# Physics 114 - February 4, 2010

- EXAM 1 coming up Feb. 11
  Hoyt Auditorium
  Regular class time
- Material coverage / how exam runs / etc
  info released ...
- Will try to post formula sheet to come
  with exam early
- Questions?

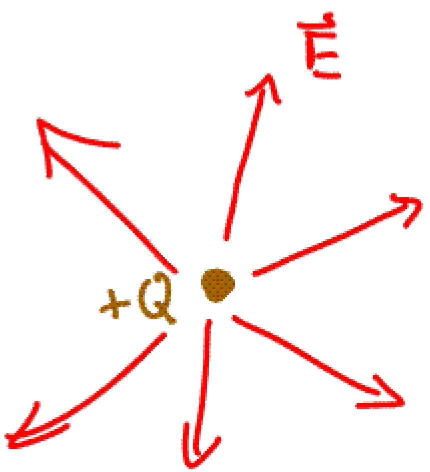
## Last Time

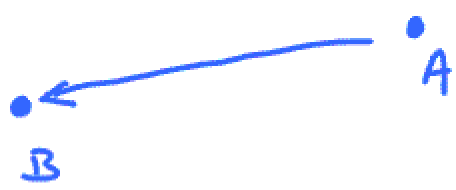
**Electric Potential (difference) between Points A + B**

$\equiv$ $\frac{\text{Work}}{\text{unit charge}}$ to move charge from Point A to Point B

$\equiv \Delta V_{AB} \equiv V_B - V_A \equiv V_{AB}$ ...

Consider potential differences in space around point charge




$$V_{AB} = kQ\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

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as $r_A \to \infty$, $\frac{1}{r_A} \to 0$

Commonly define Absolute potential at $\infty \to 0$

Then Absolute potential at point A at $r_A$

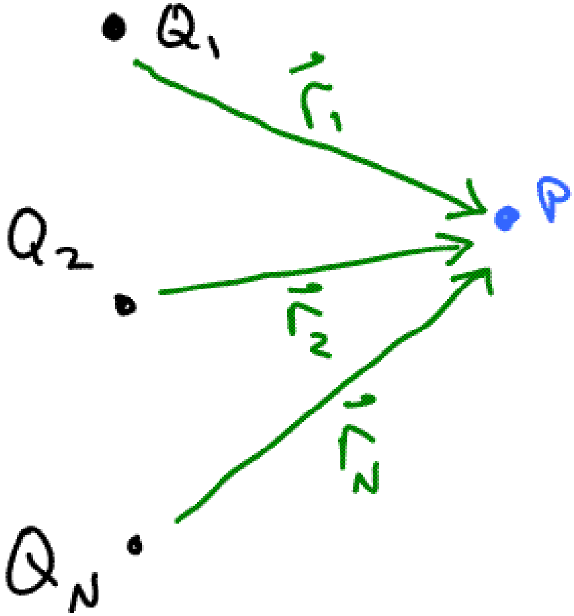
$$V_A = \frac{kQ}{r_A}$$

$\frac{\text{Work}}{\text{charge}}$ to bring charge in from $\infty$ to distance $r_A$ from charge Q

Form of potential of point charge with $V=0$ at $r \to \infty$

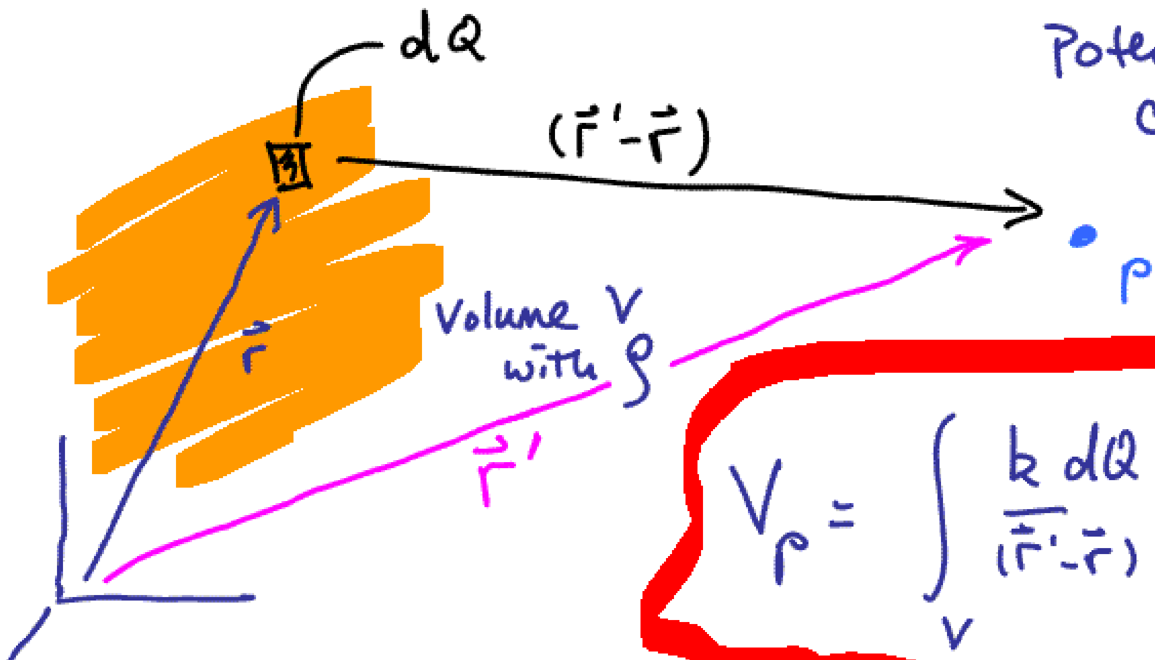
have freedom to define $V=0$ position

Similar to height convention



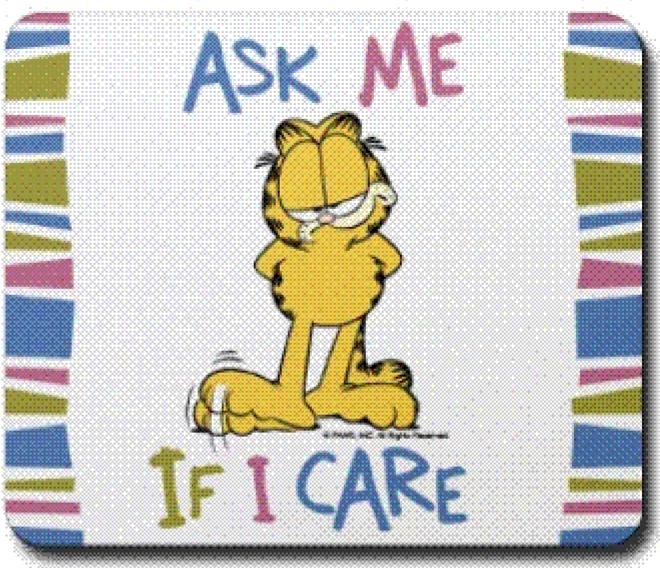

$$V_P = \sum_{i=1}^{N} V_i = \sum_{i=1}^{N} \frac{kQ_i}{r_i}$$

Potential for system of discrete point charges




Potential for a continuous charge distribution

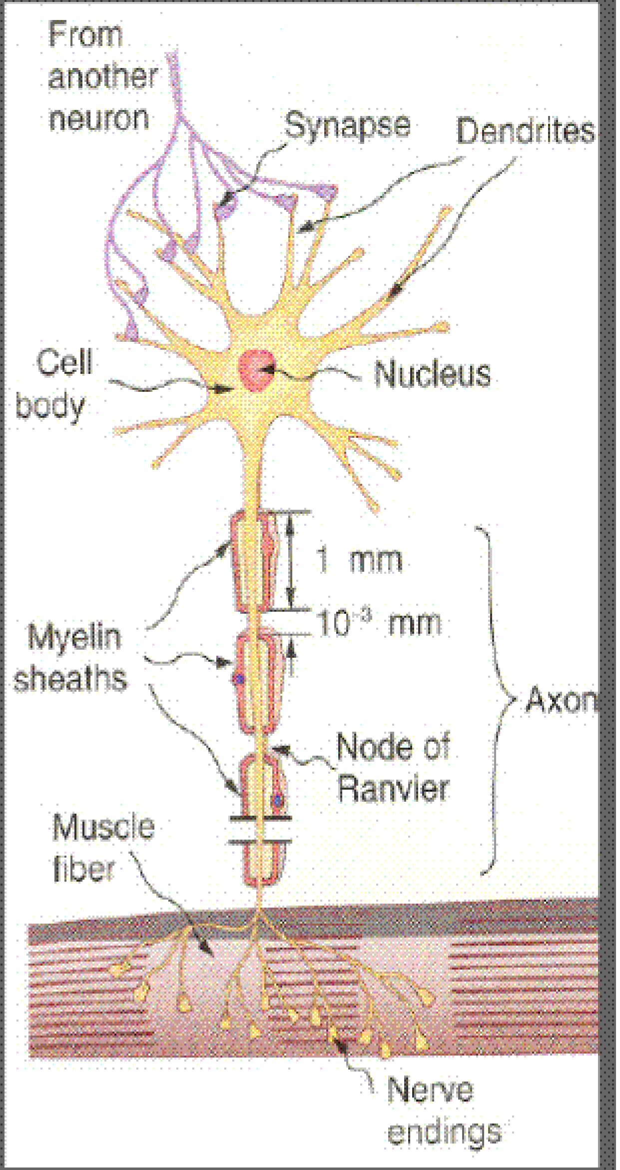
$$V_P = \int_V \frac{k\,dQ}{(\vec{r}\,' - \vec{r})} = \int_V \frac{k\,\rho(\vec{r})\,dv}{\vec{r}\,' - \vec{r}}$$




$$E_s = -\frac{dV}{ds}$$

The electric field component in a certain direction is the rate of change of the electric potential in that direction!

Nerve cells (neurons) receive "electric signals" through dendrites and pass the signal on through the axon

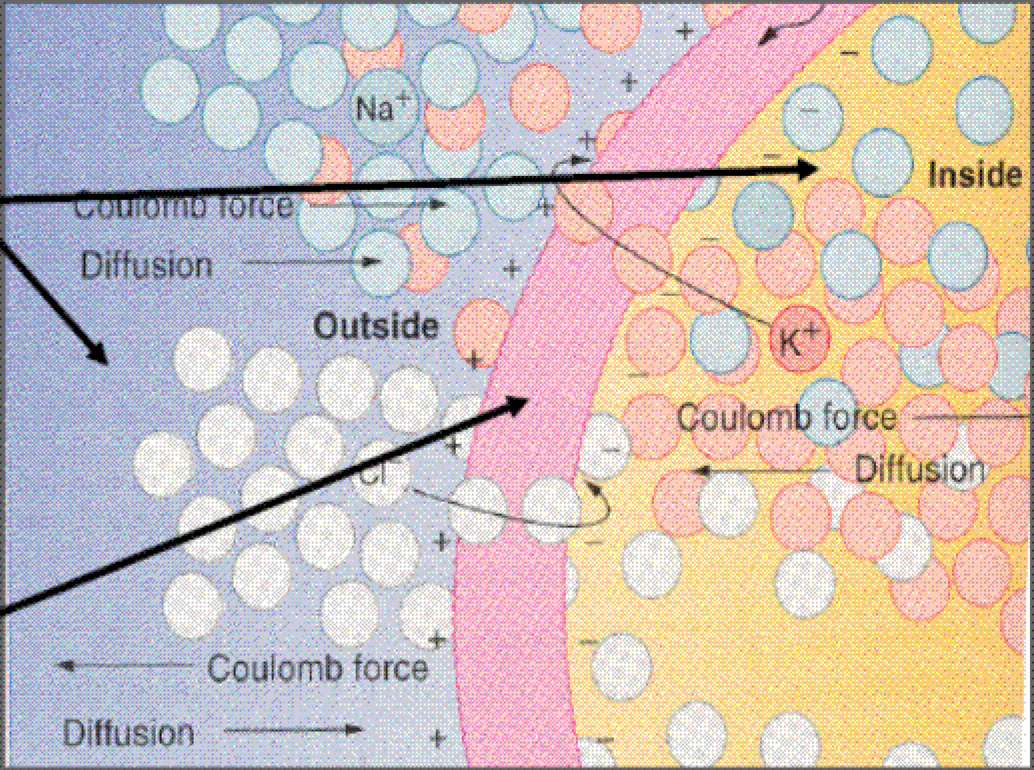



*Reference and source of photos:*

*__College Physics__ by Paul Peter Urone, 2nd ed., Brooks/Cole, 2001.*

Electrically neutral, but different, fluids

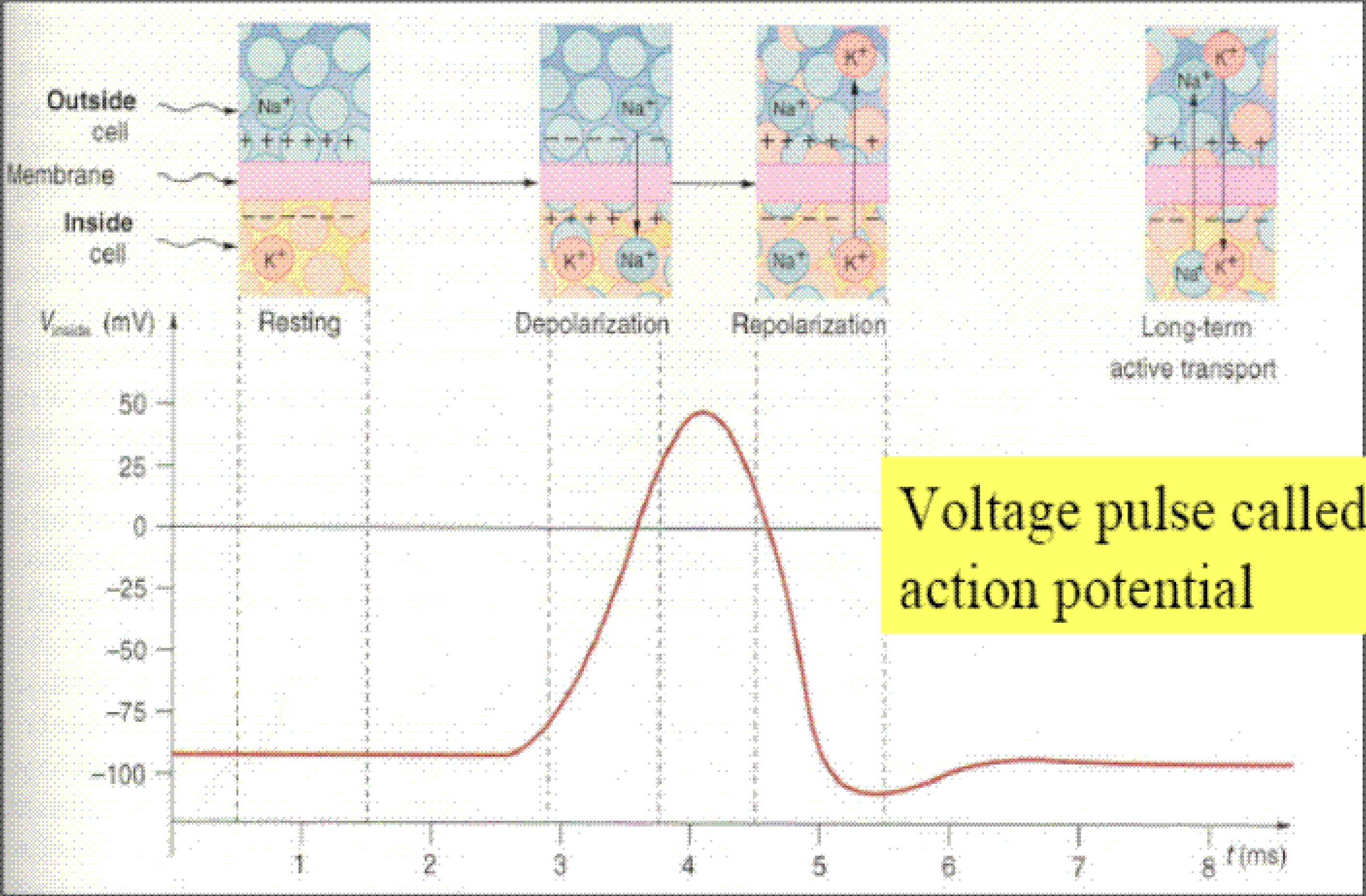
Semipermeable membrane: at rest K+ and Cl- can cross, Na+ cannot



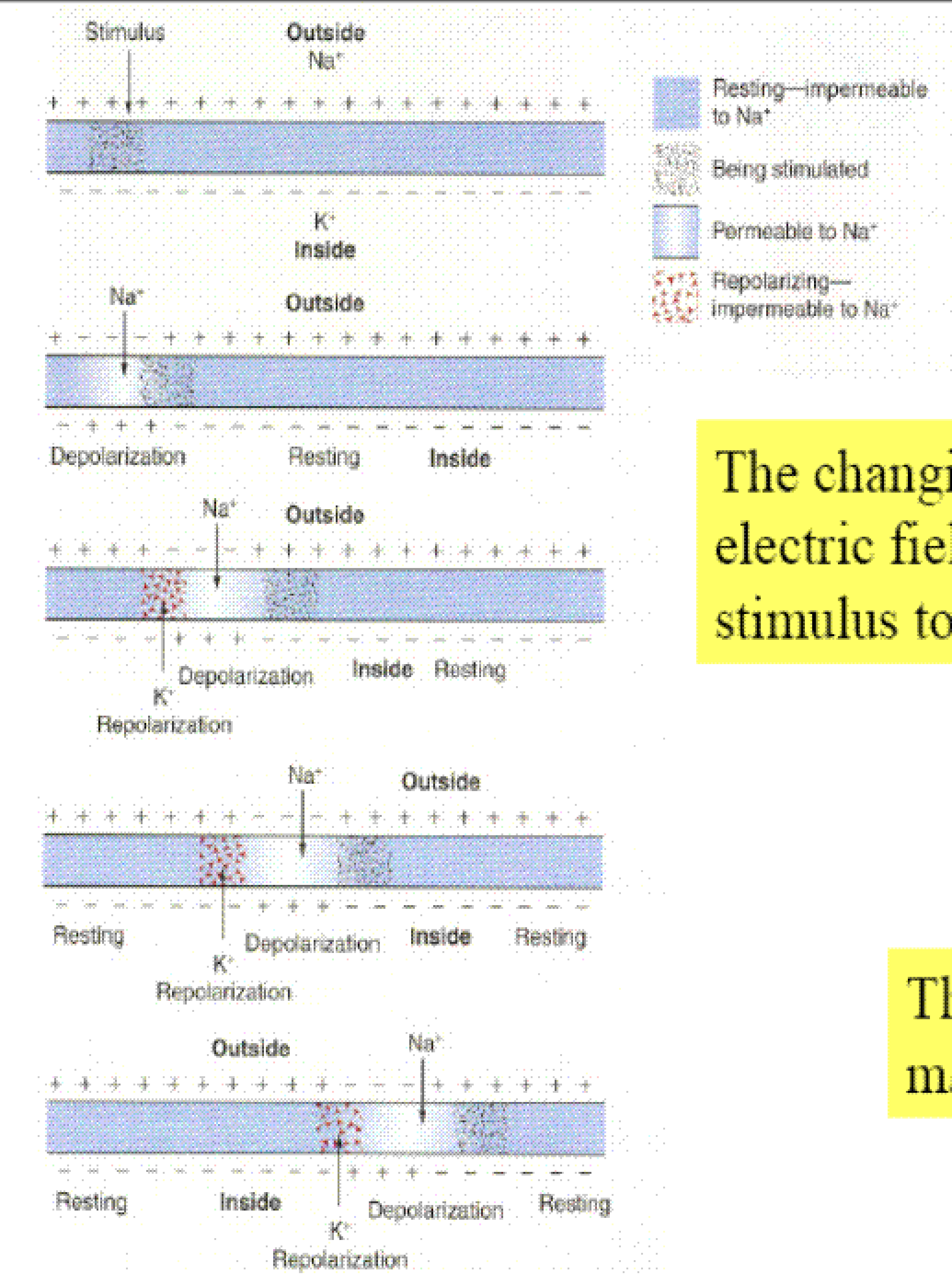

Diffusion of K+ and Cl- creates a charge separation (and a potential difference) across the membrane, until it is shut off by the Coulomb force

70-90 mV difference, 8 nm wall means E is huge!

A stimulus causes the cell membrane to become permeable to Na+ momentarily. Some Na+ rushes in and causes depolarization, which in turn, shuts off the permeability to Na+. Then repolarization occurs.



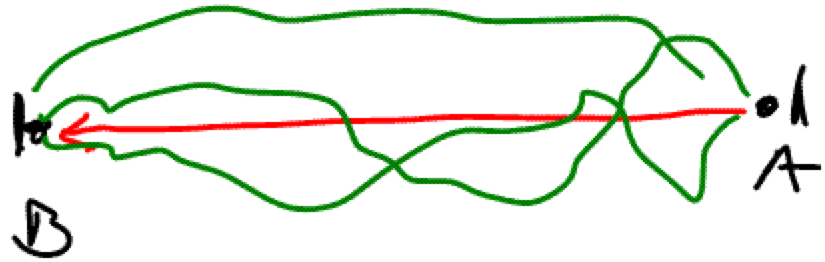

Voltage pulse called the action potential




The changing voltage and electric fields provide the stimulus to adjacent cell walls

The pulse travels about 1 m/s along the cell wall

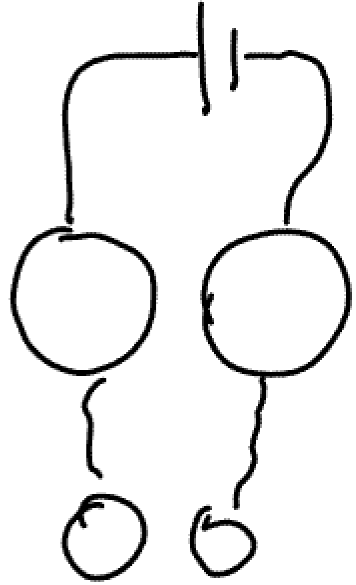
$Q^{\oplus}$




$$V_{AB} = kQ\left(\frac{1}{r_B} - \frac{1}{r_A}\right)$$

Electrostatics is Path independent

Conservative Force




$r_1 > r_2$

$$Q \rightarrow Q_1 + Q_2$$

$$\frac{kQ_1}{r_1} = \frac{kQ_2}{r_2}$$

$$\frac{Q_1}{Q_2} = \frac{r_1}{r} \qquad \frac{Q_1}{r_1} = \frac{Q_2}{r_2}$$

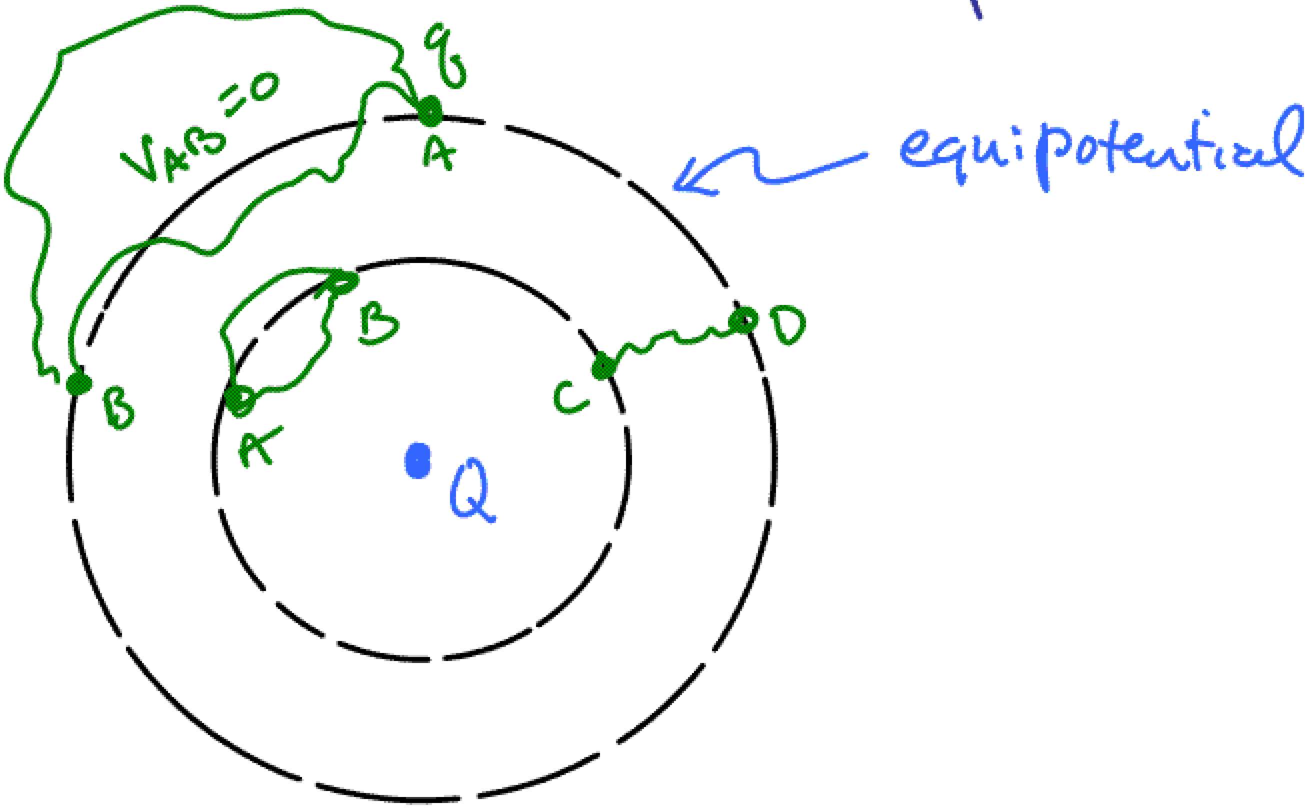
$$E_1 = \frac{kQ_1}{r_1^2} \qquad E_2 = \frac{kQ_2}{r_2^2}$$

$$k\frac{Q_1}{r_1}\frac{1}{r_1} \qquad k\frac{Q_2}{r_2}\frac{1}{r_2}$$

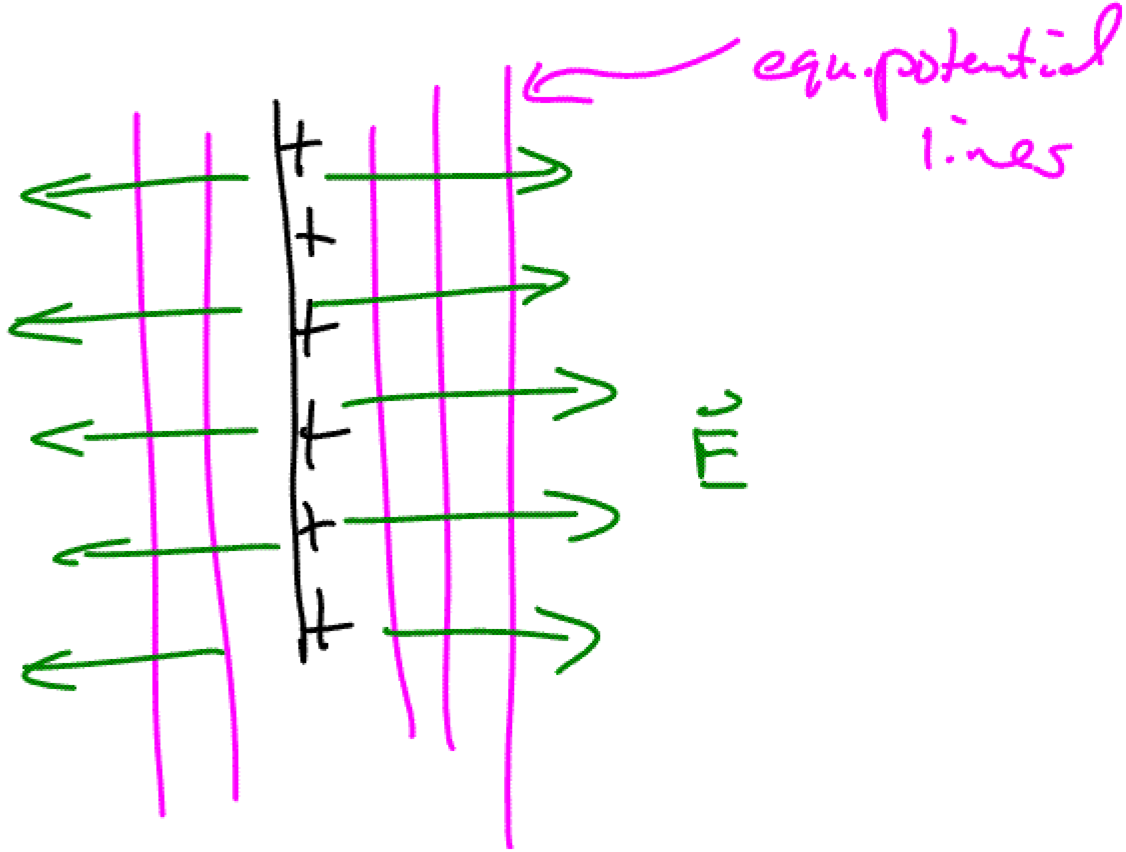
$$\frac{E_1}{E_2} = \frac{1/r_1}{1/r_2} = \frac{r_2}{r_1}$$

$$E_x = -\frac{dV}{dx}$$

$$V_p = \frac{kQ}{r}$$




Equipotential lines are $\perp$ $\vec{E}$

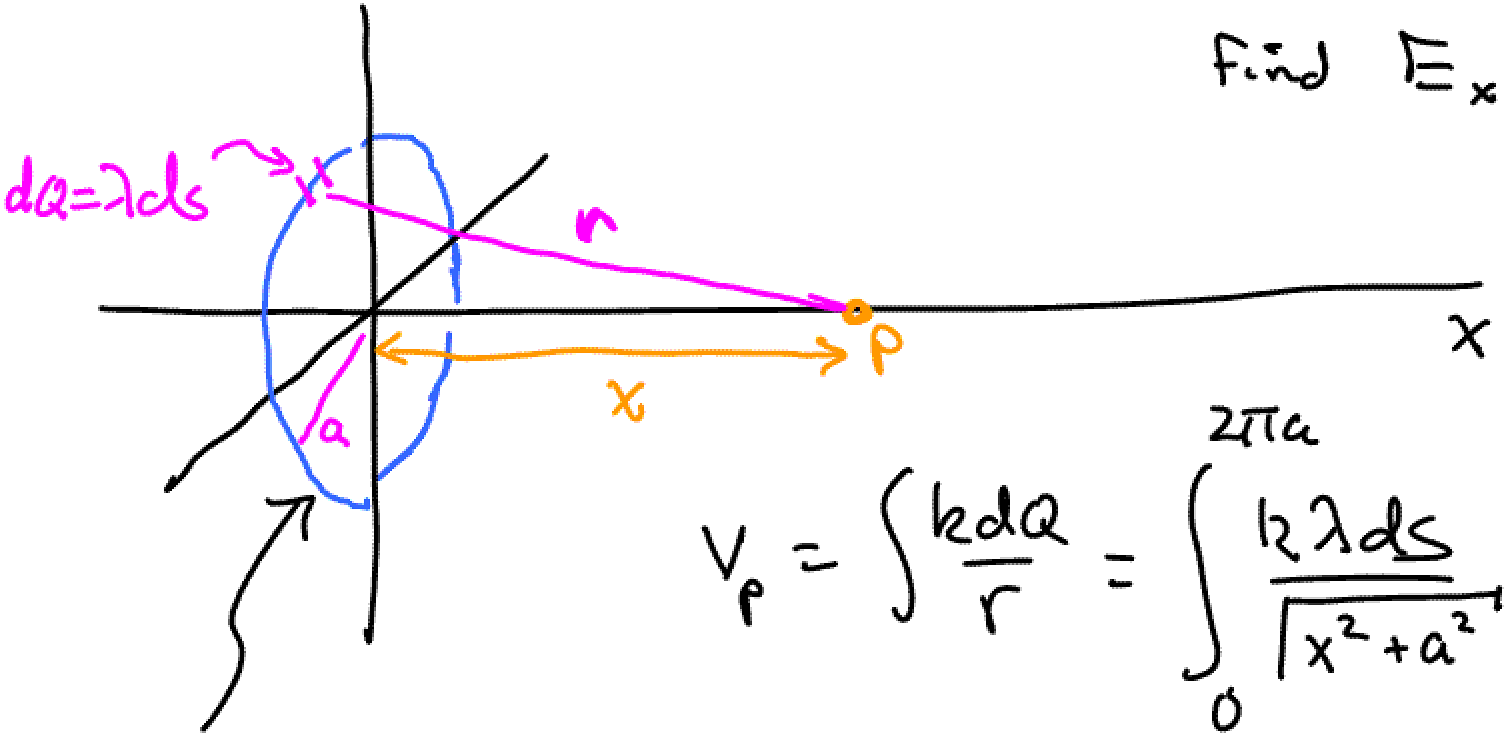

equ.potential
lines
E

$$V_p = \int_V \frac{k\,dQ}{r}$$

Calculate $V_p$

+ from that

find $E_x$




$$V_p = \int \frac{k\,dQ}{r} = \int_0^{2\pi a} \frac{k\lambda\,ds}{\sqrt{x^2+a^2}}$$

λ constant

$dQ = \lambda\,ds$

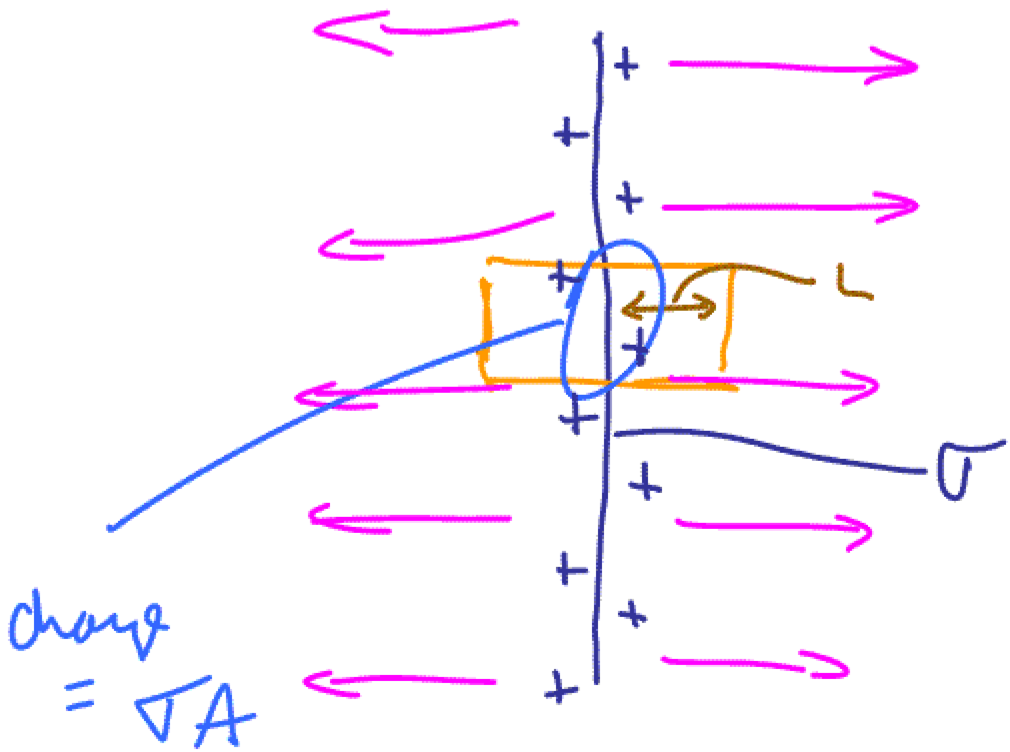
$$V_p = \frac{k\lambda}{\sqrt{x^2+a^2}} \int_0^{2\pi a} ds$$

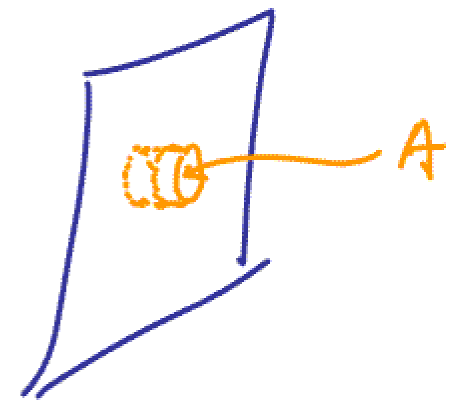
$2\pi a$

$$V_p = \frac{k \lambda 2\pi a}{\sqrt{x^2 + a^2}}$$

$$E_x = -\frac{dV}{dx} = -\left[ k \lambda 2\pi a \left(-\tfrac{1}{2}\right) \left(x^2 + a^2\right)^{-3/2} 2x \right]$$

$$E_x = \frac{k \lambda 2\pi x a}{\left(a^2 + x^2\right)^{3/2}} \sim \frac{kQ}{r^2}$$



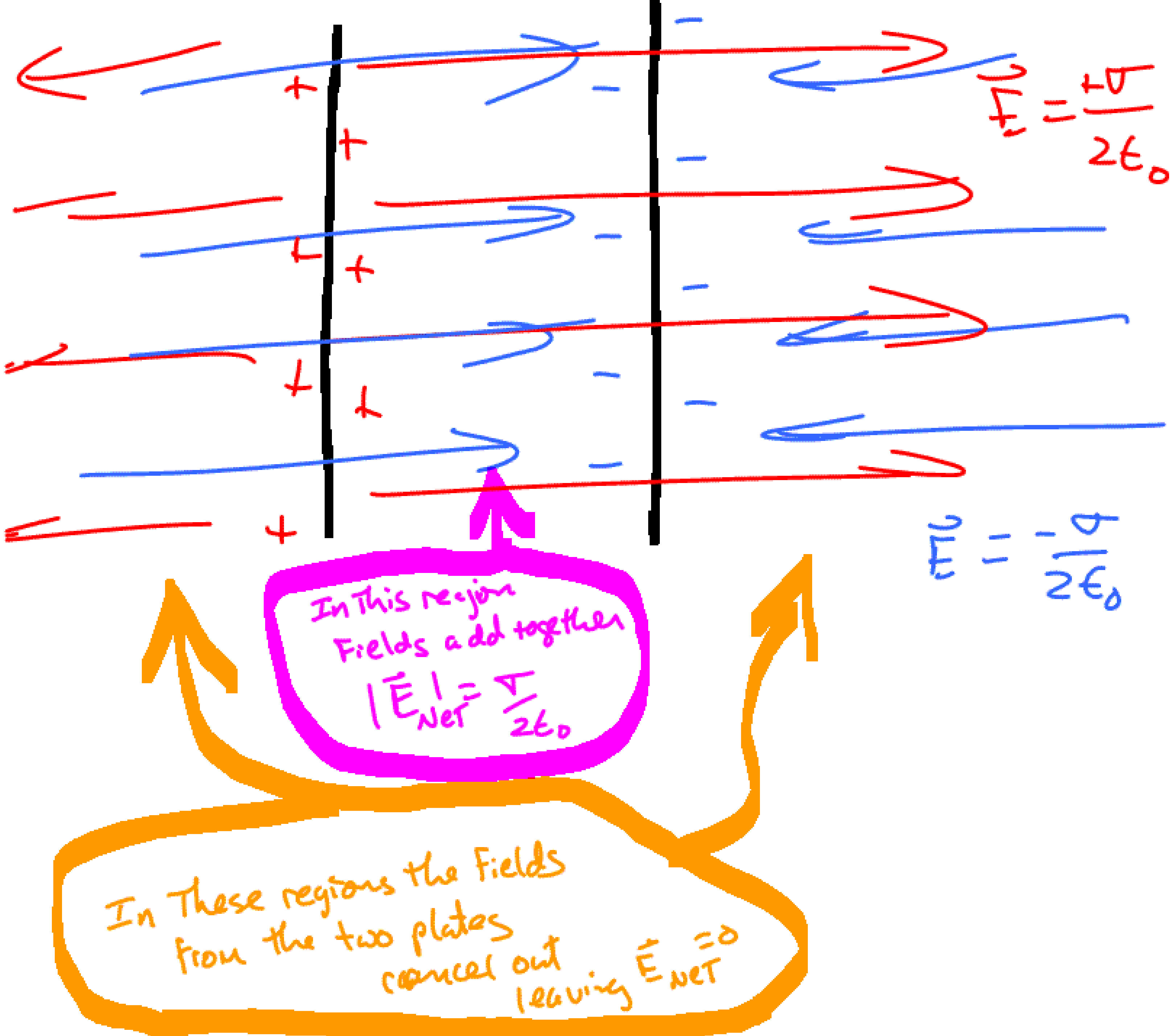




$$\int \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

$$2|\vec{E}|A = \frac{Q_{encl}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$$

$\sigma$ = area charge density

$$|E| = \frac{\sigma}{2\epsilon_0}$$



E = +σ/2ε₀
E = −σ/2ε₀
In This region Fields add together
|E_Net| = σ/2ε₀
In These regions the Fields from the two plates cancel out leaving E_NeT = 0