Table 1: Basic relationships in Magnetism :

(Sommerfeld system)

In free space	$\mathbf{B} = \mu_o \mathbf{H}$
Internal to a magnetised material in zero field,	$\mathbf{B} = \mu_o \mathbf{M}$
Internal to a magnetised material in field, H,	$\mathbf{B} = \mu_o (\mathbf{H} + \mathbf{M})$
If the material is linear, i.e. $M = \chi H$, then	$\mathbf{B} = \mu_o (\mathbf{H} + \chi \mathbf{H})$
	$= \mu_o \mathbf{H}(1+ \chi)$

Defining the relative permeability as, $\mu_r = 1 + \chi$ and $\mu = \mu_o \mu_r$ we then have,

$$\mathbf{B} = \mu_o \mathbf{H} \mu_r = \mu_o \mu_r \mathbf{H} = \mu \mathbf{H}$$

(Kennelly system)

In addition to M and H, the magnetic polarisation, **J**, and $\mathbf{B}_o$ are also often used for convenience. These are defined from,

$$\mathbf{B} = \mu_o (\mathbf{H} + \mathbf{M}) = \mu_o \mathbf{H} + \mu_o \mathbf{M} = \mu_o \mathbf{H} + \mathbf{J} = \mathbf{B}_o + \mathbf{J}$$

(Gaussian c.g.s system)

In c.g.s. units we have a similar system, except that effectively $\mu_o = 1$ and

$\mathbf{B} = \mathbf{H} + 4\pi\mathbf{M}$ or $\mathbf{B} = \mathbf{B}_o + \mathbf{M}'$ where $\mathbf{M}' = 4\pi\mathbf{M}$

Here H is measured in oersteds, M in emu/cc and B in gauss. Hence (rather confusingly),

4π emu/cc = 1 oersted = 1 gauss.

(See accompanying tables summarising the inter relationships between units.)

Table 2. **Comparison of principal units used in magnetism:**

Quantity		SI (Sommerfeld)	SI (Kennelly)	EMU (Gaussian)
moment	m	A m^2	weber metre	emu
Magnetisation	M	A/m	-	emu/cc
Field	H	A/m	A/m	oersted (Oe)
Induction (Flux density)	B	tesla (T)	tesla (T)	gauss (G)
Intensity of magn. /polrn.	J	-	tesla (T)	-
Flux	Φ	weber (Wb)	weber (Wb)	maxwell
		$B = \mu_o(H+M)$	$B = \mu_o H+J$ $B = B_o +J$	$B = H+4\pi M$

Table 3. **Conversion Table:**

B	10,000 gauss	=	1 tesla	or	10 kG	= 1 T
H & M	1 emu/cc	=	1,000 A/m	or	1 emu/cc	= 1 kA/m
m	1,000 emu	=	1 A m^2			
σ	1 emu/grm	=	1 A/m/kg	or	1 emu/grm	= 1 J/T/kg

General working conversions:

4π emu/cc = 1 gauss	1 gauss = $(10^3/4\pi)$ A/m = 79.58 A/m
1 mT = 10 gauss	1T = $(10^7/4\pi)$ A/m = 795.8 kA/m