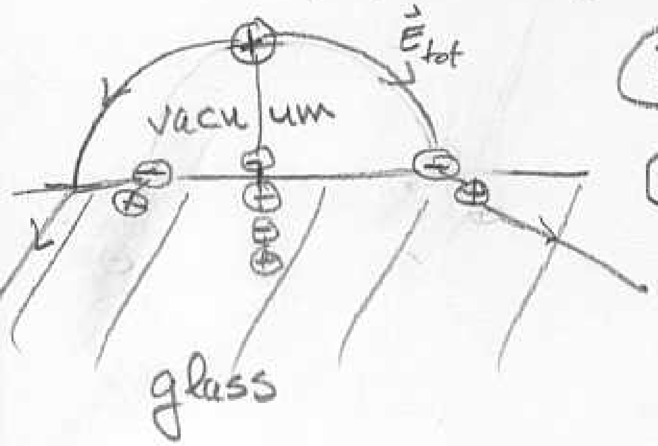
PHGN361 Exam 2: NAME KEY

1. (10 pts) A point charge is above a huge flat slab of glass (linear dielectric), as in the in-class applet. Explain your understanding of this situation in as much detail as possible.



(3pts) $\vec{E}_{tot}$ bends at interface

(3pts) Bending occurs due to σ_b

(2pts) $\vec{E}_{tot}$ is not radial in vacuum due to $\vec{E}$ from σ_b

(2pts) $\sigma_b = \vec{P}\cdot\hat{n} = \epsilon_0 \chi_e E^{\perp}_{tot}$

$$\sigma_b = \epsilon_0 \chi_e \left(E^{\perp}_{\substack{point\\charge}} + E^{\perp}_{\substack{bound\\charge}}\right)$$

2. (10 pts) Derive an expression for (a) the potential and (b) the electric field inside a parallel plate capacitor using separation of variables. The plates are separated by a distance d along the z axis. Assume infinite plates and a 12 V battery across the plates with the lower plate grounded.

$V(x,y,z) = XYZ$ put into $\nabla^2 V = 0 = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

$$YZ\frac{d^2X}{dx^2} + XZ\frac{d^2Y}{dy^2} + XY\frac{d^2Z}{dz^2} = 0$$

$$C_1 + C_2 + C_3 = 0$$

$Y(y)$ can not depend on y since changing y position in ∞ capacitor yields same situation $\Rightarrow C_2 = 0$

$X(y)$ can not depend on x for same reason $\Rightarrow C_1 = 0$

$C_1 + C_2 + C_3 = 0 \Rightarrow C_3 = 0$ ODE is $\frac{d^2Z}{dz^2} = 0$

($C_1 = 0$, $C_2 = 0$)

$\Rightarrow Z(z) = mx + b$ with bndry conditions $Z(z=0) = 0$, $Z(z=d) = 12$

($m = \frac{12}{d}$, $b = 0$)