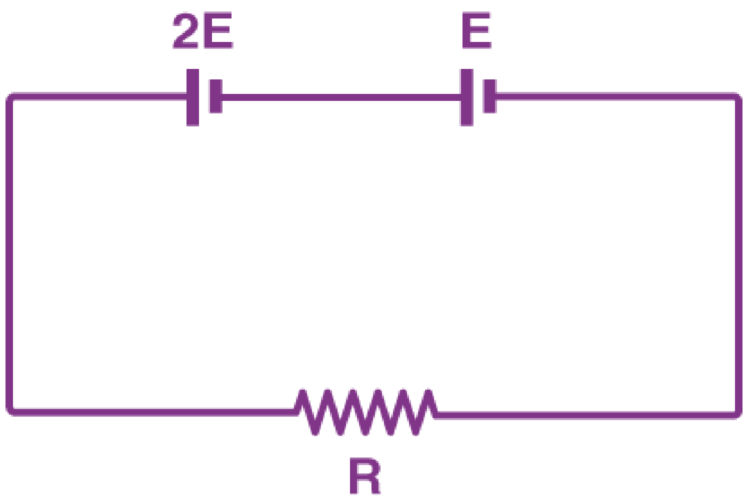
**Question 1) Two cells of emf 2E and E with internal resistance $r_1$ and $r_2$ respectively are connected in series to an external resistor R (see figure). The value of R, at which the potential difference across the terminals of the first cell becomes zero is**




(A) $r_1 - r_2$

(B) $r_1 + r_2$

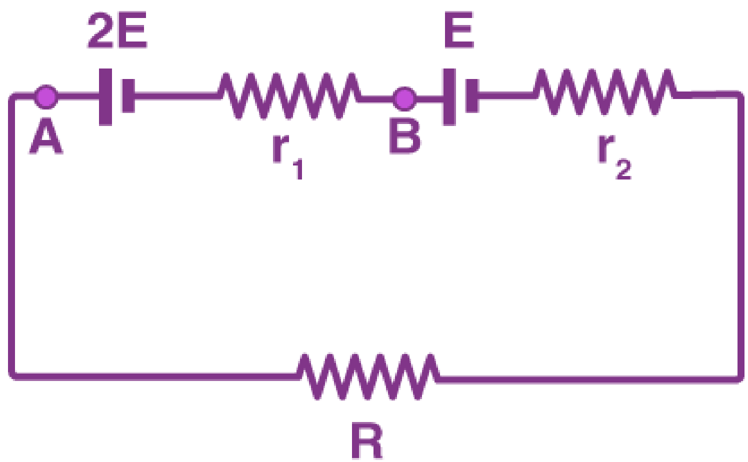
(C) $(r_1/2) + r_2$

(D) $(r_1/2) - r_2$

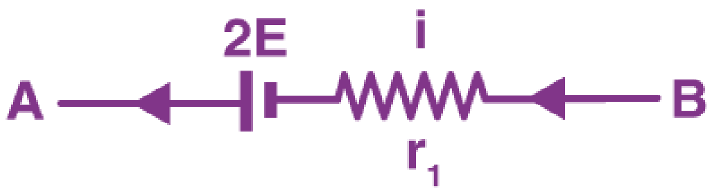
**Answer (D)**

**Solution**

$i = \frac{3E}{R+r_1+r_2}$ $i = \frac{3E}{R+r_1+r_2}$




$$i=\frac{3E}{R+r_1+r_2}$$




If potential difference across terminals of first cell is zero

$V_A = V_B$

$2E = i r_1$

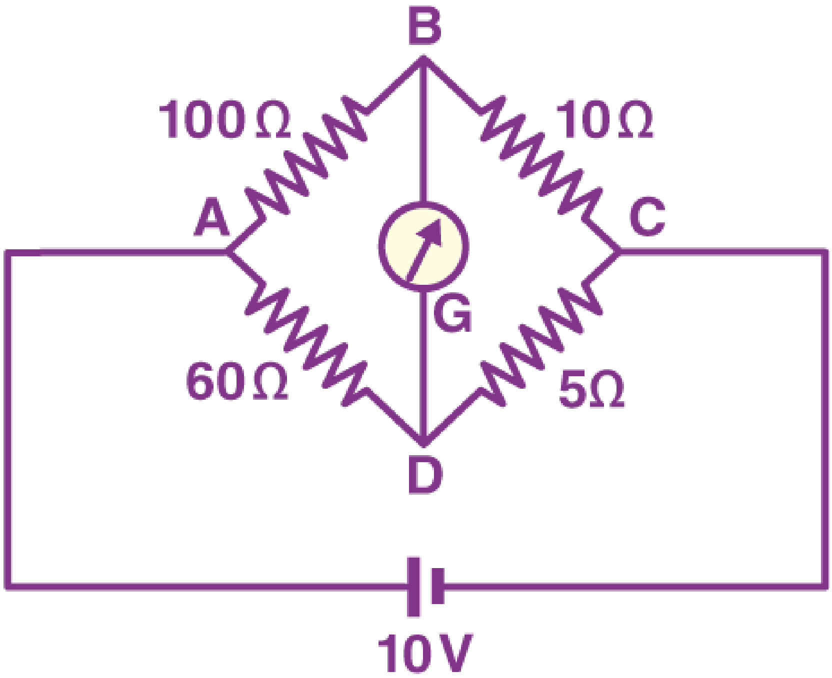
$$2E=\frac{3E}{R+r_1+r_2}r_1$$

$2R + 2r_1 + 2r_2 = 3r_1$

$R = (r_1/2) - r_2$

**Question 2) The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer**

**of 15 resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10 V is maintained across AC.**




(A) 4.87 mA

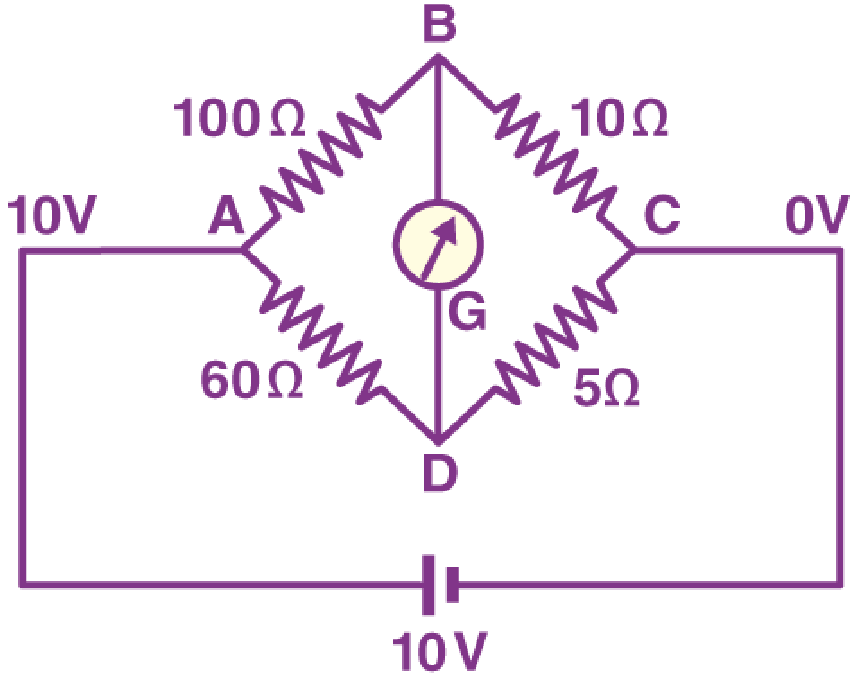
(B) 4.87 μA

(C) 2.44 μA

(D) 2.44 mA

**Answer (A)**

**Solution:**




Applying KCL for point B,

$$\frac{V_B-10}{100}+\frac{V_B-V_D}{15}+\frac{V_B-0}{10}=0$$
$$\frac{V_B-10}{20}+\frac{V_B-V_D}{3}+\frac{V_B-0}{2}=0$$

$3V_B-30+20V_B-20V_D+30V_B=0$

$53V_B - 20V_D = 30$ ____(1)

Similarly applying KCL for point D,

$$\frac{V_D-10}{60}+\frac{V_D-V_B}{15}+\frac{V_D-0}{5}=0$$

$V_D - 10 + 4V_D - 4V_B + 12V_D = 0$

$-4V_B + 17V_D = 10$ _____(2)

after solving equation (1) & (2)

$V_D = 0.792$ volt

$V_B = 0.865$ volt

Then the current through the galvanometer

$$= \frac{V_B - V_D}{R}$$
$$= \frac{0.865 - 0.792}{15}$$

= 4.67 mA

**Question 3) What happens to the inductive reactance and the current in a purely inductive circuit if the frequency is halved?**

(A) Both , including reactance and current will be doubled

(B) Both, inductive reactance and current will be halved

(C) Inductive reactance will be halved and current will be doubled

(D) Inductive reactance will be doubled and current will be halved.

**Answer: (C)**

**Solution**

$X_L = \omega L$

If frequency is halved, $X'_L = (X_L/2)$

[inductive reactance is halved]

Therefore, $I = V/X_L$

& $I' = 2V/X_L = 2I$ [current will be doubled]

**Question 4) The electric field intensity produced by the radiation coming from a 100 W bulb at a distance of 3 m is E. The electric field intensity produced by the radiation coming from 60 W at the same distance is √(x/5)E. Where the value of x = ________**

**Answer (3)**

**Solution:**

The intensity of electromagnetic radiation

$I = 1/2(C\in_0 E^2)$

where E is electric field intensity at a point

$E^2 \propto I$

I = Power/Area

$E^2 \propto (P/A)$

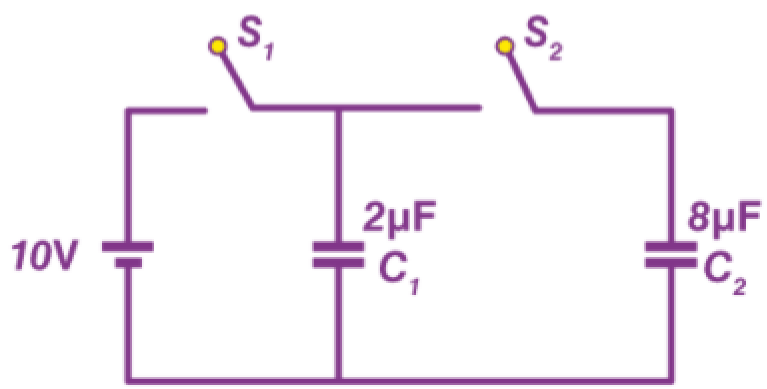
$E \propto \sqrt{P}$

[at the same distance, A will be the same]

$$\frac{E'}{E} = \sqrt{\frac{60}{100}}$$
$$E' = \sqrt{\frac{3}{5}}E$$

So the value of x = 3

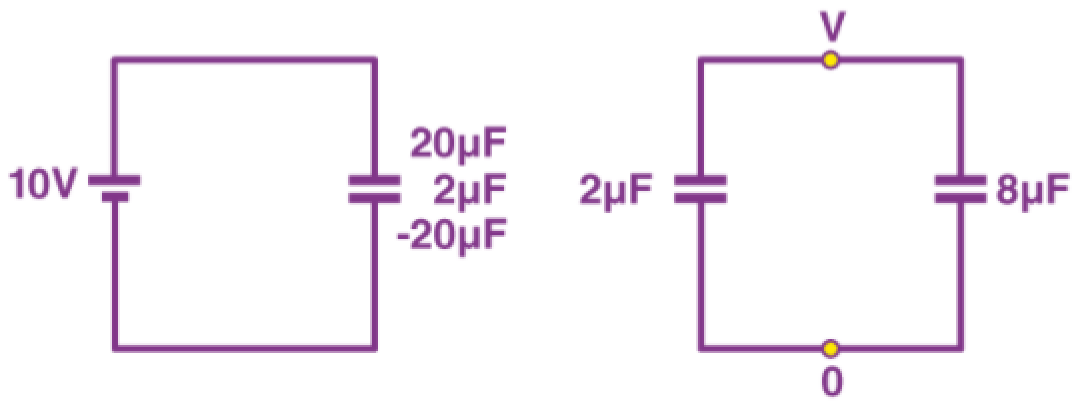
**Question 5) A 2μF capacitor $C_1$ is first charged to a potential difference of 10V using a battery. Then the battery is removed and the capacitor is connected to an uncharged capacitor $C_2$ of 8 μF. The charge in $C_2$ on equilibrium conditions is ________ μC. (Round off to the Nearest Integer)**




**Answer (16)**

**Solution**

After capacitor $C_1$ is fully charged,




When battery is removed & the capacitor is connected

At equilibrium condition, let voltage across each capacitor be V.

Then, using conservation of charge

2V + 8V = 20

10V = 20

V = 2 volt

Q = CV

Q = 8×2 = 16 μc

**Question 6) The electric field in a region is given by** $\vec{E} = \frac{2}{3}E_0 i + \frac{3}{5}E_0 j$ **with $E_0$=4.0×$10^3$N/C. The flux of this field through a rectangular surface are 0.4 $m^2$ parallel to Y–Z plane is ________$Nm^2C^{-1}$.**

**Answer (640)**

**Solution:**

From Gauss' law

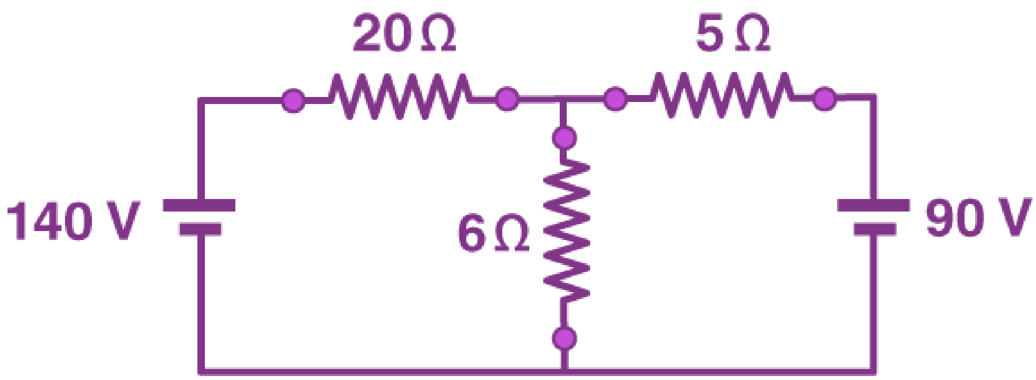
$$\phi = \oint \vec{E}.d\vec{A}$$

= (⅔)$E_0$ x (0.4)

= (⅔) x 4 x $10^3$ x 0.4

$\Phi = 640\ Nm^2\ c^{-1}$

**Question 7) In the given circuit find the current through 6Ω resistance**




(A) 10 A

(B) 7 A

(C) 25 A

(D) 30 A

**Answer: (A) 10 A**

**Solution:**

Applying Kirchoff's law,

$$\frac{V-140}{20} + \frac{V-0}{6} + \frac{V-90}{5} = 0$$

3(V-140)+10V+(V-90) =0

3V-420+10V+12V-1080 = 0

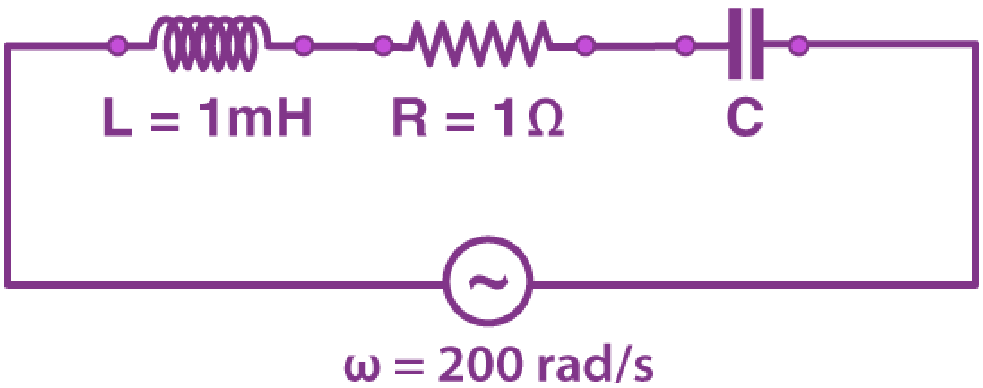
25V= 1500

V = 60

Current through 6Ω resistance, I = V/R = 60/6 = 10 A

**Question 8) An AC circuit consists of a series combination of an inductance L 1 mH, a resistance R = 1Ω and a capacitance C. It is observed that the current leads the voltage by 45°. Find the value of capacitance**

**'C' if the angular frequency of applied AC is 200 rad/s.**




(A) 5.6 mF

(B) 3.92 mF

(C) 4.16 mF

(D) 5.2 mF

**Answer: (C) 4.16 mF**

**Solution**

$$tan\Phi = \frac{X_c - X_L}{R} = \frac{\frac{1}{\omega C} - \omega L}{R}$$
$$1(1) = \frac{1}{200C} - 200(10^{-3})$$
$$\frac{1}{200C} = 1 + 0.2 = 1.2$$
$$C = \frac{1}{200 \times 1.2} = 0.00416F = 4.16mF$$

**Question 9) In a magnesium rod of area 3m$^2$, current I = 5$A$ is flowing angle of 60$^0$ from the axis of the rod. The resistivity of the material is 44 × 10$^{-2}$ ohm x m. Find an electric field inside the rod**

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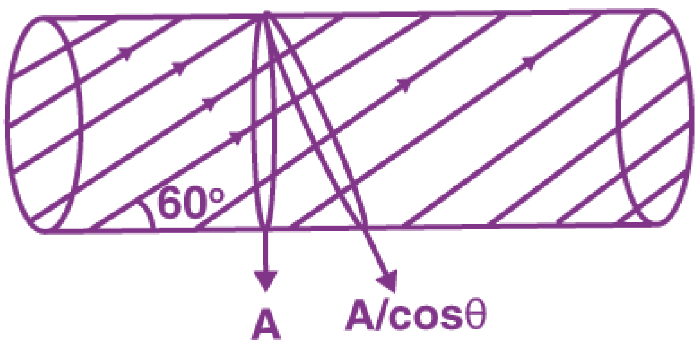


(A) 0.567

(B) 0.367

(C) 0.667

(D) 0.767

**Answer: (B) 0.367**

**Solution**

$$\frac{I}{A_{effective}} = \frac{E}{\rho}$$
$$E = \frac{\rho I}{A} cos 60^0 = \frac{44\times10^{-2}\times5}{3\times2}$$

E = 0.367

**Question 10) A RLC circuit is in its resonance condition. Its circuit components have value**

**R = 5Ω, L = 2H, C = 0.5mF, V= 250V**

**Then find the power in the circuit.**

(A) 6 kW

(B) 10 kW

(C) 12 kW

(D) 12.5 kW

**Answer: (D)**

**Solution**

A circuit is in resonance. Thus

$$X_L = X_C$$
$$\therefore \quad Z = R \text{ so, } i_{rms} = \frac{V}{Z} = \frac{V}{R}$$
$$P = i_{rms}^2 R$$
$$P = \frac{V^2}{R} = \frac{250 \times 250}{5} = 12500 \ \frac{\text{J}}{\text{s}} = 12.5 \text{ kW}$$