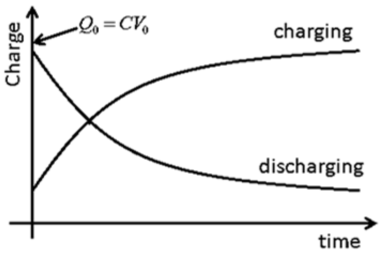
國立東華大學
Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 97401, Taiwan

General Physics II, Quiz 9
PHYS1000AA, Class year103/2015
2015-05-19, Thursday

Quiz-9 Solution

1. **Solution :** ***(Basic question, similar to 38+39 chap.28, text book 9th edition)***

(a)



(b) For a RC circuit we know the time constant is given by , $\tau = RC$

Here the given time constant τ=1 ms = 1x10^{-3}s

So we can find the resistance needed to get required flush time using , $\tau = RC$

$$1\text{x}10^{-3} = \text{R x } 5\text{x}10^{-6} \quad \text{Since C=}\frac{Q}{\varepsilon}$$

$$\therefore \text{R} = \frac{1x10^{-3}}{5\text{x}10^{-6}} = 200\ \Omega$$

(c) For a RC circuit the current generated at a cirtain time is given by $I(t) = \frac{\varepsilon}{R} e^{-\frac{t}{RC}}$

Using given parameter we get , $I(t) = \frac{5}{200} e^{-\frac{1x10^{-3}}{1x10^{-3}}} = 43\text{mA}$

2. **Solution :** ***(Similar to problem no.61+7, chap.30+29, text book 9th edition)***

(a)? or the Helmholtz coil , the separation distance is equal to the radius of the coil. The magnetic filed produced at a point on the common axis of the coils and halfway between the coils is given by

$$\mathrm{B} = \frac{2\mu_0 IR^2}{2[(\frac{R}{2})^2 + R^2]^{3/2}} = \frac{\mu_0 IR^2}{[(\frac{R}{2})^2 + R^2]^{3/2}} = \frac{\mu_0 I}{[(\frac{1}{2})^2 + 1]^{3/2} R} = \frac{\mu_0 I}{1.40R} \text{ for 1 turn ,}$$

So for N turn it will be

$$\mathrm{B} = \frac{N\mu_0 I}{1.40R} = \frac{100\times 4\pi\times 10^{-7}\times 10}{1.40\times 0.5} = 1.79\times 10^{-3}\,\mathrm{T}$$

(b) We will find the speed of the electron. Since it is in motion the energy will be the total kinetic energy , so $\Delta \mathrm{E} = \frac{1}{2}mv^2$ which is proportional to the applied voltage on eletron = $e\Delta V$,where e is the charge of electron. From this relation we can conclude $\frac{1}{2}mv^2 = e\Delta V$

So $v = \sqrt{\frac{2e\Delta V}{m}} = \sqrt{\frac{2(1.60\times 10^{-19})\times 2400}{9.11\times 10^{-31}}} = 2.90\times 10^7$ m/s

So the maximum magnetic force can be found using lorentz force , $F_B = e\vec{v}\times\vec{B}$ where e is the charge of electron, B is the magnetic field .

$\therefore\ F_{B,\,max} = (1.6\times 10^{-19})\times(2.90\times 10^{7})\times(1.80\times 10^{-3})\sin 90° = 8.35\times 10^{-15}\,\mathrm{N}$

$F_{B,\,min} = evB\sin\theta = 0$, when the v is parallel (θ=0°) or antiparallel (θ=180°) to B

3. Solution: ***(Basic question from text book 9th edition)***

(a) We know in a solinoid induced electric field is equal to the rate magnetic flux produced inside the coil . We will calculate electric field induced in a small lenght dl of solinoid for a closed loop, $\oint E.dl = \left|\frac{d\Phi_B}{dt}\right|$

If we take cross-section of solinoid we can get the circumference of it ,

$\oint dl = 2\pi r$, where r is the radius of the coil.

So we can write , $2\pi rE = \left|\frac{d\Phi_B}{dt}\right| = A\frac{dB}{dt} = \pi r^2\frac{dB}{dt}$,

where A is the area of coil , equal to the area of circle.

Using Biot -Severt Law , we can write , $B = \frac{\mu_0 I}{2\pi r}$,

So , $2\pi rE = \pi r^2\frac{\mu_0}{2\pi r}\frac{dI}{dt}$

$\therefore E = \frac{\mu_0}{4\pi}\frac{dI}{dt} = \frac{\mu_0}{4}500\cos 100\prod t = 125\mu_0\cos 100\prod t$, $\mathrm{Sin}ce\ I = 5\ \sin 100\prod t$

(b) The direction of electric field is opposite to the increasing magnetic field . It will be Clockwise .