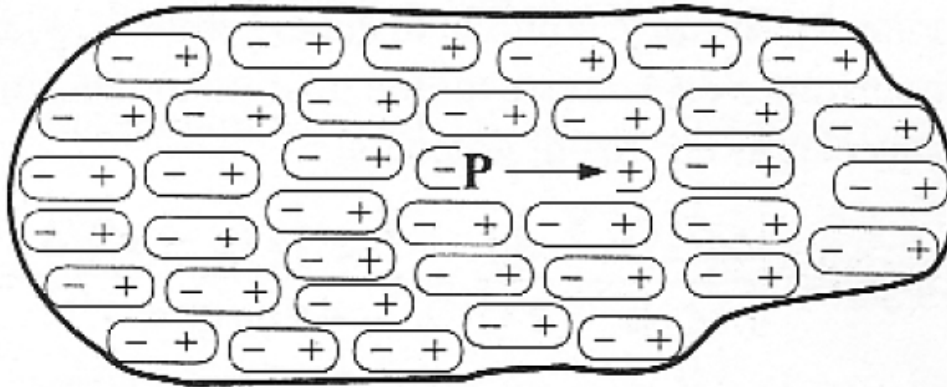


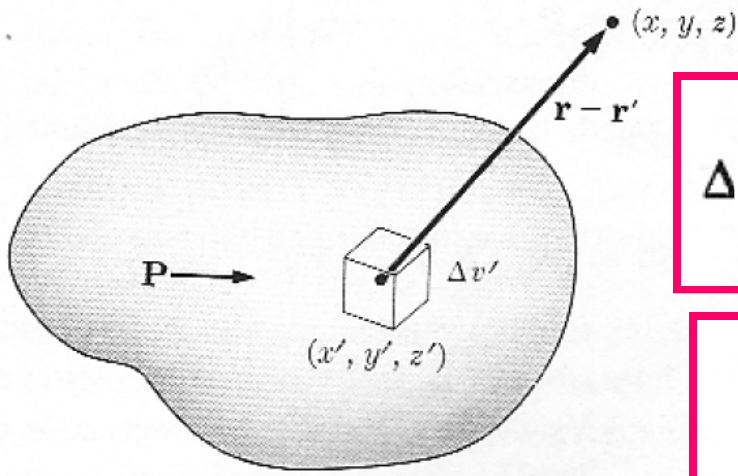
Electricidad



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

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

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

densidades de carga de polarización

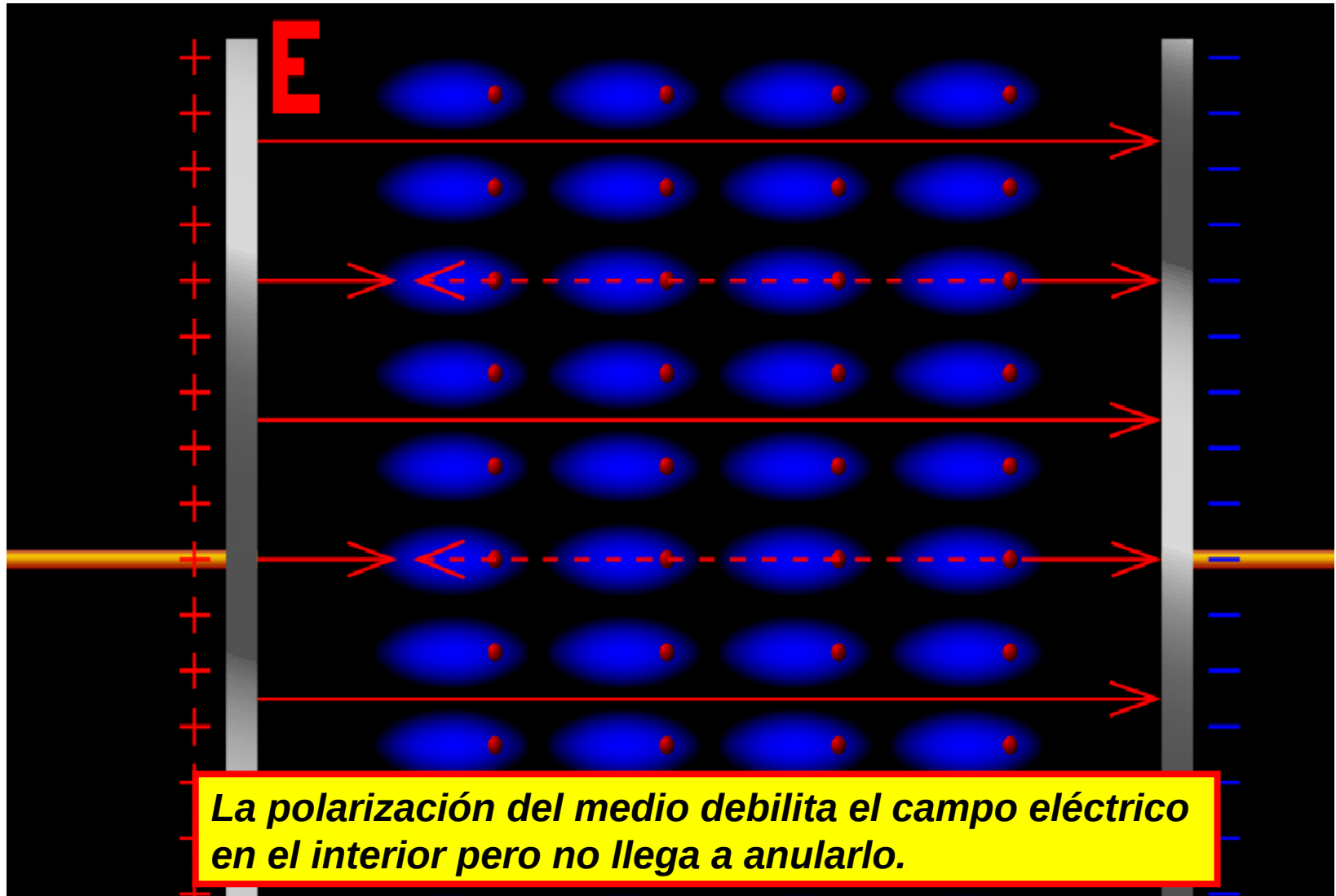
$$v(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \left[\oint_{S_0} \frac{\sigma_P da'}{|\mathbf{r} - \mathbf{r}'|} + \int_{V_0} \frac{\rho_P dv'}{|\mathbf{r} - \mathbf{r}'|} \right]$$

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

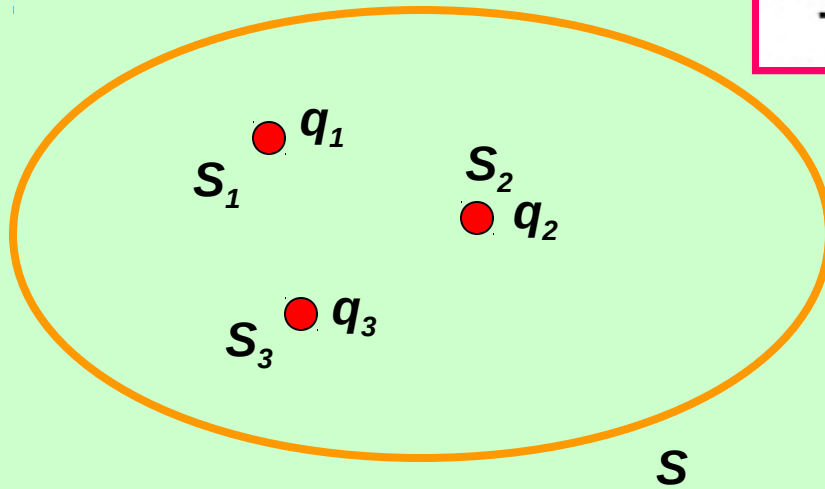
$$Q_P = \int_{V_0} (-\nabla' \cdot \mathbf{P}) dv' + \oint_{S_0} \mathbf{P} \cdot \mathbf{n} da'$$

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 $P \parallel E$

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

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

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	—



HANDBOOK OF
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Editor-in-Chief

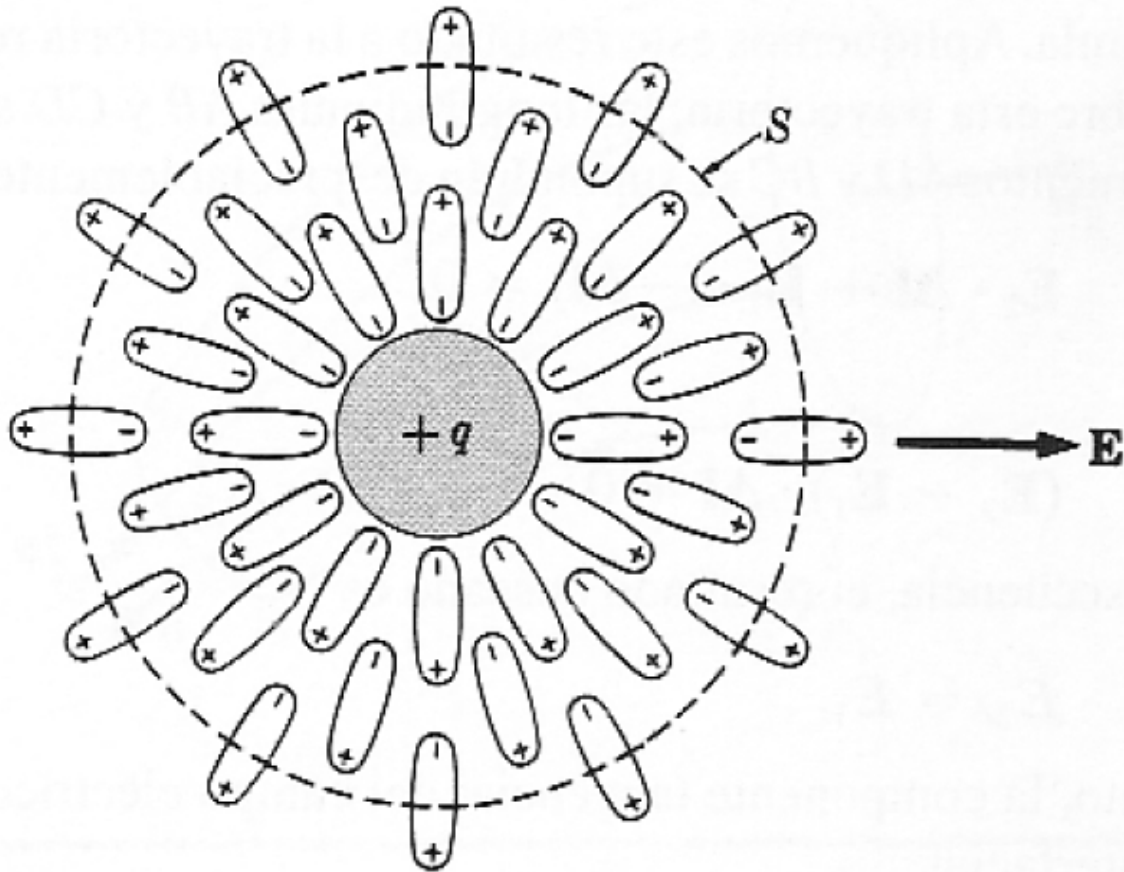
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TABLE 2. Dielectric Strength of Liquids

Material	Dielectric strength kV/mm	Ref.	Material
Helium, He, liquid, 4.2 K	10	9	Octane, C ₈ H ₁₈
Static	10	11	
Dynamic	5	11	
	23	12	Ethylbenzene, C ₈ H ₁₀
Nitrogen, N ₂ , liquid, 77K			Propylbenzene, C ₉ H ₁₂
Coaxial cylinder electrodes	20	10	Isopropylbenzene, C ₉ H ₁₂
Sphere to plane electrodes	60	10	Decane, C ₁₀ H ₂₂
Water, H ₂ O, distilled	65-70	13	Synthetic Paraffin Mixture Synfluid 2cSt PAO
Carbon tetrachloride, CCl ₄	5.5	14	Butylbenzene, C ₁₀ H ₁₄
	16.0	15	Isobutylbenzene, C ₁₀ H ₁₄
Hexane, C ₆ H ₁₄	42.0	16	Silicone oils—polydimethylsiloxanes, (CH ₃) ₃ Si-O-[Si(CH ₃) ₂] _x -O-Si(CH ₃) ₃
Two 2.54 cm diameter spherical electrodes, 50.8 μm space	156	17,18	Polydimethylsiloxane silicone fluid
Cyclohexane, C ₆ H ₁₂	42-48	16	Dimethyl silicone
2-Methylpentane, C ₆ H ₁₄	149	17,18	Phenylmethyl silicone
2,2-Dimethylbutane, C ₆ H ₁₄	133	17,18	Silicone oil, Basilone M50
2,3-Dimethylbutane, C ₆ H ₁₄	138	17,18	Mineral insulating oils
Benzene, C ₆ H ₆	163	17,18	Polybutene oil for capacitors
Chlorobenzene, C ₆ H ₅ Cl	7.1	14	Transformer dielectric liquid
	18.8	15	Isopropylbiphenyl capacitor oil
2,2,4-Trimethylpentane, C ₈ H ₁₈	140	17,18	Transformer oil
Phenylxylylethane	23.6	19	Transformer oil Agip ITE 360
Heptane, C ₇ H ₁₆	166	17,18	

Carga puntual sumergida en un fluido dieléctrico

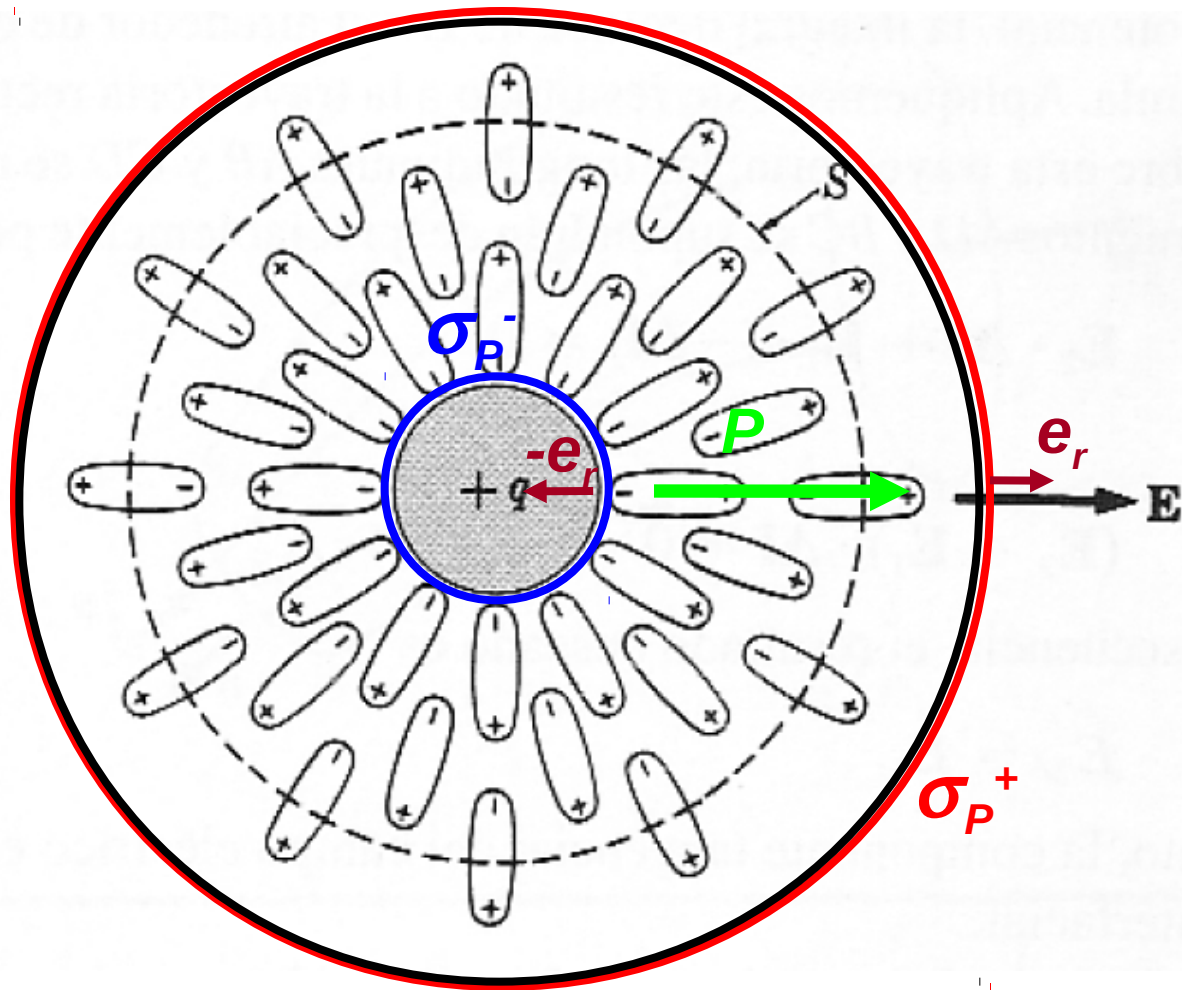


$$\mathbf{D} = \frac{q}{4\pi r^3} \mathbf{r}$$

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

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

Carga puntual sumergida en un fluido dieléctrico

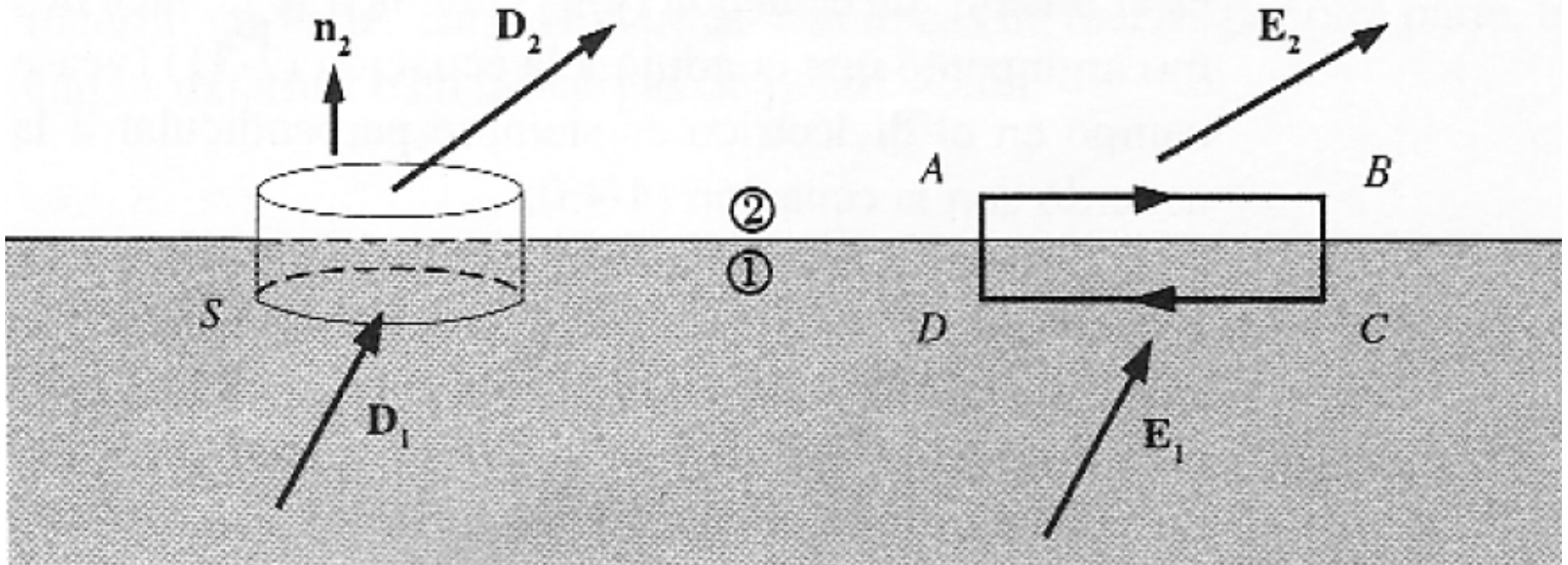


$$\mathbf{D} = \frac{q}{4\pi r^3} \mathbf{r}$$

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

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

Condiciones en la frontera entre dieléctricos



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

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