

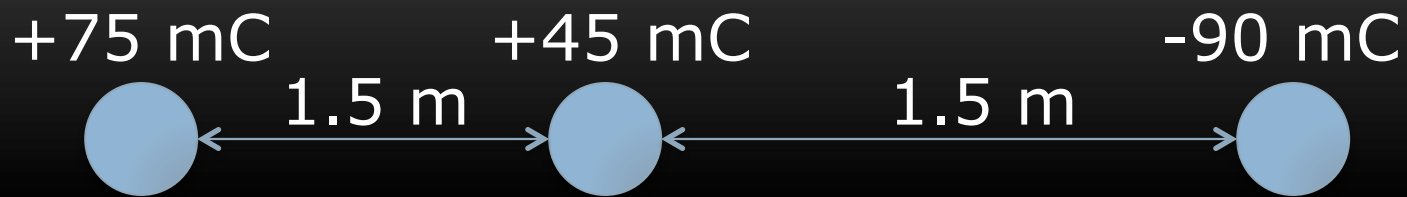
1. How far apart must two electrons be if the force between them is 3 N?

$$F = k q_1 q_2 / d^2$$

$$d = \frac{\sqrt{(9 \times 10^9 \text{ N m}^2/\text{C}^2)(-1.6 \times 10^{-19} \text{ C})(-1.6 \times 10^{-19} \text{ C})}}{3 \text{ N}}$$

$$d = 8.76 \times 10^{-15} \text{ m}$$

Electric Force: What is the net Force on the middle charge?



$$F_{\text{on middle due to L}} = (9 * 10^9 \text{ N m}^2/\text{C}^2) * (75 * 10^{-3} \text{ C} * 45 * 10^{-3} \text{ C}) / (1.5 \text{ m})^2$$

$F_{\text{on middle due to L}} = 1.35 * 10^7 \text{ N}$, positive, pushing the middle charge to the R

$$F_{\text{on middle due to R}} = (9 * 10^9 \text{ N m}^2/\text{C}^2) * (-90 * 10^{-3} \text{ C} * 45 * 10^{-3} \text{ C}) / (1.5 \text{ m})^2$$

$F_{\text{on middle due to R}} = -1.62 * 10^7 \text{ N}$, negative, pulling the middle charge to the R

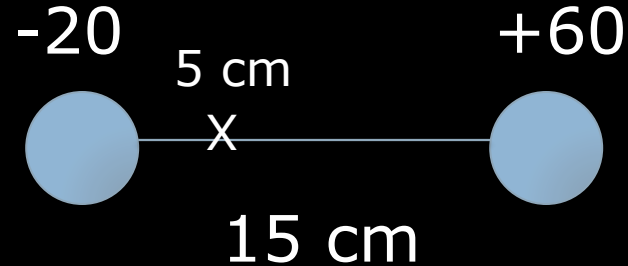
Since they're both moving the middle charge to the R, you need to combine them so that the resulting force is larger than either individual force.

$$\text{Net Force} = 1.35 * 10^7 \text{ N} - -1.62 * 10^7 \text{ N}$$

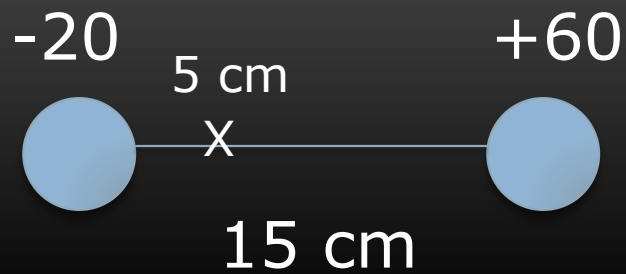
Net Force = $2.97 * 10^7 \text{ N}$, moving the middle charge to the right

This is the method to solve any Force or E field problem with multiple charges!

2. What is the magnitude and direction of the electric field, at a location shown in the image, due to a $-20\ \mu\text{C}$ and a $+60\ \mu\text{C}$ charge?



You need to determine the E field at that test point from each of the individual charges, and then determine how to combine them based on the direction of the field lines at the test point, that come from each charge



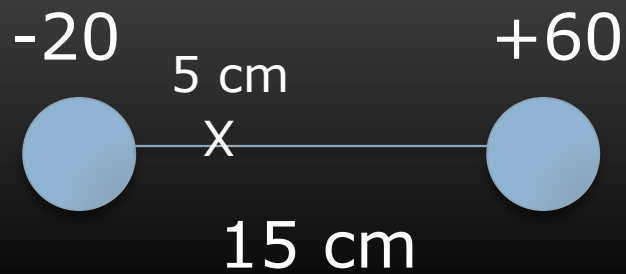
$$E_{\text{due to L}} = (9 * 10^9 \text{ N m}^2/\text{C}^2) * (20 * 10^{-6} \text{ C}) / (5 \text{ cm} * 1 \text{ m} / 100 \text{ cm})^2$$

$$E_{\text{due to R}} = (9 * 10^9 \text{ N m}^2/\text{C}^2) * (60 * 10^{-6} \text{ C}) / (10 \text{ cm} * 1 \text{ m} / 100 \text{ cm})^2$$

Notice we've ignored the signs on the charges when calculating E

$E_{\text{due to L}} = 7.2 * 10^7 \text{ N/C}$, pointing to the L, in to the negative charge

$E_{\text{due to R}} = 5.4 * 10^7 \text{ N/C}$, pointing to the L, away from the positive charge



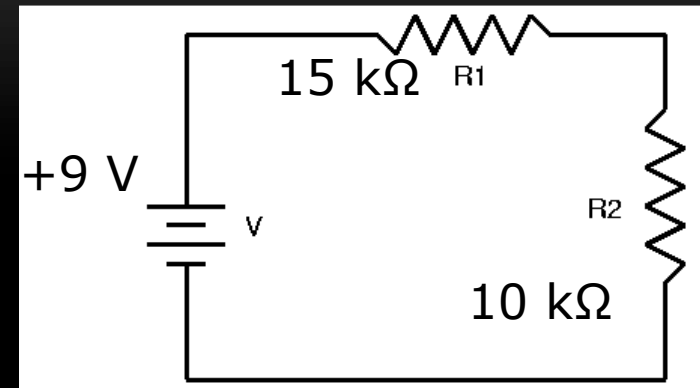
$E_{\text{due to L}} = 7.2 * 10^7\text{ N/C}$, pointing to the L, in to the negative charge

$E_{\text{due to R}} = 5.4 * 10^7\text{ N/C}$, pointing to the L, away from the positive charge

Net Field = $E_{\text{due to L}} + E_{\text{due to R}}$ because they're both pointing in the same direction

Net Field = $12.6 * 10^7\text{ N/C}$, pointing left

1. What is the current flowing through this circuit?



$$3.6 \times 10^{-4}$$

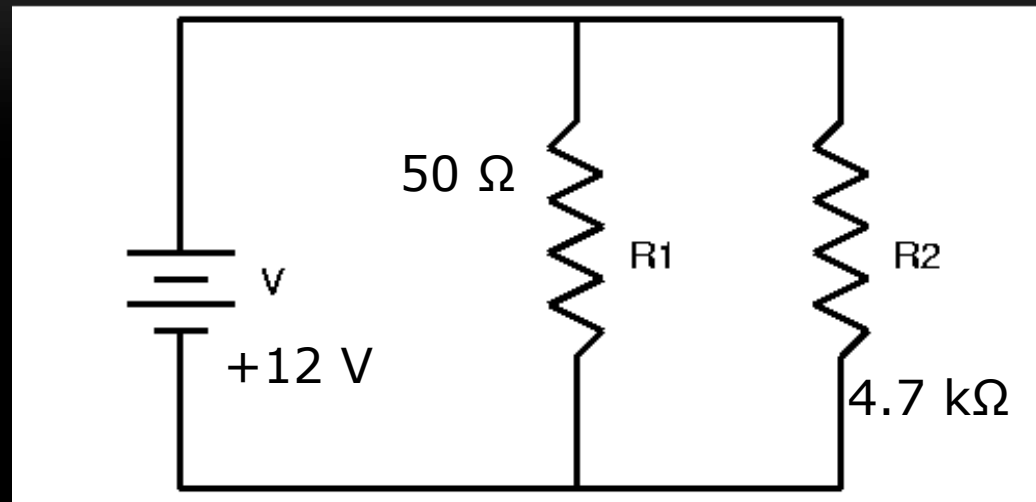
$V = I R$, where R is the total R in series, or $(15 + 10) \text{ k}\Omega$

$$I = (9 \text{ V}) / (25 \times 10^3 \Omega)$$

or $3.6 \times 10^{-4} \text{ A}$

2. What is the total resistance in this circuit?

49.47



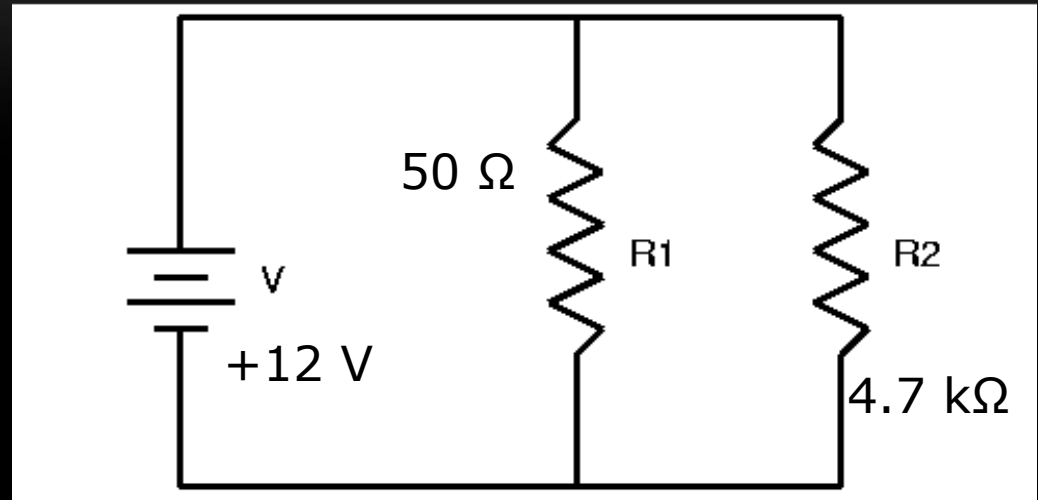
Total R is the R for resistors in parallel

$$R_{\text{total}} = \frac{1}{(1 / 50) + (1 / 4.7 \times 10^3)}$$

Or 49.47 Ω

3. What is the current running through R2 in this circuit?

0.0026 A



You can use $V = IR$, where you remember V through each branch of a parallel circuit is the same as the V of the power supply

$$I = 12 \text{ V} / (4.7 \times 10^3 \text{ } \Omega)$$

3. A current of 1 A flows in a wire. How many electrons are flowing past any point in the wire per second?

$$6.25 * 10^{18}$$

$$I = 1 \text{ Amp} = 1 \text{ C/sec} = nq / t$$

$$1 \text{ C/sec} * (1 \text{ ele} / 1.6 * 10^{-19} \text{ C})$$

$$\text{Or } 6.25 * 10^{18} \text{ ele} / \text{sec}$$