CURRENT ELECTRICITY

EXERCISE – I

SINGLE CORRECT

1. B

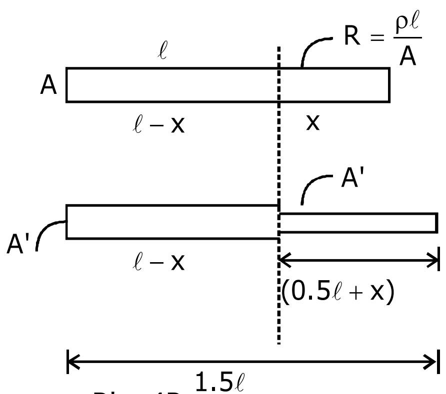
$$\frac{\rho_1\ell_1(1+\alpha_1\Delta T)}{A} + \frac{\rho_2\ell_2(1+\alpha_2\Delta T)}{A} = R$$

Total resistance is independent of temp.

$$\Rightarrow \frac{\rho_1\ell_1\alpha_1\Delta T}{A} + \frac{\rho_2\ell_2\alpha_2\Delta T}{A} = 0$$

$$\Rightarrow \rho_1\ell_1\alpha_1 + \rho_2\ell_2\alpha_2 = 0$$

2. B



$R' = 4R$

$Ax = A'(0.5\ell + x)$

$$A' = \frac{Ax}{0.5\ell + x}$$

$$\Rightarrow \frac{4\rho\ell}{A} = \frac{\rho(\ell - x)}{A} + \frac{\rho(0.5\ell + x)}{A'}$$

$$\Rightarrow \frac{4\rho\ell}{A} = \frac{\rho(\ell - x)}{A} + \frac{\rho(0.5\ell + x)^2}{Ax}$$

$\Rightarrow 4\ell x = \ell x - x^2 + (0.5\ell)^2 + \ell x + x^2$

After solving $x = (1/8)\ell$

3. D

$$\left.\begin{array}{l} x = \frac{\rho 4a}{2a^2} = \frac{2\rho}{a} \\ y = \frac{\rho a}{8a^2} = \frac{\rho}{8a} \\ z = \frac{\rho(2a)}{4a^2} = \frac{\rho}{2a} \end{array}\right\} \text{From } R = \frac{\rho\ell}{A}$$

$x > z > y$

4. A

$$R_1 = \frac{\rho_B\ell_B}{A}(1 + \alpha_B\Delta T)$$

$$R_2 = \frac{\rho_C\ell_C}{A}(1 + \alpha_C\Delta T)$$

Req. $= R_1 + R_2$

$$\text{Req.} = \frac{\rho_B\ell_B}{A} + \frac{\rho_B\ell_B}{A}\alpha_B\Delta T + \frac{\rho_C\ell_C}{A} + \frac{\rho_C\ell_C}{A}\alpha_C\Delta T$$

Net resistance is independent of temp.

$$\Rightarrow \frac{\rho_B\ell_B\alpha_B\Delta T}{A} + \frac{\rho_C\ell_C\alpha_C\Delta T}{A} = 0$$

$$\Rightarrow \frac{\ell_B}{\ell_C} = \left|\frac{\alpha_C\rho_C}{\rho_B\alpha_B}\right|$$

5. A

$$R = \frac{V}{I} \Rightarrow R = \frac{10}{2.5} = 4\Omega$$

$$dR = \frac{dV}{V} - \frac{V}{I^2}dI \Rightarrow \frac{dR}{R} = \frac{dV}{V} - \frac{dI}{I}$$

$$\frac{dR}{4} = \frac{0.1}{10} + \frac{0.05}{2.5}$$

$dR = 0.12$

$\Rightarrow R = 4 \pm 0.12$

6. C

$$i = n_1eA\,V_{d_1},\ i = n_2eA\,V_{d_2},\ \frac{n_1}{n_2} = \frac{V_{d_2}}{V_{d_1}} = \frac{4}{1}$$

7. C

$I = neAV_d$ $A = \pi r^2$

$I' = neA'V_d'$

$$= ne\frac{\pi r^2}{4}.2V_d$$

$= I/2$

8. C

y : $\rho = \rho_0(1 + \alpha\Delta T)$

α is –ve for semi conductor

z : temp ↑ τ ↓ Hence rate of collision ↑

9. D

B'coz copper is a conductor

But germanium & Si are semi conductors.

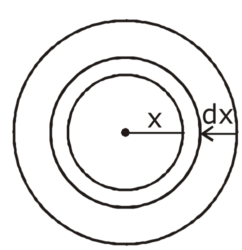
10. D

$i_1 = neAV$, $i_2 = n(2e)\,Av/4$

$i = i_1 + i_2$

$$= \frac{3neAV}{4}$$

11. D



$$I = \begin{cases} J_0\left(\frac{x}{R}-1\right) & \text{for} \quad 0 \le x < R/2 \\ J_0\frac{x}{R} & \text{for} \quad \frac{R}{2} \le x \le R \end{cases}$$

$$i = \int_0^{R/2} J_0\left(\frac{x}{R}-1\right)2\pi x dx + \int_{R/2}^{R} J_0\frac{x}{R}2\pi x dx$$

$$i = \frac{5}{12}\pi J_0 R^2$$

12. D

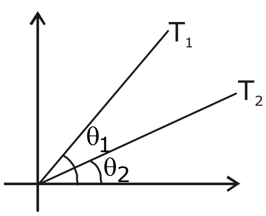
$$i_1 = ne\left(\frac{\pi d^2}{4}\right)V_d$$

$$i_2 = ne\frac{\pi d^2}{16}V'$$

$\because$ $i_1 = i_2$

$\Rightarrow$ $V' = 4V_d$

13. B



$$R = \frac{V}{I} \Rightarrow \frac{I}{V} = \frac{1}{R}$$

$\because$ $\theta_1 > \theta_2$

$\Rightarrow$ $R_1 < R_2$

$\Rightarrow$ $T_1 < T_2$

$\because$ $T\uparrow R\uparrow$

14. B

$i = neAV_d$

$$\frac{i}{\rho sq} = V_d$$

15. D

$F = -e\vec{E}$

So e^- moves randomly but slowly drift opposite to E.

16. C

$i = neAV_d$

i is same so

$A\uparrow V_d\downarrow$

17. A

$$R = \frac{\rho\ell}{A}$$

$$R_{square} = \frac{3.5\times10^{-5}\times50\times10^{-2}}{(10^{-2})^2}$$

$$= \frac{35}{2}\times10^{-2}\Omega$$

$$R_{rectangle} = \frac{3.5\times10^{-5}\times2[1\times10^{-2}]}{(50\times10^{-4})}$$

$= 7 \times 10^{-5}$

18. C

E + ir = 12.5 Volt

E + (0.5 × 1) = 12.5

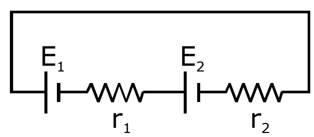
E = 12 volt

19.D E – ir = 0

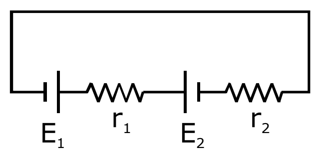
E – ir = V (Discharging)

E + ir = V (Charging)

20.A



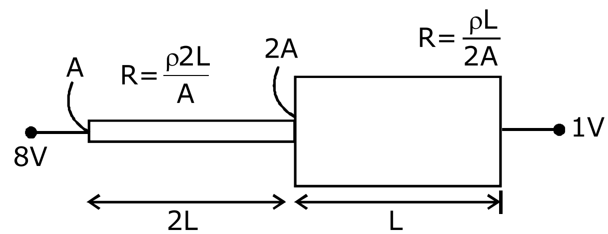
$$\frac{E_1+E_2}{r_1+r_2} = I_1$$

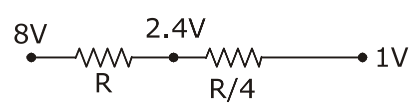


$$\frac{-(E_2-E_1)}{r_1+r_2} = I_2$$

$$\frac{E_1+E_2}{E_1-E_2} = \frac{I_1}{I_2} \Rightarrow E_1 = \frac{(I_1+I_2)}{(I_1-I_2)}E_2$$

21. A





22. A

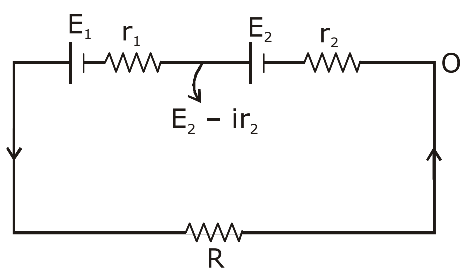
$$i = \frac{4}{4} = 1 \text{ Amp}$$

V = E + ir = 2 + 1 × 3 = 5V

23. B

In b V = E + ir

24. B



$$i = \frac{E_1+E_2}{R+r_1+r_2}$$

So for $E_2 - ir_2 < 0$ (for increasing i)

$$E_2 - \left(\frac{E_1 + E_2}{R + r_1 + r_2}\right) r_2 < 0$$

$\Rightarrow E_2 (R_2 + r_1) < E_1 r_2$

25. D

From graph I = 0 ⇒ Open ckt.

V = y = E

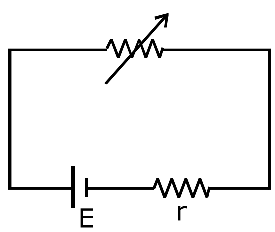
When V = 0 . I_{max}

E = ir

y = xr

r = y/x

26.D



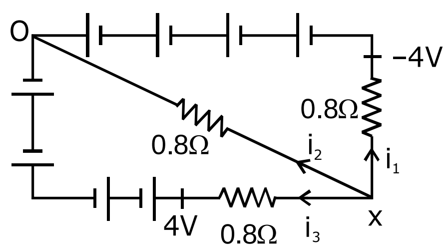
E – ir = V

$$V = E - \frac{E}{R + r}.r$$

at R = 0

V = 0

27. C



$i_1 + i_2 + i_3 = 0$

$$\frac{x+4}{0.8} + \frac{x}{0.8} + \frac{x-4}{0.8} = 0$$

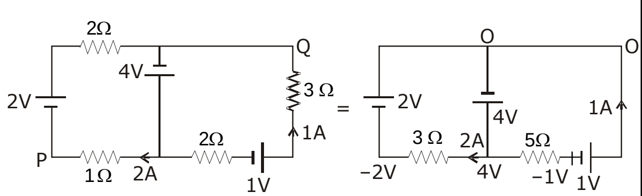
x = 0

i.e. there is no curent in 0.8 Ω resistor

$$i_1 = i_3 = i = \frac{4}{0.8} = 5A$$

$\Rightarrow$ V = E – ir = 1 – (5) (0.2) = 0

28. B



Now $V_p = + 2 - 4 + V_Q$

$V_P - V_Q = 2V$

29. A

From V : IR

When S_1 is closed $V_1 = \left(\frac{E}{4R}\right)3R = \frac{3E}{4} = 0.75E$

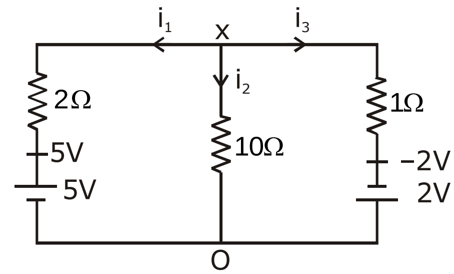
When S_2 is closed $V_2 = \frac{E}{7R} . 6R = \frac{6E}{7} = 0.85E$

When both S_1 & S_2 are closed

$$V_3 = \frac{E}{8R} \times 2R = \frac{2E}{3} = 0.6E$$

$V_2 > V_1 > V_3$

30. B



$i_1 + i_2 + i_3 = 0$

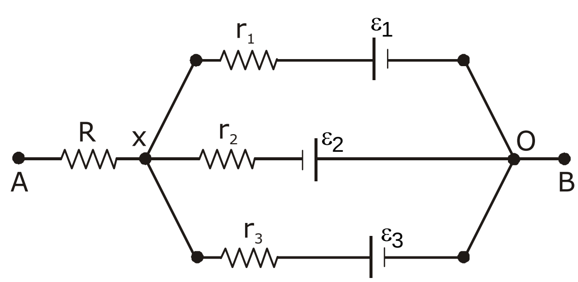
$$\frac{x-5}{2} + \frac{x}{10} + \frac{x+2}{1} = 0$$

$$x = \frac{5}{16}$$

$$\Rightarrow i_2 = \frac{5}{16 \times 10} = 0.03A$$

31. A Theory

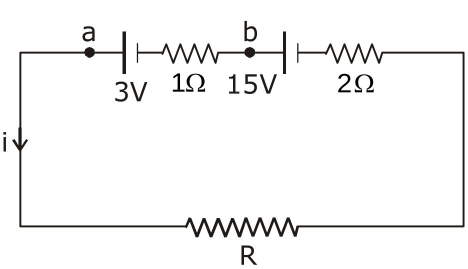
32. B



$$\frac{x-\varepsilon_1}{r_1} + \frac{x-\varepsilon_2}{r_2} + \frac{x-\varepsilon_3}{r_3} = 0$$

x = 2 volt

33. C



$$i = \frac{18}{R+3}$$

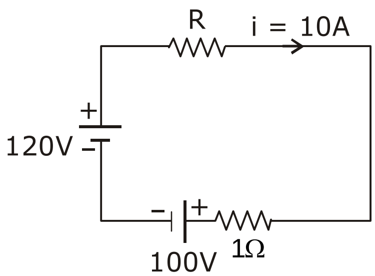
$$V_b = -\frac{-18}{R+3}(1) + 3 + V_a$$

$V_b - V_a = 0 = -18 + 3R + 9$

$\Rightarrow$ 3R = 9

R = 3Ω

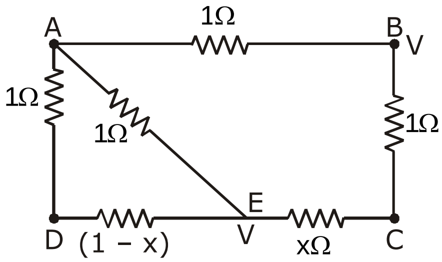
34.C



$$\Rightarrow \frac{20}{R+1} = 10$$

R = 1Ω

35. D



$$x = \frac{(2-x)1}{3-x}, \quad x^2 - 4x + 2 = 0$$

$$x = 2 \pm \sqrt{2}$$

$$\frac{CE}{ED} = \frac{2-\sqrt{2}}{\sqrt{2}-1}$$

$$\frac{CE}{ED} = \frac{(2-\sqrt{2})(\sqrt{2}+1)}{(\sqrt{2}-1)(\sqrt{2}+1)} = \frac{2\sqrt{2}+2-2-\sqrt{2}}{1}$$

$$\frac{CE}{ED} = \sqrt{2}$$

36.D

V = 0.3 × 20 = 6V

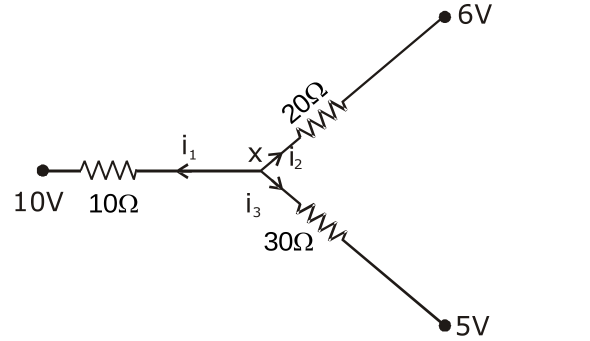
$$i_1 : i_1 : i_3 = \frac{1}{R_1} : \frac{1}{20} : \frac{1}{15}$$

$= 60 : 3R_1 : 4R_1$

$$\Rightarrow 0.3 = \frac{3R_1}{60+7R_1} \times (0.8)$$

$\Rightarrow R_1 = 60\ \Omega$

37. B

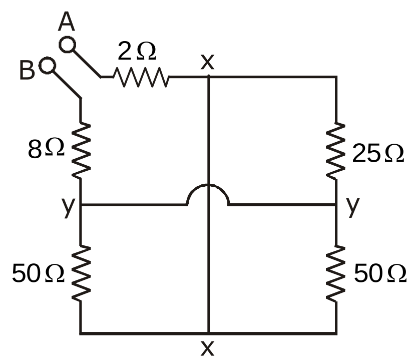


$$\text{Now } \frac{x-10}{10} + \frac{x-6}{20} + \frac{x-5}{30} = 0$$

$$x = 8V, \quad i_1 = \frac{10-8}{10} = 0.2A$$

38. C

39. B



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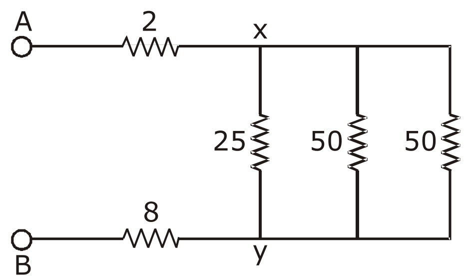


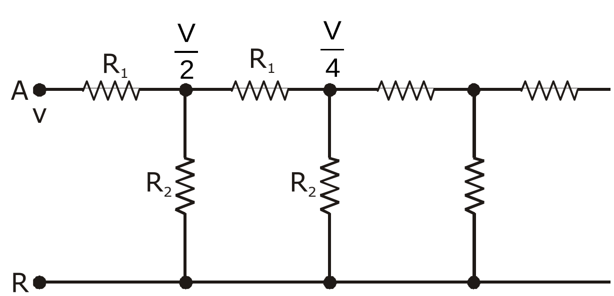
$$R_{eq.} = 2 + \frac{25}{2} + 8 = \frac{45}{2}\Omega$$

40. A S = R + R = 2R

$$P = \frac{R}{2}, \quad S = nP \Rightarrow 2R = \frac{nR}{2}$$

n = 4Ω

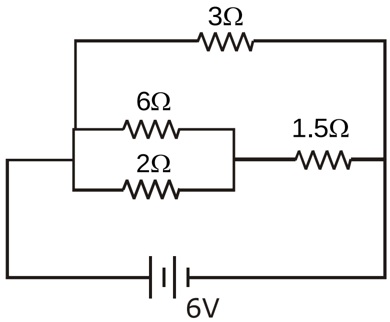
41. B



$$\frac{V}{2R_1} = \frac{V}{2R_2} + \frac{V}{4R_1}$$

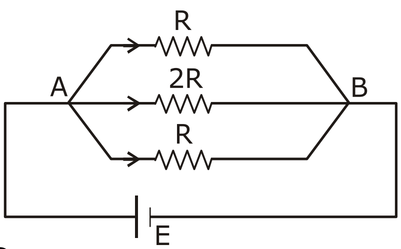
$$\frac{1}{R_1} = \frac{1}{R_2} + \frac{1}{2R_1} \Rightarrow \frac{R_2}{R_1} = 2$$

42.C

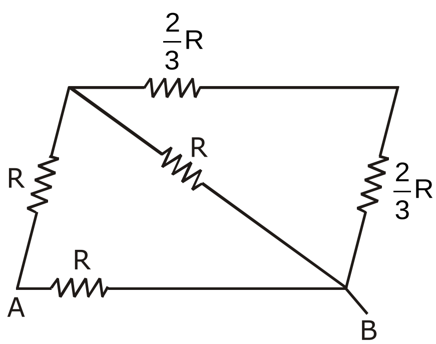


Req. = $\frac{3}{2}$, i = $\frac{6}{\frac{3}{2}}$ = 4A

43.B

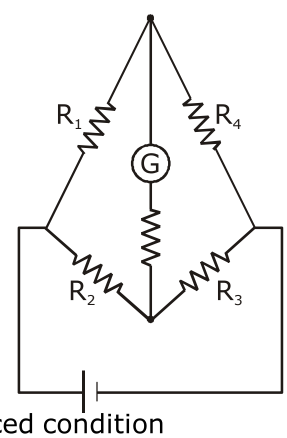


44.D



Req. = $\frac{11R}{18}$

45.C



For balanced condition

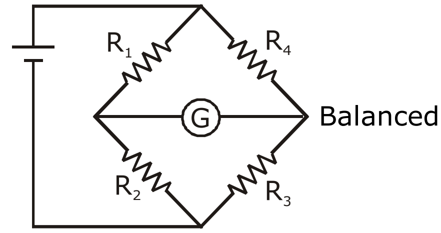
$R_1R_3 = R_4R_2$

(A) No effect of emf of battery

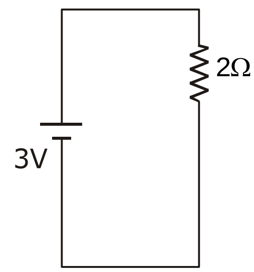
(B) $(R_1 + 10)(R_3 + 10) \neq (R_2 + 10)(R_4 + 10)$
Incorrect

(C) $(5R_1)(5R_3) = (5R_2)(5R_4)$
$R_1R_3 = R_2R_4$ correct.

(D)



46. C



i = $\frac{3}{2}$ = 1.5A

47. B

625 (P) = SQ ....(1)

when P,Q is interchanged

Q(676) = PS ....(2)

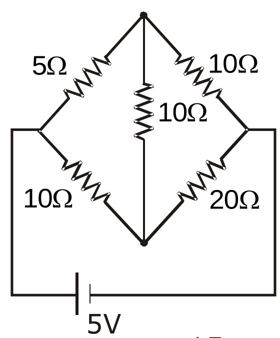
From eq. (1) & (2)

$$\frac{676}{S} = \frac{S}{625}$$

S = 650 Ω

48. D

Balanced W.S.B.



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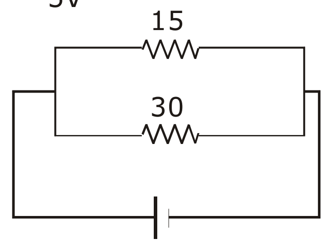
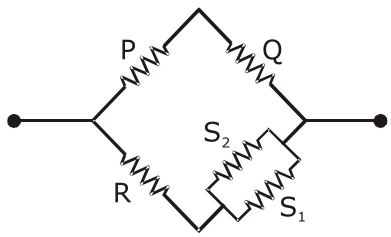


Balance W.S.B.

Req. = 10Ω

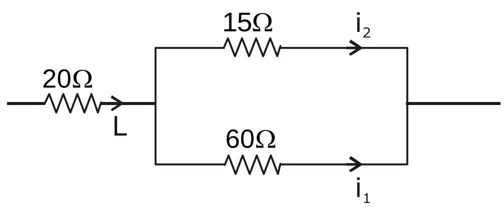
$i = \frac{5}{10} = 0.5\text{ A}$

49.D



$P\left[\frac{S_1 S_2}{S_1 + S_2}\right] = RQ$

50. B

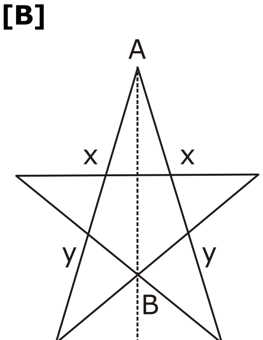


Given $\frac{15 \times i}{75} = 0.75$

Now $i_2 = \frac{60 \times i}{75} = \left[\frac{60 \times 0.75 \times 75}{15}\right]$

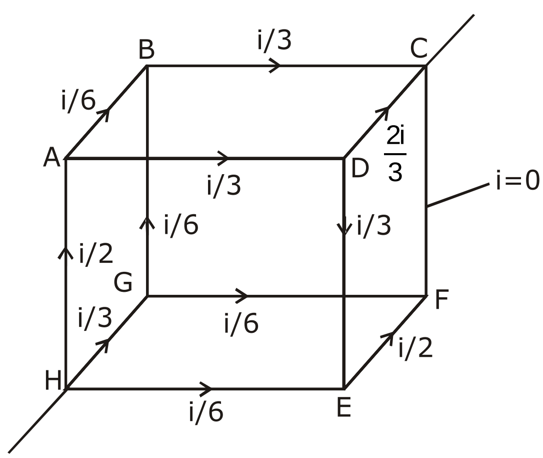
$= 3\text{A}$

51.[B]

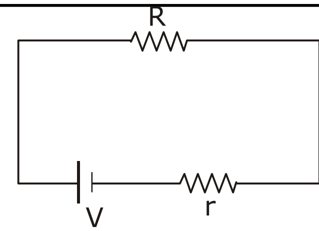


Folding symmetry

52. B

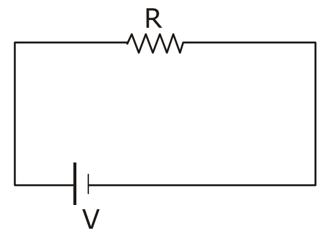


53. A



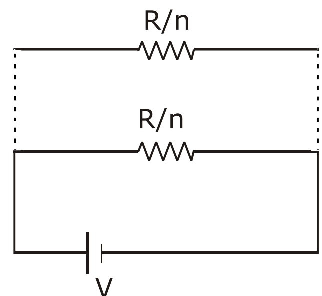
$i = \frac{V}{R + r}$

54.B



Initially $H = \frac{v^2}{R}$

Now after cutting



Power in one branch

$= \frac{V^2}{R/n} = \frac{nV^2}{R}$

Total power $= \frac{nV^2}{R} + \frac{nV^2}{R} + \ldots$

$= \frac{n^2 V^2}{R}$

55. B

$H = \frac{v^2}{R}\Delta t$, & $R = \frac{\rho \ell}{A}$

56. C

$R = \frac{V_{rated}^2}{P_{rated}} \Rightarrow R \propto V_{rated}^2$

$\because$ In series I is same.

Power $= I^2 R \propto V_{rated}^2$

57. B $P_1 = \frac{(220)^2}{R}$

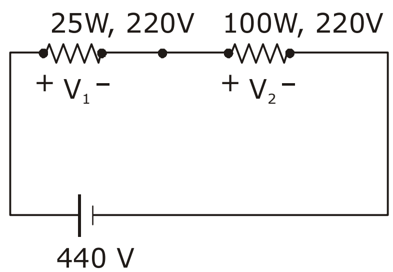
$P_2 = \frac{(220)^2}{R/2} + \frac{(220)^2}{R/2}$

P = 200 Watt

$P_2 = \frac{4(220)^2}{R}$

$\frac{P_2}{P_1} = 4$

58. A



$V_1 > 220$ Volt

59. C

P = V . i , P = E. ℓ . JA

$\frac{P}{\ell A} = EJ$

60.A

$i = \frac{dQ}{dt} = 2 - 16t$

$\text{Heat} = R\int_0^{1/8}(2-16t)^2.dt$

61.B $P = \frac{V^2}{R}$ $\qquad R = \frac{\rho\ell}{A}$

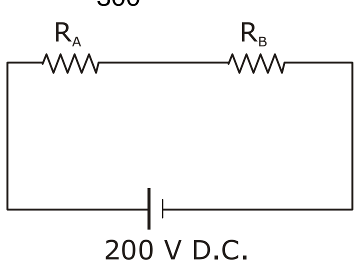
$P' = \frac{V^2}{0.9R}$ $\qquad R' = \frac{\rho(\ell - 0.1\ell)}{A}$

$P' = \frac{1.11V^2}{R}$ $\qquad = 0.9\frac{\rho\ell}{A}$

$R' = \frac{0.9\rho\ell}{A}$

62.D

$R_A = \frac{(200)^2}{300}$

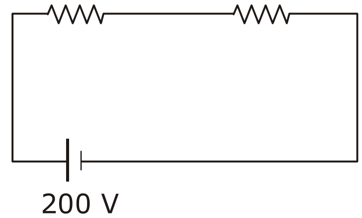


$R_B = \frac{(200)^2}{600}$

$R_{eq} = R_A + R_B, \; P = \frac{(200)^2}{\frac{(200)^2}{300} + \frac{(200)^2}{600}}$

63.[A]

$R_1 = \frac{(200)^2}{60}$ $\qquad R_2 = \frac{(200)^2}{100}$

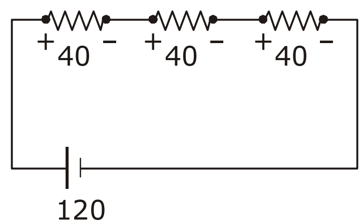


$P = \frac{(200)^2}{R_{eq}}$

$= \frac{(200)^2}{(200)^2\left[\frac{1}{60} + \frac{1}{100}\right]} = 37.5 \text{ W}$

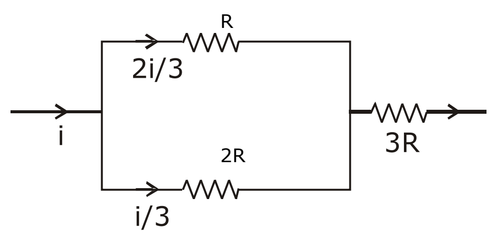
64. A

$R = (120)^2/60$



$P = \frac{(40)^2}{(120)^2} \times 60$, = 6.7 Watt

65. D



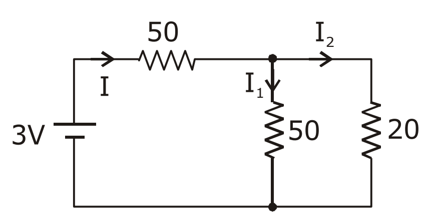
66. B

Given $\frac{(15)^2}{R} + \frac{(15)^2}{2} = 150$

$\Rightarrow \frac{1}{R} + \frac{1}{2} = \frac{10}{15}, \quad \frac{1}{R} = \frac{1}{6} \Rightarrow R = 6\Omega$

67. A

I^2R is maximum for R_1 resistance As $I > I_1$ & I_2



68. A

i = At B

at t = ΔT i = 0

$\Rightarrow$ 0 = AΔT + B

$\Rightarrow$ AΔT = –B

$$q = \int_0^{\Delta T} dq = \int_0^{\Delta T} (\Delta t - A\Delta T)\, dt$$

$$\Rightarrow q = \frac{A\Delta T^2}{2} - B\Delta T^2$$

$$\Rightarrow q = -\frac{A\Delta T^2}{2} \Rightarrow A = \frac{-2q}{\Delta T^2}$$

$$\text{Heat} = \int_0^{\Delta T} i^2 R.dt = \int_0^{\Delta T} \left(\frac{-2qt}{\Delta T^2} + \frac{2q}{\Delta T}\right)^2 Rdt$$

$$= \frac{4q^2}{\Delta T^2} \int_0^{\Delta T} \left(1 - \frac{t}{\Delta T}\right)^2 .R.dt$$

$$= \frac{4q^2}{\Delta T^2} \left[\Delta T + \frac{(\Delta T)^3}{3(\Delta T)^2} - \frac{2(\Delta T)^2}{2\Delta T}\right] R = \frac{4q^2 R}{3\Delta T}$$

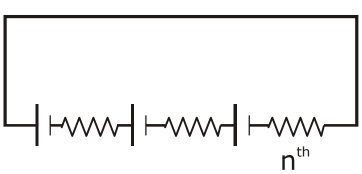
69. B

P = V.I $\quad V \propto I^2$

70. B

As R_{eq} decreases I_{net} increases hence current through X increases but as I_{net} will now be distributed in Y & Z, current in Y decreases.

71. D

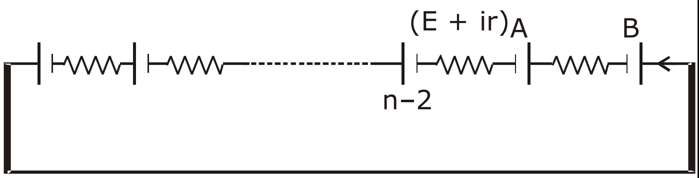


$$i = \frac{nE}{nr} = \frac{E}{r}$$

Independent of n

72. A $i = \dfrac{E}{r/n} = \dfrac{nE}{r}$

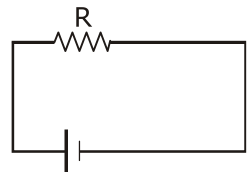
73. D

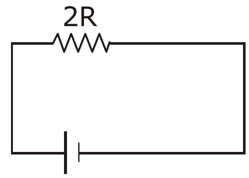


E^n_{eq} = (n – 4) . E $\quad r^n_{eq}$ = nr

$$i = \frac{(n-4)E}{nr} \qquad \left[E + \frac{(n-4)E}{nr}.r\right] = 2E\left(1 - \frac{2}{n}\right)$$

74. B





$L \longrightarrow R$

$2L \longrightarrow 2R$

$\Delta Q' = 2\Delta Q$

to raise ΔT temperature in same time t.

$I'^2 R'\Delta t = 2I^2 R\Delta T$

$I'^2 (2R)\, \Delta T = 2I^2 R\Delta T$

$\Rightarrow$ I' = I

$$\frac{nE}{2R} = \frac{3E}{R} \Rightarrow n = 6$$

75. D

From Maximum Power Transfer Theorem

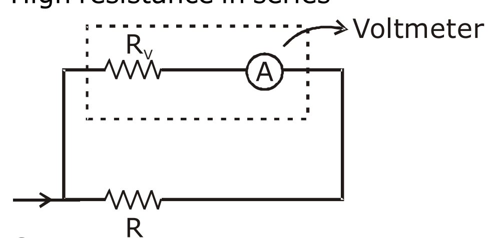
y_{max} = R + 2Ω

$\Rightarrow$ 5Ω = R + 2Ω

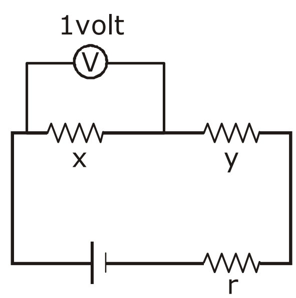
$\Rightarrow$ R = 3Ω

76. C

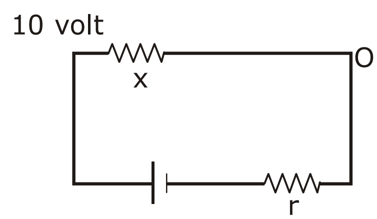
High resistance in series



77. C



$$\frac{E}{r + x + y} = 1 \;...(1)$$



$E - \frac{Er}{x+r} = 10$ volt

$\frac{Ex}{x+r} = 10$ volt ...(2)

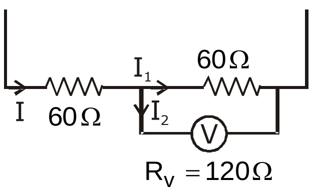
$\frac{E.x}{r+x+y} = 1$ volt ...(3)

$\Rightarrow x = 1\Omega$

$\frac{12+1}{1+r} = 10$

$\Rightarrow r = 0.2\Omega$

78. A



Net current

$I = \frac{120}{60+40} = 1.2A$

$I_1 : I_2 = \frac{1}{60} : \frac{1}{120}$

$= 2 : 1$

$I_1 = \frac{2}{3} \times 1.2 = 0.8$ Amp.

hence Reading V = 0.8 × 60 = 48 V

79. D

$\frac{i}{2} R_g = \frac{i}{2}$ (20) $\Rightarrow R_g = 20$

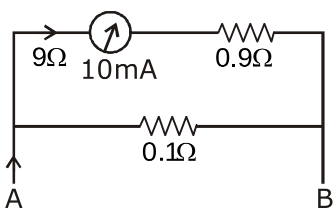
80. B

$i_g = \frac{0.2}{20} = 0.01$ Ampere

$i = i_g\left(1+\frac{r_2}{R}\right) \Rightarrow 10 = 0.01\left(1+\frac{20}{R}\right)$

$R \simeq 0.02$

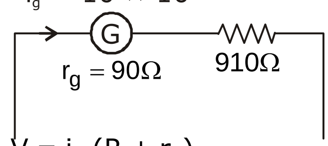
81. C



$10 \times 10^{-3} = \frac{0.1}{10} \times i \Rightarrow$ i = 1 Ampere

82. C

$i_g = 10 \times 10^{-3}$



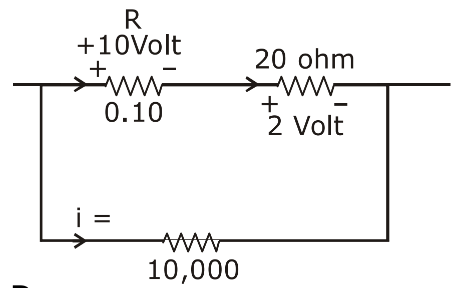
$V = i_g (R + r_g)$

$V = 10^{-2}$ (1000)

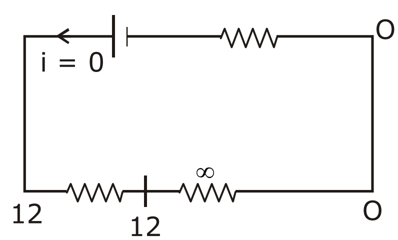
= 10 Volt

$n = \frac{10}{0.1} = 100$

83. D



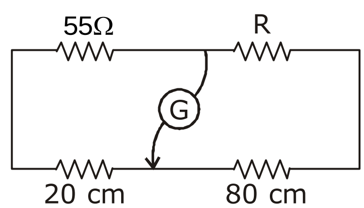
84. D



85. B

Voltmeter must be connected in parallel and Ammeter in series with the resistance in circuit.

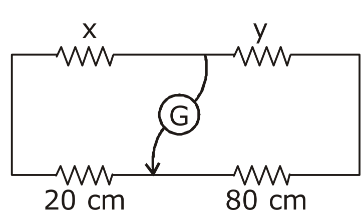
86. A



$\Rightarrow$ R (20) = 55 (80)

R = 220 Ω

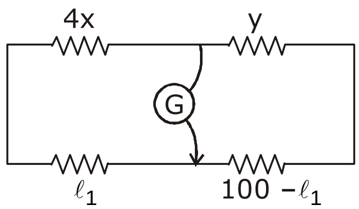
87. A



x(80) = y(20)

4x = y

when 4x & y



$4x(100 - \ell_1) = y\,\ell_1$

$\ell_1 = \frac{100}{2} = 50$ cm

88. A

$R_1 \times 60 = R_2 \times 40$ ....(1)

$R_1 \times 50 = \frac{R_2 \times 10}{R_2 + 10} \times 50$ ....(2)

89. A

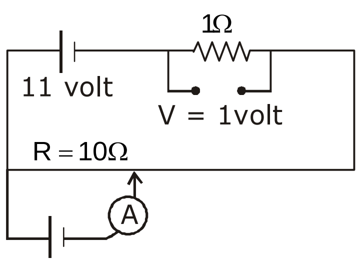
Potential gradient $x = \frac{6}{1}$

$6\ell = 4 \Rightarrow \ell = \frac{2}{3}$ m

90. B

$12 \times (100 - x) = 18 + x$
$1200 - 12x = 18x$
$30x = 1200$
$x = 40$ cm
$12 \times (100 - x) = 8x$
$1200 - 12x = 8x$
$\Rightarrow x = 60$cm

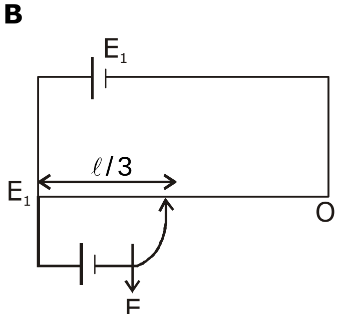
91.B



$I = \frac{11}{10+1} = 1$ Amp

$x = \frac{11-1}{10} = \frac{1\,\text{volt}}{\text{m}}$

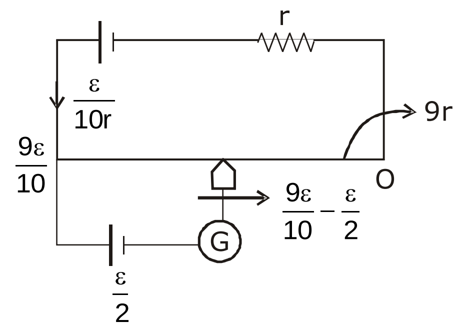
92. B



$E_1 = 3E$
$1.5\ell \to 3E$

$E \to \frac{\ell}{2}$

93. B

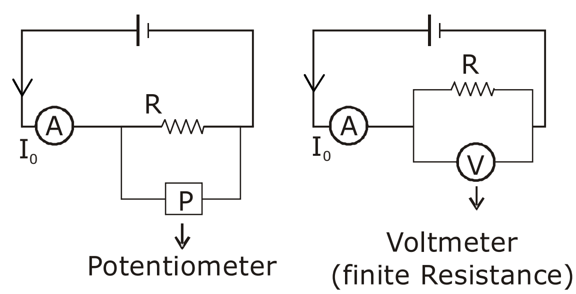


$L \to \frac{9\varepsilon}{10}$

$I \to \frac{10L}{9\varepsilon}$

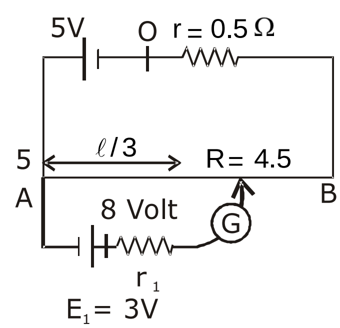
$\Rightarrow \frac{\varepsilon}{2} \to \frac{5L}{9}$

94. A



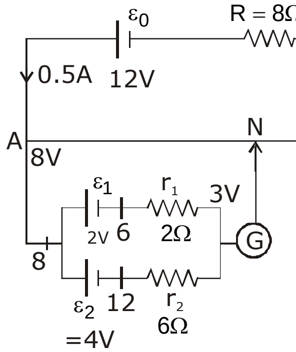
In case of voltmeter $R_{eq} < R$ hence
$I > I_0$
As voltmeter always take some current from the circuit $V < V_0$

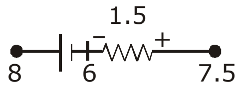
95. D



As Battery is connected in reverse order E_1 will not be balanced on entire length of wire AB.

96. C





$8 \rightarrow 4$m

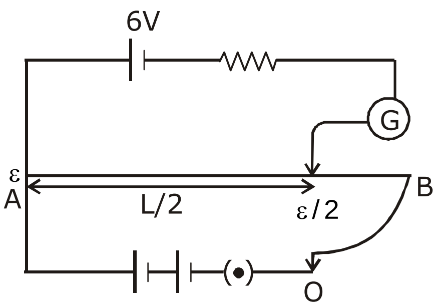
1m $\rightarrow$ 2 Volt

1 Volt $\rightarrow$ 0.5 m

0.5 volt $\rightarrow$ 25 cm

97. B

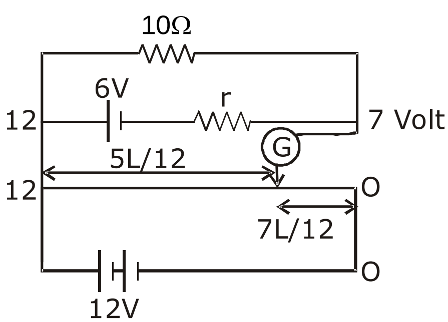
S_2 is open



$\frac{\varepsilon}{2} = 6V \quad \varepsilon = 12V$

$\ell \rightarrow 12V$

$\frac{7\ell}{12} \rightarrow 7$ volt



6 – ir = 5

$6 - \frac{6}{10+r} r = 5$

$\Rightarrow$ 6r = 10 + r $\Rightarrow$ r = 2Ω

98. S-1 $E = \frac{V}{\ell} = \frac{iR}{\ell}$

and $R = \frac{\rho\ell}{A}$.

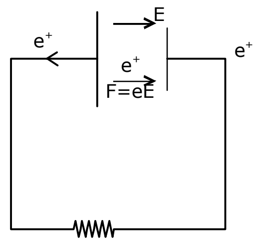
S–2 in series, current is same.

99. V = E-ir discharging

V = E + ir charging

100. $H = i^2Rt \Rightarrow T\uparrow \ R\uparrow$

101.



Work done = –ve

102. $T\uparrow \rho\uparrow$

$\sigma = \frac{1}{\rho}\downarrow$