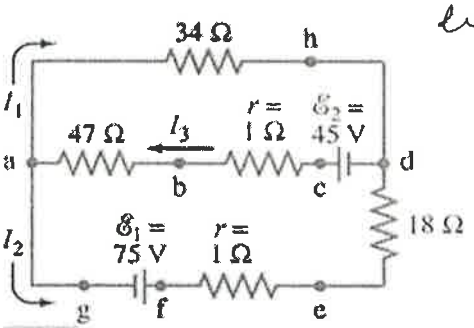
PHYS212 Exam 3 Name KEY

Problem 1 (33Points)

Calculate the currents I_1, I_2, and I_3 in the three branches of the circuit in the figure below using Kirchhoff's rules:



eq ① $I_3 = I_1 + I_2$ Junction rule (3)

loop rule $\Delta V = 0$ (3)

loop 1 (2)

a h d c b a

$-34 I_1 + 45 - I_3 - 47 I_3 = 0$ (7)

eq ② $-34 I_1 + 45 - 48 I_3 = 0$

$\Rightarrow I_3 = \frac{-34 I_1 + 45}{48} = -0.708 I_1 + 0.938$ eq ④ (2)

loop 2: a h d e f g a (2)

$34 I_1 + 18 I_2 + 1 I_2 - 75 = 0$ (7)

$-34 I_1 + 19 I_2 - 75V = 0$ eq ③ $\Rightarrow I_2 = \frac{75 + 34 I_1}{19}$ (2)

$I_2 = 1.79 + 3.95$ eq ⑤

put ④ & ⑤ in equation ① $I_3 = I_1 + I_2$ (2)

$-0.708 I_1 + 0.938 = I_1 + 1.79 I_1 + 3.45$

$-0.708 I_1 + 0.938 = 2.79 I_1 + 3.95$

$-3.012 = 3.498 I_1 \Rightarrow$ $I_1 = -0.861 A$ (1)

from eq ④ : $I_2 = 1.79 (-0.861A) + 3.95 = 2.41A$

from eq ⑤ , $I_3 = -0.708 (-0.861A) + 0.938 = 1.55A$ (1)

$I_2 = 2.41A$ $I_3 = 1.55A$ (1)

Problem 2 (34 points)

(II) An electron moves with velocity $\vec{v} = (7\hat{\imath} - 6\hat{\jmath}) \times 10^4$ m/s in a magnetic field $\vec{B} = (-0.80\hat{\imath} + 0.60\hat{\jmath})$ T. Determine **the magnitude and direction of the force on the electron**.

$\vec{F} = q(\vec{v} \times \vec{B})$ (4) q = electron $= -1.6 \times 10^{-19}$ C (4)

$$\vec{F} = -1.6 \times 10^{-19}\,C \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 7\times10^4 & -6\times10^4 & 0 \\ -0.8 & 0.6 & 0 \end{vmatrix} = -1.6\times10^{-19}\,C\,[\hat{\imath}(0-0) - \hat{\jmath}(0-0) + \hat{k}((0.6 \times 7\times10^{+4}) - (-0.8 \times -6\times10^4))]$$ (8) (8)

$$= -1.6\times10^{-19}\,C\,[4.2\times10^{+4} - 4.8\times10^4]\,\hat{k} = (0.96\times10^{-15}\,N)\,\hat{k}$$ (5)

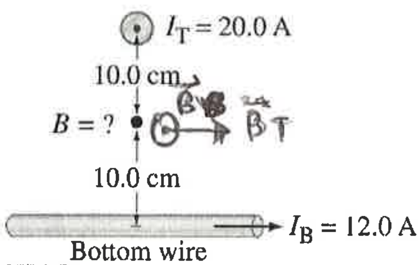
$$\boxed{\vec{F} = (9.6\times10^{-16}\,N)\,\hat{k}}$$ (2)

the force is on the z-axis (3)

Problem 3 (33 Points):

Two long wires are oriented so that they are perpendicular to each other. At their closest, they are 20.0 cm apart below.

a) Draw the magnetic fields due to each wire at a point midway between them



(10)

b) What is the magnitude of the magnetic field at a point midway between them if the top one carries a current of 20.0 A and the bottom one carries 12.0 A?

$$\vec{B}_{net} = \vec{B}_T + \vec{B}_B \quad (5)$$

$$|\vec{B}_{net}| = \sqrt{B_T^2 + B_B^2} \; (5) = \sqrt{\left(\frac{\mu_0}{2\pi r}\right)^2 \left[I_{top}^2 + I_{bottom}^2\right]} \quad (2)$$

$$= \frac{\mu_0}{2\pi r}\sqrt{I_{top}^2 + I_{bottom}^2} \; (3) = \frac{4\pi \times 10^{-7}\,\mathrm{Tm/A}}{2\pi(10\times 10^{-2}\,\mathrm{m})}\sqrt{(20.0\,\mathrm{A})^2 + (12.0\,\mathrm{A})^2} \quad (5)$$

$$|\vec{B}_{net}| = 4.66 \times 10^{-5}\,\mathrm{T} \quad (3)$$

Bonus problem (15 points)

(I) Find the direction of the force on a negative charge for each diagram shown in Figure below, where $\vec{v}$ (green) is the velocity of the charge and $\vec{B}$ (blue) is the direction of the magnetic field. (⊗ means the vector points inward. (means it points outward, toward you.)