LET US RECAPITULATE THE CHAPTER

- **Electric current** : An electric current is defined as the amount of charge flowing through any cross-section of a conductor per unit time, $I = \frac{Q}{t}$.
- Electric current in terms of number of electrons (n) in a conductor, $I = \frac{ne}{t}$, e = charge on an electron $= 1{\cdot}6 \times 10^{-19}$ C.
- **Charge on an electron** $= -1{\cdot}6 \times 10^{-19}$ C.
- $6{\cdot}25 \times 10^{18}$ electrons make one coulomb of charge.
- S.I. unit of electric current is **ampere** (A).
- Ampere (A) : Electric current through a conductor is said to be 1 ampere if one coulomb charge flows through any cross-section of the conductor in one second.
- Ammeter is used to measure electric current.
- Ammeter is always connected in series in an electric circuit.
- Electric current is a **scalar** quantity.
- **Electric potential** is defined as work done per unit charge. That is, $V = \frac{W}{q}$
- Electric potential is a **scalar** quantity.
- **Electric potential difference** is defined as the work done per unit charge in moving a unit positive charge from one point to another point. That is, $d\,V = \frac{W}{q}$
- **SI unit** of electric potential is volt (V).
- Voltmeter is used to measure the potential difference between two points in an electric circuit.
- Voltmeter is always connected in parallel in an electric circuit.
- **Ohm's Law** : This law states that, "the electric current flowing in a conductor is directly proportional to the potential difference across the ends of the conductor, provided the temperature and other physical conditions of the conductor remain the same".
- **Resistance (R)** : Resistance of a conductor is the ability of the conductor to oppose the flow of charge through it.
- Unit of resistance is **ohm**.
- **Ohm** : Resistance of a conductor is said to be 1 ohm if a potential difference of 1 volt across the ends of the conductor makes a current of 1 ampere to flow through it.
- Resistor is a component (say a metallic wire) in an electric circuit which offers resistance to the flow of electrons constituting the electric current in the electric circuit.
- **Laws of Resistance** :
  (1) Resistance of a conductor depends upon the nature of the material of the conductor.
  (2) Resistance of a conductor is directly proportional to the length of the conductor.
  (3) Resistance of a conductor is inversely proportional to the each of cross-section of the conductor.
  (4) Resistivity of metallic conductor increases with the increase of temperature and decreases with the decrease of the temperature.
- $$R = \frac{\rho l}{A}$$
- **Resistivity or Specific Resistance (ρ)** : Resistivity is defined as the resistance of the conductor of unit length and unit area of cross-section.
- **Unit of Resistivity** :
  In CGS system, unit of resistivity is **ohm-cm.**
  In SI system, unit of resistivity is **ohm-metre.**
- Two or more resistors are said to be connected *in series* if same amount of current flows through these resistors.
- *The effective resistance* of series combination of resistors is the algebraic sum of the individual resistances of the resistors in the combination.
- An electric bulb or a heater or a metallic wire acts as a resistor.
- If one of the electric bulbs connected in a series is fused, then no electric bulb will glow inspite of the fact that the combination is connected with a source of electric current.

- Two or more resistors are said to be connected in parallel if the potential difference across each resistor is equal to the applied potential difference across the combination of the resistors.
- The effective resistance of the resistors connected in parallel is less than the minimum resistance of a resistor in the combination.
- Resistors are connected in series if the resistance of the electric circuit is to be increased.
- Resistors are connected in parallel if the resistance of the electric circuit is to be decreased.
- **Joule's Law of Heating :**
  The amount of heat produced in a conductor is
  (i) directly proportional to the square of the electric current flowing through it.
  (ii) directly proportional to the resistance of the conductor.
  (iii) directly proportional to the time for which the electric current flows through the conductor.

$$H = I^2 Rt \quad \text{(joule)}$$

- **Electric fuse** is a safety device used to save the electric appliances from burning.
- Electric fuse is a wire made of a material having low melting point.
- Electric fuse wire is made of **copper** or **tin-lead alloy.**
- **Electric energy** : The work done by a source of electricity to maintain a current in an electric circuit is known as electric energy.

$$E = VIt$$

- **Electric power** : Electric power is defined as the amount of electric work done in one second.

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

- **SI unit** of power is **watt.**
- Practical unit of power is **horse power** (h.p.)

$$1 \text{ h.p.} = 746 \text{ W}$$

- Electric energy = Electric power × time
- **Commercial unit of Energy** : kilowatt–hour (kWh)

$$1 \text{ kWh} = 3{\cdot}6 \times 10^6 \text{ J}$$

QUESTIONS FROM NCERT TEXT BOOK

IN TEXT QUESTIONS

1. ***What does an electric circuit mean ?*** *(C.B.S.E. 2011)*

Ans. An electric circuit is a closed conducting path containing a source of potential difference or electric energy (*i.e.* a cell or battery) and a device or element utilizing the electric energy.

2. ***Define the unit of current.*** *(C.B.S.E. 2008)*

Ans. Unit of electric current is ampere. Electric current in a conductor is said to be 1 A if 1 coulomb charge flows through the cross-section of the conductor in 1 second.

3. ***Calculate the number of electrons consisting one coulomb of charge.***

Ans. $q = 1$ C.

Let n = number of electrons consisting 1 C of charge.

Using $q = ne$, we have

$$n = \frac{q}{e} = \frac{1\text{ C}}{1{\cdot}6\times10^{-19}\text{ C}} = 6{\cdot}25 \times 10^{18} \text{ electrons.}$$

4. ***Name a device that helps to maintain a potential difference across a conductor.*** *(C.B.S.E. 2008)*

Ans. A cell or battery.

5. ***What is meant by saying that a potential difference between two points is 1 V ?***
[C.B.S.E. (Delhi) 2008 ; C.B.S.E. (All India) 2008, 2010 Term I]

Or

Define the term "Volt". *(C.B.S.E. 2009)*

Ans. Potential difference between two points is 1 V if 1 joule work is done in moving 1 coulomb charge from one point to another point.

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

Ans. Energy = Charge × Potential difference = 1 C × 6 V = 6 J.

7. ***On what factors does the resistance of a conductor depend ?*** ***(C.B.S.E. 2009, 2011, 2012)***

Ans. Resistance of a conductor depends on (*i*) length (*l*) of the conductors, (*ii*) area of corss-section of the conductor, (*iii*) nature of the material of the conductor and (*iv*) temperature of the conductor.

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

Ans. $I = \frac{V}{R}$. Since $R \propto \frac{1}{\text{Area of cross-section}}$,

therefore, resistance of thin wire is more than the resistance of thick wire. Hence, current in thick wire flows easily than in thin wire.

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

Ans. $I = \frac{V}{R}$. When $V' = \frac{V}{2}$

$$I' = \frac{V}{2R} = \frac{I}{2}.$$

Thus, current in the component becomes half of its former value.

10. ***Why are coil of electric toasters and electric irons made of an alloy rather than a pure metal ?*** ***(C.B.S.E. 2011, 2012)***

Ans. This is because the resistivity of an alloy is more than the resistivity of a pure metal and hence more heat is produced in an alloy than in pure metal due to the flow of current. Moreover, alloy does not burn (or oxidise) easily even at higher temperature.

11. ***(a) Which among, iron and mercury is a better conductor ? (resistivity of iron = 10·0 × 10^{-8} Ω m and resistivity of mercury = 94 × 10^{-8} Ω m)***

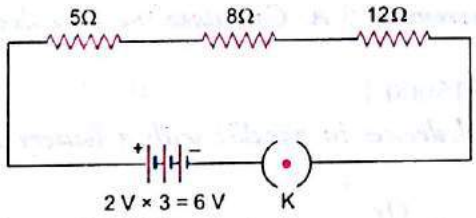
(b) Which material is the best conductor ?

Ans. (*a*) A material whose resistivity is low is a good conductor of electricity. Therefore, iron is better conductor than mercury.

(*b*) Silver is the best conductor of electricity.

12. ***Draw a schematic diagram of a circuit consisting of a batteries of three of 2 V each, a 5 Ω resistor, 8 Ω resistor and a 12 Ω resistor and a plug key, all connected in series.*** ***(C.B.S.E. 2011)***

Ans.



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

Ans. Total resistance of the circuit,

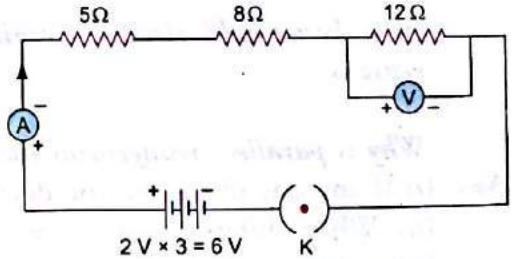
$$R = 5\ \Omega + 8\ \Omega + 12\ \Omega = 25\ \Omega$$

$$V = 6\ V$$

$$I = \frac{V}{R} = \frac{6}{25} = 0{\cdot}24\ A$$

Therefore, reading of ammeter = 0·24 A

Reading of voltmeter = IR = 0·24 A × 12 Ω = 2·88 V.



14. ***Judge the equivalent resistance when the following are connected in parallel :***

(a) 1 Ω and 10^6 Ω (b) 1 Ω and 10^3 Ω and 10^6 Ω.

Ans. (*a*) When resistors are connected in parallel, then equivalent resistance of the combination is less than the least resistance in the combination. Therefore, equivalent resistance of 1 Ω and 10^6 Ω connected in parallel is approximately 1 Ω but less than 1 Ω.

(*b*) The equivalent resistance is approximately 1 Ω but less than 1 Ω.

15. ***An electric lamp of 100 W, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω are connected in parallel to 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 ?***

Ans. Resistance of electric lamp, $R_1 = \frac{V^2}{P} = 220 \times \frac{220}{100} = 484\ \Omega$

Net resistance when all appliances are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{484} + \frac{1}{50} + \frac{1}{500} = \frac{2912}{121000} \text{ or } R = 41{\cdot}55\ \Omega$$

Therefore $I = \frac{V}{R} = \frac{220}{41{\cdot}55} = 5{\cdot}3$ A.

16. *What is (a) highest (b) lowest resistance that can be secured by combining four coils of resistances 4 Ω, 8 Ω, 12 Ω, 24 Ω ?* *(C.B.S.E. 2010 Term I, 2012)*

Ans. (*a*) Highest resistance is obtained when coils are connected in series.

Therefore $R = 4 + 8 + 12 + 24 = 48\ \Omega$

(*b*) Lowest resistance is obtained when coils are connected in parallel.

Therefore $\frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{12}{24}$ or $R = \frac{24}{12} = 2\ \Omega$.

17. *Why does the connecting cord of an electric heater not glow while the heating element does ?* *[C.B.S.E. (Delhi) 2008, 2010, 2011]*

Ans. This is because resistance of cord of electric heater is less than the resistance of heating element. So more heat is produced in the heating element and less heat is produced in the cord. Due to more heat, heating element glows.

18. *Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.* *(C.B.S.E. 2012)*

Ans. $H = VIt = V \times \frac{Q}{t} \times t \qquad \left(\because\ I = \frac{Q}{t}\right)$

or $H = VQ = 50 \times 96000 = 4{\cdot}8 \times 10^6$ J.

19. *An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 seconds.* *(C.B.S.E. 2010)*

Ans. $H = I^2Rt = 25 \times 20 \times 30 = 15000$ J.

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

Or

Give two advantages of connecting electrical devices in parallel with battery. *(C.B.S.E. 2010 Term I)*

Or

In a house-hold electric circuit different appliances are connected in parallel to one another. Give two reasons. *[C.B.S.E. Sample Papers, C.B.S.E. 2012]*

Or

Why is parallel arrangement used in domestic ? *[N.C.E.R.T Question Bank]*

Ans. (*i*) If any one of the electric devices in parallel fuses, then the working of other devices will not be affected.

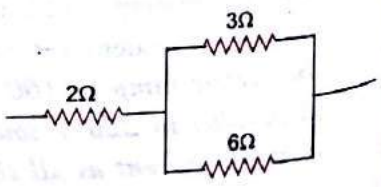
(*ii*) When different devices are connected in parallel, they draw the current as per their requirement and hence they work properly.

21. *How can three resistors of resistances 2 Ω, 3 Ω and 6 Ω be connected to give a total resistance of (a) 4Ω (b) 1 Ω ?* *(C.B.S.E. 2012)*

Ans. (*a*) We get 4 Ω resistance if 3 Ω and 6 Ω resistors are connected in parallel and this parallel combination is connected in series with 2 Ω as shown in figure.

Equivalent resistance of 3 Ω and 6 Ω is given by

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



or $R = 2\ \Omega$

Now 2 Ω and 2 Ω are in series,

So net resistance = 2 Ω + 2 Ω = 4 Ω

(*b*) We get 1 Ω resistance if all three resistors are connected in parallel.

Therefore $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}=\frac{1}{2}+\frac{1}{3}+\frac{1}{6}=\frac{3+2+1}{6}=\frac{6}{6}=1$ or $R = 1\Omega$

22. ***What determines the rate at which energy is delivered by an electric current ?*** ***[C.B.S.E. (All India) 2008]***

Ans. Electric power determines the rate at which energy is delivered by an electric current.

23. ***An electric motor takes 5 A from a 220 V line. Determine the power of the motor and energy consumed in 2 h.*** ***[C.B.S.E. (All India) 2008]***

Ans. Power, $P = VI = 220 \times 5 = 1100$ W

Energy consumed = Power × Time

= 1100 W × 2 h = 2200 Wh = 2·2 kWh.

CHAPTER END EXERCISES

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*** $\frac{R}{R}$, ***is***

(*a*) $\frac{1}{25}$ (*b*) $\frac{1}{5}$ (*c*) 5 (*d*) 25. ***(C.B.S.E. 2012)***

Ans. Resistance of each part = $\frac{R}{5}$

$\therefore \quad \frac{1}{R'}=\frac{1}{\frac{R}{5}}+\frac{1}{\frac{R}{5}}+\frac{1}{\frac{R}{5}}+\frac{1}{\frac{R}{5}}+\frac{1}{\frac{R}{5}}=5\times\frac{5}{R}=\frac{25}{R}$ or $R' = \frac{R}{25}$

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

$\therefore$ (*d*) is correct answer.

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

(*a*) I^2R (*b*) IR^2 (*c*) VI (*d*) $\frac{V^2}{R}$.

Ans. (*b*) is correct answer.

3. ***An electric bulb is rated as 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.*

Ans. Ist Case. V = 220 V, P = 100 W

We know $P = \frac{V^2}{R} \quad \therefore \quad R = \frac{V^2}{P}=\frac{220\times220}{100}=484\ \Omega$

IInd Case. V = 110 V, R = 484 Ω

$\therefore \quad P = \frac{V^2}{R}=\frac{110\times110}{484} = 25$ W

$\therefore$ (*d*) is the correct answer.

4. ***Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in an electric circuit. The ratio of heat produced in series and parallel combinations would be***

(a) 1 : 2 *(b) 2 : 1* *(c) 1 : 4* *(d) 4 : 1.*

Ans. Let resistance of each wire is R.

In series, resistance is therefore = 2R

$\therefore$ Heat produced, $H_1 = \frac{V^2}{2R}t$ ($\because$ Net resistance = 2 R)

In parallel, resistance is $= \frac{R}{2}$

$\therefore$ Heat produced, $H_2 = \frac{V^2}{\left(\frac{R}{2}\right)} t = \frac{2V^2}{R} t$

$\therefore$ $H_2 = 4H_1$ or $\frac{H_1}{H_2} = \frac{1}{4}$

$\therefore$ (*c*) is the correct answer.

5. ***How is voltmeter connected in circuit to measure the potential difference between two points ?*** ***(C.B.S.E. 2011, 2012)***

Ans. In parallel.

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 diameter is doubled ?***

Ans. $R = \rho \frac{l}{A} = \frac{\rho l}{A} = \frac{4\rho l}{\pi D^2}$

$\therefore$ $l = \frac{RA}{\rho} = \frac{R\pi D^2}{4\rho} = \frac{3{\cdot}14 \times 10 \times (0{\cdot}5 \times 10^{-3})^2}{4 \times 1{\cdot}6 \times 10^{-8}} = 122{\cdot}77$ m

When D is doubled and length remains the same, resistance becomes $\frac{1}{4}$ th of the original resistance.

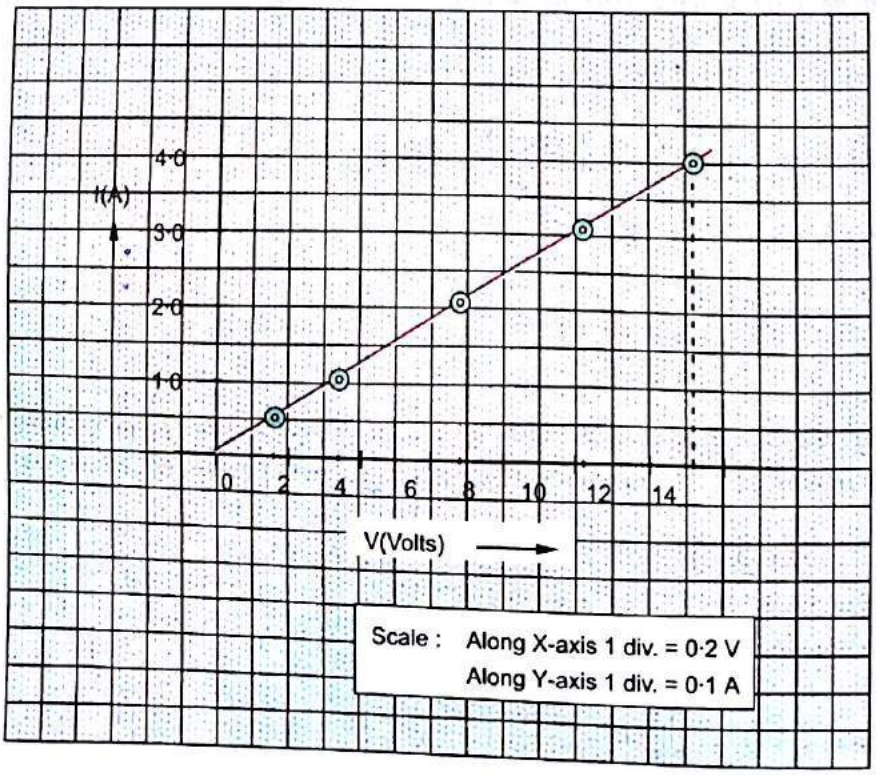
7. ***The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below :***

I (ampere)	:	*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.

Ans. Slope of the V - I curve $= \frac{4}{13{\cdot}2} = 0{\cdot}303$

$\therefore$ Resistance of resistor $= \frac{1}{\text{Slope of the V-I curve}} = \frac{1}{0{\cdot}303} = 3{\cdot}3$ ohm.



8. *When a 12 V battery is connected across an unknown resistance, there is a current of 2·5 mA in the circuit. Find the value of resistance of the resistor.*

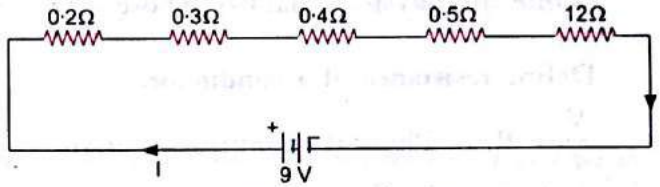
Ans. $V = 12\ V,\ I = 2{\cdot}5 \times 10^{-3}\ A$

We know $V = IR \quad \therefore \quad R = \dfrac{V}{I} = \dfrac{12}{2{\cdot}5 \times 10^{-3}} = 4800\ \Omega.$

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 12 Ω resistor ?* *(C.B.S.E. 2010 Term I)*

Ans. Total resistance = 13·4 Ω

$$\therefore \quad I = \frac{V}{R} = \frac{9}{13{\cdot}4} = 0{\cdot}67\ A$$



10. *How many 176 Ω resistors (in parallel) are required to carry 5 A on 220 V line ?* *(C.B.S.E. 2012)*

Ans. Let n = number of resistors each of resistance R

When these resistors are connected in parallel, net resistance (R′) is given by

$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{R} + \ldots\ldots \text{upto } n = \frac{n}{R} \quad or \quad R' = \frac{R}{n}$$

Now $$I = \frac{V}{R'} = \frac{nV}{R} \quad or \quad n = \frac{IR}{V} = \frac{5 \times 176}{220} = 4$$

VERY SHORT ANSWER QUESTIONS

(EACH QUESTION CARRIES 1 MARK)

1. *What is SI unit of electric current ?*

Ans. ampere (A).

2. *What is meant by potential difference between two points ?* *(C.B.S.E. 2011)*

Ans. Work done per unit charge in moving a unit positive charge from one point to another point is called potential difference between two points.

3. *How is the direction of electric current related to the direction of flow of electrons in a wire ?* *[C.B.S.E. (All India) 2009]*

Ans. The direction of electric circuit in a wire is just opposite to the directions of flow of electron in the wire.

4. *Name the instrument used to measure electric current in a circuit.* *[C.B.S.E. (Delhi) 2008, 2011, 2012]*

Ans. Ammeter.

5. *How is ammeter connected in the circuit to measure electric current ?* *(C.B.S.E. 2011, 2012)*

Ans. Ammeter is connected in series in an electric circuit.

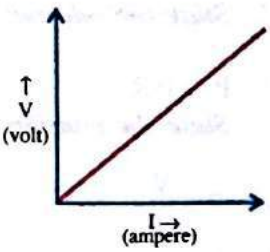
6. *What is the S.I. unit of electrical potential ?* *(C.B.S.E. 2005, 2012)*

Ans. Volt.

7. *Name the instrument used to measure the electric potential difference.* *(C.B.S.E. 2011, 2012)*

Ans. Voltmeter.

8. *Graph is plotted between the values of potential difference (V) and current (I). What conclusion do you draw about the relation between V and I from this graph. State this relation in your words.*



Ans. The potential difference (V) is directly proportional to the current (I).

9. *Define Ohm's law.* *[C.B.S.E. 2010, 2011, 2012]*

Or

State the law that gives the relationship between the potential difference (V) across the two ends of a conductor and the current (I) flowing through it. *(C.B.S.E. 2012)*

Ans. Ohm's law states that the electric current flowing through a conductor is directly proportional to the potential difference across the ends of the conductor, provided the temperature and other physical conditions of the conductor remain the same.

10. *State SI unit of resistance.* *[C.B.S.E. (Delhi) 2004(S), 2012]*

Ans. ohm (Ω).

11. *What is the shape of the graph obtained by plotting potential differene applied across a conductor against the current flowing through it ?* *(C.B.S.E. (All India) 2009)*

Ans. A straight line.

12. **What is the name the physical quantity which is equal to $\frac{V}{I}$?** *[C.B.S.E. 2007 (Delhi)]*

Or

Name the physical quantity whose unit is volt/ampere. *[C.B.S.E. 2010, 2011]*

Or

Define resistance of a conductor. *(C.B.S.E. 2012)*

Ans. $\frac{V}{I}$ = R. ∴ Physical quantity is resistance of a conductor.

13. *State SI unit of resistivity.* *[C.B.S.E. (Delhi) 2004 (S)]*

Ans. ohm–metre (Ω–m).

14. *What material is generally used for making an electric fuse ?* *(C.B.S.E. 2006)*

Ans. Copper or tin-lead alloy.

15. *What is electrical resistivity ?* *[C.B.S.E. 2010]*

Ans. Electrical resistivity of a material is defined as the resistance of the object (made of the material) of unit length and unit area of cross-section.

16. *What happens to resistance of a conductor when temperature is increased ?*

Ans. Resistance of a conductor increases with the increase in temperature.

17. *What does the slope of V-I graph at any point represent ?* *[C.B.S.E. (All India) 2009]*

Ans. Slope of V-I graph = $\frac{1}{\text{resistane of a conductor}}$. Therefore, slope of V-I graph represents reciprocal of the resistance of a conductor.

18. *Name the physical quantity expressed as the product of potential difference and electric current.*

Ans. Electric power.

19. *State SI unit of electric power.*

Ans. Volt × ampere (or Watt).

20. *Name the unit used in selling electrical energy to consumers.* *[C.B.S.E. (Foreign) 2006]*

Or

What is the commercial unit of energy ? *(C.B.S.E. 2011)*

Ans. Kilowatt hour (kWh).

21. *How does the resistance of a wire vary with its cross-section area ?*

Ans. Resistance of a wire is inversely proportional to its cross-sectional area. More is cross-sectional area of a conductor less is the resistance of the conductor.

22. *State the formula showing how the current I in a conductor varies with the potential difference V applied across it.* *[C.B.S.E. (Delhi) 2004(S), 2012]*

Ans. $V \propto I$ or $V = IR$ or $I = \frac{V}{R}$.

23. *State the relation between the power P consumed by a device, its resistance R and current I flowing through it.* *[C.B.S.E. (All India) 2008]*

Ans. $P = I^2R$

24. *State the relation between the power P consumed by a device, its resistance R and voltage V across it.*

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

25. *Write down the relation between the electric current I passing in a conductor, change Q flowing in the conductor and time t.*

Ans. $I = \frac{Q}{t}$.

26. *State the relation between the current I passing in a conductor, number of electrons (n) flowing through any cross-section of the conductor, magnitude of charge on an electron (e) and time t.*

Ans. $I = \frac{ne}{t}$.

27. *Write down the relation between the potential difference between two points A and B in a conductor, work done W in moving a unit charge from point B to A and the charge q.*

Or

State the relation between work, charge and potential difference for an electric circuit.

[C.B.S.E. (All India) 2009]

Ans. $V_A - V_B = dV = \frac{W}{q}$. That is, potential difference = $\frac{\text{Work}}{\text{Charge}}$

28. *State the relation between the resistance R of a conductor, resistivity ρ of a conductor, length l of a conductor and area of cross-section A of the condcutor.*

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

29. *You have a metal, insulator and an alloy. Write these substances in the ascending order of their electrical resistivity.*

Ans. Resistivity of metal < resistivity of alloy < resistivity of insulator.

30. *n resistors each of resistance R are connected in series in a circuit. What is the total effective resistance of the circuit ?* *(C.B.S.E. 2010 Term I)*

Ans. $R_{eff} = R + R + R + \ldots$ upto $n = nR$

31. *n resistors each of resistance R are connected in parallel in an electric circuit. What is the total effective resistance of the circuit ?* *(C.B.S.E. 2010 Term I)*

Ans. $\frac{1}{R_{eff}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \ldots \text{upto } n = \frac{n}{R}$ $\quad \therefore \quad R_{eff} = \frac{R}{n}$.

32. *n resistors each of resistance R are first connected in series and then in parallel. What is the ratio of the total effective resistance of the circuit in series combination and parallel combination ?*

Ans. In series combination, $R_s = nR$

In parallel combination, $R_p = \frac{R}{n}$

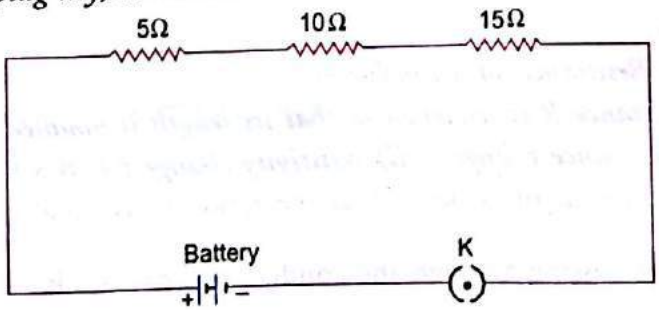
$\therefore \quad \frac{R_s}{R_p} = \frac{nR}{R/n} = n^2$

33. *Write down the relation between heat produced H in a conductor of resistance R through which current I passes for t seconds.*

Ans. $H = I^2Rt$.

34. *Draw a schematic diagram of a circuit consisting of battery of two cells each of 1.5 V, 5Ω resistor, 10Ω resistor and 15Ω resistor and a plug key, all connected in series.* *[C.B.S.E. (All India) 2009, 2011]*

Ans.



35. *What is meant by the statement that the rating of fuse in a circuit is 5A ?* *(C.B.S.E. 2012)*

Ans. It means maximum current of 5A can pass through the fuse without melting it.

36. *What is the difference between kilowatt and kilowatt hour.* *(C.B.S.E. 2012)*

Ans. Kilowatt is the unit of electric power and kilowatt hour is the commercial unit of electric energy.

SHORT ANSWER QUESTIONS

(EACH QUESTION CARRIES 2 OR 3 MARKS)

1. ***Define electric current. State and define its SI unit.*** *(C.B.S.E. 2012)*

Ans. Electric current is defined as the amount of charge flowing through a cross-section of a conductor in unit time.

$$I = \frac{\text{Charge}}{\text{Time}} = \frac{Q}{t}.$$

SI unit of electric current is ampere (A).

Electric current through a conductor is said to be 1 ampere if one coulomb charge flows through a cross-section of the conductor in one second.

2. ***Express Ohm's law both by a mathematical formula and by a graph line.***

(C.B.S.E. (Delhi) 2004 (S))

Ans. Mathematical formula of Ohm's law is

$$V = IR$$

For a graph line, refer figure 8.

3. ***What is an electric circuit ? Distinguish between an open and a closed circuit.***

[C.B.S.E. (All India) 2009, 2010, 2011]

Ans. Refer Article 1.04.2.

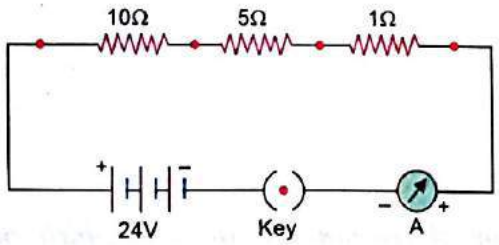
4. ***Calculate the resistance of an electric bulb which allows a 10 A current, when connected to a 220 V power source.*** *[C.B.S.E. (All India) 2009]*

Ans. Here, $I = 10A, V = 220\ V$

using, $R = \frac{V}{I}$, we get $R = \frac{220}{10} = 22$ ohm

5. ***(i) Draw a schematic diagram of a circuit consisting of a 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.***
(ii) Calculate the ammeter reading in this circuit. *[C.B.S.E. (All India) 2006, 2011, 2012]*

Ans. *(i)*



(ii) Total resistance of the circuit, $R = 10 + 5 + 1 = 16\Omega$

Voltage, $V = 24V$

$$\therefore \quad I = \frac{V}{R} = \frac{24}{16} = 1{\cdot}5\ A$$

Thus, ammeter reading is 1·5 A.

6. ***(a) What is meant by 'Electric Resistance' of a conductor ?***
(b) A wire of length L and resistance R is stretched so that its length is doubled and the area of cross section is halved. How will its (i) resistance change ? (ii) resistivity change ? *[C.B.S.E. (Delhi) 2007, 2011, 2012]*

Ans. *(a)* Electric resistance (R) of a conductor is defined as the ratio of potential difference (or voltage) across the conductor to the current passing through the conductor. That is, $R = \frac{V}{I}$.

(b) (i) We know, $R = \frac{\rho L}{A}$ ...(1)

When L'(new length) $= 2L$ and A'(new area of cross-section) $= A/2$

$$R' = \frac{\rho L'}{A'} = \frac{\rho \times 2L}{A/2} = 4\frac{(\rho L)}{A} \quad ...(2)$$

Dividing (2) by (1), we get

$$\frac{R'}{R} = 4$$

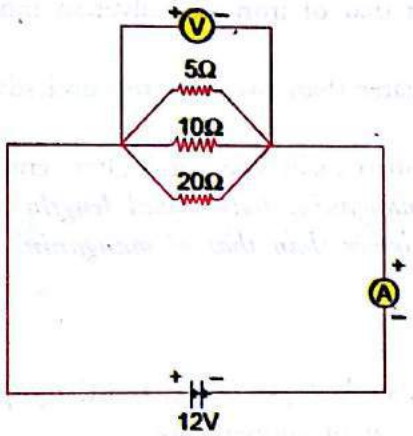
or $$R' = 4R$$

Thus, the resistance of the wire becomes 4 times its original resistance.

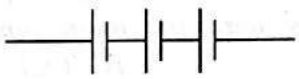
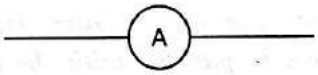
(ii) Since, resistivity of a wire does not depend on its length and area of cross-section, so the resistivity of the wire remains the same.

7. ***Draw a schematic diagram of a circuit consisting of a battery of 12V, three resistors of 5Ω, 10Ω and 20Ω connected in parallel, an ammeter to measure the total current through the circuit, voltmeter to measue the potential difference across the combination of resistors.*** ***[C.B.S.E. (All India) 2008]***

Ans.



8. ***What do the following symbols represent in a circuit ? Write the name and one function of each.***

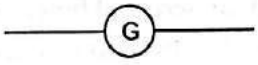
(i)  *(ii)* 

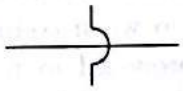
Ans. *(i)* It represents a battery. It maintains a potential difference across the circuit element for the flow of current in the circuit.

(ii) It represents an ammeter. Ammeter is used to measure the electric current in the circuit.

9. ***What do the following symbols represent in a circuit ? Write the name and one function of each ?*** ***[C.B.S.E. 2011, 2012]***

(i) *(ii)*  *(iii)* 

(iv) 

(v) 

Ans. *(i)* It represents a closed plug key. It is used to make the closed electric circuit.

(ii) It represents a variable resistance. It is used to increase or decrease the current in the circuit.

(iii) It represents a voltmeter. It is used to measure the potential difference across a resistor in the circuit.

(iv) It represents a galvanometer. It is used to detect the presence of small current in the circuit.

(v) It represents wire crossing (not connected with each other). The wires are used to connect various components in the circuit.

10. ***What is commercial unit of electrical energy ? Express it in joules.***

Or

Define 1 kWh. How is this unit of energy related to 1 joule ? ***(C.B.S.E. 2011)***

Or

Establish the relationship between 1 kWh and SI unit of energy. ***(C.B.S.E. 2012)***

Ans. Commercial unit of electrical energy is kWh. 1 kWh is the amount of electric energy consumed by 1000 W electric appliance when operates for 1 hour.

$1\text{kWh} = 1000\ \text{W} \times 3600\ \text{s} = 1000\ \text{Js}^{-1} \times 3.6 \times 10^6\ \text{J}$.

11. ***Why is the tungsten used almost exclusively for filament of electric lamps ?***

Or ***(C.B.S.E. 2011)***

Why is Tungsten used for the filament in electric bulb ?

Dividing (2) by (1), we get

$$\frac{R'}{R} = 4$$

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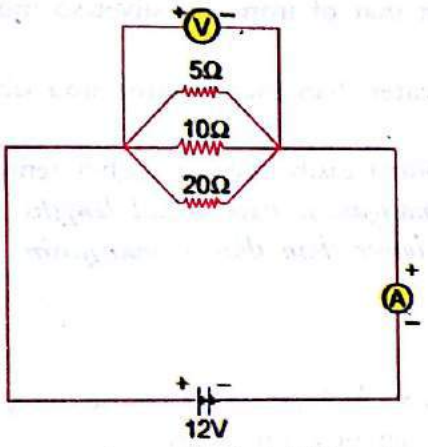
7. ***Draw a schematic diagram of a circuit consisting of a battery of 12V, three resistors of 5Ω, 10Ω and 20Ω connected in parallel, an ammeter to measure the total current through the circuit, voltmeter to measue the potential difference across the combination of resistors.*** ***[C.B.S.E. (All India) 2008]***

Ans.



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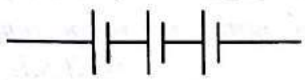
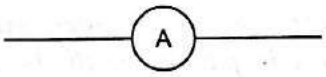
(i)  *(ii)* 

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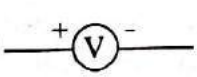
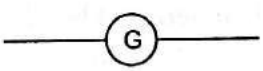
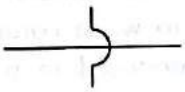
(i)  *(ii)* *(iii)* 

(iv) 

(v) 

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11. ***Why is the tungsten used almost exclusively for filament of electric lamps ?***

Or

Why is Tungsten used for the filament in electric bulb ? ***(C.B.S.E. 2011)***

Ans. This is because *(i)* melting point of tungsten is very high (about 3380°C) and *(ii)* it does not oxidise (or burn) even at higher temperatures.

12. ***Why do copper or aluminium wires usually used for electricity transmission and distribution purposes ?*** *(C.B.S.E. 2012)*

Or

Copper and aluminium wires are usually employed for electricity transmission. Explain reason.

Ans. The resistivities of copper and aluminium are very low, so electric current flows easily through them. Hence, copper and aluminium wires are usually used for electricity transmission and distribution purpose.

13. ***Should the heating element of an electric iron be made of iron, silver or nichrome wire ?*** *[C.B.S.E. (Foreign)2005]*

Ans. It should be made of nichrome wire because

(i) resistivity of nichrome is greater than that of iron and silver, so more heat is produced in the nichrome wire due to the flow of current.

(ii) melting point of nichrome wire is greater than that of iron and silver and hence it does not melt easily on heating.

(iii) nichrome wire does not oxidise (or burn) easily even at higher temperature.

14. ***Two wires, one of copper and other of manganin, have equal lengths and equal resistances. Which wire is thicker ? Give that resistivity of copper is lower than that of manganin.*** *(C.B.S.E. 2011)*

Ans. We know, $R = \frac{\rho \ell}{A}$ or $A = \frac{\rho \ell}{R}$

Since ℓ and R of both the wires are same, so $A \propto \rho$. Since, resistivity (ρ) of manganin is higher than that of copper, so manganin wire is thicker than that of copper wire.

15. ***Two identical immersion heaters are to be used to heat water in a large container. Which one of the following arrangement would heat the water faster, (i) connecting the heaters in series with the main supply, (ii) connecting the heaters in parallel with the main supply ?*** *(C.B.S.E. 2011)*

Ans. Heat produced in a heater, when connecting to main supply,

$$H = \frac{V^2}{R} t.$$

When identical heaters (i.e. having same resistance) are connecting in parallel, their net resistance decreases as compared to when connected in series. Therefore, heaters connected in parallel would heat the water faster as the heat produced in parallel combination is more than the heat produced in series combination.

16. ***Mention the condition under which charge can move in a conductor. Name the device which is used to maintain this condition in an electric circuit.*** *(C.B.S.E. 2012)*

Ans. The ends of the conductor must be maintained at different voltages. This condition is maintained in a conductor by a cell or a battery.

LONG ANSWER QUESTIONS

(EACH QUESTION CARRIES 5 MARKS)

1. ***State Ohm's law. How can this law be verified experimentally ? Does Ohm's law hold good under all conditions. Comment.*** *(N.C.E.R.T. Question Bank, C.B.S.E., 2010 Term I, 2012)*

Ans. Refer Article 1.06 and Experiment No. 1.

2. ***How will you infer with the help of an experiment that same voltage or potential difference exists across three resistors connectred in parallel arrangement to a battery ?***

Ans. Refer Activity No. 3.

3. ***Describe an experiment to study the factors on which the resistance of a conductor or a conducting wire depends.***

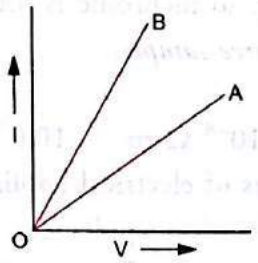
Ans. Refer experiment No. 2.

4. ***What is Joule's heating effect ? List applications of Joule's heating effect in daily life.*** *(N.C.E.R.T. Question Bank, C.B.S.E. 2012)*

Ans. Refer Article 1.10, and Article 1.11.

HIGHER ORDER THINKING SKILL BASED QUESTIONS

1. *Graphs between electric current and potential difference across two conductors A and B are plotted as shown in figure. Which of the two conductors has more resistance ?*



Ans. Resistance of a conductor $= \frac{1}{\text{Slope of graph between V and I}}$. Since, slope of graph between V and I for a conductor A is less than the slope for a conductor B, therefore, conductor A has more resistance than the conductor B.

2. *Following table gives the reistivity of three samples in (Ωm)*

Sample	A	B	C
Resistivity in Ωm	$1{\cdot}6 \times 10^{-8}$	$7{\cdot}5 \times 10^{-7}$	44×10^{-6}

Which of them is a good conductor ? And which of them is an insulator ? And why ? *(C.B.S.E. 2012)*

Ans. A material having low resistivity is a good conductor. Since, resistivity of sample A is the least among all other materials, so sample A is a good conductor. A material having high value of resistivity is an insulator. Therefore, sample C is an insulator.

3. *The electrical resistivity of few materials is given below in ohm-meter. Which of these materials can be used for making element of a heating device ?*

Material	Resistivity (in ohm-metre)
A	$6{\cdot}84 \times 10^{-8}$
B	$1{\cdot}60 \times 10^{-8}$
C	$2{\cdot}30 \times 10^{17}$
D	$1{\cdot}00 \times 10^{-6}$
E	$2{\cdot}50 \times 10^{12}$
F	$4{\cdot}40 \times 10^{-8}$

(C.B.S.E. Sample Paper, C.B.SE. 2012)

Ans. For making element of a heating device, we use alloy instead of pure metals.The resistivity of material D lies in the range of resistivities of alloys. Therefore, material D can be used for making element of a heating device.

4. *Electrical resistivities of some substances at 20°C are given below :*

Silver	$1{\cdot}60 \times 10^{-8}\ \Omega\text{-}m$
Copper	$1{\cdot}62 \times 10^{-8}\ \Omega\text{-}m$
Tungsten	$5{\cdot}20 \times 10^{-8}\ \Omega\text{-}m$
Iron	$10{\cdot}0 \times 10^{-8}\ \Omega\text{-}m$
Mercury	$94{\cdot}0 \times 10^{-8}\ \Omega\text{-}m$
Nichrome	$10{\cdot}0 \times 10^{-6}\ \Omega\text{-}m$

Answer the following questions in relation to them :

(i) Among silver and copper, which one is a better conductor ? Why ?

(ii) Which material would you advise to be used in electrical heating devices ? Why ? *(C.B.S.E. 2012)*

Ans. (*i*) A material whose electrical resistivity is low is a god conductor of electricity. Since the electrical resistivity of silver is less than that of the copper, so silver is a better conductor than the copper.

(*ii*) For making the elements of heating devices, alloy is used instead of a pure metal. This is because the resistivity of an alloy is more than that of a metal and alloy does not burn (or oxidise) even at higher temperature. Out of the given substances, nichrome is an alloy, so nichrome is used in electrical heating devices.

5. *The following table gives the resistivity of three samples :*

Sample :	A	B	C
Resistivity :	$1{\cdot}6 \times 10^{-8}\ \Omega$ m	$5{\cdot}1 \times 10^{-8}\ \Omega$ m	$10{\cdot}6 \times 10^{-6}\ \Omega$ m

Which of them is suitable for heating elements of electrical appliances and why ? *(C.B.S.E., 2010 Term I, 2012)*

Ans. For making the heating elements of electrical appliances, alloy is used instead of a pure metal. This is because alloy does not burn even at higher temperature. The resistivity of sample C is of the order of an alloy, so sample C is suitable for heating elements of electrical appliances.

6. *Two metallic wires A and B are connected in series. Wire A has length l and radius r, while wire B has length 2l and radius 2r. Find the ratio of the total resistance of series combination and the resistance of wire A, if both the wires are of same material.*

Ans. Resistance of wire A, $R_1 = \dfrac{\rho l}{A} = \dfrac{\rho l}{\pi r^2}$

Resistance of wire B, $R_2 = \dfrac{\rho l'}{A'} = \dfrac{\rho \times 2l}{\pi(2r)^2} = \dfrac{\rho l}{2\pi r^2}$

Total resistance of the series combination, $R = R_1 + R_2$

or $$R = \frac{\rho l}{\pi r^2} + \frac{\rho l}{2\pi r^2} = \frac{3\rho l}{2\pi r^2} \qquad \therefore \frac{R}{R_1} = \frac{3\rho l}{2\pi r^2} \times \frac{\pi r^2}{\rho l} = \frac{3}{2}$$

7. *Two metallic wires A and B of same material are connected in parallel. Wire A has length l and radius r and wire B has length 2l and radius 2r. Compute the ratio of the total resistance of parallel combination and the resistance of wire A.* *(C.B.S.E. Sample Paper)*

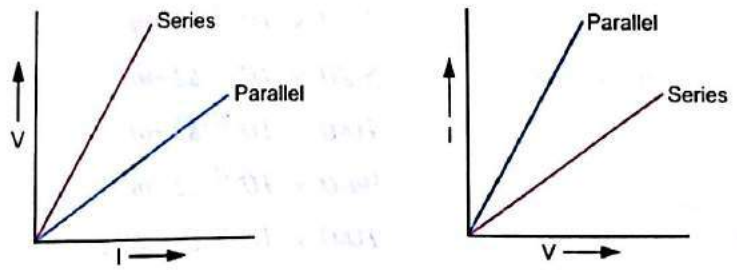
Ans. Resistance of wire A, $R_1 = \dfrac{\rho l}{A} = \dfrac{\rho l}{\pi r^2}$. Resistance of wire B, $R_2 = \dfrac{\rho \times 2l}{\pi(2r)^2} = \dfrac{\rho l}{2\pi r^2}$

Total resistance of the parallel combination,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \text{or} \quad \frac{1}{R} = \frac{\pi r^2}{\rho l} + \frac{2\pi r^2}{\rho l} = \frac{3\pi r^2}{\rho l}$$

or $$R = \frac{\rho l}{3\pi r^2} \qquad \therefore \frac{R}{R_1} = \frac{\rho l}{3\pi r^2} \times \frac{\pi r^2}{\rho l} = \frac{1}{3}$$

8. *Two students perform the experiments on series and parallel combinations of two given resistors R_1 and R_2 and plot the following V-I graphs.*



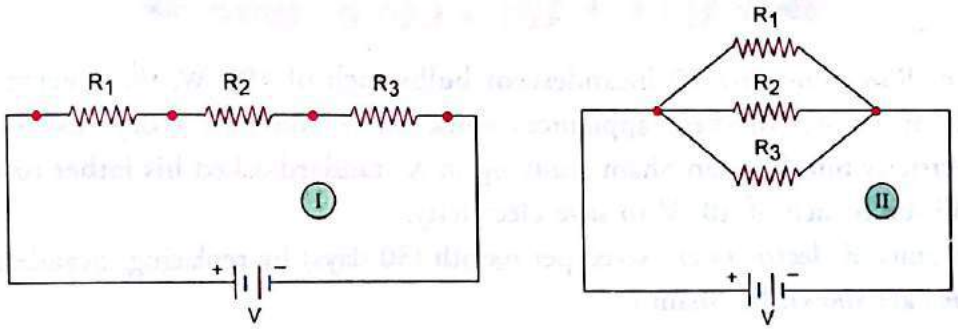
Which of the graphs is (are) correctly labelled in terms of the words 'series' and 'parallel' . Justify your answer. *(C.B.S.E. Sample Paper, 2012)*

Ans. In first graph, slope of I – V graph = Resistance. Since in series combination, resistance is more than the resistance in parallel combination, therefore slope of I–V graph for series combination is more than the slope of I–V graph for parallel combination. Hence, graph is correctly labelled. In second graph, slope of

$$V - I \text{ graph} = \frac{1}{\text{resistance}}$$

Hence, second graph is also correctly labelled.

9. *Two electric circuits I and II are shown in figure.*



(i) Which of the two circuits has more resistance ?

(ii) Through which circuit, more current passes ?

(iii) In which circuit , the potential difference across each resistor is equal.

Ans. *(i)* Equivalent resistance of series combination of resistors is more than the equivalent resistance of the parallel combination of resistors. So, the resistance of circuit I is more than the resistance of circuit II.

(ii) Since, current $\propto \frac{1}{\text{resistance}}$. So current in circuit II is more than the current in circuit II.

(iii) Potential difference across each resistor is equal in circuit II.

10. *An electrician puts a fuse of rating 5 A in that part of domestic electrical circuit in which an electrical heater of rating 1·5 kW, 220V is operating. What is likely to happen in this case and why ? What change , if any needs to be made ?* *(C.B.S.E Sample Paper)*

Ans. The fuse will melt and the circuit breaks if electric current more than the rating of fuse (*i.e.*, 5A) flows in the circuit. Electric current flowing in the circuit,

$$I = \frac{P}{V} = \frac{1{\cdot}5 \times 1000\,W}{220V} = 6{\cdot}82\ A$$

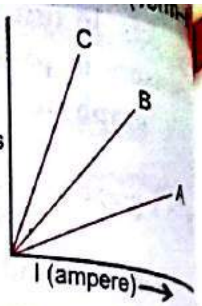
Since, current flowing in the circuit (6·82A) is more than the rating of fuse (5A), therefore, the fuse will melt and the electrical heater does not work. To operate the heater, fuse of rating 10A is to be put in the circuit.

11. *The electric power consumed by a device may be calculated by using either of the two expressions: $P = I^2R$ or $P = \frac{V^2}{R}$. The first expression indicates that the power is directly proportional to R,whereas the second expression indicates inverse proportionality. How can the seemingly different dependence of P on R in these expressions be explained ?* *(C.B.S.E Sample Paper)*

Ans. $P = I^2R$ is used when current flowing in every component of the circuit is constant. This is the case of series combination of the devices in the circuit.

$P = \frac{V^2}{R}$ is used when potential difference (V) across every component of the circuit is constant. This expression is used in case of parallel combination in the circuit. In series combination, R is greater than the value of R in parallel combination.

12. *Three V-I graphs are drawn individually for two resistors and their series combination. Out of A, B, C which one represents the graph for series combination of the other two. Give reason for yor answer.* *(C.B.S.E. 2011)*



Ans. Slope of V – I graph resistance of a resistor. When two resistors are connected in series, the resistance of this combination is more than ($R = R_1 + R_2$) the resistance of both the resistors. Since, slope of C is greater than the slopes of A and B. Therefore, C represents the graph for series combination of the other two.

VALUE BASED QUESTIONS

1. In the house of Ram, there are 20 incandescent bulbs each of 100 W, three geysers each of 2000 W and 20 tubes each of 40 W. All these appliances work for 5 hours in a day. Every month, he pays heavy amount as electricity bill. His son Sham studying in X standard asked his father to replace all incandescent bulbs with CFL bulb each of 40 W to save electricity.
   (i) How much units of electricity are saved per month (30 days) by replacing incandescent bulbs with CFL?
   (ii) What values are shown by Sham ?

Ans. (i) Electric energy consumed by 20 incandescent bulbs in 30 days = $P \times t = 20 \times 100 \times 5 \times 30$
= 300000 Wh = 300 kWh
= 300 units
Electric energy consumed by 20 CFL bulbs = $23 \times 40 \times 5 \times 30$ = 120000 Wh
= 120 kWh = 120 units
Units of electricity saved = 300 – 120 = 180 units.

(ii) Sham helped his father to pay less electricity bill. He also believes that saving energy contributes for the development of our nation.

2. Electricity plays an important role in the development of a country. Ram, a student of class X was studying in the library after school hours. When he left the library, he found that electric fans of all rooms were 'ON' although there was no one in the class rooms. He immediately switched 'OFF' all the fans and reported the matter to Principal of the school.
   (i) Comment on the attitude of Ram.
   (ii) Why, Ram reported the matter to the Principal ?

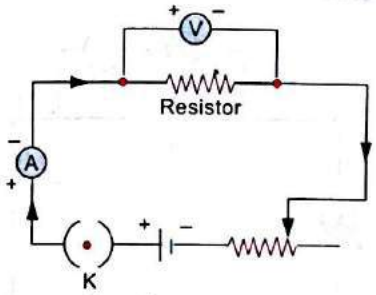
Ans. (i) Ram knows the importance of electricity. He believes that loss of electricity is the loss of school as well as the loss of nation. He is against the misuse of national resources.
(ii) He reported the matter to the Principal so that the Principal may ask the peon to ensure that such incident should not occur in future.

3. A welder was asked by Mr. Sumit to weld an iron grill in his house. He started using electricity by connecting the wires of welding set directly with the transmission wires and not through the energy meter. Sumit's neighbour objected the action of welder but Sumit sided with the welder. However, the son of Sumit appreciated the neighbour.
   (i) Why was the action of welder objected by Sumit's neighbour ?
   (ii) Why, Sumit supported the action of the welder ?
   (iii) Why, Sumit's son appreciated the action of his neighbour ?
   (iv) Write the commercial unit of electrical energy.

Ans. (i) It is a crime to steal electrical energy and no honest person can support it.
(ii) Sumit thought the welder was doing a favour to him.
(iii) Sumit's son knows that welder is doing wrong.
(iv) Kilowatt hour (kWh).

Based on Practical Skills (Experiments : Verification of Ohm's law, Electric circuits, resistors in series and parallel)

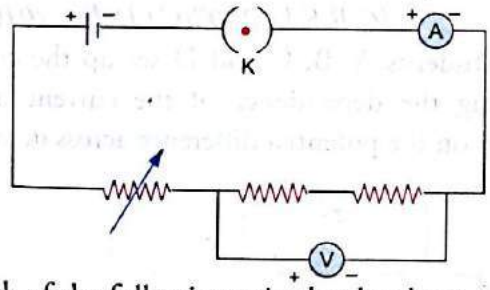
1. Which two circuit components are connected in parallel in the following circuit diagram ?



(a) Rheostat and voltmeter
(b) Voltmeter and resistor
(c) Voltmeter and ammeter
(d) Ammeter and resistor.

[C.B.S.E. 2007 (Delhi), 2010 Term I, 2011]

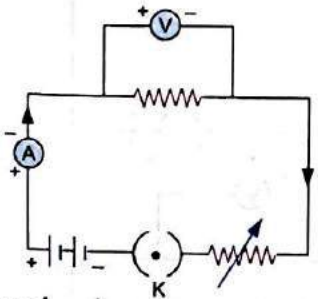
2. To determine the equivalent resistance of two resistors when connected in series, a student arranged the circuit components as shown in the diagram. But he did not succeed to achieve the objective.



Which of the following mistakes has been committed by him in setting up the circuit ?
(a) Position of ammeter is incorrect
(b) Position of voltmeter is incorrect
(c) Terminals of ammeter are wrongly connected
(d) Terminals of voltmeter are wrongly connected.

[C.B.S.E. 2007 (Delhi), 2010 Term I]

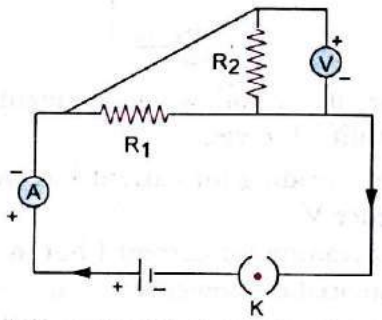
3. The following circuit diagram shows the experimental set-up for the study of dependence of current on potential difference. Which two circuit components are connected in series ?



(a) Battery and voltmeter
(b) Ammeter and voltmeter
(c) Ammeter and Rheostat
(d) Resistor and voltmeter.

[C.B.S.E. 2007, 2010 Term I]

4. Which of the circuit components in the following circuit diagram are connected in parallel ?

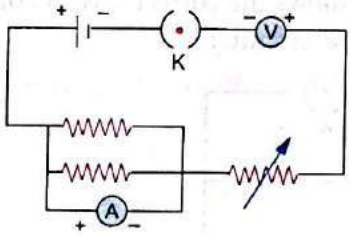


(a) R_1 and R_2 only *(b)* R_1, R_2 and V
(c) R_2 and V only *(c)* $R_1$and V only

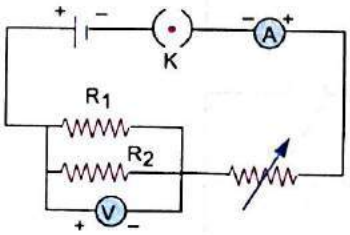
(C.B.S.E. 2007, 2011)

5. The correct set up for determining the equivalent resistance if two resistors $R_1$and $R_2$when connected in parallel is

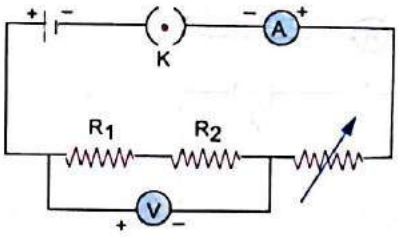
I.



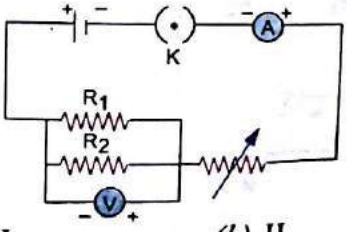
II.



III.

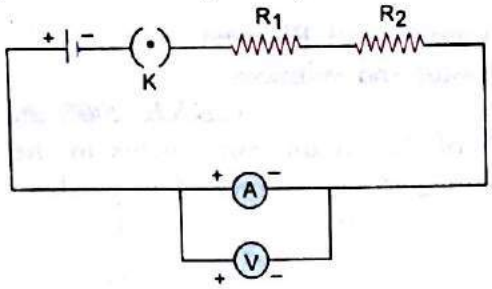


IV.



(a) I *(b)* II
(c) III *(d)* IV *[C.B.S.E. (Delhi) 2007]*

6. To determine the equivalent resistance of a series combination of two resistors R_1 and R_2, a student arranges the following set up.



Which one of the following statements will be true for this circuit ? It gives.

(a) incorrect reading for current I as well as potential difference V.

(b) correct reading for current I but incorrect reading for potential difference V.

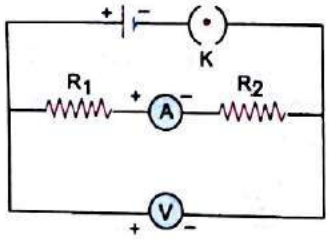
(c) correct reading for potential difference V but incorrect reading for current I.

(d) correct reading for both I and V.

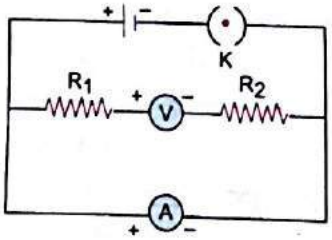
[C.B.S.E. (Delhi) 2007]

7. In an experiment to determine equivalent resistance of two resistors R_1 and R_2 in series, which one of the following diagrams shows the correct way of connecting the voltmeter in the circuit ?

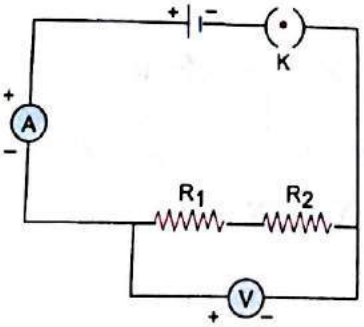
I.



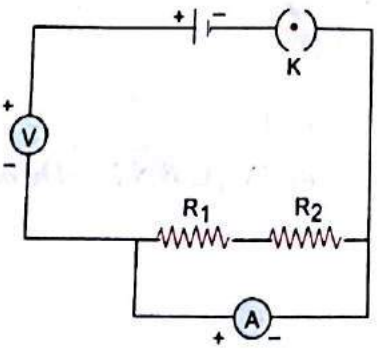
II.



III.



IV.

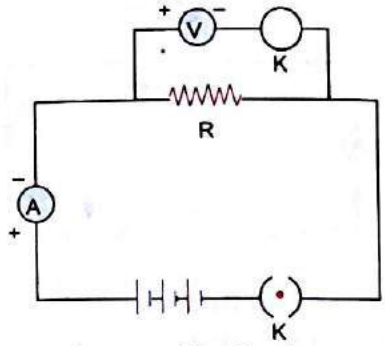


(a) I *(b)* II

(c) III *(d)* IV

(C.B.S.E. 2007, 2010 Term I, 2012)

8. For the circuit arrangement, shown below, a student would observe



(a) some reading in both the ammeter and the voltmeter

(b) no reading in either the ammeter or the voltmeter

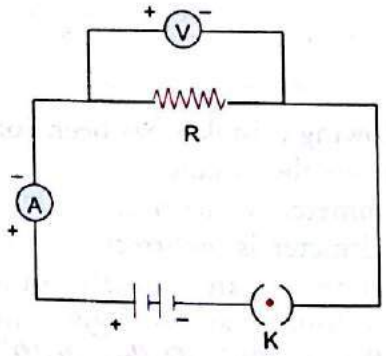
(c) some reading in the ammeter but no reading in the voltmeter.

(d) some reading in the voltmeter but no reading in the ammeter.

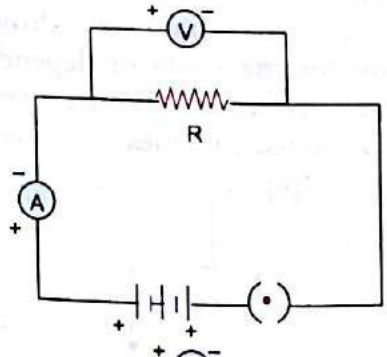
[C.B.S.E. 2007(C) Delhi, 2010 Term I]

9. Four students A, B, C and D set up the circuits for studying the dependence of the current through a resistor on the potential difference across it, as follows:

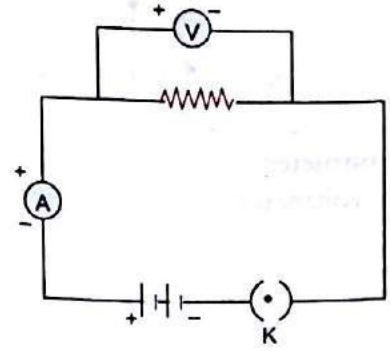
A.



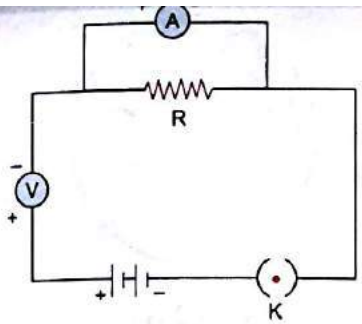
B.



C.



D.



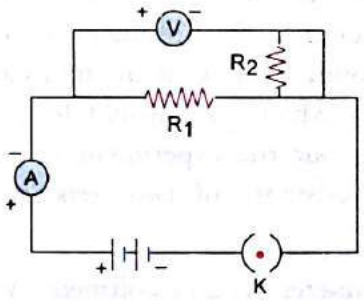
The correct set up is that of student

(a) A (b) B

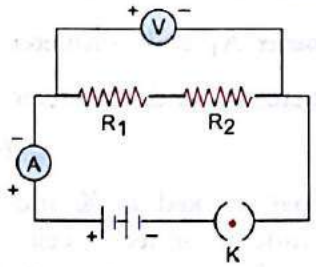
(c) C (d) D

[C.B.S.E. 2007(C) Delhi, 2010 Term I, 2012]

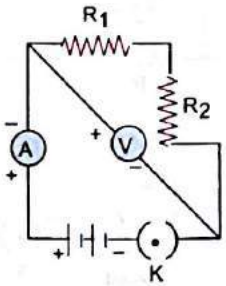
10. While doing experiment, on finding the equivalent resistance of two resistors connected in series, three students A, B and C set up their circuit as shown below :



(A)



(B)



(C)

The correct set up is that of

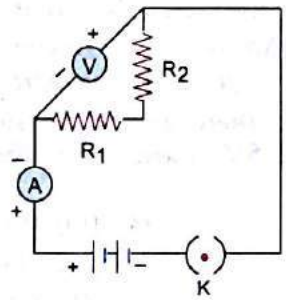
(a) Students A and B

(b) Students B and C

(c) Students C and A

(d) All the three students. *[C.B.S.E. 2007(C) Delhi]*

11. For carrying out the experiment, on finding the equivalent resistance of two resistance connected in parallel, a student sets up the circuit as shown. The teacher checks it and tells him that his circuit has one or more of the following 'faults'.



A. The resistors R_1 and R_2 have not been correctly connected in parallel.

B. The voltmeter has not been correctly connected in the circuit.

C. The ammeter and the key have not been correctly connected in the circuit.

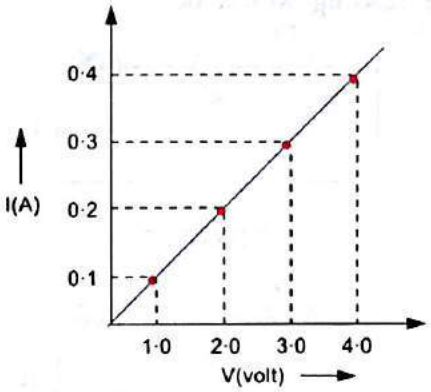
Out of these three, the actual fault in his circuit in/are :

(a) Both A and B (b) Both B and C

(c) only A (d) only B

[C.B.S.E. 2007(C) Delhi]

12. In an experiment to study the dependence of current on potential difference across a resistor, a student obtained the graph as shown in the diagram. The value of resistance of the resistor is

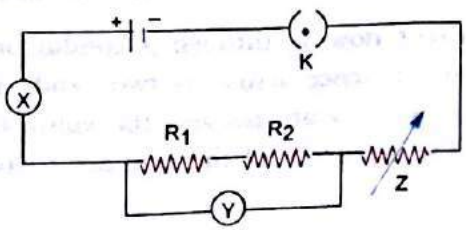


(a) 0·1 ohm (b) 1·0 ohm

(c) 10 ohm (d) 100 ohm.

[C.B.S.E. 2007 (C), 2010 Term I, 2011]

13. The given circuit diagram shows the experimental arrangement of different circuit components for determination of equivalent resistance of two resistors connected in series. The components X, Y and Z shown in the circuit respectively represent



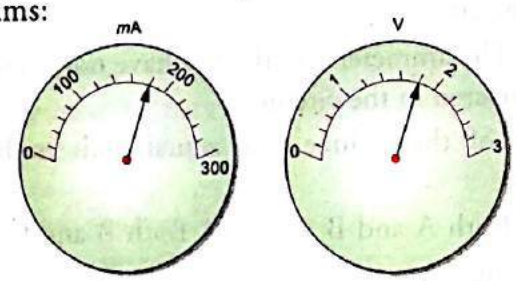
(a) Rheostat, Resistor, Ammeter
(b) Ammeter, Voltmeter, Rheostat
(c) Voltmeter, Ammeter, Rheostat
(d) Rheostat, Ammeter, Voltmeter

[C.B.S.E. 2007(C), 2010 Term I]

14. In a voltmeter, there are 20 divisions between the 0 mark and 0·5V mark. The least count of the voltmeter is
(a) 0·020V (b) 0·025V
(c) 0·050V (d) 0·250V

(C.B.S.E. 2007, 2011)

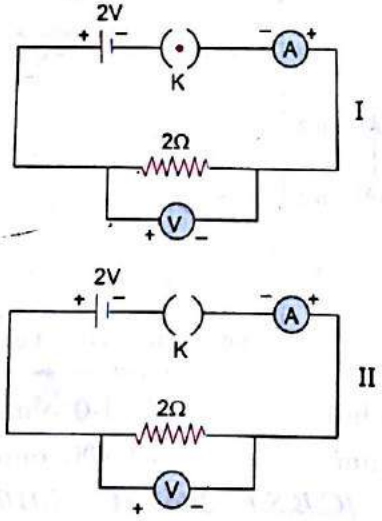
15. The current flowing through a resistor connected in an electrical circuit and the potential difference developed across its ends are shown in the given diagrams:



The value of resistance of the resistor in ohms is
(a) 25 (b) 20
(c) 15 (d) 10

[C.B.S.E. 2007 (Delhi, 2011, 2012)]

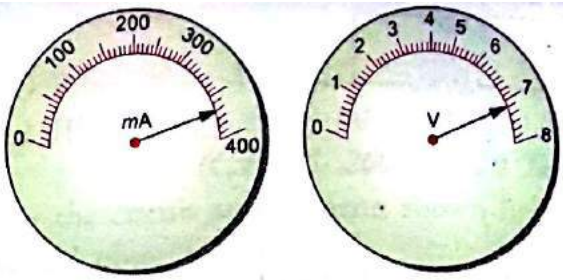
16. For the circuits shown in figure I and II, the voltmeter reading would be



(a) 2V in circuit I and OV in circuit II
(b) OV in both circuits
(c) 2V in both circuits
(d) OV in circuit I and 2V in circuit II

(C.B.S.E. 2007, 2012)

17. The current flowing through a conductor and the potential difference across its two ends are as per readings of the ammeter and the voltmeter shown below. The resistance of the conductor would be



(a) 0·02Ω (b) 0·24Ω
(c) 20·0Ω (d) 24·0Ω

(C.B.S.E. 2007, 2011)

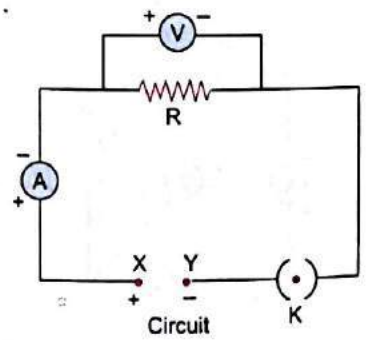
18. The following instruments are available in a laboratory :

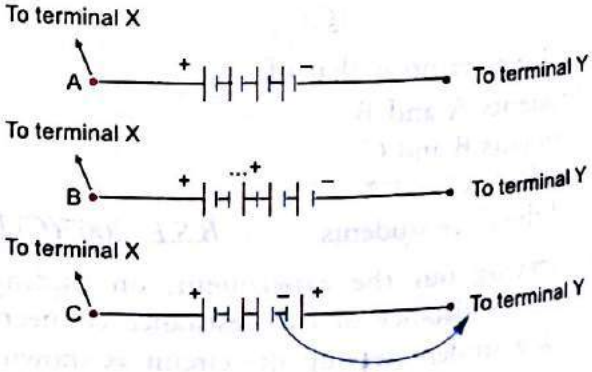
Milliammeter A_1 of range 0-300 *m*A and least count 10 *m*A. Milliammeter A_2 of range 0-200 *m*A and least count 20 *m*A. Voltmeter V_1 of range 0-5V and least count 0·2V. Voltmeter V_2 of range 0-3V and least count 0·3V. Out of the following pairs of instruments, which pair would be the best choice for carrying out the experiment to determine the equivalent resistance of two resistors connected in series ?

(a) Milliammeter A_1 and voltmeter V_1
(b) Milliammeter A_2 and voltmeter V_2
(c) Milliammeter A_1 and voltmeter V_2
(d) Milliammeter A_2 and voltmeter V_1

(C.B.S.E. 2007)

19. To the terminal marked as X and Y in the given circuit,three student connect 4 cells of voltage 1·5 V each in three different manners shown below:





Arrangement of cells by students

The readings of the voltmeter, for the three students are likely to be (nearly)

(a) V_A= 6·0 V ; V_B = 3·0 V ; V_C = 1·5 V
(b) V_A= 6·0 V ; V_B = 1·5 V ; V_C = 3·0 V
(c) V_A= 3·0 V ; V_B = 6·0 V ; V_C = 1·5 V
(d) V_A= 3·0 V ; V_B = 1·5 V ; V_C = 6·0 V

[C.B.S.E. 2007(C) Delhi]

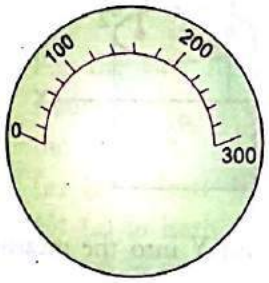
20. The given diagram shows the milliammeter reading connected in a circuit :

The value of current flowing in the circuit is

(a) 100·3 mA *(b)* 103 mA
(c) 130 mA *(d)* 160 mA

[C.B.S.E. 2007 (C)]

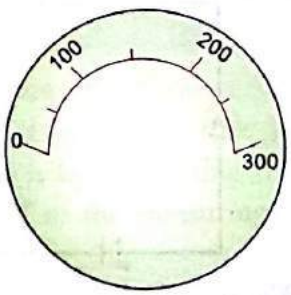
21. Which one of the given four milliammeter would you use for measurement of current flowing in a circuit ?



I

II

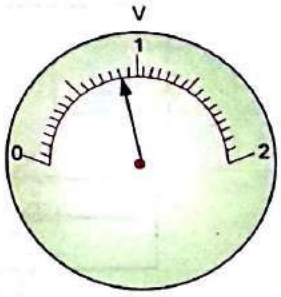
III



IV

(a) I *(b)* II
(c) III *(d)* IV. *[C.B.S.E. 2007 (C)]*

22. The current flowing through a resistor and the potential difference developed across its ends are shown in the given diagrams :

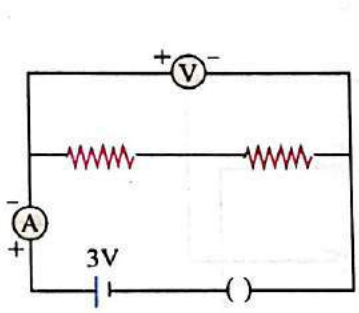


The value of resistance of the resistor is

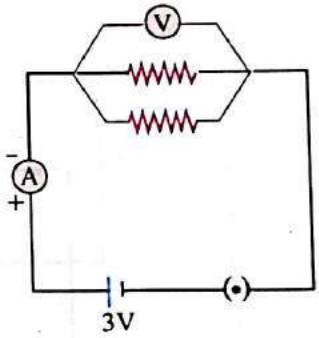
(a) 0·5 ohm *(b)* 5·0 ohm
(c) 50 ohm *(d)* 500 ohm

[C.B.S.E. 2007 (C), 2010 Term I, 2011]

23. For the two circuit I and II shown below, the voltmeter readings would be



I

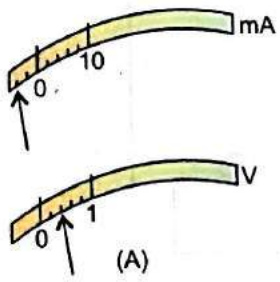


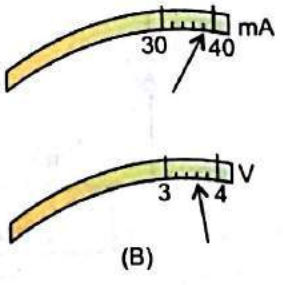
II

(a) 0V in circuit I and 2V in circuit II
(b) 3V in both the circuits
(c) 0V in circuit I and 3V in circuit II
(d) 3V in circuit I and 0V in circuit II

[C.B.S.E. 2007 (C)]

24. The rest positions of the needles in a milliammeter and voltmeter not in use are as shown in figure A. When a student uses these in his experiment, the readings of the needle are in the positions shown in figure B. The correct values of current and voltage in the experiment are :

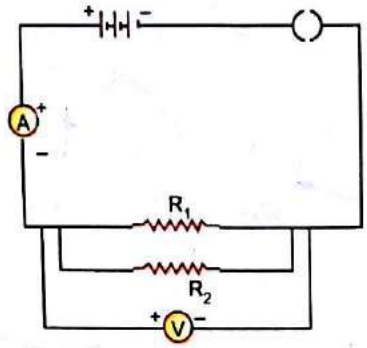




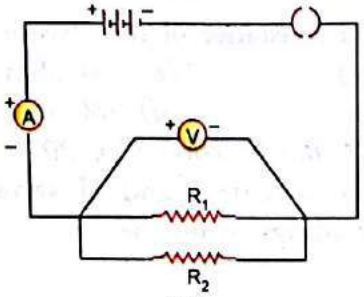
(a) 42 m A and 3·2 V *(b)* 42 mA and 4·0 V
(c) 34 mA and 3·2 V *(d)* 34 m A and 4·0 V

(C.B.S.E. 2008, 2012)

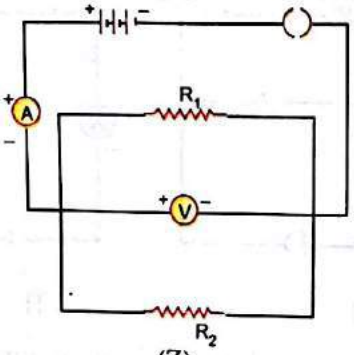
25. In the experiment on finding the equivalent resistance of two resistors, connceted in parallel, three students connected the voltmeter in their circuits, in the three ways, X, Y and Z shown here :



(X)



(Y)

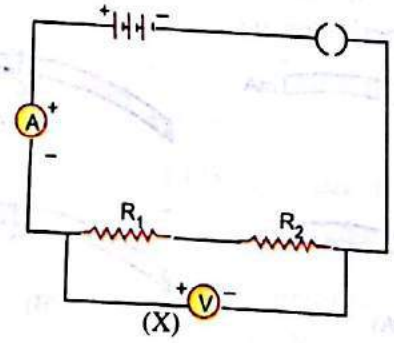


(Z)

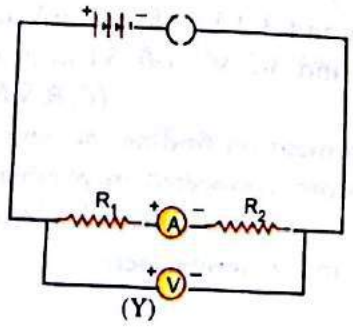
The voltmeter has been correctly connected in
(*a*) cases X and Y only (*b*) cases Y and Z only
(*c*) cases Z and X only (*d*) all the three cases.

(C.B.S.E. 2008, 2010 Term I, 2011)

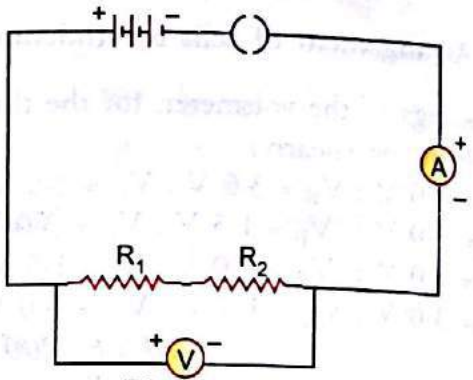
26. In the experiment on finding the equivalent resistance of two resistors connected in series, three students connected the ammeter in their circuits in the three ways X, Y and Z as shown here :



(X)



(Y)

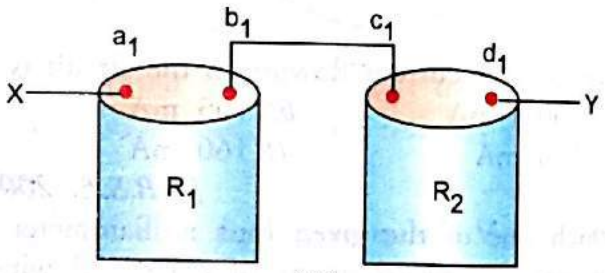


(Z)

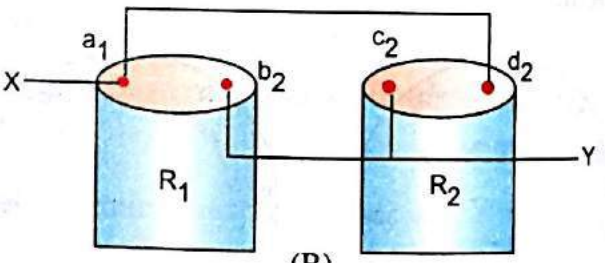
Assuming their ammeters to be ideal, the ammeter have been correctly, connected in
(*a*) cases X and Y only (*b*) cases Y and Z only
(*c*) cases Z and X only (*d*) all the three cases.

(C.B.S.E. 2008)

27. Students A and B connect the two resistors R_1 and R_2 given to them in the manners shown below :

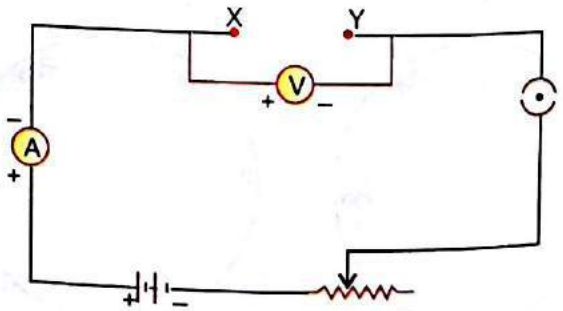


(A)



(B)

and then insert them at X and Y into the measuring circuit shown below :

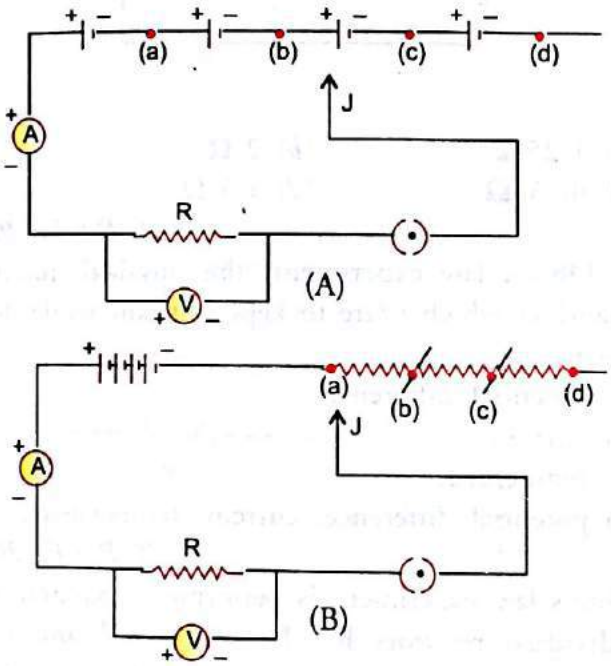


We can say that
(*a*) both the students will determine the equivalent resistance of the series combination of R_1 and R_2.
(*b*) both the students will determine the equivalent resistance of the parallel combination of R_1 and R_2.
(*c*) student A will determine the equivalent resistance of the series combination while student B will determine the equivalent resistance of the parallel combination of R_1 and R_2.

(*d*) Student A will determine the equivalent resistance of the parallel combination while student B will determine the equivalent resistance of the series combination of R_1 and R_2.

(C.B.S.E. 2008, 2010 Term I, 2011, 2012)

28. To study the dependence of current (I) on the potential difference (V) across a resistor R, two students used the two set ups shown in figure A and B respectively. They kept the contact point J in four different positions, marked (*a*), (*b*), (*c*) and (*d*) in the two figures.

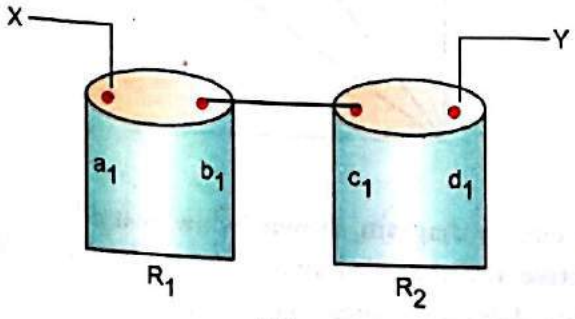


For the two students, the ammeter and voltmeter readings will be maximum when the contact J is in the position.

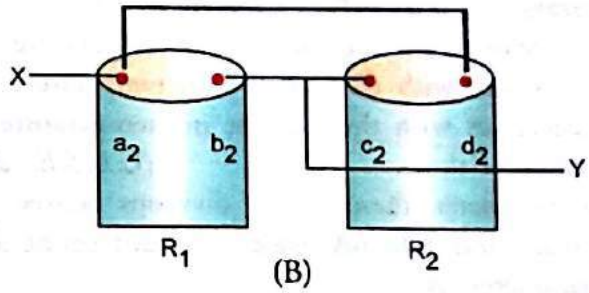
(*a*) (*d*) in both the set ups
(*b*) (*a*) in both the set ups
(*c*) (*d*) in set up A and (*a*) in set up B.
(*d*) (*a*) in set up A and (*d*) in set up B.

(C.B.S.E. 2008, 2010 Term I, 2011)

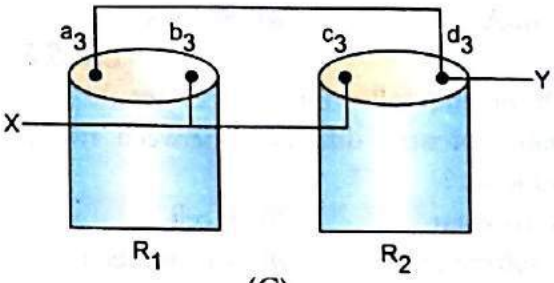
29. A student carries out the experiment for studying the dependence of current (I) flowing through a resistor system of R_1 and R_2 on the potential difference (V) applied to it by connecting the resistor system to points X and Y of the measuring circuit as shown :



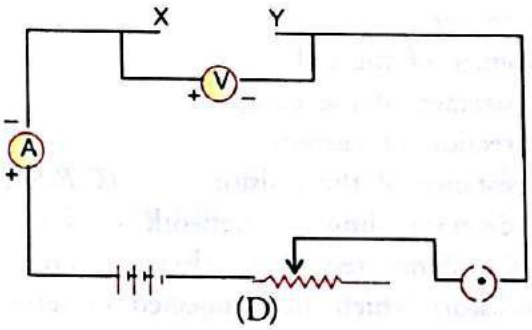
(A)



(B)



(C)



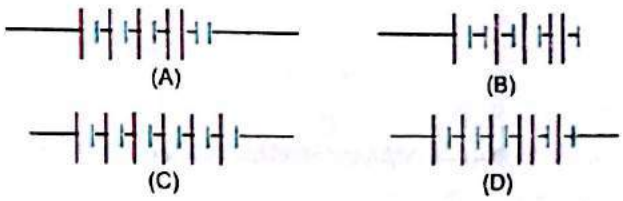
(D)

The average value of the ratio V/I, of his observations, would then be, equal

(*a*) only in cases A and B (*b*) only in cases B and C
(*c*) only in cases C and A (*d*) All the three cases.

(C.B.S.E. 2008, 2010 Term I)

30. The correct representation of sereis combination of cells for obtaining maximum potential is shown by A, B, C, D.



(*a*) A (*b*) B
(*c*) C (*d*) D

(Similar N.C.E.R.T. Question Bank, C.B.S.E. 2012)

31. Instrument used to measure electric current is

(*a*) voltmeter (*b*) ammeter
(*c*) Rheostat (*d*) generator.

32. Instrument used to measure electric potential difference is

(*a*) voltmeter (*b*) ammeter
(*c*) Rheostat (*d*) generator.

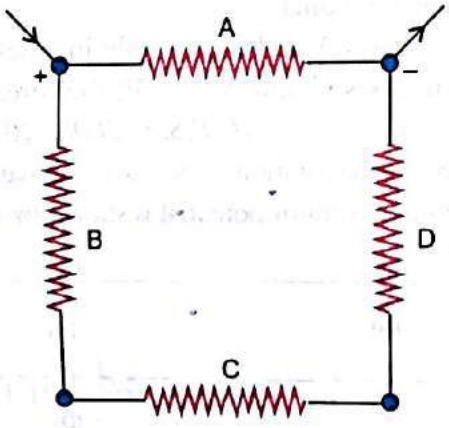
33. Resistance of a metallic conductor
(a) increases with the increase in temperature
(b) increases with the decrease in temperature
(c) decreases with the increase in temperature
(d) none of these. *(C.B.S.E. 2011)*

34. In a millimeter, there are 20 divisions between 400 mA mark and 500 mA mark. The least count of the milliammeter is
(a) 0·5 mA (b) 5 mA
(c) 10mA (d) 50 mA
(C.B.S.E. 2011)

35. Which of the following devices would you use to maintain potential difference between two points of a conductor ?
(a) A rheostat (b) A cell
(c) A voltmeter (d) An ammeter.
(C.B.S.E. 2011)

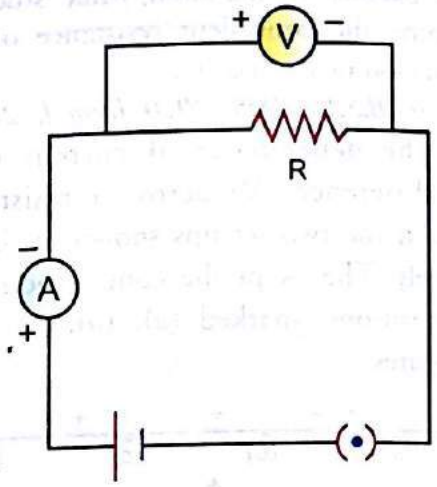
36. In the experiment to verify ohm's law, rheostat is used to vary.
(a) voltage of the cell
(b) resistance of the circuit
(c) direction of current
(d) resistance of the resistor. *(C.B.S.E. 2011)*

37. The diagram shows a network of four resistors which is connected to an electric source. Identify the resistors which are connected in series in this network.



(a) B, A and D (b) B, C and D
(c) C, D, and A (d) A, B and C
(C.B.S.E. 2011)

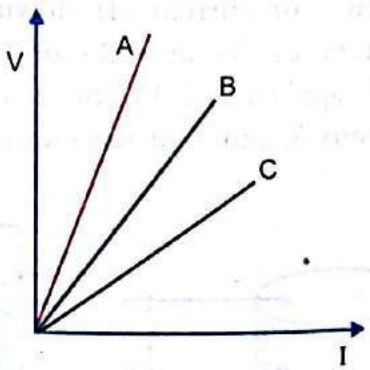
38. The number of divisions in ammeter of range 2A is 10 and voltmeter of range 5V is 20. When the switch of the circuit given below is closed, ammeter reading is at 8th division and voltmeter reading is at 8th division. The value of resistance of resistor is



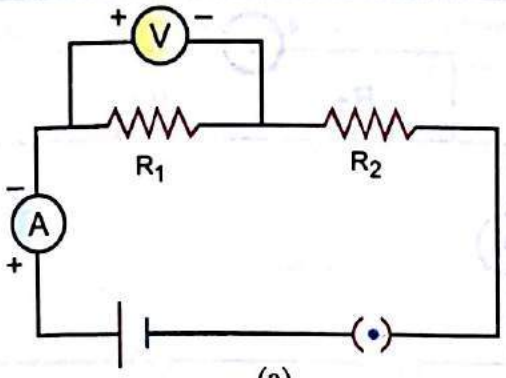
(a) 1.25Ω (b) 2 Ω
(c) 0.75 Ω (d) 1.5 Ω
(C.B.S.E. 2012)

39. In Ohm's law experiment, the physical quantity/ quantities which is/are to kept constant while doing experiment is/are :
(a) potential difference
(b) current
(c) temperature
(d) potential difference, current, temperature.
(C.B.S.E. 2012)

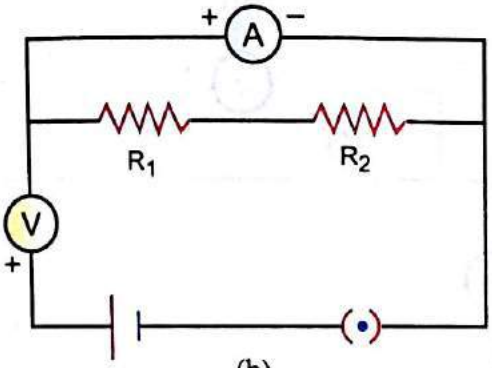
40. Ohm's law experiment is performed separately with individual resistors R_1, R_2 [$R_1 > R_2$] and series combination of R_1, R_2. Graph is plotted between potential difference (V) and current (I) as shown in figure for each case : Identify which one is for R_1, R_2 and combination of resistors ? In the graph A, B and C respectively represents.
(a) R_1, R_2 and series combination
(b) series combination, R_2, R_1
(c) R_2, R_1 and series combination
(d) series combination, R_1, R_2. *(C.B.S.E. 2012)*



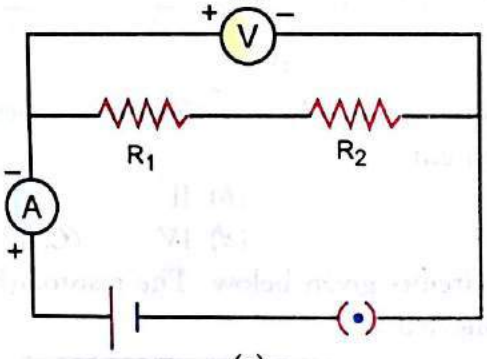
41. The circuit diagram shown below is used to find the effective resistance of two resistors in series. Which circuit diagram represents correctly ?



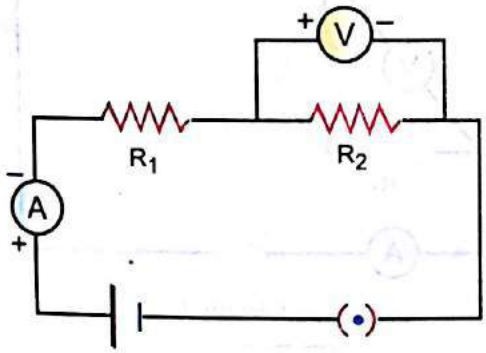
(a)



(b)

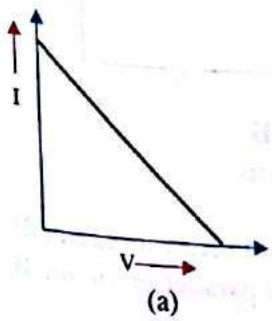


(c)

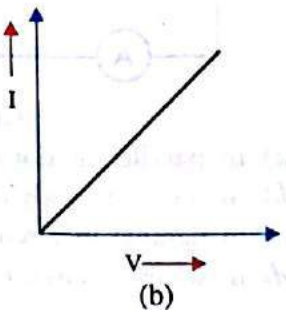


(C.B.S.E .2012)

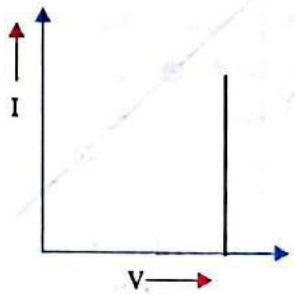
42. The graph between current (I) and the potential difference in the experimental verification of Ohm's law were drawn by four students as shown in fig. Which one of the following is correct ?



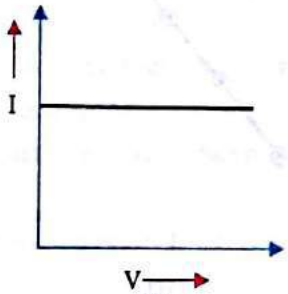
(a)



(b)



(c)



(d)

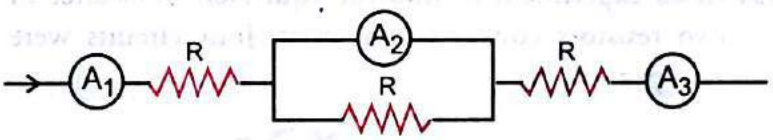
(C.B.S.E. 2012)

43. Which of the following is the correct method to connect the ammeter and voltmeter with resistance in the circuit to verify Ohm's law ?
(*a*) Ammeter and voltmeter in series
(*b*) Ammeter in series and voltmeter in parallel
(*c*) Ammeter in parallel and voltmeter in series
(*d*) Ammeter and voltmeter in parallel.

(C.B.S.E. 2012)

44. An ammeter has a range of (0 – 3) ampere and there are 30 divisions on its scale. What is its least count ?
(*a*) 1.0 A (*b*) 0.5 A
(*c*) 0.1 A (*d*) 0.01 A. *(C.B.S.E. 2012)*

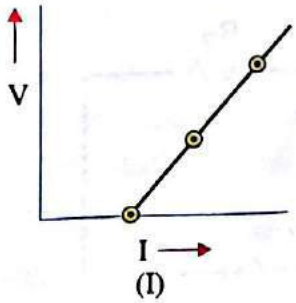
45. The statement that is most correct about the readings of ammeters A_1, A_2 and A_3 connected in the following circuit (currents read by each are shown by I_1, I_2, I_3 respectively).



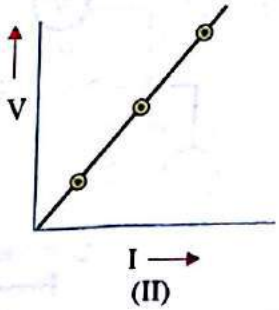
(*a*) $I_1 < I_2$ (*b*) $I_3 < I_2$
(*c*) $I_1 = I_2$ (*d*) $I_1 = I_3$. *(C.B.S.E. 2012)*

46. Equivalent resistance of three resistors each of resistance of 2Ω connected in series as determined experimentally should be :
(*a*) 4Ω (*b*) 6Ω
(*c*) 9Ω (*d*) 2Ω. *(C.B.S.E. 2012)*

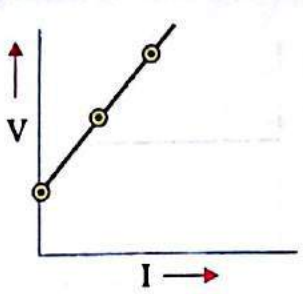
47. Four students plot graphs between V and I, showing dependence of current I on potential difference, V across a resistor, as shown :



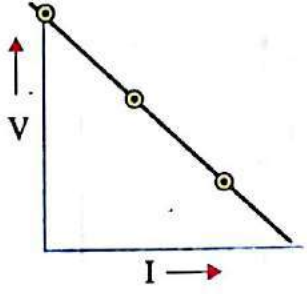
(I)



(II)



(III)

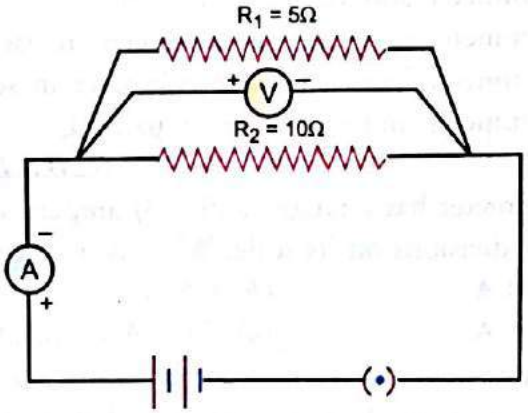


(IV)

The correct graph is

(*a*) I (*b*) II (*c*) III (*d*) IV. *(C.B.S.E. 2012)*

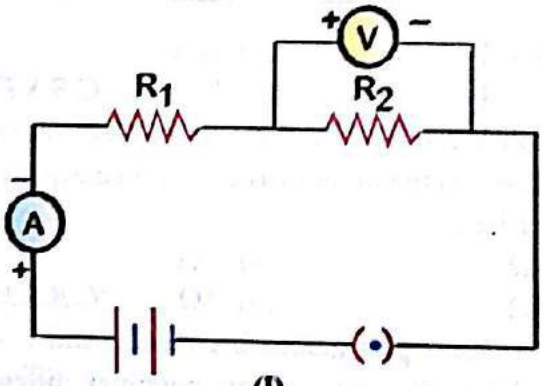
48. In the circuit given below, on plugging the key, the voltmeter reads 2.0 V but ammeter reads 0.6 A. The resistance of the combination is



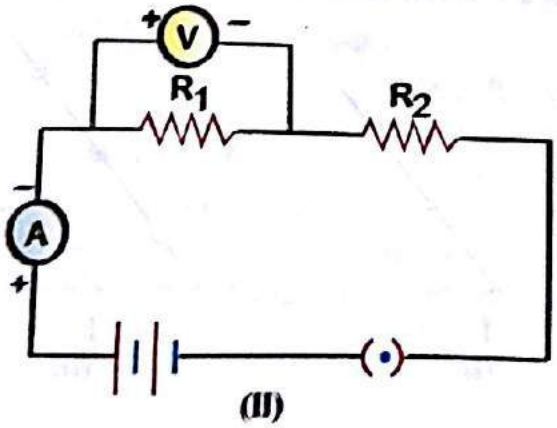
(*a*) 1·2 Ω (*b*) 3·3 Ω (*c*) 3·0 Ω (*d*) 15 Ω.

(C.B.S.E. 2012)

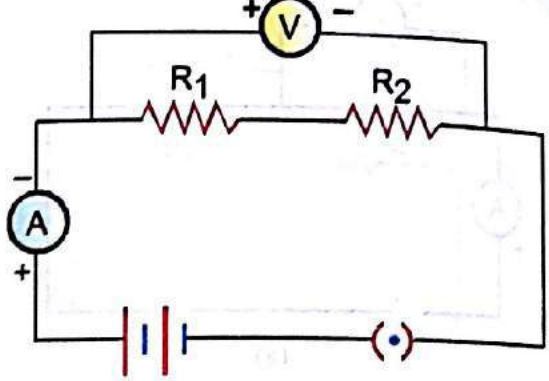
49. In an experiment to find the equivalent resistance of two resistors connected in series, four circuits were set-up as shown.



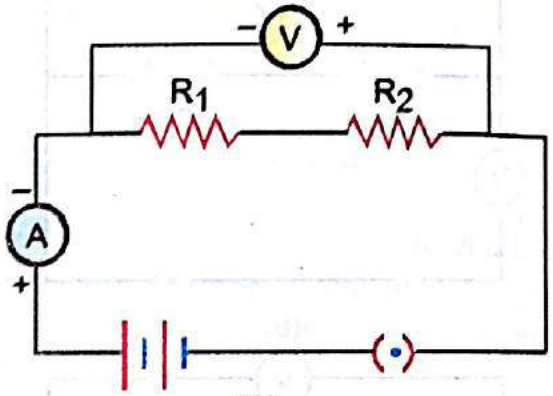
(I)



(II)



(III)



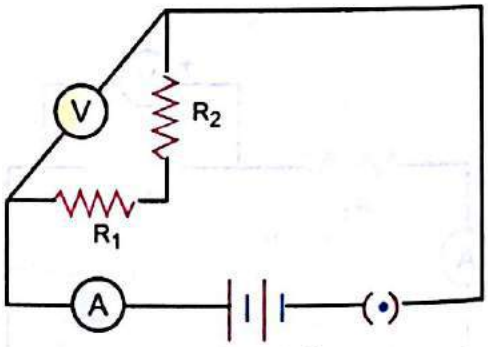
(IV)

The voltmeter has been correctly connected in the arrangement

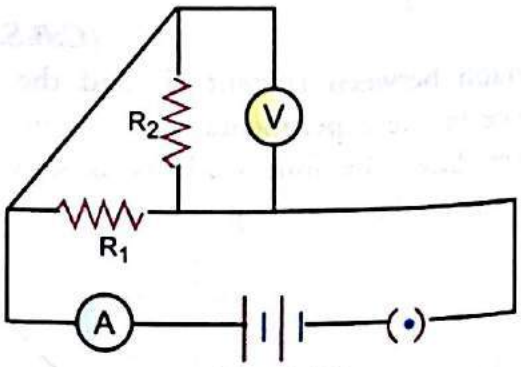
(*a*) I (*b*) II

(*c*) III (*d*) IV. *(C.B.S.E. 2012)*

50. In the circuits given below. The resistors R_1 and R_2 are connected :



Circuit-I



Circuit-II

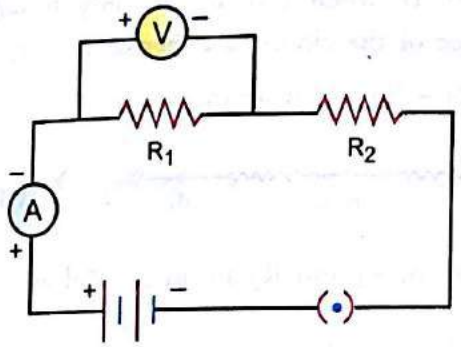
(*a*) in parallel in both circuits

(*b*) in series in both circuits

(*c*) in parallel in circuit I and series in circuit II

(*d*) in series in circuit I and parallel in circuit II.

51. A student set up electric circuit shown here for finding the equivalent resistance of two resistors in series. In this circuit.



(*a*) resistors have been connected correctly but the voltmeter has been wrongly connected.
(*b*) resistors have been connected correctly but the ammeter has been wrongly connected.
(*c*) resistors as well as voltmeter have been wrongly connected.
(*d*) resistors as well as ammeter have been wrongly connected.

Answers

1. (*b*)	**2.** (*c*)	**3.** (*c*)	**4.** (*b*)	**5.** (*b*)	**6.** (*b*)	**7.** (*c*)	**8.** (*c*)	**9.** (*a*)	**10.** (*b*)
11. (*a*)	**12.** (*c*)	**13.** (*b*)	**14.** (*b*)	**15.** (*d*)	**16.** (*d*)	**17.** (*c*)	**18.** (*a*)	**19.** (*a*)	**20.** (*c*)
21. (*b*)	**22.** (*b*)	**23.** (*c*)	**24.** (*a*)	**25.** (*d*)	**26.** (*a*)	**27.** (*c*)	**28.** (*c*)	**29.** (*b*)	**30.** (*c*)
31. (*b*)	**32.** (*a*)	**33.** (*a*)	**34.** (*b*)	**35.** (*b*)	**36.** (*b*)	**37.** (*b*)	**38.** (*a*)	**39.** (*c*)	**40.** (*d*)
41. (*c*)	**42.** (*b*)	**43.** (*b*)	**44.** (*c*)	**45.** (*d*)	**46.** (*b*)	**47.** (*b*)	**48.** (*b*)	**49.** (*c*)	**50.** (*d*)
51. (*a*)									

HINTS & EXPLANATIONS TO MCQs

2. Positive terminal of an ammeter must be connected with positive terminal of cell and negative terminal of ammeter must be connected with negative terminal of the cell.

5. In circuit I, ammeter and voltmeter are connected wrongly. Ammeter should be at the place of voltmeter and voltmeter at the place of ammeter. In circuit III, R_1 and R_2 are not in parallel but in series. In circuit IV, terminals of voltmeter are connected wrongly.

6. Voltmeter should be connected across the combination of R_1 and R_2 to give correct reading for potential difference.

8. Voltmeter gives no reading as the circuit is open. It will show some reading if the plug of the key connected in the arm of voltmeter is inserted.

9. In circuit B, battery has both positive terminals which is not correct. In circuit C, terminals of ammeter are connected wrongly. In circuit D, voltmeter is connected in place of ammeter and vice- versa.

11. R_1 and R_2 are in series and not in parallel. The terminals of voltmeter are connected wrongly.

12. $$R = \frac{1}{\text{Slope of V} - \text{I graph}}$$

$$= \frac{1}{I/V} = \frac{V}{I} = \frac{1{\cdot}0}{0{\cdot}1} = 10 \text{ ohm}$$

13. Ammeter is connected in series in a circuit and voltmeter is connected in parallel to the combination of R_1 and R_2.

14. Least count of voltmeter = value of 1 division.

20 division = 0·5 V

$$\therefore \quad 1 \text{ division} = \frac{0{\cdot}5\text{V}}{20} = 0{\cdot}025 \text{ V}$$

15. Here, least count of milliammeter = 20 *m*A

∴Reading of milliammeter,

$$I = 180 \text{ mA} = 180 \times 10^{-3}\text{A}$$

$$\text{Least count of voltmeter} = \frac{1}{5} = 0{\cdot}2 \text{ V}$$

∴Reading of voltmeter, V = 1·8V

$$\therefore \text{ Resistance, } R = \frac{V}{I} = \frac{1{\cdot}8}{180 \times 10^{-3}} = 10 \text{ ohm.}$$

16. Circuit I is open circuit.

17. Least count of milliammeter = 10 mA

∴ Reading of milliammeter, I = 370 mA = $370{\cdot}10^{-3}$ A

$$\text{Least count of voltmeter} = \frac{1}{5} = 0{\cdot}2\text{V}$$

∴ Reading of voltmmeter = 7·4V

Resistance, $R = \frac{7\cdot4}{370\times10^{-3}} = \frac{7\cdot4\times1000}{370} = 20\ \Omega$

18. Instrument which has minimum least count can measure the physical quantity accurately and precisely.

19. In arrangement A, four calls are connected in series, so the applied voltage $= 4 \times 1\cdot5V = 6\cdot0$ V.

In arrangement B, only two cells are connected in series, so applied voltage $= 2 \times 1\cdot5V = 3\cdot0$ V.

In arrangement C, only one cells is in the circuit, so applied voltage = 1·5 V.

20. Least count of milliammeter $= \frac{100}{10} = 10$ mA

$\therefore$ Reading of milliammeter, I = 130 mA

21. Least count of milliammeter II is minimum, so this milliammeter can measure current accurately and precisely.

22. Here, $I = 180\ mA = 180 \times 10^{-3}A$

$V = 0\cdot9$ V

$\therefore R = \frac{V}{I} = \frac{0\cdot9}{180\times10^{-3}} = \frac{0\cdot9\times1000}{180} = 5\cdot0$ ohm

23. Circuit I is a open circuit *i.e* no current flows in the circuit.

24. Least count of milliammeter = 2 mA

Initial reading of milliammeter = –4 mA

Final reading of milliammeter = 38 mA

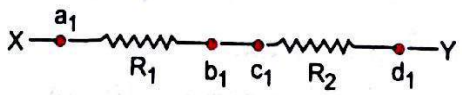
$\therefore$ Correct value of current = 38 – (–4) = 42 mA

Least count of voltmeter = 0·2 V

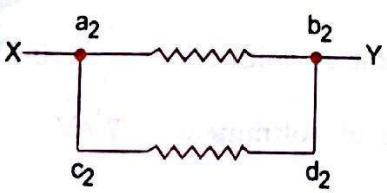
$\therefore$ Correct value of voltage = 3·6 V – 0·4 V = 3·2 V

26. Ammeter can be connected anywhere in series in a circuit. All ammeters are connected correctly but the polarity of ammeter shown in (Z) in wrong.

27. In figure A, R_1 and R_2 are in series as



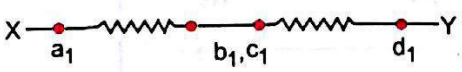
In figure B, R_1 and R_2 are in parallel as



28. In A, when J is at (*d*), applied voltage will be maximum and hence V = IR

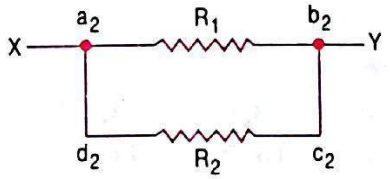
In figure B, when J is at (*a*), only R will be the resistance of the circuit and hence V = IR.

29. In A, $R_1 + R_2$ are in series,



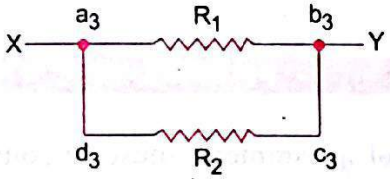
$\therefore \frac{V}{I} = R_1 + R_2.$

In figure B, R_1 and R_2 are in parallel as



$\therefore \frac{V}{I} = \frac{R_1R_2}{R_1+R_2}.$

In figure C, R_1 and R_2 are in parallel,



$\therefore \frac{V}{I} = \frac{R_1R_2}{R_1+R_2}$

38. L.C. of ammeter $= \frac{2}{10} = 0\cdot2$. A.

L.C. of voltmeter $= \frac{5}{20} = 0\cdot25$ V ; Current, $I = 8 \times 0\cdot2 = 1\cdot6$ A, Potential difference $V = 8 \times 0\cdot25 = 2V$.

$\therefore R = \frac{V}{I} = \frac{2}{1\cdot6} = 1.25\Omega.$

39. $R = \frac{V}{I}$ = constant if temperature is constant.

40. $R = \frac{V}{I}$ = slope of V-I curve. Slope of A > Slope B > Slope C.

44. L.C. $= \frac{3}{30} = 0.1A$

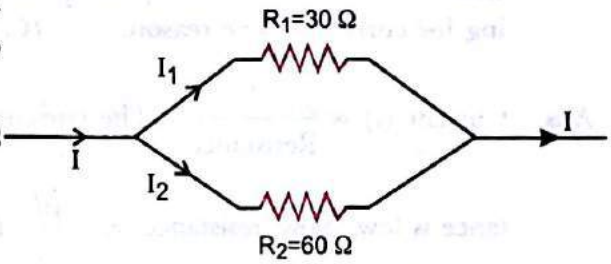
48. $R = R_1 + R_2 + R_3 = 6\Omega.$

49. $R = \frac{V}{I} = \frac{2}{0\cdot6} = 3\cdot3\ \Omega.$

QUESTIONS FROM C.B.S.E. EXAMINATION PAPERS - 2010 TO 2012

VERY SHORT ANSWER QUESTIONS

1. **Two resistors of 30Ω and 60Ω are connected in parallel in an electric circuit. How does the current passing through the two resistors compare ?** *(C.B.S.E. 2010)*



Ans. Potential difference across 30Ω = Potential difference across 60Ω

i.e. $I_1 R_1 = I_2 R_2$ or $\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{60\Omega}{30\Omega} = 2$

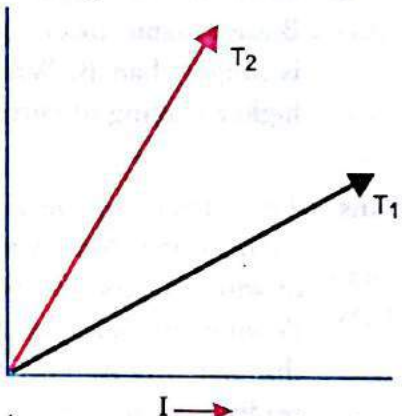
2. **A wire of resistivity 'ρ' is pulled to doubled its length. What will be its new resistivity ?** *(C.B.S.E. 2010, 2011)*

Ans. New resistivity will also be 'ρ' because resistivity of a wire does not depend on its length.

3. **The voltage – current (V–I) graph of a metallic circuit at two different temperature T_1 and T_2 is shown. Which of the two temperatures is higher and why ?** *(C.B.S.E. 2010)*

Or

The voltage-current (V – I) graph of a metallic conductor at two different temperatures T_1 and T_2 is shown in figure. At which temperature is the resistance higher ? *(C.B.S.E. 2011, 2012)*



Ans. Slope of I–V graph

= resistance of metallic conductor.

Since, slope of I–V graph at temperature T_2 is greater than the slope of I–V graph at temperature T_1, therefore, resistance at T_2 is greater than resistance at T_1. Since, resistance of a metallic conductor increases with increase in temperature, therefore, $T_2 > T_1$.

4. **Which one is having lesser resistance : A 60 W bulb or a 40 W bulb ?** *(C.B.S.E. 2010, 2011)*

Ans. $\text{Power (P)} = \frac{V^2}{R} \therefore R \propto \frac{1}{P}$ if V is constant.

Hence, bulb of higher wattage will have less resistance. In other words, resistance of 60W bulb is less than the resistance of 40 W bulb.

5. **You have two metallic wires of resistances 6Ω and 3Ω. How will you connect these wires to get the effective resistance of 2Ω ?** *(C.B.S.E. 2010, 2012)*

Ans. In parallel, $\left(\frac{1}{R} = \frac{1}{6} + \frac{1}{3} = \frac{3}{6} = \frac{1}{2} \text{ or } R = 2\Omega\right)$

6. **"The resistance of a conductor is 1Ω". What is meant by this statement ?** *(C.B.S.E. 2010, 2011, 2012)*

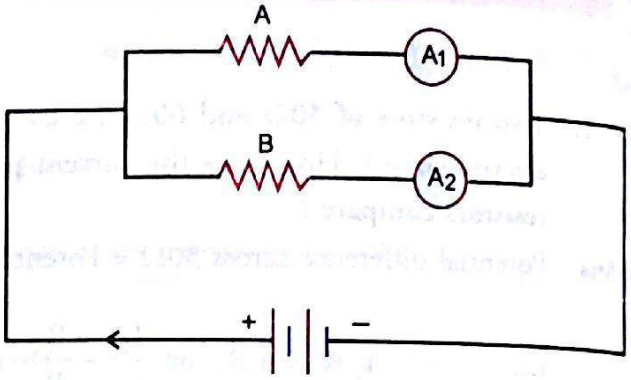
Ans. The resistance of a conductor is said to be 1Ω if a potential difference of 1V across the ends of the conductor makes a current of 1A to flow through it.

7. **Write a mathematical expression for Joule's law of heating. Name one device which works on this principle.** *(C.B.S.E. 2010)*

Ans. $H = I^2 Rt$. An electric heater.

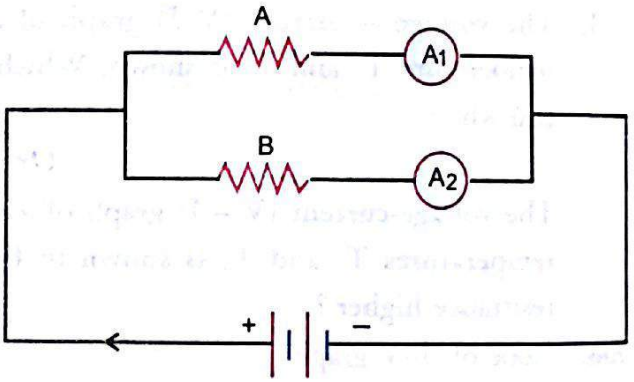
SHORT ANSWER QUESTIONS

1. **In the circuit diagram shown, the two resistance wires A and B are of the 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.** *(C.B.S.E. 2010, 2011)*



Ans. Current (I) $\propto \frac{1}{\text{Resistance}}$. The current will be high if resistance is low. Now, resistance, $R = \frac{\rho l}{A}$. ρ and l for both wires A and B are same but area of cross-section (A) of wire A is more than the wire B. Therefore, resistance of wire A is less than the resistance of the wire B. Hence, ammeter A_1 connected in series with the wire A will indicate higher reading for current.

2. **In the circuit diagram shown, the two resistance wires A and B are of same area of cross-section and same material, but A is longer than B. Which ammeter A_1 and A_2 will indicate higher reading of current ? Give reason.** *(C.B.S.E. 2010, 2011)*



Ans. The current in the circuit is high if the resistance of the circuit is low. Since wire A is longer than B, so the resistance of wire B is less than the resistance of wire A. Hence, current flowing through wire B is greater than the current flowing through wire A. Therefore, ammeter A_2 will indicate higher reading of current.

3. **A lamp rated 100 W at 220 V is connected to 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 ?** *(C.B.S.E. 2010)*

Ans. Here, $P = 200\ W,\ V = 220\ V$

(*i*) Using $P = VI$, we get

$$I = \frac{P}{V} = \frac{100\ W}{220\ V} = 0.45\ A$$

(*ii*) Using $P = \frac{V^2}{R}$, we get

$$R = \frac{V^2}{P} = \frac{220 \times 220}{100} = 484\ \Omega$$

4. **In a house, four 60 W electric bulbs are lighted for 2 hours and two 100W bulbs are lighted for 4 hours everyday. Calculate the energy consumed in the house for 30 days.** *(C.B.S.E. 2010)*

Ans. Energy consumed = Power × time

∴ Energy consumed by (4 + 2) = 6 bulbs in one day

$= 4 \times 60W \times 2h + 2 \times 100\ W \times 4\ h$

$= 480\ Wh + 800\ Wh = 1280\ Wh$

$= 1.280\ kWh$

Energy consumed in 30 days $= 1.280\ kWh \times 30 = 38.4\ kWh$

5. **An electric bulb draws a current of 0.8 A and works on 250 V on the average 8 hours a day. If energy costs ₹ 3 per kWh, calculate monthly bill for 30 days.** *(C.B.S.E. 2010, 2011)*

Ans. Power of electric bulb, P= VI = 250 × 0·8 = 200 W

Energy consumed in a day = Power × time = 200 W × 8 h

= 1600 Wh = 1·6 kWh

Energy consumed in 30 days = 1·6 kWh × 30 = 48 kWh

Cost of 1 kWh energy = ₹ 3

∴ Cost of 48 kWh energy = ₹ 3 × 48 = ₹ 144.00

Thus, monthly bill = ₹ 144.00

6. A wire is cut into three equal parts and then connected in parallel. How will its (*a*) resistance (*b*) resistivity get affected ? ***(C.B.S.E. 2010)***

Ans. (*a*) Let resistance of the wire = R

∴ Resistance of each part = R/3

Resistance of parallel combination of three parts is given by

$$\frac{1}{R'} = \frac{3}{R} + \frac{3}{R} + \frac{3}{R} = \frac{9}{R} \text{ or } R' = \frac{R}{9}.$$

(*b*) Resistivity of each part remains the same as it does not depend on the dimensions of the wire.

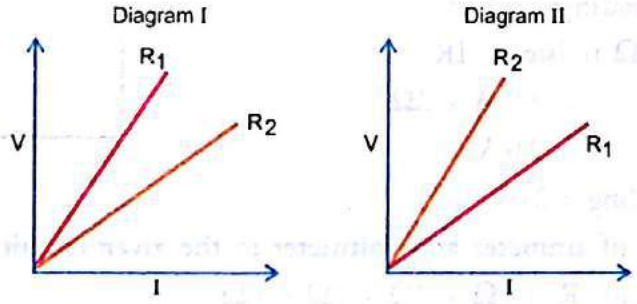
7. Which gas is filled in the electric bulb and why ? ***(C.B.S.E. 2010, 2011, 2012)***

Or

Why are electric bulbs filled with chemically inactive nitrogen or argon ? ***(C.B.S.E. 2012)***

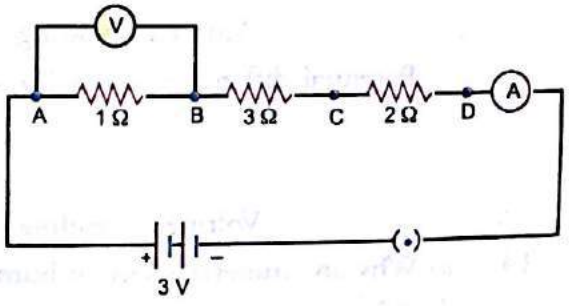
Ans. Inactive gas like nitrogen or argon is filled in the electric bulb to increase the life of the tungsten filament of the bulb.

8. 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 the two diagrams correctly represent the situation on the plotted curves ? Justify your answer. ***(C.B.S.E. 2010, 2012)***



Ans. Resistance of a conductor = slope of I–V graph. It means, resistance is high if slope of I–V graph for it is steeper. Since $R_1 > R_2$, therefore, slope of I–V graph for R_1 must be steeper than the slope of I–V graph for R_2. Thus, diagram I represents the situation correctly.

9. How would the reading of V change if it is connected between B and C. Justify your answer. ***(C.B.S.E. 2010, 2011)***



Ans. Total resistance of the circuit, R = 1 + 3 + 2 = 6 Ω

Current flowing through the circuit, $I = \frac{V}{R} = \frac{3V}{6\Omega} = 0{\cdot}5$ A

Reading of V when connected between A and B, $V_1 = IR_1$

$= 0{\cdot}5 \text{ A} \times 1\Omega = 0{\cdot}5$ V

Reading of V when connected between B and C,

$V_2 = IR_2 = 0{\cdot}5 \text{ A} \times 3\Omega = 1{\cdot}5$V

10. Two electric bulbs A and B are marked 220V, 40W and 220 V, 60W respectively. Which one of the two has greater resistance ? ***(C.B.S.E. 2010, 2011)***

Ans. $P = \frac{V^2}{R}$ or $R \propto \frac{1}{P}$ if V = constant.

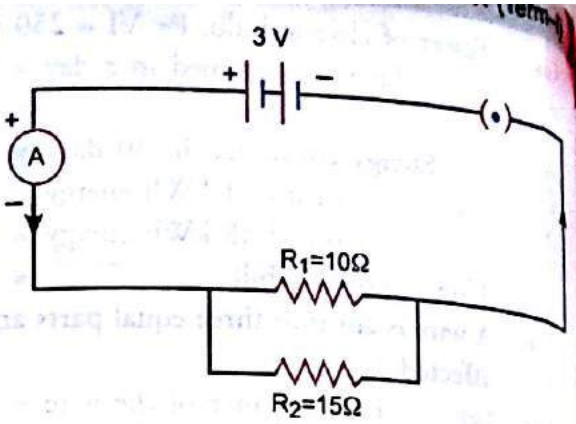
Therefore, bulb A (40 W) has greater resistance than the bulb B (60 W)

11. Study the following circuit and answer the following questions :

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

(*ii*) How much current is flowing through (*a*) 10Ω and through (*b*) 15Ω resistors

(*iii*) What is the ammeter reading ? *(C.B.S.E. 2010, 2012)*



Ans. (*i*) Resistors R_1 and R_2 are connected in parallel combination

(*ii*) (*a*) Let I_1 be the current flowing through R_1

Now $I_1R_1 = V$

or $$I_1 = \frac{V}{R_1} = \frac{3}{10} = 0{\cdot}3 \text{ A}$$

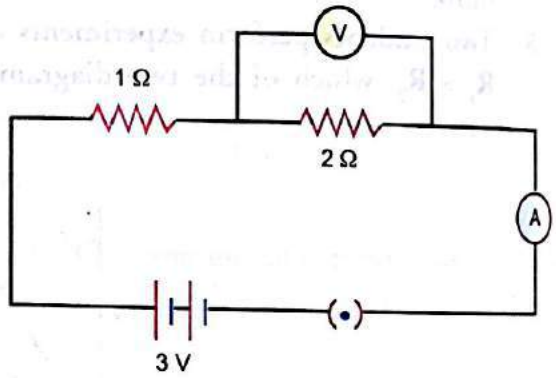
(*b*) Let I_2 be the current flowing through R_2

Now $I_2R_2 = V$

or $$I_2 = \frac{V}{R_2} = \frac{3}{15} = 0{\cdot}2 \text{ A}$$

(*iii*) Ammeter reading = $I_1 + I_2 = 0{\cdot}3 + 0{\cdot}2 = 0{\cdot}5$ A

12. What would be the reading of ammeter and voltmeter in the given circuit ? *(C.B.S.E. 2010)*



Ans. Total resistance of the circuit, R = 1Ω + 2Ω = 3V

Now $$I = \frac{V}{R} = \frac{3}{3} = 1{\cdot}0 \text{ A}$$

Therefore, ammeter reading = 1·0 A

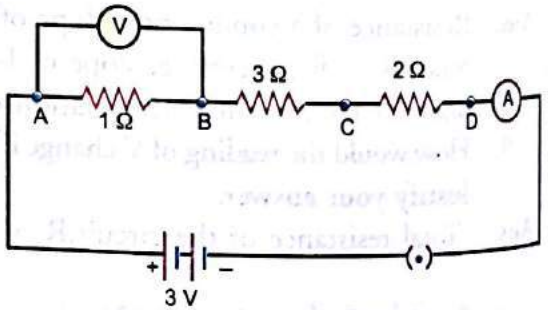
Potential difference across 2Ω resistor = IR

= 1·0 A × 2Ω

= 2·0 V

∴ Voltmeter reading = 2·0V

13. What would be the reading of ammeter and voltmeter in the given circuit ? *(C.B.S.E. 2010)*



Ans. Total resistance of the circuit, R = 1Ω + 3Ω + 2Ω = 6Ω

Now, Current, $$I = \frac{V}{R} = \frac{3}{6} = 0{\cdot}5 \text{ A}$$

∴ Ammeter reading = 0·5 A

Potential difference across 1Ω = IR

= 0·5 A × 1Ω

= 0·5 V

∴ Voltmeter reading = 0·5 V

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

(*b*) Why is series arrangement not found satisfactory for domestic lights ? *(C.B.S.E. 2010, 2011)*

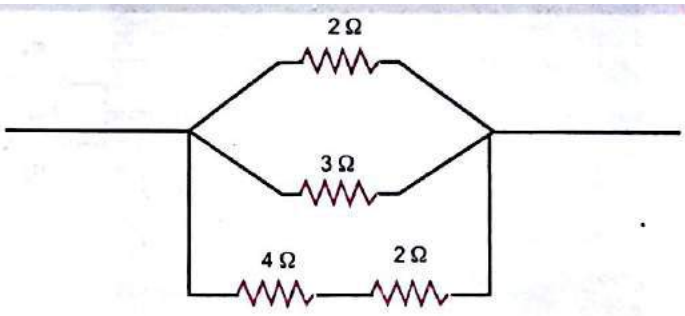
Ans. (*a*) Ammeter is a low resistance device. If it is connected in parallel, a large current flows through it. Hence, large heat is produced and it may burn the ammeter.

(*b*) If domestic lights are connected in series, then all lights are switched off even when only one light fuses.

15. Calculate the equivalent resistance from the following combination of resistors. *(C.B.S.E. 2010, 2011)*

Ans. Here 2Ω and 3Ω are connected in parallel, so equivalent resistance of this combination is

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{2 \times 3}{2+3} = \frac{6}{5}\Omega$$



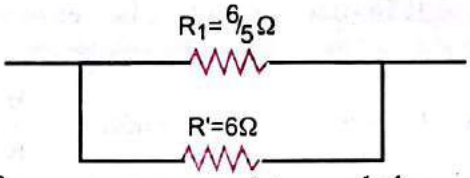
4Ω and 2Ω are connected in series, so equivalent resistance of this combination is

$$R' = 4\Omega + 2\Omega = 6\Omega$$

Now the equivalent circuit of the given diagram is given below :

Since R and R' are connected in parallel, so the equivalent resistance is given by $R' = \frac{RR'}{R + R'}$

$$= \frac{\frac{6}{5} \times 6}{\frac{6}{5} + 6} = 1\Omega$$



16. 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 reading, the trend is different from others and must be rejected. Calculate the mean value of the resistance based on the remaining sets of readings. *(C.B.S.E. 2010)*

Ans. Potential difference is increased by 1V in each set except after 3V, where potential difference is increased by 1·5 V. Thus, this set of reading must be rejected.

(*i*) When $V = 2$ V, $I = 0{\cdot}08$ A

$$\therefore \quad R_1 = \frac{V}{I} = \frac{2}{0{\cdot}08} = 25\Omega$$

(*ii*) When $V = 3$ V, $I = 0.12$ A

$$\therefore \quad R_2 = \frac{V}{I} = \frac{3}{0{\cdot}12} = 25\Omega$$

(*iii*) When $V = 5$ V, $I = 0{\cdot}20$A

$$\therefore \quad R_3 = \frac{V}{I} = \frac{5}{0.20} = 25\Omega$$

(*iv*) When $V = 6$ V, $I = 0{\cdot}24$ A

$$\therefore \quad R_4 = \frac{V}{I} = \frac{6}{0.24} = 25\Omega$$

$$\therefore \quad \text{Mean value of resistance, } R = \frac{R_1 + R_2 + R_3 + R_4}{4} = \frac{25+25+25+25}{4}$$

$$= 25\Omega$$

17. Given that $R_1 = 10\Omega$, $R_2 = 40\Omega$, $R_3 = 30\Omega$, $R_4 = 20\Omega$ and R_A is the parallel combination of R_1 and R_2 whereas R_B is the parallel combination of R_3 and R_4. Combination R_A is connected to the positive terminal of 12 V battery while combination R_B is connected to the negative terminal. Ammeter A is connected between the resistors R_A and R_B. (*a*) Find R_A and R_B. Also calculate total resistance in the circuit. (*b*) Draw the circuit diagram showing above combinations connected to battery and ammeter. *(C.B.S.E. 2012)*

Ans. $R_1 = 10\ \Omega$, $R_2 = 40\ \Omega$, $R_3 = 30\ \Omega$, $R_4 = 20\ \Omega$.

(*a*) $R_A = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 40}{50} = 8\ \Omega$, $R_B = \frac{R_3 R_4}{R_3 + R_4} = \frac{30 \times 20}{50} = 12\ \Omega$

Total resistance, $R = R_A + R_B = 8 + 12 = 20\ \Omega$