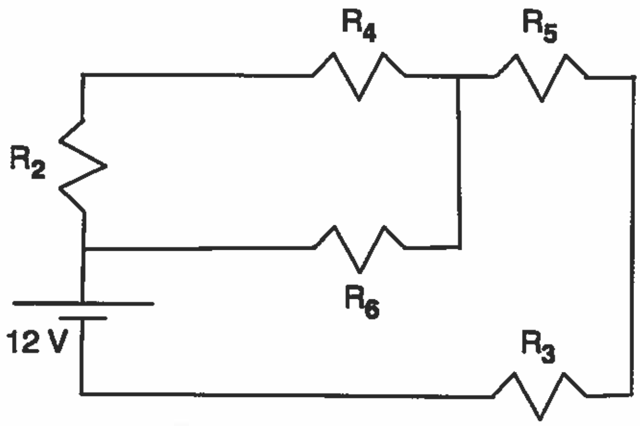
Physics 10164 - Spring 2019 Exam 2E

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 R_4 were removed from the circuit, what happens to your answer to (a)? Explain.



$R_{24} = R_2 + R_4 = 6.0\,\Omega$

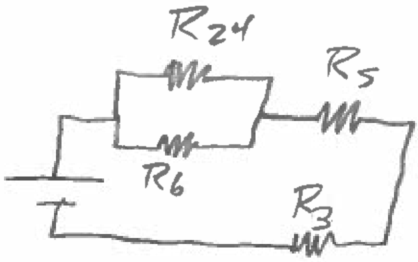
$\frac{1}{R_{246}} = \frac{1}{R_{24}} + \frac{1}{R_6}$

$\Rightarrow R_{246} = 3.0\,\Omega$

$R_{TOT} = R_{246} + R_5 + R_3$

$= 11\,\Omega$

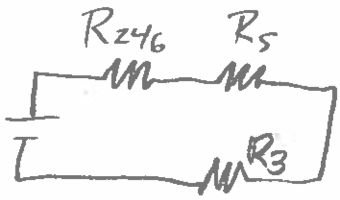
$\Rightarrow I_{TOT} = 1.09\,A$



Since R_{246}, R_5, R_3 in series,

$I_{TOT} = I_{246} = I_5 = I_3 = 1.09\,A$

$\Rightarrow \Delta V_{246} = I_{246} R_{246} = 3.27$ Volts



Since R_{24}, R_6 in parallel,

$\Delta V_{24} = \Delta V_6 = \Delta V_{246} = 3.27$ Volts

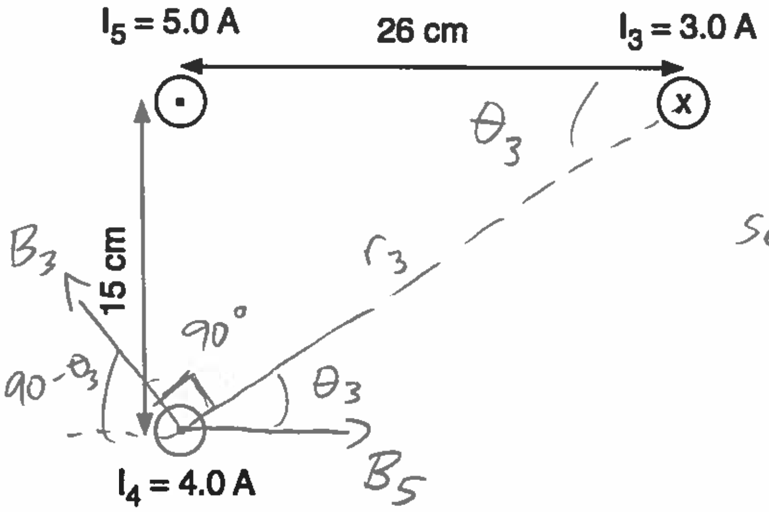
$\Rightarrow P_6 = \frac{(\Delta V_6)^2}{R_6} =$ **1.8 Watts**

b) $R_{26} = \frac{1}{1/2 + 1/6} = 1.5\,\Omega \Rightarrow R_{TOT} = 9.5\,\Omega \Rightarrow I_{TOT} = 1.26\,A$

so $I_{26} = 1.26\,A$, $\Delta V_{26} = 1.89\,V = \Delta V_6$

$P_6 = (1.89)^2/6 = 0.60$ Watts, **decrease**

2. (40 pts) Three straight wires are oriented perpendicular to the page as shown. Find the magnitude and direction of the magnetic force per unit length felt by wire 4 as a result of the magnetic field generated by wires 5 and 3.



$r_3 = \sqrt{.26^2 + .15^2} = .30$

$\theta_3 = 30.0^\circ$

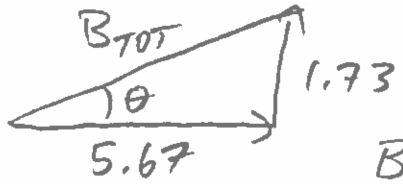
So B_3 makes ∡ of 60° above $-x$

$|B_5| = \frac{\mu_0 I_5}{2\pi(.15)} = 6.67\ \mu T, \longrightarrow B_{5x} = 6.67 \quad B_{5y} = 0$

$|B_3| = \frac{\mu_0 I_3}{2\pi(.3)} = 2.0\ \mu T,\ 60^\circ$ above $-x$

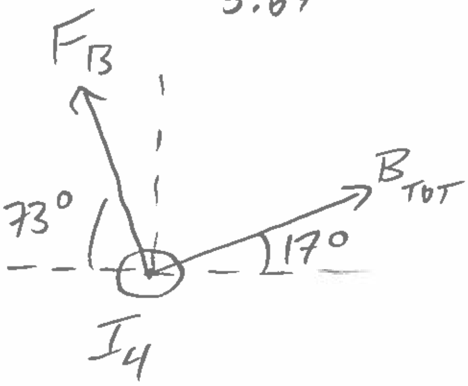
$B_{3x} = -1.0,\ B_{3y} = 1.73$

$+5.67, \quad +1.73$



$B_{TOT} = \sqrt{5.67^2 + 1.73^2} = 5.9\ \mu T$

$\theta = \tan^{-1}\left(\frac{1.73}{5.67}\right) = 17^\circ$ above $+x$

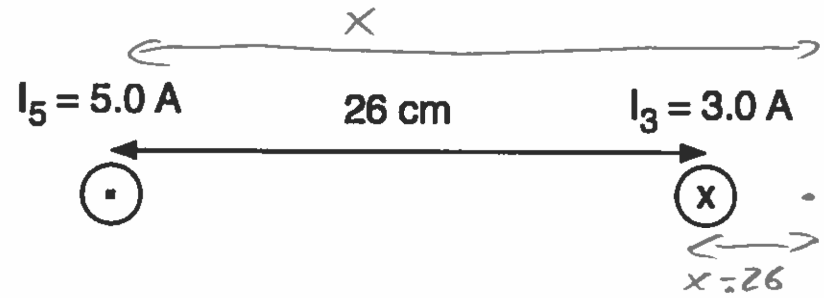


$\frac{\vec{F}_3}{l} = I_4 \times B_{TOT} = $ **2.4×10^{-5} N/m, 73° above $-x$**

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?

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? ↑ left side $v = 3.6 \times 10^5$ 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.

$|B_5| = |B_3|$

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

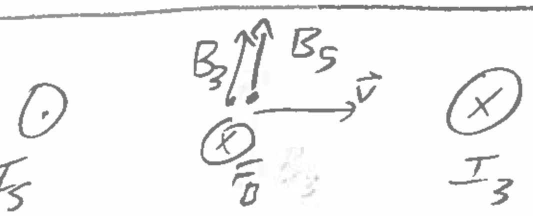
$$\frac{5}{3} = \frac{x}{x - .26}$$

$1.67(x - .26) = x$

$1.67x - 0.433 = x$

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

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

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

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