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# Physics 212 Exam 1 Review

Thank you for coming,  
please sign into the queue



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# Exam 1 Topics

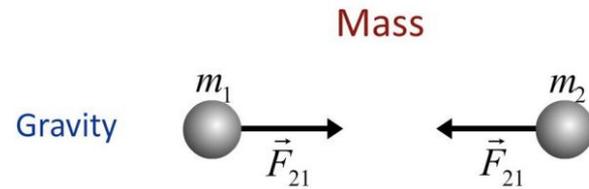
1. Coulomb's Law
2. Electric Field
3. Gauss' Law
4. Electric Potential
5. Capacitors



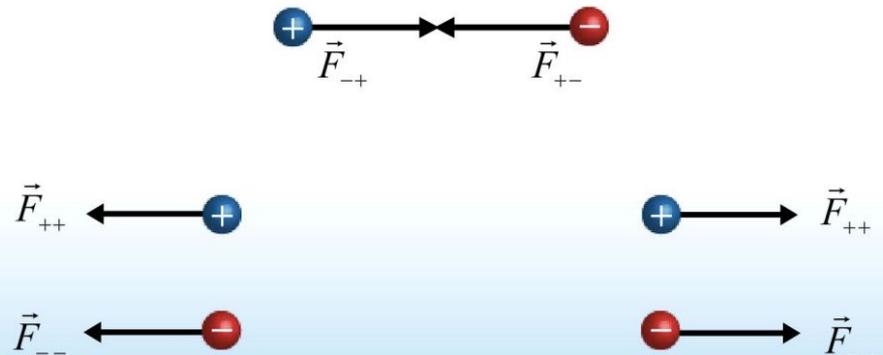
# Coulomb's Law

Electrostatic Force (2 Charges)

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



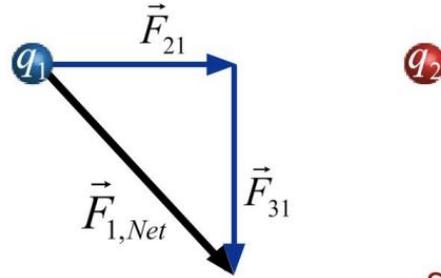
Electric Charge



# Superposition

When considering multiple charges, break the system into x- and y- components

$$\vec{F}_{1,Net} = \vec{F}_{21} + \vec{F}_{31}$$

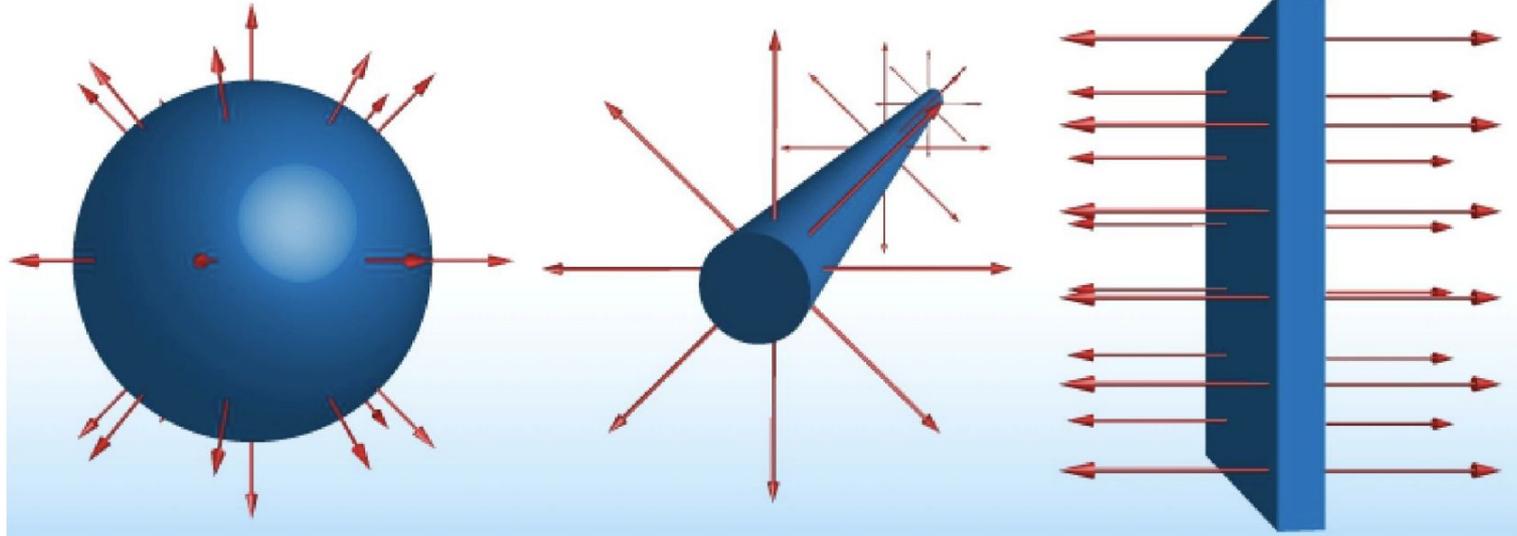


Superposition Principle

$$\vec{F}_{Net} = \sum_i \vec{F}_i$$



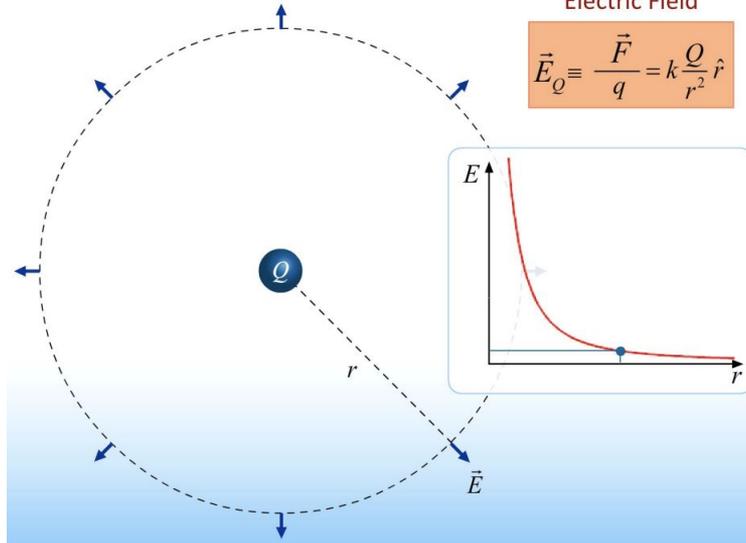
# Sources of Electric Fields



# Point Charge

$$E \propto 1/r^2$$

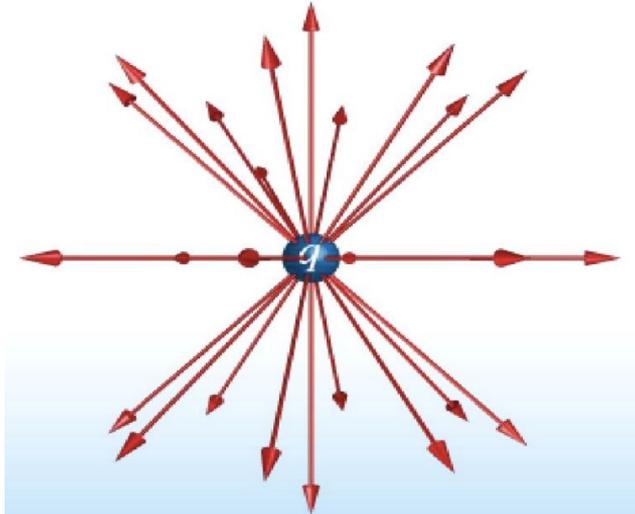
$$Q = [C]$$



Electric Field

$$\vec{E}_Q \equiv \frac{\vec{F}}{q} = k \frac{Q}{r^2} \hat{r}$$

$$E = k \frac{q}{r^2}$$

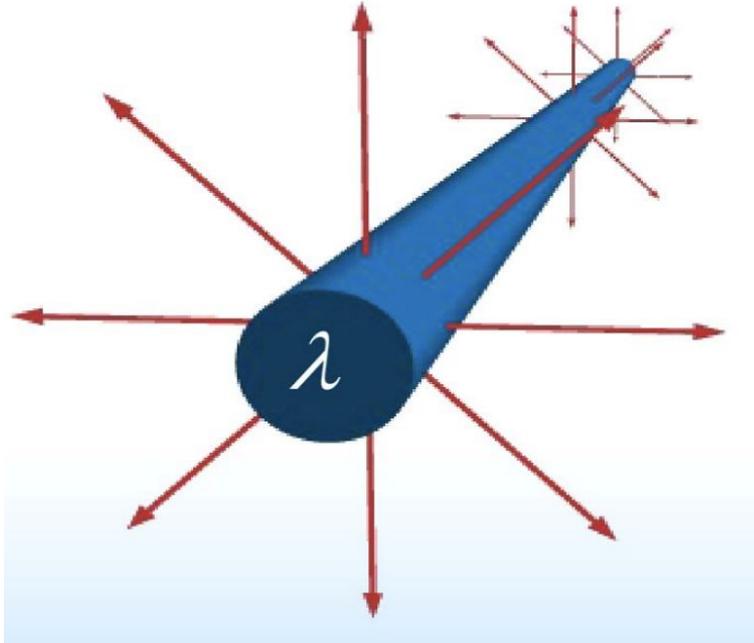


# Line Charge

$$E \propto 1/r$$

$$\lambda = [\text{Coulombs/Meter}]$$

$$E = 2k \frac{\lambda}{r}$$

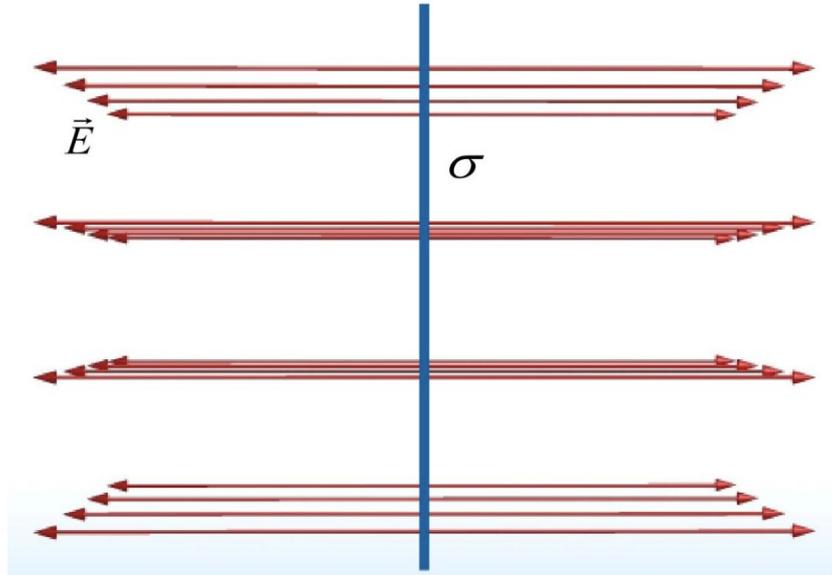


# Sheet Charge

Electric field has NO distance  
dependence

$$\sigma = [\text{Coulombs/Meter}^2]$$

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

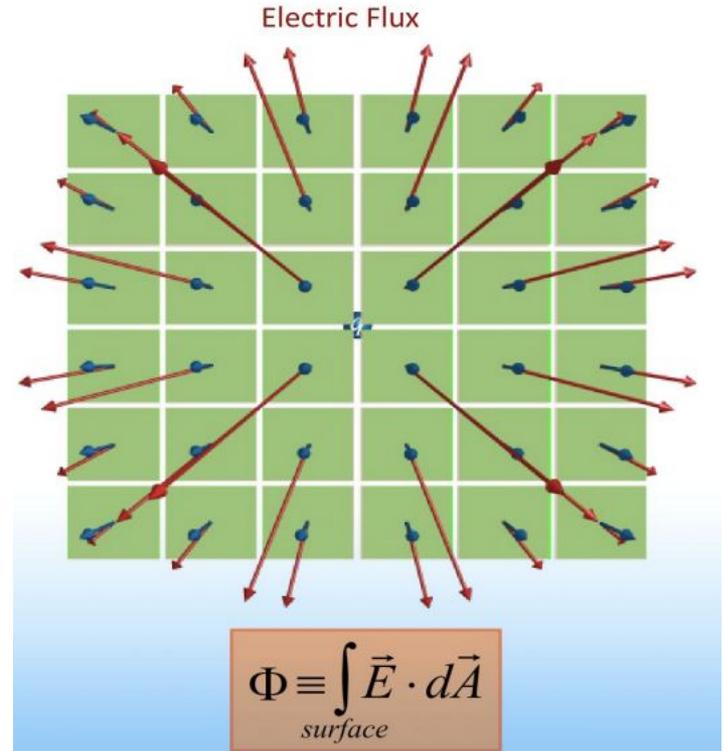


# Electric Flux

Amount of electric field that is perpendicular to a surface

+ Flux ( $\Phi$ ) = Outward Flux

- Flux ( $\Phi$ ) = Inward Flux



# Gauss' Law

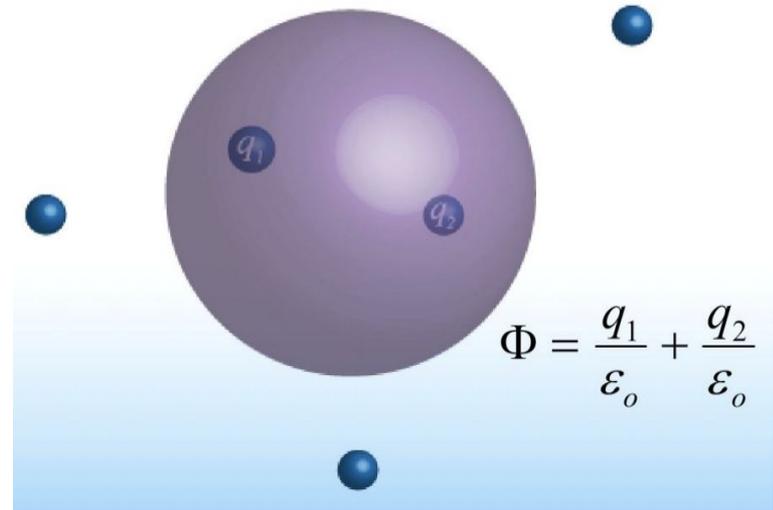
Use a Gaussian surface simplify

$$\oint \vec{E} \cdot d\vec{A} \rightarrow E * A$$

E = electric field

A = surface area of gaussian surface

$$\Phi_{Net} = \oint_{surface} \vec{E} \cdot d\vec{A} = \frac{q_{enclosed}}{\epsilon_0}$$

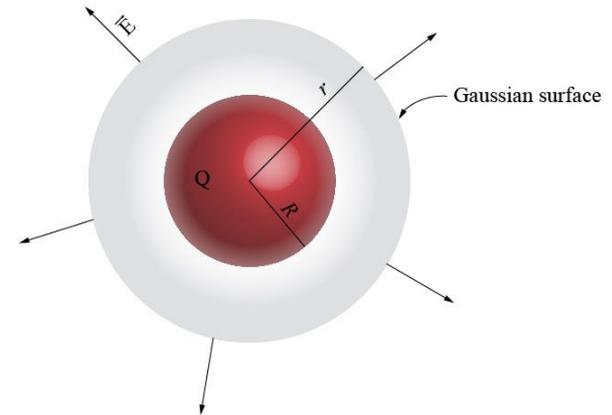


# Gaussian Surfaces

For point charge/sphere charge, use a **SPHERE**

For a line/cylinder charge, use a **CYLINDER**

$$\Phi_{Net} = \oint_{\text{surface}} \vec{E} \cdot d\vec{A} = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

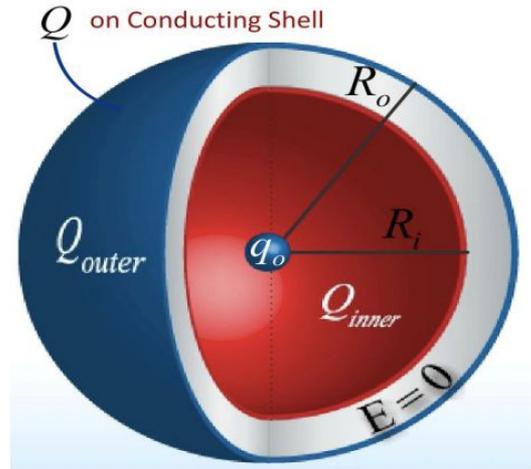


# Conductors

Charges arrange themselves so that the electric field is **always zero**

Inside:  $Q_{\text{inside}} = -1 * Q_{\text{enc}}$

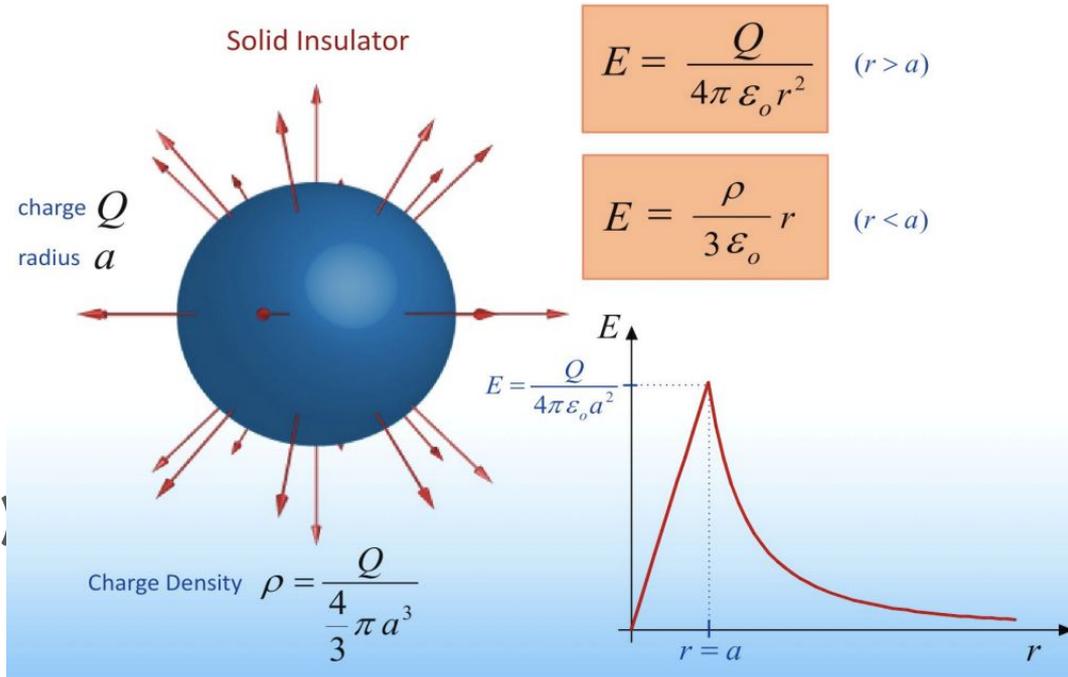
Outside:  $Q_{\text{outside}} = Q_{\text{enc}} + Q_{\text{conductor}}$



# Insulators

Electric Field inside due to  
a  $Q_{\text{enc}}$  for enclosed volume

$$Q_{\text{enc}} = Q_{\text{insulator}} \left( \frac{V_{\text{enc}}}{V_{\text{insulator}}} \right)$$



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# Potential Energy

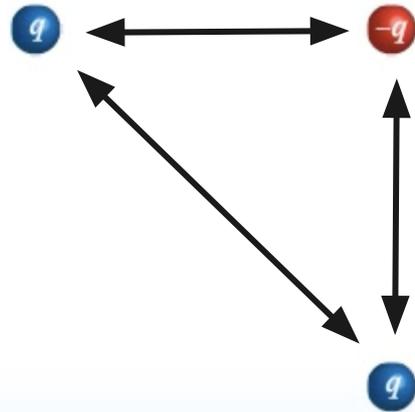
Consider all charge-charge interactions

Charges  $\infty$  have no potential energy

To increase the increase of the U takes

positive  $W_{\text{on}}$

$$U_{12} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{12}}$$





# Electric Potential (V)

$$\Delta V_{A \rightarrow B} = - \int_A^B \vec{E} \cdot d\vec{l}$$

Moving with or against electric field lines will change your V

Lines with same voltage are equipotential lines and are perpendicular to electric field lines

Voltage can be thought of as height, E field as slope, and a charge as a ball

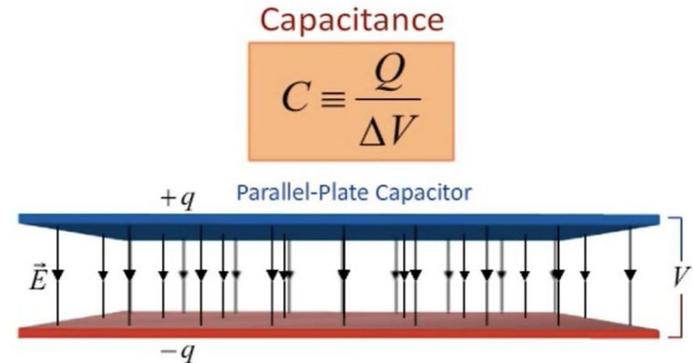
# Capacitance

$$U = \frac{1}{2} CV^2$$

$$C = \frac{\kappa\epsilon_0 A}{d}$$

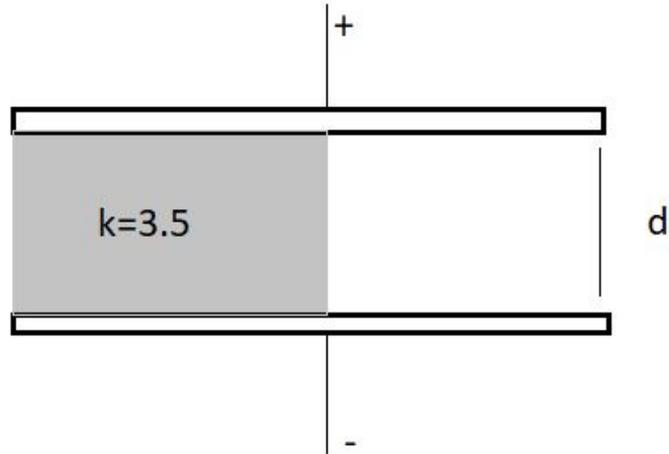
Capacitance can be calculated simply by a capacitors dimensions

Describes relationship between charges on plates and voltage between plates



# Dielectric in a Capacitor

Split the capacitor into two and  
add them up in series or parallel.  
\*Don't forget to divide the length  
or Area by two!

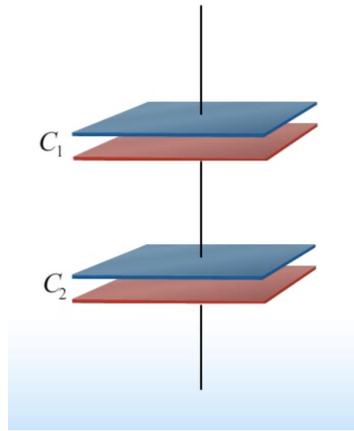


# Series and Parallel (Capacitors)

$$Q_1 = Q_2 = Q_{12}$$

$$1/C_{12} = 1/C_1 + 1/C_2$$

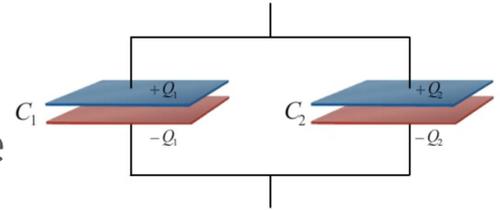
Shares Charge



$$V_1 = V_2 = V_{12}$$

$$C_{12} = C_1 + C_2$$

Share Voltage





# Kahoot Time

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# Thank You!



Sign into the queue to access the worksheet,  
solutions will be posted later!