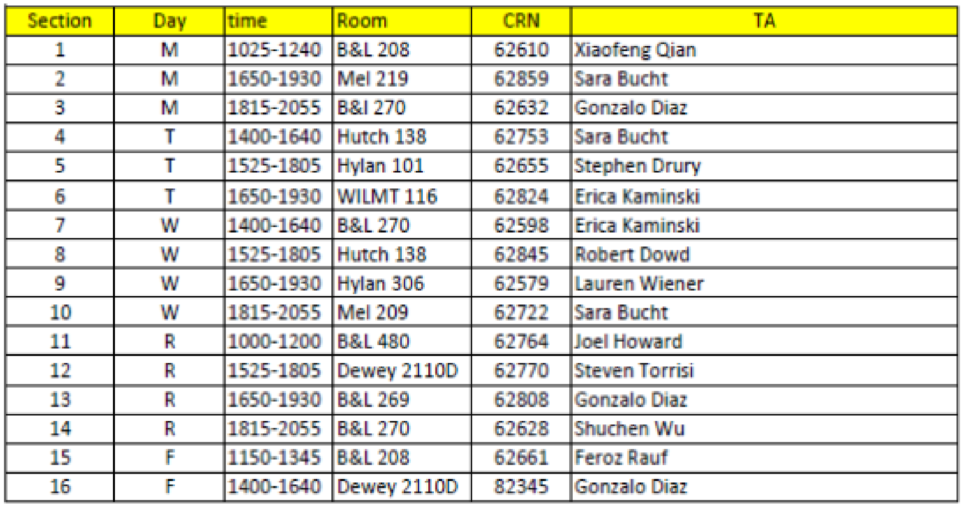
Physics 114 - January 22, 2015

- Workshops begin Monday



Section	Day	time	Room	CRN	TA
1	M	1025-1240	B&L 208	62610	Xiaofeng Qian
2	M	1650-1930	Mel 219	62859	Sara Bucht
3	M	1815-2055	B&l 270	62632	Gonzalo Diaz
4	T	1400-1640	Hutch 138	62753	Sara Bucht
5	T	1525-1805	Hylan 101	62655	Stephen Drury
6	T	1650-1930	WILMT 116	62824	Erica Kaminski
7	W	1400-1640	B&L 270	62598	Erica Kaminski
8	W	1525-1805	Hutch 138	62845	Robert Dowd
9	W	1650-1930	Hylan 306	62579	Lauren Wiener
10	W	1815-2055	Mel 209	62722	Sara Bucht
11	R	1000-1200	B&L 480	62764	Joel Howard
12	R	1525-1805	Dewey 2110D	62770	Steven Torrisi
13	R	1650-1930	B&L 269	62808	Gonzalo Diaz
14	R	1815-2055	B&L 270	62628	Shuchen Wu
15	F	1150-1345	B&L 208	62661	Feroz Rauf
16	F	1400-1640	Dewey 2110D	82345	Gonzalo Diaz

- Hand in Prob sets in lockers across hall from B+L 106
  Deposit in slot for TA Leading your section

- SPS helproom
- TA office hours TBA

Last Time – Electrostatics

- two types of charge

proportionality constant... Not to be confused w/ k... Boltzmann's constant

- Coulombs law

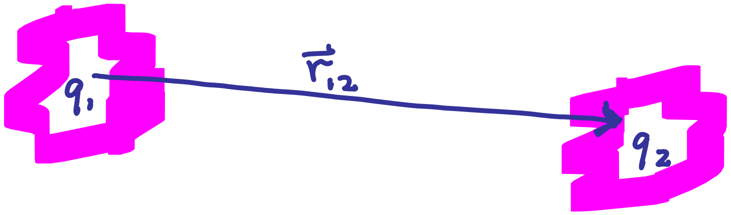
Charles Coulomb

$$\vec{F}_{12} = \frac{k q_1 q_2}{r_{12}^2} \hat{r}_{12}$$

$$k = \frac{1}{4\pi\epsilon_0} = \text{constant}$$

↑ Permittivity of Free space

inverse square force... just like gravitation



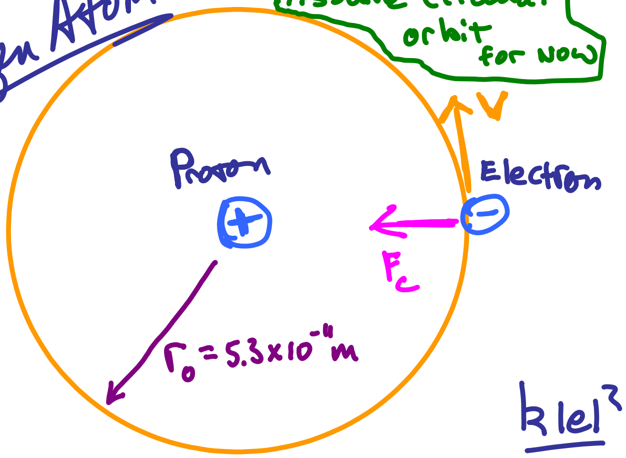
- Electric charge is conserved

$|e| = 1.6\times10^{-19}\,C$

C = Coulomb not to be conf. w/ speed of light c

- Electric charge is quantized

Hydrogen Atom



Assume circular orbit for now

F_c = Centripetal force

$$F_c = \frac{k|e|^2}{r_0^2} \quad \text{Coulomb}$$

$$= \frac{m_e v^2}{r_0} \quad \text{Newton}$$

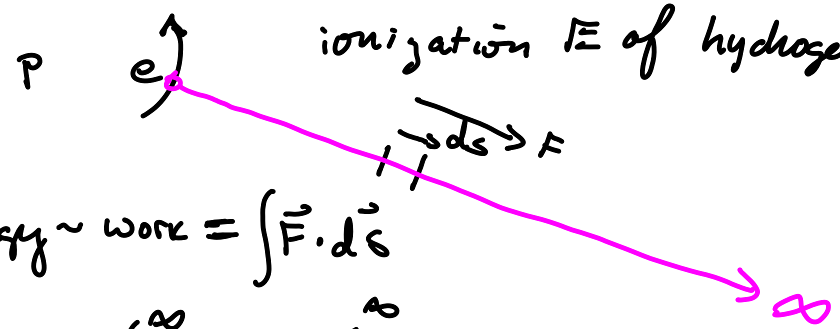
$$\frac{k|e|^2}{r_0^2} = \frac{m_e v^2}{r_0}$$

Plug in
$$\left\{\begin{array}{l} M_e = 9.11\times10^{-31}\,kg \\ k = 8.99\times10^{9}\,\frac{NM^2}{C^2} \\ r_0 = 5.3\times10^{-11}\,M \\ |e| = 1.6\times10^{-19}\,C \end{array}\right\}$$
Solve for V

Rough value for velocity of e^- in H atom in "Bohr model" ground state

↙ in term

$V = 2.2\times10^{6}\,M/s$ ~ 1% speed of light



ionization E of hydrogen

Energy ~ work = $\int \vec{F}\cdot d\vec{s}$

$$\text{Work} = \int_{r_0}^{\infty} \vec{F}\cdot d\vec{s} = \int_{r_0}^{\infty} \frac{k|e|^2\,dr}{r^2} = k|e|^2 \underbrace{\int_{r_0}^{\infty} \frac{dr}{r^2}}_{-\frac{1}{r}\Big]_{r_0}^{\infty}}$$

$$w = k|e|^2\left[-\cancelto{0}{\frac{1}{\infty}} + \frac{1}{r_0}\right] = \frac{k|e|^2}{r_0} = 4.3\times10^{-18}\,J$$

1 Joule = 6.2×10^{18} eV (electron-Volt)

$W = 26.9$ eV

True value ionization E hydrogen 13.6 eV

e^- already moving - must take this into account

$$KE = \frac{1}{2}M_e V^2 = \frac{1}{2}\left(9.11\times10^{-31}\,kg\right)\left(2.2\times10^{6}\,m/s\right)^2$$

$$= 13.6\,eV$$

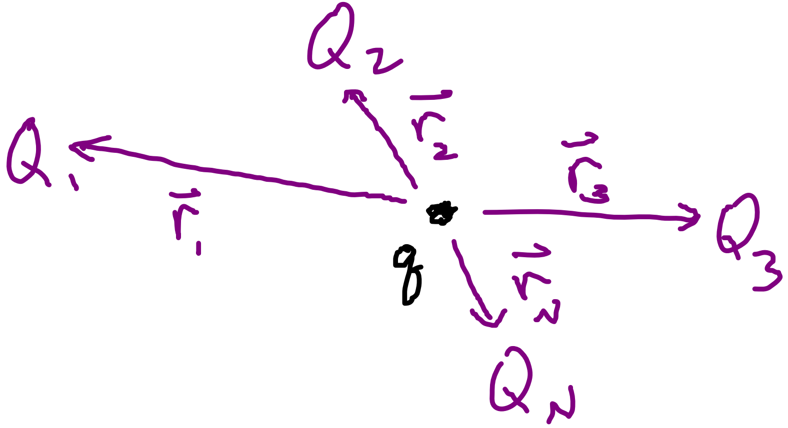
$$E_{ionization} = 26.9\,eV - 13.6\,eV$$

$$= 13.3\,eV$$

Fairly close to Accepted value

Electrostats → is a vector force

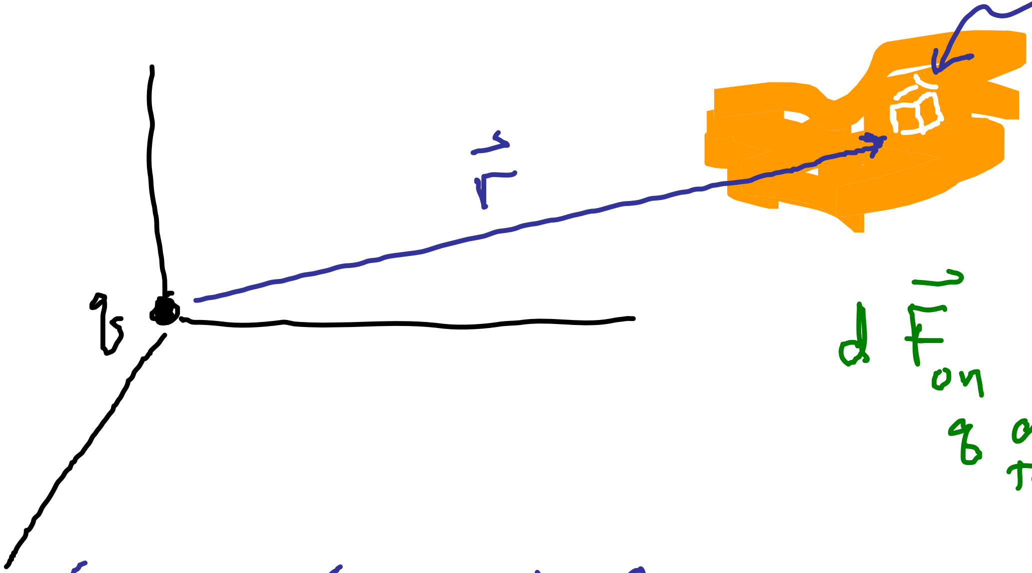
discrete system



$$\vec{F}_{\substack{NeT \\ on \\ q}} = \vec{F}_{Q_1} + \vec{F}_{Q_2} + \vec{F}_{Q_3} + \cdots + \vec{F}_{Q_N}$$

$$\vec{F}_{NeT} = \frac{kQ_1 q}{r_1^2}\hat{r}_1 + \frac{kQ_2 q}{r_2^2}\hat{r}_2 + \cdots + \frac{kQ_N q}{r_N^2}\hat{r}_N$$

Continuous charge distr.



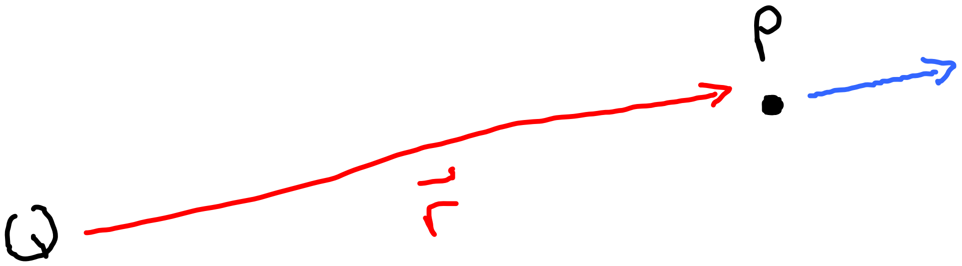
$$dq = \underbrace{\rho(\vec r)}_{\text{volume charge density}}\, dv$$

$$d\vec F_{\text{on } q \text{ due to } dq} = \frac{k q\, dq}{r^2}\,\hat r$$

$$\vec F_{\text{on } q} = \int d\vec F = \int_{\text{volume of charge dist}} \frac{k q\, dq}{r^2}\,\hat r$$

if surface $dq = \sigma\, da$

if line $dq = \lambda\, dl$

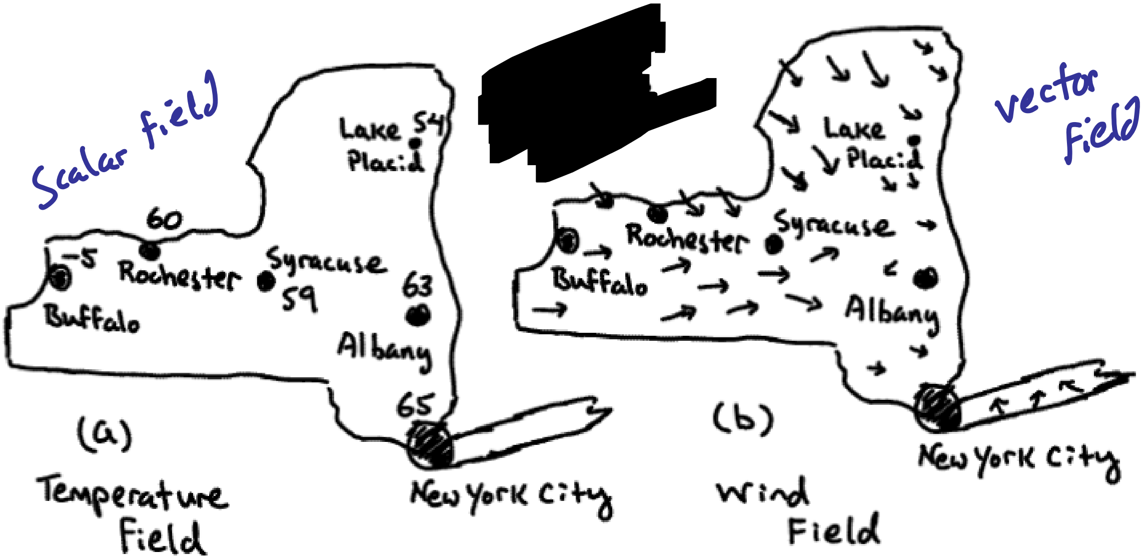


$$\vec{E} = \vec{F}/q$$

$$= \frac{kQq}{r^2}\hat{r} \Big/ q$$

$$\vec{E} = \text{Electric Field} = \frac{\vec{F}}{q}$$ on +q test charge at each

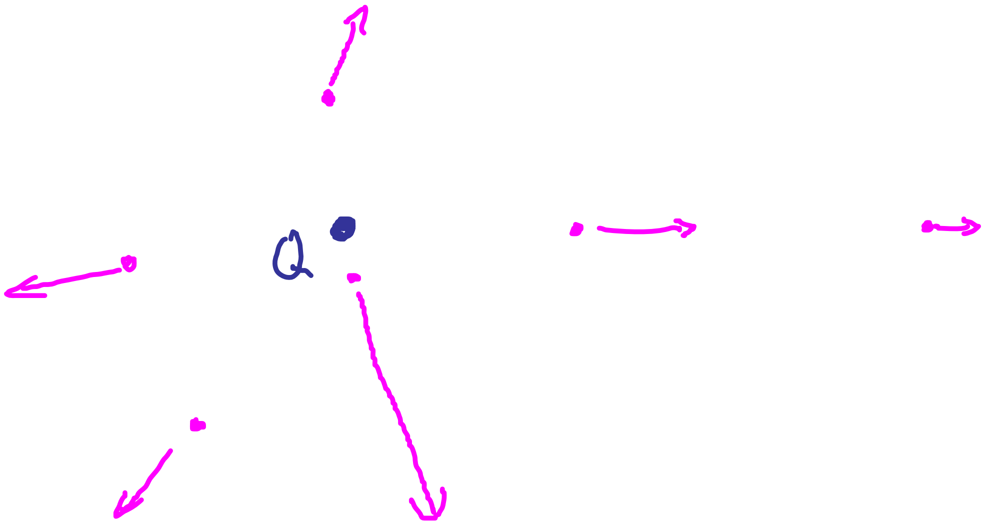
Fields are nothing new to you. . .

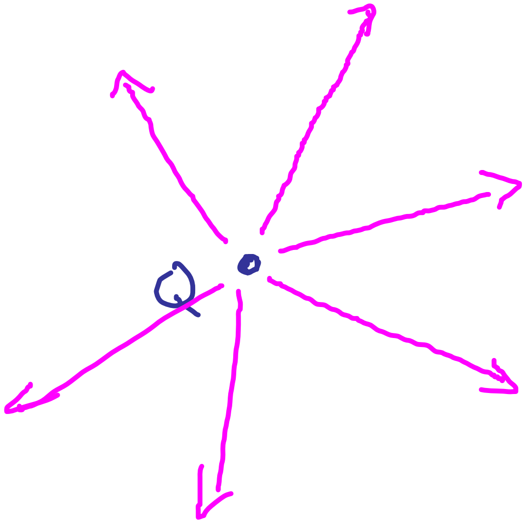


[redacted]

(a) Temperature Field

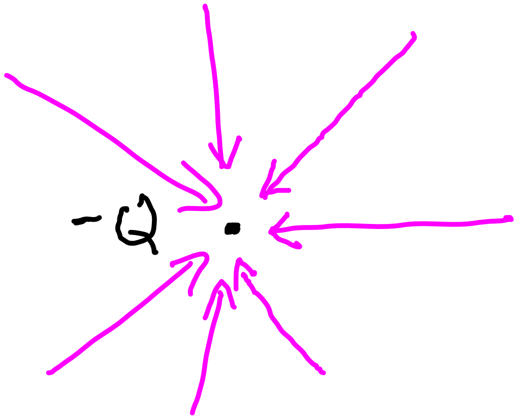
(b) Wind Field



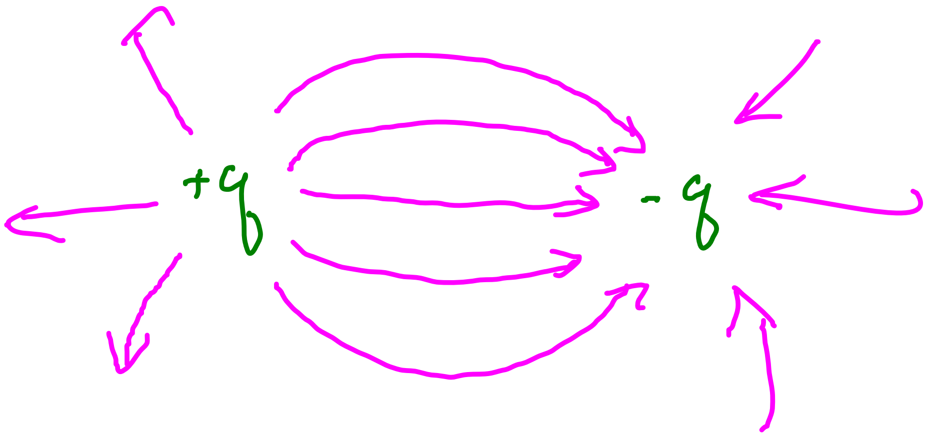


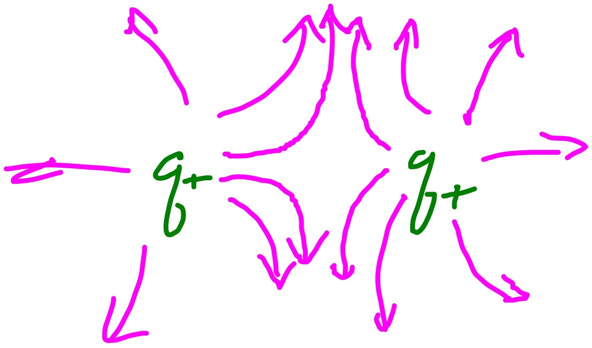
lines
of
force

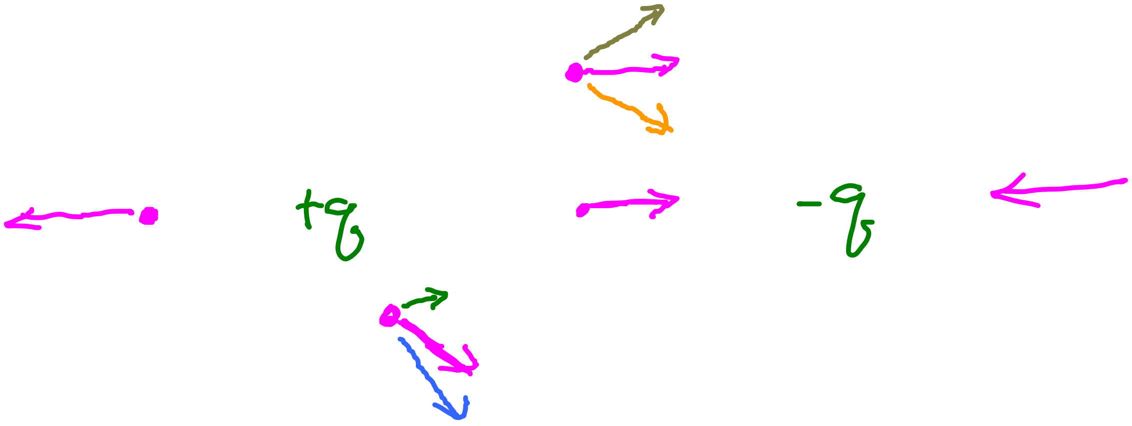
Electric
Field
lines



E

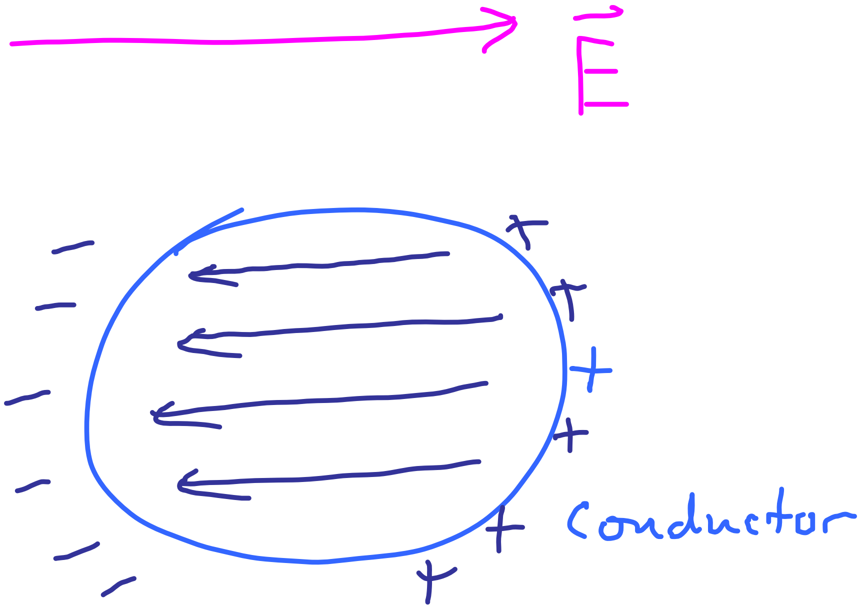


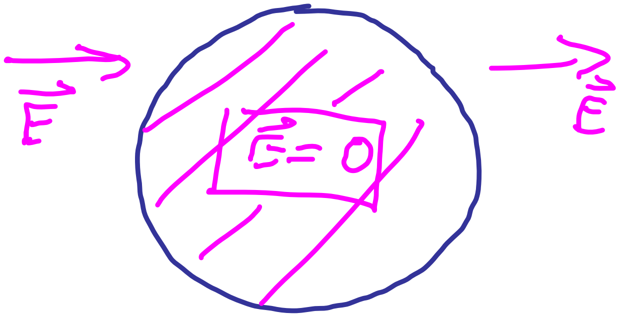




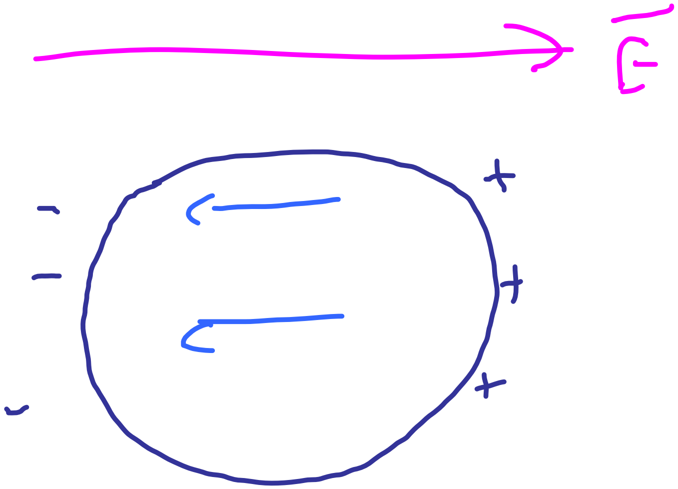
$\vec{E}$ inside conductor

$= 0$





dielectrics



Charging by induction