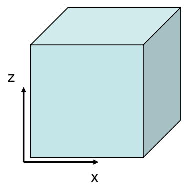
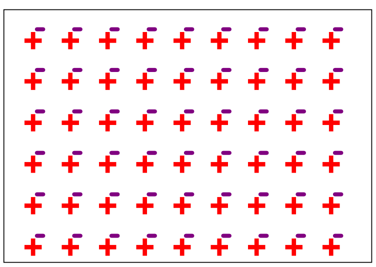
4.1

The cube below (side a) has uniform polarization $\mathbf{P}_0$
(which points in the z direction.)
What is the total dipole moment of this cube?

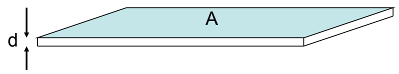
A) zero
B) $a^3\, \mathbf{P}_0$
C) $\mathbf{P}_0$
D) $\mathbf{P}_0 / a^3$
E) $2\, \mathbf{P}_0\, a^2$





MD8-2

A VERY thin slab of thickness d and area A has *volume charge density* $\rho = Q / V$.
Because it's so thin, we may think of it as a *surface charge density* $\sigma = Q / A$.



The relation between ρ and σ is

A) $\sigma = \rho$

B) $\sigma = d\,\rho$ C) $d\,\sigma = \rho$

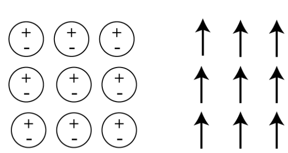
D) $\sigma = V\,\rho$ E) $V\,\sigma = \rho$

Imagine two fluids, red (+) and blue (-), each uniform, identical, in a rectangular shape (area A, height H).
This fluid has N "atoms"/m^3, and each "atom" (or unit) has available a charge q (which can separate/move). Imagine the red fluid moves UP the page, uniformly, a distance "d".

1) How much charge Q appears on the top surface? (on the bottom? the sides?)
2) What is σ on the top, in terms N, q, d, A, and/or H
3) What is the polarization P in terms of those variables?
4) What is σ on the top in terms of P?=
5) What if we displace the fluid that same distance "d", but at an angle θ with respect to the vertical. What are the answers above?

4.3

In the following case, is the bound surface and volume charge zero or nonzero?

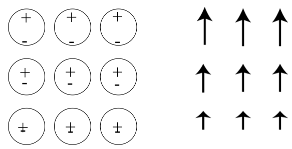


Physical dipoles idealized dipoles

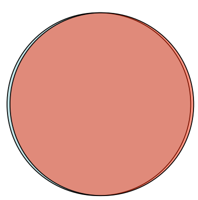
A. $\sigma_b = 0,\ \rho_b \neq 0$
B. $\sigma_b \neq 0,\ \rho_b \neq 0$
C. $\sigma_b = 0,\ \rho_b = 0$
D. $\sigma_b \neq 0,\ \rho_b = 0$

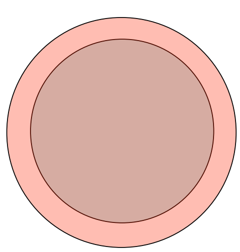
4.3
b

In the following case, is the bound surface and volume charge zero or nonzero?


Physical dipoles   idealized dipoles

A. $\sigma_b = 0$, $\rho_b \neq 0$
B. $\sigma_b \neq 0$, $\rho_b \neq 0$
C. $\sigma_b = 0$, $\rho_b = 0$
D. $\sigma_b \neq 0$, $\rho_b = 0$

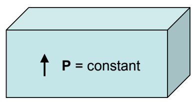




MD8-3

A linear dielectric in the shape of a rectangular block has a uniform polarization **P** (due to an external E-field) parallel to an edge, as shown. How many of the sides of the block have a non-zero surface charge density?

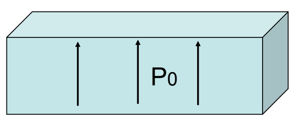
A) 1 B) 2 C) 4 D) 6 E) 0



4.4

A dielectric slab (top area A, height h) has been polarized, with **P**=P_0 (in the +z direction)

What is the surface charge density, σ_b, on the bottom surface?



A) 0
B) $-P_0$
C) P_0
D) P_0 A h
E) P_0 A

Are σ_b and ρ_b due to real charges?

A) Of course not! They are as fictitious as it gets! (Like in the 'method of images.')

B) Of course they are! They are as real as it gets! (Like σ and ρ in Chapter 2.)

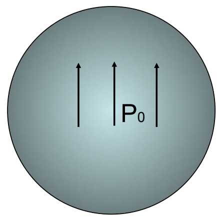
C) I have no idea ☹

A dielectric sphere is uniformly polarized,

$$\mathbf{P} = +P_0\,\hat{z}$$

What is the surface charge density?

A) 0
B) Non-zero Constant
C) cos(θ)
D) sin(θ)
E) ??

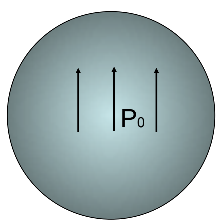


A dielectric sphere is uniformly polarized,

$$\mathbf{P} = +P_0\,\hat{z}$$

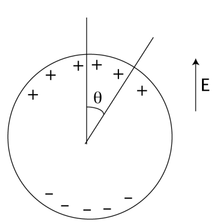
What is the volume charge density?

A) 0
B) Non-zero Constant
C) Depends on r, but not θ
D) Depends on θ, but not r
E) ?



4.2 a

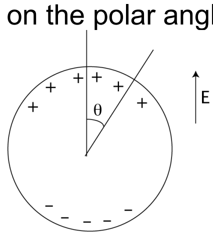
You put a conducting sphere in a uniform E-field. How do you expect the surface charge to depend on the polar angle (θ)?



a) Constant
b) cos(θ)
c) sin(θ)
d) Nothing simple, it will have to be an infinite series of sin's and cos's with coefficients.

4.2
b

Now what if the sphere is a dielectric? How do you expect the bound surface charge to depend on the polar angle (θ)?



a) Constant
b) cos(θ)
c) sin(θ)
d) Nothing simple, it will have to be an infinite series of sin's and cos's with coefficients.