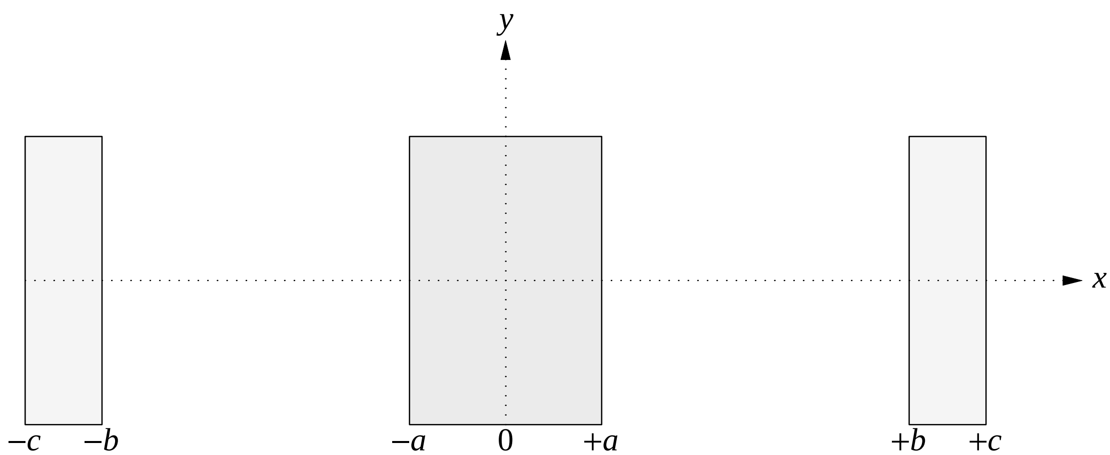
4. (40 pts.) Charge is distributed uniformly throughout a large plane insulating slab of thickness $2a$. The charge density is ρ (in Coulombs per cubic meter). The midplane of the slab is the $y-z$ plane (see figure). In addition, there are two neutral conducting planes parallel to the slab arranged as shown. (These planes are effectively infinite in the y and z directions.) *Note*: Throughout this problem, you don't have to repeat calculations that you already did in earlier parts. Simply explain briefly what you are doing and reuse those calculations that still apply.



a. (15 pts.) Use Gauss's law to calculate the magnitude of the electric field for $0 < x < a$. Show your work clearly.

b. (5 pts.) Use Gauss's law to calculate the magnitude of electric field for $a < x < b$.

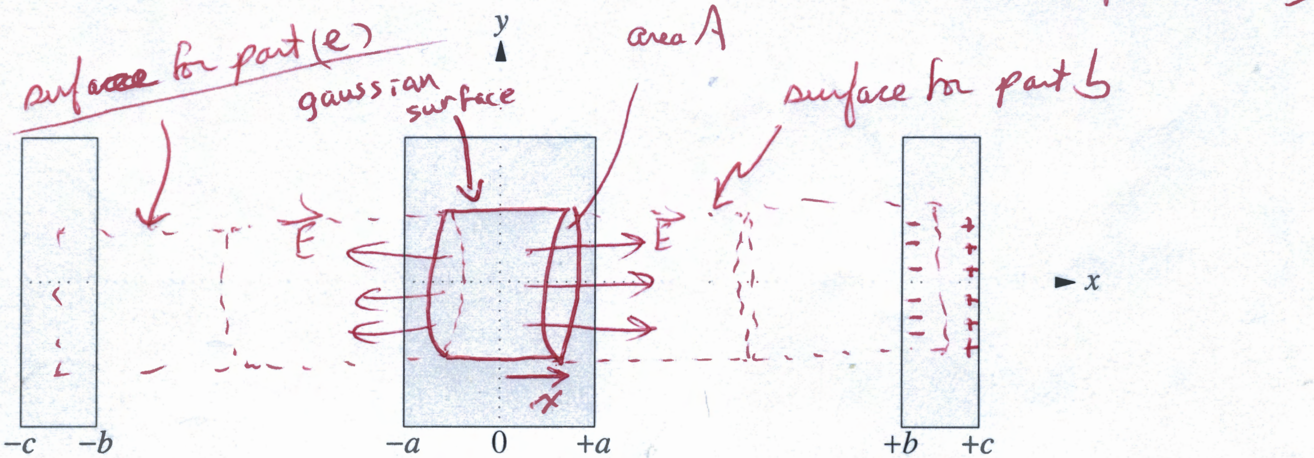
c. (5 pts.) What is the magnitude of the electric field for $b < x < c$?

d. (5 pts.) What is the magnitude of the electric field for $c < x$?

e. (10 pts.) What is the charge density on the surface of the conductor at $x = b$?

4. (40 pts.) Charge is distributed uniformly throughout a large plane insulating slab of thickness $2a$. The charge density is ρ (in Coulombs per cubic meter). The midplane of the slab is the $y-z$ plane (see figure). In addition, there are two neutral conducting planes parallel to the slab arranged as shown. (These planes are effectively infinite in the y and z directions.) *Note*: Throughout this problem, you don't have to repeat calculations that you already did in earlier parts. Simply explain briefly what you are doing and reuse those calculations that still apply.

[See Example 22-7]



a. (15 pts.) Use Gauss's law to calculate the magnitude of the electric field for $0 < x < a$. Show your work clearly.

(a) The Gaussian surface is a cylinder of length $2x$ and end areas A.

$$\oint \vec{E}\cdot d\vec{A} = Q_{inside}/\epsilon_0$$

$$E(2A) = \rho(A\,2x)/\epsilon_0$$

$$\boxed{E = \rho x/\epsilon_0}$$

(b) $a<x<b$: Q_{inside} is now $\rho(A\,2a)$. The flux is unchanged

$$E(2A) = \rho(A\,2a)/\epsilon_0$$

$$\boxed{E = \rho a/\epsilon_0}$$

(c) $b<x<c$: $\boxed{E=0.}$ (inside a conductor.)

(d) $c<x$: Same calculation as in (b), Q_{inside} doesn't change

$$\boxed{E=\rho a/\epsilon_0}$$

(e) $\Phi = Q_{inside}/\epsilon_0$

$$E(2A) = [\rho A 2a + \sigma(2A)]/\epsilon_0$$

$$0 = \rho a + \sigma \rightarrow \boxed{\sigma = -\rho a}$$