

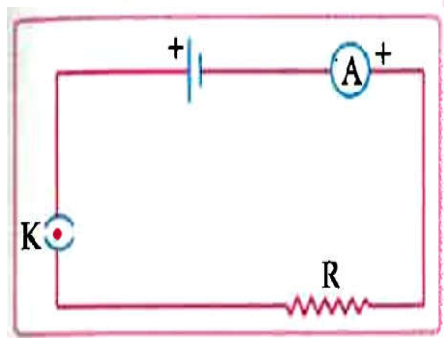
Objective Type Questions

(1 Mark each)

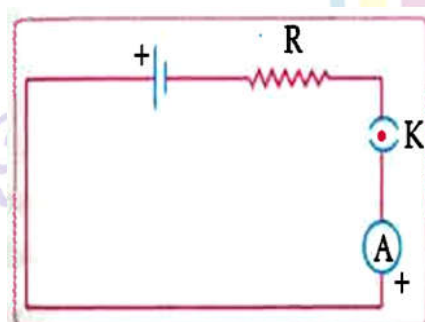
I. Multiple choice questions

1. A cylindrical conductor of length 'l' and uniform area of cross section 'A' has resistance 'R'. The area of cross section of another conductor of same material and same resistance but of length '2l' is  
 a.  $\frac{A}{2}$                       b.  $\frac{3A}{2}$                       c. 2A                      d. 3A
2. When a 4V battery is connected across an unknown resistor there is a current of 100 mA in the circuit. The value of the resistance of the resistor is:  
 a. 4Ω                      b. 40Ω                      c. 400Ω                      d. 0.4Ω
3. A cell, a resistor, a key, and ammeter are arranged as shown in the circuit diagrams of Figure. The current recorded in the ammeter will be:  
 a. maximum in (i)                      b. maximum in (ii)  
 c. maximum in (iii)                      d. the same in all the cases.

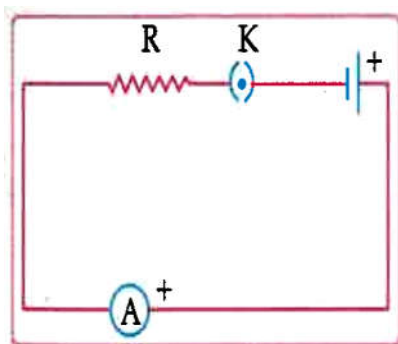
(i)



(ii)



(iii)



4. A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing through a cross section of the filament in 16 seconds would be where,  $e = 1.6 \times 10^{-19} \text{ C}$
- a.  $10^{20}$       b.  $10^{16}$       c.  $10^{18}$       d.  $10^{23}$

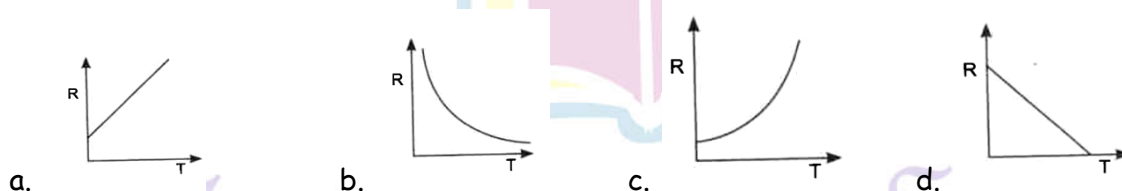
## II. Multiple choice questions

- At the time of short circuit, the electric current in the circuit:
  - vary continuously
  - does not change
  - reduce substantially
  - increases heavily**
- Two bulbs of 100 W and 40 W are connected in series. The current through the 40 w bulb will be:
  - 0.4 A
  - 0.6 A
  - 0.8 A
  - 1 A**
- What is the maximum resistance which can be made using five resistors each of  $\frac{1}{5} \Omega$ 
  - $\frac{1}{5} \Omega$
  - $10 \Omega$
  - $5 \Omega$
  - $1 \Omega$**
- What is the minimum resistance which can be made using five resistors each of  $\frac{1}{5} \Omega$ 
  - $\frac{1}{5} \Omega$
  - $\frac{1}{25} \Omega$
  - $\frac{1}{10} \Omega$
  - $25 \Omega$
- Which of the following represents voltage?
  - $\frac{\text{Work done}}{\text{Current X Time}}$
  - Work done X Charge
  - $\frac{\text{Work done X Time}}{\text{Current}}$
  - $\frac{\text{Work done X Charge}}{\text{Time}}$
- If the current I through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be
  - 100%
  - 200%
  - 300%**
  - 400%

7. In an electrical circuit three incandescent bulbs A,B, and C of rating 40 W, 60 W, and 100 W, respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?
- Brightness of all the bulbs will be the same.
  - Brightness of bulb A will be the maximum.
  - Brightness of bulb B will be more than that of A.**
  - Brightness of bulb C will be less than that of B.
8. An electric kettle consumes 1 k w of electric power when operated at 220 V. A fuse wire of what rating must be used for it?
- 1 A
  - 2 A
  - 4 A
  - 5 A**
9. The maximum resistance which can be made using four resistor each of resistance  $\frac{1}{2} \Omega$  is
- 2  $\Omega$**
  - 1  $\Omega$
  - 2.5  $\Omega$
  - 8  $\Omega$
10. Unit of electric power may also be expressed as:
- Volt- ampere**
  - Kilowattt-hour
  - Walt-second
  - Joule-second

### III. Multiple choice questions

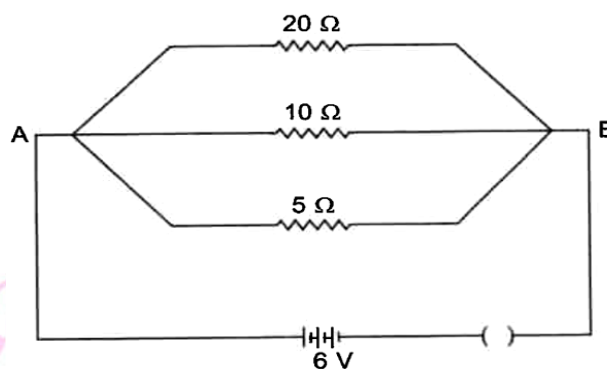
1. Wire of length l, made of material resistivity  $\rho$  is cut into two equal parts, The resistivity of the two parts are equal to,
- $\rho$
  - $\frac{\rho}{2}$
  - 2  $\rho$
  - 4  $\rho$
2. The temperature of a conductor is increased. The graph best showing the variation of its resistance.



Ans. (a)



11. Calculate the current flows through the  $10\ \Omega$  resistor in the following circuit.



- a. 1.2 A      b. 0.6 A      c. 0.2 A      d. 2.0 A

12. Two resistors are connected in series gives an equivalent resistance of  $10\ \Omega$ . When connected in parallel, give  $2.4\ \Omega$ . Then the individual resistance are

- a. each of  $5\ \Omega$       b.  $6\ \Omega$  and  $4\ \Omega$       c.  $7\ \Omega$  and  $4\ \Omega$       d.  $8\ \Omega$  and  $2\ \Omega$

13. If  $R_1$  and  $R_2$  be the resistance of the filament of 40 W and 60 W respectively operating 220 V, then

- a.  $R_1 < R_2$       b.  $R_2 < R_1$       c.  $R_1 = R_2$       d.  $R_1 \geq R_2$

14. The resistance of hot filament of the bulb is about 10 times the cold resistance. What will be the resistance the cold resistance. What will be the resistance of 100 W-220 V lamp, when not in use?

- a.  $48\ \Omega$       b.  $400\ \Omega$       c.  **$484\ \Omega$**       d.  $48.4\ \Omega$

15. If P and V are the power and potential of device, the power consumed with a supply potential  $V_1$  is

- a.  $\frac{V_1^2}{V^2} P$       b.  $\frac{V^2}{V_1^2} P$       c.  $\frac{V}{V_1} P$       d.  $\frac{V_1}{V} P$

16. A coil in the heater consume power P on passing current. If it is cut into halves and joined in parallel, it will consume power

- a. P      b.  $\frac{P}{2}$       c. 2 P      d. **4 P**

17. A fuse wire repeatedly gets burnt when used with a good heater. It is advised to use a fuse wire of

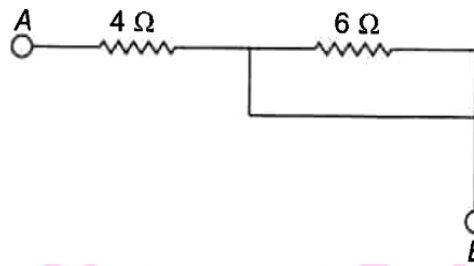
- a. more length      b. less radius      c. less length      d. **more radius**

18. A cooler of 1500 W, 200 volt and a fan of 500 W, 200 volt are to be used from a household supply. The rating of fuse to be used is

- a. 2.5 A      b. 5.0 A      c. 7.5 A      d. **10 A**



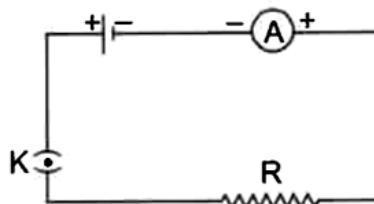
19. The effective resistance between A and B is



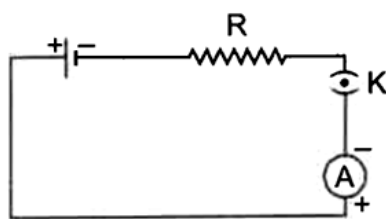
- a.  $4 \Omega$       b.  $6 \Omega$       c. May be  $10 \Omega$       d. Must be  $10 \Omega$

20. A cell, a resistor, a key and an ammeter are arranged as shown in the circuit diagrams. The current recorded in the ammeter will be

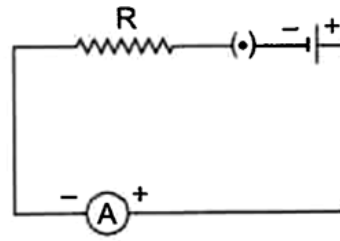
- a. maximum in (i)      b. maximum in (ii)  
c. maximum in (ii)      d. same in all the cases



(i)



(ii)



(iii)

21. A current of  $1 \text{ A}$  is drawn by a filament of an electric bulb. Number of electrons passing through a cross-section of the filament in 16 seconds would be roughly

- a.  $10^{20}$       b.  $10^{16}$       c.  $10^{18}$       d.  $10^{23}$

22. What is the maximum resistance which can be made using five resistors each of  $1/5 \text{ W}$ ?

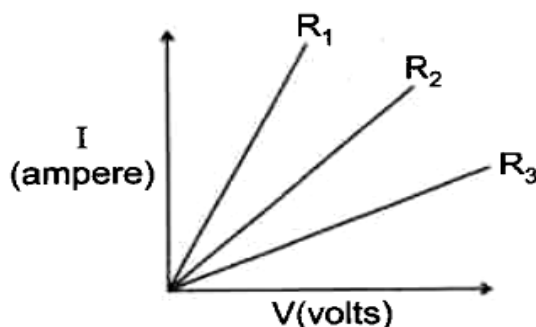
- a.  $1/5 \Omega$       b.  $10 \Omega$       c.  $5 \Omega$       d.  $1 \Omega$

23. A cylindrical conductor of length  $l$  and uniform area of cross-section  $A$  has resistance  $R$ .

Another conductor of length  $2l$  and resistance  $R$  of the same material has area of cross-section

- a.  $A/2$       b.  $3A/2$       c.  $2A$       d.  $3A$

24. A student carries out an experiment and plots the  $V$ - $I$  graph of three samples of nichrome wire with resistances  $R_1$ ,  $R_2$  and  $R_3$  respectively. Which of the following is true?



- a.  $R_1 = R_2 = R_3$                       b.  $R_1 > R_2 > R_3$   
c.  $R_3 > R_2 > R_1$                       d.  $R_2 > R_3 > R_1$

25. If the current  $I$  through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be

- a. 100 %                      b. 200 %                      c. 300 %                      d. 400 %

26. The resistivity does not change if

- a. the material is changed  
b. the temperature is changed  
c. **the shape of the resistor is changed**  
d. both material and temperature are changed

27. In an electrical circuit two resistors of  $2\ \Omega$  and  $4\ \Omega$  respectively are connected in series to a 6 V battery. The heat dissipated by the  $4\ \Omega$  resistor in 5 s will be

- a. 5 J                      b. 10 J                      c. 20 J                      d. 30 J

### I. Assertion & Reason

Directions : In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

- (A) Both A and R are true and R is the correct explanation of A.  
(B) Both A and R are true but R is Not the correct explanation of A.  
(C) A is true but R is false.  
(D) A is false and R is true.

1. **Assertion (A)** : A conductor has  $+ 3.2 \times 10^{-19}\text{ C}$  charge.  
**Reason (R)** : Conductor has gained two electrons.

2. **Assertion (A)** : The resistivity of conductor increases with the increasing of temperature.

**Reason (R)** : The resistivity is the reciprocal of the conductivity.

**Ans. Option (B) is correct.**

3. **Assertion (A)** : Bending a wire does not affect electrical resistance.

**Reason (R)** : Resistance of wire is proportional to resistivity of material.

**Ans. Option (A) is correct.**

4. **Assertion (A)** : Silver is not used to make electric wires.

**Reason (R)** : Silver is bad conductor of electricity.

**Ans. Option (C) is correct.**

## II. Assertion & Reason

Directions : In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is Not the correct explanation of A.
- (C) A is true but R is false.
- (D) A is false and R is true.

1. **Assertion (A)** : Alloys are commonly used in electrical heating devices like electric iron and heater.

**Reason (R)** : Resistivity of an alloy is generally higher than that of its constituent metals but the alloys have low melting points than their constituent metals.

**Ans. Option (C) is correct.**

2. **Assertion (A)** : In a simple battery circuit the point of lowest potential is positive terminal of the battery.

**Reason (R)** : The current flows towards the point of the lower potential as it flows in such a circuit from the positive to the negative terminal.

**Ans. Option (D) is correct.**

3. **Assertion (A)** : Electric appliances with metallic body have three connections, whereas an electric bulb has a two pin connection.





**Reason (R) :** Three pin connections reduce heating of connecting wires.

**Ans. Option (C) is correct.**

**4. Assertion (A) :** The electric bulbs glow immediately when switch is ON .

**Reason (R) :** The drift velocity of electrons in a metallic wire is very high.

**Ans. Option (A) is correct.**

**5. Assertion (A) :** Copper is used to make electric wires.

**Reason (R) :** Copper has very low electrical resistance.

**Ans. Option (A) is correct.**

### III. Assertion & Reason

**Directions :** In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is Not the correct explanation of A.

(C) A is true but R is false.

(D) A is false and R is true.

**1. Assertion (A) :** When a battery is short circuited, the terminal voltage is zero.

**Reason (R) :** In short circuit, the current is zero.

**Ans. Option (C) is correct.**

**2. Assertion (A) :** Conductors allow the current to flow through themselves.

**Reason (R) :** They have free charge carriers.

**Ans. Option (A) is correct.**

**3. Assertion (A) :** In an open circuit, the current passes from one terminal of the electric cell to another.

**Reason (R) :** Generally, the metal disc of a cell acts as a positive terminal.

**Ans. Option (D) is correct.**

**4. Assertion (A) :** The statement of ohm's law is  $V=IR$

**Reason (R) :**  $V = IR$  is the equation which defines resistance.

**Ans. Option (C) is correct.**

**5. Assertion (A) :** Bending of wire decrease the resistance of electric wire.

**Reason (R) :** The resistance of a conductor depends on length, thickness, nature of material and temperature of the conductor

**Ans. Option (A) is correct.**

### Fill in the blanks

1. Presence of argon prolongs the life of \_\_\_\_\_.

**Ans. Filament of electric bulb.**

2. Work done on unit charge is called as \_\_\_\_\_.

**Ans. Potential difference.**

3. Two resistors are in parallel when they have \_\_\_\_\_ common points.

**Ans. One.**

4. 746 watts make \_\_\_\_\_ horse power.

**Ans. One.**

### True or False

1. Rheostat used in series in a circuit can make a bulb to glow with varying brightness.

**Ans. True .**

2. One common point and no sharing devices for that point are conditions to be satisfied for two resistors to be in series.

**Ans. True.**

3. When bulbs are connected in series, the lower power bulb glows brighter.

**Ans. True.**

4. Nichrome is used for making standard resistances as it readily varies its resistance with temperature.

**Ans. False.**

5. The equivalent resistance between two diametrically opposite points as a wire of  $10\ \Omega$  resistance is made a circle is  $2.5\ \Omega$ .

**Ans. True.**

6. Devices of higher power used at home have lower resistances.

**Ans. True.**

7. 12 V means the work done to carry a unit charge from one point to another is 12 joule.

**Ans. True.**

### Match Column I with Column II

Column I	Column II
(i) Fuse wires	A. Rheostat
(ii) Bulbs	B. Higher resistance
(iii) Higher power	C. Parallel
(iv) Potential divider	D. Series
(v) Lower current	E. Lower resistance

**Ans.** (i) → D, Fuse wire always connected in series with live wire.

(ii) → C, In household circuits, bulbs are connected in parallel to get the same p.d across each bulb for desired brightness.

(iii) → E,  $P = \frac{V^2}{R}$

(iv) → A, Rheostat can also be used as potential divider.

(v) → B From ohm's Law,  $I \propto \frac{1}{R}$

### II. Very Short Answer Type Questions

1 mark each

1. Name the charge responsible for the conduction in a conductor?

**Ans.** Electron.

2. When two ends of a metallic wire are connected across the terminals of a cell, some potential difference is set up between its ends. In which direction, electrons are flowing through the conductor ?

**Ans. Direction of flow of electron:** From a lower potential end of a metallic conductor to its higher potential end.

3. Electric current flows through a metallic conductor from its one end A to other end B. Which end of the conductor is at higher potential? Why?

**Ans.** Current always flow from a higher potential to a lower potential end of the conductor. So end 'A' of the conductor is at a higher potential.

4. Is there any charge movement in a wire under normal conditions?

**Ans.** No, net motion is zero even though individual charge can move.

5. Draw the following symbols:

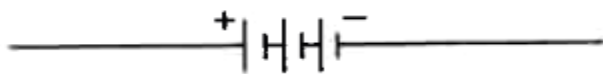
(i) Battery

(ii) Open key

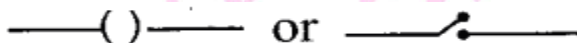
(iii) Resistor of resistance R

(iv) Bulb

Ans. (i) Battery



(ii) Open key



(iii) Resistor of resistance



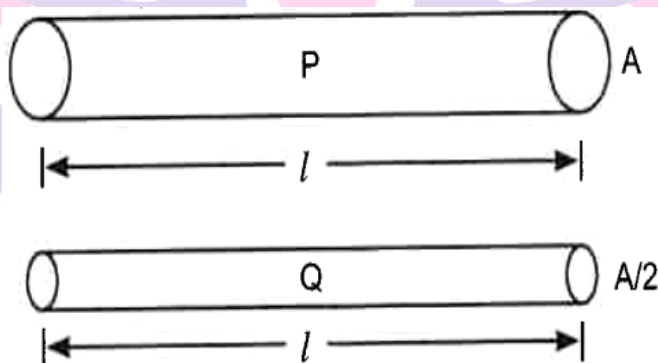
(iv) Bulb



6. What is ohm? Define it.

Ans. One ohm is that resistance offered by the wire carrying 1 A of current when 1 V is applied across its ends.

7. Out of the two wires P and Q shown below, which one has greater resistance? Justify it.



Ans. Smaller the area of cross-section, greater will be resistance as  $R \propto \frac{1}{A}$  .... ( For the same length So, wire 'Q' has greater resistance.

8. What happens to resistance of conductor when its area of cross-section is increased?

Ans. Resistance decreases as  $R \propto \frac{1}{A}$

9. The radius of conducting wire is doubled. What is doubled on itself and this process is repeated once again. By what factor does the resistance of the wire change?

Ans. Length becomes one-fourth of the original length and area of cross-section becomes four times that of original.

i.e.,  $l_2 = \frac{1}{4} l_1$  and  $A_2 = 4A_1$

$$\frac{R_2}{R_1} = \frac{l_2}{l_1} \times \frac{A_1}{A_2} = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$\Rightarrow R_2 = \frac{1}{16} R_1$$

So, new resistance is  $(\frac{1}{16})$ th of original resistance

10. Name the scientist who first studied (i) current (ii) resistance in detail.

Ans. (i) Andre - Marie, Ampere

(ii) Geog - Simon, ohm.

11. Resistance of an incandescent filament of a lamp is comparatively much more than that when it is at room temperature. Why?

Ans. When bulb is switched on (i.e., incandescent state), the temperature of filament rises. As the temperature increases, the resistance of conductor also increases.

12. Why is magnanin used for making standard resistors?

Ans. Magnanin being an alloy has a low temperature coefficient of resistance.

13. A resistance of  $1k \Omega$  has a current of  $0.25 A$  throughout it when it is connected to the terminals of a battery. What is the potential difference across the ends of a resistor.

Ans. From ohm's law,

$$V = IR = 0.25 \times 100 = 250 V$$

14. Calculate the current in a circuit if  $500 C$  of charge passes through it in 10 minutes.

Ans. Given:  $Q = 500 C$ ,  $t = 10 \text{ min.} = 10 \times 60 = 600 s$ .

$$\text{Using current, } I = \frac{Q}{t} = \frac{500}{600} = \frac{5}{6} = 0.83 A$$

15. An electric iron draws a current of  $0.6 A$  when the voltage is  $100 \text{ volt}$ . Calculate the amount of electric charge flowing through it in one hour.

Ans. As we know,  $Q = I \times t$

$$\therefore Q = 0.6 \times 3600 = 2160 C$$

16. Define the term resistivity.

Ans. The resistance offered by a wire of unit length and unit cross-sectional area is called resistivity. It is expressed in terms of ohm-metre ( $\Omega\text{-m}$ ).

17. Write the term resistivity.

Ans. The resistance offered by a wire of unit length and unit cross-sectional area is called resistivity. It is expressed in terms of ohm-metre ( $\Omega\text{-m}$ ).

18. Write S.I. unit of resistivity.

Ans. ohm-metre.



**19. How will the resistivity of a conductor change when its length is tripled by stretching it?**

**Ans.** The resistivity of a metallic conductor does not depend on the length of the wire, so it will remain same.

**20. When a battery is connected to a closed circuit, charge flow in the circuit almost instantaneously. Explain.**

**Ans.** As soon as the battery is connected to the circuit and circuit is closed, a potential difference is felt over the entire circuit. This causes the charges begin to flow.

**21. Why is closed path required for the flow of current?**

**Ans.** It makes possible to move the electrons in a particular direction, so closed path is necessary for the flow of current.

**22. A lamp draws a current of 0.5 A when it is connected to a 60 V source. What is the resistance of the lamp?**

**Ans.** From ohm's law,  $I = \frac{V}{R}$  we get,

$$R = \frac{V}{I} = \frac{60}{0.5} = 120 \Omega$$

**23. Why is a series arrangement not used for connecting domestic electrical appliances in a circuits?**

**Ans.** If any one stops working due to some reason, other will also stop working.

**24. Why is a series arrangement not used for connecting domestic electrical appliances in a circuit?**

**Ans.** If any one stops working due to some reason, other will also stop working.

**25. A torch bulb is rated at 1.5 V, 500 mA. Find its resistance.**

**Ans.** From ohm's law,  $I = \frac{V}{R}$  we get,

$$R = \frac{V}{I} = \frac{1.5}{500} \times 10^{-3} = 3 \Omega$$

**26. How is an ammeter connected in a circuit to measure current flowing through it?**

**Ans.** It is always connected in series in a circuit through which the current is to be measured.

**27. Which combination is used for connecting the device in the circuit to measure the potential difference across two points?**

**Ans.** Parallel combination.

**28. Define SI unit of electrical power.**

**Ans.** Power is expressed in joule/second or watt. When 1 ampere current is passed through a resistor of  $1 \Omega$  the heat energy produced is, 1 joule. If this flow is maintained for 1 second, the power consumed is 1 watt.

**29. What type of gases are used in bulbs?**

**Ans.** Inert gases.

**30. How are bulbs connected in a fairy light circuit used for decoration of buildings in festivals?**

**Ans.** Series combination.

**31. Write two types of resistors combination.**

**Ans.** The two type of resistors combination are:

(a) Series combination of resistances.

(b) Parallel combination of resistances.

**32. Why do we not prefer series connection at home?**

**Ans.** Even if one devices is damaged, all the devices will stop functioning.

**33. Why the bulb gets fused, if it is operated at a higher potential than its power rating?**

**Ans.** More heat will be produced when bulb is operated at higher potential than its power rating as

$$H = \frac{V^2 t}{R}, \text{ So, bulb gets fused.}$$

**34. Two bulbs 60 W, 220 V and 40 W, 220 v are connected in series. Which of the bulb will glow brighter?**

**Ans.** More power is dissipated by 40 W bulb as it has a higher resistance. ( $P = V^2/R$ ). So, it will glow brighter in series.

**35. There are two electric bulbs (i) marked 60 W, 220 V and (ii) marked 100 W, 220 V, which one of the two has a higher resistance?**

$$\text{Ans. } P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R} \Rightarrow R \propto \frac{1}{P}$$

So, 60 W bulb has higher resistance.

**36. Write relation between heat energy produced in a conductor when a potential difference V is applied across its terminals and a current I flows through for 't'.**

**Ans.** Heat produced,  $H = VIt$ .

**37. Define SI unit of potential difference.**

**Ans.** Volt is the SI unit of potential difference. One volt is said to be the potential difference between two points if one joule of work is done to bring one coulomb of charge from one point to another.



38. Name the device used to safeguard electrical devices at home?

Ans. Fuse wire.

39. Name the element of filament of a bulb?

Ans. Tungsten

40. Work done in moving 5 C charge across the ends of a conductor is 100 J. If the potential at the one end of the conductor is 10 V, find the potential at the other end of this conductor.

Ans. Potential difference, V

$$= V_A - V_B = \frac{W}{Q}$$

$$V_A - 10 = \frac{100}{5} = 20$$

$$V_A = 30 \text{ V}$$

41. What is the commercial unit of electrical energy?

Ans. k W h.

## II. Very Short Answer Type Questions

1. Some work is done to move a charge Q from infinity to a point A in space. The potential of the point A is given as V. What is the work done to move this charge from infinity in terms of Q and V?

Ans.  $W = QV$ .

2. What is the function of a galvanometer in a circuit?

Ans. Detect the presence or direction of current.

3. Write the function of voltmeter in an electric circuit.

Ans. To measure potential difference across two points.

4. Why are the heating elements of electric toasters and electric irons made of an alloy rather than a pure metal?

Ans. Due to high resistivity of alloys rather than its constituting metals.

5. Should the resistance of voltmeter be low or high? Give reason.

Ans. High, In parallel connection, less current passes through high resistance.

6. Name the device that helps to maintain a potential difference across a conductor.

Ans. A battery is used to maintain potential difference across a conductor.

7. Write SI unit of resistivity.

Ans. Ohm-metre (ohm-m)

8. Two unequal resistances are connected in parallel.

Ans. Voltage-drop is same across both.

9. Why does the cord of an electric oven not glow while its heating element does?

Ans. Cord is made up of copper wire whereas heating element is made up of alloy.

10. Why is a series arrangement not used for connecting domestic electrical appliances in a circuit?

Ans. In series connection, if one electrical appliance stops working due to some defect, then all other appliances would stop working.

11. In a circuit if two resistors of 5 W and 10 W are connected in series. Compare the current passing through the two resistors.

Ans. In series connection of resistors, same current passes through all the resistors. Hence, current will be same. Ratio of the currents will be 1 : 1.

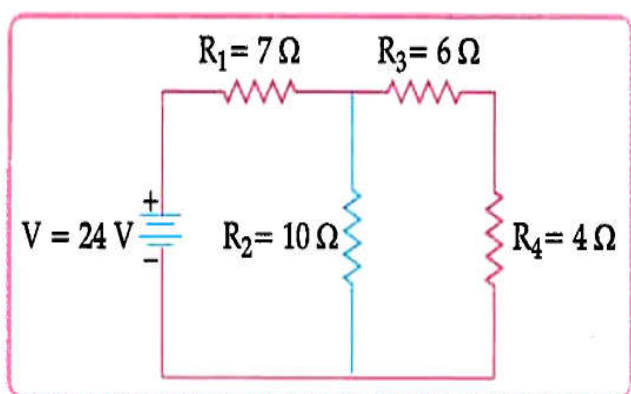
12. Write the relation between resistance (R) of filament of bulb, its power (P) and a constant voltage V applied across it.

Ans.  $R = \frac{V^2}{P}$

### Short Answer Type Questions - I

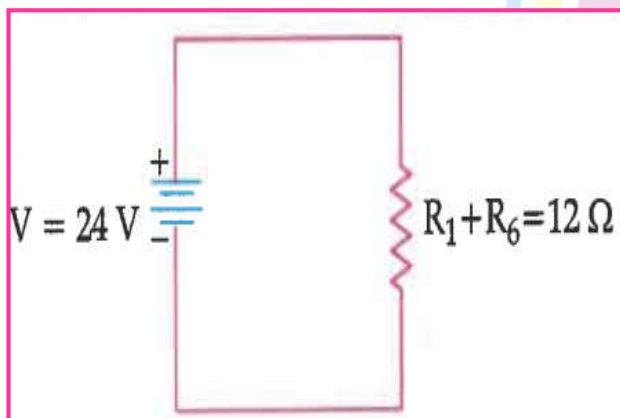
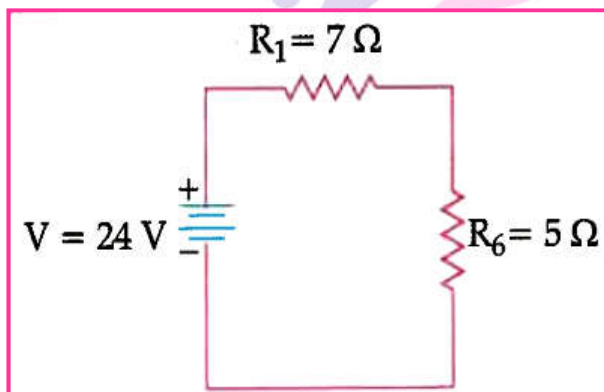
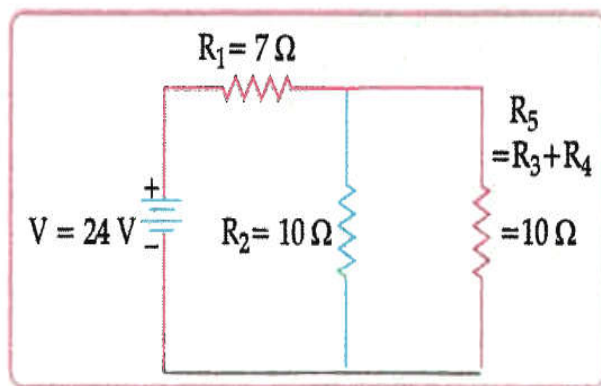
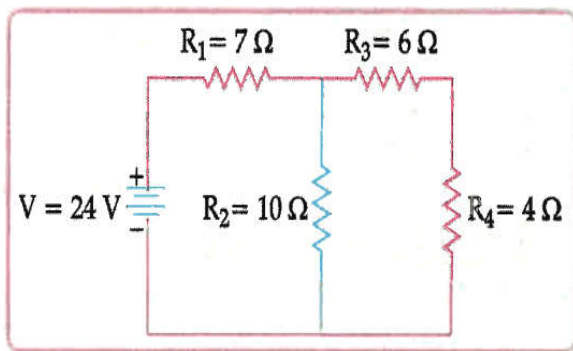
( 2 marks each)

1.



Calculate the total resistance of the circuit and find the total current in the circuit.

Ans.



$R_1$  and  $R_4$  are in series, hence the equivalent resistance of those two =  $R_1 + R_4 = 10\text{ ohms}$ .

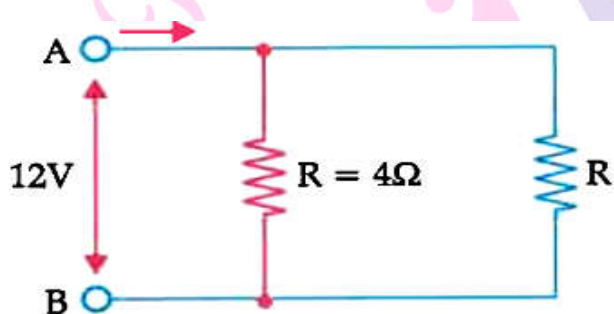


$R_5$  and  $R_2$  are in parallel, let  $R_6$  be the equivalent resistance for them. Hence  $R_6 = (R_5 \times R_2)/(R_5 + R_2) = 100/20 = 5$  ohms.

Now  $R_1$  and  $R_6$  are in series and hence the final equivalent resistance of the entire circuit is  $R = R_1 + R_6 = 12$  ohms.

By ohm's Law we know that  $V=IR$ , hence  $I = V/R$ , Hence the current in the circuit is  $24/12 \text{ A} = 2 \text{ A}$ .

2. A student has two resistors-  $2 \Omega$  and  $3 \Omega$ . She has to put one of them in place of  $R_2$  as shown in the circuit. The current that she needs in the entire circuit is exactly  $9 \text{ A}$ . Show by calculation which of the two resistors she should choose.



**Ans.** The overall current needed =  $9 \text{ A}$

The Voltage is  $12 \text{ V}$

Hence by ohm's Law  $V=IR$ ,

The resistance for the entire circuit =  $12/9 = 4/3 \Omega = R$

$R_1$  and  $R_2$  are in parallel. Hence,  $R = (R_1 R_2)/(R_1 + R_2)$

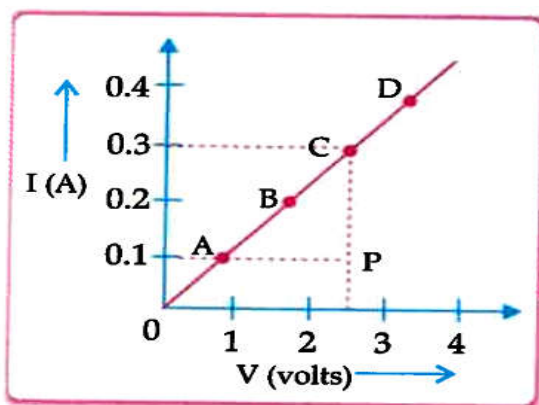
or,  $\frac{4}{3} = 4R_2/(4 + R_2) = 4/3$

$\therefore R_2 = 2\Omega$

3. While studying the dependence of potential difference ( $V$ ) across a resistor on the current ( $I$ ) passing through it, in order to determine the resistance of the resistor, a student took 5 readings for different values of current and plotted a graph between  $V$  and  $I$ . He got a straight line graph.



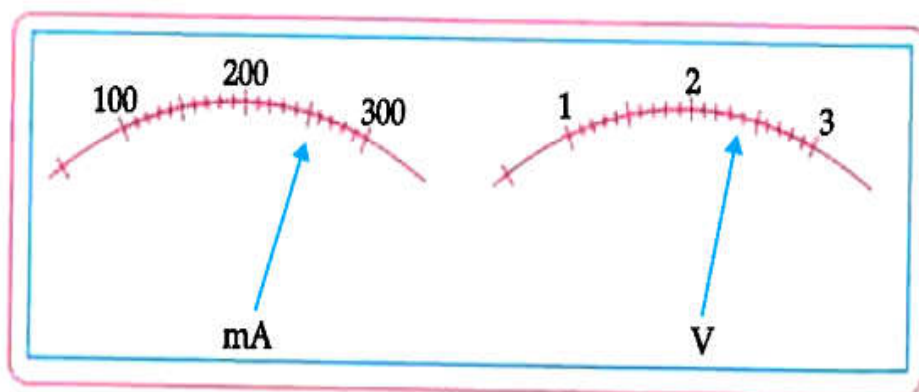
Next Generation School



4. The current flowing through a resistor connected in a circuit and the potential difference developed across its ends are as shown in the diagram by milliammeter and voltmeter readings respectively.

(a) What are the least counts of these meters?

(b) What is the resistance of the resistor?



**Ans.** (a) least count of ammeter = 10 mA

Least count of voltmeter = 0.1 V

(b)  $\frac{2.4}{0.25} = 9.6 \text{ ohm}$  (250 mA = 0.25 A)

**Detailed Answer:**

(a) Least count of milliammeter = 10 mA

Least count of voltmeter =  $\frac{1}{10} = 0.1 \text{ V}$

(b) Current  $I = 250 \text{ mA} = 250 \times 10^{-3} \text{ A}$

Potential difference,  $V = 2.4 \text{ V}$

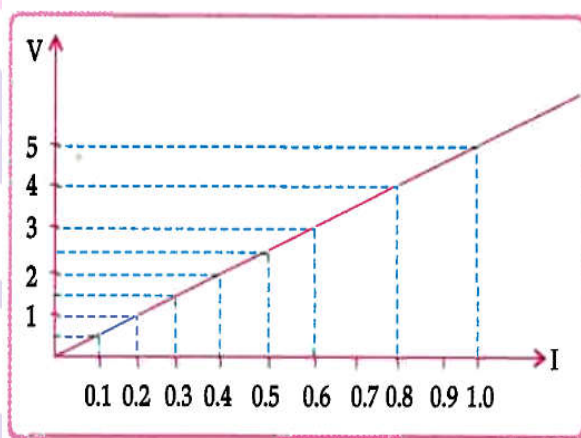
$$\text{Resistance, } R = \frac{V}{I} = \frac{24}{250 \times 10^{-3}} = 9.6 \, \Omega$$

5. The values of current (I) flowing through a given resistor (R), for the corresponding values of potential difference (V) across resistor are as given below:

V (Volts)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0
I (Ampere)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0

Plot a graph between current (I) and potential difference (V) and determine the resistance (R) of the resistor.

Ans. We know that  $V = IR$



From the graph,  $V = 0.5 \, \text{V}$

$I = 0.1 \, \text{A}$

Substituting on the equation,  $V = IR$

$$0.5 = 0.1 \times R$$

$$R = 0.5/0.1 = 5 \, \Omega$$

6. List in a tabular form two differences between a voltmeter and an ammeter.

Ans.

S.No	Voltmeter	Ammeter
1	Used to measure the potential difference.	Used to measure the current.
2	Connected in parallel in the electric circuit.	Connected in series in the electric circuit
3	Has high resistance	Has low resistance

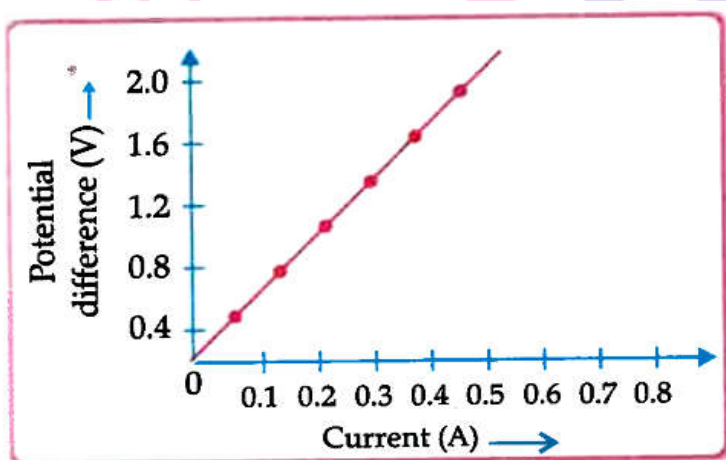
## Short Answer Type Questions - II

1. (a) State the relation correlating the electric current flowing in a conductor and the voltage applied across it. Also, draw a graph to show this relationship.
- (b) Find the resistance of a conductor if the electric current flowing through it is 0.35 A when the potential difference across it is 1.4 V.

**Ans. (a)** The flow of current (I) in the conductor is directly proportional to the potential difference (V) established across it provided the physical conditions remain same.

Or  $V = IR$ .

**Graph:**



(b) Given:

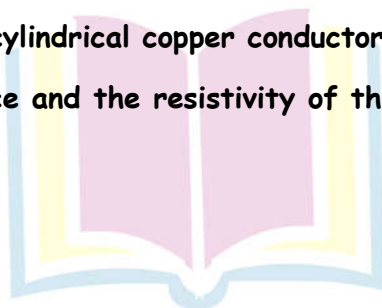
Potential Difference (V) = 1.4 V

Current (I) = 0.35 A

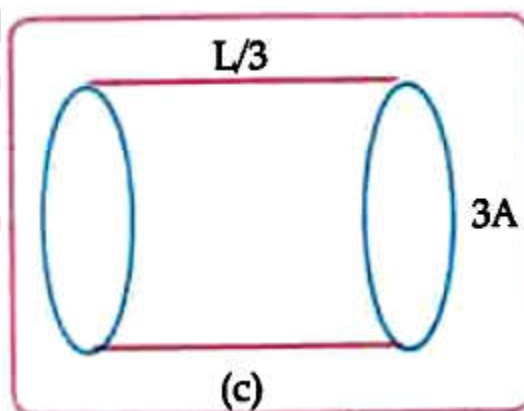
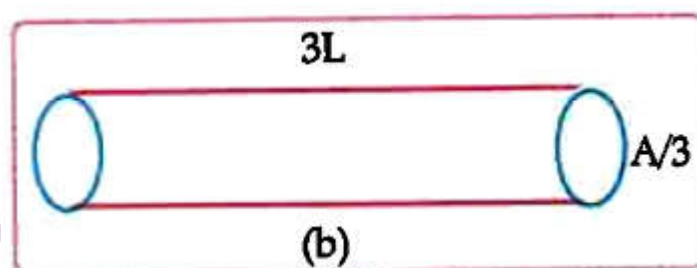
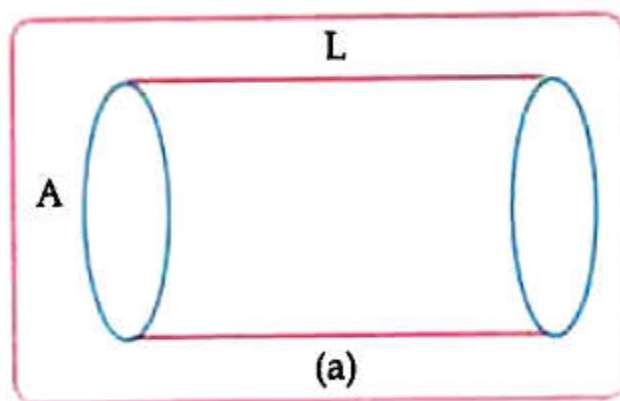
As per formula,  $V = IR$

$$\text{So, } \frac{V}{I} = \frac{1.4}{0.35} = 4 \text{ Ohm}$$

2. The figure below shows three cylindrical copper conductors along with their face areas and lengths. Compare the resistance and the resistivity of the three conductors. Justify your answer.



Next Generation School



**Ans.**  $R_a = \rho \frac{L}{A}$

$$R_b = \rho \left( \frac{3L}{\frac{A}{3}} \right) = 9 \frac{\rho L}{A} = 9 R_a$$

$$R_c = \rho \left( \frac{L/3}{3A} \right) = \frac{1}{9} \frac{\rho L}{A} = \frac{1}{9} R_a$$

Hence  $R_b > R_a > R_c$

$\rho_a = \rho_b = \rho_c$  because all the three conductors are of same material.

**3. What is electrical resistivity? Derive its SI unit. In a series electrical circuit comprising a resistor made up of a metallic wire, the ammeter reads 100mA. If the length of the wire is doubled, how will the current in the circuit change? Justify your answer.**



**Ans.** Electrical resistivity of the material of a conductor is the resistance offered by the conductor of length 1 m and area of cross-section  $1\text{m}^2$

$$\rho = \frac{RA}{l}$$

$$\text{Unit of } \rho = \frac{\text{ohm meter}^2}{\text{metre}} = \text{ohm meter}$$

Resistance of wire is doubled if its length is doubled.

Hence current is reduced to half.

$$\therefore \text{Ammeter reading} = \frac{100 \text{ mA}}{2} = 50 \text{ mA.}$$

**4. State ohm's Law. Draw a circuit diagram to verify this law indicating the positive and negative terminals of the battery and the meters. Also show the direction of current in the circuit.**

**Ans.** Statement of ohm's Law,

Circuit diagram with polarity of battery, ammeter and voltmeter

Direction of current by arrow.

**Detailed Answer:**

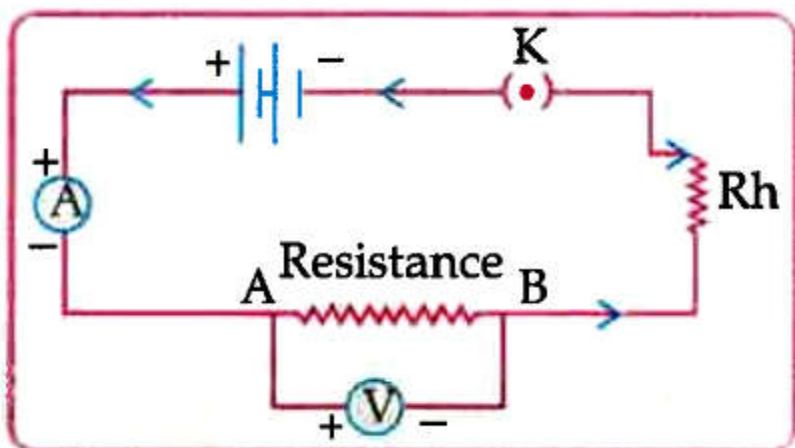
Ohm's Law: It states that 'physical conditions remaining same, the current flowing through a conductor is directly proportional to the potential difference across its two ends'.

$$\text{i.e., } I \propto V$$

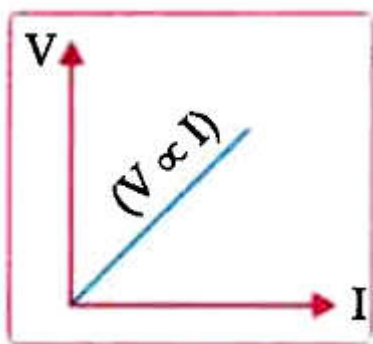
$$V = IR$$

Where, the constant of proportionality R is called the electrical resistance.

**Diagram to verify ohm's Law:**



Graph:



5. Calculate the resistance of a 1 km long copper wire of area of cross section  $2 \times 10^{-2} \text{ cm}^2$ .  
The resistivity of copper is  $1.623 \times 10^{-8} \text{ cm}^2$ . The resistivity of copper is  $1.623 \times 10^{-8}$  ohm-meter.

Ans.

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

$$= \frac{1.623 \times 10^{-8} \times 1000}{2 \times 10^{-2} \times 10^{-4} \text{ m}^2}$$

$$= 0.81 \times 10 \Omega = 8.1 \Omega.$$

6. (a) Write the mathematical expression for joule's law of heating.  
(b) Compute the heat generated while transferring 96000 coulomb of charge in two hours through a potential difference of 40 V.

Ans. (a)  $H = I^2 R t$   
(b)  $H = V \cdot I \cdot t$   
 $= V \cdot Q$

Given:  $V = 40 \text{ volts}, Q = 96000 \text{ C}$   
 $H = 40 \text{ V} \times 96000 \text{ C}$   
 $= 3.84 \times 10^6 \text{ J}$

Detailed Answer:

Ans. (a) Mathematical expression of Joule's Law of heating is :  $H = I^2 R t$

Where,  $H$  = Produced Heat

$I$  = Current flowing through the device

$t$  = Time taken

$R$  = Resistance of the appliance

(b) Given, charge (Q) = 96000 C, Time (t) = 2 h, potential difference (V) = 40 V

Potential difference (V) = 40 V

Heat generated,  $H = VI t$

or  $H = V \times Q$

or  $H = 40 \times 96000$

or  $H = 3840000 \text{ J}$   
 $= 3.84 \times 10^6 \text{ J}$

7. (a) It would cost a man Rs. 3.50 to buy 1.0 kW h of electrical energy from the Main Electricity Board. The generator has a maximum power of 2.0 kW. The generator produces energy at this maximum power for 3 hours. Calculate how much it would cost to buy the same amount of energy from the Main Electricity Board.

(b) A student boils water in an electric kettle for 20 minutes. Using the same mains supply he wants to reduce the boiling time of water. To do so should he increase or decrease the length of the heating element? Justify your answer.

Ans. (a)  $E = P \times T$  So,  $E = 3 \times 2 = 6 \text{ kWh}$

Cost of buying electricity from the main electricity board =  $6 \times 3.50 = ₹ 21.0$

(b) To reduce the boiling time using the same mains supply, the rate of heat production should be large. We know that  $P = V^2/R$ . Since V is constant, R should be decreased. Since R is directly proportional to l so length should be decreased.

8. Calculate the total cost of running the following electrical devices in the month of September, if the rate of 1 unit of electricity is ₹ 6.00

(a) Electric heater of 1000 W for 5 hours daily.

(b) Electric refrigerator of 400 W for 10 hours daily.

Ans.  $P_1 = 1000 \text{ W} = \frac{1000}{1000} \text{ kW}$ ,  $t_1 = 5 \text{ h}$

$P_2 = 400 \text{ W} = \frac{400}{1000} \text{ kW}$ ,  $t_2 = 10 \text{ h}$

No. of days,  $n = 30$

$$E_1 = P_1 \times t_1 \times n$$

$$= 1 \text{ kW} \times 5 \text{ h} \times 30 = 150 \text{ kWh}$$

$$E_2 = P_2 \times t_2 \times n$$

$$= \frac{400}{1000} \text{ kW} \times 10 \text{ h} \times 30$$

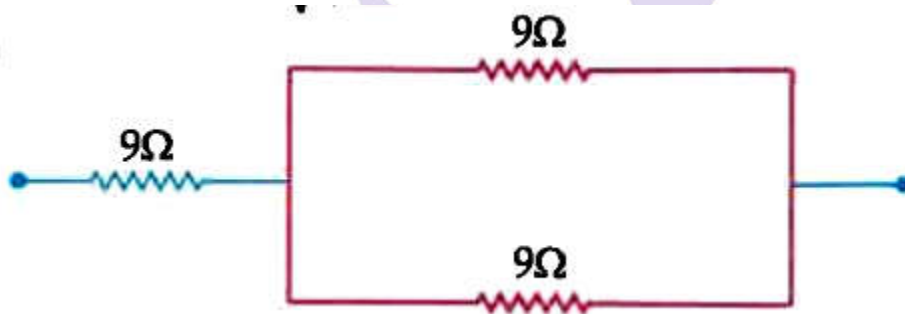
$$= 120 \text{ kWh}$$

$$\therefore \text{Total energy} = (150 + 120) \text{ kWh} = 270 \text{ kWh}$$

$$\therefore \text{Total cost} = 270 \times 6 = ₹ 1620$$

9. Show how would you join three resistors, each of resistance  $9 \Omega$  so that the equivalent resistance of the combination is (i)  $13.5 \Omega$ , (ii)  $6 \Omega$

Ans. (i)



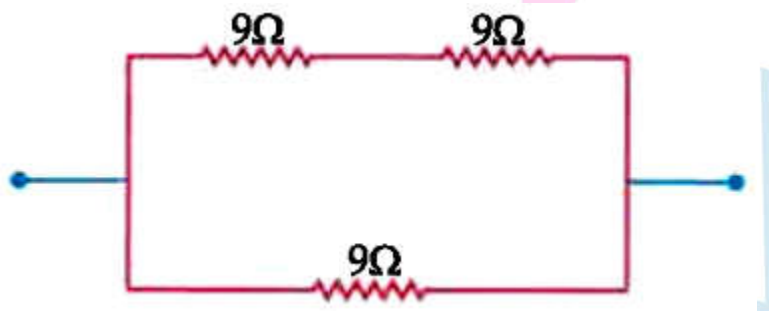
Two  $9 \text{ ohm}$  resistors in parallel connected to one  $9 \text{ ohm}$  resistor in series.

$$\frac{1}{R_p} = \frac{1}{9} + \frac{1}{9} = \frac{2}{9}$$

$$\therefore R_p = \frac{9}{2} \Omega$$

$$R = 9 \Omega + \frac{9}{2} \Omega = 13.5 \Omega$$

(ii)



Two  $9 \text{ ohm}$  resistors in series connected to one  $9 \text{ ohm}$  resistor is parallel.

$$R_2 = 9 \Omega + 9 \Omega = 18 \Omega$$

$$\frac{1}{R_p} = \frac{1}{18} + \frac{1}{9} = \frac{3}{18}$$

$$R = 6 \Omega$$

10. Three resistors of  $10\ \Omega$  and  $20\ \Omega$  connected in series in a circuit. If the potential drop across the  $15\ \Omega$  resistor is  $3\text{ V}$ , find the current in the circuit and potential drop across the  $10\ \Omega$  resistor.

**Ans.** In series circuit same current flows through all the resistors, Current through  $15\ \Omega$  resistor,

$$I = \frac{V}{R} = \frac{3\text{ V}}{15\ \Omega} = \frac{1}{5}$$

$$= 0.2\text{ A}$$

$\therefore$  Current in the circuit =  $0.2\text{ A}$

$\therefore$  Potential drop across  $10\ \Omega$  resistor is.

$$V = IR$$

$$= 0.2\text{ A} \times 10\ \Omega$$

$$= 2\text{ V}$$

11. A circuit has line of  $5\text{ A}$ . How many lamps of rating  $40\text{ W}$ ,  $200\text{ V}$  can simultaneously run on this line safely?

**Ans.** Given,  $V = 200$ ,  $P = 40\text{ W}$ ,  $I = 5\text{ A}$ ,  $n = ?$

$$nP = VI$$

$$n = \frac{VI}{P} = \frac{200 \times 5}{40}$$

12. A bulb is rated at  $200\text{ V} - 40\text{ W}$ . What is its resistance? 5 such bulbs are lighted for 5 hours. Calculate the electrical energy consumed? Find the cost if the rate is  $5.10$  per KWh.

**Ans.**

$$V = 200\text{ V}, P = 40\text{ W}$$

$$I = \frac{P}{V} = \frac{40}{200} = \frac{1}{5}\text{ A}$$

$$R = \frac{V}{I} = \frac{200}{\frac{1}{5}}$$

$$= 200 \times 5 = 1000\ \Omega$$

$$\text{Total Power} = 40\text{ W} \times 5 = 200\text{ W}$$

$$\text{Time} = 5\text{ hrs.}$$

$$\text{Electrical energy} = 200\text{ W} \times 5\text{ hrs.}$$

$$= 1000\text{ Wh}$$



$$= 1 \text{ KWh.}$$

$$\text{Cost of 1 KWh} = ₹5.10$$

$$\therefore \text{Total cost} = ₹1 \times 5.10 = ₹5.10$$

13. (a) List the factors on which the resistance of a conductor in the shape of a wire depends.

(c) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity? Give reason.

(c) Why are alloys commonly used in electrical heating devices? Give reason.

**Ans.** The factors on which the resistance of a conductor in the shape of wire depends

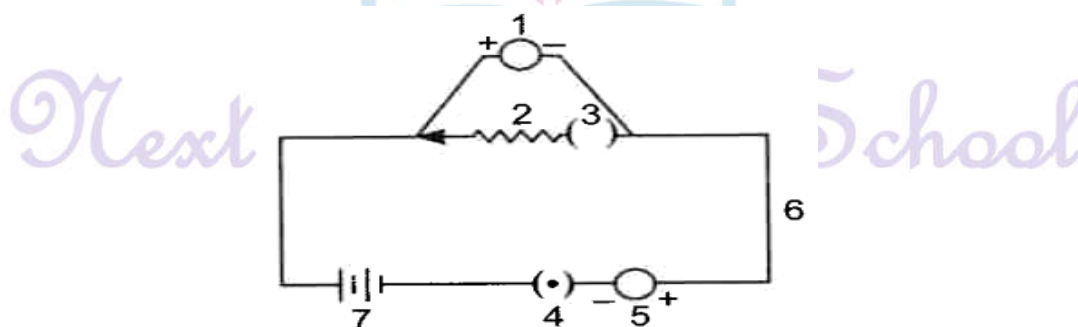
- (i) Length of the conductor : Resistance is directly proportional to length of the conductor.
- (ii) Area of cross section of the wire: The resistance is inversely proportional to area of cross section of the wire.
- (iii) The resistance of the conductor depends on the nature of its material.
- (iv) Temperature of the conductor: Resistance is directly proportional to the temperatures of the conductor.

(b) Metals are good conductor of electricity as they have free electrons to conduct whereas glass is a bad conductor of electricity as it does not allow electric current to pass through it due to non-availability of free electrons.

(c) They alloys are commonly used in electric heating device. This is because

- (i) Alloy are combination of two or more metals.
- (ii) Its resistivity is higher than that of its constituent metals.
- (iii) It neither gets oxidised nor easily at high temperature.
- (iv) It shows less rapid variations of resistivity due to change in temperature.

14. (a) Identify the various element of the circuit shown below:



(b) What does the bigger line of element represent?

Ans. (a) Various element of the circuit are

1 - Voltmeter

2 - Resistance

3 - Open key

4 - Closed key

5 - Ammeter

6 - Connecting wire

7 - Battery

(b) Bigger line of element 7 represents positive terminal of the cell.

15. Define 1 volt. Express it in terms of SI unit of work and charge. Calculate the amount of energy consumed in carrying a charge of 1 coulomb through a battery of 3 V.

Ans. When 1 joule of work is done in carrying 1 coulomb of charge, from infinity to a point in the electric field, then potential at that point is called 1 volt.

Potential difference between two point is

$$V = \frac{W}{Q}$$

or

$$W = Q \times V = 1 \times 3 = 3J$$

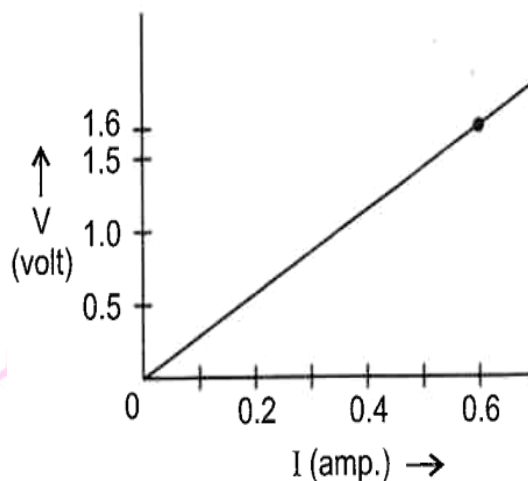
16. List in a tabular form three differences between a voltmeter and an ammeter.

Ans. Difference between ammeter and voltmeter

Ammeter	Voltmeter
(a) It measures electric current in a circuit.	(a) It measures the potential difference between two points in a circuit .
(b) It is connected in series in a circuit.	(b) It is connected in parallel across the two point in a circuit.
(c) It is a low resistance device.	(c) It is high resistance.

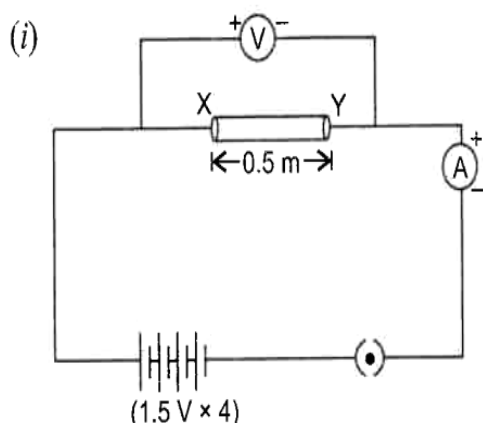
17. (i) Draw a closed circuit diagram consisting of a 0.5m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V each and a plug key.

(ii) Following graph was plotted between V and I values:



What would be the values of  $V/I$  ratios when the potential difference is 0.8 V, 1.2 V and 1.6 V respectively? What conclusion do you draw from these values?

Ans. (i)



(ii) From the graph, when p.d is 1.6 volt 0.6 A current the ratio of

$$\frac{V}{I} = \frac{1.6}{0.6} = 2.67 \Omega$$

Therefore, straight line nature of graph shows that the value of  $\frac{V}{I}$  ratio for all potential difference of 0.8 V, 1.2 V and 1.6 volt will be same and is equal to  $2.67 \Omega$ .

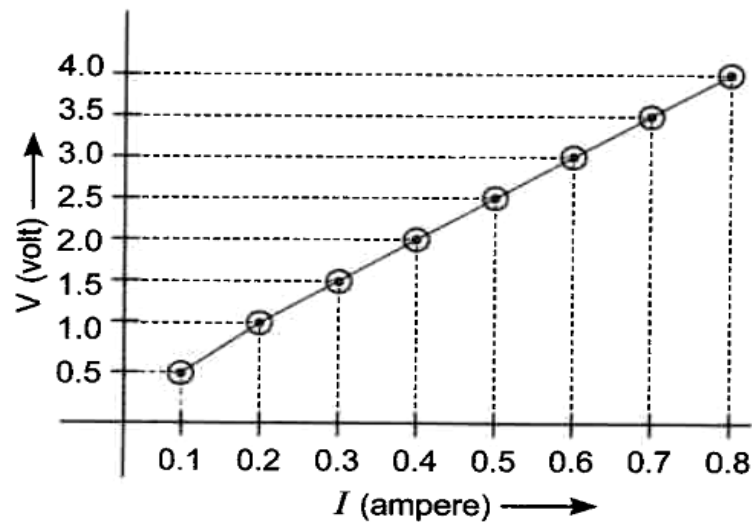
We conclude that at the given temperature, the resistance of wire is constant and is equal to  $2.67 \Omega$ .

18.

V (volts)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
I (amperes)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8

Plot a graph between Current (I) and potential difference (V) and determine the resistance (R) of the resistor.

Ans.



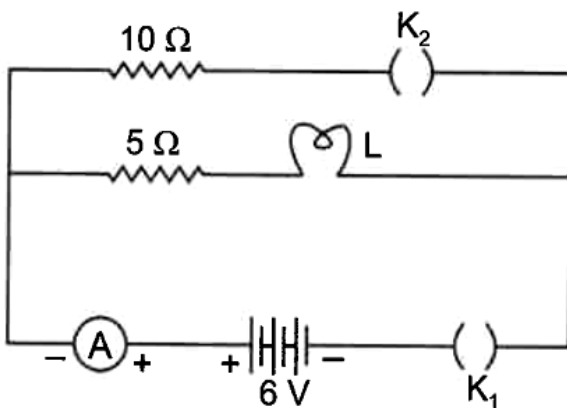
Resistance (R) of the resistor

= Slope of V - I line

$$= \frac{\Delta V}{\Delta I} = \frac{3.5 - 1.5}{0.5 - 0.3} = \frac{2.0}{0.2}$$

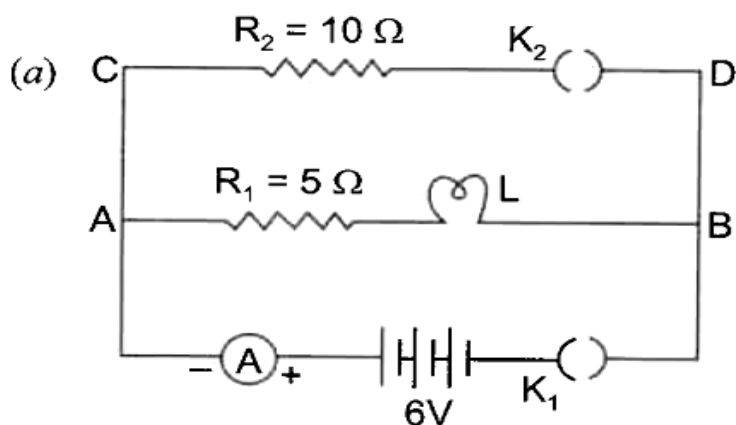
$$= 10 \, \Omega$$

19. Study the circuit shown:



A current of 0.6 A is shown by ammeter in the circuit when the key  $K_1$  is closed. Find the resistance of the lamp L. What change in current flowing through the 5  $\Omega$  resistor and potential difference across the lamp will take place, if the key  $K_2$  is also closed. Give reason for your answer.

Ans.



When  $K_1$  is closed and  $K_2$  is open

$$I_1 = 0.6 \text{ A}, R_1 = 5 \Omega, R_1 = ?$$

Using ohm's law  $V = IR_S$

$$\Rightarrow 6 = 0.6 \times (5 + R_1) \dots R_S = R_1 + R_L$$

$$\Rightarrow 10 = 5 + R_L$$

$$\Rightarrow R_L = 5 \Omega$$

(b) Potential difference across lamp

$$V_{L1} = IR_L = 0.6 \times 5 = 3.0 \text{ V}$$

Now key  $K_2$  is also closed.

$10 \Omega$  resistor is now connected in parallel with series combination of  $R_1$  and  $R_2$ , potential remains same across them.

$$\text{So, } I_2 \times R_2 = I_1 \times R_S$$

$$\Rightarrow \frac{I_1}{I_2} = \frac{R_2}{R_S} = \frac{R_2}{R_1 + R_2} = \frac{10}{5 + 5} = \frac{10}{10} = 1$$

$$\Rightarrow I_1 = I_2$$

Equivalent resistance of the circuit

$$\begin{aligned} \frac{1}{R} &= \frac{1}{R_2} + \frac{1}{R_S} = \frac{1}{10} + \frac{1}{10} \\ &= \frac{1}{5} \end{aligned}$$

$$\therefore R = 5 \Omega$$

So, total current drawn from the battery

$$I = \frac{V}{R} = \frac{6}{5} \text{ A}$$

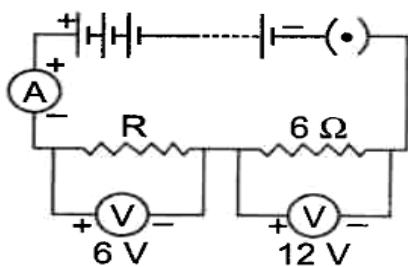
$$\text{But, } I = I_1 + I_2 = 2I_1$$

$$\therefore I_1 = \frac{I}{2} = \frac{1}{2} = \frac{1 \times 6}{2 \times 5} = \frac{3}{5} \text{ A} = 0.6 \text{ A}$$

So, there will be no change in the current flowing through  $5 \Omega$  conductor and potential difference across the lamp will also remain same in both the cases.



20. A circuit is shown in the diagram given below.



- Find the value of R.
- Find the reading of the ammeter.
- Find the potential difference across the terminals of the battery.

Ans. (a) p.d across  $6\ \Omega = 12\text{ V}$ .

$\therefore$  Current through  $6\ \Omega$ ,

$$I = \frac{V}{R} = \frac{12}{6} = 2\text{ A}$$

As R and  $6\ \Omega$  are connected in series. So, the current through R is 2 A.

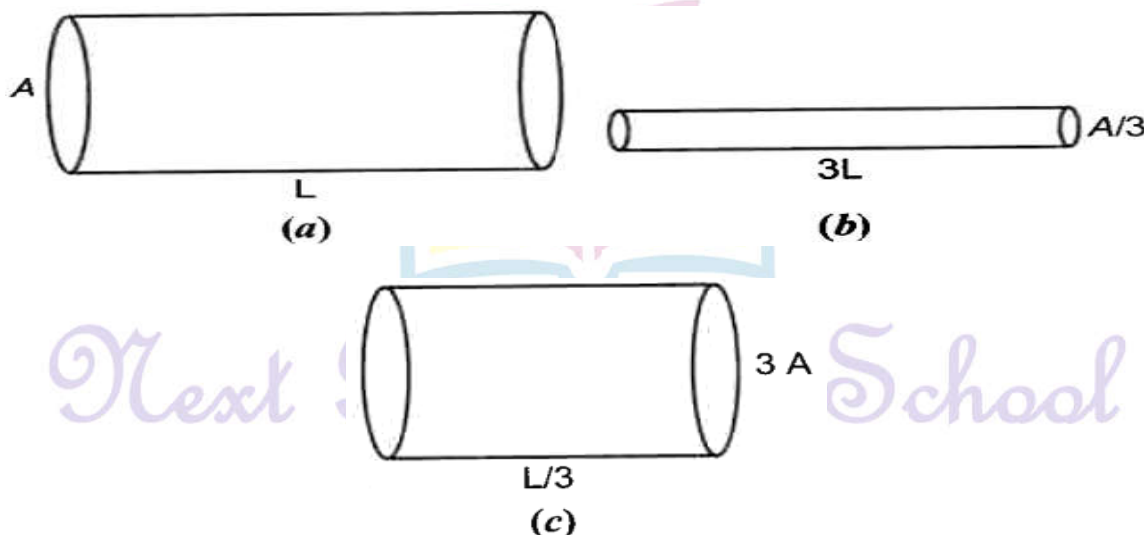
Using Ohm's law,  $R = \frac{V}{I} = \frac{6}{2} = 3\ \Omega$

(b) Reading of ammeter = 2 A

(c) p.d across the terminals of the battery

$$V = V_1 + V_2 = 6 + 12 = 18\text{ V}$$

21. The figure below shows three cylindrical copper conductors along with their face areas and lengths. Discuss in which geometrical shape the resistance will be highest.



Ans. For geometrical shape shown in

Figure (a)  $R_a = \rho \frac{L}{A}$

Figure (b)  $R_b = \rho \left( \frac{3L}{A/3} \right) = \frac{9\rho L}{A} = 9R_a$

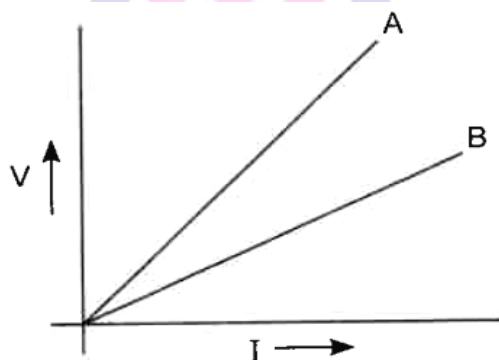
Figure (c)  $R_c = \rho \left( \frac{L/3}{3A} \right) = \frac{1}{9} \cdot \frac{\rho L}{A} = \frac{1}{9} R_a$

Hence,  $R_b > R_a > R_c$

Since all the three conductors are of same material i.e. copper. Hence, they have the same resistivity.

i.e.,  $\rho_a = \rho_b = \rho_c = \rho$

22. V-I graph for two wires A and B are shown in the figure. If both wires are of same length and same thickness, which of the two is made of a material of high resistivity? Give justification for your answer.



**Ans.**

Greater is the slope of V-I graph, greater will be the resistance of given metallic wire. In the given graph, wire A has greater slope than B, Hence, wire A has greater resistance.

For the wires of same length and same thickness resistance depends on the nature of material of the wire, i.e.

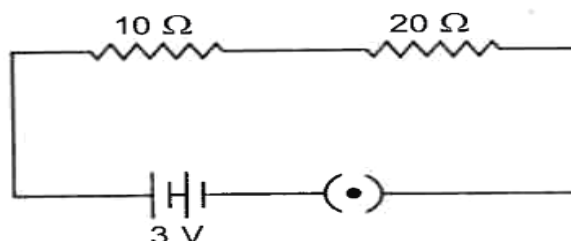
$$R_1 = \rho_1 \frac{1}{A} \text{ and } R_2 = \rho_2 \frac{1}{A}$$

$$\Rightarrow \frac{R_1}{R_2} = \frac{\rho_1}{\rho_2} \text{ or } R \propto \rho$$

Hence, wire 'A' is made of a material of high resistivity.

Next Generation School

23. Study the following electric circuit and find (i) the current flowing in the circuit and (ii) the potential difference 10  $\Omega$  resistor.



**Ans.**

10  $\Omega$  and 20  $\Omega$  are connected in series, their equivalent resistance is

$$R_S = R_1 + R_2 = 10 + 20 = 30 \Omega$$

(i) Current flowing in the circuit

$$I = \frac{V}{R_S} = \frac{3}{30} = \frac{1}{10} = 0.1 A$$

(ii) Potential difference across 10  $\Omega$  resistor

$$V = IR = \frac{1}{10} \times 10 = 1 \text{ volt.}$$

24. Series arrangements are not used for domestic circuits. List any three reasons.

**Ans.** Series arrangements are not used for domestic circuit because

- (i) The electrical appliances need current of widely different values to operate properly.
- (ii) In series arrangement, when one component fails, the circuit is broken and none of the components works.
- (iii) All electrical appliances work at a constant Voltage. But in series circuit, the current is constant throughout the electric circuit and potential is different across the different components. So, series arrangement is not suitable for domestic circuits.

25. Two resistors 3  $\Omega$  and unknown resistor are connected in a series across a 12 V battery . If the voltage drop across the unknown resistor is 6 V, find.

(a) Potential across 3  $\Omega$  resistance.

(b) the current through unknown resistor 'R'

(c) equivalent resistance of the circuit.

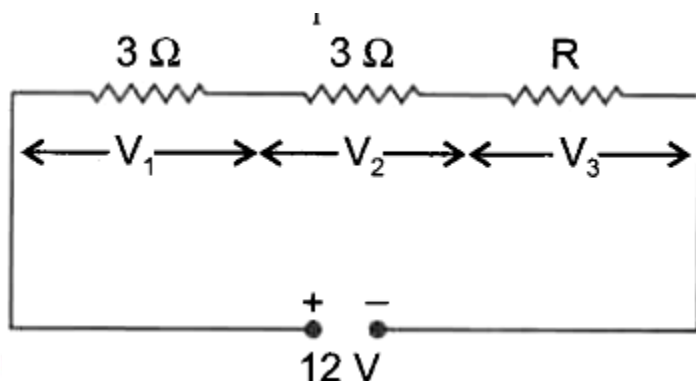
**Ans.** (a) Same current will flow through each resistor of series combination, the potential drop across both 3  $\Omega$  resistor will be same ( $V_1 = V_2$ ). In series, applied potential,

$$V = V_1 + V_2 + V_3$$

$$\Rightarrow 12 = V_1 + V_1 + 6$$

$$\Rightarrow 2V_1 = 12 - 6$$

$$V_1 = 3 \text{ volt}$$



(b) Current through  $3 \Omega$  resistance

$$I = 3 \Omega \text{ resistance}$$

So, current through unknown resistance  $R$  is  $1 \text{ A}$ .

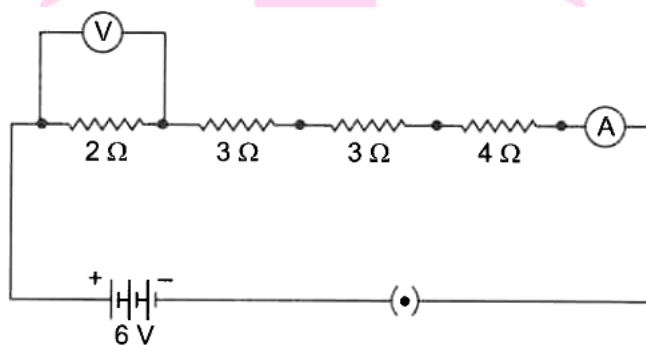
(c) Unknown resistance

$$R = \frac{V}{I} = \frac{6}{1} = 6 \Omega$$

$\therefore$  Equivalent resistance

$$\begin{aligned} R_s &= R_1 + R_2 + R_3 = 3 + 3 + 6 \\ &= 12 \Omega \end{aligned}$$

26. Find out the reading of ammeter and voltmeter in the circuit given below.



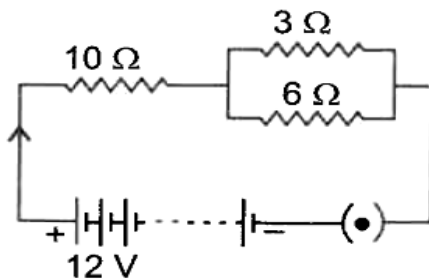
**Ans.** Equivalent resistance of given series combination

$$\begin{aligned} R_s &= R_1 + R_2 + R_3 + R_4 \\ &= 2 + 3 + 3 + 4 = 12 \Omega \end{aligned}$$

(i) Ammeter reading,  $I = \frac{V}{R} = \frac{6}{12} = 0.5 \text{ A}$

(ii) Voltmeter reading,  $V = IR = 0.5 \times 2 = 1 \text{ V}$

27. Consider the circuit shown in the diagram. Find the current in  $3\ \Omega$  resistor.



**Ans.**  $3\ \Omega$  and  $6\ \Omega$  are in parallel.

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$$

$$\therefore R_p = 2\ \Omega$$

$R_p$  and  $10\ \Omega$  are connected in series. So,

$$R_s = R_p + R_3 = 2 + 10 = 12\ \Omega$$

Total current in the circuit,

$$I = \frac{V}{R_s} = \frac{12}{12} = 1\ A$$

$$\text{P.d across } R_p = IR_p = 1 \times 2 = 2\ V$$

$$\text{So, p.d across } 3\ \Omega = 2\ V$$

$$\text{Current through } 3\ \Omega,$$

$$I_1 = \frac{V}{R_1} = \frac{2}{3} = 0.67\ A$$

28. Name the physical quantity which it (i) same (ii) different in all the bulbs when three bulbs of :

- (a) same wattage are connected in series.
- (b) same wattage are connected in parallel.
- (c) different wattage are connected in series.
- (d) different wattage are connected in parallel.

**Ans.** (a) For identical bulbs in series – same current, same potential difference.

(b) For identical bulbs in parallel – same potential different potential difference.

(c) For unidentical bulbs in series – same current, different potential difference.

(d) For unidentical bulbs in parallel – different current, same potential difference.



29. Two resistors with resistance  $5\ \Omega$  and  $10\ \Omega$  are to be connected to a battery of emf 6 V so as to obtain:

(i) minimum current (ii) maximum current

(a) How will you connect the resistances in each case?

(b) Calculate the strength of the total current in the circuit in the two cases.

Ans. (a) As current is inversely proportional to resistance for the same voltage. So, to get maximum current, the equivalent resistance of the circuit has to be less. This means the resistors must be connected in parallel.

To get minimum current, the equivalent resistance of the circuit has to be greater as  $I \propto \frac{1}{R}$ . This means the resistors must be connected in series.

(b) For parallel combination

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} = \frac{2+1}{10} \Rightarrow R_p = \frac{10}{3}\ \Omega$$

$$\therefore I_{\max} = \frac{V}{R_p} = \frac{6}{\frac{10}{3}} = \frac{18}{10} = 1.8\ A$$

For series combination,  $R_s = R_1 + R_2$

$$= 10 + 5 = 15\ \Omega$$

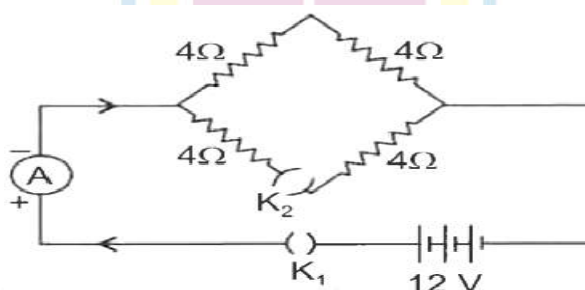
$$\therefore I_{\min} = \frac{V}{R_s} = \frac{6}{15} = \frac{2}{5} = 0.4\ A$$

30. Calculate the electric current in the given circuit when

(i) Key  $K_1$  is open and  $K_2$  is closed

(ii) both the keys are closed

(iii)  $K_1$  is closed and  $K_2$  is open



Ans. (i) Key  $K_1$  is open and  $K_2$  is closed, then no current flows in the circuit as circuit is an open circuit.

(ii) Both the keys are closed : Current flows through the circuit.

Equivalent resistance of the circuit,

$$\frac{1}{R} = \frac{1}{R_1+R_2} + \frac{1}{R_3+R_4}$$

$$= \frac{1}{4+4} + \frac{1}{4+4} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8} = \frac{1}{4}$$

So,  $R = 4 \Omega$

Electric current,

$$I = \frac{V}{R} = \frac{12}{4} = 3 A$$

(iii)  $K_1$  is closed and  $K_2$  is open

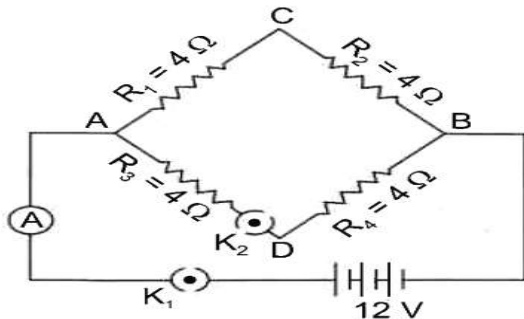
When  $K_2$  is open, the part ADB will become an open circuit, So no current will flow in the ADB part.

$\therefore$  Net resistance of circuit,

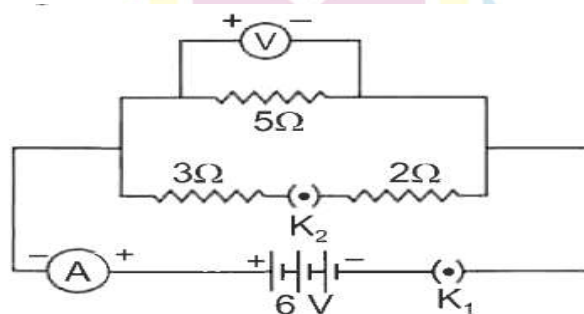
$$R = R_1 + R_2 = 4 + 4 = 8 \Omega$$

$\therefore$  Electric current,

$$I = \frac{V}{R} = \frac{12}{8} = \frac{3}{2} = 1.5 A$$



31. In the given circuit, calculate:



(i) net resistance of the circuit.

(ii) voltmeter reading when

- (a) Both the keys are open, and
- (b) Both the keys are closed.

(iii) current through  $3\ \Omega$  resistor.

Ans. (i) Equivalent resistance of the circuit.

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{3+2} = \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$$

$$\therefore R = \frac{5}{2} = 2.5\ \Omega$$

(ii) Voltmeter reading

(a) When both the keys are open, circuit acts as an open circuit, So, no current flows through it.

Hence,  $V = 0$

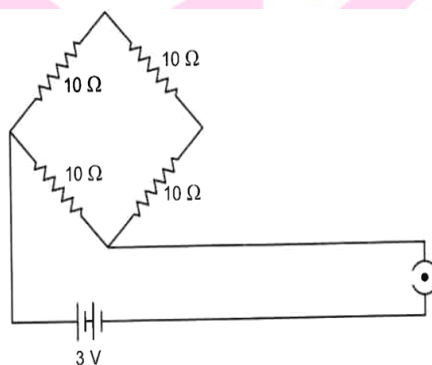
(b) When both the keys are closed due to parallel combination, voltmeter reading across  $5\ \Omega$  is  $6\text{ V}$  and voltage across the series combination of  $3\ \Omega$  and  $2\ \Omega$  is also  $6\text{ V}$ .

(iii) Current through  $3\ \Omega$ ,

$$I = \frac{V}{R} = \frac{6}{5}$$

$$= 1.2\text{ A } (R = 3 + 2 = 5\ \Omega)$$

32. Find the current drawn from the battery by the network of four resistors shown in the figure.



Ans. Equivalent resistance of the given network is

$$\frac{1}{R} = \frac{1}{R_4} + \frac{1}{R_4 + R_2 + R_3}$$

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

$$= \frac{1}{10} + \frac{1}{30} = \frac{3+1}{30} = \frac{4}{30}$$

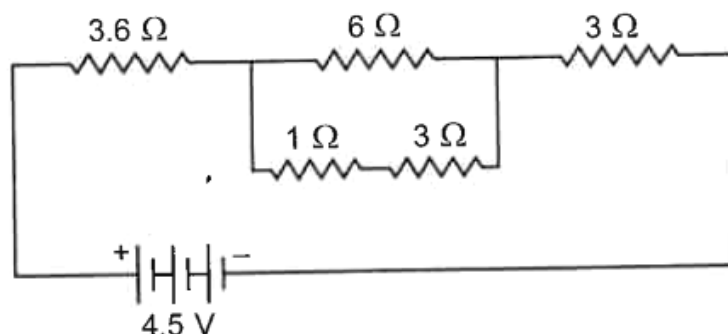
$$R = \frac{30}{4} = 7.5\ \Omega$$

Current drawn from the battery

$$I = \frac{V}{R} = \frac{3}{7.5} = \frac{30}{75} = \frac{2}{5}$$

$$I = 0.4 \text{ A}$$

33. Find the current flowing through the following electric circuit.



**Ans.** Series combination of  $1 \Omega$  and  $3 \Omega$  resistance is in parallel combination with  $6 \Omega$ . Their equivalent resistance is

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{3+1} = \frac{1}{6} + \frac{1}{4} = \frac{2+3}{12}$$

$$\therefore R_p = \frac{12}{5} = 2.4 \Omega$$

Now,  $3.6 \Omega$ ,  $2.4 \Omega$  and  $3 \Omega$  are in series, their equivalent resistance be

$$\begin{aligned} R_s &= R_1 + R_2 + R_3 \\ &= 3.6 + 2.4 + 3 = 9 \Omega \end{aligned}$$

Hence, the current flowing through the circuit is

$$I = \frac{V}{R} = \frac{4.5}{9} = \frac{45}{9} = \frac{1}{2} = 0.5 \text{ A.}$$

34. Show how would you join three resistors, each of resistance  $9 \Omega$  so that the equivalent resistance of the combination is (a)  $13.5 \Omega$ , (b)  $6 \Omega$ ?

**Ans.** (a) When two  $9 \Omega$  resistances are in parallel and the third is in combination to this, the equivalent resistance will be  $13.5 \Omega$  as shown below.

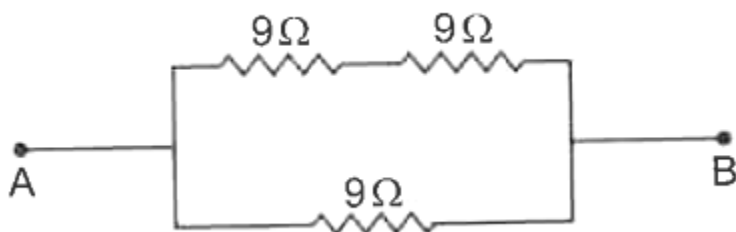
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{1}{9} + \frac{1}{9} = \frac{2}{9}$$

$$R_p = \frac{9}{2} \Omega = 4.5 \Omega$$

$$R_s = R_p + R_3 = 4.5 + 9 = 13.5 \Omega$$

(b) When two  $9 \Omega$  resistances are in series and the third is in parallel to them, then it will be  $6 \Omega$ .



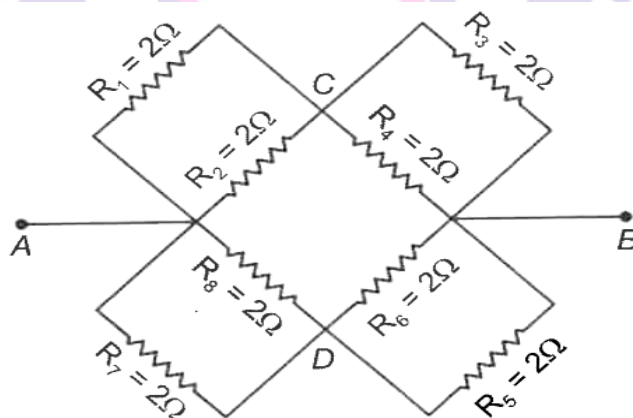
For series,  $R_s = R_1 + R_2 = 9 + 9 = 18 \Omega$

For parallel,  $\frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{R_3}$

$$= \frac{1}{18} + \frac{1}{19} = \frac{3}{18} = \frac{1}{6}$$

Therefore,  $R_p = 6 \Omega$

**35. Find the equivalent resistance across the two ends A and B of this circuit.**



**Ans.** The equivalent resistance of the resistors  $R_1$  and  $R_2$  in parallel between A and C is

$$\frac{1}{R_{AC}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1$$

Similarly, between B and C,

$$\frac{1}{R_{BC}} = \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{2} + \frac{1}{2} = 1$$

$$\therefore R_{BC} = 1 \Omega$$

Now,  $R_{AC}$  and  $R_{BC} = 1 + 1 = 2 \Omega$

Parallel combination of  $R_8$  and  $R_7$  between A and D gives

$$R_{AD} = 1 \Omega$$

And parallel combination of  $R_5$  and  $R_6$  between D and B gives.

$$R_{DB} = 1 \Omega$$



The equivalent resistance of series combination of  $R_{AD}$  and  $R_{DB}$  is

$$R^n = R_{AD} + R_{DB} = 1 + 1 = 2\Omega$$

$$R'' = R_{AD} + R_{DB} = 1 + 1 = 2\Omega$$

$R'$  and  $R''$  are connected in parallel.

The equivalent resistance is

$$\frac{1}{R_{eq}} = \frac{1}{R'} + \frac{1}{R''} = \frac{1}{2} + \frac{1}{2} = 1$$

$$\therefore R_{eq} = 1\Omega$$

**36. A student boils the water in an electric kettle for 20 minutes after being switched on. Using the same mains supply, he wants to reduce the boiling time of water. To do so, should he increase or decrease the length of the heating element? Justify your answer.**

**Ans.** reduce the boiling time of water, using the same mains supply, the rate of heat production should be large. We know that  $P = \frac{V^2}{R}$ , clearly  $R$  should be decreased. Since  $R \propto l$ , therefore, the length of heating element should be decreased.

**37. An electric geyser rated 1500 W, 250 V is connected to a 250 V line mains.**

**Calculate:**

**(i) the electric current drawn by it.**

**(ii) energy consumed by it in 50 hours.**

**(iii) cost of energy consumed if each unit cost ₹ 6.00**

**Ans.**

Given:  $P = 1500\text{ W}$ ,  $V = 250\text{ V}$

**(i)** Current drawn,  $I = \frac{P}{V} = \frac{1500}{250} = 6\text{ A}$

**(ii)** Electric energy consumed by geyser in 50 hours

= Power X time

$$= 1500 \times 50 = 75000\text{ Wh} = 75\text{ kWh}$$

Since 1 kWh = 1 unit

So, energy consumed = 75 unit

**(iii)** Cost of one unit = ₹ 6.00

$\therefore$  Cost of 75 units

$$= ₹ 75 \times 6.00 = ₹ 450.00$$

**38. (a) Write Joule's law of heating.**

**(b) Two lamps, one rated 100 W; 220 V, and the other 60 W; 220 V, are connected in parallel to electric mains supply. Find the current drawn by two bulbs from the line, if the supply voltage is 220 V.**

**Ans.** (a) Joule's law of heating: It states that the amount of heat produced in a conductor is

(i) directly proportional to the square of current flowing through it, i.e.

$$H \propto I^2$$

(ii) directly proportional to the resistance of the conductor for a given current and time, i.e.

$$H \propto R$$

(iii) directly proportional to the time for which current is flowing through it, i.e.

$$H \propto t$$

$$H \propto I^2 R t$$

or

$$H \propto K I^2 R t$$

where K is proportionality constant and in SI system, it is equal to one.

**(b) Both the bulbs are connected in parallel. The resistance of each bulb is**

$$R_{100} = \frac{220^2}{100}$$

$$R_{60} = \frac{220^2}{60} \quad \therefore \left( P = \frac{V^2}{R} \right)$$

Current drawn by 100 W bulb

$$= \frac{220}{R_{100}} = \frac{100}{220} A = 0.45 A$$

Current drawn by 60 W bulb

$$= \frac{220}{R_{60}} = \frac{60}{220} A = 0.27 A$$

$$\left( \therefore I = \frac{V}{R} \right)$$

Total current drawn from the line

$$= 0.45 A + 0.27 A = 0.72 A$$

Or

For 1<sup>st</sup> bulb,  $P = VI$

$P = 100 \text{ W}, V = 220 \text{ V}, I_1 = ?$

$$100 = 220 \times I_1$$

$$I_1 = \frac{100}{220} = \frac{5}{11} \text{ A}$$

For 2<sup>nd</sup> bulb,  $P = VI$

$P = 60 \text{ W}, V = 220 \text{ V}, I_2 = ?$

$$60 = 220 \times I_2$$

$$I_2 = \frac{60}{220} = \frac{3}{11} \text{ A}$$

Total current drawn from the lines,

$$I = I_1 + I_2$$

$$I = \frac{5}{11} + \frac{3}{11} = \frac{8}{11} \text{ A}$$

$$I = 0.72$$

**39. An electric bulb of resistance  $200 \Omega$  draws a current of 1 Ampere. Calculate the power of the bulb, the potential difference at its ends and the energy in k Wh consumed in burning it for 5 h.**

**Ans.** Power of the bulb,

$$P = I^2 R = (1)^2 \times 200$$

$$\Rightarrow P = 200 \text{ W}$$

Energy consumed by bulb in 5h in burning = power  $\times$  time =  $200 \times 5 = 1000 \text{ Wh} = 1 \text{ k Wh}$

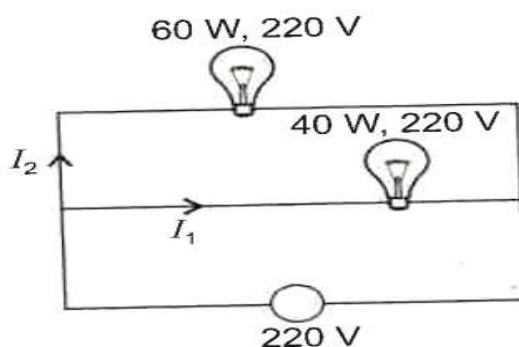
**40. Two lamps , one rated 60 W at 220 V and the other 40 W at 220 V, are connected parallel to the electric supply at 220 V.**

**(a) Draw a circuit diagram to show the connections.**

**(b) Calculate the current drawn from the electric supply.**

**(c) Calculate the total energy consumed by the two lamps together when they operate for one hour.**

**Ans. (a)**



(b) Current drawn by 40 W lamp:

$$I_1 = \frac{P}{V} = \frac{40}{220} = \frac{2}{11} \text{ A}$$

Current drawn by 60 W lamp:

$$I_2 = \frac{60}{220} = \frac{3}{11} \text{ A}$$

Total current drawn from the electric supply

$$I = I_1 + I_2$$

$$= \frac{2}{11} + \frac{3}{11} = \frac{5}{11} \text{ A} = 0.45 \text{ A}$$

(c) Total energy consumed in one hour =  $60 \times 1 + 40 \times 1 = 100 \text{ Wh} = 0.1 \text{ kWh}$

**41. Two lamps, one rated 100 W at 220 V and other 220 W at 220 V are connected (i) in series and (ii) in parallel to electric main supply of 220 V. Find the current drawn in each case.**

**Ans.** Resistance of each bulb is

$$R_1 = \frac{V^2}{P_1} = \frac{(220)^2}{100} = 484 \Omega$$

$$R_2 = \frac{V^2}{P_2} = \frac{(220)^2}{220} = 220 \Omega.$$

(i) Equivalent resistance when both are connected in series.

$$R_s = R_1 + R_2 = 484 + 220 = 704 \Omega$$

$$\text{Current, drawn, } I_s = \frac{V}{R_s} = \frac{220}{704} = \frac{5}{16} = 0.31 \text{ A}$$

(ii) Equivalent resistance when both are connected in parallel.

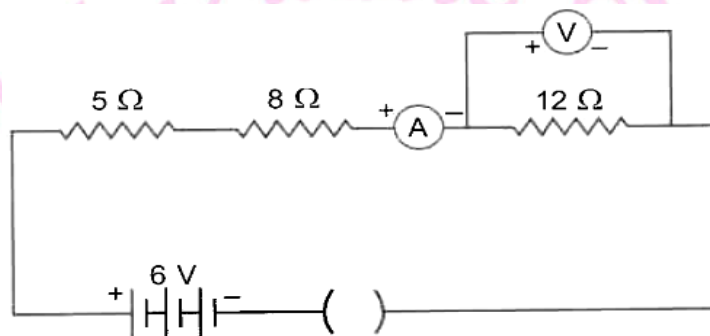
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{484} + \frac{1}{220}$$

$$= \frac{2+1}{484} = \frac{3}{484}$$

$$R_p = \frac{484}{3} \Omega$$

$$\text{Current drawn, } I_p = \frac{V}{R_p} = \frac{220 \times 3}{484} = \frac{30}{22} = 1.36 \text{ A}$$

42. Consider the following circuit:



What would be the readings of the ammeter and the voltmeter when key is closed? Give reason to justify your answer.

**Ans.** All the resistor are connected in series

$$\therefore R = R_1 + R_2 + R_3 = 5 + 8 + 12 = 25 \Omega$$

$$\text{Current, } I = \frac{V}{R} = \frac{6}{25} = 0.24 \text{ A}$$

Hence current through  $12 \Omega$  resistor

$$= \frac{6}{25} = 0.24 \text{ A}$$

Hence, reading of voltmeter

$$V = IR = \frac{6}{25} \times 12 = \frac{72}{25}$$

$$\text{or } V = 2.88 \text{ V}$$

43. What is electrical resistivity? Define its SI unit. In a series electrical circuit comprising a resistor made up of a metallic wire, the ammeter reads 100 mA. If the length of the wire is double, how will the circuit change? Justify your answer.

**Ans. Resistivity :** The resistance offered by the conductor of length 1 m area of cross-section  $1 \text{ m}^2$  is called electrical resistivity of the material of conductor.

$$\text{It is given by } \rho = \frac{RA}{l}$$

$$\therefore \text{Unit of } \rho = \frac{\text{ohm-m}^2}{\text{m}} = \text{ohm-meter}$$



Since  $R \propto l$  therefore if length is doubled resistance to half.

$$\therefore \text{Ammeter reading} = \frac{100 \text{ mA}}{2} = 50 \text{ mA}$$

**44. Calculate the total cost of running the following electrical devices in the month of September, if the rate of 1 unit of electricity is ₹ 6.00.**

(i) Electric heater of 1000 W for 5 hours daily.

(ii) Electric refrigerator of 400 W for 10 hours daily.

**Ans.**  $P_1 = 1000 \text{ W} = 1 \text{ kW}$  ;  $t = 5 \text{ h}$  : September has 30 days  $\therefore n = 30$

$$P_2 = 400 \text{ W} = \frac{400}{1000} \text{ kW} = \frac{2}{5} \text{ kW}; t = 10 \text{ h}$$

$$\text{So } E_1 = P_1 \times t_1 \times n = 1 \times 5 \times 30 = 150 \text{ kWh}$$

$$\therefore \text{Total energy} = 150 + 120 = 270 \text{ kWh}$$

$$\therefore \text{Total cost of electrical energy consumed}$$

$$= ₹ 270 \times 6 = ₹ 1620.00$$

**45. The parallel combination of two  $10 \Omega$  resistors are placed across the terminals of a 24 V battery.**

(a) What is the effective resistance of the parallel circuit.

(b) What is the current through the entire circuit?

(c) What is the current through each branch of the circuit?

**Ans.** (a) Equivalent resistance of the parallel combination is given by

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}$$

(b) From ohm's law,

$$I = V/R = 24/5 = 4.8 \text{ A}$$

$$(c) \quad I_1 = \frac{V}{R} = \frac{24}{10} = 2.4 \text{ A}$$

$$I_2 = \frac{V}{R} = \frac{24}{10} = 2.4 \text{ A}$$

**46.(a) When a particle of charge  $10 \mu\text{C}$  is brought from infinity to a point in the electric field, 10 mJ work is done by the external forces. What is the potential at that point?**

**(b) Draw an electric circuit to describe ohm's law. Label the circuit components used to measure electric current and potential difference.**

**Ans.** (a) Given:  $Q = 10 \mu C = 10 \times 10^{-6} C = 10^{-5} J$

$$W = 10 \text{ mJ} = 10 \times 10^{-3} J = 10^{-2} J$$

At infinity potential is zero

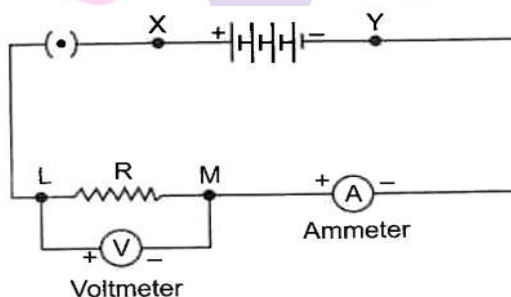
Using,  $V_A - V_B = \frac{W}{Q}$

$$\Rightarrow V - V_{\infty} = \frac{W}{Q} \text{ (let } V_A = V, V_B = V_{\infty})$$

$$\Rightarrow V - 0 = \frac{10^{-2}}{10^{-5}}$$

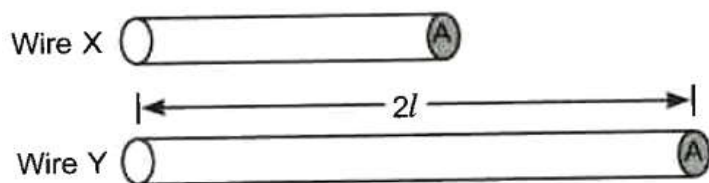
$$\Rightarrow V = 10^{-2+5} = 10^3 = 1000 \text{ V}$$

**(b) Circuit diagram**



47. (a) 100 J of work is done in transferring 20 C of charge between two points in a conductor. Find the resistance offered by the conductor, if a current of 2A flows through it.

(b) Out of the two wires X and Y shown below, which one has greater resistance? Justify your answer.



**Ans.** (a) Given:  $W = 1000 J, q = 20 C, I = 2 A, R = ?$

Work done in carrying 20 C charge

$$W = qV$$

From ohm's law,  $V = IR$

$$\therefore W = q(IR)$$

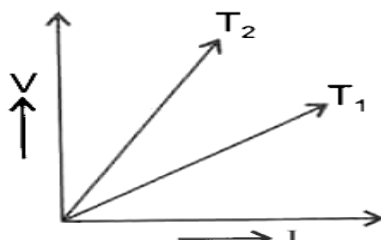
$$\Rightarrow R = \frac{W}{qI} = \frac{100}{20 \times 2} = \frac{5}{2}$$

$$\Rightarrow R = 2.5 \Omega$$

(b) Wire 'Y' has greater resistance as it has more length than wire 'X', It is because resistance of wire is directly proportional to the length of wire for the same area of cross-section for the same material.

48. (a) Keeping the potential difference constant, the resistance of a circuit is doubled. By what factor does the current change in the circuit?

(b) The voltage - current ( $V - I$ ) graph for a conductor at two different temperature  $T_1$  and  $T_2$  ( $V - I$ ) graph for a conductor at two different temperature  $T_1$  and  $T_2$  ( $V - I$ ) is shown. At which of the two temperatures the resistance of the conductor is higher? Justify your answer.



Ans. Using ohm's law,  $V = IR$

For constant potential difference

$$IR = \text{constant}$$

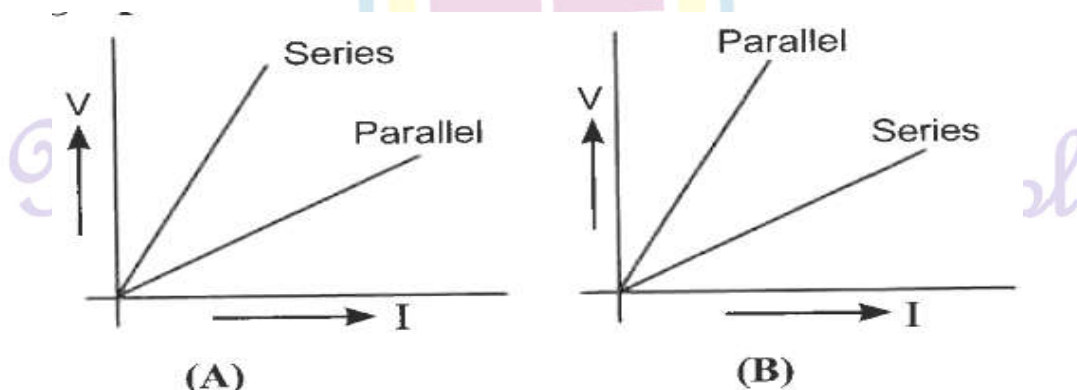
$$\text{i.e., } I_1 R_1 = I_2 R_2$$

$$\therefore \frac{I_2}{I_1} = \frac{R_1}{R_2} = \frac{R}{2R} = \frac{1}{2} \Rightarrow I_2 = \frac{1}{2} I_1$$

So, current will reduced to half of its initial value .

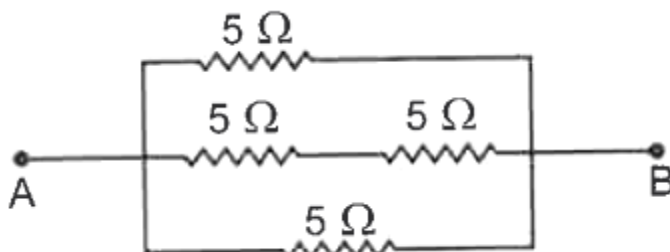
(b) Slope of the  $V - I$  graph represents the resistance of the given conductor at given temperature. At the temperature  $T_2$ , the resistance of the conductor is higher as it has greater slope than that of at temperature  $T_1$ .

49. (a) Two students perform the experiments on series and parallel combinations of two given resistors  $R_1$  and  $R_2$  and plot the following  $V - I$  graphs

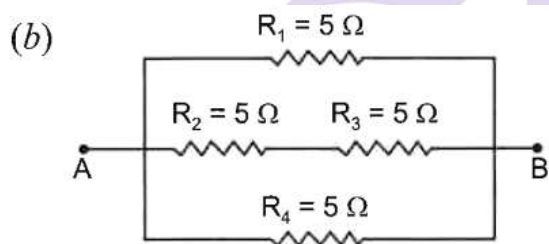


Which of the two diagrams correctly represents the labels 'series and parallel' on the plotted curves? Justify your answer.

(b) Find the equivalent resistance across the two ends A and B of the following circuit.



**Ans.** (a) In series, the resistances are added so, the equivalent resistance will be more than the case when they are connected in parallel. Also the slope ( $V/I$ ) of given  $V - I$  graph gives the resistance. Slope ( $V/I$ ) is more for series and less for parallel in 'A'. So graph 'A' is correct



$R_2$  and  $R_3$  are in series, so

$$R_s = R_2 + R_3 = 5 + 5 = 10 \, \Omega$$

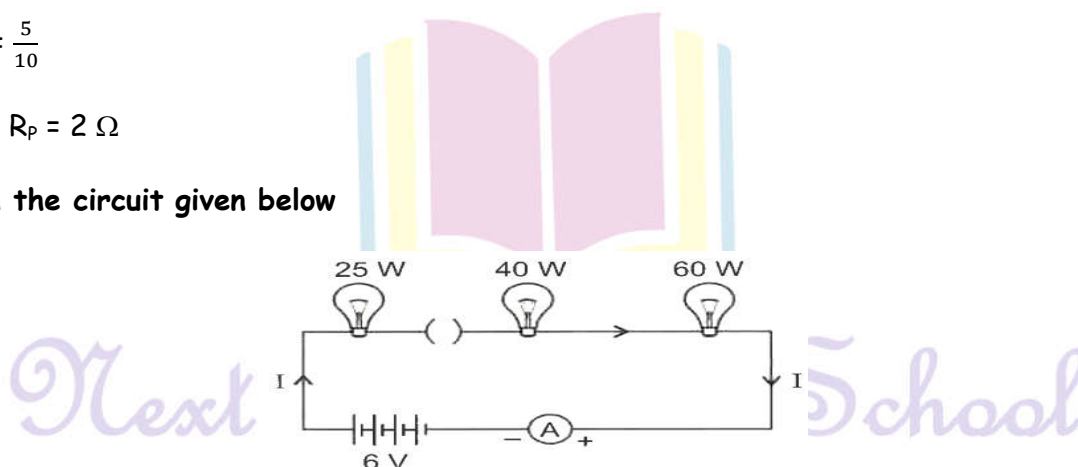
$R_1$ ,  $R_s$  and  $R_4$  are in parallel. So

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_s} + \frac{1}{R_4} = \frac{1}{5} + \frac{1}{10} + \frac{1}{5}$$

$$\frac{1}{R_p} = \frac{5}{10}$$

$$\text{or } R_p = 2 \, \Omega$$

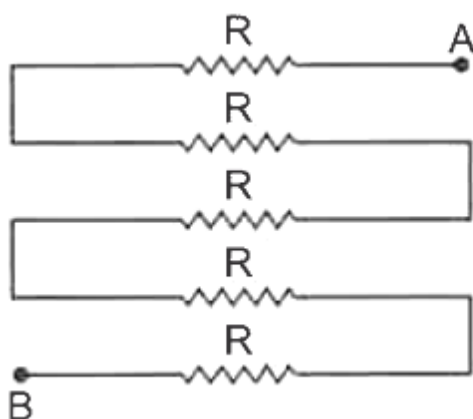
50. (a) In the circuit given below



(i) Would any bulb glow when plug key is in open position?

(ii) Write the order of brightness of the bulb when key is closed. Give reason.

(b) Find the equivalent across the two ends A and B of the following circuit.



**Ans.** (a) (i) No bulb will glow when plug key is open positions as no current would flow through the circuit.

(ii) Power of bulb,  $P = I^2 R$

For the same current  $P \propto R$

But for the same voltage  $P \propto \frac{1}{R}$  or  $R \propto \frac{1}{P}$

So, resistance order of all bulb is,

$$R_{25} > R_{40} > R_{60}$$

According to Joule's law of heating,  $H \propto R$  ( for the same current and time)

Hence, order of heating produced is

$$H_{25} > H_{40} > H_{60}$$

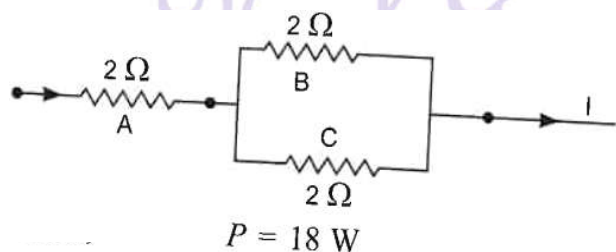
Which is order of brightness of the bulbs when key is closed.

(b) All five resistance are connected in series. Therefore, their equivalent resistance is.

$$R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5$$

$$= R + R + R + R + R = 5R$$

**51.** Three  $2\ \Omega$  resistor, A, B and C are connected as shown in figure. Each of them dissipates energy and can withstand a maximum power of 18 W without melting. Find the maximum current that can flow through the three resistors.



**Ans. Here,**

Since A is in series with the parallel combination of B and C. So, it carries maximum current.

Using  $P = I^2 R$ , we get

$$I^2 = \frac{P}{R} = \frac{18}{2} = 9$$

$$\Rightarrow I = 3 \text{ A}$$

Let  $I_B$  and  $I_C$  be the current flowing through B and C respectively. As they are in parallel, potential difference across them will be same so

$$I_B R_B = I_C R_C$$

$$\text{or } \frac{I_B}{I_C} = \frac{R_C}{R_B} = \frac{2}{2} = 1$$

$$\Rightarrow I_B = I_C$$

$$\text{But } I_B + I_C = I = 3 \text{ A}$$

$$\therefore 2I_B = 3$$

$$\text{or } I_B = \frac{3}{2} = 1.5 \text{ A}$$

**52. Should be resistance of an ammeter be low or high? Give reason.**

**Ans.** The resistance of an ammeter should be low so that it will not disturb the magnitude of current of the circuit when connected in series in a circuit.

**53. How does use of a fuse wire protect electrical appliances?**

**Ans.** The fuse wire is always connected in series with the live wire or electrical devices. If the flow of current exceeds the specified devices. If the flow of current exceeds the specified preset value due to some reason, the heat produced melts it and disconnects the circuit or the device from the mains. In this way, fuse wire protects the electrical appliances.

**54. What is electrical resistivity? In a series electrical circuit comprising a resistor made up of a metallic wire, the ammeter reads 5 A. The reading of the ammeter decrease to half when the length of the wire is doubled. Why?**

**Ans.** The resistance offered by a metallic wire of unit length and unit cross-sectional area is called electrical resistivity.

We know that

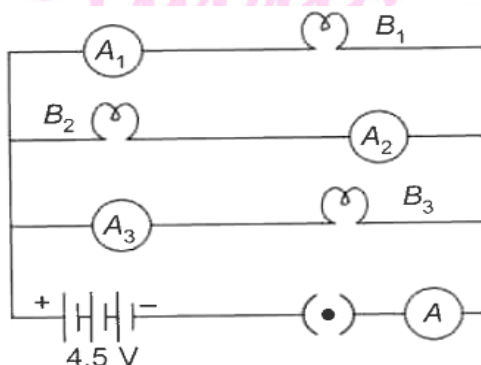
$$R = \rho \frac{L}{A} \text{ and } V = IR$$



So,  $R \propto l$  and  $I \propto \frac{1}{R}$ , ( $V$  is constant)

Hence, when the length of wire is doubled the resistance becomes double and current decreases to half.

55.  $B_1$ ,  $B_2$  and  $B_3$  are three identical bulbs connected as shown in figure. When all the three bulbs glow, a current of 3A is recorded by the ammeter A.



(i) What happens to the glow of the other two bulbs when the bulb  $B_1$  gets fused?

(ii) What happens to the reading of  $A_1$ ,  $A_2$ ,  $A_3$  and A when the bulb  $B_2$  gets fused?

(iii) How much power is dissipated in the circuit when all the three bulbs glow together?

**Ans.** (i) Since  $B_1$ ,  $B_2$  and  $B_3$  are in parallel, the potential difference across each of them will remain same. So when the bulb  $B_1$  gets fused,  $B_2$  and  $B_3$  have the same potential and continues with same energy dissipated per second, i.e. they will glow as they were glowing before.

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}$$

$$\frac{1}{R_p} = \frac{R}{3}$$

Ammeter 'A' reads 3 A current

$$\text{So, } V = IR_p$$

$$4.5 = 3 \times \frac{R}{3} \Rightarrow R = 4.5 \Omega$$

So, resistance of each bulb =  $4.5 \Omega$

Now when bulb  $B_2$  gets fused, the equivalent resistance of parallel combination of  $B_1$  and  $B_3$  is

$$\text{As } R'_p = \frac{R}{2}$$

$\therefore$  Ammeter 'A' reads now,

$$r = \frac{V}{R'_p}$$

$$r = \frac{4.5}{R/2} = \frac{4.5 \times 2}{4.5} = 2 \text{ A}$$

Since resistance of each arm is same and p.d. is also same, current divides them equally. So 1 A current will pass through each bulb  $B_1$  and  $B_3$ .

Therefore, ammeter  $A_1$  and  $A_3$  reads 1 A current while  $A_2$  will read zero and A read 2 A current.

(iii) In parallel, total power consumed

$$P_{eq} = P_1 + P_2 + P_3$$

So, when all the three bulbs glow together

$$P_{eq} = P + P + P$$

$$( \text{As } P_1 = P_2 = P_3 = P )$$

$$= 3P = 3 \times V \times I$$

$$= 3 \times 4.5 \times 1 = 13.5 \text{ W.}$$

(Current through each bulb = 1 A)

### Long Answer Type Questions

(5 Marks)

1. What is meant by electric current? Name and define its SI unit. In a conductor electrons are flowing from B to A. What is the direction of conventional current? Give justification for your answer.

A steady current of 1 ampere flows through a conductor. Calculate the number of electrons that flows through any section of the conductor in 1 second. (Charge on electron  $1.6 \times 10^{-19}$  coulomb).

**Ans. Electric current:** The amount of charge 'Q' flowing through a particular area of cross section in unit time 't' is called electric current i.e.

$$\text{Electric current, } I = \frac{Q}{t}$$

SI unit of electric current is ampere.

**One ampere** of current is that current which flow when one coulomb of electric charge flowing through particular area of cross-section of the conductor in one second, i.e  $1\text{A} = 1\text{Cs}^{-1}$

**The direction** of conventional current is A to B, i.e opposite to the direction of flow of electrons. In a metal, flow of electrons carrying negative charge constitutes the current.

Direction of flow of electrons gives the direction of electronic current by convention, the direction of flow of positive charge is taken as the direction of conventional current.

Charge,  $q = It = ne$

$$n = \frac{It}{e} = \frac{1 \times 1}{1.6 \times 10^{-19} \text{ C}} = \frac{10^{19}}{1.6}$$

$$= 6.25 \times 10^{18} \text{ electrons}$$

2. (a) Calculate the resistance of 1 km long copper wire of radius 1 mm. Resistivity of the copper is  $1.72 \times 10^{-8} \Omega \text{ m}$ .

(b) Draw a schematic diagram of a circuit consisting of a battery of 4 cells of 2 V each connected to a key, an ammeter and two resistors of  $2 \Omega$  and  $3 \Omega$  respectively in series and a voltmeter to measure potential difference across  $3 \Omega$ .

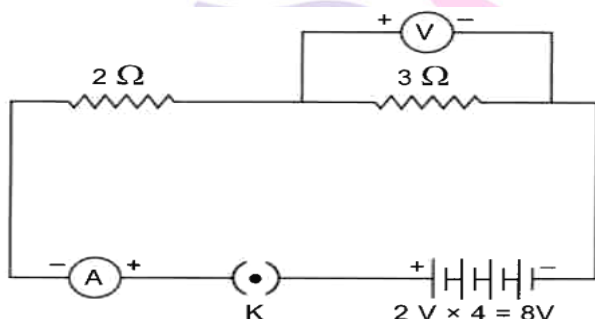
Ans. (a) Resistance,  $R = \rho \frac{1}{A} = \rho \frac{1}{\pi r^2}$

On substituting the values, we get

$$R = \frac{1.72 \times 10^{-8} \times 10^3}{3.14 \times (1 \times 10^{-3})^2}$$

$$= \frac{1.72}{3.14} \times 10 = \frac{17.2}{3.14} = 5.47 \Omega$$

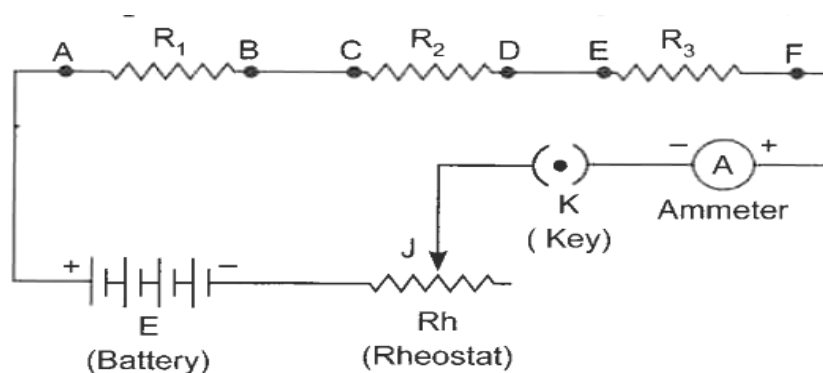
(b)



3. Draw a labelled circuit diagram showing three resistor  $R_1$ ,  $R_2$  and  $R_3$  connected in series with a battery (E), a rheostat (Rh), a plug key (k) and an ammeter (A) using standard circuit symbol. Use this circuit to show that the same current flows through every part of the circuit. List two precautions you would observe while performing the experiment.

Ans.

Next Generation School



**Aim :** Same current flows through every part of the above circuit.

**Procedure:**

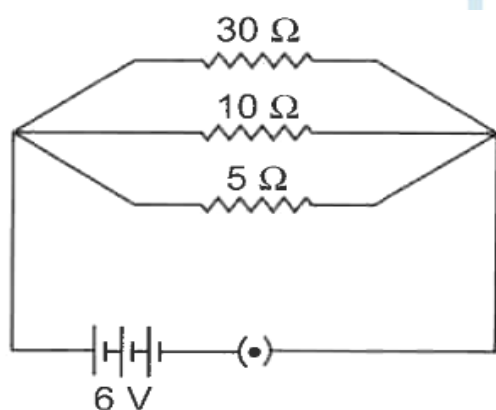
- (i) Connect the another ammeters, ' $A_1$ ' between B and C, and ' $A_2$ ' between D and E.
- (ii) Adjust the sliding contact 'J' of the rheostat initially for a small current.
- (iii) Note all the ammeter readings. This reading gives us current flowing the resistors  $R_1, R_2$  and  $R_3$ .
- (iv) The current in the circuit is now increased by changing the position of sliding contact 'J' of the rheostat.
- (v) Note all the ammeter readings each time.

**Conclusion :** Same reading of all the ammeter in each observation concluded that same current flows through every part of the circuit.

**Precautions:**

- (i) All the connection should be tight and properly connected as per circuit diagram.
- (ii) The positive terminal of the ammeter and voltmeter must be connected to the positive terminal of the battery or battery eliminator.

**4. Two wires A and B are of equal length and have equal resistance. If the resistivity of A is more than that of B which wire is thicker and why?**



For the electric circuit given below calculate:

- (i) Current in each resistor,
- (ii) Total current drawn from the battery, and
- (iii) Equivalent resistance of the circuit.

**Ans. Using,  $R = \rho \frac{l}{A}$**

$$\Rightarrow \frac{\rho}{A} = \frac{R}{l}$$

= Constant = k (for same l and R)

$$\Rightarrow \rho = k A$$

$$\Rightarrow \rho \propto A$$

So, for different material, greater resistivity material wire has more cross-sectional area.

Hence, wire A is thicker than that of B.

(i) Current through each resistor

$$I_1 = \frac{V}{R_1} = \frac{6}{5} = 1.2 \text{ A}$$

$$I_2 = \frac{V}{R_2} = \frac{6}{10} = 0.6 \text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{6}{30} = 0.2 \text{ A}$$

Current in 5  $\Omega$ , 10  $\Omega$  and 30  $\Omega$  are therefore, 1.2 A, 0.6 A and 0.2 A respectively.

(ii) current drawn from the battery

$$\begin{aligned} I &= I_1 + I_2 + I_3 = 1.2 + 0.6 + 0.2 \\ &= 2.0 \text{ A} \end{aligned}$$

(iii)  $R_1 = 5\Omega$ ,  $R_2 = 10 \Omega$  and  $R_3 = 30 \Omega$  are connected in parallel. So their equivalent resistance

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{5} + \frac{1}{10} + \frac{1}{30} = \frac{1}{3}$$

$$R = 3 \Omega$$

5. Three bulbs each having power P are connected in series in an electric circuit. In another circuit, another set of three bulbs of same power are connected in parallel to the same source.

(i) will the bulbs in both the circuit glow with the same brightness? Justify your answer.

(ii) Now let one bulb in each circuit get fused. Will the rest of the bulbs continue to glow in each circuit ? Give reason.

(iii) Representing each bulb by a resistor, draw circuit diagram for each case.

**Ans.** (i) Bulbs in parallel provide more illumination. This is because in parallel combination.

(a) Each bulb gets same voltage and is equal to the applied voltage.

(b) Each bulb draws required current from the mains. Hence, they work properly

**Mathematical justification :**

For three identical bulbs,

In series,  $R_s = 3R$

In parallel,  $R_p = \frac{R}{3}$

The bulbs in the two circuits will not glow equally bright as the current through them is not the same.

In series,  $I_s = \frac{V}{R_s} = \frac{V}{3R}$

In parallel,  $I_p = \frac{V}{R/3} = \frac{3V}{R}$

So,  $I_p > I_s$

(ii) When one bulb in each circuit get fused.

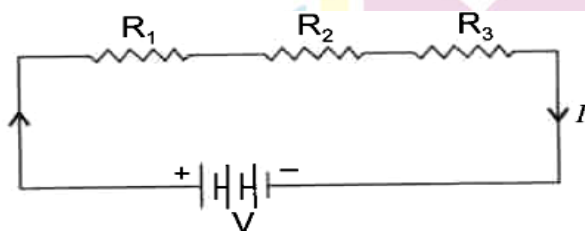
**In series:** Rest of the bulbs will not glow as circuit becomes an open circuit. This is because in series arrangement, there is only a single path for the flow of current.

**In parallel :** Rest of the bulbs will continue to glow as in parallel

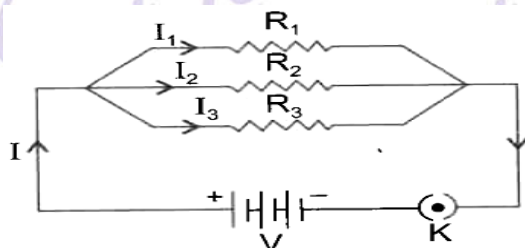
(a) Individual branch in the circuit completes its own circuit. or

(b) Different paths are available for the flow of current.

(iii) Circuit diagram



For series



For parallel



6. (a) Though same current flows through the electric line wires and the filament of bulbs, yet only the filament glows. Why?

(b) The temperature of the filament of bulb is  $2700^{\circ}\text{C}$  when it glows. Why does it not get burnt up at such high temperature?

(c) The filament of an electric lamp, which draws a current of  $0.25\text{ A}$  is used for four hours. Calculate the amount of charge flowing through circuit.

(d) An electric iron is rated  $2\text{ kW}$  at  $220\text{ V}$ . Calculate the capacity of the fuse that should be used for the electric iron.

**Ans.** (a) Electric line wires offer extremely low resistance to the flow of current, so they do not glow because negligible heat is produced in it.

The filament of bulb glows because it becomes red hot due to large amount of heat produced, as it offers high resistance to the flow of current through it.

(b) The filament of bulb when it glow at  $2700^{\circ}\text{C}$  does not get burnt because the tungsten metal of filament has

(i) a very high melting point (of  $3380^{\circ}\text{C}$ ) and

(ii) a high resistivity.

(c) Given :  $I = 0.25\text{ A}$ ,  $t = 4\text{ h} = 4 \times 60 \times 60\text{ sec}$ .

So, amount of charge flowing the filament of electric lamp

$$Q = It = 0.25 \times 4 \times 60 \times 60 = 3600\text{ C}$$

(d) Given

$$P = 2\text{ kW} = 2000\text{ W}$$

$$V = 220\text{ V}$$

Using

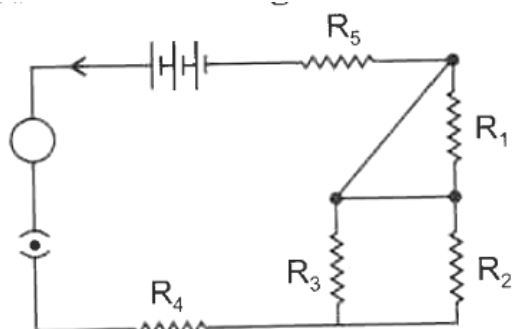
$$2000 = 220 \times I$$

$\Rightarrow$

$$I = \frac{2000}{220} = 9.09\text{ A}$$

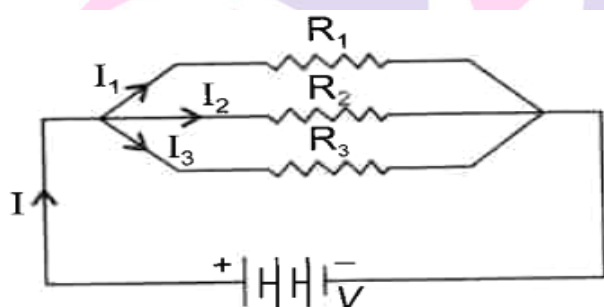
So, the capacity of the fuse that should be used for the electric iron is  $10\text{ A}$ .

7. Deduce the expression for the equivalent resistance of the parallel combination of three resistors  $R_1$ ,  $R_2$  and  $R_3$ . Consider the following electric circuit:



- Which two resistors are connected in series?
- Which two resistors are connected in parallel?
- If every resistor of the circuit is of  $2\ \Omega$ , what current will flow in the circuit?

**Ans.** Consider the following parallel circuit shown below:



[Parallel circuit]

Let  $I_1$ ,  $I_2$  and  $I_3$  be the current flow through the resistors  $R_1$ ,  $R_2$  and  $R_3$  connected in parallel.

Using Ohm's law, current through each resistor is

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

Let their equivalent resistance be  $R_p$  then

$$V = IR_p \Rightarrow I = \frac{V}{R_p}$$

Total current through the circuit is

$$I = I_1 + I_2 + I_3$$

$$\text{or } \frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\text{or } \frac{V}{R_p} = V \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$$

or 
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

For the given circuit

(a)  $R_5$  and  $R_4$  with parallel combination of  $R_2$  and  $R_3$  are in series

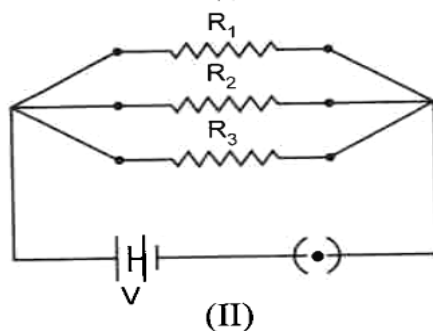
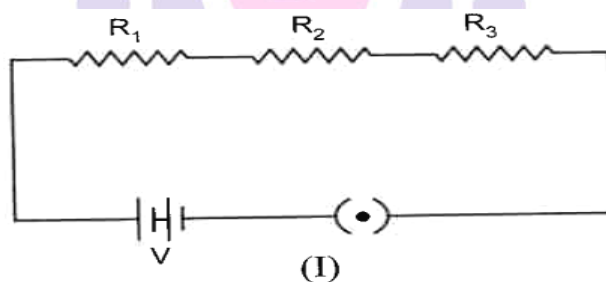
(b)  $R_2$  and  $R_3$  are in parallel.

(c)  $R_2$  and  $R_3$  are in parallel gives. So,  $R_{eq} = 5 \Omega$

$R_1$  is not to be taken as it is sorted.

Current flowing =  $I = \frac{V}{E_{eq}} = \frac{5}{5} = 1 \text{ A}$

8. (a) Name an instrument that measures potential difference between two points in a circuit. Define the unit of potential difference in terms of SI unit of charge and work. Draw terms of SI unit of charge and work. Draw the circuit symbols for a, (i) variable resistor, (ii) a plug key which is closed one.



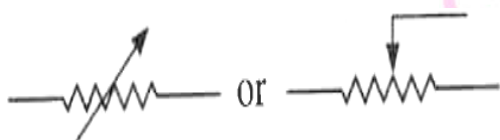
- (i) Which of the two circuits has more resistance?
- (ii) Through which circuit more current passes?
- (iii) In which circuit, the potential difference across each resistor is equal?
- (iv) If  $R_1 > R_2 > R_3$ , in which circuit more heat will be produced in  $R_1$  as compared to other two resistors? Given reason.

**Ans.** (a) Voltmeter

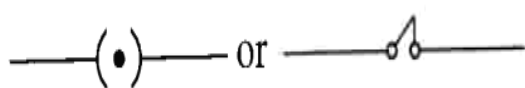
Unit of potential difference is volt.

One volt: The potential difference between two points in an electrostatic field is said to be 1 volt if one joule of work is done in moving one coulomb of electric charge from one point to another in the same electrostatic field.

(i) Variable resistor



(ii) a plug key which is closed one



(b) (i) Equivalent resistance of a series combination is more than that of a parallel combination. Hence, circuit 'I' has more resistance.

(ii) From ohm's Law, for the same applied potential difference, current is inversely proportional to equivalent resistance of the combination, i.e.

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

Therefore, in parallel combination, circuit II, has less resistance, hence, more current will pass through it.

(iii) Parallel combination, the potential difference across each resistance is equal to the applied potential difference.

(iv) More heat will be produced in  $R_1$  in circuit II as compared to other two resistors (for  $R_1 > R_2 > R_3$ ).

**Justification :** In series, less current will flow due to increase in resistance of the circuit and potential difference across each resistance is less than that of applied potential. While in parallel combination for the same potential, current is inversely proportional to resistance ( $I \propto \frac{1}{R}$ ) so more current will flow through  $R_1$  than that in series combination. Hence, from Joule's law of heating.

$$H = I^2 R t$$

Heat produced in  $R_1$  in parallel combination will be more as compared to their series combination.

9.(a) Define electric power. Express it in terms of potential difference  $V$  and resistance  $R$ .

(b) An electrical fuse is rated at 2A. What is meant by this statement?

(c) An electric iron of 1 KW is operated at 220 V. Find which of the following fuses that respectively rated at 1 A, 3a and 5 A can be used in it.

**Ans. (a) Electric power:** It is the rate of doing work by an energy source or the rate at which the electrical energy is dissipated or consumed per unit time in the electric circuit is called electric power.

$$\text{So, Power } P = \frac{\text{Work done (W)}}{\text{Time (t)}}$$

$$= \frac{\text{Electrical energy dissipated}}{\text{Time (t)}}$$

$$= \frac{VIt}{t} = VI = \frac{V^2}{R}$$

(b) It means, the maximum current will flow through it is only 2 A. Fuse wire will melt if the current exceeds 2 A value through it.

(c) Given :  $P = 1 \text{ k W} = 1000 \text{ W}$ ,  $V = 220 \text{ V}$

$$\text{Current drawn, } I = \frac{P}{V} = \frac{1000}{220} = \frac{50}{11} = 4.54$$

To run electric iron of 1 k W, rated fuse of 5 A should be used.

10. (a) Write two point of difference between electric energy and electric power.

(b) Out of 60 W and 40 W lamps, which one has higher electrical resistance when in use.

(c) What is the commercial unit of electric energy? Convert it into joules?

**Ans. (a) Difference between electric and electric power:**

Electrical energy	Electric power
(i) The work done or energy supplied by the source in maintaining the flow of electric current is called electrical energy. It appears in the form of heat given by $H = VI t = \frac{V^2 t}{R} = I^2 R t$	(i) The time rate at which electric energy is consumed or dissipated by an electrical device is called electric power and is given by $P = VI = \frac{V^2}{R} = I^2 R$
(ii) It is equal to the product of power and time $E = P \times t$	(ii) It equal to the rate of doing work by an energy source. $P = \frac{W}{t}$
(iii) Its SI unit is joule (J) $1 \text{ J} = 1 \text{ W} \times 1 \text{ s}$	(iii) Its SI unit is watt (W) $1 \text{ W} = 1 \text{ J s}^{-1}$



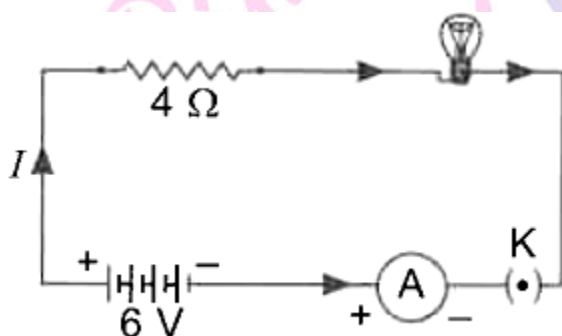
(b) For the same applied voltage,  $P \propto \frac{1}{R}$  or  $R \propto \frac{1}{P}$

i.e. less the power of electrical device, higher is its electrical resistance. Therefore, a 40 W lamp has higher electrical resistance when in use.

(c) Kilowatt hour - Commercial unit of electrical energy

$$1 \text{ k Wh} = 1000 \text{ Wh} = 1000 \frac{\text{J}}{\text{s}} \times 3600 \text{ sec} = 3600000 \text{ J} = 3.6 \times 10^6 \text{ J}$$

11. An electric lamp of resistance  $20 \Omega$  and a conductor of resistance  $4 \Omega$  are connected to a 6 V battery as shown in the circuit. Calculate:



(a) the total resistance of the circuit.

(b) the current through the circuit.

(c) the potential difference across the (i) electric lamp and (ii) conductor, and

**Ans.** (a) Total resistance in series combination

$$R_s = R_1 + R_2 = 4 + 20 = 24 \Omega$$

$$(b) \text{ Current, } I = \frac{V}{R_s} = \frac{6}{24} = 0.25 \text{ A}$$

$$\Rightarrow I = 0.25 \text{ A}$$

$$(c) (i) \text{ Potential difference across the electric lamp, } V = IR_{\text{bulb}} = 0.25 \times 20 = 5 \text{ V}$$

(ii) P.d across the conductor

$$V = IR_{\text{conductor}} = 0.25 \times 4 = 1 \text{ V}$$

$$(d) \text{ Power of the lamp, } P = VI = 5 \times 0.25 = 1.25 \text{ W}$$

12. An electric geyser consumes 2.2 'units' of electrical energy per hour of its use. It is designed to work on the mains voltage of 220 V.

(a) What is the 'power-rating' of this device?

(b) What is the current flowing through this device when it is connected across the 'mains'?

(c) What is the 'resistance' of this device?



(d) Does the resistance of this device remain constant during its operation/working?

(e) Cost of energy consumed if each unit cost ₹ 6.00

Ans. (a) Using Power (P)

$$= \frac{\text{Electrical energy dissipated}}{\text{Time (t)}}$$

$$\Rightarrow P = \frac{E}{t} = \frac{2.2 \times 1000 \text{ Wh}}{1 \text{ h}}$$

$$= 2200 \text{ W}$$

$$\therefore \text{Power rating} = 2200 \text{ W} - 220 \text{ V}$$

$$(b) \text{ Current, } I = \frac{P}{V} = \frac{2200}{220} = 10 \text{ A}$$

$$(c) \text{ Resistance, } R = \frac{V^2}{P} = \frac{220 \times 220}{2200} = 22 \Omega$$

(d) No, Resistance increases with the increase in temperature.

(e) Cost of energy consumed per hour = Number of electrical unit X Cost per unit =  $2.2 \times ₹ 6 = ₹ 13.2$

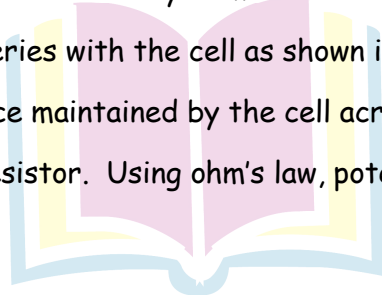
13. (a) Applied ohm's law to obtain the relation for combined resistance when three resistors  $R_1$ ,  $R_2$  and  $R_3$  are connected in series.

(b) Write any three difference between the series and parallel combination of resistance.

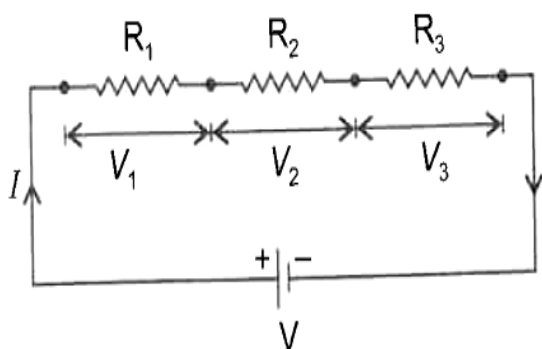
(c) A set of 'n' identical resistors each resistance R are connected in series and the effective resistance is found to be 'X'. When these are connected in parallel, the effective resistance is found to be 'Y'. Find the ration of X and Y.

Ans. (a) **Series combination** : Consider a system in which three resistances,  $R_1$ ,  $R_2$  and  $R_3$  respectively are connected in series with the cell as shown in figure.

Let V be the potential difference maintained by the cell across the combination and I be the current flowing through each resistor. Using ohm's law, potential difference across each resistor is



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$$V_1 = IR_1, V_2 = IR_2, V_3 = IR_3$$

$$\text{But } V = V_1 + V_2 + V_3$$

$$IR_s = IR_1 + IR_2 + IR_3 = I(R_1 + R_2 + R_3)$$

$$\Rightarrow R_s = R_1 + R_2 + R_3$$

Where  $R_s$  is the equivalent resistance of the series combination.

(b)

Resistances in series	Resistances in parallel
(i) The effective resistance is always equal to the sum of individual resistance i.e., $R_s = R_1 + R_2 + R_3$	(i) The reciprocal of the equivalent resistance is equal to the sum of reciprocal of the individual resistance.i.e. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
(ii) The current flowing through each resistance is same i.e. single path for the flow of current.	(ii) The current divides among the resistance i.e., multiple paths are available for the flow of current
(iii) The potential difference is different across different resistance .	(iii) The potential difference is same across different resistances.

(c) In series combination,

$$R_s = R + R + R +$$

..... n resistance

$$\Rightarrow X = nR \text{ .....(i)}$$

In parallel combination,

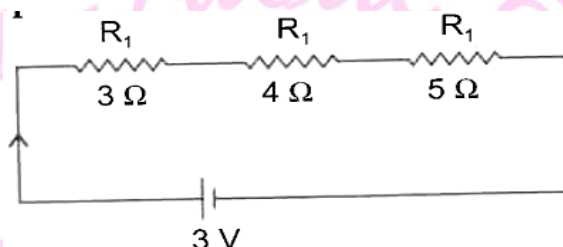
$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} \text{ ..... n times}$$

$$\Rightarrow \frac{1}{R_p} = \frac{n}{R}$$

$$\Rightarrow R_p = \frac{R}{n} = Y \quad \dots\dots\dots (ii)$$

$$\therefore \frac{X}{Y} = \frac{nR}{R/n} = n^2$$

14. (a) Study the following circuit and find the potential difference across 4Ω resistor.



(b) List two advantages of connecting electrical devices in parallel with the source in domestic circuit.

(c) Two metallic wires A and B of the same material are connected in parallel. Wire A has length  $l$  and radius  $r$ , wire B has a length  $2l$  and radius  $2r$ . Calculate the ration of the equivalent resistance in parallel combination and the resistance of wire A.

Ans. (a) Equivalent resistance of series combination,

$$R_5 = R_1 + R_2 + R_3 = 3 + 4 + 5 = 12 \Omega$$

From ohm's law,  $V = IR$

$$I = \frac{V}{R} = \frac{3}{12} = 0.25 A$$

Therefore, potential difference across 5 Ω is,

$$V = IR = 0.25 \times 5 = 1.25 V$$

(b) Advantages of parallel combination

(i) The working of other electrical appliances will not be affected, if any one of them stops working.

(ii) In parallel, each component gets same potential equal to applied potential and hence, they draw the required current from the mains to operate properly.

(c) For wire A:

$$l_1 = l, r_1 = r, \rho_1 = \rho$$

$$\text{So, } R_A = \rho_1 \frac{l_1}{A_1} = \rho_1 \frac{l_1}{\pi r_1^2} = \frac{\rho(2l)}{\pi(2r)^2}$$

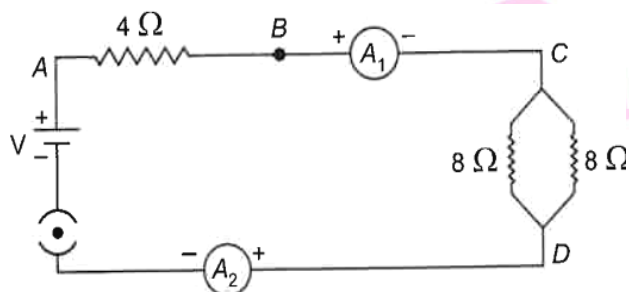
$$= \frac{1}{2} \left( \frac{\rho l}{\pi r^2} \right) = \frac{R_A}{2}$$

In parallel combination of  $R_A$  and  $R_B$

$$\frac{1}{R_P} = \frac{1}{R_A} + \frac{1}{R_B} = \frac{1}{R_A} + \frac{1}{R_A/2} = \frac{3}{R_A}$$

$$\Rightarrow \frac{R_P}{R_A} = \frac{1}{3} = 1 : 3$$

15. Find out the following in the electric circuit given in figure:



(a) Effective resistance of two  $8 \Omega$  resistors in the combination.

(b) Current flowing through  $4 \Omega$  resistor;

(c) Potential difference across  $4 \Omega$  resistor,

(d) Power dissipated in  $4 \Omega$  resistor, and

(e) Difference in ammeter readings, if any.

Ans. (a) Effective resistance, the two  $8 \Omega$  resistors are in parallel.

$$R_P = \frac{8 \times 8}{8+8} = 4 \Omega$$

(b)  $R_{eq} = 4 + R_P = 8 \Omega$

So, current through  $4 \Omega = I = \frac{V}{R} = \frac{8}{8} = 1 \text{ A}$

(c) Potential difference across resistance  $4 \Omega = V_1 = IR = 1 \times 4 = 4 \text{ V}$

(d) Power dissipated  $= I^2 R = I^2 \times 4 = 4 \text{ W}$

(e) No difference, since the ammeters are connected in series and same current will pass through them, so reading of both ammeters would be same.

16. A bulb is rated  $40\text{W}$ ,  $220\text{V}$ . Find the current drawn by it, when it is connected to a  $220\text{V}$  supply. Also find its resistance. If the given bulb is replaced by a bulb of rating  $22\text{W}$ ,  $220\text{V}$ , will there be any change in the value of current and resistance? Justify your answer and determine the change.

Ans.  $P = 40 \text{ W}$ ,  $V = 220 \text{ V}$

$$P = VI$$

$$I = \frac{P}{V} = \frac{40}{220} = \frac{2}{11} \text{ A}$$

From Ohm's law,

$$V = IR$$

$$R = \frac{V}{I} = \frac{220}{\frac{2}{11}} = 1210 \Omega$$

When replaced by 25 W, 220 V amp

$$I = \frac{P}{V} = \frac{25}{220} = \frac{5}{44} A$$

$$R = \frac{V}{I} = \frac{220}{\frac{5}{44}} = 1936 \Omega$$

Low power bulb draw less current since its resistance is higher.

**17.(a) What is meant by the statement. "The resistance of a conductor is one ohm"?**

**(b) Define electric power. Write an expression relating electric power, potential difference and resistance.**

**(c) How many  $132 \Omega$  resistors in parallel are required to carry 5A on a 220 V line?**

**Ans** (a) If the potential difference across the two ends of a conductor is 1 Volt and the current through it is 1 Ampere, then the resistance of the conductor is  $1 \Omega$

$$1 \Omega = \frac{1 \text{ Volt}}{1 \text{ Ampere}}$$

**(b) Electric power is defined as the rate at which electric energy is consumed /dissipated**

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

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

$$= \frac{220 \text{ Volt}}{5 \text{ Ampere}}$$

$$R = 44 \Omega$$

Net Resistance =  $\frac{132}{n}$ , where n is the number of the bulbs in parallel.

$$R = 44 = \frac{132}{n}$$

$$n = \frac{132}{44}$$

$$n = 3$$

**18.(a) Define Power and state its SI unit.**

**(b) A torch bulb is rated 5 V and 500 m A.**

**Calculate:**

**(i) Power (ii) Resistances (iii) Energy consumed when it is lighted for  $2\frac{1}{2}$  hours.**

**18.(a) An electric bulb is rated at 200 V-100 W. What is its resistance?**

**(b) Calculate the energy consumed by 3 such bulbs if they glow continuously for 10 hours for complete month of November**

**(c) Calculate the total cost if the rate is Rs 6.50 per unit.**

**Ans. (a)** Given, V = 200 volts and P = 100 watt

$$\text{As } P = \frac{V^2}{R} \text{ or } R = \frac{V^2}{P} = \frac{(200)^2}{100W} = 400 W$$

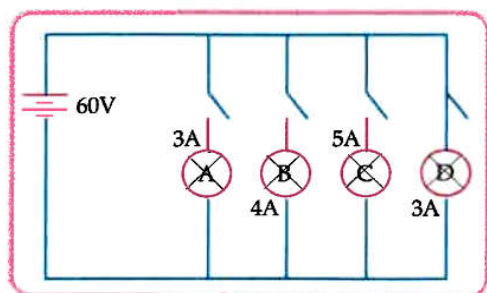


(b) Electrical energy consumed,  $E = \text{number of units} \times \text{Power of each unit} \times \text{time} \times \text{total days}$

Here,  $n = 3$ ,  $P = 100 \text{ W}$ ,  $t = 10 \text{ hours}$ ,  $\text{Days} = 30$

So,  $E = 3 \times 100 \text{ W} \times 10 \text{ h} \times 30 = 90,000 \text{ Wh} = 90 \text{ kWh} \times 6.50 = ₹ 585$

**19. In the given circuit A,B,C and D are four lamps connected with a battery of 60 V.**



Analyse the circuit to answer the following questions.

(i) What kind of combination are the lamps arranged in (series or parallel)?

(ii) Explain with reference to your above answer, what are the advantages (any two) of this combination of lamps?

(iii) The lamp with the highest power will glow the brightest.

$P = VI$  In this case, all the bulbs have the same voltage. But lamp c has the highest current.

Hence, for Lamp C

$P = 5 \times 60 \text{ Watt} = 300 \text{ W}$  (the maximum).

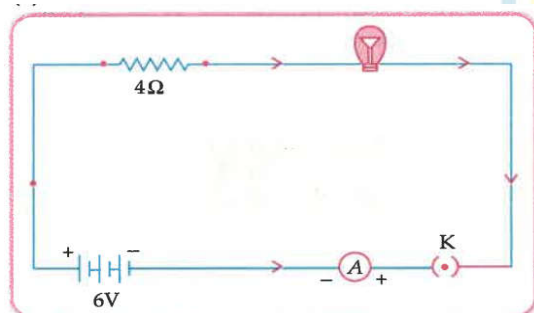
(iv) The total current in the circuit  $= 3 + 4 + 5 + 3 \text{ A} = 15 \text{ A}$  voltage  $= 60 \text{ V}$

$V = IR$  and hence  $R = VI$

$= 60/15 \text{ A} = 4 \text{ A}$

**20. An electric lamp of resistance  $20 \Omega$  and a conductor of resistance  $4 \Omega$  are connected to 6 V battery as shown in the circuit. Calculate :**

(a) the total resistance of the circuit.



(b) the current through the circuit.

(c) the potential difference across the (i) electric lamp and (ii) conductor, and



(d) Power of the lamp.

Ans.(a)  $R = R_1 + R_2$

$$= 20\Omega + 4\Omega = 24\Omega$$

(b)  $I = \frac{V}{R}$

$$= \frac{6V}{24\Omega} = 0.25 A$$

(c) (i) For electric lamp:

$$V = IR$$

$$= \frac{6}{24} \times 20 = 5 V$$

(ii) For conductor:

$$V = IR$$

$$= \frac{6}{24} \times 4 = 1 V$$

(d)  $P = VI$

$$= 5V \times \frac{6}{24} A = 1.25 W$$

**Detailed Answer:**

Given Voltage of battery,  $V = 6 V$

Resistance of electric lamp,  $R_1 = 20 \Omega$

Resistance of series conductor,  $R_2 = 4 \Omega$

(a) Total resistance of circuit,  $R_{Total} = R_1 + R_2$

$$= 20 \Omega + 4 \Omega$$

$$= 24 \Omega$$

(b) Using ohm's law  $I = \frac{V}{R_{Total}}$

$$= \frac{6V}{24\Omega} = 0.25 A$$

(c) Potential difference across

(i) Electric lamp,  $V_1 = IR_1$

$$= 0.25 A \times 4 \Omega$$

$$= 1 V$$

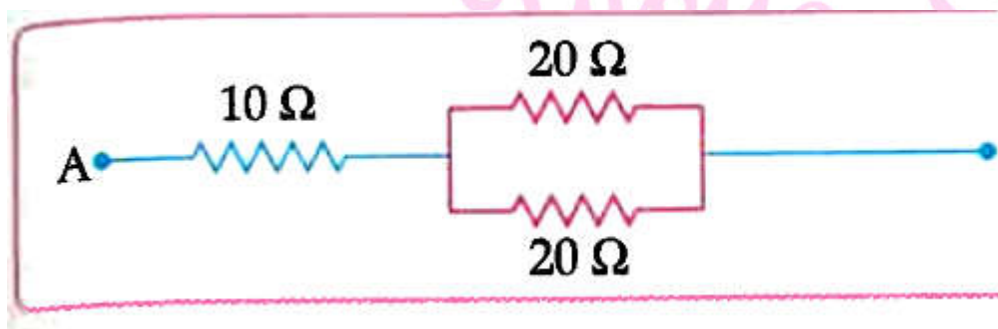
(d) Power of the lamp,  $P = I^2 R$

$$= (0.25)^2 \times 20 \Omega$$

$$= 1.25 W$$

21. (a) Three resistors  $R_1$ ,  $R_2$  and  $R_3$  are connected in parallel and the combination is connected to a battery, ammeter, voltmeter and key. Draw suitable circuit diagram and obtain an expression for the equivalent resistance of the combination of the resistors.

(b) Calculate the equivalent resistance of the following network:

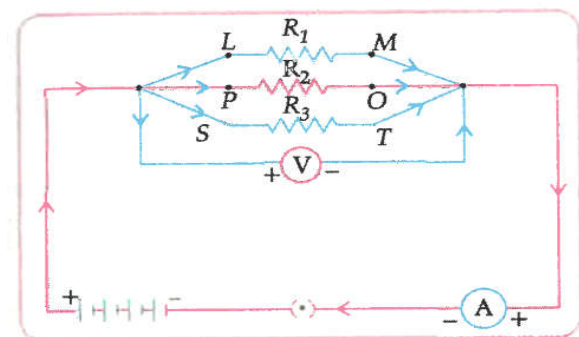


**Ans. (a)** Total current  $I = I_1 + I_2 + I_3$

Let  $R_p$  be the equivalent resistance of  $R_1, R_2, R_3$ . Then the total current  $I = \frac{V}{R_p}$

**Ans. (a)** Total current  $I = I_1 + I_2 + I_3$

Let  $R_p$  be the equivalent resistance of  $R_1, R_2, R_3$ . Then the total current  $I = \frac{V}{R_p}$



$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2}, I_3 = \frac{V}{R_3}$$

$$\therefore \frac{1}{R_p} = V \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right) = \frac{V}{R_p}$$

$$\therefore \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

(b) on applying ohm's law for each  $R_1, R_2, R_3$

$$R_p = 10 \text{ ohm}$$

$$\therefore \frac{1}{R_p} = \frac{1}{20} + \frac{1}{20} = \frac{2}{20} = \frac{1}{10}$$

$$R_p = 10 \text{ ohm}$$

Equivalent resistance of the network

$$= E_q = R_1 + R_p = 10 + 10 = 20 \text{ ohm}$$

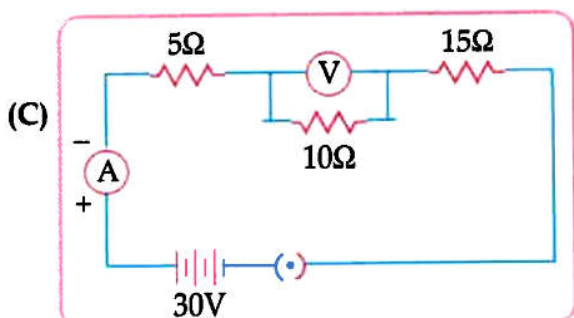
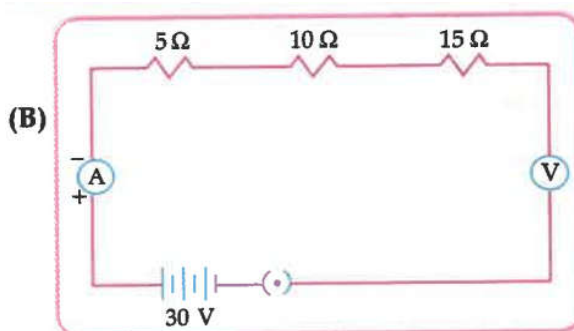
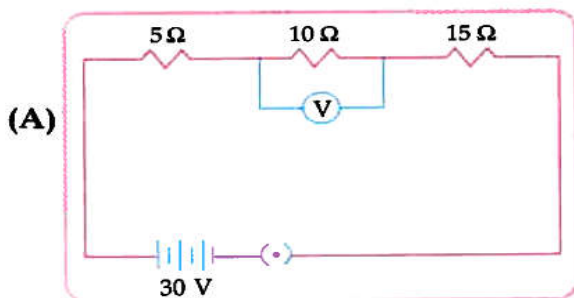
(4 marks each)

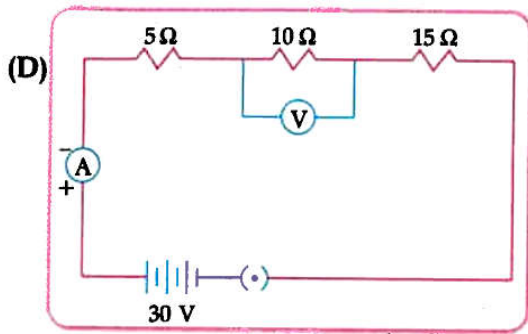
### Competency Based Questions

I. Read the passage and answer the questions given below:

Three resistor  $5 \Omega$ ,  $10 \Omega$  and  $15 \Omega$  are connected in series and the combination is connected to the battery of  $30 \text{ V}$ . Ammeter and voltmeter are connected in the circuit.

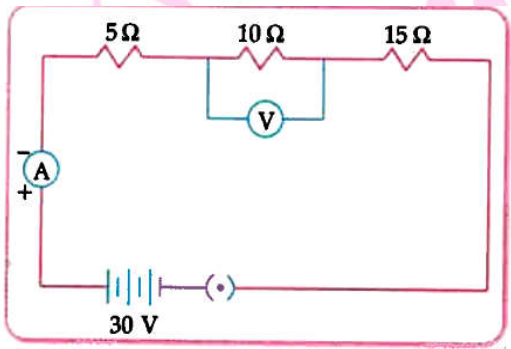
- Which of the following is the correct circuit diagram to connect all the device in proper correct order.





Ans. Option (D) is correct.

Explanation: The correct circuit diagram is :



2. How much is the total resistance in the above circuit diagram ?

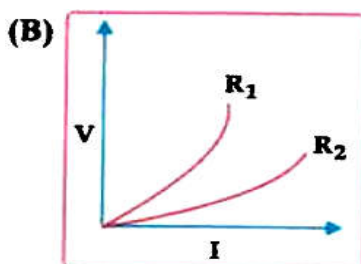
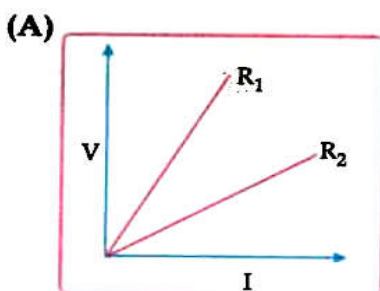
a.  $30\ \Omega$

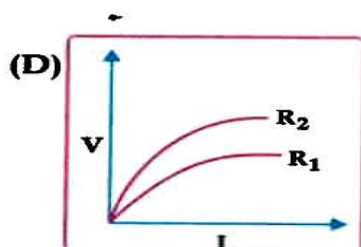
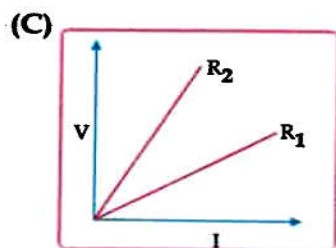
b.  $20\ \Omega$

c.  $\frac{11}{30}$

d.  $\frac{30}{11}$

3. Two students perform experiments on given resistors  $R_1$  and  $R_2$  and plot the following V-I graphs. If  $R_1 > R_2$ , which of the diagram correctly represent the situation on the plotted curves?





Ans. Option (c) is correct.

II. Electrical resistivities of some substance, at  $20^{\circ}\text{C}$  are given below in the table . Study the table and answer the given questions.

Silver	$1.60 \times 10^{-8} \Omega.m$
Copper	$1.62 \times 10^{-8} \Omega.m$
Tungsten	$5.2 \times 10^{-8} \Omega.m$
Mercury	$94 \times 10^{-8} \Omega.m$
Iron	$10 \times 10^{-8} \Omega.m$
Nichrome	$10 \times 10^{-6} \Omega.m$

1. Which is a better conductor of electric current?

- a. silver                      b. Copper                      c. Tungsten                      d. Mercury

2. Which element will be used for electrical transmission lines?

- a. Iron                      b. Copper                      c. Tungsten                      d. mercury

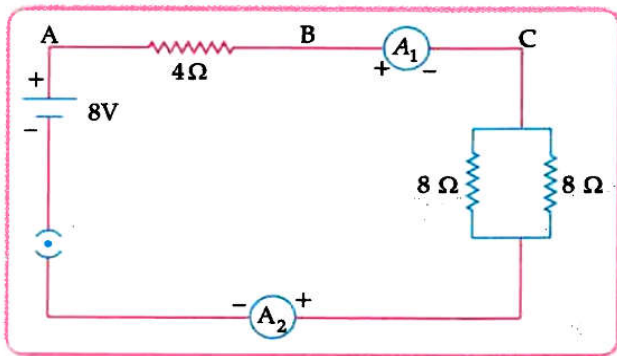
3. Nichrome is used in the heating elements of electric heating device because;

- a. It has high resistivity  
b. It does not oxidise readily at high temperature  
c. Both of the above  
d. None of the above

4. Series arrangement is not used for domestic circuits because:

- a. Current drawn is less
- b. Current drawn is more
- c. Neither of the above
- d. Both of the above

III. Study the given circuit diagram and answer the questions given below:



1. Effective resistance of two  $8\Omega$  resistors in the combination.

- a.  $4\Omega$
- b.  $16\Omega$
- c.  $8\Omega$
- d.  $1\Omega$

2. Current flowing through  $4\Omega$

- a.  $1\text{ A}$
- b.  $2\text{ A}$
- c.  $8\text{ A}$
- d.  $4\text{ A}$

3. Potential difference across is :

- a. 1
- b.  $2\text{ A}$
- c.  $8\text{ A}$
- d.  $4\text{ A}$

4. Power dissipated in  $4\Omega$  resistor is

- a.  $4\text{ W}$
- b.  $2\text{ W}$
- c.  $1\text{ W}$
- d.  $8\text{ W}$

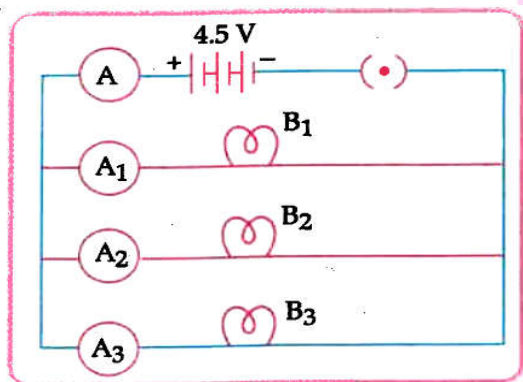


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### Case Based Subjective Questions

I. Study the circuit shown in which three identical bulb  $B_1$ ,  $B_2$  and  $B_3$  are connected in parallel with a battery of 4.5 V and answer the following questions.



1. What will happen to the glow of the other two bulbs if the bulb  $B_3$  gets fused?
2. If the wattage of each bulb is 1.5 W, how much reading will the ammeter A show when all the three bulbs glow simultaneously?
3. Find the total resistance of the circuit.
4. How many resistors of 88 W are connected in parallel to carry 10 A current on a 220 V line?

**Ans.** (1) Other bulbs will glow with same brightness.

(2) When the bulbs are in parallel, wattage will be added (4.5 W) and the ammeter reading would be,  $I = P/V = 4.5W/4.5V = 1.0$  Ampere.

(3) Since, ammeter reading is 1.0 ampere, resistance of the combination is

$$4.5V/1.0A = 4.5 \Omega$$

(4) Let  $n$  number of resistance is connected in parallel. Equivalent resistance,  $1/R_p = n/88$

$$R_p = 88/n$$

Since,  $V = IR$

$$\text{Or } R = 88/n = 220/10$$

$$\text{Or } n = 88/22 = 4 \text{ resistors.}$$