Board – CBSE	Class – 10th	Topic – Electricity

1. What does an electric circuit mean?

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

2. Define the unit of current.

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

3. Calculate the number of electrons constituting one coulomb of charge.

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

∴ 1 C of charge is contained in

$$\frac{1}{1.6\times10^{-19}} = 6.25\times10^{18} = 6\times10^{18}\ electrons$$

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

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

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

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

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

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

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

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

Work Done = Potential Difference × charge

Where,

Charge = 1 C

Potential difference = 6 V

Work Done = $6 \times 1 = 6$J

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

7. On what factors does the resistance of a conductor depend?

Ans. The resistance of a conductor depends upon the following factors.

(a) Length of the conductor

(b) Cross-sectional area of the conductor

(c) Material of the conductor

(d) Temperature of the conductor

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

Ans. Resistance of a wire, $R = \rho\frac{1}{A}$

Where, ρ = Resistivity of the material of the wire

l = Length of the wire

A = Area of a cross-section of the wire

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

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

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

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

V = IR

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

Where,

Resistance of the electrical component = R

Potential difference = V

Current = I

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

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

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

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

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

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

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

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

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

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

12. Use the data in Table 12.2 to answer the following –

Table 12.2 Electrical resistivity of some substances at 20°C

-	**Material**	Resistivity (Ωm)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
	Constantan	49×10^{-6}
Alloys	Manganin	44×10^{-6}

	(an alloy of Cu, Mn and Ni)	
	Nichrome (an alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
	Glass	$10^{10}\times10^{14}$
Insulators	Hard rubber	$10^{13}\times10^{16}$
	Ebonite	$10^{15}\times10^{17}$
	Diamond	$10^{12}\times10^{13}$
	Paper (dry)	10^{12}

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

(b) Which material is the best conductor?

Ans. (a) The Resistivity of iron $= 10.0\times10^{-8}\ \Omega\, m$

The Resistivity of mercury $= 94.0\times10^{-8}\Omega\, m$

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

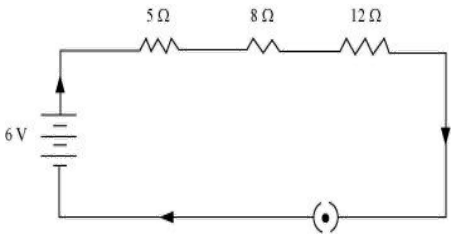
(b) It can be observed from Table 12.2 that the Resistivity of silver is the lowest among the listed materials. Hence, it is the best conductor.

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

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

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

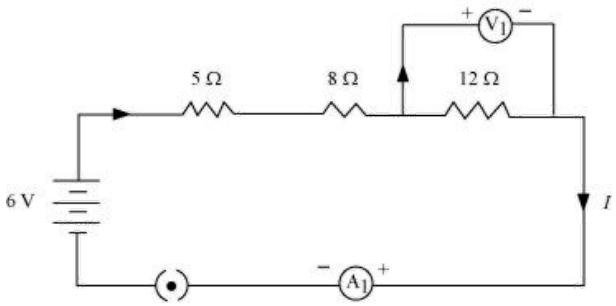
Ans. Three cells of potential 2 V, each connected in series, is equivalent to a battery of potential 2 V + 2 V + 2 V = 6V.



The following circuit diagram shows three resistors of resistances 5 Ω, 8 Ω and 12 Ω respectively connected in series and a battery of potential 6 V.

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

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



The resistances are connected in series.

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

V = IR,

Where,

The potential difference, V = 6 V

Current flowing through the circuit/resistors = I

Resistance of the circuit, R = 5 + 8 + 12 = 25 Ω m

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

The potential difference across 12 Ω resistor = V_1

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

Therefore, using Ohm's law, we obtain

$V_1 = IR = 0.24 \times 12 = 2.88\ V$

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

The reading of the voltmeter will be 2.88 V.

15. Judge the equivalent resistance when the following are connected in parallel –

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

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

Let R be the equivalent resistance.

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

Therefore, equivalent resistance $\approx 1\ \Omega$

(b) When $1\ \Omega,\ 10^3\ \Omega,\ 10^6\ \Omega$and is connected in parallel.

Let R be the equivalent resistance.

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

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

Therefore, equivalent resistance $= 0.999\ \Omega$

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

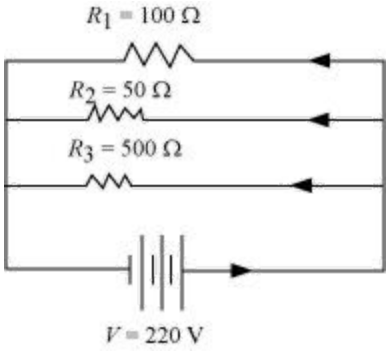
Ans. Resistance of electric lamp, $R_1 = 100\ \Omega$

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

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

The voltage of the source, $V = 220$ V

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



Let R be the equivalent resistance of the circuit.

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

$= \frac{1}{100} + \frac{1}{50} + \frac{1}{500}$

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

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

According to Ohm's law,

V = IR

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

Where,

Current flowing through the circuit = I

$I = \frac{200}{\frac{500}{16}} = \frac{220\times16}{500} = 7.04A$

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

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

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

V = IR'

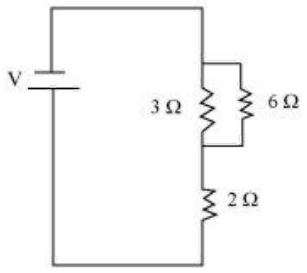
$R' = \frac{V}{I} = \frac{220}{7.04} = 31.25\ \Omega$

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

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

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

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



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

Therefore, their equivalent resistance will be given by

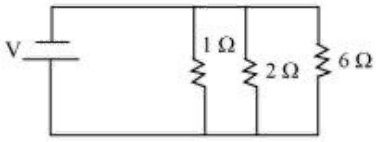
$\frac{1}{\frac{1}{6}+\frac{1}{3}} = \frac{6\times3}{6+3} = 2\Omega$

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

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

Hence, the total resistance of the circuit is 4Ω.

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



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

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

Therefore, the total resistance of the circuit is 1 Ω.

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

Ans. There are four coils of resistances4Ω, 8Ω, 12 Ω, and 24 Ω respectively.

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

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

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

Therefore, 2 Ω is the lowest total resistance.

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

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

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

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

H = VIt

Where,

Voltage, V = 50 V

Time, t = 1 h = 1 × 60 × 60 s

Amount of current, $I = \frac{Amount\ of\ charge}{Time\ of\ flow\ of\ charge} = \frac{96000}{1\times60\times60} = \frac{80}{3}\ A$

$H = 50\times\frac{80}{3}\times60\times60 = 4.8\times10^{6}J$

Therefore, the heat generated is $4.8\times10^{6}J$.

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

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

H = VIt

Where,

Current, I = 5 A

Time, t = 30 s

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

$H = 100\times5\times30 = 1.5\times10^{4}\ J$

Therefore, the amount of heat developed in the electric iron is $1.5\times10^{4}J$.

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

Ans. The expression gives power (P),

P = VI

Where,

Voltage, V = 220 V

Current, I = 5 A

P = 220 × 5 = 1100 W

Energy consumed by the motor = Pt.

Where, Time, t = 2 h = 2 × 60 × 60 = 7200 s

∴ P = 1100 × 7200 = $7.92 \times 10^{6}J$

Therefore, power of the motor = 1100 W

Energy consumed by the motor = $7.92 \times 10^{6}\ J$