Solution — Midterm Exam 02, PHYS 203B-002, 2017 Spring

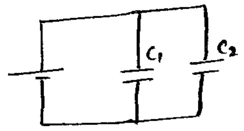
Prob. 1

$$P = \frac{V^2}{R} = \frac{(120\,V)^2}{20.0\,\Omega} = 720\,W$$

P = Power

$$\text{Energy} = \text{Power} \times \text{time}$$
$$= 720\,W \times 60\,s$$
$$= 4.32 \times 10^4\,J$$

Prob. 2



(a) $C_{eq} = C_1 + C_2 = 10.0 + 20.0 = 30.0\,\mu F$

(b) $V_1 = V_2 = V = 10.0\,V$

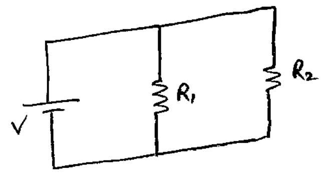
(c) $Q_1 = C_1 V_1 = (10.0\,\mu F)(10.0\,V) = 1.00 \times 10^{-4}\,C$

$Q_2 = C_2 V_2 = (20.0\,\mu F)(10.0\,V) = 2.00 \times 10^{-4}\,C$

(d) $U_1 = \frac{1}{2} C_1 V_1^2 = \frac{1}{2}(10.0\,\mu F)(10.0\,V)^2 = 0.500\,mJ$

$U_2 = \frac{1}{2} C_2 V_2^2 = \frac{1}{2}(20.0\,\mu F)(10.0\,V)^2 = 1.00\,mJ$

Prob. 3



(a) $$\frac{P_1}{P_2} = \frac{\left(\frac{V_1^2}{R_1}\right)}{\left(\frac{V_2^2}{R_2}\right)} = \frac{R_2}{R_1} = \frac{200.0\,\Omega}{100.0\,\Omega} = 2 \qquad (V_1 = V_2)$$

Thus, $P_1 = 2\,P_2$

(b) Power is a measure of intensity of light from a bulb. Thus, bulb 1 will be brighter.

Problem 4

$$R = \frac{\rho l}{A}$$

$$R' = \frac{\rho l'}{A'} = \frac{\rho (3l)}{\left(\frac{A}{3}\right)} = 9\,\frac{\rho l}{A} = 9R$$

→ Given $l' = 3l$

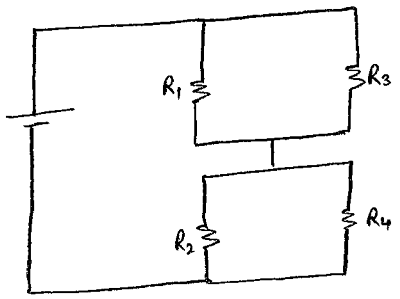
→ Volume is fixed

$$l A = l' A'$$

$$\cancel{l} A = 3 \cancel{l} A'$$

$$A' = \frac{A}{3}$$

Problem 5



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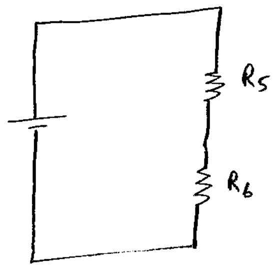


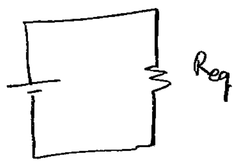
$$\frac{1}{R_5} = \frac{1}{R_1} + \frac{1}{R_3} = \frac{1}{100} + \frac{1}{100} = \frac{2}{100}$$

$$R_5 = 50.00\Omega$$

$$\frac{1}{R_6} = \frac{1}{R_2} + \frac{1}{R_4} = \frac{1}{100} + \frac{1}{100} = \frac{2}{100}$$

$$R_6 = 50.00\Omega.$$

↓

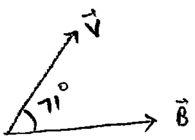


$$R_{eq} = R_5 + R_6 = 50.00 + 50.00 = 100.0\ \Omega$$

Problem 6

(a) $|\vec{F}_B| = q v B \sin\theta = (3.2\times10^{-19}\,C)\left(770\ \frac{m}{s}\right)(0.035T)\sin 71 = 8.1\times10^{-20}\ N$

(b)



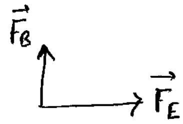
⊗ Force (into the page)

(c) $\omega = \frac{q}{m}B = \frac{3.2\times10^{-19}\ C}{6.6\times10^{-27}\,kg} \times 0.035\,T = 1.7\times10^{6}\ \frac{rad}{sec}.$

Prob. 7

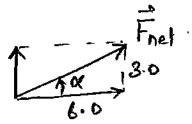
→ Electric force points along $\hat{x}$

→ Magnetic force points along $\hat{y}$ (using Right-Hand-Rule)



$$\vec{F}_E = +\hat{x}\, qE$$
$$= +\hat{x}\,(1.0\times10^{-6}\,\cancel{C})\left(6.00\times10^{3}\,\frac{N}{\cancel{C}}\right) = +\hat{x}\ 6.0\ \mu N$$

$$\vec{F}_B = +\hat{y}\ qvB\sin 90$$
$$= +\hat{y}\,(1.0\times10^{-6}\,C)\left(2.00\times10^{6}\,\frac{m}{s}\right)(1.50\,mT)(1) = +\hat{y}\ 3.0\,mN$$



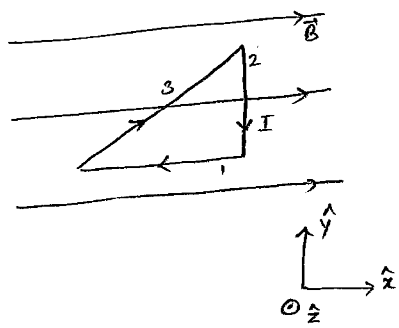
$$\vec{F}_{net} = \vec{F}_E + \vec{F}_B$$
$$= (+\hat{x}\ 6.0 + \hat{y}\ 3.0)\ mN$$

magnitude: $|\vec{F}_{net}| = \sqrt{6.0^2 + 3.0^2} = 6.7\ mN$

direction: $\alpha = \tan^{-1}\left(\frac{3.0}{6.0}\right) = 27^{\circ}$ counterclockwise w.r.t. $+\hat{x}$.

Problem 8

(a) $\vec{F}_1 = 0$, because angle between current and $\vec{B}$ is 180°.



(b)
$$\vec{F}_2 = +\hat{z}\ I L_2 B \sin 90$$
$$= +\hat{z}\,(20.0\times10^{-3}\,A)(2.0\times10^{-2}\,m)(1.0\,T)(1)$$
$$= \underbrace{+\hat{z}}_{\text{out of page}}\ \underbrace{4.0\times10^{-4}\ N}_{\text{magnitude}}$$