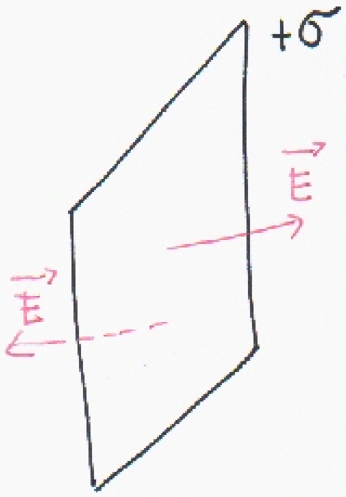
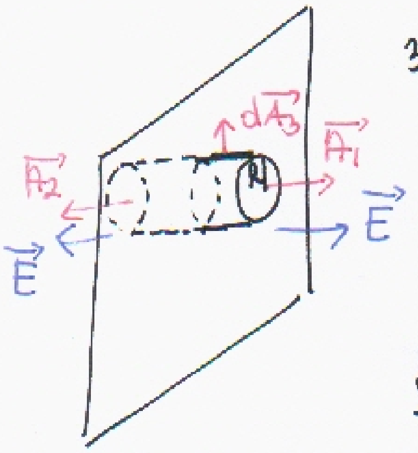
Electric field due to infinite charged plane



1. Planar symetry
   E-field constant at given distance from the plane
2. Choose Gaussian surface
   - ends have to be flat (planar symetry)

   e.g. cylinder, cube

Option 1 - cylindrical Gaussian surface



3. Find the electric field flux through the surface
   → determine the direction of E-field
   → determine the direction of surface vectors

$$\oiint \vec{E}\cdot d\vec{A} = \int_{cap1} \vec{E}\cdot\vec{A_1} + \int_{cap2} \vec{E}\cdot\vec{A_2} + \int_{core} \vec{E}\cdot d\vec{A_3}$$

$$\vec{E} \perp d\vec{A_3}$$

$$\oiint \vec{E}\cdot d\vec{A} = EA_1 + EA_2 = 2EA$$

$$A_1 = A_2 = A$$

$$\oiint \vec{E}\cdot d\vec{A} = 2EA = 2E\cdot\pi R^2$$

4. Find charged enclosed within the cylinder

$$q_{enc} = \sigma\cdot\pi R^2$$

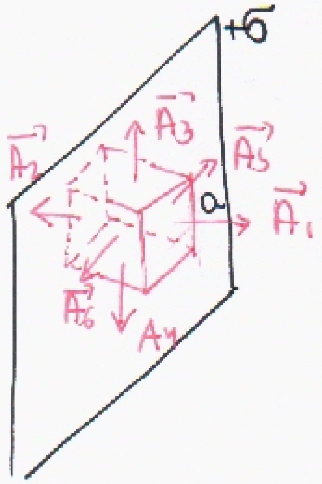
5. Apply Gauss' Law

$$\oiint \vec{E}\cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$2E\cancel{\pi R^2} = \frac{\sigma\cancel{\pi R^2}}{\varepsilon_0}$$

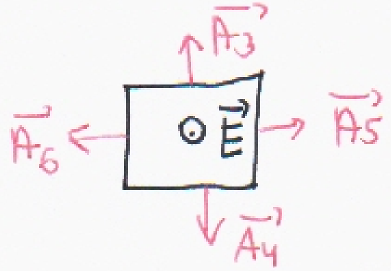
$$E = \frac{\sigma}{2\varepsilon_0}$$

Option 2 - cubical Gaussian surface



Flux through $A_3 - A_6 = 0$

because $\vec{A_3} - \vec{A_6} \perp \vec{E}$



Flux through $\vec{A_1}$ & $\vec{A_2}$

$$\oiint \vec{E} \cdot d\vec{A} = E \cdot A_1 + EA_2 = Ea^2 + Ea^2$$
$$= 2Ea^2$$

Charge enclosed:

$$q_{enc} = \sigma \cdot A = \sigma \cdot a^2$$

Applying Gauss' law:

$$\oiint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$2E\cancel{a^2} = \frac{\sigma \cancel{a^2}}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$

SAME RESULT AS FOR CYLINDRICAL GAUSSIAN SURFACE