Name______________________________

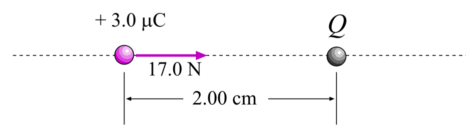
Feb. 13, 2008

Quiz #1 — Spring 2008

Phys 2020 (NSCC)

1. A $3.00\,\mu\mathrm{C}$ charge and a charge Q are separated by 2.00 cm. The $3.00\,\mu\mathrm{C}$ charge experiences a force of 17.0 N *toward* the other charge.

What is the charge Q?



To attract the first charge, Q must be negative. To get its absolute value, use

$$F = k\frac{|q_1 q_2|}{r^2} \qquad \Longrightarrow \qquad |q_2| = \frac{Fr^2}{k|q_1|}$$

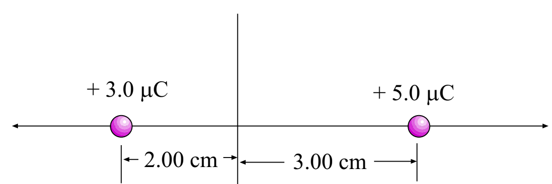
Plug in:

$$|q_2| = \frac{(17.0)(2.00\times 10^{-2})^2}{(8.99\times 10^9)(3.00\times 10^{-6})}\ \mathrm{C} = 2.52\times 10^{-7}\ \mathrm{C}$$

so the other charge must be $\boxed{-2.52\times 10^{-7}\ \mathrm{C}}$.

2. On the x axis there are point charge $3.00\,\mu\mathrm{C}$ and $5.00\,\mu\mathrm{C}$ located at the positions shown.

Find the direction and magnitude of the electric field at the origin.



At the origin the E field due to the left (positive) charge points to the right. So it gives

$$E_{1,x} = +k\frac{|q|}{r^2} = (8.99\times 10^9)\frac{(3.00\times 10^{-6})}{(2.00\times 10^{-2})^2}\ \frac{\mathrm{N}}{\mathrm{C}} = +6.74\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}}$$

and the charge on the right gives an E field which points to the left so that

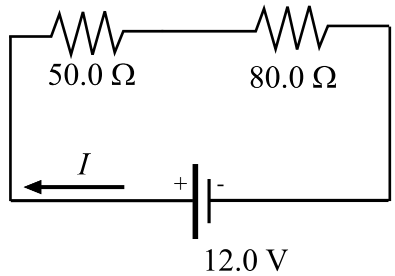
$$E_{2,x} = -k\frac{|q|}{r^2} = -(8.99\times 10^9)\frac{(5.00\times 10^{-6})}{(3.00\times 10^{-2})^2}\ \frac{\mathrm{N}}{\mathrm{C}} = -4.99\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}}$$

The total E field has

$$E_x = +6.74\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}} - 4.99\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}} = 1.75\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}}$$

that is, it has magnitude $\boxed{1.75\times 10^7\ \frac{\mathrm{N}}{\mathrm{C}}}$ and points in the $\boxed{+x}$ direction.

3. For the simple circuit shown at the right, find:



a) The (total) current I.

The equivalent resistance of the resistor combination is

$$R_{\text{eq}} = R_1 + R_2 = 50.0\,\Omega + 80.0\,\Omega = 130\,\Omega$$

so the total current is

$$I = \frac{V}{R_{\text{eq}}} = \frac{(12.0\text{ V})}{(130\,\Omega)} = 0.092\text{ A}$$

b) The potential differences across each of the two resistors.

The same current as found in (a) flows thru each resistor so Ohm's law ($V = IR$) gives the (individual) potential differences:

$$V_{50.0\,\Omega} = (0.092\text{ A})(50.0\,\Omega) = 4.6\text{ V}$$

$$V_{80.0\,\Omega} = (0.092\text{ A})(80.0\,\Omega) = 7.4\text{ V}$$

The sum of the two is 12.0 V, as it has to be.

c) The power dissipated in the $80.0\,\Omega$ resistor.

Power dissipated is

$$P = I^2R = (0.092\text{ A})^2(80.0\,\Omega) = 0.68\text{ W}$$

You must show all your work and include the right units with your answers!

$$F = k\frac{|q_1q_2|}{r^2} \qquad k = \frac{1}{4\pi\epsilon_0} \qquad \mathbf{F} = q\mathbf{E} \qquad E = k\frac{q}{r^2} \qquad E_{\text{plates}} = \frac{\sigma}{\epsilon_0}$$

$$V = -\frac{\Delta E_s}{\Delta s} \qquad V = k\frac{q}{r} \qquad q = CV \qquad C = \epsilon_0\frac{A}{d} \qquad \text{Energy} = \tfrac{1}{2}CV^2 \qquad C_{\text{diel}} = \kappa C_{\text{vac}}$$

$$V = IR \qquad P = IR = I^2R \qquad R_{\text{ser}} = R_1 + R_2 \ldots \qquad \frac{1}{R_{\text{par}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$

$$k = 8.99 \times 10^9\ \tfrac{\text{N}\cdot\text{m}^2}{\text{C}^2} \qquad \epsilon_0 = 8.854 \times 10^{-12}\ \tfrac{\text{C}^2}{\text{N}\cdot\text{m}^2} \qquad e = 1.60 \times 10^{-19}\text{ C}$$