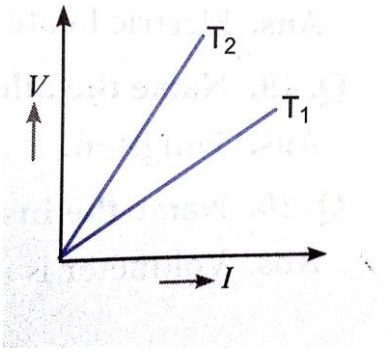
Very Short Answer Type Questions

[1 Mark]

Q. 1. The voltage-current (v-I) graph of a metallic conductor at two different temperature T_1 and T_2 is shown in figure. At which temperature is the resistance higher?



Ans. At T_2.

Q.2. Why is resistance less when resistors are joined in parallel?

Ans. We know that $R \propto \frac{1}{4}$

In parallel combination of resistors, the effective area of cross-section of the conductor increases, to the resistance decreases.

Q. 3. Why is resistance more in series combination?

Ans. We know R ∞ L. In series combination of resistors, the effective length of cross-section of the conductor increases, so the resistance increases.

Q. 4. What are the special features of a heating wire?

Ans. It must have high specific resistance and high melting point.

Q. 5. What is the resistance of an ideal ammeter?

Ans. Zero.

Q. 6. What is the resistance of an ideal voltmeter?

Ans. Infinite

Q. 7. Which one has more resistance 100 watt bulb or 60 watt bulb both operating at 220 V?

Ans. The resistance of 60 watt bulb is greater than the resistance of 100 watt bulb.

Q.8. Write the expression for the heat energy produced in a wire of resistance R and carrying current I.

Ans. Heat produced, $H = I_2 Rt$, where‘t’ stands for time, for which current l is passed through the conductor.

Q. 9. Name the physical quantity whose unit is J/C.

Ans. Electric potential.

Q. 10. What is the resistance of an air gap?

Ans. It is very large, almost infinite.

Q. 11. What is the commercial unit of electric energy?

Ans. The commercial unit of electric energy is kilowatt hour (kWh).

Q. 12. What happens to the resistance of a wire if it is made thinner?

Ans. The resistance of wire increases.

Q. 13. In series combination which remains constant-current or voltage?

Ans. Current.

Q. 14. Which substance is used for making resistance coil of electric heater and why?

Ans. Nichrome, due to its high resistivity.

Q. 15. Which physical quantity remains constant when resistances are connected in parallel?

Ans. Potential difference (voltage) remains constant.

Q. 16. How is the ammeter connected in the circuit?

Ans. An ammeter is connected in series in the circuit.

Q.17. Why is an ammeter connected in series in an electric circuit?

Ans. It is connected in series so that whole of electric current, which it has to measure, passes through it.

Q. 18. Name two devices in which electricity is converted into heat.

Ans. Electric heater and electric iron.

Q. 19. Name the alloy which is used for making the filament of bulbs.

Ans. Tungsten.

Q. 20. Name the instrument used for measuring potential difference.

Ans. Voltmeter is used for measuring potential difference.

Q. 21. Name the instrument used for measuring electric current flowing in an electric circuit.

Ans. An ammeter.

Q. 22. The following table gives the value of electrical resistivity of some materials:

Material	Copper	Silver	Constantan
Electrical resistivity (in Ω m)	1.62×10^{-8}	1.6×10^{-8}	49×10^{-6}

Which one of these materials is the best conductor of electricity?

Ans. Out of these three, silver has the lowest resistivity. Hence, silver is the best conductor of electricity.

Short Answer Type Questions – I

[2 marks]

Q. 1. Why does resistance of a metallic conductor increase with increase in temperature?

Ans. When a metallic conductor is heated, the atoms in the metal vibrate with greater amplitude and frequency. Due to increase in temperature, the thermal velocities of free electrons also increases. Therefore, the number of collisions between free electrons and atoms increases. This increases the opposition to the movement of electrons and hence the resistance of the conductor.

Q. 2. Why is it not advisable to handle high voltage electrical circuit with wet hands?

Ans. The resistance of dry-skin human body is about 50,000 Ω. When the skin is wet, the resistance gets lowered to about 10,000 Ω. If a person with wet hands touches the electrical circuit, high current will flow through the body causing risk to life.

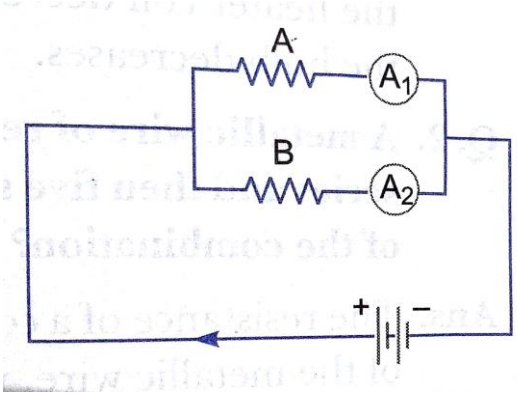
Q. 3. Though the same current flows through line wires or the filament of a bulb, yet only the latter glows. Why?

Ans. The filament of electric lamp has high resistance whereas the line wires are of negligible resistance. Since amount of heat generated is proportional to the resistance, the filament generates much more heat and it starts glowing.

Q. 4. Heat is generated continuously in an electric heater but the temperature of its element becomes constant after some time. Why?

Ans. When the temperature of the heater becomes greater than the temperature of the surrounding, some of the heat is lost to the surroundings in the form of thermal radiations. After some time, rate at which heat is being produced becomes equal to the rate of which heat is lost. Hence, the temperature of the element becomes constant.

Q. 5. In the given circuit diagram, 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 or A_2 will indicate higher reading for current? Give reason.



Ans. Ammeter A_2 shows higher reading. Since wire A_1 is longer, it has greater resistance and so draws lesser current. So more current. So more current flows through B and A_2 shows higher reading.

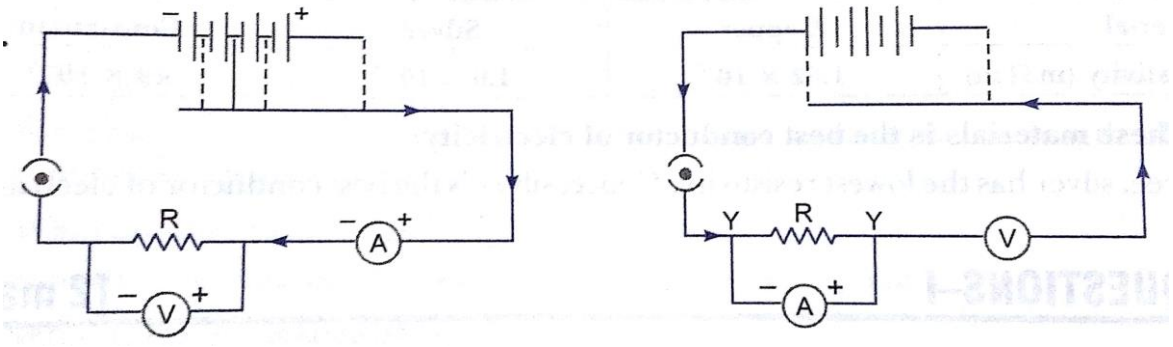
Q. 6. Two wires of equal length, one of copper and the other of manganin (an alloy) have the same thickness. Which one can be used for (i) electrical transmission lines (ii) electrical heating devices? Why?

Ans. (i) Copper wire can be used for electrical transmission lines because copper has very low resistivity and hence it is very good conductor of electricity.

(ii) Manganin can be used for electrical heating devices because the resistivity of manganin is about 25 times more than that of copper and hence it produces a lot of heat on passage of current through it.

Q. 7. A student has drawn the electric circuit to study Ohm's law as shown in figure. His teacher told that the circuit diagram needs correction. Study the circuit diagram and redraw it after making all corrections.

Ans.



Q 8. What is electrical resistivity? In a series electrical circuit comprising of a resistor having a metallic wire, the ammeter reads 5 A. The reading of the ammeter decreases to half when the length of the wire is doubled. Why?

Ans. The resistivity of a material is defined as the resistance of a conductor made of that material of that material of unit length and unit cross-sectional area.

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

Also, $V = RI$

R is doubled while V remains unchanged. Hence, current becomes half.

Short Answer Type Questions – II

[3 marks]

Q. 1. Why does an electric bulb become dim when an electric heater in parallel circuit is switched on? Why does dimness decrease after sometime?

Ans. The resistance of a heater coil is less than that of electric bulb filament. When heater is switched on in parallel, more current start flowing through the heater coil and current through the bulb filament decreases making it dim.
After some time, when heater coil becomes hot its resistance increases. As a result, current through the heater coil decreases and the current through the bulb filament increases and thus dimness of the bulb decreases.

Q. 2. A metallic wire of resistance R is cut into ten parts of equal length. Two pieces each are joined in series and then five such combinations are joined in parallel. What will be the effective resistance of the combination?

Ans. The resistance of a conductor is directly proportional to the length of the conductor. The resistance of the metallic wire, when it is cut into ten parts of equal length is

$$r = \frac{R}{10}$$

Two such pieces when joined in series, the equivalent resistance of these two parts

$$= r + r = 2r = \frac{2R}{10}.$$

Series resistance of two parts $= 2x\frac{R}{10} = \frac{R}{5}$,

5 such elements are connected in parallel. Therefore the total resistance R' will be

$$\frac{1}{R\prime} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{25}{R}$$

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

Q. 3. 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:

(a) resistance change?
(b) resistivity change?
Justify your answer in each case.

Ans. (a) Here, length is doubled and area of cross-section is halved. Thus, a wire of length l and area of cross-section A becomes a wire of length 2l and area of cross-section $\frac{A}{2}$.

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

New resistance, $R_{1=\rho\frac{2l}{A\setminus 2}}$

$R_{1=\frac{4\rho l}{A}=4\ x\ R}$

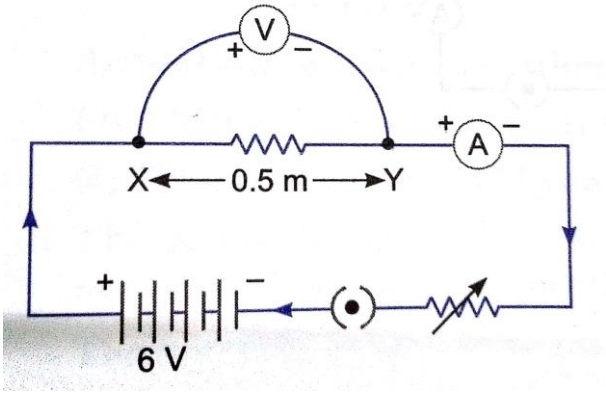
i.e., resistance becomes four times

(b) Resistivity of a substance does not depend on its length or area of cross-section. It depends on the nature of the material and temperature. Hence there is no change.

Q. 4. (a) The components of an electric circuit are 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V each, rheostat and a plug key. Draw a circuit diagram to study the relation between potential difference across the terminals X and Y of the wire and current flowing through it.

(b) State the law that relates potential difference across a conductor with the current flowing through it.

Ans. (a)



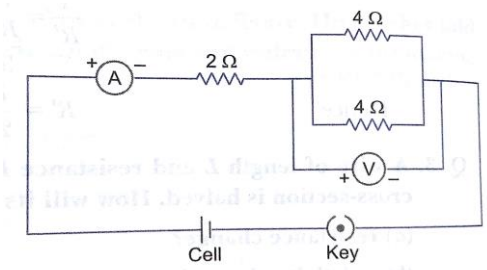
(b) Ohm's law states that the current through a conductor between two points is directly proportional to the potential difference across the two points.

Q. 5. Draw a circuit diagram of an electric circuit containing a cell, a key, an ammeter, a resistor of Ω in series with a combination of two resistors (4 Ω each) in parallel and a voltmeter across the parallel combination, will the potential difference across the 2 Ω resistor be the same as that across the parallel combination of 4 Ω resistors? Give reason.

Ans. The circuit is shown in figure. Effective resistance of combination of two resistors (4 Ω each) in parallel is

$$R_{eq} = \frac{4\,x\,4}{4+4} = 2\Omega$$

Since the resistor of 2 Ω and parallel combination of two 4 Ω resistors are in series, same current will flow through these. Hence, the potential difference across 2 Ω resistor is same as that across combination of two resistors.



Q. 6. Three incandescent bulbs of 100 W each are connected in series in an electrical circuit. In another circuit another set of three bulbs of the same wattage are connected in parallel to the same source.

(a) Will the bulb in the two circuits glow with the same brightness? Justify your answer.
(b) Now let one bulb in both the circuits get fused. Will the rest of the bulbs continue to glow in each circuit? Give reason.

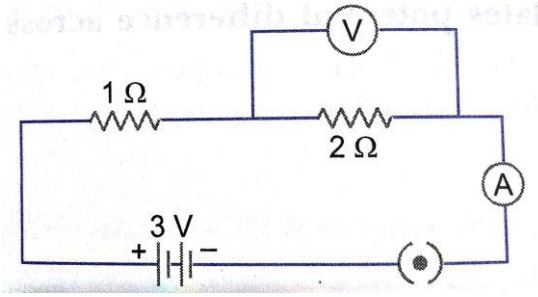
Ans. (a) No.

Reasons: Let R be the resistance of each bulb, then total resistance in series = 3R
In series, current in each bulb is same.

So current drawn by each bulb connected in series is one-third as compared to the current in each bulb in parallel arrangement, so the bulbs connected in parallel combination glow more brightly.

(b) In series arrangement, if one bulb is fused; then current in the bulbs connected in series will become zero, so bulbs will stop glowing. In parallel arrangement, if one bulb is fused, the other two bulbs will continue to glow with same brightness.

Q. 7. What would be the reading of ammeter and voltmeter in the given circuit?



Ans. $R = R_1 + R_2 = 1 + 2 = 3\Omega$

$$1 = \frac{V}{R} = \frac{3}{5} = 1A$$

Ammeter reading = 1 A
Voltmeter reading = IR = 1 x 2 = 2 V
Voltmeter reading = 2 V

Q. 8. Read the following information:

(i) Resistivity of copper is lower than that of aluminium which, in turn, is lower than that of constantan.

(ii) Six wires labelled as A, B, C, D, E, F have been designed as per the following parameters:

Answer the following question using the above data:

(a) Which of the wires has maximum resistance and why?

Wire	Length	Diameter	Material	Resistance
A	l	2d	Aluminium	R_1
B	2l	d/2	Constantan	R_2
C	3l	d/2	Constantan	R_3
D	l/2	3d	Copper	R_4
E	2l	2d	Aluminium	R_5
F	l/2	4d	Copper	R_6

(b) Which of the wires has minimum resistance and why?

(c) Arrange R_1, R_3 and R_5 in ascending order of their values. Justify your answer.

Ans. (a) Wire C has maximum resistance because it has maximum length, least thickness and highest resistivity.

(b) Wire F has the maximum resistance since it has least length, maximum thickness and least resistivity. ($Using\ R = \rho \frac{l}{A}$)

(c) $R_3 > R_5 > R_1$ (Using relation $R = \frac{l}{A}$ and comparison)

Long Answer Type Questions

[5 Marks]

Q. 1. The potential difference between two points in an electric circuit is 1 volt. What does it mean?

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

(ii) Why does the connecting cord of an electric heater not glow while the heating element does?

(iii) Electrical resistivities of some substances at 20° C are given below:

Silver	**1.60× 10-8 Ω m**
Copper	**1.62 × 10-8 Ω m**
Tungsten	**5.2 x 10-8m**
Iron	**10.0 x 10-82 m**
Mercury	**94.0× 10-8 Ω m**
Nichrome	**100 × 10-6 Ω m**

Answer the following questions using above data:

(a) Among silver and copper, which one is a better conductor? why?
(b) Which material would you advise to be used in electrical heating devices and why?

Ans. (i) The potential difference between two points is 1 volt means that if a charge of 1 coulomb is moved from one point to the other, 1 joule of work is required.
The potential difference across a conductor is measured by means of an instrument called the "voltmeter."

(ii) The electric power P is given by

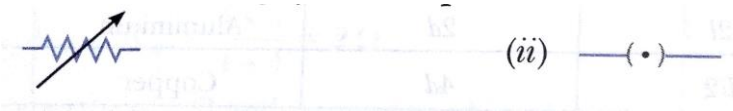
$$P = I^2 R$$

The resistance of the heating element is very high. Large amount of heat generates in the heating element and it glows hot.
The resistance of connecting cord is very low. Thus, negligible heat generates in the connecting cord and it does not glow.

(iii) (a) Silver is a better conductor due to its lower resistivity.
(b) Nichrome should be used in electrical heating devices due to very high resistivity.

Q.2. (a) Name an instrument that measures electric current in a circuit. Define the unit of electric current.

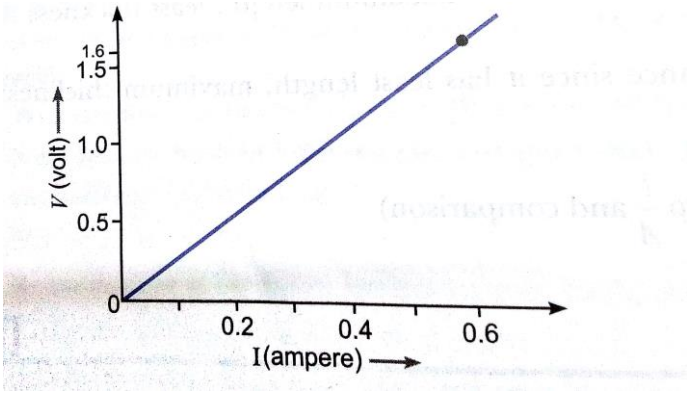
(b) What do the following symbols represent in a circuit diagram?



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

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

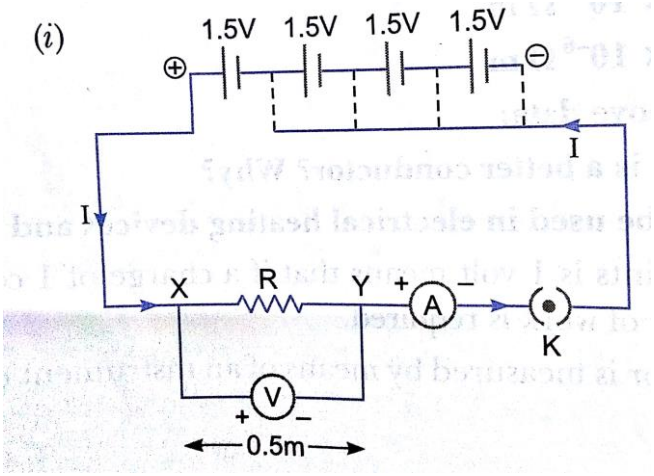
(ii) Following graph was plotted between V and I values using above circuit:



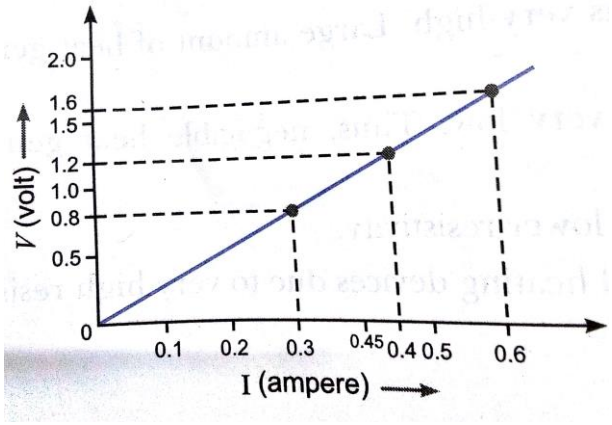
What would be the values of $\frac{V}{1}$ ratios when the potential difference is 0.8 V, 1.2 V and 1.6 V respectively? What conclusion do you draw from these values?

Ans. (a) An instrument that measures electric current in a circuit is called "ammeter". The unit of electric current is ampere (A). 1 ampere is constituted by the flow of 1 coulomb of charge through any point in an electric circuit in 1 second.

Variable resistance or rheostat Plug key or switch (closed)



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



At potential difference 0.8V,

$$\frac{V}{I} = \frac{0.8}{0.3} = \frac{8}{3} \qquad \text{.....(1)}$$

At potential difference 1.2 V,

$$\frac{V}{I} = \frac{1.2}{0.45} = \frac{8}{3} \qquad \text{..... (2)}$$

At potential difference 1.6 V,

$$\frac{V}{I} = \frac{1.6}{0.6} = \frac{8}{3} \qquad \text{..... (3)}$$

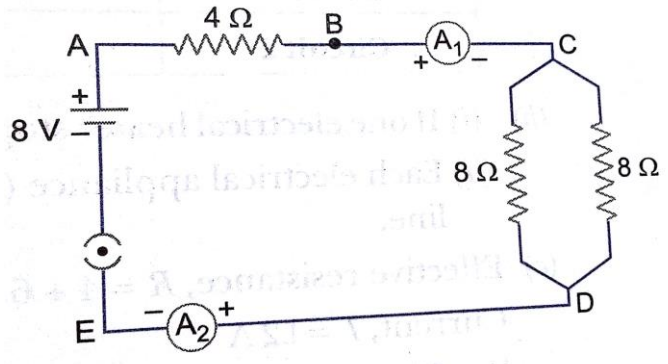
Conclusion: If I be the current through XY resistor and V be the potential difference across it, then the ratio $\frac{V}{1}$ constant.

⇒ V ∞ I and Ohm's

Law is obeyed.

Q. 3. Find out the following in the electric circuit given in figure alongside:

(a) Effective resistance of two 8 Ω resistors in the combination
(b) Current flowing through 4 Ω resistor
(c) Potential difference across 4 Ω resistance
(d) Power dissipated in 42 resistor
(e) Difference in ammeter readings, if any



Ans. (a) $R = \frac{R_1 R_2}{R_1 R_2} = \left(\frac{8\ x\ 8}{8+8}\right) = 4\Omega$

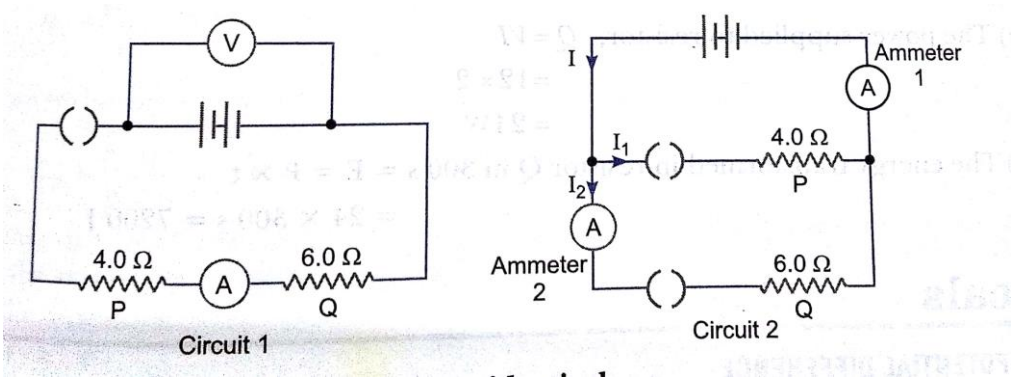
(b) $I = \frac{V}{R} = \frac{8}{4+\left(\frac{8x8}{8+8}\right)} = \frac{8}{8} = 1A$

(c) V = I R = 1 x 4 = 4V

(d) $P = I^2 R = 1^2$ x 4 = 4W

(e) No difference, same current flows through each element in a series circuit.

Q. 4. Figure shows two electrical circuits.



The batteries in circuit 1 and circuit 2 are identical.

(a) Put ticks in the table below to describe the connections of the two resistors P and Q.

	Series	**Parallel**
Circuit 1		
Circuit 2		

(b) The resistor P and Q are used as small electrical heaters.
State two advantage of connecting them as shown in circuit 2.
(c) In circuit 1, the ammeter reads 1.2A when the switch is closed.
Calculate the reading of the voltmeter in this circuit.
(d) The two switches in circuit 2 are closed. Calculate the combined resistance of the two resistors in this circuit.
(e) When the switches are closed in circuit 2, ammeter 1 reads 5 A and ammeter 2 reads 2A. Calculate
(i) the current in resistor P,
(ii) the power supplied to resistor Q,
(iii) the energy transformed in resistor Q in 300s.

Ans. (a)

	Series	Parallel
Circuit 1	✓	
Circuit 2		✓

(b) (i) If one electrical heater stops working due to some defect then other keeps working normally.

(c) Effective resistance, R = 4 + 6 = 10Ω
Current, I = 1.2 A
V = IR = 1.2 x 10 = 12 V
Voltmeter reading = 12 V

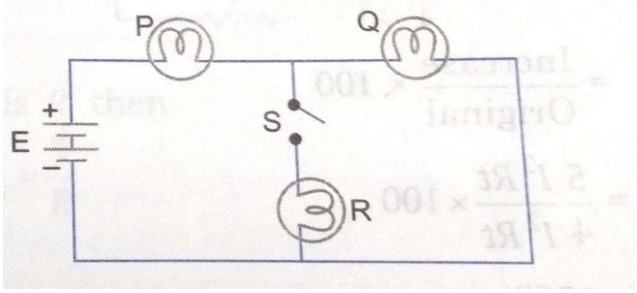
(d) Combined resistance,

$$R_P = \frac{R_1 R_2}{R_1 + R_2} = \frac{4\ x\ 6}{4 + 6} = \frac{24}{10} = 2.4\Omega$$

(e) Current I = 5 A
I_2 = 2 A
(i) The current in resistor P = $I_1 = I - l_2$
= 5A – 2A
= 3A
(ii) The Power supplied to resistor, Q = VI
= 12 x 2
= 24 W
(iii) The energy transformed in resistor Q in 300 s = E = P x t
= 24 x 300s = 7200 J

HOTS (Higher Order Thinking Skills)

Q.1. A battery E is connected to three identical lamps P, Q and R as shown in figure:

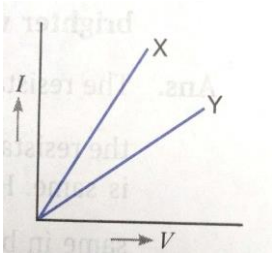


Initially the switch S is kept open and the lamp P and Q are observed to glow with some brightness.
Then switch S is closed.
How will the brightness of glow of bulbs P and Q will change? Justify your answer.

Ans. The brightness of glow of bulb P will increase and brightness of glow of bulb Q will decrease. This is because on closing S, bulbs Q and R will be in parallel and the combination will be in series with bulb P. Hence the total resistance of the circuit will decrease and the current flowing in the circuit will increase. Therefore, the glow of bulb P will increase.
Also since bulbs Q and R will be in parallel in this case, the current gets divided and lesser current flows through Q and hence the glow of bulb Q will decrease.

Q.2. V-I graph for the metallic wires X and Y at constant temperature are as shown in figure:

Assuming that the two wires have same length and same diameter, explain as to which of the two wires has higher resistivity and why?



Ans. The slope $\frac{I}{V}$ of the graph represents $\frac{1}{R}$. since the graph marked Y has lesser slope, it represents higher resistance.
Since the length and diameter of the two wires is same, using the relation $R = \rho\frac{1}{A}$, the resistively of wire Y will be higher.

Q.3. Why is an ammeter likely to be burnt out if it connected in parallel in a circuit?

Ans. The resistance of an ammeter is very low. If an ammeter is connected in parallel, the resultant resistance of the circuit decreases and excessive current passes through the instrument. Hence, the ammeter is likely to be burnt out.

Q.4. Current I flowing through a resistor results in dissipation of power P. By what percentage will the power dissipated in the resistor increase if the current through the resistor is increased by 50%? Justify your answer with the help of mathematical calculations?

Ans. The power dissipated in the resistor will increase by 125%.

$$P = I^2Rt$$

When I is increase by 50%, I becomes $\frac{3}{2}L$.

Hence, $P' = \left(\frac{3}{2}l\right)^2 Rt = \frac{9}{4}I^2\,Rt$

Increase in power dissipation $= \frac{9}{4}I^2\,Rt - I^2\,Rt$

$$= \frac{5}{4}I^2\,Rt$$

Percentage increase $= \frac{Increase}{Original} \times 100$

$$= \frac{5}{4}\frac{I^2\,Rt}{4\,I^2\,Rt} \times 100$$

Q.5. What are the possible values of resistances which one can obtain by using resistor of values 2Ω , 3 Ω and 6Ω? Justify your answer.

Ans. The following combinations can be obtained:

(i) The individual resistances: 2 Ω, 3 Ω, 6 Ω
(ii) All in series: 11 Ω
(iii) All in parallel: 1 Ω
(iv) Three different possible mixed grouping of resistors: $4\Omega, \frac{9}{2}\ \Omega, \frac{36}{5}\ \Omega$.

Q.6. Out of two electric bulbs of W – 220 V and 100W - 220 V. Which one will glow brighter when they are connected (i) in series, and (ii) in parallel?

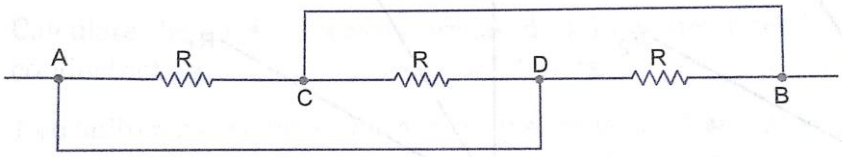
Ans. The resistance if the bulb is defined as$R = \frac{V^2}{P}$. So the resistance of 50 W bulb is double than the resistance of 100 W bulb. When they are connected in series the current through both bulbs is same. Hence 50 watt bulb will be brighter because P = I^2 R. In parallel, the voltage will be same in both bulbs. So, the 100 watt bulb will be brighter because $P = \frac{V^2}{R}$.

Q.7. Given n resistors each of resistance R, how will you combine them to get the (i) maximum; and (ii) minimum effective resistance? What is the ratio of maximum to minimum resistance?

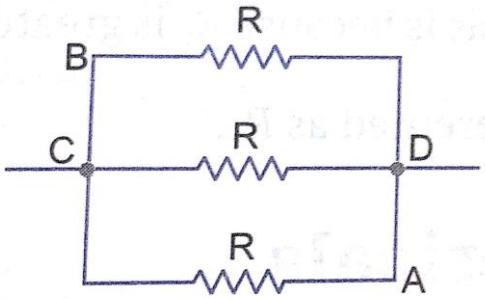
Ans. For maximum effective resistance, the resistors must be connected in series combination. If then are n resistors each of resistance R, then the maximum effective resistance = nR
For minimum effective resistance, the resistors must be connected in parallel combination. So, the minimum effective resistance $= \frac{R}{n}$

Ratio of the maximum to minimum resistance is $\frac{nR}{(R/n)} = n^2 : 1$.

Q.8. What is the resistance from A to B in the network shown in the figure?



Ans. The point C is connected to B and the point D is connected to A. Therefore, three identical resistors, each having resistance R, are connected in parallel and the equivalent circuit diagram is shown in the figure.

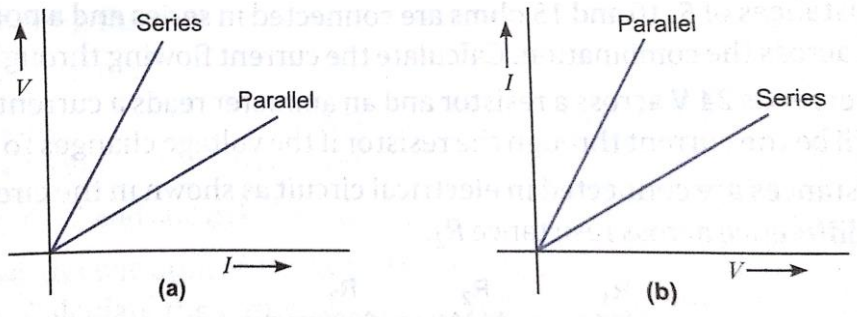


If the equivalent resistance is R' then

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

Or $$R' = \frac{R}{3}$$

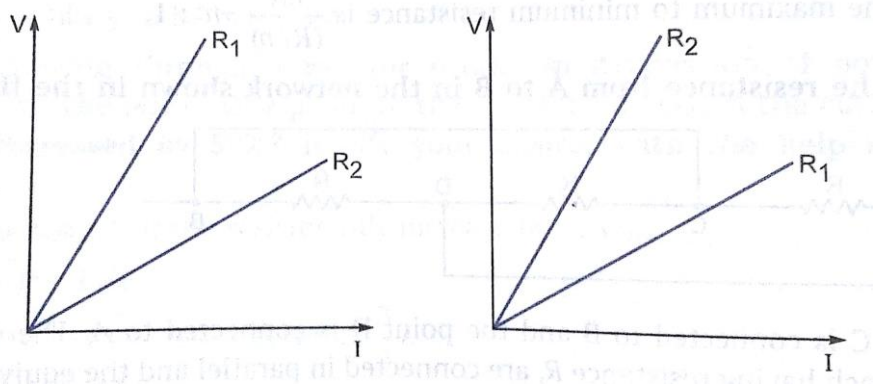
Q.9. Two students perform the experiment on series and parallel combinations of two given resistors R_1 and R_2 and plot the following V – I graphs (a) and (b). Which of the graphs is (are) correctly labelled in terms of the words 'series' and 'parallel'? Justify your answer.



Ans. (a) Slope $\frac{V}{I}$ = Resistance R

As larger resistance represented series combination and smaller resistance the parallel combination. Therefore, graph of greater slope represented series combination and hence it is correctly labelled.

Q.10 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.



Ans. As $R_1 > R_2$

Therefore, figure (a) is correct. This is because R_1 is greater so the slope of V – 1 graph $\left(\frac{V}{1}\right)$ is greater in figure (a) and is correctly represented as R_1.

Value Based Questions

Q. 1. One day the science teacher was teaching in her class, one of her student seemed very sad. The teacher asked her the reason. She told the teacher that a mishap took place in her locality where four members of a family died as they were trying to steal electricity by connecting a conducting wire with the live wire on the street.

Answer the following questions based on the situation given above.
(i) Do you think this practice of electricity theft is good?
(ii) What advice would you like to give to improve such mind-set?

Ans. (i) No, electricity theft is not good.

(ii) Proper connection, billing, safety measure can save both property and life which is more precious. People should become responsible citizens and should not be involved in any unlawful and risky events like electric theft, etc.

Q. 2. Mukesh returns home from the hostel during vacation. He notices that member of his family are very carefree about use of electric energy at home and often leave the lights, fan or the refrigerator on, even when not required. He talks to his family members at the dinner table and requests them to be more careful about use of electrical energy and the impact of excessive use of this energy on environment.

Answer the following questions based on the above information:
(i) Write two adverse effects of wastage of electrical energy on environment.
(ii) Which two values are reflected in Mukesh's thoughts and actions.
(iii) Mention one more action which Mukesh may take to convey his message of avoiding wastage of electrical energy to members of society.

Ans. (i) (a) Use of coal or nuclear fuel to generate electricity and resulting environmental pollution.

(b) Emission of harmful gases by air-conditioners, a refrigerators and its harmful effect on environment.

(ii) (a) Common good/avoidance of wastage of energy.

(b) Environmental care.

(iii) Comparison of monthly bills for electrical energy consumption and creating awareness about minimising the same. Thus saving energy as well as the environmental protection.