Chapter
19
Current Electricity

Electric Current

(1) The time rate of flow of charge through any cross-section is called current. $i = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$. If flow is uniform then $i = \frac{Q}{t}$. Current is a scalar quantity. It's S.I. unit is *ampere* (*A*) and C.G.S. unit is *emu* and is called *biot* (*Bi*), or *ab ampere*. 1*A* = (1/10) *Bi* (*ab amp.*)

(2) *Ampere* of current means the flow of 6.25 × 10^{18} *electrons/sec* through any cross-section of the conductor.

(3) The conventional direction of current is taken to be the direction of flow of positive charge, *i.e.* field and is opposite to th … gative cha …

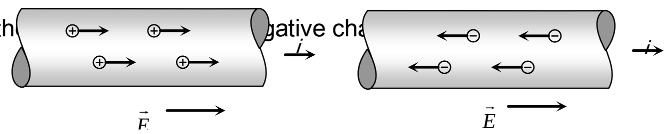


Fig. 19.1

(4) The net charge in a current carrying conductor is zero.

(5) For a given conductor current does not change with change in cross-sectional area. In the following figure $i_1 = i_2 = i_3$

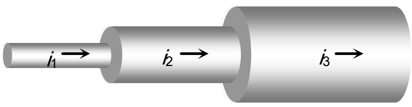


Fig. 19.2

(6) **Current due to translatory motion of charge :** If *n* particle each having a charge *q*, pass through a given area in time *t* then $\boldsymbol{i} = \frac{\boldsymbol{nq}}{\boldsymbol{t}}$

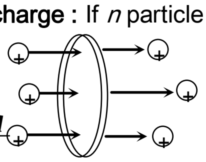
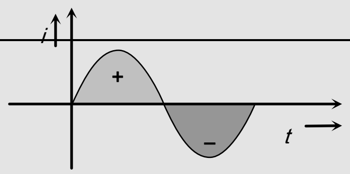
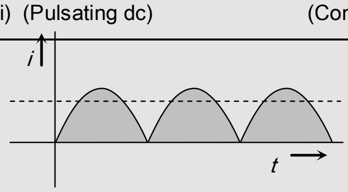
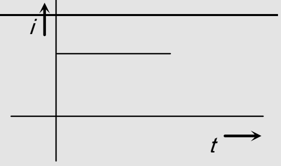


Fig. 19.3

If *n* particles each having a charge *q* pass per second per unit area, the current associated with cross-sectional area *A* is $\boldsymbol{i} = \boldsymbol{nqA}$

If there are *n* particle per unit volume each having a charge *q* and moving with velocity *v*, the current thorough, cross section *A* is $\boldsymbol{i} = \boldsymbol{nqvA}$

Table : 19.1 Types of current

Alternating current (ac)	Direct current (dc)
(i)	(i) (Pulsating dc) (Constant dc)
	 

Magnitude and direction both varies with time ac → Rectifier → dc	dc → Inverter → ac
(ii) Shows heating effect only	(ii) Shows heating effect, chemical effect and magnetic effect of current
(iii) It's symbol is —(~)—	(iii) It's symbol is —+||–—

(7) **Current due to rotatory motion of charge** : If a point charge q is moving in a circle of radius r with speed v (frequency ν, angular speed ω and time period T) then corresponding current $\boldsymbol{i = q\nu = \frac{q}{T} = \frac{qv}{2\pi r} = \frac{q\omega}{2\pi}}$

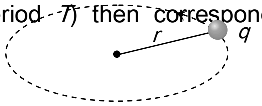


Fig. 19.4

(8) **Current carriers :** The charged particles whose flow in a definite direction constitutes the electric current are called current carriers. In different situation current carriers are different.

(i) Solids : In solid conductors like metals current carriers are free electrons.

(ii) Liquids : In liquids current carriers are positive and negative ions.

(iii) Gases : In gases current carriers are positive ions and free electrons.

(iv) Semi conductor : In semi conductors current carriers are holes and free electrons.

Current Density (J)

Current density at any point inside a conductor is defined as a vector having magnitude equal to current per unit area surrounding that point. Remember area is normal to the direction of charge flow (or current passes) through that point.

(1) Current density at point P is given by $\vec{J} = \frac{di}{dA}\vec{n}$

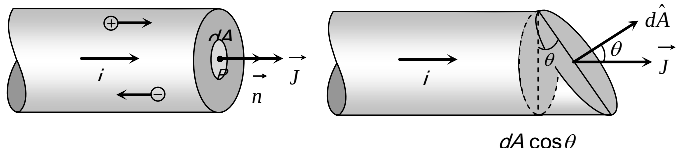


Fig. 19.5

(2) If the cross-sectional area is not normal to the current, but makes an angle θ with the direction of current then

$$J = \frac{di}{dA\cos\theta} \Rightarrow di = JdA\cos\theta = \vec{J}.\vec{dA} \Rightarrow i = \int \vec{J}\cdot\vec{dA}$$

(3) If current density $\vec{J}$ is uniform for a normal cross-section $\vec{A}$ then $\boldsymbol{J = \frac{i}{A}}$

(4) Current density $\vec{J}$ is a vector quantity. It's direction is same as that of $\vec{E}$. It's S.I. unit is *amp/m*^{2} and dimension [$L^{-2}A$].

(5) In case of uniform flow of charge through a cross-section normal to it as $i = nqvA \Rightarrow J = \frac{i}{A} = nqv$.

(6) Current density relates with electric field as $\vec{J} = \sigma\vec{E} = \frac{\vec{E}}{\rho}$; where σ = conductivity and ρ = resistivity or specific resistance of substance.

Drift Velocity

Drift velocity is the average uniform velocity acquired by free electrons inside a metal by the application of an electric field which is responsible for current through it. Drift velocity is very small it is of the order of 10^{-4} *m/s* as compared to thermal speed ($\simeq 10^5\ m/s$) of electrons at room temperature.

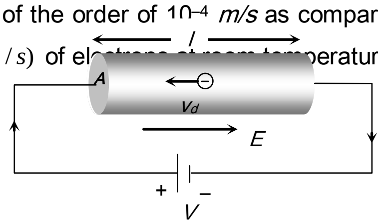


Fig. 19.6

If suppose for a conductor

n = Number of electron per unit volume of the conductor

A = Area of cross-section

V = potential difference across the conductor

E = electric field inside the conductor

i = current, J = current density, ρ = specific resistance, σ = conductivity $\left(\sigma = \frac{1}{\rho}\right)$ then current relates with drift velocity as $\boldsymbol{i = neAv_d}$ we can also write

$$\boldsymbol{v_d = \frac{i}{neA} = \frac{J}{ne} = \frac{\sigma E}{ne} = \frac{E}{\rho ne} = \frac{V}{\rho l n e}}.$$

(1) The direction of drift velocity for electron in a metal is opposite to that of applied electric field (*i.e.* current density $\vec{J}$).

$v_d \propto E$ *i.e.*, greater the electric field, larger will be the drift velocity.

(2) When a steady current flows through a conductor of non-uniform cross-section drift velocity varies inversely with area of cross-section $\left(v_d \propto \frac{1}{A}\right)$

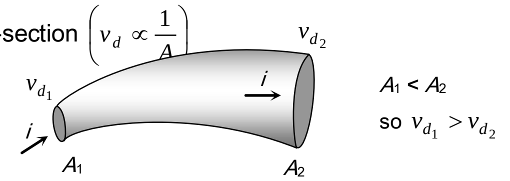


Fig. 19.7

(3) If diameter (d) of a conductor is doubled, then drift velocity of electrons inside it will not change.

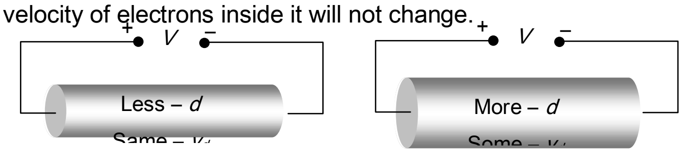


Fig. 19.8

(1) **Relaxation time (τ) :** The time interval between two successive collisions of electrons with the positive ions in the metallic lattice is defined as relaxation time $\tau = \frac{\text{mean free path}}{\text{r.m.s. velocity of electrons}} = \frac{\lambda}{v_{rms}}$. With rise in temperature v_{rms} increases consequently τ decreases.

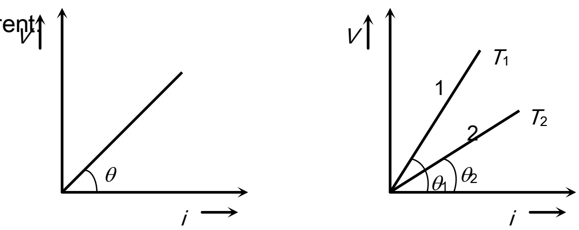
(2) **Mobility :** Drift velocity per unit electric field is called mobility of electron *i.e.* $\mu = \frac{v_d}{E}$. It's unit is $\frac{m^2}{volt - \sec}$.

Ohm's Law

If the physical conditions of the conductor (length, temperature, mechanical strain etc.) remains some, then the current flowing through the conductor is directly proportional to the potential difference across it's two ends *i.e.* $\boldsymbol{i \propto V}$ $\Rightarrow$ $\boldsymbol{V = iR}$ where R is a proportionality constant, known as electric resistance.

(1) Ohm's law is not a universal law, the substances, which obey ohm's law are known as ohmic substance.

(2) Graph between V and i for a metallic conductor is a straight line as shown. At different temperatures V-i curves are different.



(A) Slope of the line $= \tan\theta = \frac{V}{i} = R$

(B) Here $\tan\theta_1 > \tan\theta_2$ So $R_1 > R_2$

Fig. 19.9

(3) The device or substances which don't obey ohm's law *e.g.* gases, crystal rectifiers, thermoionic valve, transistors etc. are known as non-ohmic or non-linear conductors. For these V-i curve is not linear.

Static resistance $R_{st} = \frac{V}{i} = \frac{1}{\tan\theta}$

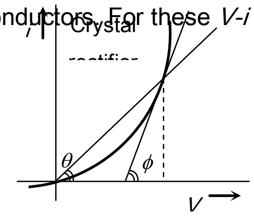


Fig. 19.10

Dynamic resistance $R_{dyn}=\frac{\Delta V}{\Delta I}=\frac{1}{\tan\phi}$

Resistance

(1) The property of substance by virtue of which it opposes the flow of current through it, is known as the resistance.

(2) **Formula of resistance :** For a conductor if *l* = length of a conductor *A* = Area of cross-section of conductor, *n* = No. of free electrons per unit volume in conductor, τ = relaxation time then resistance of conductor $R=\rho\frac{l}{A}=\frac{m}{ne^2\tau}.\frac{l}{A}$; where ρ = resistivity of the material of conductor

(3) **Unit and dimension :** It's S.I. unit is *Volt/Amp.* or *Ohm* (Ω). Also 1 *ohm* $=\frac{1 volt}{1 Amp}=\frac{10^8 emu \text{ of potential}}{10^{-1} emu \text{ of current}}$ = 10^9 *emu* of resistance. It's dimension is $[ML^2T^{-3}A^{-2}]$.

(4) **Dependence of resistance :** Resistance of a conductor depends upon the following factors.

(i) Length of the conductor : Resistance of a conductor is directly proportional to it's length *i.e.* $R\propto l$ and inversely proportional to it's area of cross-section *i.e.* $R\propto\frac{1}{A}$

(ii) Temperature : For a conductor

Resistance $\propto$ **temperature**.

If R_0 = resistance of conductor at 0°*C*

R_t = resistance of conductor at *t*°*C*

and α,β = temperature co-efficient of resistance

then $R_t=R_0(1+\alpha t+\beta t^2)$ for *t* > 300°*C* and

$R_t=R_0(1+\alpha t)$ for $t\le$ 300°*C* or $\alpha=\frac{R_t-R_0}{R_0\times t}$

If R_1 and R_2 are the resistances at t_1°*C* and t_2°*C* respectively then $\frac{R_1}{R_2}=\frac{1+\alpha t_1}{1+\alpha t_2}$.

The value of α is different at different temperature. Temperature coefficient of resistance averaged over the temperature range t_1°*C* to t_2°*C* is given by $\alpha=\frac{R_2-R_1}{R_1(t_2-t_1)}$ which gives $R_2=R_1[1+\alpha(t_2-t_1)]$. This formula gives an approximate value.

Table 19.2 : Variation of resistance of some electrical material with temperature

Material	Temp. coefficient of resistance (α)	Variation of resistance with temperature rise
Metals	Positive	Increases
Solid non-metal	Zero	Independent
Semi-conductor	Negative	Decreases
Electrolyte	Negative	Decreases
Ionised gases	Negative	Decreases
Alloys	Small positive value	Almost constant

Resistivity (ρ), Conductivity (σ) and Conductance (C)

(1) **Resistivity :** From $R=\rho\frac{l}{A}$; If *l* = 1*m*, *A* = 1 m^2 then $R=\rho$ *i.e.* resistivity is numerically equal to the resistance of a substance having unit area of cross-section and unit length.

(i) Unit and dimension : It's S.I. unit is *ohm* × *m* and dimension is $[ML^3T^{-3}A^{-2}]$

(ii) It's formula : $\rho=\frac{m}{ne^2\tau}$

(iii) Resistivity is the intrinsic property of the substance. It is independent of shape and size of the body (*i.e. l* and *A*).

(iv) For different substances their resistivity is also different *e.g.* ρ_{silver} = minimum = 1.6 × 10^{-8} Ω-*m* and $\rho_{fused\ quartz}$ = maximum ≈ 10^{16} Ω-*m*

$$\underset{(\text{Maximum for fused quartz})}{\rho_{insulator}} > \rho_{alloy} > \rho_{semi\text{-}conductor} > \underset{(\text{Minimum for silver})}{\rho_{conductor}}$$

(v) Resistivity depends on the temperature. For metals $\rho_t=\rho_0(1+\alpha\Delta t)$ *i.e.* resitivity increases with temperature.

(vi) Resistivity increases with impurity and mechanical stress.

(vii) Magnetic field increases the resistivity of all metals except iron, cobalt and nickel.

(viii) Resistivity of certain substances like selenium, cadmium, sulphides is inversely proportional to intensity of light falling upon them.

(2) **Conductivity :** Reciprocal of resistivity is called conductivity (σ) *i.e.* $\sigma = \frac{1}{\rho}$ with unit *mho/m* and dimensions $[M^{-1}L^{-3}T^{3}A^{2}]$.

(3) **Conductance :** Reciprocal of resistance is known as conductance. $C = \frac{1}{R}$ It's unit is $\frac{1}{\Omega}$ or Ω^{-1} or "Siemen".

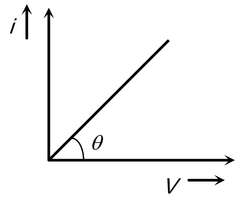
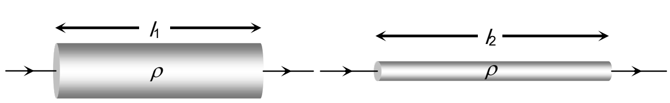


Fig. 19.11

Stretching of Wire

If a conducting wire stretches, it's length increases, area of cross-section decreases so resistance increases but volume remain constant.

Suppose for a conducting wire before stretching it's length = l_1, area of cross-section = A_1, radius = r_1, diameter = d_1, and resistance $R_1 = \rho \frac{l_1}{A_1}$



Volume remains constant *i.e.* $A_1l_1 = A_2l_2$

Fig. 19.12

After stretching length = l_2, area of cross-section = A_2, radius = r_2, diameter = d_2 and resistance $= R_2 = \rho \frac{l_2}{A_2}$

Ratio of resistances before and after stretching

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \left(\frac{l_1}{l_2}\right)^2 = \left(\frac{A_2}{A_1}\right)^2 = \left(\frac{r_2}{r_1}\right)^4 = \left(\frac{d_2}{d_1}\right)^4$$

(1) If length is given then $R \propto l^2 \Rightarrow \frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$

(2) If radius is given then $R \propto \frac{1}{r^4} \Rightarrow \frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^4$

Electrical Conducting Materials For Specific Use

(1) **Filament of electric bulb :** Is made up of tungsten which has high resistivity, high melting point.

(2) **Element of heating devices (such as heater, geyser or press) :** Is made up of nichrome which has high resistivity and high melting point.

(3) **Resistances of resistance boxes (standard resistances) :** Are made up of alloys (manganin, constantan or nichrome) these materials have moderate resistivity which is practically independent of temperature so that the specified value of resistance does not alter with minor changes in temperature.

(4) **Fuse-wire :** Is made up of tin-lead alloy (63% tin + 37% lead). It should have low melting point and high resistivity. It is used in series as a safety device in an electric circuit and is designed so as to melt and thereby open the circuit if the current exceeds a predetermined value due to some fault. The function of a fuse is independent of its length.

Safe current of fuse wire relates with it's radius as $i \propto r^{3/2}$.

(5) **Thermistors** : A thermistor is a heat sensitive resistor usually prepared from oxides of various metals such as nickel, copper, cobalt, iron etc. These compounds are also semi-conductor. For thermistors α is very high which may be positive or negative. The resistance of thermistors changes very rapidly with change of temperature.

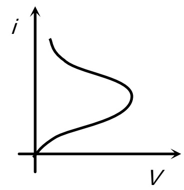


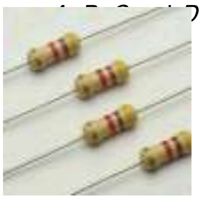
Fig. 19.13

Thermistors are used to detect small temperature change and to measure very low temperature.

Colour Coding of Resistance

To know the value of resistance colour code is used. These code are printed in form of set of rings or strips. By reading the values of colour bands, we can estimate the value of resistance.

The carbon resistance has normally four coloured rings or bands *A*, *B*, *C* and *D* as shown in following figure.



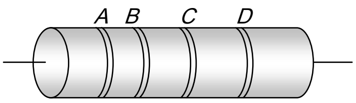


Fig. 19.14

Colour band *A* and *B* : Indicate the first two significant figures of resistance in *ohm*.

Band *C* : Indicates the decimal multiplier *i.e.* the number of zeros that follows the two significant figures *A* and *B*.

Band *D* : Indicates the tolerance in percent about the indicated value or in other words it represents the percentage accuracy of the indicated value.

The tolerance in the case of gold is ± 5% and in silver is ± 10%. If only three bands are marked on carbon resistance, then it indicate a tolerance of 20%.

Table 19.3 : Colour code for carbon resistance

Letters as an aid to memory	Colour	Figure (*A*, *B*)	Multiplier (C)
B	Black	0	10^0
B	Brown	1	10^1
R	Red	2	10^2
O	Orange	3	10^3
Y	Yellow	4	10^4
G	Green	5	10^5
B	Blue	6	10^6
V	Violet	7	10^7
G	Grey	8	10^8
W	White	9	10^9

To remember the sequence of colour code following sentence should kept in memory.

B B R O Y Great Britain Very Good Wife.

Grouping of Resistance

(1) **Series grouping**

(i) Same current flows through each resistance but potential difference distributes in the ratio of resistance *i.e.* $V \propto R$

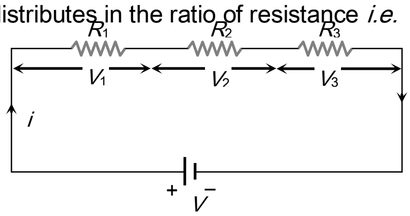


Fig. 19.15

(ii) $R_{eq} = R_1 + R_2 + R_3$ equivalent resistance is greater than the maximum value of resistance in the combination.

(iii) If *n* identical resistance are connected in series $R_{eq} = nR$ and potential difference across each resistance $V' = \frac{V}{n}$

(2) **Parallel grouping**

(i) Same potential difference appeared across each resistance but current distributes in the reverse ratio of their resistance *i.e.* $i \propto \frac{1}{R}$

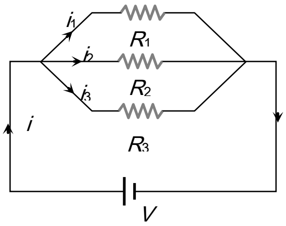


Fig. 19.16

(ii) Equivalent resistance is given by $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

or $R_{eq} = (R_1^{-1} + R_2^{-1} + R_3^{-1})^{-1}$ or $R_{eq} = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_2 R_1}$

Equivalent resistance is smaller than the minimum value of resistance in the combination.

(iv) If two resistance in parallel

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{\text{Multiplication}}{\text{Addition}}$$

(v) Current through any resistance

$$i' = i \times \left[\frac{\text{Resistance of opposite branch}}{\text{Total resistance}}\right]$$

Where *I* = required current (branch current),

i = main current

$$i_1 = i\left(\frac{R_2}{R_1 + R_2}\right)$$

and $i_2 = i\left(\frac{R_1}{R_1 + R_2}\right)$

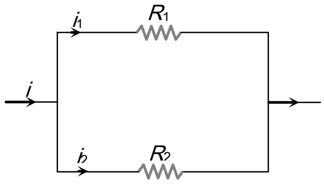


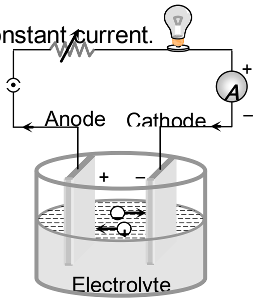
Fig. 19.17

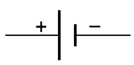
(vi) In *n* identical resistance are connected in parallel

$R_{eq} = \frac{R}{n}$ and current through each resistance $i' = \frac{i}{n}$

Cell

The device which converts chemical energy into electrical energy is known as electric cell. Cell is a source of constant emf but not constant current.





Symbol of cell

Fig. 19.18

(1) **Emf of cell (*E*) :** The potential difference across the terminals of a cell when it is not supplying any current is called it's emf.

(2) **Potential difference (*V*) :** The voltage across the terminals of a cell when it is supplying current to external resistance is called potential difference or terminal voltage. Potential difference is equal to the product of current and resistance of that given part *i.e.* *V* = *iR*.

(3) **Internal resistance (*r*) :** In case of a cell the opposition of electrolyte to the flow of current through it is called internal resistance of the cell. The internal resistance of a cell depends on the distance between electrodes ($r \propto d$), area of electrodes [$r \propto (1/A)$] and nature, concentration ($r \propto C$) and temperature of electrolyte [$r \propto$ (1/ temp.)].

A cell is said to be ideal, if it has zero internal resistance.

Cell in Various Positions

(1) **Closed circuit :** Cell supplies a constant current in the circuit.

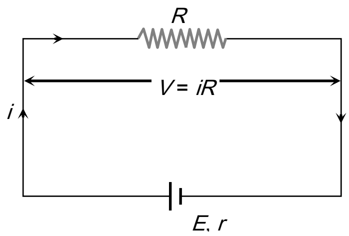


Fig. 19.19

(i) Current given by the cell $i = \frac{E}{R + r}$

(ii) Potential difference across the resistance $V = iR$

(iii) Potential drop inside the cell = *ir*

(iv) Equation of cell $E = V + ir$ (*E* > *V*)

(v) Internal resistance of the cell $r = \left(\frac{E}{V} - 1\right) \cdot R$

(vi) Power dissipated in external resistance (load)

$$P = Vi = i^2 R = \frac{V^2}{R} = \left(\frac{E}{R+r}\right)^2 .R$$

Power delivered will be maximum when $R = r$ so $P_{max} = \frac{E^2}{4r}$.

This statement in generalised from is called "*maximum power transfer theorem*".

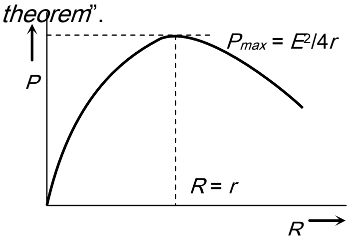


Fig. 19.20

(vii) When the cell is being charged *i.e.* current is given to the cell then $E = V - ir$ and $E < V$.

(2) **Open circuit :** When no current is taken from the cell it is said to be in open circuit

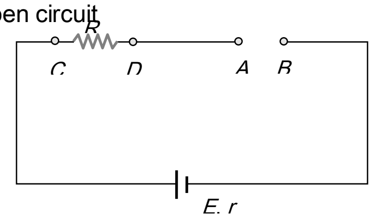


Fig. 19.21

(i) Current through the circuit $i = 0$

(ii) Potential difference between A and B, $V_{AB} = E$

(iii) Potential difference between C and D, $V_{CD} = 0$

(3) **Short circuit :** If two terminals of cell are join together by a thick conducting wire

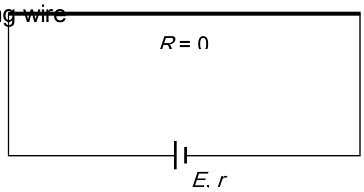


Fig. 19.22

(i) Maximum current (called short circuit current) flows momentarily $i_{sc} = \frac{E}{r}$

(ii) Potential difference $V = 0$

Grouping of Cells

Group of cell is called a battery.

In series grouping of cell's their emf's are additive or subtractive while their internal resistances are always additive. If dissimilar plates of cells are connected together their emf's are added to each other while if their similar plates are connected together their emf's are subtractive.

$E_{eq} = E_1 + E_2$ $\qquad$ $E_{eq} = E_1 - E_2$ ($E_1 > E_2$)

$r_{eq} = r_1 + r_2$ $\qquad$ $r_{eq} = r_1 + r_2$

Fig. 19.23

(1) **Series grouping :** In series grouping anode of one cell is connected to cathode of other cell and so on. If n identical cells are connected in series

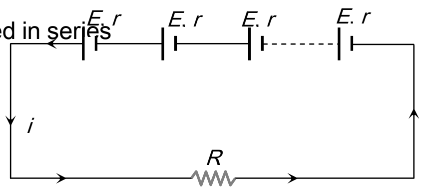


Fig. 19.24

(i) Equivalent emf of the combination $E_{eq} = nE$

(ii) Equivalent internal resistance $r_{eq} = nr$

(iii) Main current = Current from each cell $= i = \frac{nE}{R + nr}$

(iv) Potential difference across external resistance $V = iR$

(v) Potential difference across each cell $V' = \frac{V}{n}$

(vi) Power dissipated in the external circuit $= \left(\frac{nE}{R+nr}\right)^2 . R$

(vii) Condition for maximum power $R = nr$ and $P_{\max} = n\left(\frac{E^2}{4r}\right)$

(viii) This type of combination is used when $nr << R$.

(2) **Parallel grouping :** In parallel grouping all anodes are connected at one point and all cathode are connected together at other point. If *n* identical cells are connected in parallel

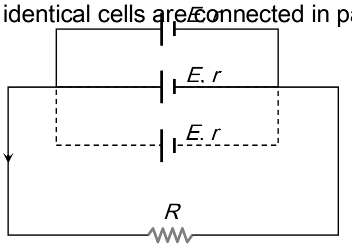


Fig. 19.25

(i) Equivalent emf $E_{eq} = E$

(ii) Equivalent internal resistance $R_{eq} = r/n$

(iii) Main current $i = \frac{E}{R + r/n}$

(iv) potential difference across external resistance = p.d. across each cell = $V = iR$

(v) Current from each cell $i' = \frac{i}{n}$

(vi) Power dissipated in the circuit $P = \left(\frac{E}{R + r/n}\right)^2 . R$

(vii) Condition for max. power is $R = r/n$ and $P_{\max} = n\left(\frac{E^2}{4r}\right)$

(viii) This type of combination is used when $nr >> R$

(3) **Mixed Grouping :** If *n* identical cell's are connected in a row and such *m* row's are connected in parallel as shown.

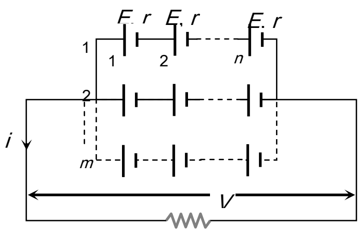


Fig. 19.26

(i) Equivalent emf of the combination $E_{eq} = nE$

(ii) Equivalent internal resistance of the combination $r_{eq} = \frac{nr}{m}$

(iii) Main current flowing through the load $i = \frac{nE}{R + \frac{nr}{m}} = \frac{mnE}{mR + nr}$

(iv) Potential difference across load $V = iR$

(v) Potential difference across each cell $V' = \frac{V}{n}$

(vi) Current from each cell $i' = \frac{i}{n}$

(vii) Condition for maximum power $R = \frac{nr}{m}$ and $P_{\max} = (mn)\frac{E^2}{4r}$

(viii) Total number of cell = mn

Kirchoff's Laws

(1) **Kirchoff's first law :** This law is also known as junction rule or current law (*KCL*). According to it the algebraic sum of currents meeting at a junction is zero *i.e.* $\Sigma i = 0$.

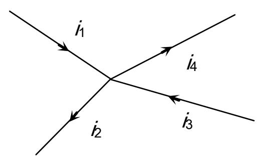


Fig. 19.27

In a circuit, at any junction the sum of the currents entering the junction must equal the sum of the currents leaving the junction. $i_1 + i_3 = i_2 + i_4$

(ii) This law is simply a statement of "*conservation of charge*".

(2) **Kirchoff's second law :** This law is also known as loop rule or voltage law (KVL) and according to it "the algebraic sum of the changes in potential in complete traversal of a mesh (closed loop) is zero", *i.e.* $\sum V = 0$

(i) This law represents "*conservation of energy*".

(ii) If there are n meshes in a circuit, the number of independent equations in accordance with loop rule will be $(n-1)$.

(3) **Sign convention for the application of Kirchoff's law :** For the application of Kirchoff's laws following sign convention are to be considered

(i) The change in potential in traversing a resistance in the direction of current is $-iR$ while in the opposite direction $+iR$

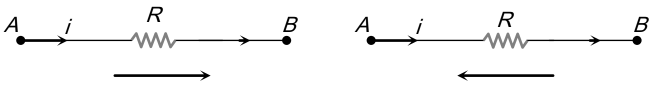


Fig. 19.28

(ii) The change in potential in traversing an emf source from negative to positive terminal is $+E$ while in the opposite direction $-E$ irrespective of the direction of current in the circuit.

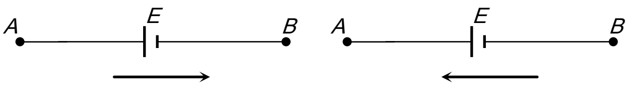


Fig. 19.29

(iii) The change in potential in traversing a capacitor from the negative terminal to the positive terminal is $+\frac{q}{C}$ while in opposite direction $-\frac{q}{C}$.

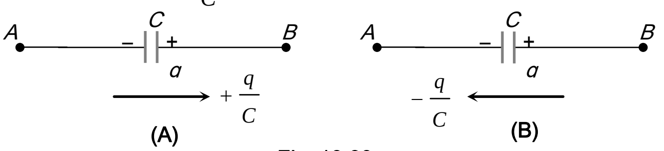


Fig. 19.30

(iv) The change in voltage in traversing an inductor in the direction of current is $-L\frac{di}{dt}$ while in opposite direction it is $+L\frac{di}{dt}$.

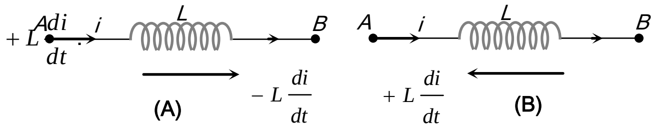
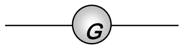


Fig. 19.31

Different Measuring Instruments

(1) **Galvanometer :** It is an instrument used to detect small current passing through it by showing deflection. Galvanometers are of different types *e.g.* moving coil galvanometer, moving magnet galvanometer, hot wire galvanometer. In dc circuit usually moving coil galvanometer are used.

(i) **It's symbol :**  ; where G is the total internal resistance of the galvanometer.

(ii) **Full scale deflection current :** The current required for full scale deflection in a galvanometer is called full scale deflection current and is represented by i_g.

(iii) **Shunt :** The small resistance connected in parallel to galvanometer coil, in order to control current flowing through the galvanometer is known as shunt.

Table 19.4 : Merits and demerits of shunt

Merits of shunt	Demerits of shunt

To protect the galvanometer coil from burning It can be used to convert any galvanometer into ammeter of desired range.	Shunt resistance decreases the sensitivity of galvanometer.

(2) **Ammeter :** It is a device used to measure current and is always connected in series with the 'element' through which current is to be measured.

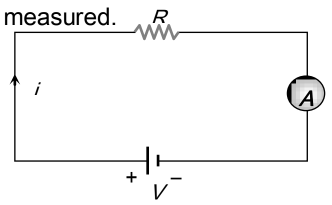


Fig. 19.32

(i) The reading of an ammeter is always lesser than actual current in the circuit.

(ii) Smaller the resistance of an ammeter more accurate will be its reading. An ammeter is said to be ideal if its resistance *r* is zero.

(iii) **Conversion of galvanometer into ammeter** : A galvanometer may be converted into an ammeter by connecting a low resistance (called shunt *S*) in parallel to the galvanometer *G* as shown in figure.

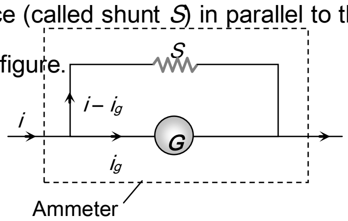


Fig. 19.33

(a) Equivalent resistance of the combination $= \frac{GS}{G+S}$

(b) *G* and *S* are parallel to each other hence both will have equal potential difference *i.e.* $i_g G = (i - i_g)S$; which gives

Required shunt $\boldsymbol{S = \frac{i_g}{(i - i_g)} G}$

(c) To pass *n*th part of main current (*i.e.* $i_g = \frac{i}{n}$) through the galvanometer, required shunt $\boldsymbol{S = \frac{G}{(n-1)}}$.

(3) **Voltmeter :** It is a device used to measure potential difference and is always put in parallel with the 'circuit element' across which potential difference is to be measured.

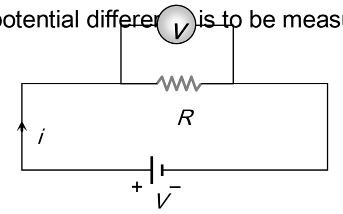


Fig. 19.34

(i) The reading of a voltmeter is always lesser than true value.

(ii) Greater the resistance of voltmeter, more accurate will be its reading. A voltmeter is said to be ideal if its resistance is infinite, *i.e.,* it draws no current from the circuit element for its operation.

(iii) **Conversion of galvanometer into voltmeter** : A galvanometer may be converted into a voltmeter by connecting a large resistance *R* in series with the galvanometer as shown in the figure.

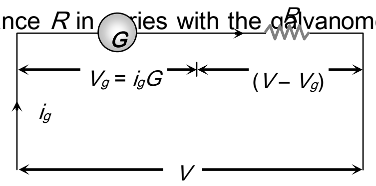


Fig. 19.35

(a) Equivalent resistance of the combination = *G* + *R*

(b) According to ohm's law $V = i_g(G + R)$; which gives

Required series resistance $\boldsymbol{R = \frac{V}{i_g} - G = \left(\frac{V}{V_g} - 1\right)G}$

(c) If n^{th} part of applied voltage appeared across galvanometer (*i.e.* $V_g = \frac{V}{n}$) then required series resistance $\boldsymbol{R = (n-1)\,G}$.

(4) **Wheatstone bridge :** Wheatstone bridge is an arrangement of four resistance which can be used to measure one of them in terms of rest. Here arms AB and BC are called ratio arm and arms AC and BD are called conjugate arms

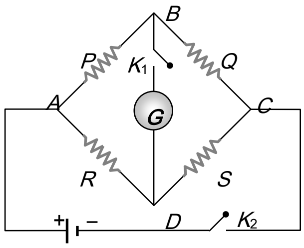


Fig. 19.36

(i) **Balanced bridge :** The bridge is said to be balanced when deflection in galvanometer is zero *i.e.* no current flows through the galvanometer or in other words $V_B = V_D$. In the balanced condition $\frac{P}{Q} = \frac{R}{S}$, on mutually changing the position of cell and galvanometer this condition will not change.

(ii) **Unbalanced bridge :** If the bridge is not balanced current will flow from D to B if $V_D > V_B$ *i.e.* $(V_A - V_D) < (V_A - V_B)$ which gives $PS > RQ$.

(iii) **Applications of wheatstone bridge :** Meter bridge, post office box and Carey Foster bridge are instruments based on the principle of wheatstone bridge and are used to measure unknown resistance.

(5) **Meter bridge :** In case of meter bridge, the resistance wire AC is 100 *cm* long. Varying the position of tapping point B, bridge is balanced. If in balanced position of bridge $AB = l$, BC $(100 - l)$ so that $\frac{Q}{P} = \frac{(100-l)}{l}$. Also $\frac{P}{Q} = \frac{R}{S} \Rightarrow S = \frac{(100-l)}{l} R$

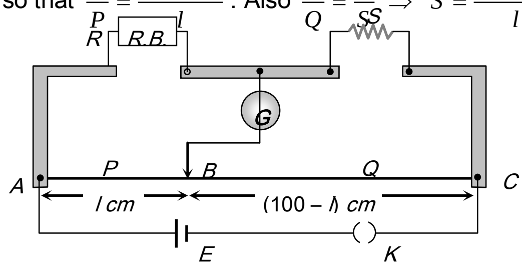


Fig. 19.37

Potentiometer

Potentiometer is a device mainly used to measure emf of a given cell and to compare emf's of cells. It is also used to measure internal resistance of a given cell.

(1) **Circuit diagram :** Potentiometer consists of a long resistive wire AB of length L (about 6*m* to 10 *m* long) made up of mangnine or constantan and a battery of known voltage e and internal resistance r called supplier battery or driver cell. Connection of these two forms primary circuit.

One terminal of another cell (whose emf E is to be measured) is connected at one end of the main circuit and the other terminal at any point on the resistive wire through a galvanometer G. This forms the secondary circuit. Other details are as follows

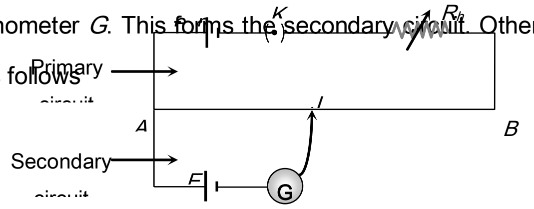


Fig. 19.38

J = Jockey

K = Key

R = Resistance of potentiometer wire,

ρ = Specific resistance of potentiometer wire.

R_h = Variable resistance which controls the current through the wire AB

(i) The specific resistance (ρ) of potentiometer wire must be high but its temperature coefficient of resistance (α) must be low.

(ii) All higher potential points (terminals) of primary and secondary circuits must be connected together at point A and all lower potential points must be connected to point B or jockey.

(iii) The value of known potential difference must be greater than the value of unknown potential difference to be measured.

(iv) The potential gradient must remain constant. For this the current in the primary circuit must remain constant and the jockey must not be slided in contact with the wire.

(v) The diameter of potentiometer wire must be uniform everywhere.

(2) **Potential gradient (*x*) :** Potential difference (or fall in potential) per unit length of wire is called potential gradient *i.e.* $x = \frac{V}{L}\frac{volt}{m}$ where $V = iR = \left(\frac{e}{R + R_h + r}\right).R$.

So $\boldsymbol{x = \frac{V}{L} = \frac{iR}{L} = \frac{i\rho}{A} = \frac{e}{(R + R_h + r)}.\frac{R}{L}}$

(i) Potential gradient directly depends upon

(a) The resistance per unit length (*R/L*) of potentiometer wire.

(b) The radius of potentiometer wire (*i.e.* Area of cross-section)

(c) The specific resistance of the material of potentiometer wire (*i.e.* ρ)

(d) The current flowing through potentiometer wire (*i*)

(ii) potential gradient indirectly depends upon

(a) The emf of battery in the primary circuit (*i.e.* *e*)

(b) The resistance of rheostat in the primary circuit (*i.e.* R_h)

(3) **Working :** Suppose jocky is made to touch a point *J* on wire then potential difference between *A* and *J* will be $V = xl$

At this length (*l*) two potential difference are obtained

(i) *V* due to battery *e* and

(ii) *E* due to unknown cell

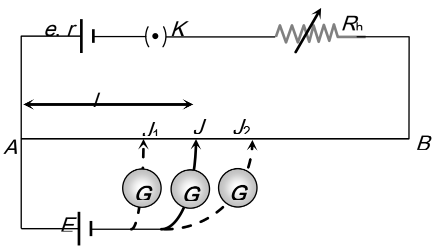
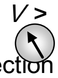


Fig. 19.39

If *V* > *E* then current will flow in galvanometer circuit in one direction 

If  *E* then current will flow in galvanometer circuit in opposite direction

If *V* = *E* then no current will flow in galvanometer circuit this condition to known as null deflection position, length *l* is known as balancing length.

In balanced condition $\boldsymbol{E = xl}$

or $\boldsymbol{E = xl = \frac{V}{L}l = \frac{iR}{L}l = \left(\frac{e}{R + R_h + r}\right).\frac{R}{L} \times l}$

If *V* is constant then $L \propto l \Rightarrow \frac{x_1}{x_2} = \frac{L_1}{L_2} = \frac{l_1}{l_2}$

(6) **Standardization of potentiometer :** The process of determining potential gradient experimentally is known as standardization of potentiometer.

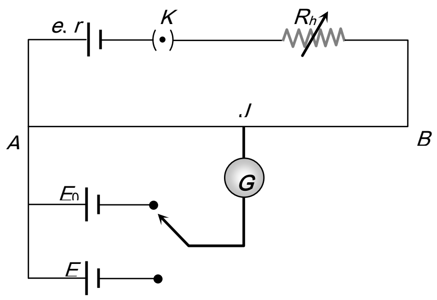


Fig. 19.40

Let the balancing length for the standard emf E_0 is l_0 then by the principle of potentiometer $E_0 = xl_0 \Rightarrow x = \frac{E_0}{l_0}$

(7) **Sensitivity of potentiometer :** A potentiometer is said to be more sensitive, if it measures a small potential difference more accurately.

(i) The sensitivity of potentiometer is assessed by its potential gradient. The sensitivity is inversely proportional to the potential gradient.

(ii) In order to increase the sensitivity of potentiometer

(a) The resistance in primary circuit will have to be decreased.

(b) The length of potentiometer wire will have to be increased so that the length may be measured more accuracy.

Table 19.5 : Difference between voltmeter and potentiometer

Voltmeter	Potentiometer
It's resistance is high but finite	Its resistance is infinite
It draws some current from source of emf	It does not draw any current from the source of unknown emf
The potential difference measured by it is lesser than the actual potential difference	The potential difference measured by it is equal to actual potential difference
Its sensitivity is low	Its sensitivity is high
It is a versatile instrument	It measures only emf or potential difference
It is based on deflection method	It is based on zero deflection method

Application of Potentiometer

(1) **To determine the internal resistance of a primary cell**

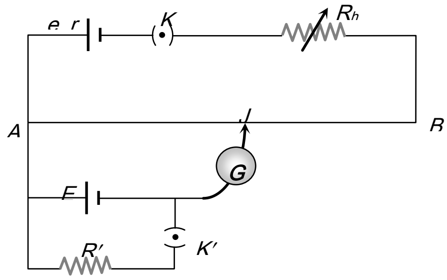


Fig. 19.41

(i) Initially in secondary circuit key K' remains open and balancing length (l_1) is obtained. Since cell E is in open circuit so it's emf balances on length l_1 *i.e.* $E = xl_1$ …. (i)

(ii) Now key K' is closed so cell E comes in closed circuit. If the process of balancing repeated again then potential difference V balances on length l_2 *i.e.* $V = xl_2$
…. (ii)

(iii) By using formula internal resistance $r = \left(\frac{E}{V} - 1\right).R'$

$$r = \left(\frac{l_1 - l_2}{l_2}\right).R'$$

(2) **Comparison of emf's of two cell :** Let l_1 and l_2 be the balancing lengths with the cells E_1 and E_2 respectively then $E_1 = xl_1$ and $E_2 = xl_2 \Rightarrow \frac{E_1}{E_2} = \frac{l_1}{l_2}$

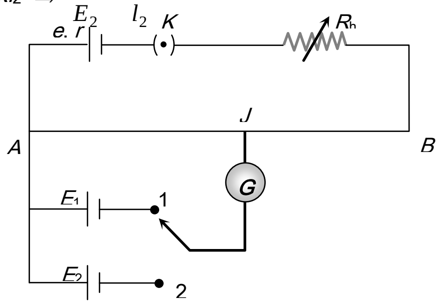
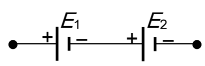
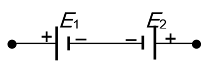


Fig. 19.42

Let $E_1 > E_2$ and both are connected in series. If balancing length is l_1 when cell assist each other and it is l_2 when they oppose each other as shown then :





$(E_1 + E_2) = xl_1$ $\qquad$ $(E_1 - E_2) = xl_2$

$$\Rightarrow \frac{E_1 + E_2}{E_1 - E_2} = \frac{l_1}{l_2} \quad \text{or} \quad \frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2}$$

(3) **Comparison of resistances :** Let the balancing length for resistance R_1 (when XY is connected) is l_1 and let balancing length for resistance $R_1 + R_2$ (when YZ is connected) is l_2.

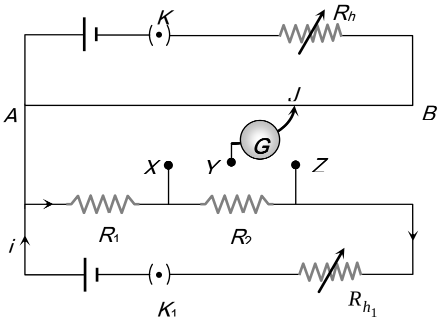


Fig. 19.43

Then $iR_1 = xl_1$ and $i(R_1 + R_2) = xl_2$ $\Rightarrow$ $\frac{R_2}{R_1} = \frac{l_2 - l_1}{l_1}$

(4) **To determine thermo emf**

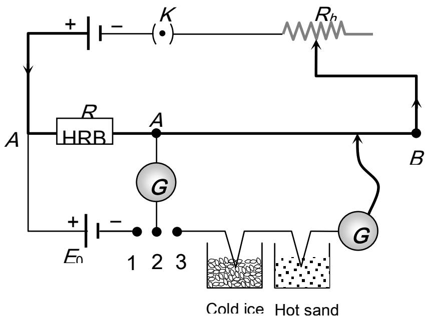


Fig. 19.44

(i) The value of thermo-emf in a thermocouple for ordinary temperature difference is very low (10^{-6} *volt*). For this the potential gradient x must be also very low (10^{-4} *V/m*). Hence a high resistance (R) is connected in series with the potentiometer wire in order to reduce current.

(ii) The potential difference across R must be equal to the emf of standard cell *i.e.* $iR = E_0$ $\therefore$ $i = \frac{E_0}{R}$

(iii) The small thermo emf produced in the thermocouple $e = xl$

(iv) $x = i\rho = \frac{iR}{L}$ $\therefore$ $e = \frac{iRl}{L}$ where L = length of potentiometer wire, ρ = resistance per unit length, l = balancing length for e

(5) **Calibration of ammeter :** Checking the correctness of ammeter readings with the help of potentiometer is called calibration of ammeter.

(i) In the process of calibration of an ammeter the current flowing in a circuit is measured by an ammeter and the same current is also measured with the help of potentiometer. By comparing both the values, the errors in the ammeter readings are determined.

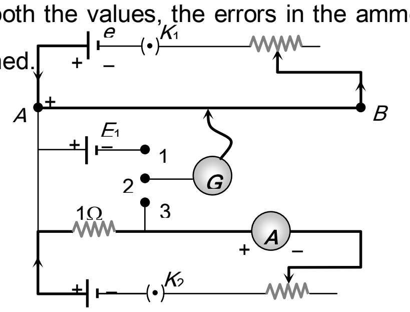


Fig. 19.45

(ii) For the calibration of an ammeter, 1 Ω standard resistance coil is specifically used in the secondary circuit of the potentiometer, because the potential difference across 1 Ω is equal to the current flowing through it *i.e.* $V = i$.

(iii) If the balancing length for the emf E_0 is l_0 then $E_0 = xl_0$ $\Rightarrow x = \frac{E_0}{l_0}$ (Process of standardisation)

(iv) Let i' current flows through 1Ω resistance giving potential difference as $V' = i'(1) = xl_1$ where l_1 is the balancing length. So error can be found as $\Delta i = i - i' = i - xl_1 = i - \frac{E_0}{l_0} \times l_1$

(6) **Calibration of voltmeter**

(i) Practical voltmeters are not ideal, because these do not have infinite resistance. The error of such practical voltmeter can be found by comparing the voltmeter reading with calculated value of p.d. by potentiometer.

(ii) If l_0 is balancing length for E_0 the emf of standard cell by connecting 1 and 2 of bi-directional key, then $x = E_0/l_0$.

(iii) The balancing length l_1 for unknown potential difference V is given by (by closing 2 and 3) $V' = xl_1 = (E_0/l_0)l_1$.

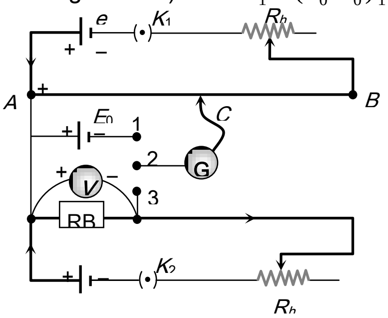


Fig. 19.46

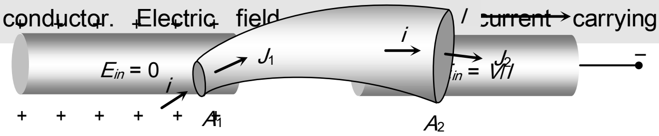
If the voltmeter reading is V then the error will be $(V' - V)$ which may be $+ve$, $-ve$ or zero.

Tips & Tricks

✍ Human body, though has a large resistance of the order of $k\Omega$ (say 10 $k\Omega$), is very sensitive to minute currents even as low as a few mA. Electrocution, excites and disorders the nervous system of the body and hence one fails to control the activity of the body.

✍ *dc* flows uniformly throughout the cross-section of conductor while ac mainly flows through the outer surface area of the conductor. This is known as skin effect.

✍ It is worth noting that electric field inside a charged conductor is zero, but it is non zero inside a current carrying conductor and is given by $E = \frac{V}{l}$ where V = potential difference across the conductor and l = length of the conductor. Electric field [illegible] current carrying conductor is zero.



✍ For a given conductor $JA = i$ = constant so that $J \propto \frac{1}{A}$ *i.e.*, $J_1A_1 = J_2A_2$; this is called equation of continuity

✍ The drift velocity of electrons is small because of the frequent collisions suffered by electrons.

✍ The small value of drift velocity produces a large amount of electric current, due to the presence of extremely large number of free electrons in a conductor.

The propagation of current is almost at the speed of light and involves electromagnetic process. It is due to this reason that the electric bulb glows immediately when switch is on.

✍ In the absence of electric field, the paths of electrons between successive collisions are straight line while in presence of electric field the paths are generally curved.

✍ Free electron density in a metal is given by $n = \frac{N_A x\, d}{A}$ where N_A = Avogadro number, x = number of free electrons per atom, d = density of metal and A = Atomic weight of metal.

✍ In the absence of radiation loss, the time in which a fuse will melt does not depends on it's length but varies with radius as $t \propto r^4$.

✍ If length (l) and mass (m) of a conducting wire is given then $R \propto \frac{l^2}{m}$.

✍ Macroscopic form of Ohm's law is $R = \frac{V}{i}$, while it's microscopic form is J = σ E.

✍ After stretching if length increases by *n* times then resistance will increase by n^2 times *i.e.* $R_2 = n^2 R_1$. Similarly if radius be reduced to $\frac{1}{n}$ times then area of cross-section decreases $\frac{1}{n^2}$ times so the resistance becomes n^4 times *i.e.* $R_2 = n^4 R_1$.

✍ After stretching if length of a conductor increases by *x*% then resistance will increases by 2*x* % (valid only if *x* < 10%)

✍ Decoration of lightning in festivals is an example of series grouping whereas all household appliances connected in parallel grouping.

✍ Using *n* conductors of equal resistance, the number of possible combinations is 2^{n-1}.

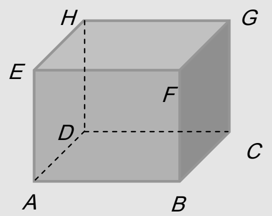
✍ If the resistance of *n* conductors are totally different, then the number of possible combinations will be 2^n.

✍ If n identical resistances are first connected in series and then in parallel, the ratio of the equivalent resistance is given by $\frac{R_p}{R_s} = \frac{n^2}{1}$.

✍ If a wire of resistance *R*, cut in n equal parts and then these parts are collected to form a bundle then equivalent resistance of combination will be $\frac{R}{n^2}$.

✍ If equivalent resistance of R_1 and R_2 in series and parallel be R_s and R_p respectively then $R_1 = \frac{1}{2}\left[R_s + \sqrt{R_s^2 - 4R_sR_p}\right]$ and $R_2 = \frac{1}{2}\left[R_s - \sqrt{R_s^2 - 4R_sR_p}\right]$.

✍ If a skeleton cube is made with 12 equal resistance each having resistance R then the net resistance across

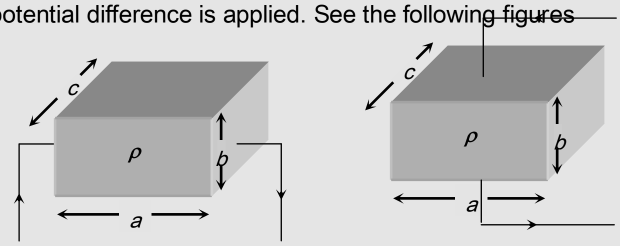


The longest diagonal (*EC* or *AG*) $= \frac{5}{6}R$

The diagonal of face (*e.g. AC, ED, ...*) $= \frac{3}{4}R$

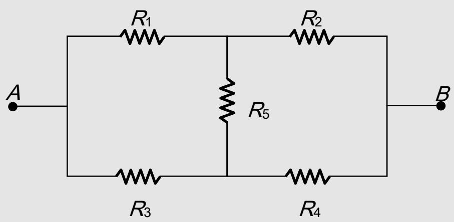
A side (*e.g. AB, BC.....*) $= \frac{7}{12}R$

✍ Resistance of a conducting body is not unique but depends on it's length and area of cross-section *i.e.* how the potential difference is applied. See the following figures

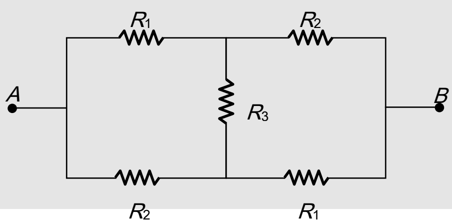


Length = *a*	Length = *b*
Area of cross-section = *b* × *c*	Area of cross-section = *a* × *c*
Resistance $R = \rho\left(\frac{a}{b \times c}\right)$	Resistance $R = \rho\left(\frac{b}{a \times c}\right)$

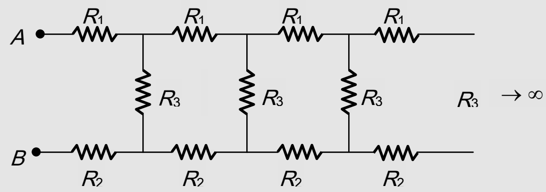
✍ Some standard results for equivalent resistance



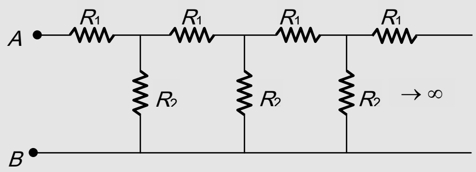
$$R_{AB} = \frac{R_1R_2(R_3+R_4)+(R_1+R_2)R_3R_4+R_5(R_1+R_2)(R_3+R_4)}{R_5(R_1+R_2+R_3+R_4)+(R_1+R_3)(R_2+R_4)}$$



$$R_{AB} = \frac{2R_1R_2 + R_3(R_1 + R_2)}{2R_3 + R_1 + R_2}$$



$$R_{AB} = \frac{1}{2}(R_1 + R_2) + \frac{1}{2}\left[(R_1 + R_2)^2 + 4R_3(R_1 + R_2)\right]^{1/2}$$



$$R_{AB} = \frac{1}{2}R_1\left[1 + \sqrt{1 + 4\left(\frac{R_2}{R_1}\right)}\right]$$

✍ It is a common misconception that "current in the circuit will be maximum when power consumed by the load is maximum."

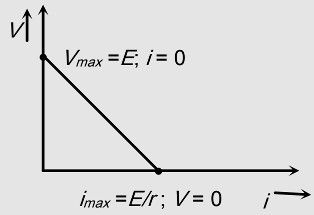
Actually current $i = E/(R + r)$ is maximum (= E/r) when R = min = 0 with $P_L = (E/r)^2 \times 0 = 0$ min. while power consumed by the load $E^2R/(R + r)^2$ is maximum (= $E^2/4r$) when $R = r$ and $i = (E/2r) \neq \max(= E/r)$.

✍ Emf is independent of the resistance of the circuit and depends upon the nature of electrolyte of the cell while potential difference depends upon the resistance between the two points of the circuit and current flowing through the circuit.

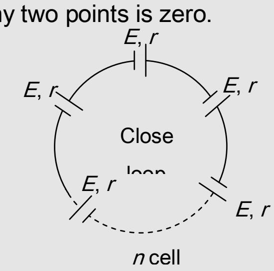
✍ Whenever a cell or battery is present in a branch there must be some resistance (internal or external or both) present in that branch. In practical situation it always happen because we can never have an ideal cell or battery with zero resistance.

✍ In series grouping of identical cells. If one cell is wrongly connected then it will cancel out the effect of two cells *e.g.* If in the combination of n identical cells (each having emf E and internal resistance r) if x cell are wrongly connected then equivalent emf $E_{eq} = (n - 2x)E$ and equivalent internal resistance $r_{eq} = nr$.

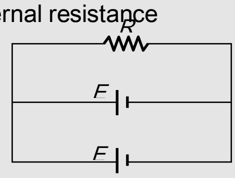
✍ Graphical view of open circuit and closed circuit of a cell.

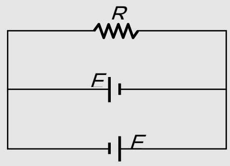


✍ If n identical cells are connected in a loop in order, then emf between any two points is zero.



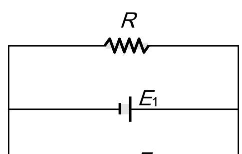
✍ In parallel grouping of two identical cell having no internal resistance





$E_{eq} = E$ $\qquad$ $E_{eq} = 0$

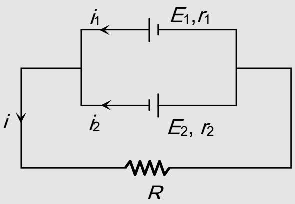
☞ When two cell's of different emf and no internal resistance are connected in parallel then equivalent emf is



indeterminate, note that connecting a wire with a cell with no resistance is equivalent to short circuiting. Therefore the total current that will be flowing will be infinity.

✍ In the parallel combination of non-identical cell's if they are connected with reversed polarity as shown then equivalent emf

$$E_{eq} = \frac{E_1 r_2 - E_2 r_1}{r_1 + r_2}$$



✍ Wheatstone bridge is most sensitive if all the arms of bridge have equal resistances *i.e.* $P = Q = R = S$

✍ If the temperature of the conductor placed in the right gap of metre bridge is increased, then the balancing length decreases and the jockey moves towards left.

✍ In Wheatstone bridge to avoid inductive effects the battery key should be pressed first and the galvanometer key afterwards.

✍ The measurement of resistance by Wheatstone bridge is not affected by the internal resistance of the cell.

✍ In case of zero deflection in the galvanometer current flows in the primary circuit of the potentiometer, not in the galvanometer circuit.

✍ A potentiometer can act as an ideal voltmeter.

OT Ordinary Thinking

Objective Questions

Electric Conduction, Ohm's Law and Resistance

1. Current of 4.8 amperes is flowing through a conductor. The number of electrons per second will be **[CPMT 1986]**

(a) 3×10^{19} (b) 7.68×10^{21}

(c) 7.68×10^{20} (d) 3×10^{20}

2. When the current i is flowing through a conductor, the drift velocity is v. If $2i$ current is flowed through the same metal but having double the area of cross-section, then the drift velocity will be

(a) $v/4$ (b) $v/2$

(c) v (d) $4v$

3. When current flows through a conductor, then the order of drift velocity of electrons will be **[CPMT 1986]**

(a) $10^{10}\ m/\sec$ (b) $10^{-2}\ cm/\sec$

(c) $10^{4}\ cm/\sec$ (d) $10^{-1}\ cm/\sec$

4. Every atom makes one free electron in copper. If 1.1 ampere current is flowing in the wire of copper having 1 mm diameter, then the drift velocity (approx.) will be (Density of copper $= 9 \times 10^3\ kg\ m^{-3}$ and atomic weight = 63)

[CPMT 1989]

(a) $0.3\ mm/\sec$ (b) $0.1\ mm/\sec$

(c) $0.2\ mm/\sec$ (d) $0.2\ cm/\sec$

5. Which one is not the correct statement **[NCERT 1978]**

(a) $1\ volt \times 1\ coulomb = 1\ joule$

(b) $1\ volt \times 1\ ampere = 1\ joule/second$

(c) $1\ volt \times 1\ watt = 1\ H.P.$

(d) Watt-hour can be expressed in eV

6. If a 0.1 % increase in length due to stretching, the percentage increase in its resistance will be

[MNR 1990; MP PMT 1996; UPSEAT 1999; MP PMT 2000]

(a) 0.2 % (b) 2 %

(c) 1 % (d) 0.1 %

7. The specific resistance of manganin is $50\times10^{-8}\ ohm\times m$.

The resistance of a cube of length $50\ cm$ will be

(a) $10^{-6}\ ohm$ (b) $2.5\times10^{-5}\ ohm$

(c) $10^{-8}\ ohm$ (d) $5\times10^{-4}\ ohm$

8. The resistivity of iron is $1\times10^{-7}\ ohm-m$. The resistance of a iron wire of particular length and thickness is 1 *ohm*. If the length and the diameter of wire both are doubled, then the resistivity in $ohm-m$ will be [CPMT 1983; DPMT 1999]

(a) 1×10^{-7} (b) 2×10^{-7}

(c) 4×10^{-7} (d) 8×10^{-7}

9. The temperature coefficient of resistance for a wire is $0.00125/°C$. At 300K its resistance is 1 *ohm*. The temperature at which the resistance becomes 2 *ohm* is

[IIT 1980; MP PET 2002; KCET 2003; MP PMT 2001; Orissa JEE 2002]

(a) 1154 K (b) 1100 K

(c) 1400 K (d) 1127 K

10. When the length and area of cross-section both are doubled, then its resistance [MP PET 1989]

(a) Will become half (b) Will be doubled

(c) Will remain the same (d) Will become four times

11. The resistance of a wire is 20 *ohms*. It is so stretched that the length becomes three times, then the new resistance of the wire will be

(a) 6.67 *ohms* (b) 60.0 *ohms*

(c) 120 *ohms* (d) 180.0 *ohms*

12. The resistivity of a wire [MP PMT 1984; DPMT 1982]

(a) Increases with the length of the wire

(b) Decreases with the area of cross-section

(c) Decreases with the length and increases with the cross-section of wire

(d) None of the above statement is correct

13. *Ohm*'s law is true

(a) For metallic conductors at low temperature

(b) For metallic conductors at high temperature

(c) For electrolytes when current passes through them

(d) For diode when current flows

14. The example for non-*ohm*ic resistance is [MP PMT 1978]

(a) Copper wire (b) Carbon resistance

(c) Diode (d) Tungsten wire

15. Drift velocity v_d varies with the intensity of electric field as per the relation [CPMT 1981; BVP 2003]

(a) $v_d \propto E$ (b) $v_d \propto \frac{1}{E}$

(c) $v_d = \text{constant}$ (d) $v_d \propto E^2$

16. On increasing the temperature of a conductor, its resistance increases because [CPMT 1982]

(a) Relaxation time decreases

(b) Mass of the electrons increases

(c) Electron density decreases

(d) None of the above

17. In a conductor 4 *coulombs* of charge flows for 2 *seconds*. The value of electric current will be [CPMT 1984]

(a) 4 *volts* (b) 4 *amperes*

(c) 2 *amperes* (d) 2 *volts*

18. The specific resistance of a wire is ρ, its volume is $3\,m^3$ and its resistance is 3 *ohms*, then its length will be

[CPMT 1984]

(a) $\sqrt{\frac{1}{\rho}}$ (b) $\frac{3}{\sqrt{\rho}}$

(c) $\frac{1}{\rho}\sqrt{3}$ (d) $\rho\sqrt{\frac{1}{3}}$

19. 62.5×10^{18} electrons per second are flowing through a wire of area of cross-section $0.1\,m^2$, the value of current flowing will be

(a) 1 A (b) 0.1 A

(c) 10 A (d) 0.11 A

20. A piece of wire of resistance 4 *ohms* is bent through $180°$ at its mid point and the two halves are twisted together, then the resistance is [CPMT 1971]

(a) 8 *ohms* (b) 1 *ohm*

(c) 2 *ohms* (d) 5 *ohms*

21. When a piece of aluminium wire of finite length is drawn through a series of dies to reduce its diameter to half its original value, its resistance will become [MP PET 1989]

[NCERT 1974; AIIMS 1997; MH CET 2000; UPSEAT 2001; CBSE PMT 2002]

(a) Two times (b) Four times

(c) Eight times (d) Sixteen times

22. A wire 100 cm long and 2.0 mm diameter has a resistance of 0.7 *ohm*, the electrical resistivity of the material is

(a) $4.4\times10^{-6}\,ohm\times m$ (b) $2.2\times10^{-6}\,ohm\times m$

(c) $1.1\times10^{-6}\,ohm\times m$ (d) $0.22\times10^{-6}\,ohm\times m$

23. A certain wire has a resistance R. The resistance of another wire identical with the first except having twice its diameter is

(a) $2R$ (b) $0.25R$

(c) $4R$ (d) $0.5R$

24. In hydrogen atom, the electron makes 6.6×10^{15} revolutions per second around the nucleus in an orbit of radius $0.5\times10^{-10}\,m$. It is equivalent to a current nearly

(a) 1 A (b) 1 mA

(c) 1 μA (d) $1.6\times10^{-19}\,A$

25. A wire of length 5 m and radius 1 mm has a resistance of 1 *ohm*. What length of the wire of the same material at the same temperature and of radius 2 mm will also have a resistance of 1 *ohm*

(a) 1.25 m (b) 2.5 m

(c) 10 m (d) 20 m

26. When there is an electric current through a conducting wire along its length, then an electric field must exist

(a) Outside the wire but normal to it

(b) Outside the wire but parallel to it

(c) Inside the wire but parallel to it

(d) Inside the wire but normal to it

27. Through a semiconductor, an electric current is due to drift of

(a) Free electrons

(b) Free electrons and holes

(c) Positive and negative ions

(d) Protons

28. In an electrolyte 3.2×10^{18} bivalent positive ions drift to the right per second while 3.6×10^{18} monovalent negative ions drift to the left per second. Then the current is

(a) 1.6 amp to the left (b) 1.6 amp to the right
(c) 0.45 amp to the right (d) 0.45 amp to the left

29. A metallic block has no potential difference applied across it, then the mean velocity of free electrons is T = absolute temperature of the block)

(a) Proportional to T
(b) Proportional to $\sqrt{T}$
(c) Zero
(d) Finite but independent of temperature

30. The specific resistance of all metals is most affected by

(a) Temperature (b) Pressure
(c) Degree of illumination (d) Applied magnetic field

31. The positive temperature coefficient of resistance is for

(a) Carbon (b) Germanium
(c) Copper (d) An electrolyte

32. The fact that the conductance of some metals rises to infinity at some temperature below a few Kelvin is called

(a) Thermal conductivity (b) Optical conductivity
(c) Magnetic conductivity (d) Superconductivity

33. Dimensions of a block are $1\,cm\times1\,cm\times100\,cm$. If specific resistance of its material is $3\times10^{-7}\,ohm-m$, then the resistance between the opposite rectangular faces is [MP PET 1993]

(a) $3\times10^{-9}\,ohm$ (b) $3\times10^{-7}\,ohm$
(c) $3\times10^{-5}\,ohm$ (d) $3\times10^{-3}\,ohm$

34. In the above question, the resistance between the square faces is

(a) $3\times10^{-9}\,ohm$ (b) $3\times10^{-7}\,ohm$
(c) $3\times10^{-5}\,ohm$ (d) $3\times10^{-3}\,ohm$

35. There is a current of 20 amperes in a copper wire of 10^{-6} square metre area of cross-section. If the number of free electrons per cubic metre is 10^{29}, then the drift velocity is

(a) $125\times10^{-3}\,m/sec$ (b) $12.5\times10^{-3}\,m/sec$
(c) $1.25\times10^{-3}\,m/sec$ (d) $1.25\times10^{-4}\,m/sec$

36. The electric intensity E, current density j and specific resistance k are related to each other by the relation [DPMT 2001]

(a) $E=j/k$ (b) $E=jk$
(c) $E=k/j$ (d) $k=jE$

37. The resistance of a wire of uniform diameter d and length L is R. The resistance of another wire of the same material but diameter $2d$ and length $4L$ will be [CPMT 1984; MP PET 2002]

(a) $2R$ (b) R
(c) $R/2$ (d) $R/4$

38. There is a current of 1.344 *amp* in a copper wire whose area of cross-section normal to the length of the wire is $1\,mm^2$. If the number of free electrons per cm^3 is 8.4×10^{22}, then the drift velocity would be [CPMT 1990]

(a) 1.0 mm/sec (b) 1.0 m/sec
(c) 0.1 mm/sec (d) 0.01 mm/sec

39. It is easier to start a car engine on a hot day than on a cold day. This is because the internal resistance of the car battery

(a) Decreases with rise in temperature
(b) Increases with rise in temperature
(c) Decreases with a fall in temperature
(d) Does not change with a change in temperature

40. 5 *amperes* of current is passed through a metallic conductor. The charge flowing in one minute in coulombs will be [MP PET 1984]

(a) 5 (b) 12
(c) 1/12 (d) 300

41. Two wires of the same material are given. The first wire is twice as long as the second and has twice the diameter of the second. The resistance of the first will be [MP PMT 1993]

(a) Twice of the second (b) Half of the second
(c) Equal to the second (d) Four times of the second

42. An electric wire is connected across a cell of e.m.f. *E*. The current I is measured by an ammeter of resistance *R*. According to *ohm*'s law

(a) $E=I^2R$ (b) $E=IR$
(c) $E=R/I$ (d) $E=I/R$

43. The resistances of a wire at temperatures $t°C$ and $0°C$ are related by [MP PMT 1993]

(a) $R_t=R_0(1+\alpha t)$ (b) $R_t=R_0(1-\alpha t)$
(c) $R_t=R_0^2(1+\alpha t)$ (d) $R_t=R_0^2(1-\alpha t)$

44. An electric wire of length '*l*' and area of cross-section a has a resistance *R ohms*. Another wire of the same material having same length and area of cross-section 4*a* has a resistance of [MP PET 1993]

(a) 4*R* (b) *R*/4
(c) *R*/16 (d) 16*R*

45. For which of the following the resistance decreases on increasing the temperature [MP PET 1993]

(a) Copper (b) Tungsten
(c) Germanium (d) Aluminium

46. If n, e, τ and m respectively represent the density, charge relaxation time and mass of the electron, then the resistance of a wire of length l and area of cross-section A will be [CPMT 1992]

(a) $\frac{ml}{ne^2\tau A}$ (b) $\frac{m\tau^2 A}{ne^2 l}$
(c) $\frac{ne^2\tau A}{2ml}$ (d) $\frac{ne^2 A}{2m\tau l}$

47. The relaxation time in conductors [DPMT 2003]

(a) Increases with the increase of temperature
(b) Decreases with the increase of temperature
(c) It does not depend on temperature
(d) All of sudden changes at 400 K

48. Which of the following statement is correct

(a) Liquids obey fully the *ohm*'s law
(b) Liquids obey partially the *ohm*'s law
(c) There is no relation between current and p.d. for liquids

(d) None of the above

49. A certain piece of silver of given mass is to be made like a wire. Which of the following combination of length (L) and the area of cross-sectional (A) will lead to the smallest resistance [MP PMT 1995; CBSE PMT 1997]

(a) L and A

(b) $2L$ and $A/2$

(c) $L/2$ and $2A$

(d) Any of the above, because volume of silver remains same

50. The resistance of a wire is $10\,\Omega$. Its length is increased by 10% by stretching. The new resistance will now be

[CPMT 2000; Pb PET 2004]

(a) $12\,\Omega$ (b) $1.2\,\Omega$

(c) $13\,\Omega$ (d) $11\,\Omega$

51. Resistance of tungsten wire at $150°C$ is $133\,\Omega$. Its resistance temperature coefficient is $0.0045/°C$. The resistance of this wire at $500°C$ will be [DPMT 2004]

(a) $180\,\Omega$ (b) $225\,\Omega$

(c) $258\,\Omega$ (d) $317\,\Omega$

52. A metal wire of specific resistance $64\times10^{-6}\,ohm-cm$ and length 198 *cm* has a resistance of 7 *ohm*, the radius of the wire will be [MP PET 1994]

(a) 2.4 *cm* (b) 0.24 *cm*

(c) 0.024 *cm* (d) 24 *cm*

53. A copper wire of length 1 *m* and radius 1 *mm* is joined in series with an iron wire of length 2 *m* and radius 3 *mm* and a current is passed through the wires. The ratio of the current density in the copper and iron wires is

[MP PMT 1994]

(a) 18 : 1 (b) 9 : 1

(c) 6 : 1 (d) 2 : 3

54. For a metallic wire, the ratio V/i ($V =$ the applied potential difference, i = current flowing) is [MP PMT 1994; BVP 2003]

(a) Independent of temperature

(b) Increases as the temperature rises

(c) Decreases as the temperature rises

(d) Increases or decreases as temperature rises, depending upon the metal

55. The resistance of a wire is R. If the length of the wire is doubled by stretching, then the new resistance will be

[Roorkee 1992; AFMC 1995; KCET 1993; AMU (Med.) 1999; CBSE PMT 1999; MP PET 2001; UPSEAT 2001]

(a) $2R$ (b) $4R$

(c) R (d) $\frac{R}{4}$

56. Which of the following has a negative temperature coefficient

(a) C (b) Fe

(c) Mn (d) Ag

57. The reciprocal of resistance is [AFMC 1995]

(a) Conductance (b) Resistivity

(c) Voltage (d) None of the above

58. A solenoid is at potential difference 60 V and current flows through it is 15 *ampere*, then the resistance of coil will be

[AFMC 1995]

(a) $4\,\Omega$ (b) $8\,\Omega$

(c) $0.25\,\Omega$ (d) $2\,\Omega$

59. All of the following statements are true except

[Manipal MEE 1995]

(a) Conductance is the reciprocal of resistance and is measured in *Siemens*

(b) *Ohm*'s law is not applicable at very low and very high temperatures

(c) *Ohm*'s law is applicable to semiconductors

(d) *Ohm*'s law is not applicable to electron tubes, discharge tubes and electrolytes

60. A potential difference of V is applied at the ends of a copper wire of length l and diameter d. On doubling only d, drift velocity

(a) Becomes two times (b) Becomes half

(c) Does not change (d) Becomes one fourth

61. If the resistance of a conductor is 5 Ω at 50°C and 7 Ω at 100°C then the mean temperature coefficient of resistance of the material is

(a) 0.008/°C (b) 0.006/°C

(c) 0.004/°C (d) 0.001/°C

62. The resistance of a discharge tube is

[AFMC 1996; CBSE PMT 1999]

(a) *Ohm*ic (b) Non-*ohm*ic

(c) Both (a) and (b) (d) Zero

63. We are able to obtain fairly large currents in a conductor because

(a) The electron drift speed is usually very large

(b) The number density of free electrons is very high and this can compensate for the low values of the electron drift speed and the very small magnitude of the electron charge

(c) The number density of free electrons as well as the electron drift speeds are very large and these compensate for the very small magnitude of the electron charge

(d) The very small magnitude of the electron charge has to be divided by the still smaller product of the number density and drift speed to get the electric current

64. A platinum resistance thermometer has a resistance of $50\,\Omega$ at $20°C$. When dipped in a liquid the resistance becomes $76.8\,\Omega$. The temperature coefficient of resistance for platinum is $\alpha = 3.92\times10^{-3}/°C$. The temperature of the liquid is

(a) $100°C$ (b) $137°C$

(c) $167°C$ (d) $200°C$

[AFMC 1995]

65. In a wire of circular cross-section with radius r, free electrons travel with a drift velocity V when a current I flows through the wire. What is the current in another wire of half the radius and of the same material when the drift velocity is $2V$

[MP PET 1997]

(a) $2I$ (b) I

(c) $I/2$ (d) $I/4$

66. The resistivity of a wire depends on its **[MP PMT/PET 1998]**

(a) Length (b) Area of cross-section

(c) Shape (d) Material

67. The conductivity of a superconductor is

[Similar to KCET 1993; MP PMT/PET 1998]

(a) Infinite (b) Very large

(c) Very small (d) Zero

68. In a neon discharge tube 2.9×10^{18} Ne^{+} ions move to the right each *second* while 1.2×10^{18} electrons move to the left per *second*. Electron charge is $1.6\times10^{-19}\,C$. The current in the discharge tube

(a) 1 *A* towards right (b) 0.66 *A* towards right

(c) 0.66 *A* towards left (d) Zero

69. A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/ quantities constant along the length of the conductor is/are

[KCET 1994, IIT 1997 Cancelled; CBSE PMT 2001]

(a) Current, electric field and drift speed

(b) Drift speed only

(c) Current and drift speed

(d) Current only

70. The resistivity of alloys $= R_{\text{alloy}}$; the resistivity of constituent metals R_{metal}. Then, usually **[KCET 1994]**

(a) $R_{\text{alloy}} = R_{\text{metal}}$

(b) $R_{\text{alloy}} < R_{\text{metal}}$

(c) There is no simple relation between R_{alloy} and R_{metal}

(d) $R_{\text{alloy}} > R_{\text{metal}}$

71. Two wires *A* and *B* of same material and same mass have radius $2r$ and r. If resistance of wire *A* is $34\,\Omega$, then resistance of *B* will be

(a) $544\,\Omega$ (b) $272\,\Omega$

(c) $68\,\Omega$ (d) $17\,\Omega$

72. Two rods of same material and length have their electric resistance in ratio $1:2$. When both rods are dipped in water, the correct statement will be **[RPMT 1997]**

(a) *A* has more loss of weight

(b) *B* has more loss of weight

(c) Both have same loss of weight

(d) Loss of weight will be in the ratio $1:2$

73. $20\,\mu A$ current flows for 30 *seconds* in a wire, transfer of charge will be **[RPMT 1997]**

(a) $2\times10^{-4}\,C$ (b) $4\times10^{-4}\,C$

(c) $6\times10^{-4}\,C$ (d) $8\times10^{-4}\,C$

74. σ_1 and σ_2 are the electrical conductivities of *Ge* and *Na* respectively. If these substances are heated, then

(a) Both σ_1 and σ_2 increase

(b) σ_1 increases and σ_2 decreases

(c) σ_1 decreases and σ_2 increases

(d) Both σ_1 and σ_2 decrease

75. 1.6 *mA* current is flowing in conducting wire then the number of electrons flowing per *second* is **[RPMT 1999]**

(a) 10^{11} (b) 10^{16}

(c) 10^{19} (d) 10^{15}

76. A current *I* is passing through a wire having two sections *P* and *Q* of uniform diameters *d* and *d*/2 respectively. If the mean drift velocity of electrons **[MP PET 1999]** in sections *P* and *Q* is denoted by v_P and v_Q respectively, then **[Roorkee 1999]**

(a) $v_P = v_Q$ (b) $v_P = \frac{1}{2}v_Q$

(c) $v_P = \frac{1}{4}v_Q$ (d) $v_P = 2\,v_Q$

77. If an electric current is passed through a nerve of a man, then man

(a) Begins to laugh

(b) Begins to weep

(c) Is excited

(d) Becomes insensitive to pain

78. The resistance of a coil is 4.2 Ω at 100° *C* and the temperature coefficient of resistance of its material is 0.004/° *C*. Its resistance at 0° *C* is **[KCET 1999]**

(a) 6.5 Ω (b) 5 Ω

(c) 3 Ω (d) 4 Ω

79. Masses of three wires of copper are in the ratio of 1 : 3 : 5 and their lengths are in the ratio of $5:3:1$. The ratio of their electrical resistances are **[AFMC 2000]**

(a) 1 : 3 : 5 (b) 5 : 3 : 1

(c) 1 : 15 : 125 (d) 125 : 15 : 1

80. Conductivity increases in the order of **[RPET 1997]** **[AFMC 2000]**

(a) *Al, Ag, Cu* (b) *Al, Cu, Ag*

(c) *Cu, Al, Ag* (d) *Ag, Cu, Al*

81. A uniform wire of resistance *R* is uniformly compressed along its length, until its radius becomes *n* times the original radius. Now resistance of the wire becomes

[KCET 2000]

(a) $\frac{R}{n^4}$ (b) $\frac{R}{n^2}$

(c) $\frac{R}{n}$ (d) *nR*

82. The resistance of a conductor is 5 *ohm* at 50°*C* and 6 *ohm* at 100°*C*. Its resistance at 0°*C* is **[KCET 2000]**

(a) 1 *ohm* (b) 2 *ohm*

(c) 3 *ohm* (d) 4 *ohm*

83. If an electron revolves in the path of a circle of radius of 0.5×10^{-10} *m* at frequency of 5×10^{15} *cycles/s* the electric current in the circle is (Charge of an electron = 1.6×10^{-19} *C*)

[EAMCET 2000]

(a) 0.4 *mA* (b) 0.8 *mA*

(c) 1.2 *mA* (d) 1.6 *mA*

84. Equal potentials are applied on an iron and copper wire of same length. In order to have the same current flow in the two wires, the ratio *r* (iron)/*r* (copper) of their radii must be (Given that specific resistance of iron = 1.0×10^{-7} *ohm–m* and specific resistance of copper = 1.7×10^{-8} *ohm-m*)

[MP PMT 2000]

(a) About 1.2 (b) About 2.4

(c) About 3.6 (d) About 4.8

85. An electron (charge = 1.6×10^{-19} *coulomb*) is moving in a circle of radius 5.1×10^{-11} *m* at a frequency of 6.8×10^{15} *revolutions/sec*. The equivalent current is approximately

[MP PET 2000]

(a) 5.1×10^{-3} *amp* (b) 6.8×10^{-3} *amp*

(c) 1.1×10^{-3} *amp* (d) 2.2×10^{-3} *amp*

86. A rod of a certain metal is 1.0 *m* long and 0.6 *cm* in diameter. Its resistance is 3.0×10^{-3} *ohm*. Another disc made of the same metal is 2.0 *cm* in diameter and 1.0 *mm* thick. What is the resistance between the round faces of the disc

(a) 1.35×10^{-8} *ohm* (b) 2.70×10^{-7} *ohm*

(c) 4.05×10^{-6} *ohm* (d) 8.10×10^{-5} *ohm*

87. At what temperature will the resistance of a copper wire become three times its value at $0^\circ C$ (Temperature coefficient of resistance for copper = 4×10^{-3} *per* $^\circ C$)

[MP PET 2000]

(a) $400^\circ C$ (b) $450^\circ C$

(c) $500^\circ C$ (d) $550^\circ C$

88. An electron revolves 6×10^{15} *times/sec* in circular loop. The current in the loop is [MNR 1995; UPSEAT 2000]

(a) 0.96 *mA* (b) 0.96 μA

(c) 28.8 *A* (d) None of these

89. The charge of an electron is 1.6×10^{-19} *C*. How many electrons strike the screen of a cathode ray tube each *second* when the beam current is 16 *mA* [AMU (Med.) 2000]

(a) 10^{17} (b) 10^{19}

(c) 10^{-19} (d) 10^{-17}

90. If potential $V = 100 \pm 0.5\, Volt$ and current $I = 10 \pm 0.2$ *amp* are given to us. Then what will be the value of resistance

(a) $10 \pm 0.7\, ohm$ (b) $5 \pm 2\, ohm$

(c) $0.1 \pm 0.2 ohm$ (d) None of these

91. A nichrome wire 50 *cm* long and one square *millimetre* cross-section carries a current of $4A$ when connected to a $2V$ battery. The resistivity of nichrome wire in *ohm metre* is

[EAMCET 2001]

(a) 1×10^{-6} (b) 4×10^{-7}

(c) 3×10^{-7} (d) 2×10^{-7}

92. If an observer is moving with respect to a stationary electron, then he observes [DCE 2001]

(a) Only magnetic field (b) Only electric field

(c) Both (a) and (b) (d) None of the above

93. Calculate the amount of charge flowing in 2 *minutes* in a wire of resistance 10 Ω when a potential difference of 20 *V* is applied between its ends [Kerala (Engg.) 2001]

(a) 120 *C* (b) 240 *C*

(c) 20 *C* (d) 4 *C*

94. If a wire of resistance *R* is melted and recasted to half of its length, then the new resistance of the wire will be

[KCET (Med.) 2001]

(a) *R*/4 (b) *R*/2

(c) *R* (d) 2*R*

95. The drift velocity does not depend upon [BHU 2001]

(a) Cross-section of the wire (b) Length of the wire

(c) Number of free electrons (d) Magnitude of the current

96. There is a current of 40 *ampere* in a wire of $10^{-6}\, m^2$ area of cross-section. If the number of free electron per m^3 is 10^{29}, then the drift velocity will be [Pb. PMT 2001]

(a) 1.25×10^{3} *m/s* (b) 2.50×10^{-3} *m/s*

(c) 25.0×10^{-3} *m/s* (d) 250×10^{-3} *m/s*

97. At room [MP PET 2000] temperature, copper has free electron density of 8.4×10^{28} per m^3. The copper conductor has a cross-section of 10^{-6} m^2 and carries a current of 5.4 *A*. The electron drift velocity in copper is [UPSEAT 2002]

(a) 400 *m/s* (b) 0.4 *m/s*

(c) 0.4 *mm/s* (d) 72 *m/s*

98. The resistance of a 5 *cm* long wire is 10 Ω. It is uniformly stretched so that its length becomes 20 *cm*. The resistance of the wire is

(a) 160 Ω (b) 80 Ω

(c) 40 Ω (d) 20 Ω

99. The resistance of an incandescent lamp is [KCET 2002]

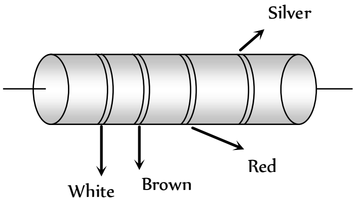
(a) Greater when switched off

(b) Smaller when switched on

(c) Greater when switched on

(d) The same whether it is switched off or switched on

100. In the figure a carbon resistor has bands of different colours on its body as mentioned in the figure. The value of the resistance is



(a) 2.2 $k\Omega$

(b) 3.3 $k\Omega$ [RPET 2001]

(c) 5.6 $k\Omega$

(d) 9.1 $k\Omega$

101. By increasing the temperature, the specific resistance of a conductor and a semiconductor [AIEEE 2002]

(a) Increases for both

(b) Decreases for both

(c) Increases, decreases

(d) Decreases, increases

102. Which of the following is vector quantity [AFMC 2002]

(a) Current density (b) Current

(c) Wattless current (d) Power

103. Masses of 3 wires of same metal are in the ratio 1 : 2 : 3 and their lengths are in the ratio 3 : 2 : 1. The electrical resistances are in ratio [CPMT 2002]

(a) 1 : 4 : 9 (b) 9 : 4 : 1

(c) 1 : 2 : 3 (d) 27 : 6 : 1

104. A current of 1 *mA* is flowing through a copper wire. How many electrons will pass a given point in one *second*

[e = 1.6 × 10^{-} *Coulomb*] [RPMT 2000; MP PMT 2002]

(a) 6.25×10^{19} (b) 6.25×10^{15}

(c) 6.25×10^{31} (d) 6.25×10^{8}

105. The drift velocity of free electrons in a conductor is 'v' when a current 'i' is flowing in it. If both the radius and current are doubled, then drift velocity will be [BHU 2002]

(a) v (b) $\frac{v}{2}$

(c) $\frac{v}{4}$ (d) $\frac{v}{8}$

106. A wire of radius r has resistance R. If it is stretched to a radius of $\frac{3r}{4}$, its resistance becomes [BHU 2002]

(a) $\frac{9R}{16}$ (b) $\frac{16R}{9}$

(c) $\frac{81R}{256}$ (d) $\frac{256R}{81}$

107. The resistance of a conductor increases with [CBSE PMT 2002]

(a) Increase in length

(b) Increase in temperature

(c) Decrease in cross–sectional area

(d) All of these

108. A copper wire has a square cross-section, 2.0 *mm* on a side. It carries a current of 8 *A* and the density of free electrons is $8 \times 10^{28}\ m^{-3}$. The drift speed of electrons is equal to [AMU (Med.) 2002]

(a) 0.156×10^{-3} *m.s* (b) 0.156×10^{-2} *m.s*

(c) 3.12×10^{-3} *m.s* (d) 3.12×10^{-2} *m.s*

109. Two wires of same material have length L and $2L$ and cross–sectional areas $4A$ and A respectively. The ratio of their specific resistance would be [MHCET 2002]

(a) 1 : 2 (b) 8 : 1

(c) 1 : 8 (d) 1 : 1

110. When a current flows through a conductor its temperature [MHCET 2002]

(a) May increase or decrease

(b) Remains same

(c) Decreases

(d) Increases

111. What length of the wire of specific resistance $48 \times 10^{-8}\ \Omega\ m$ is needed to make a resistance of 4.2 Ω (diameter of wire = 0.4 *mm*) [CBSE PMT 2000; Pb. PMT 2002]

(a) 4.1 *m* (b) 3.1 *m*

(c) 2.1 *m* (d) 1.1 *m*

112. A strip of copper and another of germanium are cooled from room temperature to 80 *K*. The resistance of [AIEEE 2003]

(a) Each of these increases

(b) Each of these decreases

(c) Copper strip increases and that of germanium decreases

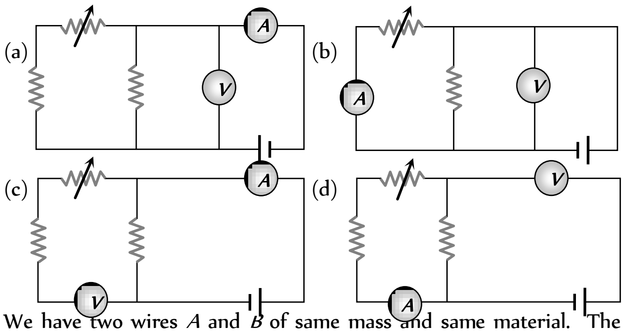
(d) Copper strip decreases and that of germanium increases

113. The length of a given cylindrical wire is increased by 100 %. Due to the consequent decrease in diameter the change in the resistance of the wire will be [AIEEE 2003]

(a) 300 % (b) 200 %

(c) 100 % (d) 50 %

114. Express which of the following setups can be used to verify Ohm's law [IIT-JEE (Screening) 2003]



115. We have two wires A and B of same mass and same material. The diameter of the wire A is half of that B. If the resistance of wire A is 24 *ohm* then the resistance of wire B will be

(a) 12 *Ohm* (b) 3.0 *Ohm*

(c) 1.5 *Ohm* (d) None of the above

116. In a hydrogen discharge tube it is observed that through a given cross-section 3.13×10^{15} electrons are moving from right to left and 3.12×10^{15} protons are moving from left to right. What is the electric current in the discharge tube and what is its direction

(a) $1 mA$ towards right (b) $1 mA$ towards left

(c) $2 mA$ towards left (d) $2 mA$ towards right

117. A steady current i is flowing through a conductor of uniform cross-section. Any segment of the conductor has [MP PET 1996]

(a) Zero charge

(b) Only positive charge

(c) Only negative charge

(d) Charge proportional to current i

118. The length of the wire is doubled. Its conductance will be [Kerala PMT 2004]

(a) Unchanged (b) Halved

(c) Quadrupled (d) 1/4 of the original value

119. A source of e.m.f. E = 15 V and having negligible internal resistance is connected to a variable resistance so that the current in the circuit increases with time as $i = 1.2\ t + 3$. Then, the total charge that will flow in first five second will be

(a) 10 *C* (b) 20 *C*

(c) 30 *C* (d) 40 *C*

120. The new resistance of wire of $R\,\Omega$, whose radius is reduced half, is [J & K CET

(a) 16 R (b) 3 R

(c) 2R (d) R

121. A resistance R is stretched to four times its length. Its new resistance will be [ISM Dhanbad 1994; UPSEAT 2003]

(a) 4 R (b) 64 R

(c) $R/4$ (d) $16\ R$

122. What is the resistance of a carbon resistance which has bands of colours brown, black and brown [DCE 1999]

(a) $100\ \Omega$ (b) $1000\ \Omega$

(c) $10\ \Omega$ (d) $1\ \Omega$

123. The lead wires should have [Pb. PMT 2000]

(a) Larger diameter and low resistance

(b) Smaller diameter and high resistance

(c) Smaller diameter and low resistance

(d) Larger diameter and high resistance

124. The alloys constantan and manganin are used to make standard resistance due to they have

[MH CET 2000; NCERT 1990]

(a) Low resistivity

(b) High resistivity

(c) Low temperature coefficient of resistance

(d) Both (b) and (c)

125. When a potential difference is applied across the ends of a linear metallic conductor [MP PET 1997]

(a) The free electrons are accelerated continuously from the lower potential end to the higher potential end of the conductor

(b) The free electrons are accelerated continuously from the higher potential end to the lower potential end of the conductor

(c) The free electrons acquire a constant drift velocity from the lower potential end to the higher potential end of the conductor

(d) The free electrons are set in motion from their position of rest

126. The electric resistance of a certain wire of iron is *R*. If its length and radius are both doubled, then [CBSE PMT 2004]

(a) The resistance will be doubled and the specific resistance will be halved

(b) The resistance will be halved and the specific resistance will remain unchanged

(c) The resistance will be halved and the specific resistance will be doubled

(d) The resistance and the specific resistance, will both remain unchanged

127. A wire of diameter 0.02 *metre* contains 10^{28} free electrons per cubic metre. For an electrical current of 100 *A*, the drift velocity of the free electrons in the wire is nearly

[UPSEAT 2004]

(a) 1×10^{-19} *m/s* (b) 5×10^{-10} *m/s*

(c) 2×10^{-4} *m/s* (d) 8×10^{3} *m/s*

128. The following four wires are made of the same material and are at the same temperature. Which one of them has highest electrical resistance [UPSEAT 2004]

(a) Length = 50 *cm*, diameter = 0.5 *mm*

(b) Length = 100 *cm*, diameter = 1 *mm*

(c) Length = 200 *cm*, diameter = 2 *mm*

(d) Length = 300 *cm*, diameter = 3 *mm*

129. The colour sequence in a carbon resistor is red, brown, orange and silver. The resistance of the resistor is

[DCE 2004]

(a) $21 \times 10^{3} \pm 10\%$ (b) $23 \times 10^{1} \pm 10$

(c) $21 \times 10^{3} \pm 5\%$ (d) $12 \times 10^{3} \pm 5\%$

130. A thick wire is stretched so that its length become two times. Assuming that there is no change in its density, then what is the ratio of change in resistance of wire to the initial resistance of wire

(a) 2 : 1 (b) 4 : 1

(c) 3 : 1 (d) 1 : 4

131. The length of the resistance wire is increased by 10%. What is the corresponding change in the resistance of wire

[MH CET 2004]

(a) 10% (b) 25%

(c) 21% (d) 9%

132. The electric field *E*, current density *J* and conductivity σ of a conductor are related as [Kerala PMT 2005]

(a) $\sigma = E/j$ (b) $\sigma = j/E$

(c) $\sigma = jE$ (d) $\sigma = 1/jE$

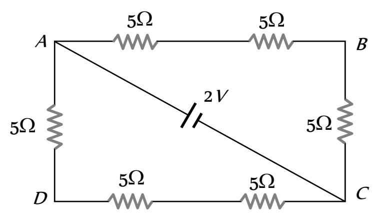
133. Two wires that are made up of two different materials whose specific resistance are in the ratio 2 : 3, length 3 : 4 and area 4 : 5. The ratio of their resistances is [Kerala PMT 2005]

(a) 6 : 5 (b) 6 : 8

(c) 5 : 8 (d) 1 : 2

Grouping of Resistances

1. The potential difference between points A and B of adjoining figure is [CPMT 1991]



(a) $\frac{2}{3}V$

(b) $\frac{8}{9}V$

(c) $\frac{4}{3}V$

(d) $2\ V$

2. Two resistors of resistance R_1 and R_2 having $R_1 > R_2$ are connected in parallel. For equivalent resistance R, the correct statement is [CPMT 1978; KCET (Med.) 2000]

(a) $R > R_1 + R_2$ (b) $R_1 < R < R_2$

(c) $R_2 < R < (R_1 + R_2)$ (d) $R < R_1$

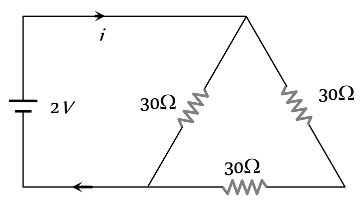
3. A wire of resistance R is divided in 10 equal parts. These parts are connected in parallel, the equivalent resistance of such connection will be [CPMT 1973, 91]

(a) 0.01 *R* (b) 0.1 *R*

(c) 10 *R* (d) 100 *R*

4. The current in the adjoining circuit will be

[IIT 1983; CPMT 1991, 92; MH CET 2002; Pb. PMT 2001; Kerala PMT 2004]



(a) $\frac{1}{45}$ *ampere*

(b) $\frac{1}{15}$ *ampere*

(c) $\frac{1}{10}$ *ampere*

(d) $\frac{1}{5} ampere$

5. There are 8 equal resistances *R*. Two are connected in parallel, such four groups are connected in series, the total resistance of the system will be [MP PMT 1987]

(a) $R/2$ (b) $2R$

(c) $4R$ (d) $8R$

6. Three resistances of one *ohm* each are connected in parallel. Such connection is again connected with $2/3\,\Omega$ resistor in series. The resultant resistance will be [MP PMT 1985]

(a) $\frac{5}{3}\Omega$ (b) $\frac{3}{2}\Omega$

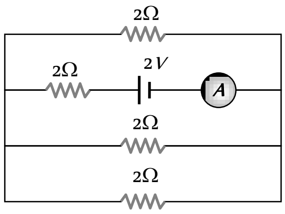
(c) 1Ω (d) $\frac{2}{3}\Omega$

7. The lowest resistance which can be obtained by connecting 10 resistors each of 1/10 *ohm* is [MP PMT 1984; EAMCET 1994]

(a) $1/250\,\Omega$ (b) $1/200\,\Omega$

(c) $1/100\,\Omega$ (d) $1/10\,\Omega$

8. The reading of the ammeter as per figure shown is



(a) $\frac{1}{8}A$

(b) $\frac{3}{4}A$

(c) $\frac{1}{2}A$

(d) 2 A

9. Three resistors each of 2 *ohm* are connected together in a triangular shape. The resistance between any two vertices will be [CPMT 1983; MP PET 1990; MP PMT 1993; DCE 2004]

(a) 4/3 *ohm* (b) 3/4 *ohm*

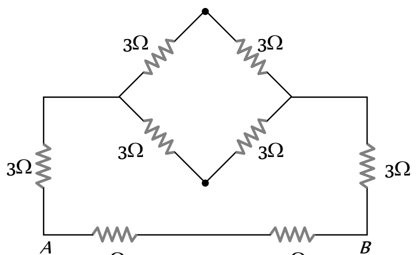
(c) 3 *ohm* (d) 6 *ohm*

10. There are n similar conductors each of resistance R. The resultant resistance comes out to be x when connected in parallel. If they are connected in series, the resistance comes out to be

(a) x/n^2 (b) n^2x

(c) x/n (d) nx

11. Equivalent resistance between *A* and *B* will be [CPMT 1981]



(a) 2 *ohm*

(b) 18 *ohm*

(c) 6 *ohm*

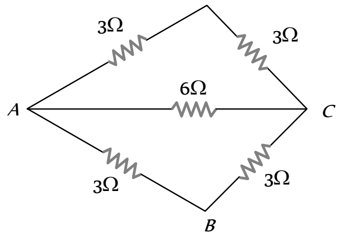
(d) 3.6 *ohm*

12. A wire has a resistance of 12 *ohm*. It is bent in the form of equilateral triangle. The effective resistance between any two corners of the triangle is

(a) 9 *ohms* (b) 12 *ohms*

(c) 6 *ohms* (d) 8/3 *ohms*

13. The effective resistance between the points A and B in the figure is [MP PET 1994]



(a) $5\,\Omega$

(b) $2\,\Omega$

(c) $3\,\Omega$

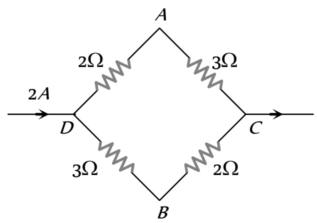
(d) $4\,\Omega$

14. Three resistances of magnitude 2, 3 and 5 *ohm* are connected in parallel to a battery of 10 volts and of negligible resistance. The potential difference across $3\,\Omega$ resistance will be

(a) 2 *volts* (b) 3 *volts*

(c) 5 *volts* (d) 10 *volts*

15. A current of 2 A flows in a system of conductors as shown. The potential difference $(V_A - V_B)$ will be [CPMT 1975, 76]



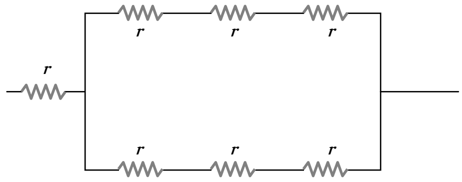
(a) $+2\,V$

(b) $+1\,V$

(c) $-1\,V$

(d) $-2\,V$

16. Referring to the figure below, the effective resistance of the network is [NCERT 1973, 75]



(a) $2r$

(b) $4r$

(c) $10r$

(d) $5r/2$

17. Two resistances are joined in parallel whose resultant is $\frac{6}{8}$ *ohm*. One of the resistance wire is broken and the effective resistance becomes $2\,\Omega$. Then the resistance in *ohm* of the wire that got broken was [DPMT 2004] [CPMT 1976; DPMT 1982]

(a) 3/5 (b) 2

(c) 6/5 (d) 3

18. Given three equal resistors, how many different combination of all the three resistors can be made [NCERT 1970]

(a) Six (b) Five

(c) Four (d) Three

19. Lamps used for household lighting are connected in

(a) Series (b) Parallel

(c) Mixed circuit (d) None of the above

20. The equivalent resistance of resistors connected in series is always [CPMT 1984;

(a) Equal to the mean of component resistors

(b) Less than the lowest of component resistors

(c) In between the lowest and the highest of component resistors

(d) Equal to sum of component resistors

21. A cell of negligible resistance and e.m.f. 2 volts is connected to series combination of 2, 3 and 5 *ohm*. The potential difference in volts between the terminals of 3 *ohm* resistance will be

(a) 0.6 (b) 2/3

(c) 3 (d) 6

22. Four wires of equal length and of resistances 10 *ohms* each are connected in the form of a square. The equivalent resistance between two opposite corners of the square is [NCERT 1977]

(a) 10 ohm (b) 40 ohm

(c) 20 ohm (d) 10/4 ohm

23. Two resistors are connected (a) in series (b) in parallel. The equivalent resistance in the two cases are 9 ohm and 2 ohm respectively. Then the resistances of the component resistors are

(a) 2 ohm and 7 ohm (b) 3 ohm and 6 ohm

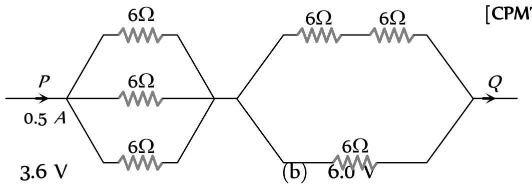
(c) 3 ohm and 9 ohm (d) 5 ohm and 4 ohm

24. Resistors of 1, 2, 3 *ohm* are connected in the form of a triangle. If a 1.5 volt cell of negligible internal resistance is connected across 3 *ohm* resistor, the current flowing through this resistance will be

(a) 0.25 *amp* (b) 0.5 *amp*

(c) 1.0 *amp* (d) 1.5 *amp*

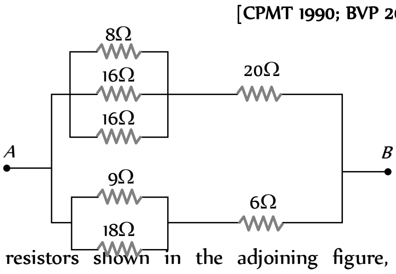
25. Resistances of 6 *ohm* each are connected in the manner shown in adjoining figure. With the current 0.5 *ampere* as shown in figure, the potential difference $V_P - V_Q$ is [CPMT 1989]



(a) 3.6 V (b) 6.0 V

(c) 3.0 V (d) 7.2 V

26. The equivalent resistance of the arrangement of resistances shown in adjoining figure between the points *A* and *B* is [CPMT 1990; BVP 2003]



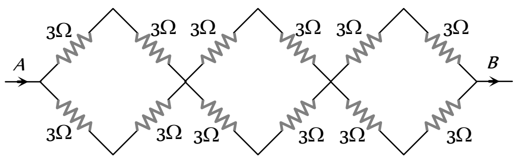
(a) 6 *ohm*

(b) 8 *ohm*

(c) 16 *ohm*

(d) 24 *ohm*

27. In the network of resistors shown in the adjoining figure, the equivalent resistance between *A* and *B* is



(a) 54 *ohm* (b) 18 *ohm*

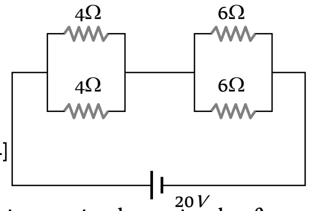
(c) 36 *ohm* (d) 9 *ohm*

28. A wire is broken in four equal parts. A packet is formed by keeping the four wires together. The resistance of the packet in comparison to the resistance of the wire will be [MP PET 1985; AFMC 2005]

(a) Equal (b) One fourth

(c) One eight (d) $\frac{1}{16}th$

29. Four resistances are connected in a circuit in the given figure. The electric current flowing through 4 *ohm* and 6 *ohm* resistance is respectively [MP PET 1993]



(a) 2 *amp* and 4 *amp*

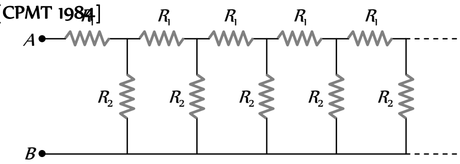
(b) 1 *amp* and 2 *amp*

(c) 1 *amp* and 1 *amp* [CPMT 1984]

(d) 2 *amp* and 2 *amp*

30. An infinite sequence of resistance is shown in the figure. The resultant resistance between *A* and *B* will be, when $R_1 = 1\,ohm$ and $R_2 = 2\,ohm$ [MP PET 1993]

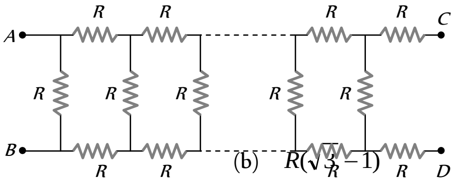
[CPMT 1984]



(a) Infinity (b) $1\,\Omega$

(c) $2\,\Omega$ (d) $1.5\,\Omega$

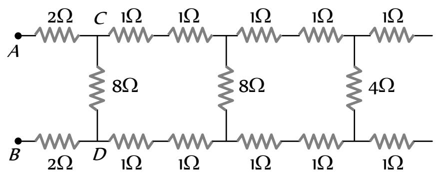
31. In the figure, the value of resistors to be connected between *C* and *D* so that the resistance of the entire circuit between *A* and *B* does not change with the number of elementary sets used is



(a) R (b) $R(\sqrt{3}-1)$

(c) 3 R (d) $R(\sqrt{3}+1)$

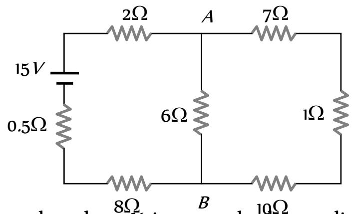
32. In the figure shown, the total resistance between *A* and *B* is



(a) $12\,\Omega$ (b) $4\,\Omega$

(c) $6\,\Omega$ (d) $8\,\Omega$

33. The current from the battery in circuit diagram shown is [IIT 1989]



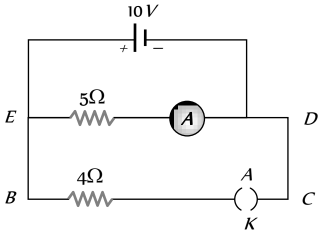
(a) 1 *A*

(b) 2 *A*

(c) 1.5 *A*

(d) 3 *A*

34. In the given figure, when key *K* is opened, the reading of the ammeter *A* will be



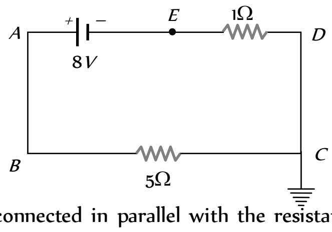
(a) 50 *A*

(b) 2 A

(c) 0.5 A

(d) $\frac{10}{9}A$

35. In the given circuit, the potential of the point E is [MP PMT 2003]



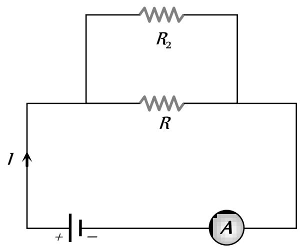
(a) Zero

(b) $-8\,V$

(c) $-4/3\,V$

(d) 4/3 V

36. If a resistance R_2 is connected in parallel with the resistance R in the circuit shown, then possible value of current through R and the possible value of R_2 will be



(a) $\frac{I}{3}, R$

(b) $I, 2R$

(c) $\frac{I}{3}, 2R$

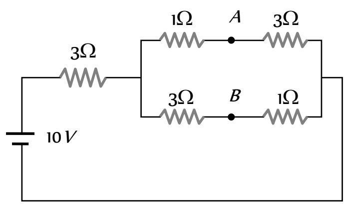
(d) $\frac{I}{2}, R$

37. Four wires AB, BC, CD, DA of resistance 4 *ohm* each and a fifth wire BD of resistance 8 *ohm* are joined to form a rectangle $ABCD$ of which BD is a diagonal. The effective resistance between the points A and B is [MP PMT 1994]

(a) 24 *ohm* (b) 16 *ohm*

(c) $\frac{4}{3} ohm$ (d) $\frac{8}{3} ohm$

38. A battery of e.m.f. 10 V is connected to resistance as shown in figure. The potential difference $V_A - V_B$ between the points A and B is



(a) $-2V$

(b) $2V$

(c) $5V$

(d) $\frac{20}{11}V$

39. Three resistances, each of 1 *ohm*, are joined in parallel. Three such combinations are put in series, then the resultant resistance will be

(a) 9 *ohm* (b) 3 *ohm*

(c) 1 *ohm* (d) $\frac{1}{3} ohm$

40. A student has 10 resistors of resistance 'r'. The minimum resistance made by him from given resistors is [AFMC 1995]

(a) 10 r (b) $\frac{r}{10}$

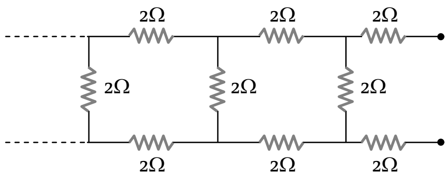
(c) $\frac{r}{100}$ (d) $\frac{r}{5}$

41. Two wires of same metal have the same length but their cross-sections are in the ratio $3:1$. They are joined in series. The resistance of the thicker wire is $10\,\Omega$. The total resistance of the combination will be [CBSE PMT 1995]

(a) $40\,\Omega$ (b) $\frac{40}{3}\Omega$

(c) $\frac{5}{2}\Omega$ (d) $100\,\Omega$

42. The equivalent resistance of the following infinite network of resistances is [AIIMS 1995]



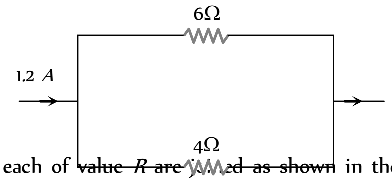
(a) Less than $4\,\Omega$

(b) $4\,\Omega$

(c) More than $4\,\Omega$ but less than $12\,\Omega$

(d) $12\,\Omega$

43. In the figure given below, the current passing through $6\,\Omega$ resistor is [Manipal MEE 1995]



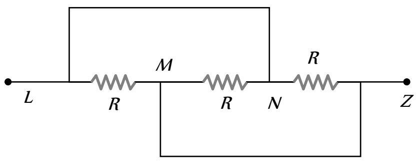
(a) 0.40 *ampere*

(b) 0.48 *ampere*

(c) 0.72 *ampere*

(d) 0.80 *ampere*

44. Three equal resistances each of value R are joined as shown in the figure. The equivalent resistance between M and N is [MP PET 1995]



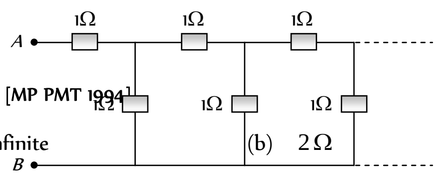
(a) R

(b) $2R$

(c) $\frac{R}{2}$[MP PMT 1994]

(d) $\frac{R}{3}$

45. The equivalent resistance between points A and B of an infinite network of resistances each of $1\,\Omega$ connected as shown, is



[MP PMT 1994]

(a) Infinite (b) $2\,\Omega$

(c) $\frac{1+\sqrt{5}}{2}\Omega$ (d) Zero

46. A copper wire of resistance R is cut into ten parts of equal length. Two pieces each are joined in series and then five such combinations are joined in parallel. The new combination will have a resistance

(a) R (b) $\frac{R}{4}$

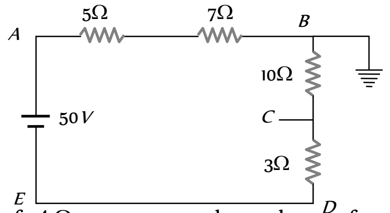
(c) $\frac{R}{5}$ (d) $\frac{R}{25}$

47. A wire has resistance 12Ω. It is bent in the form of a circle. The effective resistance between the two points on any diameter is equal to [JIPMER 1999]

(a) 12Ω (b) 6Ω

(c) 3Ω (d) 24Ω

48. In the circuit shown, the point '*B*' is earthed. The potential at the point '*A*' is



(a) 14 *V*

(b) 24 *V*

(c) 26 *V*

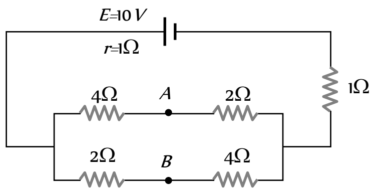
(d) 50 *V*

49. Three resistors each of 4Ω are connected together to form a network. The equivalent resistance of the network cannot be

(a) 1.33Ω (b) 3.0Ω

(c) 6.0Ω (d) 12.0Ω

50. In the circuit shown below, the cell has an e.m.f. of 10 *V* and internal resistance of 1 *ohm*. The other resistances are shown in the figure. The potential difference $V_A - V_B$ is [MP PMT 1997]



(a) 6 *V*

(b) 4 *V*

(c) 2 *V*

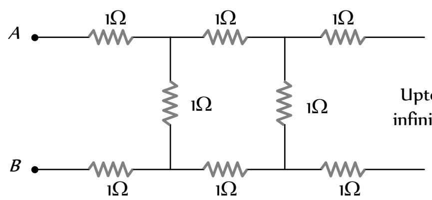
(d) $-2\,V$

51. *A* wire of resistance *R* is cut into '*n*' equal parts. These parts are then connected in parallel. The equivalent resistance of the combination will be [MP PMT/PET 1998; BHU 2005]

(a) nR (b) $\frac{R}{n}$

(c) $\frac{n}{R}$ (d) $\frac{R}{n^2}$

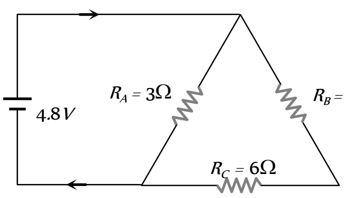
52. The resistance between the terminal points *A* and *B* of the given infinitely long circuit will be [MP PMT/PET 1998]



(a) $(\sqrt{3}-1)$ (b) $(1-\sqrt{3})$

(c) $(1+\sqrt{3})$ (d) $(2+\sqrt{3})$

53. The current in the given circuit is [CBSE PMT 1999]



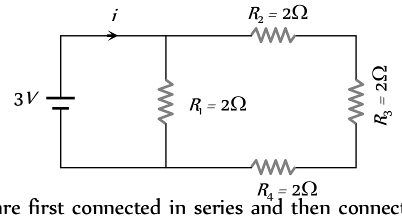
(a) 8.31 *A*

(b) 6.82 *A*

(c) 4.92 *A*

(d) 2 *A*

54. What is the current (*i*) in the circuit as shown in figure [AIIMS 1998]



(a) 2 *A*

(b) 1.2 *A*

(c) 1 *A*

(d) 0.5 *A*

55. *n* equal resistors are first connected in series and then connected in parallel. What is the ratio of the maximum to the minimum resistance [KCET 1994]

(a) n (b) $\frac{1}{n^2}$

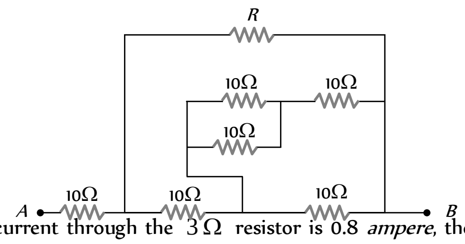
(c) n^2 (d) $\frac{1}{n}$

56. A uniform wire of 16Ω is made into the form of a square. Two opposite corners of the square are connected by a wire of resistance 16Ω. The effective resistance between the other two opposite corners is [EAMCET (Med.) 1995]

(a) 32Ω (b) 20Ω

(c) 8Ω (d) 4Ω

57. For what value of *R* the net resistance of the circuit will be 18 *ohms*



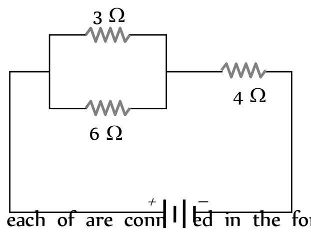
(a) 8Ω

(b) 10Ω

(c) 16Ω

(d) 24Ω

58. In the figure, current through the $3\,\Omega$ resistor is 0.8 *ampere*, then potential drop through $4\,\Omega$ resistor is [CBSE PMT 1993; AFMC 1999; MP PMT 2004]



(a) 9.6 *V*

(b) 2.6 *V*

(c) 4.8 *V*

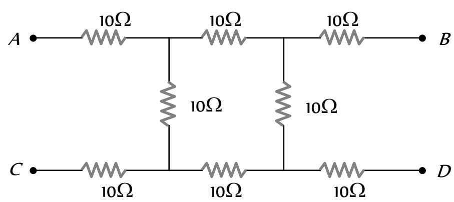
(d) 1.2 *V*

59. Three resistances $4\,\Omega$ each of are connected in the form of an equilateral triangle. The effective resistance between two corners is

(a) 8Ω (b) 12Ω

(c) $\frac{3}{8}\Omega$ (d) $\frac{8}{3}\Omega$

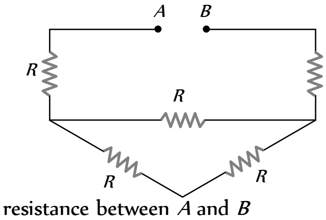
60. What will be the equivalent resistance between the two points *A* and *D* [CBSE PMT 1996]



(a) $10\,\Omega$ (b) $20\,\Omega$

(c) $30\,\Omega$ (d) $40\,\Omega$

61. What is the equivalent resistance between A and B in the figure below if $R = 3\,\Omega$ [SCRA 1996]



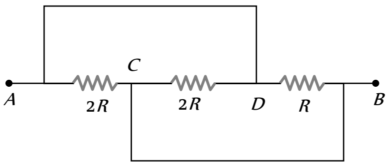
(a) $9\,\Omega$

(b) $12\,\Omega$

(c) $15\,\Omega$

(d) None of these

62. What is the equivalent resistance between A and B [BHU 1997; MP PET 2001]



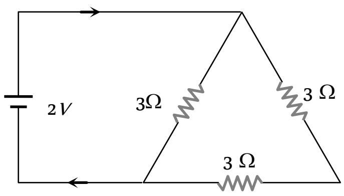
(a) $\frac{2}{3}R$

(b) $\frac{3}{2}R$

(c) $\frac{R}{2}$

(d) $2R$

63. The current in the following circuit is [CBSE PMT 1997]



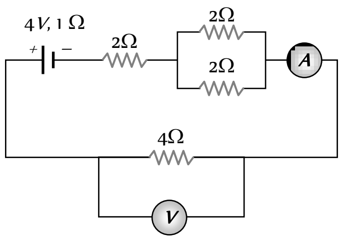
(a) $\frac{1}{8}A$

(b) $\frac{2}{9}A$

(c) $\frac{2}{3}A$

(d) $1A$

64. What is the equivalent resistance of the circuit [KCET 1998]



(a) $6\,\Omega$

(b) $7\,\Omega$

(c) $8\,\Omega$

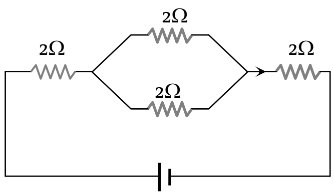
(d) $9\,\Omega$

65. 10 wires (same length, same area, same material) are connected in parallel and each has 1Ω resistance, then the equivalent resistance will be [RPMT 1999]

(a) $10\ \Omega$ (b) $1\ \Omega$

(c) $0.1\ \Omega$ (d) $0.001\ \Omega$

66. The equivalent resistance of the circuit shown in the figure is [CPMT 1999]



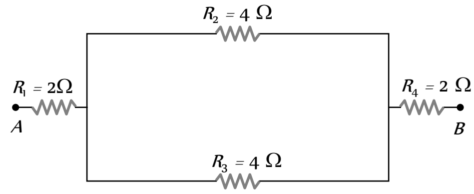
(a) $8\ \Omega$

(b) $6\ \Omega$

(c) $5\ \Omega$

(d) $4\ \Omega$

67. In the given figure, the equivalent resistance between the points A and B is [AIIMS 1999]



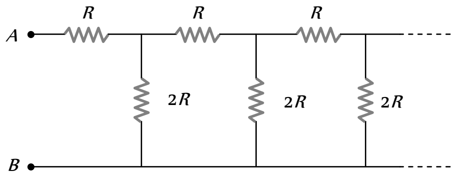
(a) $8\ \Omega$

(b) $6\ \Omega$

(c) $4\ \Omega$

(d) $2\ \Omega$

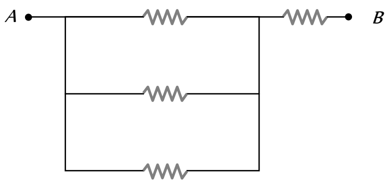
68. An infinite ladder network is arranged with resistances R and $2\ R$ as shown. The effective resistance between terminals A and B is



(a) ∞ (b) R

(c) $2\ R$ (d) $3\ R$

69. If all the resistors shown have the value 2 *ohm* each, the equivalent resistance over AB is [JIPMER 1999]



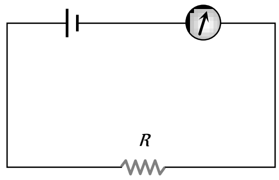
(a) 2 *ohm*

(b) 4 *ohm*

(c) $1\frac{2}{3}$ *ohm*

(d) $2\frac{2}{3}$ *ohm*

70. A battery of *emf* 10 V and internal resistance $3\,\Omega$ is connected to a resistor as shown in the figure. If the current in the circuit is 0.5 A. then the resistance of the resistor will be



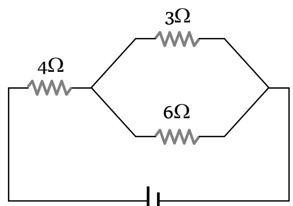
(a) $19\ \Omega$

(b) $17\ \Omega$

(c) $10\ \Omega$

(d) $12\ \Omega$

71. The potential drop across the 3Ω resistor is [CPMT 2000]



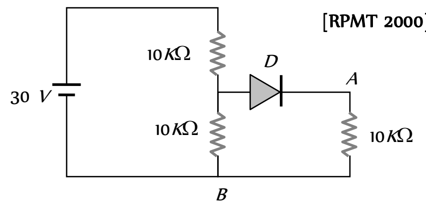
(a) 1 V

(b) 1.5 V

(c) 2 V

(d) 3 V

72. In the given figure, potential difference between A and B is [RPMT 2000]



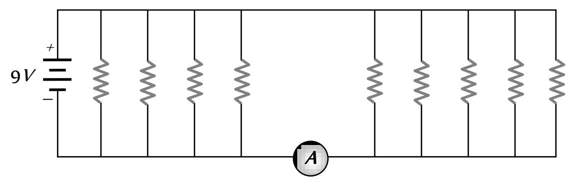
(a) 0

(b) 5 *volt*

(c) 10 *volt*

(d) 15 *volt*

73. If each resistance in the figure is of $9\ \Omega$ then reading of ammeter is



(a) 5 *A* (b) 8 *A*

(c) 2 *A* (d) 9 *A*

74. Four resistances 10 Ω, 5 Ω, 7 Ω and 3 Ω are connected so that they form the sides of a rectangle *AB, BC, CD* and *DA* respectively. Another resistance of 10 Ω is connected across the diagonal *AC*. The equivalent resistance between *A* and *B* is

(a) 2 Ω (b) 5 Ω

(c) 7 Ω (d) 10 Ω

75. Two wires of equal diameters, of resistivities ρ_1 and ρ_2 and lengths l_1 and l_2 respectively, are joined in series. The equivalent resistivity of the combination is

[EAMCET (Engg.) 2000]

(a) $\frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$ (b) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 - l_2}$

(c) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 + l_2}$ (d) $\frac{\rho_1 l_1 - \rho_2 l_2}{l_1 - l_2}$

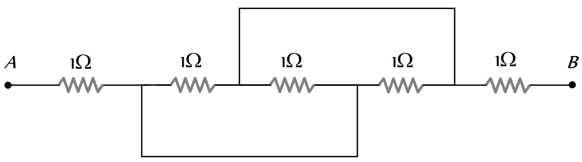
76. Four resistances of 100 Ω each are connected in the form of square. Then, the effective resistance along the diagonal points is

(a) 200 Ω (b) 400 Ω

(c) 100 Ω (d) 150 Ω

77. Equivalent resistance between the points *A* and *B* is (in Ω)

[AMU (Engg.) 2000]



(a) $\frac{1}{5}$ (b) $1\frac{1}{4}$

(c) $2\frac{1}{3}$ (d) $3\frac{1}{2}$

78. Two wires of the same material and equal length are joined in parallel combination. If one of them has half the thickness of the other and the thinner wire has a resistance of 8 *ohms*, the resistance of the combination is equal to

[AMU (Engg.) 2000]

(a) $\frac{5}{8}$ *ohms* (b) $\frac{8}{5}$ *ohms*

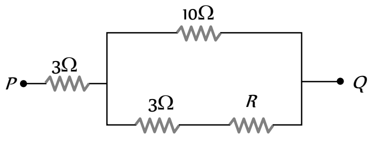
(c) $\frac{3}{8}$ *ohms* (d) $\frac{8}{3}$ *ohms*

79. In the circuit shown here, what is the value of the unknown resistor *R* so that the total resistance of the circuit between points *P* and *Q* is also equal to *R* [MP PET 2001]

(a) 3 *ohms*

(b) $\sqrt{39}$ *ohms*

(c) $\sqrt{69}$ *ohms*



(d) 10 *ohms*

80. A uniform wire of resistance 9 Ω is cut into 3 equal parts. They are connected in the form of equilateral triangle *ABC*. A cell of e.m.f. 2 *V* and negligible internal resistance is connected across *B* and *C*. Potential difference across *AB* is

[Kerala (Engg.) 2001]

(a) 1 *V* (b) 2 *V*

(c) 3 *V* (d) 0.5 *V*

81. [EAMCET (Med.) 2000] The resistors of resistances 2 Ω, 4 Ω and 8 Ω are connected in parallel, then the equivalent resistance of the combination will be [KCET 2001]

(a) $\frac{8}{7}\Omega$ (b) $\frac{7}{8}\Omega$

(c) $\frac{7}{4}\Omega$ (d) $\frac{4}{9}\Omega$

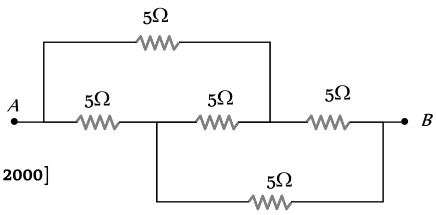
82. Effective resistance between *A* and *B* is [UPSEAT 2001]

(a) 15 Ω

(b) 5 Ω

(c) $\frac{5}{2}\Omega$

(d) 20 Ω [MH CET 2000]



83. The effective resistance of two resistors in parallel is $\frac{12}{7}\Omega$. If one of the resistors is disconnected the resistance becomes 4 Ω. The resistance of the other resistor is [MH CET 2002]

(a) 4 Ω (b) 3 Ω

(c) $\frac{12}{7}\Omega$ (d) $\frac{7}{12}\Omega$

84. Two resistance wires on joining in parallel the resultant resistance is $\frac{6}{5}$ *ohms*. One of the wire breaks, the effective resistance is 2 *ohms*. The resistance of the broken wire is

[MP PET 2001, 2002]

(a) $\frac{3}{5}$ *ohm* (b) 2 *ohm*

(c) $\frac{6}{5}$ *ohm* (d) 3 *ohm*

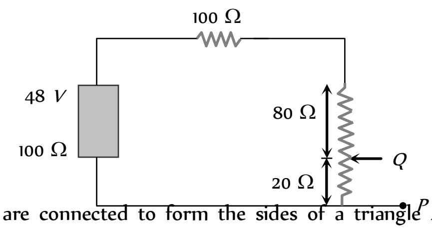
85. In the circuit, the potential difference across *PQ* will be nearest to

(a) 9.6 *V*

(b) 6.6 *V*

(c) 4.8 *V*

(d) 3.2 *V*



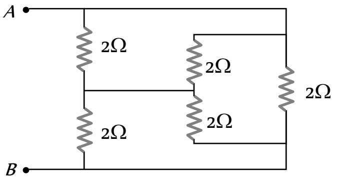
86. Three resistors are connected to form the sides of a triangle *ABC*, the resistance of the sides *AB, BC* and *CA* are 40 *ohms*, 60 *ohms* and 100 *ohms* respectively. The effective resistance between the points *A* and *B* in *ohms* will be

[JIPMER 2002]

(a) 32 (b) 64

(c) 50 (d) 200

87. Find the equivalent resistance across *AB* [Orissa JEE 2002]



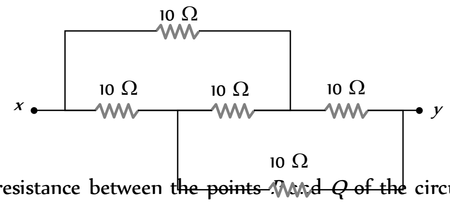
(a) 1 Ω

(b) 2 Ω

(c) 3 Ω

(d) 4 Ω

88. The equivalent resistance between *x* and *y* in the circuit shown is



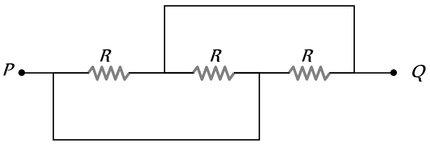
(a) 10 Ω

(b) 40 Ω

(c) 20 Ω

(d) $\frac{5}{2}$ Ω

89. The equivalent resistance between the points *P* and *Q* of the circuit given is [Pb. PMT 2002]



(a) $\frac{R}{4}$

(b) $\frac{R}{3}$

(c) 4 *R*

(d) 2 *R*

90. Two wires of the same dimensions but resistivities ρ_1 and ρ_2 are connected in series. The equivalent resistivity of the combination is

(a) $\rho_1 + \rho_2$ (b) $\frac{\rho_1 + \rho_2}{2}$

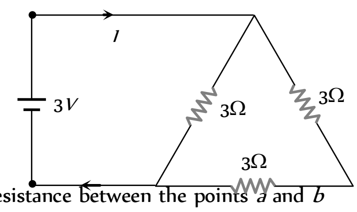
(c) $\sqrt{\rho_1 \rho_2}$ (d) $2(\rho_1 + \rho_2)$

91. Three unequal resistors in parallel are equivalent to a resistance 1 *ohm*. If two of them are in the ratio 1 : 2 and if no resistance value is fractional, the largest of the three resistances in *ohms* is

(a) 4 (b) 6

(c) 8 (d) 12

92. A 3*volt* battery with negligible internal resistance is connected in a circuit as shown in the figure. The current *I*, in the circuit will be



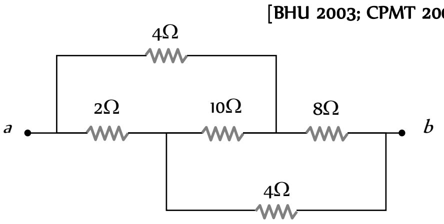
(a) 1/3 *A*

(b) 1 *A*

(c) 1.5 *A*

(d) 2 *A*

93. Find the equivalent resistance between the points *a* and *b* [BHU 2003; CPMT 2004]



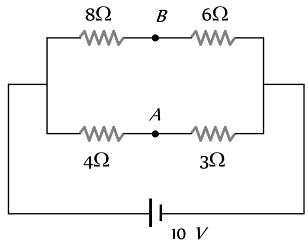
(a) 2 Ω

(b) 4 Ω

(c) 8 Ω

(d) 16 Ω

94. The potential difference between point *A* & *B* is [BHU 2003; CPMT 2004; MP PMT 2005]



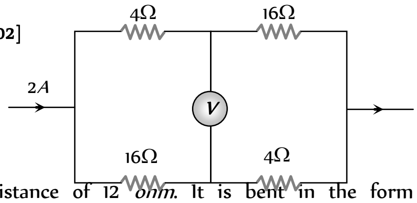
(a) $\frac{20}{7}$ *V*

(b) $\frac{40}{7}$ *V*

(c) $\frac{10}{7}$ *V*

(d) 0

95. In the circuit shown below, The reading of the voltmeter *V* is



(a) 12 *V* [MP PMT 2002]

(b) 8 *V*

(c) 20 *V*

(d) 16 *V*

96. A wire has a resistance of 12 *ohm*. It is bent in the form of equilateral triangle. The effective resistance between any two corners of the triangle is

(a) 9 *ohms* (b) 12 *ohms*

(c) 6 *ohms* (d) 8/3 *ohms*

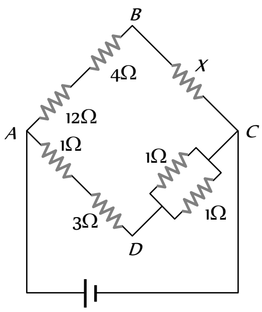
97. A series combination of two resistors 1 Ω each is connected to a 12 *V* battery of internal resistance 0.4 Ω. The current flowing through it will be [MH CET (Med.) 1999]

(a) 3.5 *A* (b) 5 *A*

(c) 6 *A* (d) 10 *A*

98. In the circuit shown in the adjoining figure, the current between *B* and *D* is zero, the unknown resistance is of [KCET 2003]

[CPMT 1986]



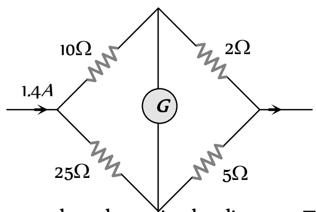
(a) 4 Ω [EAMCET 2003]

(b) 2 Ω

(c) 3 Ω

(d) *emf* of a cell is required to find the value of *X* [AIEEE 2003]

99. In the circuit shown in the figure, the current flowing in 2 Ω resistance [CPMT 1989; MP PMT 2004]



(a) 1.4 *A*

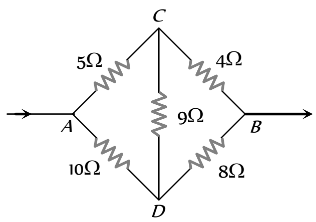
(b) 1.2 *A*

(c) 0.4 *A*

(d) 1.0 *A*

100. Five resistors are connected as shown in the diagram. The equivalent resistance between *A* and *B* is

[MP PMT 1996]



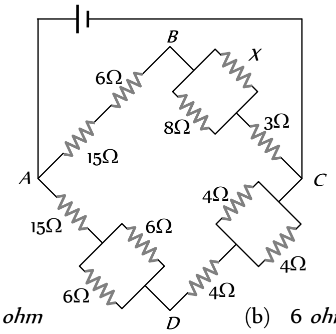
(a) 6 *ohm*

(b) 9 *ohm*

(c) $12\,ohm$

(d) $15\,ohm$

101. In the figure given the value of X resistance will be, when the p.d. between B and D is zero [MP PET 1993]

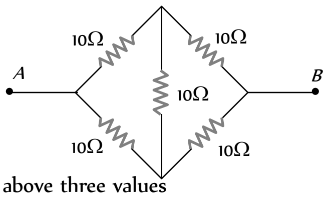


(a) 4 *ohm* (b) 6 *ohm*

(c) 8 *ohm* (d) 9 *ohm*

102. The effective resistance between points A and B is

[NCERT 1974; MP PMT 2000]



(a) $10\,\Omega$

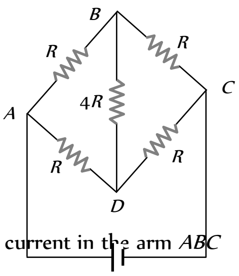
(b) $20\,\Omega$

(c) $40\,\Omega$

(d) None of the above three values

103. Five resistors of given values are connected together as shown in the figure. The current in the arm *BD* will be

[MP PMT 1995]



(a) Half the current in the arm *ABC*

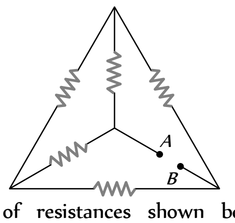
(b) Zero

(c) Twice the current in the arm *ABC*

(d) Four times the current in the arm *ABC*

104. In the network shown in the figure, each of the resistance is equal to $2\,\Omega$. The resistance between the points *A* and *B* is

[CBSE PMT 1995]



(a) $1\,\Omega$

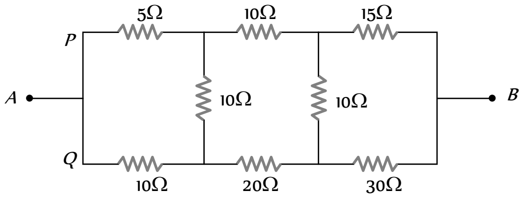
(b) $4\,\Omega$

(c) $3\,\Omega$

(d) $2\,\Omega$

105. In the arrangement of resistances shown below, the effective resistance between points *A* and *B* is

[MP PMT 1997; RPET 2001]

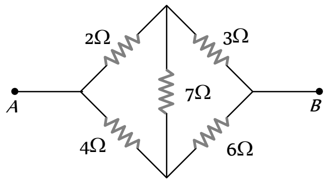


(a) $20\,\Omega$ (b) $30\,\Omega$

(c) $90\,\Omega$ (d) $110\,\Omega$

106. Five resistances are connected as shown in the figure. The effective resistance between the points *A* and *B* is

[MP PMT 1999; KCET 2001; BHU 2001, 05]



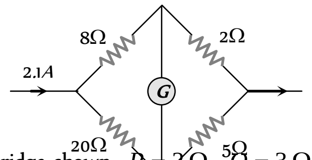
(a) $\frac{10}{3}\,\Omega$

(b) $\frac{20}{3}\,\Omega$

(c) $15\,\Omega$

(d) $6\,\Omega$

107. In the given figure, when galvanometer shows no deflection, the current (in ampere) flowing through $5\,\Omega$ resistance will be



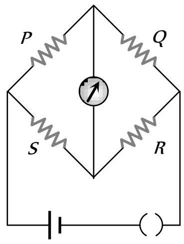
(a) 0.5

(b) 0.6

(c) 0.9

(d) 1.5

108. In the Wheatstone's bridge shown, $P = 2\,\Omega$, $Q = 3\,\Omega$, $R = 6\,\Omega$ and $S = 8\,\Omega$. In order to obtain balance, shunt resistance across 'S' must be [SCRA 1998]



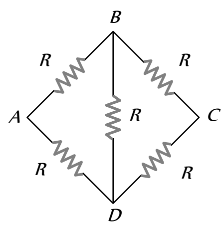
(a) $2\,\Omega$

(b) $3\,\Omega$

(c) $6\,\Omega$

(d) $8\,\Omega$

109. Five equal resistances each of value R are connected in a form shown alongside. The equivalent resistance of the network



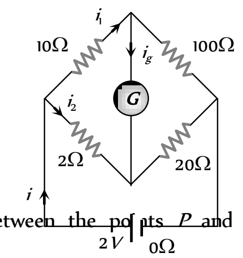
(a) Between the points *B* and *D* is R

(b) Between the points *B* and *D* is $\frac{R}{2}$

(c) Between the points *A* and *C* is R

(d) Between the points *A* and *C* is $\frac{R}{2}$

110. In the circuit shown below the resistance of the galvanometer is 20 Ω. In which case of the following alternatives are the currents arranged strictly in the decreasing order



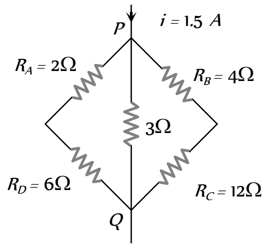
(a) $i, i\ i, i$

(b) $i, i\ i, i$

(c) $i, i\ i, i$

(d) $i, i\ i, i$

111. Potential difference between the points *P* and *Q* in the electric circuit shown is [KCET 1999]



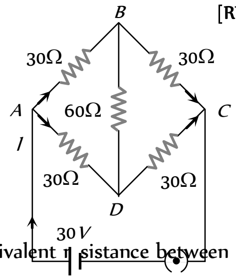
(a) 4.5 *V*

(b) 1.2 *V*

(c) 2.4 *V*

(d) 2.88 *V*

112. The current between *B* and *D* in the given figure is [RPET 2000; DCE 2001]



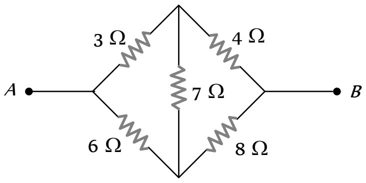
(a) 1 *amp*

(b) 2 *amp*

(c) Zero

(d) 0.5 *amp*

113. In the given figure, equivalent resistance between *A* and *B* will be



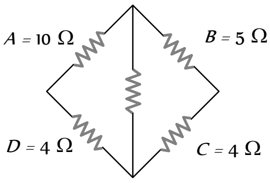
(a) $\frac{14}{3}\,\Omega$

(b) $\frac{3}{14}\,\Omega$

(c) $\frac{9}{14}\,\Omega$

(d) $\frac{14}{9}\,\Omega$

114. In a typical Wheatstone network, the resistances in cyclic order are $A = 10\ \Omega$, $B = 5\ \Omega$, $C = 4\ \Omega$ and $D = 4\ \Omega$ for the bridge to be balanced [KCET 2000]



(a) 10 Ω should be connected in parallel with *A*

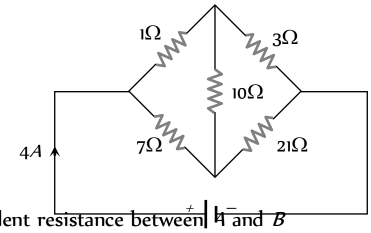
(b) 10 Ω should be connected in series with *A*

(c) 5 Ω should be connected in series with *B*

(d) 5 Ω should be connected in parallel with *B*

115. In the circuit shown in figure, the current drawn from the battery is 4*A*. If 10 Ω resistor is replaced by 20 Ω resistor, then current drawn from the circuit will be

[KCET 2000; CBSE PMT 2001]



(a) 1 *A*

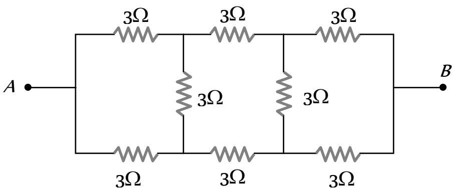
(b) 2 *A*

(c) 3 *A*

(d) 0 *A*

116. Calculate the equivalent resistance between *A* and *B*

[UPSEAT 2001]



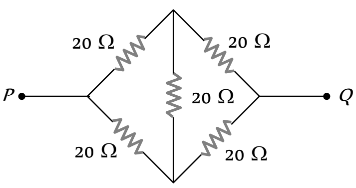
(a) $\frac{9}{2}\Omega$

(b) 3 Ω

(c) 6 Ω

(d) $\frac{5}{3}\Omega$

117. The equivalent resistance between *P* and *Q* in the given figure, is



(a) 50 Ω

(b) 40 Ω

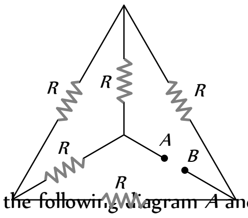
(c) 30 Ω

(d) 20 Ω

[MH CET (Med.) 2001]

118. If each of the resistance of the network shown in the figure is *R*, the equivalent resistance between *A* and *B* is

[KCET 2002]



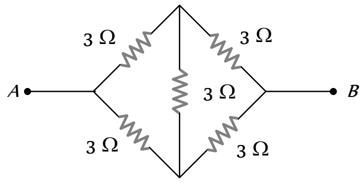
(a) 5 *R*

(b) 3 *R*

(c) *R* [CBSE PMT 2000]

(d) *R*/2

119. The equivalent resistance of the following diagram *A* and *B* is



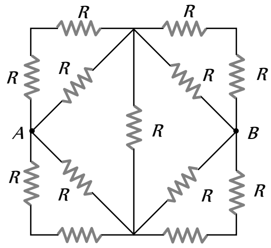
(a) $\frac{2}{3}\Omega$

(b) 9 Ω

(c) 6 Ω

(d) None of these

120. Thirteen resistances each of resistance *R ohm* are connected in the circuit as shown in the figure below. The effective resistance between *A* and *B* is [KCET 2003]



(a) 2*R* Ω

(b) $\frac{4R}{3}\ \Omega$

(c) $\frac{2R}{3}\ \Omega$

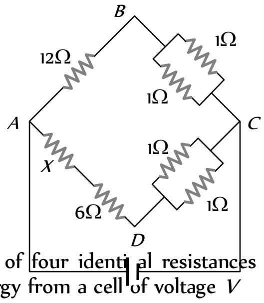
(d) *R* Ω

121. In a Wheatstone's bridge all the four arms have equal resistance *R*. If the resistance of the galvanometer arm is also *R*, the equivalent resistance of the combination as seen by the battery is

(a) $\frac{R}{2}$ (b) *R*

(c) 2 *R* (d) $\frac{R}{4}$

122. For what value of unknown resistance *X*, the potential difference between *B* and *D* will be zero in the circuit shown in the figure



(a) 4 Ω

(b) 6 Ω

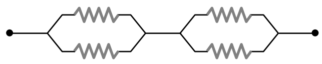
(c) 2 Ω

(d) 5 Ω

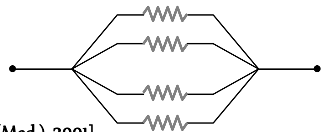
123. Which arrangement of four identical resistances should be used to draw maximum energy from a cell of voltage *V*

[MP PMT 2004]

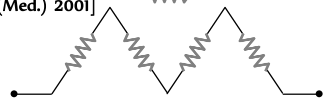
(a)

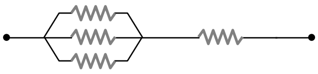


(b)



(c)



(d) 

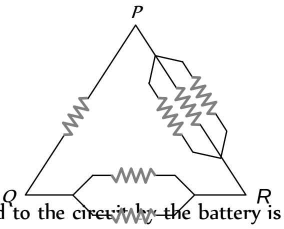
124. An unknown resistance R_1 is connected in series with a resistance of 10 Ω. This combinations is connected to one gap of a metre bridge while a resistance R_2 is connected in the other gap. The balance point is at 50 *cm*. Now, when the 10 Ω resistance is removed the balance point shifts to 40 *cm*. The value of R_1 is (in *ohm*)

(a) 60 (b) 40
(c) 20 (d) 10

125. A wire has a resistance of 6 Ω. It is cut into two parts and both half values are connected in parallel. The new resistance is ....

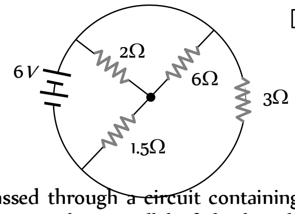
(a) 12 Ω (b) 1.5 Ω
(c) 3 Ω (d) 6 Ω

126. Six equal resistances are connected between points *P, Q* and *R* as shown in the figure. Then the net resistance will be maximum between [IIT-JEE (Screening) 2004]



(a) *P* and *Q*
(b) *Q* and *R*
(c) *P* and *R*
(d) Any two points

127. The total current supplied to the circuit by the battery is [AIEEE 2004]



(a) 1 *A*
(b) 2 *A*
(c) 4 *A*
(d) 6 *A*

128. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be [AIEEE 2004]

(a) 3 (b) 1/3
(c) 8/9 (d) 2

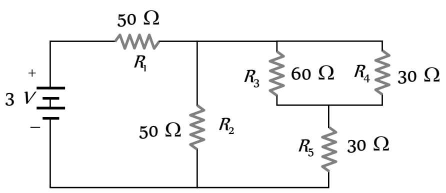
129. If a rod has resistance 4 Ω and if rod is turned as half cycle then the resistance along diameter [BCECE 2004]

(a) 1.56 Ω (b) 2.44 Ω
(c) 4 Ω (d) 2 Ω

130. If three resistors of resistance 2Ω, 4Ω and 5 Ω are connected in parallel then the total resistance of the combination will be [Pb. PMT 2004]

(a) $\frac{20}{19}\Omega$ (b) $\frac{19}{20}\Omega$
(c) $\frac{19}{10}\Omega$ (d) $\frac{10}{19}\Omega$

131. In circuit shown below, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3 *volt*. The voltage across the resistance R_4 is [UPSEAT 2004; Kerala PMT 2004]

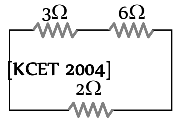
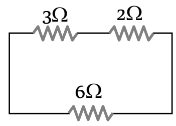
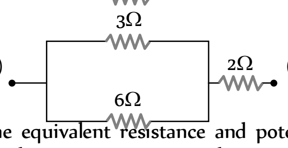


(a) 0.4 *V*
(b) 0.6 *V*
(c) 1.2 *V*
(d) 1.5 *V*

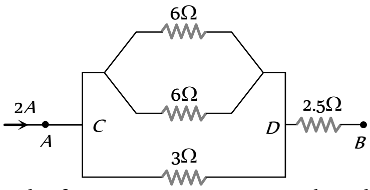
132. A parallel combination of two resistors, of 1 Ω each, is connected in series with a 1.5 Ω resistor. The total combination is connected across a 10 *V* battery. The current flowing in the circuit is

(a) 5 *A* (b) 20 *A*
(c) 0.2 *A* (d) 0.4 *A*

133. [KCET 2004] If you are provided three resistances 2 Ω, 3 Ω and 6 Ω. How will you connect them so as to obtain the equivalent resistance of 4 Ω

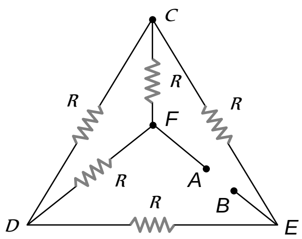
(a) 
(b) 
(c) 
(d) None of these

134. The equivalent resistance and potential difference between *A* and *B* for the circuit is respectively [Pb. PMT 2003]



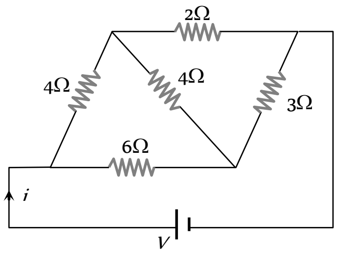
(a) 4 Ω, 8 *V*
(b) 8 Ω, 4 *V*
(c) 2 Ω, 2 *V*
(d) 16 Ω, 8 *V*

135. Five equal resistances each of resistance *R* are connected as shown in the figure. *A* battery of *V* volts is connected between *A* and *B*. The current flowing in *AFCEB* will be [CBSE PMT 2004]



(a) $\frac{3V}{R}$
(b) $\frac{V}{R}$
(c) $\frac{V}{2R}$
(d) $\frac{2V}{R}$

136. For the network shown in the figure the value of the current i is



(a) $\frac{9V}{35}$
(b) $\frac{5V}{18}$
(c) $\frac{5V}{9}$
(d) $\frac{18V}{5}$

137. When a wire of uniform cross-section a, length *l* and resistance *R* is bent into a complete circle, resistance between any two of diametrically opposite points will be [CBSE PMT 2005]

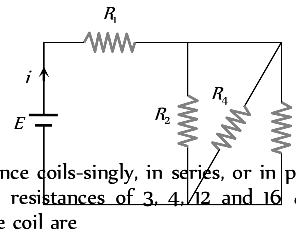
(a) $\frac{R}{4}$ (b) $\frac{R}{8}$
(c) $4R$ (d) $\frac{R}{2}$

138. The current in a simple series circuit is 5.0 *amp*. When an additional resistance of 2.0 *ohms* is inserted, the current drops to 4.0 *amp*. The original resistance of the circuit in ohms was

(a) 1.25 (b) 8
(c) 10 (d) 20

139. In the circuit given $E = 6.0$ *V*, $R_1 = 100$ *ohms*, $R_2 = R_3 = 50$ *ohms*, $R_4 = 75$ *ohms*. The equivalent resistance of the circuit, in ohms, is

(a) 11.875
(b) 26.31
(c) 118.75
(d) None of these

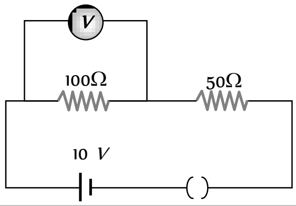


140. By using only two resistance coils-singly, in series, or in parallel one should be able to obtain resistances of 3, 4, 12 and 16 *ohms*. The separate resistances of the coil are [KCET 2005]

(a) 3 and 4 (b) 4 and 12
(c) 12 and 16 (d) 16 and 3

141. In the given circuit, the voltmeter records 5 *volts*. The resistance of the voltmeter in *ohms* is [KCET 2005]

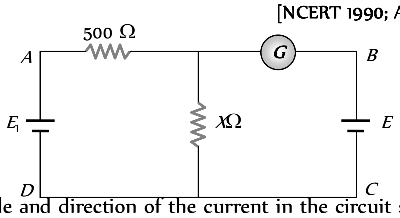
(a) 200
(b) 100
(c) 10
(d) 50



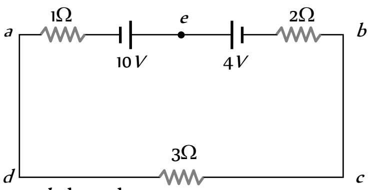
Kirchhoff's Law, Cells

1. In the adjoining circuit, the battery E_1 has an $e.m.f.$ of $12 volt$ and zero internal resistance while the battery E has an $e.m.f.$ of $2 volt$. If the galvanometer G reads zero, then the value of the resistance X in *ohm* is [NCERT 1990; AIEEE 2005]

(a) 10
(b) 100
(c) 500
(d) 200



2. The magnitude and direction of the current in the circuit shown will be [CPMT 1986, 88]



(a) $\frac{7}{3}$ *A* from *a* to *b* through *e*

(b) $\frac{7}{3}$ *A* from *b* to *a* through *e*

(c) 1*A* from *b* to *a* through *e*

(d) 1*A* from *a* to *b* through *e*

3. A cell of $e.m.f.$ $1.5\,V$ having a finite internal resistance is connected to a load resistance of 2Ω. For maximum power transfer the internal resistance of the cell should be [BIT 1988]

(a) 4 *ohm* (b) 0.5 *ohm*
(c) 2 *ohm* (d) None of these

4. By a cell a current of 0.9 A flows through 2 *ohm* resistor and 0.3 A through 7 *ohm* resistor. The internal resistance of the cell is [KCET 2003]

(a) 0.5Ω (b) 1.0Ω
(c) 1.[KCET 2005] (d) 2.0Ω

5. The e.m.f. of a cell is E volts and internal resistance is r *ohm*. The resistance in external circuit is also r *ohm*. The p.d. across the cell will be [CPMT 1985; NCERT 1973]

(a) $E/2$ (b) $2E$
(c) $4E$ (d) $E/4$

6. A cell of e.m.f. E is connected with an external resistance R, then p.d. across cell is V. The internal resistance of cell will be [MNR 1987; Kerala P

(a) $\frac{(E-V)R}{E}$ (b) $\frac{(E-V)R}{V}$

(c) $\frac{(V-E)R}{V}$ (d) $\frac{(V-E)R}{E}$

7. Two cells, e.m.f. of each is E and internal resistance r are connected in parallel between the resistance R. The maximum energy given to the resistor will be, only when [MNR 1988; MP PET 2000; UPSEAT 2001]

(a) $R = r/2$ (b) $R = r$
(c) $R = 2r$ (d) $R = 0$

8. Kirchhoff's first law $i.e.$ $\Sigma i = 0$ at a junction is based on the law of conservation of [CBSE PMT 1997; AIIMS 2000; MP PMT 2002; RPMT 2001; DPMT 2005]

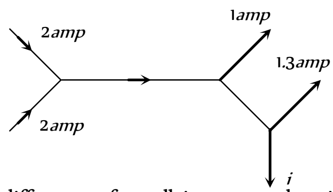
(a) Charge (b) Energy
(c) Momentum (d) Angular momentum

9. Kirchhoff's second law is based on the law of conservation of [RPET 2003; MH CET 2001]

(a) Charge (b) Energy
(c) Momentum (d) Sum of mass and energy

10. The figure below shows currents in a part of electric circuit. The current *i* is [CPMT 1981; RPET 1999]

(a) 1.7 *amp*
(b) 3.7 *amp*
(c) 1.3 *amp*
(d) 1 *amp*

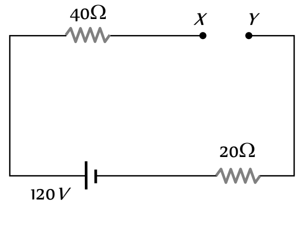


11. The terminal potential difference of a cell is greater than its e.m.f. when it is

(a) Being discharged
(b) In open circuit
(c) Being charged
(d) Being either charged or discharged

12. In the circuit shown, potential difference between *X* and *Y* will be

(a) Zero
(b) 20 *V*
(c) 60 *V*
(d) 120 *V*

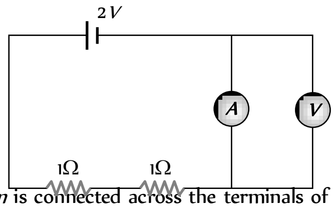


13. In the above question, potential difference across the $40\,\Omega$ resistance will be

(a) Zero (b) 80 V

(c) 40 V (d) 120 V

14. In the circuit shown, A and V are ideal ammeter and voltmeter respectively. Reading of the voltmeter will be



(a) 2 V

(b) 1 V

(c) 0.5 V

(d) Zero

15. When a resistance of $2\,ohm$ is connected across the terminals of a cell, the current is 0.5 *amperes*. When the resistance is increased to 5 *ohm*, the current is 0.25 *amperes*. The internal resistance of the cell is

(a) $0.5\,ohm$ (b) $1.0\,ohm$

(c) $1.5\,ohm$ (d) $2.0\,ohm$

16. The terminal potential difference of a cell when short-circuited is (E = E.M.F. of the cell)

(a) E (b) $E/2$

(c) Zero (d) $E/3$

17. A primary cell has an e.m.f. of 1.5 volts, when short-circuited it gives a current of 3 amperes. The internal resistance of the cell is

(a) 4.5 ohm (b) 2 ohm

(c) 0.5 ohm (d) 1/4.5 ohm

18. A 50 V battery is connected across a 10 *ohm* resistor. The current is 4.5 *amperes*. The internal resistance of the battery is

(a) Zero (b) 0.5 *ohm*

(c) 1.1 *ohm* (d) 5.0 *ohm*

19. The potential difference in open circuit for a cell is 2.2 *volts*. When a 4 *ohm* resistor is connected between its two electrodes the potential difference becomes 2 *volts*. The internal resistance of the cell will be

[MP PMT 1984; SCRA 1994; CBSE PMT 2002]

(a) 1 *ohm* (b) 0.2 *ohm*

(c) 2.5 *ohm* (d) 0.4 *ohm*

20. A new flashlight cell of e.m.f. 1.5 *volts* gives a current of 15 *amps*, when connected directly to an ammeter of resistance $0.04\,\Omega$. The internal resistance of cell is **[MP PET 1994]**

(a) $0.04\,\Omega$ (b) $0.06\,\Omega$

(c) $0.10\,\Omega$ (d) $10\,\Omega$

21. A cell whose e.m.f. is 2 V and internal resistance is $0.1\,\Omega$, is connected with a resistance of $3.9\,\Omega$. The voltage across the cell terminal will be

[CPMT 1990; MP PET 1993; CBSE PMT 1999; AFMC 1999; Pb. PMT 2000; AIIMS 2001]

(a) $0.50\,V$ (b) $1.90\,V$

(c) $1.95\,V$ (d) $2.00\,V$

22. The reading of a high resistance voltmeter when a cell is connected across it is 2.2 V. When the terminals of the cell are also connected to a resistance of $5\,\Omega$ the voltmeter reading drops to 1.8 V. Find the internal resistance of the cell

(a) $1.2\,\Omega$ (b) $1.3\,\Omega$

(c) $1.1\,\Omega$ (d) $1.4\,\Omega$

23. When cells are connected in parallel, then

[MNR 1983]

(a) The current decreases (b) The current increases

(c) The e.m.f. increases (d) The e.m.f. decreases

24. The internal resistance of a cell depends on

(a) The distance between the plates

(b) The area of the plates immersed

(c) The concentration of the electrolyte

(d) All the above

25. n identical cells each of e.m.f. E and internal resistance r are connected in series. An external resistance R is connected in series to this combination. The current through R is

[DPMT 2002]

(a) $\frac{nE}{R+nr}$ (b) $\frac{nE}{nR+r}$

[MP PMT 1996]

(c) $\frac{E}{R+nr}$ (d) $\frac{nE}{R+r}$

26. A cell of internal resistance r is connected to an external resistance R. The current will be maximum in R, if

[CPMT 1982]

(a) $R=r$ (b) $R<r$

(c) $R>r$ (d) $R=r/2$

27. To get the maximum current from a parallel combination of n identical cells each of internal resistance r in an external resistance R, when **[CPMT 1976, 83]** **[DPMT 1999]**

(a) $R>>r$ (b) $R<<r$

(c) $R=r$ (d) None of these

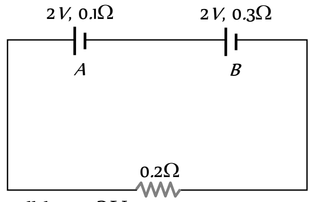
28. Two identical cells send the same current in $2\,\Omega$ resistance, **[CPMT 1985; BHU 1997; Pb. PMT 2001]** whether connected in series or in parallel. The internal resistance of the cell should be

[NCERT 1982; Kerala PMT 2002]

(a) $1\,\Omega$ (b) $2\,\Omega$

(c) $\frac{1}{2}\,\Omega$ (d) $2.5\,\Omega$

29. The internal resistances of two cells shown are $0.1\,\Omega$ and $0.3\,\Omega$. If $R=0.2\,\Omega$, the potential difference across the cell



(a) B will be zero

(b) A will be zero

(c) A and B will be 2 V

(d) A will be $>2V$ and B will be $<2V$

30. A torch battery consisting of two cells of 1.45 *volts* and an internal resistance $0.15\,\Omega$, each cell sending currents through the filament of the lamps having resistance 1.5*ohms*. The value of current will be**[MP PET 199**

(a) 16.11 *amp* (b) 1.611 *amp*

(c) 0.1611 *amp* (d) 2.6 *amp*

31. The electromotive force of a primary cell is 2 *volts*. When it is short-circuited it gives a current of 4 *amperes*. Its internal resistance in *ohms* is **[MP PET 1995]**

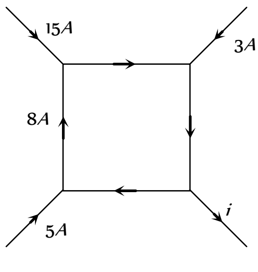
(a) 0.5 (b) 5.0

(c) 2.0 (d) 8.0

[KCET 2003; MP PMT 2003]

32. The figure shows a network of currents. The magnitude of currents is shown here. The current i will be

[MP PMT 1995]



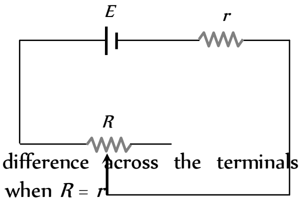
(a) 3 A

(b) 13 *A*

(c) 23 *A*

(d) – 3 *A*

33. A battery of e.m.f. *E* and internal resistance *r* is connected to a variable resistor *R* as shown here. Which one of the following is true



(a) Potential difference across the terminals of the battery is maximum when *R* = *r*

(b) Power delivered to the resistor is maximum when *R* = *r*

(c) Current in the circuit is maximum when *R* = *r*

(d) Current in the circuit is maximum when $R >> r$

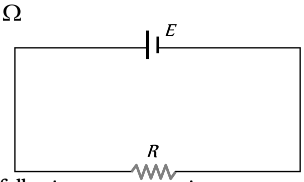
34. A dry cell has an e.m.f. of 1.5 *V* and an internal resistance of $0.05\,\Omega$. The maximum current obtainable from this cell for a very short time interval is [Haryana CEE 1996]

(a) 30 *A* (b) 300 *A*

(c) 3 *A* (d) 0.3 *A*

35. Consider the circuit given here with the following parameters

E.M.F. of the cell = 12 *V*. Internal resistance of the cell $= 2\,\Omega$. Resistance $R = 4\,\Omega$



Which one of the following statements in true

(a) Rate of energy loss in the source is = 8 *W*

(b) Rate of energy conversion in the source is 16 *W*

(c) Power output in is = 8 *W*

(d) Potential drop across *R* is = 16 *V*

36. A current of two amperes is flowing through a cell of e.m.f. 5 *volts* and internal resistance 0.5 *ohm* from negative to positive electrode. If the potential of negative electrode is 10 *V*, the potential of positive electrode will be [MP PMT 1997]

(a) 5 *V* (b) 14 *V*

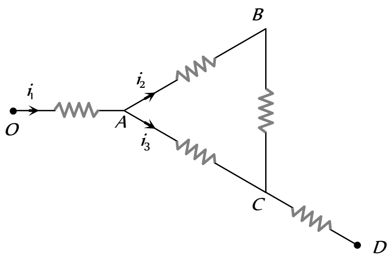
(c) 15 *V* (d) 16 *V*

37. 100 cells each of e.m.f. 5 *V* and internal resistance 1 *ohm* are to be arranged so as to produce maximum current in a 25 *ohms* resistance. Each row is to contain equal number of cells. The number of rows should be [MP PMT 1997]

(a) 2 (b) 4

(c) 5 (d) 10

38. The current in the arm *CD* of the circuit will be [MP PMT/PET 1998; MP PMT 2000; DPMT 2000]



(a) $i_1 + i_2$

(b) $i_2 + i_3$

(c) $i_1 + i_3$

(d) $i_1 - i_2 + i_3$

39. When a resistance of 2 *ohm* is connected across the terminals of a cell, the current is 0.5 *A*. When the resistance is increased to 5 *ohm*, the current is 0.25 *A*. The e.m.f. of the cell is [MP PET 1999, 2000; Pb. PMT 2002; MP PMT 2000]

(a) 1.0 *V* [MP PMT 1995] (b) 1.5 *V*

(c) 2.0 *V* (d) 2.5 *V*

40. Two non-ideal identical batteries are connected in parallel. Consider the following statements [MP PMT 1999]

(i) The equivalent e.m.f. is smaller than either of the two e.m.f.s

(ii) The equivalent internal resistance is smaller than either of the two internal resistances

(a) Both (i) and (ii) are correct

(b) (i) is correct but (ii) is wrong

(c) (ii) is correct but (i) is wrong

(d) Both (i) and (ii) are wrong

41. If six identical cells each having an e.m.f. of 6 *V* are connected in parallel, the e.m.f. of the combination is [EAMCET (Med.) 1995; Pb. PMT 1999; CPMT 2000]

(a) 1 *V* (b) 36 *V*

(c) $\frac{1}{6}V$ (d) 6 *V*

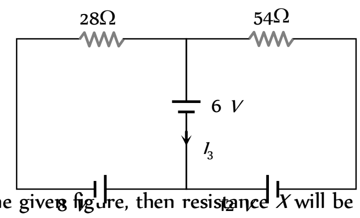
42. Consider the circuit shown in the figure. The current I_3 is equal to

(a) 5 *amp*

(b) 3 *amp*

(c) $-3\,amp$

(d) $-5/6\,amp$



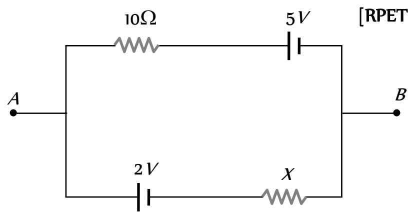
43. If $V_{AB} = 4V$ in the given figure, then resistance *X* will be [RPET 1997]

(a) $5\,\Omega$

(b) $10\,\Omega$

(c) $15\,\Omega$

(d) $20\,\Omega$



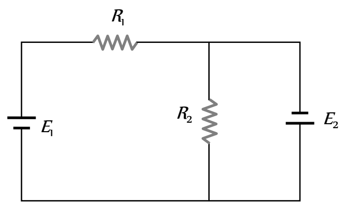
44. Two resistances R_1 and R_2 are joined as shown in the figure to two batteries of e.m.f. E_1 and E_2. If E_2 is short-circuited, the current through R_1 is [NDA 1995]

(a) E_1 / R_1

(b) E_2 / R_1

(c) E_2 / R_2

(d) $E_1 / (R_2 + R_1)$



45. A storage battery has e.m.f. 15 *volts* and internal resistance 0.05 *ohm*. Its terminal voltage when it is delivering 10 *ampere* is

(a) 30 *volts* (b) 1.00 *volts*

(c) 14.5 *volts* (d) 15.5 *volts*

46. The number of dry cells, each of e.m.f. 1.5 *volt* and internal resistance 0.5 *ohm* that must be joined in series with a resistance of 20 *ohm* so as to send a current of 0.6 *ampere* through the circuit is

(a) 2 (b) 8

(c) 10 (d) 12

47. *Emf* is most closely related to [DCE 1999]

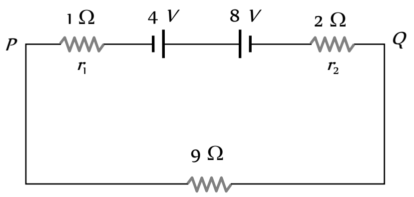
(a) Mechanical force (b) Potential difference

(c) Electric field (d) Magnetic field

48. For driving a current of 2 *A* for 6 *minutes* in a circuit, 1000 *J* of work is to be done. The e.m.f. of the source in the circuit is

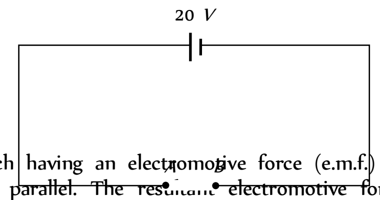
(a) 1.38 *V* (b) 1.68 *V*
(c) 2.04 *V* (d) 3.10 *V*

49. Two batteries of e.m.f. 4 *V* and 8 *V* with internal resistances 1 Ω and 2 Ω are connected in a circuit with a resistance of 9 Ω as shown in figure. The current and potential difference between the points *P* and *Q* are [AFMC 1999]



(a) $\frac{1}{3}A$ and $3V$
(b) $\frac{1}{6}A$ and $4V$
(c) $\frac{1}{9}A$ and $9V$
(d) $\frac{1}{2}A$ and $12V$

50. In the shown circuit, what is the potential difference across *A* and *B*



(a) 50 *V*
(b) 45 *V*
(c) 30 *V*
(d) 20 *V*

51. Four identical cells each having an electromotive force (e.m.f.) of 12 *V*, are connected in parallel. The resultant electromotive force (e.m.f.) of the combination is [CPMT 1999]

(a) 48 *V* (b) 12 *V*
(c) 4 *V* (d) 3 *V*

52. Electromotive force is the force, which is able to maintain a constant

(a) Current (b) Resistance
(c) Power (d) Potential difference

53. A cell of *emf* 6 *V* and resistance 0.5 *ohm* is short circuited. The current in the cell is [JIPMER 1999]

(a) 3 *amp* (b) 12 *amp*
(c) 24 *amp* (d) 6 *amp*

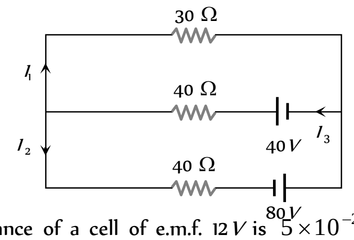
54. A storage cell is charged by 5 *amp* D.C. for 18 *hours*. Its strength after charging will be [JIPMER 1999]

(a) 18 *AH* (b) 5 *AH*
(c) 90 *AH* (d) 15 *AH*

55. A battery having e.m.f. 5 *V* and internal resistance 0.5 Ω is connected with a resistance of 4.5 Ω then the voltage at the terminals of battery is [RPMT 2000]

(a) 4.5 *V* (b) 4 *V*
(c) 0 *V* (d) 2 *V*

56. In the given circuit the current *I* is [DCE 2000]



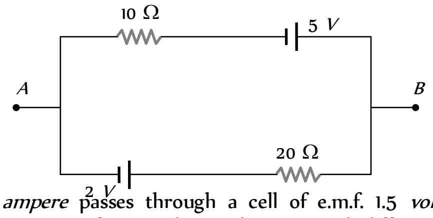
(a) 0.4 *A*
(b) – 0.4 *A*
(c) 0.8 *A*
(d) – 0.8 *A*

57. The internal resistance of a cell of e.m.f. 12 *V* is $5 \times 10^{-2}\ \Omega$. It is connected across an unknown resistance. Voltage across the cell, when a current of 60 *A* is drawn from it, is [CBSE PMT 2000]

(a) 15 *V* (b) 12 *V*
(c) 9 *V* (d) 6 *V*

58. The current in the given circuit is [CPMT 1999]

[AIIMS 2000; MH CET 2003]



(a) 0.1 *A*
(b) 0.2 *A*
(c) 0.3 *A*
(d) 0.4 *A*

59. A current of 2.0 *ampere* passes through a cell of e.m.f. 1.5 *volts* having internal resistance of 0.15 *ohm*. The potential difference measured, in *volts*, across both the ends of the cell will be

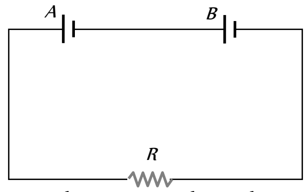
(a) 1.35 (b) 1.50
(c) 1.00 (d) 1.20

60. A battery has e.m.f. 4 *V* and internal resistance *r*. When this battery is connected to an external resistance of 2 *ohms*, a current of 1 *amp*. flows in the circuit. How much current will flow if the terminals of the battery are connected directly [AIIMS 1999]

[MP PET 2001]

(a) 1 *amp* (b) 2 *amp*
(c) 4 *amp* (d) Infinite

61. Two batteries *A* and *B* each of e.m.f. 2 *V* are connected in series to an external resistance *R* = 1 *ohm*. If the internal resistance of battery *A* is 1.9 *ohms* and that of *B* is 0.9 *ohm*, what is the potential difference between the terminals of battery *A*



(a) 2 *V*
(b) 3.8 *V* [Pb. PMT 1999]
(c) Zero
(d) None of the above

62. When a resistor of 11 Ω is connected in series with an electric cell, the current flowing in it is 0.5 *A*. Instead, when a resistor of 5 Ω is connected to the same electric cell in series, the current increases by 0.4 *A*. The internal resistance of the cell is

(a) 1.5 Ω (b) 2 Ω
(c) 2.5 Ω (d) 3.5 Ω

63. The internal resistance of a cell is the resistance of

[BHU 1999, 2000; AIIMS 2001]

(a) Electrodes of the cell
(b) Vessel of the cell
(c) Electrolyte used in the cell
(d) Material used in the cell

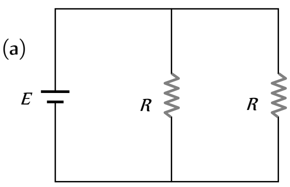
64. How much work is required to carry a 6 μC charge from the negative terminal to the positive terminal of a 9 *V* battery

[KCET (Med.) 2001]

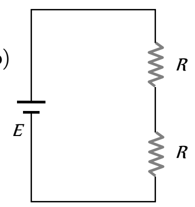
(a) $54 \times 10^{-3}\ J$ (b) $54 \times 10^{-6}\ J$
(c) $54 \times 10^{-9}\ J$ (d) $54 \times 10^{-12}\ J$

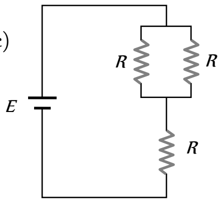
65. Consider four circuits shown in the figure below. In which circuit power dissipated is greatest (Neglect the internal resistance of the power supply) [Orissa JEE 2002]

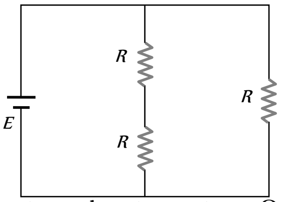
(a)



(b)



(c) 

(d) 

66. The *emf* of a battery is 2 *V* and its internal resistance is 0.5 Ω. The maximum power which it can deliver to any external circuit will be [AMU (Med.) 2002]

(a) 8 *Watt* (b) 4 *Watt*

(c) 2 *Watt* (d) None of the above

67. Kirchoff's I law and II law of current, proves the [CBSE PMT 1993; BHU 2002; AFMC 2003]

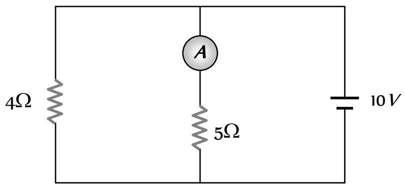
(a) Conservation of charge and energy

(b) Conservation of current and energy

(c) Conservation of mass and charge

(d) None of these

68. In the circuit, the reading of the ammeter is (assume internal resistance of the battery be zero)



(a) $\frac{40}{29}A$

(b) $\frac{10}{9}A$

(c) $\frac{5}{3}A$

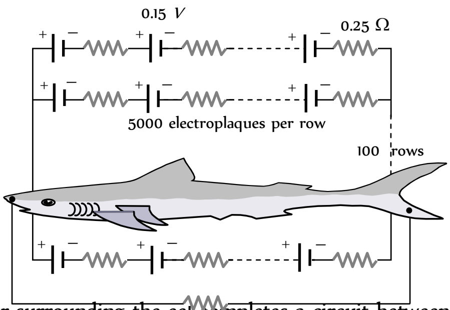
(d) 2 *A*

69. In the above question, if the internal resistance of the battery is 1 *ohm*, then what is the reading of ammeter

(a) 5/3 *A* (b) 40/29 *A*

(c) 10/9 *A* (d) 1 *A*

70. Eels are able to generate current with biological cells called electroplaques. The electroplaques in an eel are arranged in 100 rows, each row stretching horizontally along the body of the fish containing 5000 electroplaques. The arrangement is suggestively shown below. Each electroplaques has an emf of 0.15 *V* and internal resistance of 0.25 Ω [AIIMS 2004]



The water surrounding the eel completes a circuit between the head and its tail. If the water surrounding it has a resistance of 500 Ω, the current an eel can produce in water is about

(a) 1.5 *A* (b) 3.0 *A*

(c) 15 *A* (d) 30 *A*

71. Current provided by a battery is maximum when [AFMC 2004]

(a) Internal resistance equal to external resistance

(b) Internal resistance is greater than external resistance

(c) Internal resistance is less than external resistance

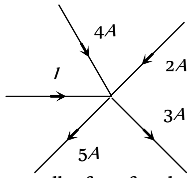
(d) None of these

72. A battery is charged at a potential of 15 *V* for 8 *hours* when the current flowing is 10 *A*. The battery on discharge supplies a current of 5 *A* for 15 *hours*. The mean terminal voltage during discharge is 14 *V*. The "*Watt-hour*" efficiency of the battery is

(a) 82.5% (b) 80 %

(c) 90% (d) 87.5%

73. In the given current distribution what is the value of *I* [Orissa PMT 2004]



(a) 3*A*

(b) 8 *A*

(c) 2*A*

(d) 5*A*

74. A capacitor is connected to a cell of emf *E* having some internal resistance *r*. The potential difference across the [CPMT 2004; MP PMT 2005]

(a) Cell is < *E* (b) Cell is *E*

(c) Capacitor is > *E* (d) Capacitor is < *E*

75. When the resistance of 9 Ω is connected at the ends of a battery, its potential difference decreases from 40 *volt* to 30 *volt*. The internal resistance of the battery is [DPMT 2003]

(a) 6 Ω (b) 3 Ω

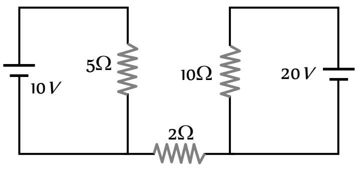
(c) 9 Ω (d) 15 Ω

76. The maximum power drawn out of the cell from a source is given by (where *r* is internal resistance) [DCE 2002]

(a) $E^2/2r$ (b) $E^2/4r$

(c) E^2/r (d) $E^2/3r$

77. Find out the value of current through 2Ω resistance for the given circuit [IIT-JEE (Screening) 2005]



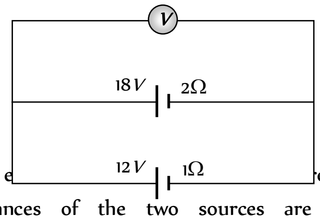
(a) 5 *A*

(b) 2 *A*

(c) Zero

(d) 4 *A*

78. Two batteries, one of emf 18 *volts* and internal resistance 2Ω and the other of emf 12 *volt* and internal resistance 1Ω, are connected as shown. The voltmeter *V* will record a reading of



(a) 15 *volt*

(b) 30 *volt*

(c) 14 *volt*

(d) 18 *volt*

79. Two sources of equal e … esistance *R*. The internal resistances of the two sources are R_1 and

$R_2\,(R_2 > R_1)$. If the potential difference across the source having internal resistance R_2 is zero, then

[AIEEE 2005]

(a) $R = R_1R_2/(R_1 + R_2)$

(b) $R = R_1R_2/(R_2 - R_1)$

(c) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$

(d) $R = R_2 - R_1$

80. An energy source will supply a constant current into the load if its internal resistance is [AIEEE 2005]

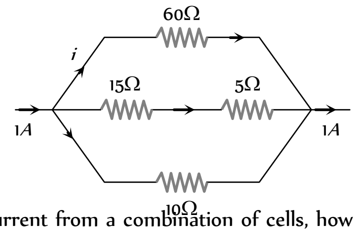
(a) Zero

(b) Non-zero but less than the resistance of the load

(c) Equal to the resistance of the load

(d) Very large as compared to the load resistance

81. The magnitude of *i* in ampere unit is [KCET 2005]



(a) 0.1

(b) 0.3

(c) 0.6

(d) None of these

82. To draw maximum current from a combination of cells, how should the cells be grouped [AFMC 2005]

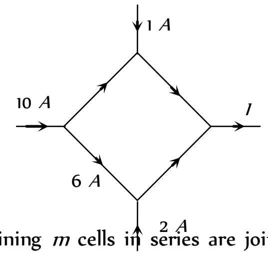
(a) Series

(b) Parallel

(c) Mixed

(d) Depends upon the relative values of external and internal resistance

83. The figure shows a network of currents. The magnitude of currents is shown here. The current *I* will be [BCECE 2005]



(a) 3 *A*

(b) 9 *A*

(c) 13 *A*

(d) 19 *A*

84. The *n* rows each containing *m* cells in series are joined in parallel. Maximum current is taken from this combination across an external resistance of 3Ω resistance. If the total number of cells used are 24 and internal resistance of each cell is 0.5 Ω then

(a) $m = 8, n = 3$ (b) $m = 6, n = 4$

(c) $m = 12, n = 2$ (d) $m = 2, n = 12$

85. A cell of constant e.m.f. first connected to a resistance R_1 and then connected to a resistance R_2. If power delivered in both cases is then the internal resistance of the cell is

[Orissa JEE 2005]

(a) $\sqrt{R_1R_2}$ (b) $\sqrt{\dfrac{R_1}{R_2}}$

(c) $\dfrac{R_1 - R_2}{2}$ (d) $\dfrac{R_1 + R_2}{2}$

Different Measuring Instruments

1. In meter bridge or Wheatstone bridge for measurement of resistance, the known and the unknown resistances are interchanged. The error so removed is

[MNR 1988; MP PET 1995]

(a) End correction

(b) Index error

(c) Due to temperature effect

(d) Random error

2. A galvanometer can be converted into an ammeter by connecting

[MP PMT 1987, 93; CPMT 1973, 75, 96, 2000; MP PET 1994; AFMC 1993, 95; RPET 2000; DCE 2000]

(a) Low resistance in series

(b) High resistance in parallel

(c) Low resistance in parallel

(d) High resistance in series

3. A cell of internal resistance $1.5\,\Omega$ and of e.m.f. 1.5 volt balances 500 *cm* on a potentiometer wire. If a wire of $15\,\Omega$ is connected between the balance point and the cell, then the balance point will shift [MP PMT 1985]

(a) To zero (b) By 500 *cm*

(c) By 750 *cm* (d) None of the above

4. $10^{-3}\,amp$ is flowing through a resistance of $1000\,\Omega$. To measure the correct potential difference, the voltmeter is to be used of which the resistance should be [MP PMT 1985]

(a) $0\,\Omega$ (b) $500\,\Omega$

(c) $1000\,\Omega$ (d) $>> 1000\,\Omega$

5. A galvanometer of $100\,\Omega$ resistance gives full scale deflection when 10 *mA* of current is passed. To convert it into 10 *A* range ammeter, the resistance of the shunt required will be

(a) $-10\,\Omega$ (b) $1\,\Omega$

(c) $0.1\,\Omega$ (d) $0.01\,\Omega$

6. $50\,\Omega$ and $100\,\Omega$ resistors are connected in series. This connection is connected with a battery of 2.4 *volts*. When a voltmeter of $100\,\Omega$ resistance is connected across $100\,\Omega$ resistor, then the reading of the voltmeter will be

[MP PMT 1985]

(a) 1.6 *V* (b) 1.0 *V*

(c) 1.2 *V* (d) 2.0 *V*

[J & K CET 2005]

7. A 2 *volt* battery, a $15\,\Omega$ resistor and a potentiometer of 100 cm length, all are connected in series. If the resistance of potentiometer wire is $5\,\Omega$, then the potential gradient of the potentiometer wire is [AIIMS 1982]

(a) 0.005 *V/cm* (b) 0.05 *V/cm*

(c) 0.02 *V/cm* (d) 0.2 *V/cm*

8. An ammeter gives full scale deflection when current of 1.0 A is passed in it. To convert it into 10 A range ammeter, the ratio of its resistance and the shunt resistance will be

[MP PMT 1985]

(a) 1 : 9 (b) 1 : 10

(c) 1 : 11 (d) 9 : 1

9. By ammeter, which of the following can be measured [MP PET 1981; DPMT 2001]

(a) Electric potential (b) Potential difference
(c) Current (d) Resistance

10. The resistance of 1 *A* ammeter is $0.018\,\Omega$. To convert it into 10 *A* ammeter, the shunt resistance required will be [MP PET 1982]

(a) $0.18\,\Omega$ (b) $0.0018\,\Omega$
(c) $0.002\,\Omega$ (d) $0.12\,\Omega$

11. For measurement of potential difference, potentiometer is preferred in comparison to voltmeter because [MP PET 1983]

(a) Potentiometer is more sensitive than voltmeter
(b) The resistance of potentiometer is less than voltmeter
(c) Potentiometer is cheaper than voltmeter
(d) Potentiometer does not take current from the circuit

12. In order to pass 10% of main current through a moving coil galvanometer of 99 *ohm*, the resistance of the required shunt is [MP PET 1990, 99; MP PMT 1994; RPET 2001; KCET 2003, 05]

(a) $9.9\,\Omega$ (b) $10\,\Omega$
(c) $11\,\Omega$ (d) $9\,\Omega$

13. An ammeter of 5 *ohm* resistance can read 5 *mA*. If it is to be used to read 100 volts, how much resistance is to be connected in series [MP PET 1991; MP PMT 1996; MP PMT 2000]

(a) $19.9995\,\Omega$ (b) $199.995\,\Omega$
(c) $1999.95\,\Omega$ (d) $19995\,\Omega$

14. The potential gradient along the length of a uniform wire is $10\,volt/metre$. B and C are the two points at $30\,cm$ and $60\,cm$ point on a meter scale fitted along the wire. The potential difference between B and C will be [CPMT 1986]

(a) $3\,volt$ (b) $0.4\,volt$
(c) $7\,volt$ (d) $4\,volt$

15. $100\,mA$ current gives a full scale deflection in a galvanometer of $2\,\Omega$ resistance. The resistance connected with the galvanometer to convert it into a voltmeter to measure $5\,V$ is

(a) $98\,\Omega$ (b) $52\,\Omega$
(c) $50\,\Omega$ (d) $48\,\Omega$

16. When a $12\,\Omega$ resistor is connected with a moving coil galvanometer then its deflection reduces from 50 divisions to 10 divisions. The resistance of the galvanometer is [CPMT 2002; DPMT 2003]

(a) $24\,\Omega$ (b) $36\,\Omega$
(c) $48\,\Omega$ (d) $60\,\Omega$

17. A galvanometer can be used as a voltmeter by connecting a [AFMC 1993; MP PMT 1993, 95; CBSE PMT 2004]

(a) High resistance in series (b) Low resistance in series
(c) High resistance in parallel (d) Low resistance in parallel

18. The tangent galvanometer, when connected in series with a standard resistance can be used as [MP PET 1994]

(a) An ammeter
(b) A voltmeter
(c) A wattmeter
(d) Both an ammeter and a voltmeter

19. In Wheatstone's bridge $P = 9$ *ohm*, $Q = 11$ *ohm*, $R = 4$ *ohm* and $S = 6$ *ohm*. How much resistance must be put in parallel to the resistance S to balance the bridge [DPMT 1999]

(a) 24 *ohm* (b) $\frac{44}{9}$ *ohm*
(c) 26.4 *ohm* (d) 18.7 *ohm*

20. A Daniel cell is balanced on 125 cm length of a potentiometer wire. Now the cell is short-circuited by a resistance 2 *ohm* and the balance is obtained at 100 cm. The internal resistance of the Daniel cell is [UPSEAT 2002]

(a) 0.5 *ohm* (b) 1.5 *ohm*
(c) 1.25 *ohm* (d) 4/5 *ohm*

21. Sensitivity of potentiometer can be increased by [MP PET 1994]

(a) Increasing the e.m.f. of the cell
(b) Increasing the length of the potentiometer wire
(c) Decreasing the length of the potentiometer wire
(d) None of the above

22. A potentiometer is an ideal device of measuring potential difference because

(a) It uses a sensitive galvanometer
(b) It does not disturb the potential difference it measures
(c) It is an elaborate arrangement
(d) It has a long wire hence heat developed is quickly radiated

23. A battery of 6 volts is connected to the terminals of a three metre long wire of uniform thickness and resistance of the order of 100 Ω. The difference of potential between two points separated by 50 cm on the wire will be [CPMT 1984; CBSE PMT 2004]

(a) 1 *V* (b) 1.5 *V*
(c) 2 *V* (d) 3 *V*

24. A galvanometer of 10 *ohm* resistance gives full scale deflection with 0.01 ampere of current. It is to be converted into an ammeter for measuring 10 ampere current. The value of shunt resistance required will be [MP PET 1984] [MNR 1994; UPSEAT 2000]

(a) $\frac{10}{999}$ *ohm* (b) 0.1 *ohm*
(c) 0.5 *ohm* (d) 1.0 *ohm*

25. A potentiometer is used for the comparison of e.m.f. of two cells E_1 and E_2. For cell E_1 the no deflection point is obtained at 20 cm and for E_2 the no deflection point is obtained at 30 cm. The ratio of their e.m.f.'s will be [MP PET 1984]

(a) 2/3 (b) 1/2
(c) 1 (d) 2

26. Potential gradient is defined as [MP PET 1994]

(a) Fall of potential per unit length of the wire
(b) Fall of potential per unit area of the wire
(c) Fall of potential between two ends of the wire

(d) Potential at any one end of the wire

27. In an experiment of meter bridge, a null point is obtained at the centre of the bridge wire. When a resistance of 10 *ohm* is connected in one gap, the value of resistance in other gap is

(a) 10Ω (b) 5Ω

(c) $\frac{1}{5}\Omega$ (d) 500Ω

28. If the length of potentiometer wire is increased, then the length of the previously obtained balance point will

(a) Increase (b) Decrease

(c) Remain unchanged (d) Become two times

29. In potentiometer a balance point is obtained, when

(a) The e.m.f. of the battery becomes equal to the e.m.f. of the experimental cell

(b) The p.d. of the wire between the $+ve$ end to jockey becomes equal to the e.m.f. of the experimental cell

(c) The p.d. of the wire between $+ve$ point and jockey becomes equal to the e.m.f. of the battery

(d) The p.d. across the potentiometer wire becomes equal to the e.m.f. of the battery

30. In the experiment of potentiometer, at balance, there is no current in the

(a) Main circuit

(b) Galvanometer circuit

(c) Potentiometer circuit

(d) Both main and galvanometer circuits

31. If in the experiment of Wheatstone's bridge, the positions of cells and galvanometer are interchanged, then balance points will

(a) Change

(b) Remain unchanged

(c) Depend on the internal resistance of cell and resistance of galvanometer

(d) None of these

32. The resistance of a galvanometer is 90 *ohms*. If only 10 percent of the main current may flow through the galvanometer, in which way and of what value, a resistor is to be used

(a) 10 *ohms* in series (b) 10 *ohms* in parallel

(c) 810 *ohms* in series (d) 810 *ohms* in parallel

33. Two cells when connected in series are balanced on $8m$ on a potentiometer. If the cells are connected with polarities of one of the cell is reversed, they balance on $2m$. The ratio of e.m.f.'s of the two cells is

(a) $3:5$ (b) $5:3$

(c) $3:4$ (d) $4:3$

34. A voltmeter has a resistance of G *ohms* and range V *volts*. The value of resistance used in series to convert it into a voltmeter of range nV volts is

[MP PMT 1999; MP PET 2002; DPMT 2004; MH CET 2004]

(a) nG (b) $(n-1)G$

(c) $\frac{G}{n}$ (d) $\frac{G}{(n-1)}$

35. Which of the following statement is wrong [MP PET 1994]

(a) Voltmeter should have high resistance

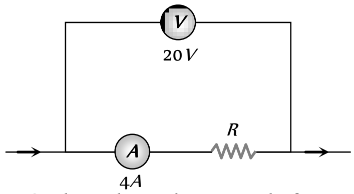
(b) Ammeter should have low resistance

(c) Ammeter is placed in parallel across the conductor in a circuit

(d) Voltmeter is placed in parallel across the conductor in a circuit

36. In the diagram shown, the reading of voltmeter is 20 V and that of ammeter is 4 A. The value of R should be (Consider given ammeter and voltmeter are not ideal) [RPMT 1997]

[MP PET 1994]



(a) Equal to 5Ω

(b) Greater from 5Ω

(c) Less than 5Ω

(d) Greater or less than 5Ω depends on the material of R

37. A moving coil galvanometer has a resistance of 50Ω and gives full scale deflection for 10 mA. How could it be converted into an ammeter with a full scale deflection for $1A$

[MP PMT 1996]

(a) $50/99\Omega$ in series (b) $50/99\Omega$ in parallel

(c) 0.01Ω in series (d) 0.01Ω in parallel

38. The current flowing through a coil of resistance 900 *ohms* is to be reduced by 90%. What value of shunt should be connected across the coil [Roorkee 1992]

(a) 90Ω (b) 100Ω

(c) 9Ω (d) 10Ω

39. A galvanometer of resistance 25Ω gives full scale deflection for a current of 10 *milliampere*, is to be changed into a voltmeter of range 100 V by connecting a resistance of 'R' in series with galvanometer. The value of resistance R in Ω is

[MP PET 1994]

(a) 10000 (b) 10025

(c) 975 (d) 9975

40. In a potentiometer circuit there is a cell of e.m.f. 2 *volt*, a resistance of 5 *ohm* and a wire of uniform thickness of length 1000 *cm* and resistance 15 *ohm*. The potential gradient in the wire is [MP PET 1996]

(a) $\frac{1}{500}V/cm$ (b) $\frac{3}{2000}V/cm$

(c) $\frac{3}{5000}V/cm$ (d) $\frac{1}{1000}V/cm$

41. The resistance of a galvanometer is 25 *ohm* and it requires $50\,\mu A$ for full deflection. The value of the shunt resistance required to convert it into an ammeter of 5 *amp* is

[MP PMT 1994; BHU 1997]

(a) $2.5\times10^{-4}\,ohm$ (b) $1.25\times10^{-3}\,ohm$

(c) 0.05 *ohm* (d) 2.5 *ohm*

42. Which is a *wrong* statement [MP PMT 1994]

(a) The Wheatstone bridge is most sensitive when all the four resistances are of the same order

(b) In a balanced Wheatstone bridge, interchanging the positions of galvanometer and cell affects the balance of the bridge

(c) Kirchhoff's first law (for currents meeting at a junction in an electric circuit) expresses the conservation of charge

(d) The rheostat can be used as a potential divider

43. A voltmeter having a resistance of 998 *ohms* is connected to a cell of e.m.f. 2 *volt* and internal resistance 2 *ohm*. The error in the measurement of e.m.f. will be [MP PMT 1994]

(a) $4\times10^{-1}\,volt$ (b) $2\times10^{-3}\,volt$

(c) $4\times10^{-3}\,volt$ (d) $2\times10^{-1}\,volt$

44. For comparing the e.m.f.'s of two cells with a potentiometer, a standard cell is used to develop a potential gradient along the wires. Which of the following possibilities would make the experiment unsuccessful [MP PMT 1994]

(a) The e.m.f. of the standard cell is larger than the E e.m.f.'s of the two cells
(b) The diameter of the wires is the same and uniform throughout
(c) The number of wires is ten
(d) The e.m.f. of the standard cell is smaller than the e.m.f.'s of the two cells

45. Which of the following is correct [BHU 1995]

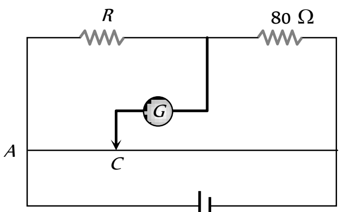
(a) Ammeter has low resistance and is connected in series
(b) Ammeter has low resistance and is connected in parallel
(c) Voltmeter has low resistance and is connected in parallel
(d) None of the above

46. An ammeter with internal resistance $90\,\Omega$ reads 1.85 A when connected in a circuit containing a battery and two resistors 700 Ω and $410\,\Omega$ in series. Actual current will be [Roorkee 1995]

(a) 1.85 A (b) Greater than $1.85\,A$
(c) Less than 1.85 A (d) None of these

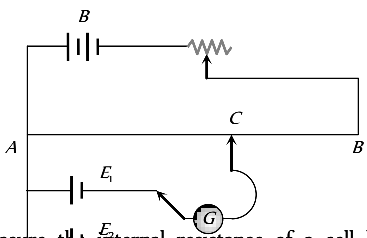
47. AB is a wire of uniform resistance. The galvanometer G shows no current when the length AC = 20 cm and CB = 80 cm. The resistance R is equal to [MP PMT 1995; RPET 2001]

(a) $2\,\Omega$
(b) $8\,\Omega$
(c) $20\,\Omega$
(d) $40\,\Omega$



48. The circuit shown here is used to compare the e.m.f. of two cells E_1 and $E_2 (E_1 > E_2)$. The null point is at C when the galvanometer is connected to E_1. When the galvanometer is connected to E_2, the null point will be [MP PMT 1995]

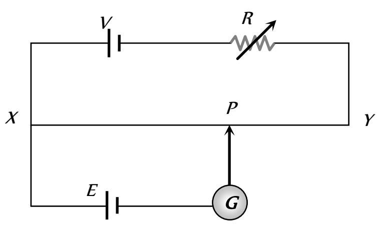
(a) To the left of C
(b) To the right of C
(c) At C itself
(d) Nowhere on AB



49. In an experiment to measure the internal resistance of a cell by potentiometer, it is found that the balance point is at a length of 2 m when the cell is shunted by a $5\,\Omega$ resistance; and is at a length of 3 m when the cell is shunted by a $10\,\Omega$ resistance. The internal resistance of the cell is, then [Haryana CEE 1996]

(a) $1.5\,\Omega$ (b) $10\,\Omega$
(c) $15\,\Omega$ (d) $1\,\Omega$

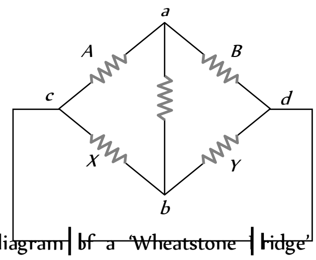
50. A potentiometer circuit shown in the figure is set up to measure e.m.f. of a cell E. As the point P moves from X to Y the galvanometer G shows deflection always in one direction, but the deflection decreases continuously until Y is reached. In order to obtain balance point between X and Y it is necessary to



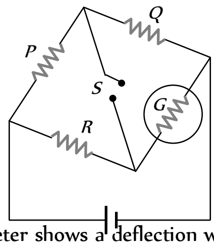
(a) Decreases the resistance R
(b) Increase the resistance R
(c) Reverse the terminals of battery V
(d) Reverse the terminals of cell E

51. In the Wheatstone's bridge (shown in figure) $X = Y$ and $A > B$. The direction of the current between ab will be

(a) From a to b
(b) From b to a
(c) From b to a through c
(d) From a to b through c



52. The figure shows a circuit diagram of a 'Wheatstone Bridge' to measure the resistance G of the galvanometer. The relation $\frac{P}{Q} = \frac{R}{G}$ will be satisfied only when



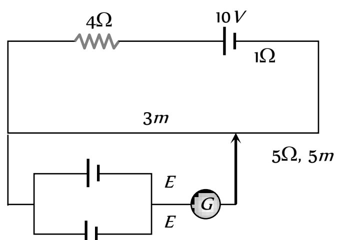
(a) The galvanometer shows a deflection when switch S is closed
(b) The galvanometer shows a deflection when switch S is open
(c) The galvanometer shows no change in deflection whether S is open or closed
(d) The galvanometer shows no deflection

53. The resistance of a galvanometer is 50 $ohms$ and the current required to give full scale deflection is $100\,\mu A$. In order to convert it into an ammeter, reading upto 10A, it is necessary to put a resistance of [MP PMT 1997; AIIMS 1999]

(a) $5 \times 10^{-3}\,\Omega$ in parallel (b) $5 \times 10^{-4}\,\Omega$ in parallel
(c) $10^5\,\Omega$ in series (d) $99{,}950\,\Omega$ in series

54. A resistance of $4\,\Omega$ and a wire of length 5 $metres$ and resistance $5\,\Omega$ are joined in series and connected to a cell of e.m.f. 10 V and internal resistance $1\,\Omega$. A parallel combination of two identical cells is balanced across 300 cm of the wire. The e.m.f. E of each cell is [MP PMT 199

(a) 1.5 V
(b) 3.0 V
(c) 0.67 V
(d) 1.33 V



55. The resistivity of a potentiometer wire is $40 \times 10^{-8}\,ohm - m$ and its area of cross-section is $8 \times 10^{-6}\,m^2$. If 0.2 amp current is flowing through the wire, the potential gradient will be

(a) $10^{-2}\ volt/m$ (b) $10^{-1}\ volt/m$

(c) $3.2\times10^{-2}\ volt/m$ (d) $1\ volt/m$

56. If only 2% of the main current is to be passed through a galvanometer of resistance *G*, then the resistance of shunt will be

(a) $\frac{G}{50}$ (b) $\frac{G}{49}$

(c) $50G$ (d) $49G$

57. The resistance of an ideal voltmeter is

[EAMCET (Med.) 1995; MP PMT/PET 1998; Pb. PMT 1999; CPMT 2000]

(a) Zero (b) Very low

(c) Very large (d) Infinite

58. A 100 *V* voltmeter of internal resistance $20\,k\Omega$ in series with a high resistance *R* is connected to a 110 *V* line. The voltmeter reads 5 *V*, the value of *R* is [MP PET 1999]

(a) $210\,k\Omega$ (b) $315\,k\Omega$

(c) $420\,k\Omega$ (d) $440\,k\Omega$

59. Constantan wire is used in making standard resistances because its

(a) Specific resistance is low

(b) Density is high

(c) Temperature coefficient of resistance is negligible

(d) Melting point is high

60. The net resistance of a voltmeter should be large to ensure that

(a) It does not get overheated

(b) It does not draw excessive current

(c) It can measure large potential difference

(d) It does not appreciably change the potential difference to be measured

61. A galvanometer has resistance of $7\,\Omega$ and gives a full scale deflection for a current of 1.0 *A*. How will you convert it into a voltmeter of range 10 *V* [MP PMT 1999]

(a) $3\,\Omega$ in series (b) $3\,\Omega$ in parallel

(c) $17\,\Omega$ in series (d) $30\,\Omega$ in series

62. A potentiometer consists of a wire of length 4 *m* and resistance $10\,\Omega$. It is connected to a cell of e.m.f. 2 *V*. The potential difference per unit length of the wire will be

[CBSE PMT 1999; AFMC 2001]

(a) 0.5 V/m (b) $2\ V/m$

(c) $5\ V/m$ (d) $10\ V/m$

63. In a meter bridge, the balancing length from the left end (standard resistance of one *ohm* is in the right gap) is found to be 20 *cm*. The value of the unknown resistance is

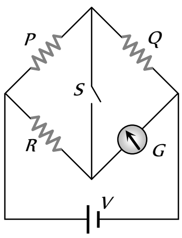
[CBSE PMT 1999; Pb PMT 2004]

(a) $0.8\,\Omega$ (b) $0.5\,\Omega$

(c) $0.4\,\Omega$ (d) $0.25\,\Omega$

64. In the circuit shown $P \neq R$, the reading of the galvanometer is same with switch *S* open or closed. Then

[IIT-JEE (Screening) 1999]



(a) $I_R = I_G$

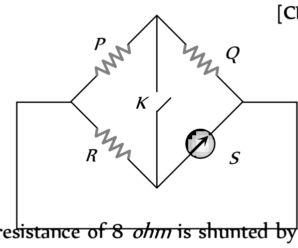
(b) $I_P = I_G$

(c) $I_Q = I_G$ [MP PMT/PET 1998]

(d) $I_Q = I_R$

65. In the following Wheatstone bridge $P/Q = R/S$. If key *K* is closed, then the galvanometer will show deflection

[CPMT 1999]



(a) In left side

(b) In right side

(c) No deflection

(d) In either side

66. A galvanometer having a resistance of 8 *ohm* is shunted by a wire of resistance 2 *ohm*. If the total current is 1 *amp*, the part of it passing through the shunt will be

[CBSE PMT 1998]

(a) 0.25 *amp* [MP PET 1999] (b) 0.8 *amp*

(c) 0.2 *amp* (d) 0.5 *amp*

67. A potentiometer wire has length 10 *m* and resistance $20\,\Omega$. A 2. 5 *V* battery of negligible internal resistance is connected across the wire with an $80\,\Omega$ series resistance. The potential gradient on the wire will be [KCET 1994] [MP PMT 1999]

(a) $5\times10^{-5}\ V/mm$ (b) $2.5\times10^{-4}\ V/cm$

(c) $0.62\times10^{-4}\ V/mm$ (d) $1\times10^{-5}\ V/mm$

68. An ammeter whose resistance is $180\,\Omega$ gives full scale deflection when current is 2 *mA*. The shunt required to convert it into an ammeter reading 20 *mA* (in *ohms*) is

[EAMCET (Engg.) 1995]

(a) 18 (b) 20

(c) 0.1 (d) 10

69. A galvanometer whose resistance is $120\,\Omega$ gives full scale deflection with a current of 0.05 *A* so that it can read a maximum current of 10 *A*. A shunt resistance is added in parallel with it. The resistance of the ammeter so formed is

[Bihar MEE 1995]

(a) $0.06\,\Omega$ (b) $0.006\,\Omega$

(c) $0.6\,\Omega$ (d) $6\,\Omega$ s

70. In a potentiometer experiment, the galvanometer shows no deflection when a cell is connected across 60 *cm* of the potentiometer wire. If the cell is shunted by a resistance of $6\,\Omega$, the balance is obtained across 50 *cm* of the wire. The internal resistance of the cell is [SCRA 1994]

(a) $0.5\,\Omega$ (b) $0.6\,\Omega$

(c) $1.2\,\Omega$ (d) $1.5\,\Omega$

71. A voltmeter of resistance $1000\,\Omega$ gives full scale deflection when a current of 100 *mA* flow through it. The shunt resistance required across it to enable it to be used as an ammeter reading 1 *A* at full scale deflection is [SCRA 1994]

(a) $10000\,\Omega$ (b) $9000\,\Omega$

(c) $222\,\Omega$ (d) $111\,\Omega$

72. The resistance of 10 *metre* long potentiometer wire is 1*ohm/meter*. A cell of e.m.f. 2.2 *volts* and a high resistance box are connected in series to this wire. The value of resistance taken from resistance box for getting potential gradient of 2.2 *millivolt/metre* will be[RPET 1997]

(a) $790\,\Omega$ (b) $810\,\Omega$

(c) $990\,\Omega$ (d) $1000\,\Omega$

73. We have a galvanometer of resistance $25\,\Omega$. It is shunted by a $2.5\,\Omega$ wire. The part of total current that flows through the galvanometer is given as

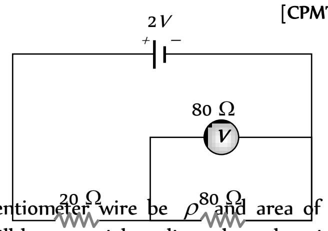
[AFMC 1998; MH CET 1999; Pb. PMT 2002]

(a) $\frac{I}{I_0} = \frac{1}{11}$ (b) $\frac{I}{I_0} = \frac{1}{10}$

(c) $\frac{I}{I_0} = \frac{3}{11}$ (d) $\frac{I}{I_0} = \frac{4}{11}$

74. In the adjoining circuit, the e.m.f. of the cell is 2 *volt* and the internal resistance is negligible. The resistance of the voltmeter is 80 *ohm*. The reading of the voltmeter will be

[CPMT 1991]



(a) 0.80 *volt*

(b) 1.60 *volt*

(c) 1.33 *volt*

(d) 2.00 *volt*

75. If the resistivity of a potentiometer wire be ρ and area of cross-section be A, then what will be potential gradient along the wire

(a) $\frac{I\rho}{A}$ (b) $\frac{I}{A\rho}$

(c) $\frac{IA}{\rho}$ (d) $IA\rho$

76. A voltmeter has resistance of 2000 *ohms* and it can measure upto $2V$. If we want to increase its range to 10 V, then the required resistance in series will be

[CPMT 1997, SCRA 1994]

(a) $2000\,\Omega$ (b) $4000\,\Omega$

(c) $6000\,\Omega$ (d) $8000\,\Omega$

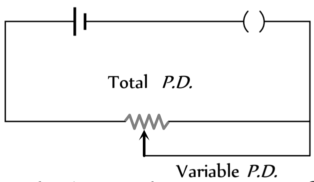
77. For a cell of e.m.f. $2V$, a balance is obtained for 50 *cm* of the potentiometer wire. If the cell is shunted by a $2\,\Omega$ resistor and the balance is obtained across 40 *cm* of the wire, then the internal resistance of the cell is [SCRA 1998]

(a) $0.25\,\Omega$ (b) $0.50\,\Omega$

(c) $0.80\,\Omega$ (d) $1.00\,\Omega$

78. The arrangement as shown in figure is called as

[CPMT 1999]



(a) Potential divider

(b) Potential adder

(c) Potential substracter

(d) Potential multiplier

79. A potentiometer wire of length $1\,m$ and resistance 10 Ω is connected in series with a cell of *emf* $2\,V$ with internal resistance 1 Ω and a resistance box including a resistance R. If potential difference between the ends of the wire is 1 mV, the value of R is [KCET 1999]

(a) 20000 Ω (b) 19989 Ω

(c) 10000 Ω (d) 9989 Ω

80. In a balanced Wheatstone's network, the resistances in the arms Q and S are interchanged. As a result of this

[KCET 1999]

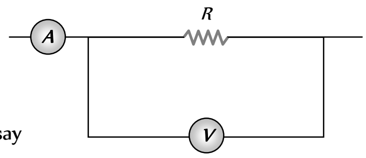
(a) Network is not balanced

(b) Network is still balanced

(c) Galvanometer shows zero deflection

(d) Galvanometer and the cell must be interchanged to balance

81. The ammeter A reads 2 A and the voltmeter V reads 20 V. the value of resistance R is (Assuming finite resistance's of ammeter and voltmeter) [JIPMER 1999; MP PMT 2004]



(a) Exactly 10 *ohm*

(b) Less than 10 *ohm*

(c) More than 10 *ohm*

(d) We cannot definitely say

82. The resistance of a galvanometer coil is R. What is the shunt resistance required to convert it into an ammeter of range 4 times

(a) $\frac{R}{5}$ (b) $\frac{R}{4}$

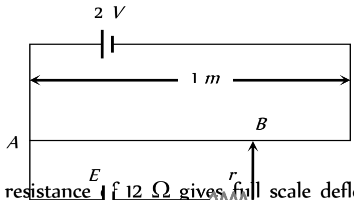
(c) $\frac{R}{3}$[RPET 1996] (d) $4\,R$

83. If an ammeter is connected in parallel to a circuit, it is likely to be damaged due to excess [BHU 2000; BCECE 2004]

(a) Current (b) Voltage

(c) Resistance (d) All of these

84. In the given figure, battery E is balanced on 55 *cm* length of potentiometer wire but when a resistance of 10 Ω is connected in parallel with the battery then it balances on 50 *cm* length of the potentiometer wire then internal resistance r of the battery is



(a) 1 Ω

(b) 3 Ω

(c) 10 Ω

(d) 5 Ω

85. A galvanometer with a resistance of 12 Ω gives full scale deflection when a current of 3 mA is passed. It is required to convert it into a voltmeter which can read up to 18 V. the resistance to be connected is [Pb. PMT 2000]

(a) 6000 Ω (b) 5988 Ω

(c) 5000 Ω (d) 4988 Ω

86. The resistance of an ideal ammeter is [KCET 2000]

(a) Infinite (b) Very high

(c) Small (d) Zero

87. A galvanometer of 25 Ω resistance can read a maximum current of $6\,mA$. It can be used as a voltmeter to measure a maximum of 6 V by connecting a resistance to the galvanometer. Identify the correct choice in the given answers [EAMCET (Med.) 2000]

(a) 1025 Ω in series (b) 1025 Ω in parallel

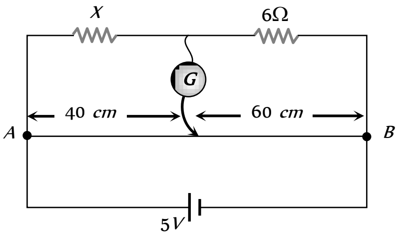
(c) 975 Ω in series (d) 975 Ω in parallel

88. A galvanometer has a resistance of 25 *ohm* and a maximum of 0.01 *A* current can be passed through it. In order to change it into an ammeter of range 10 *A*, the shunt resistance required is

(a) 5/999 *ohm* (b) 10/999 *ohm*

(c) 20/999 *ohm* (d) 25/999 *ohm*

89. In the circuit shown, a *meter* bridge is in its balanced state. The *meter* bridge wire has a resistance 0.1 *ohm/cm*. The value of unknown resistance *X* and the current drawn from the battery of negligible resistance is [AMU (Engg.) 2000]



(a) 6 Ω, 5 *amp*

(b) 10 Ω, 0.1 *amp*

(c) 4 Ω, 1.0 *amp*

(d) 12 Ω, 0.5 *amp*

90. A galvanometer has 30 divisions and a sensitivity 16 $\mu A/\text{div}$. It can be converted into a voltmeter to read 3 *V* by connecting

(a) Resistance nearly 6 $k\Omega$ in series

(b) $6k\Omega$ in parallel

(c) 500Ω in series

(d) It cannot be converted

91. Voltmeters V_1 and V_2 are connected in series across a *D.C.* line. V_1 reads 80 *volts* and has a per *volt* resistance of 200 *ohms*. V_2 has a total resistance of 32 *kilo ohms*. The line voltage is

(a) 120 *volts* (b) 160 *volts*

(c) 220 *volts* (d) 240 *volts*

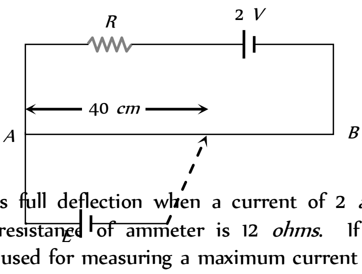
92. A potentiometer having the potential gradient of 2 *mV/cm* is used to measure the difference of potential across a resistance of 10 *ohm*. If a length of 50 *cm* of the potentiometer wire is required to get the null point, the current passing through the 10 *ohm* resistor is (in *mA*)

[AMU (Med.) 2000]

(a) 1 (b) 2

(c) 5 (d) 10

93. *AB* is a potentiometer wire of length 100 *cm* and its resistance is 10 *ohms*. It is connected in series with a resistance *R* = 40 *ohms* and a battery of e.m.f. 2 *V* and negligible internal resistance. If a source of unknown e.m.f. *E* is balanced by 40 *cm* length of the potentiometer wire, the value of *E* is [MP PET 2001]



(a) 0.8 *V*

(b) 1.6 *V*

(c) 0.08 *V*

(d) 0.16 *V*

94. An ammeter gives full deflection when a current of 2 *amp.* flows through it. The resistance of ammeter is 12 *ohms*. If the same ammeter is to be used for measuring a maximum current of 5 *amp.*, then the ammeter must be connected with a resistance of

(a) 8 *ohms* in series (b) 18 *ohms* in series

(c) 8 *ohms* in parallel (d) 18 *ohms* in parallel

95. In a circuit 5 percent of total current passes through a galvanometer. If resistance of the galvanometer is *G* then value of the shunt is [MP PET 2001]

(a) 19 *G* (b) 20 *G*

(c) $\frac{G}{20}$ (d) $\frac{G}{19}$

[MP PET 2000]

96. A voltmeter having resistance of 50×10^3 *ohm* is used to measure the voltage in a circuit. To increase the range of measurement 3 times the additional series resistance required is

(a) 10^5 *ohm* (b) 150 *k.ohm*

(c) 900 *k.ohm* (d) 9×10^6 *ohm*

97. In a potentiometer experiment two cells of e.m.f. E_1 and E_2 are used in series and in conjunction and the balancing length is found to be 58 *cm* of the wire. If the polarity of E_2 is reversed, then the balancing length becomes 29 *cm*. The ratio $\frac{E_1}{E_2}$ of the e.m.f. of the two cells is

[Kerala (Engg.) 2001]

(a) 1 : 1 (b) 2 : 1

(c) 3 : 1 (d) 4 : 1

98. A milliammeter of range 10 *mA* has a coil of resistance 1 Ω. To use it as voltmeter of range 10 *volt*, the resistance that must be connected in series with it, will be [Kerala PMT 2005] [KCET 2001]

(a) 999 Ω (b) 99 Ω

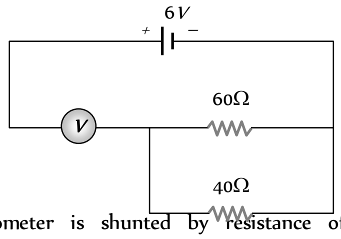
(c) 1000 Ω (d) None of these

99. A voltmeter has a range 0-*V* with a series resistance *R*. With a series resistance 2*R*, the range is 0-*V'*. The correct relation between *V* and *V'* is [CPMT 2001]

(a) $V' = 2V$ [UPSEAT 2000] (b) $V' > 2V$

(c) $V' >> 2V$ (d) $V' < 2V$

100. The measurement of voltmeter in the following circuit is [AFMC 2001]



(a) 2.4 *V*

(b) 3.4 *V*

(c) 4.0 *V*

(d) 6.0 *V*

101. A 36 Ω galvanometer is shunted by resistance of 4Ω. The percentage of the total current, which passes through the galvanometer is [UPSEAT 2002]

(a) 8 % (b) 9 %

(c) 10 % (d) 91 %

102. An ammeter and a voltmeter of resistance *R* are connected in series to an electric cell of negligible internal resistance. Their readings are *A* and *V* respectively. If another resistance *R* is connected in parallel with the voltmeter

[EAMCET 2000; KCET 2002]

(a) Both *A* and *V* will increase

(b) Both *A* and *V* will decrease

(c) *A* will decrease and *V* will increase

(d) *A* will increase and *V* will decrease [MP PET 2001]

103. A wire of length 100 *cm* is connected to a cell of *emf* 2 *V* and negligible internal resistance. The resistance of the wire is 3 Ω. The additional resistance required to produce a potential drop of 1 *milli volt* per *cm* is [Kerala PET 2002]

(a) 60 Ω (b) 47 Ω

(c) 57 Ω (d) 35 Ω

104. A galvanometer of resistance 20 Ω is to be converted into an ammeter of range 1 *A*. If a current of 1 *mA* produces full scale deflection, the shunt required for the purpose is

[Kerala PET 2002]

(a) 0.01 Ω (b) 0.05 Ω

(c) 0.02 Ω (d) 0.04 Ω

105. There are three voltmeters of the same range but of resistances 10000Ω, 8000Ω and 4000Ω respectively. The best voltmeter among these is the one whose resistance is

(a) 10000 Ω (b) 8000 Ω

(c) 4000 Ω (d) All are equally good

106. If an ammeter is to be used in place of a voltmeter then we must connect with the ammeter a

[AIEEE 2002; AFMC 2002]

(a) Low resistance in parallel

(b) High resistance in parallel

(c) High resistance in series

(d) Low resistance in series

107. A 10 *m* long wire of 20Ω resistance is connected with a battery of 3 *volt* e.m.f. (negligible internal resistance) and a 10 Ω resistance is joined to it is series. Potential gradient along wire in volt per meter is [MP PMT 2003]

(a) 0.02 (b) 0.3

(c) 0.2 (d) 1.3

108. A potentiometer has uniform potential gradient across it. Two cells connected in series (i) to support each other and (ii) to oppose each other are balanced over 6*m* and 2*m* respectively on the potentiometer wire. The e.m.f.'s of the cells are in the ratio of

(a) 1 : 2 (b) 1 : 1

(c) 3 : 1 (d) 2 : 1

109. The material of wire of potentiometer is

[MP PMT 2002]

(a) Copper (b) Steel

(c) Manganin (d) Aluminium

110. To convert a galvanometer into a voltmeter, one should connect a

(a) High resistance in series with galvanometer

(b) Low resistance in series with galvanometer

(c) High resistance in parallel with galvanometer

(d) Low resistance in parallel with galvanometer

111. To convert a 800 *mV* range *milli voltmeter* of resistance 40 Ω into a galvanometer of 100 *mA* range, the resistance to be connected as shunt is [CBSE PMT 2002]

(a) 10 Ω (b) 20 Ω

(c) 30 Ω (d) 40 Ω

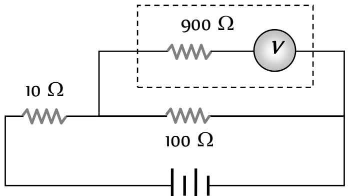
112. A 100 *ohm* galvanometer gives full scale deflection at 10 *mA*. How much shunt is required to read 100 *mA*

[MP PET 2002]

(a) 11.11 *ohm* (b) 9.9 *ohm*

(c) 1.1 *ohm* (d) 4.4 *ohm*

113. The potential difference across the 100Ω resistance in the following circuit is measured by a voltmeter of 900 Ω resistance. The percentage error made in reading the potential difference is



(a) $\frac{10}{9}$

(b) 0.1

(c) 1.0

(d) 10.0

[Kerala PET 2002]

114. A cell of internal resistance 3 *ohm* and *emf* 10 *volt* is connected to a uniform wire of length 500 *cm* and resistance 3 *ohm*. The potential gradient in the wire is [MP PET 2003]

(a) 30 *mV/cm* (b) 10 *mV/cm*

(c) 20 *mV/cm* (d) 4 *mV/cm*

115. An ammeter of 100 Ω resistance gives full deflection for the current of 10^{-5} *amp*. Now the shunt resistance required to convert it into ammeter of 1 *amp*. range, will be

[RPET 2003]

(a) $10^{-4}\ \Omega$ (b) $10^{-5}\ \Omega$

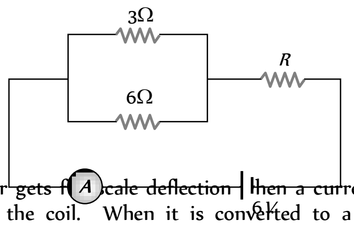
(c) $10^{-3}\ \Omega$ (d) $10^{-1}\ \Omega$

116. A galvanometer of resistance 36 Ω is changed into an ammeter by using a shunt of 4 Ω. The fraction f of total current passing through the galvanometer is [BCECE 2003]

(a) $\frac{1}{40}$ (b) $\frac{1}{4}$

(c) $\frac{1}{140}$ (d) $\frac{1}{10}$

117. If the ammeter in the given circuit reads 2 *A*, the resistance *R* is



(a) 1 *ohm*

[MP PMT 2002]

(b) 2 *ohm*

(c) 3 *ohm*

(d) 4 *ohm*

118. A 50 *ohm* galvanometer gets full scale deflection when a current of 0.01 *A* passes through the coil. When it is converted to a 10 *A* ammeter, the shunt resistance is

[Orissa JEE 2003]

[CBSE PMT 2002]

(a) 0.01 Ω (b) 0.05 Ω

(c) 2000 Ω (d) 5000 Ω

119. Resistance in the two gaps of a *meter* bridge are 10 *ohm* and 30 *ohm* respectively. If the resistances are interchanged the balance point shifts by [Orissa JEE 2003]

(a) 33.3 *cm* (b) 66.67 *cm*

(c) 25 *cm* (d) 50 *cm*

120. A potentiometer has uniform potential gradient. The specific resistance of the material of the potentiometer wire is 10^{-7} *ohm–meter* and the current passing through it is 0.1 *ampere*; cross-section of the wire is 10^{-6} m^2. The potential gradient along the potentiometer wire is [KCET 2003]

(a) 10^{-4} *V/m* (b) 10^{-6} *V/m*

(c) 10^{-2} *V/m* (d) 10^{-8} *V/m*

121. Two resistances of 400 Ω and 800 Ω are connected in series with 6 *volt* battery of negligible internal resistance. A voltmeter of resistance 10,000 Ω is used to measure the potential difference across 400 Ω. The error in the measurement of potential difference in *volts* approximately is

[AMU (Med.) 2002]

(a) 0.01 (b) 0.02

(c) 0.03 (d) 0.05

122. A galvanometer, having a resistance of 50 Ω gives a full scale deflection for a current of 0.05 *A*. The length in *meter* of a resistance wire of area of cross-section 2.97× 10 *cm* that can be used to convert the galvanometer into an ammeter which can read a maximum of 5 *A* current is (Specific resistance of the wire = 5 × 10^{-7} Ω*m*)

(a) 9 (b) 6

(c) 3 (d) 1.5

123. An ammeter reads upto 1 *ampere*. Its internal resistance is 0.81 *ohm*. To increase the range to 10 *A* the value of the required shunt is [AIEEE 2003]

(a) 0.09 Ω (b) 0.03 Ω

(c) 0.3 Ω (d) 0.9 Ω

124. The length of a wire of a potentiometer is 100 *cm*, and the *emf* of its standard cell is *E volt*. It is employed to measure the *e.m.f* of a battery whose internal resistance is 0.5 Ω. If the balance point is obtained at *l* = 30 *cm* from the positive end, the e.m.f. of the battery is [AIEEE 2003]

(a) $\frac{30E}{100}$

(b) $\frac{30E}{100.5}$

(c) $\frac{30E}{(100-0.5)}$

(d) $\frac{30(E-0.5i)}{100}$, where *i* is the current in the potentiometer

125. Resistance of 100 *cm* long potentiometer wire is 10Ω, it is connected to a battery (2 *volt*) and a resistance *R* in series. A source of 10 *mV* gives null point at 40 *cm* length, then external resistance *R* is

(a) 490 Ω (b) 790 Ω

(c) 590 Ω (d) 990 Ω

126. The e.m.f. of a standard cell balances across 150 *cm* length of a wire of potentiometer. When a resistance of $2\,\Omega$ is connected as a shunt with the cell, the balance point is obtained at $100\,cm$. The internal resistance of the cell is

[MP PET 1993]

(a) $0.1\,\Omega$ (b) $1\,\Omega$

(c) $2\,\Omega$ (d) $0.5\,\Omega$

127. What is the reading of voltmeter in the following figure

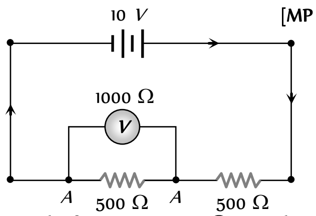
[MP PMT 2004]

(a) 3 *V*

(b) 2 *V*

(c) 5 *V*

(d) 4 *V*



128. The current flowing in a coil of resistance 90 Ω is to be reduced by 90%. What value of resistance should be connected in parallel with it [MP PMT 2004]

(a) 9 Ω (b) 90 Ω

(c) 1000 Ω (d) 10 Ω

129. The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 *mA*. It is converted into a voltmeter that can read upto 50 *V*. The resistance to be connected in series with the galvanometer is ... (in *ohm*)

[KCET 2004]

(a) 5040 (b) 4960

(c) 2010 (d) 4050

[EAMCET 2003]

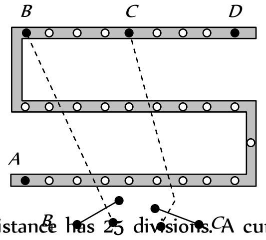
130. For the post office box arrangement to determine the value of unknown resistance the unknown resistance should be connected between [IIT-JEE (Screening) 2004]

(a) *B* and *C*

(b) *C* and *D*

(c) *A* and *D*

(d) *B* and *C*



131. A galvanometer of 50 *ohm* resistance has 25 divisions. A current of 4 × 10 *ampere* gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 *volts*, it should be connected with a resistance of

[CBSE PMT 2004]

(a) 2500 Ω as a shunt (b) 2450 Ω as a shunt

(c) 2550 Ω in series (d) 2450 Ω in series

132. In a metre bridge experiment null point is obtained at 20 *cm* from one end of the wire when resistance *X* is balanced against another resistance *Y*. If *X* < *Y*, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4*X* against *Y*

[AIEEE 2004]

[MP PMT 2003]

(a) 50 *cm* (b) 80 *cm*

(c) 40 *cm* (d) 70 *cm*

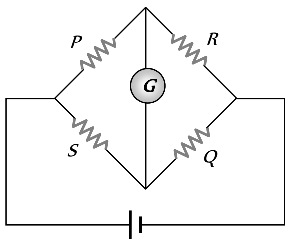
133. In the circuit given, the correct relation to a balanced Wheatstone bridge is [Orissa PMT 2004]

(a) $\frac{P}{Q}=\frac{R}{S}$

(b) $\frac{P}{Q}=\frac{S}{R}$

(c) $\frac{P}{R}=\frac{S}{Q}$

(d) None of these



134. A galvanometer coil of resistance 50 Ω, show full deflection of $100\mu A$. The shunt resistance to be added to the galvanometer, to work as an ammeter of range 10 *mA* is

[Pb PET 2000]

(a) 5 Ω in parallel (b) 0.5 Ω in series

(c) 5 Ω in series (d) 0.5 Ω in parallel

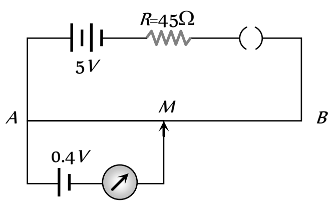
135. In given figure, the potentiometer wire *AB* has a resistance of 5 Ω and length 10 *m*. The balancing length *AM* for the emf of 0.4 *V* is

(a) 0.4 *m*

(b) 4 *m*

(c) 0.8 *m*

(d) 8 *m*



136. A potentiometer consists of a wire of length 4 m and resistance 10 Ω. It is connected to cell of emf 2 V. The potential difference per unit length of the wire will be

[Pb. PET 2002]

(a) 0.5 V/m (b) 10 V/m
(c) 2 V/m (d) 5 V/m

137. A voltmeter essentially consists of [UPSEAT 2004]

(a) A high resistance, in series with a galvanometer
(b) A low resistance, in series with a galvanometer
(c) A high resistance in parallel with a galvanometer
(d) A low resistance in parallel with a galvanometer

138. In a potentiometer experiment the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is

(a) 4 Ω (b) 2 Ω
(c) 1 Ω (d) 0.5 Ω

139. With a potentiometer null point were obtained at 140 cm and 180 cm with cells of emf 1.1 V and one unknown X volts. Unknown emf is [DCE 2002]

(a) 1.1 V (b) 1.8 V
(c) 2.4 V (d) 1.41 V

140. A moving coil galvanometer of resistance 100Ω is used as an ammeter using a resistance 0.1Ω. The maximum deflection current in the galvanometer is 100μA. Find the minimum current in the circuit so that the ammeter shows maximum deflection

(a) 100.1 mA (b) 1000.1 mA
(c) 10.01 mA (d) 1.01 mA

141. Two resistances are connected in two gaps of a metre bridge. The balance point is 20 cm from the zero end. A resistance of 15 *ohms* is connected in series with the smaller of the two. The null point shifts to 40 cm. The value of the smaller resistance in ohms is

(a) 3 (b) 6
(c) 9 (d) 12

142. If resistance of voltmeter is 10000Ω and resistance of ammeter is 2Ω then find R when voltmeter reads 12 V and ammeter reads 0.1 A

(a) 118 Ω (b) 120 Ω
(c) 124 Ω (d) 114Ω

143. Potentiometer wire of length 1 m is connected in series with 490 Ω resistance and 2 V battery. If 0.2 mV/cm is the potential gradient, then resistance of the potentiometer wire is

(a) 4.9 Ω (b) 7.9 Ω
(c) 5.9 Ω (d) 6.9 Ω

Critical Thinking

Objective Questions

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

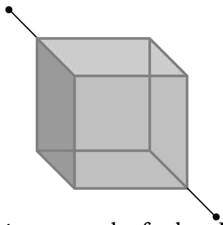
[CPMT 1988]

(a) $7.5\,\Omega$ (b) $45\,\Omega$
(c) $90\,\Omega$ (d) $270\,\Omega$

2. Two uniform wires A and B are of the same metal and have equal masses. The radius of wire A is twice that of wire B. The total resistance of A and B when connected in parallel is

(a) $4\,\Omega$ when the resistance of wire A is $4.25\,\Omega$
(b) $5\,\Omega$ when the resistance of wire A is $4.25\,\Omega$
(c) $4\,\Omega$ when the resistance of wire B is $4.25\,\Omega$
(d) $4\,\Omega$ when the resistance of wire B is $4.25\,\Omega$

3. Twelve [DCE 2002; AIEEE 2005] wires of equal length and same cross-section are connected in the form of a cube. If the resistance of each of the wires is R, then the effective resistance between the two diagonal ends would be [J & K CET 2004]



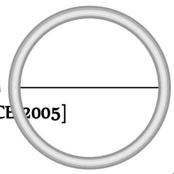
(a) $2R$
(b) $12R$
(c) $\frac{5}{6}R$
(d) $8R$

4. You are given several identical resistances each of value $R = 10\,\Omega$ [IIT-JEE (Screening) 2005] and each capable of carrying maximum current of 1 ampere. It is required to make a suitable combination of these resistances to produce a resistance of $5\,\Omega$ which can carry a current of 4 amperes. The minimum number of resistances of the type R that will be required for this job

[CBSE PMT 1990]

(a) 4 [KCET 2005] (b) 10
(c) 8 (d) 20

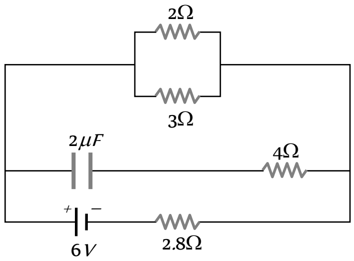
5. The resistance of a wire is $10^{-6}\,\Omega$ per metre. It is bend in the form of a circle of diameter $2\,m$. [BCECE 2005] A wire of the same material is connected across its diameter. The total resistance across its diameter AB will be



[DCE 2005]

(a) $\frac{4}{3}\pi \times 10^{-6}\,\Omega$ (b) $\frac{2}{3}\pi \times 10^{-6}\,\Omega$
(c) $0.88 \times 10^{-6}\,\Omega$ (d) $14\pi \times 10^{-6}\,\Omega$

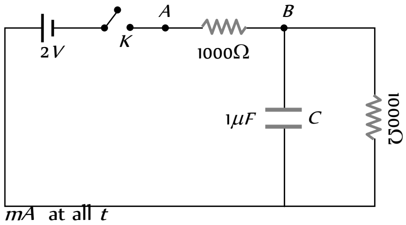
6. In the figure shown, the capacity of the condenser C is $2\,\mu F$. The current in $2\,\Omega$ resistor is [IIT 1982]



(a) 9 A (b) 0.9 A

(c) $\frac{1}{9}A$ (d) $\frac{1}{0.9}A$

7. When the key K is pressed at time $t=0$, which of the following statements about the current I in the resistor AB of the given circuit is true [CBSE PMT 1995]



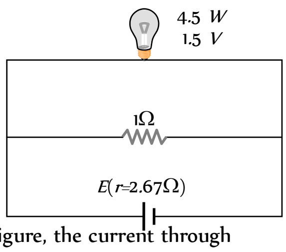
(a) I = 2 mA at all t

(b) I oscillates between 1 mA and 2mA

(c) I = 1 mA at all t

(d) At t = 0 , I = 2 mA and with time it goes to 1 mA

8. A torch bulb rated as 4.5 W, 1.5 V is connected as shown in the figure. The $e.m.f.$ of the cell needed to make the bulb glow at full intensity is [MP PMT 1999]



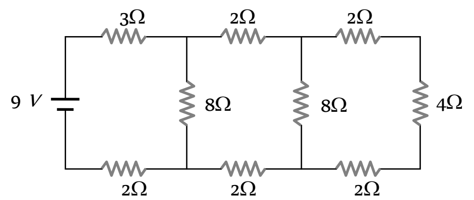
(a) 4.5 V

(b) 1.5 V

(c) 2.67 V

(d) 13.5 V

9. In the circuit shown in the figure, the current through [IIT 1998]



(a) The 3Ω resistor is 0.50A (b) The 3Ω resistor is 0.25 A

(c) The 4Ω resistor is 0.50A (d) The 4Ω resistor is 0.25 A

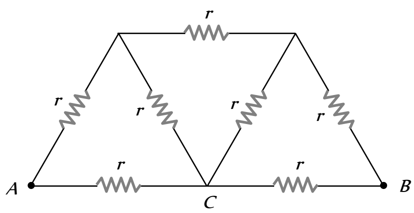
10. There are three resistance coils of equal resistance. The maximum number of resistances you can obtain by connecting them in any manner you choose, being free to use any number of the coils in any way is

[ISM Dhanbad 1994]

(a) 3 (b) 4

(c) 6 (d) 5

11. In the circuit shown, the value of each resistance is r, then equivalent resistance of circuit between points A and B will be



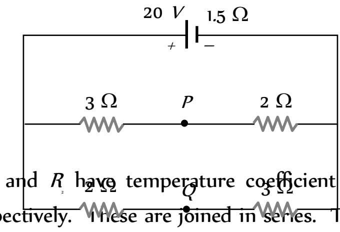
(a) (4/3) r

(b) 3r / 2

(c) r / 3

(d) 8r / 7

12. If in the circuit shown below, the internal resistance of the battery is 1.5 Ω and V_P and V_Q are the potentials at P and Q respectively, what is the potential difference between the points P and Q



(a) Zero

(b) 4 $volts$ ($V_P > V_Q$)

(c) 4 $volts$ ($V_Q > V_P$)

(d) 2.5 $volts$ ($V_Q > V_P$)

13. Two wires of resistance R_1 and R_2 have temperature coefficient of resistance α_1 and α_2, respectively. These are joined in series. The effective temperature coefficient of resistance is

(a) $\frac{\alpha_1+\alpha_2}{2}$ (b) $\sqrt{\alpha_1\alpha_2}$

(c) $\frac{\alpha_1R_1+\alpha_2R_2}{R_1+R_2}$ (d) $\frac{\sqrt{R_1R_2\alpha_1\alpha_2}}{\sqrt{R_1^2+R_2^2}}$

14. Two cells of equal $e.m.f.$ and of internal resistances r_1 and $r_2(r_1>r_2)$ are connected in series. On connecting this combination to an external resistance R, it is observed that the potential difference across the first cell becomes zero. The value of R will be

[MP PET 1985; KCET 2005; Kerala PMT 2005]

(a) r_1+r_2 (b) r_1-r_2

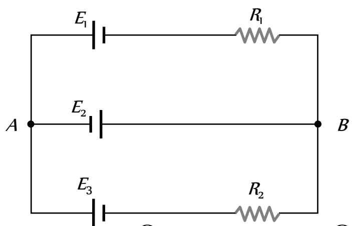
(c) $\frac{r_1+r_2}{2}$ (d) $\frac{r_1-r_2}{2}$

15. When connected across the terminals of a cell, a voltmeter measures 5 V and a connected ammeter measures 10 A of current. A resistance of 2 $ohms$ is connected across the terminals of the cell. The current flowing through this resistance will be

(a) 2.5 A (b) 2.0 A

(c) 5.0 A (d) 7.5 A

16. In the circuit shown here, $E_1=E_2=E_3=2$ V and $R_1=R_2=4$ $ohms$. The current flowing between points A and B through battery E_2 is



(a) Zero

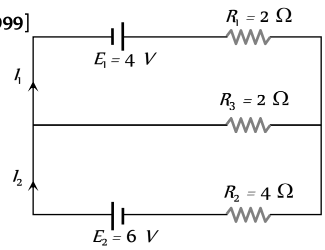
(b) 2 amp from A to B

(c) 2 amp from B to A

(d) None of the above

17. In the circuit shown below E_1 = 4.0 V, R_1 = 2 Ω, E_2 = 6.0 V, R_2 = 4 Ω and R_3 = 2 Ω. The current I_1 is [MP PET 2003]

[Similar to CBSE PMT 1999; RPET 1999]



(a) 1.6 A

(b) 1.8 A

(c) 1.25 A

(d) 1.0 A

18. A microammeter has a resistance of $100\,\Omega$ and full scale range of $50\,\mu A$. It can be used as a voltmeter or as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination

[SCRA 1996; AMU (Med.) 2001; Roorkee 2000]

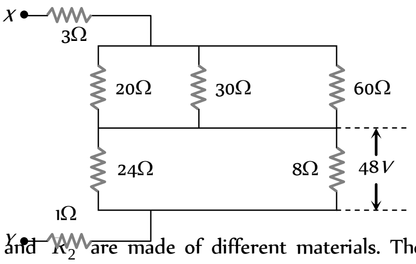
(a) 50 *V* range with $10\,k\Omega$ resistance in series

(b) 10 *V* range with $200\,k\Omega$ resistance in series

(c) 10 *mA* range with $1\,\Omega$ resistance in parallel

(d) 10 *mA* range with $0.1\,\Omega$ resistance in parallel

19. The potential difference across 8 *ohm* resistance is 48 *volt* as shown in the figure. The value of potential difference across *X* and *Y* points will be [MP PET 1996]



(a) 160 *volt*

(b) 128 *volt*

(c) 80 *volt*

(d) 62 *volt*

20. Two resistances R_1 and R_2 are made of different materials. The temperature coefficient of the material of R_1 is α and of the material of R_2 is $-\beta$. The resistance of the series combination of R_1 and R_2 will not change with temperature, if R_1/R_2 equals

(a) $\frac{\alpha}{\beta}$ (b) $\frac{\alpha+\beta}{\alpha-\beta}$

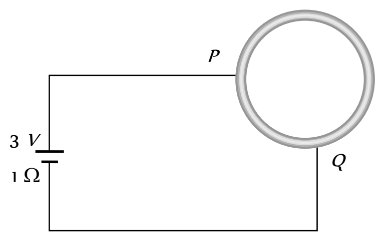
(c) $\frac{\alpha^2+\beta^2}{\alpha\beta}$ (d) $\frac{\beta}{\alpha}$

21. An ionization chamber with parallel conducting plates as anode and cathode has 5×10^7 electrons and the same number of singly-charged positive ions per cm^3. The electrons are moving at 0.4 *m/s*. The current density from anode to cathode is $4\,\mu A/m^2$. The velocity of positive ions moving towards cathode is

(a) 0.4 *m/s* (b) 16 *m/s*

(c) Zero (d) 0.1 *m/s*

22. A wire of resistance 10 Ω is bent to form a circle. *P* and *Q* are points on the circumference of the circle dividing it into a quadrant and are connected to a Battery of 3 *V* and internal resistance 1 Ω as shown in the figure. The currents in the two parts of the circle are



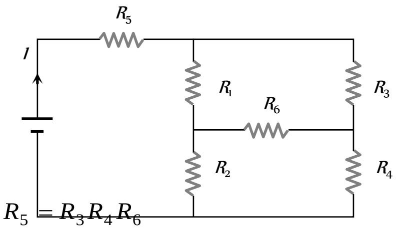
(a) $\frac{6}{23}A$ and $\frac{18}{23}A$

(b) $\frac{5}{26}A$ and $\frac{15}{26}A$

(c) $\frac{4}{25}A$ and $\frac{12}{25}A$

(d) $\frac{3}{25}A$ and $\frac{9}{25}A$

23. In the given circuit, it is observed that the current *I* is independent of the value of the resistance R_6. Then the resistance values must satisfy [IIT-JEE (Screening) 2001]



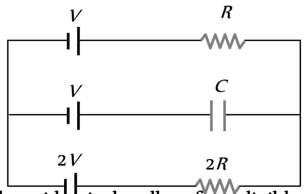
(a) $R_1R_2R_5 = R_3R_4R_6$

(b) $\frac{1}{R_5}+\frac{1}{R_6}=\frac{1}{R_1+R_2}+\frac{1}{R_3+R_4}$

(c) $R_1R_4 = R_2R_3$

(d) $R_1R_3 = R_2R_4 = R_5R_6$

24. In the given circuit, with steady current, the potential drop across the capacitor must be [IIT-JEE (Screening) 2001]



(a) V

(b) $V/2$

(c) $V/3$

(d) $2V/3$

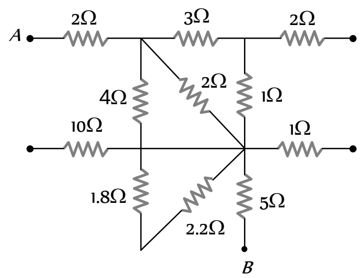
25. A wire of length *L* and 3 identical cells of negligible internal resistances are connected in series. Due to current, the temperature of the wire is raised by Δ *T* in a time *t*. A number *N* of similar cells is now connected in series with a wire of the same material and cross–section but of length 2 *L*. The temperature of the wire is raised by the same amount Δ *T* in the same time *t*. the value of *N* is

[MP PMT 1997] [IIT-JEE (Screening) 2001]

(a) 4 (b) 6

(c) 8 (d) 9

26. What is the equivalent resistance between the points *A* and *B* of the network [AMU (Engg.) 2001]



(a) $\frac{57}{7}\,\Omega$

(b) 8 Ω

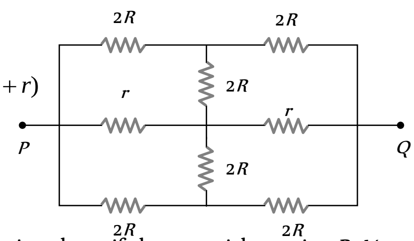
(c) 6 Ω

[CBSE PMT 1992]

(d) $\frac{57}{5}\,\Omega$

27. The effective resistance between points *P* and *Q* of the electrical circuit shown in the figure is

[Roorkee 1999] [IIT-JEE (Screening) 2002]



(a) $2Rr/(R+r)$

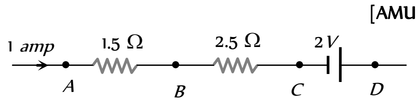
(b) $8R(R+r)/(3R+r)$

(c) $2r+4R$

(d) $5R/2+2r$

28. In the circuit element given here, if the potential at point *B*, V_B = 0, then the potentials of *A* and *D* are given as

[AMU (Med.) 2002]

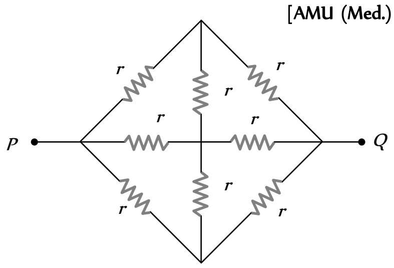


(a) $V_A = -1.5\,V, V_D = +2\,V$ (b) $V_A = +1.5\,V, V_D = +2\,V$

(c) $V_A = +1.5\,V, V_D = +0.5\,V$ (d) $V_A = +1.5\,V, V_D = -0.5\,V$

29. The equivalent resistance between the points P and Q in the network given here is equal to (given $r = \frac{3}{2}\Omega$)

[AMU (Med.) 2002]



(a) $\frac{1}{2}\,\Omega$

(b) $1\,\Omega$

(c) $\frac{3}{2}\,\Omega$

(d) $2\,\Omega$

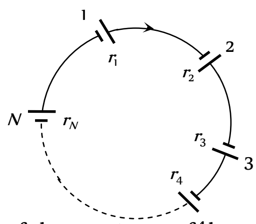
30. The current in a conductor varies with time t as $I = 2t + 3t^2$ where I is in *ampere* and t in *seconds*. Electric charge flowing through a section of the conductor during $t = 2$ *sec* to $t = 3$ *sec* is

(a) 10 C (b) 24 C

(c) 33 C (d) 44 C

31. A group of N cells whose *emf* varies directly with the internal resistance as per the equation $E = 1.5\,r$ are connected as shown in the figure below. The current I in the circuit is

[KCET 2003]



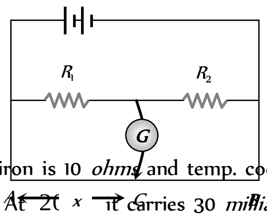
(a) 0.51 *amp*

(b) 5.1 *amp*

(c) 0.15 *amp*

(d) 1.5 *amp*

32. In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled



(a) x

(b) $x/4$

(c) $4x$

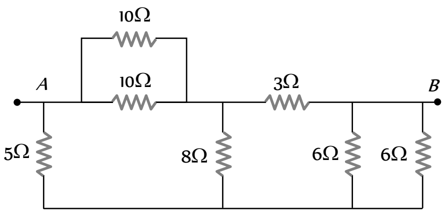
(d) $2x$

33. The resistance of a wire of iron is 10 *ohms* and temp. coefficient of resistivity is $5 \times 10^{-3}\,/°C$. At 20°C it carries 30 *milliamperes* of current. Keeping constant potential difference between its ends, the temperature of the wire is raised to $120°C$. The current in *milliamperes* that flows in the wire is

(a) 20 (b) 15

(c) 10 (d) 40

34. Seven resistances are connected as shown in the figure. The equivalent resistance between A and B is [MP PET 2000]



(a) $3\,\Omega$

(b) $4\,\Omega$

(c) $4.5\,\Omega$

(d) $5\,\Omega$

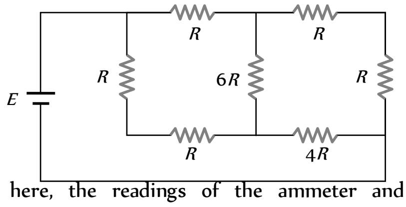
35. A battery of internal resistance 4Ω is connected to the network of resistances as shown. In order to give the maximum power to the network, the value of R (in Ω) should be

(a) 4/9

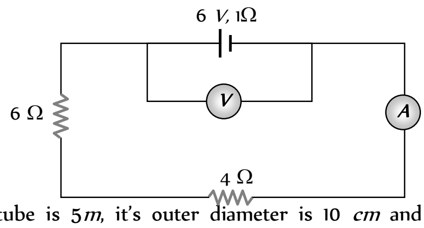
(b) 8/9

(c) 2

(d) 18



36. In the circuit shown here, the readings of the ammeter and voltmeter are [Kerala PMT 2002]



(a) 6 A, 60 V

(b) 0.6 A, 6 V

(c) 6/11 A, 60/11 V

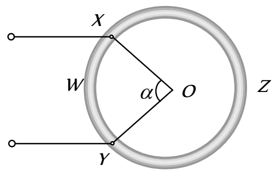
(d) 11/6 A, 11/60 V

37. Length of a hollow tube is 5m, it's outer diameter is 10 *cm* and thickness of it's wall is 5 *mm*. If resistivity of the material of the tube is $1.7 \times 10^{-8}\,\Omega \times m$ then resistance of tube will be [Orissa JEE 2003]

(a) $5.6 \times 10^{-5}\,\Omega$ (b) $2 \times 10^{-5}\,\Omega$

(c) $4 \times 10^{-5}\,\Omega$ (d) None of these

38. A wire of resistor R is bent into a circular ring of radius r. Equivalent resistance between two points X and Y on its circumference, when angle XOY is α, can be given by



(a) $\frac{R\alpha}{4\pi^2}(2\pi - \alpha)$

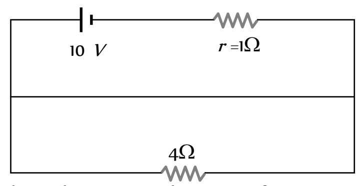
(b) $\frac{R}{2\pi}(2\pi - \alpha)$

(c) $R\,(2\pi - \alpha)$

(d) $\frac{4\pi}{R\alpha}(2\pi - \alpha)$

[IIT-JEE (Screening) 2003]

39. Potential difference across the terminals of the battery shown in figure is (r = internal resistance of battery)



(a) 8 V

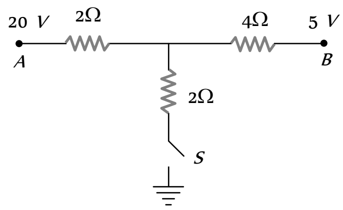
(b) 10 V

(c) 6 V

(d) Zero

40. As the switch S is closed in the circuit shown in figure, current passed through it is

[MP PMT 1994]



(a) 4.5 A

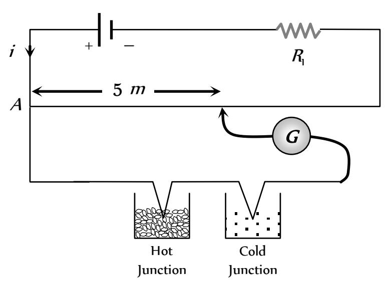
(b) 6.0 A

(c) 3.0 A

(d) Zero

41. In the following circuit a 10 m long potentiometer wire with resistance 1.2 *ohm/m*, a resistance R_1 and an accumulator of emf 2 V are connected in series. When the emf of thermocouple is 2.4 mV then the deflection in galvanometer is zero. The current supplied by the accumulator will be

[IIT 1995]



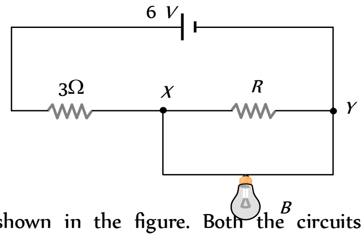
(a) $4 \times 10^{-4}\,A$

(b) 8×10^{-4} A

(c) 4×10^{-3} A

(d) 8×10^{-3} A

42. In the following circuit, bulb rated as 1.5 V, 0.45 W. If bulbs glows with full intensity then what will be the equivalent resistance between X and Y



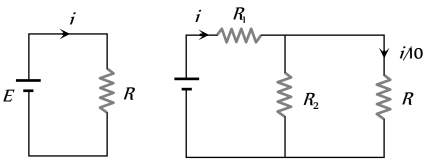
(a) 0.45 Ω

(b) 1 Ω

(c) 3 Ω

(d) 5 Ω

43. Consider the circuits shown in the figure. Both the circuits are taking same current from battery but current through R in the second circuit is $\frac{1}{10}$ th of current through R in the first circuit. If R is 11 Ω, the value of R_1



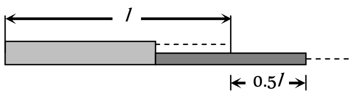
(a) 9.9 Ω

(b) 11 Ω

(c) 8.8 Ω

(d) 7.7 Ω

44. In order to quadruple the resistance of a uniform wire, a part of its length was uniformly stretched till the final length of the entire wire was 1.5 times the original length, the part of the wire was fraction equal to



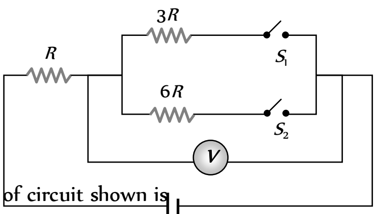
(a) 1 / 8

(b) 1 / 6

(c) 1 / 10

(d) 1 / 4

45. In the circuit shown in figure reading of voltmeter is V_1 when only S_1 is closed, reading of voltmeter is V_2 when only S_2 is closed and reading of voltmeter is V_3 when both S_1 and S_2 are closed. Then



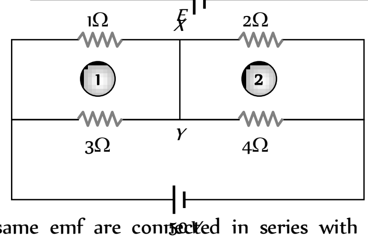
(a) $V_3 > V_2 > V_1$

(b) $V_2 > V_1 > V_3$

(c) $V_3 > V_1 > V_2$

(d) $V_1 > V_2 > V_3$

46. Current through wire XY of circuit shown is



(a) 1 A

(b) 4 A

(c) 2 A

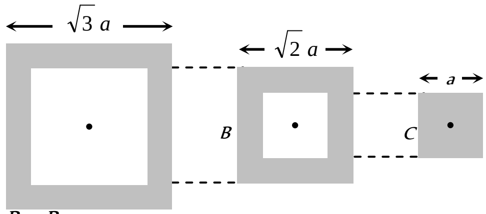
(d) 3 A

47. 12 cells each having same emf are connected in series with some cells wrongly connected. The arrangement is connected in series with an ammeter and two cells which are in series. Current is 3 A when cells and battery aid each other and is 2 A when cells and battery oppose each other. The number of cells wrongly connected is

(a) 4 (b) 1

(c) 3 (d) 2

48. Following figure shows cross-sections through three long conductors of the same length and material, with square cross-section of edge lengths as shown. Conductor B will fit snugly within conductor A, and conductor C will fit snugly within conductor B. Relationship between their end to end resistance is



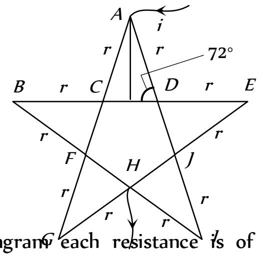
(a) $R_A = R_B = R_C$

(b) $R_A > R_B > R_C$

(c) $R_A < R_B < R$

(d) Information is not sufficient

49. In the following star circuit diagram (figure), the equivalent resistance between the points A and H will be



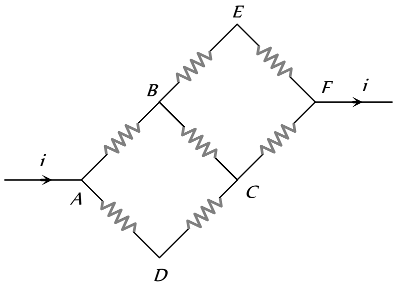
(a) 1.944 r

(b) 0.973 r

(c) 0.486 r

(d) 0.243 r

50. In the adjoining circuit diagram each resistance is of 10 Ω. The current in the arm AD will be



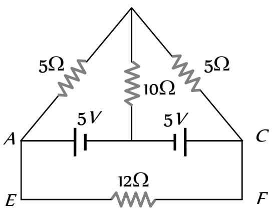
(a) $\frac{2i}{5}$

(b) $\frac{3i}{5}$

(c) $\frac{4i}{5}$

(d) $\frac{i}{5}$

51. In the circuit of adjoining figure the current through 12 Ω resister will be



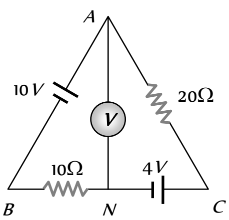
(a) 1 A

(b) $\frac{1}{5}$ A

(c) $\frac{2}{5}$ A

(d) 0 A

52. The reading of the ideal voltmeter in the adjoining diagram will be



(a) 4 V

(b) 8 V

(c) 12 V

(d) 14 V

53. The resistance of the series combination of two resistance is *S*. When they are joined in parallel the total resistance is *P*. If *S* = *nP*, then the minimum possible value of *n* is [AIEEE 2004]

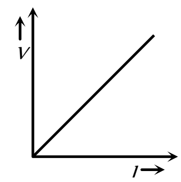
(a) 4 (b) 3
(c) 2 (d) 1

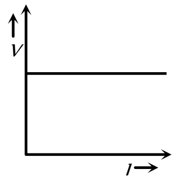
54. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 *divisions per milliampere* and voltage sensitivity is 2 *divisions per millivolt*. In order that each division reads 1 *volt*, the resistance in ohms needed to be connected in series with the coil will be [AIEEE 2005]

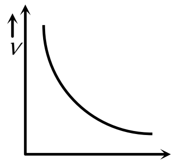
(a) 99995 (b) 9995
(c) 10^3 (d) 10^5

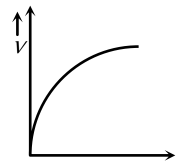
GQ Graphical Questions

1. Which of the adjoining graphs represents *ohmic* resistance [CPMT 1981; DPMT 2002]

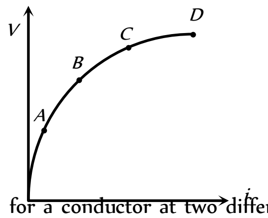
(a) 

(b) 

(c) 

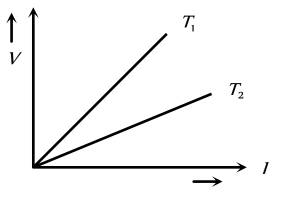
(d) 

2. Variation of current passing through a conductor as the voltage applied across its ends as varied is shown in the adjoining diagram. If the resistance (*R*) is determined at the points *A*, *B*, *C* and *D*, we will find that [CPMT 1988]



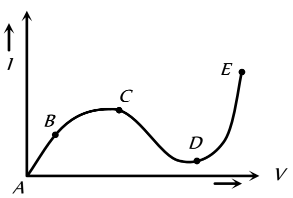
(a) $R_C = R_D$
(b) $R_B > R_A$
(c) $R_C > R_B$
(d) None of these

3. The voltage *V* and current *I* graph for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is [MP PET 1996; KCET 2002]



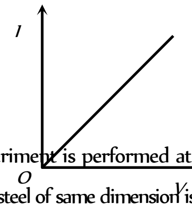
(a) $T_1 > T_2$
(b) $T_1 \approx T_2$
(c) $T_1 = T_2$
(d) $T_1 < T_2$

4. From the graph between current *I* and voltage *V* shown below, identify the portion corresponding to negative resistance [CBSE PMT 1997]



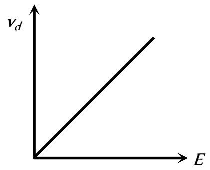
(a) *AB*
(b) *BC*
(c) *CD*
(d) *DE*

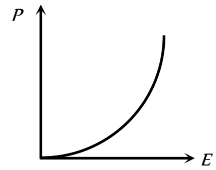
5. *I-V* characteristic of a copper wire of length *L* and area of cross-section *A* is shown in figure. The slope of the curve becomes

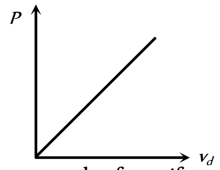


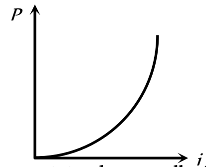
(a) More if the experiment is performed at higher temperature
(b) More if a wire of steel of same dimension is used
(c) More if the length of the wire is increased
(d) Less if the length of the wire is increased

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

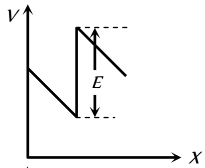
(a) 

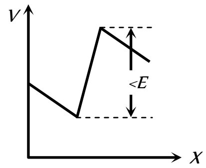
(b) 

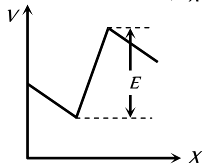
(c) 

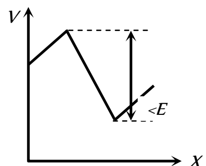
(d) 

7. The two ends of a uniform conductor are joined to a cell of e.m.f. *E* and some internal resistance. Starting from the midpoint *P* of the conductor, we move in the direction of current and return to *P*. The potential *V* at every point on the path is plotted against the distance covered (*x*). Which of the following graphs best represents the resulting curve

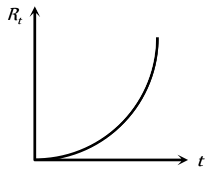
(a) 

(b) 

(c) 

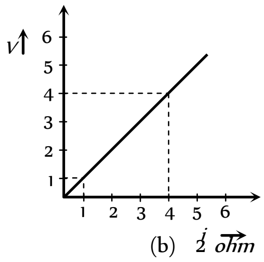
(d) 

8. The resistance R_t of a conductor varies with temperature *t* as shown in the figure. If the variation is represented by $R_t = R_0[1 + \alpha t + \beta t^2]$, then [CPMT 1988]



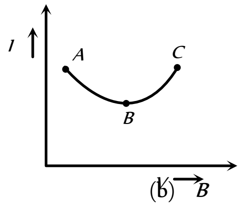
(a) α and β are both negative
(b) α and β are both positive
(c) α is positive and β is negative
(d) α is negative and β are positive

9. Variation of current and voltage in a conductor has been shown in the diagram below. The resistance of the conductor is.



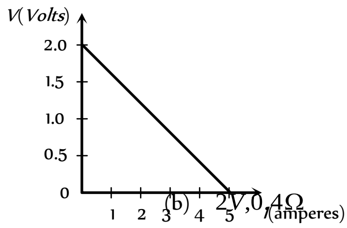
(a) 4 *ohm* (b) 2 *ohm*
(c) 3 *ohm* (d) 1 *ohm*

10. Resistance as shown in figure is negative at [CPMT 1997]



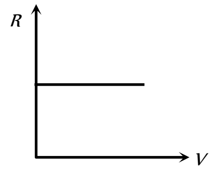
(a) *A* (b) *B*
(c) *C* (d) None of these

11. For a cell, the graph between the potential difference (*V*) across the terminals of the cell and the current (*I*) drawn from the cell is shown in the figure. The e.m.f. and the internal resistance of the cell are

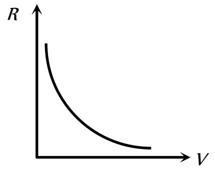


(a) $2V, 0.5\Omega$ (b) $2V, 0.4\Omega$
(c) $> 2V, 0.5\Omega$ (d) $> 2V, 0.4\Omega$

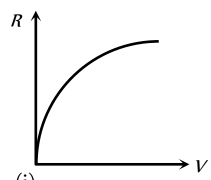
12. The graph which represents the relation between the total resistance *R* of a multi range moving coil voltmeter and its full scale deflection *V* is



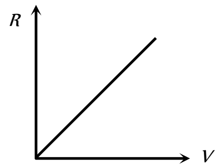
(i)



(ii)



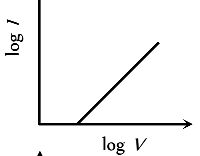
(iii)

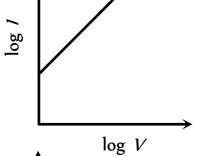


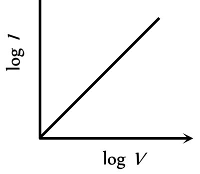
(iv)

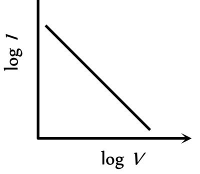
(a) (i) (b) (ii)
(c) (iii) (d) (iv)

13. When a current I is passed through a wire of constant resistance, it produces a potential difference *V* across its ends. The graph drawn between log I and log V will be

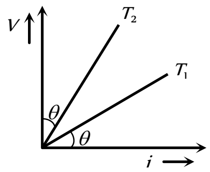
(a)


(b)


(c)


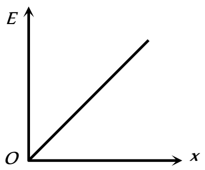
(d)


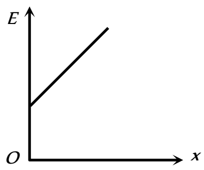
14. The *V-i* graph for a conductor at temperature T_1 and T_2 are as shown in the figure. $(T_2 - T_1)$ is proportional to

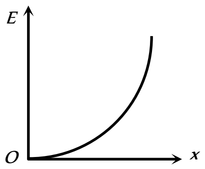


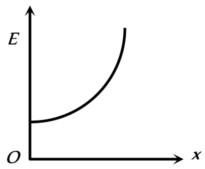
(a) $\cos 2\theta$
(b) $\sin\theta$
(c) $\cot 2\theta$
(d) $\tan\theta$

15. A cylindrical conductor has uniform cross-section. Resistivity of its material increase linearly from left end to right end. If a constant current is flowing through it and at a section distance *x* from left end, magnitude of electric field intensity is *E*, which of the following graphs is correct

(a)


(b)


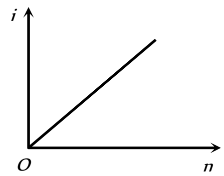
(c)


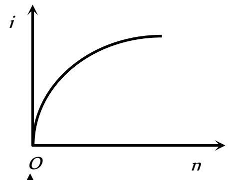
(d)


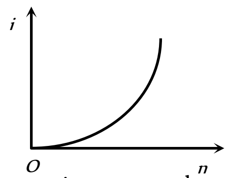
16. The *V-i* graph for a conductor makes an angle θ with *V*-axis. Here *V* denotes the voltage and *i* denotes current. The resistance of conductor is given by

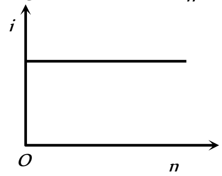
(a) $\sin\theta$ (b) $\cos\theta$
(c) $\tan\theta$ (d) $\cot\theta$

17. A battery consists of a variable number '*n*' of identical cells having internal resistances connected in series. The terminals of battery are short circuited and the current *i* is measured. Which of the graph below shows the relation ship between *i* and *n*

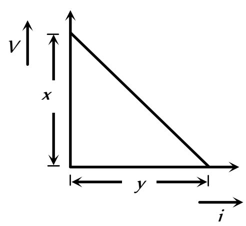
(a)


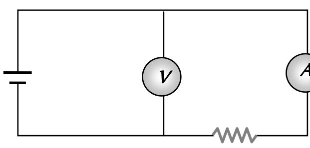
(b)


(c)


(d)


18. In an experiment, a graph was plotted of the potential difference *V* between the terminals of a cell against the circuit current *i* by varying load rheostat. Internal conductance of the cell is given by

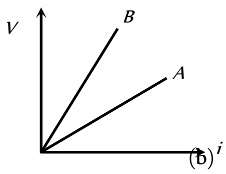




(a) xy (b) $\frac{y}{x}$

(c) $\frac{x}{y}$ (d) $(x - y)$

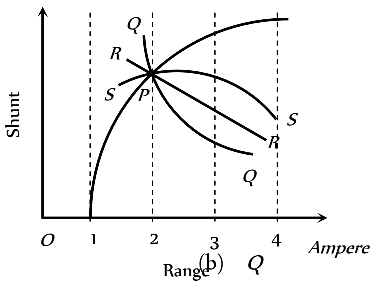
19. V-i graphs for parallel and series combination of two identical resistors are as shown in figure. Which graph represents parallel combination



(a) A (b) B

(c) A and B both (d) Neither A nor B

20. The ammeter has range 1 *ampere* without shunt. the range can be varied by using different shunt resistances. The graph between shunt resistance and range will have the nature



(a) P (b) Q

(c) R (d) S

AR Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : The resistivity of a semiconductor increases with temperature.

Reason : The atoms of a semiconductor vibrate with larger amplitude at higher temperatures thereby increasing its resistivity [AIIMS 2003]

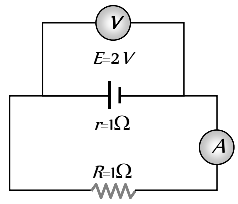
2. Assertion : In a simple battery circuit the point of lowest potential is positive terminal of the battery

Reason : The current flows towards the point of the higher potential as it flows in such a circuit from the negative to the positive terminal. [AIIMS 2002]

3. Assertion : The temperature coefficient of resistance is positive for metals and negative for p-type semiconductor.

Reason : The effective charge carriers in metals are negatively charged whereas in p-type semiconductor they are positively charged. [AIIMS 1996]

4. Assertion : In the following circuit emf is $2V$ and internal resistance of the cell is $1\ \Omega$ and $R = 1\Omega$, then reading of the voltmeter is $1V$.



Reason : $V = E - ir$ where $E = 2V$, $i = \frac{2}{2} = 1A$ and $R = 1\ \Omega$ [AIIMS 1995]

5. Assertion : There is no current in the metals in the absence of electric field.

Reason : Motion of free electron are randomly. [AIIMS 1994]

6. Assertion : Electric appliances with metallic body have three connections, whereas an electric bulb has a two pin connection.

Reason : Three pin connections reduce heating of connecting wires.

7. Assertion : The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.

Reason : On increasing temperature, conductivity of metallic wire decreases.

8. Assertion : The electric bulbs glows immediately when switch is on.

Reason : The drift velocity of electrons in a metallic wire is very high.

9. Assertion : Bending a wire does not effect electrical resistance.

Reason : Resistance of wire is proportional to resistivity of material.

10. Assertion : In meter bridge experiment, a high resistance is always connected in series with a galvanometer.

Reason : As resistance increases current through the circuit increases.

11. Assertion : Voltameter measures current more accurately than ammeter.

Reason : Relative error will be small if measured from voltameter.

12. Assertion : Electric field outside the conducting wire which carries a constant current is zero.

Reason : Net charge on conducting wire is zero.

13. Assertion : The resistance of super-conductor is zero.

Reason : The super-conductors are used for the transmission of electric power.

14. Assertion : A potentiometer of longer length is used for accurate measurement.

Reason : The potential gradient for a potentiometer of longer length with a given source of e.m.f. becomes small.

15. Assertion : The e.m.f. of the driver cell in the potentiometer experiment should be greater than the e.m.f. of the cell to be determined.

Reason : The fall of potential across the potentiometer wire should not be less than the e.m.f. of the cell to be determined.

16. Assertion : A person touching a high power line gets stuck with the line.

Reason : The current carrying wires attract the man towards it.

17. Assertion : The connecting wires are made of copper.

Reason : The electrical conductivity of copper is high.

Answers

Electric Conduction, Ohm's Law and Resistance

1	a	2	c	3	b	4	b	5	c
6	a	7	a	8	a	9	d	10	c
11	d	12	d	13	a	14	c	15	a
16	a	17	c	18	b	19	c	20	b
21	d	22	b	23	b	24	b	25	d
26	c	27	b	28	b	29	b	30	a
31	c	32	d	33	b	34	d	35	c
36	b	37	b	38	c	39	a	40	d
41	b	42	b	43	a	44	b	45	c
46	a	47	b	48	b	49	c	50	a
51	c	52	c	53	b	54	b	55	b
56	a	57	a	58	a	59	c	60	c
61	a	62	b	63	b	64	c	65	c
66	d	67	a	68	b	69	d	70	d
71	a	72	a	73	c	74	b	75	b
76	c	77	c	78	c	79	d	80	b
81	a	82	d	83	b	84	b	85	c
86	b	87	c	88	a	89	a	90	d
91	a	92	c	93	b	94	a	95	b
96	b	97	c	98	a	99	c	100	d
101	c	102	a	103	d	104	b	105	b
106	d	107	d	108	a	109	d	110	d
111	d	112	d	113	a	114	a	115	c
116	a	117	a	118	b	119	c	120	a
121	d	122	a	123	a	124	d	125	c
126	b	127	c	128	a	129	a	130	c
131	c	132	b	133	c				

Grouping of Resistances

1	c	2	d	3	a	4	c	5	b
6	c	7	c	8	b	9	a	10	b
11	d	12	d	13	b	14	d	15	b
16	d	17	c	18	c	19	b	20	d
21	a	22	a	23	b	24	b	25	c
26	b	27	d	28	d	29	d	30	c
31	b	32	d	33	a	34	b	35	c
36	d	37	d	38	b	39	c	40	b
41	a	42	c	43	b	44	d	45	c
46	d	47	c	48	b	49	b	50	d
51	d	52	c	53	d	54	a	55	c
56	d	57	c	58	c	59	d	60	c
61	d	62	c	63	d	64	c	65	c
66	c	67	b	68	c	69	d	70	b
71	a	72	c	73	a	74	b	75	a
76	c	77	c	78	b	79	c	80	a
81	a	82	b	83	b	84	d	85	d
86	a	87	a	88	a	89	b	90	b
91	b	92	c	93	b	94	d	95	a
96	d	97	b	98	b	99	d	100	a
101	c	102	a	103	b	104	d	105	a
106	a	107	b	108	d	109	bc	110	b
111	d	112	c	113	a	114	a	115	d
116	a	117	d	118	c	119	d	120	c
121	b	122	b	123	b	124	c	125	b
126	a	127	c	128	b	129	c	130	a
131	a	132	a	133	c	134	a	135	b
136	b	137	a	138	b	139	c	140	b
141	b								

Kirchhoff's Law, Cells

1	b	2	d	3	c	4	a	5	a
6	b	7	a	8	a	9	b	10	a
11	c	12	d	13	a	14	d	15	b
16	c	17	c	18	c	19	d	20	b
21	c	22	c	23	b	24	d	25	a
26	a	27	b	28	b	29	a	30	b
31	a	32	c	33	b	34	a	35	a
36	b	37	a	38	b	39	b	40	c
41	d	42	d	43	d	44	a	45	c
46	c	47	b	48	a	49	a	50	d
51	b	52	d	53	b	54	c	55	a
56	b	57	c	58	a	59	d	60	b
61	c	62	c	63	c	64	b	65	a
66	c	67	a	68	d	69	b	70	a
71	a	72	d	73	c	74	b	75	b
76	b	77	c	78	c	79	d	80	d
81	a	82	d	83	c	84	c	85	a

Different Measuring Instruments

1	a	2	c	3	d	4	d	5	c
6	c	7	a	8	d	9	c	10	c
11	d	12	c	13	d	14	a	15	d
16	c	17	a	18	b	19	c	20	a
21	b	22	b	23	a	24	a	25	a
26	a	27	a	28	a	29	b	30	b
31	b	32	b	33	b	34	b	35	c
36	c	37	b	38	b	39	d	40	b

41	a	42	b	43	c	44	d	45	a
46	b	47	c	48	a	49	b	50	a
51	b	52	c	53	b	54	b	55	a
56	b	57	d	58	c	59	c	60	d
61	a	62	a	63	d	64	a	65	d
66	b	67	a	68	b	69	c	70	c
71	d	72	c	73	a	74	c	75	a
76	d	77	b	78	a	79	b	80	a
81	c	82	c	83	a	84	a	85	b
86	d	87	c	88	d	89	c	90	a
91	d	92	d	93	d	94	c	95	d
96	a	97	c	98	a	99	d	100	d
101	c	102	d	103	c	104	c	105	a
106	c	107	c	108	d	109	c	110	a
111	a	112	a	113	c	114	b	115	c
116	d	117	a	118	b	119	d	120	c
121	d	122	c	123	a	124	a	125	b
126	b	127	d	128	d	129	b	130	c
131	d	132	a	133	c	134	d	135	d
136	a	137	a	138	b	139	d	140	a
141	c	142	a	143	a				

Critical Thinking Questions

1	a	2	a	3	c	4	c	5	c
6	b	7	d	8	d	9	d	10	b
11	d	12	d	13	c	14	b	15	b
16	b	17	b	18	b	19	a	20	d
21	d	22	a	23	c	24	c	25	b
26	b	27	a	28	d	29	b	30	b
31	d	32	a	33	a	34	b	35	c
36	c	37	a	38	a	39	d	40	a
41	a	42	b	43	a	44	a	45	b
46	c	47	b	48	a	49	b	50	a
51	d	52	b	53	a	54	b		

Graphical Questions

1	a	2	d	3	a	4	c	5	d
6	c	7	b	8	b	9	d	10	a
11	b	12	d	13	a	14	c	15	b
16	d	17	d	18	b	19	a	20	b

Assertion and Reason

1	d	2	d	3	b	4	a	5	a
6	c	7	b	8	c	9	a	10	c
11	a	12	a	13	b	14	a	15	a
16	d	17	a						

Answers and Solutions

Electric Conduction, Ohm's Law and Resistance

1. (a) Number of electrons flowing per second

$$\frac{n}{t}=\frac{i}{e}=4.8/1.6\times10^{-19}=3\times10^{19}$$

2. (c) $v_d=\frac{J}{ne}\Rightarrow v_d\propto J$ (current density)

$$J_1=\frac{i}{A}\text{ and }J_2=\frac{2i}{2A}=\frac{i}{A}=J_1;\ \therefore\ (v_d)_1=(v_d)_2=v$$

3. (b) Order of drift velocity $=10^{-4}m/sec=10^{-2}cm/sec$

4. (b) Density of $Cu=9\times10^3kg/m^3$ (mass of 1 m^3 of Cu)

$\because$ 6.0 × 10^{23} atoms has a mass = 63 × 10^{-3} kg

$\therefore$ Number of electrons per m^3 are

$$=\frac{6.0\times10^{23}}{63\times10^{-3}}\times9\times10^3=8.5\times10^{28}$$

Now drift velocity $=v_d=\frac{i}{neA}$

$$=\frac{1.1}{8.5\times10^{28}\times1.6\times10^{-19}\times\pi\times(0.5\times10^{-3})^2}$$

$$=0.1\times10^{-3}m/sec$$

5. (c) Because 1 $H.P.$ = 746 J/s = 746 $watt$

6. (a) $R\propto l^2\Rightarrow\frac{\Delta R}{R}=\frac{2\Delta l}{l}\Rightarrow\frac{\Delta R_0}{R}\%=2\times0.1=0.2\%$

7. (a) $R=\frac{\rho l}{A}=50\times10^{-8}\times\frac{50\times10^{-2}}{(50\times10^{-2})^2}=10^{-6}\Omega$

8. (a) Resistivity of some material is its intrinsic property and is constant at particular temperature. Resistivity does not depend upon shape.

9. (d) $\frac{\rho_1}{\rho_2}=\frac{(1+\alpha t_1)}{(1+\alpha t_2)}\Rightarrow\frac{1}{2}=\frac{(1+0.00125\times27)}{(1+0.00125\times t)}$

$$\Rightarrow t=854°C\Rightarrow T=1127K$$

10. (c) $R_1\propto\frac{l}{A}\Rightarrow R_2\propto\frac{2l}{2A}$ $i.e.$ $R_2\propto\frac{l}{A}$

$$\therefore R_1=R_2$$

11. (d) In case of stretching of wire $R\propto l^2$

$\Rightarrow$ If length becomes 3 times so Resistance becomes 9 times $i.e.$ $R'=9\times20=180\Omega$

12. (d) Resistivity is the property of the material. It does not depend upon size and shape.

13. (a) Because with rise in temperature resistance of conductor increase, so graph between V and i becomes non linear.

14. (c) Because V-i graph of diode is non-linear.

15. (a) $v_d=\frac{e}{m}\times\frac{V}{l}\tau$ or $v_d=\frac{e}{m}.\frac{El}{l}\tau$ (Since $V=El$)

$$\therefore v_d\propto E$$

16. (a) Resistance of conductor depends upon relation as $R\propto\frac{1}{\tau}$.

With rise in temperature rms speed of free electron inside the conductor increase, so relaxation time decrease and hence resistance increases

17. (c) $i=\frac{q}{t}=\frac{4}{2}=2\,ampere$

18. (b) Volume $=Al=3\Rightarrow A=\frac{3}{l}$

Now $R=\rho\frac{l}{A}\Rightarrow3=\frac{\rho\times l}{3/l}=\frac{\rho l^2}{3}\Rightarrow l^2=\frac{9}{\rho}=\frac{3}{\sqrt{\rho}}$

19. (c) $i=\frac{ne}{t}=\frac{62.5\times10^{18}\times1.6\times10^{-19}}{1}=10\,ampere$

20. (b) In twisted wire, two halves each of resistance 2Ω are in parallel, so equivalent resistance will be $\frac{2}{2}=1\Omega$.

21. (d) In stretching of wire $R\propto\frac{1}{r^4}$

22. (b) $R=\frac{\rho L}{A}\Rightarrow0.7=\frac{\rho\times1}{\frac{22}{7}(1\times10^{-3})^2}$

$$\rho=2.2\times10^{-6}\ ohm\text{-}m.$$

23. (b) $R\propto\frac{1}{A}\Rightarrow R\propto\frac{1}{r^2}\propto\frac{1}{d^2}$ [d = diameter of wire]

24. (b) $i=qv=1.6\times10^{-19}\times6.6\times10^{15}=10.56\times10^{-4}A=1mA$

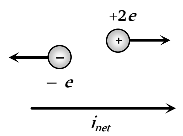
25. (d) $R\propto\frac{l}{r^2}\Rightarrow\frac{R_1}{R_2}=\frac{l_1}{l_2}\times\frac{r_2^2}{r_1^2}\Rightarrow\frac{1}{1}=\frac{5}{l_2}\times\left(\frac{2}{1}\right)^2\Rightarrow l_2=20m$

26. (c)

27. (b) In semiconductors charge carries are free electrons and holes

28. (b) Net current $i_{net}=i_{(+)}+i_{(-)}$

$$=\frac{n_{(+)}q_{(+)}}{t}+\frac{n_{(-)}q_{(-)}}{t}$$



$$=\frac{n_{(+)}}{t}\times2e+\frac{n_{(-)}}{t}\times e$$

= 3.2 × 10^{18} × 2 × 1.6 × 10^{-19} + 3.6 × 10^{18} × 1.6 × 10^{-19}

= 1.6 A (towards right)

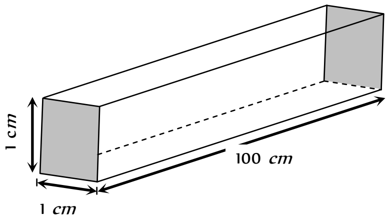
29. (b) In the absence of external electric field mean velocity of free electron (V_-) is given by $V_{rms} = \sqrt{\frac{3KT}{m}} \Rightarrow V_{rms} \propto \sqrt{T}$

30. (a) With rise in temperature specific resistance increases

31. (c) For metallic conductors, temperature co-efficient of resistance is positive.

32. (d)

33. (b) Length l = 1 cm $= 10^{-2} m$



Area of cross-section A = 1 cm × 100 cm

= 100 cm^2 = 10^{-2} m^2

Resistance R = 3 × 10^{-7} × $\frac{10^{-2}}{10^{-2}}$ = 3 × 10^{-7} Ω

34. (d) In the above question for calculating equivalent resistance between two opposite square faces.

l = 100 cm = 1 m, A = 1 cm^2 = 10^{-4} m^2, so resistance R = 3 × 10^{-7} × $\frac{1}{10^{-4}}$ = 3 × 10^{-3} Ω

35. (c) $v_d = \frac{i}{nAe} = \frac{20}{10^{29} \times 10^{-6} \times 1.6 \times 10^{-19}} = 1.25 \times 10^{-3} m/s$

36. (b) Specific resistance $k = \frac{E}{j}$

37. (b) $R \propto \frac{l}{A} \propto \frac{l}{d^2} \Rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \left(\frac{d_2}{d_1}\right)^2 = \frac{L}{4L}\left(\frac{2d}{d}\right)^2 = 1$

$\Rightarrow R_2 = R_1 = R.$

38. (c) $v_d = \frac{i}{nAe} = \frac{1.344}{10^{-6} \times 1.6 \times 10^{-19} \times 8.4 \times 10^{22}}$

$= \frac{1.344}{10 \times 1.6 \times 8.4} = 0.01 cm/s = 0.1 mm/s$

39. (a) Internal resistance $\propto \frac{1}{\text{Temperature}}$

40. (d) Charge = Current × Time = 5 × 60 = 300 C

41. (b) By $R = \rho l / A$

42. (b)

43. (a)

44. (b) $R = \frac{\rho l}{a}$ for first wire and $R' = \frac{\rho l}{4a} = \frac{R}{4}$ for second wire.

45. (c) For semiconductors, resistance decreases on increasing the temperature.

46. (a) $R = \rho \frac{l}{A} = \frac{n}{ne^2 \tau} \cdot \frac{l}{A}$

47. (b) Because as temperature increases, the resistivity increases and hence the relaxation time decreases for conductors $\left(\tau \propto \frac{1}{\rho}\right)$.

48. (b) In VI graph, we will not get a straight line in case of liquids.

49. (c) $R = \rho \frac{l}{A}$

50. (a) Since $R \propto l^2 \Rightarrow$ If length is increased by 10%, resistance is increases by almost 20%

Hence new resistance $R' = 10 + 20\%$ of 10

$= 10 + \frac{20}{100} \times 10 = 12\,\Omega.$

51. (c) $\frac{R_{150}}{R_{500}} = \frac{[1 + \alpha(150)]}{[1 + \alpha(500)]}$. Putting $R_{150} = 133\Omega$ and $\alpha = 0.0045 / °C$, we get $R_{500} = 258\Omega$

52. (c) $R = \rho \frac{l}{A} \Rightarrow 7 = \frac{64 \times 10^{-6} \times 198}{\frac{22}{7} \times r^2} \Rightarrow r = 0.024 cm$

53. (b) Current density $J = \frac{i}{A} = \frac{i}{\pi r^2} \Rightarrow \frac{J_1}{J_2} = \frac{i_1}{i_2} \times \frac{r_2^2}{r_1^2}$

But the wires are in series, so they have the same current, hence $i_1 = i_2$. So $\frac{J_1}{J_2} = \frac{r_2^2}{r_1^2} = 9:1$

54. (b) As $\frac{V}{i} = R$ and $R \propto$ temperature

55. (b) $R \propto l^2 \Rightarrow$ If l doubled then R becomes 4 times.

56. (a) Temperature coefficient of a semiconductor is negative.

57. (a) The reciprocal of resistance is called conductance

58. (a) $\text{Resistance} = \frac{\text{Potential difference}}{\text{Current}}$

59. (c) Ohm's Law is not obeyed by semiconductors.

60. (c) Drift velocity $v_d = \frac{V}{\rho l n e}$; v_d does not depend upon diameter.

61. (a) Using $R_{T_2} = R_{T_1}[1 + \alpha(T_2 - T_1)]$

$\Rightarrow R_{100} = R_{50}[1 + \alpha(100 - 50)]$

$\Rightarrow 7 = 5[1 + (\alpha \times 50)] \Rightarrow \alpha = \frac{(7-5)}{250} = 0.008 /^o C$

62. (b) This is because of secondary ionisation which is possible in the gas filled in it.

63. (b)

64. (c) $\frac{R_1}{R_2} = \frac{(1 + \alpha t_1)}{(1 + \alpha t_2)} \Rightarrow \frac{50}{76.8} = \frac{(1 + 3.92 \times 10^{-3} \times 20)}{(1 + 3.92 \times 10^{-3} t)}$

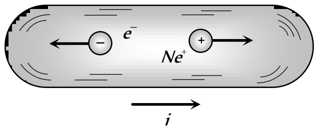
$\Rightarrow t = 167°C$

65. (c) From $v_d = \frac{i}{neA} \Rightarrow i \propto v_d A \Rightarrow i \propto v_d r^2$

66. (d) Resistivity depends only on the material of the conductor.

67. (a) A particular temperature, the resistance of a superconductor is zero $\Rightarrow G = \frac{1}{R} = \frac{1}{0} = \infty$

68. (b) Net current $i = i_+ + i_- = \frac{(n_+)(q_+)}{t} + \frac{(n_-)(q_-)}{t}$



$\Rightarrow i = \frac{(n_+)}{t} \times e + \frac{(n_-)}{t} \times e$

$= 2.9 \times 10^{18} \times 1.6 \times 10^{-19} + 1.2 \times 10^{18} \times 1.6 \times 10^{-19}$

$\Rightarrow i = 0.66\, A$

69. (d) If E be electric field, then current density $j = \sigma E$

Also we know that current density $j = \frac{i}{A}$

Hence j is different for different area of cross-sections. When j is different, then E is also different. Thus E is not constant. The drift velocity v_d is given by $v_d = \frac{j}{ne}$ = different for different j values. Hence only current i will be constant.

70. (d)

71. (a) $R = \rho \frac{l}{A}$ and mass m = volume (V) × density (d) = ($A\, l$) d

Since wires have same material so ρ and d is same for both.

Also they have same mass $\Rightarrow Al$ = constant $\Rightarrow l \propto \frac{1}{A}$

$\Rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \left(\frac{A_2}{A_1}\right)^2 = \left(\frac{r_2}{r_1}\right)^4$

$\Rightarrow \frac{34}{R_2} = \left(\frac{r}{2r}\right)^4 \Rightarrow R_2 = 544\,\Omega$

72. (a) $R = \rho \frac{l}{A} \Rightarrow \frac{R_1}{R_2} = \frac{A_2}{A_1} (\rho, L \text{ constant}) \Rightarrow \frac{A_1}{A_2} = \frac{R_2}{R_1} = 2$

Now, when a body dipped in water, loss of weight $= V\sigma_L g = AL\sigma_L g$

So, $\frac{(\text{Loss of weight})_1}{(\text{Loss of wight})_2} = \frac{A_1}{A_2} = 2$; so A has more loss of weight.

73. (c) $Q = it = 20 \times 10^{-6} \times 30 = 6 \times 10^{-4}\, C$

74. (b) Ge is semiconductor and Na is a metal. The conductivity of semiconductor increases and that of the metals decreases with the rise in temperature.

75. (b) $i = \frac{ne}{t} \Rightarrow n = \frac{it}{e} = \frac{1.6 \times 10^{-3} \times 1}{1.6 \times 10^{-19}} = 10^{16}$.

76. (c) Drift velocity $v_d = \frac{i}{neA} \Rightarrow v_d \propto \frac{1}{A}$ or $v_d \propto \frac{1}{d^2}$

$\Rightarrow \frac{v_P}{v_Q} = \left(\frac{d_Q}{d_P}\right)^2 = \left(\frac{d/2}{d}\right)^2 = \frac{1}{4} \Rightarrow v_P = \frac{1}{4} v_Q$.

77. (c) Human body, though has a large resistance of the order, of $K\Omega$ (say $10k\Omega$), is very sensitive to minute currents even as low as a few mA. Electrons, excites and disorders the nervous system of the body and hence one fails to control the activity of the body.

78. (c) $R_t = R_0(1 + \alpha t)$

$\Rightarrow 4.2 = R_0(1 + 0.004 \times 100) = 1.4 R_0 \Rightarrow R_0 = 3\Omega$.

79. (d) $R \propto \frac{l^2}{m} \Rightarrow R_1 : R_2 : R_3 = \left(\frac{l_1}{m_1}\right)^2 : \left(\frac{l_2}{m_2}\right)^2 : \left(\frac{l_3}{m_3}\right)^2$

$= \frac{25}{1} : \frac{9}{3} : \frac{1}{5} = 25 : 3 : \frac{1}{5} \Rightarrow 125 : 15 : 1$.

80. (b)

81. (a) $\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^4 \Rightarrow \frac{R}{R_2} = \left(\frac{nr}{r}\right)^4 \Rightarrow R_2 = \frac{R}{n^4}$.

82. (d) $\frac{R_1}{R_2} = \frac{(1 + \alpha t_1)}{(1 + \alpha t_2)} \Rightarrow \frac{5}{6} = \frac{(1 + \alpha \times 50)}{(1 + \alpha \times 100)} \Rightarrow \alpha = \frac{1}{200}$ per ^oC

Again by $R_t = R_0(1 + \alpha t)$

$\Rightarrow 5 = R_0\left(1 + \frac{1}{200} \times 50\right) \Rightarrow R_0 = 4\Omega$.

83. (b) $i = \frac{Q}{T} = Q\nu = 1.6 \times 10^{-19} \times 5 \times 10^{15} = 0.8 mA$.

84. (b) $\frac{r_{iron}}{r_{Copper}} = \sqrt{\frac{\rho_{iron}}{\rho_{copper}}} = \sqrt{\frac{1 \times 10^{-7}}{1.7 \times 10^{-8}}} \approx 2.4$.

85. (c) $i = e\nu = 1.6 \times 10^{-19} \times 6.8 \times 10^{15} = 1.1 \times 10^{-3}\, amp$.

86. (b) Resistivity of the material of the rod

$\rho = \frac{RA}{l} = \frac{3 \times 10^{-3} \pi (0.3 \times 10^{-2})^2}{1} = 27 \times 10^{-9} \pi\, \Omega \times m$

Resistance of disc $R = \frac{(\text{Thickness})}{(\text{Area of cross section})}$

$= 27 \times 10^{-9} \pi \times \frac{(10^{-3})}{\pi \times (1 \times 10^{-2})^2} = 2.7 \times 10^{-7}\Omega$.

87. (c) By using $R_t = R_0(1 + \alpha t)$

$3 \times R_0 = R_0(1 + 4 \times 10^{-3}\, t) \Rightarrow t = 500^o C$.

88. (a) $i = 6 \times 10^{15} \times 1.6 \times 10^{-19} = 0.96 mA$.

89. (a) $i = \frac{ne}{t} \Rightarrow 16 \times 10^{-3} = \frac{n \times 1.6 \times 10^{-19}}{1} \Rightarrow n = 10^{17}$

90. (d) $R = \frac{V}{i} = \frac{100 \pm 0.5}{10 \pm 0.2} = 10 \pm 0.25\,\Omega$.

91. (a) $R = \frac{V}{i} = \rho \frac{l}{A} \Rightarrow \frac{2}{4} = \rho \frac{50 \times 10^{-2}}{(1 \times 10^{-3})^2} \Rightarrow \rho = 1 \times 10^{-6}\, \Omega m$.

92. (c)

93. (b) $i = \frac{V}{R} = \frac{Q}{t} \Rightarrow Q = \frac{Vt}{R} = \frac{20 \times 2 \times 60}{10} = 240\, C$.

94. (a) $R \propto l^2 \Rightarrow \frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2 \Rightarrow \frac{R}{R_2} = \left(\frac{l}{l/2}\right)^2 = 4 \Rightarrow R_2 = \frac{R}{4}$.

95. (b)

96. (b) $V_d = \frac{i}{neA} = \frac{40}{10^{29} \times 10^{-6} \times 1.6 \times 10^{-19}}$

$= 2.5 \times 10^{-3}\, m/sec$.

97. (c) $V_d = \frac{i}{nAe} = \frac{5.4}{8.4 \times 10^{28} \times 10^{-6} \times 1.6 \times 10^{-19}}$

$= 0.4 \times 10^{-3}\, m/sec = 0.4 mm/sec$.

98. (a) $\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2 \Rightarrow \frac{10}{R_2} = \left(\frac{5}{20}\right)^2 = \frac{1}{16} = R_2 = 160\Omega$.

99. (c) $R \propto \frac{1}{\tau}$; where τ = Relaxation time.

When lamp is switched on, temperature of filament increase, hence τ decrease so R increases

100. (d) $R = 91 \times 10^2 \approx 9.1 k\Omega$.

101. (c)

102. (a)

103. (d) $R \propto \frac{l^2}{m} \Rightarrow R_1 : R_2 : R_3 = \frac{l_1^2}{m_1} : \frac{l_2^2}{m_2} : \frac{l_3^2}{m_3}$

$\Rightarrow R_1 : R_2 : R_3 = \frac{9}{1} : \frac{4}{2} : \frac{1}{3} = 27 : 6 : 1$.

104. (b) $n = \frac{1 \times 10^{-3}}{1.6 \times 10^{-19}} = 6.25 \times 10^{15}$.

105. (b) $v_d = \frac{i}{ne\pi r^2} \Rightarrow v_d \propto \frac{i}{r^2} \Rightarrow \frac{v}{v'} = \frac{i_1}{i_2} \times \left(\frac{r_2}{r_1}\right)^2 \Rightarrow v' = \frac{v}{2}$.

106. (d) $\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^4 \Rightarrow \frac{R}{R_2} = \left(\frac{3r/4}{r}\right)^4 = \frac{81}{256} = R_2 = \frac{256}{81} R$

107. (d)

108. (a) $v_d = \frac{i}{nAe} = \frac{8}{8 \times 10^{28} \times (2 \times 10^{-3})^2 \times 1.6 \times 10^{-19}}$

$= 0.156 \times 10^{-3}\, m/sec$.

109. (d) Specific resistance doesn't depend upon length and area.

110. (d) Heating effect of current.

111. (d) $l = \frac{R\pi r^2}{\rho} = \frac{4.2 \times 3.14 \times (0.2 \times 10^{-3})^2}{48 \times 10^{-8}} = 1.1 m$

112. (d) For conductors, resistance $\propto$ Temperature and for semi-conductor, resistance $\propto \frac{1}{\text{Temperatur e}}$

113. (a) If suppose initial length $l_1 = 100$ then $l_2 = 100 + 100 = 200$

$\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2 = \left(\frac{100}{200}\right)^2 \Rightarrow R_2 = 4R_1$

$\frac{\Delta R}{R} \times 100 = \frac{R_2 - R_1}{R_1} \times 100 = \frac{4R_1 - R_1}{R_1} \times 100 = 300\%$.

114. (a) Ammeter is always connected in series and Voltmeter is always connected in parallel.

115. (c) Same mass, same material *i.e.* volume is same or Al = constant

Also, $R = \rho \frac{l}{A} \Rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \left(\frac{A_2}{A_1}\right)^2 \left(\frac{d_2}{d_1}\right)^4$

$\Rightarrow \frac{24}{R_2} = \left(\frac{d}{d/2}\right)^4 = 16 \Rightarrow R_2 = 1.5\Omega$.

116. (a) $I = n_e q_e + n_p q_p = 1 mA$ towards right

117. (a) As steady current is flowing through the conductor, hence the number of electrons entering from one end and outgoing from the other end of any segment is equal. Hence charge will be zero.

118. (b) Conductance $C = \frac{1}{R} = \frac{A}{\rho l} \Rightarrow C \propto \frac{1}{l}$

119. (c) $i = \frac{dQ}{dt} \Rightarrow dQ = idt \Rightarrow Q = \int_{t_1}^{t_2} idt = \int_0^5 (1.2t + 3)dt$

$= \left[\frac{1.2t^2}{2} + 3t\right]_0^5 = 30C$

120. (a) In stretching, $\frac{R_2}{R_1} = \left(\frac{r_1}{r_2}\right)^4 \Rightarrow \frac{R_2}{R} = \left(\frac{2}{1}\right)^4 \Rightarrow R_2 = 16R$

121. (d) $R' = n^2 R \Rightarrow R' = 16R$

122. (a)

Significant figures		Multiplier
Brown	Black	Brown
1	0	10^1

$\therefore R = 10 \times 10^1 = 100\ \Omega$

123. (a)

124. (d)

125. (c)

126. (b) $R \propto \frac{l}{r^2} \Rightarrow \frac{R_2}{R_1} = \frac{l_2}{l_1} \times \frac{r_1^2}{r_2^2} = \left(\frac{2}{1}\right) \times \left(\frac{1}{2}\right)^2 = \frac{1}{2}$

$\Rightarrow R_2 = \frac{R_1}{2}$, specific resistance doesn't depend upon length, and radius.

127. (c) By using $v_d = \frac{i}{neA} = \frac{100}{10^{28} \times 1.6 \times 10^{-19} \times \frac{\pi}{4} \times (0.02)^2}$

$= 2 \times 10^{-4}\, m/\text{sec}$

128. (a) $R \propto \frac{l}{r^2}$. For highest resistance $\frac{l}{r^2}$ should be maximum, which is correct for option (a)

129. (a) Red, brown, orange, silver red and brown represents the first two significant figures.

Significant figures		Multiplier	Tolerance
Red	Brown	Orange	Silver
2	1	10^3	$\pm$ 10%

$\therefore R = 21 \times 10^3 \pm 10\%$

130. (c) In stretching $R \propto l^2 \Rightarrow \frac{R_2}{R_1} = \frac{l_2^2}{l_1^2} \Rightarrow \frac{R_2}{R_1} = \left(\frac{2}{1}\right)^2$

$\Rightarrow R_2 = 4R_1$. Change in resistance $= R_2 - R_1 = 3R_1$

Now, $\frac{\text{Change in resistance}}{\text{Original resistance}} = \frac{3R_1}{R_1} = \frac{3}{1}$

131. (c) $\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$, If $l_1 = 100$ then $l = 110$

$\Rightarrow \frac{R_1}{R_2} = \left(\frac{100}{110}\right)^2 \Rightarrow R_2 = 1.21R_1$

% change $\frac{R_2 - R_1}{R_1} \times 100 = 21\%$

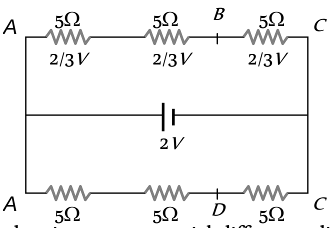
132. (b)

133. (c) Resistance $= \rho \frac{l}{A}$

$\therefore \frac{R_1}{R_2} = \frac{\rho_1}{\rho_2} \times \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{2}{3} \times \frac{3}{4} \times \frac{5}{4} = \frac{5}{8}$

Grouping of Resistances

1. (c) The given circuit can be redrawn as follows



For identical resistances, potential difference distributes equally among all. Hence potential difference across each resistance is $\frac{2}{3}V$, and potential difference between A and B is $\frac{4}{3}V$.

2. (d) Equivalent resistance of parallel resistors is always less than any of the member of the resistance system.

3. (a) Each part will have a resistance $r = R/10$

Let equivalent resistance be r_R, then

$\frac{1}{r_R} = \frac{1}{r} + \frac{1}{r} + \frac{1}{r}$.......... .10 times

$\therefore \frac{1}{r_R} = \frac{10}{r} = \frac{10}{R/10} = \frac{100}{R} \Rightarrow r_R = \frac{R}{100} = 0.01R$

4. (c) $R_{\text{equivalent}} = \frac{(30+30)30}{(30+30)+30} = \frac{60 \times 30}{90} = 20\Omega$

$\therefore i = \frac{V}{R} = \frac{2}{20} = \frac{1}{10}$ *ampere*

5. (b) Resistance of parallel group $= \frac{R}{2}$

$\therefore$ Total equivalent resistance $= 4 \times \frac{R}{2} = 2R$

6. (c) Resistance of 1 *ohm* group $= \frac{R}{n} = \frac{1}{3}\Omega$

This is in series with $\frac{2}{3}\Omega$ resistor.

$\therefore$ Total resistance $= \frac{2}{3} + \frac{1}{3} = \frac{3}{3}\Omega = 1\Omega$

7. (c) Lowest resistance will be in the case when all the resistors are connected in parallel.

$\frac{1}{R} = \frac{1}{0.1} + \frac{1}{0.1}$....... 10 times

$\frac{1}{R} = 10 + 10$....... 10 times

$\frac{1}{R} = 100$ *i.e.* $R = \frac{1}{100}\Omega$

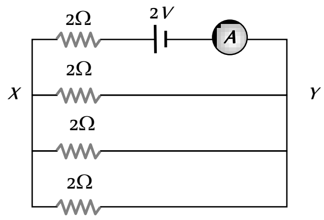
8. (b) Resistance across $XY = \frac{2}{3}\Omega$

Total resistance

$= 2 + \frac{2}{3} = \frac{8}{3}\Omega$

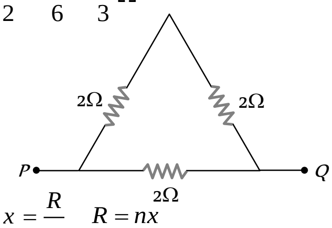
Current through ammeter

$= \frac{2}{8/3} = \frac{6}{8} = \frac{3}{4}A$



9. (a) Equivalent resistance of the combination

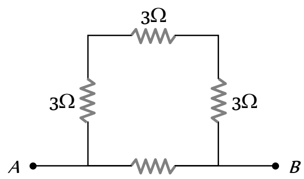
$= \frac{(2+2) \times 2}{2+2+2} = \frac{8}{6} = \frac{4}{3}\Omega$



10. (b) In parallel, $x = \frac{R}{n}$ $R = nx$

In series, $R + R + R$.... n times $= nR = n(nx) = nx$

11. (d) The circuit reduces to



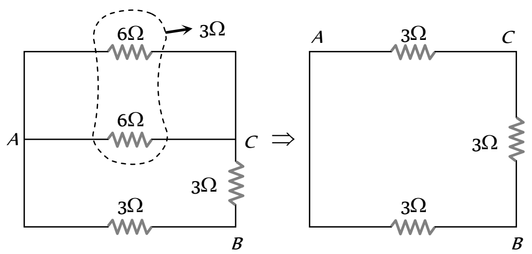
$R_{AB} = \frac{9 \times 6}{9+6} = \frac{9 \times 6}{15} = \frac{18}{5} = 3.6\Omega$

12. (d) As resistance $\propto$ Length

Resistance of each arm $= \frac{12}{3} = 4\Omega$

$\Rightarrow R_{\text{effective}} = \frac{4 \times 8}{4+8} = \frac{8}{3}\Omega$

13. (b) Given circuit is equivalent to



So the equivalent resistance between points A and B is equal to

$$R = \frac{6 \times 3}{6+3} = 2\Omega$$

14. (d) Potential difference across all resistors in parallel combination is same.

15. (b) Current through each arm DAC and DBC = 1A

$V_D - V_A = 2$ and $V_D - V_B = 3 \Rightarrow V_A - V_B = +1V$

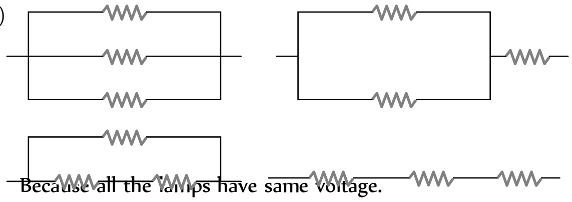
16. (d) $R = r + \frac{3r}{2} = \frac{5r}{2}$

17. (c) If resistances are R_1 and R_2 then $\frac{R_1 R_2}{R_1 + R_2} = \frac{6}{8}$ .....(i)

Suppose R_2 is broken then $R_1 = 2\Omega$ .....(ii)

On solving equations (i) and (ii) we get $R_2 = 6/5\,\Omega$

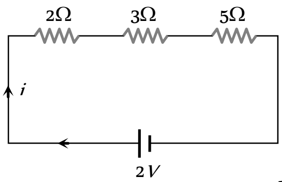
18. (c)



19. (b) Because all the lamps have same voltage.

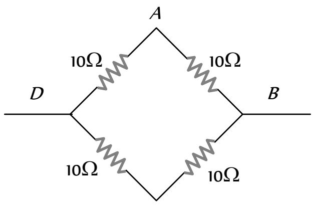
20. (d) $R_{series} = R_1 + R_2 + R_3 + ...$

21. (a) Current supplied by cell $i = \frac{2}{2+3+5} = \frac{1}{5}A$



So potential difference across 3 will be $V = \frac{3 \times 1}{5} = 0.6V$

22. (a) According to the problem, we arrange four resistance as follows



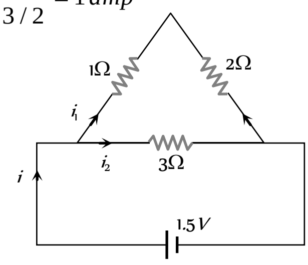
Equivalent resistance $= \frac{20 \times 20}{40} = 10\Omega$

23. (b) $R_1 + R_2 = 9$ and $\frac{R_1 R_2}{R_1 + R_2} = 2 \Rightarrow R_1 R_2 = 18$

$R_1 - R_2 = \sqrt{(R_1 + R_2)^2 - 4R_1 R_2} = \sqrt{81 - 72} = 3$

$R_1 = 6\Omega, R_2 = 3\Omega$

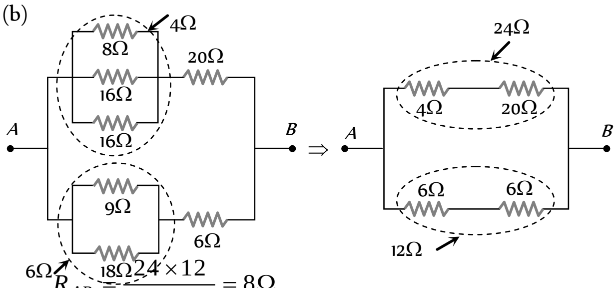
24. (b) $i_1 + i_2 = \frac{1.5}{3/2} = 1\,amp$



$\frac{i_1}{i_2} = \frac{3}{3} \Rightarrow i_1 = i_2 \quad \therefore \; i_2 = 0.5A = i_1$

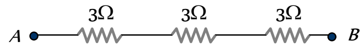
25. (c) $V_p - V_q = \left(\frac{6}{3} + \frac{12 \times 6}{12+6}\right)(0.5) = (2+4)(0.5) = 3V$

26. (b)



$R_{AB} = \frac{24 \times 12}{(24+12)} = 8\Omega$

27. (d) The network can be redrawn as follows



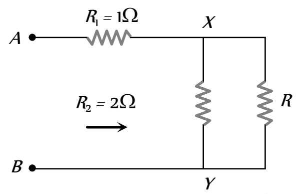
$\Rightarrow R_{eq} = 9\Omega$

28. (d) Let the resistance of the wire be R, then we know that resistance is proportional to the length of the wire. So each of the four wires will have R/4 resistance and they are connected in parallel. So the effective resistance will be

$$\frac{1}{R_1} = \left(\frac{4}{R}\right)4 \Rightarrow R_1 = \frac{R}{16}$$

29. (d) Equivalent resistance $= \frac{4 \times 4}{4+4} + \frac{6 \times 6}{6+6} = 5\,ohm$ So the current in the circuit $= \frac{20}{5} = 4$ *ampere* Hence the current flowing through each resistance = 2 *ampere.*

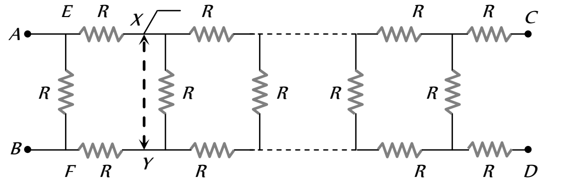
30. (c) Let the resultant resistance be R. If we add one more branch, then the resultant resistance would be the same because this is an infinite sequence.

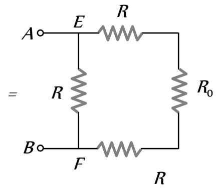


$\therefore \frac{RR_2}{R+R_2} + R_1 = R \Rightarrow 2R + R + 2 = R^2 + 2R$

$\Rightarrow R^2 - R - 2 = 0 \Rightarrow R = -1$ or $R = 2\,ohm$

31. (b) Cut the series from XY and let the resistance towards right of XY be R_0 whose value should be such that when connected across AB does not change the entire resistance. The combination is reduced to as shown below.





The resistance across $EF, = R_{EF} = (R_0 + 2R)$

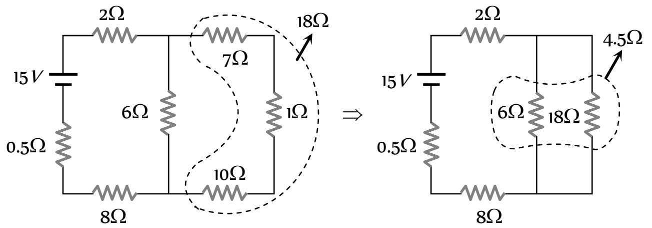
Thus $R_{AB} = \dfrac{(R_0 + 2R)R}{R_0 + 2R + R} = \dfrac{R_0 R + 2R^2}{R_0 + 3R} = R_0$

$\Rightarrow R_0^2 + 2RR_0 - 2R^2 + 0 \Rightarrow R_0 = R(\sqrt{3} - 1)$

32. (d) The last two resistance are out of circuit. Now 8Ω is in parallel with $(1 + 1 + 4 + 1 + 1)\Omega$.

$\therefore R = 8\Omega \| \; 8\Omega = \dfrac{8}{2} = 4\Omega \Rightarrow R_{AB} = 4 + 2 + 2 = 8\Omega$

33. (a) The given circuit can be simplified as follows

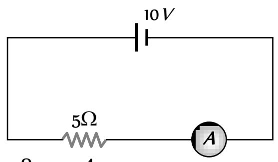


On further solving equivalent resistance $R = 15\,\Omega$

Hence current from the battery $i = \dfrac{15}{15} = 1A$

34. (b) The circuit will be as shown

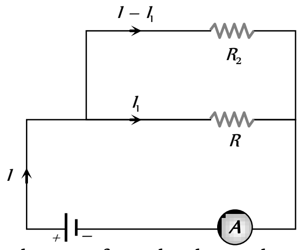
$i = \dfrac{10}{5} = 2A$



35. (c) The current in the circuit $= \dfrac{8}{5+1} = \dfrac{4}{3}$

Now $V_C - V_E = \dfrac{4}{3} \times 1 \Rightarrow V_E = -\dfrac{4}{3}V$

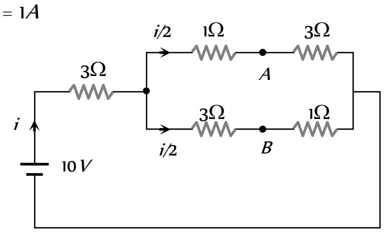
36. (d) According to the figure, $(I - I_1)R_2 = I_1 R$



Only two values satisfying the above relation are $\dfrac{I}{2}$ and R

37. (d) Effective resistance between the points A and B is $R = \dfrac{32}{12} = \dfrac{8}{3}\Omega$

38. (b) $R_{eq} = 5\Omega$, Current $i = \dfrac{10}{5} = 2A$ and current in each branch = 1A



Potential difference between C and A,

$V_C - V_A = 1 \times 1 = 1V$ ....(i)

Potential difference between C and B,

$V_C - V_B = 1 \times 3 = 3V$ ......(ii)

On solving (i) and (ii) $V_A - V_B = 2\,volt$

Shot Trick : $(V_A - V_B) = \dfrac{i}{2}(R_2 - R_1) = \dfrac{2}{2}(3 - 1) = 2V$

39. (c) $\dfrac{1}{R} = \dfrac{1}{1} + \dfrac{1}{1} + \dfrac{1}{1} = \dfrac{3}{1} \Rightarrow R = \dfrac{1}{3}ohm$

Now such three resistance are joined in series, hence total $R = \dfrac{1}{3} + \dfrac{1}{3} + \dfrac{1}{3} = 1ohm$

40. (b) To obtain minimum resistance, all resistors must be connected in parallel.

Hence equivalent resistance of combination $= \dfrac{r}{10}$

41. (a) For same material and same length

$\dfrac{R_2}{R_1} = \dfrac{A_1}{A_2} = \dfrac{3}{2} \Rightarrow R_2 = 3R_1$

Resistance of thick wire $R_1 = 10\Omega$

$\therefore$ Resistance of thin wire $R_2 = 30\Omega$

Total resistance in series = 10 + 30 = 40 Ω

42. (c) Similar to Q. No. 30

$R = 2 + 2 + \dfrac{2 \times R}{2 + R} \Rightarrow 2R + R^2 = 8 + 4R + 2R$

$\Rightarrow R^2 - 4R - 8 = 0 \Rightarrow R = \dfrac{4 \pm \sqrt{16 + 32}}{2} = 2 \pm 2\sqrt{3}$

R cannot be negative, hence $R = 2 + 2\sqrt{3} = 5.46\Omega$

43. (b) P.d. across the circuit $= 1.2 \times \dfrac{6 \times 4}{6 + 4} = 2.88\,volt$

Current through 6 *ohm* resistance $= \dfrac{2.88}{6} = 0.48\,A$

44. (d) Three resistances are in parallel.

$\therefore \dfrac{1}{R'} = \dfrac{1}{R} + \dfrac{1}{R} + \dfrac{1}{R} = \dfrac{3}{R}$

The equivalent resistance $R' = \dfrac{R}{3}\Omega$

45. (c) Similar to Q. No. 30. By formula $R = R_1 + \dfrac{R_2 \times R}{R_2 + R}$

$\therefore R = 1 + \dfrac{1 \times R}{1 + R} \Rightarrow R^2 + R = 1 + R + R$

$\Rightarrow R^2 - R - 1 = 0$ or $R = \dfrac{1 \pm \sqrt{1 + 4}}{2} = \dfrac{1 \pm \sqrt{5}}{2}$

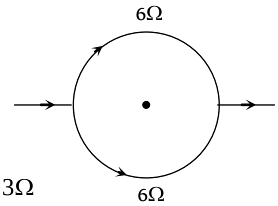
Since R cannot be negative, hence $R = \dfrac{1 + \sqrt{5}}{2}\Omega$

46. (d) $R \propto l$

Hence every new piece will have a resistance $\frac{R}{10}$. If two pieces are connected in series, then their resistance $= \frac{2R}{10} = \frac{R}{5}$

If 5 such combinations are joined in parallel, then net resistance $= \frac{R}{5 \times 5} = \frac{R}{25}$

47. (c)



$R_{eq} = \frac{6}{2} = 3\Omega$

48. (b) Current in the given circuit $i = \frac{50}{(5+7+10+3)} = 2A$

Potential difference between A and B $V_A - V_B = 2 \times 12$

$\Rightarrow V_A - 0 = 24V \Rightarrow V_A = 24\ V$

49. (b) If all are in series then $R_{eq} = 12\,\Omega$

If all are in parallel then $R_{eq} = \frac{4}{3}\Omega = 1.33\,\Omega$

If two are in series then parallel with third, $R_{eq} = \frac{8}{3} = 2.6\,\Omega$

If two are in parallel then series with third, $R_{eq} = 6\,\Omega$

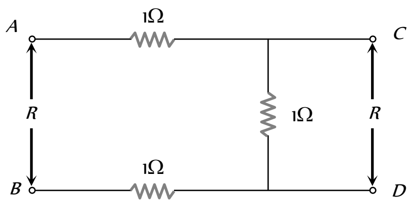
50. (d) Equivalent external resistance of the given circuit $R_{eq} = 4\,\Omega$

Current given by the cell $i = \frac{E}{R_{eq} + r} = \frac{10}{(4+1)} = 2\ A$

Hence, $(V_A - V_B) = \frac{i}{2} \times (R_2 - R_1) = \frac{2}{2}(2-4) = -2\ V.$

51. (d) Resistance of each part will be $\frac{R}{n}$; such n parts are joined in parallel so $R_{eq} = \frac{R}{n^2}$.

52. (c) Let equivalent resistance between A and B be R, then equivalent resistance between C and D will also be R.



$R' = \frac{R}{R+1} + 2 = R$ or $R^2 - 2R - 2 = 0$

$\therefore\ R = \frac{2 \pm \sqrt{4+8}}{2} = \sqrt{3} + 1$

53. (d) 6Ω and 6Ω are in series, so effective resistance is 12Ω which is in parallel with 3Ω, so

$\frac{1}{R} = \frac{1}{3} + \frac{1}{12} = \frac{15}{36} \Rightarrow R = \frac{36}{15}$

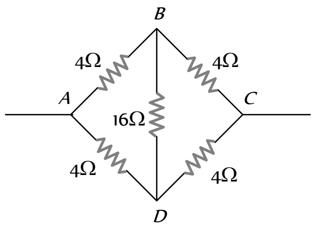
$\therefore\ I = \frac{V}{R} = \frac{4.8 \times 15}{36} = 2\ A$

54. (a) Equivalent resistance of the circuit $R = \frac{3}{2}\Omega$

$\therefore$ Current through the circuit $i = \frac{V}{R} = \frac{3}{3/2} = 2A$

55. (c) $R_{\max} = nR$ and $R_{\min} = R/n \Rightarrow \frac{R_{\max}}{R_{\min}} = n^2$

56. (d) According to the principle of Wheatstone's bridge, the effective resistance between the given points is 4Ω.



57. (c)

58. (c) Current through 6Ω resistance in parallel with 3Ω resistance = 0.4 A

So total current = 0.8 + 0.4 = 1.2 A

Potential drop across $4\Omega = 1.2 \times 4 = 4.8\ V$

59. (d) Two resistances in series are connected parallel with the third. Hence $\frac{1}{R_p} = \frac{1}{4} + \frac{1}{8} = \frac{3}{8} \Rightarrow R_p = \frac{8}{3}\Omega$

60. (c) Resistances at C and B are not in the circuit. Use laws of resistances in series and parallel excluding the two resistance.

61. (d) After simplifying the network, equivalent resistance obtained between A and B is 8Ω.

62. (c) The circuit consists of three resistances (2R, 2R and R) connected in parallel.

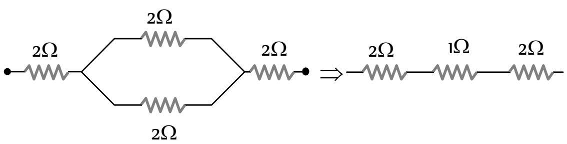
63. (d) Resistance across the battery is

$\frac{1}{R_p} = \frac{1}{3} + \frac{1}{6} = \frac{2+1}{6} = \frac{3}{6} \Rightarrow R_p = 2\Omega \Rightarrow I = \frac{2}{2} = 1\ A$

64. (c) The voltmeter is assumed to have infinite resistance. Hence (1 + 2 + 1) + 4 = 8Ω.

65. (c) $R' = \frac{R}{n} = \frac{1}{10} = 0.1\Omega$

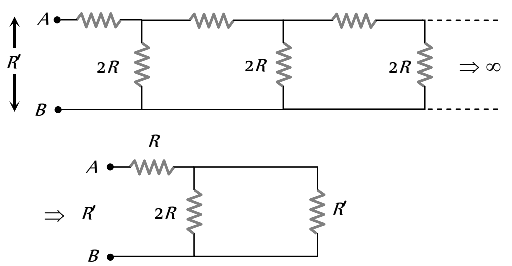
66. (c) The given circuit can be redrawn as follows



$\Rightarrow R_{eq} = 5\Omega$.

67. (b) $R_{AB} = R_1 + \frac{R_2 R_3}{R_2 + R_3} + R_4 = 2 + \frac{4 \times 4}{4+4} + 2 = 6\Omega$.

68. (c) Let equivalent resistance between A and B is R', so given circuit can be reduced as follows



$$R' = R + \frac{2R \times R'}{(2R + R')} \Rightarrow R'^2 - RR' - 2R^2 = 0$$

On solving the equation we get $R' = 2R$.

69. (d) $R_{AB} = \frac{R}{3} + R = \frac{2}{3} + 2 = \frac{8}{3} = 2\frac{2}{3}\Omega$.

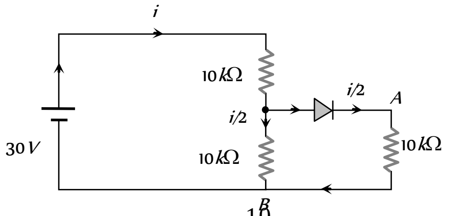
70. (b) $i = \frac{E}{R+r} \Rightarrow 0.5 = \frac{10}{R+3} \Rightarrow 10 = 0.5R + 1.5 \Rightarrow R = 17\Omega$.

71. (a) Equivalent resistance $R = 4 + \frac{3 \times 6}{3+6} = 6\Omega$ and main current $i = \frac{E}{R} = \frac{3}{6} = 0.5A$

Now potential difference across the combination of 3Ω and 6Ω, $V = 0.5 \times \left(\frac{3 \times 6}{3+6}\right) = 1 Volt$

The same potential difference, also develops across 3Ω resistance.

72. (c)



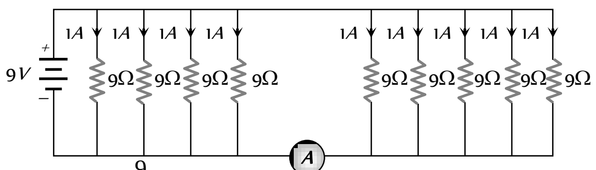
Equivalent resistance $R = 10 + \frac{10}{2} = 15\,k\Omega$

Current $i = \frac{30}{15} = 2 \times 10^{-3}\,A$

Hence, potential difference between A and B

$$V = \left(\frac{2 \times 10^{-3}}{2}\right) \times 10 \times 10^3 = 10\,Volt$$

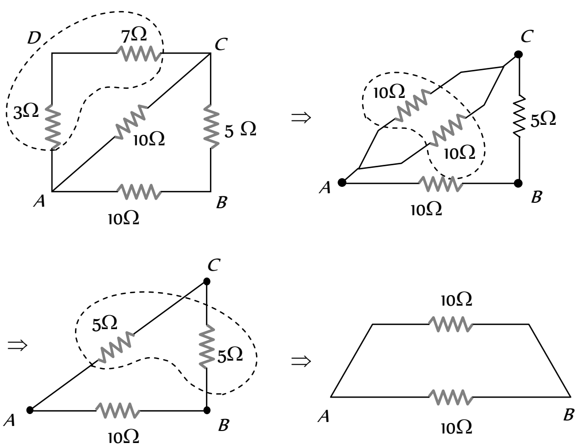
73. (a) Equivalent resistance $R = \frac{9}{9} = 1\Omega$



Current $i = \frac{9}{1} = 9A$

Current passes through the ammeter = 5A.

74. (b) The figure can be drawn as follows

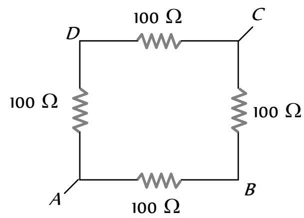


$\Rightarrow R_{AB} = 5\Omega$.

75. (a) $R_1 = \frac{\rho_1 l_1}{A}$ and $R_2 = \frac{\rho_2 l_2}{A}$. In series $R_{eq} = R_1 + R_2$

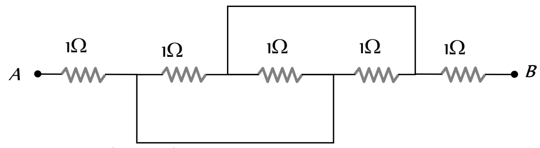
$$\frac{\rho_{eq.}(l_1 + l_2)}{A} = \frac{\rho_1 l_1}{A} + \frac{\rho_2 l_2}{A} \Rightarrow \rho_{eq} = \frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}.$$

76. (c) The figure can be drawn as follows



$$R_{AC} = \frac{200 \times 200}{200 + 200} = 100\Omega.$$

77. (c)



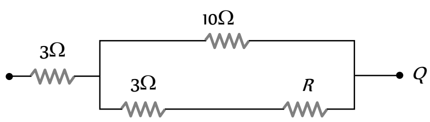
$$R_{AB} = 2 + \frac{1}{3} = 2\frac{1}{3}\Omega.$$

78. (b) ρ – same, l – same, $A_2 = \frac{1}{4}A_1$ (as $r_2 = \frac{r_1}{2}$)

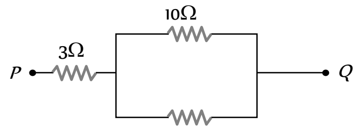
By using $R = \rho\frac{l}{A} \Rightarrow \frac{R_1}{R_2} = \frac{A_2}{A_1} \Rightarrow \frac{R_1}{8} = \frac{1}{4} \Rightarrow R_1 = 2\Omega$

Hence, $R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{2 \times 8}{(2+8)} = \frac{8}{5}\Omega$.

79. (c) The given circuit can be simplified as follows



⇒

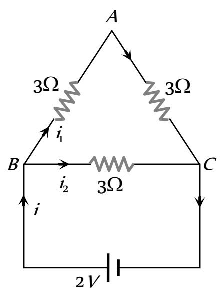


$$R = 3 + \frac{10 \times (3 + R)}{10 + 3 + R} = 3 + \frac{30 + 10R}{13 + R}$$

$$R = \frac{39 + 3R + 30 + 10R}{13 + R} = \frac{69 + 13R}{13 + R}$$

$$13R + R^2 = 69 + 13R \Rightarrow R = \sqrt{69}\Omega.$$

80. (a) The circuit can be drawn as follows



Equivalent resistance $R = \dfrac{3 \times (3+3)}{3+(3+3)} = 2\Omega$

Current $i = \dfrac{2}{2} = 1A$. So, $i_1 = 1 \times \left(\dfrac{3}{3+6}\right) = \dfrac{1}{3}A$.

Potential difference between A and $B = \dfrac{1}{3} \times 3 = 1 volt$.

81. (a) $\dfrac{1}{R_{eq}} = \dfrac{1}{2} + \dfrac{1}{4} + \dfrac{1}{8} = \dfrac{4+2+1}{8} \Rightarrow R_{eq} = \dfrac{8}{7}\Omega$.

82. (b) The given figure is balance wheat stone bridge.

83. (b) $\dfrac{7}{12} = \dfrac{1}{4} + \dfrac{1}{R} \Rightarrow R = 3\Omega$

84. (d) Suppose resistance of wires are R_1 and R_2 then $\dfrac{6}{5} = \dfrac{R_1 R_2}{R_1 + R_2}$. If R_2 breaks then $R_1 = 2\Omega$

Hence, $\dfrac{6}{5} = \dfrac{2 \times R_2}{2 + R_2} \Rightarrow R_2 = 3\Omega$.

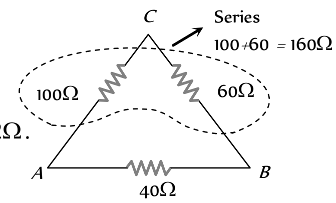
85. (d) Potential difference across PQ *i.e.* p.d. across the resistance of 20Ω, which is $V = i \times 20$

and $i = \dfrac{48}{(100+100+80+20)} = 0.16A$

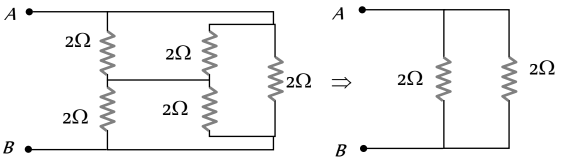
$\therefore V = 0.16 \times 20 = 3.2V$.

86. (a)

$R = \dfrac{160 \times 40}{160+40} = 32\Omega$.



87. (a)



$R_{AB} = \dfrac{2 \times 2}{2+2} = 1\Omega$.

88. (a) Given circuit is a balance Wheatstone bridge circuit.

89. (b) All of three resistance are in parallel So, $R' = R/n = \dfrac{R}{3}$.

90. (b) $R_{eq} = R_1 + R_2 \Rightarrow \dfrac{\rho_{eff.}2l}{A} = \dfrac{\rho_1 l}{A} + \dfrac{\rho_2 l}{A} \Rightarrow \rho_{eff.} = \dfrac{\rho_1 + \rho_2}{2}$.

91. (b) Two resistance are in ratio 1 : 2 and third resistance is R

So, $\dfrac{1}{x} + \dfrac{1}{2x} + \dfrac{1}{R} = 1 \Rightarrow x = \dfrac{3}{2}\left(\dfrac{R}{R-1}\right)$

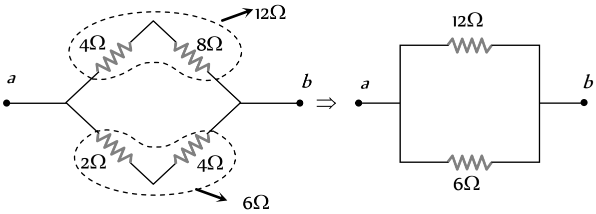
As, resistance is not fractional $\Rightarrow \dfrac{R}{R-1} = 2$

$\Rightarrow x = 3, R = 2, 2x = 6$

Hence, the value of largest resistance = 6Ω.

92. (c) $R = \dfrac{(3+3) \times 3}{(3+3)+3} = 2\Omega \Rightarrow i = \dfrac{3}{2} = 1.5A$.

93. (b) Given circuit is a balanced Wheatstone bridge circuit, hence it can be redrawn as follows

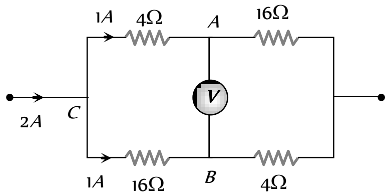


$R_{AB} = \dfrac{12 \times 6}{(12+6)} = 4\Omega$.

94. (d) The given circuit is a balanced wheatstone bridge circuit. Hence potential difference between A and B is zero.

95. (a) In the following circuit potential difference between

C and A is $V_C - V_A = 1 \times 4 = 4$ ......(i)



C and B is $V_C - V_B = 1 \times 16 = 16$ ......(ii)

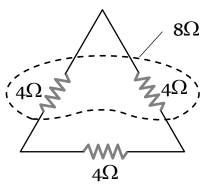
On solving equations (i) and (ii) we get

$V_A - V_B = 12V$.

96. (d) As resistance $\propto$ Length

$\therefore$ Resistance of each arm $= \dfrac{12}{3} = 4\,\Omega$

$\therefore R_{effective} = \dfrac{4 \times 8}{4+8} = \dfrac{8}{3}\Omega$



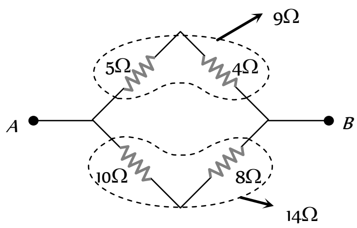
97. (b) $i = \dfrac{12}{(1+1)+0.4} = 5A$.

98. (b) By balanced Wheatstone bridge condition $\dfrac{16}{X} = \dfrac{4}{0.5}$

$\Rightarrow X = \dfrac{8}{4} = 2\,\Omega$

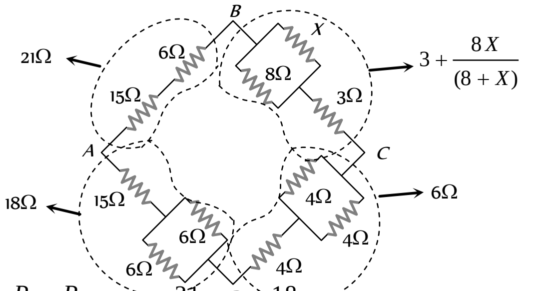
99. (d) Current through $2\Omega = 1.4\left\{\dfrac{(25+5)}{(10+2)+(25+5)}\right\} = 1A$

100. (a) Since the given bridge is balanced, hence there will be no current through 9Ω resistance. This resistance has no effect and must be ignored in the calculations.



$$R_{AB} = \frac{9 \times 18}{27} = 6\,\Omega$$

101. (c) Potential difference between B and D is zero, it means Wheatstone bridge is in balanced condition



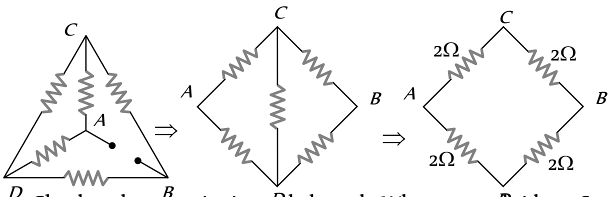
So $\frac{P}{Q} = \frac{R}{S} \Rightarrow \frac{21}{3 + \frac{8X}{(8+X)}} = \frac{18}{6} \Rightarrow X = 8\Omega$

102. (a) This is a balanced Wheatstone bridge. Therefore no current will flow from the diagonal resistance $10\,\Omega$

$\therefore$ Equivalent resistance $= \frac{(10+10)\times(10+10)}{(10+10)+(10+10)} = 10\,\Omega$

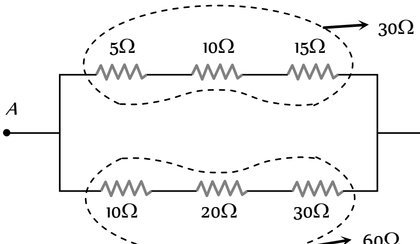
103. (b) This is a balanced Wheatstone bridge circuit. So potential at B and D will be same and no current flows through $4R$ resistance.

104. (d) The equivalent circuits are as shown below



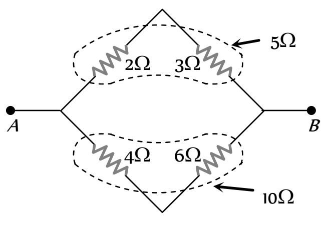
Clearly, the circuit is a balanced Wheatstone bridge. So effective resistance between A and B is $2\,\Omega$.

105. (a) By the concept of balanced Wheatstore bridge, the given circuit can be redrawn as follows



$$\Rightarrow R_{AB} = \frac{30 \times 60}{(30+60)} = 20\ \Omega$$

106. (a) The given circuit is a balanced Wheatstone bridge type, hence it can be simplified as follows



$\Rightarrow \quad R_{AB} = \frac{10}{3}\Omega$

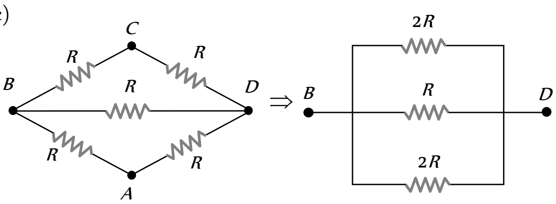
107. (b) Let current through $5\,\Omega$ resistance be i. Then

$$i \times 25 = (2.1 - i)10 \Rightarrow i = \frac{10}{35} \times 2.1 = 0.6\,A$$

108. (d) Let the value of shunt be r. Hence the equivalent resistance of branch containing S will be $\frac{Sr}{S+r}$

In balance condition, $\frac{P}{Q} = \frac{Sr/(S+r)}{R}$. This gives $r = 8\Omega$

109. (b, c)



$$\frac{1}{R_{BD}} = \frac{1}{2R} + \frac{1}{R} + \frac{1}{2R} \Rightarrow R_{BD} = \frac{R}{2}$$

Between A and C circuit becomes equivalent to balanced Wheatstone bridge so $R_{AC} = R$.

110. (b) $i \propto \frac{1}{R}$

111. (d) Equivalent resistance between P and Q

$$\frac{1}{R_{PQ}} = \frac{1}{(6+2)} + \frac{1}{3} + \frac{1}{(4+12)} \Rightarrow R_{PQ} = \frac{48}{25}\Omega$$

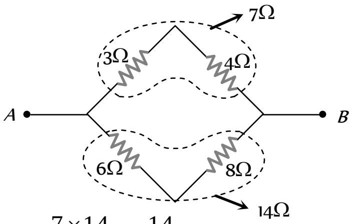
Current between P and Q; $i = 1.5A$

So, potential difference between P and Q

$$V_{PQ} = 1.5 \times \frac{48}{25} = 2.88\,V.$$

112. (c) Given circuit is a balanced Wheatstone bridge i.e. potential difference between B and D is zero. Hence, no current flows between B and D.

113. (a) The given circuit is a balanced Wheatstone bridge, hence it can be redrawn as follows



$$\Rightarrow \quad R_{eq} = \frac{7 \times 14}{(7+14)} = \frac{14}{3}\Omega.$$

114. (a) For a balance Wheatstone bridge.

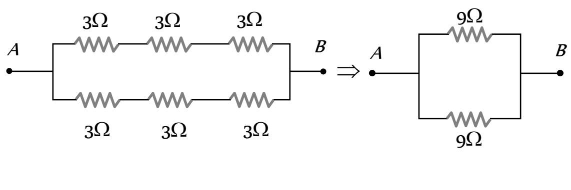
$$\frac{A}{B} = \frac{D}{C} \Rightarrow \frac{10}{5} \neq \frac{4}{4} \text{(Unbalanced)}$$

$$\frac{A'}{B} = \frac{D}{C} \Rightarrow \frac{A'}{5} = \frac{4}{4} \Rightarrow A' = 5\Omega$$

$A'(5\Omega)$ is obtained by connecting a $10\,\Omega$ resistance in parallel with A.

115. (d) Given circuit is a balanced Wheatstone bridge circuit. So there will be no change in equivalent resistance. Hence no further current will be drawn.

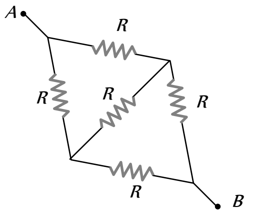
116. (a) No current flow through vertical resistances



$R_{AB} = \frac{9}{2}\Omega$.

117. (d) The given circuit is a balanced Wheatstone bridge.

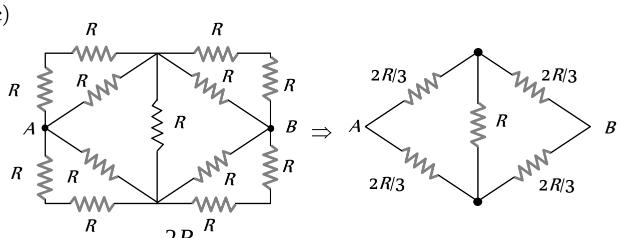
118. (c) The given circuit can be redrawn as follows



Equivalent resistance between *A* to *B* is *R*.

119. (d) Equivalent resistance of the given circuit is 3Ω.

120. (c)



Hence $R_{eq} = \frac{2R}{3}$.

121. (b)

122. (b) For balanced Wheatstone bridge $\frac{P}{Q} = \frac{R}{S}$

$\Rightarrow \frac{12}{(1/2)} = \frac{x+6}{(1/2)} \Rightarrow x = 6\Omega$

123. (b) For maximum energy equivalent resistance of combination should be minimum.

124. (c) For first balancing condition $\frac{10+R_1}{R_2} = \frac{50}{50}$

$\Rightarrow R_2 = 10 + R_1$. For second balancing condition $\frac{R_1}{R_2} = \frac{40}{60} \Rightarrow \frac{R_1}{10+R_1} = \frac{2}{3} \Rightarrow R_1 = 20\,\Omega$

125. (b) Given $R = 6\Omega$. When resistor is cut into two equal parts and connected in parallel, then

$R_{eq} = \frac{R/2}{2} = \frac{R}{4} = \frac{6}{4} = 1.5\,\Omega$

126. (a) Resistance between *P* and *Q*

$$R_{PQ} = R \,||\, \left(\frac{R}{3} + \frac{R}{2}\right) = \frac{R \times \frac{5}{6}R}{R + \frac{5}{6}R} = \frac{5}{11}R$$

Resistance between *Q* and *R*

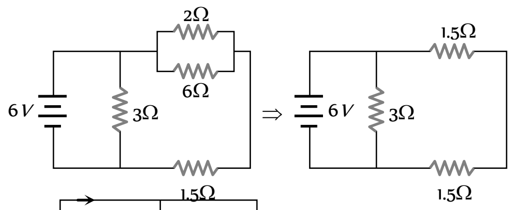
$$R_{QR} = \frac{R}{2} \,||\, \left(R + \frac{R}{3}\right) = \frac{\frac{R}{2} \times \frac{4R}{3}}{\frac{R}{2} + \frac{4R}{3}} = \frac{4}{11}R$$

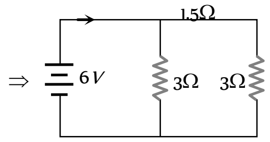
Resistance between *P* and *R*

$$R_{PR} = \frac{R}{3} \,||\, \left(\frac{R}{2} + R\right) = \frac{\frac{R}{3} \times \frac{3R}{2}}{\frac{R}{3} + \frac{3R}{2}} = \frac{3}{11}R$$

Hence it is clear that R_{PQ} is maximum.

127. (c) Given circuit can be redrawn as follows

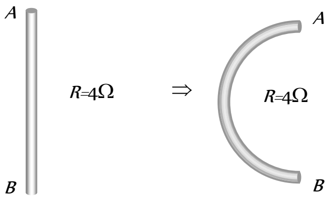




$\Rightarrow i = \frac{6}{1.5} = 4\,A$

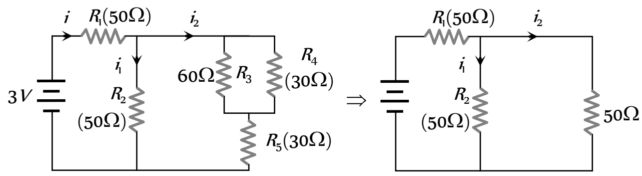
128. (b) $\frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{l_2}{l_1} \times \left(\frac{r_1}{r_2}\right)^2 = \frac{3}{4}\left(\frac{2}{3}\right)^2 = \frac{1}{3}$

129. (c)



130. (a) $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{19}{20} \Rightarrow R_{eq} = \frac{20}{19}\Omega$

131. (a) Equivalent resistance of the given network $R_{eq} = 75\,\Omega$



$\therefore$ Total current through battery $i = \frac{3}{75}$

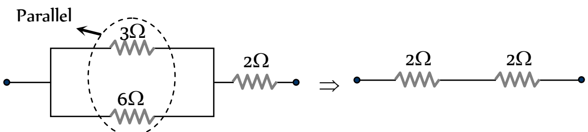
$i_1 = i_2 = \frac{3}{75 \times 2} = \frac{3}{150}$

Current through $R_4 = \frac{3}{150} \times \frac{60}{(30+60)} = \frac{3}{150} \times \frac{60}{90} = \frac{2}{150}A$

$V_4 = i_4 \times R_4 = \frac{2}{150} \times 30 = \frac{2}{5}V = 0.4\,V$

132. (a) $i = \frac{10}{1.5 + (1 \,||\, 1)} = \frac{10}{1.5 + 0.5} = 5A$

133. (c)



$R_{eq} = 4\Omega$

134. (a) The equivalent resistance between *C* and *D* is

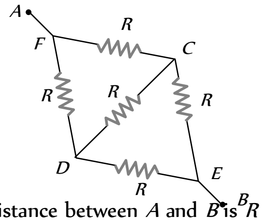
$\frac{1}{R'} = \frac{1}{6} + \frac{1}{6} + \frac{1}{3} = \frac{2}{3}$ or $R' = \frac{3}{2} = 1.5\,\Omega$

Now the equivalent resistance between A and B as $R' = 1.5\,\Omega$ and $2.5\,\Omega$ are connected in series, so

$R'' = 1.5 + 2.5 = 4\,\Omega$

Now by ohm's law, potential difference between A and B is given by $V_A - V_B = iR = 2 \times 4.0 = 8\ volt$

135. (b) The given circuit can be redrawn as follows



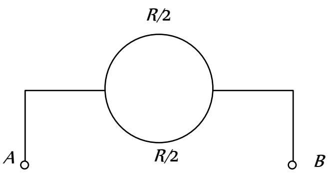
Equivalent resistance between A and B is R and

current $i = \frac{V}{R}$

136. (b) The given network is a balanced Wheatstone bridge. It's equivalent resistance will be $R = \frac{18}{5}\Omega$

So current from the battery $i = \frac{V}{R} = \frac{V}{18/5} = \frac{5V}{18}$

137. (a) $\Rightarrow R_{AB} = \frac{R/2}{2} = \frac{R}{4}$



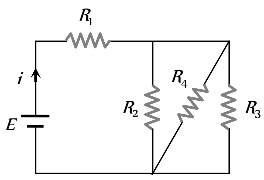
138. (b) $i \propto \frac{1}{R} \Rightarrow \frac{i_1}{i_2} = \frac{R_2}{R_1} \Rightarrow \frac{5}{4} = \frac{(R+2)}{R} \Rightarrow R = 8\Omega$

139. (c) In given circuit three resistance R_2, R_4 and R_3 are parallel.

$\frac{1}{R} = \frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_3}$

$= \frac{1}{50} + \frac{1}{50} + \frac{1}{75}$

$= \frac{75+75+50}{50 \times 75}$



$R = \frac{50 \times 75}{75+75+50} = \frac{50 \times 75}{200} = \frac{75}{4}\Omega = 18.75\Omega$

This resistance is in series with R_1

$\therefore$

$R_{\text{resultant}} = R_1 + R = 100 + 18.75 = 118.75\Omega$

140. (b) When resistances 4Ω and 12Ω are connected in series $= 4 + 12 = 16\Omega$

When these resistance are connected in parallel.

$\frac{1}{R_P} = \frac{1}{4} + \frac{1}{12} \Rightarrow R_P = \frac{4 \times 12}{4+12} = \frac{4 \times 12}{16} = 3\Omega$

141. (b) Since voltmeter records $5V$, it means the equivalent. Resistance of voltmeter and 100 Ω must be 50, because in series grouping if resistances are equal, they share equal potential difference. It conclude that resistance of voltmeter must be 100 Ω.

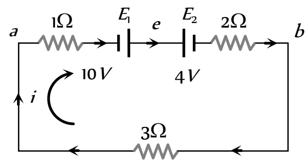
Kirchoff's Law, Cells

1. (b) For no current through galvanometer, we have

$\left(\frac{E_1}{500+X}\right)X = E \Rightarrow \left(\frac{12}{500+X}\right)X = 2 \Rightarrow X = 100\ \Omega$

2. (d) Since $E_1(10\ V) > E_2(4V)$

So current in the circuit will be clockwise.



Applying Kirchoff's voltage law

$-1 \times i + 10 - 4 - 2 \times i - 3i = 0 \Rightarrow i = 1A (a \text{ to } b \text{ via } e)$

$\therefore$ Current $= \frac{V}{R} = \frac{10-4}{6} = 1.0\ ampere$

3. (c) For maximum power, external resistance = internal resistance.

4. (a) $0.9\ (2 + r) = 0.3\ (7 + r) \Rightarrow 6 + 3r = 7 + r \Rightarrow r = 0.5\ \Omega$

5. (a) Since both the resistors are same, therefore potential difference $= V + V = E \Rightarrow V = \frac{E}{2}$

6. (b) Let the current in the circuit $= i = \frac{V}{R}$

Across the cell, $E = V + ir \Rightarrow r = \frac{E-V}{i} = \frac{E-V}{V/R} = \left(\frac{E-V}{V}\right)R$

7. (a) For maximum energy, we have

External resistance of the circuit

= Equivalent internal resistance of the circuit *i.e.* $R = \frac{r}{2}$

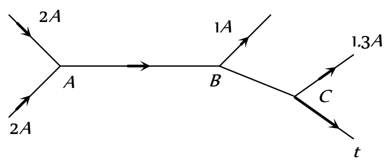
8. (a) Kirchhoff's first law is based on the law of conservation of charge.

9. (b) Kirchhoff's second law is based on the law of conservation of energy.

10. (a) According to Kirchhoff's first law

At junction A, $i_{AB} = 2 + 2 = 4A$

At junction B, $i_{AB} = i_{BC} - 1 = 3A$



At junction C, $i = i_{BC} - 1.3 = 3 - 1.3 = 1.7\ amp$

11. (c) In charging $V > E$.

12. (d) In open circuit of a cell $V = E$

13. (a) Zero (Circuit open means no current and hence no potential difference across resistance).

14. (d) Zero (No potential difference across voltmeter).

15. (b) Let the e.m.f. of cell be E and internal resistance be r. Then

$$0.5=\frac{E}{(r+2)} \text{ and } 0.25=\frac{E}{(r+5)}$$

On dividing, $2=\frac{5+r}{2+r} \Rightarrow r=1\Omega$

16. (c) In short circuiting R = 0, so V = 0

17. (c) Short circuit current $i_{SC}=\frac{E}{r} \Rightarrow 3=\frac{1.5}{r} \Rightarrow r=0.5\Omega$

18. (c) $i=\frac{50}{R+r} \Rightarrow r=\frac{50}{4.5}-10=\frac{5}{4.5}=1.1\Omega$

19. (d) $(4+r)i=2.2$ ......(i)

and $4i=2 \Rightarrow i=\frac{1}{2}$

Putting the value of i in (i), we get r = 0.4 *ohm*.

20. (b) Let the internal resistance of cell be r, then

$$i=\frac{E}{R+r} \Rightarrow 15=\frac{1.5}{0.04+r} \Rightarrow r=0.06\Omega$$

21. (c) The voltage across cell terminal will be given by

$$=\frac{E}{R+r}\times R=\frac{2}{(3.9+0.1)}\times 3.9=1.95V$$

22. (c) $E=2.2\,volt,\ V=1.8\,volt,\ R=5R$

$$r=\left(\frac{E}{V}-1\right)R=\left(\frac{2.2}{1.8}-1\right)\times 5=1.1\Omega$$

23. (b) In parallel, equivalent resistance is low $\left(i=\frac{E}{R+\frac{r}{n}}\right)$

24. (d) Internal resistance $\propto$ distance $\propto \frac{1}{\text{Area}} \propto$ concentration

25. (a) Total e.m.f. = nE, Total resistance $R+nr \Rightarrow i=\frac{nE}{R+nr}$

26. (a) Current through R is maximum when total internal resistance of the circuit is equal to external resistance.

27. (b) Cells are joined in parallel when internal resistance is higher then a external resistance. ($R<<r$)

$$i=\frac{E}{R+\frac{r}{n}}$$

28. (b) In series, $i_1=\frac{2E}{2+2r}$

In parallel, $i_2=\frac{E}{2+\frac{r}{2}}=\frac{2E}{4+r}$

Since $i_1=i_2 \Rightarrow \frac{2E}{4+r}=\frac{2E}{2+2r} \Rightarrow r=2\Omega$

29. (a) Applying Kirchhoff law

$$(2+2)=(0.1+0.3+0.2)i \Rightarrow i=\frac{20}{3}A$$

Hence potential difference across A

$$=2-0.1\times\frac{20}{3}=\frac{4}{3}V \quad \text{(less than } 2V)$$

Potential difference across $B=2-0.3\times\frac{20}{3}=0$

30. (b) Here two cells are in series.

Therefore total emf = $2E$.

Total resistance = $R+2r$

$$\therefore i=\frac{2E}{R+2r}=\frac{2\times 1.45}{1.5+2\times 0.15}=\frac{2.9}{1.8}=\frac{29}{18}=1.611\,amp$$

31. (a) $E=V+ir$

After short-circuiting, $V=0;\ \Rightarrow r=\frac{E}{i}=\frac{2}{4}=0.5\Omega$

32. (c) By Kirchhoff's current law.

33. (b) For power to be maximum

External resistance = Equivalent internal resistance of the circuit

34. (a) $i=\frac{E}{r}=\frac{1.5}{0.05}=30A$

35. (a) $i=\frac{12}{(4+2)}=2A$

Energy loss inside the source $=i^2r=(2)^2\times 2=8W$

36. (b) $V_2-V_1=E-ir=5-2\times 0.5=4\,volt$

$\Rightarrow V_2=4+V_1=4+10=14\,volt$

37. (a) If m = Number of rows

and n = Number of cells in a row

Then $m\times n$ = 100 .....(i)

Also condition of maximum current is $R=\frac{nr}{m}$

$\Rightarrow 25=\frac{1\times n}{m} \Rightarrow n=25\,m$ .....(ii)

On solving (i) and (ii) m = 2

38. (b) According to Kirchhoff's law $i_{CD}=i_2+i_3$

39. (b) Since $i=\left(\frac{E}{R+r}\right)$, we get

$0.5=\frac{E}{2+r}$ ......(i)

$0.25=\frac{E}{5+r}$ .....(ii)

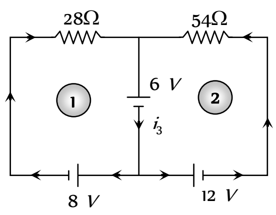
Dividing (i) by (ii), we get $2=\frac{5+r}{2+r} \Rightarrow r=1\Omega$

$\therefore 0.5=\frac{E}{2+1} \Rightarrow E=1.5V$

40. (c) Because $E_{eq}=E$ and $r_{eq}=\frac{r}{2}$

41. (d) In parallel combination $E_{eq}=E=6V$

42. (d) Suppose current through different paths of the circuit is as follows.



After applying KVL for loop (1) and loop (2)

We get $28i_1 = -6-8 \Rightarrow i_1 = -\frac{1}{2}A$

and $54i_2 = -6-12 \Rightarrow i_2 = -\frac{1}{3}A$

Hence $i_3 = i_1 + i_2 = -\frac{5}{6}A$

43. (d) $V_{AB} = 4 = \frac{5X + 2\times 10}{X+10} \Rightarrow X = 20\Omega$

44. (a) After short circuiting, R becomes meaningless.

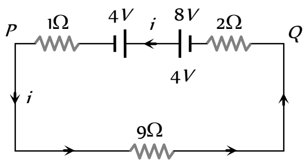
45. (c) $V = E - IR = 15 - 10\times 0.05 = 14.5V$

46. (c) In series $i = \frac{nE}{nr+R} \Rightarrow 0.6 = \frac{n\times 1.5}{n\times 0.5\times 20} \Rightarrow n = 10$

47. (b)

48. (a) $P = \frac{W}{t} = Vi \Rightarrow V = \frac{W}{it} = \frac{1000}{2\times 6\times 60} = 1.38\ V$

49. (a) Applying Kirchoff's voltage law in the given loop.



$-2i + 8 - 4 - 1\times i - 9i = 0 \Rightarrow i = \frac{1}{3}A$

Potential difference across $PQ = \frac{1}{3}\times 9 = 3V$

50. (d) Because cell is in open circuit.

51. (b) In parallel combination $E_{eq} = E = 12V$

52. (d)

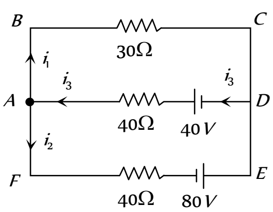
53. (b) $i = \frac{E}{r} = \frac{6}{0.5} = 12\,amp.$

54. (c) Strength = 5 × 18 = 90*AH*.

55. (a) $i = \frac{E}{R+r} = \frac{5}{4.5+0.5} = 1A$

$V = E - ir = 5 - 1\times 0.5 = 4.5$ Volt

56. (b) The circuit can be simplified as follows



Applying KCL at junction A

$i_3 = i_1 + i_2$ .....(i)

Applying Kirchoff's voltage law for the loop $ABCDA$

$-30i_1 - 40i_3 + 40 = 0$

$\Rightarrow -30i_1 - 40(i_1 + i_2) + 40 = 0$

$\Rightarrow 7i_1 + 4i_2 = 4$ .....(ii)

Applying Kirchoff's voltage law for the loop $ADEFA$.

$-40i_2 - 40i_3 + 80 + 40 = 0$

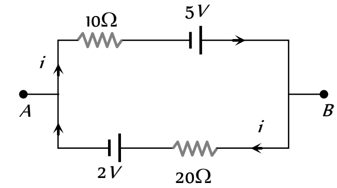
$\Rightarrow -40i_2 - 40(i_1 + i_2) = -120$

$\Rightarrow i_1 + 2i_2 = 3$ ....(iii)

On solving equation (ii) and (iii) $i_1 = -0.4A$.

57. (c) $V = E - ir = 12 - 60\times 5\times 10^{-2} = 9V.$

58. (a) Applying Kirchoff's voltage law in the loop



$-10i + 5 - 20i - 2 = 0 \Rightarrow i = 0.1A$

59. (d) $V = E - ir = 1.5 - 2\times 0.15 = 1.20 Volt.$

60. (b) $i = \frac{E}{R+r} \Rightarrow 1 = \frac{4}{2+r} = r = 2\Omega$

Short circuit when terminals of battery connected directly then current flows which is $i_{SC} = \frac{E}{r} = \frac{4}{2} = 2A$.

61. (c) $i = \frac{2+2}{1+1.9+0.9} = \frac{4}{3.8}A$

For cell A $E = V + ir \Rightarrow V = 2 - \frac{4}{3.8}\times 1.9 = 0$.

62. (c) By using $i = \frac{E}{R+r}$

$\Rightarrow 0.5 = \frac{E}{11+r} \Rightarrow E = 5.5 + 0.5r$ .....(i)

and $0.9 = \frac{E}{5+r} \Rightarrow E = 4.5 + 0.9r$ .....(ii)

On solving these equation, we have $r = 2.5\Omega$

63. (c)

64. (b) $W = qV = 6\times 10^{-6}\times 9 = 54\times 10^{-6}J$.

65. (a) $P = \frac{V^2}{R_{eq}}$; for P to be maximum R_{eq} should be less. Hence option (a) is correct.

66. (c) $P_{max} = \frac{E^2}{4r} = \frac{(2)^2}{4\times 0.5} = 2W$

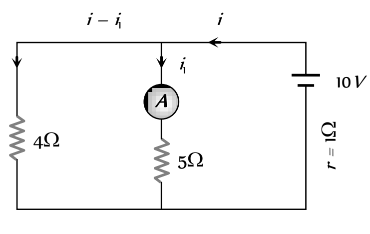
67. (a)

68. (d) Applying Kirchhoff law in the first mesh

$10 = 5\times i \Rightarrow i = \frac{10}{5} = 2A$

69. (b) Applying Kirchhoff law in the first mesh

$10 = 5i_1 + i$ .....(i)



Applying in the second mesh

$5i_1 = 4i - 4i_1$ ......(ii)

Solving equation (i) and (ii), we get $i_1 = \frac{40}{29} A$

70. (a) Given problem is the case of mixed grouping of cells

So total current produced $i = \dfrac{nE}{R + \frac{nr}{m}}$

Here $m = 100,\ n = 5000,\ R = 500\,\Omega$

$E = 0.15\,V$ and $r = 0.25\,\Omega$

$\Rightarrow \quad i = \dfrac{5000 \times 0.15}{500 + \dfrac{5000 \times 0.25}{100}} = \dfrac{750}{512.5} \approx 1.5\,A$

71. (a)

72. (d) Watt hour efficiency $= \dfrac{\text{Discharging energy}}{\text{Charging energy}}$

$= \dfrac{14 \times 5 \times 15}{15 \times 8 \times 10} = 0.875 = 87.5\%$

73. (c) From Kirchoff's junction Law

$\Rightarrow 4 + 2 + i - 5 - 3 = 0 \Rightarrow i = 2\,A$

74. (b) In the given case cell is in open circuit (i = 0) so voltage across the cell is equal to its e.m.f.

75. (b) The internal resistance of battery is given by

$r = \left(\dfrac{E}{V} - 1\right)R = \left(\dfrac{40}{30} - 1\right) \times 9 = \dfrac{9 \times 10}{30} = 3\,\Omega$

76. (b) $i = \dfrac{E}{r+R} \Rightarrow P = i^2 R \Rightarrow P = \dfrac{E^2 R}{(r+R)^2}$

Power is maximum when $r = R \Rightarrow P_{max} = E^2/4r$

77. (c) Since the current coming out from the positive terminal is equal to the current entering the negative terminal, therefore, current in the respective loop will remain confined in the loop itself.

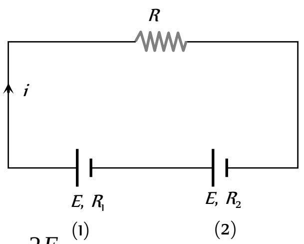
$\therefore$ current through 2Ω resistor = 0

78. (c) Reading of voltmeter

$= E_{eq} = \dfrac{E_1 r_2 + E_2 r_1}{r_1 + r_2} = \dfrac{18 \times 1 + 12 \times 2}{1 + 2} = 14\,V$

79. (d) $i = \dfrac{2E}{R + R_1 + R_2}$

From cell (2) $E = V + iR_2 = 0 + iR_2$



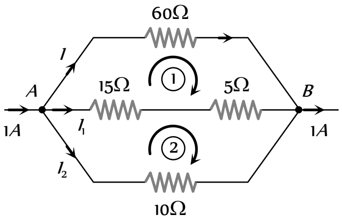
$\Rightarrow E = \dfrac{2E}{R + R_1 + R_2} \times R_2 \Rightarrow R = R_2 - R_1$

80. (d)

81. (a) Applying Kirchoff's law in following figure.

At junction A :

$i + i_1 + i_2 = 1$ .... (i)



For Loop (i)

$-60\,i + (15+5)i_1 = 0$

$\Rightarrow i_1 = 3i$ ...(ii)

For loop (2)

$-(15+5)\,i_1 + 10\,i_2 = 0$

$\Rightarrow i_2 = i_1 = (3\,i) = 6i$

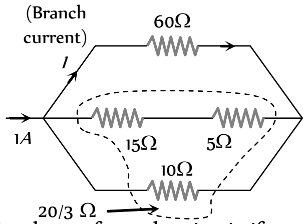
On solving equation (i), (ii) and (iii) we get i = 0.1 A

Short Trick : Branch current =

main current $\left(\dfrac{\text{Resistance of opposite branch}}{\text{Total resistance}}\right)$

$\Rightarrow i = 1 \times \left[\dfrac{\frac{20}{3}}{\frac{20}{3} + 60}\right]$

= 0.1 A



82. (d) Maximum current will be drawn from the circuit if resultant resistance of all internal resistances is equal to the value of external resistance if the arrangement s mixed. In series, $R >> nr$ and in parallel, the external resistance is negligible.

83. (c) On applying Kirchoff's current law i = 13 A.

84. (c) Total cells = $m \times n$ = 24 .... (i)

For maximum current in the circuit $R = \dfrac{mr}{n}$

$\Rightarrow 3 = \dfrac{m}{n} \times (0.5) \Rightarrow m = 6n$ ..... (ii)

On solving equation (i) and (ii), we get m = 12, n =2

85. (a) Power dissipated $= i^2 R = \left(\dfrac{E}{R+r}\right)^2 R$

$\therefore \left(\dfrac{E}{R_1 + r}\right)^2 R_1 = \left(\dfrac{E}{R_2 + r}\right)^2 R_2$

$\Rightarrow R_1(R_2^2 + r_2 + 2R_2 r) = R_2(R_1^2 + r^2 + 2R_1 r)$

$\Rightarrow R_2^2 R_1 + R_1 r^2 + 2R_2 r = R_1^2 R_2 + R_2 r^2 + 2R_1 R_2 r$

$\Rightarrow (R_1 - R_2)r^2 = (R_1 - R_2)r^2 = (R_1 - R_2)R_1 R_2$

$\Rightarrow r = \sqrt{R_1 R_2}$

Different Measuring Instruments

1. (a) In meter bridge experiment, it is assumed that the resistance of the L shaped plate is negligible, but actually it is not so. The error created due to this is called, end error. To remove this the resistance box and the unknown resistance must be interchanged and then the mean reading must be taken.

2. (c) To convert a galvanometer into an ammeter a low value resistance is to be connected in parallel to it called shunt.

3. (d) Balance point has some fixed position on potentiometer wire. It is not affect by the addition of resistance between balance point and cell.

4. (d) Resistance of voltmeter should be greater than the external circuit resistance. An ideal voltmeter has infinite resistance.

5. (c) $S = \frac{i_g G}{i - i_g} = \frac{100 \times 0.01}{(10 - 0.01)} = \frac{1}{10} = 0.1 \Omega$

6. (c) Equivalent resistance of the circuit $R_{eq} = 100 \Omega$

current through the circuit $i = \frac{2.4}{100} A$

P.D. across combination of voltmeter and 100 Ω resistance

$= \frac{2.4}{100} \times 50 = 1.2 V$

Since the voltmeter and 100 Ω resistance are in parallel, so the voltmeter reads the same value *i.e.* 1.2 *V*.

7. (a) Potential gradient $= \frac{e}{(R + R_h + r)} \cdot \frac{R}{L}$

$= \frac{2}{(15 + 5 + 0)} \times \frac{5}{1} = 0.5 \frac{V}{m} = 0.005 \frac{V}{cm}$

8. (d) $S = \frac{i_g G}{(i - i_g)} \Rightarrow \frac{G}{S} = \frac{i - i_g}{i_g} = \frac{10 - 1}{1} = \frac{9}{1}$

9. (c) Ammeter is used to measure the current through the circuit.

10. (c) $S = \frac{i_g G}{(i - i_g)} = \frac{1 \times 0.018}{10 - 1} = \frac{0.018}{9} = 0.002 \Omega$

11. (d) Potentiometer works on null deflection method. In balance condition no current flows in secondary circuit.

12. (c) Shunt resistances $S = \frac{i_g G}{(i - i_g)} = \frac{10 \times 99}{(100 - 10)} = 11 \Omega$

13. (d) By using $R = \frac{V}{i_g} - G \Rightarrow R = \frac{100}{5 \times 10^{-3}} - 5 = 19{,}995 \Omega$

14. (a) Potential gradient = Change in voltage per unit length

$\therefore\ 10 = \frac{V_2 - V_1}{30/100} \Rightarrow V_2 - V_1 = 3\, volt$

15. (d) $R = \frac{V}{i_g} - G = \frac{5}{100/10^3} - 2 = \frac{5000}{100} - 2 = 48 \Omega$

16. (c) $i_g = \frac{iS}{S + G} \Rightarrow 10 = \frac{50 \times 12}{12 + G} \Rightarrow 12 + G = 60 \Rightarrow G = 48 \Omega$

17. (a) To convert a galvanometer into a voltmeter, a high value resistance is to be connected in series with it.

18. (b)

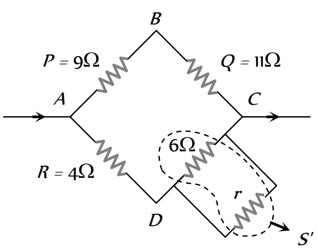
19. (c) $\frac{P}{Q} = \frac{R}{S'}$ (For balancing bridge)

$\Rightarrow S' = \frac{4 \times 11}{9} = \frac{44}{9}$

$\Rightarrow \frac{1}{S'} = \frac{1}{r} + \frac{1}{6}$

$\Rightarrow \frac{9}{44} - \frac{1}{6} = \frac{1}{r}$

$\Rightarrow r = \frac{132}{5} = 26.4 \Omega$



20. (a) $r = \left(\frac{l_1 - l_2}{l_2}\right) R = \left(\frac{25}{100}\right) 2 = 0.5 \Omega$

21. (b) The sensitivity of potentiometer can be increased by decreasing the potential gradient *i.e.* by increasing the length of potentiometer wire.

(Sensitivity $\propto \frac{1}{P.G.} \propto$ Length)

22. (b) In balance condition, potentiometer doesn't take the current from secondary circuit.

23. (a) Here same current is passing throughout the length of the wire, hence $V \propto R \propto l$

$\Rightarrow \frac{V_1}{V_2} = \frac{l_1}{l_2} \Rightarrow \frac{6}{V_2} = \frac{300}{50} \Rightarrow V_2 = 1\ V.$

24. (a) $S = \frac{i_g G}{i - i_g} = \frac{10 \times 0.01}{10 - 0.01} = \frac{10}{999} ohm$

25. (a) Ratio will be equal to the ratio of no deflection lengths *i.e.* $\frac{E_1}{E_2} = \frac{l_1}{l_2} = \frac{2}{3}$

26. (a) Potential gradient $= \frac{\text{Potential difference}}{\text{Length}}$

27. (a) Wheatstone bridge is balanced, therefore

$\frac{P}{Q} = \frac{R}{S}$ or $1 = \frac{10}{S} \Rightarrow S = 10\, ohm$

28. (a) When the length of potentiometer wire is increased, the potential gradient decreases and the length of previous balance point is increased.

29. (b)

30. (b)

31. (b) The actual circuit is same.

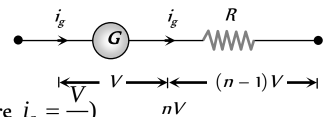
32. (b) $\because\ i_g = 10\%$ of $i = \frac{i}{10} \Rightarrow S = \frac{G}{(n - 1)} = \frac{90}{(10 - 1)} = 10 \Omega$

33. (b) $\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2} = \frac{(8 + 2)}{(8 - 2)} = \frac{5}{3}$

34. (b) Suppose resistance *R* is connected in series with voltmeter as shown.

By Ohm's law

$i_g . R = (n - 1) V$



$\Rightarrow R = (n - 1) G$ (where $i_g = \frac{V}{G}$)

35. (c) Ammeter is always connected in series with circuit.

36. (c) If resistance of ammeter is *r* then

$20 = (R + r) 4 \Rightarrow R + r = 5 \Rightarrow R < 5 \Omega$

37. (b) $S = \frac{i_g \times G}{i - i_g} = \frac{10 \times 10^{-3} \times 50}{1 - 10^{-3} \times 10} = \frac{50}{99} \Omega$ in parallel.

38. (b) $\because\ i_g = (100 - 90)\%$ of $i = \frac{i}{10}$

$\Rightarrow$ Required shunt $S = \frac{G}{(n - 1)} = \frac{900}{(10 - 1)} = 100 \Omega$

39. (d) $R = \frac{V}{i_g} - G = \frac{100}{10 \times 10^{-3}} - 25 = 9975 \Omega$

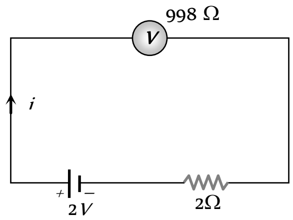
40. (b) Potential gradient $x = \frac{V}{L} = \frac{iR}{L}$

$\Rightarrow x = \frac{2}{(15+5)} \times \frac{15}{10} = \frac{3}{2000} volt / cm$

41. (a) $S = \frac{G}{\frac{i}{i_g} - 1} = \frac{25}{\frac{5}{50 \times 10^{-6}} - 1} = \frac{25}{10^5 - 1} = \frac{25}{10^5} = 2.5 \times 10^{-4} \Omega$

42. (b) In balanced Wheatstone bridge, the arms of galvanometer and cell can be interchanged without affecting the balance of the bridge.

43. (c) Error in measurement = Actual value – Measured value



Actual value = $2V$

$i = \frac{2}{998+2} = \frac{1}{500} A$

Since $E = V + ir \Rightarrow V = E - ir = 2 - \frac{1}{500} \times 2 = \frac{998}{500} V$

$\therefore$ Measured value $= \frac{998}{500} V$

$\Rightarrow$ Error $= 2 - \frac{998}{500} = 4 \times 10^{-3} volt$

44. (d) The emf of the standard cell must be greater than that of experimental cells, otherwise balance point is not obtained.

45. (a)

46. (b) In general, ammeter always reads less than the actual value because of its resistance.

47. (c) By Wheatstone bridge, $\frac{R}{80} = \frac{AC}{BC} = \frac{20}{80} \Rightarrow R = 20\,\Omega$

48. (a) $E \propto l$ (balancing length)

49. (b) $r = \left(\frac{l_1 - l_2}{l_2}\right) \times R' = \left(\frac{l_1 - 2}{2}\right) \times 5$ ... (i)

and $r = \left(\frac{l_1 - 3}{3}\right) \times 10$ ... (ii)

On solving (i) and (ii) $r = 10\,\Omega$

50. (a)

51. (b) In the part $c\,b\,d$,

$V_c - V_b = V_b - V_d \Rightarrow V_b = \frac{V_c + V_d}{2}$

In the part $c\,a\,d$

$V_c - V_a > V_a - V_d \Rightarrow \frac{V_c + V_d}{2} > V_a \Rightarrow V_b > V_a$

52. (c) In balance condition, no current will flow through the branch containing S.

53. (b) Resistance in parallel $S = \frac{Gi_g}{i - i_g} = \frac{50 \times 100 \times 10^{-6}}{(10 - 100 \times 10^{-6})}$

$\Rightarrow S = 5 \times 10^{-4}\,\Omega$

54. (b) $E = x\,l = \frac{V}{l} = \frac{iR}{L} \times l \Rightarrow E = \frac{e}{(R + R_h + r)} \times \frac{R}{L} \times l$

$\Rightarrow E = \frac{10}{(5+4+1)} \times \frac{5}{5} \times 3 = 3\,V$

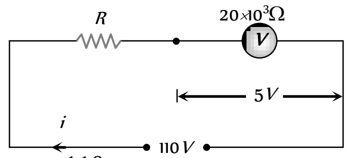
55. (a) Potential gradient $= \frac{V}{L} = \frac{iR}{L} = \frac{i\rho L}{AL} = \frac{i\rho}{A}$

$= \frac{0.2 \times 40 \times 10^{-8}}{8 \times 10^{-6}} = 10^{-2}\,V/m$

56. (b) $i_g = 2\%$ of $i = \frac{i}{50} \Rightarrow S = \frac{G}{(n-1)} = \frac{G}{(50-1)} = \frac{G}{49}$

57. (d) The resistance of an ideal voltmeter is considered as infinite.

58. (c)



Here $i = \frac{110}{20 \times 10^3 + R}$

$\because V = iR \Rightarrow 5 = \left(\frac{110}{20 \times 10^3 + R}\right) \times 20 \times 10^3$

$\Rightarrow 10^5 + 5R = 22 \times 10^5 \Rightarrow R = 21 \times \frac{10^5}{5} = 420\,K\Omega$

59. (c) Due to the negligible temperature co-efficient of resistance of constantan wire, there is no change in it's resistance value with change in temperature.

60. (d) The resistance of voltmeter is too high, so that it draws negligible current from the circuit, hence potential drop in the external circuit is also negligible.

61. (a) By connecting a series resistance

$R = \frac{V}{i_g} - G = \frac{10}{1} - 7 = 3\,\Omega$

62. (a) Since potential difference for full length of wire = 2 V

$\therefore$ P.D. per unit length of wire $= \frac{2}{4} = 0.5\,\frac{V}{m}$

63. (d) $\frac{X}{1} = \frac{20}{80} \Rightarrow X = \frac{1}{4}\Omega = 0.25\,\Omega$.

64. (a) Reading of galvanometer remains same whether switch S is open or closed, hence no current will flow through the switch *i.e.* R and G will be in series and same current will flow through them. $I_R = I_G$.

65. (d) Pressing the key does not disturb current in all resistances as the bridge is balanced. Therefore, deflection in the galvanometer in whatever direction it was, will stay.

66. (b) $i_g S = (i - i_g)G \Rightarrow i_g(S + G) = iG$

$\Rightarrow \frac{i_g}{i} = \frac{G}{S+G} = \frac{8}{2+8} = 0.8$

67. (a) Potential gradient $x = \frac{e}{(R + R_h + r)} \cdot \frac{R}{L}$

$\Rightarrow x = \frac{2.5}{(20+80+0)} \times \frac{20}{10} = 5 \times 10^{-5}\,\frac{V}{mm}$

68. (b) Given $i_g = 2mA,\; i = 20mA, G = 180\Omega$

$\frac{i_g}{i} = \frac{S}{G+S} \Rightarrow 180 + S = 10S \Rightarrow S = \frac{180}{9} = 20\Omega$

69. (c) Resistance of shunted ammeter $= \frac{GS}{G+S}$

Also $\frac{i}{i_g} = 1 + \frac{G}{S} \Rightarrow \frac{GS}{G+S} = \frac{i_g.G}{i}$

$\Rightarrow \frac{GS}{G+S} = \frac{0.05 \times 120}{10} = 0.6\,\Omega$

70. (c) $r = \frac{(l_1 - l_2)}{l_2} \times R' = \left(\frac{60-50}{50}\right) \times 6 = 1.2\,\Omega$

71. (d) By using $\frac{i}{i_g} = 1 + \frac{G}{S}$

$\Rightarrow \frac{i}{100 \times 10^{-3}} = 1 + \frac{1000}{S} \Rightarrow S = \frac{1000}{9} = 111\Omega$

72. (c) Potential gradient $x = \frac{V}{L} = \frac{e}{(R + R_h + r)} \cdot \frac{R}{L}$

$\Rightarrow 2.2 \times 10^{-3} = \frac{2.2}{(10 + R_h)} \times 1 \Rightarrow R' = 990\,\Omega$

73. (a) $\frac{i}{i_g} = \frac{G+S}{S} \Rightarrow \frac{i_g}{i} = \frac{S}{G+S} = \frac{2.5}{27.5} = \frac{1}{11}$

74. (c) Total resistance of the circuit $= \frac{80}{2} + 20 = 60\,\Omega$

$\Rightarrow$ Main current $i = \frac{2}{60} = \frac{1}{30} A$

Combination of voltmeter and 80Ω resistance is connected in series with 20Ω, so current through 20Ω and this combination will be same $= \frac{1}{30} A$.

Since the resistance of voltmeter is also 80Ω, so this current is equally distributed in 80Ω resistance and voltmeter (*i.e.* $\frac{1}{60} A$ through each)

P.D. across 80Ω resistance $= \frac{1}{60} \times 80 = 1.33\, V$

75. (a) Potential gradient $x = \frac{V}{L} = \frac{iR}{L} = \frac{i\left(\frac{\rho L}{A}\right)}{L} = \frac{i\rho}{A}$

76. (d) Here $n = \frac{10}{2} = 5$

$\therefore R = (n-1)G = (5-1)2000 = 8000\,\Omega$

77. (b) $r = \left(\frac{l_1 - l_2}{l_1}\right) R = 0.5\,\Omega$.

78. (a)

79. (b) $V = i.R. = \frac{e}{(R + R_h + r)} . R \Rightarrow 10^{-3} = \frac{2}{(10 + R + r)} \times 10$

$\Rightarrow R = 19{,}989\Omega$.

80. (a)

81. (c) $2R > 20 \Rightarrow R > 10\Omega$.

82. (c) $\frac{i}{i_g} = 1 + \frac{G}{S} \Rightarrow \frac{4}{1} = 1 + \frac{R}{S} \Rightarrow S = \frac{R}{3}$.

83. (a) When ammeter is connected in parallel to the circuit, net resistance of the circuit decreases. Hence more current is drawn from the battery, which damages the ammeter.

84. (a) $r = \left(\frac{l_1 - l_2}{l_2}\right) \times R' \Rightarrow r = \left(\frac{55-50}{50}\right) \times 10 = 1\Omega$.

85. (b) $R = \frac{V}{i_g} - G = \frac{18}{3 \times 10^{-3}} - 12 = 5988\,\Omega$

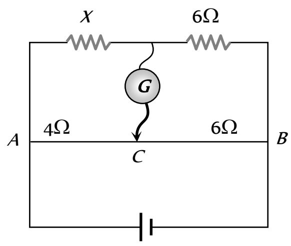
86. (d)

87. (c) $R = \frac{V}{i_g} - G = \frac{6}{6 \times 10^{-3}} - 25 = 975\Omega$ (In series).

88. (d) $i_g = i\frac{S}{G+S} \Rightarrow 0.01 = 10\frac{S}{25+S}$

$\Rightarrow 1000S = 25 + S \Rightarrow S = \frac{25}{999}\Omega$.

89. (c)



Resistance of the part AC

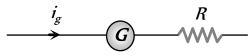
$R_{AC} = 0.1 \times 40 = 4\Omega$ and $R_{CB} = 0.1 \times 60 = 6\Omega$

In balanced condition $\frac{X}{6} = \frac{4}{6} \Rightarrow X = 4\Omega$

Equivalent resistance $R_{eq} = 5\Omega$ so current drawn from battery $i = \frac{5}{5} = 1A$.

90. (a) $(R+G)i_g = V \Rightarrow (R+G) = \frac{V}{i_g}$

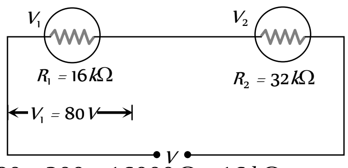
$= \frac{3}{30 \times 16 \times 10^{-6}} = 6.25k\Omega$



$\therefore$ Value of R is nearly equal to $6k\Omega$

This is connected in series in a voltmeter.

91. (d)



$R_1 = 80 \times 200 = 16000\,\Omega = 16\,k\Omega$

Current flowing through V_1 = Current flowing through V_2 = $\frac{80}{16 \times 10^3} = 5 \times 10^{-3} A$.

So, potential differences across V_2 is

$V_2 = 5 \times 10^{-3} \times 32 \times 10^3 = 160$ volt

Hence, line voltage $V = V_1 + V_2 = 80 + 160 = 240V$.

92. (d) $V = xl \Rightarrow iR = xl$

$\Rightarrow i \times 10 = \left(\frac{2 \times 10^{-3}}{10^{-2}}\right) \times 50 \times 10^{-2} = 0.1$

$\Rightarrow i = 10 \times 10^{-3} A = 10\, mA$.

93. (d) $E = \frac{e}{(R + R_h + r)} \frac{R}{L} \times l = \frac{2}{(10 + 40 + 0)} \times \frac{10}{1} \times 0.4 = 0.16V$.

94. (c) $\frac{i}{i_g}=1+\frac{G}{S} \Rightarrow \frac{5}{2}=1+\frac{12}{S} \Rightarrow S=8\Omega$. (In parallel).

95. (d) $\frac{i_g}{i}=\frac{S}{G+S} \Rightarrow \frac{5}{100}=\frac{S}{G+S} \Rightarrow S=\frac{G}{19}$

96. (a) $R=G(n-1)=50\times10^3(3-1)=10^5\,\Omega$.

97. (c) $\frac{E_1}{E_2}=\frac{l_1+l_2}{l_1-l_2}=\frac{58+29}{58-29}=\frac{3}{1}$

98. (a) $R=\frac{V}{i_g}-G=\frac{10}{10\times10^{-3}}-1=999\Omega$.

99. (d) For conversion of galvanometer (of resistances) into voltmeter, a resistance R is connected in series.

$\therefore\ i_g=\frac{V_1}{R+G}$ and $i_g=\frac{V_2}{2R+G}$

$$\Rightarrow \frac{V_1}{R+G}=\frac{V_2}{2R+G} \Rightarrow \frac{V_2}{V_1}=\frac{2R+G}{R+G}=\frac{2(R+G)-G}{(R+G)}$$

$$=2-\frac{G}{(R+G)} \Rightarrow V_2=2V_1-\frac{V_1G}{(R+G)} \Rightarrow V_2<2V_1$$

100. (d) If the voltmeter is ideal then given circuit is an open circuit, so reading of voltmeter is equal to the e.m.f. of cell *i.e.*, 6 *V*.

101. (c) $\frac{i_g}{i}=\frac{S}{G+S}=\frac{4}{36+4}=\frac{1}{10}$ *i.e.* 10%.

102. (d) After connecting a resistance R in parallel with voltmeter its effective resistance decreases. Hence less voltage appears across it *i.e.* V will decreases. Since overall resistance decreases so more current will flow *i.e.* A will increase.

103. (c) Potential gradient $x=\frac{e}{(R+R_h+r)}\cdot\frac{R}{L}$

$$\Rightarrow \frac{10^{-3}}{10^{-2}}=\frac{2}{(3+R_h+0)}\times\frac{3}{1} \Rightarrow R_h=57\Omega.$$

104. (c) $\frac{i}{i_g}=1+\frac{G}{S} \Rightarrow \frac{1}{10^{-3}}=1+\frac{20}{S} \Rightarrow S=\frac{20}{999}\approx 0.02\Omega$.

105. (a) Resistance of voltmeter should be high.

106. (c) If ammeter is used in place of voltmeter (*i.e.* in parallel) it may damage due to large current in circuit. Hence to control this large amount of current a high resistance must be connected in series.

107. (c) Potential gradient $x=\frac{e}{(R+R_h+r)}\cdot\frac{R}{L}$

$$=\frac{3}{(20+10+0)}\times\frac{20}{10}=0.2$$

108. (d) $\frac{E_1}{E_2}=\frac{l_1+l_2}{l_1-l_2}=\frac{(6+2)}{(6-2)}=\frac{2}{1}$

109. (c) Manganin or constantan are used for making the potentiometer wire.

110. (a)

111. (a) $\frac{i}{i_g}=1+\frac{G}{S} \Rightarrow \frac{i.G}{V_g}=1+\frac{G}{S} \Rightarrow \frac{100\times10^{-3}\times40}{800\times10^{-3}}=1+\frac{40}{S}$

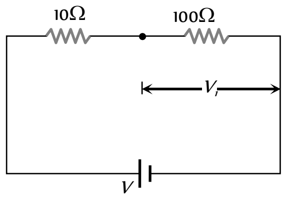
$\Rightarrow S=10\Omega$.

112. (a) $i_g=i\frac{S}{G+S} \Rightarrow 10\times10^{-3}=\frac{S}{100+S}\times100\times10^{-3}$

$$90\,S=1000 \Rightarrow S=\frac{1000}{90}=11.11\,\Omega.$$

113. (c) Before connecting the voltmeter, potential difference across 100Ω resistance

$$V_i=\frac{100}{(100+10)}\times V=\frac{10}{11}V$$

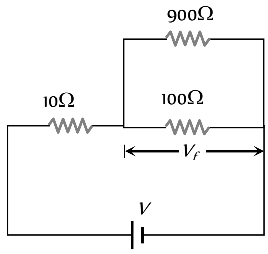


Finally after connecting voltmeter across 100Ω
Equivalent resistance

$$\frac{100\times900}{(100+900)}=90\Omega$$

Final potential difference

$$V_f=\frac{90}{(90+10)}\times V=\frac{9}{10}V$$



% error = $\frac{V_i-V_f}{V_i}\times100$

$$=\frac{\frac{10}{11}V-\frac{9}{10}V}{\frac{10}{11}V}\times100=1.0.$$

114. (b) Potential gradient = $\frac{e.R}{(R+r).L}=\frac{10\times3}{(3+3)\times5}$.

$=1V/m=10\,mV/cm$.

115. (c) $\frac{i}{i_g}=1+\frac{G}{S} \Rightarrow \frac{1}{10^{-5}}=1+\frac{100}{S} \Rightarrow S\approx\frac{100}{10^5}=10^{-3}\Omega$.

116. (d) $\frac{i_g}{i}=\frac{S}{G+S}=\frac{4}{36+4}=\frac{4}{40}=\frac{1}{10}$

117. (a) $i=\frac{V}{R} \Rightarrow 2=\frac{6}{\frac{6\times3}{6+3}+R}=\frac{6}{2+R} \Rightarrow R=1\ \Omega$.

118. (b) $i_g=i\frac{S}{G+S} \Rightarrow \frac{0.01}{10}=\frac{5}{50+S} \Rightarrow S=\frac{50}{999}=0.05\Omega$.

119. (d) $S=\left(\frac{100-l}{l}\right).R$

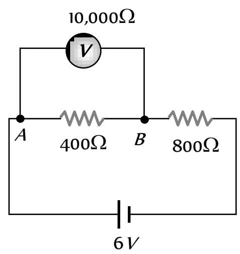
Initially, $30=\left(\frac{100-l}{l}\right)\times10 \Rightarrow l=25cm$

Finally, $10=\left(\frac{100-l}{l}\right)\times30 \Rightarrow l=75cm$

So, shift = 50*cm*.

120. (c) Potential gradient (x) $=\frac{i\rho}{A}=\frac{0.1\times10^{-7}}{10^{-6}}=10^{-2}\ V/m$

121. (d) Before connecting voltmeter potential difference across 400Ω resistance is



$$V_i = \frac{400}{(400+800)} \times 6 = 2V$$

After connecting voltmeter equivalent resistance between A and $B = \frac{400 \times 10{,}000}{(400+10{,}000)} = 384.6\Omega$

Hence, potential difference measured by voltmeter $V_f = \frac{384.6}{(384.6+800)} \times 6 = 1.95V$

Error in measurement = $V_i - V_f = 2 - 1.95$ = 0.05V.

122. (c) $\frac{i}{i_g} = 1 + \frac{G}{S} \Rightarrow \frac{5}{0.05} = 1 + \frac{50}{S}$

$\Rightarrow S = \frac{50}{99} = \frac{\rho \times l}{A} \Rightarrow l = \frac{50}{99} \times \frac{2.97 \times 10^{-2} \times 10^{-4}}{5 \times 10^{-7}} = 3m$.

123. (a) $\frac{i}{i_g} = 1 + \frac{G}{S} \Rightarrow \frac{10}{1} = 1 + \frac{0.81}{S} \Rightarrow S = 0.09\Omega$.

124. (a) From the principle of potentiometer $V \propto l$

$\Rightarrow \frac{V}{E} = \frac{l}{L}$; where V = emf of battery, E = emf of standard cell, L = Length of potentiometer wire

$V = \frac{El}{L} = \frac{30E}{100}$.

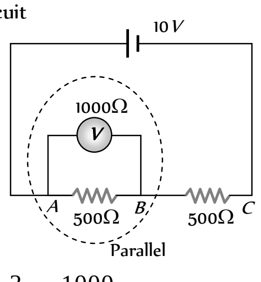
125. (b) $E = \frac{e}{(R+R_h+r)} \cdot \frac{R}{L} \times l$

$\Rightarrow 10 \times 10^{-3} = \frac{2}{(10+R+0)} \times \frac{10}{1} \times 0.4 \Rightarrow R = 790\Omega$

126. (b) Using $r = R\left(\frac{l_1}{l_2} - 1\right) = 2\left(\frac{150}{100} - 1\right) = 1\Omega$

127. (d) Resistance between A and $B = \frac{1000 \times 500}{(1500)} = \frac{1000}{3}$

So, equivalent resistance of the circuit



$R_{eq} = 500 + \frac{1000}{3} = \frac{2500}{3}$

$\therefore$ Current drawn from the cell

$i = \frac{10}{(2500/3)} = \frac{3}{250} A$

Reading of voltmeter *i.e.*

potential difference across $AB = \frac{3}{250} \times \frac{1000}{3} = 4\ V$

128. (d) $i_g = \frac{i}{10} \Rightarrow$ Required shunt $S = \frac{G}{(n-1)} = \frac{90}{(10-1)} = 10\ \Omega$

129. (b) $i_g = \frac{50}{10 \times 10^{-3}} - 40 = 4960\ \Omega$

130. (c) Post office box is based on the principle of Wheatstone's bridge

131. (d) Full deflection current $i_g = 25 \times 4 \times 10^{-4} = 100 \times 10^{-4} A$

Using $R = \frac{V}{I_g} - G = \frac{25}{100 \times 10^{-4}} - 50 = 2450\ \Omega$ in series.

132. (a) In balancing condition, $\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{l_1}{100 - l_1}$

$\Rightarrow \frac{X}{Y} = \frac{20}{80} = \frac{1}{4}$ .....(i)

and $\frac{4X}{Y} = \frac{l}{100 - l}$ .....(ii)

$\Rightarrow \frac{4}{4} = \frac{l}{100 - l} \Rightarrow l = 50\ cm$

133. (c)

134. (d) $S = \left(\frac{i_g}{i - i_g}\right) \times G = \frac{100 \times 10^{-6}}{(10 \times 10^{-3} - 100 \times 10^{-6})} \times 50 \approx 0.5\ \Omega$ (in parallel)

135. (d) $E = \frac{e}{(R+R_h+r)} \cdot \frac{R}{L} \times l \Rightarrow 0.4 = \frac{5}{(5+45+0)} \times \frac{5}{10} \times l$

$\Rightarrow l = 8\ m$

136. (a) Potential difference per unit length $= \frac{V}{L} = \frac{2}{4} = 0.5\ V/m$

137. (a)

138. (b) $r = R\left(\frac{l_1}{l_2} - 1\right) = 2\left(\frac{240}{120} - 1\right) = 2\Omega$

139. (d) $E = \frac{V}{l}$; E is constant (volt. gradient).

$\Rightarrow \frac{V_1}{l_1} = \frac{V_2}{l_2} \Rightarrow \frac{1.1}{140} = \frac{V}{180} \Rightarrow V = \frac{180 \times 1.1}{140} = 1.41\,V$

140. (a) $I_G \times G = (I - I_G)S \Rightarrow I = \left(1 + \frac{G}{S}\right) I_G \Rightarrow I = 100.1\ mA$

141. (c) Let S be larger and R be smaller resistance connected in two gaps of meter bridge.

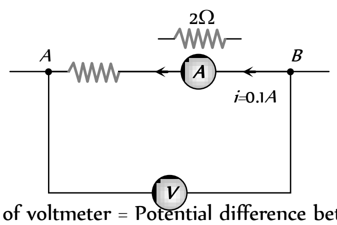
$\therefore S = \left(\frac{100 - l}{l}\right) R = \frac{100 - 20}{20} R = 4R$ .....(i)

When 15Ω resistance is added to resistance R, then

$S = \left(\frac{100 - 40}{40}\right)(R + 15) = \frac{6}{4}(R + 15)$ .... (ii)

From equations (i) and (ii) $R = 9\Omega$

142. (a) According to following figure



Reading of voltmeter = Potential difference between A and $B = i\ (R + 2) \Rightarrow 12 = 0.1\ (R + 2) \Rightarrow R = 118\ \Omega$.

143. (a) Potential gradient $x = \frac{e}{(R+R_h+r)} \cdot \frac{R}{L}$

$\Rightarrow \frac{0.2 \times 10^{-3}}{10^{-2}} = \frac{2}{(R+490+0)} \times \frac{R}{1} \Rightarrow R = 4.9\ \Omega$.

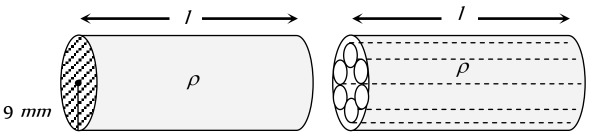
Critical Thinking Questions

1. (a) Initially : Resistance of given cable

$$R = \rho \frac{l}{\pi \times (9 \times 10^{-3})^2}$$ ....(i)

Finally : Resistance of each insulated copper wire is

$R' = \rho \frac{l}{\pi \times (3 \times 10^{-3})^2}$. Hence equivalent resistance of cable $R_{eq} = \frac{R'}{6} = \frac{1}{6} \times \left(\rho \frac{l}{\pi \times (3 \times 10^{-3})^2} \right)$ ....(ii)



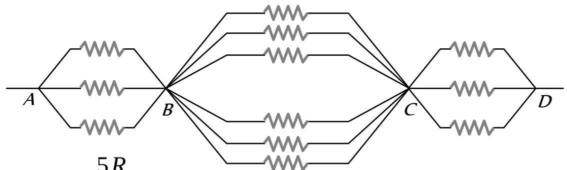
On solving equation (i) and (ii) we get $R = 7.5\ \Omega$

2. (a) $\frac{R_A}{R_B} = \left(\frac{r_B}{r_A}\right)^4 \Rightarrow \frac{R_A}{R_B} = \left(\frac{1}{2}\right)^4 = \frac{1}{16} \Rightarrow R_B = 16R_A$

When R_A and R_B are connected in parallel then equivalent resistance $R_{eq} = \frac{R_A R_B}{(R_A + R_B)} = \frac{16}{17} R_A$

If $R_A = 4.25\Omega$ then $R_{eq} = 4\Omega$ *i.e.* option (a) is correct.

3. (c) The given circuit can be simplified as follows



$\therefore R_{AD} = \frac{5R}{6}$

4. (c) Suppose *n* resistors are used for the required job. Suppose equivalent resistance of the combination is *R'* and according to energy conservation it's current rating is *i'*.

Energy consumed by the combination = *n* × (Energy consumed by each resistance)

$\Rightarrow i'^2 R' = n \times i^2 R \Rightarrow n = \left(\frac{i'}{i}\right)^2 \times \left(\frac{R'}{R}\right) = \left(\frac{4}{1}\right)^2 \times \left(\frac{5}{10}\right) = 8$

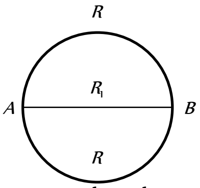
5. (c) Resistance across $AB = \frac{1}{R'} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R_1}$

$R_1 = 2 \times 10^{-6}\Omega$

and $R = \pi \times 1 \times 10^{-6}\Omega$

On solving,

$R' = 0.88 \times 10^{-6}\Omega$



6. (b) No current flows through the capacitor branch in steady state. Total current supplied by the battery

$i = \frac{6}{2.8 + 1.2} = \frac{3}{2}$.

Current through 2 Ω resistor $= \frac{3}{2} \times \frac{3}{5} = 0.9A$

7. (d) At time $t = 0$ *i.e.* when capacitor is charging, current $i = \frac{2}{1000} = 2mA$

When capacitor is full charged, no current will pass through it, hence current through the circuit $i = \frac{2}{2000} = 1mA$

8. (d) Current in the bulb $= \frac{P}{V} = \frac{4.5}{1.5} = 3A$

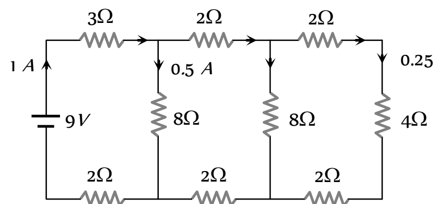
Current in 1 Ω resistance $= \frac{1.5}{1} = 1.5A$

Hence total current from the cell $i = 3 + 1.5 = 4.5A$

By using $E = V + ir \Rightarrow E = 1.5 + 4.5 \times (2.67) = 13.5V$

9. (d) Equivalent resistance of the circuit $R = 9\Omega$

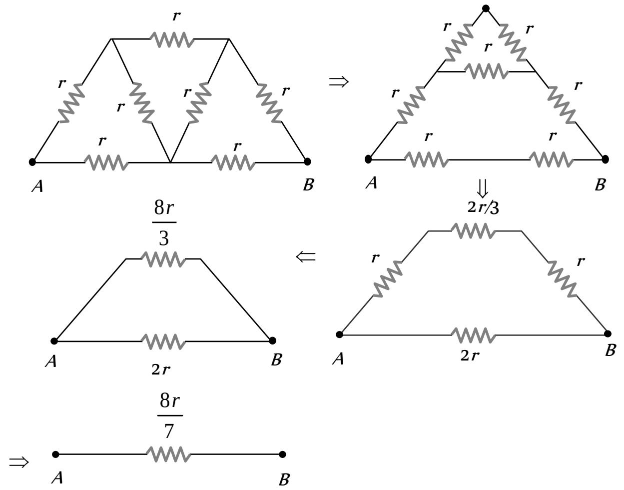
$\therefore$ Main current $i = \frac{V}{R} = \frac{9}{9} = 1A$



After proper distribution, the current through 4Ω resistance is 0.25 *A*.

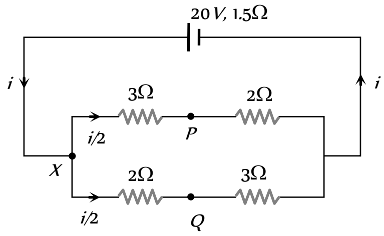
10. (b) Maximum number of resistance $= 2^{n-1} = 2^{3-1} = 4$

11. (d) The given circuit can be simplified as follows.



12. (d) $R_{eq} = \frac{5}{2}\Omega$

$i = \frac{20}{\frac{5}{2} + 1.5} = 5A$



Potential difference between *X* and *P*,

$V_X - V_P = \left(\frac{5}{2}\right) \times 3 = 7.5V$ ....(i)

$V_X - V_Q = \frac{5}{2} \times 2 = 5V$ ...(ii)

On solving (i) and (ii) $V_P - V_Q = -2.5\, volt; V_Q > V_P$.

Short Trick : $(V_P - V_Q) = \frac{i}{2}(R_2 - R_1) = \frac{5}{2}(2-3) = -2.5$

$\Rightarrow V_Q > V_P$

13. (c) $R_{t_1} = R_1(1+\alpha_1 t)$ and $R_{t_2} = R_2(1+\alpha_2 t)$

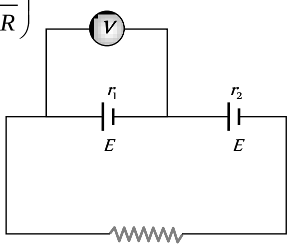
Also $R_{eq.} = R_{t_1} + R_{t_2} \Rightarrow R_{eq} = R_1 + R_2 + (R_1\alpha_1 + R_2\alpha_2)t$

$\Rightarrow R_{eq} = (R_1 + R_2)\left\{1 + \left(\frac{R_1\alpha_1 + R_2\alpha_2}{R_1 + R_2}\right).t\right\}$

So $\alpha_{eff} = \frac{R_1\alpha_1 + R_2\alpha_2}{R_1 + R_2}$

14. (b) Let the voltage across any one cell is V, then

$V = E - ir = E - r_1\left(\frac{2E}{r_1 + r_2 + R}\right)$



But $V = 0$

$\Rightarrow E - \frac{2Er_1}{r_1 + r_2 + R} = 0$

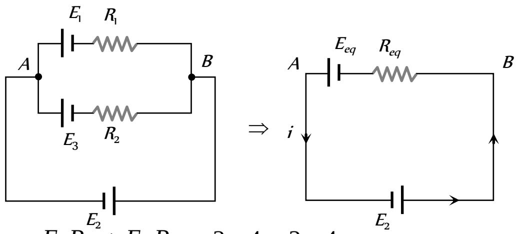
$\Rightarrow r_1 + r_2 + R = 2r_1$

$\Rightarrow R = r_1 - r_2$

15. (b) Emf $E = 5V$, Internal resistance $r = \frac{5}{10} = 0.5\Omega$

Current through the resistance $i = \frac{5}{(2+0.5)} = 2A$

16. (b) The given circuit can be redrawn

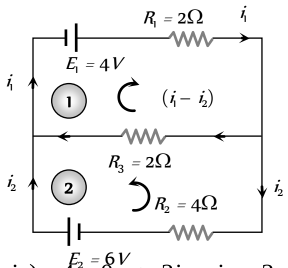


$E_{eq} = \frac{E_1R_2 + E_2R_1}{R_1 + R_2} = \frac{2\times4 + 2\times4}{4+4} = 2V$ and

$R_{eq} = \frac{4}{2} = 2\Omega$. Current $i = \frac{2+2}{2} = 2A$ from A to B through E.

17. (b) Applying Kirchhoff's law for the loops (1) and (2) as shown in figure

For loop (1)



$-2i_1 - 2(i_1 - i_2) + 4 = 0 \Rightarrow 2i_1 - i_2 = 2$ ...(i)

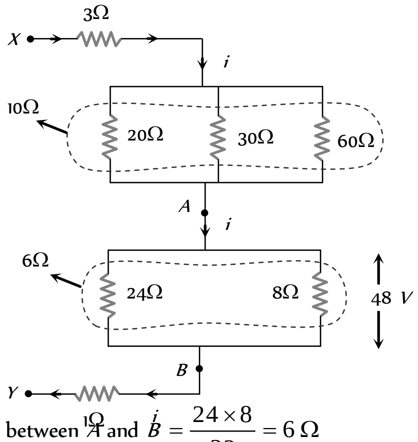
For loop (2)

$-2(i_1 - i_2) + 4i_2 - 6 = 0 \Rightarrow -i_1 + 3i_2 = 3$ ...(ii)

On solving equation (i) and (ii) $i_1 = 1.8A$.

18. (b) To convert a galvanometer into an ammeter, a shunt $S = \frac{I_g}{I - I_g}G$ is connected in parallel with it. To convert a galvanometer into a voltmeter, a resistance $R = \frac{V}{I_g} - G$ is connected in series with it.

19. (a) The given circuit can be redrawn as follows



Resistance between A and B $= \frac{24\times8}{32} = 6\,\Omega$

Current between A and B = Current between X and Y $= i = \frac{48}{6} = 8A$

Resistance between X and $Y = (3+10+6+1) = 20\,\Omega$

$\Rightarrow$ Potential difference between X and $Y = 8 \times 20 = 160\ V$

20. (d) $R_1 + R_2 = R_1(1+\alpha t) + R_2(1-\beta t)$

$\Rightarrow R_1 + R_2 = R_1 + R_2 + R_1\alpha t - R_2\beta t \Rightarrow \frac{R_1}{R_2} = \frac{\beta}{\alpha}$

21. (d) Current density of drifting electrons $j = nev$

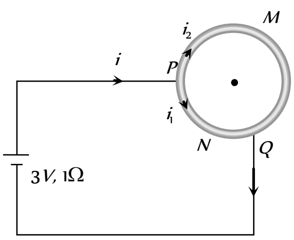
$n = 5\times10^7 cm^{-3} = 5\times10^7\times10^6 m^{-3}$.

$v = 0.4ms^{-1}, e = 1.6\times10^{-19}C \Rightarrow j = 3.2\times10^{-6}Am^{-2}$

Current density of ions $= (4 - 3.2) \times 10^{-6} = 0.8\times10^{-6}\ \frac{A}{m^2}$

This gives v for ions $= 0.1\ ms^{-1}$.

22. (a) In the following figure



Resistance of part PNQ;

$R_1 = \frac{10}{4} = 2.5\Omega$ and

Resistance of part PMQ;

$R_2 = \frac{3}{4}\times10 = 7.5\Omega$

$R_{eq} = \frac{R_1R_2}{R_1 + R_2} = \frac{2.5\times7.5}{(2.5+7.5)} = \frac{15}{8}\Omega$.

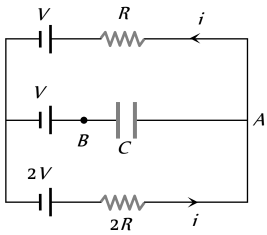
Main Current $i = \frac{3}{\frac{15}{8}+1} = \frac{24}{23}A$

So, $i_1 = i\times\left(\frac{R_2}{R_1 + R_2}\right) = \frac{24}{23}\times\left(\frac{7.5}{2.5+7.5}\right) = \frac{18}{23}A$

and $i_2 = i - i_1 = \frac{24}{23} - \frac{18}{23} = \frac{6}{23} A$.

23. (c) As I is independent of R_6, no current flows through R_6 this requires that the junction of R_1 and R_2 is at the same potential as the junction of R_3 and R_4. This must satisfy the condition $\frac{R_1}{R_2} = \frac{R_3}{R_4}$, as in the Wheatstone bridge.

24. (c) Moving anticlockwise from A



$-iR - V + 2V - 2iR = 0$

or $3iR = V$ or $i = \frac{V}{3R}$

$V_A - V_B = iR + V - V = iR$

$\Rightarrow$ Potential drop across $C = \frac{V}{3}$

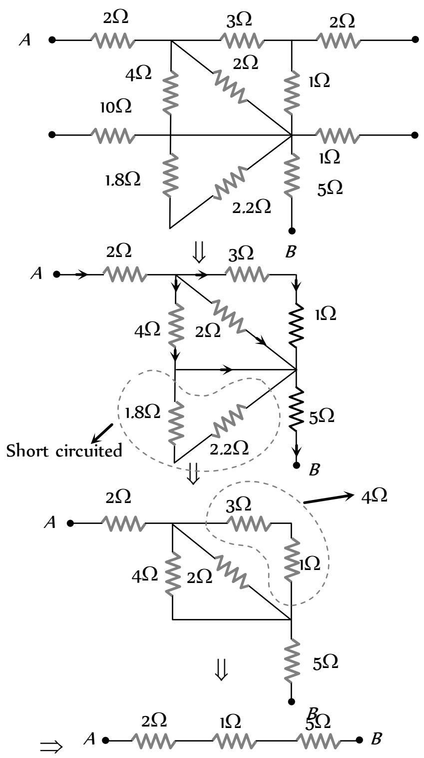
25. (b) Let R and m be the resistance and mass of the first wire, then the second wire has resistance $2R$ and mass $2m$. Let E = emf of each cell, S = specific heat capacity of the material of the wire.

For the first wire, current $i_1 = \frac{3E}{R}$ and $i_1^2 Rt = mS\Delta T$

For the second wire, $i_2 = \frac{NE}{2R}$ and $i_2^2(2R)t = 2mS\Delta T$.

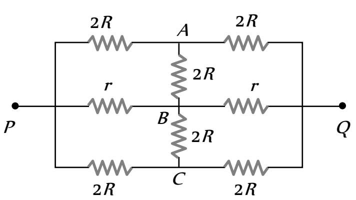
Thus, $i_1 = i_2$ or $N = 6$.

26. (b)



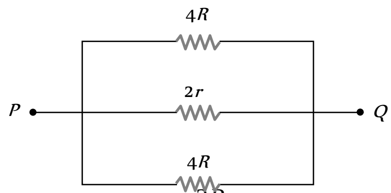
$R_{AB} = 8\Omega$.

27. (a)



In a circuit, any circuit element placed between points at the same potential can be removed, without affecting the rest of the circuit. Here, by symmetry, points A, B and C are at same potential, for any potential difference between P and Q.

The circuit can therefore be reduced as shown below



Effective resistance $R_{eq} = \frac{2Rr}{R+r}$.

28. (d) Potential difference between A and B

$V_A - V_B = 1 \times 1.5$

$\Rightarrow V_A - 0 = 1.5V \Rightarrow V_A = 1.5V$

Potential difference between B and C

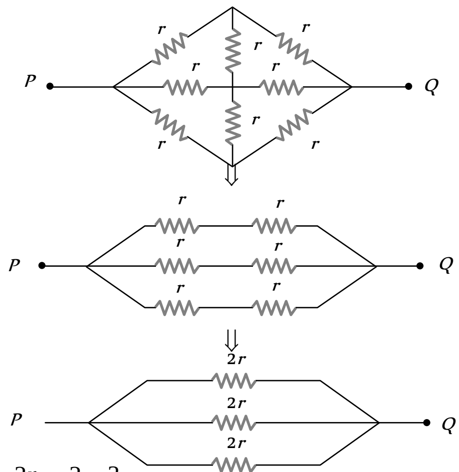
$V_B - V_C = 1 \times 2.5 = 2.5V$

$\Rightarrow 0 - V_C = 2.5V \Rightarrow V_C = -2.5V$

Potential difference between C and D

$V_C - V_D = -2V \Rightarrow -2.5 - V_D = -2 \Rightarrow V_D = -0.5V$.

29. (b) The given circuit can be simplifies as follows



$R' = \frac{2r}{3} = \frac{2}{3} \times \frac{3}{2} = 1\Omega$.

30. (b) $dQ = Idt \Rightarrow Q = \int_{t=2}^{t=3} Idt = \left[2\int_2^3 t\,dt + 3\int_2^3 t^2 dt\right]$

$= \left[t^2\right]_2^3 + \left[t^3\right]_2^3 = (9-4) + (27-8) = 5 + 19 = 24C$.

31. (d) $i = \frac{E_1 + E_2 + E_3 + ... + E_n}{(r_1 + r_2 + r_3 + ... + r_n)}$

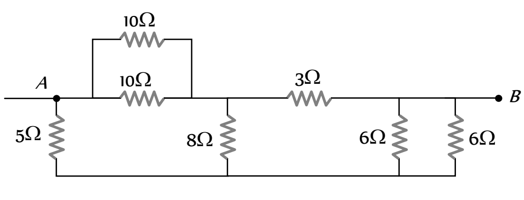
$= \frac{1.5(r_1 + r_2 + r_3 + ... + r_n)}{(r_1 + r_2 + r_3 + ... + r_n)} = 1.5A$.

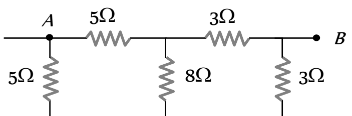
32. (a) Balancing length is independent of the cross sectional area of the wire.

33. (a) $\frac{R_1}{R_2} = \frac{(1+\alpha t_1)}{(1+\alpha t_2)} \Rightarrow \frac{10}{R_2} = \frac{(1+5\times10^{-3}\times20)}{(1+5\times10^{-3}\times120)} \Rightarrow R_2 \approx 15\Omega$

Also $\frac{i_1}{i_2} = \frac{R_2}{R_1} \Rightarrow \frac{30}{i_2} = \frac{15}{10} \Rightarrow i_2 = 20\,mA$

34. (b) The given circuit can be simplified as follows

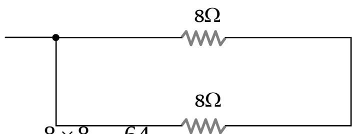




⇒

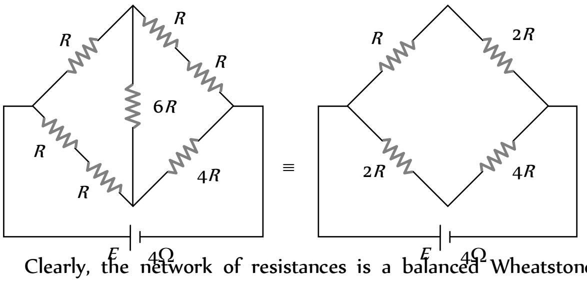
Now it is a balance Wheatstone bridge.

So,



$\Rightarrow R_{AB} = \frac{8 \times 8}{8+8} = \frac{64}{16} = 4\Omega$

35. (c) The equivalent network is

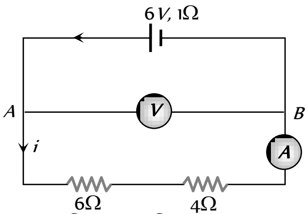


Clearly, the network of resistances is a balanced Wheatstone bridge. So R_{AB} is given by

$\frac{1}{R_{AB}} = \frac{1}{3R} + \frac{1}{6R} = \frac{2+1}{6R} = \frac{1}{2R} \Rightarrow R_{AB} = 2R$

For maximum power transfer $2R = 4\Omega \Rightarrow R = \frac{4}{2} = 2\Omega$

36. (c) The given circuit can be redrawn as follows



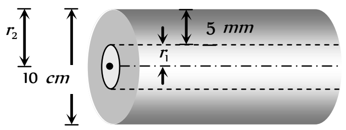
Current $i = \frac{6}{6+4+1} = \frac{6}{11} A$

P.D. between *A* and *B*, $V = \frac{6}{11} \times 10 = \frac{60}{11} V$.

37. (a) By using $R = \rho . \frac{l}{A}$; here $A = \pi(r_2^2 - r_1^2)$

Outer radius $r_2 = 5cm$

Inner radius $r_1 = 5 - 0.5 = 4.5\ cm$



So $R = 1.7 \times 10^{-8} \times \frac{5}{\pi\{(5 \times 10^{-2})^2 - (4.5 \times 10^{-2})^2\}}$

$= 5.6 \times 10^{-5}\Omega$

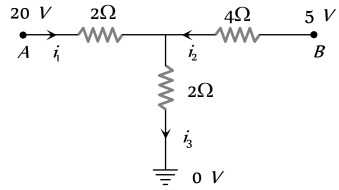
38. (a) Here $R_{XWY} = \frac{R}{2\pi r} \times (r\alpha) = \frac{R\alpha}{2\pi}$ $\left(\because \alpha = \frac{l}{r}\right)$

and $R_{XZY} = \frac{R}{2\pi r} \times r(2\pi - \alpha) = \frac{R}{2\pi}(2\pi - \alpha)$

$$R_{eq} = \frac{R_{XWY} R_{XZY}}{R_{XWY} + R_{XZY}} = \frac{\frac{R\alpha}{2\pi} \times \frac{R}{2\pi}(2\pi - \alpha)}{\frac{R\alpha}{2\pi} + \frac{R(2\pi - \alpha)}{2\pi}} = \frac{R\alpha}{4\pi^2}(2\pi - \alpha)$$

39. (d) Battery is short circuited so potential difference is zero.

40. (a) Let *V* be the potential of the junction as shown in figure. Applying junction law, we have



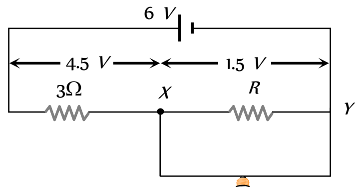
or $\frac{20 - V}{2} + \frac{5 - V}{4} = \frac{V - 0}{2}$

or $40 - 2V + 5 - V = 2V$ or $5V = 45 \Rightarrow V = 9V$

$\therefore i_3 = \frac{V}{2} = 4.5A$

41. (a) $E = x\,l = i\rho\,l \Rightarrow i = \frac{E}{\rho l} = \frac{E}{\rho l} = \frac{2.4 \times 10^{-3}}{1.2 \times 5} = 4 \times 10^{-4} A$.

42. (b) When bulb glows with full intensity, then voltage across it will be 1.5 *V* and voltage across 3 Ω resistance will be 4.5 *V*.



Current through 3 Ω resistance $i = \frac{4.5}{3} = 1.5A$

Same current will flow between *X* and *Y*

So $V_{XY} = iR_{XY} \Rightarrow 1.5 = 1.5R_{XY} \Rightarrow R_{XY} = 1\Omega$

43. (a) In figure (b) current through $R_2 = i - \frac{i}{10} = \frac{9i}{10}$

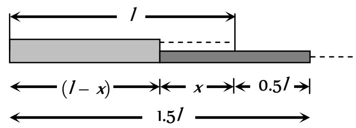
Potential difference across R_2 = Potential difference across *R*

$\Rightarrow R_2 \times \frac{9}{10} i = R \times \frac{i}{10}$ *i.e.* $R_2 = \frac{R}{9} = \frac{11}{9}\Omega$

$$R_{eq} = \frac{R_2 \times R}{(R_2 + R)} = \frac{\frac{11}{9} \times \frac{11}{1}}{\frac{11}{9} + \frac{11}{1}} = \frac{11}{10}\Omega$$

Total circuit resistance $= \frac{11}{10} + R_1 = R = 11 \Rightarrow R_1 = 9.9\Omega$

44. (a) Let *l* be the original length of wire and *x* be its length stretched uniformly such that final length is 1.5 *l*



Then $4R = \rho\frac{(l - x)}{A} + \rho\frac{(0.5l + x)}{A'}$ where $A' = \frac{x}{(0.5l + x)} A$

$\therefore\ 4\rho\frac{l}{A}=\rho\frac{l-x}{A}+\rho\frac{(0.5l+x)^2}{xA}$

or $4l=l-x+\frac{1}{4}\frac{l^2}{x}+\frac{x^2}{x}+\frac{lx}{x}$ or $\frac{x}{l}=\frac{1}{8}$

45. (b) In series : Potential difference $\propto R$

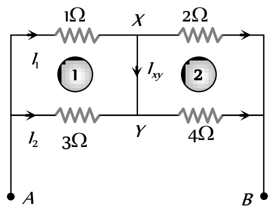
When only S_1 is closed $V_1=\frac{3}{4}E=0.75E$

When only S_2 is closed $V_2=\frac{6}{7}E=0.86E$

and when both S_1 and S_2 are closed combined resistance of $6R$ and $3R$ is $2R$

$\therefore\quad V_3=\left(\frac{2}{3}\right)E=0.67E \Rightarrow V_2>V_1>V_3$

46. (c)



$-i_1+0\times i_{xy}+3i_2=0$ *i.e.* $i_1=3i_2$ ......(i)

Also $-2(i_1-i_{xy})+4(i_2+i_{xy})=0$

i.e. $2i_1-4i_2=6i_{xy}$ ....(ii)

Also $V_{AB}-1\times i_1-2(i_1-i_{xy})=0 \Rightarrow 50=i_1+2(i_1-i_{xy})$

$=3i_1-2i_{xy}$ .... (iii)

Solving (i), (ii) and (iii), $i_{xy}=2A$

47. (b) Let n be the number of wrongly connected cells.

Number of cells helping one another $=(12-n)$

Total e.m.f. of such cells $=(12-n)E$

Total e.m.f. of cells opposing $=nE$

Resultant e.m.f. of battery $=(12-n)E-nE=(12-2n)E$

Total resistance of cells $=12r$

($\because$ resistance remains same irrespective of connections of cells)

With additional cells

(a) Total e.m.f. of cells when additional cells help battery $=(12-2n)E+2E$

Total resistance $=12r+2r=14r$

$\therefore\ \frac{(12-2n)E+2E}{14r}=3$ ......(i)

(b) Similarly when additional cells oppose the battery

$\frac{(12-2n)E-2E}{14r}=2$ ......(ii)

Solving (i) and (ii), $n=1$

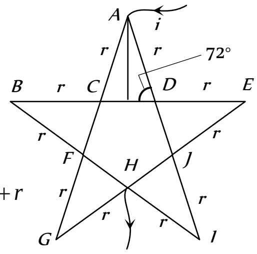
48. (a) All the conductors have equal lengths. Area of cross-section of A is $\{(\sqrt{3}\,a)^2-(\sqrt{2}\,a)^2\}=a^2$

Similarly area of cross-section of B = Area of cross-section of C $=a$

Hence according to formula $R=\rho\frac{l}{A}$; resistances of all the conductors are equal *i.e.* $R_A=R_B=R_C$

49. (b) Resistance of CD arm $=2r\cos 72^\circ=0.62r$

Resistance of CBFC branch



$\frac{1}{R}=\frac{1}{2r}+\frac{1}{0.62r}=\frac{1}{r}\left(\frac{2.62}{2\times 0.62}\right)$

$\frac{1}{R}=\frac{2.62}{1.24r}\qquad \therefore R=\frac{1.24r}{2.62}$

Equivalent $R'=2R+r=2\times\frac{1.24r}{2.62}+r$

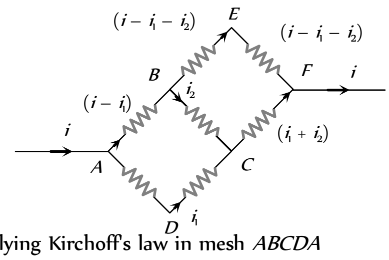
$=r\left(\frac{2.48}{2.62}+1\right)=1.946r$

Because the star circuit is symmetrical about the line AH

$\therefore$ Equivalent resistance between A and H

$\frac{1}{R_{eq}}=\frac{1}{R'}+\frac{1}{R'}\Rightarrow R_{eq}=\frac{R'}{2}=\frac{1.946}{2}r=0.973r$

50. (a)



Applying Kirchoff's law in mesh $ABCDA$

$-10(i-i_1)-10i_2+20i_1=0 \Rightarrow 3i_1-i_2=i$ ....(i)

and in mesh $BEFCB$

$-20(i-i_1-i_2)+10(i_1+i_2)+10i_2=0$

$\Rightarrow\quad 3i_1+4i_2=2i$ ......(ii)

From equation (i) and (ii) $i_1=\frac{2i}{5},i_2=\frac{i}{5}\Rightarrow i_{AD}=\frac{2i}{5}$

51. (d) Let the current in 12 Ω resistance is i

Applying loop theorem in closed mesh $AEFCA$

$12i=-E+E=0 \quad \therefore i=0$

52. (b) Current flowing in the circuit $i=\frac{E}{R}=\frac{10-4}{20+10}=\frac{1}{5}A$

P.D. across $AC=\frac{1}{5}\times 20=4V$

P.D. across $AN=4+4=8V$

53. (a) If two resistances are R_1 and R_2 then

$S=R_1+R_2$ and $P=\frac{R_1R_2}{(R_1+R_2)}$

From given condition $S=nP$ *i.e.* $(R_1+R_2)=n\left(\frac{R_1R_2}{R_1+R_2}\right)$

$\Rightarrow(R_1+R_2)^2=n\ R_1R_2\Rightarrow(R_1-R_2)^2+4R_1R_2=nR_1R_2$

So $n=4+\frac{(R_1-R_2)^2}{R_1R_2}$. Hence minimum value of n is 4.

54. (b) Voltage sensitivity $=\frac{\text{Current sensitivity}}{\text{Resistance of galvanometer G}}$

$\Rightarrow G = \frac{10}{2} = 5\,\Omega$.

Here i_g = Full scale deflection current $= \frac{150}{10} = 15\,mA$.

V = Voltage to be measured = 150 × 1 = 150 V.

Hence $R = \frac{V}{i_g} - G = \frac{150}{15 \times 10^{-3}} - 5 = 9995\,\Omega$.

Graphical Questions

1. (a) For ohmic resistance $V \propto i \Rightarrow V = Ri$ (here R is constant)

2. (d) From the curve it is clear that slopes at points A, B, C, D have following order $A > B > C > D$.
and also resistance at any point equals to slope of the V-i curve.
So order of resistance at three points will be $R_A > R_B > R_C > R_D$

3. (a) Slope of the V-i curve at any point equal to resistance at that point. From the curve slope for T_1 > slope for T_2
$\Rightarrow R_{T_1} > R_{T_2}$. Also at higher temperature resistance will be higher so $T_1 > T_2$

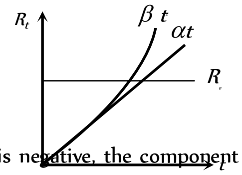
4. (c) For portion CD slope of the curve is negative *i.e.* resistance be negative.

5. (d) Slope of V-i curve $= R\left(= \frac{\rho l}{A}\right)$. But in given curve axis of i and V are interchanged. So slope of given curve $= \frac{1}{R}\left(= \frac{A}{\rho l}\right)$
i.e. with the increase in length of the wire. Slope of the curve will decrease.

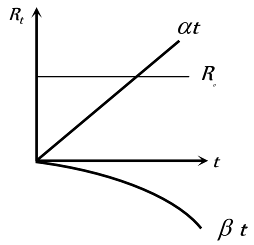
6. (c) $E = \frac{iR}{L} = \frac{i.\rho}{A} = \frac{neAv_d\rho}{A} \Rightarrow v_d \propto E$ (Straight line)
$P = i^2R = \left(\frac{EA}{\rho}\right)^2 R \Rightarrow P \propto E^2$ (Symmetric parabola)
Also $P \propto i^2$ (parabola)
Hence all graphs a, b, d are correct and c is incorrect.

7. (b) When we move in the direction of the current in a uniform conductor, the potential difference decreases linearly. When we pass through the cell, from it's negative to it's positive terminal, the potential increases by an amount equal to it's potential difference. This is less than it's emf, as there is some potential drop across it's internal resistance when the cell is driving current.

8. (b) Since the value of R continuously increases, both α and β must be positive.
Actually the components of the given equation are as follows



It α is positive, β is negative, the component will be shown in the following graph.



In this case, the value of R will not increase continuously. Hence the correct option is (c).

9. (d) Slope of V-i curve = resistance. Hence $R = \frac{1}{1} = 1\Omega$

10. (a) At point A the slope of the graph will be negative. Hence resistance is negative.

11. (b) E.m.f. is the value of voltage, when no current is drawn from the circuit so $E = 2V$. Also r = slope $= \frac{2}{5} = 0.4\Omega$

12. (d) For conversion of a galvanometer into a voltmeter
$\frac{V}{R+G} = i_g \Rightarrow \frac{V}{R_V} = i_g$; where $R_V = R + G$ = Total resistance
$\Rightarrow R_V = \frac{V}{i_g} \Rightarrow R_V \propto V$

13. (a) According to ohm's law $V = iR$
$\Rightarrow \log_e V = \log_e i + \log_e R \Rightarrow \log_e i = \log_e V - \log_e R$
The graph between $\log_e I$ and $\log_e V$ will be a straight line which cut $\log_e V$ axis and it's gradient will be positive.

14. (c) As we know, for conductors resistance ∝ Temperature.
From figure $R_1 \propto T_1 \Rightarrow \tan\theta \propto T_1 \Rightarrow \tan\theta = kT_1$ ... (i)
and $R_2 \propto T_2 \Rightarrow \tan(90° - \theta) \propto T_2 \Rightarrow \cot\theta = kT_2$ ....(ii)
From equation (i) and (ii) $k(T_2 - T_1) = (\cot\theta - \tan\theta)$
$(T_2 - T_1) = \left(\frac{\cos\theta}{\sin\theta} - \frac{\sin\theta}{\cos\theta}\right) = \frac{(\cos^2\theta - \sin^2\theta)}{\sin\theta\cos\theta} = 2\cot 2\theta$
$\Rightarrow (T_2 - T_1) \propto \cot 2\theta$

15. (b) Let resistivity at a distance 'x' from left end be $\rho = (\rho_0 + ax)$. Then electric field intensity at a distance 'x' from left end will be equal to $E = \frac{i\rho}{A} = \frac{i(\rho_0 + ax)}{A}$ where i is the current flowing through the conductor. It means $E \propto \rho$ or E varies linearly with distance 'x'. But at x = 0, E has non-zero value. Hence (b) is correct.

16. (d) At an instant approach the student will choose $\tan\theta$ will be the right answer. But it is to be seen here the curve makes the angle θ with the V-axis. So it makes an angle $(90 - \theta)$ with the i-axis.
So resistance = slope = $\tan(90 - \theta) = \cot\theta$.

17. (d) Short circuited current $i = \frac{nE}{nr} = \frac{E}{r}$ *i.e.* i doesn't depend upon n.

18. (b) Here internal resistance is given by the slope of graph *i.e.* $\frac{x}{y}$.
But conductance $= \frac{1}{\text{Resistance}} = \frac{y}{x}$

19. (a) $R_{Parallel} < R_{Series}$. From graph it is clear that slope of the line A is lower than the slope of the line B. Also slope = resistance, so line A represents the graph for parallel combination.

20. (b) To make range n times, the galvanometer resistance should be G/n, where G is initial resistance.

Assertion and Reason

1. (d) Resistivity of a semiconductor decreases with the temperature. The atoms of a semiconductor vibrate with larger amplitudes at higher temperatures thereby increasing it's conductivity not resistivity.

2. (d) It is quite clear that in a battery circuit, the point of lowest potential is the negative terminal of the battery and the current flows from higher potential to lower potential.

3. (b) The temperature co-efficient of resistance for metal is positive and that for semiconductor is negative.

In metals free electrons (negative charge) are charge carriers while in *P*-type semiconductors, holes (positive charge) are majority charge carriers.

4. (a) Here, $E = 2V$, $1 = \frac{2}{2} = 1A$ and $r = 1\Omega$

Therefore, $V = E - ir = 2 - 1 \times 1 = 1V$

5. (a) It is clear that electrons move in all directions haphazardly in metals. When an electric field is applied, each free electron acquire a drift velocity. There is a net flow of charge, which constitute current. In the absence of electric field this is impossible and hence, there is no current.

6. (c) The metallic body of the electrical appliances is connected to the third pin which is connected to the earth. This is a safety precaution and avoids eventual electric shock. By doing this the extra charge flowing through the metallic body is passed to earth and avoid shocks. There is nothing such as reducing of the heating of connecting wires by three pin connections.

7. (b) On increasing temperature of wire the kinetic energy of free electrons increase and so they collide more rapidly with each other and hence their drift velocity decreases. Also when temperature increases, resistivity increase and resistivity is inversely proportional to conductivity of material.

8. (c) In a conductor there are large number of free electrons. When we close the circuit, the electric field is established instantly with the speed of electromagnetic wave which cause electron drift at every portion of the circuit. Due to which the current is set up in the entire circuit instantly. The current which is set up does not wait for the electrons flow from one end of the conductor to the another end. It is due to this reason, the electric bulb glows immediately when switch is on.

9. (a) Resistance wire $R = \rho \frac{l}{A}$. where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is banded, resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same.

10. (c) The resistance of the galvanometer is fixed. In meter bridge experiments, to protect the galvanometer from a high current, high resistance is connected to the galvanometer in order to protect it from damage.

11. (a) Voltameter measures current indirectly in terms of mass of ions deposited and electrochemical equivalent of the substance $\left(I = \frac{m}{Zt}\right)$. Since value of m and Z are measured to 3rd decimal place and 5th decimal place respectively. The relative error in the measurement of current by voltmeter will be very small as compared to that when measured by ammeter directly.

12. (a) When current flows through a conductor it always remains uncharged, hence no electric field is produced outside it.

13. (b) Here assertion and reason both are correct but the reason is not the correct explanation of assertion.

14. (a) Sensitivity $\propto \frac{1}{\text{Potential gradient}} \propto (\text{Length of wire})$

15. (a) If either the e.m.f. of the driver cell or potential difference across the whole potentiometer wire is lesser than the e.m.f. of the experimental cell, then balance point will not obtained.

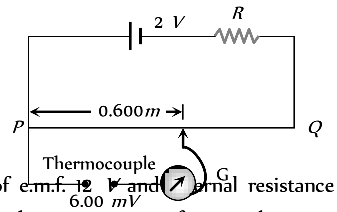
16. (d) Because there is no special attractive force that keeps a person stuck with a high power line. The actual reason is that a current of the order of 0.05 *A* or even less is enough to bring disorder in our nervous system. As a result of it, the affected person may lose temporarily his ability to exercise his nervous control to get himself free from the high power line.

17. (a) Due to high electrical conductivity of copper, it conducts the current without offering much resistance. The copper being diamagnetic material does not get magnetised due to current through it and hence does not disturb the current in the circuit.

Current Electricity

SET Self Evaluation Test -19

1. Figure shows a simple potentiometer circuit for measuring a small e.m.f. produced by a thermocouple. The meter wire *PQ* has a resistance 5 Ω and the driver cell has an e.m.f. of 2 *V*. If a balance point is obtained 0.600 *m* along *PQ* when measuring an e.m.f. of 6.00 *mV*, what is the value of resistance *R*



(a) 995 Ω
(b) 1995 Ω
(c) 2995 Ω
(d) None of these

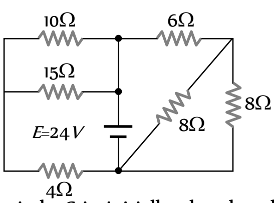
2. A car has a fresh battery of e.m.f. 12 *V* and internal resistance of 0.05 Ω. If the starter motor draws a current of 90 *A*, the terminal voltage when the starter is on will be

(a) 12 *V* (b) 10.5 *V*
(c) 8.5 *V* (d) 7.5 *V*

3. If the balance point is obtained at the 35[th] *cm* in a metre bridge the resistances in the left and right gaps are in the ratio of

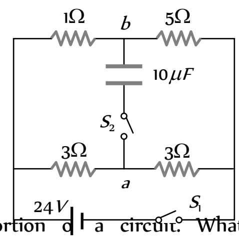
(a) 7 : 13 (b) 13 : 7
(c) 9 : 11 (d) 11 : 9

4. Find the equivalent resistance across the terminals of source of e.m.f. 24 *V* for the circuit shown in figure



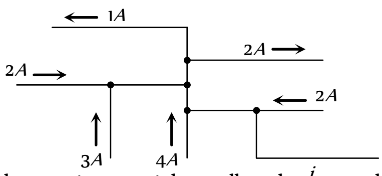
(a) 15 Ω
(b) 10 Ω
(c) 5 Ω
(d) 4 Ω

5. In the circuit shown in figure, switch S_1 is initially closed and S_2 is open. Find $V_a - V_b$



(a) 4 *V*
(b) 8 *V*
(c) 12 *V*
(d) 16 *V*

6. 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

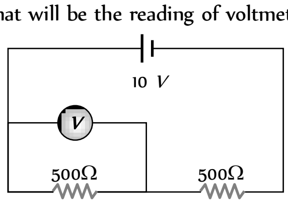


(a) 7 *A*
(b) 8 *A*
(c) 6 *A*
(d) 2 *A*

7. A carbon resistor has colour strips as violet, yellow brown and golden. The resistance is

(a) 641 Ω (b) 741 Ω
(c) 704 Ω (d) 407 Ω

8. A voltmeter of resistance 1000 Ω is connected across a resistance of 500 Ω in the given circuit. What will be the reading of voltmeter

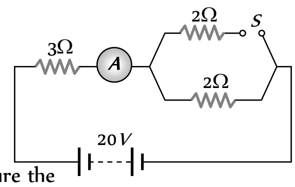


(a) 1 *V*
(b) 2 *V*
(c) 6 *V*
(d) 4 *V*

9. A beam contains 2×10^8 doubly charged positive ions per cubic centimeter, all of which are moving with a speed of 10^5 *m/s*. The current density is

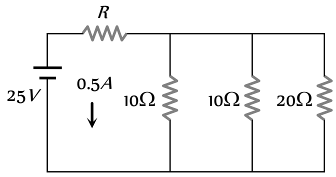
(a) 6.4 A/m^2 (b) 3.2 A/m^2
(c) 1.6 A/m^2 (d) None of these

10. In the circuit shown, the reading of ammeter when switch *S* is open and when switch *S* is closed respectively are



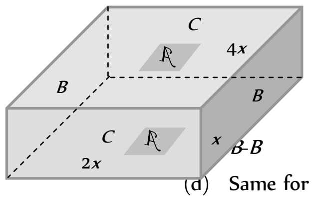
(a) 3 *A* and 4 *A*
(b) 4 *A* and 5 *A*
(c) 5 *A* and 6 *A*
(d) 6 *A* and 7 *A*

11. In the circuit as shown in figure the



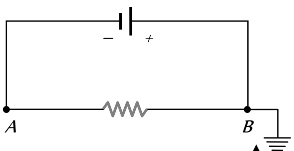
(a) Resistance *R* = 46 Ω
(b) Current through 20 Ω resistance is 0.1 *A*
(c) Potential difference across the middle resistance is 2 *V*
(d) All option are correct

12. In figure shows a rectangular block with dimensions *x*, 2*x* and 4*x*. Electrical contacts can be made to the block between opposite pairs of faces (for example, between the faces labelled *A-A*, *B-B* and *C-C*). Between which two faces would the maximum electrical resistance be obtained (*A-A* : Top and bottom faces, *B-B* : Left and right faces, *C-C* : Front and rear faces)

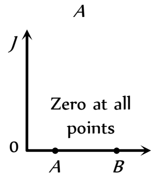


(a) *A-A* (b) *B-B*
(c) *C-C* (d) Same for all three pairs

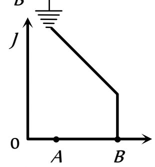
13. A battery is connected to a uniform resistance wire *AB* and *B* is earthed. Which one of the graphs below shows how the current density *J* varies along *AB*

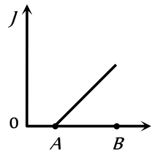


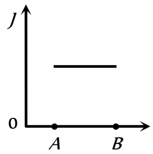
(a)



(b)







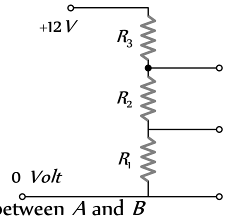
(c) (d)

14. A cylindrical metal wire of length l and cross sections area S, has resistance R, conductance G, conductivity σ and resistivity ρ. Which one of the following expressions for σ is valid

(a) $\dfrac{GR}{\rho}$ (b) $\dfrac{\rho R}{G}$

(c) $\dfrac{GS}{l}$ (d) $\dfrac{Rl}{S}$

15. A potential divider is used to give outputs of 4 V and 8 V from a 12 V source. Which combination of resistances, (R_1, R_2, R_3) gives the correct voltages ? $R_1 : R_2 : R_3$



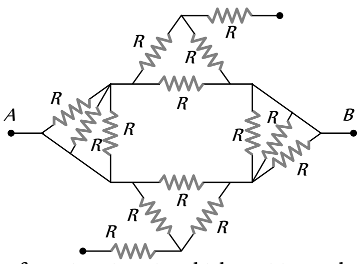
(a) 2 : 1 : 2

(b) 1 : 1 : 1

(c) 2 : 2 : 1

(d) 1 : 1 : 2

16. Find equivalent resistance between A and B



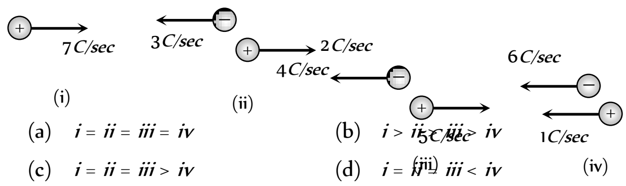
(a) R

(b) $\dfrac{3R}{4}$

(c) $\dfrac{R}{2}$

(d) $2R$

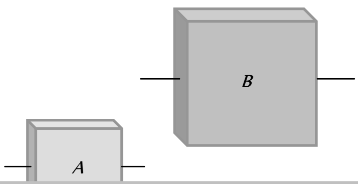
17. Following figure shows four situations in which positive and negative charges moves horizontally through a region and gives the rate at which each charge moves. Rank the situations according to the effective current through the region greatest first



(a) $i = ii = iii = iv$ (b) $i > ii > iii > iv$

(c) $i = ii = iii > iv$ (d) $i = ii = iii < iv$

18. A and B are two square plates of same metal and same thickness but length of B is twice that of A. Ratio of resistances of A and B is



(a) 4 : 1

(b) 1 : 4

(c) 1 : 1

(d) 1 : 2

19. A moving coil galvanometer is converted into an ammeter reading upto $0.03\,A$ by connecting a shunt of resistance $4r$ across it and into an ammeter reading upto $0.06\,A$ when a shunt of resistance r is connected across it. What is the maximum current which can be sent through this galvanometer if no shunt is used

(a) $0.01\,A$ (b) $0.02\,A$

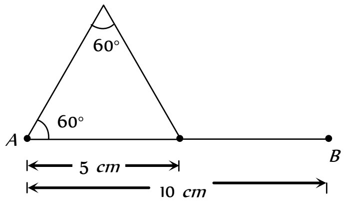
(c) $0.03\,A$ (d) $0.04\,A$

20. Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter 1.0 mm. Conductor B is a hollow tube of outside diameter 2.0 mm and inside diameter 1.0 mm. The resistance ratio R_A/R_B will be

(a) 1 (b) 2

(c) 3 (d) 4

21. A wire has resistance of 24 Ω is bent in the following shape. The effective resistance between A and B is



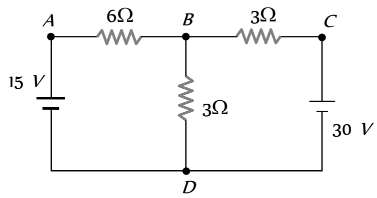
(a) 24 Ω

(b) 10 Ω

(c) $\dfrac{16}{3}\Omega$

(d) None of these

22. In the circuit shown in figure, find the current through the branch BD



(a) 5 A

(b) 0 A

(c) 3 A

(d) 4 A

23. A battery of 24 cells, each of emf 1.5 V and internal resistance 2Ω is to be connected in order to send the maximum current through a 12 Ω resistor. The correct arrangement of cells will be

(a) 2 rows of 12 cells connected in parallel

(b) 3 rows of 8 cells connected in parallel

(c) 4 rows of 6 cells connected in parallel

(d) All of these

Answers and Solutions

(SET - 19)

1. (a) The voltage per unit light of the metre wire PQ is $\left(\dfrac{6.00\,mV}{0.600\,m}\right)$ *i.e.* $10\,mV/m$. Hence potential difference across the metre wire is $10\,mV/m \times 1m = 10\,mV$. The current drawn from the driver cell is $i = \dfrac{10\,mV}{5\,\Omega} = 2\,mA$.

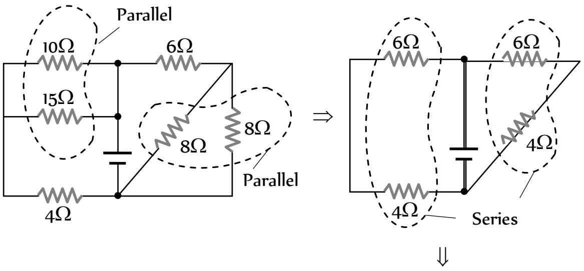
The resistance $R = \dfrac{(2V - 10mV)}{2\,mA} = \dfrac{1990\,mV}{2\,mA} = 995\,\Omega$.

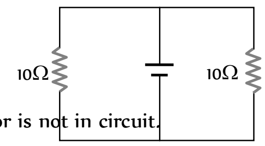
2. (d) $V = E - i.r = 12 - 90 \times 0.05 = 12 - 4.5 = 7.5\,V$.

3. (a) Using Wheatstone principle $\frac{P}{Q} = \frac{R}{S} = \frac{R}{100 - l}$

$$= \frac{35}{100-35} = \frac{35}{65} = \frac{7}{13}$$

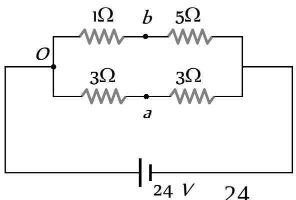
4. (c) Given circuit can be reduced to a simple circuit as shown in figures below





i.e. $R_{eq} = 5\Omega$.

5. (b) Switch S_2 is open so capacitor is not in circuit.



Current through 3Ω resistor $= \frac{24}{3+3} = 4\ A$

Let potential of point '*O*' shown in fig. is V_O

then using ohm's law

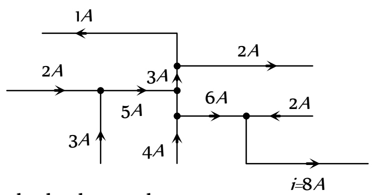
$V_O - V_a = 3 \times 4 = 12V$ ....(i)

Now current through 5Ω resistor $= \frac{24}{5+1} = 4A$

So $V_0 - V_b = 4 \times 1 = 4\ V$ .....(ii)

From equation (i) and (ii) $V_b - V_a = 12 - 4 = 8V$.

6. (b) By using Kirchoff's junction law as shown below.



7. (b) Using standard colour codes

Violet = 7, yellow = 4, brown = 1 and gold = 5 % (tolerance)

So $R = 74 \times 10^1 \pm 5\% = 740 \pm 5\%$

So its value will be nearest to $741\,\Omega$.

8. (d) Total current through the circuit

$$i = \frac{10}{\frac{1000}{3} + 500} = \frac{3}{250} A$$

Now voltmeter reading $= i_v \times R_V = \frac{2}{3} \times \frac{3}{250} \times 500 = 4V$.

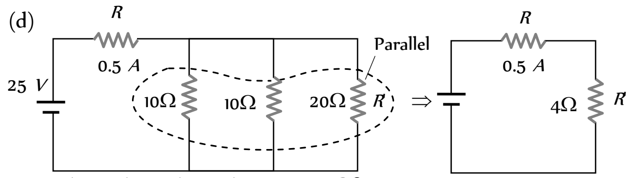
9. (a) $J = nqv = n(ze)v = \frac{2 \times 10^8 \times 2 \times 1.6 \times 10^{-19} \times 10^5}{(10^{-2})^3} = 6.4 A/m$

10. (b) When switch *S* is open total current through ammeter.

$$i = \frac{20}{(3+2)} = 4A.$$

When switch is closed $i = \frac{20}{3 + (2 \| 2)} = 5A$.

11. (d)



$$\frac{1}{R'} = \frac{1}{10} + \frac{1}{10} + \frac{1}{20} \Rightarrow R' = \frac{20}{5} = 4\ \Omega$$

Now using ohm's law $i = \frac{25}{R + R'} \Rightarrow 0.5 = \frac{25}{R+4}$

$$\Rightarrow R + 4 = \frac{25}{0.5} = 50 \Rightarrow R = 50 - 4 = 46\ \Omega$$

Current through 20Ω resistor $= \frac{0.5 \times 5}{20 + 5} = \frac{2.5}{25} = 0.1A$

Potential difference across middle resistor

= Potential difference across $20\Omega = 20 \times 0.1 = 2V$

12. (c) Let ρ is the resistivity of the material

Resistance for contact *A-A*

$$R_{AA} = \rho \frac{x}{2x \times 4x} = \frac{\rho}{8x}$$

Similar for contacts *B-B* and *C-C* are respectively

$$R_{BB} = \rho . \frac{2x}{x \times 4x} = \frac{\rho}{2x} = \frac{4\rho}{8x}$$

and $R_{CC} = \rho \frac{4x}{x \times 2x} = \frac{2\rho}{x} = \frac{16\rho}{8x}$

It is clear maximum resistance will be for contact *C-C.*

13. (d) Wire *AB* is uniform so current through wire *AB* at every across section will be same. Hence current density $J(= i/A)$ at every point of the wire will be same.

14. (a) Conductivity $\sigma = \frac{1}{\rho}$ .....(i)

and conductance $G = \frac{1}{R}$

$\Rightarrow GR = 1$ .....(ii)

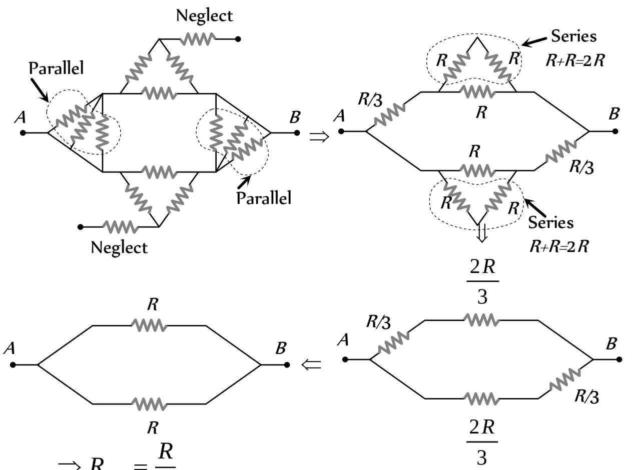
From equation (i) and (ii) $\sigma = \frac{GR}{\rho}$

15. (b) Resistors are connected in series. So current through each resistor will be same

$$\Rightarrow i = \frac{12-8}{R_3} = \frac{8-4}{R_2} = \frac{4-0}{R_1} \Rightarrow \frac{4}{R_3} = \frac{4}{R_2} = \frac{4}{R_1}$$

So, $R_1 : R_2 : R_3 :: 1 : 1 : 1$.

16. (c) Given circuit can be redrawn as follows



$\Rightarrow R_{eq} = \dfrac{R}{2}$

17. (c) For figure (i) $i_1 = 7A$

For figure (ii) $i_2 = 4 + 3 = 7A$

For figure (iii) $i_3 = 5 + 2 = 7A$

For figure (iv) $i_4 = 6 - 1 = 5A$

18. (c) $R_A = \dfrac{\rho l}{l \times t} = \dfrac{\rho}{t}$ and $R_B = \dfrac{\rho \times 2l}{2l \times t} = \dfrac{\rho}{t}$ *i.e.* $\dfrac{R_A}{R_B} = 1:1$

19. (b) $\dfrac{i_g}{i} = \dfrac{S}{G+S} \Rightarrow i_g G = (i - i_g)S$

$\therefore\ i_g G = (0.03 - i_g)4r$ .....(i)

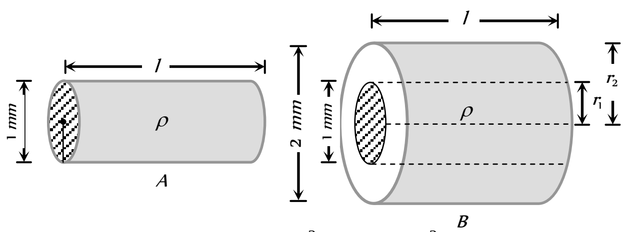
and $i_g G = (0.06 - i_g)r$ .....(ii)

From (i) and (ii)

$0.12 - 4i_g = 0.06 - i_g \Rightarrow i_g = 0.02A$.

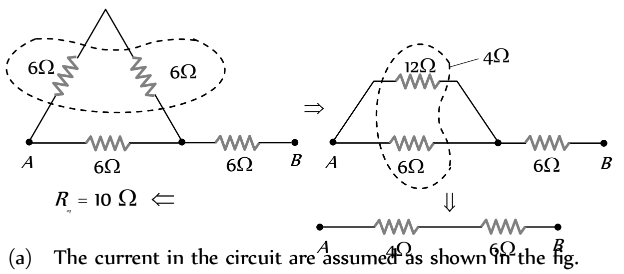
20. (c) For conductor *A*, $R_A = \dfrac{\rho l}{\pi r_1^2}$,

For conductor *B*, $R_B = \dfrac{\rho l}{\pi(r_2^2 - r_1^2)}$



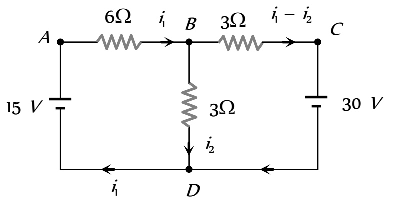
$\Rightarrow \dfrac{R_A}{R_B} = \dfrac{r_2^2 - r_1^2}{r_1^2} = \left(\dfrac{r_2}{r_1}\right)^2 - 1 = \left(\dfrac{d_2}{d_1}\right)^2 - 1 = \left(\dfrac{2}{1}\right)^2 - 1 = 3$

21. (b) Given resistance of each part will be



$R_{eq} = 10\ \Omega \Leftarrow$

22. (a) The current in the circuit are assumed as shown in the fig.



Applying KVL along the loop *ABDA*, we get

$-6i_1 - 3i_2 + 15 = 0$ or $2i_1 + i_2 = 5$ .....(i)

Applying KVL along the loop *BCDB*, we get

$-3(i_1 - i_2) - 30 + 3i_2 = 0$ or $-i_1 + 2i_2 = 10$ .....(ii)

Solving equation (i) and (ii) for i_2 we get $i_2 = 5\ A$.

23. (a) Suppose *m* rows are connected in parallel and each row contains *n* identical cells (each cell having $E = 15\ V$ and $r = 2\Omega$) For maximum current in the external resistance *R*, the necessary condition is $R = \dfrac{nr}{m}$

$\Rightarrow 12 = \dfrac{n \times 2}{m} \Rightarrow n = 6m$ ..... (i)

Total cells $= 24 = n \times m$ ..... (ii)

On solving equations (i) and (ii) $n = 12$ and $m = 2$

i.e. 2 rows of 12 cells are connected in parallel.

***