

# Physical Constants

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SIMION 8.1.0 uses CODATA2010 constants (see [Wikipedia:CODATA](#) ). This differs from the 8.0 manual.

In SIMION 6.0/7.0/8.0, the constants are CODATA1986 values. Dahl2000 notes “The physical constants used in version 6.0 and 7.0 are from the 74th edition of the CRC Handbook of Chemistry and Physics [12] Values of these physical constants (e.g.  $c$ , electron mass, and elementary charge) are defined to 8 or 9 significant place accuracy”. The 74th edition (1993-1994) uses CODATA1986, which were the latest CODATA values at that time. SIMION 8.0 also uses these constants.

## List of constants

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Note: 1.23(45) Means 1.23 +/- 0.45.

Mathematical constants:

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PI = 3.14159265358979323846

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Speed of light in vacuum:

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C\_M\_SEC = 299792458 m/s [exact]

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Elementary charge in Coulombs:

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ELEMENTARY\_CHARGE\_C =  
 1.602176565 (35) E-19 C [CODATA2010, SIMION 8.1]  
 1.602176487 (40) E-19 C [CODATA2006]  
 1.60217733 (49) E-19 C [CODATA1986, SIMION 7.0/8.0]

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Unified atomic mass in kg:

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UNIFIED\_MASS\_KG =  
 1.660538921 (73) E-27 kg [CODATA2010, SIMION 8.1]  
 1.660538782 (83) E-27 kg [CODATA2006]  
 1.6605402 (10) E-27 kg [CODATA1986, SIMION 7.0/8.0]

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Mass of electron in daltons (unified atomic mass units):

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```

MASS_ELECTRON_U =
    5.4857990946(22)E-4 u [CODATA2010, SIMION 8.1]
    5.4857990943(23)E-4 u [CODATA2006]
    5.48579903(13) E-4 u [CODATA1986, SIMION 7.0/8.0]

```

Used as the default value in the Particle definition screen but can be adjusted by the user.

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### Mass of proton in daltons:

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```

SC_MASS_PROTON_U =
    1.007276466812(90) u [CODATA2010, SIMION 8.1]
    1.00727646677(10) u [CODATA2006]
    1.007276470(12) u [CODATA1986, SIMION 7.0/8.0]

```

Used as the default value in the Particle definition screen but can be adjusted by the user.

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### Atomic mass unit-electron volt relationship:

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```

AMU_EV =
    UNIFIED_MASS_KG * C_M_SEC^2 / ELEMENTARY_CHARGE_C
    [SIMION 8.0.7-TEST1 and 8.1.0 calculate :
    9.314943336e8 eV [SIMION 7.0/8.0 approximation from above
    9.31494061(21)E8 eV [CODATA2010]
    9.31494028(23)E8 eV [CODATA2006]
    9.3149432(28)E8 eV [CODATA1986]

```

Used in speed\_to\_ke.

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### Vacuum permeability (magnetic constant):

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```

MU_0_H_M = mu_0 = 4*PI * 10^-7 H m^-1 [exact]

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### Electric constant (permittivity of free space):

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```

EPSILON_0 = 1/(mu_0 * c^2) [exact]
            = approximately 8.854187817... E-12 F/m
Used in 8.1 Poisson solver.

```

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In SIMION 8.0.6 and before, the following approximations were used (but are now computed directly in 8.0.7-TEST1 and 8.1.0):

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```

AMU_EV/(2*C_MM_USEC^2) = 5.18213611e-3      (used in speed_to_ke)
1/AMU_EV = 1.07354384e-9                    (used in ke_to_speed)
C_MM_USEC^2/AMU_EV = 9.648530821e1         (used in ke_to_speed)
C_MM_USEC^2/AMU_EV = 9.64853082e1
(magnetic factor in acceleration - H.17 "Magnetic Force Computat
UNIFIED_MASS_KG/ELEMENTARY_CHARGE_C*1E6 = 1.03642722e-2
(used in electric acceleration - H.15 "Electrostatic Force Comp
KFACTOR = C_M_SEC^2 * mu_0 / (4*PI) = C_M_SEC^2 * 1E-7 m/H
REPEL_BEAM      = -(KFACTOR / UNIFIED_MASS_KG) * ELEMENTARY_CHARGE_C
(used in beam repulsion, H.18.1 "Beam Repulsion" in SIMION 8.0 r
REPEL_COULOMB = -(KFACTOR / UNIFIED_MASS_KG) * ELEMENTARY_CHARGE_C
(used in Coulomb repulsion, H.18.2 "Coulombic Repulsion" in SIM
REPEL_FACTOR   = -(KFACTOR / UNIFIED_MASS_KG) * ELEMENTARY_CHARGE_C
(used in Factor repulsion, H.18.3 "Factor Repulsion" in SIMION {
C_MM_USEC = C_M_SEC / 1000; C_MM_USEC^2 = 8.9875517874e10
(used in the relativistic acceleration trajectory calculation)

```



## See Also

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- [simionx.Constants - Various physical constants](#)
- [Issue-I494](#)