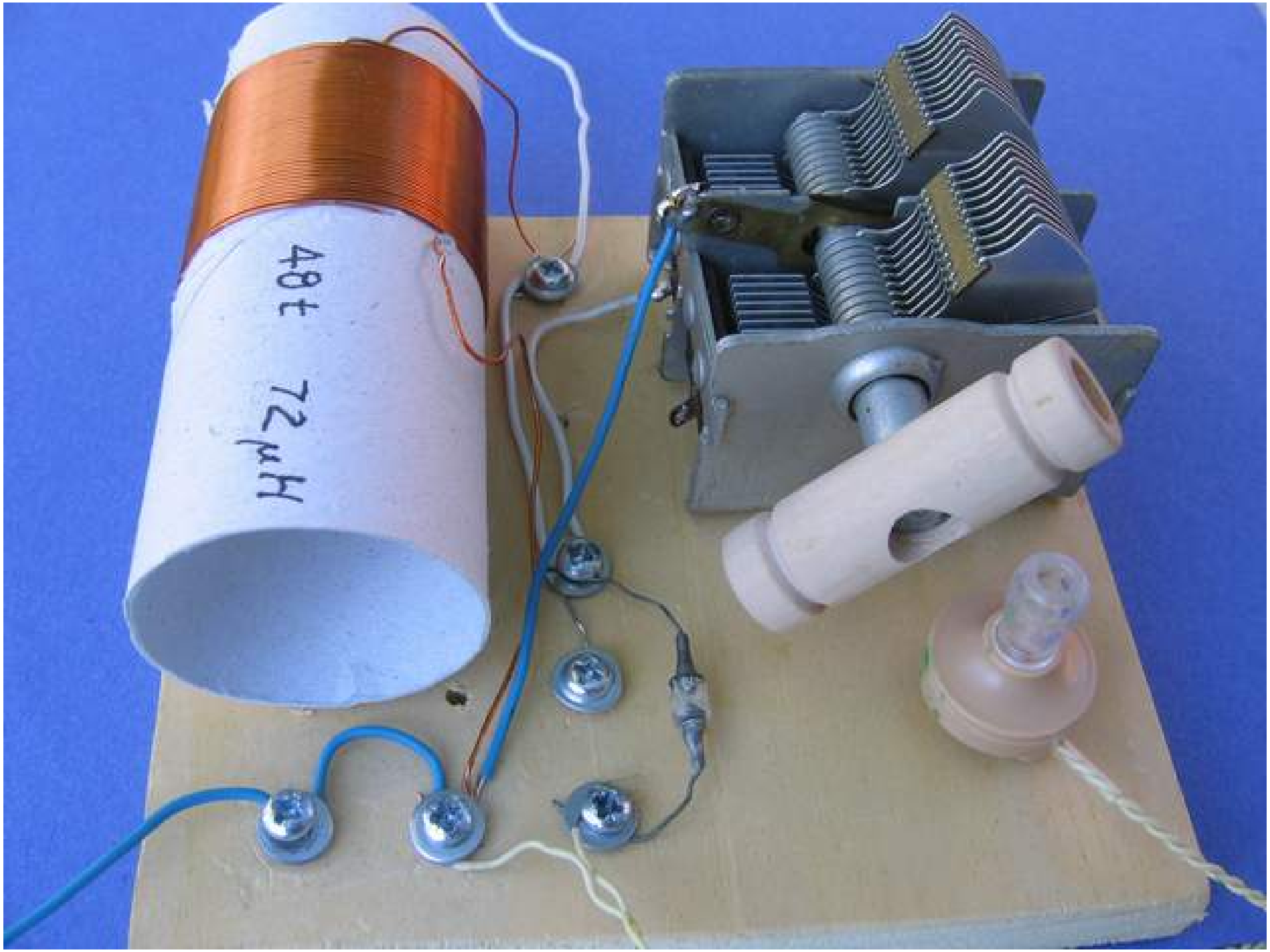
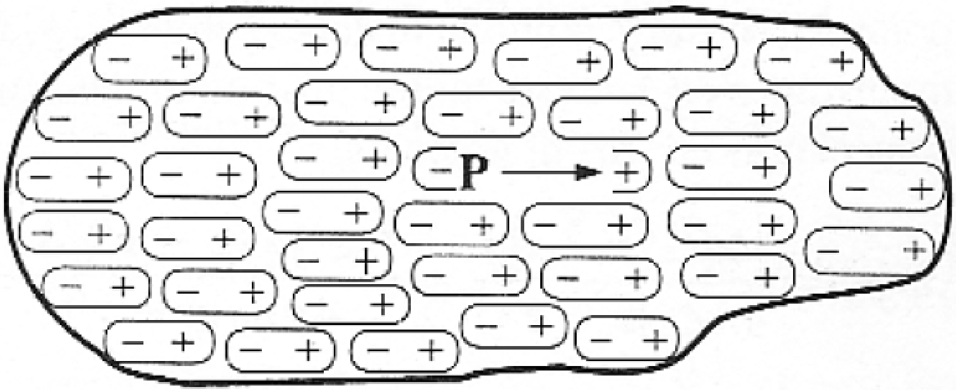
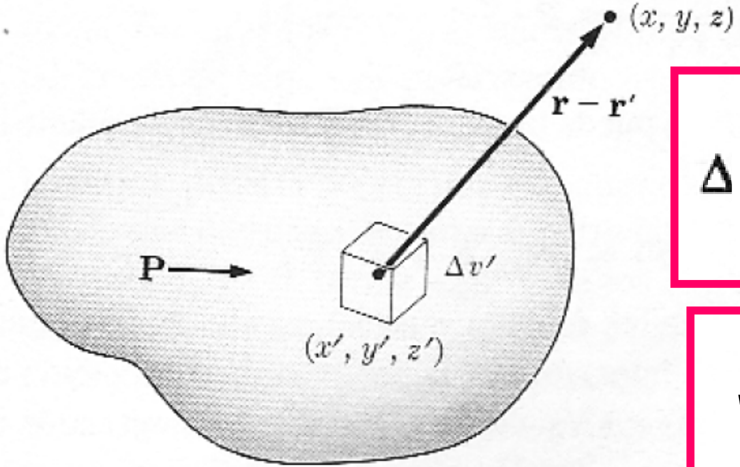
Electricidad



Repaso



$$\mathbf{P} = \frac{\Delta \mathbf{p}}{\Delta v}$$



Campo fuera de un medio dieléctrico

$$\Delta V(\mathbf{r}) = \frac{\Delta \mathbf{p} \cdot (\mathbf{r} - \mathbf{r}')}{4\pi\epsilon_0 |\mathbf{r} - \mathbf{r}'|^3} = \frac{\mathbf{P}(\mathbf{r}') \cdot (\mathbf{r} - \mathbf{r}')\, \Delta v'}{4\pi\epsilon_0 |\mathbf{r} - \mathbf{r}'|^3}$$

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \int_{V_0} \frac{\mathbf{P}(\mathbf{r}') \cdot (\mathbf{r} - \mathbf{r}')\, dv'}{|\mathbf{r} - \mathbf{r}'|^3}$$

Polarización

$$v(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\oint_{S_0}\frac{\mathbf{P}\cdot\mathbf{n}\,da'}{|\mathbf{r}-\mathbf{r}'|} + \frac{1}{4\pi\epsilon_0}\int_{V_0}\frac{(-\nabla'\cdot\mathbf{P})\,dv'}{|\mathbf{r}-\mathbf{r}'|}$$

$$\sigma_P \equiv \mathbf{P}\cdot\mathbf{n} = P_n \qquad \rho_P \equiv -\nabla\cdot\mathbf{P}$$

densidades de carga de polarización

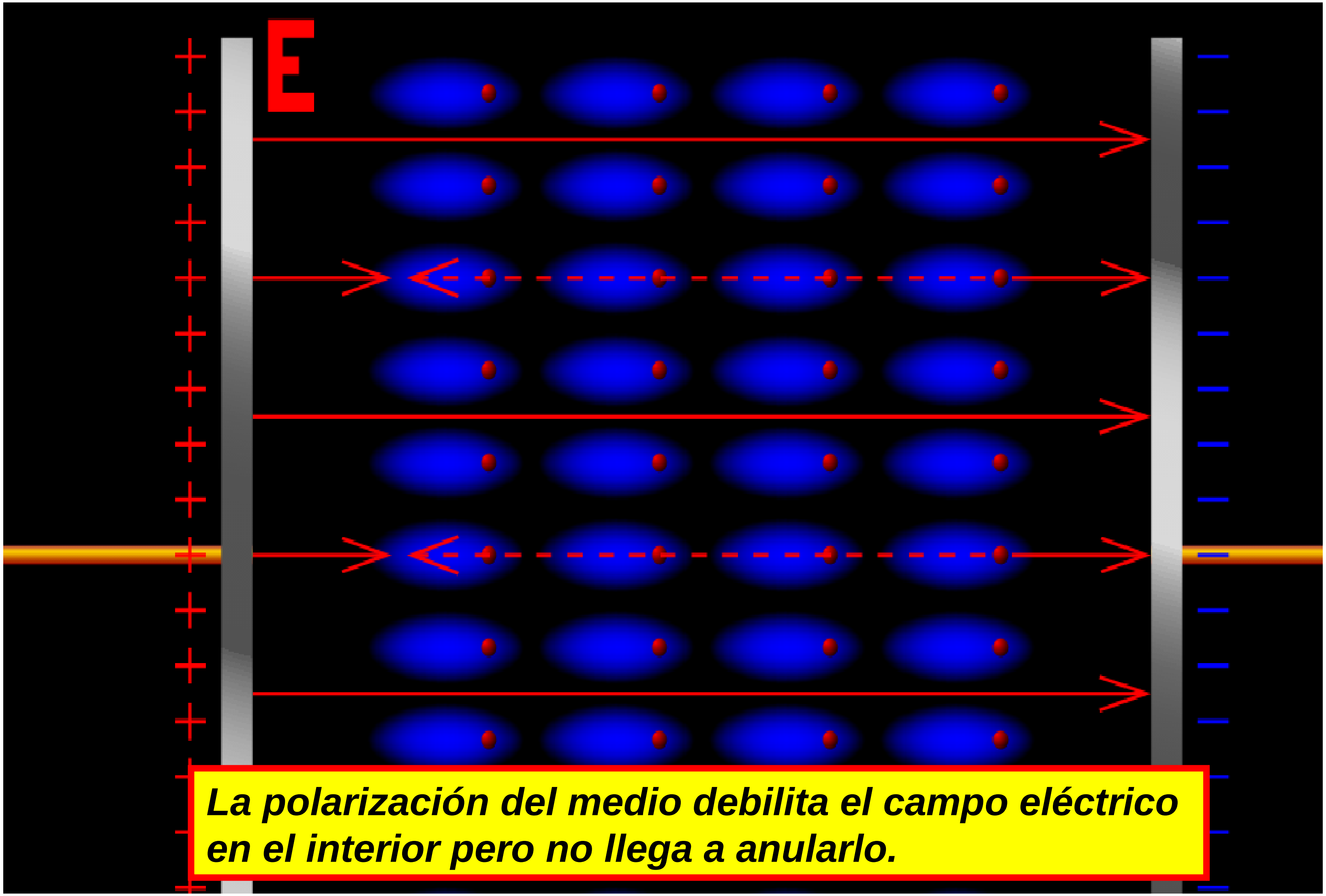
$$v(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\left[\oint_{S_0}\frac{\sigma_P\,da'}{|\mathbf{r}-\mathbf{r}'|} + \int_{V_0}\frac{\rho_P\,dv'}{|\mathbf{r}-\mathbf{r}'|}\right]$$

$$\mathbf{E}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\left[\int_{S_0}\sigma_P\frac{(\mathbf{r}-\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|^3}\,da' + \int_{V_0}\rho_P\frac{(\mathbf{r}-\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|^3}\,dv'\right]$$

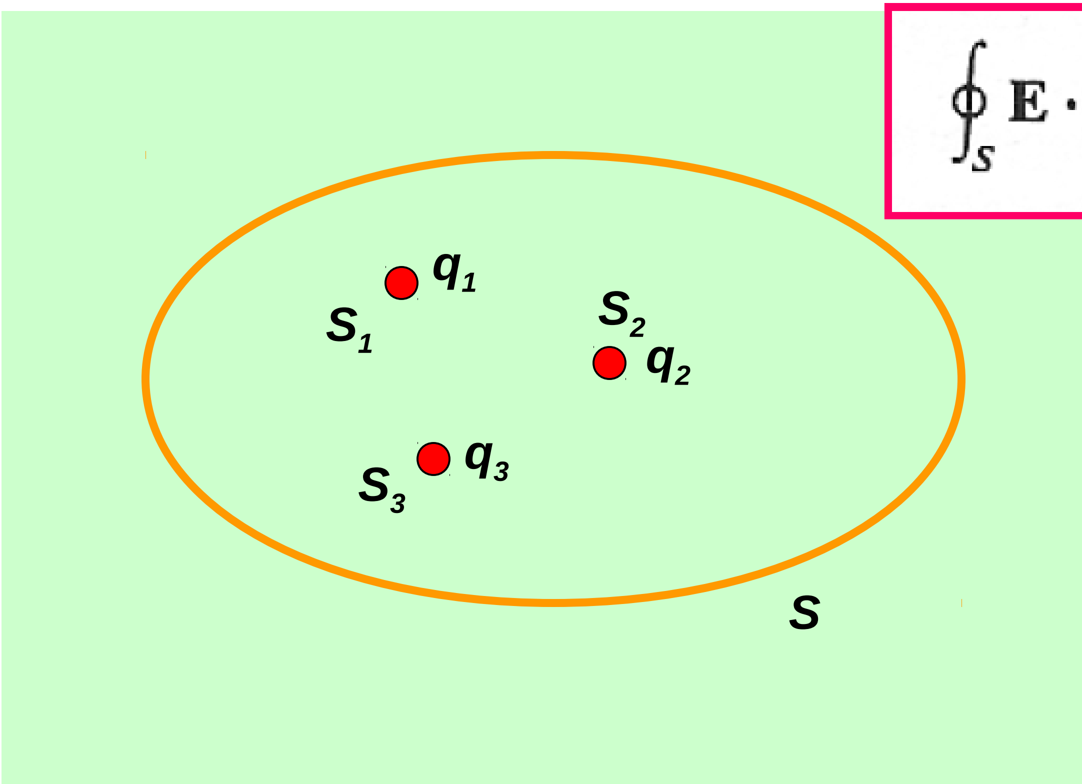
$$Q_P = \int_{V_0}(-\nabla'\cdot\mathbf{P})\,dv' + \oint_{S_0}\mathbf{P}\cdot\mathbf{n}\,da'$$

Carga de polarización

Polarización



Ley de Gauss para dieléctricos



$$\oint_S \mathbf{E} \cdot \mathbf{n} \, da = \frac{1}{\epsilon_0}(Q + Q_P)$$

$$Q = q_1 + q_2 + q_3$$

$$Q_P = \int_{S_1+S_2+S_3} \mathbf{P} \cdot \mathbf{n} \, da + \int_V (-\nabla \cdot \mathbf{P}) \, dv$$

Ley de Gauss para dieléctricos

$$Q_P = -\oint_S \mathbf{P} \cdot \mathbf{n}\, da$$

$$\oint_S (\epsilon_0 \mathbf{E} + \mathbf{P}) \cdot \mathbf{n}\, da = Q$$

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

Vector desplazamiento

$$\oint_S \mathbf{D} \cdot \mathbf{n}\, da = Q$$

Ley de Gauss para dieléctricos

$$\nabla \cdot \mathbf{D} = \rho$$

Forma diferencial

Dieléctricos Lineales

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

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

- *P se anula cuando E se anula*
- *En un material isótropo P // E*

$$\mathbf{D} = \epsilon(E)\mathbf{E}$$

$$\epsilon(E) = \epsilon_0 + \chi(E)$$

Permitividad del medio

$$\epsilon = K\epsilon_0$$

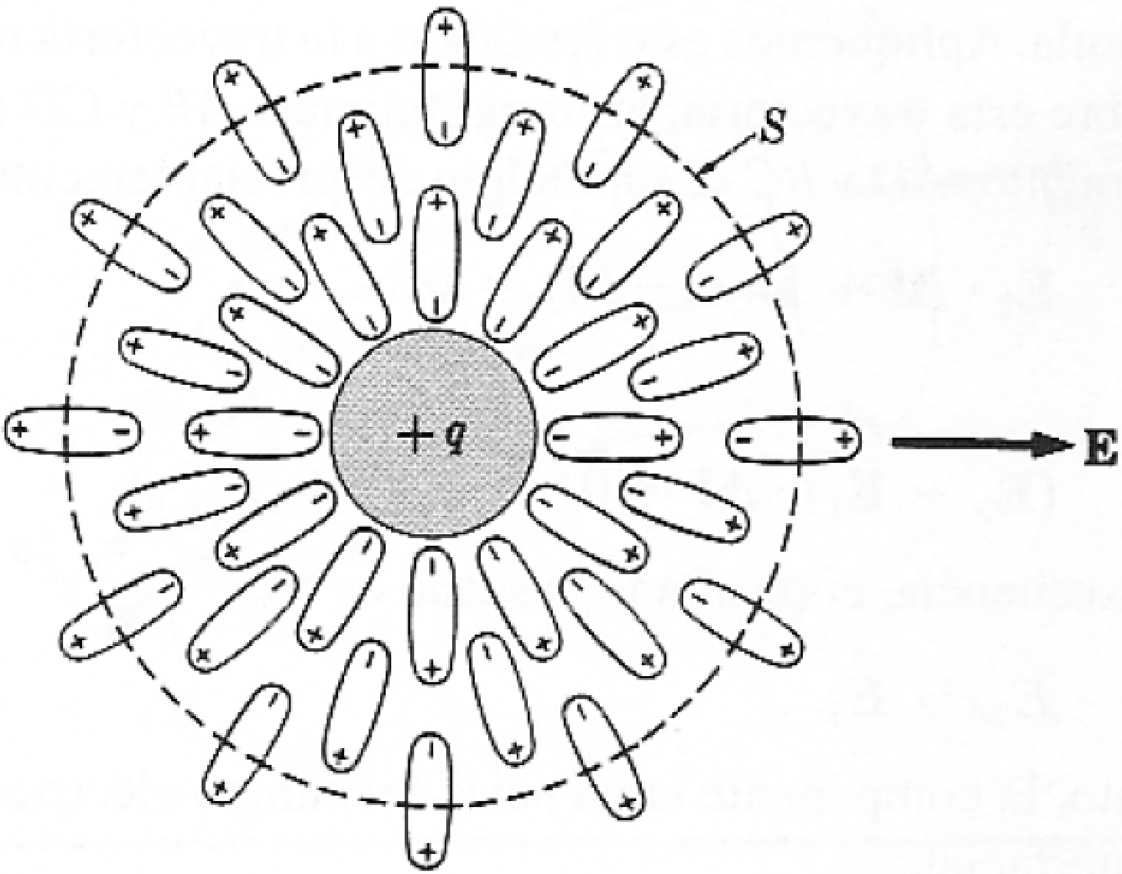
Constante dieléctrica (adimensional)

Constantes dieléctricas y de rigidez

Approximate Dielectric Constants and Dielectric Strengths of Various Materials at Room Temperature

Material	Dielectric Constant κ	Dielectric Strength[a] (10^6 V/m)
Air (dry)	1.000 59	3
Bakelite	4.9	24
Fused quartz	3.78	8
Mylar	3.2	7
Neoprene rubber	6.7	12
Nylon	3.4	14
Paper	3.7	16
Paraffin-impregnated paper	3.5	11
Polystyrene	2.56	24
Polyvinyl chloride	3.4	40
Porcelain	6	12
Pyrex glass	5.6	14
Silicone oil	2.5	15
Strontium titanate	233	8
Teflon	2.1	60
Vacuum	1.000 00	—
Water	80	—

Carga puntual sumergida en un fluido dieléctrico

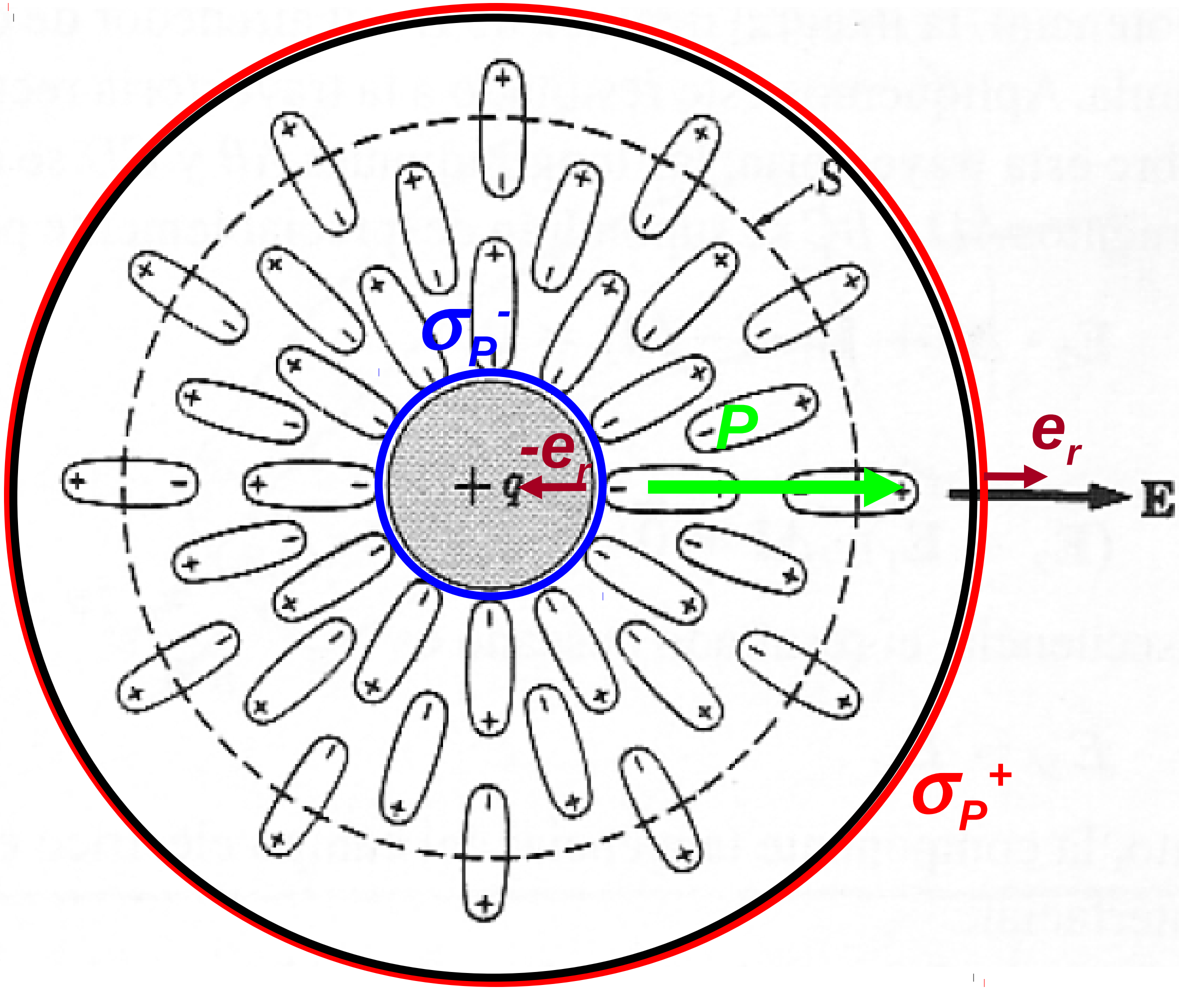


$$\mathbf{D} = \frac{q}{4\pi r^3}\mathbf{r}$$

$$\mathbf{E} = \frac{q}{4\pi K \epsilon_0 r^3}\mathbf{r}$$

$$\mathbf{P} = \frac{(K-1)q}{4\pi K r^3}\mathbf{r}$$

Carga puntual sumergida en un fluido dieléctrico

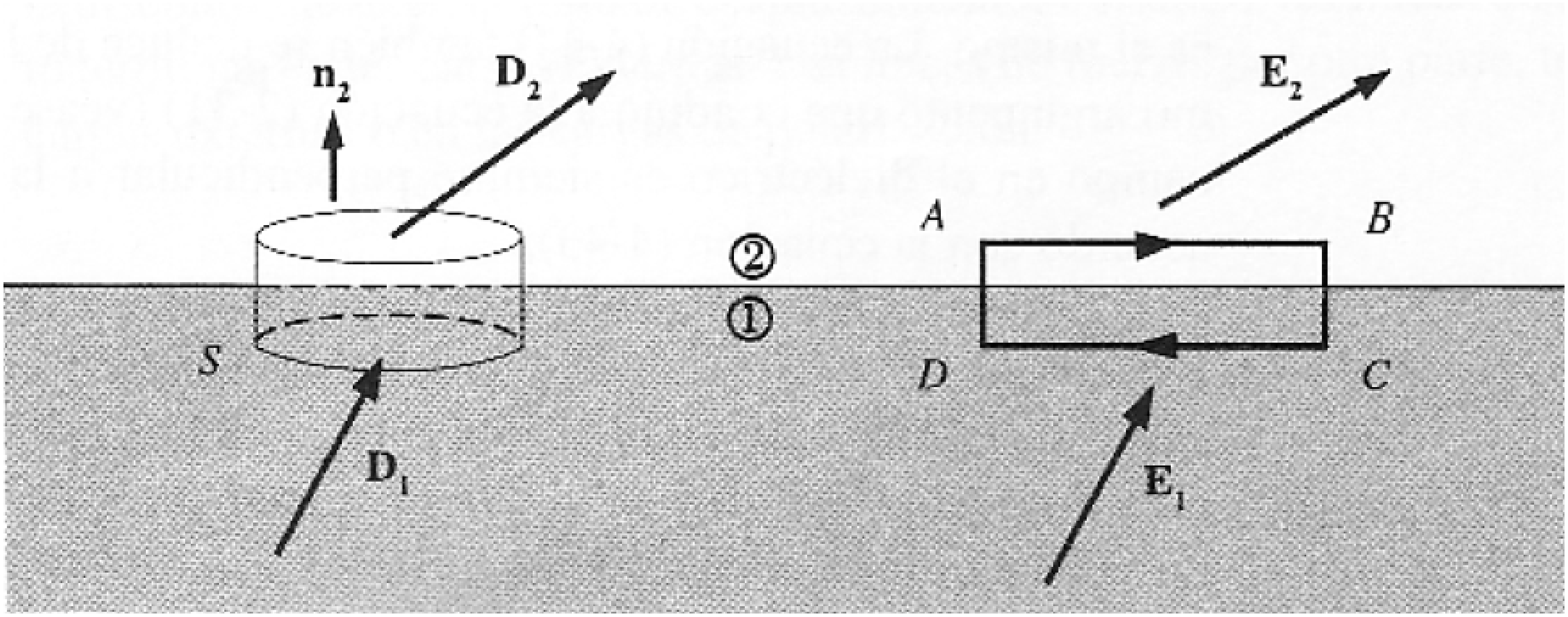


$$\mathbf{D} = \frac{q}{4\pi r^3}\mathbf{r}$$

$$\mathbf{E} = \frac{q}{4\pi K\epsilon_0 r^3}\mathbf{r}$$

$$\mathbf{P} = \frac{(K-1)q}{4\pi K r^3}\mathbf{r}$$

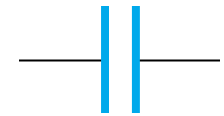
Condiciones en la frontera entre dieléctricos



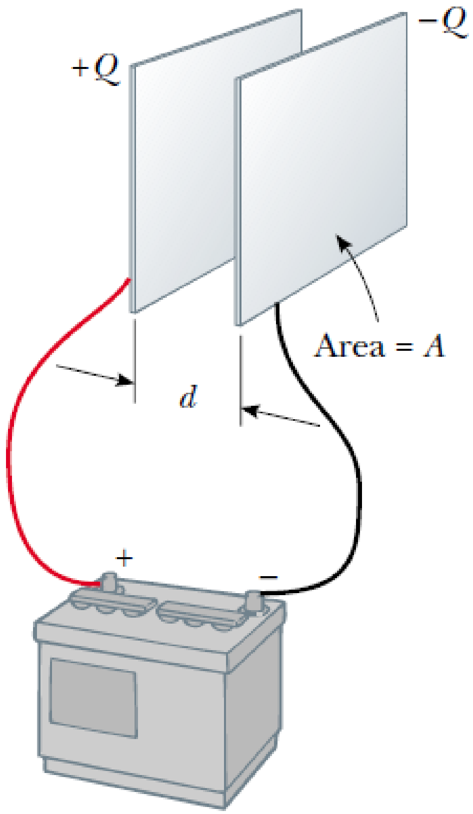
$$(\mathbf{D}_2 - \mathbf{D}_1) \cdot \mathbf{n}_2 = \sigma$$

$$(\mathbf{E}_2 - \mathbf{E}_1) \cdot \Delta \mathbf{l} = 0$$

Capacitores



Capacitor de placas paralelas

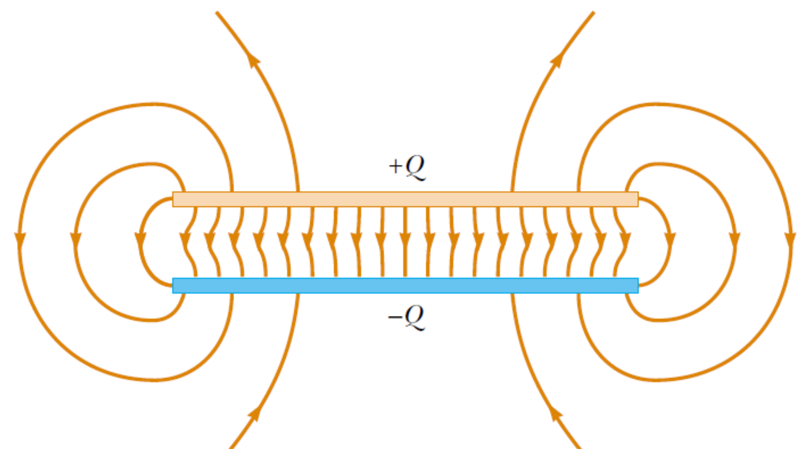


$$C \equiv \frac{Q}{\Delta V}$$

Capacitancia

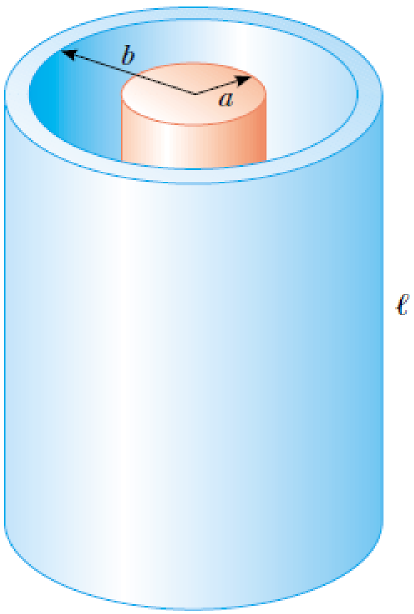
$$1\ \mathrm{F} = 1\ \mathrm{C/V}$$

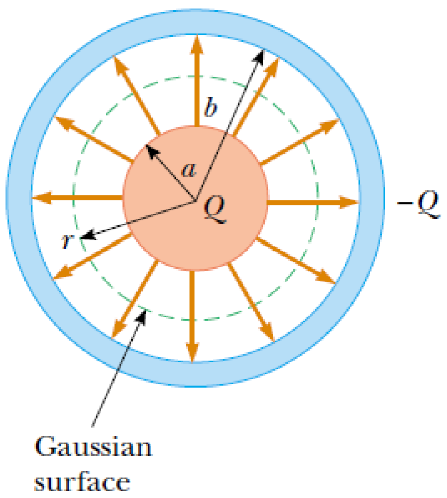
$$C = \frac{\epsilon_0 A}{d}$$



Capacitores

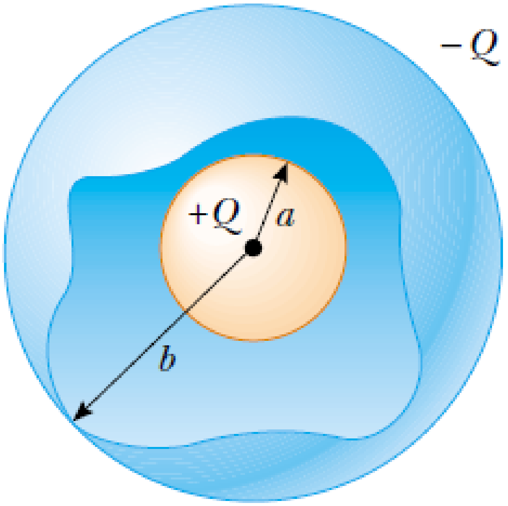
Capacitor cilíndrico





$$C = \frac{Q}{\Delta V} = \frac{Q}{(2k_e Q/\ell)\ln(b/a)}$$

Capacitor esférico



$$C = \frac{Q}{\Delta V} = \frac{ab}{k_e(b-a)}$$