Equations 1112

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$$F = k\frac{q_1 q_2}{r^2}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \frac{Nm^2}{C^2}$$

$$e = \pm1.6\times10^{-19}\,C$$

$$m_e = 9.11\times10^{-31}\,kg$$

$$E = k\frac{q}{r^2}$$

$$q_{enc} = \varepsilon_0 \sum_i \vec{E}_i \bullet \Delta\vec{A}_i$$

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

$$V = k\frac{q}{r}$$

$$W = \Delta V q$$

$$\Delta U = \Delta V q$$

$$KE = \tfrac{1}{2} m v^2$$

$$\vec{F} = qvB\sin(\phi)$$

$$\vec{F} = iLB\sin(\phi)$$

$$\Delta B = \frac{\mu_0}{4\pi}\frac{i\Delta l\sin\theta}{r^2}$$

$$B = \frac{\mu_0 i}{2\pi r}$$

$$F = \frac{\mu_0 L i_a i_b}{2\pi d}$$

$$\sum_i \vec{B}_i \bullet \Delta\vec{s}_i = \mu_0 i_{enc}$$

$$\Phi_B = BA$$

$$\varepsilon\ \cancel{E} = -N\frac{\Delta\Phi_B}{\Delta t}$$

$$L = \frac{N\Phi}{i}$$

$$\varepsilon\ \cancel{E} = \cancel{E}^{\varepsilon}_{\max}\sin(\omega_d t)$$

$$i = I\sin(\omega_d t - \varphi)$$

$$X_C = \frac{1}{\omega_d C}$$

$$X_L = \omega_d L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\varepsilon\ \cancel{E}_{\max} = IZ$$

$$\tan\varphi = \frac{X_L - X_C}{R}$$

$$P = i^2 R$$

$$V = iR$$

$$\omega = 2\pi f$$

$$1eV = 1.6\times10^{-19}\,J$$

$$\mu_0 = 4\pi\times10^{-7}\,\frac{T\cdot m}{A}$$

$$V_C = IX_C$$

$$V_L = IX_L$$

$$V_R = IR$$

Equations PHYS 2212

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$$F = k\frac{q_1 q_2}{r^2}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \frac{Nm^2}{C^2}$$

$$e = \pm1.6\times10^{-19}C$$

$$m_e = 9.11\times10^{-31}kg$$

$$E = k\frac{q}{r^2}$$

$$q_{enc} = \varepsilon_0 \oint \vec{E}\bullet d\vec{A}$$

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

$$V = k\frac{q}{r}$$

$$W = \Delta V q$$

$$\Delta U = \Delta V q$$

$$KE = \tfrac{1}{2}mv^2$$

$$1eV = 1.6\times10^{-19}J$$

$$\mu_0 = 4\pi\times10^{-7}\frac{T\cdot m}{A}$$

$$\omega = 2\pi f$$

$$\int \vec{B}\bullet d\vec{s} = i_{\text{enc}}$$

$$F = \underline{i\vec{l}\times\vec{B}} = \underline{i l B \sin\phi}$$

$$F = \underline{q\vec{v}\times\vec{B}} = \underline{q v B \sin\phi}$$

$$B = \frac{\mu_0 i}{2\pi r}$$

$$\frac{F}{l} = \frac{\mu_0 i_1 i_2}{2\pi d}$$

$$\mathcal{E} = -N\frac{d\Phi}{dt}$$

$$\Phi = BA$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$X_L = \omega L$$

$$X_C = \frac{1}{\omega C}$$

$$\mathcal{E} = IZ$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

$$F = ma$$

$$V = iR$$

$$P = i^2 R$$

$$P = iV$$

Example 1

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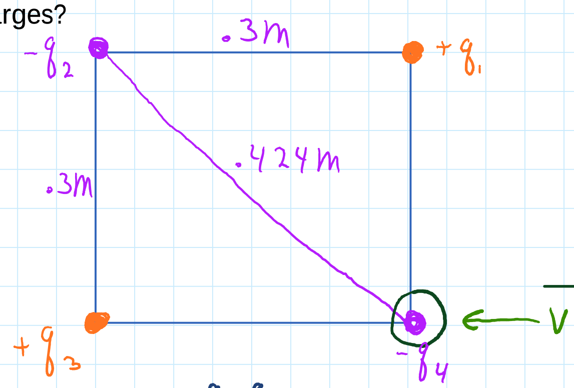
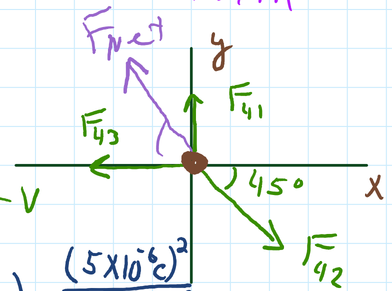
Four point charges with magnitude 5.0 μC are placed at the corners of a square that is 30 cm on a side. Two charges, diagonally opposite each other, are positive, and the other two are negative. What are the magnitude and the direction of the force on one of the charges?



$\sqrt{(.3m)^2 + (.3m)^2}$

$= .424\,m$



$$F = F_{43} = F_{41} = k\frac{q_4 q_1}{r_{41}^2} = (9\times10^9 N\frac{m^2}{C^2})\frac{(5\times10^{-6}C)^2}{(.3m)^2}$$

$$F = 2.5\ N$$

$$F_{42} = k\frac{q_4 q_2}{r_{42}^2} = (9\times10^9 N\frac{m^2}{C^2})\frac{(5\times10^{-6}C)^2}{(.424m)^2} = 1.25\,N$$

$$\Sigma F_x = -F_{43} + F_{42}\cos(45°) = -(2.5N) + (1.25N)\cos(45°)$$

$$\Sigma F_x = -1.62N$$

$$\Sigma F_y = F_{41} - F_{42}\sin(45°) = (2.5N) - (1.25N)\sin(45°)$$

$$\Sigma F_y = 1.62N$$

$$F_{Net} = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = \sqrt{(-1.62N)^2 + (1.62N)^2}$$

$$F_{Net} = 2.29N$$

$$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{-1.62N}{1.62N}\right) = -45°$$ (above -x axis)

PE of q_4 ?

$$U_4 = V q_4$$

$$U_4 = U_{41} + U_{42} + U_{43}$$

$$U_4 = k\frac{q_4 q_1}{r_{41}} + k\frac{q_4 q_2}{r_{42}} + k\frac{q_4 q_3}{r_{43}}$$

$$U_4 = k q_4\left(\frac{q_1}{r_{41}} + \frac{q_2}{r_{42}} + \frac{q_3}{r_{43}}\right)$$

$$U_4 = (9\times10^{+9}N\frac{m^2}{C^2})(-5\times10^{-6}C)\left[\frac{5\times10^{-6}C}{.3m} - \frac{5\times10^{-6}C}{.424m} + \frac{5\times10^{-6}C}{.3m}\right]$$

$$U_4 = -(9\times10^9 N\frac{m^2}{C^2})(5\times10^{-6}C)^2\left[\frac{2}{.3m} - \frac{1}{.424m}\right]$$

$U_4 = -.969 \text{ J}$

Example 2

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What are the 3 currents?

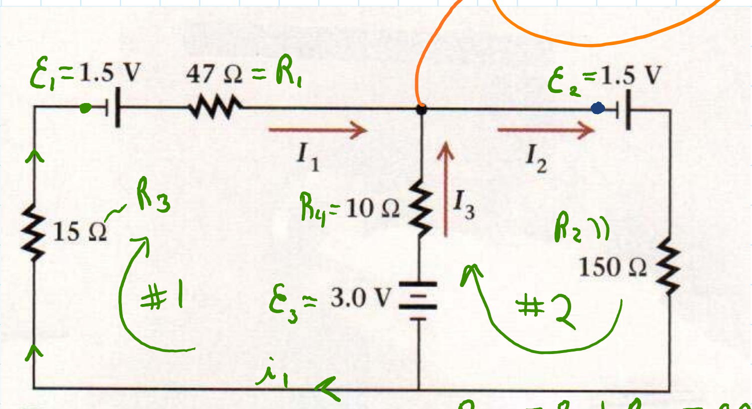

Figure 18.54

$R_{13} = R_1 + R_3 = 62\,\Omega$

$i_2 = i_1 + i_3$

$i_1 = i_2 - i_3$

$i_1 = .028A - .03A$

$i_1 = -.002A$

loop #1

$$\mathcal{E}_1 - i_1 R_1 + i_3 R_4 - \mathcal{E}_3 - i_1 R_3 = 0$$

$$\mathcal{E}_1 - i_1 R_{13} + i_3 R_4 - \mathcal{E}_3 = 0$$

$$\mathcal{E}_1 - (i_2 - i_3) R_{13} + i_3 R_4 - \mathcal{E}_3 = 0$$

$$\mathcal{E}_1 - i_2 R_{13} + i_3 R_{13} + i_3 R_4 - \mathcal{E}_3 = 0$$

$$\mathcal{E}_1 - \mathcal{E}_3 - i_2 R_{13} + i_3 (R_{13} + R_4) = 0$$

$$\mathcal{E}_1 - \mathcal{E}_3 - i_2 R_{13} + \left[\frac{\mathcal{E}_2 + \mathcal{E}_3 - i_2 R_2}{R_4}\right](R_{13} + R_4) = 0$$

$$\mathcal{E}_1 - \mathcal{E}_2 - i_2 R_{13} - i_2 \frac{R_2 (R_{13} + R_4)}{R_4} + \frac{(\mathcal{E}_2 + \mathcal{E}_3)(R_{13} + R_4)}{R_4} = 0$$

$$\mathcal{E}_1 - \mathcal{E}_2 - i_2 \left[R_{13} + \frac{R_2 (R_{13} + R_4)}{R_4}\right] + \frac{(\mathcal{E}_2 + \mathcal{E}_3)(R_{13} + R_4)}{R_4} = 0$$

$$i_2 = \frac{\mathcal{E}_1 - \mathcal{E}_2 + \frac{(\mathcal{E}_2 + \mathcal{E}_3)(R_{13} + R_4)}{R_4}}{R_{13} + \frac{R_2 (R_{13} + R_4)}{R_4}}$$

$$i_2 = \frac{\cancel{(1.5V - 1.5V)}^{\,0} + \frac{\overbrace{(1.5V + 3V)}^{4.5V}\overbrace{(62\,\Omega + 10\,\Omega)}^{72\,\Omega}}{10\,\Omega}}{62\,\Omega + \frac{(150\,\Omega)\underbrace{(62\,\Omega + 10\,\Omega)}_{72\,\Omega}}{10\,\Omega}}$$

$$i_2 = .028A$$

loop #2

$$\mathcal{E}_2 - i_2 R_2 + \mathcal{E}_3 - i_3 R_4 = 0$$

$$i_3 = \frac{\mathcal{E}_2 + \mathcal{E}_3 - i_2 R_2}{R_4}$$

$$i_3 = \frac{1.5V + 3V - (.028A)(150\,\Omega)}{10\,\Omega}$$

$$i_3 = .03A$$

Example 3

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A deuteron with mass of 3.34×10^{-27} kg and charge of 1.60×10^{-19} C moves in a magnetic field of 5.70×10^{-2} T.

What is the speed of the deuteron if it moves in a helical path of radius 0.0512 m and pitch 0. 167 m?

Example 3

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A coil contains 100 turns of wire in a loop 15 cm in diameter. The loop is placed between the poles of a large electromagnet, B =1.0 T, with the plane of the loop perpendicular to the field. If the magnetic field is steadily reduced from 1.0 T to 0 in 16 s, what is the average emf in the coil while the field is changing?

$\Phi \downarrow$

$\odot B$

$N = 100$

$.15\,m = d$

$r = .075\,m$

$B_i = 1T$

$B_f = 0$

$\Delta t = 16\,S$

$\Phi = BA\cancel{\cos\theta}^{\,1}$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$$

$$\mathcal{E} = -NA\frac{\Delta B}{\Delta t}$$

$$\mathcal{E} = -(100)\overbrace{(\pi)(.075m)^2}^{A}\,\frac{(0-1T)}{16\,S}$$

$$\mathcal{E} = .1125\,V$$