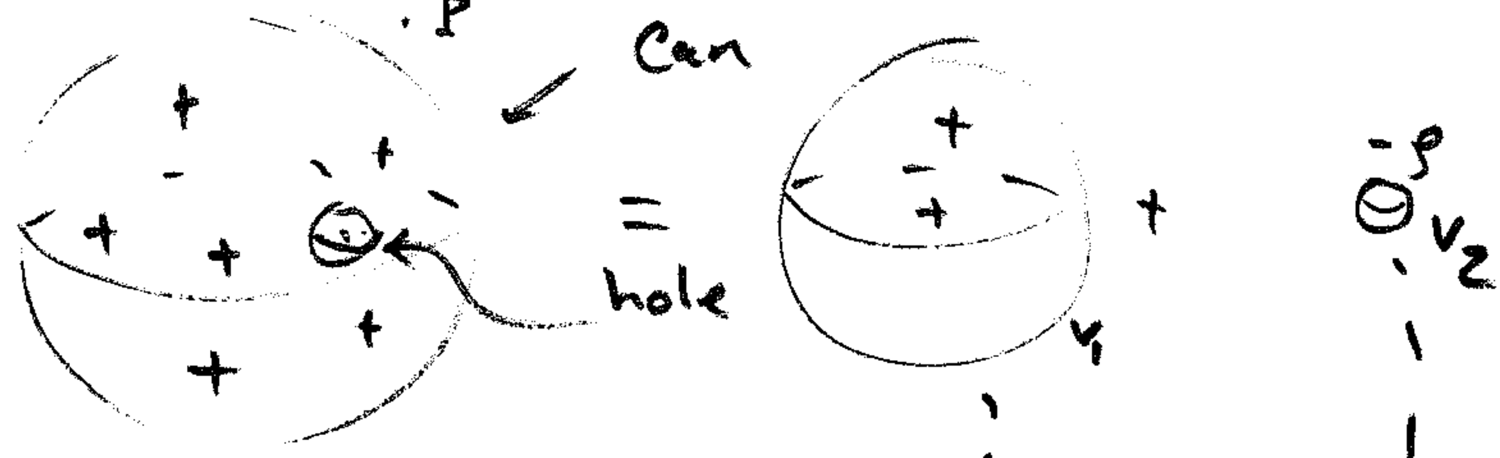
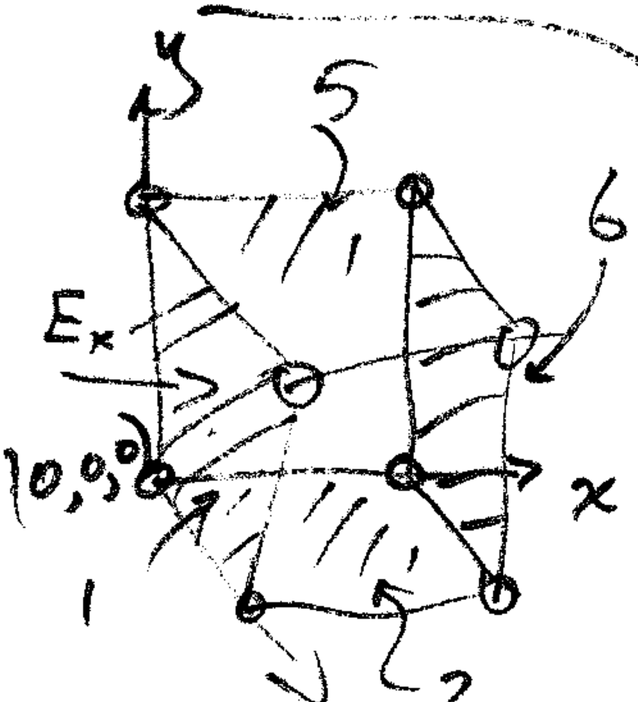
Physics 201 — Day 6

Superposition:



$+Q_1 = \rho V_1$ $\qquad$ $-Q_2 = -\rho V_2$



$$\vec{E} = \underbrace{(a+bx)}_{E_x}\hat{i} + c\hat{j}$$

$$\Phi_E = \underbrace{\Phi_{E_1} + \Phi_{E_6}}_{\text{yes}} + \underbrace{\Phi_{E_2} + \Phi_{E_5}}_{=0}$$

$$\Phi_{E_1} = E_1 A\cos\theta = a L^2 \overbrace{\cos(180^\circ)}^{-1} = -aL^2$$

$$\Phi_{E_6} = E_6 A\cos\theta = (a+bL)L^2 \underbrace{\cos(0)}_{1} =$$

$+$

answer

$= bL^3$

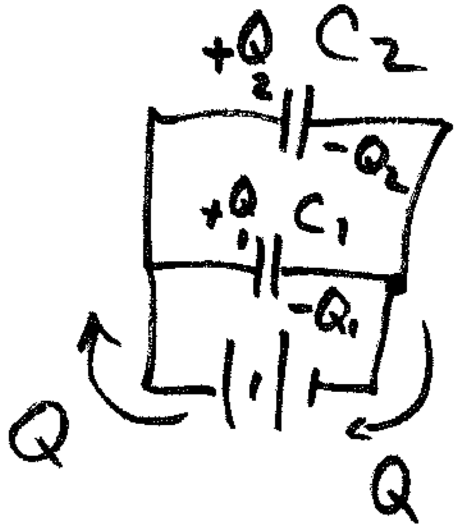
Quiz 1.0

Topic: { Point Q : $\vec{E}$ or $\vec{F}$ 19
{ Gauss' Law 17

Day: Mon Next
Wed Next
No Q Next Week

I want a Gauss' law Quiz, too ✓

Equivalent Capacitors: Series and Parallel



$V = V_1 = V_2$

$\boxed{Q = CV}$

$Q_1 = C_1 V$

$Q_2 = C_2 V$

$Q = \underbrace{C_{\parallel}}_{\text{equivalent}} V$

$Q = Q_1 + Q_2$

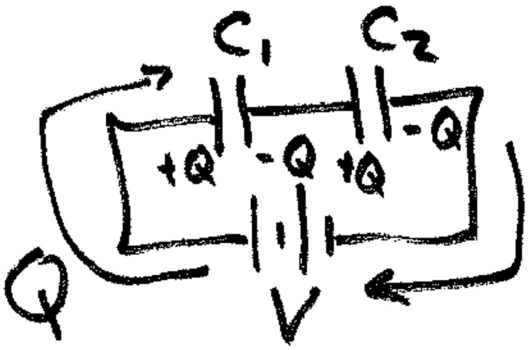
Find $C_{\parallel}$ given: C_1 and C_2.

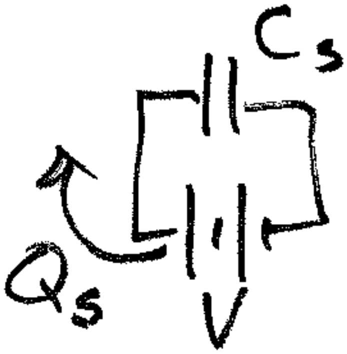
$C_{\parallel} \cancel{V} = C_1 \cancel{V} + C_2 \cancel{V}$

$\boxed{C_{\parallel} = C_1 + C_2}$

for R: $R_{\parallel} = \frac{R_1 R_2}{R_1 + R_2}$

They differ!





$$Q = Q_s$$

$$Q_s = C_s V$$

$$V_1 + V_2 = V$$

$$Q = C_s V$$

$$Q = C_1 V_1$$

$$Q = C_2 V_2$$

$$\frac{Q}{C_s} = V$$

$$\frac{Q}{C_1} = V_1$$

$$\frac{Q}{C_2} = V_2$$

$$\frac{Q}{C_1} + \frac{Q}{C_2} = \frac{Q}{C_s}$$

$$\boxed{\frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C_s}}$$

$$\frac{1}{C_1} + \frac{1}{C_2} + \cdots = \frac{1}{C_s}$$

$$\frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} \cdot \frac{C_1 C_2}{C_1 C_2} = C_s$$

Capacitance unit: Farad (F)

$$\boxed{\frac{C_1 C_2}{C_2 + C_1} = C_s}$$

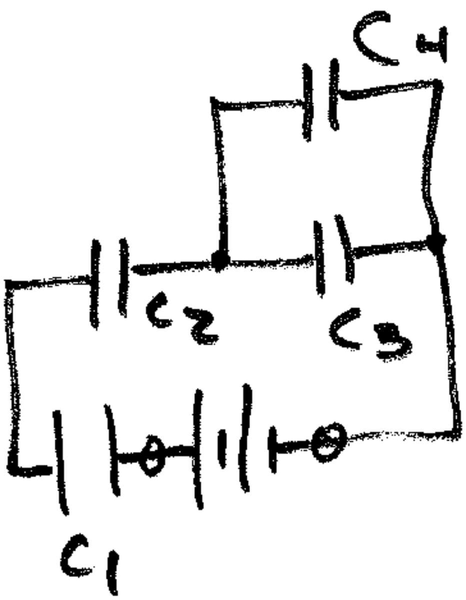
$$R_s = R_1 + R_2 + \cdots$$

Q is charge unit Coulomb

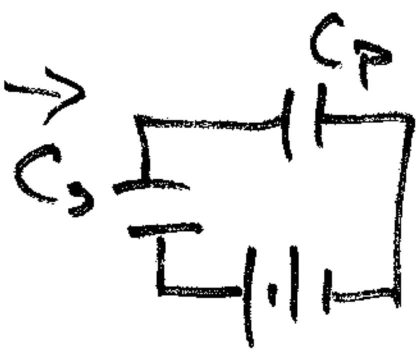
I is current unit Amp $= \frac{\text{Coulomb}}{\text{second}}$

Power (unit: Watt) $= I \cdot V$

find equivalent C.

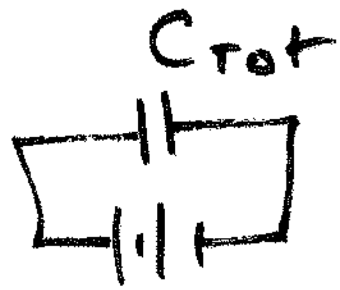


$$C_s = \frac{C_1 C_2}{C_1 + C_2}$$



$$C_{\parallel} = C_p = C_3 + C_4$$

$$\boxed{C_{Tot} = \frac{C_s C_p}{C_s + C_p}}$$

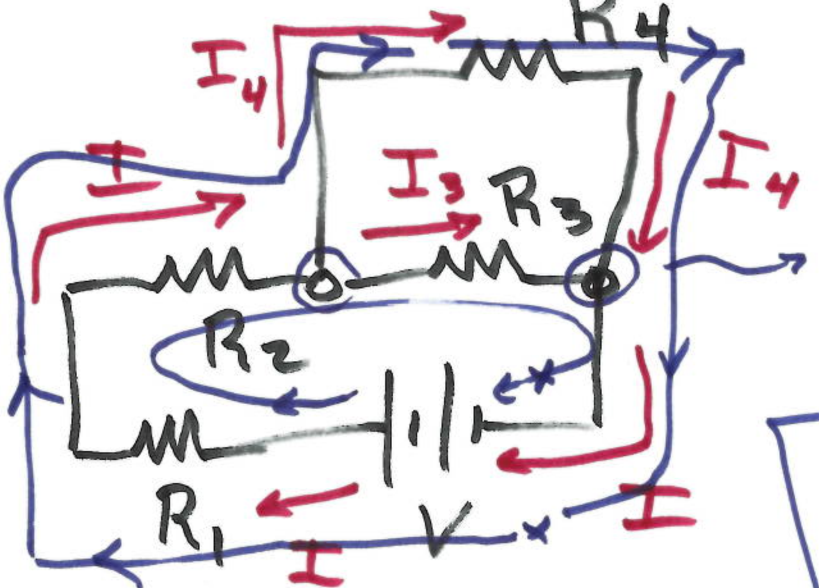


Kirchoff's Laws of Circuits:

$$\sum_{loop} V = 0$$ loop rule

$$\sum I_{IN} = \sum I_{OUT}$$ junction rule

$$V = IR$$



$$\Sigma I_{IN} = \Sigma I_{OUT}$$

$$I_3 + I_4 = I$$

Given: V R_1 R_2 R_3 R_4

compute: I through each R.

$$I = I_3 + I_4$$

loop rule

$$\Sigma V_{loop} = 0$$

lower loop:

$$+V - IR_1 - IR_2 - I_3R_3 = 0$$

outer loop:

$$+V - IR_1 - IR_2 - I_4R_4 = 0$$

$$V - I(R_1 + R_2) = I_3R_3$$

$$\frac{V}{R_3} - I\frac{(R_1+R_2)}{R_3} = I_3$$

Junc.

$$V - I(R_1 + R_2) = I_4 R_4$$ junc.

$$\frac{V}{R_4} - I\frac{(R_1 + R_2)}{R_4} = I_4$$

$$\frac{V}{R_3} - \overset{\star}{I}\frac{(R_1 + R_2)}{R_3} + \frac{V}{R_4} - \overset{\star}{I}\frac{(R_1 + R_2)}{R_4} = \overset{\star}{I}$$

$$\frac{V}{R_3} + \frac{V}{R_4} = I\left(1 + \frac{R_1 + R_2}{R_3} + \frac{R_1 + R_2}{R_4}\right)$$

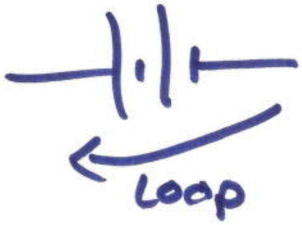
$$\frac{\frac{1}{R_3} + \frac{1}{R_4}}{1 + \frac{R_1 + R_2}{R_3} + \frac{R_1 + R_2}{R_4}} V = I$$ mult. by $\frac{R_3 R_4}{R_3 R_4}$ to clean up:

$$\frac{(R_4 + R_3)}{R_3 R_4 + R_4(R_1 + R_2) + R_3(R_1 + R_2)} V = I$$

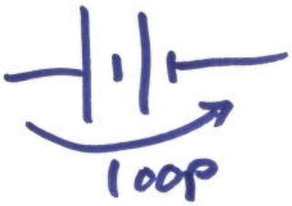
Setting up the loops is most important!

When solving, draw (guess) each current, I, direction. Then draw each loop (with direction).

Power Supply:

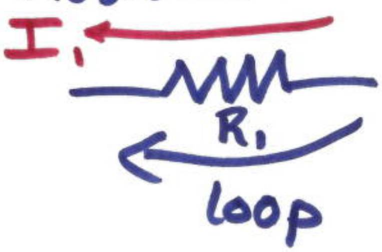


$+V$ when loop "right way" through power supply (from $-$ to $+$).

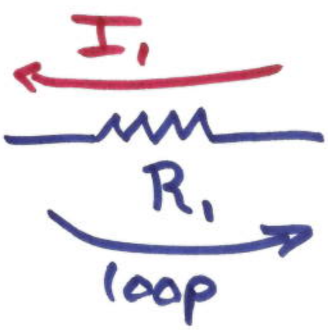


$-V$ when backwards.

Resistor:

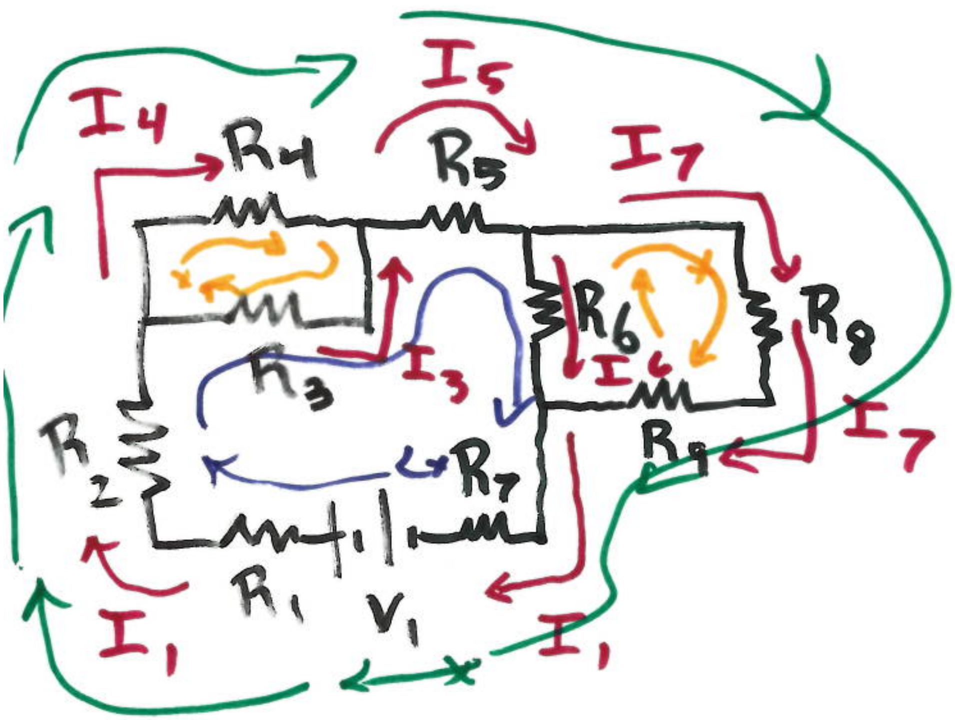


$-IR$ when loop agrees with current direction.



$+IR$ when loop opposes direction of current.

BIG EXAMPLE of Kircoff's Laws:



4 Junction Rules:

$I_1 = I_3 + I_4$
$I_3 + I_4 = I_5$ } Thus $I_1 = I_5$

$I_5 = I_6 + I_7$
$I_6 + I_7 = I_1$ } Thus $I_1 = I_5$ ...

Enough Loops to hit every element once or more.

lower: $V_1 - I_1R_1 - I_1R_2 - I_3R_3 - I_5R_5 - I_6R_6 - I_1R_7 = 0$

outer:
$V_1 - I_1R_1 - I_1R_2 - I_4R_4 - I_5R_5 - I_7R_8 - I_7R_9 - I_1R_7 = 0$

right loop:
$-I_7R_8 - I_7R_9 + I_6R_6 = 0$

top loop:
$-I_4R_4 + I_3R_3 = 0$

This is enough to solve this system's I values given V and all R values.