Solutions to HW-4

Chapter 31

Ex. 46

⇒ The differential equation which model's the given system is;

$$\frac{dq}{dt} + q\frac{1}{RC} = 0$$

$$\frac{dq}{q} = -\frac{dt}{RC} \Rightarrow \int \frac{dq}{q} = -\int \frac{dt}{RC}$$

$$\ln q + C = -\frac{t}{RC} \Rightarrow \boxed{q = \underbrace{C_0}_{q_0} e^{-t/RC}}$$

Integration const.

⇒ $q = C\,\Delta V$

$q_0 = C.\Delta V_0$ where $C = 220\,nF$ $\Delta V_0 = 5\,V$

$\boxed{q_0 = 220\,nF \,.\, 5V}$

$\boxed{q_f = 220\,nF \,.\, 800\,mV}$

$$\cancel{220nF}.\,800mV = \cancel{220\,nF}.5V\,.\,e^{-t/R(220nF)}$$

$$\frac{0{,}8\cancel{V}}{5\cancel{V}} = e^{-t/R\times 220nF}$$

$$\ln 8 - \ln 50 = \frac{-t}{R\times 220nF}$$

$$1{,}832 = \frac{t}{R\times 220nF}$$ here we know that $10\,\mu s \leq t \leq 6\,ms$

so;

$$R \times 220\times 10^{-9} \times 1{,}832\,\cancel{F} = 10\times 10^{-6}\,s$$

$$R_l = 24{,}81\,\Omega$$

$$R\times 220\times 10^{-9}\times 1{,}832\,F = 6\times 10^{-3}\,s$$

$$R_h = 14887\,\Omega$$

$\boxed{\text{So rage of resistor is } \quad 24{,}81\,\Omega \leq R \leq 14887\,\Omega}$

Chapter 31

Ex. 47

=) In this exercise we cannot use the d.e. that we used in previous question. since we have an battery connected. So:

$$\mathcal{E} = R\frac{dq}{dt} + \frac{q}{C} \quad \text{solving this d.e.:}$$

$$\frac{dq}{q - \mathcal{E}C} = -\frac{dt}{RC}$$

$$q = C\mathcal{E}\left(1 - e^{-t/RC}\right)$$

$$\Delta V_C = \mathcal{E}\left(1 - e^{-t/RC}\right)$$

here $t = 0{,}5\,s$ $\mathcal{E} = 95\,V$ is given in the question. Also we have $\Delta V_C = 72V$.

$$72V = 95V\left(1 - e^{-0{,}5s/R\times 0{,}15\mu F}\right)$$

$$+23 = 95\,e^{-0{,}5s/R\times 0{,}15\mu F}$$

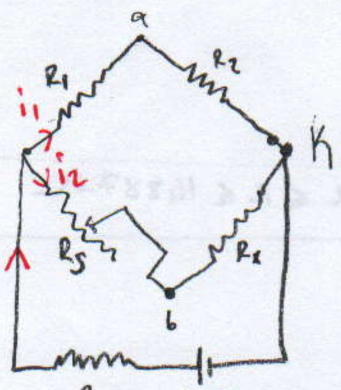
$$1{,}418 = \frac{0{,}5}{R\times 0{,}15\times 10^{-6}}\ \Omega$$

$$\boxed{R = 2350728\ \Omega \simeq 2{,}35\ M\Omega}$$

=> Here I take ΔV_C as 72 V, because when capacitor reaches to 72 V light flashes and capacitor starts to dischage again.

Chapter 31

Pr 12



=) If we want that potential difference between point a and b is 0, we need an equal drop in potentials which is mathematically modelled as:

$$i_1 R_1 = i_2 R_S$$

also at point K currents combines so we have to satisfy:

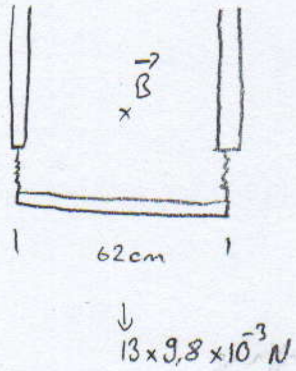
$$R_2 i_1 = R_x i_2$$

$$\frac{R_x R_1}{R_2}\cancel{i_2} = \cancel{i_2} R_S$$

$$\boxed{R_x = R_S\left(R_2/R_1\right)}$$

Chapter 32

Ex 29



$|\vec{B}| = 440\,mT$

Condition for removing tension

$-\vec{F}_{gravity} = q\vec{v} \times \vec{B}$, we can also write this equation in this form:

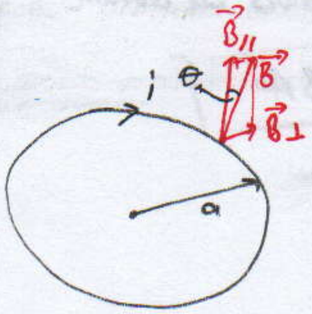
$$-\vec{F} = i\vec{L} \times \vec{B}$$

$$+13 \times 9{,}8 \times 10^{-3} N = i \cdot 0{,}62 \cdot 440 \times 10^{-3}\, T.m.$$

$i = 0{,}467$ A towards right.

Chapter 32

Pr 18

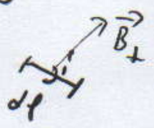


<u>Total Force due to $\vec{B}_{//}$</u>

⇒ Using the right hand rule, we can see that force exerted on the ring is towards the center of the ring. So, because of symmetry they cancel each.

<u>Total Force due to $\vec{B}_{\perp}$</u>

⇒ Again using the right-hand rule, we can see that force exerted on the ring is upward.



⇒ For this infinitesimal length element;

$$dF = i B \sin\theta \, dl$$

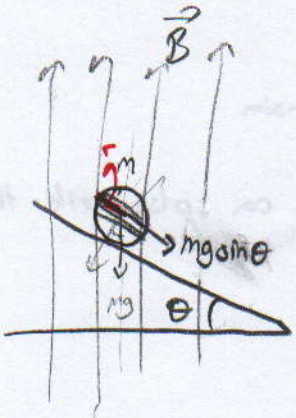
$$\int dF = \int_0^{2\pi a} i B \sin\theta \, dl$$

$\boxed{F = 2\pi a\, i B \sin\theta}$ is the total force on the ring and it towards <u>up</u>

Chapter 32

Pr 19

$\Rightarrow$



The torque due to gravitation is:

$$mgr\sin\theta$$

The torque due to magnetic field

$$2NAi\vec{A}\times\vec{B}=\vec{\tau}$$

$2N.L.r\,i\,B\sin\theta$, Two factor comes since we have two forces producing same torque.

$$2NL\cancel{r}iB\cancel{\sin\theta}=mg\cancel{r\sin\theta}$$

$$i=\frac{mg}{2NLB}$$

by putting values we obtain:

$$\boxed{i=1{,}63\,A}$$