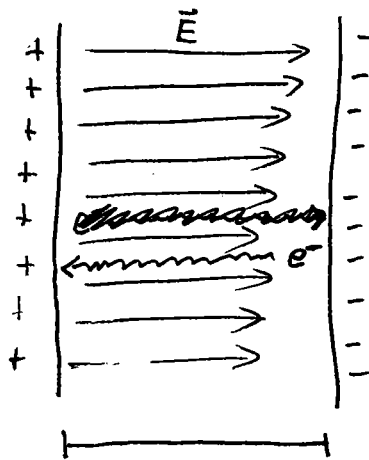


⇒ You ever heard of the electron-volt... chemical ionization energies etc.

The eV = electron-volt unit of energy



∞ parallel plates

LET  $e^-$  go from rest from  $\ominus$  side

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

⇒ is Accel. CONSTANT?

$\vec{F}$  CONSTANT

$$\vec{F} = m\vec{a}$$

∴ CONSTANT

Acceleration Problem

$$\Delta V = 1 \text{ Volt} = 1 \text{ Joule/Coulomb}$$

All kinematic eqns valid for CONSTANT Acceleration hold TRUE for example ....

1d Motion w/ Const. Acceleration

$$\hookrightarrow v_x = v_{x0} + a_x t$$

$$x = x_0 + \frac{1}{2}(v_{x0} + v_x)/t$$

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$

$$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$$

remember this?

We say ... "the  $e^-$  is accelerated through a potential difference of 1 Volt"

When  $e^-$  has reached other side PE changed to KE

$$V = \frac{\Delta W}{q} \times q_{e^-} = \Delta W = \text{K.Energy} = 1 \text{ Volt} \times |e| = 1 \text{ electron-Volt}$$

Better for charged particles in small #'s

$$1 \text{ electron Volt} = (|e|)(1 \text{ Volt}) = (1.6 \times 10^{-19} \text{ Coul})(1 \text{ Volt}) = 1.6 \times 10^{-19} \text{ joule}$$

Calculate  $|\vec{E}|$

① use Coulomb's Law  $\vec{E} = \int \frac{k dq}{r^2} \hat{r}$

② use Gauss's Law  $\int \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$

③ Calculate Potential

one way  $\int \frac{k dq}{r} \hat{r} = V$

and  $\vec{E} = -\text{grad } V \rightarrow E_x = -\frac{\partial V}{\partial x}$   
 $\vdots$   
 $\vdots$   
 $\vdots$   
 etc.

Calculate potential

① use calculation from charge dist

$$\int \frac{k dq}{r} \hat{r} = V$$

② use  $\vec{E}$

$$dV = -E \cdot ds$$

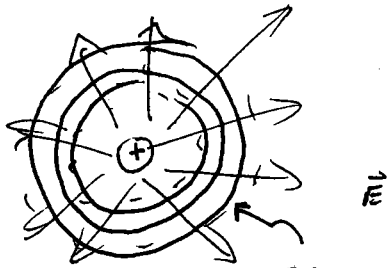
And integrate

③ other ways we will NOT do

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42-382  
42-389  
42-390  
42-399  
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500 SHEETS EYE-GAZE 5 SQUARE  
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200 SHEETS EYE-GAZE 5 SQUARE  
400 SHEETS EYE-GAZE 5 SQUARE  
400 RECYCLED WHITE 5 SQUARE  
MADE IN U.S.A.

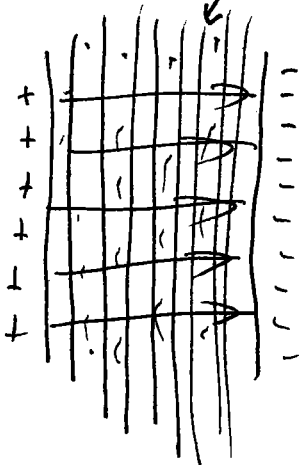
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$\therefore \vec{E}$  is  $\perp$  to equipotential surfaces at all points



What are equipotential surfaces for point charge

Equipotential lines



What are equipotential surfaces for  
2 plane,  $\parallel$  plates?  
charged

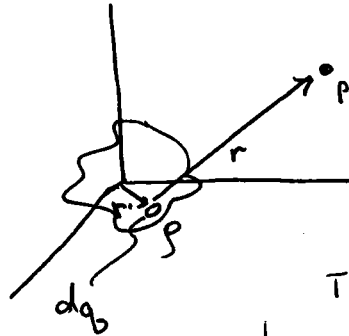
so

$V$  can be used to get  $\vec{E}$

$V$  is a scalar

$$V_p = \int_{\text{Volume}} \frac{k dq}{r}$$

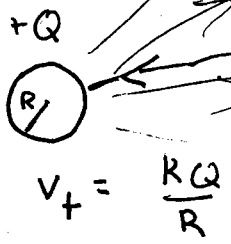
$\vec{E}$  sometimes hard to calculate  
 $V$  sometimes easier  
Then get  $\vec{E}$



There are some special techniques  
beyond the scope of this course  
for calculating  $V$ .

RESISTANCE

1st conducting sphere



far from 1st sphere have 2nd conducting sphere

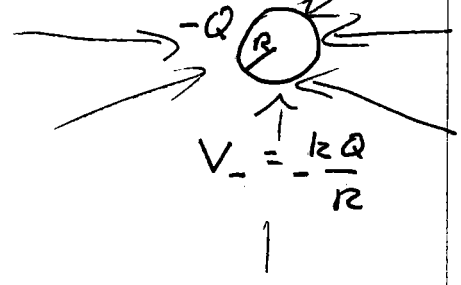


Figure out the potential of a charge on sphere w/ so as "zero" of potential

conducting sphere ... => all at same potential

$$\Delta V_{+-} = V_+ - V_- = \frac{2kQ}{R}$$

capacitance of 2 sphere system  $C = Q/V_{+-}$

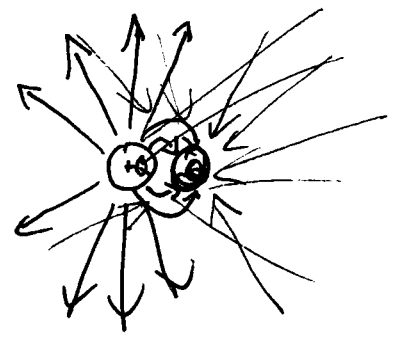
$$Q = C_+ V_+ \quad V_+ \propto Q$$

$$Q/V_+ = C_+$$

$$V_- \propto Q \quad Q = C_- V_-$$

now move two spheres close to each other

$C \equiv$  capacitance



Use two transparencies to show lines of force ~ cancelling out but of course get dipole field Lines of force do NOT cross

$$V_+ \rightarrow V_+' \quad V_+' < V_+ \quad \text{and} \quad V_+' > 0$$

$$V_- \rightarrow V_-' \quad V_-' > V_- \quad \text{and} \quad V_-' < 0$$

now

$\Delta V_{+-}$  is Reduced, Q has NOT changed

$$C = \frac{Q}{V_{+-}} \quad \leftarrow \text{defined this way}$$

Capacitance has gotten much larger

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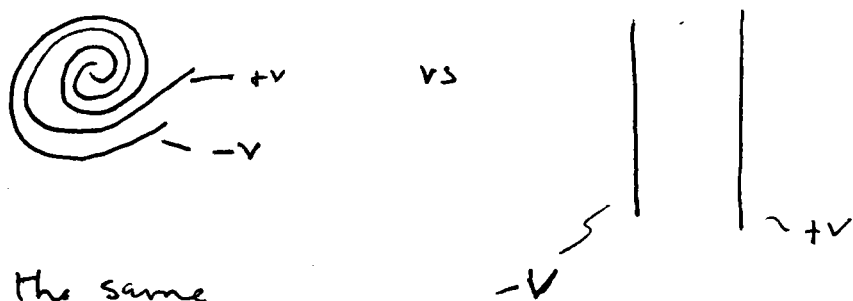
Made in U.S.A.

Capacitance is the amount of charge held in a system  
 ÷ by the potential ~~difference~~ difference between <sup>the</sup> parts  
 of the system - or if system is one conductor -  
 The other "part" of the system is at so w/ "zero" potential

$$C = \frac{q}{\Delta V} \quad \text{in coul/volt} \equiv 1 \text{ farad}$$

in honor of Michael Faraday

Capacitance depends only on geometry  
 (sizes, shapes, separations of conductors)



$\Delta V$  is the same

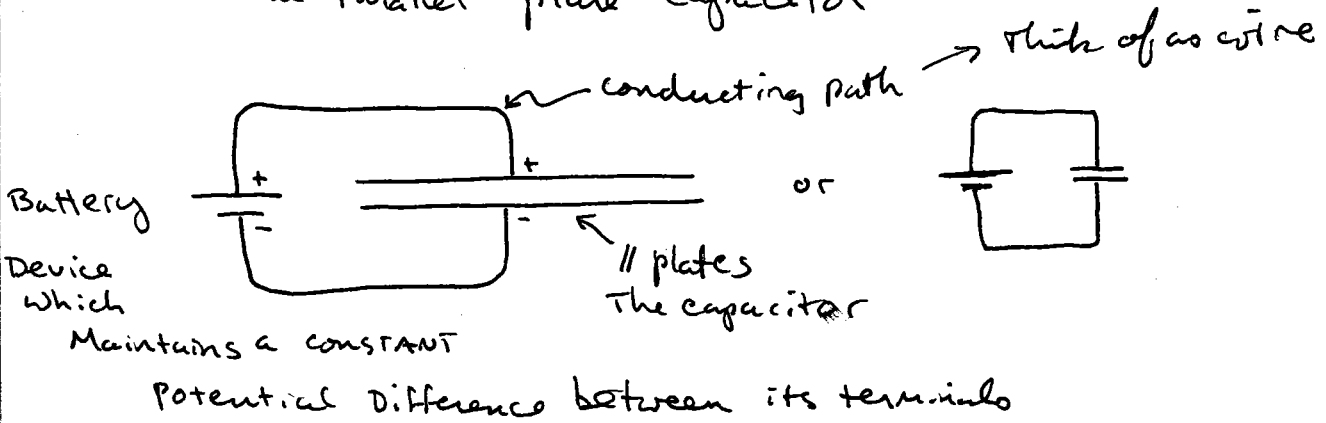
which would hold more charge? i.e., have higher capacitance?

### Capacitors

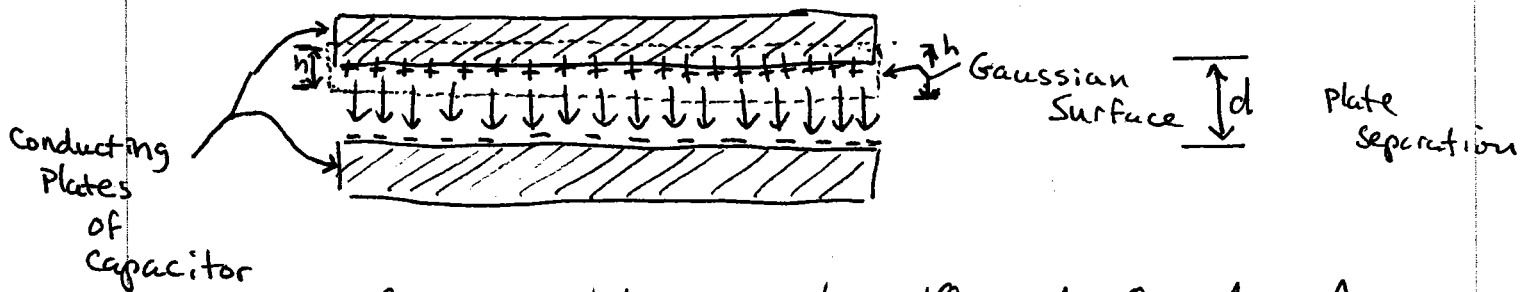
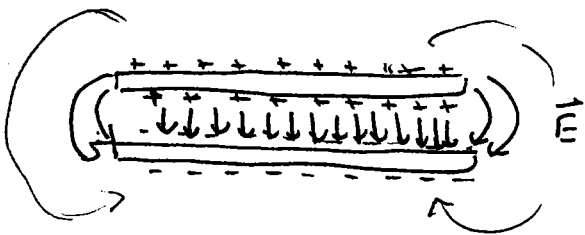
act as reservoirs of charge in electric circuits  
 implications of this to be covered later  
 can be used to store energy - which can be released  
very quickly



The most common capacitor for us is  
The Parallel plate capacitor



Your first circuit diagram!



Capacitor plates w/ charge  $+Q$  and  $-Q$ , Area  $A$ , Separation  $d$

Gauss's Law

$$\int_{\text{surf}} \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0}$$

in integral only the surface between the plates gets a contribution because either  $\vec{E} = 0$  or  $\vec{E} \cdot d\vec{A} = 0$

So

$$|\vec{E}|A = \frac{Q}{\epsilon_0} \Rightarrow Q = \epsilon_0 |\vec{E}|A$$

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National Brand

The work to carry a charge  $q_0$  from one plate to the other is  $Vq_0$  or  $q_0 \int \vec{E} \cdot d\vec{s}$

$$\therefore \int q_0 \vec{E} \cdot d\vec{s}$$

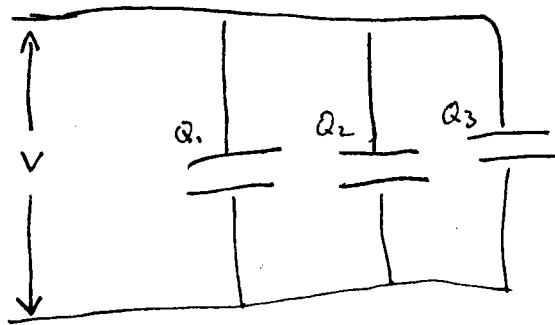
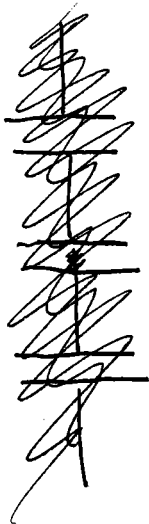
$$V = \int \vec{E} \cdot d\vec{s}$$

$$\text{NOW } C = \frac{Q}{V} = \frac{\epsilon_0 \int \vec{E} \cdot d\vec{s} A}{\int \vec{E} \cdot d\vec{s}} = \frac{\epsilon_0 A}{d}$$

Depends only on geometry ... As promised!!

### Combinations of Capacitors

in Parallel //



$$\text{TOTAL } Q = Q_1 + Q_2 + Q_3$$

$$\text{but } Q_1 = C_1 V$$

$$Q_2 = C_2 V$$

$$Q_3 = C_3 V$$

$$Q_{\text{TOTAL}} = V(C_1 + C_2 + C_3)$$

$\therefore$

$$C_{\text{cap in //}} = C_1 + C_2 + C_3$$