

# Workbook



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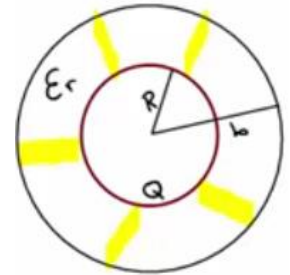
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# Dielectric Materials

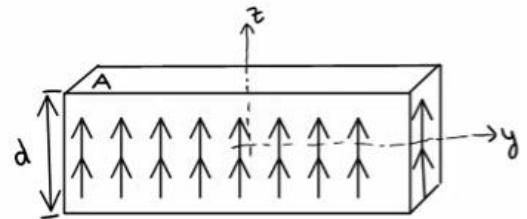
## Dielectric Materials

### Questions

- 1) A dielectric material is placed between two concentric spherical shells. The inner shell has radius  $R$  and charge  $Q$ , and the outer shell has radius  $b$ . Calculate the electric field.

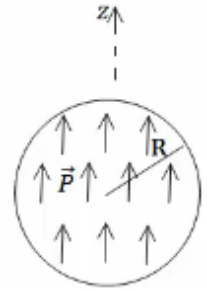


- 2) A box of area  $A$  and width  $d$  is polarized with a polarization density of  $\vec{P} = P_0 \frac{z}{d} \hat{z}$ . The origin is at the center of the box.
- Find the bound surface charge, as well as the bound volume charge.
  - What is the total bound charge in the box?



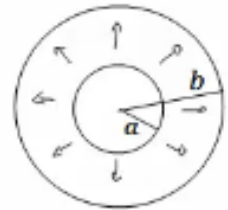
- 3) A sphere of radius  $R$  is polarised with polarisation density  $\vec{P} = A\vec{r}$ .  $A$  is a constant and  $\vec{r}$  is a vector from the center of the sphere.
- Calculate the bound charge densities.
  - Calculate the electric field inside and outside the sphere.
- 4) A cylinder of radius  $R$  and length  $L$  is uniformly polarised along its axis of symmetry. Calculate the bound charge densities and draw the field lines under the following circumstances:
- $R \ll L$
  - $L \ll R$
  - $R \approx L$

- 5) A sphere of radius  $R$  has polarisation vector  $\vec{P} = P_0 \hat{z}$ . Calculate the electric field.

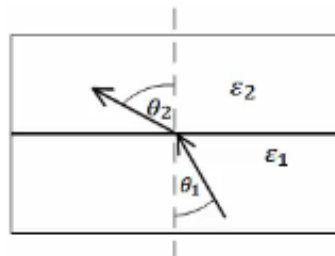


- 6) A spherical shell of inner radius  $a$  and outer radius  $b$  is made of dielectric material, of polarisation density  $\vec{P}(\vec{r}) = \frac{A}{r} \hat{r}$ .

$A$  is a constant and  $r$  is the distance from the center of the shell. Calculate the electric field throughout, once by making use of the bound charges, and again by making use of the displacement vector.



- 7) A light ray is made up of an electric and magnetic field propagating in space. Show that if the ray passes from dielectric material of constant  $\epsilon_1$  into another dielectric material of constant  $\epsilon_2$ , then we get Snell's law. Snell's law:  $\tan \theta_1 = \frac{\epsilon_1}{\epsilon_2} \tan \theta_2$



\*For the solutions go see the videos