Physics 201 Day 7

Quiz Wed Point Charges

This Friday: Review & lite H_2 gas?

Next Fri: Exam 1.

U, V in space due to point Q
continuous

$\vec{F}$, $\vec{E}$

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

$$U = q'V$$

$$\vec{E}_x = -\frac{\partial V}{\partial x}$$

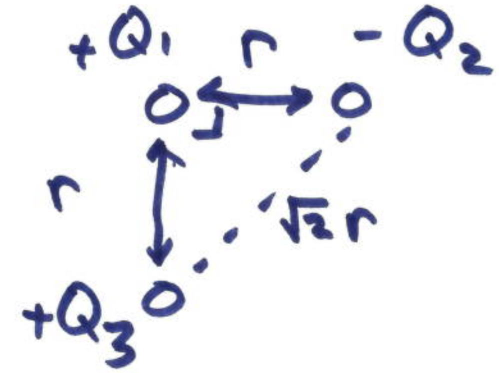
$$-\int \vec{E}\cdot\vec{dx} = \Delta V$$

Recall:

$$\vec{F}_x = -\frac{\partial U}{\partial x}$$

any conservative force (gravity, elastic, electrostatic)

$$-\int \vec{F}\cdot\vec{dx} = \Delta U$$



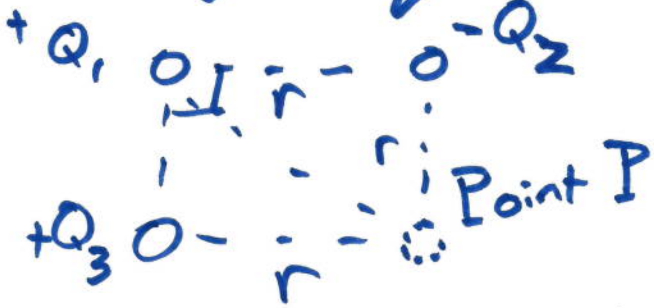
Find the U of this configuration.

$$U = k\frac{q_1 q_2}{r}$$

$$U_{Tot} = k\frac{Q_1(-Q_2)}{r} + k\frac{Q_1 Q_3}{r} + \frac{-kQ_2 Q_3}{\sqrt{2}r}$$

V defined at empty point in space.
If, later, a q' is placed there,

$$U = q'V$$



$$V \text{ at } P = \ldots = k\frac{Q_3}{r} + \frac{-kQ_2}{r} + \frac{kQ_1}{\sqrt{2}r}$$

length L
total charge Q

$$dV = \frac{k\,dq}{r} = \frac{k\overbrace{dq}^{\lambda dw}}{(x+w)}$$

$$\lambda = \frac{Q}{L}$$

$$\underbrace{\int dV}_{V} = \int_{w=0}^{L} \frac{k\lambda\,dw}{(x+w)}$$

$$V = k\lambda \int_0^L \frac{dw}{x+w} = k\lambda \int \frac{du}{u}$$

$$x + w = u \qquad \frac{du}{dw} = 1 \qquad du = dw$$

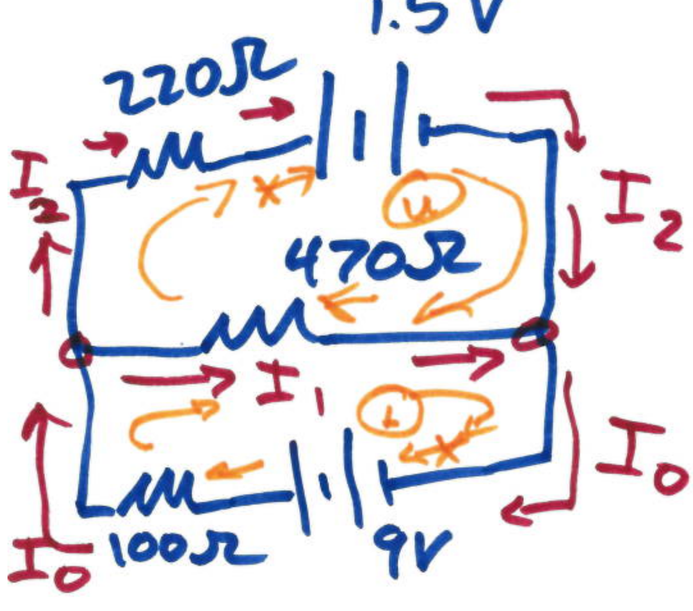
$$V = k\lambda \ln|u| = k\lambda \ln|x+w| \Big|_{w=0}^{w=L}$$

$$= k\lambda \left[\ln|x+L| - \ln|x|\right]$$

$$V = k\lambda \left[\ln(x+L) - \ln(x)\right]$$

$$E_x = -\frac{\partial V}{\partial x} = -k\lambda \left[\frac{1}{x+L} - \frac{1}{x}\right]$$

Given picture, find I in each branch of circuit with direction.



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

$$V = IR$$

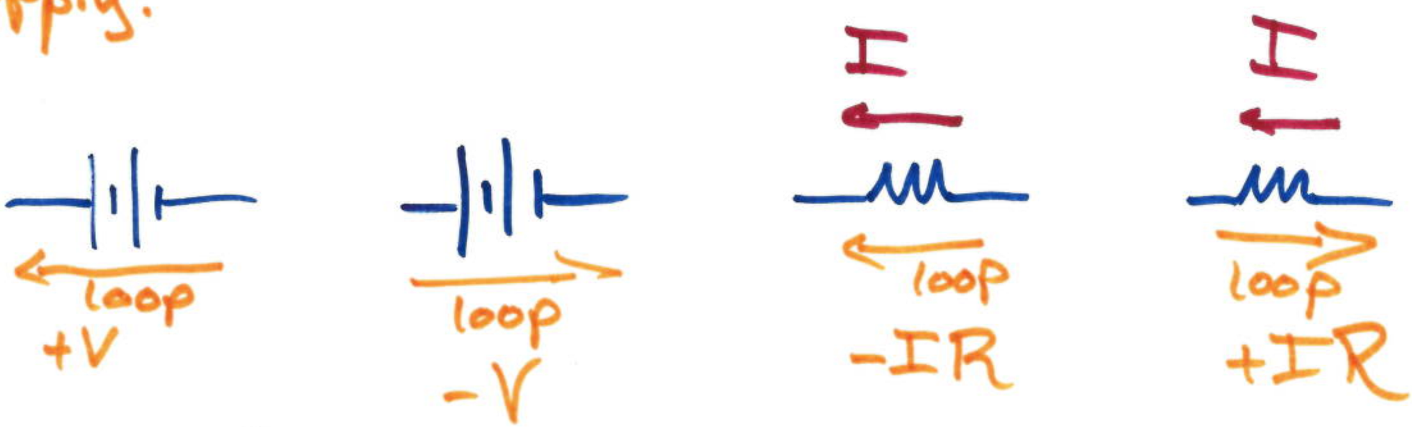
loop rules:
must draw loop direction

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

$$I_0 = I_1 + I_2$$

Ⓛ: $+9V - I_0\, 100\Omega - I_1\, 470\Omega = 0$

Ⓤ: $\underbrace{-1.5V}_{\text{loop wrong way through pow supply.}} \;\underbrace{+ I_1}_{\text{loop opposes our } I_1 \text{ direction.}} 470\Omega - I_2\, 220\Omega = 0$



Ⓛ: $9 - 470 I_1 = 100 I_0$ Drop unit

$$\frac{9}{100} - \frac{470}{100} I_1 = I_0$$

Ⓤ $$\frac{-1.5}{220} + \frac{470}{220} I_1 = \frac{220 I_2}{220}$$

$$I_0 = I_1 + I_2$$

$$\frac{9}{100} - 4.7\, I_1 = I_1 + \frac{-1.5}{220} + \frac{47}{22} I_1$$

$$\underbrace{\frac{9}{100}}_{0.09} + \frac{1.5}{220} = \left(1 + 4.7 + \frac{47}{22}\right) I_1$$

$$0.096 = 7.84\, I_1$$

$$\frac{0.096}{7.84} = I_1 = 0.01234\,A$$

$$\boxed{12.3\,mA}$$