

Chapter 19 – 21: Units

	MKS Practical (SI)	CGS Electrostatic (esu)	CGS Electromagnetic (emu)
Force	N (= Newton = $\frac{\text{kg}\cdot\text{m}}{\text{s}^2}$)	dyne ($= \frac{\text{g}\cdot\text{cm}}{\text{s}^2}$)	dyne
Charge	C (= Coulomb)	Statcoulomb (= esu = Franklin)	Abcoulomb
Electric Field	$\frac{\text{N}}{\text{C}}$ ($= \frac{\text{V}}{\text{m}}$)	$\frac{\text{dyne}}{\text{statcoulomb}}$	$\frac{\text{dyne}}{\text{abcoulomb}}$
Electric flux (= Φ)	$\frac{\text{N}\cdot\text{m}^2}{\text{C}}$	$\frac{\text{dyne}\cdot\text{cm}^2}{\text{StatC}}$ (= StatC)	$\frac{\text{dyne}\cdot\text{cm}^2}{\text{Abcoulomb}}$
Charge density (λ = linear, σ = surface, ρ = volume)	$\lambda = \frac{\text{C}}{\text{m}}$; $\sigma = \frac{\text{C}}{\text{m}^2}$; $\rho = \frac{\text{C}}{\text{m}^3}$	$\frac{\text{Statcoulomb}}{\text{cm}}$ etc..	$\frac{\text{Abcoulomb}}{\text{cm}}$ etc..
Electric Potential Energy	Joule (= N·m)	erg (= dyne·cm)	erg
Electric Potential (Voltage or Emf)	Volt	Statvolt	Abvolt
Capacitance	Farad	Statfarad (= cm)	Abfarad
Dielectric constant (= κ)	No units	No units	No units
Current	Ampere ($= \frac{\text{C}}{\text{s}}$)	Statampere	Abampere (= emu = biot)
Resistance	Ohm (= Ω)	Statohm	Abohm
Resistivity	Ohm·m	Statohm·cm	Abohm·cm
Power	Watt ($= \frac{\text{J}}{\text{s}}$)	$\frac{\text{erg}}{\text{s}}$	$\frac{\text{erg}}{\text{s}}$

Constants:

ϵ_0 = permittivity of free space = 8.854×10^{-12} Farad/m (Farad/m = $\text{C}^2/\text{N}\cdot\text{m}^2$)

$k_0 = (1/4\pi\epsilon_0) = 8.988 \times 10^9$ m/Farad (m/Farad = $\text{N}\cdot\text{m}^2/\text{C}^2$)

μ_0 = permeability of free space = $4\pi \times 10^{-7}$ Henry/m (Henry/m = N/A^2)

Derivation of esu and emu units

Electrostatic units are derived using the assumption that $k_0 = (1/4\pi\epsilon_0) = 1$. Coulomb's force law (in esu units) defines the statcoulomb:

$$F = \frac{q_1 q_2}{r^2} \left(\text{that is, } 1 \text{ dyne} = \frac{\text{statcoulomb}^2}{\text{cm}^2} \right).$$

Electromagnetic units are derived using the assumption that $(\mu_0/4\pi) = 1$. The force per unit length between two parallel currents (in emu units) defines the abamp:

$$\frac{F}{L} = \frac{2 I_1 I_2}{r} \left(\frac{\text{dyne}}{\text{cm}} = \frac{\text{abamp}^2}{\text{cm}} \right).$$

All other electrical units in the esu system are derived using the definition of the statcoulomb and all other electrical units in the emu system are derived using the definition of the abamp.

CONVERSION CHART

PRACTICAL (SI)	ELECTROSTATIC (esu)	ELECTROMAGNETIC (emu)
1 Coulomb	= 2.998×10^9 Statcoulombs	= 10^{-1} Abcoulomb
1 Ampere	= 2.998×10^9 Statamps	= 10^{-1} Abamp
1 Ohm	= $\frac{1}{8.988 \times 10^{11}}$ Statohm	= 10^9 Abohms
1 Farad	= 8.988×10^{11} Statfarads	= 10^{-9} Abfarads
1 Volt	= $\frac{1}{299.8}$ Statvolt	= 10^8 Abvolts
1 Tesla	= $\frac{1}{2.998 \times 10^6}$	= 10^4 Gauss
1 Henry	= $\frac{1}{8.988 \times 10^{11}}$ Stathenry	= 10^9 Abhenrys

Prefixes and Greek letters:

tera (T) = 10^{12}	kilo (k) = 10^3	micro (μ) = 10^{-6}
giga (G) = 10^9	centi (c) = 10^{-2}	nano (n) = 10^{-9}
mega (M) = 10^6	milli (m) = 10^{-3}	pico (p) = 10^{-12}

α A Alpha	η H Eta	ν N Nu	τ T Tau
β B Beta	θ Θ Theta	ξ Ξ Xi	υ Y Upsilon
γ Γ Gamma	ι I Iota	\omicron O Omicron	ϕ Φ Phi
δ Δ Delta	κ K Kappa	π Π Pi	χ X Chi
ϵ E Epsilon	λ Λ Lambda	ρ P Rho	ψ Ψ Psi
ζ Z Zeta	μ M Mu	σ Σ Sigma	ω Ω Omega

