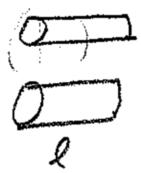
Solutions for

Physics 161 Test 3 Spring 2009, Morrison

① (c) When bulb B is removed, the resistance is decreased so the current and power are increased

② (B)



$$\left.\begin{array}{l} R_1 = \rho\, l/A_1 \\ R_2 = \rho\, l/A_2 \end{array}\right\} \quad \frac{R_1}{R_2} = \frac{A_2}{A_1} = \left(\frac{d_2}{d_1}\right)^2 = \left(\frac{2d_1}{d_1}\right)^2 = 4$$

where d = diameter of wire ; A = area of wire

So $R_2 = R_1/4$

Since $V = I_1 R_1 = I_2 R_2$, since $R_2 \neq R_1 \Rightarrow I_2 \neq I_1$

$\Rightarrow$ (A) is wrong

$$\left.\begin{array}{l} J_2 = \dfrac{I_2}{A_2} \\ J_1 = I_1/A_1 \end{array}\right\} \quad \frac{J_1}{J_2} = \frac{I_1}{I_2}\frac{A_2}{A_1} \qquad \text{But} \left\{\begin{array}{l} \dfrac{I_1}{I_2} = \dfrac{R_2}{R_1} \\ \dfrac{A_2}{A_1} = \dfrac{R_1}{R_2} \end{array}\right.$$

So $\dfrac{J_1}{J_2} = 1 \Rightarrow$ (B) is right

$$\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{1}{4} \Rightarrow I_1 = I_2/4 \Rightarrow \text{(c) + (D) are wrong}$$

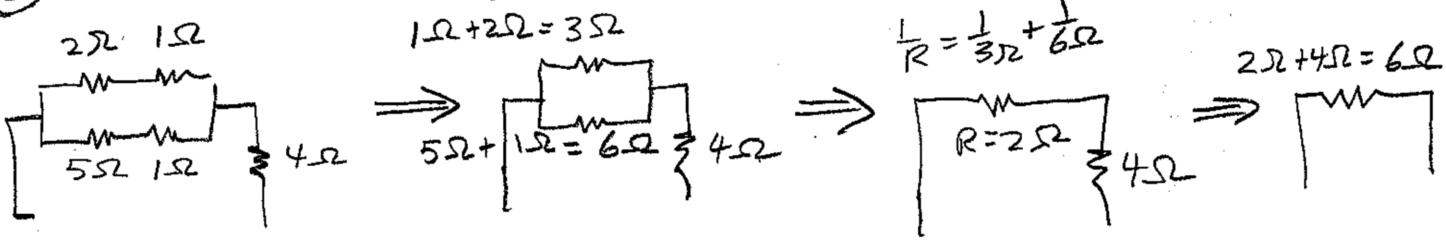
③ $R = \rho \ell / A = \dfrac{\rho \ell}{\pi \left(\frac{d}{2}\right)^2} = \dfrac{4 \rho \ell}{\pi d^2}$

So $\ell = \dfrac{\pi d^2 R}{4 \rho} = \dfrac{\pi (0.250 \times 10^{-3}\,m)^2 (50\,\Omega)}{4 * 1.0 \times 10^{-6}\,\Omega \cdot m}$

$= \underline{2.45\,\Omega}$ (B)

④ (A) Both bulbs B + C have ½ the voltage across them <u>and</u> smaller current than bulb A.

⑤ First find the equivalent resistance by reducing;



The current drawn off the battery (and the current thru the 4Ω resistor) is $I = 12V/6\Omega = 2A$

Now find the current thru the equivalent 3Ω & 6Ω resistors.

$I_{3\Omega} * 3\Omega = I_{6\Omega} * 6\Omega$ or $I_{6\Omega} = I_{3\Omega} \dfrac{3\Omega}{6\Omega} = \dfrac{I_{3\Omega}}{2}$

Also from junction rule $I_{3\Omega} + I_{6\Omega} = 2A$

or $I_{3\Omega} + I_{3\Omega}/2 = 6A$

$I_{3\Omega} = \frac{4}{3} A$

Power dissipated in the original 2Ω resistor:

$P_{2\Omega} = I^2 R = \left(\frac{4}{3} A\right)^2 (2\Omega) = \frac{32}{9} W = \underline{3.56W}$ (E)

(6) For an RC circuit that is charging

$q(t) = CV\left(1 - e^{-t/\tau}\right)$

where $\tau = RC = (0.80 \times 10^{6}\,\Omega)(30 \times 10^{-6}\,F) = 24\,s$

Thus $q(8.0s) = (30\mu F)(50V)\left(1 - e^{-8/24}\right) = \underline{430\mu C}$ (D)

(7) Total Force $= \vec{F} = \vec{F}_{gravity} + \vec{F}_{magnetic} \overset{set}{=} 0$

So $\vec{F}_{mag} = -\vec{F}_{gravity} = +mg\,\hat{k}$

$= I\vec{l} \times \vec{B} = IlB\,\hat{k}$

So $I = mg/lB = \underline{9.8\,mA}$ (B)

(8) (C)

(9) $F_{mag} = qvB = m\,v^2/R \Rightarrow R = mv/qB$

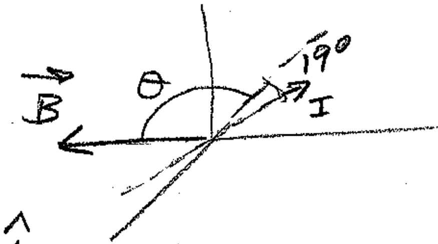
$\Rightarrow v = RqB/m$

But $a_{cent.} = \dfrac{v^2}{R} = \dfrac{(RqB/m)^2}{R} = R\left(\dfrac{qB}{m}\right)^2$

$= (0.30m)\left(\dfrac{2 \times 1.60 \times 10^{-19}\,C \times 0.40T}{6.68 \times 10^{-27}\,kg}\right)^2$

$= \underline{1.1 \times 10^{14}\,\dfrac{m}{s^2}}$ (A)

(10) $\vec{F} = I\vec{\ell} \times \vec{B}$



so $\vec{F} = I\ell B \sin\theta \,\hat{j}$

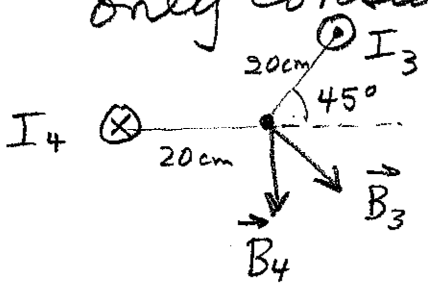
$= I\ell B \sin(90^\circ + 19^\circ)\,\hat{j}$

$= I\ell B \cos 19^\circ \hat{j} = \underline{+5.1\,N\,\hat{j}}$ (D)

or $\underline{F_y = +5.1\,N}$

(11) (A)

(12) The wireloop (I_1) and the bottom wire (I_2) product magnetic fields at the center of the loop that are along the z-axis, and do not result in a y-component. So we need only consider I_3 and I_4 which both give B_y:

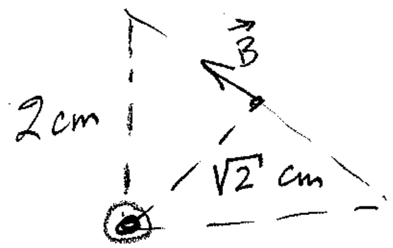


$$B_y = -(B_3 \cos 45^\circ + B_4)$$

$$= -\frac{\mu_0}{2\pi r}(I_3 \cos 45^\circ + I_4)$$

$$\underline{= -110\,\mu T} \quad (B)$$

(13) The wires at the top of the triangle and the bottom right of the triangle contribute equal and opposite magnetic fields at point P, hence we consider only the bottom left wire



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

$$= \underline{5.66 \times 10^{-5}\,T}$$

This answer is not on the list, so I will throw this question out