Solutions PHYS-2058 (Midterm Exam 02) 2023 Fall

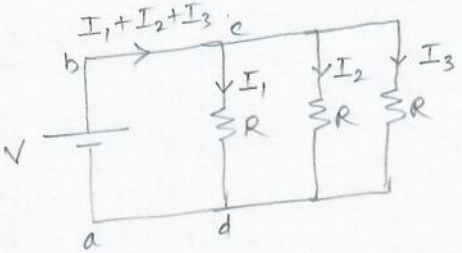
Problem 1

$$\text{Energy} = (12\ \text{W}) \times (1\ \text{year})$$

$$= 12\ \frac{\text{J}}{\text{s}} \times 365 \times 24 \times 60 \times 60\ \text{s}$$

$$= 3.8 \times 10^{8}\ \text{J}$$

Problem 2



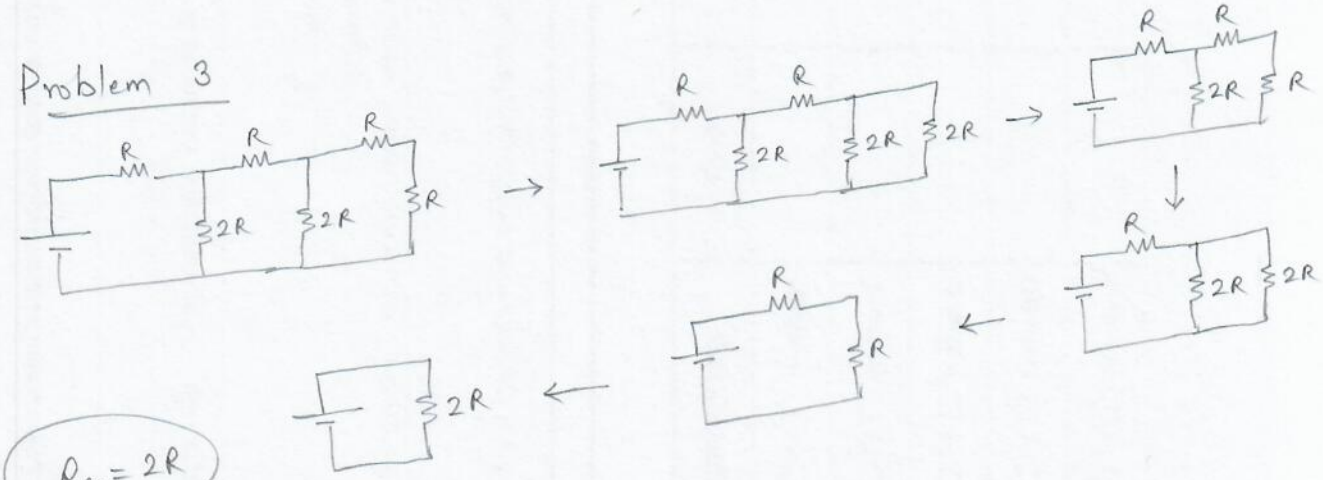
Since the resistors are identical, the currents $I_1 = I_2 = I_3$

loop abcda: $+V - I_1 R = 0$

$$\Rightarrow I_1 = \frac{V}{R} = \frac{10.0}{30.0\ \text{k}} = 0.333\ \text{mA}$$

$$I_1 = I_2 = I_3 = 0.333\ \text{mA}.$$

Problem 3



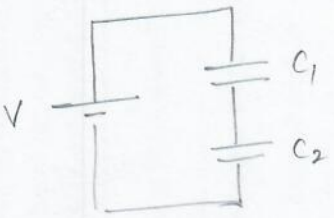
$R_{eq} = 2R$

Problem 4

Magnet forces pushes upwards and electric force downwards.

Thus, electric force is larger.

Problem 5



$$Q_1 = Q_2$$

$$V_1 + V_2 = V$$

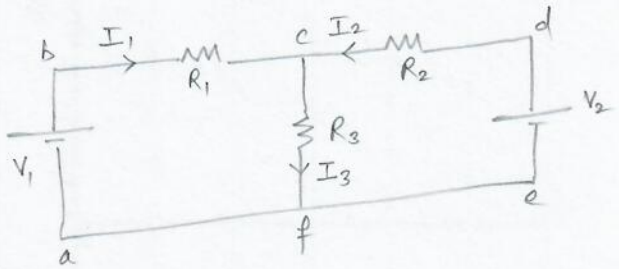
$$\frac{Q_1}{C_1} + \frac{Q_2}{C_2} = V$$

$$Q_1\left(\frac{1}{C_1} + \frac{1}{C_2}\right) = V$$

$$Q_1\left(\frac{1}{10.0\mu} + \frac{1}{20.0\mu}\right) = 10.0$$

$$Q_1 \frac{3}{20\mu} = 10.0 \quad \Rightarrow \quad Q_1 = Q_2 = 66.7\,\mu C$$

Problem 6



$I_3 = I_1 + I_2$ (junction rule)

$V_1 - I_1 R_1 - I_3 R_3 = 0$ (loop abcfa)

$10.0 - 10.0\,I_1 - (I_1 + I_2)\,10.0 = 0$

$20.0\,I_1 + 10.0\,I_2 = 10.0$

$V_2 - I_2 R_2 - I_3 R_3 = 0$ (loop edcfe)

$20.0 - 10.0\,I_2 - (I_1 + I_2)\,10.0 = 0$

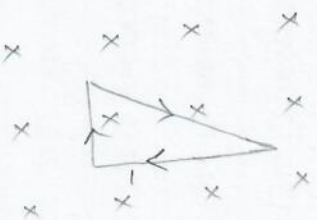
$10.0\,I_1 + 20.0\,I_2 = 20.0$

$20.0\,I_1 + 10.0\,I_2 = 10.0$

$10.0\,I_1 + 20.0\,I_2 = 20.0$

$\Rightarrow \quad I_1 = 0 \qquad I_2 = I_3 = 1.00\ A$

Problem 7



$$\vec{F}_1 = I\,\vec{L}_1 \times \vec{B}$$

$$= I\,a\,(-\hat{i}) \times (-\hat{k})\,B$$

$$= -\hat{j}\; I\,a\,B \sin 90$$

$$= -\hat{j}\; (2.0)(4.0\times10^{-2})(0.30)$$

$$= -\hat{j}\; 24\ mN$$