QB365

Important Questions - Current Electricity

12th Standard CBSE

Physics

Reg.No. :

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) Is electric current a vector or scalar quantity? Explain. **1**

2) If the electric current is passed through a nerve, the man is excited, why? **1**

3) A steady current is flowing in a cylindrical conductor. Is there any electric field within the conductor? **1**

4) How can you keep a constant current inside a conductor? **1**

5) How does the drift velocity of electrons in a metal conductor vary with the increase in temperature? **1**

6) If the temperature of a good conductor increases, how does the relaxing time of electrons in the conductor change? **1**

Section-B

7) How is the current conducted in metals? Explain. **2**

8) A conductor of length L is connected to a dc source of emf ϵ. If this conductor is replaced by another conductor of the same material and same area of cross-section but of length 3 L, how will the draft velocity change? **2**

9) If the current flowing in a copper wire be allowed to flow in another copper wire of the same length but of double the radius, then what will be the effect on the drift velocity of the electrons. If the same current is allowed to flow in an iron wire of the same thickness, then? **2**

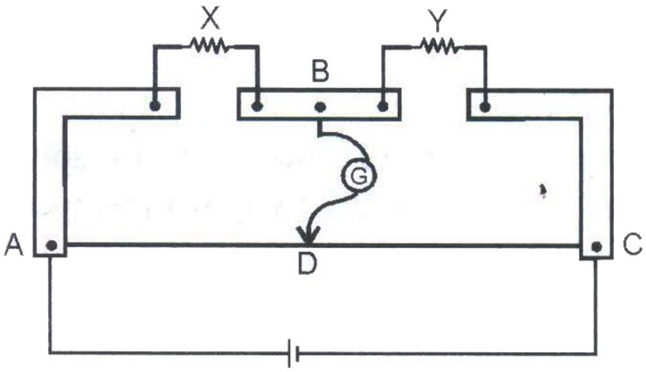
10) Write the mathematical relation between mobility and drift velocity between mobility and drift velocity of charge carriers in a conductor. Name the mobile charge carriers responsible for conduction of electric current in (a) an electrolyte (b) an ionised gas. **2**

11) If the resistance of our body is so large ($\approx 10\ k\Omega$) why does one experience a strong shock when one accidently touches the line wire, say a 240 volt supply? **2**

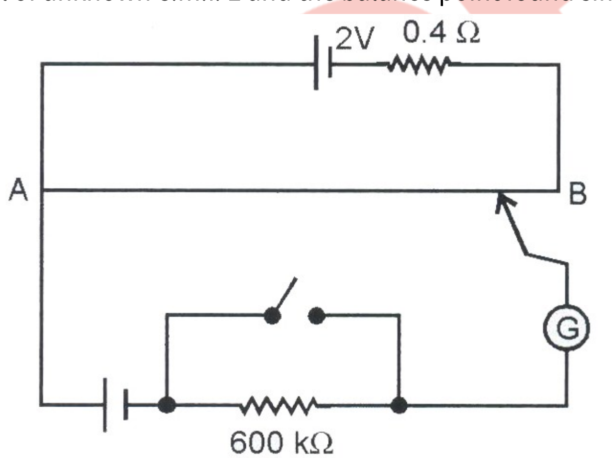
12) There is an impression among many people that a person touching a high power line gets stuck with the line. Is that true? Explain. **2**

Section-C

13) (a)In a meter bridge shown below the balance point is found to be at 39.5 cm from the end A, when the resistor Y is of 12.5Ω. Determine the resistance of X. Why are the connections between resistors in a wheatstone or meter bridge made of thick copper strips? (b)Determine the balance point of the bridge above if X and Y are interchanged. (c)What happens if the galvanometer and cell are interchanged at the balance point of the bridge? Would the galvanometer show any current? 3

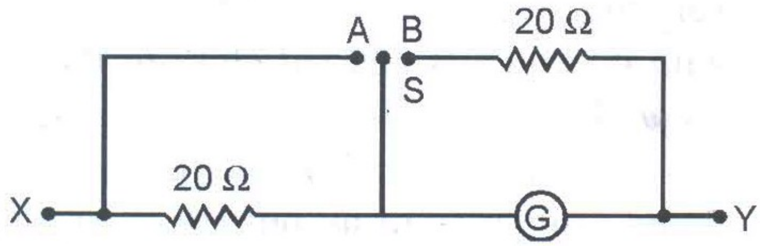


14) Figure shows a potentiometer with a cell of 2.0V and internal resistance of 0.40Ωmaintaining a potential drop across the resistor wire AB. A standard cell which maintains a constant e.m. of 1.02V (for very moderate currents upto a few mA) gives a balance point at 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell a very high resistance 600kΩ is put in series with it Which is shorted cell is then replaced by a cell of unknown e.m.f. E and the balance point found similarly, turns out to be at 82.3 cm length of the wire. 3

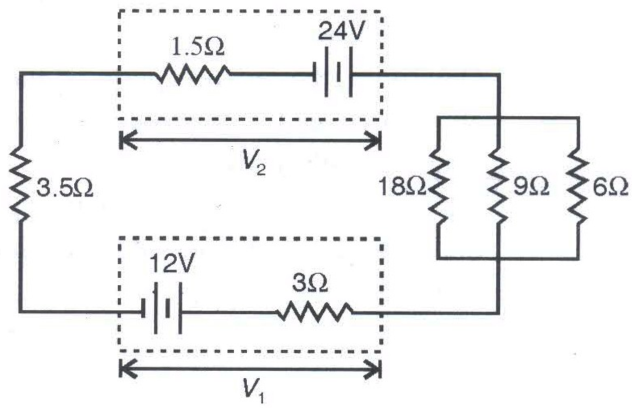


(a)What is the value E? (b)What purpose does the high resistance o 600kΩhave? (C)Is the balance point affected by this high resistance? (d)Is the balance point affected by the internal resistance of 600kΩhave? (e)Would the method work in the above situation if the driver cell of the potentiometer had an e.m.f. of 1.0V instead of 2.V? ()Would the circuit work well for determining an etremely small e.m.f. say of the order of a few mV(such as the typical e.m.f. of a thermo-couple)? If not how will you modiy the circuit?

15) The galvanometer in the circuit shown here has a resistance of 20Ω The terminals X and Y are connected to a cell of e.m.f. 1.5V and internal resistance 10Ω Calculate the current flowing in the galvanometer: (i)When the switch S is in position. (ii)When the switch S is in position B. **3**



16) A 24V battery o internal resistance 1.5Ωis connected to three coils 18Ω,9Ω and 6Ω in parallel, a resistor of 3.5 Ω and a reserved battery(e.m. =12V and internal resistance =3Ω) as shown. Calculate (i)the current in the circuit (ii)current in resistor of 18Ω coil and (iii)p.d. across each battery. **3**



Section-D

17) A room has AC run for 5 hours a day at a voltage of 220 V. The wiring of the room consists of Cu of 1mm radius and a length of 10m. Power consumption per day is 10 commercial units. What fraction of it goes in the joule heating in wires? What fraction of it goes in the joule heating in wires? What would happen if the wiring is made of aluminium of the same dimensions? **5**

18) (a) Define electric current. What is its S.I. unit? Is it a scalar or a vector quantity? What is the direction of electric current? (b) How many electrons flowing per second should flow to produce a current of 1A? **5**

19) (a) State Ohm's law. (b) Define resistance. Give its SI unit. **5**

20) How will you establish the electrons carry current? **5**

****

Section-A

1) **1**

Electric current is a scalar quantity because it does not follow the laws of vectors addition, i.e., the angle between the wires carrying the current does not affect the total current in the circuit.

2) The man is excited due to the transfer of electric energy to his body. **1**

3) **1**

Yes. A steady current in a cylindrical conductor if electric force is acting on free electrons which make the electrons to move in a particular direction. It is possible due to electric field within the conductor.

4) **1**

A constant current can be kept inside a conductor by maintaining a constant potential difference across the two ends of conductor.

5) **1**

With the increase in temperature, the drift velocity of free electrons in a metal conductor decreases due to increase in collision frequency of free electrons with the atom/ions of the conductor.

6) **1**

With the increase in temperature, the free electrons collide more frequently with the ions/atoms of conductor, resulting decrease in relaxation time.

Section-B

7) **2**

Every metal conductor has a large number of free electrons which move at random at room temperature. Their average thermal velocity at any instant is zero. When a pot. When a pot. diff. is applied across the ends of the conductor, an electric field is set up in the conductor. Due to it, the free electrons of the conductor experience force due to the electric field and drift towards the positive end of the conductor, causing the electric current in the conductor. The direction of conventional current is opposite to the direction of motion of the free electrons in the conductor.

8) Drift velocity, **2**

$v_d = \frac{I}{neA} = \frac{V/R}{neA} = \frac{V/(\rho L/A)}{neA}$

or $v_d = \frac{V}{n\rho eL}$ or $v_d \propto \frac{1}{L}$

$\frac{v'_d}{v_d} = \frac{L}{3L} = \frac{1}{3}$

or $v'_d = \frac{v_d}{3}$

9) **2**

We know that if two wires are in series, there will be the same current in each wire. The current I through the wire is related with drift velocity v_d by the relation

$I = nAev_d$ or Av_d = a constant

or $v_d \propto \frac{1}{A}$ or $v_d \propto \frac{1}{\pi r^2}$

Since in the second wire, the radius of wire becomes 2 times hence the drift velocity will become one-fourth. In the case of iron wire, the number density of free electrons will be less in comparison to copper wire and hence the drift velocity will be more in comparison to that in copper wire.

10) Mobility, $\mu = \frac{drift\ velocity}{electric\ field} = \frac{v_d}{E}$ **2**

(a) The charge carriers in an electrolyte are positive and negative ions.

(b) The charge carriers in an ionised gas are electrons and positively charged ions.

11) **2**

When a person accidently touches the line wire of a 240 V supply, a current I = 240/10000 = 0.024 A = 24 mA, flows through the body of the person. This current interferes with the nerve process related to our heart beating, which is basically electrical in nature, this, in turn, accounts for a strong shock.

12) **2**

This impression is misleading. In fact, there is no special attractive force that keeps a person stuck with a high power line while touching that wire, whereas a current of few milliampere is enough to disorganise our nervous system. As a result of it, the affected person loses temporarily his ability to exercise his nervous control to get himself free from the high power line.

Section-C

13) (a)X=8.2Ω (b)60.5 cm from A (c)No deflection **3**

14) (a)E=1.25V **3**

15) (i)0.05A (ii)0.01875A **3**

16) (i) I=12/11 A (ii)I_1=2/11 A (iii)V_2=246/11 V (iv)V_1=168/11 V **3**

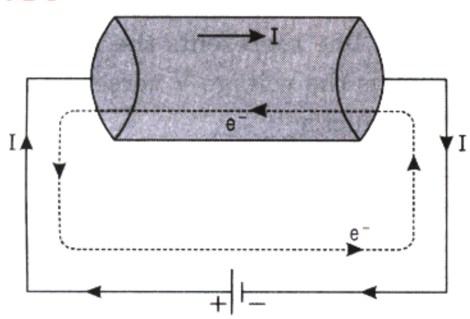
Section-D

17) **5**

Power consumption per day=10 kWh Time for which ac run per day= 5h
$P=\frac{10}{5}=2kW=2000W=2000Js^{-1}$ $I=\frac{P}{V}=\frac{2000}{220}=\alpha A$ Power loss in copper wire
$P_{cu}=R_{cu}I^2=\rho\frac{l}{A}I^2$ $=1.7\times10^{-8}\times\frac{10}{\pi\times10^{-6}}\times9^2=4Js^{-1}$ Fraction of power loss in Cu wire=
$\frac{4}{2000}$ $=\frac{2}{1000}\times100=2$ Power loss in Al wire $P_{Al}=\frac{\rho_{Al}lI^2}{\pi r^2}=\frac{2.7\times10^{-8}\times10}{\pi\times(10^{-3})^2}\times9^2=6.4Js^{-1}$ Power loss in Al wire=$\frac{6.4}{1000}\times100=0.32\%$

18) **5**

(a) Electric current: The flow of charge in a definite direction constitutes the electric current and the rate of flow of charge through any cross-section of a conductor is the measure of current i.e.,
$=\frac{Total\quad charge\quad flowing\quad (q)}{Time\quad taken\quad (t)}$ If dq charge is flowing through a section of a conductor in time dt, the electric current is given by $I=\frac{dq}{dt}$ Unit of electric current S.I unit of current is ampere. It is also called the practical unit of current. It is denoted by A,



$1\quad ampere(A)=\frac{1\quad coulomb}{1\quad second}=\quad 1Cs^{-1}$ Thus the current through a wire is said to be 1 ampere if one coulomb of charge is flowing per second through a section of the wire. Current is a scalar quantity, the direction of flow of positive charges is considered as a conventional direction of the current. In solids, positive charges being heavy do not move and currently is due to free electrons, therefore, the conventional direction of current is opposite to electronic current.

$I=\frac{q}{t}=\frac{ne}{t}$

$n=\frac{It}{e}=\frac{1\times1}{1.6\times10^{-19}}$

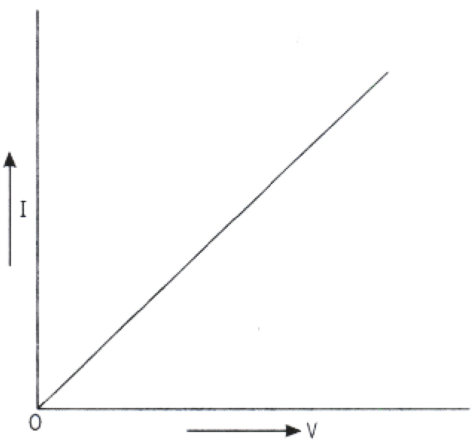
$=6.25\times10^{18}electrons\quad per\quad second.$

19)

It states that current flowing through a conductor is proportional to the potential difference across its two ends provided the physical conditions of the conductor remain unchanged. If V is the potential difference between two ends of a conductor and I is the current flowing through it, then $V \alpha I$ Where $V = RI$

R is the constant of proportionality and is called the resistance of the conductor. Its value depends upon
(i) Shape of the conductor (ii) Length of conductor (iii) Nature of the material

If a graph is plotted between V and I, the graph will be a



straight line passing through the origin. (b) Resistance is the property of a material by virtue of which it opposes the flow of current through it and quantitatively it is given by, $R = \frac{V}{I}$ Definition

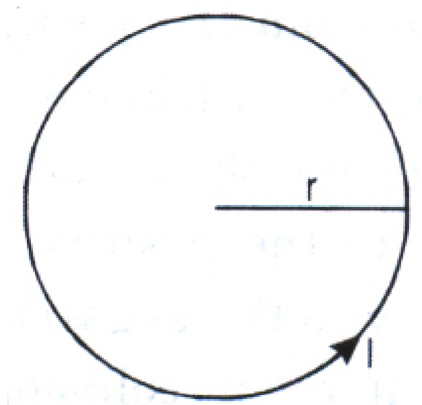
$= \frac{Potential \quad difference}{Current}$

of ohm Hence a conductor has a resistance of one ohm if a current of one ampere flows through it when a potential difference of one volt is maintained across its two ends.

20)

To establish that electrons carry current in a conductor, the $\left(\frac{e}{m}\right)$ of charge is measured from its angular momentum. Let r=radius of circular loop n=no. of electrons per unit length I=strength of current flowing through the loop v=drift velocity of charge flowing in the conductor No.of charges flowing per unit length of the loop =(nv) If e=charge on each charged particle or current carrier Total charge flowing per sec through any cross-section =(nv) e This is called current I=(nv) e When charged particle goes along a circular loop its angular momentum is given by L=mvr Total angular momentum due to all current carriers is L=(mvr)n=m(nv) r $L = m \times \frac{I}{e} r$ $\left(\frac{e}{m}\right)$ can be measured by measuring L,I and r.

$$L = I\left(\frac{m}{e}\right) r$$



The angular momentum is measured by relating it to the twist produced in a suspension from which loop is hung. On reversing the direction of current, a twist is produced in suspension due to sudden change in angular momentum. The value of twist depends upon the angular momentum. It was found that $\left(\frac{e}{m}\right)$ determined by this experiment corresponds to electron from other experiment. It thus experimentally established that current in metal is carried by negatively charged ions.