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Ave: 73
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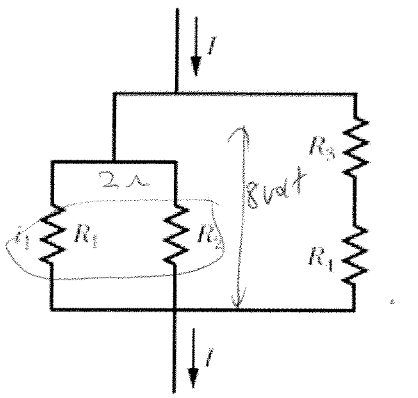
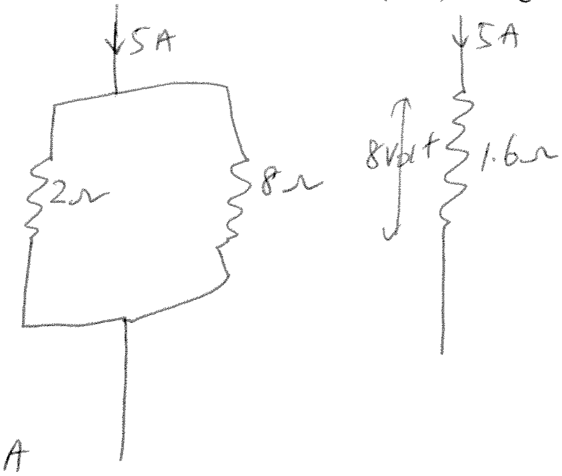
PHYS 212 (11 AM) Test #4 Spring 2012 Name: Key

Ohm's law: v = iR R in Series = add; R in parallel= $R^{-1}=R_1^{-1}+R_2^{-1}+R_3^{-1}$....

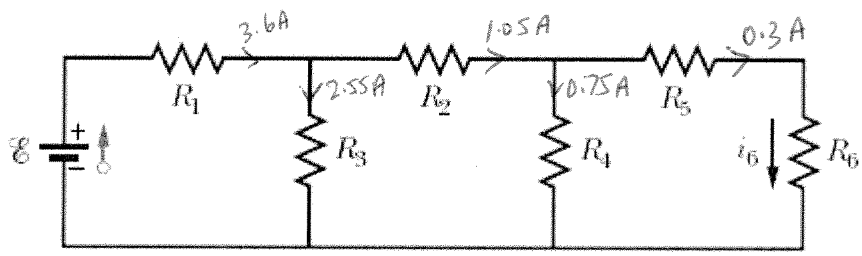
I. Figure below shows a portion of a circuit through which there is a current $I = 5.0$ A. The resistances are $R_1 = 3.0\ \Omega$, $R_2 = 6.0\ \Omega$, $R_3 = 5.5\ \Omega$, and $R_4 = 2.5\ \Omega$. What is the current i_1 (in A) through resistor 1?





$i_1 = \frac{8}{3} = 2.67\text{A}$

II. In the figure below, the current in resistance 6 is $i_6 = 0.3$ A and the resistances are $R_1 = R_2 = R_3 = 2.0\ \Omega$, $R_4 = 4.0\ \Omega$, $R_5 = 7.0\ \Omega$, and $R_6 = 3.0\ \Omega$. What is the emf of the ideal battery?



$V_4 = i_6(R_5+R_6) = 0.3(7+3) = 3$ volt

$i_4 = \frac{V_4}{R_4} = \frac{3}{4} = 0.75$ A

$V_2 = 1.05 \times R_2 = 2.1$ volt

$V_3 = V_2 + V_4 = 2.1 + 3 = 5.1$ volt ✓

$i_3 = \frac{V_3}{R_3} = \frac{5.1}{2} = 2.55$A

$i_1 = i_3 + i_2 = 2.55 + 1.05 = 3.6$ A

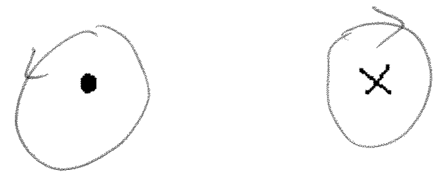
$V_1 = i_1 R_1 = 3.6 \times 2 = 7.2$ volt

$\mathcal{E} = V_1 + V_3 = 7.2 + 5.1 = \underline{12.3\text{ volt}}$

III. To make a galvanometer into a voltmeter, connect a ___high___ (high or low) resistance in ___series___ (parallel or series).

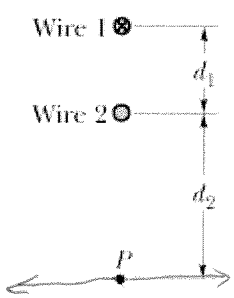
IV. The magnetic field due to a long straight wire, carrying a current I, at a distance r is given by; ($\mu_0 = 4\pi \times 10^{-7}$ T.m/A)

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



a. Show the magnetic field, circling the long-wire carrying current I (out of page and into page) using circles with directions, above.

b. In the figure below, two long straight wires are perpendicular to the page and separated by distance d_1 = 0.75 cm. Wire 1 carries 6.5 A into the page and wire 2 carries 4.5 A out of the page. What are the (a) magnitude and (b) direction of the net magnetic field due to the two currents at point P? (d_2 = 1.50 cm from wire 2)



$B_2 = \frac{\mu_0 I_2}{2\pi d_2} = \frac{4\pi \times 10^{-7} \times 4.5}{2\pi \times 1.5 \times 10^{-2}} = 6 \times 10^{-5}$ T

$B_1 = \frac{\mu_0 I_1}{2\pi(d_1 + d_2)}$

$= \frac{4\pi \times 10^{-7} \times 6.5}{2\pi \times 2.25 \times 10^{-2}} = 5.8 \times 10^{-5}$ T

0.2×10^{-5} (→)

2×10^{-6} T

2 μT

V. Faraday's law of induction is given by:

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

1. Describe the meaning of each term in the above equation including the minus sign.

$\mathcal{E}$ — Induced emf or voltage.

N — Number of turns in the coil.

Φ_B — Magnetic flux = $B \cdot A$

$\frac{d\Phi_B}{dt}$ — Rate of change of the magnetic flux

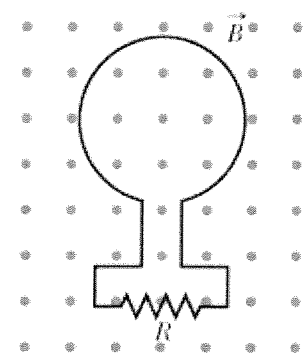
$(-)$ — Induced current will produce a magnetic field to oppose the change in magnetic flux.

2. P7: In the figure below, the magnetic flux through the loop increases according to the relation $\Phi_B = 5t^4 + 4t^3 + 3t^2 + 2t$, where Φ_B is in milliwebers and t is in seconds. What is the magnitude of the emf induced in the loop when $t = 2$ s?

$-\frac{d}{dt}(5t^4 + 4t^3 + 3t^2 + 2t)$

$-(20t^3 + 12t^2 + 6t + 2)$

$-(160 + 48 + 12 + 2) = -222$ mV



3. A uniform magnetic field $\vec{B}$ is perpendicular to the plane of a circular wire loop of radius r. The magnitude of the field varies with time according to $B = B_0 e^{-t/\tau}$, where B_0 and τ are constants. Find an expression for the emf in the loop as a function of time.

$\mathcal{E} = -\frac{d}{dt}(\Phi_B) = -\frac{d}{dt}\left(\pi r^2 \cdot B_0 e^{-t/\tau}\right)$

$\mathcal{E} = -\pi r^2 B_0 e^{-t/\tau}\left(-\frac{1}{\tau}\right) = \frac{\pi r^2 B_0}{\tau} e^{-t/\tau}$

Equations of kinematics: $e = 1.6 \times 10^{-19} C$ Electron Mass = 9.11×10^{-31}Kg

Final velocity = v, Initial velocity = v_0, Acceleration = a, Time interval = t, Displacement = x-x_0

1.	2.	3.	4.	5.
$v = v_0 + at$	$x - x_0 = \frac{1}{2}(v + v_0)t$	$v^2 = v_0^2 + 2a(x - x_0)$	$x - x_0 = v_0 t + \frac{1}{2}at^2$	$x - x_0 = vt - \frac{1}{2}at^2$

Magnetic force on a moving charge: $\vec{F_B} = q\vec{v} \times \vec{B}$.

Newton's second law: $\mathbf{F}_{\mathbf{net}}$ = ma Kinetic energy = $\frac{1}{2}mv^2$

VI. At time $t = 0$, an electron with kinetic energy 12 keV moves through $x = 0$ in the positive direction of an x axis that is parallel to the horizontal component of Earth's magnetic field $\vec{B}$. The field's vertical component is downward and has magnitude 55.0 μT.

(a) What is the magnitude of the electron's acceleration due to $\vec{B}$?

(b) What is the electron's distance from the x axis when the electron reaches, $x = 20$ cm?

$KE = 12\ keV = \frac{1}{2}mv^2$

$12 \times 10^3 \times 1.6 \times 10^{-19} = \frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 \rightarrow v^2 = \frac{2 \times 12 \times 10^3 \times 1.6 \times 10^{-19}}{9.11 \times 10^{-31}}$

$v = \sqrt{\frac{2 \times 12 \times 10^3 \times 1.6 \times 10^{-19}}{9.11 \times 10^{-31}}} = 6.5 \times 10^7\ m/s$

$a = F/m = \frac{qvB}{m} = \frac{1.6 \times 10^{-19} \times 6.5 \times 10^7 \times 55 \times 10^{-6}}{9.11 \times 10^{-31}} = 6.3 \times 10^{14}\ m/s^2$

$t = \frac{x}{v} = \frac{0.2}{6.5 \times 10^7} = 3.08 \times 10^{-9}\ s$

$\Delta z = \frac{1}{2}at^2 = \frac{1}{2} \times 6.3 \times 10^{14} \times (3.08 \times 10^{-9})^2 = 29.8 \times 10^{-4}\ m$

$= 3 \times 10^{-3}\ m$

$= 3\ mm$

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