1.2 Magnetism in SI Units and Gaussian Units

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Equations, units, dimensions and conversion factors are provided here as an aid to translation between the two languages of magnetism.

The late William Fuller Brown, Jr., founder of the field of micromagnetics, wrote a Tutorial Paper on Dimensions and Units [1.11], in which he said:

“If this seems a bit arbitrary and confusing, bear in mind two principles: first, dimensions are the invention of man, and man is at liberty to assign them in any way he pleases, as long as he is consistent throughout any one interrelated set of calculations. Second, international committees arrive at their decisions by the same irrational procedures as do various IEEE committees that you have served on.”

To writers on the subject, Brown advises, “At all costs avoid tables: with them, you never know whether to multiply or divide.” To the reader he consoled, “This terminology is quite arbitrary; don’t take it too seriously, or you may get yourself into philosophical dilemmas.”

The field of magnetism has been recently enriched by attchment to the world of surface science. This has created some demand for those in the field of magnetism to convert from the Gaussian system to the International System (SI). Workers in magnetism have been reluctant to use SI units for reasons that become apparent when the two systems are compared. Both systems have been said to be “a bit arbitrary and confusing.” The arbitrariness adds to the confusion when translation is attempted. Both systems are self-consistent, but the translations exhibit apparent contradictions. Sympathy must be expressed for those surface scientists new to the field of magnetism. The following equations, units, dimensions and conversion factors are provided as an aid to translation between the two languages of magnetism.

The SI is based on the meter, kilogram, second and ampere, mksa. The Gaussian system is based on the centimeter, gram and second, cgs. It uses the electrostatic cgs units for electrical quantities and the electromagnetic cgs units for magnetic properties. In the Gaussian system, the velocity of light c appears in equations that have both magnetic and electrical quantities. In Maxwell’s equations in Gaussian units the velocity of light multiplies each occurrence of the variable t wherever it appears, as in the expression \(1/c\sqrt{\varepsilon_0}\mu_0\), or wherever it is implied by a hidden time derivative, as in the combination \(4\pi/c\). In the Gaussian system each source term is multiplied by 4\pi. In the SI system 4\pi is banished from the fundamental equations, but reappears when fields are calculated from sources.

Tables for converting between the two systems appear in many texts. It is harder to find direct comparisons of the equations of electricity and magnetism side by side as given here along with a discussion of units and dimensions. The
1.2 Magnetism in SI Units and Gaussian Units

\[ x_{\text{SI}} = 4\pi x_{\text{Gaussian}}. \]  

(1.76)

One could say that the units of \( x_{\text{SI}} \) are \( \text{m}^{-1} \), and the units of \( x_{\text{Gaussian}} \) are \( \text{erg/(G Oe cm)} \).

The magnetic flux is defined in the same way in each system:

\[ \Phi_B = \oint \mathbf{B} \cdot \mathbf{n} \, dA, \]  

(1.77)

\( \Phi_B \) is in webers,

1 Wb = 1 T m²

Faraday's law of induction in integral form is:

\[ \oint \mathbf{E} \cdot d\mathbf{s} = -\frac{\partial}{\partial t} \Phi_B. \]  

(1.78)

\[ \oint \mathbf{E} \cdot d\mathbf{s} = -\frac{1}{c} \frac{\partial}{\partial t} \Phi_B. \]  

(1.79)

1.2.2 Translation Keys

To translate from \textbf{equations} in the Gaussian system to \textbf{equations} in SI, the following table of translation equations provides the keys [1.2]. Solve the appropriate equation for the starred variable, substitute for each quantity in the Gaussian system, and then clean up using the relation \( \varepsilon_0 \mu_0 c^2 = 1 \) to remove the \( c \)'s which are hidden in SI. To translate from \textbf{equations} in SI to \textbf{equations} in the Gaussian system, solve for the unstarrred variable, substitute for each quantity in SI, and then remove the \( \varepsilon_0 \) and \( \mu_0 \) factors using \( \varepsilon_0 \mu_0 c^2 = 1 \). The fact that eight different translation equations are needed accounts for much of the confusion that attends the subject.

\[ \sqrt{4\pi\varepsilon_0} E^* = E \]  

(1.80)

\[ \sqrt{4\pi\mu_0} H^* = H \]  

(1.81)

\[ 1 = \frac{x^*}{x} = \frac{t^*}{t} = \frac{m^*}{m} = \frac{c^*}{c} = \frac{F^*}{F} = \frac{W^*}{W}; \quad 4\pi = \frac{x}{x^*} = \frac{\mu_0}{\mu_0^*} = \frac{1}{c^*}; \quad \varepsilon_0 \mu_0 c^2 = 1. \]  

(1.82)
The dynamic equation for a magnetic moment \( \mathbf{m} \) in the presence of a magnetic induction \( \mathbf{B} \) in both systems is:

\[
\frac{1}{\gamma} \frac{\partial \mathbf{m}}{\partial t} = \mathbf{m} \times \mathbf{B}.
\]  \( \text{(1.45)} \)

There are also nonmagnetic sources of torque on a magnetic moment, e.g., exchange torques and spin-orbit interactions. These are included in the equation of motion using an effective magnetic induction \( \mathbf{B}_{\text{eff}} \), which can include any arbitrary vector parallel to \( \mathbf{m} \). When expressed in terms of \( \mathbf{M} \), the equation of motion becomes:

\[
\frac{1}{\gamma} \frac{\partial \mathbf{M}}{\partial t} = \mathbf{M} \times \mathbf{B}_{\text{eff}},
\]  \( \text{(1.46)} \)

where \( \mathbf{B}_{\text{eff}} \) is the vector gradient of the energy density \( w(\mathbf{M}) \) with respect to the magnetization components:

\[
\mathbf{B}_{\text{eff}} = -\nabla_w w(\mathbf{M}) + \lambda \mathbf{M}.
\]  \( \text{(1.47)} \)

Because \( \mathbf{M} \times \mathbf{M} = 0 \), one can include any \( \lambda \mathbf{M} \) into (1.46), where \( \lambda \) is chosen for convenience and can vary with position. Much confusion results in comparing various authors, because \( \mathbf{B}_{\text{eff}} \) is not uniquely defined. This carries over when the magnetic field \( \mathbf{H} \) is introduced into Maxwell's equations. The magnetic field \( \mathbf{H} \) is defined as that part of \( \mathbf{B} \) which is not directly the contribution of \( \mathbf{M} \) to \( \mathbf{B} \). The contribution of \( \mathbf{M} \) to \( \mathbf{B} \) is different in the two systems. It is \( \mu_0 \mathbf{M} \) in SI and \( 4\pi \mathbf{M} \) in the Gaussian system. To keep the units of \( \mathbf{H} \) and \( \mathbf{M} \) the same in the SI system, \( \mathbf{H} \) is defined with \( \mathbf{B} \) divided by \( \mu_0 \). The distinction between \( \mathbf{H} \) and \( \mathbf{B} \) is not so reinforced in Gaussian units, where they have different names for the units, but the two quantities have the same dimensions, in fact the same dimensions as \( \mathbf{M} \) and \( 4\pi \mathbf{M} \). The definitions of \( \mathbf{H} \) are:

\[
\mathbf{H} = \frac{\mathbf{B}}{\mu_0} - \mathbf{M}, \quad \text{(1.48)} \quad \mathbf{H} = \mathbf{B} - 4\pi \mathbf{M}. \quad \text{(1.49)}
\]

Some confusion can be avoided also if one uses the magnetic polarization, either \( \mu_0 \mathbf{M} \) in tesla or \( 4\pi \mathbf{M} \) in gauss, to report data. Similarly the magnetic field can be reported as \( \mu_0 \mathbf{H} \) in tesla, particularly for the applied field.

The introduction of \( \mathbf{H} \) is particularly useful in ferromagnetism. It plays an important role in magnetostatics, where div \( \mathbf{M} \) provides a source of \( \mathbf{H} \). The magnetic charge density is defined as proportional to \( -\text{div} \mathbf{M} \), but the proportionality factor is different in the two systems:

\[
\nabla \cdot \mathbf{H} = -\nabla \cdot \mathbf{M} = \rho_m, \quad \text{(1.50)} \quad \nabla \cdot \mathbf{H} = -4\pi \nabla \cdot \mathbf{M} = \rho_m. \quad \text{(1.51)}
\]

The factor of \( 4\pi \) enters SI in the expressions for the magnetic field and magnetic induction arising from a magnetic moment in the absence of material media, expressed in terms of the magnetic moment \( \mathbf{m} \) and the unit vector \( \hat{r} \):

\[
\frac{1}{4\pi} \mathbf{B} = \mathbf{H} = \frac{3(m \cdot \hat{r}) \hat{r} - m}{4\pi r^3}, \quad \text{(1.52)} \quad \mathbf{B} = \mathbf{H} = \frac{3(m \cdot \hat{r}) \hat{r} - m}{r^3}. \quad \text{(1.53)}
\]

Maxwell's equations are often written in terms of \( \mathbf{E}, \mathbf{D}, \mathbf{B}, \) and \( \mathbf{H} \), suppressing the roles of \( \mathbf{P} \) and \( \mathbf{M} \). These are particularly simple in SI units, containing neither of the constants \( \varepsilon_0 \) or \( \mu_0 \) and none of the \( 4\pi \)'s or \( c \)'s that appear in the Gaussian version of Maxwell's equations:

\[
\nabla \times \mathbf{H} - \frac{\partial \mathbf{D}}{\partial t} = \mathbf{j}, \quad \text{(1.54)} \quad \nabla \times \mathbf{H} - \frac{1}{c} \frac{\partial \mathbf{D}}{\partial t} = \frac{4\pi}{c} \mathbf{j}, \quad \text{(1.58)}
\]

\[
\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0}, \quad \text{(1.55)} \quad \nabla \times \mathbf{E} + \frac{1}{c} \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0}, \quad \text{(1.59)}
\]

\[
\nabla \cdot \mathbf{D} = \rho, \quad \text{(1.56)} \quad \nabla \cdot \mathbf{D} = 4\pi \rho, \quad \text{(1.60)}
\]

\[
\nabla \cdot \mathbf{B} = 0, \quad \text{(1.57)} \quad \nabla \cdot \mathbf{B} = 0. \quad \text{(1.61)}
\]

The equations of motion (1.45, 46) in terms of \( \mathbf{H} \) include a factor of \( \mu_0 \) in the SI units. As above, in (1.43, 44) and \([44]\), the gyromagnetic ratio is defined...
$D$ is in $C\cdot m^{-2}$ \hspace{0.5cm} 3.33564095 \times 10^{-6} \, C\cdot m^{-2} \hspace{0.5cm} D$ is in statvolt cm$^{-1}$

$[D] = \text{[current][time][length]}^{-2}$ \hspace{0.5cm} $[D] = \text{[energy][current][time]}^{-1}\times \text{[length]}^{-1}$

Magnetic quantities

The magnetic induction $B$ has no divergence. $E$ and $B$ are related by Faraday's laws of induction:

$$\nabla \cdot B = 0, \quad (1.23) \quad \nabla \cdot B = 0, \quad (1.25)$$

$$\nabla \times E + \frac{\partial B}{c \partial t} = 0, \quad (1.24) \quad \nabla \times E + \frac{1}{c} \frac{\partial B}{\partial t} = 0. \quad (1.26)$$

In Gaussian units the $c$ appears explicitly in Faraday's Law. Maxwell introduced the analogous relation between curl $B$ and the time derivative of $E$ valid in free space:

$$\nabla \times B - \frac{1}{c^2} \frac{\partial E}{\partial t} = 0, \quad (1.27) \quad \nabla \times B - \frac{1}{c} \frac{\partial E}{\partial t} = 0. \quad (1.28)$$

In the presence of current density $j$ these two equations are:

$$\nabla \times B - \frac{1}{c^2} \frac{\partial E}{\partial t} = 4\pi \kappa_m j, \quad (1.29) \quad \nabla \times B - \frac{1}{c} \frac{\partial E}{\partial t} = 4\pi \kappa_m j, \quad (1.32)$$

where

$$\kappa_m = \frac{\mu_0}{4\pi} = 10^{-17} \, \text{N} \cdot \text{A}^{-2}, \quad (1.30) \quad \kappa_m = 1/c, \quad (1.33)$$

$$\mu_0 = 4\pi \times 10^{-7} \, \text{N} \cdot \text{A}^{-2} \quad c = 2.99792458 \times 10^{10} \, \text{cm} \cdot \text{s}^{-1}.$$

In SI units the $c$'s are hidden in the expression for the sources of curl $B$, which in differential form are current densities including the polarization currents and the amperian currents as well as the true current density $j$:

$$\nabla \times B - \varepsilon_0 \mu_0 \frac{\partial E}{\partial t} \quad \nabla \times E - \frac{1}{c} \frac{\partial \mathbf{P}}{\partial t} = \mu_0 \left( j + \frac{\partial \mathbf{P}}{\partial t} + \nabla \times \mathbf{M} \right), \quad (1.35) \quad \frac{4\pi}{c} \left( j + \frac{\partial \mathbf{P}}{\partial t} + c \nabla \times \mathbf{M} \right). \quad (1.36)$$

1.2 Magnetism in SI Units and Gaussian Units

There is a $1/c^2$ in the SI equation from the combination $\mu_0 \varepsilon_0$. The $c$ appears in front of the curl $M$ term in Gaussian units to cancel the $1/c$ outside the bracket, because this term is measured in emu. The magnetization $M$ in both systems is the magnetic moment per unit volume. In both cases the magnetic moment $m$ is defined in terms of a current $I$ in a loop with a finite area $A$ and normal $\hat{n}$:

$$m = I A \hat{n}, \quad (1.37) \quad m = \frac{I A \hat{n}}{c}. \quad (1.38)$$

The $c$ appears in Gaussian units because $I$ is measured in esu and $m$ in emu. The magnetic moment of the electron is the Bohr magneton with a quantum electrodynamic correction. The Bohr magneton is:

$$\mu_B = \frac{c\hbar}{4\pi \kappa_e}, \quad (1.39) \quad \mu_B = \frac{c\hbar}{4\pi \kappa_e}. \quad (1.40)$$

Some fundamental constants in the two systems are:

Bohr magneton:

- $\mu_B = 9.2740154 \times 10^{-24} \, \text{J} \cdot \text{T}^{-1}$
- $\mu_B = 2.1869226 \times 10^{-24} \, \text{g} \cdot \text{T}^{-1}$

electron moment:

- $\mu_e = 9.2750909 \times 10^{-24} \, \text{J} \cdot \text{T}^{-1}$
- $\mu_e = 2.1869426 \times 10^{-24} \, \text{g} \cdot \text{T}^{-1}$

Planck's constant:

- $\hbar = 6.6260755 \times 10^{-24} \, \text{J} \cdot \text{s}$
- $\hbar = 6.6260755 \times 10^{-24} \, \text{g} \cdot \text{s}$

electron mass:

- $m_e = 9.1093897 \times 10^{-31} \, \text{kg}$
- $m_e = 9.1093897 \times 10^{-31} \, \text{g}$

The magnetic induction produces a torque on a magnetic moment, which follows from the Lorentz force equations (1.1), (2). In both cases:

$$T = m \times B. \quad (1.41)$$

The energy $W_m$ of a magnetic moment follows from the torque equation if the zero of energy is taken from the position where $\mathbf{m}$ is perpendicular to $\mathbf{B}$:

$$W_m = -m \cdot B. \quad (1.42)$$

The dynamic response of a magnetic moment to a torque is determined by the ratio of the magnetic moment to the angular momentum, called the gyromagnetic ratio $\gamma$. Again the equations in the two systems differ by the factor $c$:

$$\gamma = -\frac{g}{2m_e}, \quad (1.43) \quad \gamma = -\frac{g}{2cm_e}. \quad (1.44)$$
1. Introduction

$B$ are not:

\[
[B] = \text{[energy]} \times \text{[current]}^{-1} \times \text{[distance]}^{-2} \times \text{[time]}^{-1}
\]

Electrical quantities

Charge is a source of the electric field. In differential form the field has the total charge density $\rho_T$ as a source:

\[
\nabla \cdot E = 4\pi k_e \rho_T,
\]

(1.3)

\[
\rho_T = \rho + \rho_p = \rho - \nabla \cdot P_{\text{dip}},
\]

(1.4)

where $P_{\text{dip}}$ is the dipole moment per unit volume. The subscript "dip" is dropped in the remainder of this chapter.

In SI:

\[
k_e = \frac{1}{4\pi\varepsilon_0},
\]

(1.5)

\[
K = 10^{-7} \text{ N A}^{-2},
\]

(1.6)

\[
\frac{1}{4\pi\varepsilon_0} = 8.98755179 	imes 10^{-12} \text{ m}^{-1},
\]

(1.7)

\[
e_0 \varepsilon_0 = 299792458 \text{ m s}^{-1},
\]

(1.8)

\[
e_0 \nabla \cdot E = \rho_T
\]

(1.9)

\[
\nabla \cdot E = 4\pi \rho_T.
\]

(1.10)

The dimensions of $P$ are the same in the two systems:

\[
[P] = \text{[current]} \times \text{[time]} \times \text{[length]}^{-2}
\]

(1.11)

In both systems of units the electric dipole is $p = qd$ and the polarization $P$ is the dipole moment per unit volume. The torque on an electric dipole $p_{\text{dip}}$ in a field $E$ is

\[
T = p \times E. \quad \text{[Joule rad}^{-1} \text{J m m}^{-1} = 1 \text{ erg cm cm}^{-1} \quad \text{[erg rad}^{-1}]
\]

(1.12)

1.2 Magnetism in SI Units and Gaussian Units

The energy $W$ of a permanent electric dipole $p$ in a field $E$ is

\[
W = -p \cdot E.
\]

(1.13)

\[
10^{-7} J = 1 \text{ erg}
\]

\[
W = \text{in erg}
\]

\[
\rho \text{ is in} \text{ statcoulomb cm}^{-3}
\]

\[
p \text{ is in} \text{ C m}
\]

\[
P = \text{in C m}^{-2}
\]

\[
E \text{ is in V m}^{-1}
\]

\[
4\pi k_e P \text{ is in} \text{ V m}^{-1}
\]

\[
10^{-7} J = 1 \text{ erg}
\]

\[
W = \text{in erg}
\]

\[
\rho \text{ is in} \text{ statcoulomb cm}^{-3}
\]

\[
p \text{ is in} \text{ C m}
\]

\[
P = \text{in C m}^{-2}
\]

\[
E \text{ is in V m}^{-1}
\]

\[
4\pi k_e P \text{ is in} \text{ V m}^{-1}
\]

\[
W = \text{in erg}
\]

\[
\rho \text{ is in} \text{ statcoulomb cm}^{-3}
\]

\[
p \text{ is in} \text{ C m}
\]

\[
P = \text{in C m}^{-2}
\]

\[
E \text{ is in V m}^{-1}
\]

\[
4\pi k_e P \text{ is in} \text{ V m}^{-1}
\]

\[
[\rho] = \text{[current]} \times \text{[time]} \times \text{[length]}^{-2}
\]

\[
[P] = \text{[current]} \times \text{[time]} \times \text{[length]}^{-2}
\]

\[
[E] = \text{[energy]} \times \text{[current]}^{-1} \times \text{[time]}^{-1} \times \text{[length]}^{-1}
\]

\[
4\pi k_e P \text{ appears as a source of} E. \text{ The units and dimensions of} 4\pi k_e P \text{ and} E \text{ are the same as each other in both systems. Unfortunately, the definition of the electric susceptibility is different in the two systems.}
\]

\[
4\pi k_e P = \chi_e E.
\]

(1.14)

\[
P_{\text{ext}} = \chi_e E_{\text{ext}}.
\]

(1.15)

The SI electric susceptibility is dimensionless. The Gaussian electric susceptibility is in statcoulombs/statvolt · cm, which is actually dimensionless.

\[
(\chi_e)_{\text{SI}} = 4\pi (\chi_e)_{\text{Gaussian}}.
\]

(1.16)

The translation between the systems is further confused by the contrary definitions of the electric flux density $D$.

\[
4\pi k_e D = E + 4\pi k_e P,
\]

(1.17)

\[
D = E + 4\pi P,
\]

(1.18)

\[
\nabla \cdot D = \rho,
\]

(1.19)

\[
\nabla \cdot D = 4\pi k_e \rho,
\]

(1.20)

\[
\nabla \cdot D = 4\pi \rho.
\]

(1.21)
presentation starts with the Lorentz force equation to introduce $E$ and $B$. This is followed by the electrical and then magnetic quantities leading to Maxwell's equations and the equation of motion for magnetism. The latter is a torque equation with the dimensions of energy density. As it is the same for both systems of units it appears in the center of the line:

$$\frac{1}{\gamma} \frac{\partial M}{\partial t} = M \times B_{\text{eff}},$$

(1.45)

where effective magnetic induction $B_{\text{eff}}$ is the vector gradient of the energy density $w(M)$ with respect to the components of the magnetization $M$:

$$R_{\text{eff}} = - \nabla_w w(M) + \lambda M.$$  

(1.46)

When the equation of motion is presented in terms of the magnetic field $H$, the equations are different. The SI equations are put on the left and the Gaussian equations on the right.

In SI units:

$$\frac{1}{\gamma} \frac{\partial M}{\partial t} = M \times \mu_0 H_{\text{eff}},$$  

(1.62)

$$1 \frac{\partial M}{\partial t} = M \times H_{\text{eff}},$$  

(1.64)

where

$$H_{\text{eff}} = - \frac{\nabla w w(M)}{\mu_0} + \lambda M.$$  

(1.63)

$$H_{\text{eff}} = - \nabla w w(M) + \lambda M.$$  

(1.65)

The equations are explained as they are introduced. The units and dimensions of the quantities are listed on the left and right. The conversions between quantities in the two systems are given as equations in the center of the line. For example, some of the principle magnetic quantities are:

<table>
<thead>
<tr>
<th>SI units</th>
<th>conversion</th>
<th>Gaussian units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$ is in A$m^2$</td>
<td>$\mu_0$ is in SI and in Gaussian</td>
<td></td>
</tr>
<tr>
<td>$\mu_0 M$ and $\mu_0 H$ are in tesla (T)</td>
<td>$\mu_0$ is in SI and in Gaussian</td>
<td></td>
</tr>
<tr>
<td>$M$ is in A$m^{-1}$</td>
<td>$10^{-3} J/T = 1$ erg/G</td>
<td></td>
</tr>
<tr>
<td>$\gamma$ is in T$^{-1}$</td>
<td>$10^{-4} T = 1$ G</td>
<td></td>
</tr>
<tr>
<td>$H$ is in amperes (A) m$^{-1}$</td>
<td>$1000$ A$m^{-1} = 1$ erg (G$^{-1}$ cm$^{-2}$)</td>
<td></td>
</tr>
<tr>
<td>$B$ is in Gauss (G)</td>
<td>$10^4$ (T) s$^{-1} = 1$ Gs$^{-1}$</td>
<td></td>
</tr>
<tr>
<td>$\Phi_B$ is in webers (Wb)</td>
<td>$1000$ A$m^{-1} = 1$ Oe</td>
<td></td>
</tr>
<tr>
<td>$10^{-8}$ Wb = $1$ maxwell</td>
<td>$H$ is in Oe, Oe</td>
<td></td>
</tr>
<tr>
<td>$\Phi_B$ is in maxwells = G cm$^2$</td>
<td>$10^{-8}$ Wb = $1$ maxwell</td>
<td></td>
</tr>
</tbody>
</table>

These equations appear again later in this section and the numbering refers to the sequence in which they are presented there.

1.2 Magnetism in SI Units and Gaussian Units

In the Gaussian system $B$, $H$, and $M$ have the same dimensions, but not the same units. This may seem strange to a visitor from SI space to Gaussian space. Indeed it can be a source of confusion, but note that torque and energy have the same dimensions, but are quoted in different units, e.g. $N$ m and joule.

A general method of translating equations between the two systems is given in the final section. There are eight separate forms for the translation keys. The application of these to one particular equation is shown. The number of required steps illustrates why one might rather have all the pertinent equations side by side.

1.2.1 Equations of Electricity and Magnetism

in SI Units: and in Gaussian Units:

{always on the left} {always on the right}

F = qE + qv x B,  

(1.1)

$$F_{\text{cgs}} = q_{\text{cgs}} \left( F_{\text{cgs}} + \frac{v_{\text{cgs}} \times B_{\text{cgs}}}{c_{\text{cgs}}} \right)$$  

(1.2)

$F$ is in newton, N
$q$ is in coulomb, C
$E$ is in volts m$^{-1}$
$M$ is in ampere meter, A m
$I$ is in ampere, A
$10^{-5} N = 1$ dyn
$1$ coulomb = 1 statcoulomb
$10^{-1}$ m s$^{-1} = 1$ cm s$^{-1}$
$1$ ampere meter = 1 statampere
$1$ volt = 1 statvolt
$10^{-8}$ A = 1 statampere
$1$ statvolt = 1 statcoulomb
$1$ statamper cm
$3.33564095 \times 10^{-16}$ A
$1$ statampere
$299792458$ C
$1$ statcoulomb
$0.01$ m s$^{-1} = 1$ cm s$^{-1}$
$1$ newton = 1 dyne
$1$ statvolt = 1 statcoulomb
$1$ newton meter$^{-1}$
$299792458$ V
$1$ volt meter$^{-1}$
$1$ statvolt = 1 statcoulomb
$1$ statvolt = 1 statcoulomb

The dimensions [ ] of $E$ are the same in the two systems but the dimensions of
For example, start with
\[ \gamma = -g \frac{|e|}{2m_e}, \quad (1.83) \]
or start with
\[ \gamma^* = -g^* \frac{|e^*|}{2c^* m_e^*}, \quad (1.88) \]
look in the table for the transfer relation of \( \gamma \) and \( \gamma^* \):
\[ \gamma = \frac{4\pi}{\sqrt{\mu_0}} \gamma^* \quad (1.84) \]
look in the table for the transfer relation of \( \gamma \) and \( \gamma^* \):
\[ \gamma^* = \frac{\sqrt{\mu_0}}{4\pi} \gamma \quad (1.89) \]
and the transfer relation of charge:
\[ |e| = |e^*| \sqrt{4\pi \varepsilon_0}. \quad (1.85) \]
and the transfer relation of charge:
\[ |e^*| = \frac{1}{\sqrt{4\pi \varepsilon_0}} |e| \quad (1.90) \]
Substitute these, \( g = g^* \) and \( m = m^* \) in (1.83) to obtain:
\[ \frac{4\pi}{\sqrt{\mu_0}} \gamma^* = -g^* \frac{|e^*|}{2m_e^*} \sqrt{4\pi \varepsilon_0}, \quad (1.86) \]
Substitute these, \( g = g^* \), \( c^* = c \) and \( m^* = m \) in (1.88) to obtain:
\[ \sqrt{\mu_0} \gamma = -g \frac{|e|}{2cm_e \sqrt{4\pi \varepsilon_0}}, \quad (1.91) \]
which using \( c^2 \mu_0 \varepsilon_0 = 1 \) and \( c = c^* \) simplifies to:
\[ \gamma^* = -g^* \frac{|e^*|}{2c^* m_e^*}. \quad (1.87) \]
which using \( c^2 \mu_0 \varepsilon_0 = 1 \) simplifies to:
\[ \gamma = -g \frac{|e|}{2m_e}. \quad (1.92) \]

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