EXERCISE 8(B)

Question: 1

Solution:

e.m.f : When the cell is in open circuit, the potential difference between the terminals of the cell is called its electro-motive force or e.m.f

Terminal voltage: When the cell is in closed circuit, the potential difference between the electrodes of the cell is known as terminal voltage.

Internal resistance: The resistance offered by the electrolyte inside the cell, to the flow of current, is known as the internal resistance of the cell.

Solution:

e.m.f of cell	Terminal voltage of cell
1. It is the characteristic of the cell, i.e., it does not depend on the amount of current drawn from the cell	1. It depends on the amount of current drawn from the cell. More the current drawn from the cell, less is the terminal voltage
2. It is equal to the terminal voltage when the cell is not in use, while greater than the terminal voltage when cell is in use	2. It is equal to the e.m.f. of cell when cell is not in use, while less than the e.m.f. when cell is in use.

Solution:

The factors on which the internal resistance of a cell depends are:

(i) The surface area of the electrodes - larger the surface area of electrodes, less is the internal resistance.

(ii) The distance between the electrodes – more the distance between the electrodes, greater is the internal resistance.

Solution:

(a) The total resistance of circuit = R + r
(b) The current drawn from the cell
We know that,

$\varepsilon = V + v$
$= IR + Ir$
$= I (R + r)$
$I = \varepsilon / (R + r)$

(c) p.d. across the cell: $[\varepsilon / (R + r)] \times R$
(d) voltage drop inside the cell: $[\varepsilon / (R + r)] \times r$

Solution:
(a) When current is drawn from a cell, its terminal voltage V is less than its e.m.f.
∴ Terminal voltage < e.m.f.
(b) When no current is drawn, then the e.m.f. is equal to the terminal voltage.

Question: 6
Explain why the p.d. across the terminals of a cell is more in an open circuit and reduced in a closed circuit.
Solution:
The current flows through the circuit when the electric cell is in a closed circuit. There is a fall of potential across the internal resistance of the cell. Hence, the p.d. across the terminals in a closed circuit is less than the p.d. across the terminals in an open circuit by an amount equal to the potential drop across the internal resistance of the cell.

Question: 7
Write the expressions for the equivalent resistance R of three resistors R_1, R_2 and R_3 joined in (a) parallel, (b) series.
Solution:
(a) Total resistance in parallel is given by

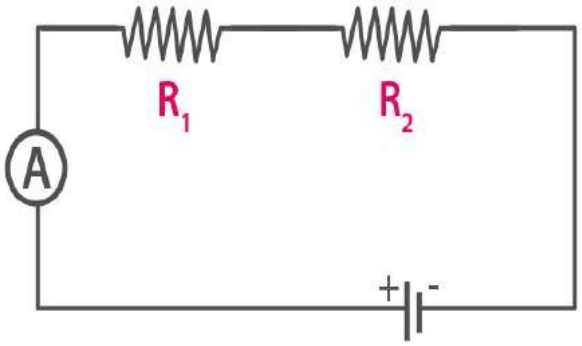
$$1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3$$

(b) Total resistance in series is given by

$$R = R_1 + R_2 + R_3$$

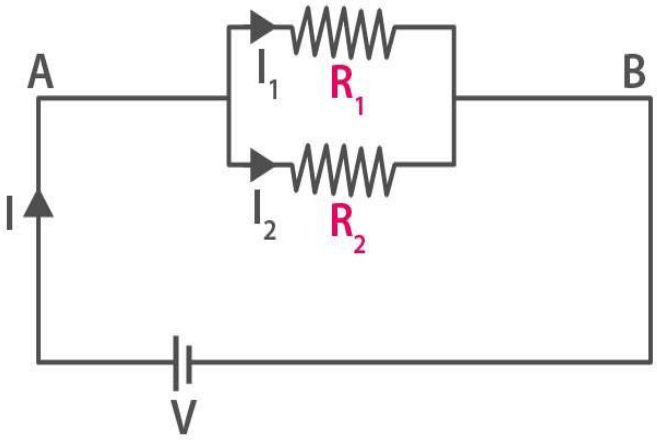
Question: 8
How would you connect two resistors in series? Draw a diagram. Calculate the total

equivalent resistance.
Solution:



If current I is drawn from the battery, the current will also be I through each resistor.
Applying Ohm's law to the two resistors separately, we get,
$V_1 = IR_1$
$V_2 = IR_2$
$V = V_1 + V_2$
$IR = IR_1 + IR_2$
$R = R_1 + R_2$
Thus total resistance in series is
$R = R_1 + R_2 + R_3$

Question: 9
Show by a diagram how two resistors R_1 and R_2 are joined in parallel. Obtain an expression for the total resistance of the combination.
Solution:



Applying Ohm's law separately to the two resistors, we have

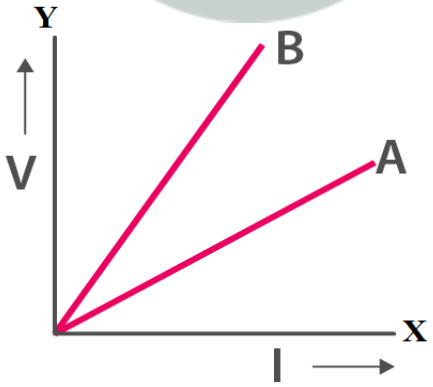
$I_1 = V / R_1$

$I_2 = V / R_2$
$I = I_1 + I_2$

$V / R = V / R_1 + V / R_2$
$1 / R = 1 / R_1 + 1 / R_2$

Question: 10
State how are the two resistors joined with a battery in each of the following cases when:
(a) same current flows in each resistor
(b) potential difference is same across each resistor.
(c) equivalent resistance is less than either of the two resistances.
(d) equivalent resistance is more than either of the two resistances.
Solution:
(a) The two resistors are in series
(b) The two resistors are in parallel
(c) The two resistors are in parallel
(d) The two resistors are in series

Question: 11
The V-I graph for a series combination and for a parallel combination of two resistors is shown in fig. Which of the two, A or B, represents the parallel combination? Give a reason for your answer.



Solution:
Change in V is less for the straight line A than for the straight line B (which means the straight line A is less steeper than B). Hence, the straight line A represents small resistance and the straight line B represents more resistance. The resistance decreases in parallel combination while the resistance increases in series combination. Thus the straight line A represents the parallel combination.

MULTIPLE CHOICE TYPE

Question: 1

In series combination of resistances:

(a) P.d. is same across each resistance

(b) Total resistance is reduced

(c) Current is same in each resistance

(d) All of the above are true

Solution:

Current is same in each resistance in series combination of resistances.

Question: 2

In parallel combination of resistances:

(a) P.D. is same across each resistance

(b) Total resistance is increased

(c) Current is same in each resistance

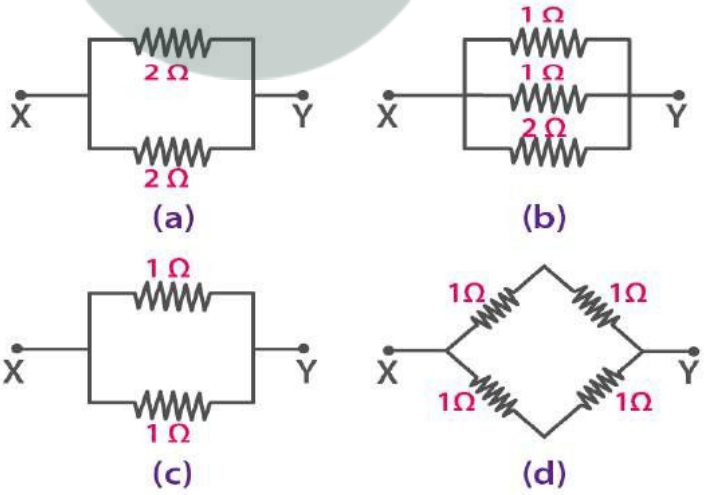
(d) All of the above are true

Solution:

P.D is same across each resistance in parallel combination of resistances

Question: 3

Which of the following combinations have the same equivalent resistance between X and Y?



Solution:

The resistors are connected in parallel in figure (a) between X and Y

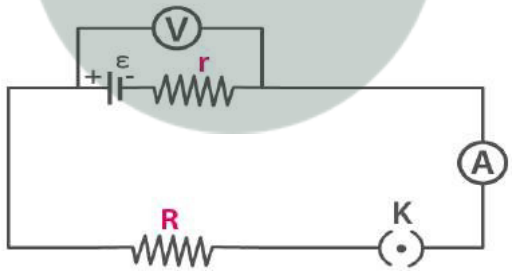
Let R' be their equivalent resistance

Now, 1 / R' = 1 / 2 + 1 / 2

= 2 / 2 ohm or

R’ = 1 ohm [1]
A series combination of two 1 ohm resistors is in parallel with another series combination of two 1 ohm resistors in figure (d)
Series resistance of two 1 ohm resistors,
R = (1 + 1) ohm
R = 2 ohm
Therefore we can say that 2 ohm resistors are connected in parallel across X and Y
Let R’ be the net resistance across X and Y.
Then, 1 / R’ = 1 / 2 + 1 / 2
1 / R’ = 2 / 2 ohm or
R’ = 1 ohm [2]
Thus it is clear from equation [1] and [2] that the figures (a) and (d) have the same equivalent resistance between X and Y

NUMERICALS
Question: 1
The diagram in figure shows a cell of e.m.f. ε = 2 volt and internal resistance r = 1 ohm connected to an external resistance R = 4 ohm. The ammeter A measures the current in the circuit and the voltmeter V measures the terminal voltage across the cell. What will be the readings of the ammetere and voltmeter when (i) the key K is open, and (ii) the key K is closed

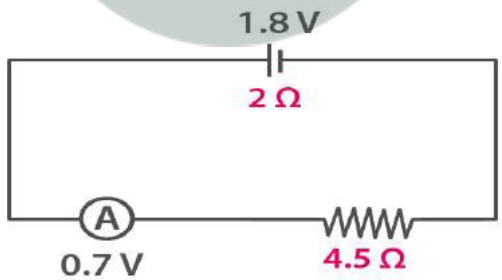


Solution:
(i) Because of no current, ammeter reading = 0
Voltage V = ε – Ir
V = 2 – 0 × 1
V = 2 volt
(ii) Ammeter reading
I = ε / (R + r)
I = 2 / (4 + 1)
I = 2 / 5
I = 0.4 amp
Voltage reading

Voltage V = ε – Ir
V = 2 – 0.4 × 1
V = 2 – 0.4
V = 1.6 V

Question: 2
A battery of e.m.f. 3.0 V supplies current through a circuit in which resistance can be changed. A high resistance voltmeter is connected across the battery. When the current is 1.5 A, the voltmeter reads 2.7 V. Find the internal resistance of the battery.
Solution:
Given
ε = 3 volt
I = 1.5 A
V = 2.7 V
V = ε – Ir
r = (e – V) / I
r = (3 – 2.7) / 1.5
r = 0.2 ohm

Question: 3
A cell of emf 1.8 V and internal resistance 2 ohm is connected in series with an ammeter of resistance 0.7 ohm and resistance of 4.5 ohm as shown in figure.



(a) What would be the reading of the ammeter?
(b) What is the potential difference across the terminals of the cell?
Solution:
(a) ε = 1.8 V
Total resistance = 2 + 4.5 + 0.7
= 7.2 W
I =?
I = ε / R (total resistance)
I = 1.8 / 7.2

I = 0.25 A
(b) Current I = 0.25 A [calculated in (a) part]
Now, excluding internal resistance total resistance = 4.5 + 0.7
= 5.2 ohm
V = IR
V = 0.25 × 5.2
V = 1.3 V

Question: 4
A battery of emf 15 V and internal resistance 3 ohm is connected to two resistors of resistances 3 ohm and 6 ohm in series. Find:
(a) the current through the battery
(b) the p.d. between the terminals of the battery.
Solution:
(a) ε = 15 V
R = 6 + 3
R = 9 ohm
r = 3 ohm
I =?
I = ε / (R + r)
I = 15 / (9 + 3)
I = 15 / 12
I = 1.25 A
(b) Current I = 1.25 A [calculated in part (a)]
External resistance R = 6 + 3
R = 9 ohm
V = IR
V = 1.25 × 9
V = 11.25 V

Question: 5
A cell of e.m.f. ε and internal resistance r sends current 1.0 A when it is connected to an external resistance 1.9 ohm. But its sends current 0.5 A when it is connected to an external resistance of 3.9 ohm. Calculate the values of e and r.
Solution:
In first case
I = 1 A, R = 1.9 ohm
ε = I (R + r)
= 1 (1.9 + r)

= 1.9 + r [1]
In second case
I = 0.5 A, R = 3.9 ohm
ε = I (R + r)
= 0.5 (3.9 + r)
= 1.95 + 0.5r [2]
From equation [1] and [2]
1.9 + r = 1.95 + 0.5r
r = 0.05 / 0.5
r = 0.1 ohm
Now, substituting the value of r
ε = 1.9 + r
ε = 1.9 + 0.1
ε = 2 V

Question: 6
Two resistors having resistance 4 ohm and 6 ohm are connected in parallel. Find their equivalent resistance.
Solution
Let the equivalent resistance of the 4 ohm and 6 ohm resistors connected in parallel be R'
Then, 1 / R' = 1 / 4 + 1 / 6
= (3 + 2) / 12
= 5 / 12 ohm or
R' = 12 / 5
R' = 2.4 ohm

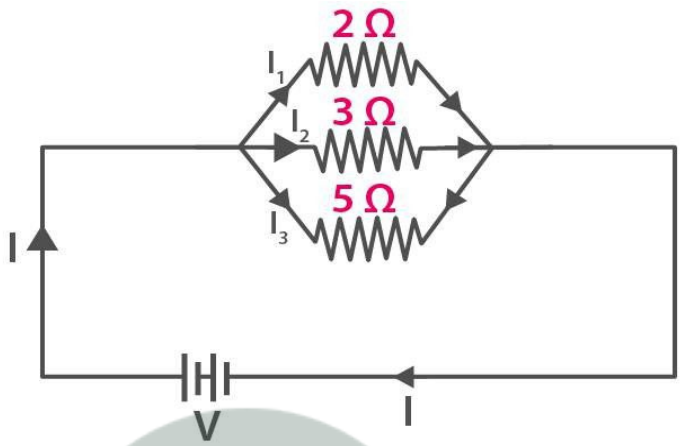
Question: 7
Four resistors each of resistance 2 ohm are connected in parallel. What is the effective resistance?
Solution:
R_1 = 2 ohm
R_2 = 2 ohm
R_3 = 2 ohm
R_4 = 2 ohm
$1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3 + 1 / R_4$
1 / R = 1 / 2 + 1 / 2 + 1 / 2 + 1 / 2
1 / R = 2
R = 0.5 ohm

Question: 8

You have three resistors of values 2 Ω, 3 Ω and 5 Ω. How will you join them so that the total resistance is less than 1 Ω? Draw diagram and find the total resistance.

Solution:

To get a total resistance less than 1 Ω, the three resistors should be connected in parallel



Let the total resistance be R'

Then, 1 / R' = 1 / 2 + 1 / 3 + 1 / 5

1 / R' = (15 + 10 + 6) / 30

1 / R' = 31 / 30 Ω or

R' = 30 / 31

R' = 0.97 Ω

Question: 9

Three resistors each of 2 W are connected together so that their total resistance is 3 W. Draw a diagram to show this arrangement and check it by calculation.

Solution:

A parallel combination of two resistors, in series with one resistor.

R_1 = 2 ohm

R_2 = 2 ohm

R_3 = 2 ohm

$1 / R' = 1 / R_1 + 1 / R_2$

1 / R' = 1 / 2 + 1 / 2

1 / R' = 1

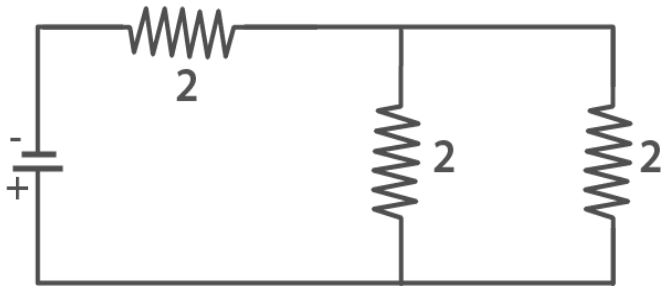
R' = 1 ohm

$R = R' + R_3$

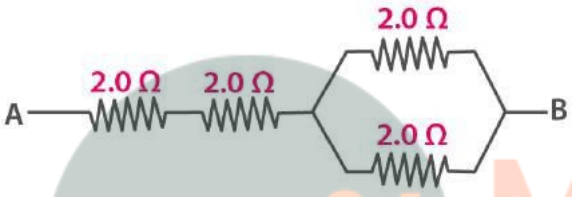
R = 1 + 2

R = 3 ohm

Diagram is shown below



Question: 10
Calculate the equivalent resistance between the points A and B in figure if each resistance is 2.0 Ω

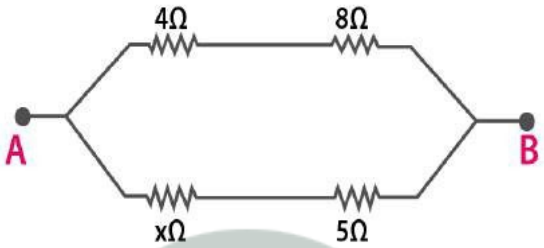


Solution:
For a parallel resistances
$R_{eff} = (R_1R_2) / (R_1 + R_2)$
$R_{eff} = (2 \times 2) / (2 + 2)$
$R_{eff} = 4 / 4$
$R_{eff} = 1\ \Omega$
Hence, total resistance = 2 + 2 + 1
= 5 Ω

Question: 11
A combination consists of three resistors in series. Four similar sets are connected in parallel. If the resistance of each resistor is 2 ohm, find the resistance of the combination.
Solution:
Resistance of each set:
$r_1 = 2 + 2 + 2 = 6$ ohm
$r_2 = 2 + 2 + 2 = 6$ ohm
$r_3 = 2 + 2 + 2 = 6$ ohm
$r_4 = 2 + 2 + 2 = 6$ ohm
Now, the above resistances are arranged in parallel

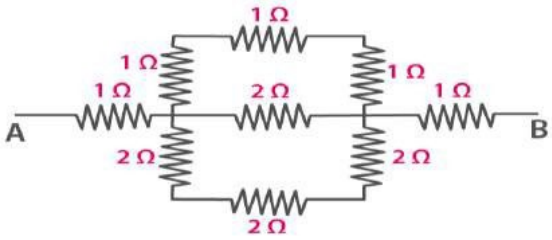
$1 / r = 1 / r_1 + 1 / r_2 + 1 / r_3 + 1 / r_4$
$1 / r = 1 / 6 + 1 / 6 + 1 / 6 + 1 / 6$
$1 / r = 4 / 6$
$r = 6 / 4$
$r = 1.5$ ohm

Question: 12
In the circuit shown below in figure, calculate the value of x if the equivalent resistance between the points A and B is 4 ohm

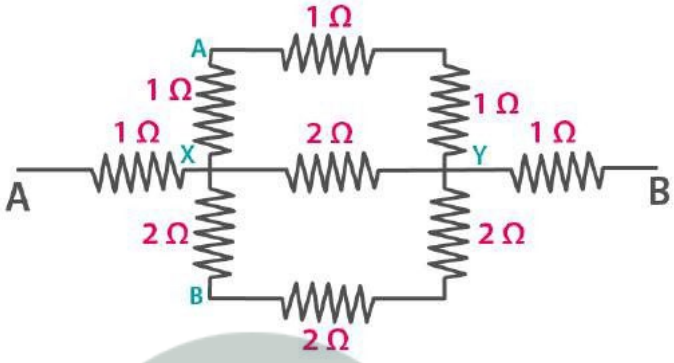


Solution:
$r_1 = 4$ ohm
$r_2 = 8$ ohm
$r_3 = x$ ohm
$r_4 = 5$ ohm
$r = 4$ ohm
$r' = r_1 + r_2$
$r' = 4 + 8$
$r' = 12$ ohm
$r'' = r_3 + r_4$
$r'' = (x + 5)$ ohm
$1 / r = 1 / r' + 1 / r''$
$1 / 4 = 1 / 12 + 1 / (5 + x)$
$1 / 4 – 1 / 12 = 1 / (5 + x)$
$(3 – 1) / 12 = 1 / (5 + x)$
$2 / 12 = 1 / (5 + x)$
$1 / 6 = 1 / (5 + x)$
$x = 1$ ohm

Question: 13
Calculate the effective resistance between the points A and B in the circuit shown in figure



Solution:

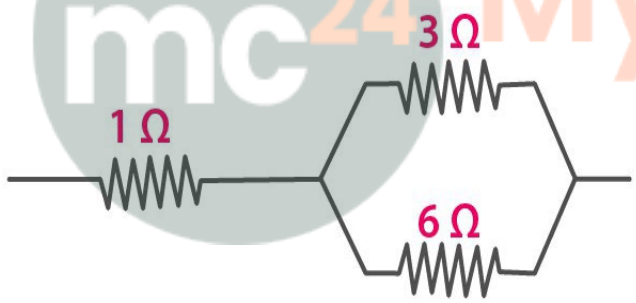


In above figure,
Resistance between XAY = (1 + 1 + 1)
= 3 ohm
Resistance between XY = 2 ohm
Resistance between XBY = 6 ohm
Let the net resistance between the points X and Y be R'
Then, 1 / R' = 1 / 2 + 1 / 3 + 1 / 6
1 / R' = (3 + 2 + 1) / 6
1 / R' = 6 / 6
1 / R' = 1 ohm or
R' = 1 ohm
Therefore, we can say that three 1 ohm resistors are connected in series between points A and B
Let the net resistance between points A and B be R_{AB}
Then, R_{AB} = (1 + 1 + 1) ohm
R_{AB} = 3 ohm

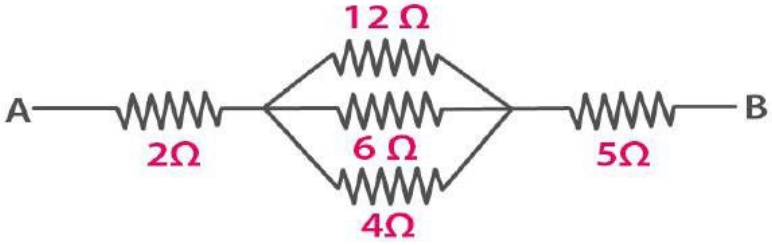
Question: 14
A uniform wire with a resistance of 27 ohm is divided into three equal pieces and then they are joined in parallel. Find the equivalent resistance of the parallel combination.
Solution:
Since the wire is divided into three pieces, the new resistance = 27 / 3 = 9

Now, three resistance are joined in parallel
$1 / r = 1 / r_1 + 1 / r_2 + 1 / r_3$
$1 / r = 1 / 9 + 1 / 9 + 1 / 9$
$1 / r = 3 / 9$
$1 / r = 1 / 3$
$r = 3$ ohm

Question: 15
A circuit consists of a 1 ohm resistor in series with a parallel arrangement of 6 ohm and 3 ohm resistors. Calculate the total resistance of the circuit. Draw a diagram of the arrangement.
Solution:
$1 / r = 1 / 6 + 1 / 3$
$1 / r = 1 / 2$
$r = 2$ ohm
$R = 2 + 1$
$R = 3$ ohm
Diagram



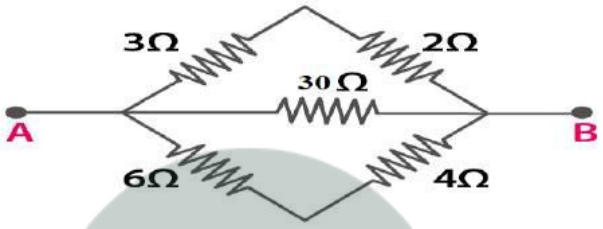
Question: 16
Calculate the effective resistance between the points A and B in the network shown below in figure.



Solution:
For parallel resistance

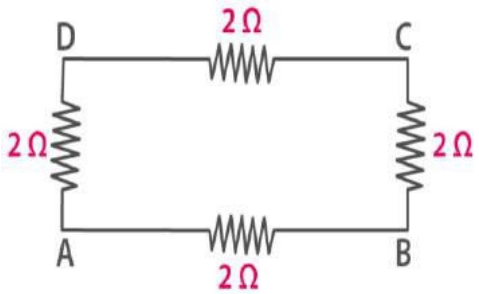
1 / R = 1 / 12 + 1 / 6 + 1 / 4
1 / R = (1 + 2 + 3) / 12
1 / R = 6 / 12
R = 12 / 6
R = 2 ohm
Now, all the resistances are in series
R = 2 + 2 + 5
R = 9 ohm

Question: 17
Calculate the equivalent resistance between the points A and B in figure



Solution:
Given
$R_1 = 3 + 2 = 5$ ohm
$R_2 = 30$ W
$R_3 = 6 + 4 = 10$ ohm
The resistors R_1, R_2 and R_3 are connected in parallel
$1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3$
1 / R = 1 / 5 + 1 / 30 + 1 / 10
1 / R = (6 + 1 + 3) / 30
1 / R = 10 / 30
1 / R = 1 / 3
R = 3 ohm

Question: 18
In the network shown in adjacent figure, calculate the equivalent resistance between the points (a) A and B (b) A and C



Solution:

(a) $R_1 = 2 + 2 + 2$

$R_1 = 6$ ohm

$R_2 = 2$ ohm

R_1 and R_2 are connected in parallel

$1 / R = 1 / R_1 + 1 / R_2$

$1 / R = 1 / 6 + 1 / 2$

$1 / R = (1 + 3) / 6$

$1 / R = 4 / 6$

$R = 6 / 4$

$R = 1.5$ ohm

(b) $R_1 = 2 + 2$

$R_1 = 4$ ohm

$R_2 = 2 + 2$

$R_2 = 4$ ohm

The resistors R_1 and R_2 are connected in parallel

$1 / R = 1 / R_1 + 1 / R_2$

$1 / R = 1 / 4 + 1 / 4$

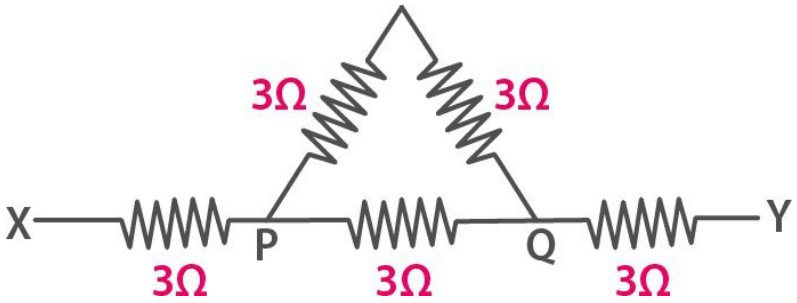
$1 / R = 2 / 4$

$1 / R = 1 / 2$

$R = 2$ ohm

Question: 19

Five resistors, each of 3 ohm, are connected as shown in figure. Calculate the resistance (a) between the points P and Q, and (b) between the points X and Y.



Solution:

(a) $R_1 = 3 + 3$

$R_1 = 6$ ohm

$R_2 = 3$ ohm

R_1 and R_2 are connected in parallel

$1 / R = 1 / R_1 + 1 / R_2$

$1 / R = 1 / 6 + 1 / 3$

$1 / R = (1 + 2) / 6$

$1 / R = 3 / 6$

$1 / R = 1 / 2$

$R = 2$ ohm

(b) We know that $R = 2$ ohm from the above calculation

$R_3 = 3$ ohm

$R_4 = 3$ ohm

$R' = R + R_3 + R_4$

$R' = 2 + 3 + 3$

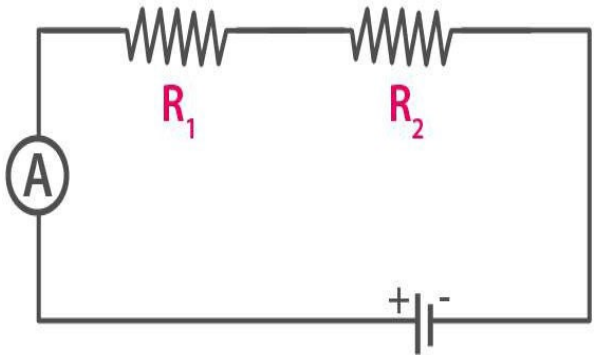
$R' = 8$ ohm

Question: 20

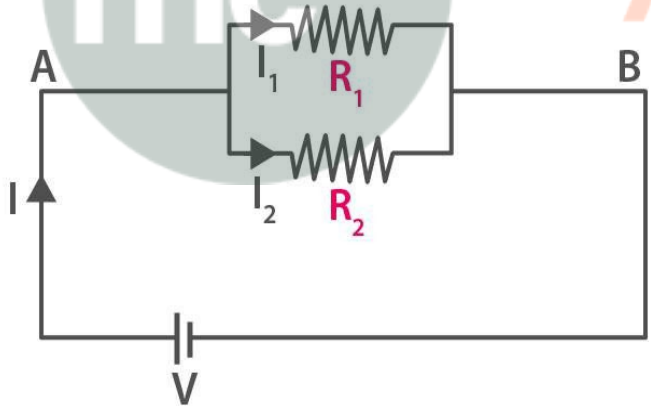
Two resistors of 2 ohm and 3 ohm are connected (a) in series, (b) in parallel, with a battery of 6.0 V and negligible internal resistance. For each case draw a circuit diagram and calculate the current through the battery.

Solution:

(a)



$R_1 = 2$ ohm
$R_2 = 3$ ohm
$R = R_1 + R_2$
$R = 2 + 3$
$R = 5$ ohm
$V = 6$ V
Now, $I = V / R$
$I = 6 / 5$
$I = 1.2$ ohm
(b)

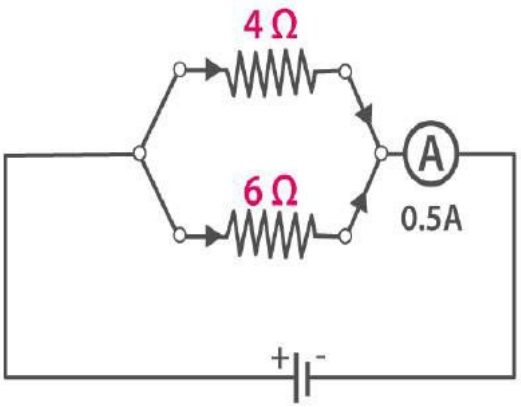


Here, R_1 and R_2 are connected in parallel
$1 / R = 1 / R_1 + 1 / R_2$
$1 / R = 1 / 2 + 1 / 3$
$1 / R = (3 + 2) / 6$
$1 / R = 5 / 6$
$R = 6 / 5$
$R = 1.2$ ohm
$V = 6$ V
We know that,

I = V / R
I = 6 / 1.2
I = 5 A
Therefore in series: 1.2 A and in parallel: 5 A

Question: 21
A resistor of 6 ohm is connected in series with another resistor of 4 ohm. A potential difference of 20 V is applied across the combination. (a) Calculate the current in the circuit and (b) potential difference across the 6 ohm resistor.
Solution:
(a) To calculate current in the circuit
R_1 = 6 ohm
R_2 = 4 ohm
$R = R_1 + R_2$
R = 6 + 4
R = 10 ohm
V = 20 V
I = V / R
I = 20 / 10
I = 2 A
(b) To calculate the potential difference across the 6 ohm resistor
R = 6 ohm
I = 2 A
V =?
V = IR
V = 6 × 2
V = 12 V

Question: 22
Two resistors of resistance 4 Ω and 6 Ω are connected in parallel to a cell to draw 0.5 A current from the cell.
(a) Draw a labeled diagram of the arrangement
(b) Calculate current in each resistor.
Solution:
(a) Circuit diagram



(b) Equivalent resistance of the circuit

$1 / R = 1 / 4 + 1 / 6$

$1 / R = (3 + 2) / 12$

$1 / R = 5 / 12$

$R = 12 / 5$

$R = 2.4$ ohm

Thus, the e.m.f. of the cell is

$V = IR$

$V = 0.5 \times 2.4$

$V = 1.2$ V

∴ Current through each resistor is

$I_4 = V / R_4$

$I_4 = 1.2 / 4$

$I_4 = 0.3$ A

$I_6 = V / R_6$

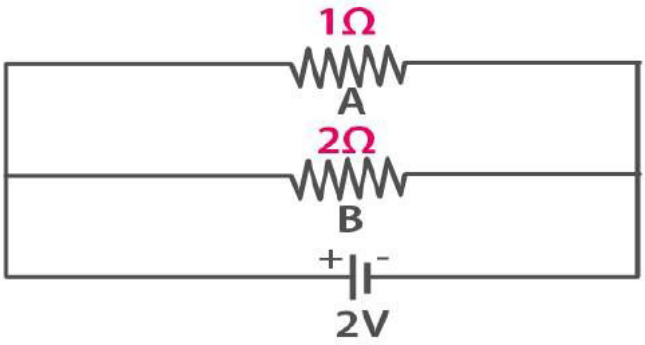
$I_6 = 1.2 / 6$

$I_6 = 0.2$ A

Hence, 0.3 A in 4 ohm and 0.2 A in 6 ohm

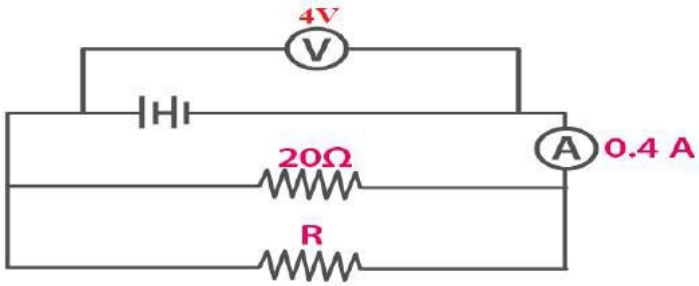
Question: 23

Calculate the current flowing through each of the resistors A and B in the circuit shown in figure?



Solution:
For resistor A
R = 1 ohm
V = 2 V
I = V / R
I = 2 / 1
I = 2 A
For resistor B
R = 2 ohm
V = 2 V
I = V / R
I = 2 / 2
I = 1 A
Hence, current flowing in resistor A is 2 A and current flowing in resistor B is 1 A

Question: 24
In figure, calculate :
(a) the total resistance of the circuit.
(b) the value of R, and
(c) the current flowing in R



Solution:
(a) To calculate the total resistance of the circuit
V = 4 V

I = 0.4 A
Total resistance R' =?
R' = V / I
R' = 0.4 / 4
R' = 10 ohm
(b) To calculate the value of R
R_1 = 20 ohm
R' = 10 ohm
1 / R'= 1 / R + 1 / R_1
1 / 10 = 1 / R + 1 / 20
1 / R = 1 / 10 – 1 / 20
1 / R = (2 – 1) / 20
1 / R = 1 / 20
R = 20 ohm
(c) To calculate the current flowing in R
R = 20 ohm
V = 4 V
I = V / R
I = 4 / 20
I = 0.2 A

Question: 25
A particular resistance wire has a resistance of 3 ohm per meter. Find:
(a) The total resistance of three lengths of this wire each 1.5 m long, in parallel.
(b) The potential difference of the battery which gives a current of 2 A in each of the 1.5 m length when connected in the parallel to the battery (assume that resistance of the battery is negligible).
(c) The resistance of 5 m length of a wire of the same material, but with twice the area of cross section.
Solution:
(a) Resistance of wire per meter = 3 ohm
So, resistance of three lengths of this wire each 1.5 m long = 3 × 1.5 = 4.5 W
1 / R = 1 / 4.5 + 1 / 4.5 + 1 / 4.5
1 / R = 3 / 4.5
R = 1.5 ohm
(b) I = 2 A
V = IR
V = 2 × 4.5
V = 9 V

(c) R = 3 ohm for 1 meter wire
For 5 m
R = 3 × 5
R = 15 ohm
Here the area is twice i.e 2 A and Resistance is inversely proportional to area. Thus resistance becomes half
R = 15 / 2
R = 7.5 ohm

Question: 26
A cell supplies a current of 1.2 A through two 2 ohm resistors connected in parallel. When resistors are connected in series, it supplies a current of 0.4 A. Calculate: (i) the internal resistance and (ii) e.m.f. of the cell.
Solution:
In parallel R = 1 / 2 + 1 / 2 = 1 ohm
I = 1.2 A
ε = I (R + r)
ε = 1.2 (1 + r)
ε = 1.2 + 1.2r
In series
R = 2 + 2
R = 4 ohm
I = 0.4 A
ε = I (R + r)
ε = 0.4 (4 + r)
ε = 1.6 + 0.4r
This means:
1.2 + 1.2r = 1.6 + 0.4r
1.2r – 0.4r = 1.6 – 1.2
0.8r = 0.4
r = 0.4 / 0.8
r = 0.5 ohm
(i) Internal resistance r = 0.5 ohm
(ii) ε = I(R + r)
ε = 1.2 (1 + 0.5)
ε = 1.8 V

Question: 27
A battery of emf 15 V and internal resistance 3 ohm is connected to two resistors 3

ohm and 6 ohm connected in parallel. Find (a) the current through the battery (b) p.d. between the terminals of the battery (c) the current in 3 ohm resistor (d) the current in 6 ohm resistor.

Solution:

(a) In parallel

$1 / R = 1 / 3 + 1 / 6$

$1 / R = (2 + 1) / 6$

$1 / R = 3 / 6$

$1 / R = 1 / 2$

$R = 2$ ohm

$r = 3$ W

$\varepsilon = 15$ V

$\varepsilon = I (R + r)$

$15 = I (2 + 3)$

$I = 15 / 5$

$I = 3$ A

(b) V =?

$R = 2$ ohm

$V = IR$

$V = 3 \times 2$

$V = 6$ V

(c) V = 6 V

$R = 3$ ohm

$I = V / R$

$I = 6 / 3$

$I = 2$ A

(d) R = 6 ohm

$V = 6$ V

$I = V / R$

$I = 6 / 6$

$I = 1$ A

Question: 28

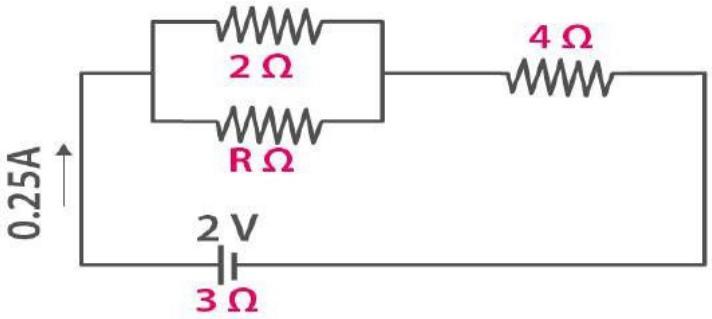
The circuit diagram in figure shows three resistors 2 ohm, 4 ohm and R ohm connected to a battery of e.m.f. 2 V and internal resistance 3 ohm. If main current of 0.25 A flows through the circuit, find:

(a) the p.d. across the 4 ohm resistor

(b) the p.d. across the internal resistance of the cell,

(c) the p.d. across the R ohm or 2 ohm resistor, and

(d) the value of R.



Solution:

(a) To calculate the p.d. across the 4 ohm resistor

R = 4 ohm

I = 0.25 A

V = IR

V = 0.25 × 4

V = 1 V

(b) To calculate the p.d. across the internal resistance of the cell

Internal resistance r = 3 ohm

I = 0.25 A

V = IR

V = 0.25 × 3

V = 0.75 V

(c) To calculate the p.d. across the 2 ohm resistor

Effective resistance of parallel combination of 2 ohm resistances = 1 ohm

V = I / R

V = 0.25 / 1

V = 0.25 V

(d) To calculate the value of R

I = 0.25 A

ε = 2 V

r = 3 ohm

ε = I (R' + r)

2 = 0.25 (R' + 3)

R' = 5 W

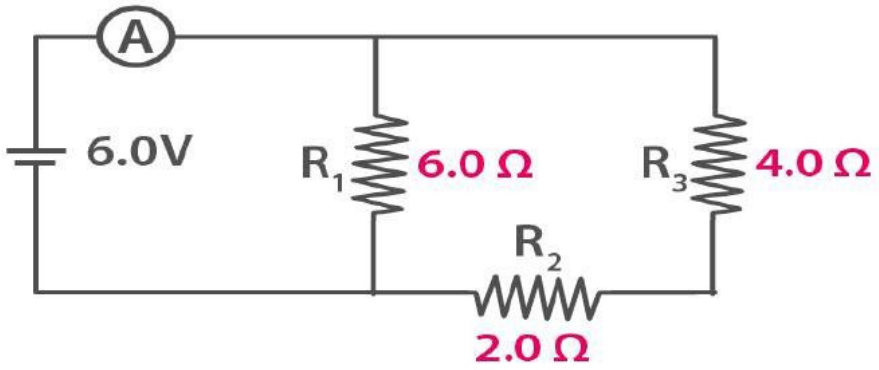
[2R / 2 + R] + 4 = 5

R = 2 ohm

Question: 29

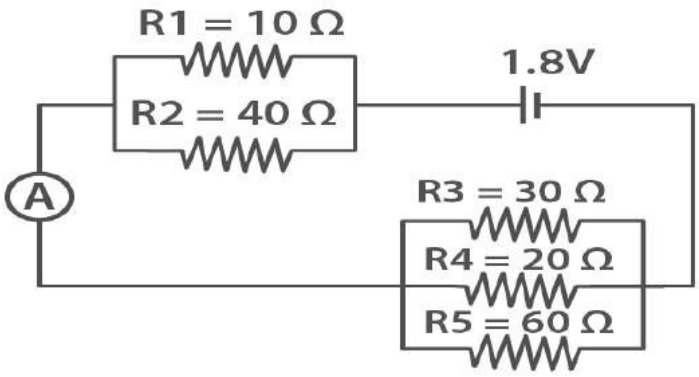
Three resistors of 6.0 ohm, 2.0 ohm and 4.0 ohm are joined to an ammeter A and a

cell of emf 6.0 V as shown in figure. Calculate:
(a) the efective resistance of the circuit.
(b) the reading of ammeter

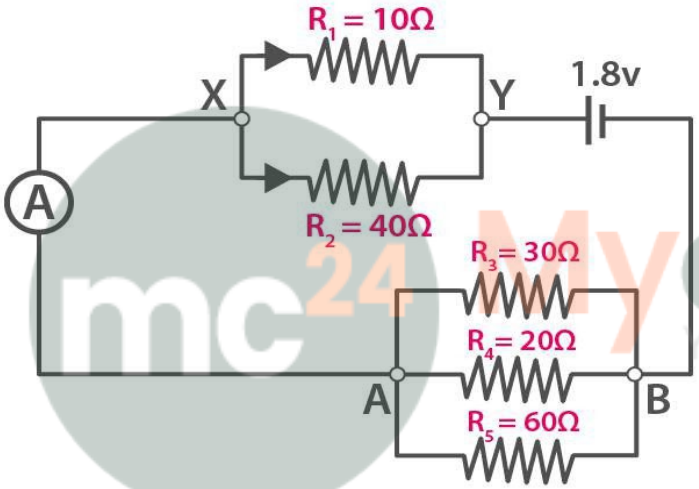


Solution:
(a) $R_1 = 6$ W
$R' = R_2 + R_3$
$R' = 2 + 4$
$R' = 6$ W
R_1 and R' are connected in parallel
$1 / R = 1 / R_1 + 1 / R'$
$1 / R = 1 / 6 + 1 / 6$
$1 / R = 2 / 6$
$1 / R = 1 / 3$
R = 3 ohm
(b) R = 3 ohm
V = 6 V
I =?
I = V / R
I = 6 / 3
I = 2 A

Question: 30
The diagram below in Fig., shows the arrangement of five different resistances connected to a battery of e.m.f. 1.8 V. Calculate:



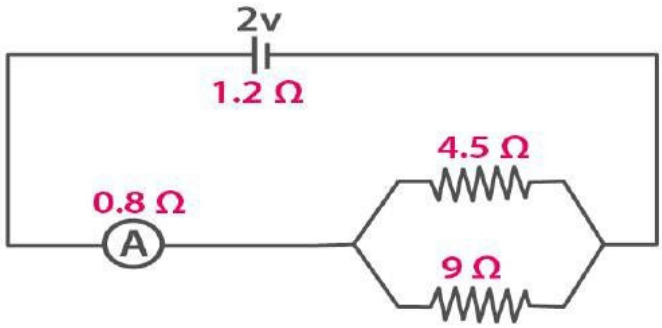
a. The total resistance of the circuit
b. The reading of ammeter A.
Solution:



(a) In the above figure,
Let R_{XY} be the resistance between X and Y
Then, $1 / R_{XY} = 1 / 10 + 1 / 40$
$1 / R_{XY} = (4 + 1) / 40$
$1 / R_{XY} = 5 / 40$ ohm
Or $R_{XY} = 8$ ohm
Let the net resistance between points A and B be R_{AB}
Then, $1 / R_{AB} = 10$ ohm
∴ The total resistance of the circuit = 8 ohm + 10 ohm
= 18 ohm
(b) Current I = Voltage / Total resistance
I = 1.8 / 18 A
I = 0.1 A
Hence, the reading of ammeter is 0.1 A

Question: 31

A cell of e.m.f. 2 V and internal resistance 1.2 Ω is connected to an ammeter of resistance 0.8 Ω and two resistors of 4.5 Ω and 9 Ω as shown in fig.



Find:

(a) The reading of the ammeter,

(b) The potential difference across the terminals of the cells, and

(c) The potential difference across the 4.5 ohm resistor.

Solution:

The total resistance of the circuit is

$R_{eq} = R_{cell} + R_{ammeter} + R_1 \parallel R_2$

$\therefore R_{eq} = 1.2 + 0.8 + (R_1R_2) / R_1 + R_2$

$\therefore R_{eq} = 2 + (4.5 \times 9) / 4.5 + 9$

$R_{eq} = 2 + 40.5 / 13.5$

$\therefore R_{eq} = 5$ ohm

(a) The current through the ammeter is

$I = E_{cell} / R_{eq}$

$I = 2 / 5$

$I = 0.4$ A

(b) The potential difference across the ends of the cells is

$V_{cell} = E_{cell} - IR_{cell}$

$V_{cell} = 2 – 0.4 \times 1.2$

$V_{cell} = 2 – 0.48$

$\therefore V_{cell} = 1.52$ V

(c) The potential difference across the 4.5 ohm resistor is

$V_{4.5} = V_{cell} - V_{ammeter}$

$V_{4.5} = 1.52 – 0.4 \times 0.8$

$V_{4.5} = 1.52 – 0.32$

$\therefore V_{4.5} = 1.2$ V