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VALUES OF RESONANCE INTEGRALS

E. S. Wilson

Element or Material	Form Measured (When Known)	$\int_0^{\infty} \sigma(E) \frac{dE}{E}$	Method	Reference and Remarks
Ag		650 bri.		(1)
Al	pure	0.17 bri.	pile osc.	(1)
	28 rods	0.17 bri.	pile osc.	(1)
		0.14 bri.	boron abs.	(3) 0.019 due to resonance
Al ₂ O ₃	fire pellets	3.2 bri.	pile osc.	(1)
Au	Au	410 bri.	pile osc.	(1) self protected, probably low
Ba	BaF ₂	8 bri.	pile osc.	(1)
Be		1.22 bri.	pile osc.	(2) $\sigma_s^f p = 1.13$
Bi		0.59 bri.	pile osc.	(2) probably too high
		0.50 bri.	pile osc.	(1)
C		0.02 bri.	pile osc.	(2) $\sigma_s^f p = 0.69$; capture too small to measure accurately
		0.01 bri.	pile osc.	(4)
Ca		2.0 bri.	pile osc.	(1)
Cb	Cb ₂ O ₃	2.1 bri.	pile osc.	(2)
		8.5 bri.	pile osc.	(1)
		8.1 bri.	pile osc.	(1)
		4.55 bri.	boron abs.	(3) 3.85 due to resonance
Cl	PbCl ₂ ; NaCl	14 bri.	pile osc.	(1)
Cl ³⁷		0.087 bri.	boron abs.	(3) 0.0064 due to resonance
Co	Co	47 bri.	pile osc.	(1)
Cu	Cu	2.6 bri.	pile osc.	(1)

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Element or Material	Form Measured (When Known)	$\int \sigma_a(E) \frac{dE}{E}$	Method	Reference and Remarks
Cu ⁶³		0.621 bri.	boron abs.	(3) 0.299 due to resonance
D ₂ O		0.19 bri.	pile osc.	(2) $\int \sigma_p = 4.75$
F		0.59 bri.	pile osc.	(2) $\int \sigma_p = 0.37$
Fe	Fe	2.1 bri.	pile osc.	(1) "puron" brand, pure Fe
H	H ₂ O in D ₂ O	17 bri.	pile osc.	(1)
HfO ₂	pellet	300 bri.	pile osc.	(1) probably low-not spread out enough
Hg	H ₂ O	31 bri.	pile osc.	(1)
I	PbI	89 bri.	pile osc.	(1) self protected, probably low
In		2800 bri.	pile osc.	(1) average over several values reported
		2790 bri.	boron abs.	(3)
In-Pb	$\frac{.169 \text{ In}}{.46 \text{ Pb}}$ by vt.	1880 bri.	pile osc.	(1)
K		1.12	pile osc.	(2) $\sigma_p = 0.07$
Li		28.4	pile osc.	(2)
		29.4	pile osc.	(1)
Mg	Mg	0.9 bri.	pile osc.	(1)
Mn	strip	11.0 bri.	pile osc.	(1)
		14.0 bri.	pile osc.	(2)
		14.31 bri.	boron abs.	(3)
		15.7 bri.		(6)
Na		0.27 bri.	pile osc.	(2) $\sigma_p = .27$
		0.27 bri.	boron abs.	(3) 0.051 due to resonance
Ni	Ni	4 bri.	pile osc.	(1)

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Element or Material	Form Measured (When Known)	$\int \sigma_a(E) \frac{dE}{E}$	Method	Reference and Remarks
O		< 0.40 bri.	pile osc.	(2) $\sigma_{sf} p = 0.45$
P	red P	2 bri.	pile osc.	(1) may have been moist
Pb	Pb	0.08 bri.	pile osc.	(1)
Pd	Pd	23 bri.	pile osc.	(1)
Pu ²³⁹		520 bri.		(5) $\int \sigma_f \frac{dE}{E} = 325$; See MonP-28
S		0.65 bri.	pile osc.	(2)
		0.64 bri.	pile osc.	(1)
Si	Si	0.5 bri.	pile osc.	(1)
		0.51 bri.	pile osc.	(2)
Sn	Sn	4.5 bri.	pile osc.	(1)
Sr	SrF ₂	16 bri.	pile osc.	(1)
Te	Te	17 bri.	pile osc.	(1)
Th ²³²		81.3 bri.		(5) See CP-3093
U ²³³		442 bri.	Calculated from U ²³³ curve	(5) $\int \sigma_f \frac{dE}{E} = 384$
U ²³⁵		400 bri.	Calculated in WAPD-2	(5) $\int \sigma_f \frac{dE}{E} = 340$; See WAPD-2
U ²³⁸		240 bri.		(5) Anderson and Fermi, A-2
V		3.04 bri.	boron abs.	(3) 0.36 due to resonance
Zn	Zn	2 bri.	pile osc.	(1)
ZrO ₂	"pure powder"	3.6 bri.	pile osc.	(1)
Zr		2.8 bri.	pile osc.	(1) ZrO ₂ result corrected for O ₂

Abbreviations:

bri. = "barns of resonance integral"
pile osc. = pile oscillator
boron abs. = boron absorption

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References:

- (1) ANL-4342, "The Thermal Neutron Reactor as an Instrument for Measuring Neutron Cross Sections," by A. Langsdorf, Jr. The pile oscillator method was used.

Note: Of those values listed from Reference 1, D_2O , Graphite, Na, K, In, Bi, Pb, Al, Mn, Cb, ZrO_2 and H_2O_2 were extensively tested. Less extensively tested materials were: Li, Be, S, Mn and Ag. Those materials measured only a few times include: H, Mg, Si, P, Cl, Ca, Fe, Co, Ni, Cu, Zn, Sr, Cb, Pd, Sn, Te, I, Ba, Au and Hg. Of the latter group, it might be stated that they involve errors of a few tenths of a barn due to scattering effects, and may also be in error from impurities.

- (2) CP-3209, 1 (1945) and CP-3750, 5 (1946), by A. Langsdorf, S. Harris, and F. Seidl. Measurements were made of $\int \sigma \frac{dE}{E}$ above the Cd cut-off by the oscillator method. The quantity measured was $\sigma_t = \int \sigma \frac{dE}{E} + \sigma_s \int p$. The tables give $\int \sigma \frac{dE}{E} = \sigma_t - \sigma_s \int p$. The first report contains a table of values for a number of elements, the second newer results for a few.
- (3) Phy. Review 72, 164 (1947) and CP-3781 (1946) by H. V. Lichtenberger, R. G. Nobles, G. D. Monk and H. Kubitschek. $\int \sigma \frac{dE}{E}$ was measured by the boron absorption method. The tables are also reported in MDDC-639 (declassified January 28, 1947).
- (4) GERE-2 (November 1947). Pile oscillator method.
- (5) CP 51-5-98. "Theory of Chain Reactions," by A. Weinberg and L. Moderer. Chapter IV of this report covers resonance absorption and neutron moderation.
- (6) CP-1825 (1944), CP-1824, H. Kubitschek and H. L. Anderson.