## Electrostatic Equations for Dielectrics in MKSA and Gauss Units

THE DISPLACEMENT FIELD AND THE GAUSS LAW:

In MKSA units:

$$\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P} \tag{1}$$

$$\nabla \cdot \mathbf{D} = \rho_{\text{free}} \tag{2}$$

In Gauss units:

$$\mathbf{D} = \mathbf{E} + 4\pi \mathbf{P} \tag{3}$$

$$\nabla \cdot \mathbf{D} = 4\pi \rho_{\text{free}} \tag{4}$$

Susceptibility, permittivity, and the dielectric constant:

In MKSA units:

$$\mathbf{P} = \chi \epsilon_0 \mathbf{E} \tag{5}$$

$$\mathbf{D} = \epsilon_{\rm abs} \mathbf{E} = \epsilon_{\rm rel} \epsilon_0 \mathbf{E} \tag{6}$$

$$\epsilon_{\rm rel} = 1 + \chi \tag{7}$$

In Gauss units:

$$\mathbf{P} = \chi \mathbf{E} \tag{8}$$

$$\mathbf{D} = \epsilon \mathbf{E} \tag{9}$$

$$\epsilon = 1 + 4\pi\chi \tag{10}$$

Note: the dielectric constant  $\epsilon = \epsilon_{\rm rel}$  is dimensionless and has the same numeric value in both systems of units. But the susceptibility  $\chi$  — which is also dimensionless — differs between the two systems by a factor of  $4\pi$ ,  $\chi[{\rm MKSA}] = 4\pi \times \chi[{\rm Gauss}]$ .

COULOMB FORCE IN A DIELECTRIC:

In MKSA units 
$$F = \frac{1}{4\pi\epsilon_{\rm rel}\epsilon_0} \times \frac{q_1q_2}{r^2}$$
 (11)

In Gauss units 
$$F = \frac{1}{\epsilon} \times \frac{q_1 q_2}{r^2}$$
 (12)