

**ELEMENTS, ATOMIC NUMBERS AND WEIGHTS, VALENCE, AND THERMAL NEUTRON
CAPTURE CROSS SECTIONS**

Element	Symbol	Atomic Number (Z)	Atomic Weight (A)	Valence	Thermal Neutron Capture Cross Section * (Barns)
Hydrogen	H	1	1.008	+1, -1	.33
Helium	He	2	4.003	0	.0000
Lithium	Li	3	6.939	+1	.0376
Beryllium	Be	4	9.013	+2	.009
Boron	B	5	10.811	+3	758.86
Carbon	C	6	12.011	+2, +4, -4	.0034
Nitrogen	N	7	14.007	+1, +2, +3, +4, +5, -1, -2, -3	.075
Oxygen	O	8	15.999	-2	.0002
Fluorine	F	9	18.998	-1	.0098
Neon	Ne	10	20.183	0	.0038
Sodium	Na	11	22.898	+1	.400
Magnesium	Mg	12	24.120	+2	.0625
Aluminum	Al	13	26.982	+3	.232
Silicon	Si	14	28.086	+2, +4, -4	.1638
Phosphorous	P	15	30.974	+3, +4, -3	.190
Sulphur	S	16	32.065	+4, +6, -2	.49
Chlorine	Cl	17	35.457	-1, +1, +5, +7	33.338
Argon	Ar	18	39.946	0	.668
Potassium	K	19	39.102	+1	2.152
Calcium	Ca	20	40.080	+2	.455
Scandium	Sc	21	44.956	+3	25.000
Titanium	Ti	22	47.90	+2, +3, +4	6.401
Vanadium	V	23	50.942	+2, +3, +4, +5	4.800
Chromium	Cr	24	51.996	+2, +3, +6	3.074
Manganese	Mn	25	54.938	+2, +3, +4, +7	13.300
Iron	Fe	26	55.847	+2, +3	2.514
Cobalt	Co	27	58.933	+2, +3	37.5
Nickel	Ni	28	58.71	+2, +3	4.264
Copper	Cu	29	63.54	+1, +2	3.812
Zinc	Zn	30	65.38	+2	1.06
Gallium	Ga	31	69.72	+3	1.147
Germanium	Ge	32	72.60	+2, +4	1.470
Arsenic	As	33	74.92	+3, +5, -3	4.300
Selenium	Se	34	78.96	+4, +6, -2	12.0
Bromine	Br	35	79.916	-1, +1, +5	2.798
Krypton	Kr	36	83.80	0	31.0
Rubidium	Rb	37	85.48	+1	.7
Strontium	Sr	38	87.63	+2	1.2
Yttrium	Y	39	88.92	+3	1.3
Zirconium	Zr	40	91.22	+4	.18
Niobium	Nb	41	92.91	+3, +5	1.2
Molybdenum	Mo	42	95.95	+6	2.7
Technetium	Tc	43	97.00	+4, +6, +7	22.
Ruthenium	Ru	44	101.1	+3	2.6
Rhodium	Rh	45	102.91	+3	150.
Paladium	Pd	46	106.4	+2, +4	8.
Silver	Ag	47	107.870	+1	96.00
Cadmium	Cd	48	112.41	+2	7,000.00

*Based on percent abundance in nature.

Element	Symbol	Atomic Number (Z)	Atomic Weight (A)	Valence	Thermal Neutron Capture Cross Section * (Barns)
Indium	In	49	114.82	+3	190.
Tin	SN	50	118.70	+2, +4	.62
Antimony	Sb	51	121.76	+3, +5, -3	5.7
Tellurium	Te	52	127.61	+4, +5, -2	4.7
Iodine	I	53	126.91	-1, +1, +5, +7	6.20
Xenon	Xe	54	131.30	0	35.
Cesium	Cs	55	132.91	+1	28.
Barium	Ba	56	137.36	+2	1.20
Lanthanum	La	57	138.92	+3	8.9
Cerium	Ce	58	140.13	+3, +4	.73
Praseodymium	Pr	59	140.92	+3	3.90
Neodymium	Nd	60	144.27	+3	46.
Promethium	Pm	61	145.0	+3	
Samarium	Sm	62	150.35	+2, +2	5,600.
Europium	Eu	63	152.0	+2, +3	1,400.
Gadolinium	Gd	64	157.26	+3	46,000.
Terbium	Tb	65	158.93	+3	46.
Dysprosium	Dy	66	162.50	+3	930.
Holmium	Ho	67	164.94	+3	65.
Erbium	Er	68	167.20	+3	173.
Thulium	Tm	69	168.94	+3	127.
Ytterbium	Yb	70	173.04	+2, +3	37.
Lutetium	Lu	71	174.99	+3	112.
Hafnium	Hf	72	178.49	+4	105.
Tantalum	Ta	73	180.95	+5	21.
Tungsten	W	74	183.86	+6	19.2
Rhenium	Re	75	186.2	+4, +6, +7	86.
Osmium	Os	76	190.2	+3, +4	15.3
Iridium	Ir	77	192.2	+3, +4	440.
Platinum	Pt	78	195.09	+2, +4	8.8
Gold	Au	79	197.0	+1, +3	98.8
Mercury	Hg	80	200.61	+1, +2	380.
Thallium	Tl	81	204.39	+1, +3	7.0
Lead	Pb	82	207.19	+2, +4	.17
Bismuth	Bi	83	208.99	+3, +5	.034
Polonium	Po	84	209.	+2, +4	.003
Astatine	At	85	210.	-1	
Radon	Rn	86	222.	0	.72
Francium	Fr	87	223.	+1	
Radium	Ra	88	226.	+2	20.
Actinium	Ac	89	227.	+3	510.
Thorium	Th	90	232.04	+4	7.4
Protractinium	Pa	91	231.	+4, +5	260.
Uranium	U	92	238.03	+3, +4, +5, +6	2.7
Neptunium	Np	93	237.	+3, +4, +5, +6	Various Unstable
Pluthonium	Pu	94	244.	+3, +4, +5, +6	Isotopes
Americium	Am	95	243.	+3, +4, +5, +6	"
Curium	Cm	96	247.	+3, +4	"
Berkelium	Bk	97	247.	+3, +4	"
Californium	Cf	98	251.	+3	"

*Based on percent abundance in nature.

BOILING POINTS OF HYDROCARBONS

Gas		Temperature	
Methane	(C ₆ H ₄)	-296.5°F	-182.5°C
Ethane	(C ₂ H ₆)	-127.5°F	- 88.6°C
Propane	(C ₃ H ₈)	- 43.7°F	- 42.1°C
Iso Butane	(C ₄ H ₁₀)	+ 10.9°F	- 11.7°C
Norm Butane	(C ₄ H ₁₀)	+ 31.1°F	- 0.5°C
Iso Protane	(C ₅ H ₁₂)	+ 82.1°F	+ 27.9°C
Norm Protane	(C ₅ H ₁₂)	+ 96.9°F	+ 36.1°C
Norm Hexane	(C ₆ H ₁₄)	+155.7°F	+ 68.7°C
Norm Heptane	(C ₇ H ₁₆)	+209.2°F	+ 98.4°C
Octane	(C ₈ H ₁₈)	+258.2°F	+125.7°C
N-Nonane	(C ₉ H ₂₀)	+303.4°F	+150.8°C
N-Decane	(C ₁₀ H ₂₂)	+345.2°F	+174.0°C

HALF LIFE & EMISSIONS OF RADIOISOTOPES

Isotope	Half life*	Principal radiation emitted (mev.)			Isotope	Half life*	Principal radiation emitted (mev.)		
		β	τ	Other			β	τ	Other
Ag ^{110m}	270d	2.86	1.5		K ⁴²	12.4h	3.58	1.51	
Au ¹⁹⁸	2.69d	0.97	0.41		Kr ⁸⁵	10.3y	0.69	0.54	
Ba ¹⁹³	9.5y		0.36	K	Mo ⁹⁹	2.79d	1.23	0.78	
Ba ¹⁴⁰	12.8d	1.02	0.03 to	0.54	Na ²⁴	15.1h	1.39	2.75	
La ¹⁴⁰	40h	2.26	0.09 to	3.0	Ni ⁶³	85y	0.07		
Bi ²¹⁰	5.02d	1.17		5.0α	P ³²	14.3d	1.70		
Br ⁸²	35.9h	0.46	1.31		Pb ²¹⁰	22y	.03	.05	
C ¹⁴	5568y	0.155			Pd ¹⁰⁹	13.6h	0.96	0.09	
Ca ⁴⁵	163d	0.25			Pm ¹⁴⁷	2.6y	0.22		
{ Ce ¹⁴⁴	282d	0.30	0.13		Po ²¹⁰	138d		0.8	5.3α
{ Pr ¹⁴⁴	17.5m	3.0	2.2		Rb ⁸⁶	18.6d	1.82	1.08	
Cl ³⁶	3x10 ⁵ y	0.71			{ Ru ¹⁰⁶	1.0y	0.04		
Co ⁶⁰	5.3y	0.31	1.33		{ Rh ¹⁰⁶	30s	3.55	0.51 to	2.41
Cr ⁵¹	27.8d		0.32	K	S ³⁵	87.1d	0.17		
Cs ¹³⁴	2.3y	0.65	0.78		Sb ¹²⁵	2.7y	0.62	0.03 to	0.64
{ Cs ¹³⁷	30y	0.51			Sc ⁴⁶	85d	0.36	1.12	
{ Ba ¹³⁷	2.6m		0.66		Sn ¹¹³	112d		0.40	K
Cu ⁶⁴	12.8h	0.66	1.34	K	Sr ⁸⁹	53d	1.5		
Fe ⁵⁵	2.94y			K	{ Sr ⁹⁰	28y	0.61		
Fe ⁵⁹	45.1d	0.46	1.3		{ Y ⁹⁰	2.67d	2.18		
Ga ⁷²	14.3h	3.15	2.5		Ta ¹⁸²	115d	0.53	0.07 to	1.22
H ³	12.5y	0.018			Tl ²⁰¹	4.0y	0.76		K
Hg ²⁰³	45d	0.21	0.28		Tm ¹⁷⁰	127d	0.97	0.08	
I ¹³¹	8.14d	0.61	0.08 to	0.72	Zn ⁶⁵	245d	0.32	1.11	K
Ir ¹⁹²	74d	0.67	0.14 to	1.16	Zr ⁹⁵	65d	0.4	0.73	

* y – year
 h – hour
 d – day
 s – second

CHEMICAL COMPOSITION (AVERAGE) OF FORMATION TYPES – (% WEIGHT)

CONSTITUENT	SANDSTONE (CLARKE)	LIMESTONE (STOKES)	DOLOMITE (PETTICORN)	GYPSUM (PETTICORN)	NORITE (TURNER)	SYNITE (IDDINGS)	GRANDIORITY (TURNER)	BASALT (TURNER)	GABBRO (TURNER)	DIORITE (IDDINGS)	DUNITE (IDDINGS)	DIABASE (TURNER)	GRANITE (TURNER)	GLAUCONITE (TWENHOFEL)	KAOLINITE (GRIM)	MONTMORILLONITE (GRIM)	ILLITE (GRIM)
SiO ₂	78.33	5.19	5.60	0.40	52.05	60.26	73.4	48.03	51.22	63.04	40.12	52.46	71.89	53.61	45.65	52.38	50.38
TiO ₂	0.25	0.06	0.06	---	0.21	0.32	0.2	3.93	1.59	0.37	0.28	0.83	0.38	---	0.80	0.12	0.33
Al ₂ O ₃	4.77	0.81	1.07	2.97	17.24	18.27	14.1	14.77	14.49	16.19	0.57	14.63	15.13	9.56	37.37	18.31	26.97
Fe ₂ O ₃	1.07	0.54	0.16	0.77	0.65	2.31	0.7	3.96	2.91	1.88	1.77	1.45	0.95	21.46	0.69	2.58	3.57
FeO	0.30	---	0.31	---	6.65	3.35	1.7	8.22	11.66	4.21	8.40	9.18	1.09	1.58	0.03	0.21	1.07
MnO	---	0.05	0.04	---	0.13	0.07	0.02	0.13	0.14	0.08	0.10	0.13	0.11	---	---	---	---
MgO	1.16	7.89	20.15	1.53	8.98	0.75	0.4	7.27	4.33	2.61	45.46	8.00	0.69	2.87	0.34	3.93	2.61
CaO	5.50	42.57	28.15	30.76	11.37	2.62	2.1	8.18	7.66	4.33	0.23	9.76	1.22	1.39	0.48	1.87	0.30
Na ₂ O	0.45	0.05	0.21	---	1.83	5.14	3.4	3.64	3.21	3.58	0.03	1.78	2.60	0.42	0.20	0.66	0.40
K ₂ O	1.31	0.33	0.06	---	0.40	5.46	3.5	1.34	1.05	1.99	0.05	0.90	3.94	3.49	0.63	0.31	6.48
H ₂ O	1.63	0.77	0.46	17.53	0.63	0.95	0.3	---	0.56	1.52	2.12	0.96	0.13	5.96	13.81	19.78	7.69
P ₂ O ₅	0.08	0.04	0.46	---	0.12	---	---	0.51	0.23	0.34	---	0.08	0.18	---	---	---	---
BaO	0.05	---	---	---	---	---	---	---	0.01	0.04	---	---	0.08	---	---	---	---
CO ₂	5.03	41.54	43.34	2.80	---	0.38	---	---	0.01	---	---	0.03	---	---	---	---	---
SrO	---	---	---	---	---	---	---	---	0.01	---	---	---	---	---	---	---	---
C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SO ₃	0.07	0.05	---	43.78	---	---	---	---	---	---	---	---	---	---	---	---	---
S	---	0.09	0.09	---	---	---	---	---	0.06	---	---	---	---	---	---	---	---
ZrO ₂	---	---	---	---	---	---	---	---	---	---	---	---	0.01	---	---	---	---
	100.00	99.98	100.16	100.54	100.26	99.88	99.92	98.98	99.14	100.18	99.13	100.19	98.41	100.34	100.00	100.15	99.80

UNITS AND CONVERSION FACTORS

		multiply \longrightarrow	by \longrightarrow	to obtain
		\longleftarrow	by \longleftarrow	divide
DISTANCE/ DEPTH/LENGTH				
	mm		0.039370	in
	cm		0.39370	in
			0.03281	ft
			.01	m
	in	25.40005		mm
		2.54000		cm
		0.02540		m
		0.08333		ft
	ft	30.48006		cm
		12.0		in
		0.3333		yd
		0.30480		m
	yd	91.44018		cm
		36.0		in
		3.0		ft
		0.9144		m
	rod	5.5		yd
	m	10,000,000,000.		Å
		1,000,000.		u
		1,000.		mm
		100.0		cm
		39.370		in
		3.2808		ft
		1.0936		yd
	km	3,280.83		ft
		1,000.0		m
		.62137		mi
	mi	5,280.0		ft
		1,760.0		yd
		1,609.34		m
		1.60934		km
		1.19599		yd ²
	cm ²	0.15499		in ²
	in ²	6.4516		cm ²
	ft ²	929.0341		cm ²
		0.092903		m ²
	yd ²	9.0		ft ²
		0.83612		m ²
	m ²	1,549.9969		in ²
		10.76387		ft ²
		1.19599		in ²
	acres	43,560.0		ft ²
		4,840.0		yd ²
		4,046.873		m ²
		0.40468		Hectare
		0.00405		km ²
		0.0015625		mi ²
	hectare	2.47105		acres
		10,000.0		m ²
	km ²	247.104		acres
		0.386		mi ²

AREA

multiply → by → to obtain
 to obtain ← by ← divide

VOLUME/CAPACITY

rod ²	30.25	yd ²
mi ²	640.0	acres
	258.999	Hectares
	2.5899	km ²
cm ³	1,000.0	mm ³
	0.001	l
	0.06102	in ³
	0.0002642	gal
	0.00003531	ft ³
in ³	16.387025	cm ³
	0.004329	gal
	0.01638	l
	0.0005787	ft ³
	0.0001031	bbbl
1	1,000.0	cm ³
	1,000.0	ml
	61.02705	in ³
	1.057	qt
	0.26417	gal (U.S.)
	0.03532	ft ³
gal (U.S.)	3,785.0	cm ³
	231.0	in ³
	4.0	qt (U.S.)
	3.7853	l
	0.83268	gal (Imp.)
	0.13368	ft ³
	0.02381	bbbl (42)
	0.003785	m ³
gal (Imp.)	4.5459	l
	1.20095	gal (U.S.)
bbbl (U.S.)	158.984	l
	42.0	gal (U.S.)
	34.973	gal (Imp.)
	5.61458	ft ³
	6.29 ÷ density of liquid = tons (metric)	
	0.9997	bbbl (Imp.)
bbbl (Imp.)	159.031	l
	42.0112	gal (U.S.)
ft ³	1,728.0	in ³
	28.31684	l
	7.4809	gal (U.S.)
	0.1781	bbbl (42)
	0.037037	yd ³
	0.02831	m ³
m ³	264.17	gal (U.S.)
	219.97	gal (Imp.)
	1.3079	yd ³
	35.314	ft ³
	6.290	bbbl (42)
acre-ft	325,850.0	gal (U.S.)
	43,560.0	ft ³
	7,758.4	bbbl (42)

multiply \longrightarrow by \longrightarrow to obtain
 to obtain \longleftarrow by \longleftarrow divide

	acre-ft.	1,613.33	yd ³
		1,233.49	m ³
	yd ³	201.974	gal
		27.	ft ³
DENSITY/ CONCENTRATION	gm/cc	350.51	lb/bbl (42)
		62.42976	lb/cu ft
		8.34544	lb/gal (U.S.)
		.036127	lb/cu in
	lb/gal (U.S.)	42.0	lb/bbl (42)
	7.4809	lb/cu ft	
	0.119826	gm/cc	
lb/cu ft	5.6146	lb/bbl (42)	
	0.13368	lb/gal (U.S.)	
	0.016018	gm/cc	
lb/cu in	27,680.	gm/cc	
WEIGHT/MASS	grain	0.06479	gm
		0.00229	oz
	gm	15.43236	grain
		0.03528	oz
		0.00220	lb
	oz	437.5	grain
		28.34952	gm
		0.0625	lb
	kg	35.274	oz
		2.2046	lb
lb	453.59237	gm	
	16.0	oz	
	0.4536	kg	
ton (short)	2,000.	lb	
	0.90718	ton (metric)	
	0.89286	ton (long)	
ton (metric)	2,204.62	lb	
	1.10231	ton (short)	
	0.98421	ton (long)	
		\cong 6 bbls 17°oil	
		\cong 7 bbls 42°oil	
ton (long)	2,240.0	lb	
	1.12	ton (short)	
	1.01605	ton (metric)	
RESISTIVITY	ohm cm ² /cm	.01	ohms m ² /m
	ohm m ² /m	100.	ohms cm ² /cm
PRESSURE	psi	70.3067	gm/cm ²
		0.0703070	kg/cm ²
		0.0689474	bar
		0.0680458	atm
		14.6960	psi
		1.01325	bar
	kg/cm ²	14.22333	psi
		0.980665	bar
		0.967842	atm
	atm	1,033.23	gm/cc
	1.03323	kg/cm ²	
	14.6960	psi	

multiply \longrightarrow by \longrightarrow to obtain
to obtain \longleftarrow by \longleftarrow divide

HEAT/ENERGY	bar	1,000,000.		dynes/cm ²
			14.5038	psi
			1.01972	kg/cm ²
			0.986924	atm
	btu		1.05 x 10 ¹⁰	ergs
			1,054.8	joules
			251.996	cal
	cal		4.19 x 10 ⁷	ergs
			4.1840	joules
			0.003968	btu

TEMPERATURE

	^o Fahrenheit	^o Rankine	^o Centigrade	^o Kelvin
Water boils	212.	672.	100.	373.
68 ^o F	68.	528.	20.	293.
60 ^o F	60.	520.	15.56	288.56
Water freezes	32.	492.	0	273.
0 ^o F	0.	450.	-17.8	255.
absolute zero	-460.	0	-273.	0

BTU EQUIVALENT CHART

Crude Oil BBL	=	5,800,000 Btu
Natural Gas (cubic ft.)	=	1,032 Btu
Coal Per Ton	=	24 - 28 Million Per Ton
Kilowatt - Hour	=	3,412 Btu

SPECIFIC GRAVITY OF COMMON GASES

60^oF 14.7 PSI

AIR=1

Gas	Specific Gravity
Methane (CH ₄)	0.5543
Ethane (C ₂ H ₆)	1.0488
Propane (C ₃ H ₈)	1.5617
n - Butane (C ₄ H ₁₀)	2.0665
Helium (He)	0.1368
Carbon Dioxide (CO ₂)	1.5282
Nitrogen (N ₂)	0.9718
Oxygen (O ₂)	1.1053
Hydrogen Sulphide (N ₂ S)	1.1895
Air (Dry)	1.0000

THERMAL CONDUCTIVITY OF GEOLOGIC MATERIALS

Material	Thermal Conductivity 10^{-3} (cal/cm ² -sec) / (°C/cm)*			Material	Thermal Conductivity 10^{-3} (cal/cm ² -sec) / (°C/cm)*		
Carbon dioxide	.040 @ 80°F		20C	Shale			2-4
	.044 @ 120		49	Sandstone			3-12.2
Ethane	.043 @ 32		0	Fused silica			3.2
	.051 @ 80		27	Limestone			2.4-8
	.074 @ 200		93	Polyhalite			3.7
Air (dry)	.057 @ 32		0	Serpentine			4.3-5.9
	.061 @ 68		20	Basalt			4-7
	.074 @ 212		100	Granite			5-8.4
	.088 @ 392		200	Calcite			5-13
Nitrogen	.062 @ 80		27	Feldspar			5.8
	.065 @ 120		49	Slate			6
Methane	.073 @ 32		0	Norite			6.42
	.081 @ 80		27	Grandpiorite			6.64
	.106 @ 200		93	Quartz			6-30
Crude oil	.3 @ 68		20	C-axis	26 @ 100°F		38C
Helium	.332 @ 68		20	A-axis	14 @ 100°F		38
Kerosene	.357 @ 86		30		12 @ 200°F		93C
Sulfur (monoclinic)	.38 @ 212		100	Syenite			7.66
(rhombic)	.56 @ 176		80	Salt			14.3 (8-15)
	.65 @ 68		20	Garnite			8.5
Coal-lignite	.33-1 @ 68		20	Dolomite			9.3-11.9
Cement (Portland)	.71 @ 68		20	Dunite			10
Water	1.39 @ 32		0	Chlorite			12.5
	1.43 @ 68		20	Anhydrite			7-13.4
	1.60 @ 167°F		75C	Quartzite			16.05
Clay	2-3			Pyrite			25-40
Chalk	2-3			Hematite			25
Gypsum	3.6 (2-4)			Magnetite			30
Lead	83			Sphalirite			63.6
Iron	180 @ 68°F		20C				
Magnesium	380 @ 68°F		20				
Aluminum	530 @ 68°F		20				
Copper	940 @ 68°F		20C				

*To convert to BTU/ft²hr/°F/ft multiply by 242.08

BTU/ft²hr/°F/ft multiplied by 0.00413 = (cal/cm²/sec) / (°C/cm)

Values of thermal conductivity are commonly temperature dependent, increasing with temperature.

Moisture content and grain orientation are also important when measuring thermal conductivity.