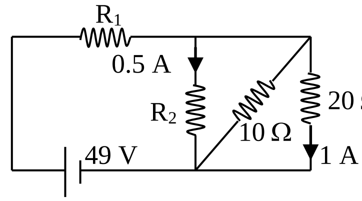
2PUC – CHAPTER 03
CURRENT ELECTRICITY

1. In the circuit shown in the given figure the resistances R_1 and R_2 are respectively



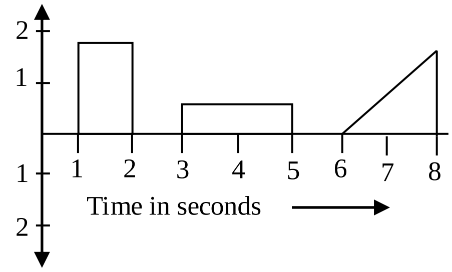
a) 14 Ω and 40 Ω
b) 40 Ω and 14 Ω
c) 40 Ω and 30 Ω
d) 14 Ω and 30Ω

(a)
Potential difference across 20Ω = 20 × 1 = 20 volt = potential difference across R_2.
Current in R_2 = 0.5 A. R_2 = 20/0.5 = 40Ω
Potential difference across R_1 = 69 – 20 = 49 volts.
Current in R_1 = 0.5 A + $\frac{20}{10}$ + 1 A = 3.5 A
$\therefore R_1 = \frac{49}{3.5} = 14\ \Omega$

2. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross-section but of length 2L. The temperature of the wire is raised by the same amount ΔT in the same time t. The value of N is
a) 4 b) 6 c) 8 d) 3
(b)
$P_1 = \frac{E_1^2}{R}$ & $P_2 = \frac{E_2^2}{R}$ $(\because E = V)$
$$\frac{P_1}{P_2} = \frac{[(3\varepsilon)^2/(\rho L/A)]}{[(N\varepsilon)^2/(\rho \times 2L/A)]} = \frac{(LA\rho)s\ \Delta T}{(2L\ A\rho)s\ \Delta T}$$ (using $V^2/R = ms\Delta T$)
ρ = resistivity; s = specific heat capacity of material of the wire.
A = area of cross section
$\frac{9x2}{N^2} = \frac{1}{2} \Rightarrow N^2 = 36 \Rightarrow N = 6$

3. A cell of constant emf first connected to a resistance R_1 and then connected to a resistance R_2. If power delivered in both cases is same then the internal resistance of the cell is
a) $\sqrt{R_1R_2}$ b) $\sqrt{\frac{R_1}{R_2}}$ c) $\frac{R_1 - R_2}{2}$ d) $\frac{R_1 + R_2}{2}$
(a)
Power dissipated = $i^2R = \left(\frac{E}{R+r}\right)^2 R$
$$\therefore \left(\frac{E}{R_1+r}\right)^2 R_1 = \left(\frac{E}{R_2+r}\right)^2 R_2$$
$\Rightarrow R_1(R_2^2 + r^2 + 2R_2r) = R_2(R_1^2 + r^2 + 2R_1r)$
$\Rightarrow R_2^2R_1 + R_1r^2 + 2R_1R_2r = R_1^2R_2 + R_2r^2 + 2R_1R_2r$
$\Rightarrow (R_1 - R_2)r^2 = (R_1 - R_2)R_1R_2 \Rightarrow r = \sqrt{R_1R_2}$

4. The plot represents the flow of current through a wire at three different times. The ratio of charges flowing through the wire at different times is



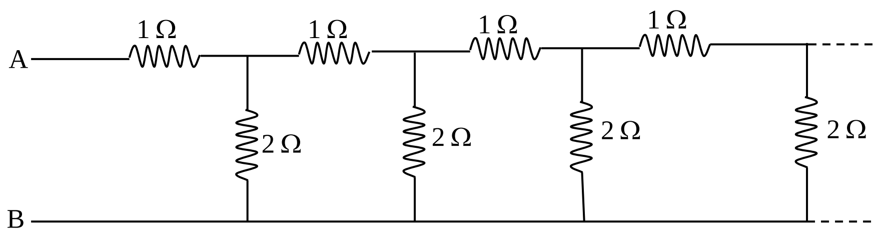
a) 2 : 1 : 2
b) 1 : 3 : 3
c) 1 : 1 : 1
d) 2 : 3 : 4

(c)
Charge = area under the current-time graph

$q_1 = 2 \times 1 = 2$, $q_2 = 1 \times 2 = 2$, and $q_3 = \frac{1}{2} \times 2 \times 2 = 2$

$q_1 : q_2 : q_3 = 2 : 2 : 2 = 1 : 1 : 1$

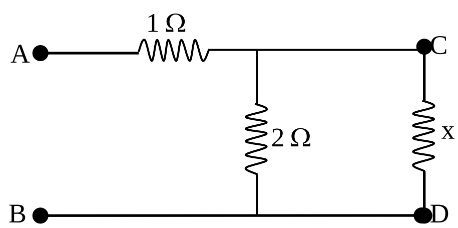
5. Find the equivalent resistance of the infinite ladder between A and B.



a) 1 Ω   b) $1 + \sqrt{5}\ \Omega$ c) 2 Ω   d) ∞ Ω

(c)

$R_{AB} = R_{CD} = x$



$x = \frac{2x}{2+x} + 1 \Rightarrow x = \frac{2x+2+x}{2+x}$

$2x + x^2 = 3x + 2$

$x^2 - x - 2 = 0$

$x^2 - 2x + x - 2 = 0$

$x(x - 2) + 1(x - 2)$

$x = 2$ or $x = -1$

$x = -1$ is not possible hence $x = 2\ \Omega$.

6. The current flowing through a wire depends on time as $I = 3t^2 + 2t + 5$. The charge flowing through the cross section of the wire in time from t= 0 s to t = 2 s. Is

a) 22C   b) 20C   c) 18C   d) 5C

(a)

$I = \frac{dq}{dt} = 3t^2 + 2t + 5$

$\therefore dq = (3t^2 + 2t + 5)\, dt$

$\therefore q = \int_{t=0}^{t=2}(3t^2 + 2t + 5)\,dt = \left.\frac{3t^3}{3} f + \frac{2t^2}{2} + 5t\right|_0^2 = \left.t^3 + t^2 + 5t\right|_0^2 = 22C$

7. A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/quantities that remains/remain constant along the length of the conductor is/are

a) current, electric field and drift speed   b) drift speed only
c) current and drift speed   d) current only

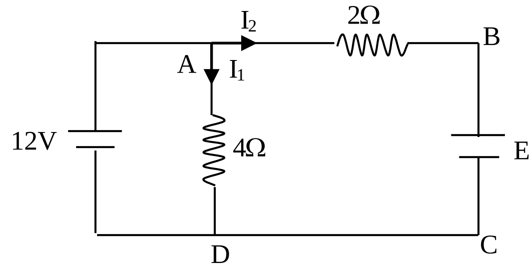
(d)

The drift speed depends on A, the cross-sectional area of the conductor but the current is independent of A.

8. In the circuit shown in Fig., current $I_2 = 0$. The value of E is

a) 3 V　　b) 6 V

c) 9 V　　d) 12 V



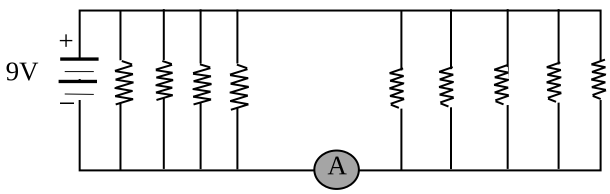
(d)

$$I_1 = \frac{12V}{4\Omega} = 3A$$

Applying Kirchoff's law to ABCDA: $2I_2 + E - 4I_1 = 0$

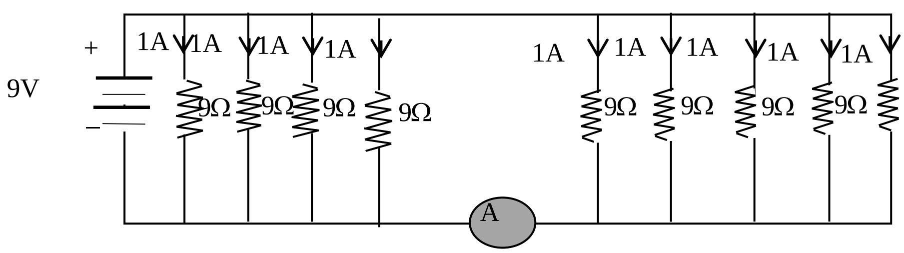
Substitute I_1=3A and I_2=0 in the above equation we get E=12V

9. If each resistance in the figure is of 9 Ω then reading of ammeter is



a) 5A　　b) 8A　　c) 2A　　d) 9A

(a)



Current i = $\frac{9}{1}$ = 9A

Current passing through the ammeter = 5A.

10. Tow wires of equal diameters, of resistivities ρ_1 and ρ_2 and lengths I_1 and I_2, respectively, are joined in series. The equivalent resistivity of the combination is

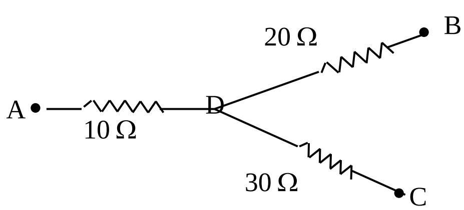
a) $\frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$　　b) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 - l_2}$　　c) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 + l_2}$　　d) $\frac{\rho_1 l_1 - \rho_2 l_2}{l_1 + l_2}$

(a)

$R_1 = \frac{\rho_1 I_1}{A}$ and $R_2 = \frac{\rho_2 l_2}{A}$. In series $R_{eq} = R_1 + R_2$

$$\frac{\rho_{eq}(l_1 + l_2)}{A} = \frac{\rho_1 l_1}{A} + \frac{\rho_2 l_2}{A} \Rightarrow \rho_{eq} = \frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$$

11. In the circuit given here, the points A, B and C are 70V, zero, 10V respectively. Then



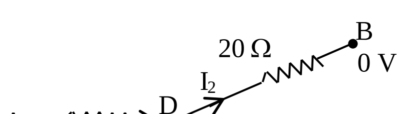
a) The point D will be at a potential of 60V

b) The point D will be at a potential of 20 V

c) Currents in the paths AD, DB and DC are in the ratio of 1 : 2: 3

d) Currents in the paths AD, DB and DC are in the ratio of 3:2:1

(d)



Applying Kirchhoff's law at point D

$I_1 = I_2 + I_3$

$$\frac{V_A - V_D}{10} = \frac{V_D - V_B}{20} + \frac{V_D - V_C}{30}$$

$$\frac{70 - V_D}{10} = \frac{V_D - 0}{20} + \frac{V_D - 10}{30}$$

$$70 - V_D = \frac{V_D}{2} + \frac{V_D - 10}{3}$$

$6(70-V_D) = 3V_D + 2(V_D - 10)$

$420-6V_D = 3V_D + 2V_D - 20$

$11V_D = 440 \Rightarrow V_D = 40V$

$$I_1 = \frac{V_A - V_D}{10} = \frac{70 - 40}{10} = 3A$$

$$I_2 = \frac{V_D - V_B}{20} = \frac{40 - 0}{20} = 2A$$

12. Two different conductors have same resistance at 0°C. It is found that the resistance of the first conductor at t_1°C is equal to the resistance of the second conductor at t_2°C. The ratio of the temperature coefficients of resistance of the conductors, $\frac{\alpha_1}{\alpha_2}$ is

a) $\frac{t_1}{t_2}$ b) $\frac{t_2 - t_1}{t_2}$ c) $\frac{t_2 - t_1}{t_1}$ d) $\frac{t_2}{t_1}$

(d)

Resistance of a conductor varies linearly with temperature as $R_t = R_0 (1 + \alpha t)$

For the first conductor $R_{t_1} = R_0 (1 + \alpha_1 t_1)$

For the second conductor $R_{t_2} = R_0 (1 + \alpha_2 t_2)$

$R_{t_1} = R_{t_2}$

$$\frac{\alpha_1}{\alpha_2} = \frac{t_2}{t_1}$$

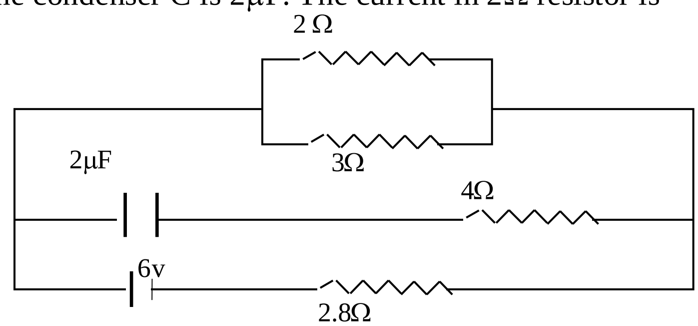
13. In the figure shown, the capacity of the condenser C is 2μF. The current in 2Ω resistor is

a) 9A

b) 0.9A

c) $\frac{1}{9}$ A

d) $\frac{1}{0.9}$ A



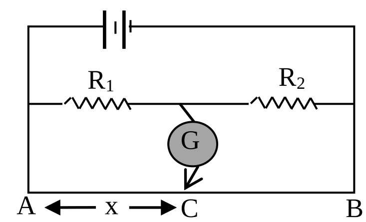
(b)

No current flows through the capacitor branch in steady state.

Total current supplied by the battery, $I = \frac{6}{2.8+1.2} = \frac{3}{2}A$

Current through 2Ω resistor $= \frac{3}{2} \times \frac{3}{5} = 0.9A$

14. In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled



a) x b) x/4

c) 4x d) 2x

(a)

Balancing length is independent of the cross sectional area of the wire

15. If voltage across a bulb rated 220 Volt-100 Watt drops by 2.5% of its rated value by which the power would decrease is

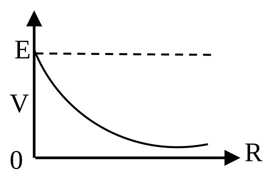
a) 20% b) 2.5% c) 5% d) 10%

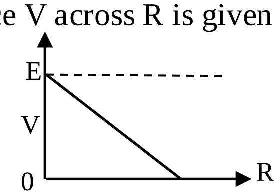
(c)

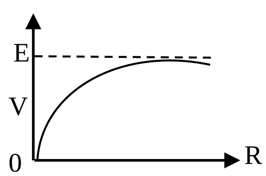
Resistance of bulb is constant $P = \frac{V^2}{R} \Rightarrow \frac{\Delta P}{P} = \frac{2\Delta V}{V} + \frac{\Delta R}{R}$

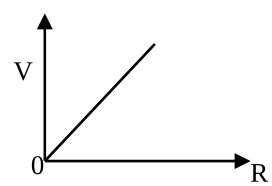
$\frac{\Delta P}{P} = 2 \times 2.5 + 0 = 5\%$

16. Cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by

a) 

b) 

c) 

d) 

(c)

$I = \left(\frac{E}{R + r}\right)$

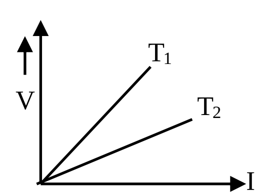
$V = IR = \left(\frac{E}{R + r}\right)R$

$V = \frac{E}{\left(1 + \frac{r}{R}\right)}$

When R = 0, V = 0,

R = ∞, V = E

17. The voltage V and current l graph for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is



a) $T_1 > T_2$

b) $T_1 \approx T_2$

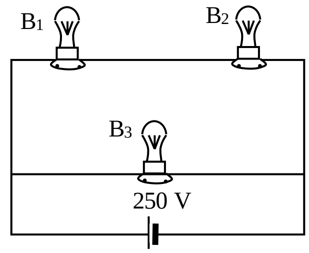
c) $T_1 = T_2$

d) $T_1 < T_2$

(a)

Slope of the V-i curve at any point equals to resistance at the point. From the curve slope for T_1> slope for $T_2 \Rightarrow R_{t_1} > R_{t_2}$.
Also at higher temperature resistance will be higher so $T_1 > T_2$.

18. A 100 W bulb B_1 and two 60 W bulbs B_2 and B_3 are connected to a 250 V source, as shown in figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3, respectively. Then:

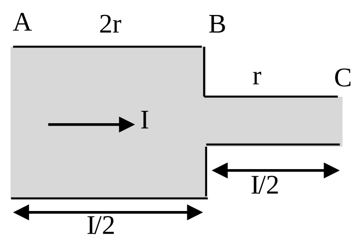


a) $W_1 > W_2 = W_3$ b) $W_1 > W_2 > W_3$

c) $W_1 < W_2 = W_3$ d) $W_1 < W_2 < W_3$

(d)
Bulbs B_2 and B_3 are of the same rating.
Out of B_2 and B_3, voltage across B_3 is more than that of B_2
Therefore $W_3 > W_2$ $(P = V^2/R)$
In series combination of bulbs, bulb with lesser wattage glows brighter. $W_2 > W_1$

19. If a steady current I is flowing through a cylindrical element ABC. Choose the correct relationship:
a) $V_{AB} = 2\,V_{BC}$
b) Power across BC is 4 times the power across AB
c) Current densities in AB and BC are equal
d) Electric field due to current inside AB and BC are equal



(b)
$R = \frac{\rho l}{\pi r^2}$. Since the two wires are made of the same material, resistivity ρ is the same for wires AB and BC. Since the wires have equal lengths, it follows that $R \propto l/r^2$.
Hence $\frac{R_{AB}}{R_{BC}} = \frac{1}{4}$ i.e. $R_{BC} = 4R_{AB}$
Since the current is same in the two wires, it follows from Ohm's law (V = IR) that $V_{BC}=4V_{AB}$.
Hence choice (a) is wrong. Now power dissipated is $P = I^2 R$.
Since I is same, $P \propto R$
Hence $\frac{P_{BC}}{P_{AB}} = \frac{R_{AB}}{R_{BC}} = 4$
Hence choice (b) is correct, Choice (c) is wrong because current density (i.e. current per unit area) is different in wires AB and BC because their cross sectional areas are different.
The electric field in a wire is $E = V/\ell$. Since the two wires have the same length (ℓ), E is proportional to potential difference (V). Since $V_{BC} = 4V_{AB}$, $E_{BC} = 4E_{AB}$

20. To get maximum current in a resistance of 3 ohm, one can use n rows of m cells in each row. If the total number of cells is 24 and the internal resistance of a cell is 0.5 ohm then:
a) m = 12, n = 2 b) n = 3, m = 8
c) m = 2, n = 12 d) m = 6, n = 4
(a)
For one row of m cells: $r_i = mr$
For n rows of m cells each, $\frac{1}{R_i} = \frac{1}{mr} + \frac{1}{mr} + \ldots + n \text{ times} = \frac{n}{mr}$

For maximum current in the circuit, $R_{ext} = R_i$

$3 = \frac{mr}{n}$

$3 = \frac{m}{n}(0.5)$

m = 6n

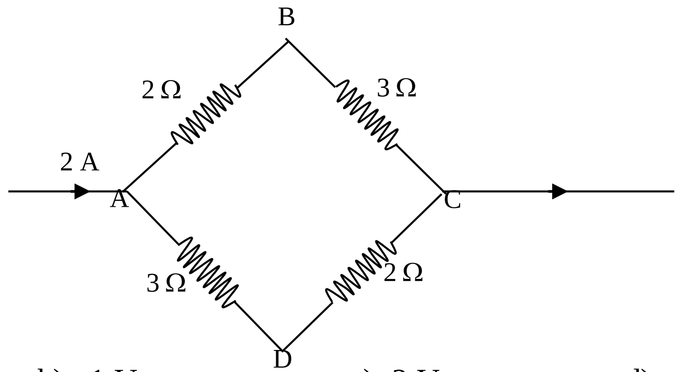
Given that total number of cells are 24

$\therefore$ mn = 24

n (6 n) = 24 $\Rightarrow$ n = 2 $\quad\therefore$ m = 6n = 6 × 2 = 12

Hence, n = 2, m = 12.

21. A current of 2 A flows through the network shown in fig. The PD between points B and D is:



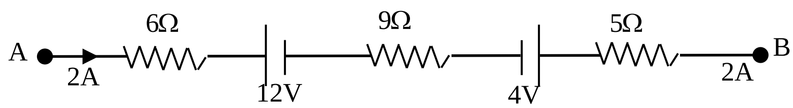
a) -1 V b) +1 V c) -2 V d) +2 V

(b)

Current through upper and lower branches are 1 A each $\therefore V_B = 3 \times 1 = 3$ V

$V_D = 2 \times 1 = 2$ V $\therefore V_B - V_D = 3 - 2 = +1$ V.

22. The potential difference between A and B in the fig.



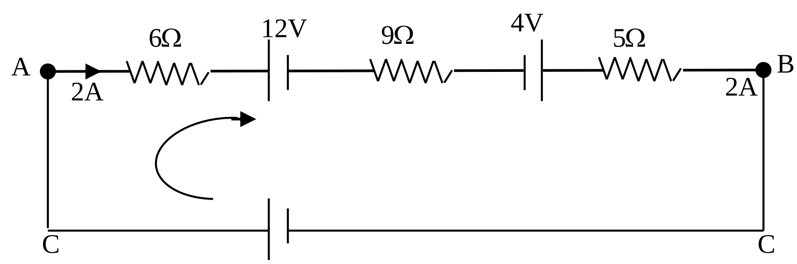
a) 24 V b) 14 V c) 32 V d) 48 V

(d)

Apply KVL to a mesh ABCDA

$V_A - 12 - 12 - 18 + 4 - 10 - V_B = 0$

$V_A - V_B = 48$ V



23. If R_1 and R_2 are respectively the filament resistance of a 200 W bulb and a 100 W bulb designed to operate on the same voltage

a) R_1 is two times R_2 b) R_2 is two times R_1

c) R_2 is four times R_1 d) R_1 is four times R_2

(b)

$R = \frac{V^2}{P} \Rightarrow R \propto \frac{1}{p} \Rightarrow \frac{R_1}{R_2} = \frac{p_2}{p_1}$

$\frac{R_1}{R_2} = \frac{100}{200}\ \frac{1}{2} \Rightarrow R_2 = 2R_1$

24. If a given volume of water in a 220 V heater is boiled in 5 min, then how much time will it take for the same volume of water in a 110 V heater to be boiled?

a) 20 min b) 30 min c) 25 min d) 40 min

(a)

$H = V^2 t/R$. When voltage is halved, the heat becomes one-fourth,

Hence, time taken to heat the water becomes four times.

25. The heating element of an electric heater should be made with a material which has:

a) high specific resistance and high melting point

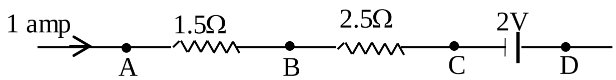
b) high specific resistance and low melting point

c) low specific resistance and high melting point

d) low specific resistance and high melting point

(a)

26. In the circuit element given here, if the potential at point B, $V_B = 0$, then the potentials of A and D are given as



a) $V_A = 1.5V$, $V_D = +2V$ b) $V_A = +1.5V$, $V_D = +2V$

b) $V_A = +1.5V$, $V_D = +0.5V$ d) $V_A = 1.5V$, $V_D = -0.5V$

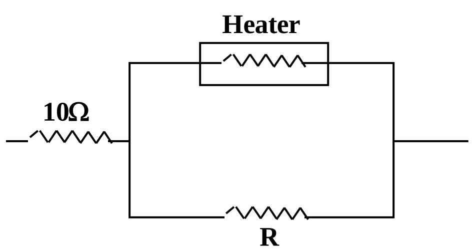
(d)

Potential difference between A and B: $V_A - V_B = 1 \times 1.5 \Rightarrow V_A - 0 = 1.5V \Rightarrow V_A = 1.5V$

Potential difference between B and C: $V_B - V_C = 1 \times 2.5 = 2.5V \Rightarrow 0 - V_C = 2.5V \Rightarrow V_C = -2.5V$

Potential difference between C and D: $V_C - V_D = -2V \Rightarrow -2.5 - V_D = -2 \Rightarrow V_D = -0.5V$

27. A heater is designed to operate with a power of 1000 W on a line of 100V. It is connected in combination with resistance of 10Ω and a resistance R to line of 100 V. The value of R so that the entire circuit operates with a power of 625 W is



a) 5Ω b) 10Ω c) 15Ω d) 20 Ω

(c)

Power of the heater is P = 1000W. Potential difference is V = 100V.

Therefore, resistance is $R_1 = \frac{V^2}{P} = \frac{100 \times 100}{1000} = 10\,\Omega$

Now resistance of the circuit is $R_2 = 10 + \frac{10R}{10+R} = \frac{100+20R}{10+R}$

Therefore, power is $\frac{V^2}{R_2} = 625\text{ W}$

or $R_2 = \frac{V^2}{625}$ or $\frac{100+20R}{10+R} = \frac{625}{100 \times 100} \Rightarrow R = 15\Omega$

28. There is a fixed potential difference between the two ends of a potentiometer. Two cells are connected in series in such a way that in one arrangement they help each other whereas in the second arrangement they oppose each other. The balance points for these two combinations are obtained at 120 cm and 60 cm length respectively. The ratio of the emf of the cells is

a) 2 : 1 b) 3 : 1 c) 1 : 1 d) 4 : 1

(b)

Ist case: $E_1 + E_2 = kl_1 = k(120)$

IInd case: $E_1 - E_2 = kl_2 = k(60)$

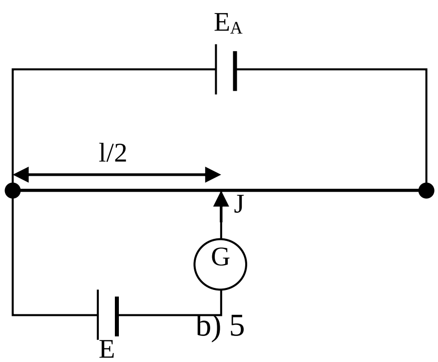
Dividing, $\frac{E_1 + E_2}{E_1 - E_2} = \frac{k(120)}{k(60)} = 2$

$\frac{E_1}{E_2} = \frac{3}{1}$

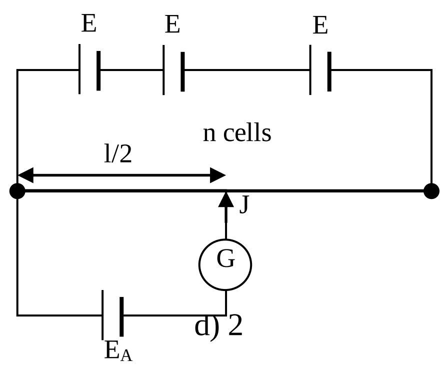
$\therefore E_1 : E_2 = 3 : 1$

29. Fig. shows a potentiometer circuit. Length of the potentiometer wire is 'ℓ'. As shown, a cell of emf E is balanced by length '$\ell/2$' of the potentiometer wire. b) shows cell of emf E_A in place of E and a combination of n cells each of emf E in place of E_A. For balancing E_A at $\ell/2$, n should be

a)



b)



a) 6 b) 5 c) 4 d) 2

(c)

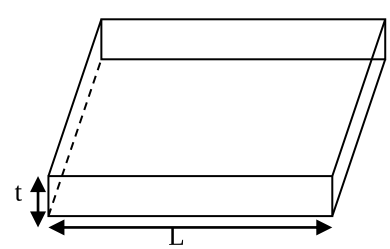
Ist case: potential gradient = E_A/ℓ $\therefore$ E = (pot. grad) $\frac{l}{2} = \left(\frac{E_A}{l}\right)\frac{l}{2} = \frac{E_A}{2}$

IInd case: potential gradient = $\frac{nE}{l}$ $\therefore$ E_A = (pot. grad) $\frac{l}{2} = \left(\frac{nE}{l}\right)\frac{l}{2} = \frac{nE}{2}$

From eqns, (i) and (ii) $2E = \frac{nE}{2}$

n = 4

30. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The opposite faces, shown by the shaded areas in the figures is



a) directly proportional to L
b) directly proportional to t
c) independent of L
d) independent of t

(c)

Resistance, $R = \rho \times \frac{\text{Length}}{\text{Area}}$

$R = \rho \frac{L}{Lt} = \frac{\rho}{t}$

31. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to

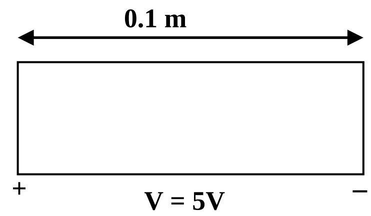
a) 1.6×10^{-8} Ωm b) 1.6×10^{-7} Ωm c) 1.6×10^{-6} Ωm d) 1.6×10^{-5} Ωm

(d)

$v_d = 2.5 \times 10^{-4}$ m/s

$n = 8 \times 10^{28}/m^3$

$I = neAv_d$



$$\rho = \frac{RA}{\ell} = \frac{VA}{I\ell} = \frac{V}{nev_d\ell} = \frac{5}{8\times10^{28}\times1.6\times10^{-19}\times2.5\times10^{-4}\times0.1} = 1.6 \times 10^{-5}\,\Omega m.$$

32. A wire of a certain material is stretched slowly by ten percent. Its new resistance and specific resistance become respectively.

a) Both remain the same b) 1.1 times, 1.1 times

c) 1.2 times 1.1 times d) 1.21 times, same

(d)

In stretching of wire $R \propto l^2 \Rightarrow \frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$

If $l_1 = 100$, then $l_2 = 110 \Rightarrow \frac{R_1}{R_2} = \left(\frac{100}{110}\right)^2 \Rightarrow R_2 = 1.21\,R_1$

Resistivity doesn't change with stretching.

33. The resistance of an incandescent lamp is

a) Greater when switched off

b) Smaller when switched on

c) Greater when switched on

d) The same whether it is switched off or switched on

(c)

$R \propto \frac{1}{\tau}$; where τ = relaxation time.

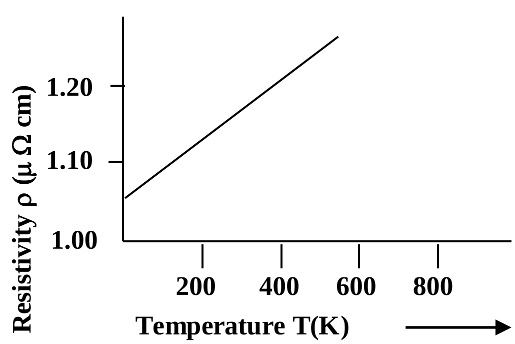
When lamp is switched on, temperature of filament increases, hence τ decreases so R increases.

34. The graph between resistivity and temperature, for a limited range of temperatures, is a straight line for a material like

a) Copper b) Nichrome c) Silicon d) Mercury

(b)

For a limited range of temperature, the graph between resistively and temperature is a straight line for a material like nichrome as shown in the figure.



35. The alloys constantan and manganin are used to make standard resistance because they are

a) Low resistivity

b) High resistivity

c) Low temperature coefficient of resistance

d) Both (b) and (c)

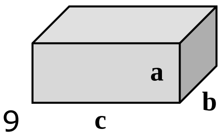
(d)

36. A block has dimensions 1 cm, 2 cm, 3 cm, Ratio of the maximum resistance to maximum resistance to minimum resistance between any points of opposite faces of his block is

a) 9 : 1 b) 1 : 9 c) 18 : 1 d) 1 : 6

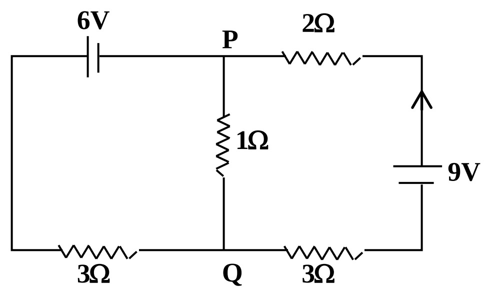
(a)

$a = 1, b = 2, c = 3 \Rightarrow R_{max} = \frac{\rho.L}{A} = \frac{\rho.c}{a.b}$



$R_{min} = \frac{\rho.L}{A} = \frac{\rho.a}{b.c} \Rightarrow \frac{R_{max}}{R_{min}} = \frac{\frac{\rho.c}{a.b}}{\frac{\rho.a}{b.c}} = \frac{c}{a} \times \frac{c}{a} \Rightarrow \frac{c^2}{a^2} = \left(\frac{c}{a}\right)^2 = \left(\frac{3}{1}\right)^2 = \frac{9}{1}.$

37. In the circuit shown, the current in the 1Ω resistor is



a) 1.3A, from P to Q

b) 0A

c) 0.13 A, from Q to P

d) 0.13 A, from P to Q

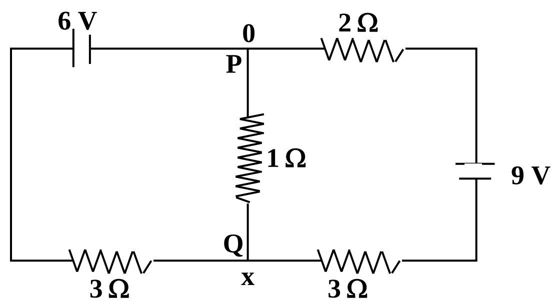
(c)

$E_{eq} = \frac{E_1 r_2 - E_2 r_1}{r_1 + r_2} = \frac{6 \times 5 - 9 \times 3}{3 + 5} = \frac{3}{8} V$

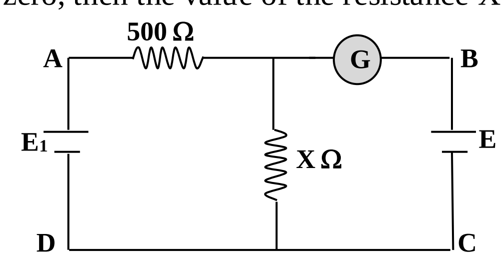
$r_{eq} = \frac{r_1 r_2}{r_1 + r_2} = \frac{5 \times 3}{3 + 5} = \frac{15}{8} \Omega$

$I = \frac{E_{eq}}{R + r_{eq}} = \frac{3/8}{1 + 15/8} = \frac{3}{23} = 0.13A$

From Q to P



38. In the adjoining circuit, the battery E_1 has an e.m.f of 12 volt and zero internal resistance while the battery E has an e.m.f of 2 volt. If the galvanometer G reads zero, then the value of the resistance X in ohm is



a) 10
b) 100
c) 500
d) 200

(b)

For no current through galvanometer, we have

$\left(\frac{E_1}{500 + X}\right) X = E \Rightarrow \left(\frac{12}{500 + X}\right) X = 2 \Rightarrow$ X = 100 Ω.

39. A student measures the terminal potential difference (V) of cell (of emf E and internal resistance r) as a function of the current (I) flowing through it. The slope, and intercept, of the graph between V and I, then, respectively, equal

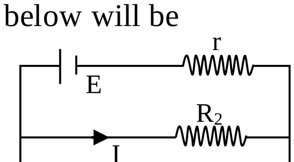
a) E and –r b) –r and E c) r and –E d) –E and r

(b)

$E = V + ir \Rightarrow V = -ri + E$

Comparing it with y = mx + c; slope (m) = -r and intercept = E.

40. The charge on the capacitor of capacitance C shown in the figure below will be



a) CE b) $\frac{CER_1}{R_1 + r}$

c) $\frac{CER_2}{R_2 + r}$ d) $\frac{CER_1}{R_2 + r}$

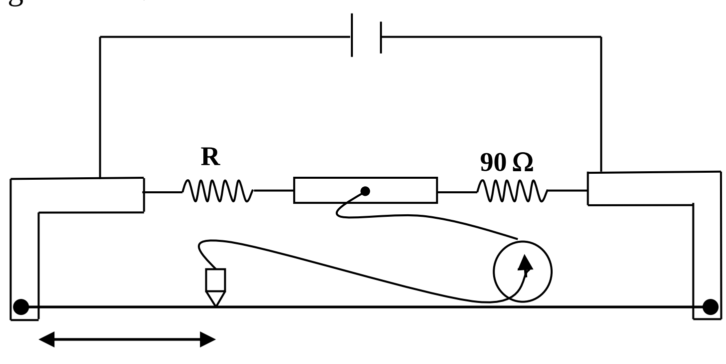
(c)

$I = \frac{E}{R_2 + r}$ (since no current flows through capacitor under steady state)

$\therefore$ Potential difference across R_2, $V = IR_2 = \frac{ER_2}{R_2 + r}$

$\therefore$ Charge on the capacitor $Q = CV = \frac{CER_2}{R_2 + r}$

41. During experiment with a metre bridge, the galvanometer shows a null point when the jockey is pressed at 40.0 cm using a standard resistance of 90 Ω, as shown in the figure. The least count of the scale used in the metre bridge is 1mm. The unknown resistance is



a) 60 ± 0.15 Ω b) 135 ± 0.56 Ω c) 60 ± 0.25 Ω d) 135 ± 0.23 Ω

(c)

For balance meter bridge

$\frac{X}{R} = \frac{\ell}{(100 - \ell)}$ $\frac{X}{40} = \frac{90}{60} \Rightarrow x = 60\ \Omega.$

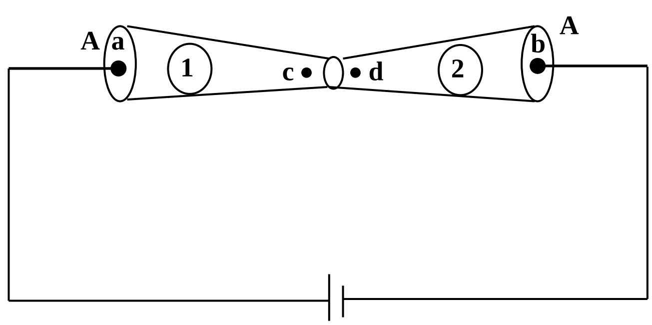
$X = R\frac{\ell}{(100 - \ell)}$

$\frac{\Delta X}{x} = \frac{\Delta \ell}{\ell} + \frac{\Delta \ell}{100 - \ell} = \frac{0.1}{40} + \frac{0.1}{60}$

$\Delta X = 0.25$

So $X = (60 \pm 0.25)\Omega$.

42. Two conductors (1) and (2) having non-uniform cross section are joined end to end as shown. Their areas of cross section where they join are the same. If we compare equal volumes of the two conductors, there are more electrons in conductor (1). Referring to fig, as current passes through the system of two conductors:



a) drift speed of electrons at ‘c’ is less than at ‘a’
b) drift speed of electrons at ‘b’ is more than at ‘a’
c) drift speed of electrons at ‘c’ is the same as that at ‘d’
d) drift speed of electrons at ‘a’ is same as that at ‘b’.
(b)
$v_d = \frac{I}{neA} \Rightarrow V_d \propto \frac{1}{n}$
As $n_1 > n_2$, therefore, drift speed at the end ‘b’ will be more than that at the end ‘a’.

43. Resistance of resistor at temperature t°C is $R_t = R_0(1 + \alpha t + \beta t^2)$, where R_0 is the resistance at 0°C. The temperature coefficient of resistance at temperature t°C is

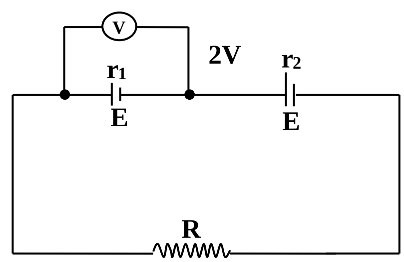
a) $\frac{1+\alpha t+\beta t^2}{\alpha + 2\beta t}$ b) $(\alpha + 2\beta t)$ c) $\frac{\alpha+2\beta t}{(1+\alpha t+\beta t^2)}$ d) $\frac{\alpha+2\beta t}{2(1+\alpha t+\beta t^2)}$

(c)
$\alpha = \frac{1}{R_t}\frac{dR_t}{dt} = \frac{1}{R_t}R_0[\alpha + 2\beta t]$
$\alpha = \frac{R_0[\alpha+2\beta t]}{R_0[1+\alpha t+\beta t^2]} = \frac{\alpha+2\beta t}{1+\alpha t+\beta t^2}$

44. Two cells of equal emf and of internal resistance r_1 and r_2 ($r_1 > r_2$) are connected in series. On connecting this combination to an external resistance R, it is observed that the potential difference across the first cell becomes zero. The value of R will be

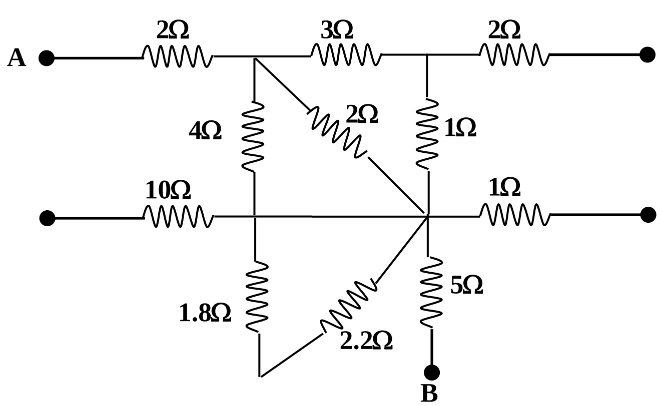
a) $r_1 + r_2$ b) $R = r_1 - r_2$ c) $\frac{r_1+r_2}{2}$ d) $\frac{r_1-r_2}{2}$

(b)
Let the voltage across any one cell is V, then



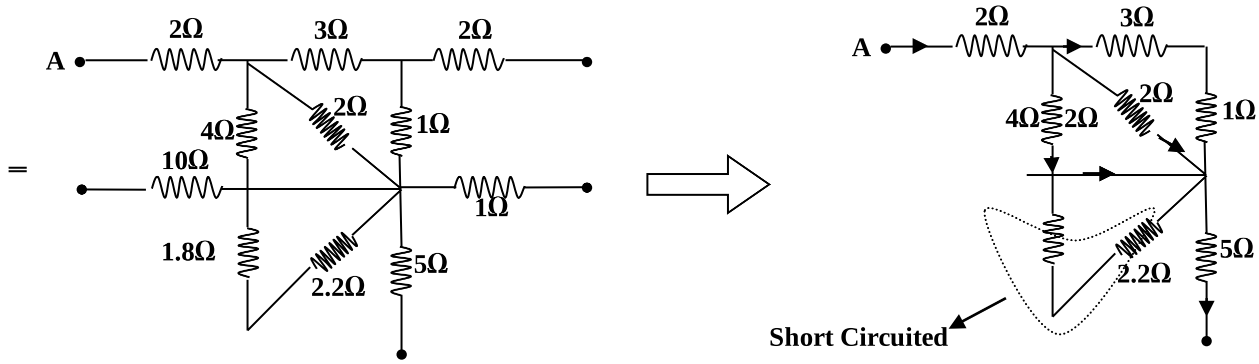
$V = E - ir = E - r_1\left(\frac{2E}{r_1+r_2+R}\right)$
But V = 0
$\Rightarrow E - \frac{2Er_1}{r_1+r_2+R} = 0 \quad \Rightarrow r_1 + r_2 + R = 2r_1 \quad \Rightarrow R = r_1 - r_2$

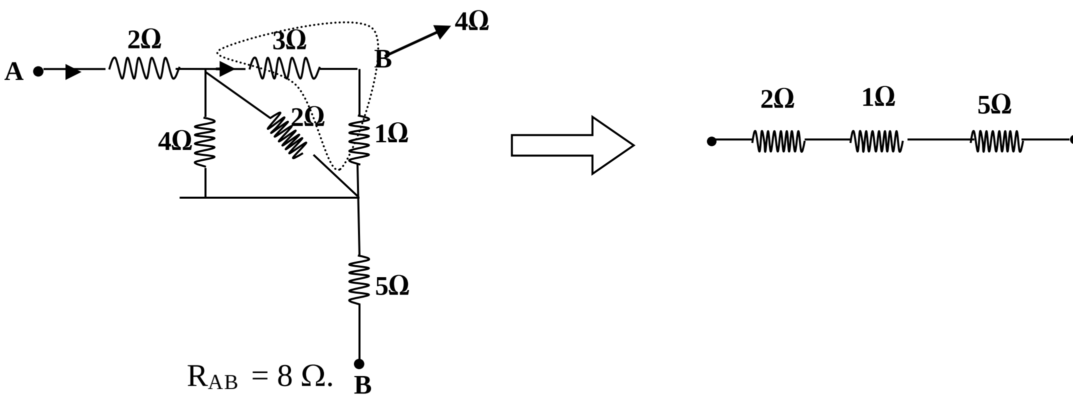
45. What is the equivalent resistance between the points A and B of the network



a) $\frac{57}{7}\Omega$ b) 8 Ω c) 6 Ω d) $\frac{57}{5}\Omega$

(b)





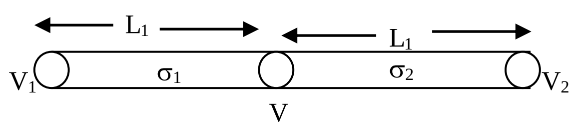
$R_{AB} = 8\ \Omega$.

46. A copper wire and an iron wire, each having an area of cross-section A and lengths L_1 and L_2 are joined end to end. The copper end is maintained at a potential V_1 and the iron end at a lower potential V_2. If σ_1 and σ_2 are the conductivities of copper and iron respectively, then the potential of the junction will be

a) $\dfrac{\sigma_1 V_1 + \sigma_2 V_2}{(\sigma_1/L_1)+(\sigma_2/L_2)}$ b) $\dfrac{\frac{\sigma_1 V_1}{L_1} + \frac{\sigma_2 V_2}{L_2}}{(\sigma_1/L_1)+(\sigma_2/L_2)}$ c) $\dfrac{(\sigma_1/L_1)+(\sigma_2/L_2)}{\sigma_1 V_1 + \sigma_2 V_2}$ d) $\dfrac{\sigma_1 V_1 - \sigma_2 V_2}{(\sigma_1/L_1)-(\sigma_2/L_2)}$

(b)

$R_1 = \dfrac{L_1}{\sigma_1 A}$, $R_2 = \dfrac{L_2}{\sigma_2 A}$ $(\because \sigma\ \dfrac{1}{\rho})$

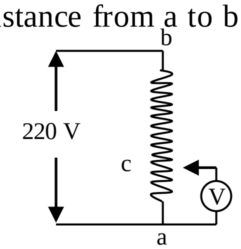


V = Potential at junction.

$$\frac{V_1 - V}{R_1} = \frac{V - V_2}{R_2}$$

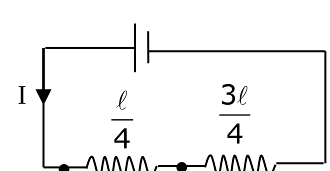
Solving for R_1 & R_2 we get $V = \dfrac{\frac{\sigma_1 V_1}{L_1} + \frac{\sigma_2 V_2}{L_2}}{(\sigma_1/L_1)+(\sigma_2/L_2)}$

47. A potential difference of 220 V is maintained across a 12000 ohm rheostat, as shown in the figure. The voltmeter has a resistance of 6000 ohm and point c at one-fourth of the distance from a to b. Therefore, the reading of the voltmeter will be



a) 32 V
b) 36 V
c) 40 V
d) 42 V

(c)



Total resistance $= \left(\frac{3000 \times 6000}{3000+6000}\right) + 9000 = 2000 + 9000 = 11000\ \Omega$

Resistance of I = $\frac{220}{11000}$ = 20mA

$\frac{1}{4}$ part = 3000Ω

Remaining part = 9000 Ω

∴ P.D. across voltmeter $V_G = I R = 20 \times 10^{-3} \times 2000 = 40V$

48. Two resistances equal at 0°C with temperature coefficient of resistance α_1 and α_2 joined in series act as a single resistance in a circuit. The temperature coefficient of their single resistance will be

a) $\alpha_1 + \alpha_2$ b) $\frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ c) $\frac{\alpha_1-\alpha_2}{2}$ d) $\frac{\alpha_1+\alpha_2}{2}$

(d)

$R_s = R_0(1 + \alpha_1 t) + R_0(1 + \alpha_2 t) = 2R_0\left(1+\frac{\alpha_1+\alpha_2}{2}t\right)$

Comparing with $R_s = R_0(1 + \alpha_s t)$ $\alpha_s = \frac{\alpha_1+\alpha_2}{2}$

49. The current density varies with radial distance r as $J = a r^2$, in a cylindrical wire of radius R. The current passing through the wire between radial distance R/3 and R/2 is

a) $\frac{65\pi a R^4}{2592}$ b) $\frac{25\pi a R^4}{72}$ c) $\frac{65\pi a^2 R^3}{2938}$ d) $\frac{81\pi a^2 R^4}{144}$

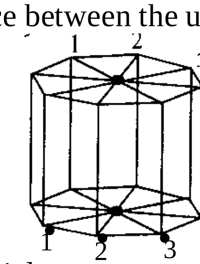
(a)

Given, $J = ar^2$

$I = \int_1^2 J \times 2\pi r\,dr = \int_{R/3}^{R/2} ar^2 \times 2\pi r\,dr$

$= 2\pi a\int_{R/3}^{R/2} r^3\,dr = 2\pi a\left|\frac{R^4}{4}\right|_{R/3}^{R/2} = \frac{\pi a}{2}\left[\left(\frac{R}{2}\right)^4 - \left(\frac{R}{3}\right)^4\right] = \frac{\pi a R^4}{2} \times \frac{65}{81 \times 16} = \frac{65\pi a R^4}{2592}$

50. In the diagram shown, all the wires have resistance R. the equivalent resistance between the upper and lower points shown in the diagram is



a) R/8
b) R
c) 2R/5
d) 3R/8

(d)

Points 1, 2, 3, …….. are equipotential and 1', 2', 3', ……. are also equipotential