^{48}Ti	73.72(3)		7.9(9)	3.6(2)	- 8.09(2)
^{49}Ti	5.41(2)		1.9(5)	1.2(2)	1.04(5)
^{50}Ti	5.18(2)		0.179(3)	0.12(2)	6.18(8)
^{23}V			5.0(1)	2.8(1)	- 0.382(1)
^{50}V	0.250(2)	$>1.4 \times 10^{17}$ y	40.(20)	60.(40)	7.6(6)
^{51}V	99.750(2)		4.9(1)	2.7(3)	- 0.402(2)
^{24}Cr			3.0(2)	1.7(1)	3.635(7)
^{50}Cr	4.345(13)	27.70 d	15.(1)	8.(1)	- 4.50(5)
^{51}Cr			< 10 .		
^{52}Cr	83.79(2)		0.8(1)	0.6(2)	4.92(1)
^{53}Cr	9.50(2)		18.(2)	8.9(10)	- 4.20(3)
^{54}Cr	2.365(7)		0.36(4)	0.25(5)	4.6(1)
^{25}Mn			13.3(1)	14.0(3)	- 3.73(2)
^{53}Mn		3.7×10^6 y	70.(10)	32.(5)	
^{54}Mn		312.2 d	< 10 .		
^{55}Mn	100.		13.3(1)	14.0(3)	- 3.73(2)
^{26}Fe			2.60(4)	1.4(2)	9.45(2)
^{54}Fe	5.85(4)	2.73 y	2.7(5)	1.4(2)	4.2(1)
^{55}Fe			13.(2)	6.(1)	
^{56}Fe	91.75(4)		2.6(2)	1.4(2)	9.93(3)
^{57}Fe	2.12(1)	44.51 d	2.5(5)	1.6(3)	2.3(1)
^{58}Fe	0.28(1)		1.3(1)	1.2(2)	15.(7)
^{59}Fe			13.(3)	6.(1)	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{27}Co			37.19(8)	74.(2)	2.49(2)
$^{58\text{m}}\text{Co}$		9.1 h	$1.4(1)\times 10^5$	$2.5(10)\times 10^5$	
^{58}Co		70.88 d	$1.9(2)\times 10^3$	$7.(1)\times 10^3$	
^{59}Co	100.		(20.7+18.5)	(39.+35.)	2.49(2)
$^{60\text{m}}\text{Co}$		10.47 m	58.(8)	230.(50)	
^{60}Co		5.271 y	2.0(2)	4.3(10)	
^{28}Ni			4.5(2)	2.3(2)	10.3(1)
^{58}Ni	68.077(9)		4.6(4)	2.3(2)	14.4(1)
^{59}Ni		$\approx 7.6\times 10^4$ y	92.(4)	138.(8)	
^{60}Ni	26.223(8)		2.9(3)	1.5(2)	2.8(1)
^{61}Ni	1.140(1)		2.5(5)	1.5(4)	7.6(6)
^{62}Ni	3.634(2)		15.(1)	6.8(3)	- 8.7(2)
^{63}Ni		100. y	24.(3)		
^{64}Ni	0.926(1)		1.8(1)	1.2(2)	- 0.38(7)
^{65}Ni		2.517 h	22.(2)	10.(1)	
^{29}Cu			3.8(1)	4.1(4)	7.718(4)
^{63}Cu	69.17(3)		4.5(2)	5.(1)	6.43(15)
^{64}Cu		12.701 h	$\approx 270.$		
^{65}Cu	30.83(3)		2.17(3)	2.2(1)	10.61(19)
^{66}Cu		5.10 m	$1.4(1)\times 10^2$	60.(20)	
^{30}Zn			1.1(2)	2.8(4)	5.680(5)
^{64}Zn	48.6(3)		0.74(5)	1.4(3)	5.22(4)
^{65}Zn		243.8 d	68.(8)		
^{66}Zn	27.9(2)		1.0(2)	1.8(2)	5.97(5)
^{67}Zn	4.1(1)		6.9(1.4)	25.(5)	7.56(8)
^{68}Zn	18.8(4)		(0.072+0.8)	(0.2+2.9)	6.03(3)
^{70}Zn	0.6(1)		(8.1+83.) mb	0.9(2)	
^{31}Ga			2.9(1)	22.(3)	7.288(2)
^{69}Ga	60.108(9)		1.68(7)	16.(2)	7.88(4)
^{71}Ga	39.892(9)		4.7(2); $\sigma_{\text{a}}=0.15$	31.(3)	6.40(3)
^{32}Ge			2.2(1)	6.(2)	8.19(2)
^{70}Ge	21.23(4)		(0.3+2.7)	2.3(1)	10.0(1)
^{72}Ge	27.66(3)		0.9(2)	0.8(3)	8.5(1)
^{73}Ge	7.73(1)		15.(1)	68.(20)	5.02(4)
^{74}Ge	35.94(2)		(0.14+0.28)	(0.4+0.5)	7.6(1)
^{76}Ge	7.44(2)		(0.09+0.06)	(1.3+0.6)	8.2(15)
^{33}As			4.0(4)	61.(5)	6.58(1)
^{75}As	100.		4.0(4)	61.(5)	6.58(1)

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
³⁴ Se			12.(1)	14.(3)	7.970(9)
⁷⁴ Se	0.89(2)	119.78 d	50.(4)	650.(50)	0.8(3)
⁷⁵ Se			3.3(10)x10 ²		
⁷⁶ Se	9.36(11)		(22.+83.)	(6.+38.)	12.2(1)
⁷⁷ Se	7.63(6)		42.(4)	30.(5)	8.25(8)
⁷⁸ Se	23.78(9)		$\sigma_{\text{a}}=0.38(2)$	$RI_{\text{a}}=3.7(5)$	8.24(9)
⁸⁰ Se	49.61(10)		(0.07+0.39)	(0.3+1.7)	7.48(3)
⁸² Se	8.73(6)		(39.+5.8) mb	0.04(1)	6.34(8)
³⁵ Br			6.8(2)	92.(8)	6.79(2)
⁷⁶ Br		16.0 h	224.(42)		
⁷⁸ Br	50.69(7)		(2.5+8.3)	(36.+96.)	6.79(7)
⁸¹ Br	49.31(7)		(2.4+0.24)	51.(5)	6.78(7)
³⁶ Kr			24.(1)	39.(6)	7.81(2)
⁷⁸ Kr	0.35(2)	10.73 y	(0.17+6.)	20.(2)	
⁸⁰ Kr	2.25(2)		(4.6+7.)	57.(6)	
⁸² Kr	11.6(1)		(14.+7.)	130.(13)	
⁸³ Kr	11.5(1)		183.(30)	183.(20)	
⁸⁴ Kr	57.0(3)		$\sigma_{\text{a}}=0.09; \sigma_{\text{a}+\text{g}}=0.11$	2.4(3)	
⁸⁵ Kr			1.7(2)	2.(1)	
⁸⁶ Kr	17.3(2)		3.(2)mb	$\approx 1.$ mb	8.1(3)
³⁷ Rb			0.39(4)	6.(3)	7.08(2)
⁸⁴ Rb		32.9 d	$\sigma_{\text{p}}=12.(2)$		
⁸⁵ Rb	72.17(2)		(0.06+0.44)	(0.7+7.)	7.0(1)
⁸⁶ Rb		18.65 d	< 20.		
⁸⁷ Rb	27.83(2)	4.88x10 ¹⁰ y	0.10(1)	2.3(2)	7.3(1)
⁸⁸ Rb		17.7 m	1.2(3)	0.5	
³⁸ Sr			1.2(1)	7.(4)	7.02(2)
⁸⁴ Sr	0.56(1)	50.52 d	(0.6+0.2)	(9.+1.)	5.(2)
⁸⁶ Sr	9.86(1)		$\sigma_{\text{a}}=0.81(4)$	$RI_{\text{a}}=4.(1)$	5.68(5)
⁸⁷ Sr	7.00(1)			118.(30)	7.41(7)
⁸⁸ Sr	82.58(1)		5.8(4)mb	0.07(3)	7.16(6)
⁸⁹ Sr		29.1 y	0.42(4)	0.2	
⁹⁰ Sr			9.7(7)mb	4. mb	
³⁹ Y			(0.001+1.25)	1.0(1)	7.75(2)
⁸⁹ Y	100.	2.67 d	(0.001+1.25)	(0.003+1.0)	7.75(2)
⁹⁰ Y			< 7.		
⁹¹ Y			1.4(3)	0.6	
⁴⁰ Zr			0.19(1); $\sigma_{\alpha}<0.1\text{mb}$	0.95(9)	7.16(3)
⁹⁰ Zr	51.45(3)	1.5x10 ⁶ y	≈ 0.014	0.2(1)	6.4(1)
⁹¹ Zr	11.22(4)		1.2(3)	5.(2)	8.8(1)
⁹² Zr	17.15(2)		0.2(1)	0.6(2)	7.5(2)
⁹³ Zr			< 4.	16.(5)	
⁹⁴ Zr	17.38(4)		0.049(6)	0.25(3)	8.3(2)
⁹⁶ Zr	2.80(2)		0.020(3)	5.0(5)	5.5(1)

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{41}Nb			$1.11(1); \sigma_a < 0.1\text{mb}$	$8.5(6)$	$7.14(3)$
^{93}Nb	100.		$1.1; \sigma_{\text{th}} = 0.86$	$(6.2+2.3)$	$7.14(3)$
^{94}Nb		$2.4 \times 10^4 \text{ y}$	$\sigma_{\text{th}+g} = 15.(1)$	$126.(13)$	
^{95}Nb		34.97 d	$\sigma_{\text{th}} = 0.6(1)$ $< 7.$	$< 200.$	
^{42}Mo			$2.5(1)$	$28.(5)$	$6.72(2)$
^{92}Mo	$14.84(4)$			≈ 0.8	$6.93(8)$
^{94}Mo	$9.25(3)$			≈ 0.8	$6.82(7)$
^{95}Mo	$15.92(5)$		$13.4(5)$	$109.(5)$	$6.93(6)$
^{96}Mo	$16.68(5)$			$17.(3)$	$6.22(6)$
^{97}Mo	$9.55(3)$		$2.5(3)$	$14.(3)$	$7.26(8)$
^{98}Mo	$24.13(7)$		$0.14(1)$	$7.2(7)$	$6.60(7)$
^{100}Mo	$9.63(3)$		$0.19(1)$	$3.7(3)$	$6.75(7)$
^{43}Tc					
^{98}Tc		$4.2 \times 10^6 \text{ y}$	$\sigma_{\text{th}} = 0.9$		
^{99}Tc		$2.13 \times 10^5 \text{ y}$	$20.$	$340.(20)$	$6.8(3)$
^{44}Ru			$2.6(1)$	$43.(5)$	$7.03(3)$
^{96}Ru	$5.52(6)$		$0.23(4)$	$7.(2)$	
^{98}Ru	$1.88(6)$		$< 8.$		
^{99}Ru	$12.7(1)$		$4.(1)$	$195.(20)$	
^{100}Ru	$12.6(1)$		$5.8(6)$	$11.(2)$	
^{101}Ru	$17.0(1)$		$5.(1)$	$80.(10)$	
^{102}Ru	$31.6(2)$		$1.2(1)$	$4.3(5)$	
^{103}Ru		39.27 d	$< 20.$	$\approx 30.$	
^{104}Ru	$18.7(2)$		$0.49(2)$	$6.(2)$	
^{105}Ru		4.44 h	$0.30(3)$		
^{106}Ru		1.020 y	$0.15(4)$	$2.0(6)$	
^{45}Rh			$145.(2)$	$1.2(1) \times 10^3$	$5.88(4)$
^{103}Rh	100.		$(11.+134.)$	$(0.09+1.1) \times 10^3$	$5.88(4)$
$^{104\text{m}}\text{Rh}$		4.36 m	$800.(100)$		
^{104}Rh		42.3 s	$40.(30)$		
^{105}Rh		35.4 h	$1.1(3) \times 10^4$	$1.7(4) \times 10^4$	
^{46}Pd			$7.(1)$	$82.(8)$	$5.91(6)$
^{102}Pd	$1.02(1)$		$3.2(10)$	$10.(2)$	
^{104}Pd	$11.14(8)$			$16.(2)$	
^{105}Pd	$22.33(8)$		$22.(2)$	$60.(20)$	$5.5(3)$
^{106}Pd	$27.33(3)$		$(0.013+0.28)$	$(0.2+5.5)$	$6.4(4)$
^{107}Pd		$6.5 \times 10^6 \text{ y}$	$1.8(2)$	$108.(4)$	
^{108}Pd	$26.46(9)$		$(0.19+8.5)$	$(2.+240.)$	$4.1(3)$
^{110}Pd	$11.72(9)$		$(0.033+0.7)$	$(0.7+8.)$	
^{47}Ag			$62.(1)$	$767.(60)$	$5.922(7)$
^{107}Ag	$51.839(7)$		$(0.37+35.)$	$(1.2+105.)$	$7.56(1)$
^{109}Ag	$48.161(7)$		$(4.2+87.)$	$(0.7+14.1) \times 10^2$	$4.17(1)$
$^{110\text{m}}\text{Ag}$		249.8 d	$82.(11)$	$20.(4)$	
^{111}Ag		7.47 d	$3.(2)$	$105.(20)$	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
⁴⁸ Cd			2.52(5)x10 ³	73.(8)	4.87(5)
¹⁰⁶ Cd	1.25(4)		0.20(3)	4.(1)	5.4(1)
¹⁰⁸ Cd	0.89(2)		1.	14.(3)	
¹⁰⁹ Cd		462.0 d	≈180.	8.7(12)x10 ³	
¹¹⁰ Cd	12.49(12)		(0.06+11.)	(6.+34.)	
¹¹¹ Cd	12.80(8)		24.(3)	51.(6)	6.5(1)
¹¹² Cd	24.13(14)		(0.012+2.2)	15.	6.4(1)
¹¹³ Cd	12.22(8)	9x10 ¹⁵ y	2.08(4)x10 ⁴	390.(40)	- 8.0(2)
¹¹⁴ Cd	28.73(28)		(0.04+0.30)	16.(7)	7.5(1)
¹¹⁶ Cd	7.49(12)		(28.+52.)mb	1.2	6.3(1)
⁴⁹ In			197.(4)	3.3(2)x10 ³	4.07(2)
¹¹³ In	4.29(2)		(3.1+5.4+3.9)	(230.+80)	5.39(6)
¹¹⁵ In	95.71(2)	4.4x10 ¹⁴ y	(88.+73.+44.)	(1.5+1.2+0.7)x10 ³	4.01(2)
⁵⁰ Sn			0.61(3)	8.(2)	6.225(2)
¹¹² Sn	0.97(1)		(0.15+0.40)	(8.+19.)	
¹¹³ Sn		115.1 d	≈ 9.	210.(50)	
¹¹⁴ Sn	0.65(1)		≈ 0.12	5.(1)	6.2(3)
¹¹⁵ Sn	0.34(1)		σ _α =0.06 mb	29.(6)	
¹¹⁶ Sn	14.53(11)		(0.006+0.14)	(0.5+11.)	5.93(5)
¹¹⁷ Sn	7.68(7)		1.1(1)	16.(5)	6.48(5)
¹¹⁸ Sn	24.23(11)		σ _n =4. mb	4.7(5)	6.07(5)
¹¹⁹ Sn	8.59(4)		2.(1)	2.9(5)	6.12(5)
¹²⁰ Sn	32.59(10)		(0.001+0.13)	1.2(3)	6.49(5)
¹²² Sn	4.63(3)		(0.15+0.001)	0.81(4)	5.74(5)
¹²⁴ Sn	5.79(5)		(0.13+0.005)	RI _n =8.0(2)	5.97(5)
⁵¹ Sb			5.3(2)	169.(20)	5.57(3)
¹²¹ Sb	57.21(5)		(0.4+5.8)	(13.+192.)	5.71(6)
¹²³ Sb	42.79(5)		(0.02+0.04+4.0)	(1.+119.)	5.38(7)
¹²⁴ Sb		60.20 d	17.(3)	≈ 8.	
⁵² Te			4.2(1)	47.(3)	5.80(3)
¹²⁰ Te	0.096(2)		(0.25+2.0)	≈ 1.	5.3(5)
¹²² Te	2.603(4)		2.4(5)	80.(20)	3.8(2)
¹²³ Te	0.908(2)	1.3x10 ¹³ y	370.(40)	4.5(3)x10 ³	- 0.05
¹²⁴ Te	4.816(6)		(0.05+7.)	5.2(7)	8.0(1)
¹²⁵ Te	7.139(6)		1.3(2)	21.(4)	5.02(8)
¹²⁶ Te	18.952(11)		(0.12+0.8)	8.2(6)	5.56(7)
¹²⁸ Te	31.687(11)		(0.016+0.20)	(0.08+1.5)	5.89(7)
¹³⁰ Te	33.799(10)	2.5x10 ²¹ y	(0.03+0.20)	(0.08+0.34)	6.02(7)
⁵³ I			6.15(10)	148.(7)	5.28(2)
¹²⁵ I		59.4 d	900.(100)	1.4(2)x10 ⁴	
¹²⁷ I	100.		6.15(10)	148.(7)	5.28(2)
¹²⁸ I		25.00 m	22.(4)	≈ 10.	
¹²⁹ I		1.7x10 ⁷ y	(20.7+10.3)	36.(4)	
¹³⁰ I		12.36 h	18.(3)	≈ 8.	
¹³¹ I		8.040 d	≈ 0.7	8.(4)	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
$_{54}\text{Xe}$			25.(1)	263.(50)	4.92(3)
^{124}Xe	0.10(1)		(28.+137.)	(0.6+3.0) $\times 10^3$	
^{125}Xe		17.1 h	$\sigma_{\alpha} \leq 0.03$		
^{126}Xe	0.09(1)		(0.45+3.)	(8.+52.)	
^{127}Xe		36.4 d	$\sigma_{\alpha} \leq 0.01$		
^{128}Xe	1.91(3)		$\sigma_{\text{m}} = 0.48$	$\text{RI}_{\text{m}} = 38.(10)$	
^{129}Xe	26.4(6)		22.(5)	250.(50)	
^{130}Xe	4.1(1)		$\sigma_{\text{m}} = 0.45$	$\text{RI}_{\text{m}} = 16.(4)$	
^{131}Xe	21.2(4)		90.(10)	9.(1) $\times 10^2$	
^{132}Xe	26.9(5)		(0.05+0.4)	(0.9+3.7)	
^{133}Xe		5.243 d	190.(90)		
^{134}Xe	10.4(2)		(0.003+0.26)	0.40(4)	
^{135}Xe		9.10 h	2.85(11) $\times 10^6$	7.6(5) $\times 10^3$	
^{136}Xe	8.9(1)		0.26(2)	0.7(2)	
$_{55}\text{Cs}$			30.4(8)	422.(50)	5.42(2)
^{132}Cs		6.48 d	$\sigma_{\alpha} < 0.15$		
^{133}Cs	100.		(2.7+27.7)	(32.+390.)	
^{134}Cs		2.065 y	140.(10)	54.(9)	
^{135}Cs		2.3 $\times 10^6$ y	8.9(5)	90.(20)	
^{137}Cs		30.3 y	0.25(1)	0.36(7)	
$_{56}\text{Ba}$			1.3(2)	10.(2)	5.07(3)
^{130}Ba	0.106(2)		(1.+8.)	(25.+200.)	- 3.6(6)
^{132}Ba	0.101(2)		(0.84+9.7)	(4.7+24.)	7.8(3)
^{133}Ba		10.53 y	4.(1)	85.(30)	
^{134}Ba	2.417(27)		(0.1+1.3)	(5.6+18.)	5.7(1)
^{135}Ba	6.592(18)		(0.014+5.8)	(0.47+131.)	4.7(1)
^{136}Ba	7.854(36)		(0.010+0.44)	(0.1+1.5)	4.91(8)
^{137}Ba	11.23(4)		5.(1)	4.(1)	6.8(1)
^{138}Ba	71.70(7)		0.41(2)	0.4(1)	4.84(8)
^{139}Ba		1.396 h	5.(1)	2.2(5)	
^{140}Ba		12.75 d	1.6(3)	14.(1)	
$_{57}\text{La}$			9.2(2)	12.(1)	8.24(4)
^{138}La	0.0902(2)	1.06 $\times 10^{11}$ y	57.(6)	4.1(9) $\times 10^2$	
^{139}La	99.9098(2)		9.2(2)	12.(1)	8.24(4)
^{140}La		1.678 d	2.7(3)	69.(4)	
$_{58}\text{Ce}$			0.64(4)	0.71(6)	4.84(2)
^{136}Ce	0.19(1)		(1.0+6.5)	58.(12)	5.80(9)
^{138}Ce	0.25(1)		(0.018+1.)	(1.5+5.2)	6.70(9)
^{140}Ce	88.43(10)		0.58(4)	0.50(5)	4.84(9)
^{141}Ce		32.50 d	29.(3)	13.(2)	
^{142}Ce	11.13(10)		0.97(3)	1.3(3)	4.75(9)
^{143}Ce		1.38 d	6.1(7)	2.7(3)	
^{144}Ce		284.6 d	1.0(1)	2.6(3)	
$_{59}\text{Pr}$			11.5(4)	14.(3)	4.58(5)
^{141}Pr	100.		(4.+7.5)	14.(3)	4.58(5)
^{142}Pr		19.12 h	20.(3)	9.(1)	
^{143}Pr		13.57 d	90.(10)	190.(25)	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{60}Nd			51.(2)	49.(5)	7.68(5)
^{142}Nd	27.13(12)		19.(1)	34.(11)	7.7(3)
^{143}Nd	12.18(6)		330.(10)	128.(30)	
^{144}Nd	23.80(12)	2.1×10^{15} y	3.6(3)	3.9(5)	2.8(3)
^{145}Nd	8.30(6)		47.(6)	260.(40)	
^{146}Nd	17.19(9)		1.5(2)	3.0(4)	8.7(2)
^{147}Nd		10.98 d	440.(150)	210.	
^{148}Nd	5.76(3)		2.4(1)	13.(2)	5.7(3)
^{150}Nd	5.84(3)		1.0(1)	14.(2)	5.3(2)
^{61}Pm					
^{146}Pm		5.53 y	$8.4(1.7) \times 10^3$		
^{147}Pm		2.6234 y	(84.+96.)	(1000.+1280.)	12.6(4)
^{148}mPm		41.3 d	10800.(800)		
^{148}Pm		5.37 d	$\approx 10^3$	$3.6(2.4) \times 10^3$	
^{149}Pm		2.212 d	1400.(200)		
^{151}Pm		1.183 d	$\approx 150.$		
^{62}Sm			$5.6(1) \times 10^3$	$1.4(2) \times 10^3$	
^{144}Sm	3.1(1)		1.6(1)	2.4(3)	
^{145}Sm		340. d	280.(20)	600.(90)	
^{147}Sm	15.0(2)	1.06×10^{11} y	58.(4)	710.(50)	14.(3)
^{148}Sm	11.3(1)	7×10^{15} y	2.4(6)	27.(14)	
^{149}Sm	13.8(1)	10^{16} y	40100.(600)	3100.(500)	
^{150}Sm	7.4(1)		102.(5)	290.(30)	14.(3)
^{151}Sm		90. y	15200.(300)	3520.(60)	
^{152}Sm	26.7(2)		206.(15)	3000.(300)	- 5.0(6)
^{153}Sm		1.929 d	420.(180)		
^{154}Sm	22.7(2)		7.5(3)	32.(6)	9.(1)
^{63}Eu			4570.(100)	$3.8(5) \times 10^3$	5.3(3)
^{151}Eu	47.8(5)		(4.+3150.+6000.)	(2000.+4000.)	
$^{152\text{m}}\text{Eu}$		9.30 h	68000.(15000)	< 100000.	
^{152}Eu		13.48 y	11000.(2000)	1600.(200)	
^{153}Eu	52.2(5)		300.(20)	1800.(400)	8.2(1)
^{154}Eu		8.59 y	1500.(300)	1600.(200)	
^{155}Eu		4.71 y	3900.(200)	16000.(2000)	
^{64}Gd			$48.8(6) \times 10^3$	400.(10)	9.5(2)
^{152}Gd	0.20(1)		700.(200)	700.(200)	
^{153}Gd		241.6 d	20000.(10000)		
^{154}Gd	2.18(3)		(0.06+60.)	230.(50)	
^{155}Gd	14.80(5)		61000.(1000)	1540.(100)	
^{156}Gd	20.47(4)		≈ 2.0	104.(15)	6.3(4)
^{157}Gd	15.65(3)		$2.54(3) \times 10^5$	800.(100)	
^{158}Gd	24.84(12)		2.3(3)	73.(7)	9.(2)
^{160}Gd	21.86(4)		1.5(7)	6.(1)	9.15(5)
^{161}Gd		3.66 m	$2.0(6) \times 10^4$		
^{65}Tb			23.2(5)	420.(50)	7.38(3)
^{159}Tb	100.		23.2(5)	420.(50)	7.38(3)
^{160}Tb		72.3 d	570.(110)		

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
⁶⁶ Dy			9.5(2)x10 ²	1.5(2)x10 ³	16.9(3)
¹⁵⁶ Dy	0.06(1)		33.(3)	1000.(100)	
¹⁵⁸ Dy	0.10(1)		43.(6)	120.(10)	6.1(5)
¹⁵⁹ Dy		144. d	8.(2)x10 ³		
¹⁶⁰ Dy	2.34(6)		60.(10)	1100.(200)	6.7(4)
¹⁶¹ Dy	18.9(2)		600.(50)	1100.(100)	10.3(4)
¹⁶² Dy	25.5(2)		170.(20)	2755.(300)	- 1.4(5)
¹⁶³ Dy	24.9(2)		120.(10)	1600.(400)	5.0(4)
¹⁶⁴ Dy	28.2(2)		(1.7+1.0)x10 ³	(420.+100.)	49.4(2)
^{165m} Dy		1.26 m	2.0(6)x10 ³		
¹⁶⁵ Dy		2.33 h	3.5(3)x10 ³	2.2(3)x10 ⁴	
⁶⁷ Ho			61.(2)	670.(40)	8.01(8)
¹⁶⁵ Ho	100.		(3.1+58.)	(7+670.)	8.01(8)
¹⁶⁶ Ho		1.2x10 ³ y	9140.(650)	1140.(90)	8.01(8)
⁶⁸ Er			169.(20)	730.(10)	7.78(2)
¹⁶² Er	0.14(1)		19.(3)	480.(50)	8.8(2)
¹⁶⁴ Er	1.61(2)		13.(3)	105.(10)	8.2(2)
¹⁶⁶ Er	33.6(2)		(15.+5.)	96.(12)	10.6(2)
¹⁶⁷ Er	22.95(15)		700.(200)	2970.(70)	3.0(3)
¹⁶⁸ Er	26.8(2)		2.0(6)	37.(5)	7.4(4)
¹⁷⁰ Er	14.9(2)		6.(2)	26.(4)	9.6(5)
¹⁷¹ Er		7.52 h	370.(40)	170.(20)	
⁶⁹ Tm			106.(5)	1.5(2)x10 ³	7.07(3)
¹⁶⁹ Tm	100		(8.+98.)	1.5(2)x10 ³	7.07(3)
¹⁷⁰ Tm		128.6 d	100.(20)	460.(50)	
¹⁷¹ Tm		1.92 y	≈ 160.	118.(6)	
⁷⁰ Yb			52.(10)	1.7(2)x10 ²	12.43(3)
¹⁶⁶ Yb	0.13(1)		2.4(2)x10 ³	2.0(5)x10 ⁴	
¹⁶⁸ Yb		32.03 d	3.6(3)x10 ³	5200.(500)	
¹⁷⁰ Yb	3.05(6)		12.(2)	320.(30)	6.8(1)
¹⁷¹ Yb	14.3(2)		50.(10)	315.(30)	9.7(1)
¹⁷² Yb	21.9(3)		≈ 1.3	25.(3)	9.4(1)
¹⁷³ Yb	16.12(21)		16.(2)	380.(30)	9.56(7)
¹⁷⁴ Yb	31.8(4)		(46.+74.)	(13.+47.)	19.3(1)
¹⁷⁶ Yb	12.7(2)		3.1(2)	8.(2)	8.7(1)
⁷¹ Lu			78.(7)	8.3(7)x10 ²	7.21(3)
¹⁷⁵ Lu	≈ 7.41(2)		(16.+8.)	(550.+270.)	7.24(3)
¹⁷⁶ Lu	2.59(2)	3.8x10 ¹⁰ y	(2.+2100.)	(3.+1100.)	6.1(2)
^{177m} Lu		160.7 d	3.2(3)	1.4(2)	
¹⁷⁷ Lu		6.68 d	1000.(300)		
⁷² Hf			106.(3)	19.7(5)x10 ²	7.8(1)
¹⁷⁴ Hf	0.162(3)	2.0x10 ¹⁵ y	600.(50)	400.(50)	
¹⁷⁶ Hf	5.206(5)		23.(4)	700.(100)	11.(1)
¹⁷⁷ Hf	18.606(13)		(1.+375.)	7170.(200)	6.6(2)
¹⁷⁸ Hf	27.297(4)		(53.+32.)	(1000.+850.)	5.9(2)
¹⁷⁹ Hf	13.629(6)		(0.43+46.)	(6.8+620.)	7.5(2)
¹⁸⁰ Hf	35.100(7)		13.(1)	32.(2)	13.2(3)
¹⁸¹ Hf		42.4 d	30.(25)		

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{73}Ta			20.(1)	650(20.)	6.91(7)
$^{180\text{m}}\text{Ta}$	0.012(2)	$> 1.2 \times 10^{15}$ y	$\approx 560.$	1350.(100)	
^{181}Ta	99.998(2)		(0.012+20.)	(0.4+650.)	6.91(7)
^{182}Ta		114.43 d	8200.(600)	900.(90)	
^{74}W			18.(1)	$3.6(3) \times 10^2$	4.86(2)
^{180}W	0.12(1)		$\approx 4.$	210.(30)	
^{182}W	26.50(3)		20.(1)	600.(90)	6.97(4)
^{183}W	14.31(1)		10.5(3)	340.(50)	6.53(4)
^{184}W	30.64(1)		(0.002+2.0)	15.(2)	7.48(6)
^{185}W		74.8 d	≈ 3.3	300.(50)	
^{186}W	28.43(4)		37.(2)	510.(50)	- 0.72(4)
^{187}W		23.9 h	70.(10)	2760.(550)	
^{75}Re			90.(4)	$8.4(2) \times 10^2$	9.2(3)
^{185}Re	37.40(2)		(0.33+110.)	1700.(50)	9.0(3)
^{187}Re	62.60(2)	4.2×10^{10} y	(2.+72.)	(9.+310.)	9.3(3)
^{76}Os			17.(1)	$1.5(1) \times 10^2$	10.7(2)
^{184}Os	0.020(3)		$3.3(3) \times 10^3$	660.(60)	
^{186}Os	1.58(2)	$2. \times 10^{15}$ y	$\approx 80.$	280.(40)	12(2)
^{187}Os	1.6(4)		$2.(1) \times 10^2$	500.(70)	
^{188}Os	13.3(1)		$\approx 5.$	150.(20)	7.6(3)
^{189}Os	16.1(1)		(0.00026+40.)	(0.013+670.)	10.7(3)
^{190}Os	26.4(2)		(9.+4.)	(22.+8.)	11.0(3)
^{191}Os		15.4 d	$3.8(6) \times 10^2$		
^{192}Os	41.0(3)		3.(1)	6.(1)	11.5(4)
^{193}Os		30.5 h	40.(10)		
^{77}Ir			$4.2(1) \times 10^2$	$2.8(4) \times 10^3$	10.6(3)
^{191}Ir	37.27(9)		(660.+260.)	(1000.+4200.)	
^{192}Ir		73.83 d	1450.(250)	4800.(700)	
^{193}Ir	62.73(9)		(6.+110.)	1400.(200)	
^{194}Ir		19.3 h	$1.5(3) \times 10^3$		
^{78}Pt			10.(1)	$1.3(1) \times 10^2$	9.60(1)
^{190}Pt	0.01(1)	6.5×10^{11} y	$1.5(1) \times 10^2$	70.(10)	9(1)
^{192}Pt	0.79(6)		(2.0+6.)	115.(20)	9.9(5)
^{194}Pt	32.9(6)		(0.1+1.1)	(4.+?)	10.55(8)
^{195}Pt	33.8(6)		28.(1)	365.(50)	8.8(1)
^{196}Pt	25.3(6)		(0.045+0.55)	7.(2)	9.89(8)
^{198}Pt	7.2(2)		(0.027+3.6)	(0.5+56.)	7.8(1)
^{199}Pt		30.8 m	$\approx 16.$		
^{79}Au			98.7(1)	$1.55(3) \times 10^3$	7.90(7)
^{197}Au	100.		98.7(1)	$1.55(3) \times 10^3$	7.90(7)
^{198}Au		2.694 d	$26.5(15) \times 10^3$	$\approx 4. \times 10^4$	
^{199}Au		3.14 d	$\approx 30.$		

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{80}Hg			$3.7(1)\times 10^2$	87.(5)	12.69(2)
^{186}Hg	0.15(1)		(105.+3000.)	(53.+410.)	30.(1)
^{198}Hg	9.97(8)		(0.017+2.)	(1.7+70.)	
^{199}Hg	16.87(10)		$2.1(2)\times 10^3$	435(20)	16.9(4)
^{200}Hg	23.10(16)		< 60.	2.1(5)	
^{201}Hg	13.18(8)		< 60.	30.(3)	
^{202}Hg	29.86(20)		4.9(5)	4.5(2)	
^{204}Hg	6.87(4)		0.4(1)	0.8(2)	
^{81}Tl			3.3(1)	12.5(8)	8.776(5)
^{203}Tl	29.52(1)		11.(1)	41.(2)	7.0(2)
^{204}Tl		3.78 y	22.(2)	90.(20)	
^{205}Tl	70.48(1)		0.11(2)	0.6(2)	9.52(7)
^{82}Pb			0.172(2)	0.14(4)	9.405(3)
^{204}Pb	1.4(1)		0.68(7)	2.0(2)	9.9(1)
^{205}Pb		1.51×10^7 y	≈ 5 .		
^{206}Pb	24.1(1)		0.030(1)	0.10(1)	9.22(5)
^{207}Pb	22.1(1)		0.70(1)	0.38(1)	9.28(4)
^{208}Pb	52.4(1)		0.49(3) mb	2.0(2) mb	9.50(2)
^{210}Pb		22.6 y	< 0.5		
^{83}Bi			0.034(1)	0.19(2)	8.532(2)
^{209}Bi	100.		(11.+23.) mb	0.19(2)	8.532(2)
$^{210\text{m}}\text{Bi}$		3.0×10^6 y	54.(4) mb	0.20(3)	
^{84}Po					
^{210}Po		138.38 d	$\sigma_{\text{th}} < 0.5$ mb $\sigma_{\text{g}} < 30$ mb		
^{85}At					
^{86}Rn					
^{220}Rn		55.6 s	< 0.2		
^{222}Rn		3.8235 d	0.74(5)		
^{88}Ra					
^{223}Ra		11.435	$1.3(2)\times 10^2$		
^{224}Ra		3.68 d	12.0(5)		
^{226}Ra		1599. y	≈ 13 .	280.(50)	10.(1)
^{228}Ra		5.76 y	36.(5)		
^{89}Ac					
^{227}Ac		21.77 y	$8.8(7)\times 10^2$	$1.5(4)\times 10^3$	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
^{90}Th			7.4	85.(3)	10.31(3)
^{227}Th		18.72 d	$\sigma_f = 2.0(2) \times 10^2$		
^{228}Th		1.913 y	$1.2(2) \times 10^2$	1014.(400)	
^{229}Th		7.9×10^3 y	$\approx 80.$	$1.0(2) \times 10^3$ $RI_f = 466.(75)$	
^{230}Th		7.54×10^4 y	23.4(5) $\sigma_f < 0.5 \text{ mb}$	$1.0(1) \times 10^3$	
^{232}Th	100.	1.4×10^{10} y	7.37(4) $\sigma_f = 3.(1) \mu\text{b}$ $\sigma_\alpha < 1. \text{ mb}$	85.(3)	10.31(3)
^{233}Th		22.3 m	$1.5(1) \times 10^3$ $\sigma_f = 15.(2)$	$4.(1) \times 10^2$	
^{234}Th		24.10 d	1.8(5) $\sigma_f < 0.01$		
^{91}Pa					
^{230}Pa		17.4 d	$1.5(3) \times 10^3$		
^{231}Pa		3.25×10^4 y	$2.0(1) \times 10^2$ $\sigma_f = 20.(1) \text{ mb}$	750.(80) $RI_f = 0.05(1)$	9.1(3)
^{232}Pa		1.31 d	$4.6(10) \times 10^2$ $\sigma_f = 7.(1) \times 10^2$	300.(70)	
^{233}Pa		27.0 d	39.(2) $\sigma_m = 20.(4)$ $\sigma_g = 19.(3)$ $\sigma_f < 0.1$	(460.+440.)	
^{92}U			$3.4(3); \sigma_f = 4.2(1)$	2.8(2)	8.417(5)
^{230}U		20.8 d	$\sigma_f \approx 25.$		
^{231}U		4.2 d	$\sigma_f \approx 250.$		
^{232}U		68.9 y	73.(2) $\sigma_f = 74.(8)$	280.(15) $RI_f = 350.(30)$	
^{233}U		1.59×10^5 y	47.(2) $\sigma_f = 5.3(1) \times 10^2$ $\sigma_\alpha < 0.2 \text{ mb}$	137.(6) $RI_f = 760.(17)$	10.1(2)
^{234}U	0.0055(5)	2.45×10^5 y	96.(2) $\sigma_f < 5. \text{ mb}$	660.(70) $RI_f = 6.5$	12.(4)
^{235}U	0.720(1)	7.04×10^8 y	95.(5) $\sigma_f = 586.(2)$ $\sigma_\alpha < 0.1 \text{ mb}$	144.(6) $RI_f = 275(5)$	10.47(4)
^{236}U		2.34×10^7 y	5.1(3) $\sigma_f = 0.04$	380.(15) $RI_f = 4.38(50)$	
^{237}U		6.75 d	$\approx 10^2$ $\sigma_f < 0.35$	1200.(200)	
^{238}U	99.2745(15)	4.46×10^9 y	2.7(1) $\sigma_f \approx 3. \mu\text{b}$ $\sigma_\alpha = 1.4(5) \mu\text{b}$	277.(3) $1.54(15) \text{ mb}$	8.402(5)
^{239}U		23.5 m	22.(2) $\sigma_f = 15.(3)$		
^{93}Np					
^{234}Np		4.4 d	$\sigma_f = 9.(3) \times 10^2$		
^{235}Np		1.085 y	$1.6(1) \times 10^2$		
$^{236\text{m}}\text{Np}$		22.5 h	$\sigma_f = 2.7(2) \times 10^3$	700.(400)	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
²³⁶ Np		1.55x10 ⁵ y	$\sigma_f=2.6(5)\times 10^3$	1030.(100)	
²³⁷ Np		2.14x10 ⁶ y	180. $\sigma_f=20.(4)\text{mb}$	8.(2)x10 ² RI _f =0.32	10.6(1)
²³⁸ Np		2.117 d	$\sigma_f=2.1(1)\times 10^3$	9.(1)x10 ²	
²³⁹ Np		2.355 d	(32.+19.) $\sigma_f < 1.$		
⁹⁴ Pu					
²³⁶ Pu		2.87 y	$\sigma_f=1.6(3)\times 10^2$	1000.(60)	
²³⁷ Pu		45.2 d	$\sigma_f=2.3(3)\times 10^3$		
²³⁸ Pu		87.74 y	5.1(2)x10 ² $\sigma_f=17.(1)$	1.6(2)x10 ² RI _f =33.(5)	14.1(5)
²³⁹ Pu		2.411 x 10 ⁴ y	2.7(1)x10 ² $\sigma_f=752.(3)$ $\sigma_{\alpha} \leq 0.3 \text{ mb}$	2.0(2)x10 ² 3.0(1)x10 ²	7.7(1)
²⁴⁰ Pu		6537. y	2.9(1)x10 ² $\sigma_f \approx 44.\text{mb}$	8.4(3)x10 ³ RI _f =2.4	3.5(1)
²⁴¹ Pu		14.4 y	3.7(1)x10 ² $\sigma_f=1.01(1)\times 10^3$	1.6(1)x10 ² 5.7(4)x10 ²	
²⁴² Pu		3.76 x 10 ⁵ y	19.(1) $\sigma_f < 0.2$	1.1(1)x10 ³ RI _f =0.23	8.1(1)
²⁴³ Pu		4.956 h	<100. $\sigma_f=2.0(2)\times 10^2$		
²⁴⁴ Pu		8.2x10 ⁷ y	1.7(1)	41.(3)	
²⁴⁵ Pu		10.5 h	1.5(3)x10 ²	220.(40)	
⁹⁵ Am					
²⁴¹ Am		432.2 y	(0.5+5.7)x10 ² $\sigma_f=3.1(2)$	(2.0+12.3)x10 ² 14.(1)	
^{242m} Am		141. y	1.7(4)x10 ³ $\sigma_f=7.0(3)\times 10^3$	$\approx 200.$ RI _f =1.8(1)x10 ³	
²⁴² Am		16.02 h	$\sigma_f=2.1(2)\times 10^3$	RI _f < 300.	
²⁴³ Am		7.37x10 ³ y	(75.+5.) $\sigma_f=74.(4) \text{ mb}$	(1.0+17.1)x10 ² RI _f =0.056	8.3(2)
^{244m} Am		$\approx 26. \text{ m}$	$\sigma_f=1.6(3)\times 10^3$		
²⁴⁴ Am		10.1 h	$\sigma_f=2.2(3)\times 10^3$		
⁹⁶ Cm					
²⁴² Cm		162.8 d	$\approx 20.$ $\sigma_f \approx 5.$	120.(50)	
²⁴³ Cm		28.5 y	1.3(1)x10 ² $\sigma_f=6.2(2)\times 10^2$	214.(20) RI _f =1.6(1)x10 ³	
²⁴⁴ Cm		18.11 y	15.(1) $\sigma_f=1.1(2)$	640.(50) RI _f =10.8(8)	9.5(3)
²⁴⁵ Cm		8.5x10 ³ y	3.5(2)x10 ² $\sigma_f=2.1(1)\times 10^3$	110.(10) RI _f =8.(1)x10 ²	
²⁴⁶ Cm		4.78x10 ³ y	1.2(2) $\sigma_f=0.16(7)$	120.(10) 13.(2)	9.3(2)
²⁴⁷ Cm		1.56x10 ⁷ y	60.(30) $\sigma_f=82.(5)$	5.(1)x10 ² 7.3(7)x10 ²	

NEUTRON PROPERTIES (Continued)

Elem. or Isot.	Natural Abundance (%)	Half-life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fermi)
²⁴⁸ Cm		3.4x10 ⁵ y	2.6(3) $\sigma_f=0.36(7)$	270.(30) 13.(2)	7.7(2)
²⁴⁹ Cm		64.15 m	≈ 1.6		
²⁵⁰ Cm		$\approx 9.7 \times 10^3$ y	$\approx 80.$		
⁹⁷ Bk					
²⁴⁹ Bk		320. d	7.(1)x10 ² $\sigma_f \approx 0.1$	9.(1)x10 ²	
²⁵⁰ Bk		3.217 h	$\sigma_f=1.0(2) \times 10^3$		
⁹⁸ Cf					
²⁴⁹ Cf		351. y	5.0(3)x10 ² $\sigma_f=1.7(1) \times 10^3$	7.7(4)x10 ² $RI_f=2.1(3) \times 10^3$	
²⁵⁰ Cf		13.1 y	2.0(2)x10 ³ $\sigma_f=110.(80)$	12.(2)x10 ³ $RI_f=160.(40)$	
²⁵¹ Cf		9.0x10 ² y	2.9(2)x10 ³ $\sigma_f=4.5(5) \times 10^3$	1.6(1)x10 ³ $RI_f=5.5(3) \times 10^3$	
²⁵² Cf		2.84 y	20.(2) $\sigma_f=32.(4)$	43.(3) $RI_f=1.1(3) \times 10^2$	
²⁵³ Cf		17.8 d	18.(2) $\sigma_f=1.3(2) \times 10^3$	8.(1)	
²⁵⁴ Cf		60.5 d	4.5(10)	2.	
⁹⁹ Es					
²⁵³ Es		20.47 d	(180.+5.8)	(37.5+1.1)x10 ²	
^{254m} Es		1.84 d	$\sigma_f=1.8(1) \times 10^3$		
²⁵⁴ Es		276. d	28.(3) $\sigma_f=1.8(2) \times 10^3$	18.(2) $RI_f=1.2(3) \times 10^3$	
²⁵⁵ Es		40. d	$\approx 55.$		
¹⁰⁰ Fm					
²⁵⁵ Fm		20.1 h	26.(3) $\sigma_f=3.3(2) \times 10^3$	14.(2)	
²⁵⁷ Fm		100.5 d	$\sigma_f=3.0(2) \times 10^3$		

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