12 Electricity

IMPORTANT NOTES

1. There are two kinds of electric charges i.e., positive and negative. The opposite charges attract each other and the similar charges repel each other. Coulomb (C) is the standard unit of charge.
2. **Conductors:** The substances through which electricity can flow are called conductors. Silver, copper, gold and aluminium are examples of conductors.
3. **Insulators:** The substances through which electricity cannot flow are called insulators. Glass, wood, porcelain and rubber are examples of insulators.
4. **One coulomb:** A body is said to have one coulomb charge if it has 6.25×10^{18} electrons on it or is deficit as compared to the normal number of electrons.
5. **Electric current:** The rate of flow of charge from a body at higher potential to a body at lower potential is called electric current. Ampere (A) is the standard unit of current.
6. **Electric potential:** The amount of work done in moving a unit positive charge from infinity to a given point in an electric field is called the electric potential at that point. Thus, electric potential is a condition which determines the direction of flow of charges. The unit of electric potential is volt (V).
7. **Potential difference:** The amount of work done in moving a unit positive charge from one point to another in an electric field is called potential difference.
8. **Closed electric circuit:** An electric circuit in which all the components of the circuit are joined to one another, such that continuous current flows through them, is called closed electric circuit.
9. **Open electric circuit:** An electric circuit in which electric contact is broken at some point (say by a switch), such that no current flows through the components of the circuit is called an open circuit.
10. **Electric resistance:** The opposition or obstruction offered by a conductor to the flow of the electrons is called electric resistance. In SI system unit of resistance is ohm (Ω).
11. **Resistivity:** It is the amount of resistance offered by a conductor of unit length and unit area of cross-section, such that current enters and leaves from its opposite faces is called its resistivity or specific resistance.
12. **Series circuit of resistors:** When a number of resistors are connected end to end such that tail end of one resistor is connected to the initial end of the other resistor so as to form a closed circuit, then such a circuit is called the series circuit.
13. **Parallel circuit of resistors:** When a number of resistors are connected in such a way that they have common positive terminal and a common negative terminal, then the resistors are said to be connected in parallel circuit.
14. **Ohm's law:** All physical conditions of a conductor remaining the same, the current flowing through it is directly proportional to the potential difference at its ends.

    If I is the current flowing through a conductor, such that V is the potential difference at its ends, then

    $$V \propto I$$
    $$\Rightarrow V = IR$$

    Where R is the constant of proportionality and commonly called the resistance of a conductor.
15. **Electric work:** Electric work is said to be done when a charge flows through a conductor at some potential difference.

    If W is the amount of workdone in carrying Q charge from one point to another in an electric field, such that, V is the potential difference, then

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

16. Electric power: The rate of doing electric work is called the electric power. The SI unit of power is watt (W).

If W is the amount of electric work done in time *t*, such that *P* is the power, then

$$P = \frac{W}{t}$$

But, $W = I^2Rt$

Thus, $P = \quad = I^2R.$

17. Overloading: Overloading of circuit means, passing more current through the circuit than it can tolerate without damage.

18. Short circuit: It means that live and neutral wires come in contact with each other, thereby bypassing the electrical device. It is caused due to melting of insulation of connecting wires or the live wire getting connected to earth.

19. Fuse: It is a safety device in an electric circuit. It is the weakest point in an electric circuit, which melts and breaks the electric circuit, when the circuit gets overloaded.

ASSIGNMENTS FOR SUMMATIVE ASSESSMENT

I. VERY SHORT ANSWER QUESTIONS (1 Mark)

A. IMPORTANT QUESTIONS

1. Define electric work.

2. What is the unit of electric work? Define it, in relation to quantity of charge and potential difference.

3. Name two bigger units of electric work.

4. What do you understand by the term current electricity?

5. Define the term "electric current".

6. How is an ammeter connected in an electric circuit so as to measure electric current?

7. What is the unit of electric charge? How much electric charge is on one electron?

8. If 12 J of work is done in moving 2 coulomb of electric charge through a conductor, what is the potential difference at the ends of the conductor?

9. State and define the SI unit of potential difference.

10. State SI unit of electric power.

11. Define the SI unit of electric power.

12. Name and define the smallest commercial unit of electricity.

13. Define kWh.

14. Prove : 1 kWh = 3.6 MJ.

15. Name two common materials used as heating elements.

16. Name a metal which is used as filament in an electric bulb.

17. What do you understand by the term fuse in an electric circuit?

18. State the composition of material of the fuse wire.

19. Where is a fuse placed in an electric circuit?

20. A bulb in an electric circuit is glowing. Is it a close or open electric circuit?

21. What do you understand by the term electric resistance?

22. How does electric resistance change with the change in the length of conductor?

23. How does electric resistance change with the change in the area of cross-section of conductor?

24. How does electric resistance of solid ionic compounds compare with respect to molten compounds?

25. Why does a conducting wire offer resistance to the flow of electrons?

26. What do you understand by the term electric potential?

27. What do you understand by the term potential difference?

B. QUESTIONS FROM CBSE EXAMINATION PAPERS

1. Two resistors of 20 Ω and 40 Ω are connected in parallel in an electric circuit. How does the current passing through the two resistors compare? **[2010 (T-I)]**

2. Two resistors of 30 Ω and 60 Ω are connected in parallel in an electric circuit. How does the current passing through the two resistors compare? **[2010 (T-I)]**

3. Define electric circuit. Distinguish between open and closed circuit. **[2010 (T-I)]**

4. What is the lowest resistance that can be obtained by combining four coils of resistors of 4 Ω, 8 Ω, 12 Ω and 24 Ω? **[2010 (T-I)]**

5. Write a mathematical expression for Joule's law of heating. Name one device which works on this principle. **[2010 (T-I)]**

6. What happens to the resistance of a conductor when the length of the conductor is reduced to half? **[2010 (T-I)]**

7. Define the SI unit of resistance. **[2010 (T-I)]**

8. What happens to resistance of a conductor when temperature is increased? **[2010 (T-I)]**

9. 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 decreases to half when the length of the wire is doubled. Why? **[2010 (T-I)]**

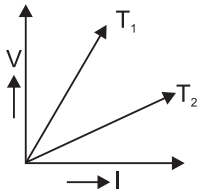
10. What is the minimum resistance which can be made using five resistors each of 1/5 Ω?

11. You have two metallic wires of resistances 6 ohm and 3 ohm. How will you connect these wires to get the effective resistance of 2 ohm? **[2010 (T-I)]**

12. Draw a schematic diagram of a circuit consisting of a cell of 1.5 V, 10 Ω resistor and 15 Ω resistor and a plug key, all connected in series. **[2010 (T-I)]**

13. Name the instrument used to measure electric current in a circuit. **[2010 (T-I)]**

14. The voltage-current (V-I) graph of a metallic circuit at two different temperatures T_1 and T_2 is shown, which of the two temperatures is higher and why? **[2010 (T-I)]**



15. What is meant by saying that the potential difference between two points is 1V? **[2010 (T-I)]**

16. A wire of resistivity 'r' is pulled to double its length. What will be its new resistivity? **[2010 (T-I)]**

17. Name the physical quantity whose unit is Volt/ampere. **[2010 (T-I)]**

18. Why do we use copper and aluminium wire for transmission of electric current? **[2010 (T-I)]**

19. What is commercial unit of energy? **[2010 (T-I)]**

20. Name the instrument used for measuring:

(i) potential difference **[2010 (T-I)]**

(ii) current

21. Define Ohm's Law. **[2010 (T-I)]**

22. How is a Voltmeter connected in the circuit to measure the potential difference between two points? **[2010 (T-I)]**

23. How is an ammeter connected in the circuit to measure current flowing through a conductor? **[2010 (T-I)]**

24. Nichrome is used to make the elements of electric heater. Why? **[2010 (T-I)]**

25. Calculate the energy consumed by 1200 W toaster in 200 minutes. **[2009]**

26. A lamp rated 100 W and 220 V is connected to mains electric supply. What current is drawn from the supply line, if the voltage is 220 V? **[2009]**

27. Out of 60 W and 40 W lamps, which one has higher resistance when we use? **[2008]**

28. If the distance between two electric charges is doubled, how much will the force exerting between them change to? **[2007]**

29. Should the heating element of an electric iron be made of iron, silver or nichrome wire? **[2005]**

30. Define the term 'resistivity' of a material. **[2005]**

31. Calculate the resistance of a conductor, if the current flowing through it is 0.2 A when the applied potential difference is 0.8 volt. **[2004]**

II. SHORT ANSWER QUESTIONS–I (2 Marks)

A. IMPORTANT QUESTIONS

1. Name two devices which can produce continuous current. Which form of energy is responsible for the generation of electric current in the devices named by you?

2. The resistance of a wire of length 80 cm and of uniform area of cross-section 0.025 cm^2, is found to be 1.50 ohm. Calculate specific resistance of wire in SI units.

3. What should be the length of nichrome wire of resistance 4.5 Ω, if the length of similar wire is 60 cm and resistance 2.5 Ω?

4. A charge of 5000 C flows through an electric circuit in 2.5 hours. Calculate the magnitude of current flowing through the circuit.

5. A battery can supply a charge of 2.5×10^3C. If the current drawn from the battery is 12.5 A, calculate the time in which battery will get discharged.

6. What is the resistance of (hot) electric arc lamp when it uses a current of 25 A, while working at 440 V?

7. A current of 0.2 A flows through a conductor of resistance 4.5 Ω. Calculate the p.d. at the ends of the conductor.

8. A bulb of resistance 400 Ω connected to 200 V mains supply. Calculate the magnitude of the current flowing through the bulb.

9. Amongst the units given below, which units are of (i) electric energy; (ii) electric power?

(a) watt hour (b) watt

(c) kilowatt (d) kilowatt hour

10. (i) Distinguish between kilowatt and kilowatt hour.

(ii) How many kilowatts are equal to one horse power?

11. Name two materials which are commonly used for making heating appliances and give their composition.

12. Answer the following questions regarding an electric heater :

(i) Why is the heating coil placed in a circular porcelain plate?

(ii) Why does heating coil not produce any visible light?

13. Calculate the energy consumed by a heater, which draws a current of 5 A at 200 V for 1 minute.

14. An electric press consumes 120 kJ of energy in 5 minutes, when the magnitude of current flowing through it is 2A. Calculate the electric potential at which press operates.

15. A soldering rod draws energy of 45 kJ in 4 minutes when current flowing through it is 6 A. Calculate the resistance of heating element.

16. An electric device draws an energy of 500 kJ in 1 minute. If the resistance of heating device is 20 Ω, calculate the current flowing through the device.

17. Calculate the electric energy flowing into the filament of an electric bulb in 20 s, when its resistance is 40 Ω and potential difference across its terminals is 12 V.

18. An electric heater draws a current of 3.5 A at a p.d. of 250 V. Calculate the power consumed by 4 such heaters.

19. An electric heater of power 1600 W has a resistance of 36 Ω. Calculate the magnitude of current and p.d. at its ends.

20. (a) What is the potential of Earth?

(b) By drawing a diagram, show the movement of electrons when a positively charged is connected to Earth.

21. A charge of 50 C is moved from infinity to two points A and B in an electric field. The work done to do so upto A and B is 20 J and 25 J respectively. What is the potential difference between points A and B?

22. How is electric potential generated in a conductor during the flow of charges?

23. Chemical cells or dynamos do not produce electrons. How do they produce current electricity?

B. QUESTIONS FROM CBSE EXAMINATION PAPERS

1. In an experiment to study the relation between the potential difference across a resistor and the current through it, a student recorded the following observations :

Potential difference V (volt)	1.0	2.2	3.0	4.0	6.4
Current I (ampere)	0.1	0.2	0.6	0.4	0.6

On examining the above observations, the teacher asked the student to reject one set of readings as the values were out of agreement with the rest. Which one of the above sets of readings can be rejected? Calculate the mean value of resistance of the resistor based on the remaining four sets of readings. **[2010 (T-I)]**

2. In an experiment to study the relation between the potential difference across a resistor and the current through it, a student recorded the following observations.

Potential difference V (volt)	1.5	3.0	4.5	6.0	7.5
Current I (ampere)	0.05	0.10	0.18	0.20	0.25

On examining the above observations, the teacher asked the student to reject one set of readings as the values were out of agreement with the rest. Which one of the above sets of readings can be rejected? Calculate the mean value of resistance of the resistor based on the remaining four sets of readings. **[2010 (T-I)]**

3. Define resistivity and state its S.I. unit. Does it vary with temperature? **[2010 (T-I)]**

4. A wire is 1.0 m long, 0.2 mm diameter has resistance of 20 Ω. Calculate the resistivity of material. **[2010 (T-I)]**

5. State the factors on which the resistance of a cylindrical conductor depends. How will resistance of a conductor change if it is stretched so that its length is doubled?

[2010 (T-I)]

6. In an experiment to study the relationship between the potential difference across a resistor and the current through it, a student recorded the following observations:

Potential difference (V)	2	3	4.5	5	6
Current (A)	0.08	0.12	0.15	0.20	0.24

Find in which one of the above sets of readings the trend is different from others and must be rejected. Calculate the mean value of resistance of the resistor based on the remaining sets of readings.

7. State Ohm's law. "The resistance of a conductor is 1Ω." What is meant by this statement?

[2010 (T-I)]

8. Two electric bulbs A and B are marked 220 V, 40 W and 220 V, 60 W respectively. Which one of the two has greater resistance? **[2010 (T-I)]**

9. (a) What material is used in making the filament of an electric bulb?

(b) Name the characteristics which make it suitable for this. **[2010 (T-I)]**

10. Differentiate between overloading and short circuiting. **[2010 (T-I)]**

11. Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why? Name the factors on which the resistance of a wire depends. **[2010 (T-I)]**

12. An electric lamp is marked 220 V, 100 W. It is used for 5 hours daily. Calculate: **[2010 (T-I)]**

(a) its resistance while glowing

(b) energy consumed in kWh/day.

13. How are ammeters and voltmeters connected in a circuit? What do they help us measure?

[2010 (T-I)]

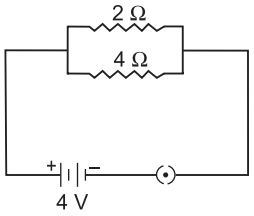
14. An electric iron of resistance 20 Ω takes a current of 5A. Calculate the heat developed in 30 seconds. **[2010 (T-I)]**

15. The following table gives the resistivity of three samples : **[2010 (T-I)]**

	A	B	C
Resistivity→	1.6×10^{-8} Ωm	5.2×10^{-8} Ωm	100×10^{-6} Ωm

Which of them is suitable for heating elements of electrical appliances and why?

16. Calculate the current flowing through the resistors.



17. Aluminium wire has radius 0.25 mm and length of 75 m. If the resistance of the wire is 10 Ω. Calculate the resistivity of aluminium.

[2010 (T-I)]

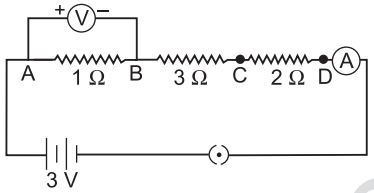
18. Give reason why

(a) tungsten is used for making filament of electric lamps.

(b) The elements of heating electrical appliances are made up of an alloy rather than pure metal. **[2010 (T-I)]**

19. Copper wire has resistance R. If the length of the wire is doubled, find the new resistance in terms of original resistance? **[2010 (T-I)]**

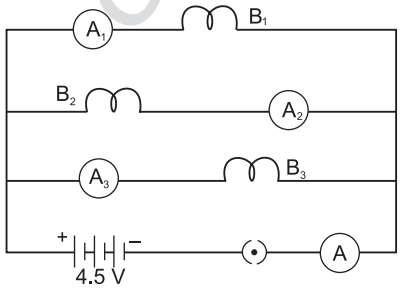
20. How would the reading of (V) change if it is connected between B and C? **[2010 (T-I)]**



21. B_1, B_2 and B_3 are three identical bulbs connected as shown in the figure. When all the three bulbs glow, a current of 3A is recorded by the ammeter A. **[2010 (T-I)]**

(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?

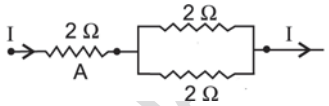


22. What is the role of fuse, used in series with any electrical appliance? Why should a fuse with defined rating not be replaced by one with a larger rating? **[2010 (T-I)]**

23. Draw a schematic labelled diagram of a domestic wiring circuit which includes: **[2010 (T-I)]**

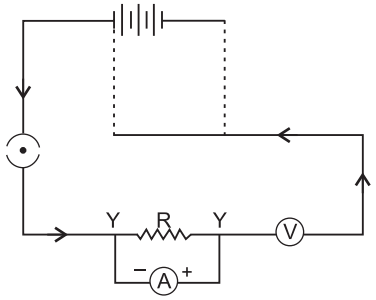
(i) a main fuse (ii) a power meter
(iii) one light point (iv) a power plug

24. Three 2 Ω resistors, 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. **[2010 (T-I)]**



25. A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω resistors. How much current would flow through the 12 Ω resistor? **[2010 (T-I)]**

26. A child has drawn the electric circuit to study Ohm's law as shown in figure. His teacher told that the circuit diagram needs correction. Study the circuit diagram and redraw it after making all corrections. **[2010 (T-I)]**



27. A current of 5.0 A flows through a 12 Ω resistor. What is the rate at which heat energy is produced in the resistor? **[2010 (T-I)]**

28. Calculate the electrical energy consumed by a 1200 W toaster in 20 minutes. **[2010 (T-I)]**

29. Why does the cord of an electric heater not glow while the heating element does? **[2010 (T-I)]**

30. A lamp rated 100 W at 220 V is connected to the mains electric supply. (i) What amount of current is drawn from the supply line if the voltage is 220 V? (ii) what is its resistance? **[2010 (T-I)]**

31. What is an electric circuit? Distinguish between an open and a closed circuit. **[2010 (T-I)]**

32. What is the (a) highest (b) lowest resistance that can be secured by combining four coils of resistance 4 Ω, 8 Ω, 12 Ω and 24 Ω. **[2010 (T-I)]**

33. An electric bulb draws a current 0.8 A and works on 250 V on the average 8 hours a day. If energy costs Rs 3 per kWh, calculate monthly bill for 30 days. **[2010 (T-I)]**

34. An electric device operates at 24 V and has a resistance of 8 Ω calculate the power consumed by the device and current flowing through it.

[2010 (T-I)]

35. When do you say that the resistance of a wire is 1 Ω? **[2010 (T-I)]**

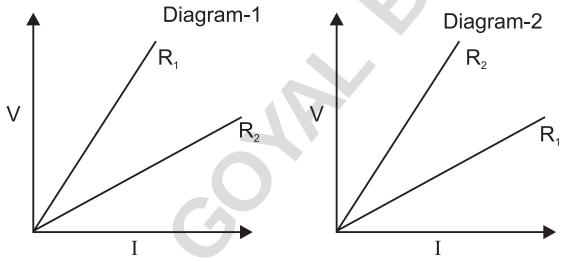
36. Two identical resistors each of resistance 10 Ω are connected: (i) in series and (ii) in parallel, to a battery of 6V. Calculate the ratio of power consumed in the combination of resistors in the two cases. **[2010 (T-I)]**

37. A TV set shoots out a beam of electrons. The beam current is 10 mA. How many electrons strike the TV screen per second? How much charge strikes the screen in a minute?

[2010 (T-I)]

38. In an electric circuit with a resistance wire and a cell, the current flowing is I. What would happen to this current if the wire is replaced by another thicker wire of same material and same length? Give reason. **[2010 (T-I)]**

39. Two students perform experiments on two given resistors R_1 and R_2 and plot the following V-I graphs. If $R_1 > R_2$, which of two diagrams correctly represent the situation on the plotted curves? Justify your answer. **[2010 (T-I)]**



40. In a house, four 60 W electric bulbs are lighted for 2 hours and two 100 W bulbs are lighted for 4 hours everyday. Calculate the energy consumed in the house for 30 days. **[2010 (T-I)]**

41. A wire of resistance R is cut into three equal parts. **[2010 (T-I)]**

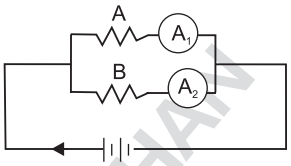
(i) Find the value of resistance of each part in terms of the original resistance R?

(ii) If these three pieces are connected in parallel, what is the ratio of the resistance so obtained to the original resistance?

42. State the law that relates current through a conductor and the potential difference between its ends. Represent the law mathematically.

[2010 (T-I)]

43. In the circuit diagram shown, the two resistance wires A and B are of same length and same material, but A is thicker than B. Which ammeter A_1 or A_2 will indicate higher reading for current? Give reason. **[2010 (T-I)]**



44. State Ohm's law of electricity and write the condition in which this law is obeyed.

[2010 (T-I)]

45. On what factors does the resistance of a conductors depend? Write SI unit of resistance.

[2010 (T-I)]

46. Why do we use parallel circuit arrangement for domestic wiring? **[2010 (T-I)]**

47. Which gas is filled in the electric bulb and why?

[2010 (T-I)]

48. A wire is cut into three equal parts and then connected in parallel. How will its: **[2010 (T-I)]**

(a) resistance (b) resistivity get affected?

49. How many electrons will flow for the charge of 4C? (Charge on 1 electron = 1.6×10^{-19} C)

[2010 (T-I)]

50. Calculate the resistance of a conductor when the current flowing through it is 0.2 A and the potential difference is 0.8 V? **[2010 (T-I)]**

51. When a 12 V battery is connected across an unknown resistor, 2.5 mA current flows in the circuit. Find the resistance of the resistor.

[2010 (T-I)]

52. When a 22 V battery is connected across a resistor, 2.2 mA current flows in the circuit. Find the resistance of the resistor. **[2010 (T-I)]**

53. Four resistors of 5 Ω, 10 Ω, 15 Ω and 20 Ω are connected in parallel. Calculate equivalent resistance. **[2010 (T-I)]**

54. An electric heater is used on 220 V supply and takes a current of 3.4 A. Calculate : (i) its power; and (ii) its resistance, when it is in use.

[2007]

55. One lamp is rated 40 W at 220 V and the other 60 W at 220 V. These two lamps are connected

in parallel to a 220 V supply. Calculate the current drawn from the supply line by each lamp. **[2007]**

56. An electric iron draws a current of 0.5 A, when the voltage is 200 V. Calculate the amount of electric charge flowing through it, in one hour. **[2004]**

57. An electric iron has a rating of 750 W, 220 V. Calculate **[2007]**

(i) current passing through it, and

(ii) its resistance, when in use.

58. An immersion heater has a rating of 2 kW, 220 V. While in use, calculate **[2007]**

(i) current passing through it and

(ii) its resistance.

59. A 40 watt lamp required 0.20 A of current at 220 volts when in use. Calculate : (i) its power; (ii) its resistance. **[2007]**

III. SHORT ANSWER QUESTIONS-II (3 Marks)

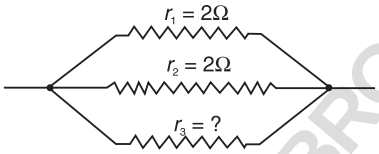
A. IMPORTANT QUESTIONS

1. A piece of wire having a resistance R is cut into six equal parts.

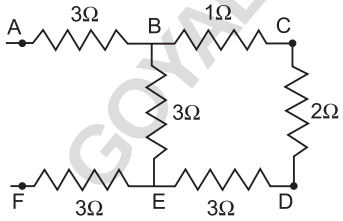
(a) How will the resistance of each part compare with the original resistance?

(b) If the six parts are placed in parallel, how will joint resistance compare with the resistance of the original wire?

2. The overall resistance of the circuit diagram below is 0.5 Ω. Calculate the value of resistance r_3.



3. In the given circuit diagram, calculate:



(i) Total resistance between the points B and E.

(ii) Total resistance between the points A and F.

4. Answer the following questions about electric bulb:

(i) Why is its filament coiled?

(ii) Why is it filled with argon gas at low pressure?

(iii) State one disadvantage of filling it with argon.

5. (a) An electric bulb gives bright light when connected to 12 V-D.C. source. Will it glow, if connected to 12 V-A.C. source?

(b) Two bulbs of 100 W and 25 W are connected in series to 200 V-A.C. mains. Which bulb glows brightly? Explain the observation.

6. (a) Wires used as leads of an electric oven are thicker than those used in the leads of table lamp. Explain.

(b) The heating element of a room heater becomes red hot, but the lamp wires remain cold. Why?

7. A heater coil connected to 200 V has a resistance of 80 W. If the heater is plugged in for the time '*t*', such that 1 kg of water at 20°C attains a temperature of 60° C, then calculate

(a) Power of heater,

(b) Heat absorbed by water,

(c) The value of '*t*' in seconds.

8. A 40 W lamp requires 0.182 A current at 220 V while a 60 W lamp requires 0.272 A current at same volts. If 40 W and 60 W lamps are connected in series with 220 V line, how many ampere of current will flow through each lamp?

9. Name an instrument used for measuring electric potential difference by drawing diagram showing how this instrument is connected in an electric circuit. Why does not this instrument practically consume any electric energy from the electric circuit?

10. (i) Name an instrument used for measuring the electric current.

(ii) How this instrument is connected in an electric circuit? Support your answer by a diagram.

(iii) Why does not this instrument practically consume any electric energy from the electric circuit.

11. (a) How does the resistance of the following change with the rise in temperature?

(i) pure metals,

(ii) German silver;

(iii) carbon

(b) Name three substances whose resistance changes very little with the rise in temperature?

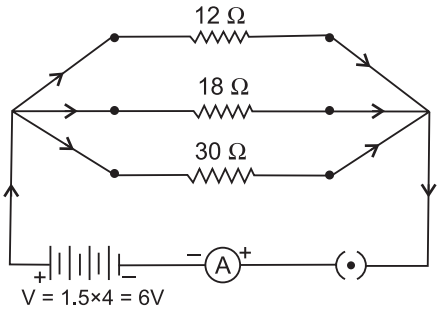
12. (a) Why are conductors of electric heating devices, such as toasters and electric iron made of an alloy, rather than pure metals?

(b) Why is an ammeter likely to burn, if connected in parallel?

13. A piece of wire is redrawn by pulling it, until its length is trebled. Compare the new resistance of wire with the original resistance.

B. QUESTIONS FROM CBSE EXAMINATION PAPERS

1. For the circuit shown in the diagram given: **[2010 (T-I)]**



Calculate:

(i) the total effective resistance of the circuit,

(ii) the total current drawn from the battery and

(iii) the value of current through each resistor.

2. Define electric current and state its SI unit. With the help of Ohm's law explain the meaning of 1 Ohm resistance. **[2010 (T-I)]**

3. The rating of an electric heater is 1100 W; 220 V. Calculate its resistance when it operates at 220 V. Also calculate the energy consumed in kWh in the month of November if the heater is used daily for four hours at the rated voltage. **[2010 (T-I)]**

4. An air conditioner of rating 2000 W; 220 V is operated in a domestic circuit (220 V) that has a current rating of 5A. What result do you expect? Justify your answer. **[2010 (T-I)]**

5. Explain reason for the following: **[2010 (T-I)]**

(i) Tungsten is used almost exclusively for filament of electric lamps.

(ii) The series arrangement is not used for domestic circuits.

(iii) Copper and aluminium wires are usually employed for electricity transmission.

6. The rating of an electric oven is 4400 W; 220 V. Calculate its resistance when it operates at 220 V. Also calculate the energy consumed in kWh in the month of September if the oven is used daily for 5 hours at the rated voltage. **[2010 (T-I)]**

7. A piece of wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Calculate the resistance of the wire in the new situation. **[2010 (T-I)]**

8. (a) What is the total resistance of *n* resistors each of resistance 'R' connected in:

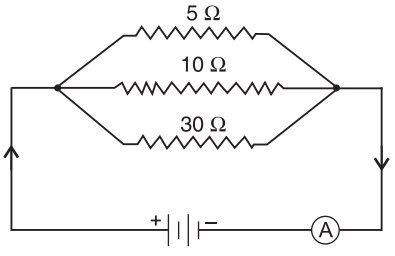
(i) series (ii) parallel?

(b) Calculate the resultant resistance of 3 resistors 3Ω, 4Ω and 12Ω connected in parallel. **[2010 (T-I)]**

9. (a) For the circuit shown below in the diagram, calculate: **[2010 (T-I)]**

(i) value of current through the 30Ω resistor.

(ii) total resistance of the circuit.



(b) Give two advantages of connecting electrical devices in parallel with battery.

10. (a) Electric fuse is an important component of all domestic circuits. Why? **[2010 (T-I)]**

(b) An electric oven of rating 2 kW, 220 V is operated in a domestic circuit with a current rating of 5 A. What result would you expect? Explain.

11. (i) State Ohm's law. Write a mathematical expression for it.

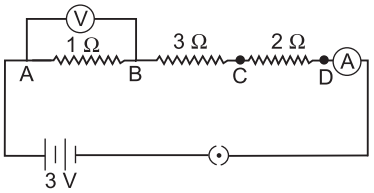
(ii) What kind of graph is obtained by plotting values of 'V' and 'I' why?

12. A lamp rated 40 W and an electric iron rated 800 W are used for 6 hours everyday. Calculate the total energy consumed in 30 days. **[2010 (T-I)]**

13. (a) Explain the function of electric fuse.

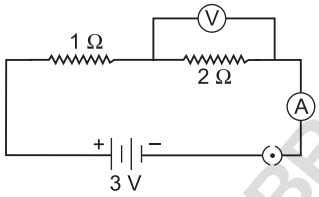
(b) An electric bulb is marked 60 W. What does this mean? How much energy does it consume if used for 1 hour? **[2010 (T-I)]**

14. What would be the reading of ammeter and voltmeter in the given circuit? **[2010 (T-I)]**



15. Two conducting wires of same material, equal length and equal diameter are first connected in series. How does the heat produced by the combination of resistance change? **[2010 (T-I)]**

16. What would be the reading of ammeter and voltmeter in the given circuit? **[2010 (T-I)]**



17. Table gives the resistivity of three samples **[2010 (T-I)]**

(a)	**Samples**	A	B	C
	Resistivity (in Ωm)	1.6×10^{-8}	7.5×10^{17}	44×10^{-6}

Which of them is a good conductor and which is an insulator? Why?

(b) A resistance wire (4Ω resistance) is doubled on it, calculate the new resistance of the wire.

18. Name two safety measures commonly used in electric circuits and appliances. What precautions should be taken to avoid the over loading of domestic electric circuits? **[2010 (T-I)]**

19. State Ohm's law. How can it be verified experimentally? Does it hold good under all conditions? Comment. **[2010 (T-I)]**

20. (a) How much current will an electric bulb draw from a 220 V source if the bulb filament has a resistance of 1200 Ω.

(b) How much current will an electric heater draw from a 220 V source if the resistance of the heater is 100 Ω?

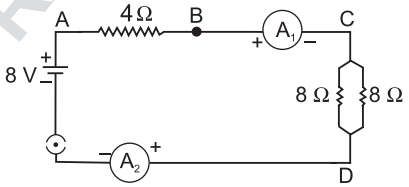
[2010 (T-I)]

21. 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 decreases to half when the length of the wire is doubled. Why?

[2010 (T-I)]

22. What is the role of fuse, used in series with any electrical appliance? Why should a fuse with defined rating not be replaced by one with a larger rating? **[2010 (T-I)]**

23. Find out the following in the electric circuit given in figure. **[2010 (T-I)]**



(a) Potential difference across 4Ω resistance

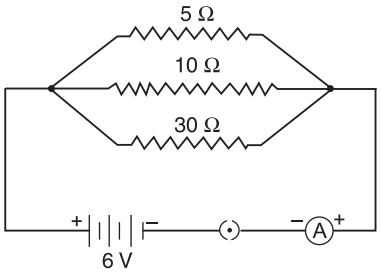
(b) Power dissipated in 4Ω resistor

(c) Difference in ammeter readings, if any

24. (i) What precautions should be taken to avoid the overloading of domestic electric circuits?

(ii) An electric oven of 2 kW power rating is operated in a domestic electric circuit. (220V), that has a current rating 5A. What result do you expect? Explain. **[2010 (T-I)]**

25. **[2010 (T-I)]**



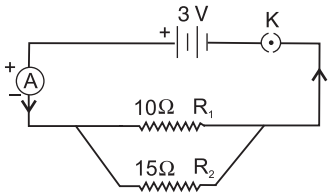
In the above circuit diagram calculate:

(a) the value of current through each resistor,

(b) the total current in the circuit and

(c) the total effective resistance of the circuit.

26. Study the following circuit and answer the questions: **[2010 (T-I)]**



(i) State the type of combination of the two resistors in the circuit.

(ii) How much current is flowing through

(a) 10 Ω and

(b) 15 Ω resistors?

(iii) What is the ammeter reading?

27. (a) What is meant by electric resistance of conductor? **[2010 (T-I)]**

(b) A wire of length L and resistance R is stretched so that the length is doubled and area of cross section is halved. How will (i) resistance change and (ii) resistivity change?

28. Express Joule's law of heating mathematically. What is the resistance of 12 m wire having radius 2×10^{-4} m, specific resistivity is 3.14×10^{-8} Ωm. **[2010 (T-I)]**

29. Draw a schematic diagram of a circuit consisting of 24 V battery, a 10 ohm resistor, a 5 ohm resistor, a 1 ohm resistor, an ammeter and a plug key, all connected in series. Calculate the ammeter reading in this circuit. **[2010 (T-I)]**

30. (a) Why are electric toaster and electric iron made of an alloy rather than pure metal?

(b) An electric iron of resistance 20 Ω takes a current of 5 A, calculate the heat developed in 30 second. **[2010 (T-I)]**

31. (a) Why is an ammeter likely to burn out if you connect it in parallel?

(b) Why is series arrangement not found satisfactory for domestic lights? **[2010 (T-I)]**

32. A copper wire has a diameter of 0.5 mm and a resistivity of 1.6×10^{-6} ohm-cm. How much of this wire would be necessary to make a resistance of 10 ohm? **[2010 (T-I)]**

33. A copper wire of length 3m and the area of cross section 1.7×10^{-6} m^2 has a resistance of 3×10^{-2} ohm. Calculate the resistivity of copper. **[2010 (T-I)]**

34. An electric lamp of 24 W, and a conductor of 6 W are connected in series to a 12 V battery. Calculate the: **[2010 (T-I)]**

(i) total resistance

(ii) total current in the circuit

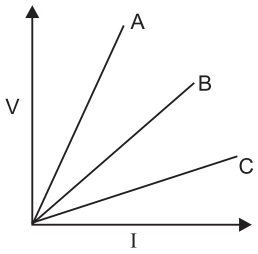
(iii) potential difference across the conductor.

35. In a household electric circuit, different appliances are connected in parallel to one another. Give two advantages of such connection. **[2010 (T-I)]**

Two bulbs rated 100 W, 200 V and 25 W, 200 V are connected in parallel to a 200 V supply. What will be the current drawn from the supply line?

36. A student performs an experiment with 4 cells and a resistance wire and an ammeter in series and observes that when the number of cells in the circuit is decreased, the value of current through the wire also decreases. Name the law that is involved in the experiment and write its mathematical form.

V-I graph for two resistors R_1, R_2 and their series combination is as below. Which graph represents the series combination of the other two? Give reason. **[2010 (T-I)]**

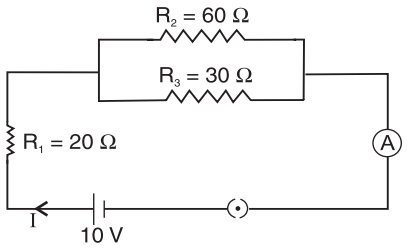


37. For the circuit shown in the diagram calculate: **[2010 (T-I)]**

(a) the total effective resistance of the circuit.

(b) the total current in the circuit.

(c) the value of current through 20Ω resistor.



38. Two identical resistors, each of resistance 50Ω are connected (i) in series (ii) in parallel, in turn, to a battery of 10 V. Calculate the ratio of power consumed in the combination for resistors in the two cases. **[2010 (T-I)]**

39. Two resistors of resistances 3Ω and 6Ω respectively are connected to a battery of 6V so as to have : **[2010 (T-I)]**

(a) Maximum resistance

(b) Maximum current

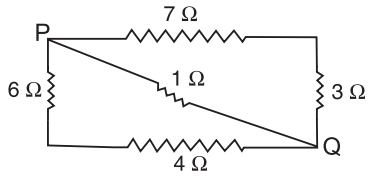
(i) How will you connect the resistances in each case?

(ii) Calculate the strength of the current in the circuit in both cases.

40. Two identical resistors, each of resistance 20Ω are connected (i) in parallel (ii) in series, in turn, to a battery of 10 V. Calculate the ratio of power consumed in the combination of resistors in the two cases. **[2010 (T-I)]**

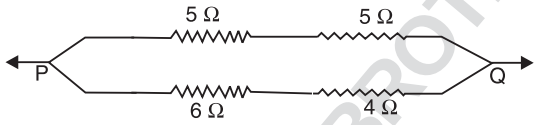
41. A 400 W refrigerator operates for 16 hrs/day, calculate the cost to operate it for 30 days at Rs. 3.40 per kWh. **[2010 (T-I)]**

42. Calculate the effective resistance between P and Q. **[2010 (T-I)]**



43. A 500W electric iron used in a house for 2 hours per day. Calculate the cost to use it for 60 days at Rs. 3.20 per kWh. **[2010 (T-I)]**

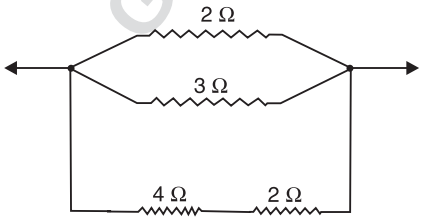
44. Calculate the effective resistance between P and Q. **[2010 (T-I)]**



45. An electric heater connected to a 220 V line has two resistance coil of 22 ohms each. Calculate the current if these coils are used **[2010 (T-I)]**

(a) Separately (b) In series (c) In Parallel

46. Calculate the Equivalent Resistance from the following combination of resistors. **[2010 (T-I)]**



47. Explain the following: **[2010 (T-I)]**

(a) Why is Tungsten used for the filament in electric bulbs?

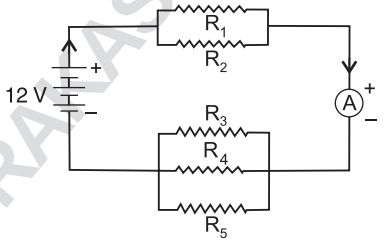
(b) Why are the conductors of electric heating devices, made of an alloy?

(c) How does the resistance of a wire vary with its cross sectional area?

48. How many resistors of 88Ω are connected in parallel to carry 10 A current on 220 V line? **[2010 (T-I)]**

49. An electric iron consumes energy at a rate of 840 W when heating is at the maximum rate and 360 W when the heating is at the minimum. The voltage is 220 V. What are the current and the resistance in each case? **[2010 (T-I)]**

50. In figure 'A' $R_1 = 10\Omega$, $R_2 = 40\Omega$, $R_3 = 30\Omega$, $R_4 = 20\Omega$, $R_5 = 60\Omega$ and a 12 V battery are connected to the arrangement. Calculate: **[2010 (T-I)]**



(a) total resistance in the circuit and

(b) total current flowing in the circuit.

51. In figure 'B' $R_1 = 10\Omega$, $R_2 = 20\Omega$, $R_3 = 25\Omega$, $R_4 = 5\Omega$ and a 12V battery is connected to the arrangement. Calculate: **[2010 (T-I)]**

(a) Total resistance in the circuit.

(b) Total current flowing in the circuit.

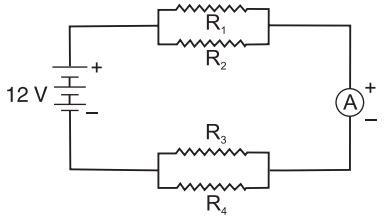


Figure-B

52. (a) State Ohm's Law. **[2007]**

(b) Draw a schematic diagram of the circuit for studying Ohm's Law.

53. State the formula correlating the electric current flowing in a conductor and the voltage applied across it. Also show this relationship by drawing a diagram.

What would be resistance of a conductor if the current flowing through it is 0.35 ampere when the potential difference across it is 1.4 volts? **[2004]**

IV. LONG ANSWER QUESTIONS (5 Marks)

IMPORTANT QUESTIONS

1. Derive an expression for equivalent resistance (R), when resistors R_1, R_2, R_3 are connected in series.

2. (i) What do you understand by the term fuse in an electric circuit?

(ii) State two properties of a material, which make it suitable for making fuse wire.

(iii) Why is fuse wire always placed in the live wire of an electric circuit?

(iv) How does fuse wire protect an electric circuit?

(v) Two fuse wires A and B of the same length are rated 15 A and 5A. Which amongst the A and B will be thicker and why?

3. What is electrical resistivity of a material? What is its unit? Describe an experiment to study the factor is on which the resistance of conducting wire depends. **[HOTS]**

4. How will you infer with the help of an experiment that same current flows through every part of the circuit containing three resistances in series connected to a battery? **[HOTS]**

5. How will you conclude that the same potential difference (voltage) exists across three resistors connected in a parallel arrangement to a battery? **[HOTS]**

B. QUESTIONS FROM CBSE EXAMINATION PAPERS

1. (a) State Ohm's law. Express it mathematically.

(b) Write symbols used in electric circuits to represent:

(i) Variable resistance (ii) Voltmeter

(c) An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, what will be the power consumed? **[2010 (T-I)]**

2. (a) Why is the series arrangement not used for domestic circuits?

(b) Why is tungsten used almost exclusively for filament of electric lamps?

(c) Why are the conductors of electric heating devices such as bread toasters and electric irons made of an alloy rather than a pure metal?

(d) Why are copper and aluminium wires usually employed for electricity transmission?

(e) Why does the cord of an electric heater not glow while the heating element does? **[2010 (T-I)]**

3. (a) Resistors are given as $R_1 = 10\ \Omega$, $R_2 = 20\ \Omega$ and $R_3 = 30\ \Omega$. Calculate the effective resistance when they are connected in series. Also calculate the current flowing when the combination is connected to a 6V battery.

(b) 3 resistors R_1, R_2 and R_3 are connected in series to a battery V. Draw the circuit diagram showing the arrangement. Derive an expression for the equivalent resistance of the combination. **[2010 (T-I)]**

4. (a) State Ohm's law.

(b) Draw a circuit diagram for the verification of Ohm's law. Also plot graphically the variation of current with potential difference.

(c) Calculate the resistance of a wire, when a potential difference of 2V is maintained for 1A current to flow through it. **[2010 (T-I)]**

5. Find out the following in the electric circuit given in figure. **[2010 (T-I)]**

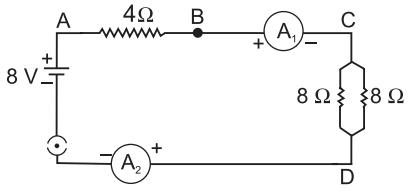
(a) Effective resistance of two 8 Ω resistors in the combination

(b) Current flowing through 4 Ω resistor

(c) Potential difference across 4 Ω resistor

(d) Power dissipated in 4 Ω resistor

(e) Difference in ammeter readings, if any.



6. A current of 1 ampere flows in a series circuit containing an electric lamp and a conductor of 5 Ω when connected to a 10 V battery. Calculate the resistance of the electric lamp. Now if a

resistance of 10 Ω is connected in parallel with this series combination, what change (if any) in current flowing through 5 Ω conductor and potential difference across the lamp will take place? Give reason. Draw circuit diagram.

[2010 (T-I)]

7. (a) Which effect of the electric current is utilised in the working of an electrical fuse?

(b) A fuse is connected in series or in parallel in household circuit?

(c) Draw a schematic labelled diagram of a domestic circuit which has a provision of a main fuse, meter, one light bulb and a switch/socket. **[2010 (T-I)]**

8. (a) What is the function of earth wire in electrical instruments? Why is it necessary to earth the metallic electric appliances?

(b) Explain what is short circuiting and overloading in an electric supply?

[2010 (T-I)]

9. (a) Derive an expression for the equivalent resistance of three resistors R_1, R_2 and R_3 connected in parallel. **[2010 (T-I)]**

(b) Fuses of 3A, 5A and 10A are available. Calculate and select the fuse for operating electric iron of 1 kW power at 220 V line.

10. (a) Define one ohm. **[2010 (T-I)]**

(b) How many 330Ω resistors in parallel are required to carry 20 A on 220 V line?

(c) Name a component used to regulate current without changing the voltage source.

(d) A 10Ω resistance wire is doubled on it calculate the new resistance of wire.

11. (a) Draw a shcematic diagram of the common domestic circuit.

(b) Write difference between overloading and short circuiting.

12. Answer the following questions:

(i) Why do we connect earth wire in a house? Give two reasons.

(ii) What type of current is used in household supply?

(iii) What type of current is given by a cell?

(iv) To which wire do you connect fuse-wire in a household circuit? **[2010 (T-I)]**

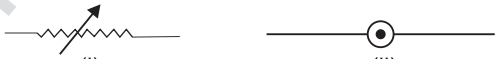
13. A current of 1 ampere flows in a series circuit containing an electric lamp and a conductor of 5 Ω when connected to a 10 V battery. Calculate the resistance of the electric lamp. Now if a resistance of 10 Ω is connected in parallel with this series combination, what change (if any) in current flowing through 5 Ω conductor and potential difference across the lamp will take place? Give reason. Draw circuit diagram.

[2010 (T-I)]

14. (a) Define the term 'volt'.

(b) State the relationship between work, charge and potential difference for an electric circuit. Calculate the potential difference between two terminals of a battery, if 100 joules of work is required to transfer 20 coulombs of charge from one terminal of battery to the other. **[2008]**

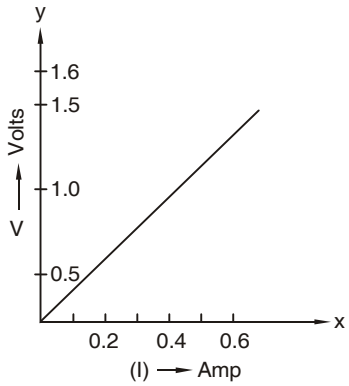
15. (a) What do the following symbols mean in the circuit diagrams? **[2008]**



(i) (ii)

(b) An electric circuit consisting of 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V each and plug key were set-up.

(i) Draw the diagram of this electric circuit to study the relation between potential difference maintained between the points X and Y and electric current flowing through XY.



(ii) The graph shown is plotted between V and I values. What would be the value of ratio, when potential difference is 0.8 V, 1.2 V and 1.6 V. What conclusion you draw from these values?

ASSIGNMENTS FOR FORMATIVE ASSESSMENT

A. Activities

1. Objective

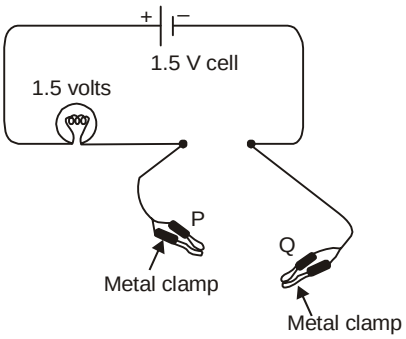
To identify conductors and insulators.

Materials required

1.5 V cell, 1.5 V lamp; insulated connecting wires, cello tape, metal clamps and different kinds of materials.

Procedure

1. Set up the apparatus as shown in figure.
2. Collect atleast 10 item of various kinds at home such as plastic pipe, a steel spoon, a rubber, an aluminium wire, a copper plate, plastic spoon, a paper cup etc.



3. Insert each piece one by one in the metal clamps P and Q.
4. Record with which item the bulb glows and with which item the bulb does not glow.
5. Tabulate the items as conductors and insulators.

Conductor	Insulators

Caution: Do not perform this activity with electric supply of your house.

B. Demonstrations

1. Objective

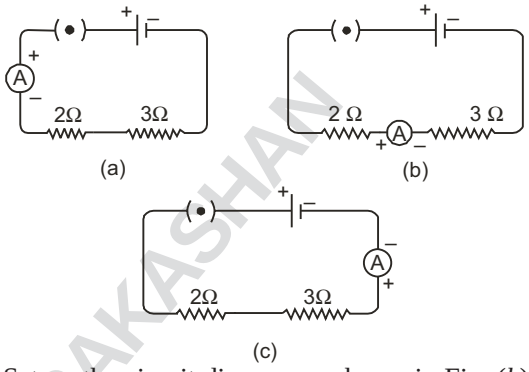
To show magnitude of current does not change in series circuit.

Materials required

A 6V battery or battery eliminator, two resistors of 2Ω and 3Ω. An ammeter of range 0-2 A, a single key, connecting wires.

Procedure

1. Set up the circuit diagram as shown in figure (*a*).
   Insert the key. Read and record current in ammeter A.



2. Set up the circuit diagram as shown in Fig. (*b*). Insert the key. Read and record current in ammeter A.
3. Set up the circuit diagram as shown in Fig. (*c*). Insert the key. Read and record current in ammeter A.

Observation

It is observed that ammeter shows same magnitude of current in all the three cases.

Conclusion

In series circuit magnitude of current remain same throughout the circuit.

2. Objective

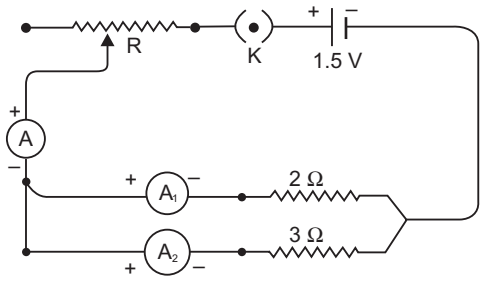
To show in a parallel circuit, the current in the main circuit is equal to the sum of currents in parallel branches.

Materials required

A 1.5 V cell, a single key, rheostat 3, ammeter (0–1.5) labelled A, A_1 and A_2, two resistors of 2Ω and 3Ω, connecting wires.

Procedure

1. Set up the circuit diagram as shown in the figure. Insert the key.



2. Switch on the circuit by inserting key.
3. Read and record the values of current in A, A_1, A_2.
4. Change the magnitude of current in main circuit by increasing or decreasing the resistance of rheostat. Again read and record the values of current.
5. Repeat the experiment at least four times to have five sets of readings.

Observations:

S. No.	Current in A (in Amp)	Current in A_1 (in Amp)	Current in A_2 (in Amp)	Current (A_1 + A_2) (in Amp)
1.				
2.				
3.				
4.				
5.				

It is noticed that the magnitude of current in ammeter A is equal to the sum of current in A_1 and A_2.

Conclusions

1. The current in main circuit is equal to the sum of currents in parallel branches.
2. The current in the parallel branches divides in the inverse ratio of the resistance of these branches. From the above statement it implies that more is the resistance in a parallel branch, less is the current flowing through it.

3. Objective

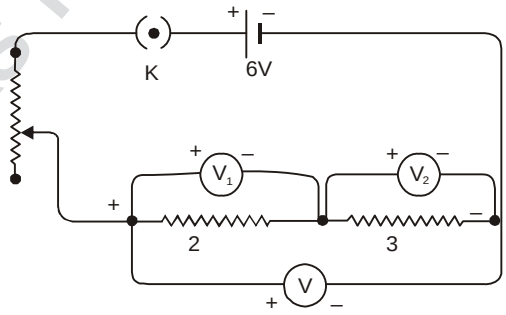
To prove that potential difference varies all along in a series circuit and total potential difference across the circuit is sum total potential difference across the ends of individual resistors.

Materials required

3 voltmeters (0–3V), labelled V, V_1 and V_2, a six volt battery or a battery eliminator, a single key, a rheostat, two resistors of 2Ω and 3Ω, connecting wires.

Procedure

1. Connect the 2Ω and 3Ω resistors in series and set up the circuit as shown in figure.



2. Insert the key and read the values of e.m.f. for V, V_1 and V_2. Tabulate the values.
3. Change the current in main circuit with help of rheostat. Again read and record the values of emf for V, V_1, V_2.
4. Repeat the experiment so as to have five sets of readings.

Observations:

S. No.	Voltage in V (in Volts)	Voltage in V_1 (in Volts)	Voltage in V_2 (in Volts)	Voltage V_1 + V_2 (in Volts)
1.				
2.				
3.				
4.				
5.				

Conclusions

1. There is a drop in potential in series circuit, but the p.d. goes on increasing.
2. The total p.d. across series circuit is equal to the sum total of p.d. across individual resistance.

4. Objective

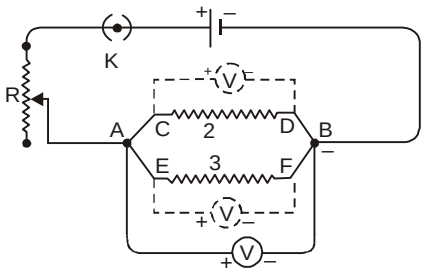
To show potential difference across all the resistors in parallel is a constant quantity.

Materials required

1.5 V cell, voltmeter (0–1.5 V), single key, rheostat, resistors of 2Ω and 3Ω each, connecting wires.

Procedure

1. Connect the 2Ω and 3Ω resistors in parallel and connect the voltmeter in parallel with them.
2. Set up the rest of circuit as shown in Figure and insert key. Read and record the voltmeter reading across the resistors of 2Ω and 3Ω.
3. Switch off the circuit. Disconnect voltmeter from points A and B and reconnect it along points C and D, *i.e.*, in parallel with resistor of 2Ω.



4. Insert the key. Read and record the reading of voltmeter.
5. Switch off the circuit. Disconnect voltmeter form points C and D and reconnect it along point E and F, *i.e.*, in parallel with resistor of 3Ω.
6. Insert the key. Read and record the reading of voltmeter.
7. Change the main current from rheostat and repeat experiment three more times so as to take four sets of readings.

Observations:

S. No.	Reading of voltmeter Across AB (in volts)	Reading of voltmeter across CD (in volts)	Reading of voltmeter across EF (in volts)
1.			
2.			
3.			
4.			

Conclusion

Potential difference across number of resistors in series circuit is the same as the potential difference across individual resistors connected in parallel.

5. Objective

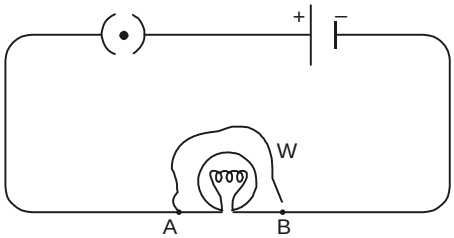
To find the meaning of short circuit.

Materials required

A 6V battery, a 6V bulb, connecting wires and one way key.

Procedure

1. Connect the battery, through the one way key and 6V lamp.
2. Connect another wire W at point A, but do not touch it to point B.
3. Insert the key. You will observe the bulb glows brightly.



4. Now touch the other end of wire W to the point B for not more than one second.

Observation

You will observe that bulb goes off as long as the wire W is touching point B.

Conclusion

1. Where does current go? Why the bulb stops glowing?

Well the current takes the passage of least resistance. As the bulb offers far greater resistance than the copper wire W, therefore all the current flows through copper wire, bypassing the lamp. This is called short circuit.

Note: 1. Short circuit does not mean shortest path taken by current. Instead it means the path of least resistance taken by the current.

2. During short circuit a huge amount of current flows through the wires, which in turn can heat up the wire to such an extent that they catch fire.

6. Objective

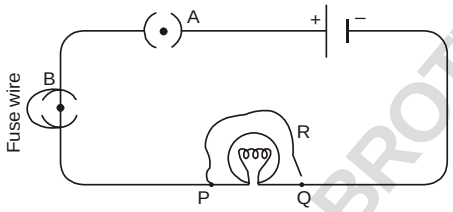
To show a fuse melts and breaks circuit, during short circuit.

Materials required

A 6 volt battery, 2 single keys (A) and (B), 6V bulb in bulb holder, connecting wires, fuse wire of 1A or 36 SWG.

Procedure

1. Take out the keys from single one way keys A and B.



2. Fix the keys and bulb of 6 V in series.

3. Fix one end of thick copper wire to the end P of the bulb. Keep other end free.

4. Take off 4 cm of fuse wire and connect it to the terminals of single one way key. Make sure that no key is inserted in it throughout the demonstration.

5. Switch on the circuit by inserting key in single one way key A. You will observe the bulb glows brightly.

6. Touch the free end of the wire R for a second or two only to the terminal Q of the bulb.

Observations

1. The bulb goes off and does not glow even when the wire R is provided from end Q.

2. The fuse wire melts and breaks.

3. The circuit can be restored only by fixing a new fuse wire.

Conclusions

1. When the wire R is touched to the end Q, a short circuit takes place and hence very large current flows through the battery, without passing through bulb.

2. This huge current, while flowing through fuse, heats it up to such a temperature (about 200°C) that it melts. This, in turn, breaks the circuit.

3. Much the same way electric fuses in our houses operate. They are placed in series in the live wire of a given circuit. When the circuit gets short circuited or overloaded, the fuse melts. This helps in preventing electrical fires.

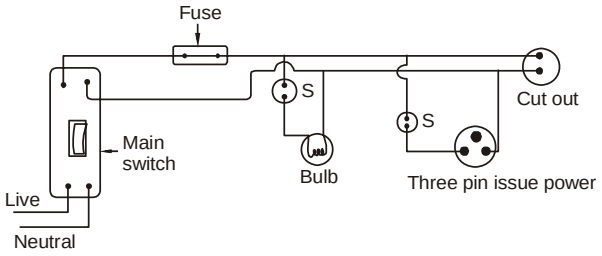
C. Models and Charts

To prepare working model of a switch board which can be connected to the mains and can operate a main switch, fuse, bulb and a three pin plug shoe by individual switches.

[**Important:** This activity should be done in presence of trained electrician or your physics teacher]

Materials required

10 m of insulated copper wire (22 SWG), plugs, set of screw drivers, a main switch, a fuse socket with fuse wire, two switches, one bulb holder, one three pin issue switch and a wooden board of 30 cm × 50 cm.



Method

1. Draw the circuit on the board.

2. Mark the position of main switch, fuse, switches, bulb holder, and three pin issue point.

3. Fix the above with the help of screw.

4. Connect the wires as shown in diagram.

5. Before connecting it to mains, get it checked from electrician or school teacher. Do not do this project on your own. You can get a very severe electric shock or can start electric fire.

Group Discussion

Discuss the following questions in groups and arrive at correct answers.

1. Why does the resistance of a conductor increase with its length?
2. Why the resistance of a conductor decrease with the increase in thickness of conductor?
3. Why different conductors offer different resistances?
4. Why the resistance of conductor in general increases with the rise in temperature?
5. Why the filament of electric bulb gets white hot, but the connecting wires do not?
6. Why is the fuse always placed in the live wire of a circuit?
7. Why a fuse wire should never be replaced by a copper wire?
8. Why is electric wiring in a house done in parallel?
9. Why is it not advisible to wire house hold in series?
10. What harm can take place, if there is no fuse in an electric circuit?

Question 1:

What does an electric circuit mean?

Answer:

An electric circuit consists of electric devices, switching devices, source of electricity, etc. that are connected by conducting wires.

Question 2:

Define the unit of current.

Answer:

The unit of electric current is ampere (A). 1 A is defined as the flow of 1 C of charge through a wire in 1 s.

Question 3:

Calculate the number of electrons constituting one coulomb of charge.

Answer:

One electron possesses a charge of 1.6×10^{-19} C, i.e., 1.6×10^{-19} C of charge is contained in 1 electron.

∴ 1 C of charge is contained in $\frac{1}{1.6\times10^{-19}} = 6.25\times10^{18} = 6\times10^{18}$ electrons

Therefore, 6×10^{18} electrons constitute one coulomb of charge.

Question 1:

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

Answer:

A source of electricity such as cell, battery, power supply, etc. helps to maintain a potential difference across a conductor.

Question 2:

What is meant by saying that the potential difference between two points is 1 V?

Answer:

If 1 J of work is required to move a charge of amount 1 C from one point to another, then it is said that the potential difference between the two points is 1 V.

Question 3:

How much energy is given to each coulomb of charge passing through a 6 V battery?

Answer:

The energy given to each coulomb of charge is equal to the amount of work required to move it. The amount of work is given by the expression,

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Charge}}$$

$$\text{Work Done} = \text{Potential Difference} \times \text{Charge}$$

Where,

Charge = 1 C

Potential difference = 6 V

$$\text{Work Done} = 6 \times 1 = 6 \text{ J}$$

Therefore, 6 J of energy is given to each coulomb of charge passing through a battery of 6 V.

Question 1:

On what factors does the resistance of a conductor depend?

Answer:

The resistance of a conductor depends upon the following factors:

(a) Length of the conductor

(b) Cross-sectional area of the conductor

(c) Material of the conductor

(d) Temperature of the conductor

Question 2:

Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

Answer:

Resistance of a wire, $R = \rho \frac{l}{A}$

Where,

ρ = Resistivity of the material of the wire

l = Length of the wire

A = Area of cross-section of the wire

Resistance is inversely proportional to the area of cross-section of the wire.

Thicker the wire, lower is the resistance of the wire and vice-versa. Therefore, current can flow more easily through a thick wire than a thin wire.

Question 3:

Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half of its former value. What change will occur in the current through it?

Answer:

The change in the current flowing through the component is given by Ohm's law as,

$V = IR$

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

Where,

Resistance of the electrical component = R

Potential difference = V

Current = I

The potential difference is reduced to half, keeping resistance constant.

Let the new resistance be R' and the new amount of current be I '.

Therefore, from Ohm's law, we obtain the amount of new current.

$$I' = \frac{V'}{R'} = \frac{\frac{V}{2}}{R} = \frac{1}{2}\left(\frac{V}{R}\right) = \frac{I}{2}$$

Therefore, the amount of current flowing through the electrical component is reduced by half.

Question 4:

Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Answer:

The resistivity of an alloy is higher than the pure metal. Moreover, at high temperatures, the alloys do not melt readily. Hence, the coils of heating appliances such as electric toasters and electric irons are made of an alloy rather than a pure metal.

Question 5:

Use the data in Table 12.2 to answer the following –

Table 12.2 Electrical resistivity of some substances at 20°C

–	**Material**	**Resistivity (Ω m)**
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}

	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
	Constantan (alloy of Cu and Ni)	49×10^{-6}
Alloys	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
	Glass	$10^{10} - 10^{14}$
Insulators	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

(a) Which among iron and mercury is a better conductor?

(b) Which material is the best conductor?

Answer:

(a) Resistivity of iron = $10.0 \times 10^{-8} \Omega$ m

Resistivity of mercury = $94.0 \times 10^{-8} \Omega$ m

Resistivity of mercury is more than that of iron. This implies that iron is a better conductor than mercury.

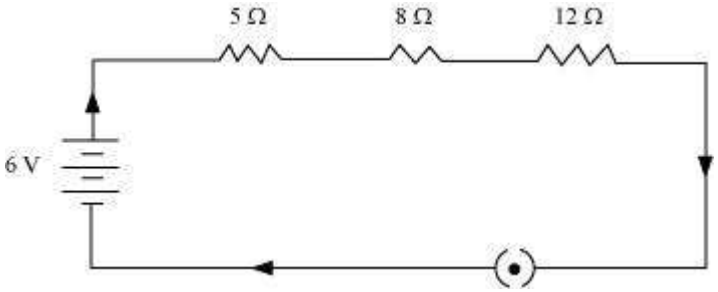
(b) It can be observed from Table 12.2 that the resistivity of silver is the lowest among the listed materials. Hence, it is the best conductor.

Question 1:

Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.

Answer:

Three cells of potential 2 V, each connected in series, is equivalent to a battery of potential 2 V + 2 V + 2 V = 6V. The following circuit diagram shows three resistors of resistances 5 Ω, 8 Ω and 12 Ω respectively connected in series and a battery of potential 6 V.

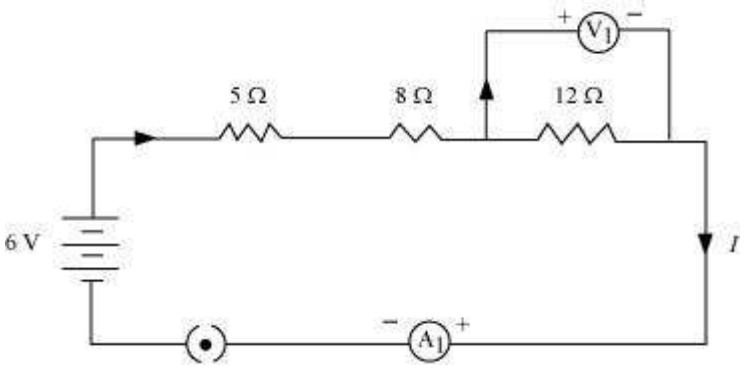


Question 2:

Redraw the circuit of question 1, putting in an ammeter to measure the current through the resistors and a voltmeter to measure potential difference across the 12 Ω resistor. What would be the readings in the ammeter and the voltmeter?

Answer:

To measure the current flowing through the resistors, an ammeter should be connected in the circuit in series with the resistors. To measure the potential difference across the 12 Ω resistor, a voltmeter should be connected parallel to this resistor, as shown in the following figure.



The resistances are connected in series.

Ohm's law can be used to obtain the readings of ammeter and voltmeter. According to Ohm's law,

$V = IR$,

Where,

Potential difference, V = 6 V

Current flowing through the circuit/resistors = I

Resistance of the circuit, $R = 5+8+12 = 25\ \Omega$

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

Potential difference across 12 Ω resistor = V_1

Current flowing through the 12 Ω resistor, I = 0.24 A

Therefore, using Ohm's law, we obtain

$V_1 = IR = 0.24 \times 12 = 2.88\ \text{V}$

Therefore, the reading of the ammeter will be 0.24 A.

The reading of the voltmeter will be 2.88 V.

Question 1:

Judge the equivalent resistance when the following are connected in parallel – (a) 1 Ω and $10^6\Omega$, (b) 1 Ω and $10^3\Omega$ and $10^6\Omega$.

Answer:

(a) When 1 Ω and 10^6 Ω are connected in parallel:

Let R be the equivalent resistance.

$$\therefore \frac{1}{R} = \frac{1}{1} + \frac{1}{10^6}$$

$$R = \frac{10^6}{10^6 + 1} \approx \frac{10^6}{10^6} = 1\ \Omega$$

Therefore, equivalent resistance $\approx$ 1 Ω

(b) When 1 Ω, $10^3\Omega$, and $10^6\Omega$ are connected in parallel:

Let R be the equivalent resistance.

$$\frac{1}{R}=\frac{1}{1}+\frac{1}{10^3}+\frac{1}{10^6}=\frac{10^6+10^3+1}{10^6}$$

$$R=\frac{1000000}{1001001}=0.999\ \Omega$$

Therefore, equivalent resistance = 0.999 Ω

Question 2:

An electric lamp of 100 Ω, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω are connected in parallel to a 220 V source. What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances, and what is the current through it?

Answer:

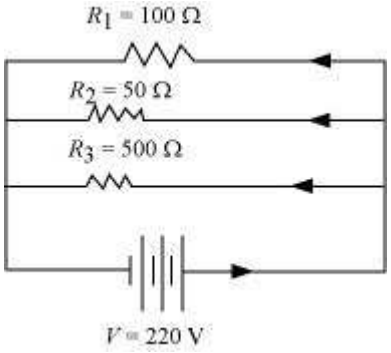
Resistance of electric lamp, $R_1=100\ \Omega$

Resistance of toaster, $R_2=50\ \Omega$

Resistance of water filter, $R_3=500\ \Omega$

Voltage of the source, V = 220 V

These are connected in parallel, as shown in the following figure.



Let R be the equivalent resistance of the circuit.

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}=\frac{1}{100}+\frac{1}{50}+\frac{1}{500}$$

$$=\frac{5+10+1}{500}=\frac{16}{500}$$

$$R=\frac{500}{16}\ \Omega$$

According to Ohm's law,

$V = IR$

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

Where,

Current flowing through the circuit = I

$$I = \frac{220}{\frac{500}{16}} = \frac{220 \times 16}{500} = 7.04\,\text{A}$$

7.04 A of current is drawn by all the three given appliances.

Therefore, current drawn by an electric iron connected to the same source of potential 220 V = 7.04 A

Let R' be the resistance of the electric iron. According to Ohm's law,

$V = IR'$

$$R' = \frac{V}{I} = \frac{220}{7.04} = 31.25\ \Omega$$

Therefore, the resistance of the electric iron is $31.25\ \Omega$ and the current flowing through it is 7.04 A.

Question 3:

What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Answer:

There is no division of voltage among the appliances when connected in parallel. The potential difference across each appliance is equal to the supplied voltage.

The total effective resistance of the circuit can be reduced by connecting electrical appliances in parallel.

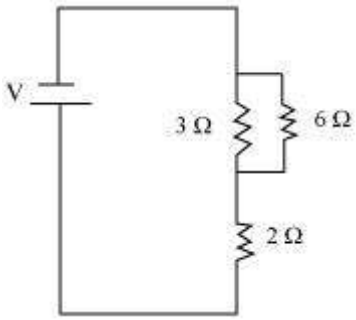
Question 4:

How can three resistors of resistances 2 Ω, 3 Ω and 6 Ω be connected to give a total resistance of (a) 4 Ω, (b) 1 Ω?

Answer:

There are three resistors of resistances 2 Ω, 3 Ω, and 6 Ω respectively.

(a) The following circuit diagram shows the connection of the three resistors.



Here, 6 Ω and 3 Ω resistors are connected in parallel.

Therefore, their equivalent resistance will be given by

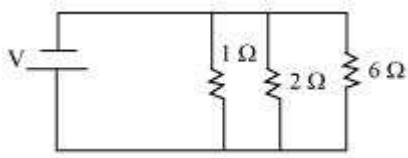
$$\frac{1}{\frac{1}{6}+\frac{1}{3}}=\frac{6\times 3}{6+3}=2\ \Omega$$

This equivalent resistor of resistance 2 Ω is connected to a 2 Ω resistor in series.

Therefore, equivalent resistance of the circuit = 2 Ω + 2 Ω = $4\ \Omega$

Hence, the total resistance of the circuit is $4\ \Omega$.

2. The following circuit diagram shows the connection of the three resistors.



All the resistors are connected in series. Therefore, their equivalent resistance will be given as

$$\frac{1}{\frac{1}{2}+\frac{1}{3}+\frac{1}{6}}=\frac{1}{\frac{3+2+1}{6}}=\frac{6}{6}=1\ \Omega$$

Therefore, the total resistance of the circuit is $1\ \Omega$.

Question 5:

What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4 Ω, 8 Ω, 12 Ω, 24 Ω?

Answer:

There are four coils of resistances $4\ \Omega$, $8\ \Omega$, 12 Ω, and 24 Ω respectively.

(a) If these coils are connected in series, then the equivalent resistance will be the highest, given by the sum 4 + 8 + 12 + 24 = $48\ \Omega$

(b) If these coils are connected in parallel, then the equivalent resistance will be the lowest, given by

$$\frac{1}{\frac{1}{4}+\frac{1}{8}+\frac{1}{12}+\frac{1}{24}} = \frac{1}{\frac{6+3+2+1}{24}} = \frac{24}{12} = 2\ \Omega$$

Therefore, 2 Ω is the lowest total resistance.

Question 1:

Why does the cord of an electric heater not glow while the heating element does?

Answer:

The heating element of an electric heater is a resistor. The amount of heat produced by it is proportional to its resistance. The resistance of the element of an electric heater is very high. As current flows through the heating element, it becomes too hot and glows red. On the other hand, the resistance of the cord is low. It does not become red when current flows through it.

Question 2:

Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Answer:

The amount of heat (H) produced is given by the Joule's law of heating as

$H = VIt$

Where,

Voltage, V = 50 V

Time, t = 1 h = 1 × 60 × 60 s

Amount of current, $I = \frac{\text{Amount of charge}}{\text{Time of flow of charge}} = \frac{96000}{1 \times 60 \times 60} = \frac{80}{3}$ A

$H = 50 \times \frac{80}{3} \times 60 \times 60 = 4.8 \times 10^6$ J

Therefore, the heat generated is 4.8×10^6 J.

Question 3:

An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Answer:

The amount of heat (H) produced is given by the joule's law of heating as

$H = VIt$

Where,

Current, I = 5 A

Time, t = 30 s

Voltage, V = Current × Resistance = 5 × 20 = 100 V

$H = 100 \times 5 \times 30 = 1.5 \times 10^4 \text{ J}$

Therefore, the amount of heat developed in the electric iron is $1.5 \times 10^4 \text{ J}$.

Question 1:

What determines the rate at which energy is delivered by a current?

Answer:

The rate of consumption of electric energy in an electric appliance is called electric power. Hence, the rate at which energy is delivered by a current is the power of the appliance.

Question 2:

An electric motor takes 5 A from a 220 V line. Determine the power of the motor and the energy consumed in 2 h.

Answer:

Power (P) is given by the expression,

$P = VI$

Where,

Voltage, V = 220 V

Current, I = 5 A

$P = 220 \times 5 = 1100 \text{ W}$

Energy consumed by the motor = Pt

Where,

Time, t = 2 h = 2 × 60 × 60 = 7200 s

$\therefore P$ = 1100 × 7200 = 7.92 × 10^6 J

Therefore, power of the motor = 1100 W

Energy consumed by the motor = 7.92 × 10^6 J

Question 1:

A piece of wire of resistance *R* is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is *R'*, then the ratio *R*/*R'* is –

(a) $\frac{1}{25}$

(b) $\frac{1}{5}$

(c) 5

(d) 25

Answer:

(d) Resistance of a piece of wire is proportional to its length. A piece of wire has a resistance *R*. The wire is cut into five equal parts.

Therefore, resistance of each part = $\frac{R}{5}$

All the five parts are connected in parallel. Hence, equivalent resistance (R') is given as

$$\frac{1}{R'}=\frac{5}{R}+\frac{5}{R}+\frac{5}{R}+\frac{5}{R}+\frac{5}{R}=\frac{5+5+5+5+5}{R}$$

$$\frac{1}{R'}=\frac{25}{R}$$

$$\frac{R}{R'}=25$$

Therefore, the ratio $\frac{R}{R'}$ is 25.

Question 2:

Which of the following terms does not represent electrical power in a circuit?

(a) I^2R

(b) IR^2

(c) VI

(d) $\frac{V^2}{R}$

Answer:

(b) Electrical power is given by the expression, $P = VI$ … (i)

According to Ohm's law, $V = IR$ … (ii)

Where,

V = Potential difference

I = Current

R = Resistance

$\therefore P = VI$

From equation (i), it can be written

$P = (IR) \times I$

$\therefore P = I^2R$

From equation (ii), it can be written

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

$$\therefore P = V \times \frac{V}{R}$$

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

$$\therefore P = VI = I^2R = \frac{V^2}{R}$$

Power P cannot be expressed as IR^2.

Question 3:

An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be –

(a) 100 W

(b) 75 W

(c) 50 W

(d) 25 W

Answer:

(d)Energy consumed by an appliance is given by the expression,

$$P = VI = \frac{V^2}{R}$$

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

Where,

Power rating, P = 100 W

Voltage, V = 220 V

Resistance, $R = \frac{(220)^2}{100} = 484\ \Omega$

The resistance of the bulb remains constant if the supply voltage is reduced to 110 V. If the bulb is operated on 110 V, then the energy consumed by it is given by the expression for power as

$$\therefore P' = \frac{(V')^2}{R} = \frac{(110)^2}{484} = 25\ \text{W}$$

Therefore, the power consumed will be 25 W.

Question 4:

Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be –

(a) 1:2

(b) 2:1

(c) 1:4

(d) 4:1

Answer:

(c) Heat produced in the circuit is inversely proportional to the resistance R.

Let R_S and R_P be the equivalent resistances of the wires if connected in series and parallel respectively. Hence, for same potential difference V, the ratio of heat produced in the circuit is given by

$$\frac{H_S}{H_P} = \frac{\frac{V^2}{R_S}t}{\frac{V^2}{R_P}t} = \frac{R_P}{R_S}$$

Where,

Heat produced in the series circuit = H_S

Heat produced in the parallel circuit = H_P

Equivalent resistance, $R_S = R + R = 2R$

Equivalent resistance, $R_P = \frac{1}{\frac{1}{R}+\frac{1}{R}} = \frac{R}{2}$

Hence, ratio $\frac{H_S}{H_P} = \frac{R}{2R} = \frac{1}{4}$

Therefore, the ratio of heat produced in series and parallel combinations is 1:4.

Question 5:

How is a voltmeter connected in the circuit to measure the potential difference between two points?

Answer:

To measure the potential difference between two points, a voltmeter should be connected in parallel to the points.

Question 6:

A copper wire has diameter 0.5 mm and resistivity of 1.6×10^{-8} Ω m. What will be the length of this wire to make its resistance 10 Ω? How much does the resistance change if the diameter is doubled?

Answer:

Resistance (R) of a copper wire of length l and cross-section A is given by the expression,

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

Where,

Resistivity of copper, $\rho = 1.6\times10^{-8}\ \Omega\text{m}$

Area of cross-section of the wire, $A = \pi\left(\frac{\text{Diameter}}{2}\right)^2$

Diameter= 0.5 mm = 0.0005 m

Resistance, R = 10 Ω

Hence, length of the wire, $l = \frac{RA}{\rho} = \frac{10 \times 3.14 \times \left(\frac{0.0005}{2}\right)^2}{1.6 \times 10^{-8}} = \frac{10 \times 3.14 \times 25}{4 \times 1.6} = 122.72 \text{ m}$

If the diameter of the wire is doubled, new diameter $= 2 \times 0.5 = 1 \text{ mm} = 0.001 \text{ m}$

Therefore, resistance R'

$$R' = \rho \frac{l}{A} = \frac{1.6 \times 10^{-8} \times 122.72}{\pi \left(\frac{1}{2} \times 10^{-3}\right)^2}$$

$$= \frac{1.6 \times 10^{-8} \times 122.72 \times 4}{3.14 \times 10^{-6}} = 250.2 \times 10^{-2} = 2.5 \ \Omega$$

Therefore, the length of the wire is 122.7 m and the new resistance is $2.5 \ \Omega$.

Question 7:

The values of current *I* flowing in a given resistor for the corresponding values of potential difference *V* across the resistor are given below –

I (amperes) 0.5 1.0 2.0 3.0 4.0

V (volts) 1.6 3.4 6.7 10.2 13.2

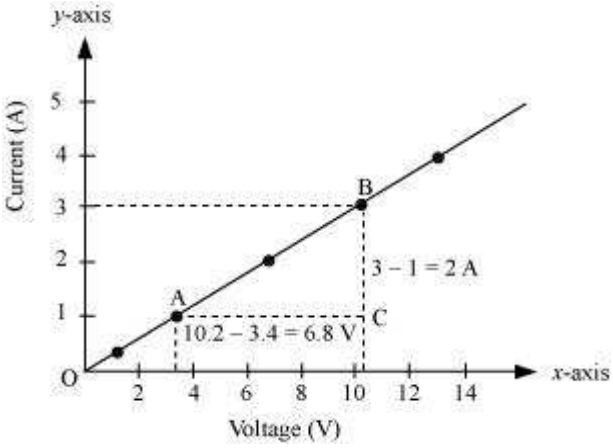
Plot a graph between *V* and *I* and calculate the resistance of that resistor.

Answer:

The plot between voltage and current is called *IV* characteristic. The voltage is plotted on *x*-axis and current is plotted on *y*-axis. The values of the current for different values of the voltage are shown in the given table.

V (volts)	1.6	3.4	6.7	10.2	13.2
I (amperes)	0.5	1.0	2.0	3.0	4.0

The *IV* characteristic of the given resistor is plotted in the following figure.



The slope of the line gives the value of resistance (R) as,

$$\text{Slope} = \frac{1}{R} = \frac{BC}{AC} = \frac{2}{6.8}$$

$$R = \frac{6.8}{2} = 3.4\ \Omega$$

Therefore, the resistance of the resistor is $3.4\ \Omega$.

Question 8:

When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.

Answer:

Resistance (R) of a resistor is given by Ohm's law as,

$$V = IR$$

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

Where,

Potential difference, V = 12 V

Current in the circuit, I = 2.5 mA = 2.5×10^{-3} A

$$R = \frac{12}{2.5 \times 10^{-3}} = 4.8 \times 10^{3}\ \Omega = 4.8\ \text{k}\Omega$$

Therefore, the resistance of the resistor is $4.8\ \text{k}\Omega$.

Question 9:

A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?

Answer:

There is no current division occurring in a series circuit. Current flow through the component is the same, given by Ohm's law as

$V = IR$

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

Where,

R is the equivalent resistance of resistances $0.2\ \Omega, 0.3\ \Omega, 0.4\ \Omega, 0.5\ \Omega, \text{and } 12\ \Omega$. These are connected in series. Hence, the sum of the resistances will give the value of R.

R = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4 Ω

Potential difference, V = 9 V

$$I = \frac{9}{13.4} = 0.671\ \text{A}$$

Therefore, the current that would flow through the 12 Ω resistor is 0.671 A.

Question 10:

How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

Answer:

For x number of resistors of resistance 176 Ω, the equivalent resistance of the resistors connected in parallel is given by Ohm's law as

$V = IR$

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

Where,

Supply voltage, V = 220 V

Current, I = 5 A

Equivalent resistance of the combination = R,given as

$$\frac{1}{R} = x \times \left(\frac{1}{176}\right)$$

$$R = \frac{176}{x}$$

From Ohm's law,

$$\frac{V}{I}=\frac{176}{x}$$

$$x=\frac{176\times I}{V}=\frac{176\times 5}{220}=4$$

Therefore, four resistors of 176 Ω are required to draw the given amount of current.

Question 11:

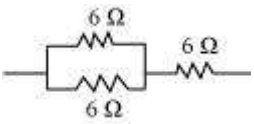
Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (i) 9 Ω, (ii) 4 Ω.

Answer:

If we connect the resistors in series, then the equivalent resistance will be the sum of the resistors, i.e., 6 Ω + 6 Ω + 6 Ω = 18 Ω, which is not desired. If we connect the resistors in parallel, then the equivalent resistance will be

$\frac{6}{2}=3\ \Omega$, which is also not desired. Hence, we should either connect the two resistors in series or parallel.

(i) Two resistors in parallel

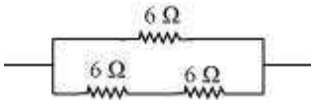


Two 6 Ω resistors are connected in parallel. Their equivalent resistance will be

$$\frac{1}{\frac{1}{6}+\frac{1}{6}}=\frac{6\times 6}{6+6}=3\ \Omega$$

The third 6 Ω resistor is in series with 3 Ω. Hence, the equivalent resistance of the circuit is 6 Ω + 3 Ω = 9 Ω.

(ii) Two resistors in series



Two 6 Ω resistors are in series. Their equivalent resistance will be the sum $6+6=12\ \Omega$

The third 6 Ω resistor is in parallel with 12 Ω. Hence, equivalent resistance will be

$$\frac{1}{\frac{1}{12}+\frac{1}{6}}=\frac{12\times 6}{12+6}=4\ \Omega$$

Therefore, the total resistance is $4\ \Omega$.

Question 12:

Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A?

Answer:

Resistance R_1 of the bulb is given by the expression,

$$P_1=\frac{V^2}{R_1}$$

$$R_1=\frac{V^2}{P_1}$$

Where,

Supply voltage, V = 220 V

Maximum allowable current, I = 5 A

Rating of an electric bulb $P_1=10\ \text{W}$

$$R_1=\frac{(220)^2}{10}=4840\ \Omega$$

According to Ohm's law,

$V = I R$

Where,

R is the total resistance of the circuit for x number of electric bulbs

$$R=\frac{V}{I}=\frac{220}{5}=44\ \Omega$$

Resistance of each electric bulb, $R_1=4840\ \Omega$

$$\therefore \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_1} + \text{...up to } x \text{ times}$$

$$\frac{1}{R} = \frac{1}{R_1} \times x$$

$$x = \frac{R_1}{R} = \frac{4840}{44} = 110$$

Therefore, 110 electric bulbs are connected in parallel.

Question 13:

A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistances, which may be used separately, in series, or in parallel. What are the currents in the three cases?

Answer:

Supply voltage, V = 220 V

Resistance of one coil, $R = 24\ \Omega$

(i) Coils are used separately

According to Ohm's law,

$$V = I_1 R_1$$

Where,

I_1 is the current flowing through the coil

$$I_1 = \frac{V}{R_1} = \frac{220}{24} = 9.166\ \text{A}$$

Therefore, 9.16 A current will flow through the coil when used separately.

(ii) Coils are connected in series

Total resistance, $R_2 = 24\ \Omega + 24\ \Omega = 48\ \Omega$

According to Ohm's law,

$$V = I_2 R_2$$

Where,

I_2 is the current flowing through the series circuit

$$I_2 = \frac{V}{R_2} = \frac{220}{48} = 4.58\ \text{A}$$

Therefore, 4.58 A current will flow through the circuit when the coils are connected in series.

(iii) Coils are connected in parallel

Total resistance, R_3 is given as $\frac{1}{\frac{1}{24}+\frac{1}{24}}=\frac{24}{2}=12\ \Omega$

According to Ohm's law,

$V = I_3 R_3$

Where,

I_3 is the current flowing through the circuit

$I_3 = \frac{V}{R_3} = \frac{220}{12} = 18.33\ \text{A}$

Therefore, 18.33 A current will flow through the circuit when coils are connected in parallel.

Question 14:

Compare the power used in the 2 Ω resistor in each of the following circuits: (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

Answer:

(i) Potential difference, *V* = 6 V

1 Ω and 2 Ω resistors are connected in series. Therefore, equivalent resistance of the circuit, *R* = 1 + 2 = 3 Ω

According to Ohm's law,

V = *IR*

Where,

I is the current through the circuit

$I = \frac{6}{3} = 2\ \text{A}$

This current will flow through each component of the circuit because there is no division of current in series circuits. Hence, current flowing through the 2 Ω resistor is $2\ \text{A}$. Power is given by the expression,

$$P = (I)^2 R = (2)^2 \times 2 = 8 \text{ W}$$

(ii) Potential difference, V = 4 V

12 Ω and 2 Ω resistors are connected in parallel. The voltage across each component of a parallel circuit remains the same. Hence, the voltage across 2 Ω resistor will be 4 V.

Power consumed by 2 Ω resistor is given by

$$P = \frac{V^2}{R} = \frac{4^2}{2} = 8 \text{ W}$$

Therefore, the power used by 2 Ω resistor is 8 W.

Question 15:

Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V?

Answer:

Both the bulbs are connected in parallel. Therefore, potential difference across each of them will be 220 V, because no division of voltage occurs in a parallel circuit.

Current drawn by the bulb of rating 100 W is given by,

$$\text{Power} = \text{Voltage} \times \text{Current}$$

$$\text{Current} = \frac{\text{Power}}{\text{Voltage}} = \frac{100}{220} \text{ A}$$

Similarly, current drawn by the bulb of rating 100 W is given by,

$$\text{Power} = \text{Voltage} \times \text{Current}$$

$$\text{Current} = \frac{\text{Power}}{\text{Voltage}} = \frac{60}{220} \text{ A}$$

$$\text{Hence, current drawn from the line} = \frac{100}{220} + \frac{60}{220} = 0.727 \text{ A}$$

Question 15:

Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V?

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Both the bulbs are connected in parallel. Therefore, potential difference across each of them will be 220 V, because no division of voltage occurs in a parallel circuit.

Current drawn by the bulb of rating 100 W is given by,

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$$\text{Current} = \frac{\text{Power}}{\text{Voltage}} = \frac{60}{220}\ \text{A}$$

$$\text{Hence, current drawn from the line} = \frac{100}{220} + \frac{60}{220} = 0.727\ \text{A}$$

Question 16:

Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

Answer:

Energy consumed by an electrical appliance is given by the expression,

$$H = Pt$$

Where,

Power of the appliance = P

Time = t

Energy consumed by a TV set of power 250 W in 1 h = 250 × 3600 = 9×10^5 J

Energy consumed by a toaster of power 1200 W in 10 minutes = 1200 × 600

= 7.2×10^5 J

Therefore, the energy consumed by a 250 W TV set in 1 h is more than the energy consumed by a toaster of power 1200 W in 10 minutes.

Question 17:

An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

Answer:

Rate of heat produced by a device is given by the expression for power as

$$P = I^2R$$

Where,

Resistance of the electric heater, R = 8 Ω

Current drawn, I = 15 A

$P = (15)^2 \times 8 = 1800 \text{ J/s}$

Therefore, heat is produced by the heater at the rate of 1800 J/s.

Question 18:

Explain the following.

(a) Why is the tungsten used almost exclusively for filament of electric lamps?

(b) Why are the conductors of electric heating devices, such as bread-toasters and electric irons, made of an alloy rather than a pure metal?

(c) Why is the series arrangement not used for domestic circuits?

(d) How does the resistance of a wire vary with its area of cross-section?

(e) Why are copper and aluminium wires usually employed for electricity transmission?

Answer:

(a) The melting point and resistivity of tungsten are very high. It does not burn readily at a high temperature. The electric lamps glow at very high temperatures. Hence, tungsten is mainly used as heating element of electric bulbs.

(b) The conductors of electric heating devices such as bread toasters and electric irons are made of alloy because resistivity of an alloy is more than that of metals. It produces large amount of heat.

(c) There is voltage division in series circuits. Each component of a series circuit receives a small voltage for a large supply voltage. As a result, the amount of current decreases and the device becomes hot. Hence, series arrangement is not used in domestic circuits.

(d) Resistance (R) of a wire is inversely proportional to its area of cross-section (A), i.e.,

$$R \propto \frac{1}{A}$$

(e) Copper and aluminium wires have low resistivity. They are good conductors of electricity. Hence, they are usually employed for electricity transmission.