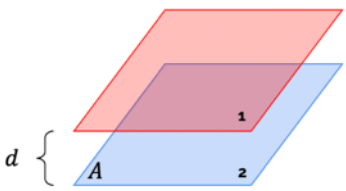
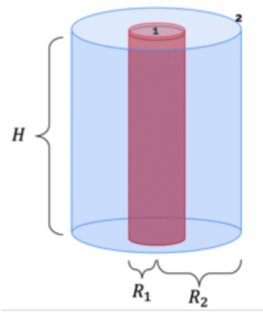
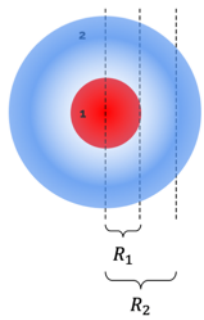
¿Cómo cambia la **capacidad** de un capacitor si lleno el espacio con un **dieléctrico**?

$$Q_1 = C\,(V_1 - V_2)$$







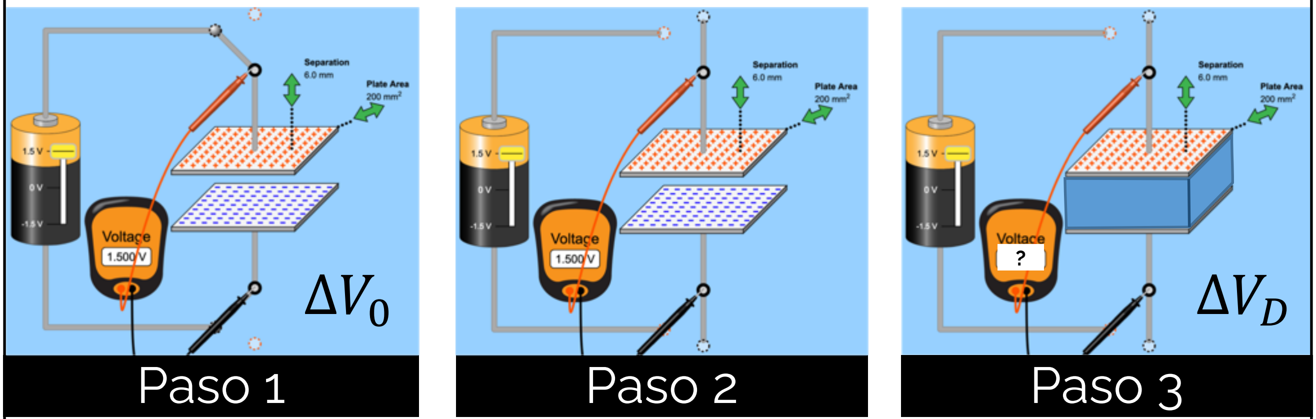
$$C = \frac{\varepsilon_0\, A}{d}$$

$$C = \frac{2\pi\, \varepsilon_0\, H}{\log {R_2}/{R_1}}$$

$$C = \frac{4\pi\, \varepsilon_0}{\left({1}/{R_1} - {1}/{R_2}\right)}$$

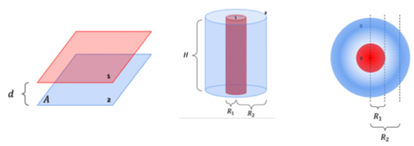
¿Cómo cambia la **capacidad** de un capacitor si lleno el espacio con un **dieléctrico**?

$$Q_1 = C\,(V_1 - V_2) = C\,\Delta V$$



¿Cómo cambia la **capacidad** de un capacitor si lleno el espacio con un **dieléctrico**?

$$Q_1 = C\,(V_1 - V_2)$$



Cualquier otra forma
y tamaño

$$\frac{\Delta V_0}{\Delta V_D} = \frac{\Delta V_0'}{\Delta V_D'} = \frac{\Delta V_0''}{\Delta V_D''} = \ldots = \frac{\Delta V_0'''}{\Delta V_D'''} = \varepsilon_r > 1$$

Depende del material

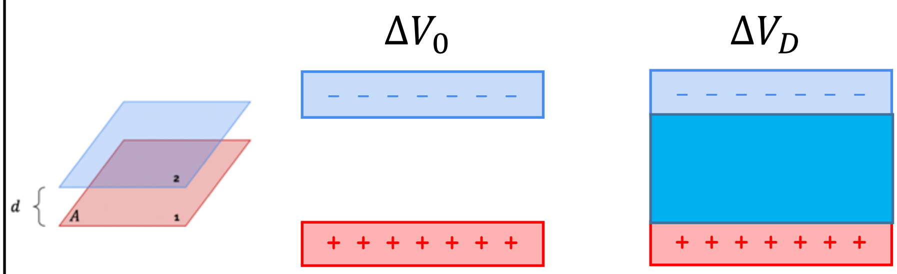
Permitividad eléctrica relativa

$$C_D = \varepsilon_r\, C$$

Ejemplos de Dieléctricos

Example	Polarization	Static ε_r	Comment
Ar gas	Electronic	1.0005	Small N in gases: $\varepsilon_r \approx 1$
Ar liquid (T < 87.3 K)	Electronic	1.53	van der Waals bonding
Si crystal	Electronic polarization due to valence electrons	11.9	Covalent solid; bond polarization
NaCl crystal	Ionic	5.90	Ionic crystalline solid
CsCl crystal	Ionic	7.20	Ionic crystalline solid
Water	Orientational	80	Dipolar liquid
Nitromethane (27 °C)	Orientational	34	Dipolar liquid
PVC (Polyvinyl chloride)	Orientational	7	Dipole orientation partly hindered in the solid

Dieléctricos en un capacitor plano



$$\varepsilon_r = \frac{\Delta V_0}{\Delta V_D} = \frac{-\int_A^B \vec{E}_{tot,0}\, d\vec{\ell}}{-\int_A^B \vec{E}_{tot,D}\, d\vec{\ell}} = \frac{|\vec{E}_{tot,0}|}{|\vec{E}_{tot,D}|}$$

$$|\vec{E}_{tot,0}| = \varepsilon_r\, |\vec{E}_{tot,D}|$$

(medio lineal, isótropo y homogéneo)

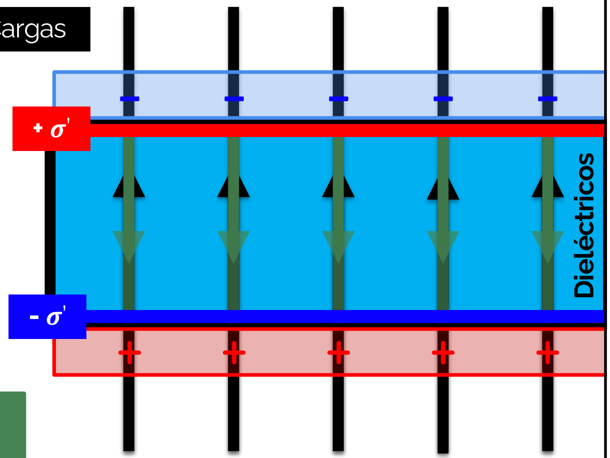
Campo eléctrico en materiales

$$\left|\vec{E}_{tot,D}\right| = \frac{1}{\boldsymbol{\varepsilon_r}}\left|\vec{E}_{tot,0}\right|$$

$$\left|\vec{E}_{tot,D}\right| = \frac{1}{\boldsymbol{\varepsilon_r}}\frac{|\sigma|}{\boldsymbol{\varepsilon_0}} = \frac{|\sigma|}{\boldsymbol{\varepsilon}}$$

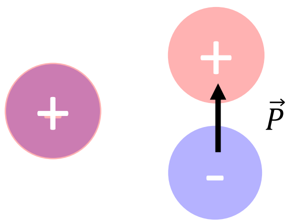
$$\boldsymbol{\varepsilon} = \boldsymbol{\varepsilon_r \varepsilon_0}$$

Permitividad eléctrica



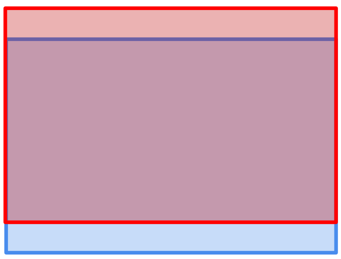
Cargas de polarización y el vector **P**

Sin campo externo | **Con** campo externo



Sin campo externo

Con campo externo

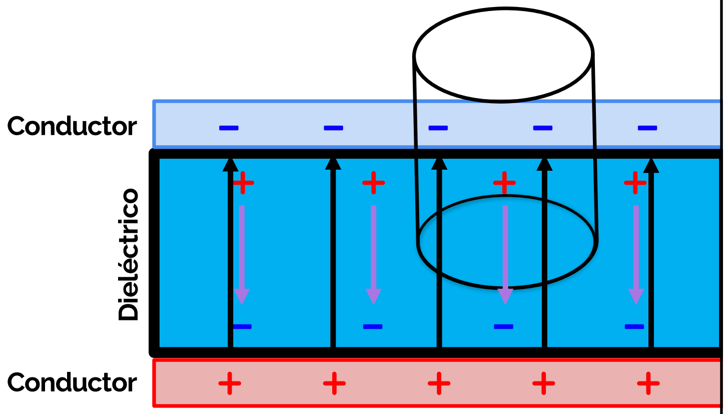


Cargas de polarización

$$\Phi = \frac{Q_{\text{enc}}}{\varepsilon_0}$$

$$Q_{\text{enc}} = Q_{\text{libre}} + Q_{\text{pol}}$$

$$\Phi = \oiint_{S(V)} \vec{E}(\vec{r})\, d\vec{S}$$



$$\sigma_{\text{pol}} = -\left(1 - \frac{\varepsilon_0}{\varepsilon}\right)\sigma$$

Cargas de polarización y el vector **P**

ΔQ

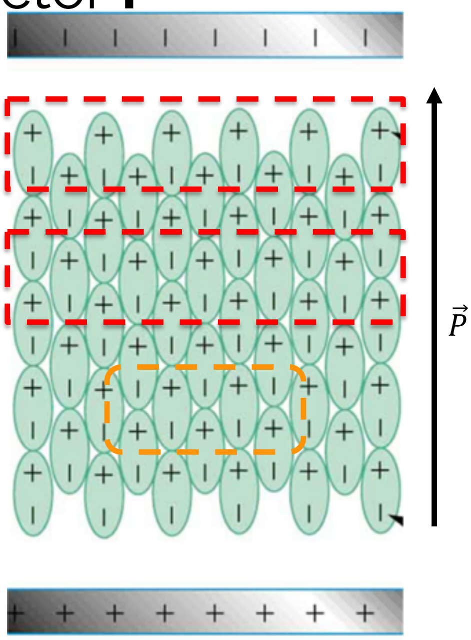
$$\Delta Q = -\oiint_{S(V)} \vec{P} \cdot d\vec{S}$$

$$= \iiint_V \rho_{pol}\, dV'$$

$$\rho_{pol} = -\vec{\nabla} \cdot \vec{P}$$

$$\sigma_{pol} = \vec{P} \cdot \hat{n}$$

$$\rho_{pol} = 0$$



Las ecuaciones de **Maxwell** en presencia de **Dieléctricos**

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0} = \frac{\rho_{\text{libre}} + \rho_{\text{pol}}}{\varepsilon_0}$$

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho_{\text{libre}} - \vec{\nabla} \cdot \vec{P}}{\varepsilon_0}$$

$$\vec{\nabla} \cdot \left(\vec{E} + \frac{\vec{P}}{\varepsilon_0}\right) = \frac{\rho_{\text{libre}}}{\varepsilon_0}$$

$$\vec{\nabla} \cdot \left(\boldsymbol{\varepsilon_0 \vec{E} + \vec{P}}\right) = \rho_{\text{libre}}$$

$$\vec{\nabla} \cdot \boldsymbol{\vec{D}} = \rho_{\text{libre}}$$

$$\boldsymbol{\vec{D} = \varepsilon_0 \vec{E} + \vec{P}}$$
$$\boldsymbol{= \varepsilon_r \varepsilon_0 \vec{E} = \varepsilon \, \vec{E}}$$

(medio lineal, isótropo y homogéneo)