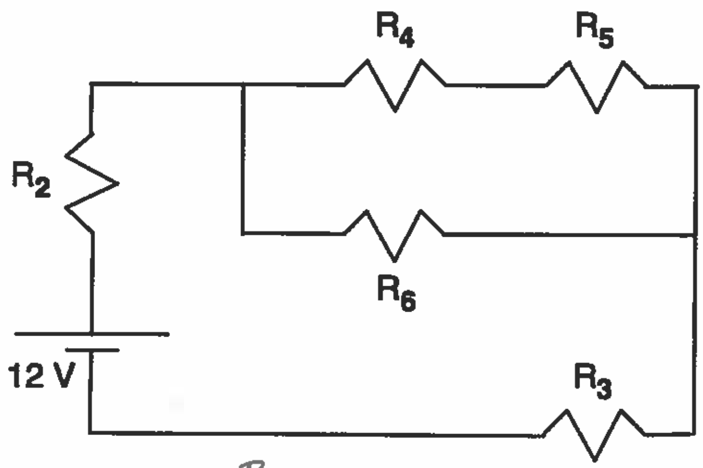
# Physics 10164 - Spring 2019 Exam 2C

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

(30 pts) For the circuit below, $R_2$ = 2.0 Ohms, $R_3$ = 3.0 Ohms, $R_4$ = 4.0 Ohms, $R_5$ = 5.0 Ohms, $R_6$ = 6.0 Ohms.

(a) Find the power dissipated by the resistor $R_6$.

(b) If the branch containing $R_4$ and $R_5$ were removed from the circuit, what happens to your answer to (a)? Explain.



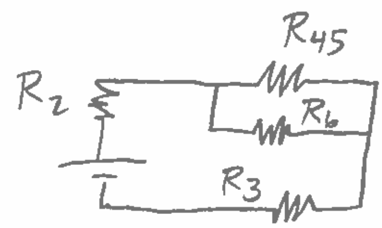

$R_{45} = R_4 + R_5 = 9.0\,\Omega$

$\frac{1}{R_{456}} = \frac{1}{R_{45}} + \frac{1}{R_6}$

$\Rightarrow R_{456} = 3.6\,\Omega$

$R_{TOT} = R_2 + R_{456} + R_3$

$= 8.6\,\Omega$



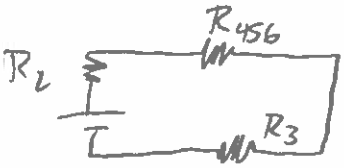

Since $R_{TOT} = 8.6\,\Omega$

$I_{TOT} = \frac{12}{8.6} = 1.4\,A$

$R_2, R_{456}, R_3$ in series, so

$I_{TOT} = I_2 = I_{456} = I_3 = 1.4\,A$

$\Rightarrow \Delta V_{456} = I_{456} R_{456} = (1.4)(3.6) = 5.0\,V$




$R_{45}, R_6$ in parallel, so

$\Delta V_{456} = \Delta V_{45} = \Delta V_6 = 5.0\,V$

$\Rightarrow I_6 = \frac{5.0}{6.0} = 0.84\,A \Rightarrow P_6 = I_6^2 R_6 = \boxed{4.2\,W}$


b) $R_2, R_3, R_6$ in simple series. $R_{TOT} = 11\,\Omega \Rightarrow I_{TOT} = 1.09\,A$

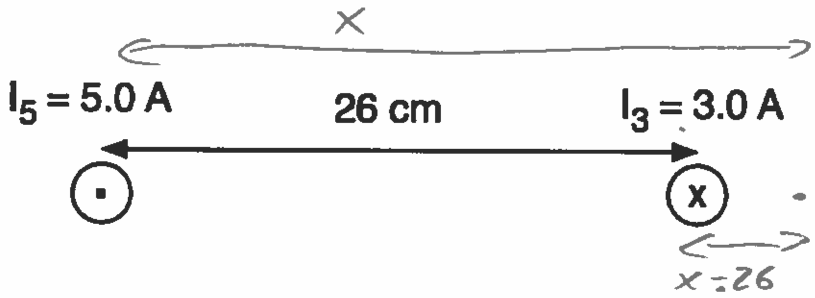
$I_{TOT} = I_2 = I_6 = I_3 \Rightarrow I_6 = 1.09\,A$

$P_6 = I_6^2 R_6 = 7.1\,W$, $\boxed{\text{increases}}$

2. (40 pts) Two straight wires are oriented perpendicular to the page as shown. Wire 5 passes through the origin and wire 3 passes through x = 26 cm.

a) For what value of x (besides infinity) is the total magnetic field due to the two wires equal to zero? *left side*

b) An electron is moving toward the [redacted] of the page through the point midway between the two wires. What is the magnitude and direction of the magnetic force on the electron? $v = 3.6 \times 10^5$ m/s




$\vec{B} = 0$ closer to $I_3$ since it has smaller $\vec{B}_3$, we have to be closer to cancel $B_5$.

$|B_5| = |B_3|$

$$\frac{\mu_0 I_5}{2\pi x} = \frac{\mu_0 I_3}{2\pi (x - .26)}$$

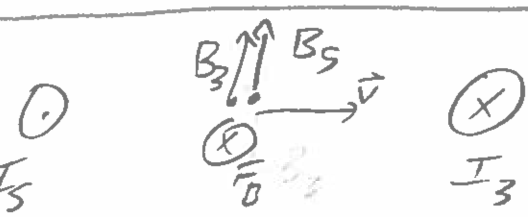
$$\frac{5}{3} = \frac{x}{x - .26}$$

$$1.67(x - .26) = x$$

$$1.67x - 0.433 = x$$

$$x = \frac{.433}{.67} = \boxed{0.65\ m}$$

b)




$$B_{TOT} = + \frac{\mu_0 I_3}{2\pi(.13)} + \frac{\mu_0 I_5}{2\pi(.13)}$$

$$= 1.23 \times 10^{-5}\ T$$

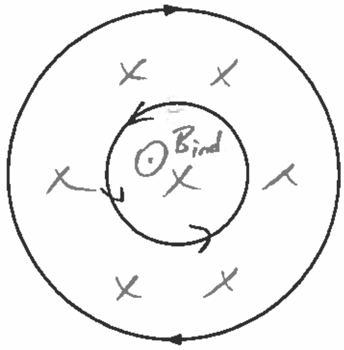

$F_B$ due to left-hand rule

$$F_B = (1.6 \times 10^{-19})(3.6 \times 10^5) * (1.23 \times 10^{-5})$$

$$= \boxed{7.1 \times 10^{-19}\ N, \odot}$$

3. (30 pts) Below, we are looking end-on at a 330 turns/cm solenoid of radius 28 cm with a clockwise current of 3.5 Amps. Inside the solenoid is a single-turn wire loop with a radius of 12 cm oriented so that its area vector is parallel with the axis of the solenoid. The current in the solenoid is increased to 15 Amps during a time interval of 0.50 seconds.

a) What is the magnitude of the induced EMF in the single-turn wire loop during this time interval?
b) What is the direction of the induced current in the single-turn wire loop during this time interval?
c) What is the magnitude of the torque on the single-turn wire loop during this time interval?




$$B_i = \frac{\mu_0 (330)(3.5)}{.01} = 0.1455$$

$$B_f = \frac{\mu_0 (330)(15)}{.01} = 0.6237$$

$$\Delta B = 0.4782$$

a) $$\mathcal{E}_{ind} = \frac{N_{loop} \Delta B A_{loop} \cos\theta}{\Delta t} = \frac{(1)(.4782)\pi(.12)^2(1)}{0.50}$$

$$= \boxed{4.3 \times 10^{-2} \text{ Volts}}$$

b) $\Delta \Phi_B = \otimes$, increasing

$\Rightarrow B_{ind} = \odot$

$\Rightarrow \boxed{I_{ind} = \text{ccw}}$

c) Since $\vec{\mu}_{loop}$ + $\vec{B}_{sol}$ are parallel, $\theta = 0°$

$\tau \propto \sin 0° = \boxed{0}$