BASIC NUMERIC VALUES

CODATA 2006 DOWNLOADED: AUG 29, 2009

Fundamental Physical Constants --- Complete Listing

From: http://physics.nist.gov/constants

$e^{-x} \approx 10^{-x}$ → S.I

Quantity	Value	Uncertainty	Unit
{220} lattice spacing of silicon	192.015 5762 e-12	0.000 0050 e-12	m
alpha particle-electron mass ratio	7294.299 5365	0.000 0031	
alpha particle mass	6.644 656 20 e-27	0.000 000 33 e-27	kg
alpha particle mass energy equivalent	5.971 919 17 e-10	0.000 000 30 e-10	J
alpha particle mass energy equivalent in MeV	3727.379 109	0.000 093	MeV
alpha particle mass in u	4.001 506 179 127	0.000 000 000 062	u
alpha particle molar mass	4.001 506 179 127 e-3	0.000 000 000 062 e-3	kg mol^-1
alpha particle-proton mass ratio	3.972 599 689 51	0.000 000 000 41	
Angstrom star	1.000 014 98 e-10	0.000 000 90 e-10	m
atomic mass constant	1.660 538 782 e-27	0.000 000 083 e-27	kg
atomic mass constant energy equivalent	1.492 417 830 e-10	0.000 000 074 e-10	J
atomic mass constant energy equivalent in MeV	931.494 028	0.000 023	MeV
atomic mass unit-electron volt relationship	931.494 028 e6	0.000 023 e6	eV
atomic mass unit-hartree relationship	3.423 177 7149 e7	0.000 000 0049 e7	E_h
atomic mass unit-hertz relationship	2.252 342 7369 e23	0.000 000 0032 e23	Hz
atomic mass unit-inverse meter relationship	7.513 006 671 e14	0.000 000 011 e14	m^-1
atomic mass unit-joule relationship	1.492 417 830 e-10	0.000 000 074 e-10	J
atomic mass unit-kelvin relationship	1.080 9527 e13	0.000 0019 e13	K
atomic mass unit-kilogram relationship	1.660 538 782 e-27	0.000 000 083 e-27	kg
atomic unit of 1st hyperpolarizablity	3.206 361 533 e-53	0.000 000 081 e-53	C^3 m^3 J^
atomic unit of 2nd hyperpolarizablity	6.235 380 95 e-65	0.000 000 31 e-65	C^4 m^4 J^
atomic unit of action	1.054 571 628 e-34	0.000 000 053 e-34	J s
atomic unit of charge	1.602 176 487 e-19	0.000 000 040 e-19	C
atomic unit of charge density	1.081 202 300 e12	0.000 000 027 e12	C m^-3
atomic unit of current	6.623 617 63 e-3	0.000 000 17 e-3	A
atomic unit of electric dipole mom.	8.478 352 81 e-30	0.000 000 21 e-30	C m
atomic unit of electric field	5.142 206 32 e11	0.000 000 13 e11	V m^-1
atomic unit of electric field gradient	9.717 361 66 e21	0.000 000 24 e21	V m^-2
atomic unit of electric polarizablity	1.648 777 2536 e-41	0.000 000 0034 e-41	C^2 m^2 J^
atomic unit of electric potential	27.211 383 86	0.000 000 68	V
atomic unit of electric quadrupole mom.	4.486 551 07 e-40	0.000 000 11 e-40	C m^2
atomic unit of energy	4.359 743 94 e-18	0.000 000 22 e-18	J
atomic unit of force	8.238 722 06 e-8	0.000 000 41 e-8	N
atomic unit of length	0.529 177 208 59 e-10	0.000 000 000 36 e-10	m
atomic unit of mag. dipole mom.	1.854 801 830 e-23	0.000 000 046 e-23	J T^-1
atomic unit of mag. flux density	2.350 517 382 e5	0.000 000 059 e5	T
atomic unit of magnetizability	7.891 036 433 e-29	0.000 000 027 e-29	J T^-2
atomic unit of mass	9.109 382 15 e-31	0.000 000 45 e-31	kg
atomic unit of momentum	1.992 851 565 e-24	0.000 000 099 e-24	kg m s^-1
atomic unit of permittivity	1.112 650 056... e-10	(exact)	F m^-1
atomic unit of time	2.418 884 326 505 e-17	0.000 000 000 016 e-17	s
atomic unit of velocity	2.187 691 2541 e6	0.000 000 0015 e6	m s^-1
Avogadro constant	6.022 141 79 e23	0.000 000 30 e23	mol^-1
Bohr magneton	927.400 915 e-26	0.000 023 e-26	J T^-1
Bohr magneton in eV/T	5.788 381 7555 e-5	0.000 000 0079 e-5	eV T^-1
Bohr magneton in Hz/T	13.996 246 04 e9	0.000 000 35 e9	Hz T^-1
Bohr magneton in inverse meters per tesla	46.686 4515	0.000 0012	m^-1 T^-1
Bohr magneton in K/T	0.671 7131	0.000 0012	K T^-1
Bohr radius	0.529 177 208 59 e-10	0.000 000 000 36 e-10	m
Boltzmann constant	1.380 6504 e-23	0.000 0024 e-23	J K^-1
Boltzmann constant in eV/K	8.617 343 e-5	0.000 015 e-5	eV K^-1
Boltzmann constant in Hz/K	2.083 6644 e10	0.000 0036 e10	Hz K^-1
Boltzmann constant in inverse meters per kelvin	69.503 56	0.000 12	m^-1 K^-1
characteristic impedance of vacuum	376.730 313 461...	(exact)	ohm
classical electron radius	2.817 940 2894 e-15	0.000 000 0058 e-15	m
Compton wavelength	2.426 310 2175 e-12	0.000 000 0033 e-12	m
Compton wavelength over 2 pi	386.159 264 59 e-15	0.000 000 53 e-15	m
conductance quantum	7.748 091 7004 e-5	0.000 000 0053 e-5	S
conventional value of Josephson constant	483 597.9 e9	(exact)	Hz V^-1
conventional value of von Klitzing constant	25 812.807	(exact)	ohm
Cu x unit	1.002 076 99 e-13	0.000 000 28 e-13	m
deuteron-electron mag. mom. ratio	-4.664 345 537 e-4	0.000 000 039 e-4	
deuteron-electron mass ratio	3670.482 9654	0.000 0016	
deuteron g factor	0.857 438 2308	0.000 000 0072	
deuteron mag. mom.	0.433 073 465 e-26	0.000 000 011 e-26	J T^-1
deuteron mag. mom. to Bohr magneton ratio	0.466 975 4556 e-3	0.000 000 0039 e-3	
deuteron mag. mom. to nuclear magneton ratio	0.857 438 2308	0.000 000 0072	
deuteron mass	3.343 583 20 e-27	0.000 000 17 e-27	kg
deuteron mass energy equivalent	3.005 062 72 e-10	0.000 000 15 e-10	J
deuteron mass energy equivalent in MeV	1875.612 793	0.000 047	MeV

deuteron mass in u	2.013 553 212 724	0.000 000 000 078	u
deuteron molar mass	2.013 553 212 724 e-3	0.000 000 000 078 e-3	kg mol^-1
deuteron-neutron mag. mom. ratio	-0.448 206 52	0.000 000 11	
deuteron-proton mag. mom. ratio	0.307 012 2070	0.000 000 0024	
deuteron-proton mass ratio	1.999 007 501 08	0.000 000 000 22	
deuteron rms charge radius	2.1402 e-15	0.0028 e-15	m
electric constant	8.854 187 817... e-12	(exact)	F m^-1
electron charge to mass quotient	-1.758 820 150 e11	0.000 000 044 e11	C kg^-1
electron-deuteron mag. mom. ratio	-2143.923 498	0.000 018	
electron-deuteron mass ratio	2.724 437 1093 e-4	0.000 000 0012 e-4	
electron g factor	-2.002 319 304 3622	0.000 000 000 0015	
electron gyromag. ratio	1.760 859 770 e11	0.000 000 044 e11	s^-1 T^-1
electron gyromag. ratio over 2 pi	28 024.953 64	0.000 70	MHz T^-1
electron mag. mom.	-928.476 377 e-26	0.000 023 e-26	J T^-1
electron mag. mom. anomaly	1.159 652 181 11 e-3	0.000 000 000 74 e-3	
electron mag. mom. to Bohr magneton ratio	-1.001 159 652 181 11	0.000 000 000 000 74	
electron mag. mom. to nuclear magneton ratio	-1838.281 970 92	0.000 000 80	
electron mass	9.109 382 15 e-31	0.000 000 45 e-31	kg
electron mass energy equivalent	8.187 104 38 e-14	0.000 000 41 e-14	J
electron mass energy equivalent in MeV	0.510 998 910	0.000 000 013	MeV
electron mass in u	5.485 799 0943 e-4	0.000 000 0023 e-4	u
electron molar mass	5.485 799 0943 e-7	0.000 000 0023 e-7	kg mol^-1
electron-muon mag. mom. ratio	206.766 9877	0.000 0052	
electron-muon mass ratio	4.836 331 71 e-3	0.000 000 12 e-3	
electron-neutron mag. mom. ratio	960.920 50	0.000 23	
electron-neutron mass ratio	5.438 673 4459 e-4	0.000 000 0033 e-4	
electron-proton mag. mom. ratio	-658.210 6848	0.000 0054	
electron-proton mass ratio	5.446 170 2177 e-4	0.000 000 0024 e-4	
electron-tau mass ratio	2.875 64 e-4	0.000 47 e-4	
electron to alpha particle mass ratio	1.370 933 555 70 e-4	0.000 000 000 58 e-4	
electron to shielded helion mag. mom. ratio	864.058 257	0.000 010	
electron to shielded proton mag. mom. ratio	-658.227 5971	0.000 0072	
electron volt	1.602 176 487 e-19	0.000 000 040 e-19	J
electron volt-atomic mass unit relationship	1.073 544 188 e-9	0.000 000 027 e-9	u
electron volt-hartree relationship	3.674 932 540 e-2	0.000 000 092 e-2	E_h
electron volt-hertz relationship	2.417 989 454 e14	0.000 000 060 e14	Hz
electron volt-inverse meter relationship	8.065 544 65 e5	0.000 000 20 e5	m^-1
electron volt-joule relationship	1.602 176 487 e-19	0.000 000 040 e-19	J
electron volt-kelvin relationship	1.160 4505 e4	0.000 0020 e4	K
electron volt-kilogram relationship	1.782 661 758 e-36	0.000 000 044 e-36	kg
elementary charge	1.602 176 487 e-19	0.000 000 040 e-19	C
elementary charge over h	2.417 989 454 e14	0.000 000 060 e14	A J^-1
Faraday constant	96 485.3399	0.0024	C mol^-1
Faraday constant for conventional electric current	96 485.3401	0.0048	C_90 mol^-
Fermi coupling constant	1.166 37 e-5	0.000 01 e-5	GeV^-2
fine-structure constant	7.297 352 5376 e-3	0.000 000 0050 e-3	
first radiation constant	3.741 771 18 e-16	0.000 000 19 e-16	W m^2
first radiation constant for spectral radiance	1.191 042 759 e-16	0.000 000 059 e-16	W m^2 sr^-
hartree-atomic mass unit relationship	2.921 262 2986 e-8	0.000 000 0042 e-8	u
hartree-electron volt relationship	27.211 383 86	0.000 000 68	eV
Hartree energy	4.359 743 94 e-18	0.000 000 22 e-18	J
Hartree energy in eV	27.211 383 86	0.000 000 68	eV
hartree-hertz relationship	6.579 683 920 722 e15	0.000 000 000 044 e15	Hz
hartree-inverse meter relationship	2.194 746 313 705 e7	0.000 000 000 015 e7	m^-1
hartree-joule relationship	4.359 743 94 e-18	0.000 000 22 e-18	J
hartree-kelvin relationship	3.157 7465 e5	0.000 0055 e5	K
hartree-kilogram relationship	4.850 869 34 e-35	0.000 000 24 e-35	kg
helion-electron mass ratio	5495.885 2765	0.000 0052	
helion mass	5.006 411 92 e-27	0.000 000 25 e-27	kg
helion mass energy equivalent	4.499 538 64 e-10	0.000 000 22 e-10	J
helion mass energy equivalent in MeV	2808.391 383	0.000 070	MeV
helion mass in u	3.014 932 2473	0.000 000 0026	u
helion molar mass	3.014 932 2473 e-3	0.000 000 0026 e-3	kg mol^-1
helion-proton mass ratio	2.993 152 6713	0.000 000 0026	
hertz-atomic mass unit relationship	4.439 821 6294 e-24	0.000 000 0064 e-24	u
hertz-electron volt relationship	4.135 667 33 e-15	0.000 000 10 e-15	eV
hertz-hartree relationship	1.519 829 846 006 e-16	0.000 000 000 010 e-16	E_h
hertz-inverse meter relationship	3.335 640 951... e-9	(exact)	m^-1
hertz-joule relationship	6.626 068 96 e-34	0.000 000 33 e-34	J
hertz-kelvin relationship	4.799 2374 e-11	0.000 0084 e-11	K
hertz-kilogram relationship	7.372 496 00 e-51	0.000 000 37 e-51	kg
inverse fine-structure constant	137.035 999 679	0.000 000 094	
inverse meter-atomic mass unit relationship	1.331 025 0394 e-15	0.000 000 0019 e-15	u
inverse meter-electron volt relationship	1.239 841 875 e-6	0.000 000 031 e-6	eV
inverse meter-hartree relationship	4.556 335 252 760 e-8	0.000 000 000 030 e-8	E_h
inverse meter-hertz relationship	299 792 458	(exact)	Hz
inverse meter-joule relationship	1.986 445 501 e-25	0.000 000 099 e-25	J
inverse meter-kelvin relationship	1.438 7752 e-2	0.000 0025 e-2	K
inverse meter-kilogram relationship	2.210 218 70 e-42	0.000 000 11 e-42	kg
inverse of conductance quantum	12 906.403 7787	0.000 0088	ohm

Josephson constant	483 597.891 e9	0.012 e9	Hz V^-1
joule-atomic mass unit relationship	6.700 536 41 e9	0.000 000 33 e9	u
joule-electron volt relationship	6.241 509 65 e18	0.000 000 16 e18	eV
joule-hartree relationship	2.293 712 69 e17	0.000 000 11 e17	E_h
joule-hertz relationship	1.509 190 450 e33	0.000 000 075 e33	Hz
joule-inverse meter relationship	5.034 117 47 e24	0.000 000 25 e24	m^-1
joule-kelvin relationship	7.242 963 e22	0.000 013 e22	K
joule-kilogram relationship	1.112 650 056... e-17	(exact)	kg
kelvin-atomic mass unit relationship	9.251 098 e-14	0.000 016 e-14	u
kelvin-electron volt relationship	8.617 343 e-5	0.000 015 e-5	eV
kelvin-hartree relationship	3.166 8153 e-6	0.000 0055 e-6	E_h
kelvin-hertz relationship	2.083 6644 e10	0.000 0036 e10	Hz
kelvin-inverse meter relationship	69.503 56	0.000 12	m^-1
kelvin-joule relationship	1.380 6504 e-23	0.000 0024 e-23	J
kelvin-kilogram relationship	1.536 1807 e-40	0.000 0027 e-40	kg
kilogram-atomic mass unit relationship	6.022 141 79 e26	0.000 000 30 e26	u
kilogram-electron volt relationship	5.609 589 12 e35	0.000 000 14 e35	eV
kilogram-hartree relationship	2.061 486 16 e34	0.000 000 10 e34	E_h
kilogram-hertz relationship	1.356 392 733 e50	0.000 000 068 e50	Hz
kilogram-inverse meter relationship	4.524 439 15 e41	0.000 000 23 e41	m^-1
kilogram-joule relationship	8.987 551 787... e16	(exact)	J
kilogram-kelvin relationship	6.509 651 e39	0.000 011 e39	K
lattice parameter of silicon	543.102 064 e-12	0.000 014 e-12	m
Loschmidt constant (273.15 K, 101.325 kPa)	2.686 7774 e25	0.000 0047 e25	m^-3
mag. constant	12.566 370 614... e-7	(exact)	N A^-2
mag. flux quantum	2.067 833 667 e-15	0.000 000 052 e-15	Wb
molar gas constant	8.314 472	0.000 015	J mol^-1 K
molar mass constant	1 e-3	(exact)	kg mol^-1
molar mass of carbon-12	12 e-3	(exact)	kg mol^-1
molar Planck constant	3.990 312 6821 e-10	0.000 000 0057 e-10	J s mol^-1
molar Planck constant times c	0.119 626 564 72	0.000 000 000 17	J m mol^-1
molar volume of ideal gas (273.15 K, 100 kPa)	22.710 981 e-3	0.000 040 e-3	m^3 mol^-1
molar volume of ideal gas (273.15 K, 101.325 kPa)	22.413 996 e-3	0.000 039 e-3	m^3 mol^-1
molar volume of silicon	12.058 8349 e-6	0.000 0011 e-6	m^3 mol^-1
Mo x unit	1.002 099 55 e-13	0.000 000 53 e-13	m
muon Compton wavelength	11.734 441 04 e-15	0.000 000 30 e-15	m
muon Compton wavelength over 2 pi	1.867 594 295 e-15	0.000 000 047 e-15	m
muon-electron mass ratio	206.768 2823	0.000 0052	
muon g factor	-2.002 331 8414	0.000 000 0012	
muon mag. mom.	-4.490 447 86 e-26	0.000 000 16 e-26	J T^-1
muon mag. mom. anomaly	1.165 920 69 e-3	0.000 000 60 e-3	
muon mag. mom. to Bohr magneton ratio	-4.841 970 49 e-3	0.000 000 12 e-3	
muon mag. mom. to nuclear magneton ratio	-8.890 597 05	0.000 000 23	
muon mass	1.883 531 30 e-28	0.000 000 11 e-28	kg
muon mass energy equivalent	1.692 833 510 e-11	0.000 000 095 e-11	J
muon mass energy equivalent in MeV	105.658 3668	0.000 0038	MeV
muon mass in u	0.113 428 9256	0.000 000 0029	u
muon molar mass	0.113 428 9256 e-3	0.000 000 0029 e-3	kg mol^-1
muon-neutron mass ratio	0.112 454 5167	0.000 000 0029	
muon-proton mag. mom. ratio	-3.183 345 137	0.000 000 085	
muon-proton mass ratio	0.112 609 5261	0.000 000 0029	
muon-tau mass ratio	5.945 92 e-2	0.000 97 e-2	
natural unit of action	1.054 571 628 e-34	0.000 000 053 e-34	J s
natural unit of action in eV s	6.582 118 99 e-16	0.000 000 16 e-16	eV s
natural unit of energy	8.187 104 38 e-14	0.000 000 41 e-14	J
natural unit of energy in MeV	0.510 998 910	0.000 000 013	MeV
natural unit of length	386.159 264 59 e-15	0.000 000 53 e-15	m
natural unit of mass ≈ electron mass	9.109 382 15 e-31	0.000 000 45 e-31	kg
natural unit of momentum	2.730 924 06 e-22	0.000 000 14 e-22	kg m s^-1
natural unit of momentum in MeV/c	0.510 998 910	0.000 000 013	MeV/c
natural unit of time	1.288 088 6570 e-21	0.000 000 0018 e-21	s
natural unit of velocity	299 792 458	(exact)	m s^-1
neutron Compton wavelength	1.319 590 8951 e-15	0.000 000 0020 e-15	m
neutron Compton wavelength over 2 pi	0.210 019 413 82 e-15	0.000 000 000 31 e-15	m
neutron-electron mag. mom. ratio	1.040 668 82 e-3	0.000 000 25 e-3	
neutron-electron mass ratio	1838.683 6605	0.000 0011	
neutron g factor	-3.826 085 45	0.000 000 90	
neutron gyromag. ratio	1.832 471 85 e8	0.000 000 43 e8	s^-1 T^-1
neutron gyromag. ratio over 2 pi	29.164 6954	0.000 0069	MHz T^-1
neutron mag. mom.	-0.966 236 41 e-26	0.000 000 23 e-26	J T^-1
neutron mag. mom. to Bohr magneton ratio	-1.041 875 63 e-3	0.000 000 25 e-3	
neutron mag. mom. to nuclear magneton ratio	-1.913 042 73	0.000 000 45	
neutron mass	1.674 927 211 e-27	0.000 000 084 e-27	kg
neutron mass energy equivalent	1.505 349 505 e-10	0.000 000 075 e-10	J
neutron mass energy equivalent in MeV	939.565 346	0.000 023	MeV
neutron mass in u	1.008 664 915 97	0.000 000 000 43	u
neutron molar mass	1.008 664 915 97 e-3	0.000 000 000 43 e-3	kg mol^-1
neutron-muon mass ratio	8.892 484 09	0.000 000 23	
neutron-proton mag. mom. ratio	-0.684 979 34	0.000 000 16	
neutron-proton mass ratio	1.001 378 419 18	0.000 000 000 46	

neutron-tau mass ratio	0.528 740	0.000 086	
neutron to shielded proton mag. mom. ratio	-0.684 996 94	0.000 000 16	
Newtonian constant of gravitation	6.674 28 e-11	0.000 67 e-11	m^3 kg^-1
Newtonian constant of gravitation over h-bar c	6.708 81 e-39	0.000 67 e-39	(GeV/c^2)^
nuclear magneton	5.050 783 24 e-27	0.000 000 13 e-27	J T^-1
nuclear magneton in eV/T	3.152 451 2326 e-8	0.000 000 0045 e-8	eV T^-1
nuclear magneton in inverse meters per tesla	2.542 623 616 e-2	0.000 000 064 e-2	m^-1 T^-1
nuclear magneton in K/T	3.658 2637 e-4	0.000 0064 e-4	K T^-1
nuclear magneton in MHz/T	7.622 593 84	0.000 000 19	MHz T^-1
Planck constant	6.626 068 96 e-34	0.000 000 33 e-34	J s
Planck constant in eV s	4.135 667 33 e-15	0.000 000 10 e-15	eV s
Planck constant over 2 pi	1.054 571 628 e-34	0.000 000 053 e-34	J s
Planck constant over 2 pi in eV s	6.582 118 99 e-16	0.000 000 16 e-16	eV s
Planck constant over 2 pi times c in MeV fm	197.326 9631	0.000 0049	MeV fm
Planck length	1.616 252 e-35	0.000 081 e-35	m
Planck mass	2.176 44 e-8	0.000 11 e-8	kg
Planck mass energy equivalent in GeV	1.220 892 e19	0.000 061 e19	GeV
Planck temperature	1.416 785 e32	0.000 071 e32	K
Planck time	5.391 24 e-44	0.000 27 e-44	s
proton charge to mass quotient	9.578 833 92 e7	0.000 000 24 e7	C kg^-1
proton Compton wavelength	1.321 409 8446 e-15	0.000 000 0019 e-15	m
proton Compton wavelength over 2 pi	0.210 308 908 61 e-15	0.000 000 000 30 e-15	m
proton-electron mass ratio	1836.152 672 47	0.000 000 80	
proton g factor	5.585 694 713	0.000 000 046	
proton gyromag. ratio	2.675 222 099 e8	0.000 000 070 e8	s^-1 T^-1
proton gyromag. ratio over 2 pi	42.577 4821	0.000 0011	MHz T^-1
proton mag. mom.	1.410 606 662 e-26	0.000 000 037 e-26	J T^-1
proton mag. mom. to Bohr magneton ratio	1.521 032 209 e-3	0.000 000 012 e-3	
proton mag. mom. to nuclear magneton ratio	2.792 847 356	0.000 000 023	
proton mag. shielding correction	25.694 e-6	0.014 e-6	
proton mass	1.672 621 637 e-27	0.000 000 083 e-27	kg
proton mass energy equivalent	1.503 277 359 e-10	0.000 000 075 e-10	J
proton mass energy equivalent in MeV	938.272 013	0.000 023	MeV
proton mass in u	1.007 276 466 77	0.000 000 000 10	u
proton molar mass	1.007 276 466 77 e-3	0.000 000 000 10 e-3	kg mol^-1
proton-muon mass ratio	8.880 243 39	0.000 000 23	
proton-neutron mag. mom. ratio	-1.459 898 06	0.000 000 34	
proton-neutron mass ratio	0.998 623 478 24	0.000 000 000 46	
proton rms charge radius	0.8768 e-15	0.0069 e-15	m
proton-tau mass ratio	0.528 012	0.000 086	
quantum of circulation	3.636 947 5199 e-4	0.000 000 0050 e-4	m^2 s^-1
quantum of circulation times 2	7.273 895 040 e-4	0.000 000 010 e-4	m^2 s^-1
Rydberg constant	10 973 731.568 527	0.000 073	m^-1
Rydberg constant times c in Hz	3.289 841 960 361 e15	0.000 000 000 022 e15	Hz
Rydberg constant times hc in eV	13.605 691 93	0.000 000 34	eV
Rydberg constant times hc in J	2.179 871 97 e-18	0.000 000 11 e-18	J
Sackur-Tetrode constant (1 K, 100 kPa)	-1.151 7047	0.000 0044	
Sackur-Tetrode constant (1 K, 101.325 kPa)	-1.164 8677	0.000 0044	
second radiation constant	1.438 7752 e-2	0.000 0025 e-2	m K
shielded helion gyromag. ratio	2.037 894 730 e8	0.000 000 056 e8	s^-1 T^-1
shielded helion gyromag. ratio over 2 pi	32.434 101 98	0.000 000 90	MHz T^-1
shielded helion mag. mom.	-1.074 552 982 e-26	0.000 000 030 e-26	J T^-1
shielded helion mag. mom. to Bohr magneton ratio	-1.158 671 471 e-3	0.000 000 014 e-3	
shielded helion mag. mom. to nuclear magneton ratio	-2.127 497 718	0.000 000 025	
shielded helion to proton mag. mom. ratio	-0.761 766 558	0.000 000 011	
shielded helion to shielded proton mag. mom. ratio	-0.761 786 1313	0.000 000 0033	
shielded proton gyromag. ratio	2.675 153 362 e8	0.000 000 073 e8	s^-1 T^-1
shielded proton gyromag. ratio over 2 pi	42.576 3881	0.000 0012	MHz T^-1
shielded proton mag. mom.	1.410 570 419 e-26	0.000 000 038 e-26	J T^-1
shielded proton mag. mom. to Bohr magneton ratio	1.520 993 128 e-3	0.000 000 017 e-3	
shielded proton mag. mom. to nuclear magneton ratio	2.792 775 598	0.000 000 030	
speed of light in vacuum	299 792 458	(exact)	m s^-1
standard acceleration of gravity	9.806 65	(exact)	m s^-2
standard atmosphere	101 325	(exact)	Pa
Stefan-Boltzmann constant	5.670 400 e-8	0.000 040 e-8	W m^-2 K^-
tau Compton wavelength	0.697 72 e-15	0.000 11 e-15	m
tau Compton wavelength over 2 pi	0.111 046 e-15	0.000 018 e-15	m
tau-electron mass ratio	3477.48	0.57	
tau mass	3.167 77 e-27	0.000 52 e-27	kg
tau mass energy equivalent	2.847 05 e-10	0.000 46 e-10	J
tau mass energy equivalent in MeV	1776.99	0.29	MeV
tau mass in u	1.907 68	0.000 31	u
tau molar mass	1.907 68 e-3	0.000 31 e-3	kg mol^-1
tau-muon mass ratio	16.8183	0.0027	
tau-neutron mass ratio	1.891 29	0.000 31	
tau-proton mass ratio	1.893 90	0.000 31	
Thomson cross section	0.665 245 8558 e-28	0.000 000 0027 e-28	m^2
triton-electron mag. mom. ratio	-1.620 514 423 e-3	0.000 000 021 e-3	
triton-electron mass ratio	5496.921 5269	0.000 0051	
triton g factor	5.957 924 896	0.000 000 076	

triton mag. mom.	1.504 609 361 e-26	0.000 000 042 e-26	J T^-1
triton mag. mom. to Bohr magneton ratio	1.622 393 657 e-3	0.000 000 021 e-3	
triton mag. mom. to nuclear magneton ratio	2.978 962 448	0.000 000 038	
triton mass	5.007 355 88 e-27	0.000 000 25 e-27	kg
triton mass energy equivalent	4.500 387 03 e-10	0.000 000 22 e-10	J
triton mass energy equivalent in MeV	2808.920 906	0.000 070	MeV
triton mass in u	3.015 500 7134	0.000 000 0025	u
triton molar mass	3.015 500 7134 e-3	0.000 000 0025 e-3	kg mol^-1
triton-neutron mag. mom. ratio	-1.557 185 53	0.000 000 37	
triton-proton mag. mom. ratio	1.066 639 908	0.000 000 010	
triton-proton mass ratio	2.993 717 0309	0.000 000 0025	
unified atomic mass unit	1.660 538 782 e-27	0.000 000 083 e-27	kg
von Klitzing constant	25 812.807 557	0.000 018	ohm
weak mixing angle	0.222 55	0.000 56	
Wien frequency displacement law constant	5.878 933 e10	0.000 010 e10	Hz K^-1
Wien wavelength displacement law constant	2.897 7685 e-3	0.000 0051 e-3	m K

$G \quad 6.67428(67) \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2} \quad M^{-1} L^{+3} t^{-2}$

~ -7.17559514

VALUPDATE3.WPD August 31, 2009

VALUES DOWNLOADED FROM **CODATA 2006**

	value SI	$\log_{10}$(cgs)	
c	2.99792458	10.476 820 703	Velocity of light
G	6.67428 e-11	-7.175 60	Newton's gravitational constant
$\hbar$	1.054571628 e-34	-26.976 923 917	Planck's constant
a_o	0.52917720859 e-10	-8.276 398 869	Bohr radius
α	7.2973525376 e-3	-2.136 834 672	Fine structure constant
λ_c	$\alpha\, a_o$	-10.413 233 541	Compton wave length
r_e	$\alpha^2\, a_o$	-12.550 068 213	Electron radius fermi
m_n	1.674927211 e-27	-23.776 004 062	Neutron mass
m_p	1.672621637 e-27	-23.776 602 289	Proton mass
m_e	9.10938215 e-31	-27.040 511 078	Electron mass
μ	m_p / m_e	3.263 908 789	Proton/electron mass ratio
N_A	6.02214179 e+23	23.779 750 977	Avogadro's number
α^{-1}		137.035 999 679	Eddington's number
m_o	$\sqrt{(\hbar c/G)}$	-4.662 3	Planck mass
l_o	$\sqrt{(G\hbar/c^3)}$	-32.791 5	Planck length

July 9, 2010

Proton radius 0.84184 femto meters(10^{-15}) $-12,747704$

4% smile

NEWG.WPD November 23, 2006 August 31, 2009

NUMERICALLY NEW

A CONSISTENT VALUE FOR NEWTON'S CONSTANT: G

Several basic physical quantities have been determined to accuracies better than eight places, but Newton's gravitational constant, G, has yet to be determined with certainty to more than five places. This in turn has limited the accuracy of those other constants involving G, such as the Planck mass, $m_o = \sqrt{(\hbar c/G)}$ and the Planck length, $l_o = \sqrt{(G\hbar/c^3)}$.

numerically approved additional places for

Here is presented a "consistency process" for determining G, m_o, l_o, etc to more places:
The present values of relevant constants are taken from CODATA 2006
The $\log_{10}$(cgs) values of those constants are given in TABLE I

TABLE I

fine structure constant	α =	−2.136 834 672	[0]
proton mass	m_p =	−23.776 602 289	[M]
electron mass	m_e =	−27.040 511 078	[M]
proton/electron mass ratio	μ =	3.263 908 789	[0]
electron radius	r_e =	−12.550 068 213	[L]
velocity of light	c =	10.476 820 703	[L/T]
Planck's constant	$\hbar$ =	-26.976 923 917	[ML²/T]
and			
Newton's constant	G =	−7.175 6(0)	[L³/MT²
Planck mass	m_o =	−4.662(8)3	[M]
Planck length	l_o =	−32.791(8)5	[L]

20.241 4
19.114 3 = 5
39.355 7

Using the values from TABLE I,

m_o/m_p = 19.114 3 [0] r_e/l_o = 20.241 4 [0]

$m_p r_e/m_o l_o$ = 1.127 1 [0] $\alpha\mu$ = 1.127 074 115 [0]

The equality between the first four places of $m_p r_e/m_o l_o$ and $\alpha\mu$ suggests that the quantities are possibly equal, and that the other ratios may also be functions of α and μ. related to

if exact equal
$\alpha^{-23}\mu^{-3} = 5$

Calculating powers of α and μ, we find that $\alpha^{-12}\,\mu^{-2} = 19.114\,198\,500$
Comparing and assuming m_o/m_p agrees 19.114 198 500 and using the value of m_p from TABLE I,
m_o becomes = −4.662 403 789 But $m_o = \sqrt{(\hbar c/G)}$, or $G = \hbar c/m_o^2$
Using the values of $\hbar$ and c from TABLE I,

G becomes = −7.175 295 636

Again calculating powers of α and μ, we find that $\alpha^{-11}\,\mu^{-1} = 20.241\,272\,615$
Similarly, assuming r_e/l_o = 20.241 272 615 and using the value of r_e from TABLE I,
l_o becomes = −32.791 340 828, But $l_o = \sqrt{(G\hbar/c^3)}$, or $G = c^3 l_o^2/\hbar$,
Using the values of $\hbar$ and c from TABLE I,

G becomes = −7.175 295 630

Summarizing: The $\log_{10}$(cgs) values become: 5 let

Newton's constant	G =	−7.175 295 6(33)	[L³/MT²
Planck mass	m_o =	−4.662 403 7(89)	[M]
Planck length	l_o =	−32.791 340 8(28)	[L]

The coulomb/gravity force ratio, Dirac's number, $S = \hbar\alpha c/Gm_p m_e$ = + 39.355 471 115 [0]

Value of G and m_o test: PLANK TIME to −43. 266 161 5277

$G m_o^2$ = −16. 500 103 197

hc = −16. 500 103 227

030

7 ϕ places

NEWNUMB.WPD March 26, 2007

Values 2002 [American Scientist]			Log_{10}(cgs)
Fine structure constant	α	7.297 352 533 10^{-3}	-2.136 834 6726
Proton–electron mass ratio	μ	1836.152 667 5	3.263 908 7879
Planck's constant	$\hbar$	1.054 571 596 10^{-34} Js	-26.976 923 9302
Velocity of light	c	299 792 458 km/s	10.476 820 7029
Proton mass	m_p	1.672 621 58 10^{-27} kg	-23.776 602 3043
Electron radius	r_e	2.817 940 285 10^{-15} m	-12.550 068 2143
Compton wave length	λ_c	386.159 2642 10^{-15} m	-10.413 233 5417
Bohr radius	a_o	0.529 177 2083 10^{-10} m	-8.276 398 8691

A revised value for G:

The current value for the Planck mass is $m_o = -4.662\ 199$

Using the above value for m_p, $m_p/m_o = -19.114\ 403$

$\alpha^{12}\mu^2 = -19.114\ 198\ 4954$ and $m_p/(\alpha^{12}\mu^2) = -4.662\ 403\ 8089$

Assume this last value is the correct value of m_o, then since $m_o = \checkmark(\hbar c/G)$,

$G = \hbar c/m_o^2 = -7.175\ 295\ 6095$ vs the current value $G = -7.175\ 705$

The revised value of $G = -7.175\ 296$ leads to the following values:

planck mass	$m_o = (\hbar c/G)^{1/2}$	=	–4.662 403 8089
planck length	$l_o = (G\hbar/c^3)^{1/2}$	=	–32.791 340 8242
planck time	$t_o = (G\hbar/c^5)^{1/2}$	=	–43.268 161 5271
planck force	$f_o = c^4/G$	=	49.082 578 4211
planck power	$p_o = c^5/G = \hbar/t_o^2$	=	59.559 399 1240
planck energy	$\epsilon_o = (\hbar c^5/G)^{1/2}$	=	16.291 237 5969
planck density	$\rho_o = m_o/l_o^3$	=	93.711 618 6637
	$\alpha\mu$	=	1.127 074 1153
force ratio	$S = \alpha\mu(m_o/m_p)^2$	=	39.355 471 4061

NEWG.WPD November 23, 2006 July 4, 2008 June 3, 2011

A CONSISTENCY VALUE FOR NEWTON'S CONSTANT: G

Several basic physical quantities have been determined to accuracies better than eight places, but Newton's gravitational constant, G, has yet to be determined with certainty to more than four places. This in turn has limited the accuracy of other constants involving G, such as the Planck mass, $m_o = \sqrt{(\hbar c/G)}$ and the Planck length, $l_o = \sqrt{(G\hbar/c^3)}$. Herewith is presented a "consistency assumption" for determining G, m_o, l_o, etc to more significant places:

The present values of relevant constants are taken from [Physics Today 2002 pp BG6 – BG13]
The $\log_{10}$(cgs) values of the constants are given in TABLE I

TABLE I

fine structure constant	α =	-2.136 834 673	[0]
proton mass	m_p =	-23.776 602 304	[M]
electron mass	m_e =	–27.040 511 092	[M]
proton/electron mass ratio	μ =	3.263 908 788	[0]
electron radius	r_e =	-12.550 068 214	[L]
velocity of light	c =	10.476 820 703	[L/T]
Planck's constant	$\hbar$ =	-26.976 923 930	[ML^2/T]
and			
Newton's constant	G =	-7.175 7	[L^3/MT^2
Planck mass	m_o =	-4.662 2	[M]
Planck length	l_o =	-32.791 6	[L]

Using the values from TABLE I,

$m_p r_e/m_o l_o$ = 1.127 1 [0] $\quad m_o/m_p$ = 19.114 4 [0]

$\alpha\mu$ = 1.127 074 115 [0] $\quad r_e/l_o$ = 20.241 5 [0]

The equality between the first five places of $m_p r_e/m_o l_o$ and $\alpha\mu$ suggests that the quantities are possibly equal, and that the other ratios may also be functions of α and μ.

Calculating powers of α and μ, we find that $\alpha^{-12}\mu^{-2} = 19.114\ 198\ 500$
Comparing and assuming m_o/m_p = 19.114 198 500 and using the value of m_p from TABLE I, m_o becomes = -4.662 403 804 But $m_o = \sqrt{(\hbar c/G)}$, hence $G = \hbar c/m_o^2$
Using the values of $\hbar$ and c from TABLE I, G becomes = -7.175 295 619

Again calculating powers of α and μ, we find that $\alpha^{-11}\mu^{-1} = 20.241\ 272\ 615$
Similarly, assuming r_e/l_o = 20.241 272 615 and using the value of r_e from TABLE I, l_o becomes = -32.791 340 829, But $l_o = \sqrt{(G\hbar/c^3)}$, hence $G = c^3 l_o^2/\hbar$,
Using the values of $\hbar$ and c from TABLE I, again G becomes = -7.175 295 619

Summarizing: The $\log_{10}$(cgs) values become:

Newton's constant	G =	-7.175 295 619	[L^3/MT^2]
Planck mass	m_o =	-4.662 403 804	[M]
Planck length	l_o =	-32.791 340 829	[L]
Planck time	$t_o = l_o/c$ =	–43.268 161 532	.[T]

Dirac's Number, the coulomb/gravity force ratio at the baryon level,

$S = \hbar\alpha c/Gm_p m_e$, = + 39.355 471 115 [0]

Planck Temperature
32.151158 °K

Boltzmann log constant = −15.859 915 ergs/°Kelvin

Current Codata G
−7.175 59

6 places

METVAL.WPD

September 28, 2007November 2, 2007 February 18, 2008 June 13, 2008

METRIC NUMERIC VALUES

1998 values

ALL VALUES ARE LOG_{10}(cgs)

$G^{3/2} = 10.762\,944\,619$

$\sqrt{\frac{S}{\alpha\mu}} = 19.114\,198\,500$

FUNDAMENTAL CONSTANTS:

$G = -7.175\,295\,619$

$\sqrt{\alpha\mu S} = 20.241\,272\,615$

NEWTON'S CONSTANT	G	=	−7.175 295 619	[L^3/MT^2]
PLANCK'S CONSTANT	ħ	=	−26.976 923 930	[ML^2/T]
VELOCITY OF LIGHT	c	=	10.476 820 703	[L/T]
PROTON MASS/ELECTRON MASS	μ	=	3.263 908 788 7	[0]
FINE STRUCTURE CONSTANT	α	=	−2.136 834 673	[0]
COULOMB/GRAVITY FORCE RATIO	S	=	39.355 471 115	[0]
	αμ	=	1.127 074 115	[0]
	natlog α^{-1}		137.035 999 7	[0]

$\frac{h^2}{G} = -46.788\,552\,2?$

$S = \frac{\alpha\mu\hbar c}{G m_p^2}$

EDDINGTON'S NUMBER.

$\log \alpha^{-1} = 137.035\,999\,9$

PLANCK VALUES:

PLANCK MASS	$m_o = \sqrt{c\hbar/G}$	=	−4.662 403 804	[M]
PLANCK LENGTH	$l_o = \sqrt{G\hbar/c^3}$	=	−32.791 340 829	[L]
PLANCK TIME	$t_o = \sqrt{G\hbar/c^5}$	=	−43.268 161 532	[T]
	c/G	=	17.652 116 322	[MT/L^2]
SCHWARTZSCHILD BOUND	c^2/G	=	28.128 937 025	[M/L]
TIME FACTOR	c^3/G	=	38.605 757 728	[M/T]
PLANCK FORCE	c^4/G	=	49.082 578 431	[ML/T^2]
PLANCK POWER	c^5/G	=	59.559 399 134	[ML^2/T^3]
PLANCK ENERGY	$\sqrt{\hbar c^5/G}$	=	16.291 237 602	[ML^2/T^2]
"	$\sqrt{\hbar c^5/G}$	=	$m_o c^2 = Gm_o^2/l_o = \hbar/t_o$	[ML^2/T^2]
PLANCK DENSITY	$c^5/\hbar G^2$	=	93.711 618 683	[M/L^3]
[PLANCK CHARGE]^2	ħc	=	−16.500 103 227	[ML^3/T^2]
$m_o \cdot l_o$	ħ/c	=	−37.453 744 633	[ML]
$m_o \cdot t_o$	ħ/c^2	=	−47.930 565 336	[MT]

$m_o^2 = -9.324\,807\,578$

$Gm_o =$

m_o/l_o

$\frac{m_o l_o}{t_o^2} = \frac{Gm_o^2}{l_o^2} \Rightarrow \frac{m_o}{l_o} = \frac{c^2}{G}$

$G\hbar c = \frac{L^6}{T^4} C^4 L^2$

$= -23.675\,398\,846$

PLANCK CURRENT $= \frac{c^3}{\sqrt{G}}$

Volt $= \frac{c^2}{\sqrt{G}}$

Planck resistance $= \frac{1}{c}$

$= -47.553\,204$

$\frac{\hbar c^2}{G} = 1.152013$

$[\frac{M^2L}{T}]$

$\frac{\hbar c^3}{G} = [\frac{L}{T}M]$

$= 11.628\,834$

BARYON VALUES:

PROTON MASS	m_p	=	−23.776 602 304	[M]
NEUTRON MASS	m_n	=	−23.776 004 075	[M]
ELECTRON MASS	m_e	=	−27.040 511 092 1	[M]
ELECTRON RADIUS	r_e	=	−12.550 068 214	[L]
ELECTRON FREQUENCY	c/r_e	=	23.026 888 917	[1/T]
[ELECTRON CHARGE]^2 e^2	ħαc	=	−18.636 937 900	[ML^3/T^2]
	Gm_p	=	−30.951 897 923	[L^3/T^2]
	e		$e^2 = 9.318\,468$	

$\log(m_p + m_e) = -23.776\,365\,84$

$SG/c^3 = 0.749\,714 = 3/4$

$19.174\,198\,510$

$\frac{\hbar}{G} = -46.778\,552\,241 = m_o^2 l_o$ [M^3L]

$\frac{\hbar}{c} S = 1.901\,728$ [ML]

$0.950\,864$ $\sqrt{ML}$

$SG = \frac{\alpha_\mu \hbar c}{m_p^2} = 32.180\,175\,496$ defn

$SG = \frac{r_e c^2}{m_p} = 32.180\,175\,496$ $\qquad \alpha_\mu = 1.127\,074\,126$

from $\frac{\alpha_\mu \hbar}{m_p} = r_e c \Rightarrow m_p r_e = \alpha_\mu \frac{\hbar}{c}$

$\sim m_0 l_0 = \frac{1}{c}$

$cG\hbar = -23.675\,398\,816$ $\quad [c^4 L^2]$

$\frac{\hbar c}{m_p^2} = 31.053\,101\,370$

$\frac{c^7}{G^2 \hbar} = 114.665\,261$ $\quad \left[\frac{M}{LT^2}\right]$

$\left(\frac{S}{\alpha_\mu}\right)^3 = 114.685\,191$ $\quad [0]$

PLANCK TEMPERATURE?

TEMPLATE VALUES

$S^{1/2}$	= 19.677 735 557			$(\alpha\mu)^{1/2}$	= 0.563 537 057
S	= 39.355 471 115	=	$\alpha^{-23}\mu^{-3}$	$(\alpha\mu)$	= 1.127 074 115
$S^{3/2}$	= 59.033 206 671			$(\alpha\mu)^{3/2}$	= 1.690 611 171
S^2	= 78.710 942 230	=	$\alpha^{-46}\mu^{-6}$	$(\alpha\mu)^2$	= 2.254 148 230
$S^{5/2}$	= 98.388 677 785			$(\alpha\mu)^{5/2}$	= 2.817 685 288
S^3	= 118.066 413 342	=	$\alpha^{-69}\mu^{-9}$	$(\alpha\mu)^3$	= 3.381 222 342
$S^{7/2}$	= 137.744 148 899			$(\alpha\mu)^{7/2}$	= 3.944 759 403
S^4	= 157.421 884 456	=	$\alpha^{-92}\mu^{-12}$	$(\alpha\mu)^4$	= 4.508 296 460
$S^{9/2}$	= 177.099 620 013			$(\alpha\mu)^{9/2}$	= 5.071 833 518
S^5	= 196.777 355 570	=	$\alpha^{-115}\mu^{-15}$	$(\alpha\mu)^5$	= 5.635 370 575
$S^{11/2}$	= 216.455 091 127			$(\alpha\mu)^{11/2}$	= 6.198 907 633
S^6	= 236.132 826 684	=	$\alpha^{-138}\mu^{-18}$	$(\alpha\mu)^6$	= 6.762 444 690
$S^{13/2}$	= 255.810 562 241			$(\alpha\mu)^{13/2}$	= 7.325 981 741
S^7	= 275.488 297 798	=	$\alpha^{-161}\mu^{-21}$	$(\alpha\mu)^7$	= 7.889 518 798
$S^{15/2}$	= 295.166 033 355			$(\alpha\mu)^{15/2}$	= 8.453 055 855
S^8	= 314.843 768 912	=	$\alpha^{-184}\mu^{-24}$	$(\alpha\mu)^8$	= 9.016 592 912
9 = ~~314.199 24~~				9 = 10.143 667 04	
10 = ~~393.554 711~~				10 = 11.270 741 142	
9 = 354.199 240 027	$\alpha^{207}\mu^{-27}$			11 = 12.397 815 257	
10 = 893.554 711 142	$\alpha^{230}\mu^{-30}$			12 = 13.524 889 372	

$(S/\alpha\mu)^{1/4}$	= 9.557 099 250	=	$\alpha^{-6}\mu^{-1}$	$(\alpha\mu S)^{1/4}$	= 10.120 636 308 = $\alpha^{-11/2}\mu^{-1/2}$
$(S/\alpha\mu)^{1/2}$	= 19.114 198 500	=	$\alpha^{-12}\mu^{-2}$	$(\alpha\mu S)^{1/2}$	= 20.241 272 615 = $\alpha^{-11}\mu^{-1}$
$(S/\alpha\mu)$	= 38.228 397 000	=	$\alpha^{-24}\mu^{-4}$	$(\alpha\mu S)$	= 40.482 545 230 = $\alpha^{-22}\mu^{-2}$
$(S/\alpha\mu)^{3/2}$	= 57.342 595 500	=	$\alpha^{-36}\mu^{-6}$	$(\alpha\mu S)^{3/2}$	= 60.723 817 845 = $\alpha^{-33}\mu^{-3}$
$(S/\alpha\mu)^2$	= 76.456 794 000	=	$\alpha^{-48}\mu^{-8}$	$(\alpha\mu S)^2$	= 80.965 090 460 = $\alpha^{-44}\mu^{-4}$
$(S/\alpha\mu)^{5/2}$	= 95.570 992 500	=	$\alpha^{-60}\mu^{-10}$	$(\alpha\mu S)^{5/2}$	= 101.206 363 075 = $\alpha^{-55}\mu^{-5}$
$(S/\alpha\mu)^3$	= 114.685 191 000	=	$\alpha^{-72}\mu^{-12}$	$(\alpha\mu S)^3$	= 121.447 635 690 = $\alpha^{-66}\mu^{-6}$
$(S/\alpha\mu)^{7/2}$	= 133.799 389 500	=	$\alpha^{-84}\mu^{-14}$	$(\alpha\mu S)^{7/2}$	= 141.688 908 305 = $\alpha^{-77}\mu^{-7}$
$(S/\alpha\mu)^4$	= 152.913 588 000	=	$\alpha^{-96}\mu^{-16}$	$(\alpha\mu S)^4$	= 161.930 180 920 = $\alpha^{-88}\mu^{-8}$
$(S/\alpha\mu)^{9/2}$	= 172.027 786 500	=	$\alpha^{-108}\mu^{-18}$	$(\alpha\mu S)^{9/2}$	= 182.171 453 535 = $\alpha^{-99}\mu^{-9}$
$(S/\alpha\mu)^5$	= 191.141 985 000	=	$\alpha^{-120}\mu^{-20}$	$(\alpha\mu S)^5$	= 202.412 726 15 = $\alpha^{-110}\mu^{-10}$
$(S/\alpha\mu)^{11/2}$	= 210.256 183 500	=	$\alpha^{-132}\mu^{-22}$	$(\alpha\mu S)^{11/2}$	= 222.653 998 765 = $\alpha^{-121}\mu^{-11}$
$(S/\alpha\mu)^6$	= 229.370 382 000	=	$\alpha^{-144}\mu^{-24}$	$(\alpha\mu S)^6$	= 242.895 271 38 = $\alpha^{-132}\mu^{-12}$

G $-7.175\,295\,619$

G^2 $-14.350\,591\,238$

G^3 $-21.525\,886\,86$

$\alpha^{10} = -21.368\ 346\ 722$

$\alpha^{1/2}$	= −1.068 417 336	$\mu^{1/2}$	= 1.631 954 394	$(\alpha/\mu)^{1/2}$	= −2.700 371 731
α	= −2.136 834 673	μ	= 3.263 908 788	(α/μ)	= −5.400 743 462
$\alpha^{3/2}$	= −3.205 252 008	$\mu^{3/2}$	= 4.895 863 182	$(\alpha/\mu)^{3/2}$	= −8.101 115 193
α^{2}	= −4.273 669 346	μ^{2}	= 6.527 817 576	$(\alpha/\mu)^{2}$	= −10.801 486 924
$\alpha^{5/2}$	= −5.342 086 680	$\mu^{5/2}$	= 8.159 771 970	$(\alpha/\mu)^{5/2}$	= −13.501 858655
α^{3}	= −6.410 504 016	μ^{3}	= 9.791 726 364	$(\alpha/\mu)^{3}$	= −16.202 230 386
$\alpha^{7/2}$	= −7.478 921 352	$\mu^{7/2}$	= 11.423 680 758	$(\alpha/\mu)^{7/2}$	= −18.902 602 117
α^{4}	= −8.547 338 688	μ^{4}	= 13.055 635 152	$(\alpha/\mu)^{4}$	= −21.602 973 848
$\alpha^{9/2}$	= −9.615 756 024	$\mu^{9/2}$	= 14.687 589 546	$(\alpha/\mu)^{9/2}$	= −24.303 345 579
α^{5}	= −10.684 173 36	μ^{5}	= 16.319 543 940	$(\alpha/\mu)^{5}$	= −27.003 717 310
$\alpha^{11/2}$	= −11.752 590 696	$\mu^{11/2}$	= 17.951 498 334	$(\alpha/\mu)^{11/2}$	= −29.704 089 041
α^{6}	= −12.821 008 032	μ^{6}	= 19.583 452 728	$(\alpha/\mu)^{6}$	= −32.404 460 772
$\alpha^{13/2}$	= −13.889 425 368	$\mu^{13/2}$	= 21.215 407 122	$(\alpha/\mu)^{13/2}$	= −35.104 832 503
α^{7}	= −14.957 842 704	μ^{7}	= 22.847 361 516	$(\alpha/\mu)^{7}$	= −37.805 204 234
$\alpha^{15/2}$	= −16.026 260 004	$\mu^{15/2}$	= 24.479 315 910	$(\alpha/\mu)^{15/2}$	= −40.505 575 965
α^{8}	= −17.094 677 376	μ^{8}	= 26.111 270 304	$(\alpha/\mu)^{8}$	= −43.205 947 696
$\alpha^{9} = -19.231\ 512\ 049$		μ^{9}	29.375 179 092	$(\alpha/\mu)^{9}$	−48.606 691 158
POWERS AND ROOTS:		μ^{10}	32.639 087 880	$(\alpha/\mu)^{10}$	−54.007 434 620

c	10.476 820 703	l_o	−32.791 340 829	r_e	−12.550 068 214
c^2	20.953 641 406	l_o^2	−65.582 681 658	r_e^2	−25.100 136 428
c^3	31.430 462 109	l_o^3	−98.374 022 487	r_e^3	−37.650 204 642
c^4	41.907 282 812	l_o^4	−131.165 363 316.	r_e^4	−50.200 272 856
c^5	52.384 103 515	l_o^5	−163.956 704 145	r_e^5	−62.750 341 070
c^6	62.860 924 218	l_o^6	−196.748 044 974	r_e^6	−75.300 409 284
c^7	73.337 744 921	l_o^7	−229.539 385 803	r_e^7	−87.850 477 498
c^8	83.814 565 624	l_o^8	−262.330 726 632	r_e^8	−100.400 545 712
c^9	94.291 386 327	l_o^9	−295.122 067 461	r_e^9	−112.950 613 926
c^{10}	104.768 207 03	l_o^{10}	−327.913 408 29	r_e^{10}	−125.500 682 14

fermi	r_e	= −12.550 068 214	$\hbar\alpha/m_ec$	[L]
compton wave length	λ_c	= −10.413 233 541 2	$\hbar/m_ec$	[L]
bohr radius	a_o	= −8.276 398 868 9	$\hbar/m_ec\alpha$	[L]
rydberg *	r_∞^{-1}	= −6.139 564 195	$\hbar/m_ec\alpha^2$	[L]

Each of the above lengths differ by α.

*The Rydberg constant $R_\infty = m_ec\ \alpha^2/4\pi\hbar = 5.040\ 354\ 331$ [L^{-1}].

The above quantity $r_\infty^{-1} = \hbar/m_ec\alpha^2$. (i.e.no 4π) [L]

$r_e = a_o\ \alpha^{\Omega}$

$\alpha = \left(\frac{r_e}{a_o}\right)^{1/\Omega}$

Table of α's based on r_e

PHYSICAL QUANTITIES UPDATE
all values are $\log_{10}$ cgs units

Fundamental Constants:

$c = 10.476821$ [L/T]; $G = -7.175705$ [L^3/MT^2]; $\hbar = -26{,}976924$ [ML^2/T]

$c^2 = 20.953642$; $c^3 = 31.430463$; $c^4 = 41.907284$; $c^5 = 52.384105$, $c^6 = 62.860926$

$c^2/G = 28.129347$ [M/L]; $c^3/G = 38.606168$ [M/T];

$c^4/G = 49.082989$ [ML/T^2] (Force); $c^5/G = 59.559810$ [ML^2/T^3] (Power); 566

$\hbar c = -16.500103$ [ML^3/T^2]; $\hbar/c = -37.453745$ [ML] $\hbar/c^2 = -47.930386$ [MT];

$\hbar\alpha c = -18.636938 = e^2$ [ML^3/T^2]; $\hbar/\alpha^2 c = -33.180075$ [ML]; $\hbar/\alpha^2 c^2 = -43.656896$ [MT]

$\hbar G/c^4 = -76.059913$ [LT]; $\hbar^2/G = -46.778143$ [M^3L]; $a_o = -8.276399$ [L]

Dimensionless Constants:

$\alpha^{1/2} = -1.068418$; $\alpha = -2.136835$; $\alpha^{3/2} = -3.205253$; $\alpha^2 = -4.273670$; $\alpha^3 = -6.410505$

$\alpha^{1/8} = -0.267104$; $\alpha^{2/3} = -1.424556$

$\mu^{1/2} = 1.631955$; $\mu = 3.263909$; $\mu^{3/2} = 4.895864$; $\mu^2 = 6.527818$; $\mu^3 = 9.791727$

$(\alpha\mu)^{1/2} = 0.563537$; $\alpha\mu = 1.127074$; $(\alpha\mu)^{3/2} = 1.690611$; $(\alpha\mu)^2 = 2.254148$

$(\alpha\mu)^{2/3} = 0.751383$; $(\alpha\mu)^{3/4} = 0.845306$; [$\log_{10} 7 = 0.845098$]

$S^{1/2} = 19.677940$; $S = 39.355880$; $S^{3/2} = 59.033820$; $S^2 = 78.711760$; $S^3 = 118.067643$

The Planck Particle

$m_o = \sqrt{(\hbar c/G)} = -4.662199$[M]; $l_o = \sqrt{(\hbar G/c^3)} = -32.791545$ [L]

$t_o = l_o/c = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T]; $\tau_o = \sqrt{(l_o^3/Gm_o)} = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T]

$E_o = m_o c^2 = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2]; $\epsilon_o = Gm_o^2/l_o = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2]

$\varrho_o = c^5/\hbar G^2 = 93.712439$ [M/L^3]; $G\varrho_o\tau_o^2 = 1$; $E_o t_o = \epsilon_o \tau_o = \hbar$; $\hbar\nu_o = 16.291442$

The Baryon:

$m_p = -23.776602$ [M]; $m_n = -23.776004$[M]

$r_e = -12.550068$ [L]; $r_e^3 = -37{,}650204$ [L^3]

$t_b = -23.026889 = r_e/c$ [T]; $\tau_b = -3.348949 = \sqrt{(r_e^3/Gm_p)}$ [T]

$\left(\frac{t}{\tau}\right)^2 = S^{-1}$

$\varrho_b = 13.873602 = m_p/r_e^3$ [M/L^3]; Lifetime of neutron = 2.947924 = 887 sec

The Electron:

$m_e = -27.040511$ [M]

$t_e = -23.026889 = r_e/c$ [T]; $\tau_e = -1.716994 = (G\varrho_e)^{-1/2}$ [T]

$\left(\frac{t}{\tau}\right) = (\mu S)^{-1}$

$e = -9.318469$ (charge); $e^2 = -18.636938 = \hbar\alpha c$ [ML^3/T^2]; $e^2/\alpha = -16.500103$ [ML^3/T^2]

$\varrho_e = 10.609693$ [M/L^3]; $e/\sqrt{G} = -5.730617$ [M] $\hbar/[(\alpha c)^2 t_o] = -0.388530$ [M]

Mathematical Quantities:

$\pi = 0.497150$; $2\pi = 0.798180$; $4\pi^2 = 1.596360$; $4\pi/3 = 0.622089$; $8\pi/3 = 0.923119$

$e = 0.434294$; $\Phi = 0.208988$;

Miscellaneous Quantities:

Earth: Mass = 27.776243 [M]; $\rho = 0.74153$ [M/L^3]; $g = 2.991521$ [L^2/T];

Rotation Period (fixed stars) = 4.935236; Rotation Period (sun) = 4.936514; $\delta = 236$ sec

Schuster period = 3.704137 [T];. Schuman frequency = 0.874433 [1/T]; Sec in year: = 7.499112

Mean radius: Earth = 8.804208 [L]; Moon = 8.2401 [L]; Sun = 10.842302 [L];

Mass (Earth+Moon) = 27.781552 [M]; Moon = 25.866465 [M]; Sun = 33.298645 [M]

A.U. = 13.174927 [L]; L.Y. = 17.975932 [L]; MPC = 24.489352 [L]

Heliopause = 14.95 to 15.175 [L]; Cosmic time 17.456065 sec [T]

UNITDIST.WPD March 14, 2006 March 21, 2006

UNITS OF LENGTH AND DISTANCE

LENGTH	VALUE meters	$\log_{10}$ (VALUE) meters	
PLANCK LENGTH	1.616051 x 10^-35 m	- 34.791 341 m	$[G\hbar/c^3]^{1/2}$
YOCTOMETER	10^-24 m		
ZEPTOMETER	10^-21 m		
ATTOMETER	10^-18 m		
FEMTOMETER	10^-15 m		
FERMI = r_e	2.817914 x 10^-15 m	- 14.550 068 m	$[\hbar\alpha/cm_e]$
COMPTON λ	3.861589 x 10^-13 m	- 12.413 234 m	$[\hbar/cm_e]$
PICOMETER	10^-12 m		
BOHR RADIUS = a_o	5.291781 x 10^-11 m	- 10.276 398 m	$[\hbar/\alpha cm_e]$
ANGSTROM	10^-10 m		
NANOMETER	10^- 9 m		
$(RYDBERG)^{-1} = 1/R_\infty$	9.112698 x 10^ -8 m	–7.040 353 m	$[4\pi a_o/\alpha]$
MICRON	10^- 6 m		
MILLIMETER	10^- 3 m		
KILOMETER	10^ 3 m		
MEGAMETER	10^6 m		
GIGAMETER	10^9 m		
ASTRONOMICAL U	1.495985 x 10^11 m	11.174 927 m	
TERAMETER	10^12 m		
PETAMETER	10^15 m		
LIGHT YEAR	9.460896 x 10^15 m	15.975 932 m	
PARSEC	3.085691 x 10^16 m	16.489 352 m	
EXAMETER	10^18 m		
ZETTAMETER	10^21 m		
MEGAPARSEC	3.085691 x 10^22	22.489 352 m	
YOTTAMETER	10^24 m		
HUBBLE*	9.460530 x 10^24 m	24.975 916 m	
RADIUS OF UNIV**	8.568129 x 10^25 m	25.932 886 m	

* A HUBBLE is the distance light travels in 10^9 years

** The distance traveled by light since the big bang. [based on log(age) = 17.456065 seconds]

Seconds in Sidereal Year	3.155 815 x 10^7 sec	7.499 112 sec
Velocity of Light	2.997 924 x 10^8 m/s	8.476 821 m/s
Astronomical Units/light Year	6.324 191 x 10^4	4.801 005
Astronomical Units/parsec	206,264.807	5.314 425
Light years /parsec	3.261 521	0.513 420

The fermi in planck units: log = 20.241 477 = $[\alpha\mu S]^{1/2}$, where S = $\hbar\alpha c/Gm_em_p$

Radius of universe in fermi units: log = 40.482 954 = $[\alpha\mu S]$

Radius of universe in plank units: log = 60.724 431 = $[\alpha\mu S]^{3/2}$

1983 Meter = distance vel of light in 1 sec
= 1/ 299,792,455 sec

AU 149,597,870 km

in

ft = 12 in

Yard = 3 ft

Rod = 16 ½ ft = 5 ½ yards

chain = 22 yards = 4 rods

furlong = 220 yards = 10 chains = 1.609344 km

Mile = 8 furlongs = 1760 yards = 5280 ft = 80 chains = 320 rods

Fathom = 6 ft

cable = 120 fathom = $\frac{1}{10}$ nautical mile

$$(\alpha\mu s)\, t_0 = -2.785\,616\,282 \text{ sec}$$

BASEFREQ1.WPD JUNE 15, 2008 November 24, 2008

BASIC TIMES AND FREQUENCIES

ITEM	FORMULA	LOG_{10} VALUE	SECONDS	HERTZ
planck particle	$\sqrt{(G\hbar/c^5)}$	–43.268 162		
electron Schuster	$2\pi\sqrt{(r_e^3/Gm_e)}$	-0.919 018	0.120 499	8.298 824
baryon Schuster	$2\pi\sqrt{(r_e^3/Gm_p)}$	-2.550 973	0.002 810	355.609 210
hydrogen Schuster	$2\pi\sqrt{(a_o^3/Gm_p)}$	3.859 939	7243.3421	0.000 138
earth Schuster	$2\pi\sqrt{(R_e^3/GM_e)}$	3.704427	5063.2223	0.000 198
earth Schumann	$2\pi R_e/c$	-0.874 433	0.133 526	7.489 158
earth Schwarzschild	GM_e/c^3	-10.829 515	1.480761×10^{-11}	6.753284×10^{10}
orbit Schumann	2π(A.U.)/c	3.496 286	3135.3498	0.0003189
earth rotation ⊙		4.936 514	86400	1.157407×10^{-5}
earth rotation ☆		4.935 326	86164.09054	1.160576×10^{-5}
earth geosync*	$2\pi R_g/c$	-0.052 906	0.885 307	1.129 55
neutron star	$\alpha\mu S\ t_p$	-2.785 617	0.001 638	610.5000
sun Schuster	$2\pi\sqrt{(R_s^3/GM_s)}$	4.000 367	10008.4541	0.00009991
sun Schumann	$2\pi R_s/c$	1.163 661	14.576 760	0.068 602
Sun Schwarzschild	GM_s/c^3	-5.307523	0.000004926	203012.6031
Univ Schuster	$\sqrt{(R_u^3/GM_u)}$	17.455 657	9.056 346 gyr	
Univ Schumann	R_u/c	17.455 657	"	
Univ Schwarzschild	GM_u/c^3	17.455 657	"	
1/2Universe			4.428 173 gyr	
3/2 Universe			13.584 519 gyr	

minute = 84.3870

* This is the Schumann period at the distance R_g = 42241 km (26,247 miles) for synchronous satellites in equatorial orbits.

NOTE: (Earth Schuster)^4 ≈ (Earth rotation)^3, 14.818 = 14.806

Earth Schuster / Hydrogen = 0.699017 ≈ $\frac{7}{10}$

1 band = 1 pulse/sec

t_p = planck time

EARTHCYC.WPD November 28, 2010

EARTH CYCLES

I. CYCLES > 1 YEAR

ORBITAL ECCENTRICITY CYCLE	93,408 ANOMOLYSTIC YEARS
OBLIQUITY OF THE ECLIPTIC 23^{O} 27' 8.26"	40,032 YEAR INCLINATION CYCLE
PRECESSION OF EQUINOXES	25,725 YEAR CYCLE
ZERO CHECK CYCLE	4,668 YEARS (LAST LINE UP 1437)
4 PULSE	556 YEARS (LAST 1996)
SOTHIC CYCLE	1,461 YEARS
DIONYSIAN CYCLE	532 YEARS
METONIC CYCLE	235 LUNATIONS = 19 YEARS
SAROS	223 LUNATIONS = 18.03 YEARS = 6585.33 DAYS

PLANCKUN.WPD

January 13, 2000

PLANCK UNITS

NAME	DIMENSION	SYMBOL	FORMULA	$\log_{10}$ cgs VALUE
MASS	[M]	m_o	$(c\hbar/G)^{1/2}$	- 4.662199
LENGTH	[L]	l_o	$(\hbar G/c^3)^{1/2}$	- 32.791545
TIME	[T]	t_o	$(\hbar G/c^5)^{1/2}$	- 43.268366
VELOCITY	[L/T]	c	c	10.476821
ACTION	$[ML^2/T]$	$\hbar$	$\hbar$	- 26.976924
G	$[L^3/MT^2]$	G	G	- 7.175704
ENERGY	$[ML^2/T^2]$	ϵ_o	$(\hbar c^5/G)^{1/2}$	16.291442
ENERGY	$[ML^2/T^2]$	ϵ_o^4	$(\hbar c^5/G)^2$	65.165768
FORCE	$[ML/T^2]$	k_o	c^4/G	49.082989
POWER	$[ML^2/T^3]$	w_o	c^5/G	59.559810
DENSITY	$[M/L^3]$	ρ_o	$c^5/G^2\hbar$	93.712439
PRESSURE	$[M/LT^2]$	y_o	$c^7/G^2\hbar$	114.666081 *
electron charge	$[ML^3/T^2]$	e_o^2	$\hbar\alpha c$	- 18.636938
CHARGE	$[ML^3/T^2]$	q_o^2	$\hbar c = e_o^2/\alpha$	- 16.500103
	[M/L]	m_o/l_o	c^2/G	28.129374
	[ML]	$m_o l_o$	$\hbar/c$	- 37.453745
	[M/T]	m_o/t_o	c^3/G	38.606168
	[MT]	$m_o l_o$	$\hbar/c^2$	- 47.930386
	[LT]	$l_o t_o$	$\hbar G/c^4$	- 76.059913
	$[M^3L]$	$m_o^3 l_o$	$\hbar^2/G$	- 46.778144
			c^2	20.953642
			c^3	31.430463
			c^4	41.907284
			c^5	52.384105
$e_o/\sqrt{G}$	[M]	$m_o\sqrt{\alpha}$	$(\hbar\alpha c/G)^{1/2}$	- 5.730617

* $\left(\frac{S}{\alpha\mu}\right)^3 = 114.686418$

$S = 0.020337$

Space-Time = J = $\alpha^3 \alpha^{12} \mu^2 = \alpha^{15} \mu^2 = \alpha^{-7} (\alpha\mu S)^{-1}$ $\frac{\hbar}{c} = \alpha\mu$ $\frac{c^3}{G} = \frac{M}{\alpha}$

ALTERN.WPD July 5, 2007 November 24, 2008 Up 0774

THE ALPHA–MU DIMENSIONS RESENTATIONS

NAME	SYMBOL	PLANCK	$\alpha^X \mu^Y S^Z$	$\alpha^u \mu^v$	$\log_{10}(\alpha^u \mu^v)$
LENGTH	L	$\sqrt{(G\hbar/c^3)}$	α^1	α^1	–2.136 835
TIME	T	$\sqrt{(G\hbar/c^5)}$	$\alpha^{1/2} \mu^{1/2} S^{-1/2}$	$\alpha^{12} \mu^2$	–19.114 202
MASS	M	$\sqrt{(c\hbar/G)}$	μ^1	μ^1	3.263 909
G	L^3/MT^2	G	$\alpha^2 \mu^{-2} S$	$\alpha^{-21} \mu^{-5}$	28.553 990
VELOCITY c	L/T	c	$\alpha^{1/2} \mu^{-1/2} S^{1/2}$	$\alpha^{-11} \mu^{-2}$	16.977 367
FREQUENCY	1/T	$\sqrt{(c^5/G\hbar)}$	$\alpha^{-1/2} \mu^{-1/2} S^{1/2}$	$\alpha^{-12} \mu^{-2}$	19.114 202
ACCELERATION	L/T^2	$\sqrt{(c^7/G\hbar)}$	$\mu^{-1} S$	$\alpha^{-23} \mu^{-4}$	36.091 569
MOMENTUM	ML/T	$\sqrt{(c^3\hbar/G)}$	$\alpha^{1/2} \mu^{1/2} S^{1/2}$	$\alpha^{-11} \mu^{-1}$	20.241 276
AREA	L^2	$G\hbar/c^3$	α^2	α^2	–4.273 670
VOLUME	L^3	$(G\hbar/c^3)^{3/2}$	α^3	α^3	–6.410 505
DENSITY	M/L^3	$c^5/G^2\hbar$	$\alpha^{-3} \mu$	$\alpha^{-3} \mu$	9.674 414
ACTION $\hbar$	ML^2/T	$\hbar$	$\alpha^{3/2} \mu^{1/2} S^{1/2}$	$\alpha^{-10} \mu^{-1}$	18.104 441
FORCE	ML/T^2	c^4/G	S	$\alpha^{-23} \mu^{-3}$	39.355 471
ENERGY	ML^2/T^2	$\sqrt{(c^5\hbar/G)}$	α S	$\alpha^{-22} \mu^{-3}$	37.218 643
POWER	ML^2/T^3	c^5/G	$\alpha^{1/2} \mu^{-1/2} S^{3/2}$	$\alpha^{-34} \mu^{-5}$	56.332 845
PRESSURE	M/LT^2	$c^7/G^2\hbar$	α^{-2} S	$\alpha^{-25} \mu^{-3}$	43.629 148
[CHARGE] ^{2}	ML^3/T^2	$\hbar c$	α^{+2} S	$\alpha^{-21} \mu^{-3}$	35.081 808
CHARGE	$\sqrt{(ML^3/T^2)}$	$\sqrt{(\hbar c)}$	α $S^{1/2}$	$\alpha^{-21/2} \mu^{-3/2}$	17.540 904
CURRENT	$\sqrt{(ML^3/T^4)}$	$c^3/\sqrt{G}$	$\alpha^{1/2} \mu^{-1/2}$ S	$\alpha^{-45/2} \mu^{-7/2}$	36.655 106
VOLTAGE $\sqrt{F}$	$\sqrt{(ML/T^2)}$	$c^2/\sqrt{G}$	$S^{1/2}$	$\alpha^{-23/2} \mu^{-3/2}$	19.677 739
RESISTANCE	T^2/L	$\sqrt{(G\hbar/c^7)}$	μ S^{-1}	$\alpha^{23} \mu^4$	–36.091 569
	M/L	c^2/G	$\alpha^{-1} \mu$	$\alpha^{-1} \mu$	5.400 744
	~~M/T~~	c^3/G	$\alpha^{-12} \mu^{-1}$	$\alpha^{-12} \mu^{-1}$	22.378 107

The α μ system is based on the force ratio, $S = \hbar\alpha c/Gm_p m_e = \alpha^{-23} \mu^{-3}$

$ML = \hbar/c = \alpha\mu$ $\alpha\mu$ 1.127074

NOTE ~~$c = (GS)^{1/4}$~~, ~~$G = c^4 S^{-1}$~~, ~~$\hbar = \alpha c$~~

$c^4 = GS$ $\hbar = \alpha\mu a$

$t = \frac{\alpha}{\mu^2} \frac{\hbar}{G} = \frac{\alpha^2}{\mu} \frac{c}{G}$ $t = T = \tau$ $= \alpha^{1/2} \mu^{1/2} S^{-1/4}$

TIMARAY0.WPD

TIME TABLE: T=T(G,c,h,M,L)

[T] = 1

M\L	–3/2	–1	–1/2	0	1/2	1	3/2
+3		$\sqrt{G^5M^6/L^2hc^{11}}$		G^2M^3/hc^4		$\sqrt{G^3M^6L^2/h^3c^5}$	
2.5	$\sqrt{G^5M^5/L^3c^{12}}$		$\sqrt{G^4M^5/Lhc^9}$		$\sqrt{G^3M^5L/h^2c^6}$		$\sqrt{G^2M^5L^3/h^3c^3}$
+2		G^2M^2/Lc^5		$\sqrt{G^3M^4/hc^7}$		GM^2L/hc^2	
1.5	$\sqrt{G^4M^3h/L^3c^{11}}$		$\sqrt{G^3M^3/Lc^8}$		$\sqrt{G^2M^3L/hc^5}$		$\sqrt{GM^3L^3/h^2c^2}$
+1		$\sqrt{G^3M^2h/L^2c^9}$		GM/c^3		$\sqrt{GM^2L^2/hc^3}$	
+1/2	$\sqrt{G^3Mh^2/L^3c^{10}}$		$\sqrt{G^2Mh/Lc^7}$		$\sqrt{GML/c^4}$		$\sqrt{ML^3/hc}$
0		Gh/Lc^4		$\sqrt{Gh/c^5}$		L/c	
-1/2	$\sqrt{G^2h^3/ML^3c^9}$		$\sqrt{Gh^2/MLc^6}$		$\sqrt{Lh/Mc^3}$		$\sqrt{L^3/GM}$
-1		$\sqrt{Gh^3/M^2L^2c^7}$		h/Mc^2		$\sqrt{L^2h/GM^2c}$	
-3/2	$\sqrt{Gh^4/M^3L^3c^8}$		$\sqrt{h^3/M^3Lc^5}$		$\sqrt{Lh^2/GM^3c^2}$		$\sqrt{L^3hc/G^2M^3}$
-2		h^2/M^2Lc^3		$\sqrt{h^3/GM^4c^3}$		Lh/GM^2	
-5/2	$\sqrt{h^5/M^5L^3c^7}$		$\sqrt{h^4/GM^5Lc^4}$		$\sqrt{Lh^3/G^2M^5c}$		$\sqrt{L^3h^2c^2/G^3M^5}$
-3		$\sqrt{h^5/GM^6L^2c^5}$		h^2/GM^3c		$\sqrt{L^2h^3c/G^3M^6}$	

Notation: In the above table h is used for ħ, the Planck constant / 2π .
√ is for entire expression

TIMATRX4.WPD November 8, 2009

TIME TABLE: T=T(G,M,L,ħ,c)

[T] = 1

M\L	0	0.5	+1	1.5	+2	+2.5	+3
+3	G^2M^3/hc^4		$\sqrt{G^3M^6L^2/h^3c^5}$		GM^3L^2/h^2c		$\sqrt{GM^6L^6c/h^5}$
+2.5		$\sqrt{G^3M^5L/h^2c^6}$		$\sqrt{G^2M^5L^3/h^3c^3}$		$\sqrt{GM^5L^5/h^4}$	
+2	$\sqrt{G^3M^4/hc^7}$		GM^2L/hc^2		$\sqrt{GM^4L^4/h^3c}$		M^2L^3c/h^2
+1.5		$\sqrt{G^2M^3L/hc^5}$		$\sqrt{GM^3L^3/h^2c^2}$		$\sqrt{M^3L^5c/h^3}$	
+1	GM/c^3		$\sqrt{GM^2L^2/hc^3}$		ML^2/h		$\sqrt{M^2L^6c^3/Gh^3}$
+1/2		$\sqrt{GML/c^4}$		$\sqrt{ML^3/hc}$		$\sqrt{ML^5c^2/Gh^2}$	
0	$\sqrt{Gh/c^5}$	$(GL^2\hbar/c^7)^{1/4}$	L/c	$(L^6/c\,G\hbar)^{1/4}$	$\sqrt{L^4c/Gh}$	$(L^{10}c^5/G^3\hbar^3)^{1/4}$	L^3c^2/Gh
-1/2		$\sqrt{Lh/Mc^3}$		$\sqrt{L^3/GM}$		$\sqrt{L^5c^3/G^2Mh}$	
-1	h/Mc^2		$\sqrt{L^2\hbar/GM^2c}$		L^2c/GM		$\sqrt{L^6c^5/G^3M^2h}$
-3/2		$\sqrt{Lh^2/GM^3c^2}$		$\sqrt{L^3hc/G^2M^3}$		$\sqrt{L^5c^4/G^3M^3}$	
-2	$\sqrt{h^3/GM^4c^3}$		Lh/GM^2		$\sqrt{L^4hc^3/G^3M^4}$		L^3c^3/G^2M^2
-5/2		$\sqrt{Lh^3/G^2M^5c}$		$\sqrt{L^3h^2c^2/G^3M^5}$		$\sqrt{L^5hc^5/G^4M^5}$	
-3	h^2/GM^3c		$\sqrt{L^2h^3c/G^3M^6}$		L^2hc^2/G^2M^3		$\sqrt{L^6hc^7/G^5M^6}$

Notation: In the above table h is used for ħ, the Planck constant / 2π .
√ is for entire expression

The Geometric Mean Rule
for vertical, horizontal and both diagonals

SCALE VS. DIMENSIONALITY

TABLE Ia

[Values given in $\log_{10}$(cgs) units]

LEVEL	LENGTH=L	TIME =L/c	MASS	VOLUME	M/L	M ·L
units	centimeters	seconds	grams	centimeters^3	gr/cm	gr ·cm
DARK MTR.	–53.032 612	–63.509 434	14.451796	–159.097 836	67.484 408	–38.580 816
Planck c G ħ	$(Għ/c^3)^{1/2}$	$(Għ/c^5)^{1/2}$	$(cħ/G)^{1/2}$	$(Għ/c^3)^{3/2}$	c^2/G	ħ/c
Planck number	–32.791 340	–43.268 161	–4.662 403	–98.374 020	28.128 937	–37.453 745
BARYON	–12.550 068	–23.026 889	–23.776 602	–37.650 204	–11.226 534	–36.326 670
STAR	7.691 205	–2.785 617	33.565 995	23.073 614	25.874 790	41.257 200
UNIVERSE	27.932 478	17.455 657	52.680 194	83.797 432	24.747 716	80.612 672

TABLE Ib

[Values given in $\log_{10}$(cgs) units]

LEVEL	ENERGY =Mc^2	POWER	FORCE	GRAVITY	DENSITY	M ·V
units	ergs	ergs/sec	dynes	dynes	gr/cm^3	gr ·cm^3
DARK MTR.	35.405 440	98.914 874	88.438 046	127.793 520	173.549 632	–144.646 040
Planck c G ħ	$(ħc^5/G)^{1/2}$	c^5/G	c^4/G	c^4/G	$c^5/ħG^2$	$G\ ħ^2/c^4$
Planck number	16.291 237	59.559 399	49.082 578	49.082 578	93.711 617	–103.036 423
BARYON	–2.822 960	20.203 929	9.727 108	10.854 182	13.873 602	–61.426 806
STAR	54.519 639	57.305 256	46.828 434	44.574 284	10.492 381	56.639 609
UNIVERSE	73.633 836	56.178 179	45.701 358	42.320 136	–31.117 238	136.477 626

TABLE IIa

Values are [$\log_{10}$(cgs)LEVEL –$\log_{10}$(cgs)PLANCK]

LEVEL	LENGTH=L	TIME=L/c	MASS	VOLUME	M/L	M ·L
DARK MTR.	–20.241 272	–20.241 272	19.114 199	–60.723 818	39.355 471	–1.127 074
PLANCK	1	1	1	1	1	1
BARYON	20.241 272	20.241 272	–19.114 199	60.723 818	–39.355 471	1.127 074
STAR	40.482 544	40.482 544	38.228 398	121.447 636	2..254 148	78.710 942
UNIVERSE	60.723 816	60.723 816	57.342 597	182.171 454	3.381 222	118.066 413

TABLE IIb

Values are [$\log_{10}$(cgs)LEVEL –$\log_{10}$(cgs)PLANCK]

LEVEL	ENERGY=Mc^2	POWER	FORCE	GRAVITY	DENSITY	M ·V
DARK MTR.	19.114197	39.355 471	39.355468	78.710942	79.838 015	–41.609 617
PLANCK	1	1	1	1	1	1
BARYON	–19.114 199	–39.355 471	–39.355 471	–38.228 396	–79.838 015	41.609 617
STAR	38.228 520	–2.254 025	–2.254 085	–4.508412	–83.219 236	159.676 032
UNIVERSE	57.342 719	.–3.381 222	–3.381 222	–6.762538	–124.828 855	239.514 049

TABLE IIIa

[Values are in α, μ, S unit with planck values taken = 1]

LEVEL	LENGTH=L	TIME=L/c	MASS	VOLUME	M/L	M·L
DARK MTR.	$(\alpha\mu S)^{-1/2}$	$(\alpha\mu S)^{-1/2}$	$(S/\alpha\mu)^{1/2}$	$(\alpha\mu S)^{-3/2}$	S	$(\alpha\mu)^{-1}$
PLANCK	1	1	1	1	1	1
BARYON	$(\alpha\mu S)^{1/2}$	$(\alpha\mu S)^{1/2}$	$(S/\alpha\mu)^{-1/2}$	$(\alpha\mu S)^{3/2}$	S^{-1}	$(\alpha\mu)$
STAR	$(\alpha\mu S)$	$(\alpha\mu S)$	$(S/\alpha\mu)$	$(\alpha\mu S)^{3}$	$(\alpha\mu)^{2}$	S^{2}
UNIVERSE	$(\alpha\mu S)^{3/2}$	$(\alpha\mu S)^{3/2}$	$(S/\alpha\mu)^{3/2}$	$(\alpha\mu S)^{9/2}$	$(\alpha\mu)^{3}$	S^{3}
DIMENSION	α	$\alpha^{12}\,\mu^{2}$	μ	α^{3}	$\alpha^{-1}\,\mu$	$\alpha\,\mu$

TABLE IIIb

[Values are in α, μ, S unit with planck values taken = 1]

LEVEL	ENERGY=Mc^2	POWER	FORCE	GRAVITY	DENSITY	M·V
DARK MTR.	$(S/\alpha\mu)^{1/2}$	S	S	S^{2}	$(\alpha\mu)\,S^{2}$	$(\alpha\mu)^{-2}\,S^{-1}$
PLANCK	1	1	1	1	1	1
BARYON	$(S/\alpha\mu)^{-1/2}$	S^{-1}	S^{-1}	$(S/\alpha\mu)^{-1}$	$(\alpha\mu)^{-1}\,S^{-2}$	$(\alpha\mu)^{2}\,S$
STAR	$(S/\alpha\mu)$	$(\alpha\mu)^{-2}$	$(\alpha\mu)^{-2}$	$(\alpha\mu)^{-4}$	$(\alpha\mu)^{-4}\,S^{-2}$	$(\alpha\mu)^{2}\,S^{4}$
UNIVERSE	$(S/\alpha\mu)^{3/2}$	$(\alpha\mu)^{-3}$	$(\alpha\mu)^{-3}$	$(\alpha\mu)^{-6}$	$(\alpha\mu)^{-6}\,S^{-3}$	$(\alpha\mu)^{3}\,S^{6}$
DIMENSION	α S	$\alpha^{-11}\,\mu^{-2}$ S	S	S	$\alpha^{-3}\,\mu$	$\alpha^{3}\,\mu$

TABLE IVa

[Values are in α, μ, units with planck values taken = 1]

LEVEL	LENGTH=L	TIME=L/c	MASS	VOLUME	M/L	M ·L
DARK MTR.	$\alpha^{11}\,\mu^{1}$	$\alpha^{11}\,\mu^{1}$	$\alpha^{-12}\,\mu^{-2}$	$\alpha^{33}\,\mu^{3}$	$\alpha^{-23}\,\mu^{-3}$	$\alpha^{-1}\,\mu^{-1}$
PLANCK	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$
BARYON	$\alpha^{-11}\,\mu^{-1}$	$\alpha^{-11}\,\mu^{-1}$	$\alpha^{12}\,\mu^{2}$	$\alpha^{-33}\,\mu^{-3}$	$\alpha^{23}\,\mu^{3}$	$\alpha^{1}\,\mu^{1}$
STAR	$\alpha^{-22}\,\mu^{-2}$	$\alpha^{-22}\,\mu^{-2}$	$\alpha^{-24}\,\mu^{-4}$	$\alpha^{-66}\,\mu^{-6}$	$\alpha^{2}\,\mu^{2}$	$\alpha^{-46}\,\mu^{-6}$
UNIVERSE	$\alpha^{-33}\,\mu^{-3}$	$\alpha^{-33}\,\mu^{-3}$	$\alpha^{-36}\,\mu^{-6}$	$\alpha^{-99}\,\mu^{-9}$	$\alpha^{3}\,\mu^{3}$	$\alpha^{-69}\,\mu^{-9}$
DIMENSION	α	$\alpha^{12}\,\mu^{2}$	μ	α^{3}	$\alpha^{-1}\,\mu$	$\alpha\,\mu$

TABLE IVb

[Values are in α, μ, units with planck values taken = 1]

LEVEL	ENERGY=Mc^2	POWER	FORCE	GRAVITY	DENSITY	M ·V
DARK MTR.	$\alpha^{-12}\,\mu^{-2}$	$\alpha^{-23}\,\mu^{-3}$	$\alpha^{-23}\,\mu^{-3}$	$\alpha^{-46}\,\mu^{-6}$	$\alpha^{-45}\,\mu^{-5}$	$\alpha^{21}\,\mu^{1}$
PLANCK	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$	$\alpha^{0}\,\mu^{0}$
BARYON	$\alpha^{11}\,\mu^{1}$	$\alpha^{23}\,\mu^{3}$	$\alpha^{23}\,\mu^{3}$	$\alpha^{24}\,\mu^{4}$	$\alpha^{45}\,\mu^{5}$	$\alpha^{-21}\,\mu^{-1}$
STAR	$\alpha^{-24}\,\mu^{-4}$	$\alpha^{-2}\,\mu^{-2}$	$\alpha^{-2}\,\mu^{-2}$	$\alpha^{-4}\,\mu^{-4}$	$\alpha^{42}\,\mu^{2}$	$\alpha^{-90}\,\mu^{-10}$
UNIVERSE	$\alpha^{-36}\,\mu^{-6}$	$\alpha^{-3}\,\mu^{-3}$	$\alpha^{-3}\,\mu^{-3}$	$\alpha^{-6}\,\mu^{-6}$	$\alpha^{63}\,\mu^{3}$	$\alpha^{-135}\,\mu^{-15}$
DIMENSION	$\alpha^{-22}\,\mu^{-3}$	$\alpha^{-34}\,\mu^{-5}$	$\alpha^{-23}\,\mu^{-3}$	$\alpha^{-23}\,\mu^{-3}$	$\alpha^{-3}\,\mu$	$\alpha^{3}\,\mu$

$\alpha=-1, b=0$

ALTERNATE TIME TYPES

$\alpha=0, b=1$ $\alpha=1, b=0$ Values are in $\log_{10}$(cgs) units $\alpha=0, b=-1$ $\alpha=-\frac{1}{2}\ b=+\frac{3}{2}$ $\alpha+\frac{1}{2}, b-\frac{3}{2}$

LEVEL	TIME t	TIME T	TIME K	TIME Z	TIME τ	TIME η
formulae	$t=L/c$	$T=GM/c^3$	$K=\hbar/Mc^2$	$Z=G\hbar/c^4L$	$\tau=\sqrt{L^3/GM}$	$\eta=\sqrt{G^3\hbar^2M/c^{10}L^3}$
DARK MTR.	–63.509 433	–24.153 960	–62.382 361	–23.026 889	–83.187 168	–3.349 154
Planck c G ħ	$(G\hbar/c^5)^{1/2}$	$(G\hbar/c^5)^{1/2}$	$(G\hbar/c^5)^{1/2}$	$(G\hbar/c^5)^{1/2}$	$(G\hbar/c^5)^{1/2}$	$(G\hbar/c^5)^{1/2}$
Planck numer	–43.268 161	–43.268 161	–43.268 161	–43.268 161	–43.268 161	–43.268 161
BARYON	–23.026 889	–62.382 358	–24.153 963	–63.509 433	–3.349 154	–83.187 168
STAR	–2.785 617	–5.039 761	–81.496 560	–83.750 706	–1.658 543	–84.877 779
UNIVERSE	17.455 655	14.074 438	–100.610759	–103.991 979	19.146 267	–105.682 591

$\Psi = a^{1/2} b^{1/2} = \sqrt{\frac{GML}{C^4}}$

Ψ

$\Psi = \sqrt{\frac{GML}{C^4}}$

TABLE A $\log_{10}$ (gcs) [$E=Mc^2$]

LEVEL	ENERGY (Time used is $t=L/c$)	POWER	FORCE	ENERGY (Time used is $T=GM/c^3$)	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	35.405 440	98.914 874	88.438 046	35.405 440	59.559 399	88.438 046
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–2.822 960	20.203 929	9.727 108	–2.822 960	59.559 399	~~9.727 108~~
STAR	54.519 639	57.305 256	46.828 434	54.519 639	59.559 399	~~46.828 434~~
UNIVERSE	73.633 836	56.178 179	45.701 358	73.633 836	59.559 399	~~45.701 358~~

2

T SUN - S

88.438 049

51.336 782

52.463 796

TABLE B $\log_{10}$ (gcs) [$E = Mc^2$]

Time used is $K = \hbar/Mc^2$ Time used is $Z = G\hbar/c^4L$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	35.405 440	97.787 798	88.438 046	35.405 440	58.432 326	88.438 046
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–2.822 960	21.331 002	9.727 108	–2.822 960	60.686 472	9.727 108
STAR	54.519 639	136.016 199	46.828 434	54.519 639	138.270 345	46.828 434
UNIVERSE	73.633 836	174.244 595	45.701 358	73.633 836	177.625 815	45.701 358

TABLE C $\log_{10}$ (gcs) [$E = Mc^2$]

Time used is $\tau = \sqrt{L^3/GM}$ Time used is $\eta = \sqrt{G^3\hbar^2M/c^{10}L^3}$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	35.405 440	118.592 608	88.438 046	35.405 440	38.754 594	88.438 046
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–2.822 960	0.526 194	9.727 108	–2.822 960	80.364 208	9.727 108
STAR	54.519 639	56.178 182	46.828 434	54.519 639	139.397 415	46.828 434
UNIVERSE	73.633 836	54.487 569	45.701 358	73.633 836	179.316 427	45.701 358

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TABLE A $\log_{10}$ (gcs) [E = ħ/time]

	Time used is t =L/c			Time used is T = GM/c^3		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	36.532 509	100.041 942	89.565 121	–2.822 964	21.330 996	50.209 648
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–3.950 035	19.076 854	8.600 033	35.405 436	97.787 774	47.955 504
STAR	–24.191 307	–21.405 690	–31.882 512	–21.937 163	–16.897 402	–29.628 368
UNIVERSE	–44.432 579	–62.888 234	–72.365 057	–41.051 362	–55.125 805	–68.983 840

TABLE B $\log_{10}$ (gcs) [E = ħ/time]

	Time used is K = ħ/Mc^2			Time used is Z = G ħ/c^4L		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	35.405 440	97.787 798	88.438 046	–3.950 035	19.076 854	49.082 578
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–2.822 960	–21.331 002	9.727 108	36.532 509	100.041 942	49.082 578
STAR	54.519 639	136.016 196	46.828 434	56.773 782	140.524 488	49.082 578
UNIVERSE	73.633 836	174.244 594	45.701 358	77.015 035	181.007 035	49.082 578

COSTEMP2.WPD

TABLE C $\log_{10}$ (gcs) [E = ħ/time]

Time used is $\tau = \sqrt{L^3/GM}$ Time used is $\eta = \sqrt{G^3\hbar^2M/c^{10}L^3}$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	56.210 244	139.397 412	109.242 856	–23.627 770	–20.278 616	29.404 842
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–23.627 770	–20.278 617	–11.077 700	56.210 244	139.397 412	68.760 312
STAR	–25.408 381	–23.659 838	–33.009 586	57.900 855	142.778 634	50.209 650
UNIVERSE	–46.123 191	–65.269 458	–74.055 669	78.705 661	184.388 246	50.773 183

TABLE A $\log_{10}$ (gcs) [F = ML/time^2]

Time used is t =L/c Time used is T = GM/c^3

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	35.405 440	98.914 874	88.438 046	–43.305 508	–19.151 818	9.727 104.
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–2.822 960	20.203 929	9.727 108	88.438 406	150.820 944	100.988 474
STAR	54.519 639	57.305 256	46.828 434	59.027 986	56.376 542	51.336 781
UNIVERSE	73.633 836	56.178 179	45.701 358	80.396 381	66.321 943	52.463 404

.) TABLE B $\log_{10}$ (gcs [F = ML/time^2]

	Time used is K = ħ/Mc^2			Time used is Z = G ħ/c^{4}L		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	33.151 294	95.533 655	86.183 906	–45.559 650	–22.532 761	7.472 962
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	0.568 812	24.722 775	11.981 256	78.142 128	141.651 561	90.692 196
STAR	211.941 625	293.438 185	204.250 320	216.449 817	300.200 523	208.758 612
UNIVERSE	309.766 668	410.377 427	281.834 190	316.529 108	420.521 087	288.596 630

. TABLE C $\log_{10}$ (gcs) [F = ML/time^2]

	Time used is $\tau = \sqrt{L^3/GM}$			Time used is $\eta = \sqrt{G^3\hbar^2M/c^{10}L^3}$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
units	ergs	ergs/sec	dynes	ergs	ergs/sec	dynes
DARK MTR.	94.760 908	177.948 076	147.793 520	–84.915 120	–81.565 966	–31.882 508
Planck c G ħ	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G	$(\hbar c^5/G)^{1/2}$	c^5/G	c^4/G
Planck numer	16.291 237	59.559 399	49.082 578	16.291 237	59.559 399	49.082 578
BARYON	–29.627 664	–26.278 161	–17.077 596.	117.497 598	200.684 766	130.047 666
STAR	52.265 550	53.924 093	44.474 345	118.703 963	103.581 742	111.012 758
UNIVERSE	70.252 673	51.111 406	42.320 196	319.910 320	425.572 905	291.977 842

TABLE A [Log_{10}(cgs) values / log_{10} (planck) values] [$E = Mc^2$]

	Time used is t = L/c			Time used is T = GM/c^3		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	19.114 197	39.355 471	39.355 468	19.114 197	1	39.355 468
PLANCK	1	1	1	1	1	1
BARYON	–19.114 199	–39.355 471	–39.355 471	–19.114 199	1	–39.355 471
STAR	38.228 520	–2.254 025	–2.254 085	38.228 520	1	–2.254 085
UNIVERSE	57.342 719	.–3.381 222	–3.381 222	57.342 719	1	–3.381 222

TABLE B [Log_{10}(cgs) values / log_{10} (planck) values] [$E = Mc^2$]

	Time used is K = $\hbar/Mc^2$			Time used is Z = $G\hbar/c^4L$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	19.114197	38.228 400	39.355 468	19.114 197	–1.127 074	39.355 468
PLANCK	1	1	1	1	1	1
BARYON	–19.114 199	–38.228 400	–39.355 471	–19.114 199	1.127 074	–39.355 471
STAR	38.228 520	76.456 800	–2.254 085	38.228 520	78.710 946	–2.254 085
UNIVERSE	57.342 719	114.685 146	–3.381 222	57.342 719	118.066 416	–3.381 222

TABLE C [Log_{10}(cgs) values / log_{10} (planck) values] [$E = Mc^2$]

Time used is $\tau = \sqrt{L^3/Gm}$ Time used is $\eta = \sqrt{G^3 \hbar^2 M/c^{10} L^3}$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	19.114 197	59.033 209	39.355 468	19.114197	–20.804 805	39.355 468
PLANCK	1		1	1	1	1
BARYON	–19.114 199	–59.033 209	–39.355 471	–19.114 199	20.804 805	–39.355 471
STAR	38.228 520	–3.381 217	–2.254 085	38.228 520	79.838 016	–2.254 085
UNIVERSE	57.342 719	–5.071 830	–3.381 222	57.342 719	119.757 028	–3.381 222

TABLE A [Log_{10}(cgs) values / log_{10} (planck) values] [$E = \hbar/time$]

Time used is $t = L/c$ Time used is $T = GM/c^3$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	20.241 272	40.482 543	40.482 543	–19.114 201	–38.228 403	1.127 074
PLANCK	1	1	1	1	1	1
BARYON	–20.241 272	–40.482 543	–40.482 543	–19.114 199	38.228 375	–1.127 074
STAR	–40.482 543	–80.965 089	–80.965 089	–38.228 400	–76.456 801	–78.710 946
UNIVERSE	–60.723 816	–121.447 633	–121.447 635	–57.342 599	–114.685 264	–118.066 418

TABLE B [Log_{10}(cgs) values / log_{10} (planck) values] [E = ħ/time]

Time used is K = $ħ/Mc^2$ Time used is Z = $G ħ/c^4L$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	19.114 203	38.228 399	39.355 468	–20.241 272	–40.482 545	1
PLANCK	1	1	1	1	1	1
BARYON	–19.114 203	--38.228 399	39.355 468	20.241 272	40.482 545	1
STAR	38.228 399	76.456 866	2.254 144	40.482 545	80.965 089	1
UNIVERSE	57.342 599	114.685 195	3.381 220	60.724 798	121.447 63	1

TABLE C [Log_{10}(cgs) values / log_{10} (planck) values] [E = ħ/time]

Time used is $\tau = \sqrt{L^3/Gm}$ Time used is $\eta = \sqrt{G^3 ħ^2 M/c^{10} L^3}$

LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	39.919 008	79.838 016	60.160 278	–39.919 008	–79.838 016	–19.677 736
PLANCK	1	1	1	1	1	1
BARYON	–39.919 008	–79.838 016	–60.160 278	39.919 008	79.838 016	19.677 736
STAR	–41.609 618	–83.219 238	82.092 164	41.609 618	83.219 238	1.127 072
UNIVERSE	–62.414 428	–124.828 957	123.138 247	62.414 428	124.828 957	1.690 605

TABLE A [Log_{10}(cgs) values / log_{10} (planck) values $\Rightarrow$ α,μ,S] [$E = Mc^2$]

	Time used is $t = L/c$			Time used is $T = GM/c^3$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2}(\alpha\mu)^{-1/2}$	S	S	$S^{1/2}(\alpha\mu)^{-1/2}$	1	S
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1/2}(\alpha\mu)^{1/2}$	S^{-1}	S^{-1}	$S^{-1/2}(\alpha\mu)^{1/2}$	1	S^{-1}
STAR	$S(\alpha\mu)^{-1}$	$(\alpha\mu)^{-2}$	$(\alpha\mu)^{-2}$	$S(\alpha\mu)^{-1}$	1	$(\alpha\mu)^{-2}$
UNIVERSE	$S^{3/2}(\alpha\mu)^{-3/2}$	$(\alpha\mu)^{-3}$	$(\alpha\mu)^{-3}$	$S^{3/2}(\alpha\mu)^{-3/2}$	1	$(\alpha\mu)^{-3}$

TABLE B [Log_{10}(cgs) values / log_{10} (planck) values $\Rightarrow$ α,μ,S] [$E = Mc^2$]

	Time used is $K = \hbar/Mc^2$			Time used is $Z = G\hbar/c^4L$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2}(\alpha\mu)^{-1/2}$	$S(\alpha\mu)^{-1}$	S	$S^{1/2}(\alpha\mu)^{-1/2}$	$(\alpha\mu)^{-1}$	S
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1/2}(\alpha\mu)^{1/2}$	$S^{-1}(\alpha\mu)$	S^{-1}	$S^{-1/2}(\alpha\mu)^{1/2}$	$(\alpha\mu)$	S^{-1}
STAR	$S(\alpha\mu)^{-1}$	$S^2(\alpha\mu)^{-2}$	$(\alpha\mu)^{-2}$	$S(\alpha\mu)^{-1}$	S^2	$(\alpha\mu)^{-2}$
UNIVERSE	$S^{3/2}(\alpha\mu)^{-3/2}$	$S^3(\alpha\mu)^{-3}$	$(\alpha\mu)^{-3}$	$S^{3/2}(\alpha\mu)^{-3/2}$	S^3	$(\alpha\mu)^{-3}$

TABLE C [Log_{10}(cgs) values / log_{10} (planck) values ⇒ α,μ,S] [$E = Mc^2$]

	Time used is $\tau = \sqrt{L^3/Gm}$			Time used is $\eta = \sqrt{G^3 \hbar^2 M/c^{10} L^3}$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2} (\alpha\mu)^{-1/2}$	$S^{3/2}$	S	$S^{1/2} (\alpha\mu)^{-1/2}$	$S^{-1/2} (\alpha\mu)^{-1}$	S
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1/2} (\alpha\mu)^{1/2}$	$S^{-3/2}$	S^{-1}	$S^{-1/2} (\alpha\mu)^{1/2}$	$S^{1/2} (\alpha\mu)$	S^{-1}
STAR	$S (\alpha\mu)^{-1}$	$(\alpha\mu)^{-3}$	$(\alpha\mu)^{-2}$	$S (\alpha\mu)^{-1}$	$S^2 (\alpha\mu)$	$(\alpha\mu)^{-2}$
UNIVERSE	$S^{3/2} (\alpha\mu)^{-3/2}$	$(\alpha\mu)^{-9/2}$	$(\alpha\mu)^{-3}$	$S^{3/2} (\alpha\mu)^{-3/2}$	$S^3 \alpha\mu)^{3/2}$	$(\alpha\mu)^{-3}$

TABLE A [Log_{10}(cgs) values / log_{10} (planck) values ⇒ α,μ,S] [$E = \hbar/time$]

	Time used is $t = L/c$			Time used is $T = GM/c^3$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2} (\alpha\mu)^{1/2}$	$S (\alpha\mu)$	$S (\alpha\mu)$	$S^{-1/2} (\alpha\mu)^{1/2}$	$S^{-1} (\alpha\mu)$	$(\alpha\mu)$
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1/2} (\alpha\mu)^{-1/2}$	$S^{-1} (\alpha\mu)^{-1}$	$S^{-1} (\alpha\mu)^{-1}$	$S^{-1/2} (\alpha\mu)^{1/2}$	$S (\alpha\mu)^{-1}$	$(\alpha\mu)^{-1}$
STAR	$S^{-1} (\alpha\mu)^{-1}$	$S^{-2} (\alpha\mu)^{-2}$	$S^{-2} (\alpha\mu)^{-2}$	$S^{-1} (\alpha\mu)$	$S^{-2} (\alpha\mu)^2$	S^{-2}
UNIVERSE	$S^{-3/2} (\alpha\mu)^{-3/2}$	$S^{-3} (\alpha\mu)^{-3}$	$S^{-3} (\alpha\mu)^{-3}$	$S^{-3/2} (\alpha\mu)^{3/2}$	$S^{-3} (\alpha\mu)^3$	S^{-3}

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TABLE B [Log_{10}(cgs) values / log_{10} (planck) values ⇒ α,μ,S] [E = ħ/time]

	Time used is K = ħ/Mc²			Time used is Z = G ħ/c⁴L		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2}(\alpha\mu)^{-1/2}$	$S(\alpha\mu)^{-1}$	$S(\alpha\mu)^{-1}$	$S^{-1/2}(\alpha\mu)^{-1/2}$	$S^{-1}(\alpha\mu)^{-1}$	1
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1/2}(\alpha\mu)^{1/2}$	$S^{-1}(\alpha\mu)$	$S(\alpha\mu)^{-1}$	$S^{1/2}(\alpha\mu)^{1/2}$	$S(\alpha\mu)$	1
STAR	$S(\alpha\mu)^{-1}$	$S^2(\alpha\mu)^{-2}$	$(\alpha\mu)^2$	$S(\alpha\mu)$	$S^2(\alpha\mu)^2$ OR	1
UNIVERSE	$S^{3/2}(\alpha\mu)^{-3/2}$	$S^3(\alpha\mu)^{-3}$	$(\alpha\mu)^3$	$S^{3/2}(\alpha\mu)^{3/2}$	$S^3(\alpha\mu)^3$	1

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TABLE C [Log_{10}(cgs) values / log_{10} (planck) values ⇒ α,μ,S] [E = ħ/time]

	Time used is $\tau = \sqrt{L^3/Gm}$			Time used is $\eta = \sqrt{G^3\hbar^2M/c^{10}L^3}$		
LEVEL	ENERGY	POWER	FORCE	ENERGY	POWER	FORCE
DARK MTR.	$S^{1/2}(\alpha\mu)^{1/2}$	$S^2(\alpha\mu)$	$S^{3/2}(\alpha\mu)$	$S^{-1}(\alpha\mu)^{-1/2}$	$S^{-2}(\alpha\mu)^{-1}$	$S^{-1/2}$
PLANCK	1	1	1	1	1	1
BARYON	$S^{-1}(\alpha\mu)^{-1/2}$	$S^{-2}(\alpha\mu)^{-1}$	$S^{-3/2}(\alpha\mu)^{-1}$	$S(\alpha\mu)^{1/2}$	$S^2(\alpha\mu)$	$S^{1/2}$
STAR	$S^{-1}(\alpha\mu)^{-2}$	$S^{-2}(\alpha\mu)^{-4}$	$S^2(\alpha\mu)^3$	$S(\alpha\mu)^2$	$S^2(\alpha\mu)^4$	$(\alpha\mu)$
UNIVERSE	$S^{-3/2}(\alpha\mu)^{-3}$	$S^{-3}(\alpha\mu)^{-6}$	$S^3(\alpha\mu)^{-9/2}$	$S^{3/2}(\alpha\mu)^3$	$S^3(\alpha\mu)^6$	$(\alpha\mu)$

ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL ARRAY

$a := -2.136834673$ $b := 3.263908788$ + αs + μs

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$ ma + pb

J =

	0	1	2	3	4
0	0	-2.136834673	-4.273669346	-6.410504019	-8.547338692
1	3.263908788	1.127074115	-1.009760558	-3.146595231	-5.283429904
2	6.527817576	4.390982903	2.25414823	0.117313557	-2.019521116
3	9.791726364	7.654891691	5.518057018	3.381222345	1.244387672
4	13.055635152	10.918800479	8.781965806	6.645131133	4.50829646
5	16.31954394	14.182709267	12.045874594	9.909039921	7.772205248
6	19.583452728	17.446618055	15.309783382	13.172948709	11.036114036
7	22.847361516	20.710526843	18.57369217	16.436857497	14.300022824
8	26.111270304	23.974435631	21.837600958	19.700766285	17.563931612
9	29.375179092	27.238344419	25.101509746	22.964675073	20.8278404
10	32.63908788	30.502253207	28.365418534	26.228583861	24.091749188
11	35.902996668	33.766161995	31.629327322	29.492492649	27.355657976
12	39.166905456	37.030070783	34.89323611	32.756401437	30.619566764
13	42.430814244	40.293979571	38.157144898	36.020310225	33.883475552
14	45.694723032	43.557888359	41.421053686	39.284219013	37.14738434
15	48.95863182	46.821797147	44.684962474	42.548127801	40.411293128
16	52.222540608	50.085705935	47.948871262	45.812036589	43.675201916

K =

	0	1	2	3	4
0	55.486449396	53.349614723	51.21278005	49.075945377	46.939110704
1	58.750358184	56.613523511	54.476688838	52.339854165	50.203019492
2	62.014266972	59.877432299	57.740597626	55.603762953	53.46692828
3	65.27817576	63.141341087	61.004506414	58.867671741	56.730837068
4	68.542084548	66.405249875	64.268415202	62.131580529	59.994745856
5	71.805993336	69.669158663	67.53232399	65.395489317	63.258654644
6	75.069902124	72.933067451	70.796232778	68.659398105	66.522563432
7	78.333810912	76.196976239	74.060141566	71.923306893	69.78647222
8	81.5977197	79.460885027	77.324050354	75.187215681	73.050381008
9	84.861628488	82.724793815	80.587959142	78.451124469	76.314289796
10	88.125537276	85.988702603	83.85186793	81.715033257	79.578198584
11	91.389446064	89.252611391	87.115776718	84.978942045	82.842107372
12	94.653354852	92.516520179	90.379685506	88.242850833	86.10601616
13	97.91726364	95.780428967	93.643594294	91.506759621	89.369924948
14	101.181172428	99.044337755	96.907503082	94.770668409	92.633833736
15	104.445081216	102.308246543	100.17141187	98.034577197	95.897742524
16	107.708990004	105.572155331	103.435320658	101.298485985	99.161651312

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

J =

	5	6	7	8	9
0	-10.684173365	-12.821008038	-14.957842711	-17.094677384	-19.231512057
1	-7.420264577	-9.55709925	-11.693933923	-13.830768596	-15.967603269
2	-4.156355789	-6.293190462	-8.430025135	-10.566859808	-12.703694481
3	-0.892447001	-3.029281674	-5.166116347	-7.30295102	-9.439785693
4	2.371461787	0.234627114	-1.902207559	-4.039042232	-6.175876905
5	5.635370575	3.498535902	1.361701229	-0.775133444	-2.911968117
6	8.899279363	6.76244469	4.625610017	2.488775344	0.351940671
7	12.163188151	10.026353478	7.889518805	5.752684132	3.615849459
8	15.427096939	13.290262266	11.153427593	9.01659292	6.879758247
9	18.691005727	16.554171054	14.417336381	12.280501708	10.143667035
10	21.954914515	19.818079842	17.681245169	15.544410496	13.407575823
11	25.218823303	23.08198863	20.945153957	18.808319284	16.671484611
12	28.482732091	26.345897418	24.209062745	22.072228072	19.935393399
13	31.746640879	29.609806206	27.472971533	25.33613686	23.199302187
14	35.010549667	32.873714994	30.736880321	28.600045648	26.463210975
15	38.274458455	36.137623782	34.000789109	31.863954436	29.727119763
16	41.538367243	39.40153257	37.264697897	35.127863224	32.991028551

K =

	5	6	7	8	9
0	44.802276031	42.665441358	40.528606685	38.391772012	36.254937339
1	48.066184819	45.929350146	43.792515473	41.6556808	39.518846127
2	51.330093607	49.193258934	47.056424261	44.919589588	42.782754915
3	54.594002395	52.457167722	50.320333049	48.183498376	46.046663703
4	57.857911183	55.72107651	53.584241837	51.447407164	49.310572491
5	61.121819971	58.984985298	56.848150625	54.711315952	52.574481279
6	64.385728759	62.248894086	60.112059413	57.97522474	55.838390067
7	67.649637547	65.512802874	63.375968201	61.239133528	59.102298855
8	70.913546335	68.776711662	66.639876989	64.503042316	62.366207643
9	74.177455123	72.04062045	69.903785777	67.766951104	65.630116431
10	77.441363911	75.304529238	73.167694565	71.030859892	68.894025219
11	80.705272699	78.568438026	76.431603353	74.29476868	72.157934007
12	83.969181487	81.832346814	79.695512141	77.558677468	75.421842795
13	87.233090275	85.096255602	82.959420929	80.822586256	78.685751583
14	90.496999063	88.36016439	86.223329717	84.086495044	81.949660371
15	93.760907851	91.624073178	89.487238505	87.350403832	85.213569159
16	97.024816639	94.887981966	92.751147293	90.61431262	88.477477947

p =

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

J =

	10	11	12	13	14
0	-21.36834673	-23.505181403	-25.642016076	-27.778850749	-29.915685422
1	-18.104437942	-20.241272615	-22.378107288	-24.514941961	-26.651776634
2	-14.840529154	-16.977363827	-19.1141985	-21.251033173	-23.387867846
3	-11.576620366	-13.713455039	-15.850289712	-17.987124385	-20.123959058
4	-8.312711578	-10.449546251	-12.586380924	-14.723215597	-16.86005027
5	-5.04880279	-7.185637463	-9.322472136	-11.459306809	-13.596141482
6	-1.784894002	-3.921728675	-6.058563348	-8.195398021	-10.332232694
7	1.479014786	-0.657819887	-2.79465456	-4.931489233	-7.068323906
8	4.742923574	2.606088901	0.469254228	-1.667580445	-3.804415118
9	8.006832362	5.869997689	3.733163016	1.596328343	-0.54050633
10	11.27074115	9.133906477	6.997071804	4.860237131	2.723402458
11	14.534649938	12.397815265	10.260980592	8.124145919	5.987311246
12	17.798558726	15.661724053	13.52488938	11.388054707	9.251220034
13	21.062467514	18.925632841	16.788798168	14.651963495	12.515128822
14	24.326376302	22.189541629	20.052706956	17.915872283	15.77903761
15	27.59028509	25.453450417	23.316615744	21.179781071	19.042946398
16	30.854193878	28.717359205	26.580524532	24.443689859	22.306855186

K =

	10	11	12	13	14
0	34.118102666	31.981267993	29.84443332	27.707598647	25.570763974
1	37.382011454	35.245176781	33.108342108	30.971507435	28.834672762
2	40.645920242	38.509085569	36.372250896	34.235416223	32.09858155
3	43.90982903	41.772994357	39.636159684	37.499325011	35.362490338
4	47.173737818	45.036903145	42.900068472	40.763233799	38.626399126
5	50.437646606	48.300811933	46.16397726	44.027142587	41.890307914
6	53.701555394	51.564720721	49.427886048	47.291051375	45.154216702
7	56.965464182	54.828629509	52.691794836	50.554960163	48.41812549
8	60.22937297	58.092538297	55.955703624	53.818868951	51.682034278
9	63.493281758	61.356447085	59.219612412	57.082777739	54.945943066
10	66.757190546	64.620355873	62.4835212	60.346686527	58.209851854
11	70.021099334	67.884264661	65.747429988	63.610595315	61.473760642
12	73.285008122	71.148173449	69.011338776	66.874504103	64.73766943
13	76.54891691	74.412082237	72.275247564	70.138412891	68.001578218
14	79.812825698	77.675991025	75.539156352	73.402321679	71.265487006
15	83.076734486	80.939899813	78.80306514	76.666230467	74.529395794
16	86.340643274	84.203808601	82.066973928	79.930139255	77.793304582

p =

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

$J =$

	15	16	17	18	19
0	-32.052520095	-34.189354768	-36.326189441	-38.463024114	-40.599858787
1	-28.788611307	-30.92544598	-33.062280653	-35.199115326	-37.335949999
2	-25.524702519	-27.661537192	-29.798371865	-31.935206538	-34.072041211
3	-22.260793731	-24.397628404	-26.534463077	-28.67129775	-30.808132423
4	-18.996884943	-21.133719616	-23.270554289	-25.407388962	-27.544223635
5	-15.732976155	-17.869810828	-20.006645501	-22.143480174	-24.280314847
6	-12.469067367	-14.60590204	-16.742736713	-18.879571386	-21.016406059
7	-9.205158579	-11.341993252	-13.478827925	-15.615662598	-17.752497271
8	-5.941249791	-8.078084464	-10.214919137	-12.35175381	-14.488588483
9	-2.677341003	-4.814175676	-6.951010349	-9.087845022	-11.224679695
10	0.586567785	-1.550266888	-3.687101561	-5.823936234	-7.960770907
11	3.850476573	1.7136419	-0.423192773	-2.560027446	-4.696862119
12	7.114385361	4.977550688	2.840716015	0.703881342	-1.432953331
13	10.378294149	8.241459476	6.104624803	3.96779013	1.830955457
14	13.642202937	11.505368264	9.368533591	7.231698918	5.094864245
15	16.906111725	14.769277052	12.632442379	10.495607706	8.358773033
16	20.170020513	18.03318584	15.896351167	13.759516494	11.622681821

$K =$

	15	16	17	18	19
0	23.433929301	21.297094628	19.160259955	17.023425282	14.886590609
1	26.697838089	24.561003416	22.424168743	20.28733407	18.150499397
2	29.961746877	27.824912204	25.688077531	23.551242858	21.414408185
3	33.225655665	31.088820992	28.951986319	26.815151646	24.678316973
4	36.489564453	34.35272978	32.215895107	30.079060434	27.942225761
5	39.753473241	37.616638568	35.479803895	33.342969222	31.206134549
6	43.017382029	40.880547356	38.743712683	36.60687801	34.470043337
7	46.281290817	44.144456144	42.007621471	39.870786798	37.733952125
8	49.545199605	47.408364932	45.271530259	43.134695586	40.997860913
9	52.809108393	50.67227372	48.535439047	46.398604374	44.261769701
10	56.073017181	53.936182508	51.799347835	49.662513162	47.525678489
11	59.336925969	57.200091296	55.063256623	52.92642195	50.789587277
12	62.600834757	60.464000084	58.327165411	56.190330738	54.053496065
13	65.864743545	63.727908872	61.591074199	59.454239526	57.317404853
14	69.128652333	66.99181766	64.854982987	62.718148314	60.581313641
15	72.392561121	70.255726448	68.118891775	65.982057102	63.845222429
16	75.656469909	73.519635236	71.382800563	69.24596589	67.109131217

$p =$

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

J =

	20	21	22	23	24
0	-42.73669346	-44.873528133	-47.010362806	-49.147197479	-51.284032152
1	-39.472784672	-41.609619345	-43.746454018	-45.883288691	-48.020123364
2	-36.208875884	-38.345710557	-40.48254523	-42.619379903	-44.756214576
3	-32.944967096	-35.081801769	-37.218636442	-39.355471115	-41.492305788
4	-29.681058308	-31.817892981	-33.954727654	-36.091562327	-38.228397
5	-26.41714952	-28.553984193	-30.690818866	-32.827653539	-34.964488212
6	-23.153240732	-25.290075405	-27.426910078	-29.563744751	-31.700579424
7	-19.889331944	-22.026166617	-24.16300129	-26.299835963	-28.436670636
8	-16.625423156	-18.762257829	-20.899092502	-23.035927175	-25.172761848
9	-13.361514368	-15.498349041	-17.635183714	-19.772018387	-21.90885306
10	-10.09760558	-12.234440253	-14.371274926	-16.508109599	-18.644944272
11	-6.833696792	-8.970531465	-11.107366138	-13.244200811	-15.381035484
12	-3.569788004	-5.706622677	-7.84345735	-9.980292023	-12.117126696
13	-0.305879216	-2.442713889	-4.579548562	-6.716383235	-8.853217908
14	2.958029572	0.821194899	-1.315639774	-3.452474447	-5.58930912
15	6.22193836	4.085103687	1.948269014	-0.188565659	-2.325400332
16	9.485847148	7.349012475	5.212177802	3.075343129	0.938508456

K =

	20	21	22	23	24
0	12.749755936	10.612921263	8.47608659	6.339251917	4.202417244
1	16.013664724	13.876830051	11.739995378	9.603160705	7.466326032
2	19.277573512	17.140738839	15.003904166	12.867069493	10.73023482
3	22.5414823	20.404647627	18.267812954	16.130978281	13.994143608
4	25.805391088	23.668556415	21.531721742	19.394887069	17.258052396
5	29.069299876	26.932465203	24.79563053	22.658795857	20.521961184
6	32.333208664	30.196373991	28.059539318	25.922704645	23.785869972
7	35.597117452	33.460282779	31.323448106	29.186613433	27.04977876
8	38.86102624	36.724191567	34.587356894	32.450522221	30.313687548
9	42.124935028	39.988100355	37.851265682	35.714431009	33.577596336
10	45.388843816	43.252009143	41.11517447	38.978339797	36.841505124
11	48.652752604	46.515917931	44.379083258	42.242248585	40.105413912
12	51.916661392	49.779826719	47.642992046	45.506157373	43.3693227
13	55.18057018	53.043735507	50.906900834	48.770066161	46.633231488
14	58.444478968	56.307644295	54.170809622	52.033974949	49.897140276
15	61.708387756	59.571553083	57.43471841	55.297883737	53.161049064
16	64.972296544	62.835461871	60.698627198	58.561792525	56.424957852

p =

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

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J =

	25	26	27	28	29
0	-53.420866825	-55.557701498	-57.694536171	-59.831370844	-61.968205517
1	-50.156958037	-52.29379271	-54.430627383	-56.567462056	-58.704296729
2	-46.893049249	-49.029883922	-51.166718595	-53.303553268	-55.440387941
3	-43.629140461	-45.765975134	-47.902809807	-50.03964448	-52.176479153
4	-40.365231673	-42.502066346	-44.638901019	-46.775735692	-48.912570365
5	-37.101322885	-39.238157558	-41.374992231	-43.511826904	-45.648661577
6	-33.837414097	-35.97424877	-38.111083443	-40.247918116	-42.384752789
7	-30.573505309	-32.710339982	-34.847174655	-36.984009328	-39.120844001
8	-27.309596521	-29.446431194	-31.583265867	-33.72010054	-35.856935213
9	-24.045687733	-26.182522406	-28.319357079	-30.456191752	-32.593026425
10	-20.781778945	-22.918613618	-25.055448291	-27.192282964	-29.329117637
11	-17.517870157	-19.65470483	-21.791539503	-23.928374176	-26.065208849
12	-14.253961369	-16.390796042	-18.527630715	-20.664465388	-22.801300061
13	-10.990052581	-13.126887254	-15.263721927	-17.4005566	-19.537391273
14	-7.726143793	-9.862978466	-11.999813139	-14.136647812	-16.273482485
15	-4.462235005	-6.599069678	-8.735904351	-10.872739024	-13.009573697
16	-1.198326217	-3.33516089	-5.471995563	-7.608830236	-9.745664909

K =

	25	26	27	28	29
0	2.065582571	-0.071252102	-2.208086775	-4.344921448	-6.481756121
1	5.329491359	3.192656686	1.055822013	-1.08101266	-3.217847333
2	8.593400147	6.456565474	4.319730801	2.182896128	0.046061455
3	11.857308935	9.720474262	7.583639589	5.446804916	3.309970243
4	15.121217723	12.98438305	10.847548377	8.710713704	6.573879031
5	18.385126511	16.248291838	14.111457165	11.974622492	9.837787819
6	21.649035299	19.512200626	17.375365953	15.23853128	13.101696607
7	24.912944087	22.776109414	20.639274741	18.502440068	16.365605395
8	28.176852875	26.040018202	23.903183529	21.766348856	19.629514183
9	31.440761663	29.30392699	27.167092317	25.030257644	22.893422971
10	34.704670451	32.567835778	30.431001105	28.294166432	26.157331759
11	37.968579239	35.831744566	33.694909893	31.55807522	29.421240547
12	41.232488027	39.095653354	36.958818681	34.821984008	32.685149335
13	44.496396815	42.359562142	40.222727469	38.085892796	35.949058123
14	47.760305603	45.62347093	43.486636257	41.349801584	39.212966911
15	51.024214391	48.887379718	46.750545045	44.613710372	42.476875699
16	54.288123179	52.151288506	50.014453833	47.87761916	45.740784487

p =

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J =

	30	31	32	33	34
0	-64.10504019	-66.241874863	-68.378709536	-70.515544209	-72.652378882
1	-60.841131402	-62.977966075	-65.114800748	-67.251635421	-69.388470094
2	-57.577222614	-59.714057287	-61.85089196	-63.987726633	-66.124561306
3	-54.313313826	-56.450148499	-58.586983172	-60.723817845	-62.860652518
4	-51.049405038	-53.186239711	-55.323074384	-57.459909057	-59.59674373
5	-47.78549625	-49.922330923	-52.059165596	-54.196000269	-56.332834942
6	-44.521587462	-46.658422135	-48.795256808	-50.932091481	-53.068926154
7	-41.257678674	-43.394513347	-45.53134802	-47.668182693	-49.805017366
8	-37.993769886	-40.130604559	-42.267439232	-44.404273905	-46.541108578
9	-34.729861098	-36.866695771	-39.003530444	-41.140365117	-43.27719979
10	-31.46595231	-33.602786983	-35.739621656	-37.876456329	-40.013291002
11	-28.202043522	-30.338878195	-32.475712868	-34.612547541	-36.749382214
12	-24.938134734	-27.074969407	-29.21180408	-31.348638753	-33.485473426
13	-21.674225946	-23.811060619	-25.947895292	-28.084729965	-30.221564638
14	-18.410317158	-20.547151831	-22.683986504	-24.820821177	-26.95765585
15	-15.14640837	-17.283243043	-19.420077716	-21.556912389	-23.693747062
16	-11.882499582	-14.019334255	-16.156168928	-18.293003601	-20.429838274

K =

	30	31	32	33	34
0	-8.618590794	-10.755425467	-12.89226014	-15.029094813	-17.165929486
1	-5.354682006	-7.491516679	-9.628351352	-11.765186025	-13.902020698
2	-2.090773218	-4.227607891	-6.364442564	-8.501277237	-10.63811191
3	1.17313557	-0.963699103	-3.100533776	-5.237368449	-7.374203122
4	4.437044358	2.300209685	0.163375012	-1.973459661	-4.110294334
5	7.700953146	5.564118473	3.4272838	1.290449127	-0.846385546
6	10.964861934	8.828027261	6.691192588	4.554357915	2.417523242
7	14.228770722	12.091936049	9.955101376	7.818266703	5.68143203
8	17.49267951	15.355844837	13.219010164	11.082175491	8.945340818
9	20.756588298	18.619753625	16.482918952	14.346084279	12.209249606
10	24.020497086	21.883662413	19.74682774	17.609993067	15.473158394
11	27.284405874	25.147571201	23.010736528	20.873901855	18.737067182
12	30.548314662	28.411479989	26.274645316	24.137810643	22.00097597
13	33.81222345	31.675388777	29.538554104	27.401719431	25.264884758
14	37.076132238	34.939297565	32.802462892	30.665628219	28.528793546
15	40.340041026	38.203206353	36.06637168	33.929537007	31.792702334
16	43.603949814	41.467115141	39.330280468	37.193445795	35.056611122

p =

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J =

	35	36	37	38	39
0	-74.789213555	-76.926048228	-79.062882901	-81.199717574	-83.336552247
1	-71.525304767	-73.66213944	-75.798974113	-77.935808786	-80.072643459
2	-68.261395979	-70.398230652	-72.535065325	-74.671899998	-76.808734671
3	-64.997487191	-67.134321864	-69.271156537	-71.40799121	-73.544825883
4	-61.733578403	-63.870413076	-66.007247749	-68.144082422	-70.280917095
5	-58.469669615	-60.606504288	-62.743338961	-64.880173634	-67.017008307
6	-55.205760827	-57.3425955	-59.479430173	-61.616264846	-63.753099519
7	-51.941852039	-54.078686712	-56.215521385	-58.352356058	-60.489190731
8	-48.677943251	-50.814777924	-52.951612597	-55.08844727	-57.225281943
9	-45.414034463	-47.550869136	-49.687703809	-51.824538482	-53.961373155
10	-42.150125675	-44.286960348	-46.423795021	-48.560629694	-50.697464367
11	-38.886216887	-41.02305156	-43.159886233	-45.296720906	-47.433555579
12	-35.622308099	-37.759142772	-39.895977445	-42.032812118	-44.169646791
13	-32.358399311	-34.495233984	-36.632068657	-38.76890333	-40.905738003
14	-29.094490523	-31.231325196	-33.368159869	-35.504994542	-37.641829215
15	-25.830581735	-27.967416408	-30.104251081	-32.241085754	-34.377920427
16	-22.566672947	-24.70350762	-26.840342293	-28.977176966	-31.114011639

K =

	35	36	37	38	39
0	-19.302764159	-21.439598832	-23.576433505	-25.713268178	-27.850102851
1	-16.038855371	-18.175690044	-20.312524717	-22.44935939	-24.586194063
2	-12.774946583	-14.911781256	-17.048615929	-19.185450602	-21.322285275
3	-9.511037795	-11.647872468	-13.784707141	-15.921541814	-18.058376487
4	-6.247129007	-8.38396368	-10.520798353	-12.657633026	-14.794467699
5	-2.983220219	-5.120054892	-7.256889565	-9.393724238	-11.530558911
6	0.280688569	-1.856146104	-3.992980777	-6.12981545	-8.266650123
7	3.544597357	1.407762684	-0.729071989	-2.865906662	-5.002741335
8	6.808506145	4.671671472	2.534836799	0.398002126	-1.738832547
9	10.072414933	7.93558026	5.798745587	3.661910914	1.525076241
10	13.336323721	11.199489048	9.062654375	6.925819702	4.788985029
11	16.600232509	14.463397836	12.326563163	10.18972849	8.052893817
12	19.864141297	17.727306624	15.590471951	13.453637278	11.316802605
13	23.128050085	20.991215412	18.854380739	16.717546066	14.580711393
14	26.391958873	24.2551242	22.118289527	19.981454854	17.844620181
15	29.655867661	27.519032988	25.382198315	23.245363642	21.108528969
16	32.919776449	30.782941776	28.646107103	26.50927243	24.372437757

p =

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J =

	40	41	42	43	44
0	-85.47338692	-87.610221593	-89.747056266	-91.883890939	-94.020725612
1	-82.209478132	-84.346312805	-86.483147478	-88.619982151	-90.756816824
2	-78.945569344	-81.082404017	-83.21923869	-85.356073363	-87.492908036
3	-75.681660556	-77.818495229	-79.955329902	-82.092164575	-84.228999248
4	-72.417751768	-74.554586441	-76.691421114	-78.828255787	-80.96509046
5	-69.15384298	-71.290677653	-73.427512326	-75.564346999	-77.701181672
6	-65.889934192	-68.026768865	-70.163603538	-72.300438211	-74.437272884
7	-62.626025404	-64.762860077	-66.89969475	-69.036529423	-71.173364096
8	-59.362116616	-61.498951289	-63.635785962	-65.772620635	-67.909455308
9	-56.098207828	-58.235042501	-60.371877174	-62.508711847	-64.64554652
10	-52.83429904	-54.971133713	-57.107968386	-59.244803059	-61.381637732
11	-49.570390252	-51.707224925	-53.844059598	-55.980894271	-58.117728944
12	-46.306481464	-48.443316137	-50.58015081	-52.716985483	-54.853820156
13	-43.042572676	-45.179407349	-47.316242022	-49.453076695	-51.589911368
14	-39.778663888	-41.915498561	-44.052333234	-46.189167907	-48.32600258
15	-36.5147551	-38.651589773	-40.788424446	-42.925259119	-45.062093792
16	-33.250846312	-35.387680985	-37.524515658	-39.661350331	-41.798185004

K =

	40	41	42	43	44
0	-29.986937524	-32.123772197	-34.26060687	-36.397441543	-38.534276216
1	-26.723028736	-28.859863409	-30.996698082	-33.133532755	-35.270367428
2	-23.459119948	-25.595954621	-27.732789294	-29.869623967	-32.00645864
3	-20.19521116	-22.332045833	-24.468880506	-26.605715179	-28.742549852
4	-16.931302372	-19.068137045	-21.204971718	-23.341806391	-25.478641064
5	-13.667393584	-15.804228257	-17.94106293	-20.077897603	-22.214732276
6	-10.403484796	-12.540319469	-14.677154142	-16.813988815	-18.950823488
7	-7.139576008	-9.276410681	-11.413245354	-13.550080027	-15.6869147
8	-3.87566722	-6.012501893	-8.149336566	-10.286171239	-12.423005912
9	-0.611758432	-2.748593105	-4.885427778	-7.022262451	-9.159097124
10	2.652150356	0.515315683	-1.62151899	-3.758353663	-5.895188336
11	5.916059144	3.779224471	1.642389798	-0.494444875	-2.631279548
12	9.179967932	7.043133259	4.906298586	2.769463913	0.63262924
13	12.44387672	10.307042047	8.170207374	6.033372701	3.896538028
14	15.707785508	13.570950835	11.434116162	9.297281489	7.160446816
15	18.971694296	16.834859623	14.69802495	12.561190277	10.424355604
16	22.235603084	20.098768411	17.961933738	15.825099065	13.688264392

p =

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 50$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

$J =$

	45	46	47	48	49
0	-96.157560285	-98.294394958	-100.431229631	-102.568064304	-104.704898977
1	-92.893651497	-95.03048617	-97.167320843	-99.304155516	-101.440990189
2	-89.629742709	-91.766577382	-93.903412055	-96.040246728	-98.177081401
3	-86.365833921	-88.502668594	-90.639503267	-92.77633794	-94.913172613
4	-83.101925133	-85.238759806	-87.375594479	-89.512429152	-91.649263825
5	-79.838016345	-81.974851018	-84.111685691	-86.248520364	-88.385355037
6	-76.574107557	-78.71094223	-80.847776903	-82.984611576	-85.121446249
7	-73.310198769	-75.447033442	-77.583868115	-79.720702788	-81.857537461
8	-70.046289981	-72.183124654	-74.319959327	-76.456794	-78.593628673
9	-66.782381193	-68.919215866	-71.056050539	-73.192885212	-75.329719885
10	-63.518472405	-65.655307078	-67.792141751	-69.928976424	-72.065811097
11	-60.254563617	-62.39139829	-64.528232963	-66.665067636	-68.801902309
12	-56.990654829	-59.127489502	-61.264324175	-63.401158848	-65.537993521
13	-53.726746041	-55.863580714	-58.000415387	-60.13725006	-62.274084733
14	-50.462837253	-52.599671926	-54.736506599	-56.873341272	-59.010175945
15	-47.198928465	-49.335763138	-51.472597811	-53.609432484	-55.746267157
16	-43.935019677	-46.07185435	-48.208689023	-50.345523696	-52.482358369

$K =$

	45	46	47	48	49
0	-40.671110889	-42.807945562	-44.944780235	-47.081614908	-49.218449581
1	-37.407202101	-39.544036774	-41.680871447	-43.81770612	-45.954540793
2	-34.143293313	-36.280127986	-38.416962659	-40.553797332	-42.690632005
3	-30.879384525	-33.016219198	-35.153053871	-37.289888544	-39.426723217
4	-27.615475737	-29.75231041	-31.889145083	-34.025979756	-36.162814429
5	-24.351566949	-26.488401622	-28.625236295	-30.762070968	-32.898905641
6	-21.087658161	-23.224492834	-25.361327507	-27.49816218	-29.634996853
7	-17.823749373	-19.960584046	-22.097418719	-24.234253392	-26.371088065
8	-14.559840585	-16.696675258	-18.833509931	-20.970344604	-23.107179277
9	-11.295931797	-13.43276647	-15.569601143	-17.706435816	-19.843270489
10	-8.032023009	-10.168857682	-12.305692355	-14.442527028	-16.579361701
11	-4.768114221	-6.904948894	-9.041783567	-11.17861824	-13.315452913
12	-1.504205433	-3.641040106	-5.777874779	-7.914709452	-10.051544125
13	1.759703355	-0.377131318	-2.513965991	-4.650800664	-6.787635337
14	5.023612143	2.88677747	0.749942797	-1.386891876	-3.523726549
15	8.287520931	6.150686258	4.013851585	1.877016912	-0.259817761
16	11.551429719	9.414595046	7.277760373	5.1409257	3.004091027

$p =$

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ALPHAMU5.MCD ALPHA HORIZONTAL; MU VERTICAL

$a := -2.136834673$ $b := 3.263908788$

$n := 0, 1 .. 54$ $m := 0, 1 .. 16$

$J_{m,n} := n \cdot a + m \cdot b$ $K_{m,n} := n \cdot a + (m + 17) \cdot b$ $p := 17, 18 .. 33$

J =

	50	51	52	53
0	-106.84173365	-108.978568323	-111.115402996	-113.252237669
1	-103.577824862	-105.714659535	-107.851494208	-109.988328881
2	-100.313916074	-102.450750747	-104.58758542	-106.724420093
3	-97.050007286	-99.186841959	-101.323676632	-103.460511305
4	-93.786098498	-95.922933171	-98.059767844	-100.196602517
5	-90.52218971	-92.659024383	-94.795859056	-96.932693729
6	-87.258280922	-89.395115595	-91.531950268	-93.668784941
7	-83.994372134	-86.131206807	-88.26804148	-90.404876153
8	-80.730463346	-82.867298019	-85.004132692	-87.140967365
9	-77.466554558	-79.603389231	-81.740223904	-83.877058577
10	-74.20264577	-76.339480443	-78.476315116	-80.613149789
11	-70.938736982	-73.075571655	-75.212406328	-77.349241001
12	-67.674828194	-69.811662867	-71.94849754	-74.085332213
13	-64.410919406	-66.547754079	-68.684588752	-70.821423425
14	-61.147010618	-63.283845291	-65.420679964	-67.557514637
15	-57.88310183	-60.019936503	-62.156771176	-64.293605849
16	-54.619193042	-56.756027715	-58.892862388	-61.029697061

K =

	50	51	52	53	54
0	-51.355284254	-53.492118927	-55.6289536	-57.765788273	-59.902622946
1	-48.091375466	-50.228210139	-52.365044812	-54.501879485	-56.638714158
2	-44.827466678	-46.964301351	-49.101136024	-51.237970697	-53.37480537
3	-41.56355789	-43.700392563	-45.837227236	-47.974061909	-50.110896582
4	-38.299649102	-40.436483775	-42.573318448	-44.710153121	-46.846987794
5	-35.035740314	-37.172574987	-39.30940966	-41.446244333	-43.583079006
6	-31.771831526	-33.908666199	-36.045500872	-38.182335545	-40.319170218
7	-28.507922738	-30.644757411	-32.781592084	-34.918426757	-37.05526143
8	-25.24401395	-27.380848623	-29.517683296	-31.654517969	-33.791352642
9	-21.980105162	-24.116939835	-26.253774508	-28.390609181	-30.527443854
10	-18.716196374	-20.853031047	-22.98986572	-25.126700393	-27.263535066
11	-15.452287586	-17.589122259	-19.725956932	-21.862791605	-23.999626278
12	-12.188378798	-14.325213471	-16.462048144	-18.598882817	-20.73571749
13	-8.92447001	-11.061304683	-13.198139356	-15.334974029	-17.471808702
14	-5.660561222	-7.797395895	-9.934230568	-12.071065241	-14.207899914
15	-2.396652434	-4.533487107	-6.67032178	-8.807156453	-10.943991126
16	0.867256354	-1.269578319	-3.406412992	-5.543247665	-7.680082338

p =

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SIZE

COMPTON WAVE LENGTH, BOHR RADIUS

$a := -2.136834673$

$r := -12.550068214$

$n := 1, 2 .. 15$

$J_n := n \cdot a$

$J =$

	0
0	0
1	-2.136834673
2	-4.273669346
3	-6.410504019
4	-8.547338692
5	-10.684173365
6	-12.821008038
7	-14.957842711
8	-17.094677384
9	-19.231512057
10	-21.36834673
11	-23.505181403
12	-25.642016076
13	-27.778850749
14	-29.915685422
15	-32.052520095

Powers of a

$m := 0, 1 .. 18$

$H_m := m \cdot a + r$

$H =$

	0
0	-12.550068214
1	-14.686902887
2	-16.82373756
3	-18.960572233
4	-21.097406906
5	-23.234241579
6	-25.371076252
7	-27.507910925
8	-29.644745598
9	-31.781580271
10	-33.918414944
11	-36.055249617
12	-38.19208429
13	-40.328918963
14	-42.465753636
15	-44.602588309
16	-46.739422982
17	-48.876257655
18	-51.013092328

A

Powers of $\alpha^n \pm r_e$

$G_m := r - m \cdot a$

$G =$

	0
0	-12.550068214
1	-10.413233541
2	-8.276398868
3	-6.139564195
4	-4.002729522
5	-1.865894849
6	0.270939824
7	2.407774497
8	4.54460917
9	6.681443843
10	8.818278516
11	10.955113189
12	13.091947862
13	15.228782535
14	17.365617208
15	19.502451881
16	21.639286554
17	23.776121227
18	25.9129559

r_e

λ_c

a_0

R

$\forall$

SIZE

COMPTON2

$a := -2.136834673$

$r := -12.550068214$

$s := r + 15 \cdot a$

$q := r - 15 \cdot a$

$m := 0, 1 .. 18$

$H_m := m \cdot a + s$ $\qquad$ $G_m := q - m \cdot a$

$H =$

	0
0	-44.602588309
1	-46.739422982
2	-48.876257655
3	-51.013092328
4	-53.149927001
5	-55.286761674
6	-57.423596347
7	-59.56043102
8	-61.697265693
9	-63.834100366
10	-65.970935039
11	-68.107769712
12	-70.244604385
13	-72.381439058
14	-74.518273731
15	-76.655108404
16	-78.791943077
17	-80.92877775
18	-83.065612423

$G =$

	0
0	19.502451881
1	21.639286554
2	23.776121227
3	25.9129559
4	28.049790573
5	30.186625246
6	32.323459919
7	34.460294592
8	36.597129265
9	38.733963938
10	40.870798611
11	43.007633284
12	45.144467957
13	47.28130263
14	49.418137303
15	51.554971976
16	53.691806649
17	55.828641322
18	57.965475995

Additional powers of $\alpha^m \pm re$

MASS

PROTON ELECTRON MASSES

$a := 3.263908788$

$r := -23.776602304$

$n := 1, 2 .. 15$ $\qquad$ $m := 0, 1 .. 18$

$J_n := n \cdot a$

	0
0	0
1	3.263908788
2	6.527817576
3	9.791726364
4	13.055635152
5	16.31954394
6	19.583452728
7	22.847361516
8	26.111270304
9	29.375179092
10	32.63908788
11	35.902996668
12	39.166905456
13	42.430814244
14	45.694723032
15	48.95863182

J =

powers of μ

$\mu \approx \frac{m_p}{m_e}$

$H_m := m \cdot a + r$

	0
0	-23.776602304
1	-20.512693516
2	-17.248784728
3	-13.98487594
4	-10.720967152
5	-7.457058364
6	-4.193149576
7	-0.929240788
8	2.334668
9	5.598576788
10	8.862485576
11	12.126394364
12	15.390303152
13	18.65421194
14	21.918120728
15	25.182029516
16	28.445938304
17	31.709847092
18	34.97375588

H =

$\approx m_p$

$G_m := r - m \cdot a$

	0
0	-23.776602304
1	-27.040511092
2	-30.30441988
3	-33.568328668
4	-36.832237456
5	-40.096146244
6	-43.360055032
7	-46.62396382
8	-49.887872608
9	-53.151781396
10	-56.415690184
11	-59.679598972
12	-62.94350776
13	-66.207416548
14	-69.471325336
15	-72.735234124
16	-75.999142912
17	-79.2630517
18	-82.526960488

G =

$\approx m_p$

m_e

$+$ $\qquad$ $-$

$m_p \pm \mu^n$

HIGGS?

ASTDATA.WPD October 10, 2007

ASTRONOMICAL VALUES

Allen's Astrophysical Quantities 4th Ed 2000 [Cox ed]

		$\log_{10}$(cgs) values	
			$\frac{M}{V} = 0.71172$
mass of earth	$5.597\,42 \times 10^{27}$ g	~~27.776 243~~ ?	27.747 988 ✓
radius of earth	$6.378\,14 \times 10^{8}$ cm	8.804 694	8.804 694 ✓
density of earth	5.5148 g/cm^3	0.741 53	Vol = 27.036 171
mass of sun	1.989×10^{33} g	33.299	33.2986
radius of sun	$6.955\,08 \times 10^{10}$ cm	10.842 30	
density of sun	1.409 g/cm^3	0.148 9	
mass of moon	7.353×10^{25} g	25.866 5	MOON + EARTH =
radius of moon	$1.738\,2 \times 10^{8}$ cm	8.240 1	27.753 650
density of moon	3.341 g/cm^3	0.523 9	
mass of Mercury	$0.330\,22 \times 10^{27}$ g	26.518 80	
radius of Mercury	$2.439\,7 \times 10^{8}$ cm	8.387 34	
mass of Venus	4.8690×10^{27} g	27.687 44	
radius of Venus	$6.051\,8 \times 10^{8}$ cm	8.781 88	
mass of Mars	0.64191×10^{27} g	26.807 47	
radius of Mars	3.397×10^{8} cm	8.531 10	
mass of Jupiter	1898.7×10^{27} g	30.278 46	
radius of Jupiter	71.492×10^{8} cm	9.854 26	
mass of Saturn	568.51×10^{27} g	29.754 74	
radius of Saturn	60.268×10^{8} cm	9.780 09	
mass of Uranus	86.849×10^{27} g	28.938 76	
radius of Uranus	25.559×10^{8} cm	9.407 54	
mass of Neptune	102.44×10^{27} g	29.010 47	
radius of Neptune	24.764×10^{8} cm	9.393 82	

M ☆ observed $\frac{1}{10}$ ⊙ to 1200

32.299 35.378

$\oplus_{sch} = 2\pi\sqrt{\frac{R^3}{GM}}$

= 5056.6745 sec

= 84 m 16.67 sec

= 84 m 2779

THE HUBBLE PARAMETER AND THE HUBBLE TIME

SOME FUNDAMENTAL VALUES

	ITEM	VALUE	LOG_{10}VALUE
1	SECONDS IN SIDEREAL YEAR	3.1558150×10^{7}	7.499112
2	VELOCITY OF LIGHT cm/sec	2.9979246×10^{10}	10.476821
3	ASTRONOMICAL UNITS/PARSEC	206,264.807	5.314425
4	THE ASTRONOMICAL UNIT cm	1.495985×10^{13}	13.174927
5	LIGHT YEAR cm **1 X 2**	9.460896×10^{17}	17.975932
6	PARSEC cm **3 X 4**	3.085691×10^{18}	18.489352
7	LIGHT YEARS/PARSEC **6 ÷ 5**	3.261521	0.513420
8	MEGAPARSEC km	3.085691×10^{19}	19.489352

H_O, the Hubble parameter (or constant), is usually expressed in km/sec/mpc, kilometers per second per megaparsec. It has the dimensionality of [1/T]. The reciprocal, 1/Ho is called the Hubble time, **T**, and is usually expressed in billions of years (Gyr). A value of H_O = 1 km/sec/mpc is equivalent to a **T** of 19.489352 seconds (log_{10} value) [from **8** above]. This is equivalent to 11.990240 years (log_{10} value) [**8 - 1**] or 2.990240 billion years (log_{10} value), or to 977.777 billion years. (Gyr)

Thus, $\mathbf{T} = 977.8/H_O$

That is, the Hubble time in billion years (Gyr) is 977.8 divided by the Hubble parameter in kilometers per second per megaparsec.

The relation between the Hubble time, **T**, and the age of the universe, **A**, depends on which cosmological model is employed.

For a flat universe, $k = 0$, $\Omega = 1$, and $\Lambda = 0$, **A = 2/3 T**

If $k = 1$, $\Omega > 1$, and $\Lambda = 0$, then $0 < A < 2/3\ T$

If $k = -1$, $\Omega < 1$, and $\Lambda = 0$, then $2/3T < A < T$

REHVBBLE1.WPD

HUBCONV.WPD November 20, 2008

CONVERSION: FROM AND TO THE HUBBLE PARAMETER

Conversion from the Hubble Parameter to cgs times:

H_o = the Hubble Parameter in km/sec/mpc, (kilometers per second per megaparsec).
T = the Hubble Time in billion years = $977.8/H_o$
Take log(T)
To log(T) add 9 to convert from billion years to years
Add 7.499112 to convert from years to seconds.

Example: H_o = 72 km/sec/mpc
T = 977.8/72 = 13.5805 billion years
For A = 2/3 T, A = 9.053 666 gyr
log A = 0.956 825 log gyr
+9 = 9.956 825 log years
add 7.499 112
A = 17.455 937 log sec

Conversion from log(seconds) to H_o in km/sec/mpc

From log(seconds) subtract 7.499112 to give log(years)
Subtract 9 to give log(billion years)
Take the anti log which will be A in gyr (billion years)
T = 3/2 A
H_o = 977.8/T in km/sec/mpc

Example: A = Log_{10} sec = 17.455 656 3 1 3 $= (KMS)^{3/2}$ to
subtract 7.499 112 = $\log_{10}$ sec/yr
log years = 9.956 544
less 9 log gyr = 0.956 544
Anti log A = 9.047 821 gyr (billion years)
If T = 3/2 A = 13.571 732 gyr
H_o = 977.8/T = 72.046 813 km/sec/mpc

log3 1 BY = 16.499104 sec + log 4.5 =
4.5 BY = 17.152 316 sec + log 2 =
9 BY = 17.453 347 sec

4.5 B.Y + log 3 = 17.629437 sec
anti log ~ 13.499 B.Y

HUBBLE TIME

THE HUBBLE PARAMETER AND THE HUBBLE TIME

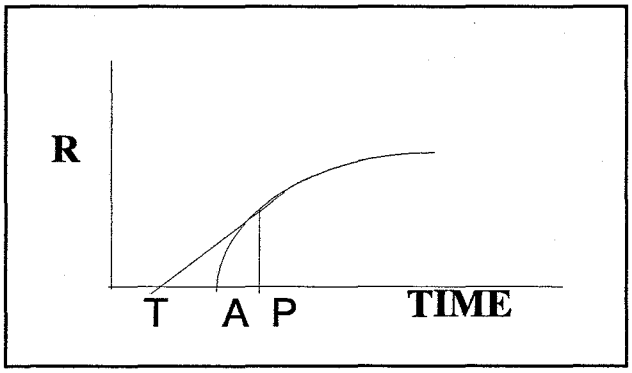
SOME FUNDAMENTAL VALUES

	ITEM	VALUE	LOG_{10}VALUE
1	SECONDS IN SIDEREAL YEAR	3.1558150×10^{7}	7.499112
2	VELOCITY OF LIGHT cm/sec	2.9979246×10^{10}	10.476821
3	ASTRONOMICAL UNITS/PARSEC	206,264.807	5.314425
4	THE ASTRONOMICAL UNIT cm	1.495985×10^{13}	13.174927
5	LIGHT YEAR cm **1 X 2**	9.460896×10^{17}	17.975932
6	PARSEC cm **3 X 4**	3.085691×10^{18}	18.489352
7	LIGHT YEARS/PARSEC **6 ÷ 5**	3.261521	0.513420
8	MEGAPARSEC km	3.085691×10^{19}	19.489352

H, the Hubble parameter (or constant), is usually expressed in km/sec/mpc, kilometers per second per megaparsec. It has the dimensionality of [1/T]. The reciprocal, 1/H, is called the Hubble time and is usually expressed in billions of years. A value of H = 1 km/sec/mpc is equivalent to a T of 19.489352 seconds (log value) [from **8** above]. This is equivalent to 11.990240 years (log value) **[8 - 1]** or 2.990240 billion years (log value), or to 977.777 billion years.

$$T = 978/H$$

Thus we have the Hubble time in billion years is 978 divided by the Hubble parameter in kilometers per second per megaparsec.



RADIUS VS. TIME

In the diagram, P is the present; A is the time at which expansion began; P - A is the so-called age of the universe; and P - T is the Hubble time. In any model in which the expansion is slowing the Hubble Time will be greater than the actual age.

A TABLE OF HUBBLE TIME T vs HUBBLE PARAMETER H

H in kilometers per second per megaparsec; T in billions of years

H	5	10	15	20	25	30	35	40	45	50
T	196	98	65	49	39	33	28	25	22	20

H	55	60	65	70	75	80	85	90	95	100
T	18	16	15	14	13	12	11.5	10.9	10.3	9.8

PISIGMA5.WPD December 12, 2005

THE AGE OF THE UNIVERSE
Alternate Approaches

Three alternate models are compared with the relativistic model. Comparisons are made between each model's values for the Hubble parameter, Hubble time, and age of the universe.

PARAMETER			
Current measures –>	H_o= 74 ± 7 Freedman	HubbleTime13.7±0.2	Age 9.133 B. Y
Alternate Models –>	I. $(\alpha\mu S)^{3/2}t_o$	II. 2v - 160	III. Two Kalpas
$\log_{10}$(Age) in seconds	17.456065	17.459666	17.435626
$\log_{10}$(Age) in years	9.956945	9.960554	9.936514
$\log_{10}$(Age) in B.Y.	0.956945	0.960554	0.936514
Age in Billion years	9.056179	9.131749	8.640
Half Age in B.Y.	4.528089	4.565875	4.320
Hubble Time in B.Y.	13.584268	13.697624	12.960
H_o in km/sec/mpc	71.995	71.399	75.463

Model I is from a template based on the observed values of α, the fine structure constant, μ, the proton/electron mass ratio, S, the coulomb/gravity force ration, and t_o, the planck time.

Model II derives from the properties of the recursion equation $A_{n+2} = 10(A_{n+1} - A_n)$. v being a root of the characteristic equation, with numerical value $5 + \sqrt{15}$.

Model III compares the ancient Hindu values for extremely large times with current scientific values. [see 2005 #29]

There appears to be an important cosmic cycle with a period of about 4.5 billion years. This is the estimated age of our sun, which is a second generation star. The row in the table, Half Age in B.Y. gives each model's value for this cycle.

COMPILE.WPD January 26, 2007

STANDARDIZATION OF UNITS

"Entitation is vastly more important than quantitation. Let us look at the universe in terms of some new kinds of entities, some new kinds of units; or, what really comes to the same thing, in some new way of combining units, because combining units gives a new unit at the superordinate level "–Ralph Gerard

While the scientific world has long since discovered the value of standardization of units, it is surprising that it still tolerates a bog of diverse units among and within its various disciplines. As much as the cgs and SI systems were improvements over rods and furlongs, grains and drams, matins and vespers, there still exist disparate units obtained with diverse apparati and various theoretical assumptions needing to be linked. While the history and evolution of measurements, including the methods and apparatus used in their determination, is important, we have reached a level when additional convergence of units is possible. Now that the values of the fundamental constants are known with improved accuracy, it would seem feasible that a system of units based on the Planck mass, length, and time could be adopted by all the physical sciences and for parts of biology and possibly even some aspect of the social sciences.

An initial step in this direction was taken by particle physicists in their introduction of the electron-volt. The electron volt is basically a unit of energy, but can be used to measure mass, frequency, wavelength, and several other physical parameters. This is because energy can be used as a basic measure whenever another physical parameter can be dimensionally equated to energy using a function of the fundamental constants, c, G, ħ. That is,

$$E^n = \text{function}(c,G,\hbar\,;\, M,\nu,\lambda, \ldots)$$

where n is the power to which the energy, E, must be raised.

For example, a relation between energy and mass is $M = E/c^2$
between energy and frequency, $\nu = E/\hbar$;
between energy and power, $P = E^2/\hbar$
between energy and force, $F = E^2/\hbar c$.
etc.

In addition to energy, another useful parameter for relating physical parameters is frequency, ν

For example, a relation between frequency and mass is $M = c^3/G\,\nu$
between frequency and energy, $E = \hbar\,\nu$
between frequency and power, $P = \hbar\,\nu^2$
between frequency and force, $F = \hbar\,\nu^2/c$
etc

CHARUNITS.WPD March 15, 2006 March 23, 2006

UNITS OF CHARGE:

The basic dimensionality of charge is $[ML^3/T^2]^{1/2}$

Historically, there are four basic units of charge:

q, the electrostatic unit of charge, defined as the value of two equal charges separated by 1 cm exerting a force of 1 dyne: $q \cdot q' / r^2 = 1$ dyne, where $r = 1$ cm. $\mathbf{q} = 1$

e, the natural unit of charge, the charge on an electron, $= (\hbar\alpha c)^{1/2}$, $= c(m_e \cdot r_e)^{1/2}$

$\log_{10}$ values: $\mathbf{e} = -9.318469\mathbf{q}$, $\mathbf{e}^2 = -18.636938\mathbf{q}^2$

ϵ, the planck charge, $= (\hbar c)^{1/2}$, $= c(m_o \cdot l_o)^{1/2}$

$\log_{10}$ values: $\epsilon = -8.250052\mathbf{q}$, $= 1.068417\mathbf{e}$, $\epsilon^2 = -16.500103\mathbf{q}^2$

C, the "practical" or SI unit of charge, the Coulomb, defined as the value of two equal charges separated by 1 meter exerting a force of 1 newton. This is also the charge conveyed by one ampere flowing for one second.

$\log_{10}$values: $\mathbf{C} = 9.476821\mathbf{q}$, $= 18.795290\mathbf{e}$, $= 17.726904\epsilon$

Conversion factors between the units:

The conversion factor between the coulomb and the electron charge, $\mathbf{e} = 1.602177 \times 10^{-19}$ **C** and the conversion factor between electron-volts and joules, 1 ev $= 1.602177 \times 10^{-19}$ joules, are the same. Call this factor B, $\log_{10}$B is -18.795290 (Physics Today 1986)

The value of $\log_{10}(c/\hbar\alpha)^{1/2} = 19.795290$, hence $\log(1/B) + 1 = \log(c/\hbar\alpha)^{1/2}$ or $B = 10 \cdot (\hbar\alpha/c)^{1/2}$

$\mathbf{C} = \mathbf{e}/B = 10^{-1} \cdot (\hbar\alpha c^2/\hbar\alpha)^{1/2} = c/10$, that is for cgs values, **C** is one tenth the velocity of light.

Conversion factors $\log_{10}$ values FROM ROW TO COLUMN

	COULOMB C	esu q	electron e	PLANCK ϵ
C	0	9.476821	18.795289	17.726873
q	-9.476821	0	9.318469	8.250052
e	-18.795289	-9.318469	0	1.068417
ϵ	-17.726873	-8.250052	-1.068417	0

Conversion factors FROM ROW TO COLUMN

	COULOMB C	esu q	electron e	PLANCK ϵ
C	1	2.998141E+9	6.241508E+18	5.331790E+17
q	3.333540E-10	1	2.081944E+9	1.778492E+8
e	1.602177E-19	4.803203E-10	1	11.706228
ϵ	1.875543E-18	5.622740E-9	0.085425	1

ELECUNIT.WPD March 23, 2006 September 19, 2006 December 23, 2009

DIMENSIONALITY OF ELECTRICAL UNITS

NAME	SYMBOL	DIMENSION	PLANCK	NAME
ENERGY	E	$M L^2 T^{-2}$	$\sqrt{(\hbar c^5/G)}$	joules
POWER	P	$M L^2 T^{-3}$	c^5/G	watts
FORCE	F	MLT^{-2}	c^4/G	dynes
CURRENT	I	$L T^{-2} \sqrt{(ML)}$	$c^3/\sqrt{G}$	amperes
POTENTIAL	V	$T^{-1} \sqrt{(ML)}$	$c^2/\sqrt{G}$	volts
CHARGE	Q	$L T^{-1} \sqrt{(ML)}$	$\sqrt{(\hbar c)}$	coulombs
RESISTANCE	Ω	T / L	$\sqrt{(G\hbar/c^7)}$	ohms

FORMULAE:

CHARGE • VOLTAGE = ENERGY ; ✓ CURRENT ^{2} • RESISTANCE = ~~ENERGY~~ POWER

CURRENT • VOLTAGE = POWER ; ✓ VOLTAGE ^{2} = FORCE

CHARGE / LENGTH = VOLTAGE ; CHARGE / TIME = CURRENT

VOLTAGE • LENGTH = CURRENT • TIME

VOLTAGE = CURRENT • RESISTANCE (OHM'S LAW)

$T \cdot V = \sqrt{(ML)}$; $I \cdot T^2/L = \sqrt{(ML)}$; $Q \cdot \Omega = \sqrt{(ML)}$; $E/I = \sqrt{(ML)}$

Capacitance: $C = \frac{\text{charge}}{\text{volts}} = [L]$ ✓

INDUCTANCE: $H = \frac{\text{VOLTS}}{\frac{d\,\text{current}}{dt}} = \left[\frac{T^2}{L}\right]$ ✓

(symbol L)

RESISTANCE

ELECUNIT2.WPD December 23, 2009 • Ω √ ħ

NAME	SYMBOL	SI UNIT	DIMENSION	PLANCK		
ENERGY	E	JOULES	$M L^2 T^{-2}$	$\sqrt{(\hbar c^5/G)}$	Q • V	$I^2 • \Omega$
POWER	W	WATTS	$M L^2 T^{-3}$	c^5/G	I • V	V^2 / Ω
FORCE	F	NEWTONS	$M L T^{-2}$	c^4/G	V^2	
CHARGE	Q	COULOMBS	$T^{-1}L \sqrt{ML)}$	$\sqrt{(\hbar c)}$	C • V	I • T
CURRENT	I	AMPERES	$T^{-2}L \sqrt{ML)}$	$c^3/\sqrt{G}$	Q / T	
POTENIAL	V	VOLTS	$T^{-1} \sqrt{ML)}$	$c^2/\sqrt{G}$	Q / L	I • Ω *
RESISTANCE	Ω	OHMS	T/L	1/c	V / I	
CAPACITANCE	C	FARADS	L	$\sqrt{(G\hbar/c^3)}$	Q / V	
INDUCTANCE	L					

* OHMS'S LAW

EVEQUATE.WPD March 30, 2006

ELECTRON–VOLT EQUATIONS

DERIVATION OF ϵ_o EQUATIONS:

MASS:	$E \cdot Y = M$, $\epsilon_o \Psi = M$	$Y \cdot ML^2/T^2 = M$,	$Y = T^2/L^2$ $\Psi = 1/c^2$	ϵ_o/c^2 –> mass
POWER:	$E^2 \cdot Y = ML^2/T^3$, $\epsilon_o^2/\hbar = ML^2/T^3$,	$Y \cdot M^2L^4/T^4 = ML^2/T^3$,	$Y = T/ML^2$ $\Psi = 1/\hbar$	$\epsilon_o^2/\hbar$ –> power
LENGTH:	$Y/E = L$, $\hbar c/\epsilon_o = L$	$Y \cdot T^2/ML^2 = L$,	$Y = ML^3/T^2$ $\Psi = \hbar c$	$\hbar c/\epsilon_o$ –> length
DENSITY:	$E^4 \cdot Y = M/L^3$, $\epsilon_o^4/\hbar^3c^5 = M/L^3$	$Y \cdot M^4L^8/T^8 = M/L^3$	$Y = T^8/M^3L^{11}$ $\Psi = 1/\hbar^3c^5$	$\epsilon_o^4/\hbar^3c^5$ –>density

---

DIMENSIONALITY CONVERSIONS:

Definition: One Gev = –2.795290 ergs = ϵ_o ;
inversely, one erg = +2.795290 Gev, ∴ to convert energy in ergs to Gev add 2.795290
[e.g. The energy of the Planck particle is 16,291442 ergs or ϵ_o = 19.086732 Gev]

MASS CONVERSION:
$M = \epsilon_o/c^2$ = –2.795290 –20.953642 = –23.748931
[e.g. For the Planck particle: 19.086732 –23.748931 = –4.662199 grams]

POWER CONVERSION:
$W = \epsilon_o^2/\hbar$ = –5.590580 + 26.976924 = 21.386344
[e.g. for the Planck particle: 38.173464 + 21.386344 = 59.559808 watts]

LENGTH CONVERSION:
$L = \hbar c/\epsilon_o$ = 2.795290 –16.500103 = –13,704813
[e.g. for the Planck particle: –19.086732 –13.704813 = –32.791545 cm]

DENSITY CONVERSION:
$\rho = \epsilon_o^4/\hbar^3c^5$ = –11.181160 + 49.500309 –20.953642 = 17.365507
[e.g. for the Planck particle: 76.346928 + 17.365507 = 93.712435 g/cm^3

E/V

ELECTRON VOLT UNIT CONVERSIONS

The electron volt has been found by particle physicists to be a useful unit with which to measure several parameters. Although the electron volt is basically a unit of energy, it can be used to measure mass, frequency, wavelength, and other physical parameters. Energy can be used as a basic measure whenever another physical parameter, such as mass or frequency, can be dimensionally equated to energy through functions of the fundamental constants, c, G, ħ.
That is, E^n = function(c,G,ħ), where n is an exponent of the energy, E, c is the velocity of light, G is the gravitational constant, and ħ is Planck's constant.
In the specific case of the Planck Particle:

Planck energy, $E = \sqrt{(\hbar c^5/G)}$.
Planck frequency, $\nu_o = \sqrt{(c^5/\hbar G)} = E/\hbar$
Planck wavelength, $\lambda_o = \sqrt{(\hbar G/c^3)} = \hbar c/E$
Planck mass, $m_o = \sqrt{(\hbar c/G)} = E/c^2$
Planck power, $p_o = c^5/G = E^2/\hbar$
Planck force, $f_o = c^4/G = E^2/\hbar c$
Planck density, $\rho_o = c^5/\hbar G^2 = E^4/\hbar^3 c^5$

PART I ENERGY UNIT CONVERSIONS:[1]

One electron volt = 1.602 177 x 10^{-12} ergs or 1.602 177 x 10^{-19} joules.
[Note this value is the conversion factor from a charge of one coulomb to the electron charge = $\sqrt{(\hbar\alpha c)}$. It is also $10\sqrt{(\hbar\alpha/c)}$ joules]
In terms of logarithms to base 10,

a) one ev = −11.795290 ergs = −18.795290 joules
b) one Mev = 10^6 ev = − 5.795290 ergs = −12.795290 joules
c) one Gev = 10^9 ev = − 2.795290 ergs = − 9.795290 joules

Hence, to convert:

Energy in ev to ergs subtract 11.79529; to joules subtract 18.79529
Energy in mev to ergs subtract 5.79529; to joules subtract 12.79529
Energy in Gev to ergs subtract 2.79529 to joules subtract 9.79529
Energy in ergs to ev add 11.79529 Energy in joules to ev add 18.79529
Energy in ergs to mev add 5.79529 Energy in joules to mev add 12.79529
Energy in ergs to Gev add 2.79529 Energy in joules to Gev add 9.79529

For example, the log value of the energy of the Planck Particle is 16.291442 ergs.
16.291442 + 11.795290 = 28.086732 ev = 22.086732 mev = 19.086732 Gev

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[1] The electron volt is the amount of work required to move a unit charge through a potential difference of one volt. Other units commonly used to measure energy:
The erg = 1 dyne centimeter (cgs); One joule = 10^7 ergs (SI);
The kilowatt-hour = 3.60 x 10^{13} ergs, $\log_{10}$ = 13.556303
The calorie = 4.19002 x 10^7 ergs, $\log_{10}$ = 7.622216
The BTU = 1.05587 x 10^{10} ergs, $\log_{10}$ = 10.023610

PART II CONVERTING ELECTRON-VOLTS TO OTHER PARAMETERS:[2]

ELECTRON-VOLTS TO FREQUENCY:

$\nu = E/\hbar$, where E is the energy in e-volts, ν is the frequency in hertz, and $\hbar$ is Planck's constant.

The frequency in hertz = the energy in electron volts + 15.181634
The frequency in hertz = the energy in mev + 21.181634
The frequency in hertz = the energy in Gev + 24.181634

ELECTRON-VOLTS TO WAVELENGTH:

$\lambda = \hbar c/E$, where E is the energy in electron-volts, λ is the wave length in cm, $\hbar$ is Planck's constant, and c is the velocity of light.

The wavelength in centimeters = –(the energy in electron volts + 4.704812)
The wavelength in centimeters = –(the energy in mev + 10.704812)
The wavelength in centimeters = –(the energy in Gev + 13.704812)

ELECTRON-VOLTS TO MASS:

$m = E/c^2$, where E is the energy in electron-volts, m the mass in grams, and c is the velocity of light.

The mass in grams = the energy in electron volts –32.748931
The mass in grams = the energy in mev –26.748931
The mass in grams = the energy in Gev –23.748931

ELECTRON-VOLTS TO POWER:

$p = E^2/\hbar$, where E is the energy in electron-volts, p is the power in watts, and $\hbar$ is Planck's constant.

The power in watts = the energy in $(\text{electron-volts})^2$ + 3.386344
The power in watts = the energy in $(\text{mev})^2$ + 15.386344
The power in watts = the energy in $(\text{Gev})^2$ + 21.386344

ELECTRON-VOLTS TO FORCE:

$f = E^2/\hbar c$, where E is the energy in electron-volts, f is the force in dynes, $\hbar$ is Planck's constant and c is the velocity of light.

The force in dynes = the energy in $(\text{ev})^2$ – 7.090475
The force in dynes = the energy in $(\text{mev})^2$ + 4.909525
The force in dynes = the energy in $(\text{Gev})^2$ + 10.909525

ELECTRON-VOLTS TO MASS DENSITY:

$\rho = E^4/\hbar^3c^5$, where E is the energy in ev, $\hbar$ is Planck's constant, and c is the velocity of light.

The density in grams/cm^3 = the energy in $(\text{ev})^4$ – 18.634493
The density in grams/cm^3 = the energy in $(\text{mev})^4$ + 5.365507
The density in grams/cm^3 = the energy in $(\text{Gev})^4$ + 17.365507

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[2] $\log_{10}$ values are used for all conversion formulae.

ELECTRON-VOLTS TO TEMPERATURE:

Boltzman's constant, $\sigma = 1.380658 \times 10^{-16}$ ergs/ degree Kelvin, log = –15.859914

One Gev = 1.1604×10^{13} K or $\log_{10} = 13.064608$ K

The temperature in degrees Kelvin = the energy in ev + 4.064608

The temperature in degrees Kelvin = the energy in mev + 10.064608

The temperature in degrees Kelvin = the energy in Gev + 13.064608

September 9, 2009

An updated download value for the electron volt is:

1 ev = 1.602 176 46 E-19 joules

PLANCKUN.WPD January 13, 2000 Rev March 28, 2006

PLANCK UNITS

NAME	DIMENSIONS	SYMB	FORMULA	$\log_{10}$ cgs	electronvolts	$\log_{10}$ Gev *
ENERGY	$[ML^2/T^2]$	ϵ_o	$(\hbar c^5/G)^{1/2}$	16.291442	ϵ_o	+19.086732
MASS	[M]	m_o	$(c\hbar/G)^{1/2}$	- 4.662199	ϵ_o/c^2	-23.748931
LENGTH	[L]	l_o	$(\hbar G/c^3)^{1/2}$	-32.791545	$\hbar c/\epsilon_o$	-13.704812
TIME	[T]	t_o	$(\hbar G/c^5)^{1/2}$	- 43.268366	$\hbar/\epsilon_o$	-24.181634
FREQUENCY	$[T^{-1}]$	ν_o	$(c^5/\hbar G)^{1/2}$	+43.268366	$\epsilon_o/\hbar$	+24.181634
MOMENTUM	[ML/T]	p_o	$(\hbar c^3/G)^{1/2}$	5.81462	ϵ_o/c	-13.272111
FORCE	$[ML/T^2]$	k_o	c^4/G	49.082989	$\epsilon_o^2/\hbar c$	+10.909525
POWER	$[ML^2/T^3]$	w_o	c^5/G	59.559810	$\epsilon_o^2/\hbar$	+21.386344
DENSITY	$[M/L^3]$	ρ_o	$c^5/G^2\hbar$	93.712439	$\epsilon_o^4/\hbar^3c^5$	+17.365507
PRESSURE	$[M/LT^2]$	y_o	$c^7/G^2\hbar$	114.666081	$\epsilon_o c^3/G^3\hbar^3$	+95.579345
TEMPERATURE		θ_o		32.151340	ϵ_o/σ **	+13.064608
$CHARGE^2$	$[ML^3/T^2]$	q_o^2	$\hbar c = e_o^2/\alpha$	- 16.500103	$\epsilon_o^2 G/c^4$	-54.673569
VOLTAGE	$[ML/T^2]^{1/2}$	v_o	$c^2/G^{1/2}$	24.541496	$\epsilon_o/c^{1/2}\hbar^{1/2}$	+5.454762
CURRENT	$[ML^3/T^4]^{1/2}$	i_o	$c^3/G^{1/2}$	35.018315	$\epsilon_o c^{1/2}/\hbar^{1/2}$	+15.931583
RESISTANCE	T^2/L	Ω_o	$(\hbar G/c^7)^{1/2}$	-53.745187	$\epsilon_o G/c^6$	-72.831921
VELOCITY	[L/T]	c	c	10.476821	$\epsilon_o{}^\circ c$	10.476821
ACTION	$[ML^2/T]$	$\hbar$	$\hbar$	- 26.976924	$\epsilon_o{}^\circ \hbar$	–26.976924
G	$[L^3/MT^2]$	G	G	-7.175705	$\epsilon_o{}^\circ G$	–7.175705

* The value in the shaded cell is the Gev for the Planck particle:

$\epsilon_o = 2.795290 + 16.291442 = 19.086732$

The other values in this column can to be added to or subtracted from ϵo^N where N = –1,0,1,2,4, to give the values in the $\log_{10}$ cgs column. These $\log_{10}$ Gev values are valid not only for the Planck constant but in general for other ϵ_o's.

** The Boltzman constant $\sigma = 1.380658 \times 10^{-16}$ ergs/K° ; $\log_{10}$ value = –15.859914

practically the same distance from the center, we may add up the rotational inertias of all the particles, and we shall evidently get Mr^2 for the sum, where M is the mass of the whole hoop. If the body is a solid *cylinder,* rotating about its own axis, its rotational inertia is found by adding together the values of the quantity mr^2 for each of its particles, where the distances r are now variable. This problem is easily done by the methods of calculus, and most students meet with it when they study that subject. The result is $I = \frac{1}{2}MR^2$, where M is the whole mass and R the outside radius of the cylinder.

7–5. Radius of gyration. One may express the rotational inertia of this cylinder in another way. Imagine the whole mass to be concentrated in a ring at a distance from the center of rotation, called the ***radius of gyration,*** k, such that the rotational inertia remains unchanged. Since $I = \frac{1}{2}MR^2 = M\left(\frac{R}{\sqrt{2}}\right)^2 = Mk^2$, we see that k must be equal in the case of this cylinder to $\frac{R}{\sqrt{2}}$. A cylinder spinning about any other axis, or any other form of rotating body, requires a different expression for its rotational inertia or radius of gyration. These results will not be derived here, but the most useful ones are listed in the table below, for convenience in solving problems.

TABLE III

Rotational Inertia. Radii of Gyration

	Rotational Inertia (= Moment of Inertia)	Radius of Gyration
Sphere, about an axis through the center	$\frac{2}{5}Mr^2$	$\sqrt{\frac{2}{5}} \times r = 0.632r$
Cylinder, about its own axis	$\frac{1}{2}Mr^2$	$\sqrt{\frac{1}{2}} \times r = 0.707r$
Rod (length l), about axis through middle point, perpendicular to length	$\frac{1}{12}Ml^2$	$\sqrt{\frac{1}{12}} \times l = 0.289l$
Rod about axis through end, perpendicular to length	$\frac{1}{3}Ml^2$	$\sqrt{\frac{1}{3}} \times l = 0.577l$

7–6. Work, energy, and power in rotation. It is easy to obtain expressions for the work done in making a body rotate, and for the kinetic energy which it thus acquires. Consider only the simplest case, a massive particle attached to a light hinged rod, as in Fig. 7–2, page 103, and urged forward by a force always perpendicular to the rod. The *work done* is the force multiplied by

TABLE IV

Straight motion		*Rotation*	
Mass	m	Rotational Inertia	I
Force	F	Torque	L
Distance	s	Angle	θ
Velocity	$v = s/t$	Angular velocity	$\omega = \theta/t$
Acceleration	a	Angular acceleration	α
Work	Fs		$L\theta$
Kinetic energy	$\frac{1}{2}mv^2$		$\frac{1}{2}I\omega^2$
Momentum	mv		$I\omega$
Impulse	Ft		Lt
For uniform acceleration			
v	$= at$	ω	$= \alpha t$
s	$= \frac{1}{2}at^2$	θ	$= \frac{1}{2}\alpha t^2$
v^2	$= 2as$	ω^2	$= 2\alpha\theta$
s	$= \frac{1}{2}vt$	θ	$= \frac{1}{2}\omega t$
Newton's second law			
F	$= ma$	L	$= I\alpha$

7-9. Uniformly accelerated rotation. Problems involving uniformly accelerated rotation are to be treated in the same way as those on uniform acceleration in a straight line. As illustrations of this fact, let us consider the following examples.

Example 1. A bicycle wheel, acted on by a steady torque, is observed to make its first revolution from rest in 4 sec. Find the angular acceleration (assumed to be uniform), the time it will take to cover 4 revolutions, and the angular velocity at the end of that time.

A complete revolution is 2π radians; this is θ in this problem.

$\theta = \frac{1}{2} \times \alpha t^2$, or $2\pi = \frac{1}{2} \times \alpha 4^2$, whence $\alpha = \frac{\pi}{4}$ radians per second per second.

Four revolutions make 8π radians of angle. Using the same formula again,

$$8\pi = \tfrac{1}{2} \times \left(\frac{\pi}{4}\right) t^2, \text{ or } t^2 = 64, \text{ and } t = 8 \text{ seconds.}$$

The angular velocity then is

$$\omega = \alpha t = \frac{\pi}{4} \times 8 = 2\pi = 6.28 \text{ radians per second.}$$

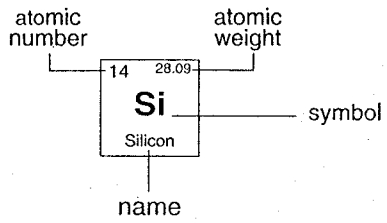
Example 2. If a bicycle wheel, moving as in the preceding example, is doing so because it is being pushed by a force of 400 gm. applied in the most effective direction on a spoke 20 cm. out from the center, what must be the rotational inertia of the wheel?

The torque is 400×20 or 8000 gr.-cm. (gravitational units), or $980 \times 8000 = 7{,}840{,}000$ dyne-cm. Since the equation $L = I\alpha$ applies in this example,

Survey of Physics for College Students
Frederick A. Saunders 1936

Periodic Table of the Elements

Parentheses indicate undiscovered elements.



alkali metals | alkaline earth metals | transitional metals | nonmetals | noble gases | other metals

1 1.01 **H** Hydrogen																	2 4.003 **He** Helium
3 6.94 **Li** Lithium	4 9.01 **Be** Beryllium											5 10.81 **B** Boron	6 12.01 **C** Carbon	7 14.01 **N** Nitrogen	8 15.999 **O** Oxygen	9 18.998 **F** Fluorine	10 20.18 **Ne** Neon
11 22.99 **Na** Sodium	12 24.31 **Mg** Magnesium											13 26.98 **Al** Aluminum	14 28.09 **Si** Silicon	15 30.97 **P** Phosphorus	16 32.06 **S** Sulfur	17 35.45 **Cl** Chlorine	18 39.95 **Ar** Argon
19 39.10 **K** Potassium	20 40.08 **Ca** Calcium	21 44.96 **Sc** Scandium	22 47.90 **Ti** Titanium	23 50.94 **V** Vanadium	24 51.996 **Cr** Chromium	25 54.94 **Mn** Manganese	26 55.85 **Fe** Iron	27 58.93 **Co** Cobalt	28 58.70 **Ni** Nickel	29 63.55 **Cu** Copper	30 65.37 **Zn** Zinc	31 69.72 **Ga** Gallium	32 72.59 **Ge** Germanium	33 74.92 **As** Arsenic	34 78.96 **Se** Selenium	35 79.90 **Br** Bromine	36 83.80 **Kr** Krypton
37 85.47 **Rb** Rubidium	38 87.62 **Sr** Strontium	39 88.91 **Y** Yttrium	40 91.22 **Zr** Zirconium	41 92.91 **Nb** Niobium	42 95.94 **Mo** Molybdenum	43 98 **Tc** Technetium	44 101.07 **Ru** Ruthenium	45 102.91 **Rh** Rhodium	46 106.40 **Pd** Palladium	47 107.87 **Ag** Silver	48 112.41 **Cd** Cadmium	49 114.82 **In** Indium	50 118.69 **Sn** Tin	51 121.75 **Sb** Antimony	52 127.60 **Te** Tellurium	53 126.90 **I** Iodine	54 131.30 **Xe** Xenon
55 132.91 **Cs** Cesium	56 137.33 **Ba** Barium	57 138.91 **La** Lanthanum	72 178.49 **Hf** Hafnium	73 180.95 **Ta** Tantalum	74 183.85 **W** Tungsten	75 186.21 **Re** Rhenium	76 190.20 **Os** Osmium	77 192.22 **Ir** Iridium	78 195.09 **Pt** Platinum	79 196.97 **Au** Gold	80 200.59 **Hg** Mercury	81 204.37 **Tl** Thallium	82 207.19 **Pb** Lead	83 208.98 **Bi** Bismuth	84 209 **Po** Polonium	85 210 **At** Astatine	86 222 **Rn** Radon
87 223 **Fr** Francium	88 226.03 **Ra** Radium	89 227.03 **Ac** Actinium	104 261 **Rf** Rutherfordium	105 262 **Db (Ha)** Dubnium (Hahnium)	106 266 **Sg** Seaborgium	107 267 **Bh** Bohrium	108 269 **Hs** Hassium	109 268 **Mt** Meitnerium	110 271 **Ds** Darmstadtium	111 272 **(Rg)** Roentgenium	***112***	***113***	***114***	***115***	***116***	(117)	(118)

Lanthanide series	58 140.12 **Ce** Cerium	59 140.91 **Pr** Praseodymium	60 144.24 **Nd** Neodymium	61 145 **Pm** Promethium	62 150.35 **Sm** Samarium	63 151.96 **Eu** Europium	64 157.25 **Gd** Gadolinium	65 158.93 **Tb** Terbium	66 162.50 **Dy** Dysprosium	67 164.93 **Ho** Holmium	68 167.26 **Er** Erbium	69 168.93 **Tm** Thulium	70 173.04 **Yb** Ytterbium	71 174.97 **Lu** Lutetium
Actinide series	90 232.04 **Th** Thorium	91 231.04 **Pa** Protactinium	92 238.03 **U** Uranium	93 237.05 **Np** Neptunium	94 244 **Pu** Plutonium	95 243 **Am** Americium	96 247 **Cm** Curium	97 247 **Bk** Berkelium	98 251 **Cf** Californium	99 252 **Es** Einsteinium	100 257 **Fm** Fermium	101 258 **Md** Mendelevium	102 259 **No** Nobelium	103 262 **Lr** Lawrencium

Inertia: the tendency of an object to resist a change in its state of motion (i.e., to stay at rest if it is at rest, or to continue moving at a constant speed if it is moving at a constant speed). Inertia is proportional to mass, so a heavier object has more inertia.

Laser: light consisting of a cascade of photons all having the same wavelength; *laser* stands for Light Amplification by Stimulated Emission of Radiation.

Neutrino: a tiny fundamental particle with no electrical charge and very small mass that moves very quickly through the universe; comes in three varieties, or flavors, called electron, muon, and tau.

Neutron: a neutral particle found in the nuclei of atoms.

Particle accelerator: a large machine with a long tunnel in which atoms smash into each other at high speeds; physicists use these machines to study subatomic particles.

Photon: the elementary unit, or quantum, of light or electromagnetic radiation, having no mass or electrical charge; one of the fundamental force-carrying particles, or bosons, described by the Standard Model.

Plasma: a high-energy state of matter different from solid, liquid or gas in which atomic nuclei and the electrons orbiting them separate from each other.

Proton: a positively charged subatomic particle found in the nuclei of atoms.

Quantum: a natural unit of some physically measurable property, such as energy or electrical charge.

Quark: a fermion and a fundamental matter particle that makes up neutrons and protons, forming atomic nuclei; there are 6 different "flavors" of quarks grouped in pairs; up and down, charm and strange, top and bottom.

Radiation: energy emitted as rays or particles; radiation includes heat, light, ultraviolet rays, gamma rays, X rays, cosmic rays, alpha particles, beta particles, and the protons, neutrons, and electrons of radioactive atoms.

Relativity, general theory of: a theory of space-time proposed by Albert Einstein in 1915; gravitational and other forces are transmitted through the effects of the curvature of space-time.

Relativity, special theory of: Einstein's theory of space and time: all laws of physics are valid in all uniformly moving frames of reference and the speed of light in a vacuum is always the same, so long as the source and the observer are moving uniformly (not accelerating).

Standard Model: prevailing theory of fundamental particles and forces of matter; matter particles are fermions: either leptons or quarks; force-carrying particles are bosons: either gluons, W or Z bosons or photons; gravity has not yet been worked into the model.

String theory: a theory that seeks to unify quantum mechanics and general relativity, positing that the basic constituents of matter can best be understood not as point objects but as tiny closed loops ("strings").

Subatomic particle: one of the small particles, such as electrons, neutrons, and protons, which make up an atom.

Superconductivity: the property of certain materials, usually metals and chemically complex ceramics, to conduct electricity without resistance, generally at very cold temperatures.

Thermodynamics: the branch of physics that describes how energy, heat, and temperature flow in physical systems.

Ultraviolet radiation: a form of light, invisible to the human eye, that has a shorter wavelength and greater energy than visible light but a longer wavelength and less energy than X rays.

Uncertainty principle: the theory that certain pairs of observable quantities—like energy and time, or position and momentum—cannot be measured with complete accuracy simultaneously; presented in 1927 by German physicist Werner Heisenberg; also known as indeterminacy principle.

Virtual particle: subatomic particles that rapidly pop into and out of existence and can exert real forces; usually occur in particle-antiparticle pairs and are rapidly annihilated.

Chemical Elements, Atomic Numbers, Year Discovered

Reviewed by Darleane C. Hoffman, Ph.D., Lawrence Berkeley National Laboratory and Department of Chemistry, Univ. of California, Berkeley.

See Periodic Table of the Elements on page 337 for atomic weights.

Element	Symbol	Atomic number	Year discov.
Actinium	Ac	89	1899
Aluminum	Al	13	1825
Americium	Am	95	1944
Antimony	Sb	51	1450
Argon	Ar	18	1894
Arsenic	As	33	13th c.
Astatine	At	85	1940
Barium	Ba	56	1808
Berkelium	Bk	97	1949
Beryllium	Be	4	1798
Bismuth	Bi	83	15th c.
Bohrium	Bh	107	1981
Boron	B	5	1808
Bromine	Br	35	1826
Cadmium	Cd	48	1817
Calcium	Ca	20	1808
Californium	Cf	985	1950
Carbon	C	6	BC
Cerium	Ce	58	1803
Cesium	Cs	55	1860
Chlorine	Cl	17	1774
Chromium	Cr	24	1797
Cobalt	Co	27	1735
Copper	Cu	29	BC
Curium	Cm	96	1944
Darmstadtium	Ds	110	1995
Dubnium (Hahnium)[1]	Db (Ha)	105	1970
Dysprosium	Dy	66	1886
Einsteinium	Es	99	1952
Erbium	Er	68	1843
Europium	Eu	63	1901
Fermium	Fm	100	1953
Fluorine	F	9	1771
Francium	Fr	87	1939
Gadolinium	Gd	64	1886
Gallium	Ga	31	1875
Germanium	Ge	32	1886
Gold	Au	79	BC
Hafnium	Hf	72	1923
Hassium	Hs	108	1984
Helium	He	2	1868
Holmium	Ho	67	1878
Hydrogen	H	1	1766
Indium	In	49	1863
Iodine	I	53	1811
Iridium	Ir	77	1804
Iron	Fe	26	BC
Krypton	Kr	36	1898
Lanthanum	La	57	1839
Lawrencium	Lr	103	1961
Lead	Pb	82	BC
Lithium	Li	3	1817
Lutetium	Lu	71	1907
Magnesium	Mg	12	1829
Manganese	Mn	25	1774
Meitnerium	Mt	109	1982
Mendelevium	Md	101	1955
Mercury	Hg	80	BC
Molybdenum	Mo	42	1782
Neodymium	Nd	60	1885
Neon	Ne	10	1898
Neptunium	Np	93	1940
Nickel	Ni	28	1751
Niobium[2]	Nb	41	1801
Nitrogen	N	7	1772
Nobelium	No	102	1958
Osmium	Os	76	1804
Oxygen	O	8	1774
Palladium	Pd	46	1803
Phosphorus	P	15	1669
Platinum	Pt	78	1735
Plutonium	Pu	94	1941
Polonium	Po	84	1898
Potassium	K	19	1807
Praseodymium	Pr	59	1885
Promethium	Pm	61	1945
Protactinium	Pa	91	1917
Radium	Ra	88	1898
Radon	Rn	86	1900
Rhenium	Re	75	1925
Rhodium	Rh	45	1803
Roentgenium	Rg	111	1995
Rubidium	Rb	37	1861
Ruthenium	Ru	44	1845
Rutherfordium	Rf	104	1969
Samarium	Sm	62	1879
Scandium	Sc	21	1879
Seaborgium	Sg	106	1974
Selenium	Se	34	1817
Silicon	Si	14	1823
Silver	Ag	47	BC
Sodium	Na	11	1807
Strontium	Sr	38	1790
Sulfur	S	16	BC
Tantalum	Ta	73	1802
Technetium	Tc	43	1937
Tellurium	Te	52	1782
Terbium	Tb	65	1843
Thallium	Tl	81	1861
Thorium	Th	90	1828
Thulium	Tm	69	1879
Tin	Sn	50	BC
Titanium	Ti	22	1791
Tungsten (Wolfram)	W	74	1783
Uranium	U	92	1789
Vanadium	V	23	1830
Xenon	Xe	54	1898
Ytterbium	Yb	70	1878
Yttrium	Y	39	1794
Zinc	Zn	30	BC
Zirconium	Zr	40	1789

Note: 111 elements are listed here. The discovery of element 111 with a mass number of 272 was reported by S. Hoffman *et al.* in 1995 and was approved by a Joint Working Party of the International Unions of Pure & Applied Chemistry (IUPAC) and Pure and Applied Physics (IUPAP) in 2003. The discoverers proposed the name Roentgenium with symbol Rg in early 2004 and it has been recommended to the IUPAC Bureau and Council by the Inorganic Chemistry Division of IUPAC and will probably be confirmed in late 2004. The discovery of element 112 by S. Hofman *et al.* in 1996 still awaits confirmation. Between 1999 and 2004, a multinational group and a Dubna/Lawrence Livermore National Laboratory group working in Dubna, Russia, have published evidence in refereed journals for observation of many isotopes of elements 112 through 116. These reports all await confirmation and are shown in Italics in the periodic table. Reports of still heavier elements have not yet been published in refereed journals and are shown in parentheses. (1) The name Dubnium (Db) has been approved by IUPAC for element 105, but the name Hahnium (Ha) is used in most of the scientific literature before 1998 and is still sometimes used in the U.S. (2) Formerly Columbium.

THE STANDARD MODEL

There are 61 basic particles, including anti-particles. These are 36 quarks, 12 leptons, and 13 guage bosons.

Particles marked with an asterisk are considered **stable*.**	FERMIONS SPIN = 1/2 OBEY PAULI PRINIPLE	BOSONS SPIN = 0,1 NO PAULI PRINCIPLE
HADRONS CONTAIN QUARKS STRONG FORCE PRESENT	BARYONS 3 QUARKS	MESONS 2 QUARKS
NO QUARKS NO STRONG FORCE	LEPTONS	GUAGE BOSONS FORCE CARRIERS

GUAGE BOSONS

The force exchangers employed by the four forces. All have spin 1

FORCE	MASS	CARRIER
STRONG	0	GLUONS (EIGHT TYPES)
WEAK	83 GeV	INTERMEDIATE VECTOR BOSONS, W+, W-; Z 93GeV
ELECTRIC	0	PHOTONS*
GRAVITY	0	GRAVITONS

LEPTONS

All have 1/2 spin, are not subject to the strong force, but obey the Pauli Exclusion Principle. [ν is symbol for neutrino]

PARTICLE	MASS	CHARGE	ANTI-PRTCL	MASS	CHARGE
ELECTRON*	0.511 MeV	-1	POSITRON*	same as	+1
MUON	105.6 MeV	-1	ANTI-MUON	particle	+1
TAU PRTCL	1.784 MeV	-1	ANTI-TAU	"	+1
e NEUTRINO	< 50 eV	0	ANTI-eν	"	0
μ NEUTRINO	< 0.5 MeV	0	ANTI-$\mu\nu$	"	0
τ NEUTRINO	< 70 MeV	0	ANTI-$\tau\nu$	"	0

THE STANDARD MODEL

QUARKS

All quarks come in three colors: red, blue, green, making a total of 36quarks.

QUARKS			ANTI-QUARKS		
FLAVOR	SYMBOL	CHARGE	FLAVOR	SYMBOL	CHARGE
UP*	u	+2/3	ANTI-UP	$\bar{u}$	-2/3
DOWN	d	-1/3	ANTI-DOWN	$\bar{d}$	+1/3
STRANGE	s	-1/3	ANTI-STRANGE	$\bar{s}$	+1/3
CHARM	c	+2/3	ANTI-CHARM	$\bar{c}$	-2/3
BOTTOM-BEAUTY	b	-1/3	ANTI-BOTTOM	$\bar{b}$	+1/3
TOP-TRUTH	t	+2/3	ANTI-TOP	$\bar{t}$	-2/3

MESONS

NAME	MASS	CHARGE	SPIN	QUARKS
PION Pi-0	135 MeV	0	0	uu or dd
Pi+	140 MeV	+1	0	ud
Pi-	140 MeV	-1	0	du
KAON K-0	498 MeV	0	0	ds
K+	494 MeV	+1	0	us
K-	494 MeV	-1	0	su
J/PSI	3.1 GeV	0	1	cc
D-0	1.87 GeV	0	0	cu
D+	1.87 GeV	+1	0	cd
UPSILON	9.46 GeV	0	1	bb

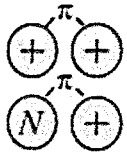
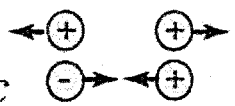
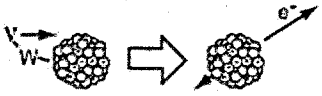
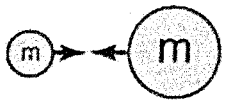
THE STANDARD MODEL

BARYONS

Baryons all have spin 1/2.

NAME	LIFETIME	MASS	CHARGE	QUARKS
PROTON*	STABLE	938.3 MeV	+1	uud
ANTI-PROTON*	STABLE	"	0	uud
NEUTRON	15 MINUTES	939.6 MeV	-1 ?	ddu
ANTI-NEUTRON	"	"	0 ?	ddu
LAMBDA	~10^-10 s	1.115 GeV	0	uds
ANTI-LAMBDA	"	"	0	uds
SIGMA+	"	1.189 GeV	+1	uus
SIGMA-	"	1.197 GeV	-1	dds
SIGMA-0	~10^-20 s	1.192 GeV	0	uds
XI-	~10^-10 s	1.321 GeV	-1	dss
XI-0	"	1.315 GeV	0	uss
OMEGA-	"	1.672 GeV	-1	sss
CHARMED Λ	~10^-13 s	2.28 GeV	+1	udc

Fundamental Forces

		Strength	Range (m)	Particle
Strong	 Force which holds nucleus togeher	1	10^{-15} (diameter of a medium sized nucleus)	gluons. π(nucleons)
Electro-magnetic		$\frac{1}{137}$	Infinite	photon mass = 0 spin = 1
Weak	 neutrino interaction induces beta decay	10^{-6}	10^{-18} (0.1% of the diameter of a proton)	Intermediate vector bosons W^+, W^-, Z_0, mass > 80 GeV spin =1
Gravity		6×10^{-39}	Infinite	graviton ? mass = 0 spin = 2

Index

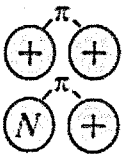
Fundamental force concepts

Coupling constants

HyperPhysics***** Quantum Physics R Nave

Go Back

The Strong Force

		Strength	Range (m)	Particle
Strong	 Force which holds nucleus togeher	1	10^{-15} (diameter of a medium sized nucleus)	gluons. π(nucleons)

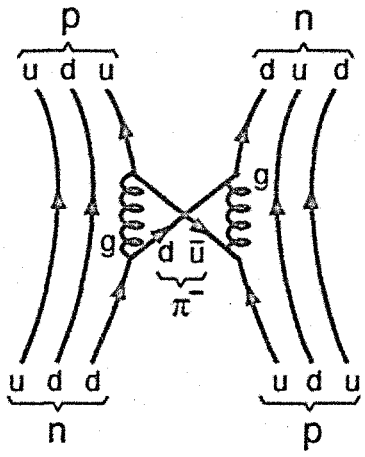
Index

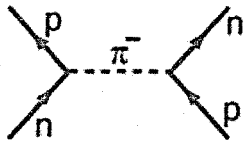
Fundamental force concepts

A force which can hold a nucleus together against the enormous forces of repulsion of the protons is strong indeed. However, it is not an inverse square force like the electromagnetic force and it has a very short range. Yukawa modeled the strong force as an exchange force in which the exchange particles are pions and other heavier particles. The range of a particle exchange force is limited by the uncertainty principle. It is the strongest of the four fundamental forces

Since the protons and neutrons which make up the nucleus are themselves considered to be made up of quarks, and the quarks are considered to be held

together by the color force, the strong force between nucleons may be considered to be a residual color force. In the standard model, therefore, the basic exchange particle is the gluon which mediates the forces between quarks. Since the individual gluons and quarks are contained within the proton or neutron, the masses attributed to them cannot be used in the range relationship to predict the range of the force. When something is viewed as emerging from a proton or neutron, then it must be at least a quark-antiquark pair, so it is then plausible that the pion as the lightest meson should serve as a predictor of the maximum range of the strong force between nucleons.





The sketch is an attempt to show one of many forms the gluon interaction between nucleons could take, this one involving up-antiup pair production and annililation and producing a π^- bridging the nucleons.

Feynman diagrams and the strong force

HyperPhysics***** Quantum Physics *R Nave* Go Back

The Electromagnetic Force

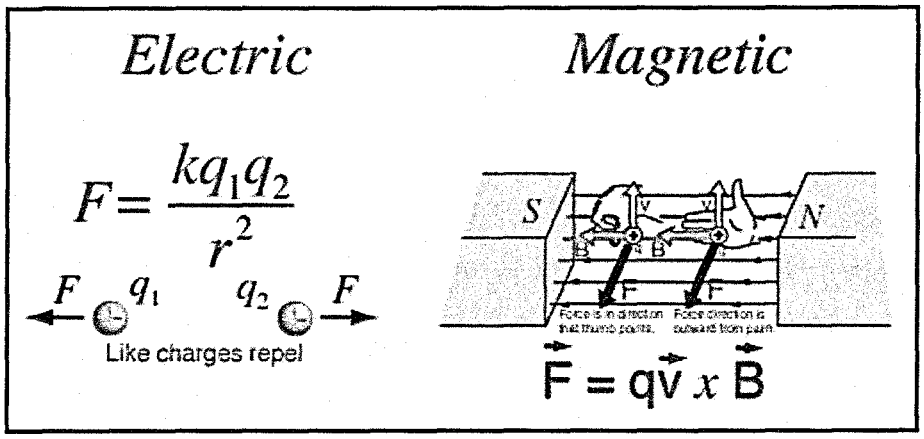
	Strength	Range (m)	Particle
Electro-magnetic	$\frac{1}{137}$	Infinite	photon mass = 0 spin = 1

Index

Fundamental force concepts

One of the four fundamental forces, the electromagnetic force manifests itself through the forces between charges (Coulomb's Law) and the magnetic force,

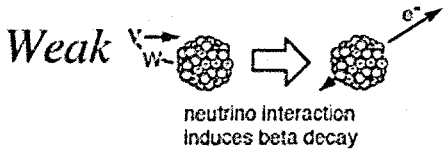
both of which are summarized in the Lorentz force law. Fundamentally, both magnetic and electric forces are manifestations of an exchange force involving the exchange of photons . The quantum approach to the electromagnetic force is called quantum electrodynamics or QED. The electromagnetic force is a force of infinite range which obeys the inverse square law, and is of the same form as the gravity force.



The electromagnetic force holds atoms and molecules together. In fact, the forces of electric attraction and repulsion of electric charges are so dominant over the other three fundamental forces that they can be considered to be negligible as determiners of atomic and molecular structure. Even magnetic effects are usually apparent only at high resolutions, and as small corrections.

HyperPhysics***** Quantum Physics *R Nave* Go Back

The Weak Force



Strength	Range (m)	Particle
10^{-6}	10^{-18} (0.1% of the diameter of a proton)	Intermediate vector bosons W^+, W^-, Z_0. mass > 80 GeV spin =1

One of the four fundamental forces, the weak interaction involves the exchange of the intermediate vector bosons, the W and the Z. Since the mass of these particles is on the order of 80 GeV, the uncertainty principle dictates a range of about 10^{-18} meters which is about 0.1% of the diameter of a proton.

Index
Fundamental force concepts
Reference Griffiths Ch 2

The weak interaction changes one flavor of quark into another. It is crucial to the structure of the universe in that

1. The sun would not burn without it since the weak interaction causes the transmutation p -> n so that deuterium can form and deuterium fusion can take place.

2. It is necessary for the buildup of heavy nuclei.

The role of the weak force in the transmutation of quarks makes it the interaction involved in many decays of nuclear particles which require a change of a quark from one flavor to another. It was in radioactive decay such as beta decay that the existence of the weak interaction was first revealed. The weak interaction is the only process in which a quark can change to another quark, or a lepton to another lepton - the so-called "flavor changes".

The discovery of the W and Z particles in 1983 was hailed as a confirmation of the theories which connect the weak force to the electromagnetic force in electroweak unification.

The weak interaction acts between both quarks and leptons, whereas the strong force does not act between leptons. "Leptons have no color, so they do not participate in the strong interactions; neutrinos have no charge, so they experience no electromagnetic forces; but *all* of them join in the weak interactions."(Griffiths)

Show Feynmann diagrams

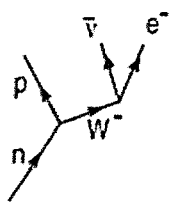
HyperPhysics***** Quantum Physics *R Nave* Go Back

Feynman Diagrams for Weak Force

Index

Fundamental force concepts

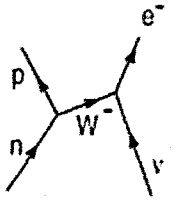
Reference



Decay of neutron

$n \rightarrow p + e^- + \bar{\nu}$

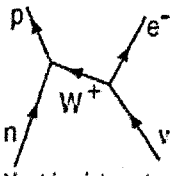
A free neutron will decay by emitting a W^-, which produces an electron and an antineutrino.



Neutrino interacts with neutron

$n + \nu \rightarrow p + e^-$

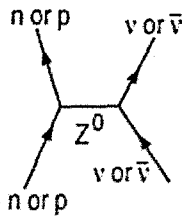
When a neutrino interacts with a neutron, a W^- can be exchanged, transforming the neutron into a proton and producing an electron.



Neutrino interacts with neutron

$n + \nu \rightarrow p + e^-$

This interaction is the same as the one at left since a W^+ going right to left is equivalent to a W^- going left to right.



n or p interacts with neutrino or antineutrino

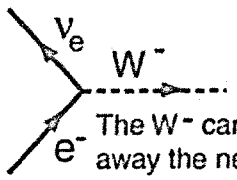
A neutron or proton can interact with a neutrino or antineutrino by the exchange of a Z^0.

One of the four fundamental forces, the weak interaction involves the exchange of the intermediate vector bosons, the W and the Z. Since the mass of these particles is on the order of 80 GeV, the uncertainty principle dictates a range of about 10^{-18} meters which is about .1% of the diameter of a proton. The weak interaction changes one flavor of quark into another. For example, in the neutron decay depicted by the Feynman diagram at left above, one down quark is changed to an up quark, transforming the neutron into a proton.

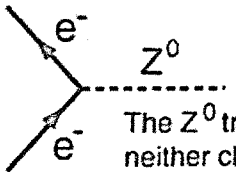
Kaufmann Ch. 29

Griffiths Ch 2

The primitive vertices in the Feynman diagrams for the weak interaction are of two types, charged and neutral. For leptons they take the following form



The W^- carries away the negative charge and transforms the electron to an electron neutrino

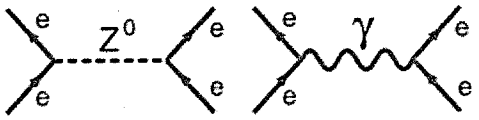


The Z^0 transforms neither charge nor mass.

The electron is used as an example in these diagrams, but any lepton can be substituted on the incoming side. The exit side (top) will be the same for the neutral vertex, but determined by the charge of the W in the charged vertex. Besides conserving charge, the vertex must conserve lepton number, so the process with the electron can produce an electron

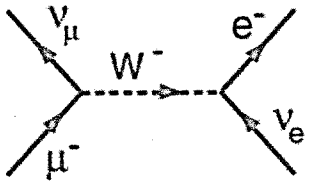
neutrino but not a muon neutrino.

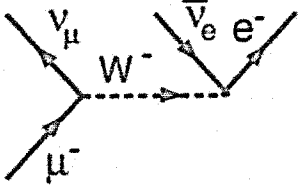
The neutral interaction is simpler to conceive, but rarely observed because it competes with the much stronger electromagnetic interaction and is masked by it.



Neutral weak interaction | Electromagnetic interaction

With the charged vertices, one can postulate an interaction like
m, n_e -> e, n_m and draw a Feynman diagram for it. This interaction is not likely to be oberved because of the incredible difficulty of observing the scattering of neutrinos, but it suggests other interactions which may be obtained by rotating or twisting the diagram.

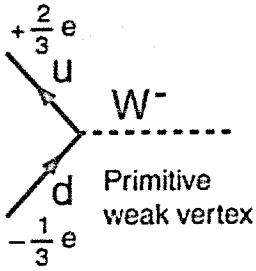




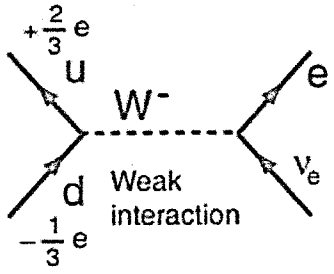
With a twist of the Feynman diagram above, one can arrive at the interaction responsible for the decay of the muon, so the structures obtained from the primitive vertices can be used to build up a family of interactions. The transformation between the two Feynman diagrams can also be seen as an example of crossing symmetry.

Twisted Feynman diagrams and crossing symmetry

The charged vertices in the weak interaction with quarks take the form

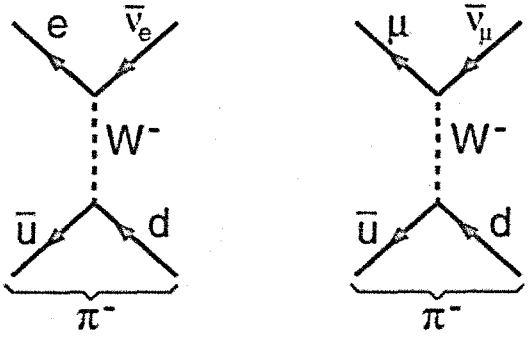


Primitive weak vertex



Weak interaction

So it is seen that the quark changes its flavor when interacting via the W^- or W^+. As drawn, this interaction cannot be observed because it implies the isolation of an up quark. Because of quark confinement, isolated quarks are not observed. But rotating the Feynman diagram gives an alternative interaction, shown below for both electron and muon products.



This suggests the weak interaction mechanism for the decay of the pion, which is observed to happen by the muon pathway.

$$\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$$

The weak interaction in the electron form at left above is responsible for the decay of the neutron and for beta decay in general.

Discussion of weak force