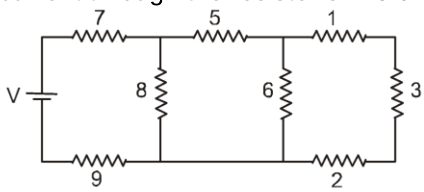
Self Practice Paper (SPP)

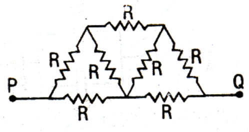
1. Two non-ideal batteries are connected in parallel. Consider the following statements. **[RPMT 2008]**
(i) The equivalent emf is smaller than either of the two emfs.
(ii) The equivalent internal resistane is smaller than either of the two internal resistances.
(1) Both (i) and (ii) are correct (2) (i) correct but (ii) is wrong
(3) (ii) is correct but (i) is wrong (4) Both (i) and (ii) are wrong

2. In the ladder network shown, current through the resistor 3 Ω is 0.25 A. The input voltage 'V' is equal to



(1) 10 V (2) 20 V (3) 5 V (4) $\frac{15}{2}$ V

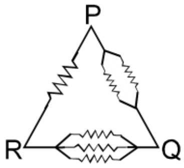
3. In the network shown in figure each resistance is 1 ohm. The effective resistance between P and Q is



(1) $\frac{4}{3}\Omega$ (2) $\frac{3}{2}\Omega$ (3) 7Ω (4) $\frac{8}{7}\Omega$

4. 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 Δ T 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:
[JEE(Scr.) _2001,3/105]
(1) 4 (2) 6 (3) 8 (4) 9

5. In the given circuit all resistors are of equal value then equivalent resistance will be maximum between the points.



(1) PR (2) PQ (3) RQ (4) same for all

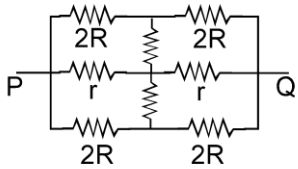
6. A resistance of 2 Ω is connected across one gap of a metre-bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2 Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is **[JEE' 2007_Paper-1, 3/81]**
(1) 3 Ω (2) 4 Ω (3) 5 Ω (4) 6 Ω

7. A silver wire of length 10 metre and cross-sectional area 10^{-8} m^2 is suspended vertically and a weight of 10 N is attached to it. Young's modulus of silver and its resistivity are 7×10^{10} N/m^2 and 1.59×10^{-8} Ω-m respectively. The increase in its resistance is equal to (keeping volume constant)
(1) 0.0455 Ω (2) 0.455 Ω (3) 0.91 Ω (4) 0.091 Ω

8. The potential difference applied to an X-ray tube is 5 kV and the current through it is 3.2 mA. Then the number of electrons striking the target per second is **[JEE(Scr.) - 2002,3/105]**
(1) 2×10^{16} (2) 5×10^{16} (3) 1×10^{17} (4) 4×10^{15}

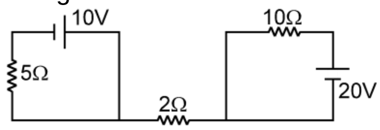
9. The effective resistance between points P and Q of the electrical circuit shown in the figure is:

[JEE(Scr.) - 2002, 3/105]



(1) $\frac{2Rr}{R+r}$ (2) $\frac{2R(R+r)}{3R+r}$ (3) $2r + 4R$ (4) $\frac{5R}{2} + 2r$

10. In the figure shown the current through 2Ω resistor is **[JEE (Scr.) - 2005, 3/84]**



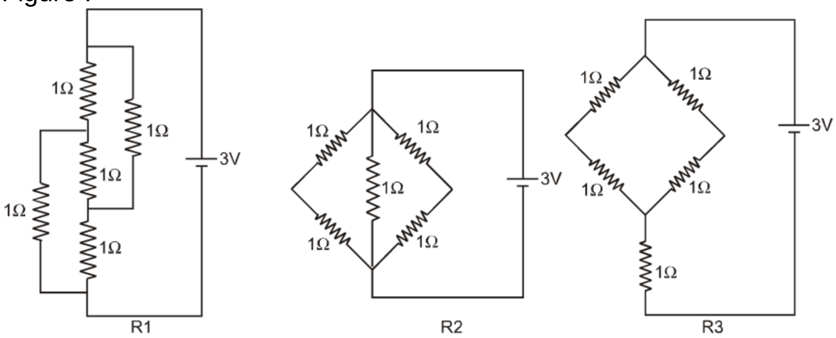
(1) 2A (2) 0 A (3) 4 A (4) 6A

11. A galvanometer has resistance 100Ω and it requires current 100μA for full scale deflection. A resistor 0.1Ω is connected in parallel to make it an ammeter. The smallest current required in the circuit to produce the full scale deflection is **[JEE (Scr.) - 2005, 3/84]**

(1) 1000.1 mA (2) 1.1 mA (3) 10.1 mA (4) 100.1 mA

12. Figure shows three resistor configurations R1, R2 and R3 connected to 3 V battery. If the power dissipated by the configuration R1, R2 and R3 is P1, P2 and P3, respectively, then

Figure : **[JEE' 2008_Paper-1, 3/163]**



(1) P1 > P2 > P3 (2) P1 > P3 > P2 (3) P2 > P1 > P3 (4) P3 > P2 > P1

13. **STATEMENT-1 :** In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

and **[JEE' 2008 Paper-1, 3/163]**

STATEMENT -2 : Resistance of a metal increases with increase in temperature.

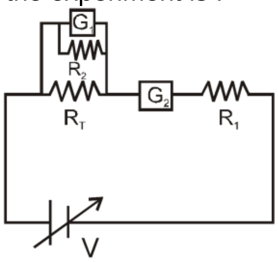
(1) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is a correct explanation for STATEMENT -1

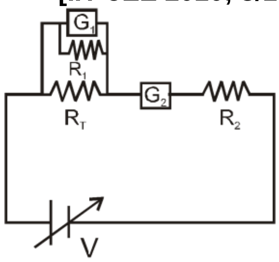
(2) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is NOT a correct explanation for STATEMENT -1

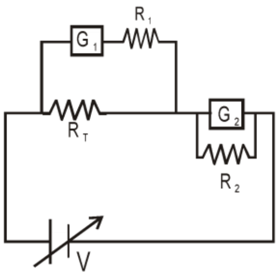
(3) STATEMENT -1 is True, STATEMENT -2 is False

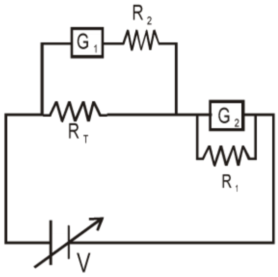
(4) STATEMENT -1 is False, STATEMENT -2 is True.

14. To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2, and a variable voltage source V. The correct circuit to carry out the experiment is : **[IIT-JEE 2010; 3/163, –1]**

(1)


(2)


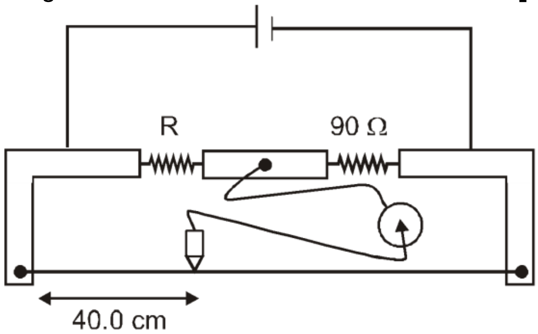
(3)


(4)


15. A galvanometer gives full scale deflection with 0.006 A current. By connecting it to a 4990Ω resistance, it can be converted into a voltmeter of range 0-30 V. If connected to a $\frac{2n}{249}\Omega$ resistance, it becomes an ammeter of range 0-1.5 A. The value of n is: **[JEE (Advanced)-2014,P-1, 3/60]**

(1) 5 (2) 15 (3) 8 (4) 10

16. During an experiment with a metre bridge, the galvanometer shows a null point when the joceky 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 meter bridge is 1 mm. The unknown resistance is :**[JEE (Advanced)-2014, 3/60, –1]**



(1) $60 \pm 0.15\Omega$ (2) $135 \pm 0.56\Omega$ (3) $60 \pm 0.25\Omega$ (4) $135 \pm 0.23\Omega$

17. The thermo-emf of a thermocouple is 25μ V/°C at room temperature. A galvanometer of 40 Ω resistance, capable of detecting Current as low as 10^{-5} A, is connected with the thermocouple. The smallest temperature difference that can be detected by this system is **[RPMT 2008]**

(1) 16°C (2) 12°C (3) 8°C ` (4) 20°C

SPP Answers

1.	(3)	**2.**	(2)	**3.**	(4)	**4.**	(2)	**5.**	(1)	**6.**	(1)	**7.**	(2)
8.	(1)	**9.**	(1)	**10.**	(2)	**11.**	(4)	**12.**	(3)	**13.**	(4)	**14.**	(3)
15.	(1)	**16.**	(3)	**17.**	(1)								

SPP Solutions

1. Let emf of both cells are E_1 and E_2 and internal resistances are r_1 and r_2. In parallel order, we have

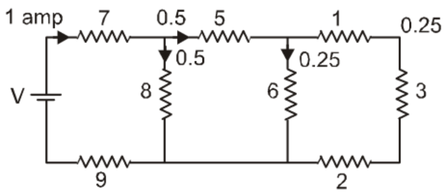
$E = E_1 = E_2$

Effective internal resistance of both cells

$$\frac{1}{R} = \frac{1}{r} + \frac{1}{r}$$

$\Rightarrow$ $R = \frac{r}{2}$

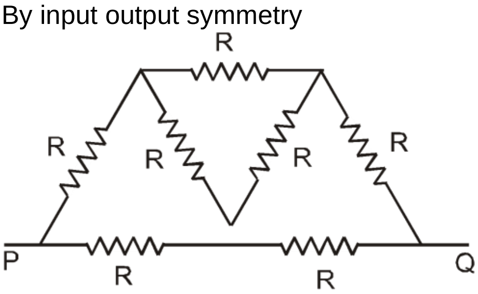
So, emf is equal to the emf of any of the cell and internal resistance is less than the resistance of any of cell.
Hence, (ii) is right and (i) is wrong.



2. $R_{eq} = 7 + 4 + 9 = 20\Omega$

$V = IR_{eq} = 1 \times 20 = 20$ V

3. By input output symmetry



$R_{PQ} = \frac{8}{7}\Omega$

4. In the first case $\frac{(3E)^2}{R} . t = ms\,\Delta T$ .... (1) $\left[H = \frac{V^2}{R}.t\right]$

When length of the wire is doubled, resistance and mass both are doubled.

Therefore, in the second case, $\frac{(NE)^2}{2R} .t = (2m)_2\,\Delta T$ .... (2)

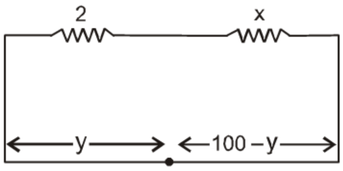
Dividing (2) by (1) , we get

$\frac{N^2}{18} = 2$ or $N_2 = 36$ or $N = 6$

5. $R_{PQ} = \frac{5}{11}r$, $R_{QR} = \frac{4}{11}r$ and $R_{PR} = \frac{3}{11}r$

$\therefore$ RPQ is maximum .

6.



$2(100 - y) = xy$
Also $(100 - y) - y = 20$
on solving $y = 40$ cm, $x = 3\ \Omega$

7. $Y = \dfrac{F \times \ell}{A \times x}$

$7 \times 10^{10} = \dfrac{10 \times 10}{10^{-8} \times x}$

$\Rightarrow \quad x = \dfrac{10^{10}}{7 \times 10^{10}} = \dfrac{1}{7}$ m

By volume conservation $A_1 \ell_1 = A_2 \ell_2$

$10 \times 10^{-8} = \left(10 + \dfrac{1}{7}\right) A$

$\Delta R = R - R_0 = \dfrac{\rho \ell_2}{A_2} - \dfrac{\rho \ell_1}{A_1}$

$\Delta R = \dfrac{\rho(10 + x)\left(10 + \dfrac{1}{7}\right)}{10 \times 10^{-8}} - \dfrac{\rho \times 10}{10^{-8}}$

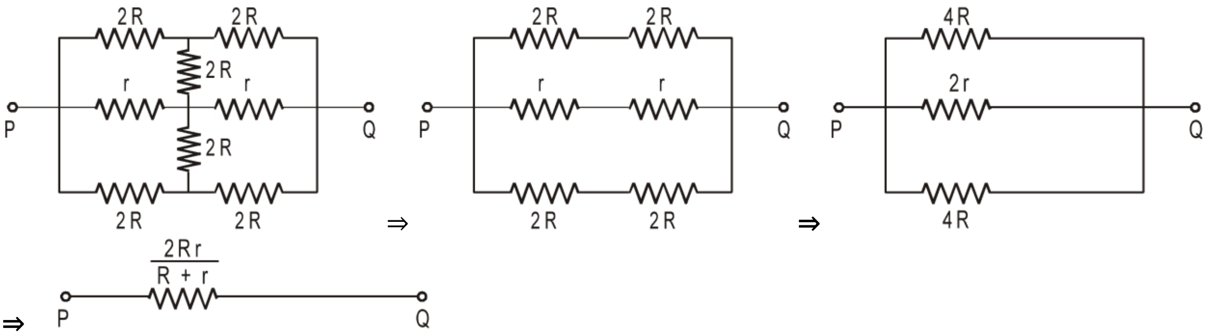
$\Delta R = \dfrac{1.59 \times 10^{-8} \times 10}{10^{-8}} \left\{\left(1 + \dfrac{1}{70}\right)^2 - 1\right\}$

$= 15.9 \times \dfrac{2}{70} = 0.454\ \Omega$

8. $i = \dfrac{q}{t} = \dfrac{ne}{t} \quad \therefore \quad n = \dfrac{it}{e}$

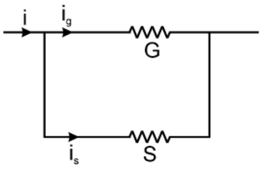
substituting $i = 3.2 \times 10^{-3}$ A
$e = 1.6 \times 10^{-19}$ C and $t = 1$ s
we get $n = 2 \times 10^{16}$

9. The circuit can be redrawn as follows :



10. From kirchoff's junction law, current in 2Ω is zero, because 2Ω resistance is not a part of closed circuit.

11.



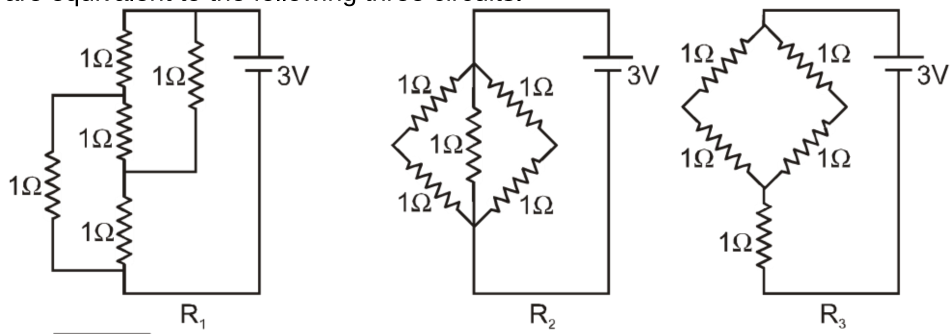
$i = i_g + i_s$ ....(1)

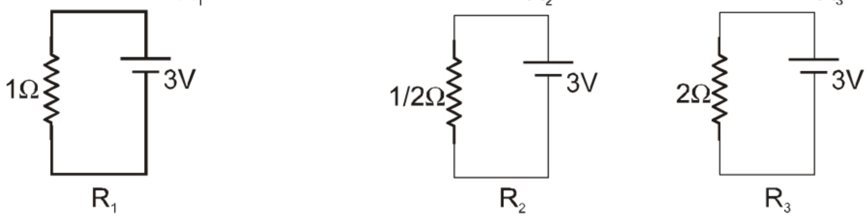
$i_g G = i_s S$ ....(2)

from (1) & (2) (putting $i_g = 0.1$ mA, G = 100Ω) we have

i = 100.1 mA

12. The given three circuits R1, R2 and R3
are equivalent to the following three circuits.





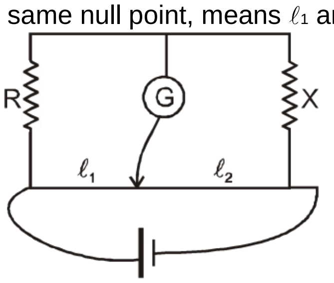
$P_1 = \frac{3^2}{1} = 9$ W $\quad P_2 = \frac{3^2}{1/2} = 18$ W $\quad P_3 = \frac{3^2}{2} = 4.5$ W

$P_2 > P_1 > P_3$

13. $R\ell_2 = \ell_1 X$

$$X = \frac{\ell_2 R}{\ell_1}$$

To keep same null point, means ℓ_1 and ℓ_2 are same. As



temperature increases value of unknown resistance increases. To get same null point, R must be increased.
So statement 1 is wrong.
Statement-2 is true.

14. To verify Ohm's law one galvaometer is used as ammeter and other galvanometer is used as voltameter. Voltameter should have high resistance and ammeter should have low resistance as voltameter is used in parallel and ammeter in series that is in option (C).

15. $\frac{6}{1000}(G + 4990) = 30$

$\Rightarrow G + 4990 = \frac{30,000}{6} = 5000$

$\Rightarrow G = 10$

$\frac{6}{1000} \times 10 = \left(1.5 - \frac{6}{1000}\right)S$

$\Rightarrow S = \frac{60}{1494} = \frac{2n}{249}$

$\Rightarrow n = \frac{249 \times 30}{1494} = \frac{2490}{498} = 5$

16. For balanced 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 $X = (60 \pm 0.25)\ \Omega$

17. Thermo-emf of thermocouple = 25 μV/°C. Let θ be the smallest temperature difference.

Therefore, after connecting the thermocouple with the galvanometer, thermo-emf

$E = (25\mu\ V/°C) \times (°C)$

$= 25\ \theta \times 10^{-6}\ V$

potential drop developed across the galvanometer

$= iR = 10^{-5} \times 40 = 4 \times 10^{-4}\ V$

$\therefore \quad 4 \times 10^{-4} = 25\theta \times 10^{-6}$

$\therefore \quad \theta = \frac{4}{25} \times 10^{2} = 16°C$