Q-1 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Consider two infinite large parallel current carrying sheet. Current unit width in both sheets is $\frac{1}{\sqrt{\pi}} A/m$. If direction of current in both sheets is same than force per unit area on each sheet will be :

(A) $10^{-7} N/m^2$

(B) $0.5 \times 10^{-7} N/m^2$

(C) $2 \times 10^{-7} N/m^2$

(D) $10^{-5} N/m^2$

Correct Option : C

SOLUTION

Magneic field due to one of the sheet

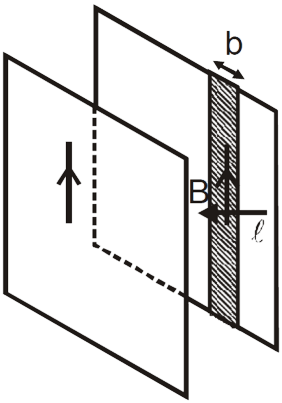
$B = \frac{\mu_0 K}{2}$ Parallel to second sheet Force on section of width b

$F = bKl\frac{\mu_0 K}{2}$

Force per unit area

$P = \frac{B}{lb} = \frac{\mu_0 K^2}{2}$

$P = 4\pi \times 10^{-7}\frac{1}{2\pi}$



Consider two uniformaly charged concentric and coaxial rings of radii R and 2R. Total charge on inner ring is Q_1 and that on outer ring is Q_2. Both rings are revolving in same sence with same angular velocity about its axis. If net magnetic induction at a distance R feom the centre of the rings, on axis of rings is zero then $\frac{Q_1}{Q_2}$ is :

(A) -1

(B) $-\frac{2\sqrt{2}}{5\sqrt{5}}$

(C) $-\frac{8\sqrt{2}}{5\sqrt{5}}$

(D) $-\frac{4\sqrt{2}}{3\sqrt{3}}$

Correct Option : C

SOLUTION

Magnetic field due to circular current carrying loop on axis of loop is:

$$B = \frac{\mu_0}{4\pi}\frac{2I\pi R^2}{(R^2+X^2)^{3/2}} = 0$$

$$B_1 + B_2 = 0$$

$$\frac{Q_1 R_2}{(R^2+R^2)^{3/2}} + \frac{Q_2 4R^2}{(4R^2+R^2)^{3/2}} = 0$$

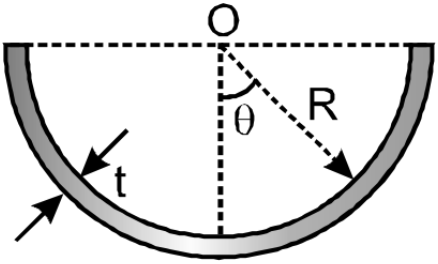
$$\frac{Q_1}{2\sqrt{2}} + \frac{Q_2 4}{5\sqrt{5}} = 0$$

$$\frac{Q_1}{Q_2} = \frac{8\sqrt{2}}{5\sqrt{5}}$$

Q-3 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Conductor of length l has shape of a semi cylinder of radius $R(<<l)$. Cross section of the conductor is shown in the figure. Thickness of the conductor is $(<<R)$ and conductivity

of its material varies with angle θ according to the law $\sigma = \sigma_0 \cos\theta$ where σ_0 is a constant. If a battery of emf ε is connected across its end faces (across the semi-circular cross-sections), the magnetic induction at the mid point O of the axis of the semi-cylinder is :



(A) $\frac{\mu_0\sigma_0\varepsilon t}{8l}$

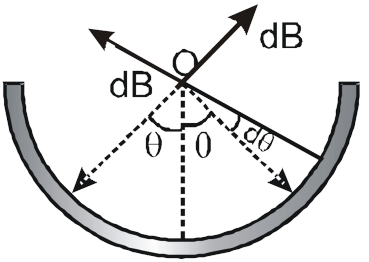
(B) $\frac{\mu_0\sigma_0\varepsilon t}{4l}$

(C) $\frac{\mu_0\sigma_0\varepsilon t}{l}$

(D) $\frac{2\mu_0\sigma_0\varepsilon t}{l}$

Correct Option : B

SOLUTION



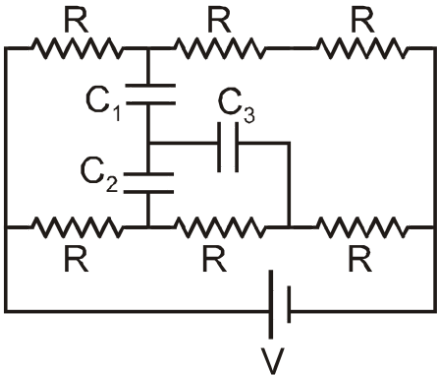
$$dB = \frac{\mu_0 di}{2\pi R} = \frac{\mu_0 \times \frac{\varepsilon}{1}(\sigma_0 \cos\theta) R d\theta \times t}{2\pi R}$$

$$B = \int_0^{\pi/2} 2dB\cos\theta = \frac{\mu_0 \sigma_0 \varepsilon t}{4l}$$

Q-4 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the shown circuit, all three capacitor are identical and have capacitance $C\mu F$ each. Each resistor has resistance of $R\Omega$. An ideal cell of emf V volts is connected as shown. Then the magnitude of potential difference across cpacitor C_3 in steady

state is :



(A) $\frac{V}{3}$

(B) $\frac{V}{2}$

(C) $\frac{2}{9}V$

(D) $\frac{3}{4}V$

Correct Option : C

SOLUTION

No current passes through capacitors in steady state Assume potential at point , $'4,'$ to be zero. Then points , $'1,'$ and , $'2,'$

are at same potential $\frac{2V}{3}$.

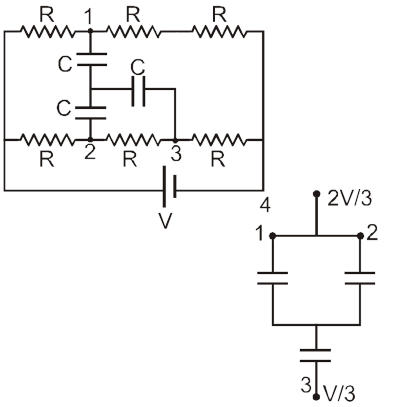
Hence C_1 and C_2 can be take in parallel.

The potential at point 3 is $\frac{V}{3}$.

$\therefore$ Equivalent circuit of all three capacitors is show Hence

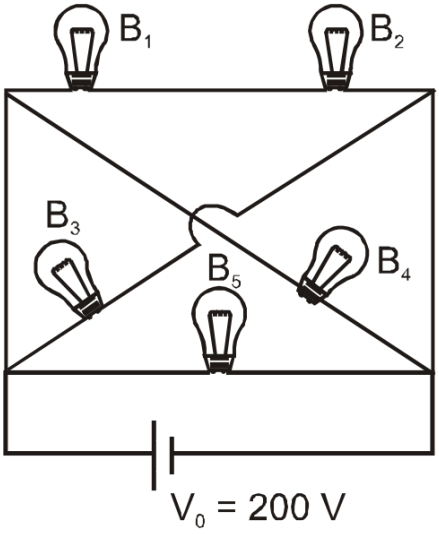
potential difference across capacitor C_3 is

$$= \frac{2C}{2C + C} \times \left(\frac{2V}{3} - \frac{V}{3} \right) = \frac{2V}{9}$$



Q-5 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Five bulbs B_1, B_2, B_3 and B_4 each of rating $60W / 200V$ and B_5 of rating $120W / 400V$ are connected as shown in circuit. Total consumption by all the bulbs is :



(A) $240W$

(B) $270W$

(C) $90W$

(D) $180W$

Correct Option : D

SOLUTION

$P_{B_1+B_2} = 30W$

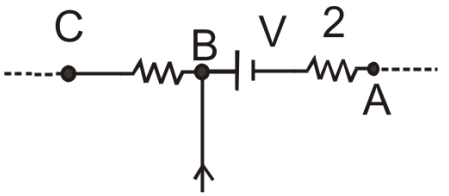
$P_{B_3} = 60W, P_{B_4} = 60W$

$P_{B_5} = \frac{(200)^2}{\frac{(400)^2}{120}} = \frac{120}{4} = 30W$

$P_{\rightarrow tal} = 180W$

Q-6 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

If an ideal cell of emf 5 volt shown in the figure gives a power of 10 W, find the powers consumed by the resistors 2Ω and 1Ω.



(A) $2W, 18W$

(B) $8W, 49W$

(C) $8W, 18W$

(D) $2W, 49W$

Correct Option : B

SOLUTION

Since the cell gives out a power of $10W$, a current $2A$ must flow through the cell towards left.

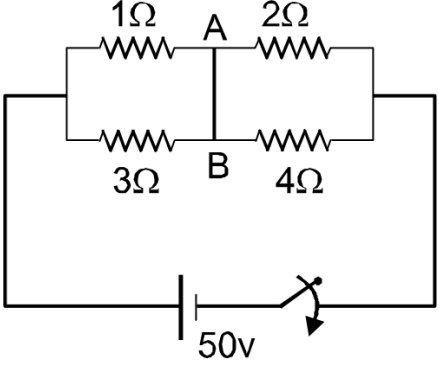
$\therefore$ Power consumed in 2Ω resistor $= 2^2 \times 2 = 8W$

Total current flowing $1\Omega = 7Amp$.

$\therefore$ Power consumed by $1\Omega = 7^2 \times 1 = 49W$

Q-7 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Four resistance are connected by an ideal battery of emt 50 volt, circuit is in steady state then the current in write AB is :



(A) 1A

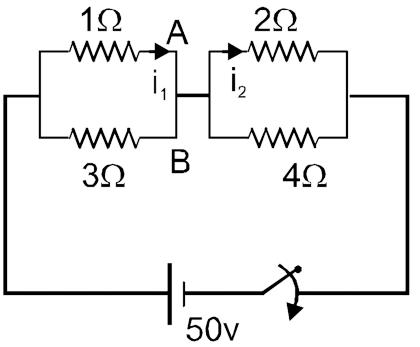
(B) 2A

(C) 3A

(D) 4A

Correct Option : B

SOLUTION



$$R_{eq} = \frac{3}{4} + \frac{8}{6} = \frac{25}{12} \Rightarrow i_0 = \frac{V}{R_{eq}} = 24Amp\,.$$

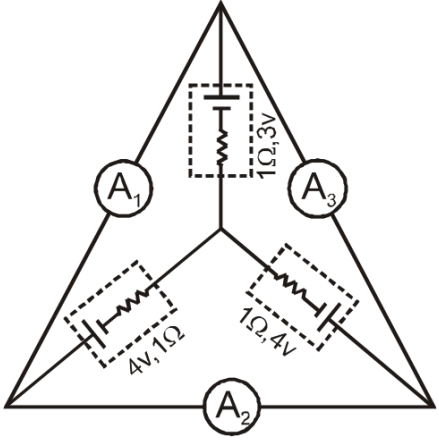
$$i_1 = \frac{3}{4} \times 24 = 18Amp\,., i_2 = \frac{4}{6} \times 24 = 32Amp\,.$$

Current the branch AB

$$\Delta i = 2Amp\,.$$

Q-8 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Three batteries are connected as shown in figure. Reading of ideal ammeters A_1, A_2 & A_3 are :



(A) $\frac{1}{3}A, 0, \frac{1}{3}A$

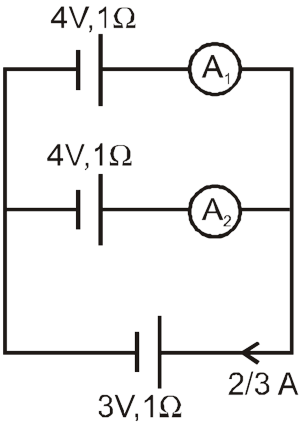
(B) $0.5A, 0.5A$ & 1 A respectively

(C) zero, $0.5A$ & zero respectively

(D) zero, zero & 1A respectively

Correct Option : A

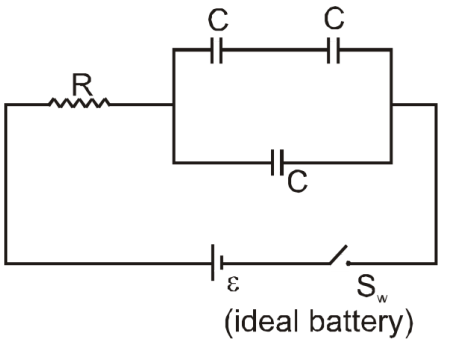
SOLUTION



Q-9 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

The time when the across the resistor drops to nearly $37\ \%$ of the value just after the switch S_w is closed :

$(R = 100k\Omega, C = 1\mu F)$ is :



(A) $0.15s$

(B) $0.30s$

(C) $0.45s$

(D) $0.60s$

Correct Option : A

SOLUTION

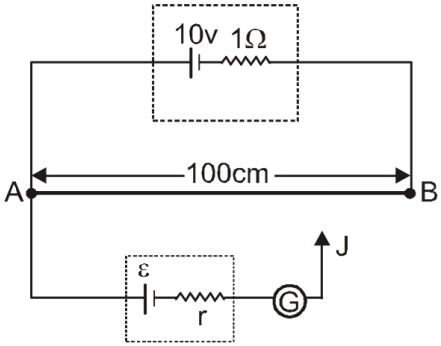
$\tau = RC = \frac{3}{20}s$

voltage in capacitor rises to $63\ \%$ of maximum value

$0.63 = \left(1 - e^{t/\tau}\right)$

$t = 0.15s$

AB is potentiometer write resistance per unit length $0.09\Omega/cm$ and ε is anunknown emf of a battery to be measured. ε cannot be measured using the potentiometer shown if the value of ε is (select the most appropriate answer)



(A) greater than $8.0V$

(B) greater then $8.5V$

(C) greater than $9.0V$

(D) greater than $9.5V$

Correct Option : C

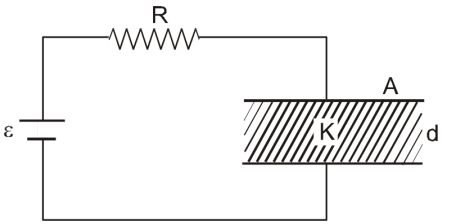
SOLUTION

Potential on AB wire is $9V$.

Hence ε greater then $9v$ cannot be measured.

Q-11 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the circuit diagram a capacitor which is initially uncharged is connected to an ideal cell of emf ε through a resistor ,\'R,\'. A leaky dielectric fills the space between the plates of dielectric. The capacitance of the capacitor with dielectric is C. Resistance of the dielectric is R,\' = R.



(A) Charge on the capacitor as function of time t is $\frac{\varepsilon C}{2}\left[1-e^{-\frac{2t}{RC}}\right]$

(B) Maximum charge on the capacitor is $\frac{\varepsilon C}{2}$.

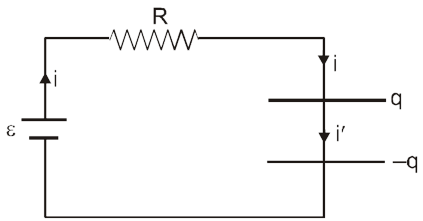
(C) When charge on the capacitor is maximum, then current in the circuit is $\frac{\varepsilon}{2R}$

(D) All of the above options are true

Correct Option : D

SOLUTION

(i) at $t > 0$



$I,'$= current through dielectric

$= \frac{q}{C.R}$.(i)

By $K.V.L.\ \varepsilon - iR - \frac{q}{c} = 0$ ..(2)

$i = I,' + \frac{dq}{dt} = \frac{q}{RC} + \frac{dq}{dt}$.(3)

By (2) and $\varepsilon - \left(\frac{q}{RC} + \frac{dq}{dt}\right)R - \frac{q}{c} = 0$

$\Rightarrow \varepsilon C - 2q - RC\frac{dq}{dt} = 0$

$\Rightarrow \varepsilon C - 2q = RC\frac{dq}{dt} \Rightarrow \int_0^q \frac{dq}{\varepsilon C - 2q} = \int_0^t \frac{dt}{RC}$

$\Rightarrow -\frac{1}{2}\ln\frac{\varepsilon C - 2q}{\varepsilon C} = \frac{t}{RC} \Rightarrow q = \frac{\varepsilon C}{2}\left(1 - \frac{e^{2t}}{RC}\right)$

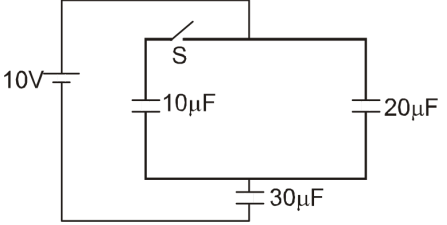
(ii) $q_{\max} = \frac{\varepsilon C}{2}$ as $t \to \infty$

and by (2) $\varepsilon - iR - \frac{\varepsilon}{2R}$ at that time.

Q-12 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Chrge flow through the battery after closing the switch is

(initially all capacitors are unxharged) :



(A) $20mC$

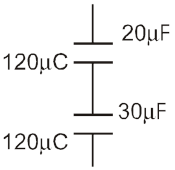
(B) $30mC$

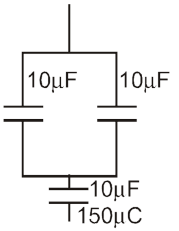
(C) $120mC$

(D) $150mC$

Correct Option : B

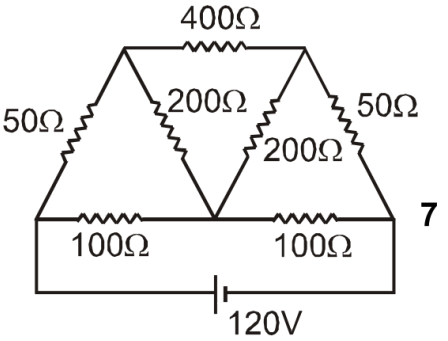
SOLUTION





Q-13 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Electric current through 400Ω resistor is :



7

(A) $0.8A$

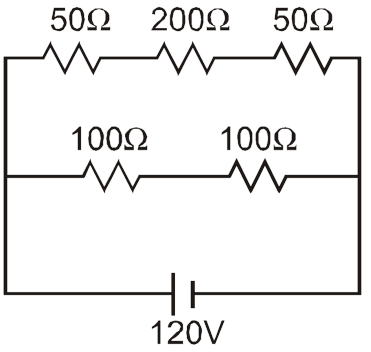
(B) $0.6A$

(C) 0.4

(D) $0.2A$

Correct Option : D

SOLUTION



Q-14 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Two coaxial long solenoids of equal length have current, i_1, i_2, number of turns per unit length n_1, n_2 and radius r_1, r_2 respectively. If $n_1 i_1 = n_2 i_2$ and the two solenoids carry current in opposite sence, the magnetic energy stored per until length is $[r_2 > r_1]$

(A) $\frac{\mu_0}{2} n_1^2 \pi \left(r_2^2 - r_1^2\right)$

(B) $\mu_0 n_1^2 i_1^2 \pi\left(r_2^2 r_1^2\right)$

(C) $\frac{\mu_0}{2} n_1^2 i_1^2 \pi r_1^2$

(D) $\frac{\mu_0}{2} n_2^2 i_2^2 \pi r_2^2$

Correct Option : A

SOLUTION

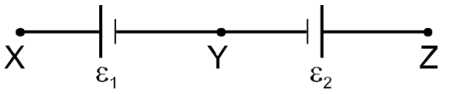
Magnetic field is non zero only in the region between the two solenoids, where $B = \mu_0 n_2 i_2$

$\therefore$ energy stored per unit volume $= \frac{B_2}{2\mu_0} = \frac{\mu_0 n_2^2 i_2^2}{2}$

The energy per unit length.=energy per unit volume x area of cross section where $B \neq 0$

$= \frac{\mu_0 n_2^2 i_2^2}{2}\left[\pi\left(r_2^2 - r_1^2\right)\right] = \frac{\mu_0 n_1^2 i_1^2}{2}\left[\pi\left(r_2^2 - r_1^2\right)\right]$, since $n_i i_1 - n_2 i_2$

Two cells of emf ε_1 and $\varepsilon_2 (\varepsilon_2 < \varepsilon_1)$ are joined as shown in figure :



When a potentiometer is connected between X and Y it balances for 300 cm length against ε_1. On connecting the same potentiometer between X and Z it balances for 100 cm length against ε_1 and ε_2. Then the ratio $\frac{\varepsilon_2}{\varepsilon_1}$ is :

(A) $\frac{1}{3}$

(B) $\frac{3}{4}$

(C) $\frac{1}{4}$

(D) $\frac{2}{3}$

Correct Option : D

SOLUTION

$\varepsilon_1 300\alpha$.(i)

$-\varepsilon_2 + \varepsilon_1 - 100\alpha$.(ii)

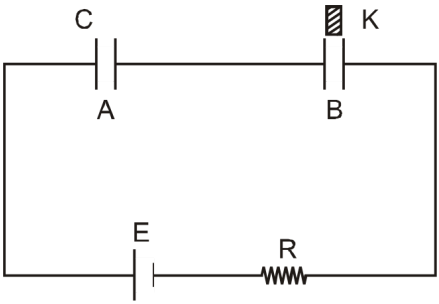
where, α is the potential gradient

$\therefore \frac{\varepsilon_2}{\varepsilon_1} = \frac{2}{3}$.

Q-16 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the figure shown capacitors A and B of capacitance C are in steady state. A dielectric slab of dielectric constant K = 2 and dimensions equal to the inner dimmensions of the capacitor is inserted in the space between the plates of the capacitor B. In

stedy state choose the correct options



(A) Charge on each capacitor will increase by $\frac{CE}{6}$.

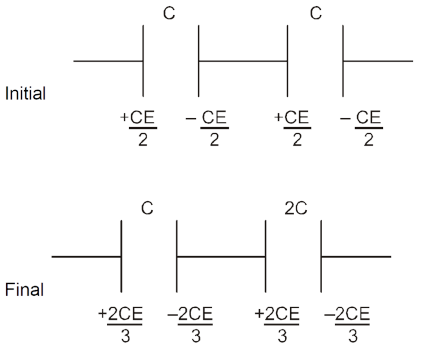
(B) In the process of inserting the dielectric, energy of the battery decreases by an amount of $\frac{CE^2}{6}$.

(C) If the process of inserting the dielectric, energy of the battery increases by an amount of $\frac{CE^2}{6}$.

(D) In the process of inserting the dielectric, energy in the capacitor A increases by an amount of $\frac{7CE^2}{72}$.

Correct Option : A

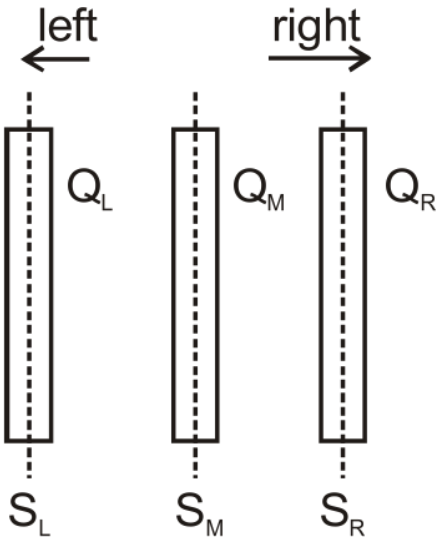
SOLUTION



Q-17 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Three large identical conducting plates of area A are closely placed parallel to each other as shown (the area A is perpendicular to plane of diagram). The net charge on left, middle and right plates are Q_L, Q_M and Q_R respectively. Three infinitely large parallel surface S_L, S_M and S_R are drawn passing through middle of each plate such that surface are perpendicular

to plane of diagram as shown. Then pick up the correct option(s).



(A) The net charge on left side of surface S_L is equal to net charge on right side of surface S_R

(B) The net charge on left side of surface S_L is equal to net charge on right side of surface S_M

(C) The net charge on left side of surface S_L is equal to net charge on right side of surface S_L

(D) The net charge on right side of surface S_L is equal to net charge on left side of surface S_R

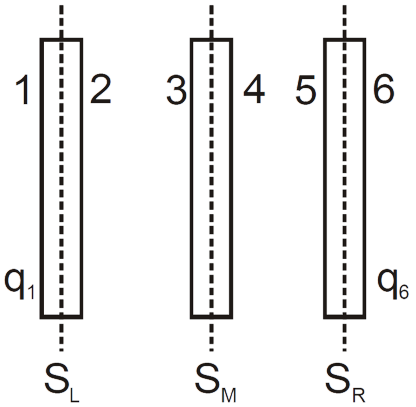
Correct Option : A

SOLUTION

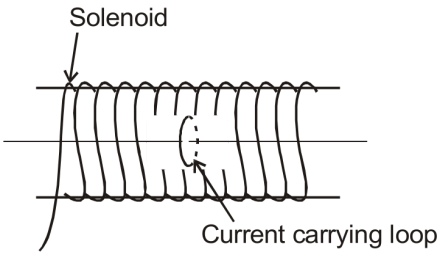
Since electric field on plate at surface S_L is zero, net charge on left side of S_L is equal to net charhge on right side of S_L .

Further net charge between any two dotted surfaces (out of S_L, S_M and S_R) is zero from Gauss theorem.

$\therefore$ Charge on left most surface q_1 is equal to charge on rigth most surface q_6, that is, $q_1 = q_6$ hence all statements are true.



A single circular loop of write radius $0.02m$ carries a current of $8.0A$. It is placed at the centre of a solenoid that the length $0.65m$, radius $0.080m$ and 1300 turns.



(A) The value of the current in the solenoid so that the magnetic field at the centre of the loop becomes zero, is equal to 44 mA.

(B) The value of the current in the solenoid so that the magnetic field at the centre of the loop becomes zero, is equal to 100 mA.

(C) The magnitude of the total magnetic field at the centre of the loop (due to both the loop and the solenoid) if the current in the loop is reversed in direction from that needed to make the total field equal to zero tesla, is $8\pi \times 10^{-5} T$.

(D) The magnitude of the total magnetic field at the centre of the loop (due to both the loop and the solenoid) if the current in the loop is reversed in direction from that needed to make the total field equal to zero tesla, is $16\pi \times 10^{-5} T$.

Correct Option : B

SOLUTION

For given condition:

$$\text{Magnitudde of } B_{\text{solenoid}} = \text{ Magnitude of } B_{\text{loop}}$$

$$\mu_0 ni = \frac{\mu_0 I}{2R} \text{ here } n = \frac{\text{Total no. of turn}}{\text{Total length}} = \frac{1300}{0.65}$$

$$i = \frac{I}{2R} \times \frac{1}{n} = \frac{8 \times 0.65}{2 \times 0.02 \times 1300} = 100mA$$

For given condition:

Total magnetic field at the contre of loop

$$= |B_{\text{loop}}| + |B_{\text{solenoid}}| \therefore |B_{l\infty p}| = \; | \; | \; B_{\text{solenoid}}$$

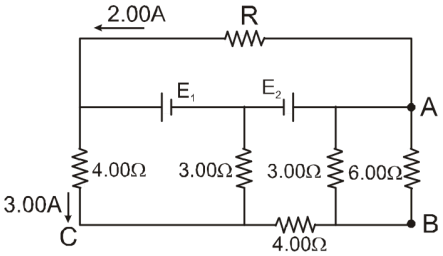
$$= 2|B_{\text{loop}}| = 2 \times \frac{\mu_0 I}{2R}$$

$$= \frac{2 \times 4\pi \times 10^{-7} \times 8}{2 \times 0.02} = 16\pi \times 10^{-5} T \, .$$

Q-19 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the circuit shown in figure, E_1 and E_2 are two ideal sources of unknown emfs. Some currents are shown. Potential difference appearing across 6Ω resistance is $V_A - V_B = 10V$. Choose

correct options.



(A) The current in the 4.00Ω resistance between C & B is 5A.

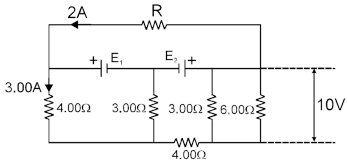
(B) The unknown emf E_1 is 36 V.

(C) The unknown emf E_2 is 54 V.

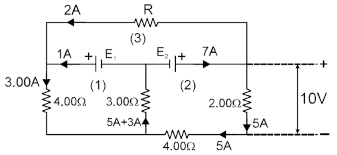
(D) the resistance R is equal to 9Ω.

Correct Option : A

SOLUTION



after redrawing the circuit



after redrawing the circuit

(a) $I_4 = 5A$

(b) From loop (1) to (1)

$-8(3) + E_1 - 4(3) = 0 \Rightarrow E_1 = 36$volt from loop (2) to (2)

$+4(5) + 5(2) - E_2 + 8(3) = 0$

$E_2 = 54$ volt

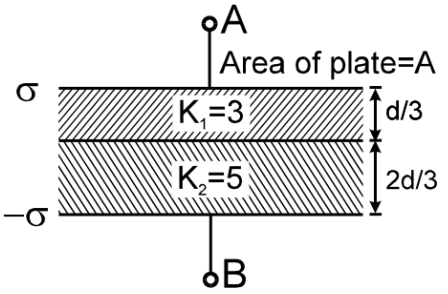
(c) from loop (3) to (3)

$-2R - E_1 + E_2 = 0$

$R = (E_2 - E_1)\frac{,}{2} = \frac{54}{2} - 36 = 9\Omega$

Q-20 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the figure shown



(A) the ratio of energy density in I^{st} dielectric to second dielectric is $\frac{5}{3}$

(B) the ratio of energy density in I^{st} dielectric to second dielectric is $\frac{1}{1}$

(C) total induced surface charge on the interface of the two dielectric is $\frac{2\sigma}{15}$

(D) total induced surface charge on the interface of the two dielectric is $-\frac{2\sigma}{15}$

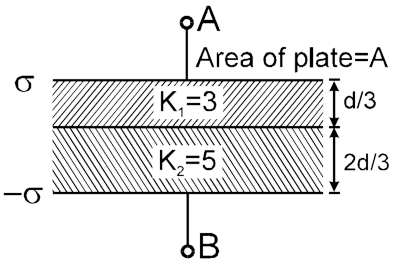
Correct Option : A

SOLUTION

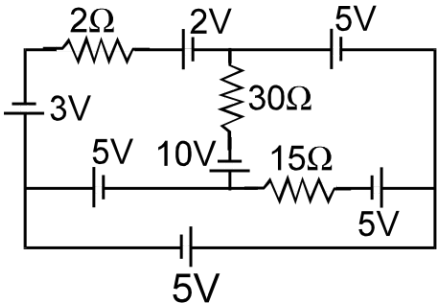
$$(i)\frac{e_1}{e_2}=\frac{\in_1 E_1^2}{\in_2 E_2^2}=\frac{k_1E_1^2}{k_2E_2^2}=\left(\frac{k_1}{k_2}\right)\left(\frac{k_1}{k_2}\right)^2=\frac{k_2}{k_1}=\frac{5}{3}$$

(ii)

$$\sigma_B=\sigma\left(1-\frac{1}{k_1}\right)-\sigma\left(1-\frac{1}{k_2}\right)=\sigma\left(\frac{1}{k_2}-\frac{1}{k_2}\right)=-\frac{2\sigma}{15}$$



In the ciruit shown, current throught the resistance 2Ω is i_1 and current through the resistance 30Ω is i_2. Find the ratio $\frac{i_1}{i_2}$.



(A) 3

(B) 6

(C) 8

(D) 9

Correct Option : D

SOLUTION

potentials are indicated in figure

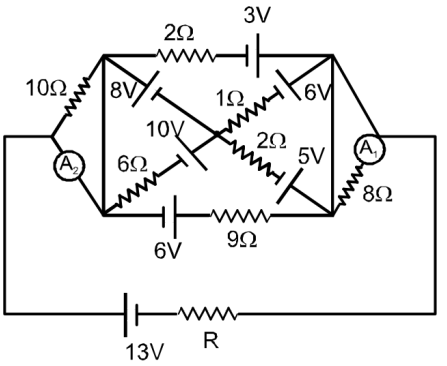
Current in $2\Omega = \frac{10-(-5)}{2} = \frac{15}{2} = 7.5A$, leftwards

Current in $30\Omega = \frac{10-(-15)}{30} = \frac{25}{30} = \frac{5}{6}A$, downwards

$\frac{i_1}{i_2} = 9$

Q-22 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Find the value of $R(\text{in}\,\Omega)$ so that there is no current through 5V cell. All the cells & ammeters are ideal in the circuit shown.



(A) 0

(B) 2

(C) 4

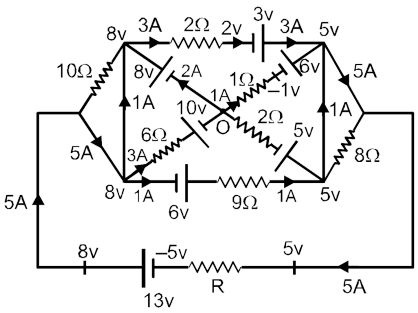
(D) 6

Correct Option : B

SOLUTION

Let the junction located at the center of rectangular portion of circuit be at zero potentials of many other points can be shown in the figure.Now current can be written in every branch satisfying KCL.

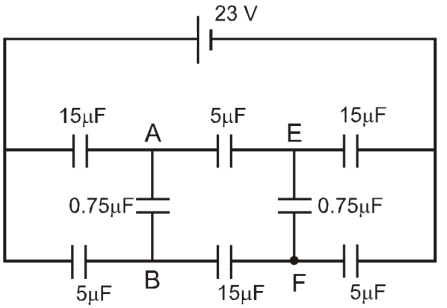
So, $R = \dfrac{5-(-5)}{5} = 2\Omega$



Reading of $A_1 = 0$ & reading $A_2 = 5A$

Q-23 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

Find potential difference (in volt) between the points A and B of the circuit shown in figure.



(A) 5

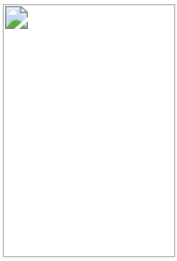
(B) 10

(C) 7

(D) 8

Correct Option : A

SOLUTION



The distribution of charge is shown in figure

$$\frac{-q_2}{5}+\frac{q_3}{0.75}+\frac{q_1}{15}=0$$

$$\Rightarrow q_1-3q_2+20q_3=0\text{(i)}$$

$$-\left(\frac{q_2+q_3}{15}\right)-\frac{q_3}{0.75}+\frac{q_1-q_3}{5}=\frac{q_3}{0.75}=0$$

$$\Rightarrow 3q_1-q_2-44q_3=0\text{...(ii)}$$

$$23-\frac{q_2}{5}-\left(\frac{q_2+q_3}{15}\right)-\frac{q_2}{5}=0$$

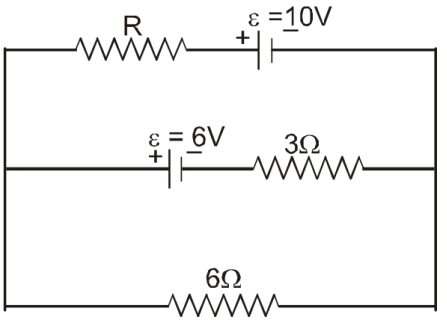
$345=7q_2+q_3$...(ii) From eq.(i),(ii),(iii)

$$q_1=\frac{19\times 345}{92}, q_2=\frac{13\times 345}{92}, q_3=\frac{345}{92}$$

Potential difference between A and B $= \frac{q_3}{0.75} = 5V$

Q-24 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

In the given circuit if the internal resistance of the batteries are negligible, then for what value of resistance $R(\text{in}\,\Omega)$ will the thermal power generated in it be maximum.



(A) 1

(B) 2

(C) 3

(D) 4

Correct Option : B

SOLUTION

Given circuit can be simplified as dotted part can be replaced as

$$\varepsilon =_{eq} = \frac{\frac{6}{3}+\frac{0}{6}}{\frac{1}{3}+\frac{1}{6}} = 4V$$

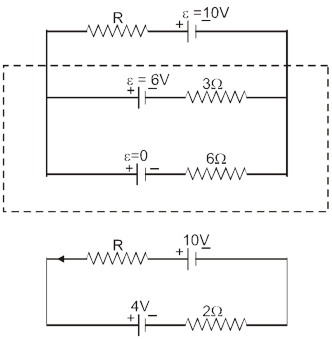
$$\frac{1}{r_{eq}} = \frac{1}{3}+\frac{1}{6} \Rightarrow r_{eq} = 2\Omega$$

then current $I = \frac{10-4}{2+R} = \frac{6}{2+R}$

Power in R, $P = \left(\frac{6}{2+R}\right)^2 R = \frac{36R}{(2+R)^2}$

for P to be maximum $\frac{dP}{dR} = 0$

on solving $R = 2\Omega$



Q-25 - JEE ADVANCED-PART TEST-7 (PHYSICS)-PHYSICS

A long straight write is carrying current $I_1 = 2/5A$ in $+z$ direction. The x-y plane contains a closed circular loop carrying current $l_2 = 5/2A$ and not encircling the straight write, then the force (in newton) on the loop will b ? (radius of the circular loop $R = 3/4m$).

(A) 0

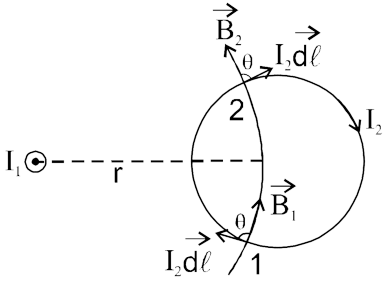
(B) 4

(C) 6

(D) 3

Correct Option : A

SOLUTION



The force on current elements 1 and 2 is equal in magnitude and opposite in direction

$\Rightarrow F_{\text{net}} = 0$