Electricity: In-Text Questions

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Q.1 What does an electric circuit mean?
Sol. A continuous closed path which is made up of electric components through which an electric current can flow, known as an electric circuit. These electric components are conductors, cell, switch, connective wire etc.

Q.2 Define the unit of current.
Sol. SI unit of electric current is ampere (A).
Ampere is defined as the flow of electric charges through a cross section area at the rate of one coulomb per second.

Q.3 Calculate the number of electrons constituting one coulomb of charge.
Sol. ***Since,*** 1 electron have charges = 1.6×10^{-19} coulomb
So, 1.6×10^{-19} C of charge have the number of electrons = 1 electron
1 C of charge has the number of electrons = $\frac{1}{1.6 \times 10^{-19}}$ Electrons
= $\frac{10^{19}}{1.6}$ electrons = 6.25×10^{18} electrons

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Q.1 Name a device that helps to maintain a potential difference across a conductor.
Sol. Battery or a cell helps to maintain a potential difference across a conductor

Q.2 What is meant by saying that the potential difference between two points is 1 V?
Sol. The potential difference between two points is 1 V, this means that 1 joule of work is done to move 1 coulomb electric charge from one point to another point.

Q.3 How much energy is given to each coulomb of charge passing through a 6 V battery?
Sol. Given: Charge Q = 1C
Potential difference, V = 6V
Since, energy will be equal to work done, W:
We know that, V = W/Q
Therefore, 6V = W/1C
⇒ W = 6V × 1C = 6J
So, required energy to each coulomb of charge passing through a 6 V battery = 6J

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Q.1 On what factors does the resistance of a conductor depend?
Sol. The **factors on which the resistance of a conductor depends are:**
(i) Nature of materials,
(ii) Length of conductor
(iii) Cross section area of conductor

Q.2 Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

Sol. The current will flow easily through a thick wire compared to a thin wire of the same material. Since, resistance is inversely proportional to the cross section area. Large cross section area provides less resistance to flow of current. So, current will flow more easily through tick wire.

Q.3 Let the resistance of an electrical component remain 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?

Sol. According to ohm's law, potential difference across the conductor is directly proportional to current flowing through it.

Resistance (R) $= \frac{\text{Potential Difference (V)}}{\text{Electric current (I)}}$

R = Constant

Potential difference α Electric current

If potential difference between two ends of the conductor decreases to halved, and resistance remains constant, then electric current would also be halved.

Q.4 Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Sol. For more production of heat, the high melting point of conductors is required. The alloys of metal have higher melting points than pure metals. Therefore, to get more heat, alloy is used rather than pure metal in electrical heating devices like bread-toaster, electric iron, etc.

Q.5 Use the data in Table 12.2 to answer the following –
(a) Which among iron and mercury is a better conductor?
(b) Which material is the best conductor?

Sol. (a) Iron is a better conductor because iron has low resistivity that mercury.
(b) Silver is the best conductor it has lowest resistivity.

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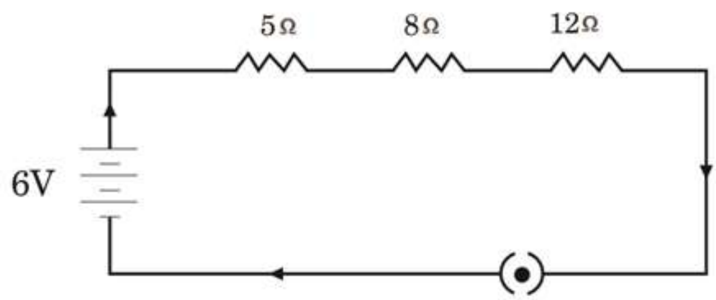
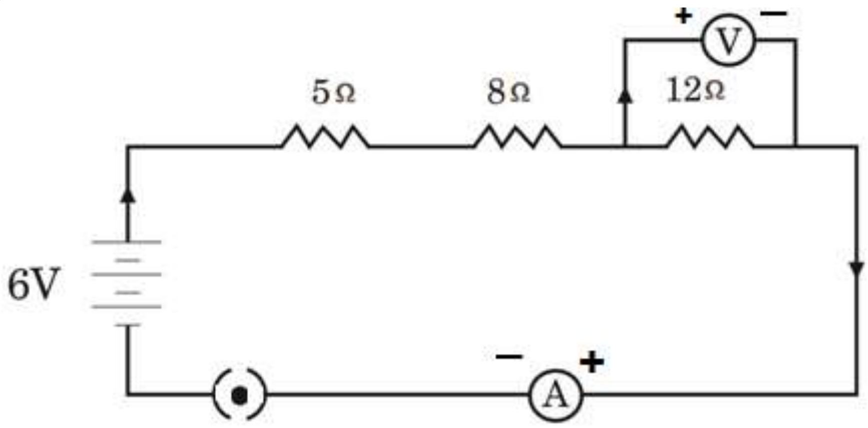
Q.1 Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.

Sol. A schematic diagram of a circuit:



Q.2 Redraw the circuit of Question 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?

Sol.



The total resistance or equivalent resistance in the circuit:

$R_{eq.}$ = 5 Ω + 8 Ω + 12Ω

= 25 Ω

According to ohm's law:

R = V / I

Or, 25Ω = 6V / I

Or, I = 6V / 25Ω = 0.24A

All the resistances are connected in series, thus electric current remains same in all resistors.

So, Electric current through 12Ω resistance, I = 0.24A

Resistance, R = 12Ω

Potential difference across the resistor of 12Ω, V = I x R

V = 0.24A x 12Ω = 2.88 V

Thus, reading of ammeter = 0.24A

Reading of voltmeter across resistor of 12Ω = 2.88V

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Q.1 Judge the equivalent resistance when the following are connected in parallel – (a) 1 Ω and 106 Ω, (b) 1 Ω and 103 Ω, and 106 Ω.

Sol.

Since Equivalent resistance, when resistance are connected in parallel,

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots . \frac{1}{R_n}$$

(a) 1 Ω and 106 Ω

Thus, $\frac{1}{R_{eq}} = \frac{1}{1} + \frac{1}{106} = \frac{106+1}{106}$=107/106

Thus, R_{eq} = 106 / 107 = 0.99Ω

Therefore, equivalent resistance of 1Ω and 106Ω are connected in parallel is 0.99Ω.

(b) 1 Ω and 103 Ω, and 106 Ω

Thus, $\frac{1}{R_{eq}} = \frac{1}{1} + \frac{1}{103} + \frac{1}{106} = \frac{10918+106+103}{103x106}$

Thus, R_{eq}=10918 / 11127Ω = 1.02Ω

Therefore, equivalent resistance of 1 Ω, 103 Ω and 106 Ω are connected in parallel is 1.02Ω.

Q.2 An electric lamp of 100 Ω, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω are connected in parallel to a 220 V source.
What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances, and what is the current through it?

Sol.
Given: Resistance of electric lamp $R_1 = 100\Omega$,
Resistance of toaster $R_2 = 50\ \Omega$,
Resistance of water filter $R_3 = 500\ \Omega$
All these devices are connected in parallel.
Potential difference, V = 220V
Therefore equivalent resistance R_{eq}:
$\frac{1}{R_{eq}} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500} = \frac{5+10+1}{500}$=16 / 500
Therefore, R_{eq} = 500 / 16 = 31.25Ω
Therefore required resistance of electric iron = Equivalent resistance of three appliances = 31.25

According to ohm's law, electric current (I) = V / R
⇒ I = 220V / 31.25Ω = 7.04A

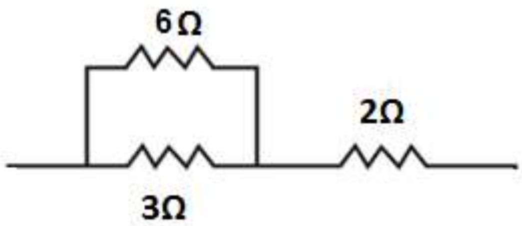
Since it takes same current as flow in the circuit of three appliances connected in parallel.
Thus, electric current through the electric iron = 7.04A
Resistance of electric iron = 31.25 Ω

Q.3 What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Sol. The advantages of connecting electrical devices in parallel instead of connecting in series are:
(a) Voltage remains same across all the devices.
(b) Devices connected in parallel circuit, reduce the equivalent resistance of the circuit.
(c) In parallel circuit, if any electrical device stops working due to some defect, then all other devices will keep working normally.

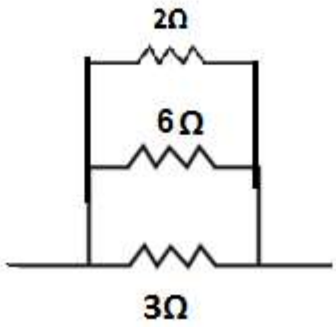
Q.4 How can three resistors of resistances 2 Ω, 3 Ω, and 6 Ω be connected to give a total resistance of (a) 4 Ω, (b) 1 Ω?

Sol. Given Three resistors of resistance= 2 Ω, 3 Ω, and 6 Ω
(a) For getting total resistance 4Ω: When resistors of resistance 3 Ω and 6 Ω are connected in parallel and one resistor of resistance 2 Ω is connected in series as shown in figure.



Let total resistance due to resistors having resistance equal to 6 Ω and 3 Ω = R_1
Therefore, $\frac{1}{R_1} = \frac{1}{3} + \frac{1}{6}$ = 3 / 6 = 1 / 2
Thus R_1=2Ω
This R_1 is connect in series with 2 Ω resistor.
Now, total effective resistance in the circuit = R_1 + 2 Ω = 2 Ω + 2 Ω = 4 Ω

(b) **For getting total resistance 1Ω:** When all the three resistance is connected in parallel as shown in figure.



Then

$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$ = 6 / 6Ω = 1Ω

Thus, Total resistance of the circuit R = 1Ω

Q.5 What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4 Ω, 8 Ω, 12 Ω, 24 Ω?

Sol. Given: four coils of resistance 4 Ω, 8 Ω, 12 Ω and 24 Ω.

(a) When all the resistors are connected in series, then we get the highest total resistance:

Thus, total resistance = 4 Ω + 8 Ω + 12 Ω + 24 Ω = 48 Ω

So, the highest resistance = 48Ω

(b) When all the resistors are connected in parallel, then we get the lowest total resistance:

Then the $\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{12} = \frac{6+3+2+1}{24}$ =12 / 24Ω = 1 / 2Ω

R = 2 Ω

So, lowest resistance = 2 Ω

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Q.1 Why does the cord of an electric heater not glow while the heating element does?

Sol. The heating element of an electric heater is made of an alloy nichrome which has a very high resistance as compare to the cord of an electric heater. Since, heat produced in circuit is given by I^2Rt, which is directly proportional to the resistance, thus element of electric heater glows because of production of more heat.

Q.2 Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Sol.

Given: Potential difference, V = 50V

Charge, Q = 96000 coulomb

Time, t = 1 hour = 60 X 60 s = 3600 s

then, heat produced:

Since, electric current (I) = Q / t = 96000C / 3600s = (96000 / 3600) A

Now, heat produced (H) in the time (t) is = VIt

$$H = 50V \times \frac{96000}{3600} A \times 3600s$$

$$= 50 \times 96000 J$$

$$= 4800000 J = 4.8 \times 10^6 \text{ Joule}$$

Q.3 An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Sol. Given: Electric current, I = 5A,
Resistance of electric iron, R = 20 Ω,
Time, t = 30s
Therefore, Heat produced (H):
Since, $V = I \times R = 5A \times 20\Omega = 100V$
Now, Heat produced, H = VIt
$\Rightarrow H = 100V \times 5A \times 30s = 15000J = 1.5\times10^4 J$.

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Q.1 What determines the rate at which energy is delivered by a current?

Sol. The rate at which energy is delivered by a current is the power of electric device.

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

Sol. Given: Electric current, I = 5A
Potential difference, V = 220V
Time, t = 2h = 2 x 60 x 60 s = 7200 s
The Power, P:
And energy consumed:
Since, $P = VI = 220V \times 5A = 1100W$
As we know that energy consumed by the electric appliance in t time = P × t
⇒So, Energy consumed by electric device:

$$E = 1100\ W \times 7200\ s = 7920000\ J = 7.92 \times 10^6\ J$$