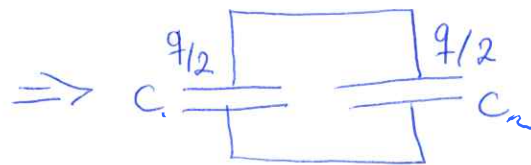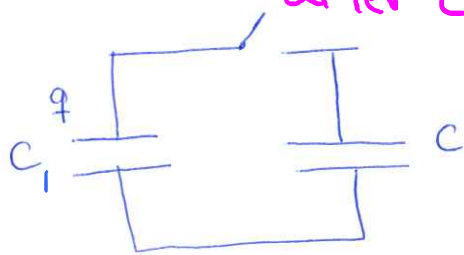Q1. 2016.F. energy conservation → total energy befor and after Closing the switch is the same

$$U_i = \frac{1}{2}\frac{q^2}{C} + 0$$
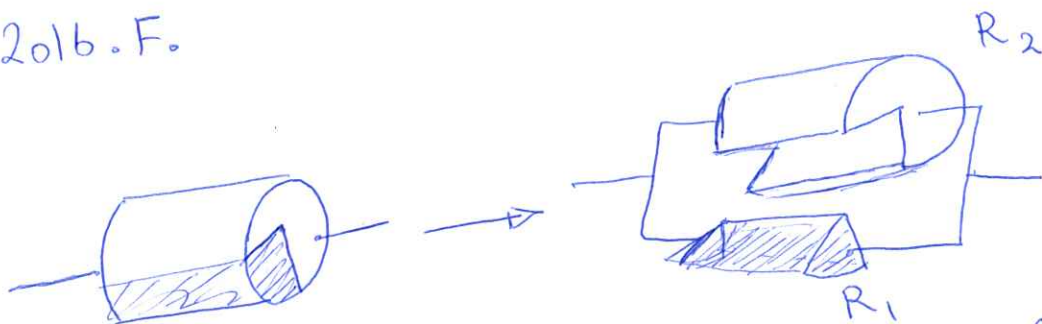
$$= \frac{1}{2}\frac{q^2}{C}$$

for $C_1 \Rightarrow U_f = \frac{1}{2}\frac{(q/2)^2}{C}$

$$= \frac{1}{2}\left[\frac{1}{2}\frac{q^2}{C}\right]$$

$$\underset{C_1 \qquad C_1}{\Rightarrow} U_i = 4 U_f \Rightarrow U_f = \frac{4J}{4} = 7\,J$$

But for the total energy on C_1 & C_2 → total energy does not change because energy is conserved
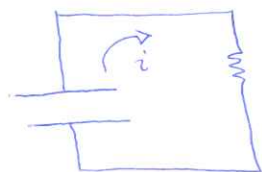
Q2. 2016.F.

$R_1 = P_1 \frac{L}{A_1} = 2.35 \times 10^{-8} \times \dfrac{L}{\frac{1}{3}\pi(55\times10^{-6})^2} = 7.42 L$

$R_2 = P_2 \frac{L}{A_2} = 9.68 \times 10^{-8} \times \left(\dfrac{L}{\frac{2}{3}\pi(55\times10^{-6})^2}\right) = 15.27 L$

$R_1 + R_2 \Rightarrow R_1 \| R_2 \Rightarrow R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} = 5L$

Also we know $R_{eq} = 1.5\,\Omega$

$\Rightarrow L = 0.3^m$

Q3. 2016. F.

$$V_c - iR = 0$$

$$\frac{q}{c} = iR = \frac{dq}{dt} R$$

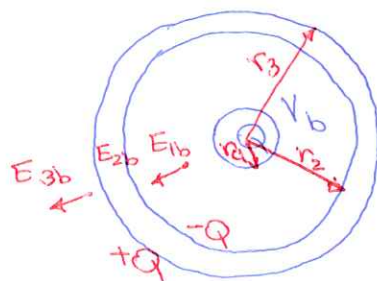$$\Rightarrow \frac{dq}{q} = (RC)^{-1} dt \Rightarrow q(t) = A e^{-t/RC}$$

$$A = CV = C\mathcal{E}$$

$$\Rightarrow q(t) = C\mathcal{E} e^{\pm t/RC}$$

$$\Rightarrow q(t=10^{ms}) = 1\times10^{-6} \times 100 \times e^{-\left[10\times10^{-3}/\left(1\times10^{3} \times 1\times10^{-6}\right)\right]} = 4.5 \; nC$$

Q7. 2016. F. $\rightarrow$ loosing energy $\rightsquigarrow$ loosing speed

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Q10. 2016. F.

$$E_a = k\frac{Q}{r^2}$$

$$\boxed{\Delta V = V_\infty - V_a = -\int E\cdot dl}$$
$$\boxed{\text{or } -\Delta V = V_a - V_\infty = \int E\cdot dl}$$

$$V_\infty = 0$$

$$\Rightarrow V_a - V_\infty = \int_{r_a}^{\infty} E\cdot dl$$

$$= \int_{r_a}^{r_2} E\cdot dl + \int_{r_2}^{r_3} \frac{kQ}{r^2} dr + \int_{r_3}^{\infty} \frac{kQ}{r^2} dr$$

$$E_{1b} = k\frac{Q}{r^2}, \quad E_{2b} = 0 \quad \text{inside the conductor}$$
$$E_{3b} = k\frac{Q}{r^2}$$

$$V_b - V_\infty = \int_{r_a}^{\infty} E\cdot dr = \int_{r_a}^{r_2} E_1 dr + \int_{r_2}^{r_3} E_2 dr + \int_{r_3}^{\infty} E_3 dr$$
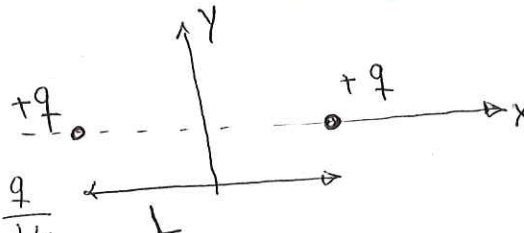
$$= \int_{r_a}^{r_2} \frac{kQ}{r^2} dr + \int_{r_2}^{r_3} 0\cdot dr + \int_{r_3}^{\infty} \frac{kQ}{r^2} dr$$

the same

This term exist in the calculation for V_a however goes to zero for V_b

$$\Rightarrow V_a > V_b$$

Q14. 2016.F

in General $\qquad V_\infty = 0$

Here the question set $V_\infty \equiv$ Unknown

since they set $V(x=0) = 0$

if $V_\infty = 0$ then:

$+q$ .... $+q$ on X axis, L along $-y$

$V(\text{at } x=0) = \frac{1}{4\pi\epsilon_o} \frac{q}{42} + \frac{1}{4\pi\epsilon_o} \frac{q}{42}$

$= \frac{1}{4\pi\epsilon_o} \frac{4q}{L}$

Setting $V(\text{at } x=0) = 0$

means we are subtracting

$\frac{1}{4\pi\epsilon_o} \frac{4q}{L}$ from it

$\Rightarrow V(\text{at } x=0) = \frac{1}{4\pi\epsilon_o} \frac{4q}{L} + V_s = 0 \Rightarrow V_s = -\frac{1}{4\pi\epsilon_o} \frac{4q}{L}$

$\Rightarrow V(x=\infty) = 0 + V_s = 0 - \underline{\frac{1}{4\pi\epsilon_o} \frac{4q}{L}}$

Q16. 2016.F. $\qquad \vec{dl} = dx\,\hat{i}$ & $\vec{E} = y^2\,\hat{i} + 2xy\,\hat{j}$

$\vec{E}.\vec{dl} = y^2\,dx$

$V_{ab} = -\int \vec{E}.\vec{dl} = -\int_a^b y^2\,dx = -y^2 \int_{a=1}^{b=3} dx = -2^2(3-1) = -8\,V$

Q.24.2016.F.

$$i(t) = \frac{\mathcal{E}}{R}\left(1 - e^{-t/\tau}\right) \qquad \tau = \frac{L}{R} = 12$$

$$i(t) = 2.4$$

$$2.4 = \frac{15}{5}\left(1 - e^{-t/12}\right) \Rightarrow \ln\left(e^{-t/12} = 0.2\right)$$
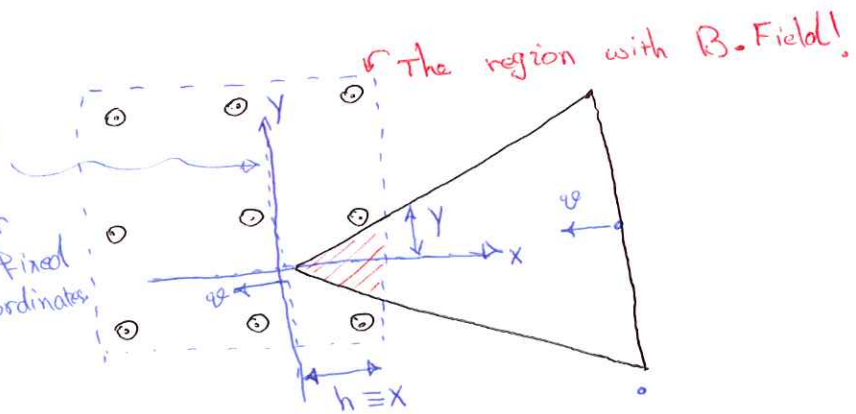
$$\Rightarrow -t/12 = \ln(0.2) \Rightarrow t = 12 \times \ln(0.2)$$

$$\Rightarrow \boxed{t = 19.3 \text{ s}}$$

Q.25.2016.F.

The coordinate is
moving with the
triangle. The corner
of triangular wire is fixed
at the origin of coordinates

The region with B.Field!

$$N=1$$

$$\mathcal{E} = -N\frac{d\Phi}{dt} = -\frac{d(B \cdot A)}{dt} = -B\frac{dA}{dt}$$

$$A\left(\begin{array}{c}\text{area}\\\text{inside the B field}\end{array}\right) = [\text{red region in the Fig}] = \frac{1}{2}[x \cdot 2y] = xy$$

in general $\qquad y = mx \qquad$ where m is the slope.

$$\Rightarrow A = x \cdot mx = mx^2$$

since the change on x depend on velocity: $\qquad X(t) = \nu t$

$$\Rightarrow A = m\nu^2 t^2 \Rightarrow \mathcal{E}(t) = -B\frac{dA}{dt} = -m\nu^2 B\frac{dt^2}{dt} = -2m\nu^2 B t$$

linear relation to $\mathcal{E}(t)$

$$i(t) = \frac{\mathcal{E}(t)}{R} \quad \& \Rightarrow \begin{cases} t < t_1 \rightarrow \text{No change of flux} \Rightarrow \mathcal{E}=0 \Rightarrow i=0 \\ t_1 < t < t_2 \quad \boxed{|i(t)| = |+2m\nu^2 B|t} \rightarrow \begin{array}{l}\text{linear increase}\\ \text{induced in positive} \end{array} \\ \qquad \qquad \text{using Lenz's Law} \rightarrow \text{direction defined by question!} \\ t > t_2 \rightarrow \text{No change of flux} \rightarrow \mathcal{E}=0 \Rightarrow i=0 \end{cases}$$