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NCERT Solutions for Class 12 Physics Chapter 3 Current Electricity talks about the laws that control the nature of electric current and various other related concepts. It is an important chapter and students must cover this topic in detail to ensure better scores in Class 12 Physics exams. To help the students with the same, we have provided the complete NCERT Solutions for Class 12 Physics Chapter 3 in this article below. NCERT Solutions given on this page will offer detailed and easy to understand answers for all the in-text questions. This is great learning material for students who are preparing for Class 12 Physics exams and will help them solve questions more efficiently. Practice Embibe’s Exclusive CBSE Class 12 Term 2 Sample Papers Based on New Guidelines: Class 12 Physics Chapter 3 Current Electricity: Overview It is necessary for you to know the topics and sub-topics of NCERT Class 12 Physics Chapter 3 in order to move further with the topic. Accurate knowledge of the topics under NCERT Class 12 Physics Chapter 3 will help you in retaining the information: 3.1Introduction3.2Electric Current3.3Electric Currents in Conductors3.4OHM’s Law3.5Drift of Electrons and the Origin of Resistivity3.5.1Mobility3.6Limitations of OHM’s Law3.7Resistivity of Various Materials3.8Temperature Dependence of Resistivity3.9Electrical Energy, Power3.10Combination of Resistors- Series and Parallel3.11Cells, EMF, Internal Resistance3.12Cells in Series and in Parallel3.13Kirchhoff’s Rules3.14Wheatstone Bridge3.15Meter Bridge3.16Potentiometer Learn 12th CBSE Exam Concepts NCERT Solutions for Class 12 Physics Chapter 3 PDF Download Class 12 Physics Chapter 3 Current Electricity will teach you about circuit diagrams, graphs, illustrations, energy diagrams through examples associated with daily life to make the topic easy for you. You will also learn that current is a scalar although it is represented with an arrow. Currents do not obey the law of vector addition. Moreover, homogeneous conductors like silver or semiconductors like pure germanium or germanium containing impurities obey Ohms’s law. However, this may be applicable within some range of electric field values. Kirchhoff’s junction rule is based on conservation of charge and the outgoing currents add up and are equal to the incoming current at a junction. Along with the NCERT Class 12 Physics Chapter 3 description, it is recommended for the students to solve the NCERT Solutions for Class 12 Physics Chapter 3 in order to understand the topic better. 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Did Embibe provide NCERT Solutions For Class 12 Physics for all chapters?A. Yes, Embibe has given all the NCERT Solutions For Class 12 Physics for all Chapters here. Q5. How many topics are there in NCERT Solutions For Class 12 Physics Chapter 3? A. There are a total of 16 Exercises or topics are there in NCERT Solutions For Class 12 Physics Chapter 3 ATTEMPT JEE MAIN MOCK TEST SERIES AND ANALYZE SCORE If you have any queries regarding this article, do let us know about it in the comment section below. We will get back to you soon. 1. The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is \[0.4\Omega \] , what is the maximum current that can be drawn from the battery?Ans: In the above question it is given that:Emf of the battery, $E=12V$Internal resistance of the battery, $r=0.4\Omega $Consider the maximum current drawn from the battery to be I.Therefore, using Ohm’s law,$E=Ir$$\Rightarrow I=\frac{E}{r}$$\Rightarrow I=\frac{12}{0.4}$$\Rightarrow I=30A$Clearly, the maximum current drawn from the given battery is $30A$ .2. A battery of emf 10 V and internal resistance $3\Omega $ is connected to a resistor. If the current in the circuit is 0.5 A, what is the resistance of the resistor? What is the terminal voltage of the battery when the circuit is closed?Ans: In the above question it is given that:Emf of the battery, E = 10 VInternal resistance of the battery, $r=3\Omega $Current in the circuit, $I=0.5A$ Consider the resistance of the resistor to be R.Therefore, using Ohm’s law,$I=\frac{E}{R+r}$$R+r=\frac{E}{I}$$\Rightarrow R+r=\frac{10}{0.5}$$\Rightarrow R+r=20$$\Rightarrow R=20-3=17\Omega $Let the terminal voltage of the resistor be V.Using the Ohm’s law,$V=IR$$\Rightarrow V=0.5\times 17=8.5V$Thus, the resistance of the resistor is $17\Omega $ and the terminal voltage is $8.5V$ .3.a) Three resistors $1\Omega $, $2\Omega $ and $3\Omega $ are combined in series. What is the total resistance of the combination?Ans: In the above question it is given that three resistors of resistances $1\Omega $, $2\Omega $ and $3\Omega $ are combined in series. The total resistance of a series combination of resistors is the algebraic sum of individual resistances.Hence the total resistance is given by:Total Resistance $=1+2+3=6\Omega $b) If the combination is connected to a battery of emf 12 V and negligible internal resistance, obtain the potential drop across each resistor.Ans: Consider the current flowing through the circuit to be I.Emf of the battery, $E=12V$Total resistance of the circuit, $R=6\Omega $The relation for current using Ohm’s law is given by:$I=\frac{E}{R}$$\Rightarrow I=\frac{12}{6}=2A$Consider potential drop across $1\Omega $ resistor to be ${{V}_{1}}$ .Using Ohm’s law, the value of ${{V}_{1}}$ can be obtained as:${{V}_{1}}=2\times 1=2V$ ...... (1)Consider potential drop across $2\Omega $ resistor to be ${{V}_{2}}$ .Again, using Ohm’s law, the value of ${{V}_{2}}$ can be obtained as:${{V}_{2}}=2\times 2=4V$ ...... (2)Consider potential drop across $3\Omega $ resistor to be ${{V}_{3}}$.${{V}_{3}}=2\times 3=6V$ ...... (3)Clearly, the potential drops across $1\Omega $, $2\Omega $ and $3\Omega $ resistors are $2V$, $4V$ and $6V$ respectively.4.a) Three resistors $2\Omega $, $4\Omega $ and $5\Omega $ are combined in parallel. What is the total resistance of the combination?Ans: In the above question it is given that there are three resistors of resistances $2\Omega $, $4\Omega $ and $5\Omega $ connected in parallel as shown below:(Image will be uploaded soon)Let ${{R}_{1}}=2\Omega ;{{R}_{2}}=4\Omega ;{{R}_{3}}=5\Omega $Now, using the rule for parallel combination of resistors, total resistance R of the combination will be:$\frac{1}{R}=\frac{1}{{{R}_{1}}}+\frac{1}{{{R}_{2}}}+\frac{1}{{{R}_{3}}}$$\Rightarrow \frac{1}{R}=\frac{1}{2}+\frac{1}{4}+\frac{1}{5}=\frac{19}{20}$$\Rightarrow R=\frac{20}{19}\Omega $Clearly, total resistance of the given parallel combination is $\frac{20}{19}\Omega $ .b) If the combination is connected to a battery of emf 20 V and negligible internal resistance, determine the current through each resistor, and the total current drawn from the battery.Ans: In the above question, it is given that the parallel combination mentioned in (a) is connected to a battery and negligible internal resistance as shown:(Image will be uploaded soon)It is known that ${{R}_{1}}=2\Omega ;{{R}_{2}}=4\Omega ;{{R}_{3}}=5\Omega $.Also given that,Emf of the battery, $V=20V$Ohm’s law can be used to determine the individual current flowing through each resistor and hence, the total current in the circuit.If current ${{I}_{1}}$ is flowing through resistor ${{R}_{1}}$, it is given by:${{I}_{1}}=\frac{V}{{{R}_{1}}}$$\Rightarrow {{I}_{1}}=\frac{20}{2}=10A$If current ${{I}_{2}}$ is flowing through resistor ${{R}_{2}}$, it is given by:${{I}_{2}}=\frac{V}{{{R}_{2}}}$$\Rightarrow {{I}_{2}}=\frac{20}{4}=5A$If current ${{I}_{3}}$ is flowing through resistor ${{R}_{3}}$, it is given by:${{I}_{3}}=\frac{V}{{{R}_{3}}}$$\Rightarrow {{I}_{3}}=\frac{20}{5}=4A$Now, the total current will be:$I={{I}_{1}}+{{I}_{2}}+{{I}_{3}}$$\Rightarrow I=10+5+4=19A$Clearly, the current through resistors $2\Omega $, $4\Omega $ and $5\Omega $ are $10A$, $5A$ and $4A$ respectively while the total current in the circuit is $19A$.5. At room temperature ${{27.0}^{\circ }}C$, the resistance of a heating element is $100\Omega $. What is the temperature of the element if the resistance is found to be $117\Omega $, given that the temperature coefficient of the material of the resistor is $1.70\times {{10}^{-4}}^{\circ }{{C}^{-1}}$?Ans: In the above question it is given that at room temperature $(T={{27.0}^{\circ }}C)$, the resistance of the heating element is $100\Omega $ (say R).Also, the heating element’s temperature coefficient is given to be $\alpha =1.70\times {{10}^{-4}}{}^\circ {{C}^{-1}}$.Now, it is said that the resistance of the heating element at an increased temperature (say ${{T}_{1}}$) is $117\Omega $. To compute this unknown increased temperature ${{T}_{1}}$, the formula for temperature coefficient of a material can be used. It is known that temperature co-efficient of a material provides information on the nature of that material with respect to its change in resistance with temperature. Mathematically,$\alpha =\frac{{{R}_{1}}-R}{R\left({{T}_{1}}-T \right)}$$\Rightarrow {{T}_{1}}-T=\frac{{{R}_{1}}-R}{R\alpha }$Substituting the given values,$\Rightarrow {{T}_{1}}-27=\frac{117-100}{100\times 1.70\times {{10}^{-4}}}$$\Rightarrow {{T}_{1}}-27=1000$$\Rightarrow {{T}_{1}}={{1027}^{\circ }}C$Clearly, it is at ${{1027}^{\circ }}C$ when the resistance of the element is $117\Omega $.6. A negligibly small current is passed through a wire of length 15 m and uniform cross-section $6.0\times {{10}^{-7}}{{m}^{2}}$, and its resistance is measured to be $5.0\Omega $. What is the resistivity of the material at the temperature of the experiment?Ans: In the above question it is given that:Length of the wire, $l=15m$Area of cross-section of the wire, $a=6.0\times {{10}^{-7}}{{m}^{2}}$Resistance of the material of the wire, $R=5.0\Omega $Let resistivity of the material of the wire be $\rho $It is known that, resistance is related with the resistivity as:$R=\rho \frac{l}{A}$$\Rightarrow \rho =\frac{RA}{l}$$\Rightarrow \rho =\frac{5\times 6.0\times {{10}^{-7}}}{15}$$\Rightarrow \rho =2\times {{10}^{-7}}{{m}^{2}}$Therefore, the resistivity of the material is $2\times {{10}^{-7}}{{m}^{2}}$ .7. A silver wire has a resistance of \[2.1\Omega \] at ${{27.5}^{\circ }}C$, and a resistance of $2.7\Omega $ at ${{100}^{\circ }}C$. Determine the temperature coefficient of resistivity of silver.Ans: In the above question it is given that:Temperature, ${{T}_{1}}={{27.5}^{\circ }}C$.Resistance of the silver wire at ${{T}_{1}}$ is ${{R}_{1}}=2.1\Omega $ .Temperature, ${{T}_{2}}={{100}^{\circ }}C$ .Resistance of the silver wire at ${{T}_{2}}$ is ${{R}_{2}}=2.7\Omega $ .Let the temperature coefficient of silver be $\alpha $. It is known that temperature co-efficient of a material provides information on the nature of that material with respect to its change in resistance with temperature. Mathematically, it is related with temperature and resistance by the formula:$\alpha =\frac{{{R}_{2}}-{{R}_{1}}}{{{R}_{1}}\left({{T}_{2}}-{{T}_{1}} \right)}$$\Rightarrow \alpha =\frac{2.7-2.1}{2.1\left(100-27.5 \right)}={{0.0039}^{\circ }}{{C}^{-1}}$Clearly, the temperature coefficient of silver is ${{0.0039}^{\circ }}{{C}^{-1}}$.8. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is ${{27}^{\circ }}C$? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is $1.70\times {{10}^{-4}}^{\circ }{{C}^{-1}}$ .Ans: In the above question it is given that:Supply voltage is $V=230V$Initial current drawn is ${{I}_{1}}=3.2A$.Let the initial resistance be ${{R}_{1}}$ .Therefore, using Ohm’s law,${{R}_{1}}=\frac{V}{{{I}_{1}}}$$\Rightarrow {{R}_{1}}=\frac{230}{3.2}=71.87\Omega $Steady state value of the current is ${{I}_{2}}=2.8A$.Let the resistance of the steady state be ${{R}_{2}}$ .Therefore, using Ohm’s law.${{R}_{2}}=\frac{V}{{{I}_{2}}}$$\Rightarrow {{R}_{2}}=\frac{230}{2.8}=82.14\Omega $Temperature co-efficient of nichrome is $\alpha =1.70\times {{10}^{-4}}^{\circ }{{C}^{-1}}$ .Initial temperature of nichrome is ${{T}_{1}}={{27}^{\circ }}C$.Let steady state temperature reached by nichrome be ${{T}_{2}}$ .Now, it is known that temperature co-efficient of a material provides information on the nature of that material with respect to its change in resistance with temperature. Mathematically, it is given by$\alpha =\frac{{{R}_{2}}-{{R}_{1}}}{{{R}_{1}}\left({{T}_{2}}-{{T}_{1}} \right)}$$\Rightarrow \left({{T}_{2}}-{{T}_{1}} \right)=\frac{{{R}_{2}}-{{R}_{1}}}{{{R}_{1}}\alpha }$Substituting the given values,$\Rightarrow \left({{T}_{2}}-27 \right)=\frac{82.14-71.87}{71.87\times 1.70\times {{10}^{-4}}}$$\Rightarrow {{T}_{2}}-27=840.5$$\Rightarrow {{T}_{2}}={{867.5}^{\circ }}C$Clearly, the steady temperature of the heating element is ${{867.5}^{\circ }}C$.9. Determine the current in each branch of the network shown in figure:(Image will be uploaded soon)Ans: Current flowing through various branches of the circuit is represented in the given figure.(Image will be uploaded soon)Consider${{I}_{1}}=$Current flowing through the outer circuit${{I}_{2}}=$Current flowing through branch AB${{I}_{3}}=$Current flowing through branch AD${{I}_{2}}-{{I}_{4}}=$Current flowing through branch BC${{I}_{3}}+{{I}_{4}}=$Current flowing through branch CD${{I}_{4}}=$Current flowing through branch BDFor the closed circuit ABDA, potential is zero i.e.,$10{{I}_{2}}+5{{I}_{4}}-5{{I}_{3}}=0$$2{{I}_{2}}+{{I}_{4}}-{{I}_{3}}=0$${{I}_{3}}=2{{I}_{2}}+{{I}_{4}}$ ...... (1)For the closed circuit BCDB, potential is zero i.e.,$5\left({{I}_{2}}-{{I}_{4}} \right)-10\left({{I}_{3}}+{{I}_{4}} \right)-5{{I}_{4}}=0$$5{{I}_{2}}+5{{I}_{4}}-10{{I}_{3}}-10{{I}_{4}}-5{{I}_{4}}=0$$5{{I}_{2}}-10{{I}_{3}}-20{{I}_{4}}=0$${{I}_{2}}=2{{I}_{3}}+4{{I}_{4}}$ ...... (2)For the closed circuit ABCFEA, potential is zero i.e.,$-10+10\left({{I}_{1}} \right)+10\left({{I}_{2}} \right)+5\left({{I}_{2}}-{{I}_{4}} \right)=0$$10=15{{I}_{2}}+10{{I}_{1}}-5{{I}_{4}}$$3{{I}_{3}}+2{{I}_{1}}-{{I}_{4}}=2$ ...... (3)From equations (1) and (2), we obtain${{I}_{3}}=2\left(2{{I}_{3}}+4{{I}_{4}} \right)+{{I}_{4}}$${{I}_{3}}=4{{I}_{3}}+8{{I}_{4}}+{{I}_{4}}$$-3{{I}_{3}}=9{{I}_{4}}$$-3{{I}_{4}}=+{{I}_{3}}$ ...... (4)Putting equation (4) in equation (1), we obtain${{I}_{3}}=2{{I}_{2}}+{{I}_{4}}$$-4{{I}_{4}}=2{{I}_{2}}$ ...... (5)It is evident from the given figure that,${{I}_{1}}={{I}_{3}}+{{I}_{2}}$ ...... (6)Putting equation (6) in equation (1), we obtain$3{{I}_{2}}+2\left({{I}_{3}}+{{I}_{2}} \right)-{{I}_{4}}=2$$5{{I}_{2}}+2{{I}_{3}}-{{I}_{4}}=2$ ...... (7)Putting equations (4) and (5) in equation (7), we obtain$5\left(-2{{I}_{4}} \right)+2\left(-3{{I}_{4}} \right)-{{I}_{4}}=2$$-10{{I}_{4}}-6{{I}_{4}}-{{I}_{4}}=2$$17{{I}_{4}}=-2$${{I}_{4}}=-\frac{2}{17}A$Equation (4) reduces to${{I}_{3}}=-3\left({{I}_{4}} \right)$${{I}_{3}}=-3\left(-\frac{2}{17} \right)=\frac{6}{17}A$${{I}_{2}}=-2\left({{I}_{4}} \right)$${{I}_{2}}=-2\left(-\frac{2}{17} \right)=\frac{4}{17}A$${{I}_{2}}-{{I}_{4}}=\frac{4}{17}-\left(-\frac{2}{17} \right)=\frac{6}{17}$${{I}_{3}}+{{I}_{4}}=\frac{6}{17}+\left(\frac{-2}{17} \right)=\frac{4}{17}A$${{I}_{1}}={{I}_{3}}+{{I}_{2}}$$\therefore {{I}_{1}}=\frac{6}{17}+\frac{4}{17}=\frac{10}{17}A$Therefore, current in branch AB $=\frac{4}{17}A$Current in branch BC $=\frac{6}{17}A$Current in branch CD $=\frac{-4}{17}A$Current in branch AD $=\frac{6}{17}A$Current in branch BD $=\left(\frac{-2}{17} \right)A$Total current $=\frac{4}{17}+\frac{6}{17}+\frac{-4}{17}+\frac{6}{17}+\frac{-2}{17}=\frac{10}{17}A$ .10.a) In a metre bridge the balance point is found to be at 39.5 cm from the end A, when the resistor Y is of $12.5\Omega $. Determine the resistance of X. Why are the connections between resistors in a Wheatstone or meter bridge made of thick copper strips?Ans: A metre bridge with resistors X and Y is represented in the given figure.(Image will be uploaded soon)A meter bridge works with the same principle as that of a Wheatstone bridge, which is an electrical circuit used to measure unknown resistances. It forms a bridge circuit, wherein the two legs of the circuit are balanced, out of which, one leg has the unknown resistance. Here, the concept of balance point is used, when there is no deflection in the galvanometer (no current flow condition). In the above question it is given that:Balance point from end A is at distance, ${{l}_{1}}=39.5cm$Resistance of the resistor \[Y=12.5\Omega \] .Condition for the balance with respect to the given meter bridge is given by$\frac{X}{Y}=\frac{100-l_1}{l_1}$$\Rightarrow X=\frac{100-39.5}{39.5}\times 12.5=8.2\Omega $Thus, the resistance of resistor X is $8.2\Omega $.The connection between resistors in a Wheatstone or metre bridge is made of thick copper strips which helps to minimize the resistance. Hence it is not taken into consideration in the bridge formula.b) Determine the balance point of the bridge above if X and Y are interchanged.Ans: When X and $Y$are interchanged, then ${{l}_{1}}$ and $100-{{l}_{1}}$ also get interchanged.Thus, the balance point of the bridge would be $100-{{l}_{1}}$ from A.$\therefore 100-{{l}_{1}}=100-39.5=60.5cm$Clearly, the balance point is $60.5cm$ from A.c) What happens if the galvanometer and cell are interchanged at the balance point of the bridge? Would the galvanometer show any current?Ans: When the galvanometer and cell are swapped at the balance point of the bridge, the galvanometer would show zero deflection. As there is null deflection, zero current would flow through the galvanometer.11. A storage battery of emf 8.0 V and internal resistance $0.5\Omega $ is being charged by a 120 V DC supply using a series resistor of $15.5\Omega $. What is the terminal voltage of the battery during charging? What is the purpose of having a series resistor in the charging circuit?Ans: In the above question it is given that:Emf of the storage battery is $E=0.8V$.Internal resistance of the battery is $r=0.5\Omega $ .DC supply voltage is $V=120V$Resistance of the resistor is $R=15.5\Omega $.Consider effective voltage in the circuit to be V', which would be the difference in the supply voltage and the emf of the battery.$V'=V-E$$\Rightarrow V'=120-8=112V$Now, current flowing in the circuit is I and the resistance R is connected in series to the storage battery. Therefore, using Ohm’s law,$I=\frac{V'}{R+r}$$\Rightarrow I=\frac{112}{15.5+0.5}=7A$Thus, voltage across resistor Rwould be:$IR=7\times 15.5=108.5V$DC supply voltage = Terminal voltage of battery + Voltage drop across RTerminal voltage of battery $=120-108.5=11.5V$A series resistor in a charging circuit takes the responsibility for controlling the current drawn from the external source. Excluding this series resistor is dangerous as the current flow would be extremely high if so.12. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?Ans: A potentiometer arrangement facilitates adjustable voltage dividing. It can be used to compare the emf’s of two different cells with the help of balance points in each case. Balance point or null point is the point when the galvanometer in the circuit shows no deflection. i.e., when there is no current flowing in the circuit. In the above question it is given that when the cell has an emf ${{E}_{1}}=1.25V$, the balance point of the potentiometer is given to be at a distance, ${{l}_{1}}=35cm$. Now, when the cell is replaced by another cell of emf ${{E}_{2}}$, the balance point of the potentiometer is given to be at a distance ${{l}_{2}}=63cm$.The balance condition to compare the emf’s of two cells using a potentiometer setup is given by the relation,$\frac{{{E}_{1}}}{{{E}_{2}}}=\frac{{{l}_{1}}}{{{l}_{2}}}$$\Rightarrow {{E}_{2}}={{E}_1}\times \frac{{{l}_{1}}}{{{l}_{2}}}$$\Rightarrow {{E}_{2}}=1.25\times \frac{63}{35}=2.25V$Clearly, the emf of the second cell is $2.25V$ .13. The number density of free electrons in a copper conductor estimated in Example 3.1 is $8.5\times {{10}^{28}}{{m}^{-3}}$. How long does an electron take to drift from one end of a wire 3.0 m long to its other end? The area of cross-section of the wire is $2.0\times {{10}^{-6}}{{m}^{2}}$ and it is carrying a current of 3.0 A.Ans: In the above question it is given that:Number density of free electrons in a copper conductor is $n=8.5\times {{10}^{28}}{{m}^{-3}}$.Length of the copper wire is $l=3.0m$.Area of cross-section of the wire is $A=2.0\times {{10}^{-6}}{{m}^{2}}$.Current carried by the wire is $I=3.0A$.Now we know that:$I=nAe{{V}_{d}}$Where,e is the electric charge of magnitude $1.6\times {{10}^{-19}}C$.${{V}_{d}}$ is the drift velocity and\[Drift\text{ }velocity=\frac{\text{Length of the wire }\left(\text{l} \right)}{\text{Time taken to cover }\left(\text{t} \right)}\]$I=nAe\frac{l}{t}$$\Rightarrow t=\frac{nAel}{I}$$\Rightarrow t=\frac{3\times 8.5\times {{10}^{28}}\times 2\times {{10}^{-6}}\times 1.6\times {{10}^{-19}}}{3.0}$$\therefore t=2.7\times {{10}^{4}}s$ .Hence the time taken by an electron to drift from one end of the wire to the other is $2.7\times {{10}^{4}}s$.14. The earth’s surface has a negative surface charge density of ${{10}^{-9}}C{{m}^{-2}}$. The potential difference of 400 kV between the top of the atmosphere and the surface results (due to the low conductivity of the lower atmosphere) in a current of only 1800 A over the entire globe. If there were no mechanism of sustaining atmospheric electric field, how much time (roughly) would be required to neutralize the earth’s surface? (This never happens in practice because there is a mechanism to replenish electric charges, namely the continual thunderstorms and lightning in different parts of the globe). (Radius of earth = $6.37\times {{10}^{6}}m$.)Ans: In the above question it is given that:Surface charge density of the earth is $\sigma ={{10}^{-9}}C{{m}^{-2}}$.Current over the entire globe is $I=1800A$.Radius of the earth is $r=6.37\times {{10}^{6}}m$.Surface area of the earth is given by:$A=4\pi {{r}^{2}}$$\Rightarrow A=4\pi \times {{\left(6.37\times {{10}^{6}} \right)}^{2}}$$\Rightarrow A=5.09\times {{10}^{14}}{{m}^{2}}$Charge on the earth surface is given by:$q=\sigma A$$\Rightarrow q={{10}^{-9}}\times 5.09\times {{10}^{14}}$$\Rightarrow q=5.09\times {{10}^{5}}C$Now, when the time taken to neutralize the surface of the earth is taken to be t, then,Current, $I=\frac{q}{t}$$\Rightarrow t=\frac{q}{I}$$\Rightarrow t=\frac{5.09\times {{10}^{5}}}{1800}=282.77s$Clearly, the time taken to neutralize the surface of the earth is $282.77s$.15.a) Six lead-acid type of secondary cells each of emf 2.0 V and internal resistance $0.015\Omega $ are joined in series to provide a supply to a resistance of $8.5\Omega $. What is the current drawn from the supply and its terminal voltage?Ans: In the above question, it is given that six lead-acid type of secondary cells are joined in series as shown below:(Image will be uploaded soon)Here, number of secondary cells is $n=6$.Emf of each secondary cell is $E=2.0V$.Internal resistance of each cell is $r=0.015\Omega $ .Series resistor is connected to the combination of cells.Resistance of the resistor R is $8.5\Omega $.If the current drawn from the supply is I, then $I=\frac{nE}{R+nr}$$\Rightarrow I=\frac{6\times 2}{8.5+6\times 0.015}$$\Rightarrow I=1.39A$Now the terminal voltage would be$V=IR=1.39\times 8.5=11.87V$Clearly, the current drawn from the supply is $1.39A$ and the terminal voltage is $11.87V$.b) A secondary cell after long use has an emf of 1.9 V and a large internal resistance of $380\Omega $. What maximum current can be drawn from the cell? Could the cell drive the starting motor of a car?Ans: It is given that after using a secondary cell for long, emf of the secondary cell is $E=1.9V$.Also, the internal resistance of the cell is $r = 380\Omega$.Here, using Ohm’s law, the maximum current $=\frac{E}{r}$$\Rightarrow \frac{E}{r}=\frac{1.9}{380}=0.005A$.Clearly, the maximum current used from the cell is $0.005A$. To start the motor of a car, a large amount of current is required. Thus, this cell which produces just 0.005A cannot be used for this purpose.16. Two wires of equal length, one of aluminium and the other of copper have the same resistance. Which of the two wires is lighter? Hence explain why aluminium wires are preferred for overhead power cables.${{\rho }_{Al}}=2.63\times {{10}^{8}}\Omega m;{{\rho }_{Cu}}=1.72\times {{10}^{-8}}\Omega m;$$\text{Relative density of Al}=2.7;\text{Relative density of Cu}=8.9$Ans: In the above question it is given that:Resistivity of aluminium is ${{\rho }_{Al}}=2.63\times {{10}^{8}}\Omega m$.Relative density of aluminium is ${{d}_{1}}=2.7$.Consider ${{l}_{1}}$ to be the length of aluminium wire, ${{m}_{1}}$ as its mass, the resistance of the copper wire as ${{R}_{2}}$, and area of cross-section of the copper wire as ${{A}_{2}}$.Therefore, using the relation between resistance and resistivity,${{R}_{1}}={{\rho }_{1}}\frac{{{l}_{1}}}{{{A}_{1}}}$ ...... (1)And ${{R}_{2}}={{\rho }_{2}}\frac{{{l}_{2}}}{{{A}_{2}}}$ ...... (2)However, we have ${{R}_{1}}={{R}_{2}}$$\Rightarrow {{\rho }_{1}}\frac{{{l}_{1}}}{{{A}_{1}}}={{\rho }_{2}}\frac{{{l}_{2}}}{{{A}_{2}}}$Also, we have ${{l}_{1}}={{l}_{2}}$.\[\Rightarrow \frac{{{\rho }_{1}}}{{{A}_{1}}}=\frac{{{\rho }_{2}}}{{{A}_{2}}}\]$\Rightarrow \frac{{{A}_{1}}}{{{A}_{2}}}=\frac{{{\rho }_{1}}}{{{\rho }_{2}}}$$\Rightarrow \frac{{{A}_{1}}}{{{A}_{2}}}=\frac{2.63\times {{10}^{8}}}{1.72\times {{10}^{-8}}}=\frac{2.63}{1.72}$Now, mass of the aluminium wire is given by:${{m}_{1}}=Volume\times Density$$\Rightarrow {{m}_{1}}={{A}_{1}}{{l}_{1}}\times {{d}_{1}}={{A}_{1}}{{l}_{1}}{{d}_{1}}$ ...... (3)Similarly mass of the copper wire is given by:${{m}_{2}}=Volume\times Density$$\Rightarrow {{m}_{2}}={{A}_{2}}{{l}_{2}}\times {{d}_{2}}={{A}_{2}}{{l}_{2}}{{d}_{2}}$ ...... (4)Dividing equation (3) by equation (4), we get:$\frac{{{m}_{1}}}{{{m}_{2}}}=\frac{{{A}_{1}}{{l}_{1}}{{d}_{1}}}{{{A}_{2}}{{l}_{2}}{{d}_{2}}}$As ${{l}_{1}}={{l}_{2}}$,$\frac{{{m}_{1}}}{{{m}_{2}}}=\frac{{{A}_{1}}{{d}_{1}}}{{{A}_{2}}{{d}_{2}}}$As \[\frac{{{A}_{1}}}{{{A}_{2}}}=\frac{2.63}{1.72}\]$\frac{{{m}_{1}}}{{{m}_{2}}}=\frac{2.63}{1.72}\times \frac{2.7}{8.9}=0.46$It indicated that ${{m}_{1}}

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