

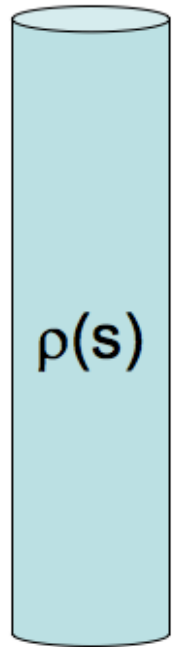
True or False

"Frozen" or "Baked-In" Polarization means that the dipoles in the material will shift when an external field is present.

- A. True
- B. False
- C. ???

A solid non-conducting dielectric rod has been injected ("doped") with a fixed, known charge distribution $\rho(s)$. (The material responds, polarizing internally.)

When computing D in the rod, do you treat this $\rho(s)$ as the "free charges" or "bound charges"?



- A. "free charge"
- B. "bound charge"
- C. Neither of these - $\rho(s)$ is some combination of free and bound
- D. Something else.

We define "Electric Displacement" or "D" field,

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

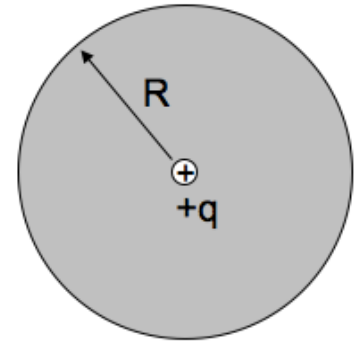
If you put a dielectric in an **external** field, it polarizes, adding a new **induced** field (from the bound charges). These superpose, making a **total** electric field. Which of these three E fields is the "E" in the formula for D above?

- A. \mathbf{E}_{ext}
- B. $\mathbf{E}_{induced}$
- C. \mathbf{E}_{tot}

We define $\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$, with

$$\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$$

A point charge $+q$ is placed at the center of a dielectric sphere (radius R). There are no other free charges anywhere. What is $|\mathbf{D}(r)|$?



- A. $q/(4\pi r^2)$ everywhere
- B. $q/(4\epsilon_0\pi r^2)$ everywhere
- C. $q/(4\pi r^2)$ for $r < R$, but $q/(4\epsilon_0\pi r^2)$ for $r > R$
- D. None of the above, it's more complicated
- E. We need more info to answer!

For linear dielectrics the relationship between the polarization, \mathbf{P} , and the total electric field, \mathbf{E} , is given by:

$$\mathbf{P} = \epsilon_0 \chi_e \mathbf{E}$$

where χ_e is typically a known constant. Think about what happens if (1) $\chi_e \rightarrow 0$ or if (2) $\chi_e \rightarrow \infty$. What do each of these limits describe?

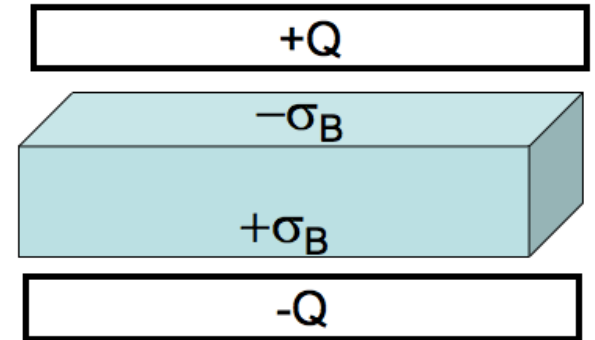
- A. (1) describes a metal and (2) describes vacuum
- B. (1) describes vacuum and (2) describes a metal
- C. Any material can give either $\chi_e \rightarrow 0$ or $\chi_e \rightarrow \infty$

When there are no free charges, $\rho_{free} = 0$, in a linear dielectric material, the electric potential, V , in that material satisfies Laplace's equation.

$$\nabla^2 V = 0$$

- A. True
- B. False
- C. ???

A very large (effectively infinite) capacitor has charge Q . A neutral (*homogeneous*) dielectric is inserted into the gap (and of course, it will polarize). We want to find \mathbf{E} everywhere.



Which equation would you head to first?

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

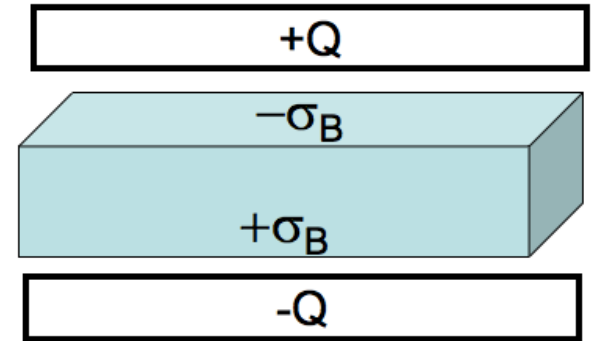
B. $\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$

C. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$

D. More than one of these would work

E. Can't solve unless we know the dielectric is linear.

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Which equation would you head to first?

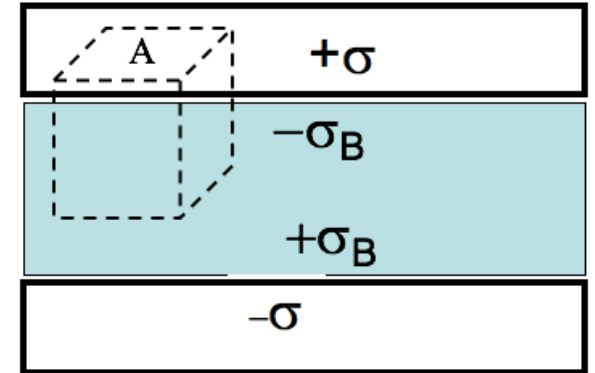
A. $\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$

B. $\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$

C. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$

D. More than one of these would work

An ideal (large) capacitor has charge Q . A neutral linear dielectric is inserted into the gap. We want to find \mathbf{D} in the dielectric.

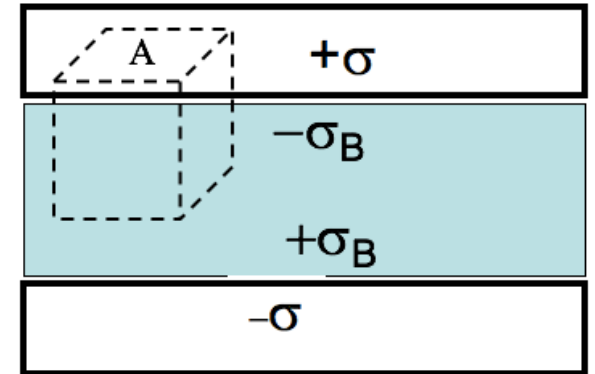


$$\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$$

For the Gaussian pillbox shown, what is $Q_{free,enclosed}$?

- A. σA
- B. $-\sigma_B A$
- C. $(\sigma - \sigma_B)A$
- D. $(\sigma + \sigma_B)A$
- E. Something else

An ideal (large) capacitor has charge Q . A neutral linear dielectric is inserted into the gap. We want to find \mathbf{D} in the dielectric.

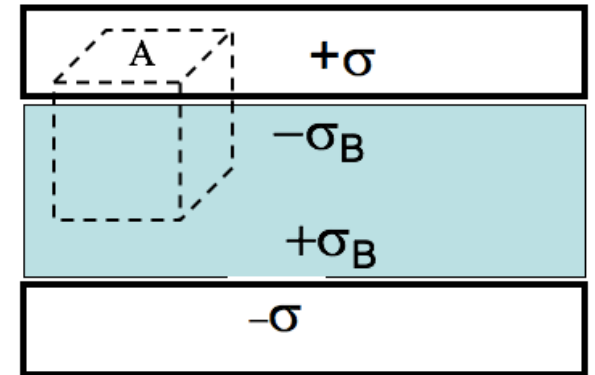


$$\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$$

Is \mathbf{D} zero INSIDE the metal? (i.e., on the top face of our cubical Gaussian surface)

- A. It must be zero in there.
- B. It depends.
- C. It is definitely not zero in there.

An ideal (large) capacitor has charge Q . A neutral linear dielectric is inserted into the gap. We want to find \mathbf{D} in the dielectric.

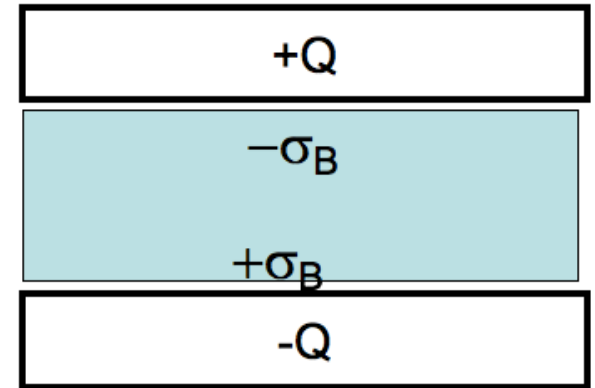


$$\oint \mathbf{D} \cdot d\mathbf{A} = Q_{free}$$

What is $|\mathbf{D}|$ in the dielectric?

- A. σ
- B. 2σ
- C. $\sigma/2$
- D. $\sigma + \sigma_b$
- E. Something else

An ideal (large) capacitor has charge Q . A neutral linear dielectric is inserted into the gap. Now that we have \mathbf{D} in the dielectric, what is \mathbf{E} inside the dielectric?



- A. $\mathbf{E} = \mathbf{D}\epsilon_0\epsilon_r$
- B. $\mathbf{E} = \mathbf{D}/\epsilon_0\epsilon_r$
- C. $\mathbf{E} = \mathbf{D}\epsilon_0$
- D. $\mathbf{E} = \mathbf{D}/\epsilon_0$
- E. Not so simple! Need another method