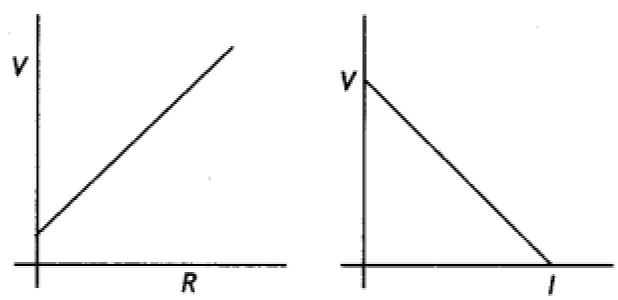
IMPORTANT QUESTIONS CLASS – 12
PHYSICS CHAPTER – 3 CURRENT ELECTRICITY

Question 1.
A cell of emf ‘E’ and internal resistance ‘r’ is connected across a variable load resistor R. Draw the plots of the terminal voltage V versus (i) R and (ii) the current l.
It is found that when R = 4 Ω the current is 1 A and when R is increased to 9 Ω, the current reduces to 0.5 A. Find the values of the emf E and internal resistance r.
Answer:
The plots are as shown



Here l_1 = 1.0 A, R_1 =4 ohm, l_2 = 0.5 A, R_2 =9 ohm
Using the equation l = E(R+r) Or E = l(R + r)

we have
1.0 × (4 + r) = 0.5 × (9 + r)

Solving the above equation for r we have r = 1 ohm
Also E = 0.5 (9 + 1) = 5 V

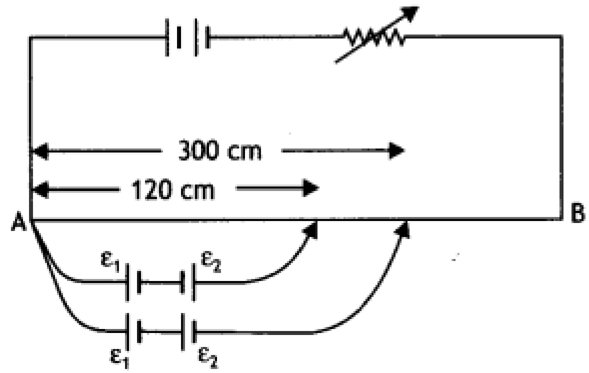
Question 2.
A wire of resistance R, length l and area of cross-section A is cut into two parts, having their lengths in the ratio 1:2. The shorter wire is now stretched till its length becomes equal to that of the longer wire. If they are now connected in parallel, find the net resistance of the combination.
Answer:
Since the wires are cut in the ratio of 1:2 therefore,
Resistance of the shorter wire R_1 = R3 and
Resistance of the longer wire R_2 = 2R3
Since the shorter wire is stretched to make it equal to the longer wire therefore, it is stretched by n = 2 times its length. Hence New resistance of the shorter wire

$$R_3 = n^2R_1 = (2)^2\frac{R}{3} = \frac{4R}{3}$$

Hence net resistance

$$R_P = \frac{R_1R_3}{R_1+R_3} = \frac{\left(\frac{4}{3}R\right)\left(\frac{2}{3}R\right)}{\left(\frac{4}{3}R\right)+\left(\frac{2}{3}R\right)} = \frac{4R}{9}$$

Question 3.
In the figure, a long uniform potentiometer wire AB is having a constant potential gradient along its length. The null points for the two primary cells of EMFs ε_1 and ε_2 connected in the manner shown are obtained at a distance of 120 cm and 300 cm from the end A. Find (i) $\varepsilon_1/\varepsilon_2$ and (ii) position of null point for the cell ε_1. How is the sensitivity of a potentiometer increased?



Answer:
From the diagram we have
ε1−ε2ε1+ε2=120300=25
Or
$5\varepsilon_1 - 5\varepsilon_2 = 2\varepsilon_1 + 2\varepsilon_2$

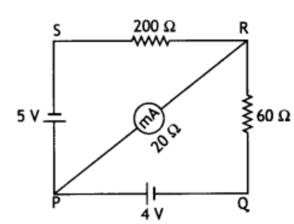
Solving we have
ε1ε2=73 ....(1)

Also let L be the balancing length for cell of emf
ε1, then
ε1ε1+ε2=L300

Using equation (1) we have
ε1ε1+37ε1=L300

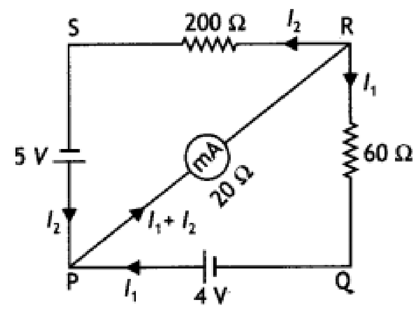
Solving for L we have L = 210 cm
The sensitivity of a potentiometer can be increased by increasing the length of the potentiometer wire.

Question 4.
The network PQRS, shown in the circuit diagram, has batteries of 4 V and 5 V and negligible internal resistance. A milli- ammeter of 20 Ω resistance is connected between P and R. Calculate the reading in the milliammeter.



Answer:
Using Kirchhoff's junction rule to distribute current we have

Consider the loop SRPS, by Kirchhoff's loop rule we have



$200\, l_2 + 20\, (l_1 + l_2) - 5 = 0$ ...(1)
Or
$220\, l_2 + 20\, l_1 = 5$ ...(2)

Consider the loop PRQP, by Kirchhoff's loop rule we have
$-60\, l_1 + 4 - 20\, (l_1 + l_2) = 0$ ...(3)
$80\, l_1 + 20\, l_2 = 4$ ...(4)

Multiplying equation (2) by (4) we have
$880\, l_2 + 80\, l_1 = 20$ ...(5)

Subtracting equation (4) from equation (5) we have
$860\, l_2 = 16$ or $l_2 = 4/215$ A

Substituting in equation (4) we have
$l_1 = 39860$A

Therefore reading of the milliammeter is
$l_1 + l_2 = 4215 + 39860 = 0.063$ A = 63 mA

Question 5.
A set of 'n' identical resistors, each of resistance 'R' when connected in series have an effective resistance 'X'. When they are connected in parallel, their effective resistance becomes 'Y'. Find out the product of X and Y.

Answer:
In series
$R_S = R_1 + R_2 + R_3 + \ldots\ldots$
$R_S = X = R + R + R + \ldots.$ upto n
$X = nR$

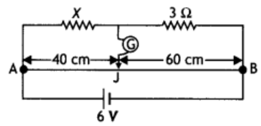
In Parallel

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots \text{ upto } n$$

$$Y = \frac{R}{n}$$

Hence
$XY = R^2$

Question 6.
In the following circuit, a metre bridge is shown in its balanced state. The metre bridge wire has a resistance of 1 ohm per centimetre. Calculate the value of the unknown resistance X and the current drawn from the battery of negligible internal resistance.



Answer:
Using the Wheatstone bridge principle we have
4060=X3
or X = 2 Ω

Now total resistance of the combination is
R = 5×1005+100=500105 = 4.76 Ω

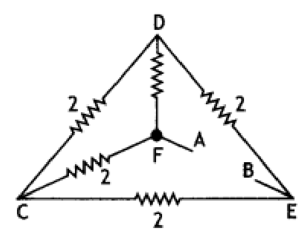
Current drawn is
l = V/R = 6/4.76 = 1.26 A

Question 7.
Calculate the electrical conductivity of the material of a conductor of length 3 m, area of cross-section 0.02 mm^2 having a resistance of 2 ohms.
Answer:
Given L = 3 m,
A = 0.02 mm2 = 0.02 × 10-6 m2
R = 2 ohm.

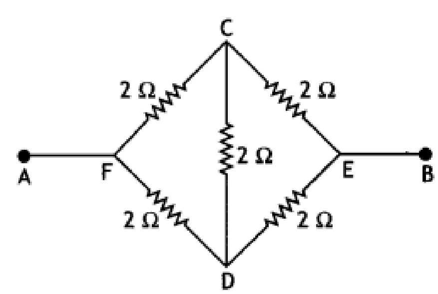
Using the equation
R = ρLA
Or
ρ = RAL

σ = LAR = 30.02×10−6×2 = 7.5 × 107 Sm-1

Question 8.
A potential difference of 2 volts is applied between points A and B has shown in the network drawn in the figure. Calculate (i) equivalent resistance of the network across the points A and B and (ii) the magnitudes of currents in the arms AFCEB and AFDEB.



Answer:
The circuit can be redrawn as shown below.



As seen the circuit is a balanced Wheatstone bridge; therefore the resistance in the arm CD is superfluous.
(i) Resistance of arm FCE = 2 + 2 = 4 Ω
Resistance of arm FDE = 2 + 2 = 4 Ω
Hence net resistance of the circuit between A and B is
R = 4×44+4=168 = 2 Ω

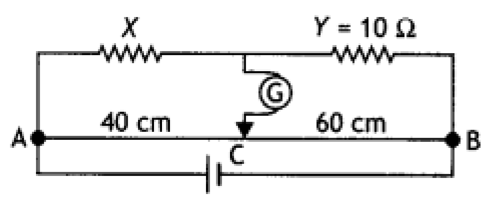
(ii) current in the arm AFCEB
$I = V/R = 2/4 = 0.5$ A

Current in the arm AFDEB
$I = V/R = 2/4 = 0.5$ A

Question 9.
A cell of emf E and internal resistance ‘r’ gives a current of 0.8 A with an external resistor of 24 ohms and a current of 0.5 A with an external resistor of 40 ohms.
Calculate
(i) emf E and
(ii) internal resistance ‘r’ of the cell.
Answer:
Given $I_1 = 0.8$ A, $R_1 = 24$ ohm $I_2 = 0.5$ A, $R_2 = 40$ ohm
Using the equation
$E = I(R + r)$ we have
$0.8 \times (24 + r) = 0.5 \times (40 + r)$

Solving for r we have r = 2.67 ohm
Also E = 0.5(40 + 2.67) = 21.3 V

Question 10.
In the circuit diagram of the metre bridge given below, the balance point is found to be at 40 cm from A. The resistance of X is unknown and Y is 10 ohms.
(i) Calculate the value of X;
(ii) if the positions of X and Y are interchanged in the bridge, find the position of the new balance point from A; and
(iii) if the galvanometer and the cell are interchanged at the balance point, would the galvanometer show any current.



Answer:
(i) Using the Wheatstone bridge principle we have
4060=X10
Or
X = 6.67 Ω

(ii) If X and Y are interchanged then
L(100−L)=106.67 solving for L we have
L = 59.9cm

(iii) The galvanometer will not show any current.