PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

CURRENT AND RESISTANCE

Sample Problems

1. What flows through a garden hose at a volume flow rate dV/dt of $450 cm^3 / s$. What

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2. (a) The current density in a cylindrical wire of radius R=2.0mm is uniform across a cross section of the wire and is $J = 2.0 \times 10^5 A / m^2$. What is the current through the outer portion of the wire between radial distances R/2 and R?

(b) Suppose, instead, the current density through a cross section varies with radial distance r as $J = ar^2$, in which $a = 3.0 \times 10^{11} A / m^4$ and r is in meters. What now is the current through the same outer portion of the wire?

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3. What is the drift speed of the conduction electrons in a copper wire with radius $r = 900 \mu m$ when it has a uniform current $I = 17 mA$? Assume that each copper atom contributes one conduction electron to the current and the current density is uniform across the wire's cross section. The density of copper is $9.0 \times 10^3 kgm^{-3}$ and its atomic mass is $63.5u$.

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4. A rectangular block of iron has dimension $1.2cm \times 1.2cm \times 1.5cm$. A potential difference is to be applied to the block between parallel sides and in such a way that those sides are equipotential surfaces. What is the resistance of the block if the two parallel sides are (1) the square ends (with dimensions

$1.2cm \times 1.2cm$) and (2) two rectangular sides (with dimensions $1.2cm \times 15cm$)?

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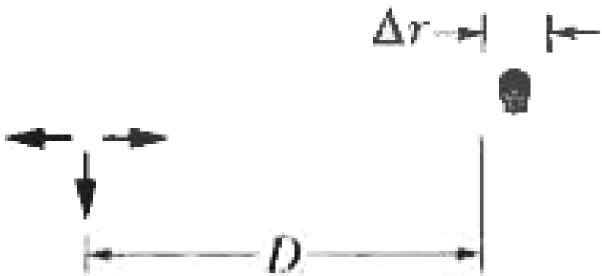
5. Figure 26-11 shows a swimmer at distance D=38.0 m from a lightning strike to the water, with current I=78kA. The water has resistivity $30\Omega.m$, the width of the swimmer along a radial from the strike is 0.70m, and his resistance across that width is $4.00k\Omega$. Assume that the current spreads through the water over a hemisphere centered on the strike point. What is the current through the swimmer?



Swimmer at a distance of 38m from where lightning strikes water.

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6. (a) What is the sum free time τ between collisions for the conduction electrons in copper?

(b) The mean free path λ of the conduction electrons in a particular conductor is the average distance traveled by an electron between collisions. What is λ for the conduction electrons in copper, assuming that their effective speed v_{eff} is $1.6 \times 10^6 m / s$?

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7. You are given a length of uniform heating wire made of nickel-chromium-iron alloy called Nichrome, it has a resistance R of 72Ω. At what rate is energy dissipated in each of the following situations? (1) A potential difference of 120V is applied across the full length of the wire (2) The wire is cut in half, and a potential difference of 120V is applied across the length of each half.

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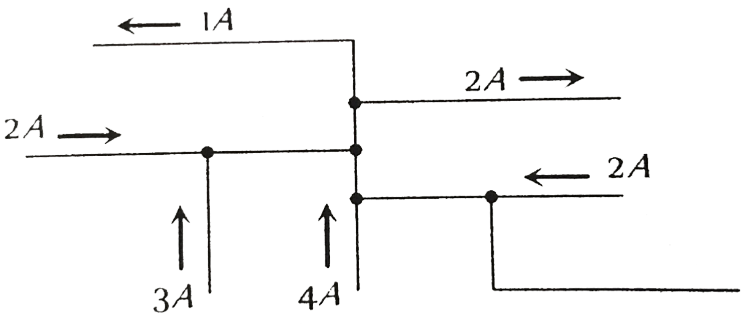
Checkpoints

1. The figure here shows a portion of a circuit. What are the magnitude and direction of the current i in the lower right-hand wire



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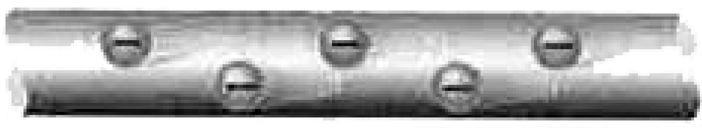
2. The figure shows conduction electrons moving leftward in a wire. Are the following

leftward or rightward. (a) the current I, (b) the current density $\overline{J}$, (c) the electric field $\overrightarrow{E}$ in the wire?



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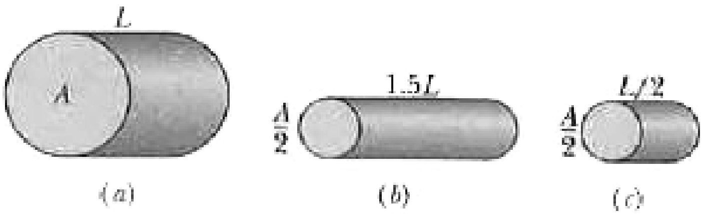
3. The figure here shows three cylindrical copper conductors along with their faces areas and lengths. Rank them according to the current through them, greatest first, when the same potential differnce V is placed across their lengths.



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4. The following tables gives the current i (in amperes) through two devices for several values of potential difference V (in volts). From these data, determine which device does not obey Ohm's law.

Device 1		Device 2	
V	i	V	i
2.00	4.50	2.00	1.50
3.00	6.75	3.00	2.20
4.00	9.00	4.00	2.80

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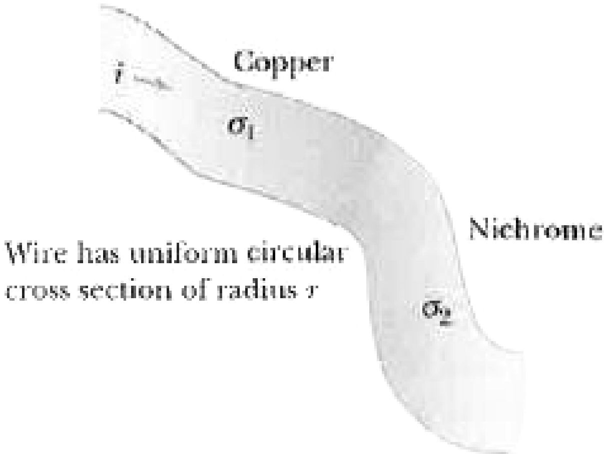
5. Can you see how the two wires having different conductivities connected in a circuit will have different values of the electric field inside them? What will be the sign of excess charge built up on the interface between two cylindrical conductors as shown in the figure?



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6. A potential difference V is connected across a device with resistance R, causing current I through the device. Rank the following variations according to the change in the rate at which electrical energy is converted to thermal energy due to the following greatest change first. (a) V is doubles with R unchanged. (b) i doubled with R unchanged. (c) R is doubled with V unchanged. (d) R is doubled with i unchanged.

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Problems

1. A wire 8.00 m long and 6.00 mm in diameter has a resistance of 30.0 $m\Omega$. A potential difference of 23.0 V is applied between the ends. (a) What is the current in the wire? (b) What is the magnitude of the current density? (c) Calculate the resistivity of the wire material.

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2. In Fig. 26-18a, a 9.00 V battery is connected to a resistive strip that consists of three sections with the same cross-sectional areas but different conductivities. Figure 26-18h gives the electric potential V(x) versus position x along the strip. The horizontal scale is set by x= 8.00 mm. Section 3 has conductivity $4.00 \times 10^7 (\Omega .\ m)^{-1}$. What is the conductivity of section (a) 1 and (b) 2 ?

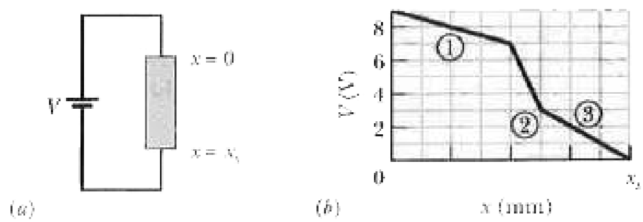

Figure 26-18 Problem 2.

a.

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3. In Fig. 26.19, current is set up through a truncated right circular cone of resistivity $731\Omega.m$ lelt radius d= 1.70 mm. right radius b= 2.30 mm, and length L= 3.50 cm. Assume that the current density is uniform across any cross section taken perpendicular to the length.

What is the resistance of the conc?

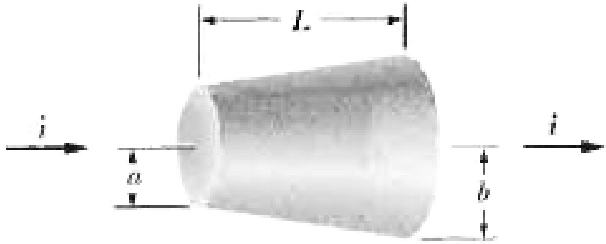

Figure 26-19 Problem 3.

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4. Kiting during a storm. The legend that Benjamin Franklin flew a kite as a storm approached is only a legend-he was neither stupid nor suicidal. Suppose a kite string of radius 2.00 mm extends directly upward by 1.80 km and is coated with a 0.500 mm layer of water having resistivity $150\Omega.m$. If the potential difference between the two ends of the string is 213 MV, what is the current through the water layer? The danger is not this current but the chance that the string draws a lightning strike, which can have a current as large as 500 000 A (way beyond just being lethal).

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5. Earth's lower atmosphere contains negative and positive ions that are produced by radioactive elements in the soil and cosmic rays from space. In a certain region, the atmospheric electric field strength is 120 V/m and the field is directed vertically down. This field causes singly charged positive ions, at a density of $640 cm^{-1}$ to drift downward and singly charged negative ions, at a density of 550 cm^{-3}. ? to drift upward (Fig. 26-20). The measured conductivity of the air in that region is $2.70 \times 10^{-14} W(\Omega.\, m)^{-1}$. Calculate (a) the magnitude of the current densily and (b) the ion drift speed, assumed to be the same for positive and negative ions.

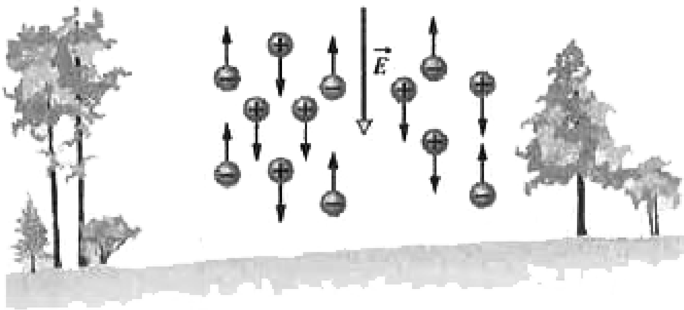

Figure 26-28 Problem 5.

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6. A potential difference of 6.00 nV is set up across a 1.50 cm length of copper wire that has a radius of 2.00 mm. How much charge drifts through a cross section in 4.70 ms?

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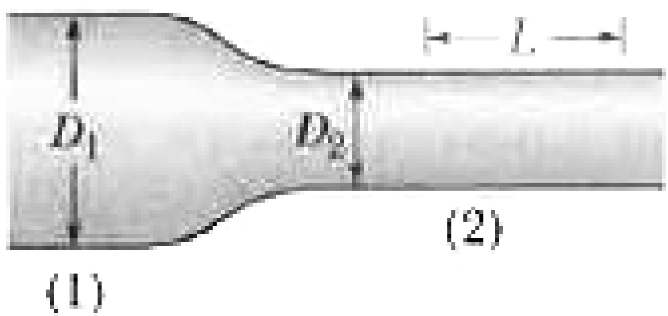
7. Figure 26-21 shows wire section 1 of diameter $D_1 = 4.00R$ and wire section 2 of diameter $D_2 = 1.75R$, connected by a tapered section. The wire is Copper and carries a current. Assume that the current is uniformly distributed across any cross-sectional area through the wire's width. The electric potential change V along the length L= 2.00 m shown in section 2 is $10.0 \mu V$. The number of charge carners per unit volume is $8.49 \times 10^{28} m^{-3}$. What is the drift speed of the conduction electrons in section 1?



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8. When 230 V is applied across a wire that is 14.1 m long and has a 0.30 mm radius, the magnitude of the current density is $198 \times 10^{8} A / m^{2}$. Find the resistivity of the wire.

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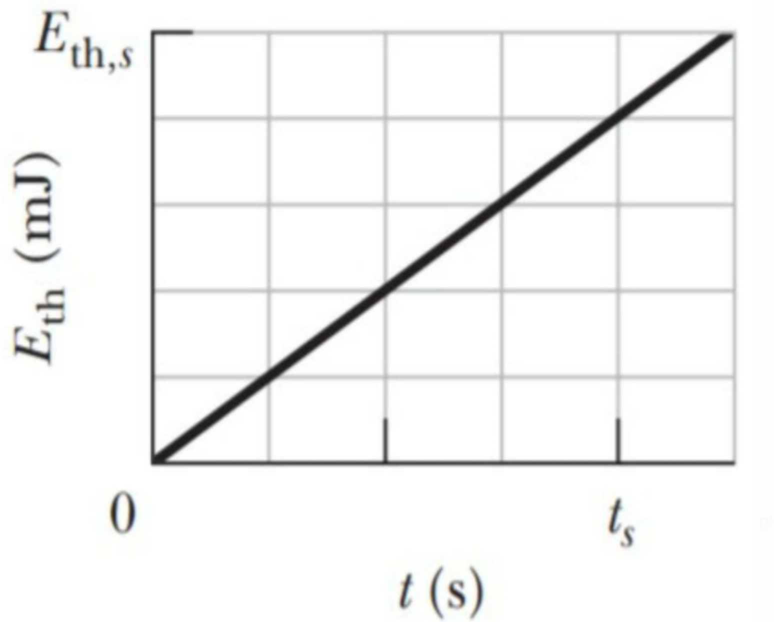
9. In Fig. 26-22a, a 15Ω resister is connected to a battery. Figure 26-22b shows the increase of thermal energy E_{th} in the resistor as a function of time t. The vertical scale is set by $E_{th\,.s} = 2.50 mJ$, and the herizontal scale is set by $t_s = 4.0 s$. What is the electric potential across the battery?



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10. Nichrome wire consists of a nickel-chromium-iron alloy, is commonly used in heating elements such as on a stove, and has conductivity $2.0 \times 10^6 (\Omega. m)^{-1}$. If a Nichrome wire with a cross-sectional area of 2.3 mm^2 ? carries a current of 5.5 A when a 1.4 V potential difference is applied between its ends, what is the wire's length?

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11. A heater contains a Nichrome wire $(\text{resistivity } 5.0 \times 10^{-7} \Omega. m)$ of length 5.85 m, with an end-to-end potential difference of 112 V and with a dissipation power of 4000 W. (a) What is the wire's cross-sectional area? (b) If 100 V is used to obtain the same dissipation rate, what should the length be?

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12. An unknown resistor is connected between the terminals of a 3.00 V battery. Energy is dissipated in the resistor at the rate of 0.707 W. The same resistor is then connected between the terminals of a 12.0 V battery. At what rate is energy now dissipated?

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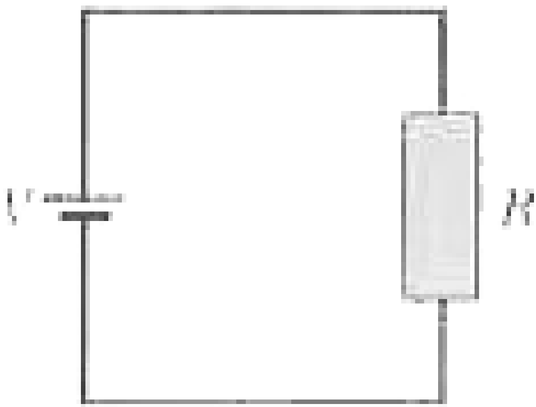
13. In Fig. 26.23, a battery of potential differenc V= 12 V is connected to a resistive strip of resistance $R = 4.0\Omega$. When an electron moves through the strip from one end to the other, (a) in which direction in the figure does the electron move, (b) how much work is done on the electron by the electric field in the strip, and (c) how much energy is transferred to the thermal energy of the strip by the electron?



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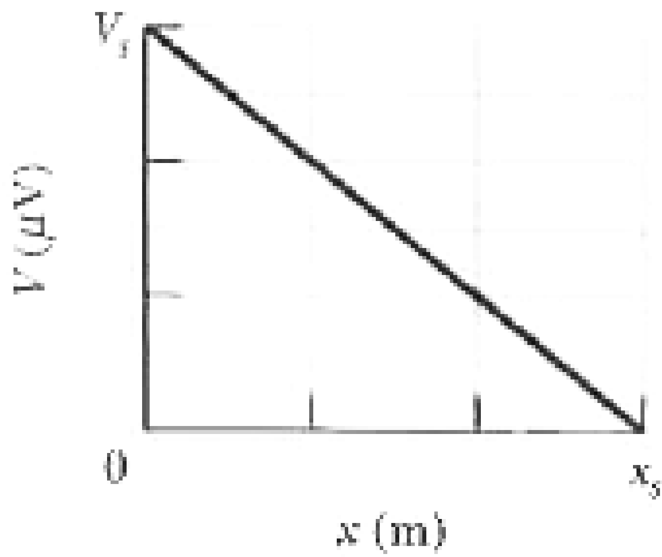
14. Figure 26-24 gives the electric potential V(x) along a copper wire carrying uniform current, from a point of higher potential $V = 12.0\mu V$ at x= 0 to a point of zero potential at x= 3.00 m. The wire has a 0 radius of 2.20 mm. What is x (m) the current in the



wire?.

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15. A 890 W radiant heater is constructed to operate at 115 V. (a) What is the current in the heater when the unit is operating? (b) What is the resistance of the heating coil? (c) How much thermal energy is produced in 5.00 h?

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16. Wire C and wire D are made from different materials and have length $L_C = L_D = 1.0m.$ The resistivity and radius of wire C are $2.0 \times 10^{-6}. \Omega m$ and 1.00 mm, and those of wire D are $1.0 \times 1.0^{-6}\Omega. m.$ and 0.50 mm. The wires are joined as shown in Fig. 26-25, and a current of 2.0 A is set up in them. What is the electric potential difference between a) points 1 and 2 and (b) points 2 and 3? What is the rate at which energy is dissipated between c) points 1 and 2 and (d) points 2 and 3?

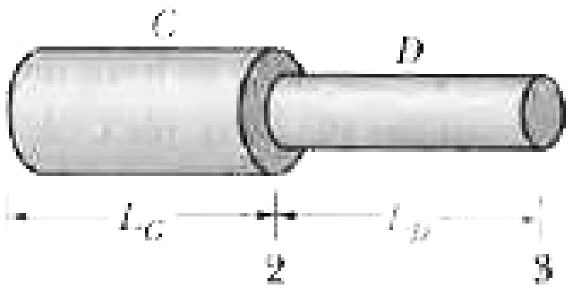

Figure 26-25 Problem 16.

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17. A small but measurable current of $1.2 \times 10^{-10} A$ exists in a copper wire whose diameter is 3.0 mm. The number of charge carriers per unit volume is $8.49 \times 10^{28} m^{-3} m.$

Assuming the current is uniform, calculate the (a) current density and (b) electron drift speed.

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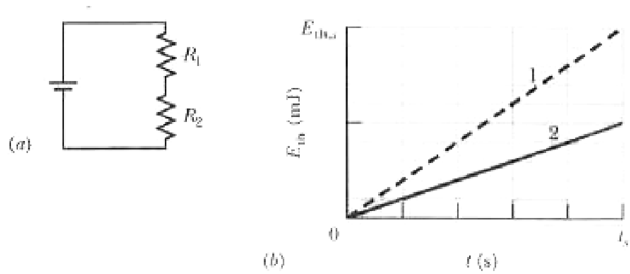
18. The current through the battery and resistors 1 and 2 in Fig. 26-26a is 1.50 A. Energy is transferred from the current to thermal energy E_{th} in both resistors. Curves 1 and 2 in Fig. 26-26b give that thermal energy Ein for resistors 1 and 2, respectively, as a function of time i. The vertical scale is set by $E_{th\,.s} = 40.0mJ$ and the horizotal scale is set by $t_s = 5.00s$. What is the power of the



battery?

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19. A copper wire of cross-sectional area $2.40 \times 10^{-6} m^2$ and length 4.00 m has a current of 2.00 A uniformly distributed across that area. (a) What is the magnitude of the electric field along the wire? (b) How much electrical energy is transferred to thermal energy in 30 min?

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20. For a current set up in wire for 28.0 d, a total of 1.36×10^{26} electrons pass through any cross section across the wire's width at a steady rate. What is the current?

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21. The current-density magnitude in a certain circular wire is $J = (2.75 \times 10^{10} A / m^4) r^2$, where r is the radial distance out to the wire's radius of 3.00 mm. The potential applied to the wire (end to end) is 80.0 V. How much energy is converted to thermal energy in 1.00 h?

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22. A charged belt, 50 cm wide, travels at 30 m/s between a source of charge (electrons) and a sphere. The belt carries charge into the sphere at a rate corresponding to 76 A. (a) Compute the surface charge density on the belt. (b) What is the number density (number per unit area) of the electrons on the belt?

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23. A wire initially has length L_0 and resistance 5.00Ω. The resistance is to be increased to 45.0Ω by stretching the wire. Assuming that the resistivity and density of the material are unaffected by the stretching, find the ratio of the new length to L_0.

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24. A human being can be electrocuted if a current as small as 50 mA passes near the heail. An electrician working with sweaty hands makes good contact with the two conductors he is bolding one in each hand. If his resistance is 2100Ω. What might the fatal voltage be?

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25. A 120 V potential difference is applied to a space heater that dissipates 1500W during operation. (a) What is the resistance during operation? (b) At what rate do electrons flow through any cross section of the heater element?

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26. A certain wire has a resistance R. What is the resistance of a second wire, made of the same material, that is twice as long and has twice the diameter?

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27. Figure 26-27 a shows a rod of resistive material. The resistance per unit length of the rod increases in the positive direction of the x axis. At any position x along the rod, the resistance dR of a narrow (differential) section of width dx is given by dR =5.00x dx, where dR is in ohms and x is in meters. Figure 26-27 shows such a narrow section. You are to slice off a length of the rod between x= 0 and some position x= L and then connect that length to a battery with potential difference V=8.0 V (Fig. 26-27c). You want the current in the length to transfer energy to thermal energy at the rate of 180 W. At what position x =L should you cut the rod?

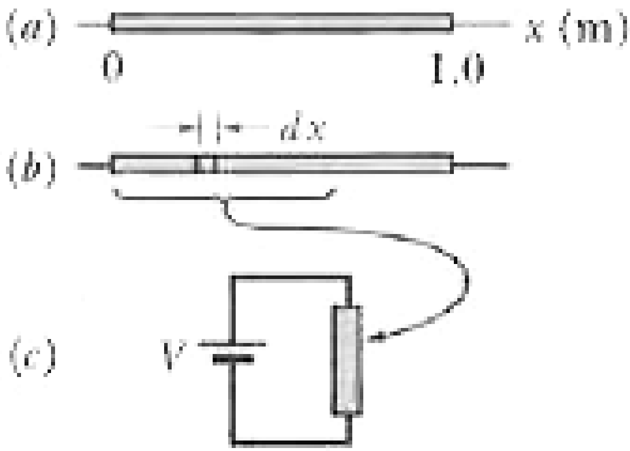

Figure 26-27 Problem 27

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28. A fuse in an electric circuit is a wire that is designed to melt, and thereby open the circuit, if the current exceeds a predetermined value. Suppose that the material to be used in fise melts whien the current derisity rises to 440 $\frac{A}{c}m^2$. What radius of cylindrical wire should be used to make a haal will little current to 6.0A?

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29. How long does it take electrons to get from a car battery to the starting motor? Assume the current is 285 A and the electrons travel through a copper wire with cross-sectional area $0.17 cm^2$ and length 0.43 m. The number of charge carriers per unit volume is $8.49 \times 10^{28} m^{-3}$.

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30. What is the current in a wire of radius R = 2.67 mm if the magnitude of the current density is given by (a) $J_n = J_0 r / R$ and $(b) J_b = J_0 (1 - r / R)$, in which r is the radial distance and $J_0 = 5.50 \times 10^4 A / m^2$? (c) Which function maximizes the current density near the wire's surface?

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31. A certain cylindrical wire carries current. We draw a circle of radius r around its central axis in Fig. 26-28a to determine the current i within the circle. Figure 26-28b shows current i as a function of r^2. The vertical scale is set by $i_s = 4.0mA$, and the horizontal scale is set by $r_s^2 = 8.0mm^2$. (a) Is the current density uniform? (b) If so, what is its magnitude? (c)

What is the current between r = 0 and r=2.0

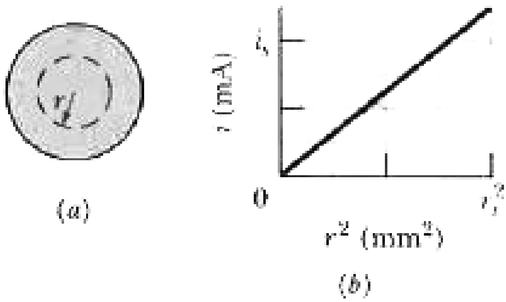

Figure 26-28 Problem 31.

mm?

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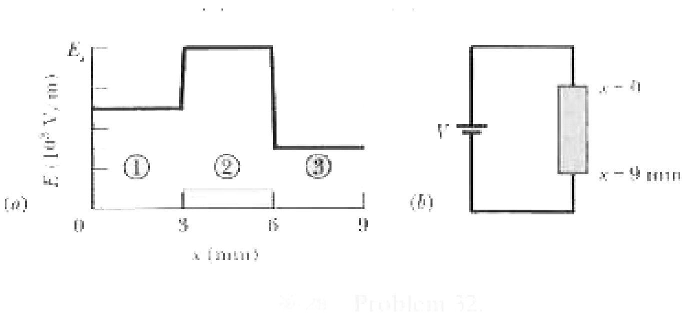
32. Figure 26-29a gives the magnitude E(x) of the electric fields that have been set up by a battery along a resistive rod of length 9.00 mm (Fig. 26-296). The vertical scale is set by

$E_s = 8.00 \times 10^3 V / m$. The rod consists of three sections of the same material but with different radii. (The schematic diagram of Fig. 26.29b does not indicate the differencet radii). The radius of section 3 is 1.70 mm. What is the radius of (a) section 1 and (b) section 2?



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33. Two conductors are made of the same material and have the same length. Conductor A is a solid wire of radius 1.0 mm. Conductor B is a hollow tube of outside radius 2.2 mm and inside radius 1.0 mm. What is the resistance rate R_A / R_B measured between their ends?

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34. Near Earth the density of protons in the solar wind (a stream of particles from the Sun) can be $4.63cm^{-3}$ and their suced can be 391 km/s. (a) Find the current density of these protons. (b) If Earth's magnetic field did not deflect the protons, what total current would Earth receive?

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35. An isolated conducting sphere has a 20 cm radius. One wire carries a current of 1.000 002 0 A into it. Another wire carries a current of 1.000 000 0 A out of it. How long would it take for the sphere to increase in potential by 1000 V?

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36. The magnitude of the current density in a certain lab wire with a circular cross section of radius R=2.50 mm is given by $J = (3.00 \times 10^8) r^2$, with J in amperes per square meter and radial distance rin meters. What is the current through the outer section bounded by r= 0.900R and r=R?

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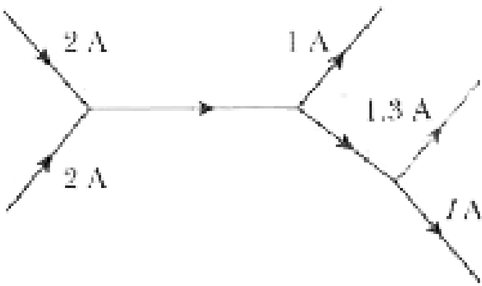
Practice Questions Single Corret Choice Type

1. The following figure shows current in a part of electric circuit, then current I is



A. 1.7A

B. 3.7A

C. 1.3A

D. 1A

Answer: A

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2. A wire of length l is drawn such that its diameter is reduced to half of its original diameler. If the initial resistance of the wire were 10Ω. its resistance would become

A. 40Ω

B. 60Ω

C. 120Ω

D. 160Ω

Answer: D

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3. A wire of resistance $1\ \Omega$ is elongated by 10%.

The resistance of the elongated wire is

A. 1.1Ω

B. 11.1Ω

C. 1.21Ω

D. 12.1Ω

Answer: C

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4. A $5^{\circ}C$ rise in the temperature is observed in a conductor by passing some current. When the current is doubled, then rise in temperature will be equal to

A. $5^\circ C$

B. $20^\circ C$

C. $15^\circ C$

D. $25^\circ C$

Answer: B

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5. The masses of the three wires of copper are in the ratio $5:3:1$ and their lengths are in the ratio $1:3:5$. The ratio of their electrical resistances is

A. $1:3:5$

B. $5:3:1$

C. $1:15:125$

D. $125:15:1$

Answer: C

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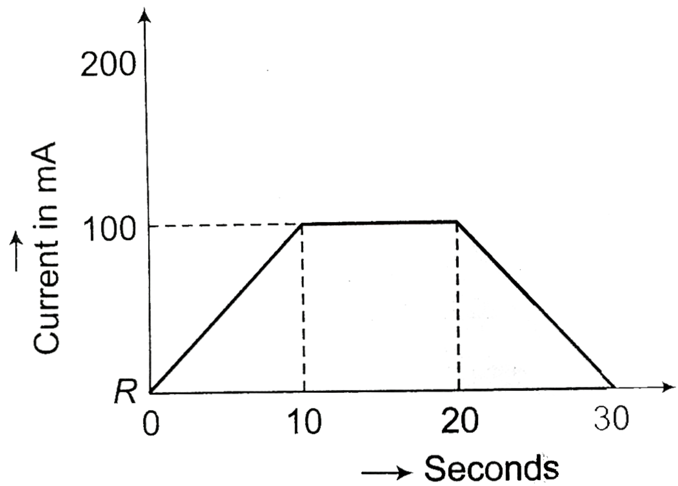
6. In a copper voltmeter, mass deposite in 30 seconds is $'m'$ gram. If the time-current graph is as shown in figure. ECE of copper is



A. m/2

B. 2m

C. 0.5m

D. 0.7m

Answer: A

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7. The resistivity of a wire

A. Varies with its length

B. Varies with its mass

C. Varies with it cross section

D. Is independent of length, cross section and mass of the wire

Answer: D

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8. When a current flows in a conductor, the order of magnitude of drift velocity of electrons through it is :

A. $10^{-7} cm/s$

B. $10^{-2}cm/s$

C. $10^{4}cm/s$

D. $10^{10}cm/s$

Answer: B

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9. Assume that each atom of copper contributes one free electron. Density of Cu is 9 g/cm^3 and atomic weight is 63 g. If current flowing through a Cu wire of 1 mm diameter is

11 A, drift velocity of clectrons will be

A. 0.1 mm/s

B. 0.2 mm/s

C. 0.3 mm/s

D. 0.5 mm/s

Answer: A

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10. In an electrical cable there is a single wire of radius $9mm$ of copper. Its resistance is 5Ω. The cable is replaced by 6 different insulated copper, wires the radius of each wire is $3mm$. Now the total resistance of the cable will be

A. 7.5Ω

B. 45Ω

C. 90Ω

D. 270Ω

Answer: A

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11. If n, e, τ, m, are representing electron density charge, relaxation time and mass of an electron respectively then the resistance of wire of length 1 and cross sectional area A is given by

A. $\frac{ml}{\text{ne}^2\tau A}$

B. $\frac{2m\tau A}{\text{ne}^2 l}$

C. $\frac{\text{ne}^2\tau A}{2m}$ $\frac{l}{B}$

D. $\frac{ne^2 m}{2\tau}\frac{l}{A}$

Answer: A

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12. In which one of the following situations does a conventional electric current flow due north?

A. Protons in a beam are moving due south

B. A water molecule is moving due north

C. Electrons in a beam are moving due south

D. Electrons a wire connected to a battery are moving from south to north

Answer: C

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13. A conducting ring of radius R has charge Q distributed unevenly over it. If it rotates with an angular velocity ω, the equivalent current will be

A. Zero

B. $Q\omega$

C. $\frac{Q\omega}{2\pi}$

D. $\frac{Q\omega}{2\pi R}$

Answer: C

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14. A long conductor having charge q, with charge density λ is moving with a velocity 2v parallel to its own axis. The convectional current I due to motion of conductor is

A. $I = \lambda v / 2$

B. $I = 2\lambda v$

C. $I = \lambda v$

D. $I = 3\lambda v$

Answer: B

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15. In an ionic solution, sodium ions (Na^+) are moving to the right and chlorine ions (CI^-) are moving to the left. In which direction is the current due to the motion of (1) the sodium ions and (2) the chlorine ions?

A. Both are to the right

B. Current due to Na^+ is to the left, current due to Cl^- is to the right

C. Current due to Na^{+} is to the right, current due to Cl^{-} is to the left

D. Both are to the left

Answer: A

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16. When you flip a switch to turn on a light, the delay before the light turns on is determined by:

A. The speed of the electric field moving in the wire

B. The density of electrons in the wire

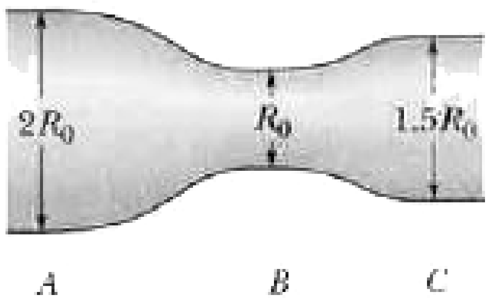
C. The drift speed of the electrons in the wire

D. The number of election collisions per second

Answer: C

Watch Video Solution

17. The following ligure shows the cross section of a wire. Which of the following statement(s) about current (I) and drift velocity (v) is true?



A. $I_A = I_B = I_C$ and $v_A = v_C > v_B$

B. $I_A = I_B = I_C$ and $v_A > v_C > v_B$

C. $I_A = I_B < l_C$ and $v_A = v_C = v_B$

D. $I_A = I_B = l_C$ and $v_A < v_C < v_B$

Answer: D

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18. A hollow copper tube of 5 m length has got external diameter equal to 10 cm and its walls are 5 mm thick. The specific resistance of copper is $1.7 \times 10^{-8} \Omega$ m. The resistance of the copper tube, approximately

A. $5.4 \times 10^{-3} \Omega$

B. $5.4 \times 10^{-9}\Omega$

C. $5.4 \times 10^{-5}\Omega$

D. $5.4 \times 10^{-7}\Omega$

Answer: C

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19. A copper wire is fabricated that has a gradually increasing diameter along its length as shown in the following figure. If an electric current is moving through the wire, which quantities vary along the length of the wire?

A. Current

B. Current and current density

C. Current density

D. Resistivity and current

Answer: C

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20. The magnitude of the electric field within a conducting wire depends on which of the following quantities?

A. Potential difference, wire diameter, wire length, and wire conductivity

B. Potential ditorence and wire conductivity only

C. Potential difference, wire length, and wire conductivity only

D. Wire diameter, wire length, and wire conductivity only

Answer: C

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21. Which one of the following statements concerning the electric field inside a conductor is true if electrons are moving from right to left in a conducting wire?

A. The electric field must be zero in this case

B. The electric field is directed perpendicular to the direction the electrons are moving

C. The electric field is directed toward the left

D. The electric field is directed toward the right

Answer: D

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22. Wires A and B are identical except that each is made from a different material. The one end of wire A is connected to one end of wire B. The two remaining ends are connected across a battery and current flows through the two wires. Which one of the following statements concerning this situation is true?

A. The potential difference across the two wires is the same, but the current through each wire is different

B. The potential difference across the two wires is the same, and the current through each wire is the same

C. The potential difference across the two wires is different, but the current through each wire is the same

D. Both the potential difference across the two wires. and the current through each wire is different

Answer: C

Watch Video Solution

23. A conductor of area of cross-section. A having charge carries, each having a charge q is subjected to a polential difference V. The number density of charge carries in the conductor is an und the charge carries (along with Their random) are moving with a velocity. If s is the conductivity of the conductor and ris the average relaxation

A. $\tau = \frac{m}{nq^2\sigma}$

B. $\tau = \frac{m\sigma}{nq^2}$

C. $\tau = \frac{2m\sigma}{nq^2}$

D. $\tau = \frac{m\sigma}{2nq^2}$

Answer: B

View Text Solution

24. How does the resistivity of a metal wire change if either the number of electrons per unit volume increases or the mean free time increases?

A. In both cases, the resistivity will increase

B. In both cases, the resistivity will decrease

C. Increasing the number of electrons will increase the resistivity, but it will decrease if the mean free time

D. Increasing the number of electrons will decrease the resistivity, but it will increase if the mean free time increases

Answer: B

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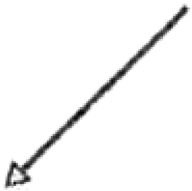
25. The given figure represents a portion of a wire in a circuit. A current is flowing in the wire in the direcnon shown. Under the convention that is positive charge that flows, the electric field point field in the direction of the charge rent. There will be some charge

accumulation at the bend to change the direction of the electric field. What is the direction of the electric field due to charges at the bend?

A. 

B. 

C. 

D. 

Answer: D

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26. Lengths and cross-sectional areas of four pieces of nichrome wire are (L,A), (2L, A), (L, 2A) and (2L, 2A), respectively. If the same voltage difference V is applied across their lengths, which of the wires will get the hottest in steady state?

A. Wire (L,A)

B. Wire (2L,A)

C. Wire (L,2A)

D. Wire (2L,2A)

Answer: C

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27. The insulated wiring in a house can safely carry a maximum current of 18 A. The electrical outlets in the house provide an alternating voltage of 120 V. A space heater when plugged into the ouilet opsates at an average power of 1500 W. How many space heaters can safely. be plugged into a single electrical outlet and turned on for an extended period of time?

A. Zero

B. One

C. Two

D. Three

Answer: B

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28. If the current in an electric bulb decreases by 0.5%, the power in the bulb decreases by approximately

A. 0.005

B. 0.01

C. 0.02

D. 0.002

Answer: B

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29. When a $500 - W$ electric and a $500 - W$ heater operate at their rates voltages, the filament of the bulb reaches a much higher temperature than the filament of the heater. The most important reason for this that

A. Their resistances are not equal

B. They are made of different materials

C. Their dimensions are very different

D. The emissivity of their surface is different

Answer: C

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30. The charge flowing in a conductor varies with times as $Q = at - bt^2$. Then, the current

A. Decreases linearly with time

B. Reaches a maximum and then decreases

C. Falls to vero after time t=a/2b

D. Changes at the rate of -2b

Answer: A::C::D

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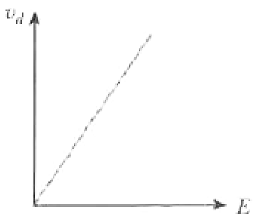
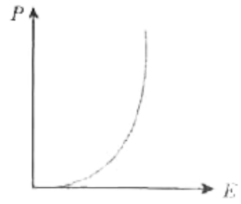
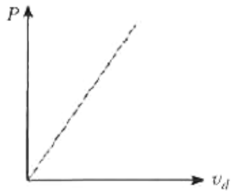
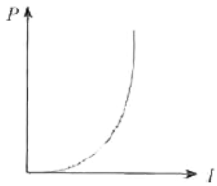
31. E denotes electric field in a uniform conductor, I corresponding current through it, v_d velocity of electrons and P denotes thermal power produced in the conductor, then which of the following graph is correct?

A. 

B. 

C. 

D. 

Answer: A::B::D

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32. A voltmeter and an ammeter are joined, in series to an ideal cell, giving reading V and A respectively. If a resistance equal to the resistance of the ammeter is now joined in parallel to the ammeter then :

A. V will not change.

B. V will increase slightly.

C. A will become exactly half of its initial value.

D. A will become slightly more than half of its initial value.

Answer: B::D

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33. A current passes through a wire of nonuniform cross-section. Which of the following quantites are independent of the cross section?

A. Free electron density

B. Current density

C. Drift speed

D. The charge crossing in a given time interval

Answer: A::D

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34. A uniform wire of resistance R is slaped into a regular n-sided polygon (n is seven). The equivalent resistance between any two corners can have :

A. The maximum value R/4

B. The maximum value R/n

C. The minimum value R $\frac{n-1}{n^2}$

D. The minimum value R/n

Answer: A::C

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35. A copper strip AB and an iron strip AC are joined at A. The junction A is maintained at $0^{\circ}C$ and the free ends B and C are maintained at $100^{\circ}C$. There is a potential difference between

A. The free ends B and C

B. The two ends of copper strip

C. The two ends of iron strip

D. The junction of copper end and iron end

Answer: A::B::C

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36. When no current is passed through a conductor,

A. The free electrons do not move

B. The average speed of a free electron over a large period of time is zero

C. The average thermal velocity of a free electromover large period of time is zero

D. The average of thermal velocity of all the free electrons at an istant is zero

Answer: C::D

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37. Which of the following statements is/are correct?

A. Resistivity of electrolytes decreases on increasing temperature

B. Resistance of mercury falls on decreasing its temperature

C. When joined in series, a 40 W bulb glows more than a 60 W bulb

D. Resistance of a 40 W bulb is less than the resistance of a 60 W bulb

Answer: A::B::C

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38. Which one of the following statements is false?

A. The electrons in a wire carrying an electrical current normally move very slowly ($< 1m/s$)

B. A battery supplies the same current to any object to which it is connected

C. The electric current leaving the positive terminal of a battery is the same as the current returning to the negative terminal

D. A conductor in which an electric current is flowing has an electric field in its interior

Answer: A::B

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39. Which of the following statements are true for a metallic conductor ?

A. The electrical conductivity depends on the mass of atoms

B. The electrical conductivity decreases with rise in temperature

C. The current density depends upon the drift velocity of electronis

D. The electrical conductivity increases with increase in voltage across it

Answer: A::B::C

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Practice Questions Linked Comprehension

1. The alternate discs of iron and carbon, having same area of cross-section are cemented together to make a cylinder whose temperature coefficient of resistivity is zero. The change in temperature in two alternate discs is same. The ratio of their thickness and ratio of heat produced in them is found out. The resistivity of iron and carbon at $20^\circ C$ are 1×10^{-7} and $3 \times 10^{-5} \Omega m$ and their temperature coefficient of resistance are $5 \times 10^{-3} {}^\circ C$ and $-7.5 \times 10^{-4} {}^\circ C$, respectively, Thermal expansion is neglected. Here, $\triangle R_1 + \triangle R_2 = 0$ (where $\triangle R_1$, and $\triangle R_2$, are the increase in resistances of iron and carbon, respectively, with the rise in temperature) because combined temperature coefficient of resistivity is given as zero.

Ratio of their thickness is

A. 54

B. 45

C. 35

D. 21

Answer: B

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2. The alternate discs of iron and carbon, having same area of cross-section are cemented together to make a cylinder whose temperature coefficient of resistivity is zero. The change in temperature in two alternate discs is same. The ratio of their thickness and ratio of heat produced in them is found out. The resistivity of iron and carbon at $20^{\circ} C$ are 1×10^{-7} and $3 \times 10^{-5} \Omega m$ and their temperature coefficient of resistance are $5 \times 10^{-3} {}^{\circ}C$ and $-7.5 \times 10^{-4} {}^{\circ}C$, respectively, Thermal expansion is neglected.

Here, $\triangle R_1 + \triangle R_2 = 0$ (where $\triangle R_1$, and $\triangle R_2$, are the increase in resistances of iron and carbon, respectively, with the rise in temperature) because combined temperature coefficient of resistivity is given as zero.

Ratio of heat produced in them is

A. 0.51

B. 1

C. 0.15

D. 2

Answer: C

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3. The alternate discs of iron and carbon, having same area of cross-section are cemented together to make a cylinder whose temperature coefficient of resistivity is zero. The change in temperature in two alternate discs is same. The ratio of their thickness and ratio of heat produced in them is found out. The resistivity of iron and carbon at

$20^\circ C$ are 1×10^{-7} and $3 \times 10^{-5} \Omega m$ and their temperature coefficient of resistance are $5 \times 10^{-3} {}^\circ C$ and $-7.5 \times 10^{-4} {}^\circ C$, respectively, Thermal expansion is neglected.

Here, $\triangle R_1 + \triangle R_2 = 0$ (where $\triangle R_1$, and $\triangle R_2$, are the increase in resistances of iron and carbon, respectively, with the rise in temperature) because combined temperature coefficient of resistivity is given as zero.

A copper wire is stretched to make it 1% longer. The percentage change in its resistance is Electrical resistance of certain materials, known as super conductors changes abruptly from a non zero value to zero as their temperture is lowered below a critical temperature $T_c(0)$ An interesting property of superconductors is that their critical temperature becomes smaller than $T_c(0)$ if they are placed in a magnetic field, that is, the critical temperature $T_c(B)$ is a function of the magnetic field strength B. The dependence of $T_c(P)$ on magnetic field is shown in the below figure.

A. 0.002

B. 0.01

C. 0.015

D. 0.025

Answer: A

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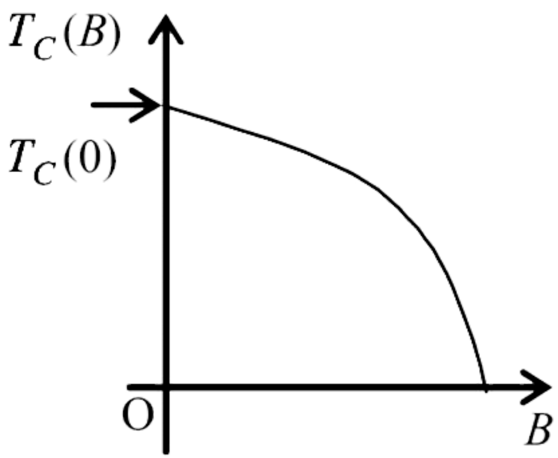
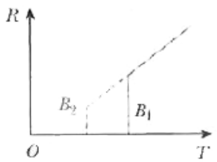
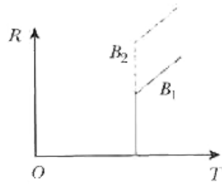
4. Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value of zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of super conductors is that their critical temperature becomes smaller than $T_C(0)$ if they are placed in a magnetic field, i.e., the critical temperature $T_C(B)$ is a function of the magnetic field strength B. The dependence of $T_C(B)$ on B is shown in the figure.

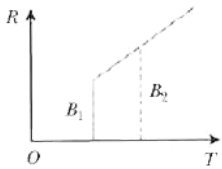


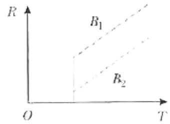
.

In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1(solid line) and B_2 (dashed line). If B_2 is larget than B_1 which of the following graphs shows the correct variation of R with T in these fields?

A. 

B. 

C. 

D. 

Answer: A

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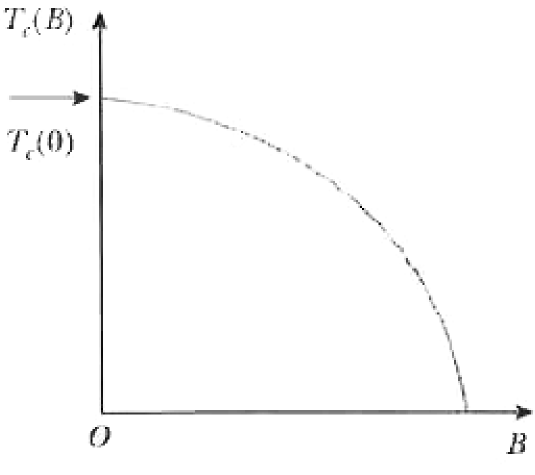
5. Electrical resistance of certain materials, known as superconductors , changes abruptly from a non-zero value to zero as their temperature is lowered below a critical temperature $T_c(0)$ An interesting property of superconductors is that their critical temperature becomes smaller than $T_c(0)$ if they are placed in a magnetic field, that is, the critical temperature $T_c(B)$ is a function of the magnetic field strength B. The dependence of $T_c(B)$ on magnetic field is shown in the below figure .



A superconductor has $T_c(0) = 100K$. When a magnetic field of 7.5T is applied, its T_c

decreases to 75K. For this material, one can definetly say that when

A. $B = 5T, T_C(B) = 80K$

B. $B = 5T, 75K < T_c(B) < 100K$

C. $B = 10T, 75K < T_c < 100K$

D. $B = 10T, T_c = 70K$

Answer: B

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Practice Questions Matrix Match

1. Match the following

Column I	Column II
(a) A conductor of larger length is connected across the battery instead of conductor of shorter length, made of same material	**(p)** A constant current flows through the conductor
(b) The temperature of the connected conductor does not change when connected to the battery	**(q)** The current density is not same throughout conductor
(c) The graph between V and I is a straight line passing through the length of the origin	**(r)** The conductor is a conductor but does not be an ohmic resistor
(d) A conductor of variable area of cross-section is connected across a battery of voltage V	**(s)** The resistivity of the conductor does not change

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2. Match the following

...

Column I	Column II
(a) emf	(p) Motion of electrons in a closed path
(b) current	(q) Motion of electrons through a conductor without any collision
(c) Superconductor	(r) Motion of electrons in a definite direction
(d) Resistance	(s) The collision of electrons while moving through the conductor

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3. Match the following

...

Column I	Column II
(a) The fuse wire	(p) of nickel–chromium alloy
(b) The heating wire	(q) of tin–lead alloy
(c) The best connecting wire	(r) of silver metal
(d) The standard resistance coil	(s) of copper manganese–nickel alloy

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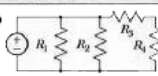
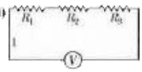
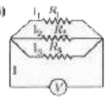
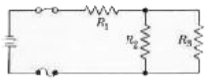
4. There are mainly two types of combinations of resistors in a circuit, series and parallel. In the given table, Column I shows voltages of different arrangements of resistors, Column II shows different arrangement of resistors and Column III shows currents of different arrangements of resistors.

What are the conditions when resistor is in the parallel network?

Column I	Column II	Column III
(I) Voltage remains the same across each resistor in the circuit.	(i) 	(J) Current in the circuit is different through each resistor.
(II) Voltage across resistors in a series connection will be different.	(ii) 	(K) Current will be the same which passes through each resistor.
(III) Voltage across resistors R_2 and R_3 are same.	(iii) 	(L) Current in the circuit is different through resistors R_1 and R_2.
(IV) Voltage across resistors R_1 and R_2 are same.	(iv) 	(M) Current in the circuit is different through resistors R_2 and R_3.

A. (I) (ii) (J)

B. (IV) (ii) (M)

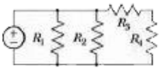
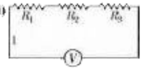
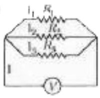
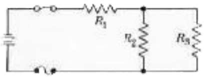
C. (II) (ii) (J)

D. (I) (iii) (J)

Answer: D

5. There are mainly two types of combinations of resistors in a circuit, series and parallel. In the given table, Column I shows voltages of different arrangements of resistors, Column II shows different arrangement of resistors and Column III shows currents of different arrangements of resistors.

What are the conditions when resistors are in mixed combination, that is, parallel and series combination respectively?

Column I	Column II	Column III
(I) Voltage remains the same across each resistor in the circuit.	(i) 	(J) Current in the circuit is different through each resistor.
(II) Voltage across resistors in a series connection will be different.	(ii) 	(K) Current will be the same which passes through each resistor.
(III) Voltage across resistors R_2 and R_3 are same.	(iii) 	(L) Current in the circuit is different through resistors R_1 and R_2.
(IV) Voltage across resistors R_1 and R_2 are same.	(iv) 	(M) Current in the circuit is different through resistors R_2 and R_3.

A. (IV) (iv) (K)

B. (III) (iv) (M)

C. (II) (iii) (L)

D. (I) (i) (M)

Answer: B

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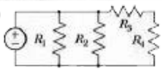
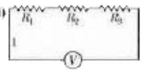
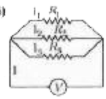
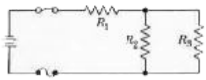
6. There are mainly two types of combinations of resistors in a circuit, series and parallel. In the given table, Column I shows voltages of different arrangements of resistors, Column II shows different arrangement of resistors and Column III shows currents of different arrangements of resistors.

What are the conditions when resistors are in mixed combination, that is series and parallel combination respectively?

Column I	Column II	Column III
(I) Voltage remains the same across each resistor in the circuit.	(i) 	(J) Current in the circuit is different through each resistor.
(II) Voltage across resistors in a series connection will be different.	(ii) 	(K) Current will be the same which passes through each resistor.
(III) Voltage across resistors R_2 and R_3 are same.	(iii) 	(L) Current in the circuit is different through resistors R_1 and R_2.
(IV) Voltage across resistors R_1 and R_2 are same.	(iv) 	(M) Current in the circuit is different through resistors R_2 and R_3.

A. (III) (i) (L)

B. (I) (i) (J)

C. (IV) (i) (L)

D. (II) (iii) (M)

Answer: C

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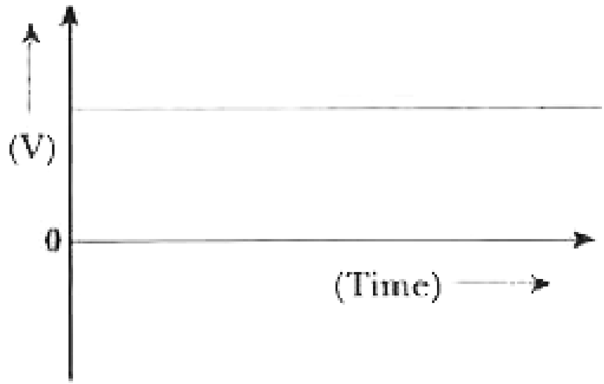
7. Electrical current is the flow of charged particles. The electric current flows through a wire the same way as how water moves in a river. The electricity is nothing but the flow of electrons.

Column I	Column II	Column III
(I) Direct Current	(i) based on Kirchoff's current law.	(J) $\sum V_{abda} = 0$
(II) Loop Current	(ii) electric charge changes the direction periodically	(K) $\sum_i I_i = 0 = I_1 + I_2 + I_3$
(III) Alternating Current	(iii) unidirectional flowofelectric charge	(L) produced by the sources such as batteries
(IV) Node Voltage	(iv) based on Kirchoff's voltage law.	(M) produced by alternator

What does the graph signify?



A. (II) (iv) (J)

B. (IV) (i) (M)

C. (I) (ii) (L)

D. (III) (iv) (K)

Answer: D

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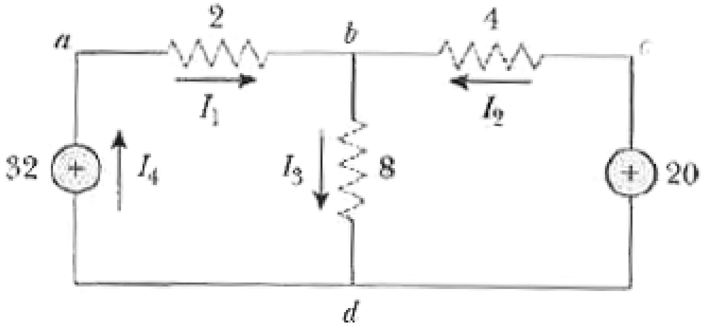
8. Electrical current is the flow of charged particles. The electric current flows through a wire the same way as how water moves in a river. The electricity is nothing but the flow of electrons.

Column I	Column II	Column III
(I) Direct Current	(i) based on Kirchoff's current law.	(J) $\sum V_{abda} = 0$
(II) Loop Current	(ii) electric charge changes the direction periodically	(K) $\sum_i I_i = 0 = I_1 + I_2 + I_3$
(III) Alternating Current	(iii) unidirectional flowofelectric charge	(L) produced by the sources such as batteries
(IV) Node Voltage	(iv) based on Kirchoff's voltage law.	(M) produced by alternator

What does the circuit diagram signify?



A. (III) (i) (K)

B. (IV) (i) (J)

C. (III) (iii) (M)

D. (III) (ii) (M)

Answer: A

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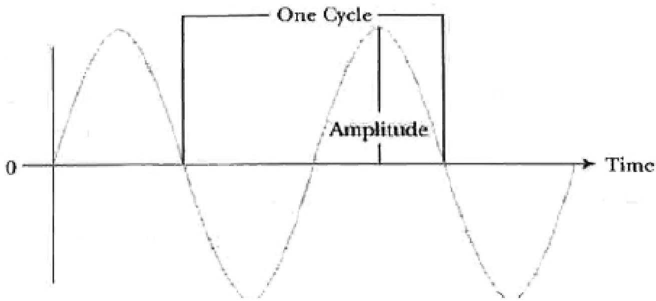
9. Electrical current is the flow of charged particles. The electric current flows through a wire the same way as how water moves in a river. The electricity is nothing but the flow of electrons.

Column I	Column II	Column III
(I) Direct Current	(i) based on Kirchoff's current law.	(J) $\sum V_{abda} = 0$
(II) Loop Current	(ii) electric charge changes the direction periodically	(K) $\sum_i I_i = 0 = I_1 + I_2 + I_3$
(III) Alternating Current	(iii) unidirectional flowofelectric charge	(L) produced by the sources such as batteries
(IV) Node Voltage	(iv) based on Kirchoff's voltage law.	(M) produced by alternator

What does the graph signify?



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Practice Questions Integer Type

1. The length of a potentiometer wire is 10 cm. A cell of emf E is balanced at a length 10/3 cm from the positive end of the wire. If the length of the wire is increased by 5 cm, at what distance (in cm) from positive end will the same cell give a balance point?

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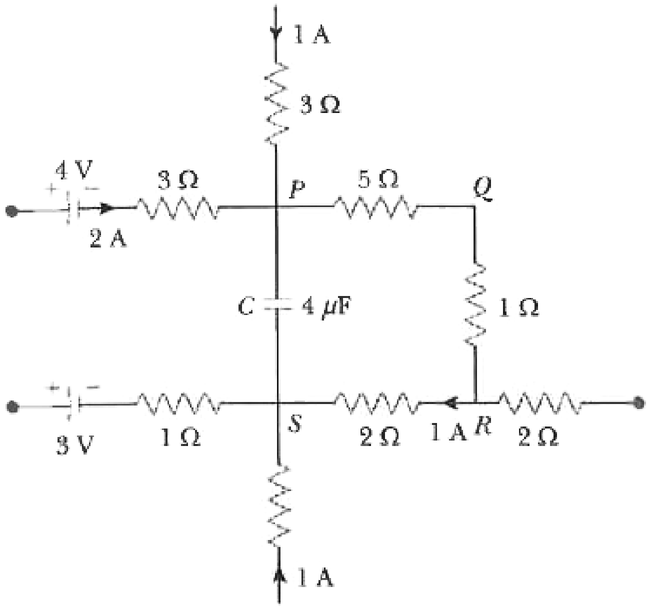
2. The following figure shows a part of complete circuit. The current in various branches in steady state are shown in the figure. What is the energy stored in capacitor in unit of $10^{-4} J$?



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3. A spherical drop of capacitane $2 \mu F$ is broken into eight drops of equal radius. Then

the capacitance of each small drop is $(\text{in } \mu F)$

.

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