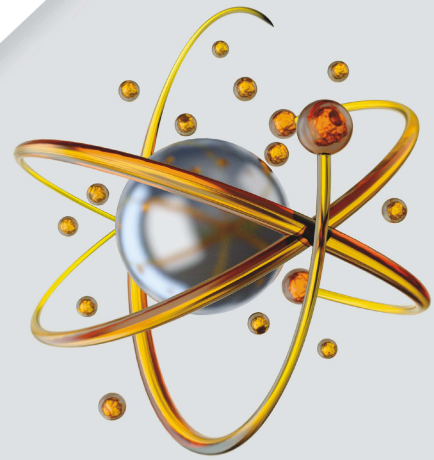
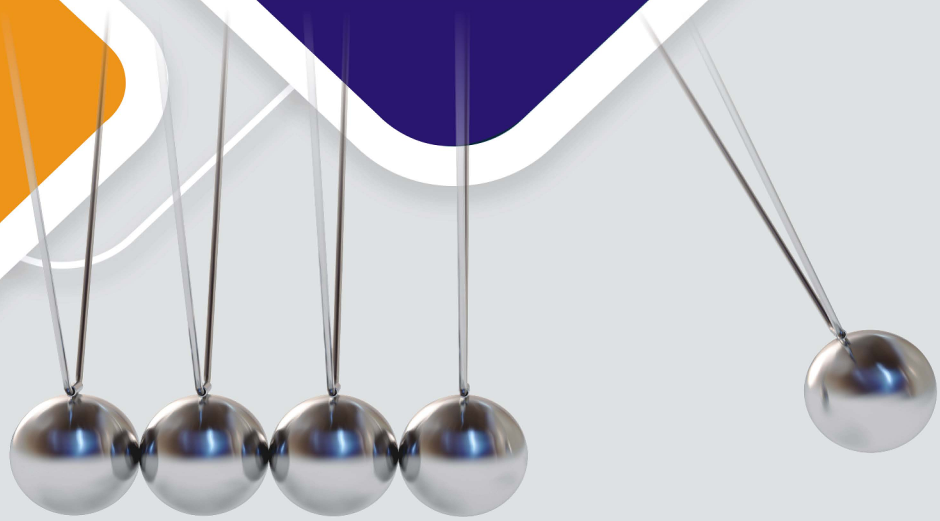
JEE Mains + Advance

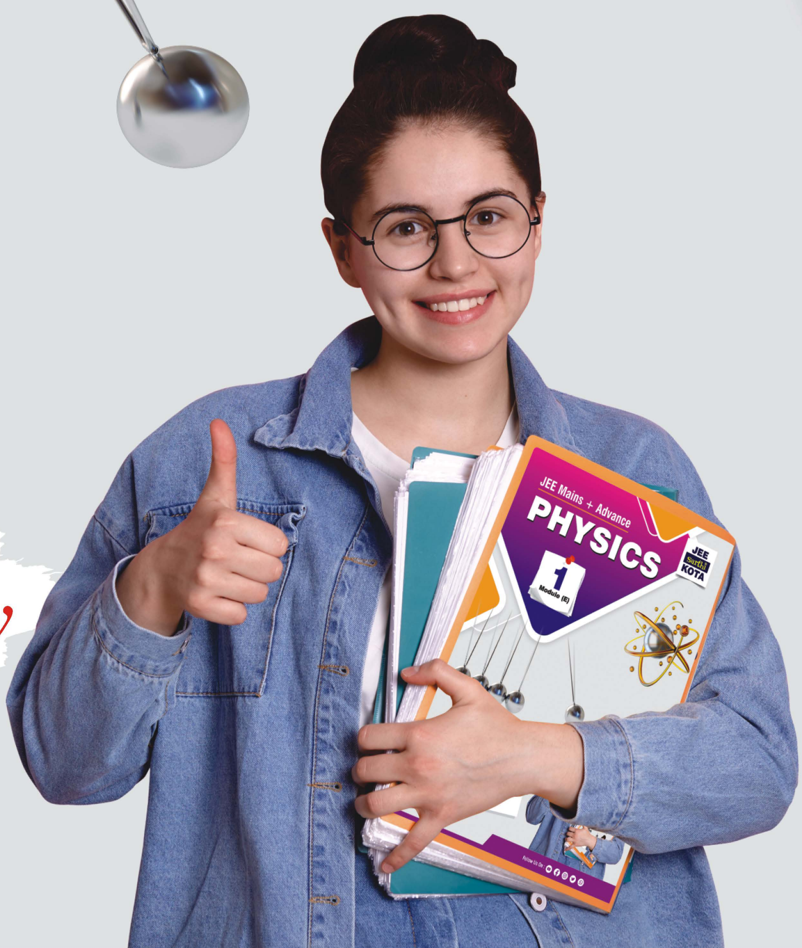
PHYSICS

JEE Sarthi KOTA

Sample Module







Chapter

Current Electricity

JEE Module Details

(Total = 24)

CLASS - XI : 12 MODULES

PHYSICS

Module - 1

Ch. No.	Chapter Name
1.	Mathematical Tools
2.	Vector
3.	Unit, Dimension and Measurement
4.	Kinematics
5.	Newton's Laws of Motion

Module - 2

Ch. No.	Chapter Name
1.	Work Power and Energy
2.	Center of Mass & Collision
3.	Rotational Motion
4.	Gravitation

Module - 3

Ch. No.	Chapter Name
1.	Fluid Mechanics
2.	Surface Tension
3.	Elasticity & Viscosity
4.	Simple Harmonic Motion

Module - 4

Ch. No.	Chapter Name
1.	Thermometry & Calorimetry
2.	Thermal Expansion
3.	Kinetic Theory of Gases
4.	Thermodynamics
5.	Heat Transfer

CHEMISTRY

Module - 1

Ch. No.	Chapter Name
1.	Some Basic Concept of Chemistry
2.	Atomic Structure
3.	Redox Reactions
4.	States of Matter

Module - 2

Ch. No.	Chapter Name
1.	Chemical Equilibrium
2.	Ionic Equilibrium
3.	Chemical Thermodynamics & Energetics

Module - 3

Ch. No.	Chapter Name
1.	Periodic Table and Periodic Properties
2.	Chemical Bonding
3.	Hydrogen and its compounds
4.	s-Block elements
5.	p-Block (13 to 14 groups)

Module - 4

Ch. No.	Chapter Name
1.	IUPAC
2.	Isomerism
3.	GOC-I
4.	Hydrocarbons
5.	Environmental Chemistry

MATHEMATICS

Module - 1

Ch. No.	Chapter Name
1.	Set & Relations
2.	Trigonometric Ratios
3.	Trigonometric Equation
4.	Solution of a Triangle

Module - 2

Ch. No.	Chapter Name
1.	Sequence and Series
2.	Quadratic Equations and Inequalities
3.	Complex Numbers
4.	Limits & Derivative

Module - 3

Ch. No.	Chapter Name
1.	Binomial Theorem
2.	Permutations and Combinations
3.	Straight Lines
4.	Circle

Module - 4

Ch. No.	Chapter Name
1.	Parabola
2.	Hyperbola
3.	Ellipse

JEE : Physics

Sample Module

STUDENT NAME:____

SECTION: __________________________ROLL NO: ____________

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❖ PREFACE ❖

This module covers the theoretical concepts associated with NEET syllabus and contain sufficient multiple choice and previous year questions. We are confident that students would find this module helpful for their preparations.

Research & Development team of NEET Sarthi keeps working to improve the study material. Suggestions and inputs from students and readers are always welcome.

About NEET Sarthi

NEET Sarthi, A platform for JEE, NEET, NTSE and other competitive exams, is an initiative by highly renowned faculties from Kota (the coaching capital of India) and Tech team from Bangalore (the Silicon Valley of India). Our mission is to provide extensive and high-quality education to students. Specially, our vision is to be top most institute in terms of academic quality & student care.

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"If you can dream it, you can do it" **-Dr. A.P.J. Abdul kalam**

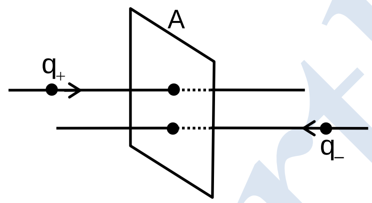
Chapter-01

Current Electricity

- **Electric Current**
- **Current Density**
- **Mechanism of Current Flow in Conductors**
- **Factors Responsible for Current Flow**
- **Electrical Resistance**
- **Dependance of Resistance**
- **Temperature Dependance of Resistance**
- **Colour Coding of Resistors**
- **Combination of Resistors**
- **Cell : Emf, Internal Resistance & Terminal Voltage**
- **Wheat Stone Bridge**
- **Electric Energy and Power**

1. ELECTRIC CURRENT:

Consider a small area A kept perpendicular to the direction of flow of charges as shown in figure.



Positive charges q_+ are flowing from left to right and negative charge q_- are flowing from right to left across the area. Net charge flowing through the area in the interval t from left to right $q = q_+ - q_-$.

The quotient $\frac{q}{t} = i$, is defined as the current across the area in the direction left to right. If the quotient is negative then the current is in the direction right to left.

The electric current in measured by 'rate of flow of charge'.

Current $i = \frac{\text{Charge}}{\text{Time}} = \frac{dq}{dt}$, if flow is uniform

$$i = \frac{q}{t}$$

Unit: Ampere (A)

1 ampere = 1 coulomb/second

Dimension: $(M^0L^0T^0A^1)$

If n electrons pass through any cross section in every t seconds then $i = \frac{ne}{t}$

where $e = 1.6 \times 10^{-19}$ coulomb.

1.1 Average & Instantaneous Current

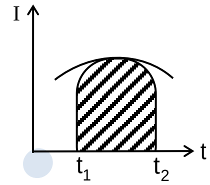
1. **Average current:** If ΔQ charge flows through any cross section of conductor in the interval t to $t + \Delta t$, then average current in that interval is defined as the ratio of ΔQ to Δt; $I_{av} = \frac{\Delta Q}{\Delta t}$

2. **Instantaneous current :** If the limit of Δt is tending to zero, then the current is defined to be instantaneous current at time t.

$$I = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$$

KEY POINTS

Instantaneous current through a cross-section $I = \frac{dQ}{dt}$



Charge passed through the cross section in the interval t to t + dt

$$dQ = Idt$$

Total charge in the interval t_1 to t_2

$Q = \int_{t_1}^{t_2} Idt$ = Area below I versus t graph in the interval t_1 to t_2 as shown in figure.

Average current in the interval t_1 to t_2

$$I_{av} = \frac{\Delta Q}{\Delta t} = \frac{\int_{t_1}^{t_2} Idt}{\int_{t_1}^{t_2} dt} = \frac{\text{Area below I v/s t graph}}{\text{Time interval}}$$

1.2 1 Ampere

If 1 coulomb of charge flows per second then 1 ampere of current is said to be flowing.

1 ampere of current means the flow of

6.25×10^{18} electrons per second through any cross section of conductor

1.3 Direction of current flow

By convention, direction of current is taken as direction of motion of positively charged particles and opposite to the direction of negatively charged particles.

Electric current is a scalar quality Although in diagrams, we represent current in a wire by an arrow but the arrow simply indicate the direction of flow of positive charges in the wire.

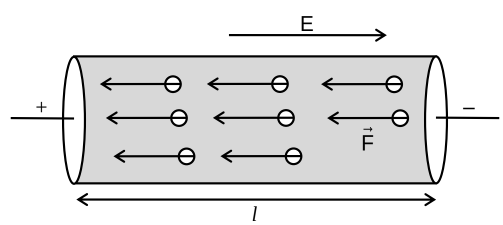
Current is a scalar quantity because it does not obey law of vector.

1.4 Flow of charge in conductors

Value of the current is same throughout the conductor, irrespective of the cross section of conductor at different points.

Net charge in a current carrying conductor is zero at any instant of time.

A current carrying conductor cannot said to be charged, because in conductor the current is caused by electron (free electron). The no. of electron (negative charge) and proton (positive charge) in a conductor is same. Hence the net charge in a current carrying conductor is zero.



- Electric field outside a current carrying conductor is zero, but it is non zero inside the conductor.
- The electric field inside charged conductor is zero in electrostatic condition, but it is non zero inside a current carrying conductor.

KEY POINTS

1. In liquids, the charge carriers are positive and negative ions.
2. In gases, the charge carriers are positive ions and free electrons.
3. In semiconductors, the charge carriers are holes and free electrons. The conventional direction of flow of current is opposite to the direction of flow of electrons.

2. CURRENT DENSITY :

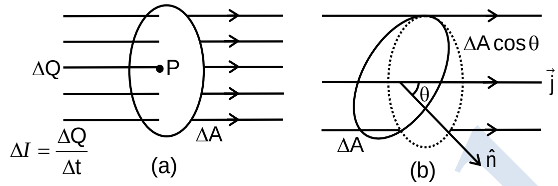
The current density at a point in a conductor is the ratio of the current at that point to the area of cross–section of the conductor at that point.

It is denoted by J i.e. J = $\frac{I}{A}$

I = Electric current and A = Area of cross section.

And area A is normal to current I.

If A is not normal to I, but makes an angle θ with the normal to current, then



$J = \frac{I}{A_{normal}} = \frac{I}{A\cos\theta} \Rightarrow I = J\,A\cos\theta = \vec{J}.\vec{A}$

$dI = \vec{J}.d\vec{A} \Rightarrow I = \int \vec{J}.d\vec{A}$

Electric current is the flux of current density.

It is a vector quantity. It's direction is the direction of motion of the positive charges at that point.

Unit : ampere / meter^2 (A/m^2)

Dimension : [$M^0L^{-2}T^0A$]

3. MECHANISM OF CURRENT FLOW IN CONDUCTORS

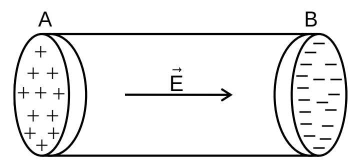
If an electric field is applied to an electric charge, it will experience a force. If it is free to move then it will contribute to a current.

In atoms and molecules, negatively charged electrons and positively charged nuclei are bound to each other and thus are not free to move in electric field.

In some materials, the electrons will still be bound so when electric field is applied, they will not accelerate to develop current. These materials are generally called **insulators**. In electric solutions both positive and negative ions move to develop current.

In **bulk matter,** these molecules are so closely packed that electrons no longer are attached to individual nuclei. If an electric field is applied some of the electrons are practically free to move within the bulk material to develop currents in them. These materials are generally called **conductors** and these electrons are known as free electrons.

in the absence of electric field, the electrons move with their thermal motion. During their random motion they collide with fixed ions such that their speed before collision is equal to speed after collision but the direction of velocity after collision is completely random. Therefore, number of electrons in any direction will be equal to the number of electrons travelling in opposite direction, so there is no net electric current.



When electric field $\vec{E}$ is applied the electrons will be accelerated due to the field $\vec{E}$ from end B to A. The motion constitute an electric current.

4. FACTORS RESPONSIBLE FOR CURRENT FLOW

4.1 Thermal speed (order of $v_T = 10^5$ m/s)

Conductor contain a large number of free electrons, which are in continuous random motion. Due to random motion, the free electrons collide with positive metal ions with high frequency and undergo change in direction at each collision. So, the thermal velocities are randomly distributed in all possible directions are, individual thermal velocities of the free electrons at any given time. the total number of free electrons in the conductor = N

average velocity $\vec{u}_{avg.} = \left[\frac{\vec{u}_1 + \vec{u}_2 + ... + \vec{u}_N}{N}\right] = 0$

4.2 Drift Speed

Drift velocity is defined as the velocity with which the free electrons get drifted towards the positive terminal under the effect of the applied electric field.

4.3 Relaxation time

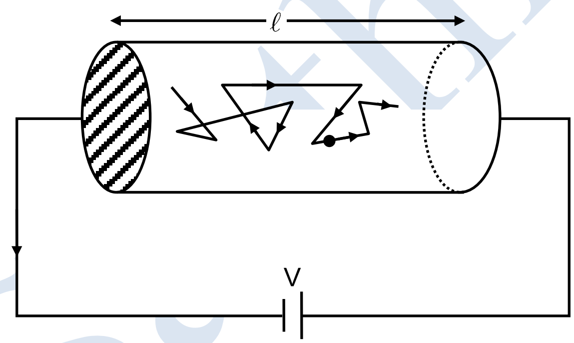
Average time elapsed between two successive collisions. It is of the order of 10^{-14} s. It is a temperature dependent characteristic of the material of the conductor. It decreases with increases in temperature.

4.4 Relation between drift velocity & relaxation time

When the ends of a conductor are connected to a source of emf, an electric field E is established in the conductor, such that $E = \frac{V}{\ell}$

where V = the potential difference across the conductor

and ℓ = the length of the conductor.



Under the action of electric field Randommotion of an electron with superimposed drift

The electric field $\vec{E}$ exerts an electrostatic force $-e\vec{E}$ on each electron in the conductor.

The acceleration of each electron $\vec{a} = \frac{-e\vec{E}}{m}$

m = mass of electron, e = charge of electron

so velocity of each electron $\vec{v} = \vec{u} + \vec{a}t$

So $\vec{v}_{av} = \vec{v}_d = <\vec{u} + \vec{a}t> \Rightarrow \vec{v}_d = <\vec{u}> + \vec{a} < t >$

since the average thermal velocity of free electrons is zero.

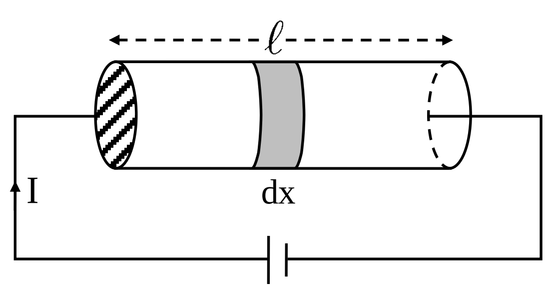
$\vec{v}_d = \vec{a}\tau \Rightarrow \vec{v}_d = -\frac{e\vec{E}}{m}\tau$ order of drift velocity is 10^{-4} m/s

4.5 Mean free Path (λ)

The mean distance travelled by a conduction electron during relaxation time is known as mean free path λ. Mean free path of conduction electron = Thermal velocity × Relaxation time

(order of λ = 10Å)

4.6 Relation between current density, conductivity and electric field



Let the number of free electrons per unit volume in a conductor = n

Total number of electron in dx distance = n(Adx)

Total charge ΔQ = n(Adx)e

Cross sectional area = A

Current $\frac{\Delta Q}{\Delta t} = nAe\frac{\Delta x}{\Delta t} \Rightarrow I = neAv_d$

Current density $J = \frac{I}{A} = nev_d \Rightarrow J = ne\left(\frac{eE}{m}\right)\tau$

$J = \left(\frac{ne^2\tau}{m}\right)E \qquad \because v_d = \left(\frac{eE}{m}\right)\tau$

again for ohmic conductor $\vec{J} = \sigma\vec{E} \Rightarrow \sigma = \frac{ne^2\tau}{m} = \frac{1}{\rho}$

In vector form where σ is conductivity &ρ is resistivity.

σ depends only on the material of the conductor and its temperature.

4.7 Mobility (μ)

It is defined as the magnitude of the drift velocity per unit electric field $\mu = \frac{|\vec{v}_d|}{|E|}$

Its SI unit is $m^2V^{-1}s^{-1}$ Its practical unit is $cm^2V^{-1}s^{-1}$

We have $V_d = \frac{e\tau E}{m}$ $\Rightarrow \mu = \frac{v_d}{E} = \frac{e\tau}{m}$

Mobility of free electrons is independent of electric field and dimension of conductor.

5. ELECTRICAL RESISTANCE

It is the property of any conductor by the virtue of which each electron requires an external electric field to move with a drift speed (corresponding to the applied electric field) against the electron cloud and metallic kernels (lattice atoms and ions). It means that some work must be done by an external agent in pushing an electron with a constant drift speed v_d along the wire (conductor). In other words, a potential is dropped along the conductor in the direction of the electric current.

In short, the resistance is the property of conductor which produces hinderance to the current flow, causing the potential drop across the conductor.

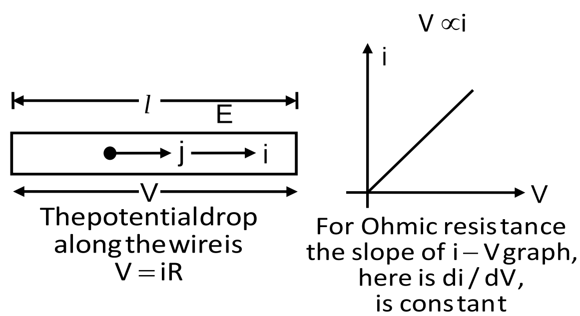
5.1 Ohm's law (microscopic form)

It is experimentally verified that the potential drop (voltage) V is directly proportional to the current i flowing through the conductor

Hence, $\frac{V}{i}$ = constant which is defined as the resistance of a conductor denoted by R.

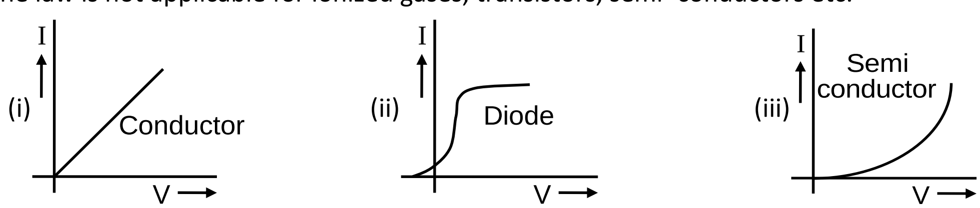
or $\frac{V}{i} = R$

The above relation holds good upon certain temperature for some conductors.



KEY POINTS

- Unit of resistance R: ohm(Ω) 1ohm = 1volt /1ampere
- Dimension of resistance R: $[M^1L^2T^{-3}A^{-2}]$
- This is true for metallic conductors only which have free electrons
- The law is not applicable for ionized gases, transistors, semi–conductors etc.



6. DEPENDANCE OF RESISTANCE

Resistance of conductor does not depend upon the current i flowing through it and the potential difference (P.D.) along the conductor. However, it depends upon

(a) length i.e. $R \propto \ell$ (b) area i.e $R \propto \frac{1}{A}$ (c) resistivity i.e $R \propto \rho$

$R \propto l$; $R \propto \frac{1}{A}$

Then $R \propto \frac{l}{A} \Rightarrow R = \rho\frac{l}{A}$

where ρ = resistivity of the conductor R is in Ohm(Ω)

- Unit of ρ is Ω–m
- Dimension of ρ is $[M^1 L^3 T^{-3} A^2]$
- Inverse of resistivity is called conductivity (σ) of the material $\sigma = \frac{1}{\rho}$ (unit : mho m^{-1})
- Inverse of resistance is called conductance (G) $G = \frac{1}{R}$ (unit : mho)
- Resistivity is also defined as the ratio of the intensity of the electric field E at any point within the conductor and the current density J at that point $\rho = \frac{E}{J}$ or $J \propto E$

KEY POINTS

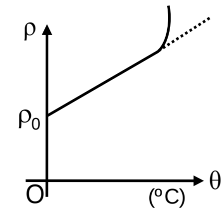
- Resistivity is characteristic property of the material of the conductor. It does not depend upon length, area etc. of the conductor. Although it depends on temperature. It increases with increase in temperature.
- Value of resistivity is least for conductors and more for insulators.
- $\rho_{insulator} > \rho_{semiconductor} > \rho_{conductor}$
- Effect of stretching a wire on its resistance
- If the length of wire is changed, then $\frac{R_1}{R_2} = \frac{\ell_1^2}{\ell_2^2}$
- If the radius of wire is changed, then $\frac{R_1}{R_2} = \frac{r_2^4}{r_1^4}$
- If x% change is brought in length of a wire, it's resistance will change by 2x%. This is true for x < 5% only.
- If a conductor is stretched such that it's radius is reduced to $1/n^{th}$ of it's original values, then resistance will increases n^4 times similarly resistance will decrease n^4 times if radius is increased n times by contraction.
- Keeping volume of the conductor constant, its resistance $R = \rho\frac{L}{A} = \rho\frac{LA}{A^2} = \frac{\rho V}{A} = \frac{\rho m}{A^2 d}$

  Where m = mass and d = density of material

  (a) If length of conductor is made n times, then resistance of the conductor becomes n^2 times the initial value. ($R \propto L^2$)

  (b) If area of cross-section is made n times, then resistance of conductor becomes $\frac{1}{n^2}$ times the initial value. $\left(R \propto \frac{1}{A^2}\right)$

7. TEMPERATURE DEPENDANCE OF RESISTANCE



$r = r_0(1+\alpha\theta)$ upto certain temperature

If the temperature of a conductor increases, the atoms of the lattice vibrate with more amplitude and velocities. Furthermore, the conduction electron move with greater speeds.

Since $\sigma \propto \tau\left(\frac{\lambda}{\bar{v}}\right)$ and $\bar{v}$ increases with temperature we can say that σ decreases or ρ increases with temperature hence the rate of collision of the conduction electrons with the lattice sites increases. It means that the resistivity of the conductor increases.

- It is experimentally verified that the resistivity of a conductor varies linearly with temperature upto certain temperature. If ρ_0 = resistivity at 0°C, the resistivity at θ°C is given as

  $$\rho_\theta = \rho_0(1+\alpha\theta)$$

  where α = temperature coefficient of resistivity given as

  $$\alpha = \frac{\rho_\theta - \rho_0}{\rho_0\theta}$$ and its unit is K^{-1} or $°C^{-1}$.

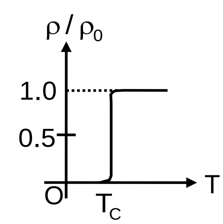
  In differential form, $$\boxed{\alpha = \frac{d\rho}{\rho_0 d\theta}}$$

  Then, resistance R_θ at any temperature θ can be given as $R_\theta = R_0(1 + \alpha\theta)$ where R_0 = resistance at 0°C and α = average temperature coefficient of resistance.

- The alloys have very small value of α. Hence, their resistance does not change appreciably with increase (or decrease) in temperature. Therefore, the alloys can be used for making resistances of constant value.

7.1 Superconductivity

At a very low temperature, the resistivity of a metal is considerably lesser than that at room temperature. Some metal lose their resistances completely at temperature near 0 K (absolute zero). This property of a conductor is called super conductivity and the material is called "super-conductor". The temperature at which a material becomes superconductor is called critical temperature T_C.



- A superconducting ring can retain electric currents of hundreds of amperes for a year without any external source.

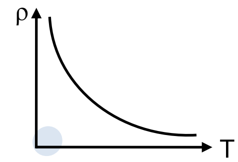
KEY POINTS

- $R_2 = R_1 [1 + \alpha (t_2 - t_1)]$. This formula gives an approximate value.
- Resistance of the conductor decreases linearly with decrease in temperature and becomes zero at a specific temperature. This temperature is called critical or transition temperature, at this temperature conductor becomes a super conductor.
- There is no loss of energy in a circuit formed by super conductors. Current passed in loop formed by superconductor will continue flowing for infinite time if there is no resistance in the loop.
- Resistivity of a material is found to depend on the temperature. In conductors

  resistivity $\rho = \frac{m}{ne^2\tau}$, where $\rho \propto \frac{1}{n}$ and $\rho \propto \frac{1}{\tau}$.

- When the temperature of conductor increases, average speed of free electrons increases. As a result collision frequency increases or relaxation time decreases. In metals n is not dependent on temperature to any appreciable extent and ρ increases with rise in temperature.
- For semiconductors, α is negative as their resistivity decreases with rise in temperature (n increases with rise in temperature.

  Temperature dependence of resistivity ρ of a semiconductor is as shown in figure.



8. COLOUR CODING OF RESISTORS

Commercially produced resistors for are of two major types

(a) Wire bound resistors (b) Carbon resistors

Wire bound resistors are made by winding wires of an alloy i.e. magnanin, constantan nichrome etc. These wire are chosen because their resistivities are relatively insensitive to temperature. These resistances are in the range of a fraction of an ohm to a few hundred ohm.

Resistors of range higher than wire bound resistors are mostly made of carbon. Carbon resistors are small, compact and less expensive, so are used widely in electronic circuits. Their resistances are measured from their colour code.

Colour	Number	Multiplier	Tolerance(%)
Black	0	1	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
No colour			20

A carbon resistor has a set of coaxial coloured rings in them, whose significance are listed in above table.

First two bands : First two digits of the resistance in ohm.

Third band : Decimal multiplier as shown in table.

Last band : Tolerance or possible variation in percentage as per the indicated value. For gold ±5%, for silver +10% and no colour ±20%

SOLVED EXAMPLES

Ex.1: The no. of electrons flowing per second through any cross section of wire, if it carries a current of one ampere, will be –

(1) 2.5×10^{18} (2) 6.25×10^{18} (3) 12.5×10^{18} (4) 5×0^{18}

Sol. $I = \frac{q}{t} = \frac{ne}{t}$ [$\because$ q = ne, from quantization of charge] $\Rightarrow n = \frac{I \times t}{e} = \frac{1 \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$

Ex.2: In hydrogen atom, the electron moves in an orbit of radius 5×10^{-11} m with a speed of 2.2×10^{6} m/sec. the equivalent current will be –

(1) 1.12 mA (2) 4.32 mA (3) 3.32 mA (4) 7.12 mA

Sol. Time taken by the electron in 1 revolution is

$T = \frac{2\pi r}{v}$; current $I = \frac{Q}{T} = \frac{Qv}{2\pi R}$

where R is the radius of orbit and v is the speed. $I = \frac{2.2 \times 10^{6} \times 1.6 \times 10^{-19}}{2 \times \left(\frac{22}{7}\right) \times (5 \times 10^{-11})} = 1.12$ mA

Ex.3: A conductor of non–uniform cross–sectional area, has cross–sectional area at three points as $A_1 = 2cm^2$, $A_2 = 4cm^2$ and $A_3 = 6cm^2$. If a current of 5 ampere is passed through A_1, the current will give values, when passed through A_2 and A_3 respectively as–

(1) 10 A, 15 A (2) 20 A, 30 A (3) 2.5 A, 1.66 A (4) 5A, 5A

Sol. (4) Current will remain same.

Ex.4: The total momentum of electrons in a straight wire of length $\ell = 1000$ m carrying a current $I = 70A$, will be – (in Ns)

(1) 0.40×10^{-6} (2) 0.20×10^{-6} (3) 0.80×10^{-6} (4) 0.16×10^{-6}

Sol. We know $I = neAv_d$ where $v_d \rightarrow$ drift velocity

$n \rightarrow$ no. density of electron.

Total no. of electron $N = nA\ell$

Total momentum (P) of electron $= Nmv_d$

or $P = (nA\ell m) \times \frac{I}{neA} = \frac{I\ell m}{e} \Rightarrow P = \frac{70 \times 1000 \times 9.3 \times 10^{-31}}{1.6 \times 10^{-19}} = 0.40\mu$ Ns

Ex.5 What do you mean by thermal motion of free electrons in conductors?

Sol. In conductors some of the electrons are practically free to move within the conductor. Kinetic energy of these electrons depends on the temperature T of conductor i.e., $E = \frac{3}{2}kT$, where k = Boltzmann constant. So, the motion in these electrons is known as thermal motion.

Ex.6 Can electrons produce current due to their thermal speed. Explain.

Sol. No, velocity of free electrons during thermal motion is random. So, their net flow through any cross section is zero.

Ex.7 What are the possible paths of free electrons inside a conductor?

Sol. In the absence of electric field inside conductor, Free electrons are unaccelerated, so their path between consecutive collisions is straight line.

In the presence of electric field inside conductor, free electrons are accelerated so their path is generally curved.

Ex.8 The number of density of electrons in copper is $8.5 \times 10^{28}\ m^{-3}$. Find the current flowing through a copper wire of length 0.2 m, area of cross section $1 mm^2$, when connected to a battery of 3V. Given that electron mobility $= 4.5 \times 10^{-6} m^2\ V^{-1} s^{-1}$ and charge on electron $= 1.6 \times 10^{-19}$ C.

Sol. Here, V = 3 volt; $\ell = 0.2$ m; $A = 1\ mm^2 = 10^{-6}\ m^2$; $n = 8.5 \times 10^{28}\ m^{-3}$; $\mu = 4.5 \times 10^{-6}\ m^2 V^{-1} s^{-1}$

and $e = 1.6 \times 10^{-19}$C

The electric field set up across the conductor,

$$E = \frac{V}{\ell} = \frac{3}{0.2} = 15\ Vm^{-1}$$

Now, the current through the wire,

$I = n A \mu E e = 8.5 \times 10^{28} \times 10^{-6} \times 4.5 \times 10^{-6} \times 15 \times 1.6 \times 10^{-19} = 0.92$ A

Ex.9 A wire is pulled through a dice so that its length is doubled. What happens to its resistance?

Sol. $R = \rho\frac{l}{A} = \rho\frac{l^2}{Al}$ Since, volume (=Al)

remains constant $R \propto l^2$. As the length is doubled, resistance becomes four times of the initial resistance.

Ex.10: The potential difference across a wire of $10^{-3}\ cm^2$ cross–sectional area and 50 cm length is 2 volt, when a current of 0.25 amp exists in wire. Calculate-

(i) field strength in the wire

(ii) the current density

(iii) the conductivity of the metal

Sol. (i) E= V/d = 2 volt/50 cm = $\frac{2Volt}{0.5meter}$ = 4 V/m

(ii) $J = i/A = 0.25\ amp/10^{-3} \times 10^{-4}\ m^2$

$= 2.5 \times 10^6\ A/m^2$

(iii) $\sigma = J/E = (2.5 \times 10^6\ A/m^2$ or V/m)

$= 6.25 \times 10^5$ mho/m

Ex.11 : The resistance of a tungsten filament at 150° C is 133 ohm. Its resistance at 500° C will be –

(The temperature coefficient of resistance of tungsten is 0.0045 per °C)

(1)257 Ω (2)79 Ω (3) 50 Ω (4) none of these

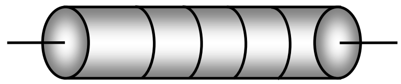
Sol.: If the resistance of a wire at 0° C be R_0 and at t^0C be R_t, then $R_t = R_0(1 + \alpha t)$ or $R_0 = \frac{R_1}{1+\alpha t}$

where α is the temperature coefficient of resistance. The resistance of the filament at 150°C is 133 ohm. Therefore, its resistance at 0° C will be given by $R_0 = \frac{133}{1+(0.0045)\times 150}$ = 79.0 ohm

Now, the resistance of the filament at 500° C will be

$R_{500} = R_0\ (1 + \alpha\ t_{500}) = 79.0\ [1+ (0.0045) \times 500] = 257\ \Omega$

Ex.12 Find the resistance of following carbon resistor.



Sol. First two bands = Red and Red So, first two significant figures of the resistance = 22

So decimal multiplier = 10^2

Last band = silver so, tolerance = ±10%

$\therefore$ R = $(22 \times 10^2)\Omega \pm 10\%$

PRACTICE SECTION-01

Q.1 Charge through a cross-section of a conductor is given by $Q = (2t^2 + 5t)$ C. Find the current through the conductor at the instant t = 2s.

Q.2 Current through a wire decreases from 4 A to zero in 10 sec. Calculate charge flown through the wire during this interval of time.

Q.3 The diameter of a copper wire is 2mm. If a steady current of 6.25 A is caused by 8.5×10^{28} /m^{-3} electrons flowing through it. The drift velocity of conduction electrons will be –

Q.4 Are the paths of free electrons straight lines between successive collisions (with the positive ions of metal wire) in the –

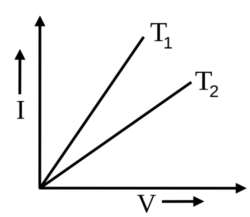
(1) Absence of electric field (2) Presence of electric field

Q.5 A potential difference of 200 volt is maintained across a conductor of resistance 100 ohm. Calculate the number of electrons flowing through it in one second. Charge on electron, $e = 1.6 \times 10^{-19}$ C.

Q.6 In a wire of length 8m and diameter 3mm, a current of 10 ampere is passed. The potential difference across the wire is found to be 6 volt. The resistance of wire will be–

Q.7 A cylindrical wire is stretched to increase its length by 10%. What will be the percentage increase in the resistance of the wire.

Q.8 The current voltage graphfor a given metallic wire at two different temperatures T_1 and T_2 are shown in fig. Which is true –



(1) $T_1 = T_2$ (2) $T_1 > T_2$

(3) $T_1 < T_2$ (4) None

Q.9 The resistance of a conductor at 20°Cs is 3.15 ohm and at 100° C is 3.75 ohm. Determine the temperature coefficient of resistance of the conductor also the resistance of the conductor at 0° C.

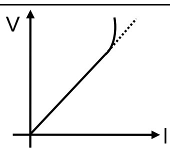
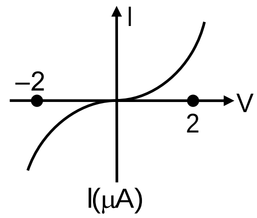
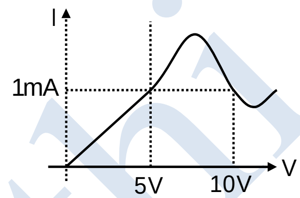
Q.10 How will you represent a resistance of 3700Ω ±10% by colour code?

ANSWER KEY

Q.1	i = 13 amp	**Q.2**	20 C	**Q.3**	0.15 mm/s	**Q.4**	(1) Yes, (2) No
Q.5	1.25×10^{19}	**Q.6**	R = 0.6 Ω	**Q.7**	22% increases	**Q.8**	(3)
Q.9	$R_0 = 3.0\ \Omega$, $\alpha = 0.025$ per °C			**Q.10**	Orange, Violet, Red, Silver		

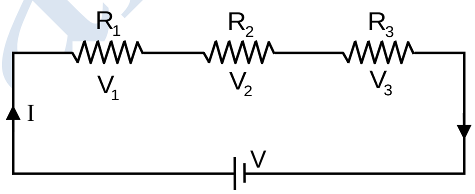
9. LIMITATIONS OF OHM'S LAW

The proportionality of V and I does not hold for certain materials and devices used in electric circuits. Followings are few types of deviations.

(i) V proportional to I for a good conductor	(ii) Value of current is different for same potential difference on reversing the direction of V in semiconductors	(iii) Value of potential is different for same current.
	 Characteristic curve of diode	 Variation of current Vs voltage for GaAs

10. COMBINATION OF RESISTORS

10.1 Series combination :



The combination of resistors will be termed as series, if same amount of current is flowing through the resistors.

$V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

Sum of the voltages across resistances is equal to the voltage applied across the circuit i.e.

$V = V_1 + V_2 + V_3 \quad V = IR_1 + IR_2 + IR_3$

$\frac{V}{I} = R_1 + R_2 + R_3 = R$

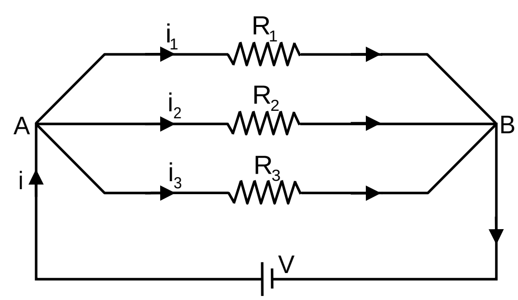
Where, R = equivalent resistance

In series combination, the potential drop across the circuit is divided in the ratio of resistance

i.e. $V_1 : V_2 : V_3 = R_1 : R_2 : R_3$ & $V_1 + V_2 + V_3 = V$

so $V_1 = \frac{R_1}{R_1+R_2+R_3}V \Rightarrow V_2 = \frac{R_2}{R_1+R_2+R_3}V \;\&\; V_3 = \frac{R_3}{R_1+R_2+R_3}V$

10.2 Parallel combination :



"Resistors will be parallel if the potential drop across them is same"

Current in each resistance is inversely proportional to the value of resistance i.e.

$i_1 = \frac{V}{R_1}$, $i_2 = \frac{V}{R_2}$, $i_3 = \frac{V}{R_3}$

Current flowing in the circuit is sum of the currents in individual resistances i.e.

$i = i_1 + i_2 + i_3 \qquad \Rightarrow i = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

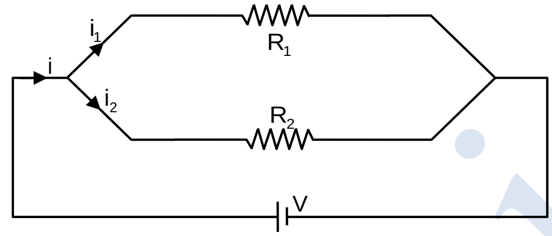
$\frac{i}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad \Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad \left(\because \frac{i}{V} = \frac{1}{R}\right)$

where R = equivalent resistance

KEY POINTS

- There is same drop of potential across each resistance.
  (i) The equivalent resistance of parallel combination is lower than the value of lowest resistance in the combination.
  (ii) For a parallel combination of two resistances

  $i = i_1 + i_2 = \dfrac{V(R_1 + R_2)}{R_1 R_2}$



If N identical resistances (i.e. each R) are connected

(a) in series, their equivalent resistance will be nR i.e. $R_s = nR$

(b) in parallel, their equivalent resistance will be R/n i.e. $R_p = R/n$

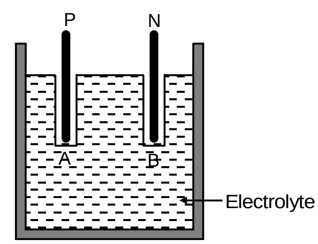
(c) $\dfrac{R_s}{R_p} = n^2$

11. CELL : EMF, INTERNAL RESISTANCE & TERMINAL VOLTAGE

11.1 Cell & Battery :

An electroltic cell consistic of two electrodes, called anode (P) and cathode (N) immersed in an electrolytic solution as shown in figure.

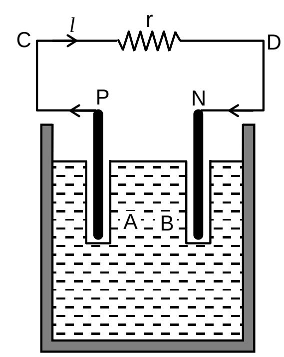
Electrodes exchange charges with the electrolyte.



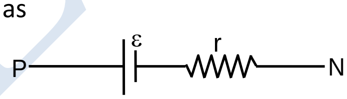
Battery can be considered as combination of multiple cells

When there is no current, the electrolyte is at same potential throughout, so the potential difference between P and N is known as electromotive force (emf) of the cell and denoted by ε.

Emf is a potential difference not a force. When a resistance R is connected across the cell as shown in figure, a current I flows from C to D. A steady current flows from P to N through the resistance R and flows from N to P through the electrolyte. the electrolyte through which current passes has a finite resistance r known as internal resistance of the cell.



A cell can be represented as



11.2 Parameter of cell

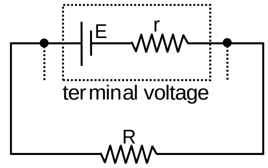
(a) Electro Motive Force (EMF):

The energy given by the cell in the flow of unit charge in the whole circuit (including the cell) is called the EMF of the cell. The potential difference across the terminals of a cell when it is not giving any current is called EMF of the cell. $E = \dfrac{W}{Q}$

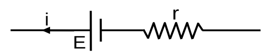
- emf depends on:
  (i) nature of electrolyte (ii) metal of electrodes
- emf does not depend on:
  (i) area of plates (ii) distance between the electrodes
  (iii) quantity of electrolyte (iv) size of cell

(b) Terminal voltage (V) :

- When current is drawn through the cell or current is supplied to cell then, the potential difference across its terminals is called terminal voltage.



- When i current is drawn from cell, then terminal voltage is less than it's emf E.
  $V = E - i\,r$



  Where V = terminal voltage, r = internal resistance of battery
- When current is supplied to the cell, the terminal voltage is greater than the emf E i.e. $V = E + i\,r$
- Units of both emf and terminal voltage are volt.

(c) Internal resistance (r):

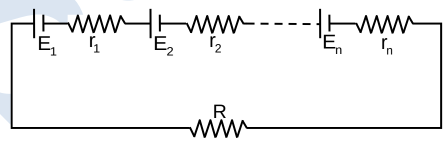
The resistance offered by the electrolyte of the cell to the flow of current through it is called internal resistance of the cell.

- Distance between two electrodes r
- Area dipped in electrolyte r↓
- Concentration of electrolyte r↓
- Temperature r ↓

11.3 Combination of Cell :

(a) Series Combination :

When the cells are connected in series the total e.m.f. of the series combination is equal to the sum of the e.m.f.'s of the individual cells and internal resistance of the cell also come in series.



equivalent internal resistance $r = r_1 + r_2 + r_3 + ...$

equivalent emf $= E = E_1 + E_2 + E_3 + ...$

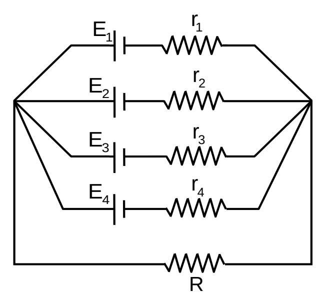
Current $I = \dfrac{E_{net}}{r_{net} + R}$

If all n cell are identical then $I = \dfrac{nE}{nr + R}$

- If nr >> R, $I = \dfrac{E}{r} \simeq$ current from one cell
- If nr << R, $I = \dfrac{nE}{R} \simeq$ n current from one cell

(b) Parallel Combination :

When the cells are connected in parallel, the cells can be replaced with a single cell of emf E_{net} & internal resistance r_{net}.



Internal resistance is $\dfrac{1}{r_{net}} = \dfrac{1}{r_1} + \dfrac{1}{r_2} + ...$ and $E_{net} = \dfrac{\dfrac{E_1}{r_1} + \dfrac{E_2}{r_2} + ...}{\dfrac{1}{r_1} + \dfrac{1}{r_2} + ...}$

If m identical cell connected in parallel then total internal resistance of this combination $r_{net} = \dfrac{r}{m}$

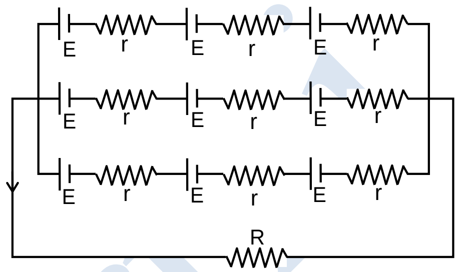
Total e.m.f. of this combination $E_T = E$

Current in the circuit $I = \dfrac{E_r}{R + \dfrac{r}{m}} = \dfrac{E}{R + \dfrac{r}{m}} = \dfrac{mE}{mR + r}$

$\rightarrow$ If $r << mR$; $I = \dfrac{E}{R}$ = Current from one cell $\rightarrow$ If $r >> mR$; $I = \dfrac{mE}{r}$ = m current from one cell

(c) Mixed combination :

Total number of identical cell in this circuit is nm. If n cells connected in series and their are m such branches in the circuit.



The internal resistance of the cells connected in a row = nr

Total internal resistance of the circuit

$r_{net} = \dfrac{nr}{m}$ ($\because$ There are such m rows)

Total e.m.f. of the circuit = total e.m.f. of the cells connected in a row i.e. E_T or $E_{net} = nE$

$$I = \frac{E_{net}}{R + r_{net}} = \frac{nE}{R + \dfrac{nr}{m}}$$

Current in the circuit is maximum when external resistance in the circuit is equal to the total internal resistance of the cells $R = \dfrac{nr}{m}$

12. KIRCHOFF'S RULE :

Kirchhoff in 1842 gave two laws for solving complicated electrical circuits. These laws are as follows–

12.1 First law :

In an electrical circuit, the algebric sum of the current meeting at any junction in the circuit is zero.

OR

Sum of the currents entering the junction is equal to sum of the currents leaving the junction

$\Rightarrow \Sigma i = 0$

$i_1 - i_2 - i_3 - i_4 + i_5 = 0$ or $i_1 + i_5 = i_2 + i_3 + i_4$

This law is based on law of conservation of charge. In other words, when a steady current flows in a circuit then their is neither accumulation of charge at point in the circuit nor any charge is removed from there.

12.2 Second law :

In a 'closed' mesh of a circuit the algebric sum of the products of the current and the resistance in each part of the mesh is equal to the algebric sum of the e.m.f.'s in that mesh. i.e.

$\Sigma iR = \Sigma E$

Important notes :

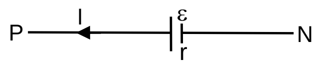
(i) In applying this law, when we traverse in the direction of current then the product of the current and the corresponding resistance is taken as positive, and the emf is taken as positive when we traverse from the negative to the positive electrode of the cell through the electrolyte.

(ii) This law is based on 'law of conservation of energy'.

12.3 Sign Conventions

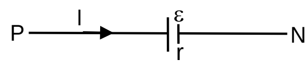
If the current is flowing through the resistance R from A to B, then potential difference across AB is $V_A - V_B = IR$ (Is determined to be positive).

Similarly potential difference across BA, $V_B - V_A = -IR$ (I is determined to be negative).



then, potential difference across the cell $V = V_P - V_N = \varepsilon - Ir$

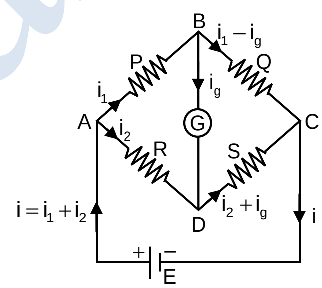
If the current is flowing from P to N



then $V = V_P - V_N = \varepsilon + Ir$

13. WHEAT STONE BRIDGE

- The configuration in the adjacent figure is called wheat stone bridge.
- If $i_g = 0$ i.e. current in galvanometer is zero, then bridge is said to be balanced.
- For $i_g = 0$ (i) $V_D = V_B$ (ii) $\frac{P}{Q} = \frac{R}{S}$
- Equivalent resistance in balanced condition = $\frac{(P+Q)(R+S)}{P+Q+R+S}$
- If $\frac{P}{Q} < \frac{R}{S}$ then $V_B > V_D$ and current will flow from B to D.
- If $\frac{P}{Q} > \frac{R}{S}$,then $V_B < V_D$ and current will flow from D to B.
- Meter bridge and post office box work on this principle.

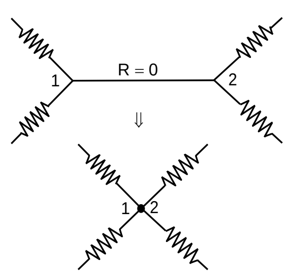


14. SHORTING / EQUIPOTENTIAL POINTS

Equipotential Points

In a current carrying electrical network, two points are said to be equipotential if they are at same potential. Between the points 1 and 2,

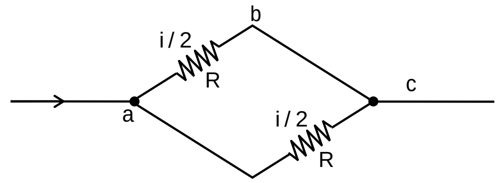
$V_1 = V_2$, if $\Delta V = iR = 0$.



Then we have two cases, if R = 0, $\Delta V = 0$ ($i \neq 0$) and if i = 0 (R is finite) $\Delta V = 0$. The first case tells that when we connect any two points by an ideal conductor, the potential difference between them becomes zero. It is called "short circuiting". The second case tells that, if we connect any two points by a non-zero resistor and find no current along the resistor, we can call these points equipotential. After finding equipotential points join them to a single point to simplify the given circuit.

15. ELECTRIC SYMMETRY :

If the branches ab and ac have same resistances, and same current, same potential will be dropped along them. hence the branches ab and ac are electrically symmetrical. In this case, case, the points b and c are equipotential points. Then you can join these points



16. EARTHING OF A CIRCUIT POINT:

If any Node junction of the circuit is earthed, the potential of that node junction becomes zero. i.e. the same node junction becomes the reference potential.

17. ELECTRICAL ENERGY & POWER

17.1 Electric energy :

When a potential difference is applied across a wire, current starts flowing in it. The free electrons collide with the positive ions of the metal and lose energy. Thus energy taken from the battery is dissipated. The battery constantly provide energy to continue the motion of electron and hence electric current in the circuit. This energy is given to ions of the metal during collision and thus temperature of wire rises. Thus, energy taken from the battery gets transferred in to heat. This energy is called electrical energy. This effect is also called 'Heating Effect of Current'. If

R = Resistance of wire   I = Current in wire

V = Potential difference across wire.   Flow of charge in 'dt' time = Idt.

Energy dissipated dW = Vdq = VIdt,

$\because$ V = IR, $\therefore$ $dW = VIdt = I^2Rdt = \frac{V^2}{R}dt = Vdq$

This energy is equal to work done by battery or heat produced in the wire.

If energy is to be written in calorie–

Then $dW \text{ joule} = \frac{dW}{4.2} \text{ cal}$ Where dW is energy in Joules.

17.2 Electrical power:

The rate of loss of energy in an electrical circuit is called electrical power. It is denoted by 'P'

$P = \frac{dW}{dt} = I^2 R = IV = \frac{V^2}{R}$

units of power = joule/sec, watt, horse power

1 watt = 1 joule/sec, 1 HP = 746 watt

unit of electrical energy = watt second, kilowatt hour

1 kilowatt hour (kwh) = 36×10^5 Joule

17.3 Power loss in transmission lines :

Consider a device of resistance R to be operated at voltage V and current through is I, then power of devices P = VI. If resistance of connecting wires from power station to the device, then

$$P_C = I^2R_C = \frac{P^2R_c}{V^2}$$

Therefore to drive a device of power P, the power wasted in the connecting wires $P_C \propto \frac{1}{V^2} \propto R_c$

As the distance of power station is very large, R_C is considerable. So to decrease P_C, these wires carry current at enormous values of V and this is the reason for high voltage danger signs on transmission lines. These voltages are lowered to a value suitable for use by a device known as transformer.

KEY POINTS

1. **Fuse Wire :** Fuse wire is used in a circuit to control the maximum current flowing in a circuit. It is a thin wire having high resistance and is made up of a material with low melting point.

Current capacity $I \propto r^{3/2}$, $I \propto \ell^0$

2. House wiring circuits are in parallel therefore the voltage across each bulb is constant. The power of the bulb is given by the formula : $P = V^2/R$. For constant voltage $P \propto (1/R)$ therefore, the greater the resistance, the smaller is the power. Hence, if we take two bulbs of 60W and 100W, then the resistance of 60W bulb will be more than the resistance of 100 W bulb.

3. The filament of 60W bulb is thinner than the filament of 100 watt bulb.

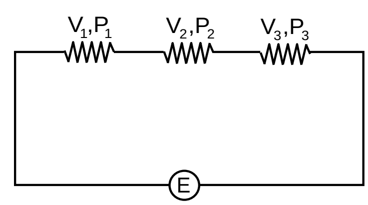
18. CONNECTION OF ELECTRICAL APPLIANCES:

18.1 Rating

If 220V and 40W is written on an electrical instrument then this is called it's standard Ratings. It means that if 220V is applied across this instrument then 40W of power will be generated. Thus the resistance will be given by

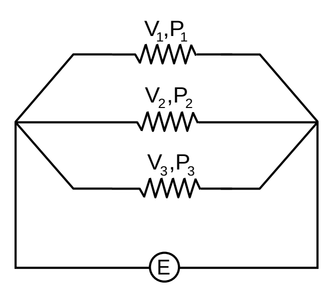
$$R = \frac{V^2}{P} = \frac{(220)^2}{40} \text{ ohm}$$

18.2 Series combination :



- If total power dissipated if P, then $\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3}$,
- In this combination, the bulb with least power will glow most and bulb with highest power will glow least or we can say that bulb with highest R will glow brightest and bulb with least R will glow least.

18.3 Parallel combination :



- Net power dissipation $P = P_1 + P_2 + P_3$
- Bulb with least power will glow least or the bulb in which maximum current is flowing will glow brightest and vice–versa.

Note :

(1) These formulae are applicable only if the voltage ratings of all the instruments are equal along with the power source. If voltage ratings are different then circuit is solved by considering equivalent resistances of the instruments as follows.

(2) Replace the instrument by it's equivalent resistance. If standard rating is (V&P) then it resistance is $R = V^2/P$

(3) Find the currents and voltages in different branches using kirchoff's first and second laws.

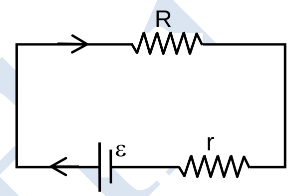
(4) If rating of a bulb is changed from (V_1,P_1) to (V_2,P_2) then $\frac{V_1^2}{P_1} = \frac{V_2^2}{P_2} = R$ or $P_2 = \frac{V_2^2}{V_1^2} P_1$

KEY POINTS

- Two identical heater coils gives total heat H_s when connected in series and H_p when connected in parallel than $H_p/H_s = 4$ [In this, it is assumed that supply voltage is same]
- If a heater boils m kg water in time T_1 and another heater boils the same water in time T_2, then both connected in series will boil the same water in time $T_s = T_1 + T_2$ and if in parallel $T_p = T_1T_2/(T_1+T_2)$
- Instruments based on heating effect of current, works on both A.C. and D.C. Equal value of A.C. (RMS) and D.C. produces, equal heating effect. That's why brightness of bulb is same whether it is operated by A.C. or same value D.C.

19. POWER DISTRIBUTION BY CELL

(i) When a load resistance 'R' is connected with a battery of EMF & internal resistance 'r'. then



(a) Current through the load $I = \dfrac{\varepsilon}{R+r}$

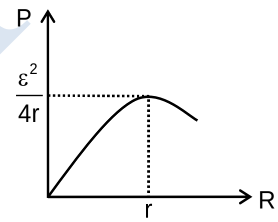
Power delivered at the load $P = I^2R = \dfrac{\varepsilon^2 R}{(R+r)^2}$

Power delivered at load is maximum, when $\dfrac{dP}{dR} = 0$

Solving above equation R = r

$P_{max} = \dfrac{\varepsilon^2 r}{(r+r)^2} = \dfrac{\varepsilon^2}{4r}$

(b) P versus r graph will be



SOLVED EXAMPLES

Ex.13 Resistance R, (R + 1), (R + 2) .... (R + n) Ω are connected in series, their equivalent resistance will be –

(1) $(n+1)\left[R+\dfrac{n}{2}\right]$ (2) $(n-1)\left[R-\dfrac{n}{2}\right]$ (3) n (R + n) (4) n (R – n)

Sol.: Suppose the equivalent resistance of the given resistance be R', then

$R' = R + (R+1) + (R+2) + \ldots\ldots (R+n) = \dfrac{(n+1)}{2}[2R + (n+1) - 1] = \dfrac{(n+1)}{2}[2R+n] = (n+1)\left[R+\dfrac{n}{2}\right]$

Ex.14 The resistance of two conductors in series is 40Ω and their resistance becomes 7.5Ω when connected in parallel. The resistance are–

(1) $R_1 = 25\Omega, R_2 = 15\Omega$ (2) $R_1 = 5\Omega, R_2 = 35\Omega$ (3) $R_1 = 30\Omega, R_2 = 10\Omega$ (4) $R_1 = 20\Omega, R_2 = 20\Omega$

Sol. In Series $R_1 + R_2 = 40\Omega$ .... (1)

In Parallel $\dfrac{R_1R_2}{R_1+R_2} = 7.5\ \Omega$

Since $(R_1 - R_2)^2 = (R_1+R_2)^2 - 4R_1R_2 = 40^2 - 1200 = 400$

$R_1 - R_2 = 20$ .... (2)

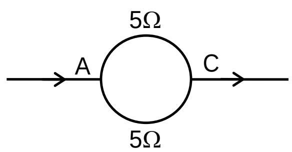
Solving (1) and (2),

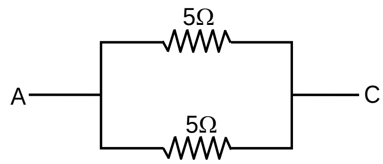
$R_1 = 30\Omega$ and $R_2 = 10\Omega$

Ex.15 A wire of resistance 10 Ω is bent to form a complete circle. It's resistance between two diametrically opposite points will be (in Ω)

(1) 3.5 (2) 5 (3) 2.5 (4) 1.5

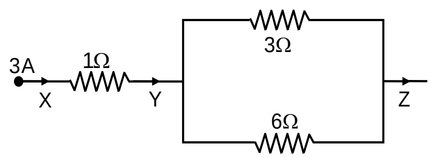
Sol. The configuration is similar to





Hence, equivalent resistance = $\frac{5\times5}{5+5}$ Ω = 2.5Ω

Ex.16 In the following figure, the ratio of current in 3Ω and 1Ω resistances is–

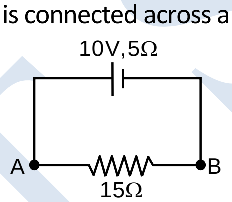


(1) 1/3 (2) 2/3 (3) 1 (4) 2

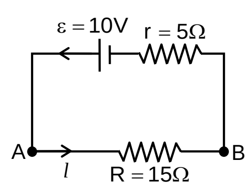
Sol. The current in 1 Ω resistance is 3A. The current in 3Ω resistance is $I_1 = \frac{R_2}{R_1+R_2} I = \frac{6}{3+6} \times 3 = 2A$.

Therefore, the ratio is 2/3.

Ex.17 A cell of emf 10 V and internal resistance 5Ω is connected across a resistance 15Ω. Find potential difference across AB.



Sol. Above circuit can be redrawn as Current I through R is from A to B.



Network is simple series network.

Total resistance = R + r = (15 + 5) Ω = 20Ω

Current $I = \frac{\varepsilon}{R+r} = \frac{10V}{20\Omega} = 0.5$ A

Potential difference across AB

$V_A - V_B = IR = (0.5\ A) \times 15\Omega = 7.5$ V

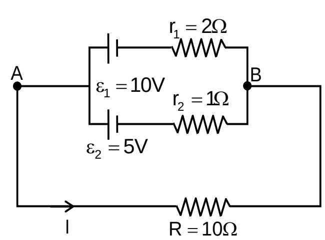
Ex.18 A battery of emf 2 volts and internal resistance 0.1Ω is being charged with a current of 5A. The potential difference between terminal of the battery is?

(1) 1.5V (2) 2.5V (3) 3.5V (4) 4.5V

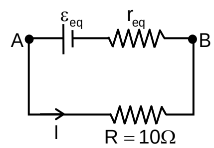
Sol: Potential drop across internal resistance = 0.1 × 5 = 0.5V

Hence, potential difference across terminals will be 2 + 0.5 = 2.5V

Ex.19 Find the current I through the 10Ω resistance in the network shown in figure.



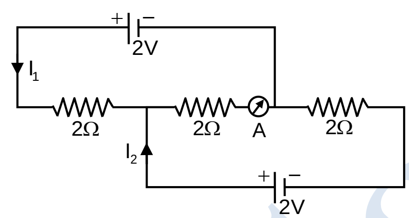
Sol. Across A and B two cells are used in parallel so above circuit can be redrawn as



$$\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} = \frac{10\times1+5\times2}{1+2} = \frac{20}{3}\,V \Rightarrow r_{eq} = \frac{r_1 r_2}{r_1 + r_2} = \frac{1\times2}{1+2} = \frac{2}{3}\Omega$$

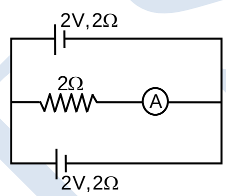
$$\text{current through R} \Rightarrow I = \frac{\varepsilon_{eq}}{R + r_{eq}} = \frac{\frac{20}{3}}{10+\frac{2}{3}} = \frac{20}{32}\times A = \frac{5}{8}\,A$$

Ex.20 The reading in the ammeter is –



(1) 1 A (2) 2 A (3) 0.67 A (4) 1.5 A

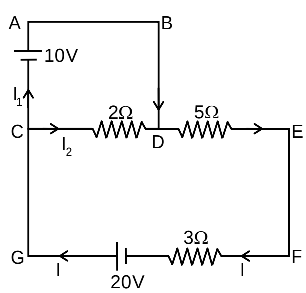
Sol. The circuit can be redrawn as



So the current flowing through the load will be (as based on parallel combination of cells)

$$I = \frac{E_r}{R+\frac{r}{m}} = \frac{E}{R+\frac{r}{m}} = \frac{2}{2+\frac{2}{2}} = 0.67\text{ Amp}$$

Ex.21 In the network in given find the current I_1 through the 10 V battery.



Sol. Applying junction rule to C to D

$I = I_1 + I_2$ ....(i)

10 V battery is connected alone across CD so

$V_D - V_C = 10$ V

$\therefore\ I_2 = \dfrac{V_C - V_D}{2\Omega} = \dfrac{-10V}{2\Omega} = -5A$ ....(ii)

(Negative sign indicated current I_2 is from D to C)

Applying loop rule to CDEFGC

$2I_2 + 5I + 3I - 20 = 0 \Rightarrow 2(-5) + 8I - 20 = 0$

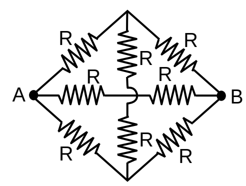
$\Rightarrow -10 + 8I - 20 = 0$

$\Rightarrow \quad I = \frac{30}{8} = \frac{15}{4} A$

From equation (i) we get

$I_1 = I - I_2 = \frac{15}{4} A - (-5A) = \left(\frac{15}{4} + 5\right) A = \frac{35}{4} A$

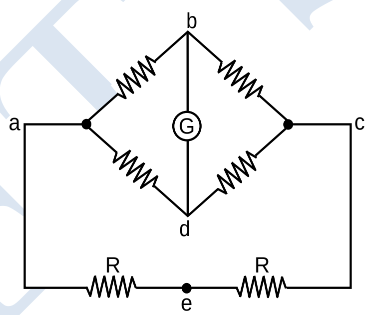
Ex.22: The equivalent resistance between A and B is–



(1) 2R/3 (2) R/3 (3) R (4) 3R

Sol. The circuit is equivalent to Fig. It is a balanced wheatstone bridge between abcd, and then in parallel (2R) resistances. Thus ignoring resistance between bd arm. The circuit is equivalent to three (2R) resistances in parallel (abc, adc, aec).

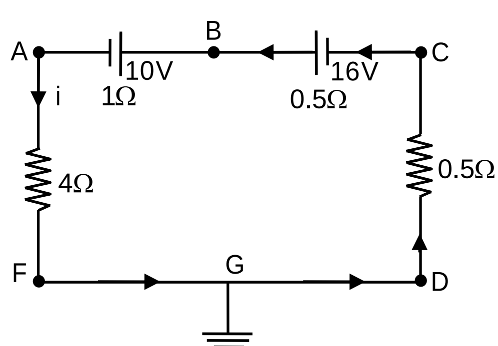
i.e. $\frac{1}{R_{eq}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{2R} = \frac{3}{2R} \Rightarrow R_{eq} = \frac{2}{3} R$



Ex.23: From the fig. determine

(i) potential at A (ii) potential at C

(iii) reading of the voltmeter connected across the 10V battery



Sol. The current in circuit is (consider loop (CBAFGDC)

$$I = \frac{E_2 - E_1}{r_1 + r_2 + R_1 + R_2} = \frac{16 - 10}{1 + 0.5 + 4 + 0.5} = 1A$$

(i) $V_A - V_F = IR = 4$ volt

Because $V_F = 0$(grounded), therefore $V_A = 4$ volt

(ii) $V_D - V_C = 1 \times 0.5 = 0.5$ volt

$\therefore$ $V_D = 0$ (grounded),

So, $V_C = -0.5$ volt

(iii) The 10V battery is being charged therefore

$V = E + Ir = 10 + 1 \times 1 = 11$ volt

Ex.24 Calculate the number of electrons moving per second through the filament of a lamp of 100 watt operating at 200 volt. Given charge on electron $e = 1.6 \times 10^{-19}$ C.

Sol. Here, charge on the electron, $e = 1.6 \times 10^{-19}$C

Power of the lamp, P = 100 W   operating voltage, V = 200 volt

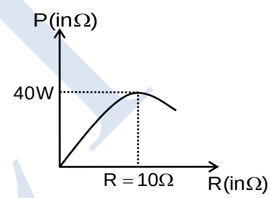
Now, P = V I $\therefore I = \frac{P}{V} = \frac{100}{200} = 0.5$ A

The charge passing through the lamp in 1s, $q = I \times t = 0.5 \times 1 = 0.5$ C

Therefore, the number of electrons moving through the filament per second is

$$n = \frac{q}{e} = \frac{0.5}{1.6 \times 10^{-19}} = 3.125 \times 10^{18}$$

Ex.25 The power delivered across a variable load varies with load resistor as shown. Find out its emf & internal resistance



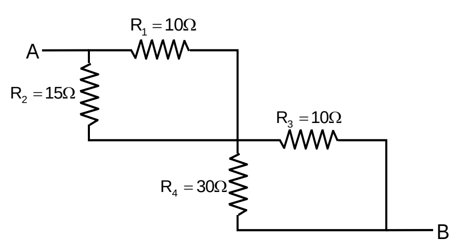
Sol. For maximum power delivery

$r = R = 10\Omega$

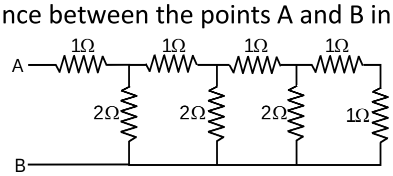
$P_{max} = 40W = \frac{\varepsilon^2}{4r} \Rightarrow \varepsilon = 40$ V

PRACTICE SECTION-02

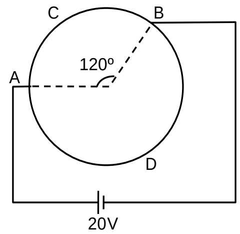
Q.1 Find the resistance across AB.



Q.2 What will be the resultant resistance between the points A and B in the following diagram?



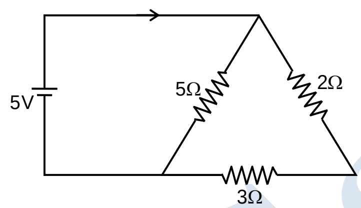
Q.3 A wire of resistance 15Ω is connected with a battery after being bent in the form of circuit as shown calculate



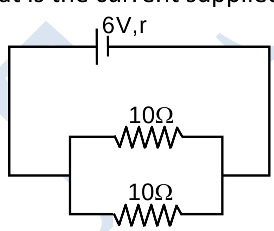
(A) Effective resistance across A & B
(B) Current supplied by the battery
(C) Current flowing through ADB

Q.4 An electric current of 17 A. is divided in three branches forming a parallel combination. The length of the wire in the three branches are in the ratio, 2 : 3 : 1; their diameters are in the ratio 1 : 2 : 1. Find the currents in each branch if the wire are of the same material.

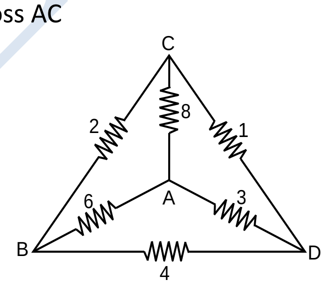
Q.5 The current I through the cell in the network shown is



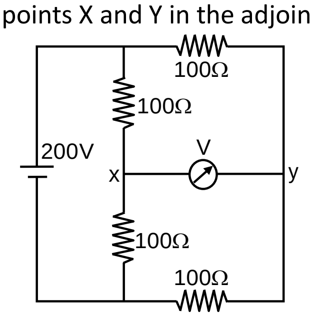
Q.6 A battery of emf 6 volts and internal resistance 0.4Ω is being charged. The potential difference between terminal of the battery is 7 V, then what is the current supplied to the battery ?



Q.7 Calculate equivalent resistance across AC

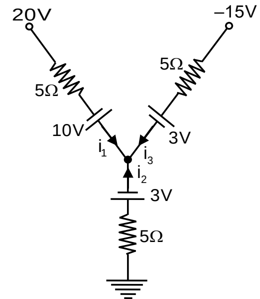


Q.8 The potential different between the points X and Y in the adjoining diagram Fig. will be –



(1) zero (2) 50 V (3) 10 V (4) 100V

Q.9 In the network of three cells, find the potential V of their junction(O).



Q.10 A lamp of 100 W works at 220 volt. What is its resistance and current capacity ?

Q.11 Two batteries of EMF 12 volts & internal resistance 6Ω& 3Ω. When connected in series delivers equal power along resistors of value 2Ω& R. Calculate the value of R.

ANSWER KEY

Q.1 R_{AB} = 13.5 Ω **Q.2** R_{AB} = 2Ω **Q.3** (A) $R_{eff} = \frac{10}{3}\Omega$; (B) I = 6 A; (C) I_{ADB} = 2A

Q.4 I_1 = 3 amp; I_2 = 8 amp; I_3 = 6 amp **Q.5** I = 2A **Q.6** I = 2.5 A

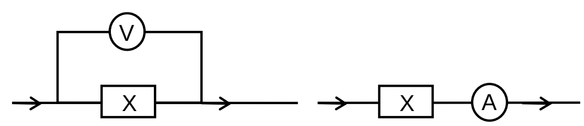
Q.7 R_{eq} = 2Ω **Q.8** (1) **Q.9.** 3 V

Q.10 R = 484 Ω, I = 0.45 A **Q.11** R = 40.5 Ω

MEASURING DEVICES :

20. CURRENT & VOLTAGE MEASUREMENT

In D.C. circuits, we talked about emf, voltage, current and resistance. We measure the unknown resistance by using Ohm's law as $R = \frac{V}{I}$. The voltage across any circuit element can be measured by "voltmeter" and current along any branch can be measured by "ammeter". The emf of a cell can be measured by "potentiometer". Generally, we measure the voltage and current in a circuit element X by connecting the voltmeter and ammeter in two possible ways. The basic instrument that can be used for measuring both voltage and current is called "galvanometer". A galvanometer can be used as an ammeter and voltmeter by attaching it with a suitable resistance.

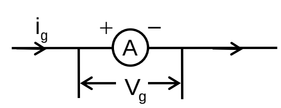


20.1 Galvanometer

This device measures the current by means ofmagnetic force which will be discussed in next chapter. The maximum current that can flow through the galvanometer is current i_g (or full scale deflection) and the corresponding voltage drop across the galvanometer is V_g. Then $\frac{V_g}{i_g}$ = Galvanometric resistance = G. The deflection θ in moving coil galvanometer is directly proportional to current i flowing through it.

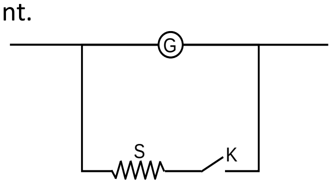
$i \propto \theta$; or $i = k\theta$; (k is called galvanometric constant),

where $\frac{\theta}{i} = \frac{1}{k}$ is called sensitivity which is defined as the current per unit deflection.



(A) Shunt

The small resistance connected in parallel to galvanometer coil, in order to control current flowing through the galvanometer is known as shunt.



(B) Merits of shunt

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

(C) Demerits of shunt

Shunt resistance decreases the sensitivity of galvanometer.

20.2 Ammeter

- Ammeter is a shunted galvanometer which is used to measure current in a circuit.
- It is always connected in series so that the entire current passes through it.
- In principle, the current in the circuit must not change when a current measuring device like ammeter is introduced in the circuit therefore, **AN IDEAL AMMETER MUST HAVE ZERO RESISTANCE.**
- However in practice, a moving coil meter has some resistance. Due to this the current in circuit is modified (reduced) when a moving coil ammeter is connected in circuit.

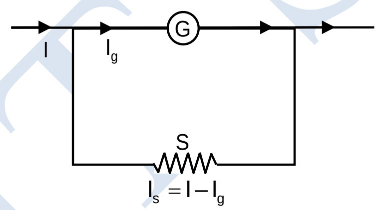
20.3 Voltmeter

Voltmeter is a device used to measure p.d. across two points in an electrical circuit. It is connected in parallel to these points.

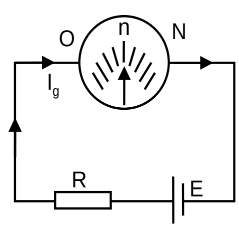
Note: The ammeter is connected in series to a circuit, while voltmeter in parallel to circuit.

20.4 Conversion of galvanometer into ammeter :

- A galvanometer can be converted into an ammeter of a given range by connecting low resistance in parallel to its coil.
- From fig. $I_g G = (I - I_g)S$ or $S = \frac{I_g G}{I - I_g}$



- Higher is the range of I of ammeter, lower is the value of S required for conversion of galvanometer into ammeter.
- Let n is the deflection (in division) in the galvanometer. Let N is the total number of division on the scale of galvanometer, then $I_g = \frac{E}{R+G}\left(\frac{N}{n}\right)$



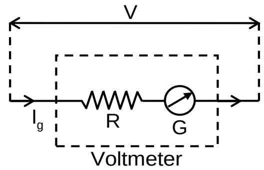
The effective resistance of the ammeter is $R_A = \frac{GS}{G+S}$

For an IDEAL AMMETER, $R_A = 0$

20.5 Conversion of galvanometer into voltmeter :

- A galvanometser is converted into a voltmeter by connecting a high resistance R in series with the galvanometer.

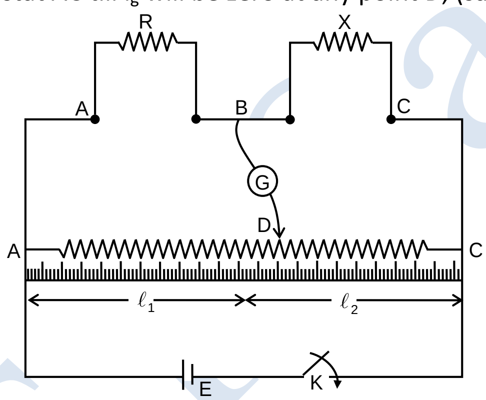
- From fig. $I_g (R + G) = V$ or $R = \frac{V}{I_g} - G$



- Higher is the range of V of the voltmeter, higher is the value of R required for conversion of galvanometer into voltmeter.
- The effective resistance of the voltmeter is $R_V = R + G$
  For an IDEAL VOLTMETER, $R_V = \infty$.

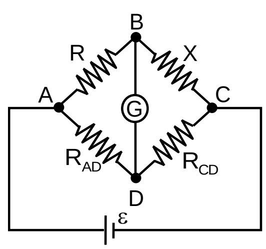
21. METER BRIDGE

It is an instrument based on the balanced wheatstone bridge to measure the unknown resistance X, say fitted between the tapping points B and C when a known resistance R is fitted between the tapping points A and B. The slider D is moved along the rheostat AC till i_g will be zero at any point D, (say).



Then, $\frac{R_{AD}}{R_{DC}} = \frac{\ell_1}{\ell_2}$, where ℓ_1 and ℓ_2 are the lengths of the resistance R_{AD} and R_{DC} measured by the scale.

If $\ell_1 + \ell_2 = 1$ m, $\ell_1 = y$, we have $\ell_2 = (1 - y)$. After finding the value of $\frac{\ell_1}{\ell_2}$, equate it with the ratio R/X to obtain the unknown resistance.

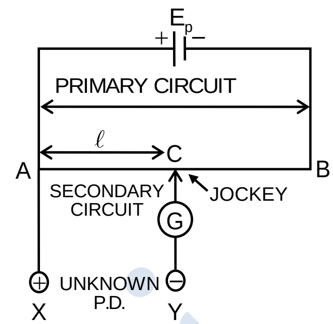


22. POTENTIOMETER

- It is an ideal instrument for measuring the emf of a cell or potential difference between two points of an electric circuit.
- It is equivalent to a voltmeter with infinite resistance because, when it is used in an electric circuit, it does not draw any current from the main circuit. That's why it is called 'Ideal Voltmeter'.
- Potentiometer consists of a long wire (1m to 10m long) of uniform cross–section and homogeneous material.
- Potentiometer wire is made of material for which temperature coefficient = Low, and Resistivity = High.
- Materials used to construct potentiometer are alloys e.g. eureka, manganin, constantan etc.

22.1 Principle

The potentiometer is based upon the principle that when a constant current is passed through a wire of uniform area of cross–section, the potential drop across any portion of wire is directly proportional to the length of that portion.



$E_P \rightarrow$ e.m.f. of cell used in primary circuit

$E_S \rightarrow$ e.m.f of cell used in secondary circuit

$R_W \rightarrow$ Resistance of potentiometer wire

$L \rightarrow$ length of potentiometer wire

- In balanced stage it does not draw any current from the main circuit, whose p.d. is being measured.
- When we connect unknown p.d. between X and Y and if galvanometer does not show any deflection then p.d across A and C = p.d. across X and Y
- Also at this stage no current flows from X to A or A to X or C to Y or Y to C. i.e. primary circuit and secondary circuit work independently.

22.2 Potential Gradient (ϕ)

(i) The fall of potential per unit length of potentiometer wire is known as potential gradient

From above fig. $\phi = \frac{V_{AB}}{L} = \frac{IR_w}{L}$

(ii) ϕ **directly depends upon–**

- the resistance per unit length of potentiometer wire ρ $\left(\therefore \rho = \frac{R_w}{L}\right)$
- the radius of potentiometer wire (a)
- the specific resistance of the material of potentiometer wire (ρ)
- the current flowing through potentiometer wire.

$$I = \frac{E_p}{R + r + R_w}$$

(iii) ϕ **indirectly depends on–**

- the e.m.f. of battery in the primary circuit (E_P)
- the resistance of rheostat in the primary circuit (R_h)
- the total resistance of potentiometer wire R and its total length ($\therefore$ $R_W = \rho L$)
- When no resistance other than the potentiometer wire is connected in the potentiometer circuit.

$$\phi = \frac{E_p}{L}$$

E_P = e.m.f. of the battery used in primary circuit.

L = length of potentiometer wire.

- When the current flowing in the primary circuit is given

$\Rightarrow \phi = I\rho$ where $\rho = \frac{R_p}{L}$ ρ = resistance per unit length of potentiometer wire.

- When potential difference V is constant. Then

$$\frac{\phi_1}{\phi_2} = \frac{L_2}{L_1}$$

- When two wires of lengths L_1 and L_2 and resistance R_1 and R_2 are joined together to form the potentiometer wire, them

  $$\frac{\phi_1}{\phi_2} = \frac{R_1}{R_2} \cdot \frac{L_2}{L_1}$$

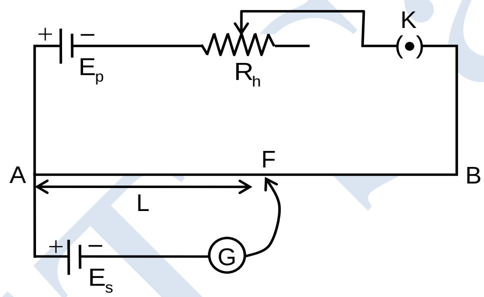
- potential gradient, $\phi = \dfrac{E_p R_w}{(Rw + R + r)L}$

  If $r \to 0$ & $R \to 0$ then $\phi_{max} = \dfrac{E_p}{L}$

- If the length of potentiometer wire and potential difference across its ends are kept constant and if its diameter is changed from d_1 to d_2 then potential gradient remains unchanged i.e. $\phi_1 = \phi_2$
- If the specific resistance of material of wire is changed from R_1 to R_2, then also potential gradient remains unchanged.
- The unit of potential gradient is V/m or V/cm.
- The dimension of ϕ are $MLT^{-3} A^{-1}$.

22.3 Standardization of potentiometer:

The process of determining potential gradient experimentally is known as standardization of potentiometer.



22.4 Sensitivity :

- A potentiometer is said to be more sensitive, if it measures a small potential difference more accurately.
- The sensitivity of potentiometer is assessed by its potential gradient. The sensitivity is inversely proportional to the potential gradient.
- In order to increase the sensitivity of potentiometer the resistance in primary circuit will have to increase.
- The length of potentiometer wire will have to be increased so that the length may be measured more accuracy.

22.5 Difference between

Potentiometer and voltmeter :

(A) Potentiometer :

- Its resistance is infinite
- It does not draw any current from the source of known e.m.f
- The potential difference measured by it the actual potential difference
- Its sensitivity is high
- It is a versatile instrument
- It is based on zero deflection method.

(B) Voltmeter :

- Its resistance is high but finite.
- It draws some current from source of e.m.f.
- The potential difference measured by it < actual potential difference.
- Its sensitivity is low.
- It measures only e.m.f. or potential difference.
- It is based on deflection method.

22.6 Based on the principle of potentiometer

- Consider the circuit shown in fig. If on switching on the key K, the current in the circuit remains the same then what is the emf E_1 ?

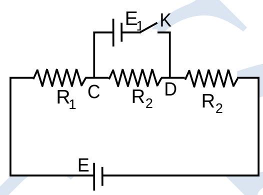
  Obviously, the p.d. across points C, D is equal to emf E_1

  $E_1 = IR_2$

  where current I in the circuit is

  $I = E/(R_1 + R_2 + R_3)$

  Thus $E_1 = ER_2/(R_1 + R_2 + R_3)$

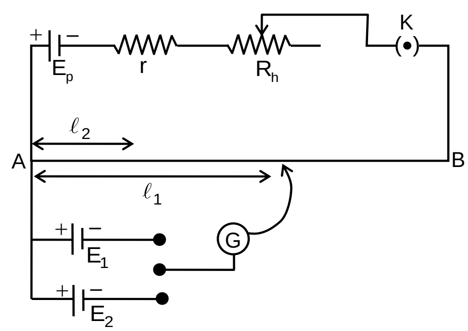


23. APPLICATION OF THE POTENTIOMETER:

23.1 Comparison of emf's :

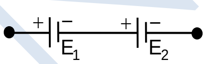
Let ℓ_1 and ℓ_2 be the balancing lengths with the cells E_1 and E_2 respectively then $E_1 \alpha\, \ell_1$ and $E_2 \alpha\, \ell_2$

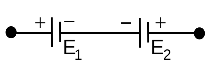
$$\Rightarrow \frac{E_1}{E_2} = \frac{\ell_1}{\ell_2}$$



Note :

Let $E_1 > E_2$ and both are connected in series.

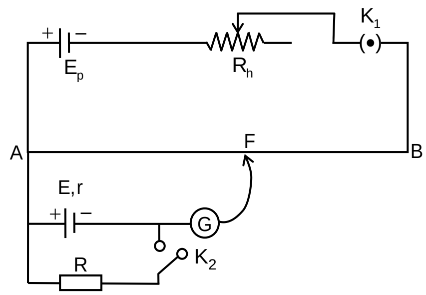
(a) 

(b) 

- For this combination, let ℓ_1 be balancing length, then $E_1 + E_2 = \phi\, \ell_1$ See figure (a)
- For this combination, let ℓ_2 be the balancing length, then $E_1 - E_2 = \phi\, \ell_2$ See figure (b)
- $\frac{E_1}{E_2} = \frac{\ell_1 + \ell_2}{\ell_1 - \ell_2}$

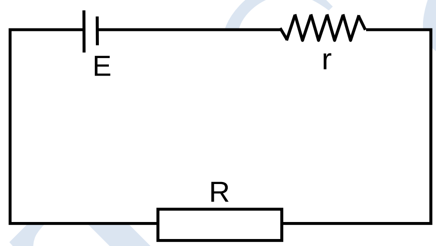
23.2 (Measurement of internal resistance) :

- The balance point (ℓ_1) is found with the key K_2 open, this measures E, since no current is flowing from the cell. $E = \phi\ell_1$



- The key K_2 is now closed and a second balanced point (ℓ_2) is found. This measure the p.d. (V) between the terminals of the cell (in this case, some current flows through resistor R so V < E)
  $V = \phi\ell_2$

- $\because E = V + Ir \Rightarrow \ r = \dfrac{E-V}{I} \Rightarrow r = \left(\dfrac{E-V}{V}\right)R$ or $r = \left(\dfrac{\ell_1 - \ell_2}{\ell_2}\right)R$



23.3 Measurement of current :

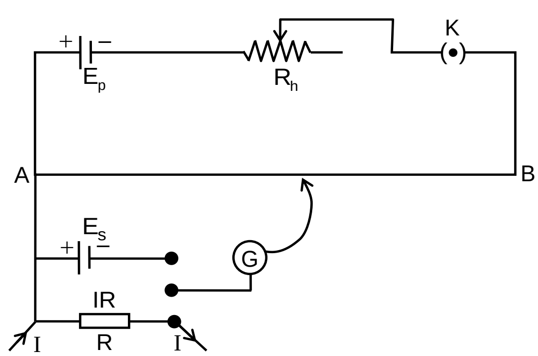
- First the balancing length (ℓ_1) is determined for the standard cell E_S

  $E_S = \phi\ell_1$ ....(i)

  This determines the potential gradient ϕ.

- Next the potential drop V = IR across a known resistance is balanced (balancing length ℓ_2)

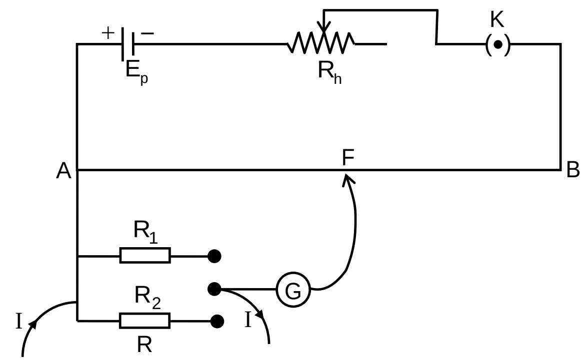
  Then $V = IR = \phi\ell_2$ ......(ii)



From (i) and (ii) $I = \left(\dfrac{\ell_2}{\ell_1}\right)\dfrac{E_S}{R}$ Usually $R = 1\Omega$ is taken then $I = \dfrac{\ell_2}{\ell_1}E_S$

23.4 Comparison of resistances

- If the balancing length for R_1 and R_2 are respectively, ℓ_1 and ℓ_2, then $\frac{R_1}{R_2} = \frac{\ell_1}{\ell_2}$



SOLVED EXAMPLES

Ex.26 A galvanometer has a coil of resistance of 60Ω and shows a fullscale deflection for 50 μA current. To convert this galvanometer into an ammeter of range 10 mA, required shunt resistance will be–

(1) 0.30 Ω (2) 0.20 Ω (3) 0.6 Ω (4) 0.40 Ω

Sol. Given, $I_g = 50\ \mu A = 50 \times 10^{-6}$ A

$I = 10$ mA $= 10 \times 10^{-3}$ A, G = 60 Ω

thus, $S = \frac{I_g G}{I - I_g} = \frac{50 \times 10^{-6} \times 60}{10 \times 10^{-3} - 50 \times 10^{-6}} = 0.30\ \Omega$

Ex.27 A voltmeter, an ammeter and a resistance are connected in series to a lead accumulator. There is a deflection in the voltmeter but the deflection in ammeter is negligible. Why ?

Sol. The voltmeter being in series, the resistance of the circuit becomes very high and so the current very low. This current on passing through the coil of the voltmeter produces some deflection, but in ammeter most of its part goes through the shunt of the ammeter and so the current going in the coil of the ammeter is too small to produce any deflection.

Ex.28 A galvanometer has a coil of resistance 100 Ω and shows a full scale deflection, when 100 μA current is passed through it. Resistance required to use it as a voltmeter of range 5V, will be–

(1) 95 kΩ (2) 9.5 kΩ (3) 49.9 kΩ (4) 4.99 kΩ

Sol. Given $I_g = 100\ \mu A = 100 \times 10^{-6}$ A G = 100Ω and V = 5volt

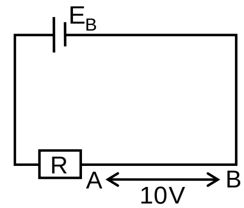
Thus $R = \frac{V}{I_g} - G = 5 \times 10^4 - 100 = 49.9$ kΩ

Ex.29 A potentiometer wire of length 10 m and resistance 10 ohm/m and a resistance box are connected in series with a 2 volt battery. A potential difference of 10 mV is balanced across the whole length of potentiometer wire. The resistance introduced in the resistance box will be-

(1) 1990 Ω (2) 990 Ω (3) 199 Ω (4) 99 Ω

Sol : $V_{AB} = \phi\ell = \frac{ER_w\ell}{(R + R_W)L}$

$\Rightarrow \quad 10\times10^{-3} = \left(\frac{2\times10}{R+100}\right)\times\frac{10}{10}$ $\qquad (\because L = 10)$



or $\quad R = 1990\ \Omega$

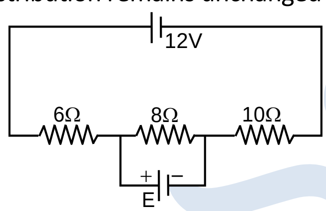
Ex.30 If the current in the primary circuit of a potentiometer wire is 0.2 A, specific resistance of the material of wire 40 × $10^{-8}\Omega$m and area of cross–section of wire is 8 × 10^{-7} m^2. The potential gradient will be–

(1) 0.1 V/m (2) 0.001 V/m (3) 0.1 V/cm (4) 0.01 V/m

Sol. $\phi = I(R_W/L) = I\ \rho/\pi r^2$ [$\therefore$ $R_W = \rho\frac{L}{A} = \rho.\frac{L}{\pi r^2}$]

$= 0.2 \times 40 \times 10^{-8}/8 \times 10^{-7} = 0.1$ V/m.

Ex.31 In the circuit shown fig, if the current distribution remains unchanged on connecting E, then the value of E will be –



(1) 12 V (2) 6 V (3) 4 V (4) 2 V

Sol. $I = \frac{E_p}{R_1+R_2+R_3} = \frac{12}{6+8+10} = 0.5$ A .....(1)

$R_2 = 8\Omega$, Voltage across 8Ω resistance

$V_2 = I\ R_2 = 0.5 \times 8$

$V_2 = 4$ volt .....(2)

For current distribution to remain unchanged

$V_2 = E = 4$ Volt

Ex.32 In a potentiometer arrangement a cell of emf 1.5 V gives a balance point at 30 cm length of wire. Now when the cell is replaced by another cell, the balance point shifts to 50 cm. What is the emf of second cell ?

Sol. $e_1 = 1.5$ V, $\ell_1 = 30$ cm ; $e_2 = ?$, $\ell_2 = 50$ cm

Using the formula for comparison of emf of cells by potentiometer, we have $\frac{\varepsilon_2}{\varepsilon_1} = \frac{\ell_2}{\ell_1}$

$\Rightarrow \quad \varepsilon_2 = \frac{\ell_2}{\ell_1}\times\varepsilon_1 = \frac{50}{30}\times 1.5\text{ V} = 2.5\text{ V}$

Ex.33 The potential difference across two wires of same resistance connected in series get balanced against 400 cm of a potentiometer wire. If the wires are connected in parallel and same current is passed through them, then the balancing length will be-

(1) 400 cm (2) 200 cm (3) 100 cm (4) 800 cm

Sol. $V = 2iR = 400\ \phi$ $\qquad \Rightarrow V' = i\ \frac{R}{2} = \ell\phi$

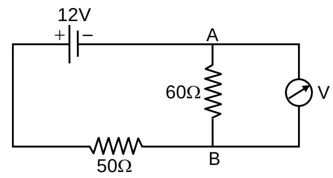
$\therefore\ \ell = 100$ cm

PRACTICE SECTION-03

Q.1 The shunt required for 10% of main current to be sent through the moving coil galvanometer of resistance 99Ω will be-

(1) 0.9 Ω (2) 11 Ω (3) 90 Ω (4) 9.9 Ω

Q.2 The voltmeter shown in fig, reads 6V across the 60Ω resistor. Then the resistance of the voltmeter is-

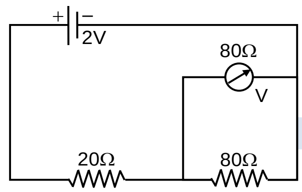


(1) 0 Ω (2) ∞ Ω (3) 200 Ω (4) 300 Ω

Q.3 The internal resistance of a cell is 4Ω and its e.m.f. is 2V. If it is connected to a voltmeter of resistance 996Ω then the percentage error in the voltmeter reading will be-

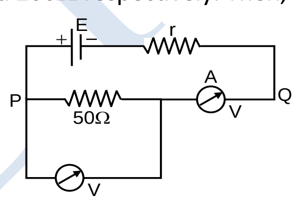
(1) 0.4 (2) 0.2 (3) 0.1 (4) 0.8

Q.4 The reading of voltmeter in the following circuit fig, will be



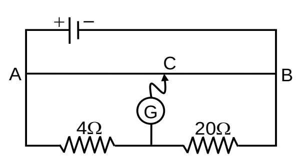
(1) 2 volt (2) 0.80 volt (3) 1.33 volt (4) 1.60 volt

Q.5 The emf E and internal resistance r of the cell shown in fig. are 4.3 V and 1 ohm respectively. The resistances of ammeter A and voltmeter V are 2Ω and 200Ω respectively. Then, the readings in the ammeter and voltmeter are-



(1) 0.081 A, 4.06 V (2) 0.1 A, 4.0 V (3) 1.05 A, 4.2 V (4) None

Q.6 In a potentiometer (length 3m) the galvanometer shows null deflection then balancing length BC will be



(1) 1 m (2) 1.5 m (3) 2 m (4) 2.5 m

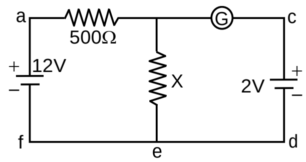
Q.7 The length of a potentiometer wire is 1m and its resistance is 4Ω. A current of 5 mA is flowing in it. An unknown source of e.m.f. is balanced on 40 cm length of this wire, then the e.m.f. of the source will be-

(1) 6 mV (2) 12 mV (3) 10 mV (4) 8 mV

Q.8 A cell of emf 2V and internal resistance 1.5 Ω is connected to two ends of 100 cm wire. The resistance of the wire is 0.005 Ω/cm. The potential gradient of the wire is–

(1) 0.005 V/m (2) 0.5 V/m (3) 0.05 V/m (4) 0.005 V/cm

Q.9 In a circuit shown, the galvanometer G reads zero. If batteries have negligible internal resistances, the value of resistance X wil be –



Q.10 The balancing lengths corresponding to two cells are in the ratio 2 : 1. When the cells are connected so as to support each other then balancing length is ℓ_1. When they are connected so as to oppose each other, the balancing length is ℓ_2. The value of $\ell_1 : \ell_2$ will be-

(1) 3 : 1 (2) 1 : 2 (3) 1 : 1 (4) 2 : 1

ANSWER KEY

Q.1	S = 11Ω	**Q.2**	(4)	**Q.3**	ΔV% = 0.4%	**Q.4**	(3)
Q.5	(2)	**Q.6**	x = 2.5 m	**Q.7**	(4)	**Q.8**	(4)
Q.9	100 Ω	**Q.10**	(1)				

EXERCISE-I Topic-wise Questions

ELECTRIC CURRENT, AVERAGE CURRENT, TYPES OF CURRENT, INSTANTANEOUS & AVERAGE CURRENT

Q.1 A current of 5 A exist on a 10 ohm resistance for 4 min. How much charge pass through any cross-section of the resistor in this time ?

(1) 12 coulombs (2) 120 coulombs
(3) 1200 coulombs (4) 12000 coulombs

Q.2 A charge of 2×10^{-2} C moves at 30 revolution per second in a circle of diameter 0.80 m. The current linked with the circuit will be -

(1) 0.1 A (2) 0.2 A (3) 0.4 A (4) 0.6 A

Q.3 The current in a conductor varies with time t is $I = 2t + 3t^2$ where I is in ampere and t in seconds. Electric charge flowing through a section of conductor during t = 2 sec to t = 3 sec. is -

(1) 10 C (2) 24 C (3) 33 C (4) 44 C

CURRENT FLOW DRIFT VELOCITY, FREE CHARGE DENSITY, MEAN RELXATION TIME, MEAN FREE PATH

Q.4 The drift velocity of electrons in a conducting wire is of the order of 1mm/s, yet the bulb glows very quickly after the switch is put on because :

(1) The random speed of electrons is very high, of the order of 10^5 m/s
(2) The electrons transfer their energy very quickly through collisions
(3) Electric field is set up in the wire very quickly, producing a current through each cross section, almost intantaneously
(4) All of above

Q.5 A steady current is passing through a linear conductor of non-uniform cross-section. The net quantity of charge crossing any cross-section per second is -

(1) independent of area of cross-section
(2) directly proportional to the length of conductor
(3) directly proportional to the area of cross-section
(4) inversely proportional to the lengths of conductor

Q.6 A current (I) flows through a uniform wire of diameter (d) when the mean drift velocity is v. The same current will flow through a wire of diameter d/2 made of the same material then the mean drift velocity of the electron is -

(1) v/4 (2) v/2 (3) 4v (4) 2v

Q.7 A wire of non-uniform cross-section is carrying a steady current along the wire -

(1) current and current density are constant
(2) only current is constant
(3) only current density is constant
(4) neither current nor current density is constant

Q.8 A cross–sectional area of a copper wire is 3×10^{-6} m^2. The current of 4.2 amp is flowing through it. The current density in amp/m^2 through the wire is –

(1) 1.4×10^3 (2) 1.4×10^4
(3) 1.4×10^5 (4) 1.4×10^6

OHM'S LAW, RESISTANCE, CONDUCTANCE, MOBILITY

Q.9 The current in a copper wire is increased by increasing the potential difference between its end. Which one of the following statements regarding n, the number of charge carriers per unit volume in the wire and v the drift velocity of the charge carriers is correct -

(1) n is unaltered but v is decreased
(2) n is unaltered but v is increased
(3) n is increased but v is decreased
(4) n is increased but v is unaltered

Q.10 A current flows in a wire of circular cross-section with the free electrons travelling with a mean drift velocity. If an equal current flows in a wire of twice the radius, new mean drift velocity is -

(1) $\vec{v}$ (2) $\vec{v}/2$
(3) $\frac{\vec{v}}{4}$ (4) None of these

Q.11 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 -

(1) 1.0 mm per sec (2) 1.0 metre per sec

(3) 0.1 mm per sec (4) 0.01 mm per sec

Q.12 When the resistance of copper wire is 0.1 Ω and the radius is 1 mm, then the length of the wire is (specific resistance of copper is 3.14×10^{-8} ohm x m):

(1) 10 cm (2) 10 m (3) 100 m (4) 100cm

Q.13 When a potential difference (V) is applied across a conductor, the thermal speed of electrons is -

(1) zero (2) proportional to $\sqrt{T}$

(3) proportional to T (4) proportional to V

Q.14 Specific resistance of a wire depends on the

(1) length of the wire

(2) area of cross–section of the wire

(3) resistance of the wire

(4) material of the wire

Q.15 The resistance of wire is 20Ω. The wire is stretched to three times its length. Then the resistance will now be –

(1) 6.67 Ω (2) 60 Ω

(3) 120 Ω (4) 180 Ω

Q.16 The dimensions of a manganin block are 1 cm × 1 cm × 100 cm. The electrical resistivity of manganin is 4.4×10^{-7} ohm–meter. The resistance between the opposite rectangular faces is –

(1) 4.4×10^{-7} ohm (2) 4.4×10^{-3} ohm

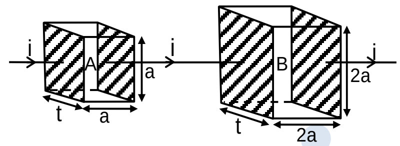
(3) 4.4×10^{-5} ohm (4) 4.4×10^{-1} ohm

Q.17 When the resistance wire is passed through a die the cross–section area decreases by 1%, the change in resistance of the wire is -

(1) 1% decrease (2) 1% increase

(3) 2% decrease (4) 2% increase

Q.18 In the following diagram two parallelopiped A and B are of the same thickness. The arm of B is double that of A. Compare these resistances and find out the value of R_A/R_B is –



(1) 1 (2) 2 (3) $\frac{1}{2}\pi$ (4) 4

Q.20 Ohm's law is valid when the temperature of the conductor is -

(1) constant (2) very high

(3) very low (4) varying

Q.21 A certain piece of copper is to be shared into a conductor of minimum resistance. Its length and diameter should be respectively -

(1) ℓ, d (2) 2ℓ, d (3) $\ell/2$, 2d (4) 2ℓ, d/2

Q.22 A wire has a resistance of 10Ω. A second wire of the same material is having length double and radius of cross-section half that of the wire. The resistance of the second wire is -

(1) 20Ω (2) 40Ω (3) 80Ω (4) 10Ω

Q.23 A cylindrical copper rod is reformed to twice its original length with no change in volume. The resistance between its ends before the change was (R). Now its resistance -

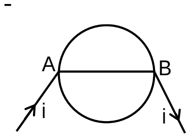
(1) 8R (2) 6R (3) 4R (4) 2R

Q.24 The length of a conductor is halved. Its conductance will be -

(1) halved (2) unchanged

(3) doubled (4) quadrupled

Q.25 A wire of resistance $0.5\Omega\ m^{-1}$ is bent into a circle of radius 1m. The same wire is connected across a diameter AB as shown in fig. The equivalent resistance is -



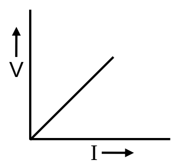
(1) πΩ (2) $\frac{\pi}{\pi+2}\Omega$

(3) $\frac{\pi}{\pi+4}\Omega$ (4) (π + 1) Ω

Q.26 A wire of resistance 2Ω is redrawn so that its length becomes four times. The resistance of the redrawn wire is –
(1) 2Ω (2) 8Ω (3) 16Ω (4) 32Ω

Q.27 A wire is cut into 4 pieces, which are put together side by side to obtain one conductor. If the original resistance of the wire was R. The resistance of the bundle will be -
(1) R/4 (2) R/8
(3) R/16 (4) R/32

Q.28 The current -voltage variation for a wire of copper of length (L) and area (A) is shown in fig. The slope of the line will be -



(1) less if experiment is done at a higher temperature
(2) more if a wire of silver of same dimensions is used
(3) will be doubled if the lengths of the wire is doubled
(4) will be halved if the length is doubled

Q.29 A wire has resistance 12 ohms. It is bent in the form of a circle. The effective resistance between the two points on any diameter of the circle is -
(1) 12 Ω (2) 24Ω (3) 6 Ω (4) 3Ω

Q.30 Consider two conducting wires of same length and material, one wire is solid with radius r. The other is a hollow tube of outer radius 2r while inner r. The ratio of resistance of the two wires will be -
(1) 1 : 1 (2) 1 : 2
(3) 1 : 3 (4) 1 : 4

Q.31 If a copper wire is stretched to make its radius decrease by 0.1%, then the percentage increase in resistance is approximately -
(1) 0.1% (2) 0.2%
(3) 0.4% (4) 0.8%

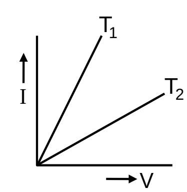
RESISTIVITY, COLOUR CODING, TEMPERATURE DEPENDENCE OF RESISTIVITY, CONCEPT OF SUPER CONDUCTORS

Q.34 The resistance of some substances become zero at very low temperature, then these substances are called –
(1) good conductors (2) super conductors
(3) bad conductors (4) semi conductors

Q.35 If the temperatures of iron and silicon wires are increased from 30°C to 50°C, the correct statement is–
(1) resistance of both wires increase
(2) resistance of both wires decrease
(3) resistance of iron wire increases and the resistance of silicon wire decreases
(4) resistance of iron wire decreases and the resistance of silicon wire increases

Q.36 When the temperature of a metallic conductor is increased, its resistance -
(1) always decreases
(2) always increases
(3) may increase or decrease
(4) remains the same

Q.37 The current (I) and voltage (V) graphs for a given metallic wire at two different temperature (T_1) and (T_2) are shown in fig. It is concluded that -



(1) $T_1 > T_2$ (2) $T_1 < T_2$ (3) $T_1 = T_2$ (4) $T_1 = 2T_2$

Q.38 A carbon and an aluminium wire connected in series. If the combination has resistance of 30 ohm at 0°C, what is the resistance of carbon and aluminium wire at 0°C so that the resistance of the combination does not change with temperature-
[$\alpha_c = -0.5 \times 10^{-3}$ (C°)$^{-1}$ and $\alpha_{Al} = 4 \times 10^{-3}$ (C°)$^{-1}$]
(1) $\frac{10}{3}\Omega, \frac{80}{3}\Omega$ (2) $\frac{80}{3}\Omega, \frac{10}{3}\Omega$
(3) 10 Ω, 80 Ω (4) 80 Ω, 10 Ω

Q.39 A potential difference of 200 V is applied to a coil at a temperature of 15°C and the current is 10A. What will be the mean temperature of the coil when the current has fallen to 5A, the applied voltage being the same as before -

(Given $\alpha = \frac{1}{234}$ C^{-1} at 0°C)

(1) 254° (2) 256° (3) 258° (4) 264°

Q.40 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-

(1) $\frac{\alpha_1+\alpha_2}{2}$ (2) $\sqrt{\alpha_1\alpha_2}$

(3) $\frac{\alpha_1R_1+\alpha_2R_2}{R_1+R_2}$ (4) $\frac{\alpha_1R_2+\alpha_2R_1}{R_1+R_2}$

Q.41 As the temperature of a metallic resistor is increased, the product of resistivity and conductivity-

(1) increases

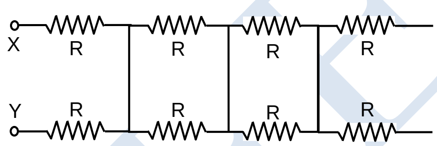
(2) decreases

(3) may increase or decrease

(4) remains constant

COMBINATION OF RESISTORS

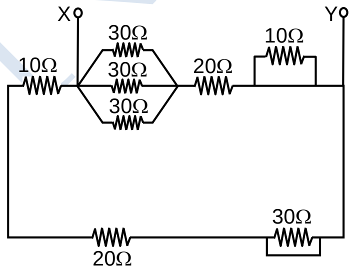
Q.42 Net resistance between X and Y is –



(1) R (2) 2R

(3) $\frac{R}{2}$ (4) 4R

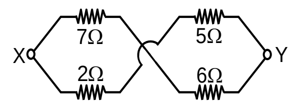
Q.43 Net resistance between X and Y is -



(1) 5 Ω (2) 10 Ω

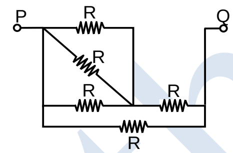
(3) 15 Ω (4) 60 Ω

Q.44 Net resistance between X and Y is -



(1) 4 Ω (2) 4.55 Ω (3) 2 Ω (4) 20 Ω

Q.45 The equivalent resistance between the terminal point P and Q is 4Ω in the given circuit, then find out the resistance of R in ohms -



(1) 7 (2) 4

(3) 2 (4) 5

Q.46 In a closed circuit the sum of total emf is equal to the sum of the –

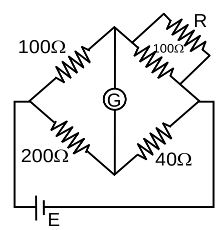
(1) currents

(2) resistances

(3) products of current and the resistances

(4) none of the above

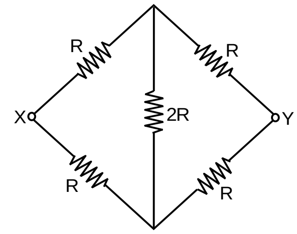
Q.47 For following diagram the galvanometer shows zero deflection, then the value of R is -



(1) 52 Ω (2) 50 Ω

(3) 100 Ω (4) 25 Ω

Q.48 For following circuit the value of total resistance between X and Y in ohm is -



(1) R (2) 4 R

(3) 5 R (4) 6 R

Q.49 The equivalent resistance in series combination is-

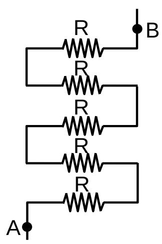
(1) smaller than the largest resistance

(2) larger than the largest resistance

(3) smaller than the smallest resistance

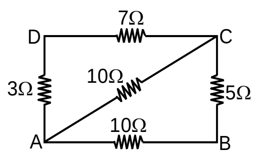
(4) larger than the smallest resistance

Q.50 Five identical resistance are connected as shown in fig. The equivalent resistance between point (A) and (B) is -



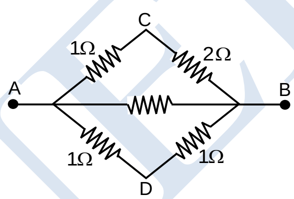
(1) R (2) 5R (3) R/5 (4) 2R/5

Q.51 Five resistance are connected as shown in the adjoining figure. The equivalent resistance between A and B is -



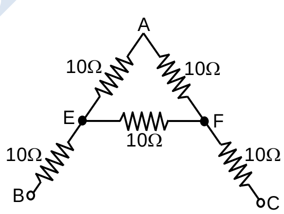
(1) 35Ω (2) 5Ω (3) 15/4Ω (4) 25Ω

Q.52 The equivalent resistance between points (A) and (B) in the adjoining fig. is one ohm. What is the value of middle resistance -



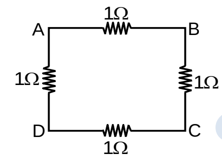
(1) 9Ω (2) 1Ω (3) 6Ω (4) 3Ω

Q.53 The effective resistance (in Ω) between (B) and (C) is



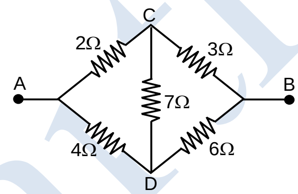
(1) 60 (2) 40 (3) 80/3 (4) 160/9

Q.54 Four identical resistances are joined as shown in fig. The equivalent resistance between points A and B is R_1. The equivalent resistance between points A and C is R_2 then ratio of R_1/R_2 is -



(1) 1 : 1 (2) 4 : 3 (3) 3 : 4 (4) 1 : 2

Q.55 Five resistances are connected as shown in fig. The effective resistance between the points A and B is -



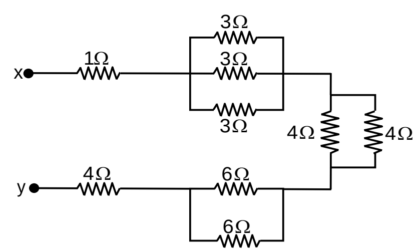
(1) 10/3Ω (2) 20/3 Ω

(3) 15Ω (4) 6Ω

Q.56 Twelve wires of equal resistance (R) are connected to form a cube. The effective resistance between two diagonal ends will be -

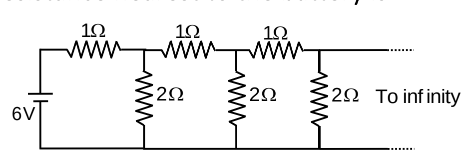
(1) 5/6 R (2) 6/5 R (3) 3R (4) 12 R

Q.57 In fig the equivalent resistance between points x and y -



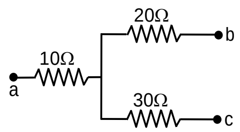
(1) 16Ω (2) 14 Ω (3) 11Ω (4) 18Ω

Q.58 An infinite ladder network of resistance is constructed with 1Ω and 2Ω resistance. The 6V battery between A and B has negligible internal resistance. The current that passes through 2Ω resistance nearest to the battery is -



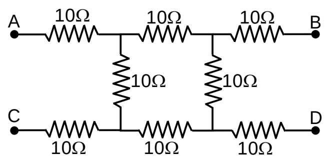
(1) 1A (2) 1.5 A (3) 2 A (4) 2.5 A

Q.59 In a given electric circuit the potentials at the points a, b and c are 30 V, 12 V and 2 V respectively. The current through resistors 10 Ω, 20 Ω and 30 Ω are -



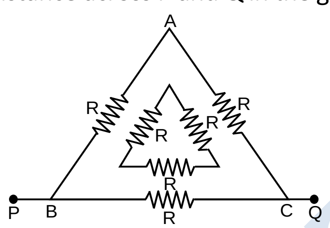
(1) 1, 0.4, 0.6 (2) 2, 0.8, 1.2
(3) 0.6 A, 0.4 A, 1A (4) None of these

Q.60 What will be the equivalent resistance between the A and D ?



(1) 10 Ω (2) 20 Ω
(3) 30 Ω (4) 40Ω

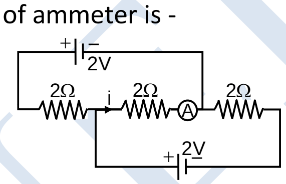
Q.61 The resistance across P and Q in the given figure is-



(1) $\frac{2R}{3}$ (2) $\frac{R}{2}$ (3) 2R (4) 6R

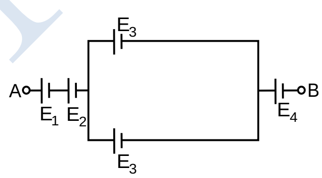
INTRODUCTION OF CELLS, EMF, INTERNAL RESISTANCE, TERMINAL P.D., GROUPING OF CELLS

Q.62 Reading of ammeter is -



(1) 1 (2) 2 (3) $\frac{2}{3}$ (4) 3

Q.63 In the following circuit the resultant emf between AB is -



(1) $E_1 + E_2 + E_3 + E_4$ (2) $E_1 + E_2 + 2E_3 + E_4$
(3) $E_1 + E_2 + (E_3/2) + E_4$ (4) $E_1 + E_2 + (E_3/4) + E_4$

Q.64 A cell of e.m.f (E) and internal resistance (r) is connected in series with an external resistance (nr) then the ratio of the terminal p.d. to E.M.F is-

(1) 1/n (2) 1/(n+1)
(3) n/(n+1) (4) (n+1)/n

Q.65 The terminal potential difference of a cell, when cell is short circuited is -

(1) E (2) E/2 (3) zero (4) E/3

Q.66 Five dry cell each of e.m.f 1.5V are connected in parallel. The e.m.f of the combination is -

(1) 7.5 V (2) 0.3 V (3) 3V (4) 1.5 V

Q.67 The internal resistance of cell is 0.1Ω and its emf is 2V. When a current of 2A is being drawn from it, the potential difference across its terminals will be -

(1) more than 2V (2) 2V
(3) 1.8V (4) none of the above

Q.68 A dry cell has an e.m.f of 1.5V and internal resistance 0.5Ω. If the cell sends a current of 1A through an external resistance, the p.d. of the cell will be -

(1) 1.5V (2) 1V (3) 0.5V (4) 0V

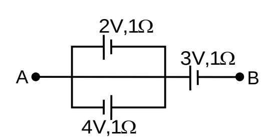
Q.69 Five cells each of e.m.f (E) and internal resistance (r) are connected in series. If one cell is connected wrongly, then the equivalent e.m.f and internal resistance of the combination is -

(1) 5E and 5r (2) 3E and 3r
(3) 3E and 5r (4) 5E and 4r

Q.70 A cell of e.m.f (E) volt and internal resistance (r) ohms is connected to an external resistance of (r) ohms. The potential difference across the terminals of the cell will be

(1) E volt (2) E/2 Volt
(3) E/4 volt (4) 2E volt

Q.71 The potential difference between points A and B is -



(1) 2 V (2) 6 V (3) 4 V (4) 3 V

Q.72 The number of dry cells, each of e.m.f. 1.5 volt and internal resistance 0.5 Ω 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 -

(1) 2 (2) 8 (3) 10 (4) 12

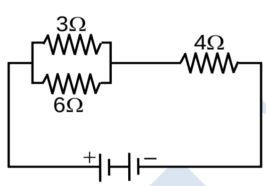
Q.73 Two batteries of different e.m.f. and internal resistance are connected in series with each other and with an external load resistor. The current is 3.0 amp. When the polarity of one battery is reversed, the current becomes 1.0 amp. The ratio of the e.m.f. of the two batteries is -

(1) 2.5 (2) 2.0 (3) 1.5 (4) 1.0

Q.74 When a cell is connected to 1 ohm resistance, 1 ampere current flows through the circuit. When 3 ohm resistance is used then 0.5 amp current flows, then internal resistance of the cell is -

(1) 1Ω (2) 1.5 Ω (3) 2 Ω (4) 2.5 Ω

Q.75 In the following figure, current through 3Ω resistor is 0.8 amp; then the potential drop through 4Ω resistor is -



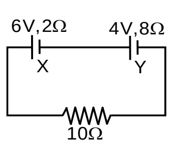
(1) 9.6 V (2) 2.6 V (3) 4.8 V (4) 1.2 V

Q.76 A cell supplies a current I_1 through a resistor of resistance R_1 and a current I_2 through a resistor of resistance R_2, then internal resistance of the cell is -

(1) $R_1 - R_2$ (2) $R_1 + R_2$

(3) $\frac{I_1R_2 - I_1R_1}{I_1 + I_2}$ (4) $\frac{I_2R_2 - I_1R_1}{I_1 - I_2}$

Q.77 Two cells X and Y are connected to a resistance of 10Ω as shown in the figure. The terminal voltage of cell Y is-

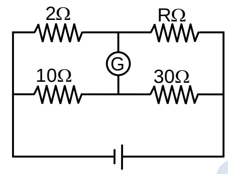


(1) zero (2) 2V

(3) 4V (4) 10V

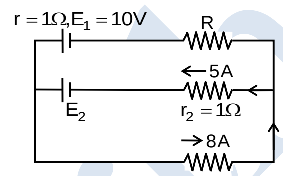
KIRCHOFF'S LAW, (KVL & KCL), WHEAT STONE BRIDGE

Q.78 In the adjoining fig. there is no deflection in the galvanometer. Then R is equal to -



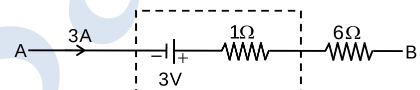
(1) 2Ω (2) 30Ω (3) 6Ω (4) (2/3)Ω

Q.79 In fig the current through resistance R is -



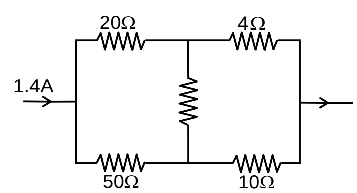
(1) 3A (2) 13A (3) 6.5 A (4) 9A

Q.80 Figure represents a part of a closed circuit. The potential difference between (A) and (B) i.e. $V_A - V_B$ is -



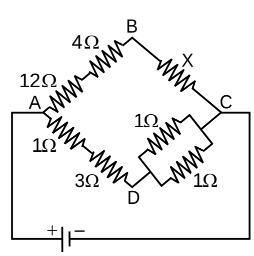
(1) 24 V (2) 0V (3) 6V (4) 18 V

Q.81 In the following figure the current through 4 ohm resistor is -



(1) 1.4 A (2) 0.4 A (3) 1.0 A (4) 0.7 A

Q.82 In the arrangement of resistances shown in the circuit, the potential difference between points B and D will be zero, when the unknown resistance X is –

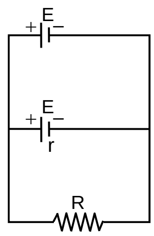


(1) 4Ω (2) 3Ω

(3) 2Ω (4) 1Ω

ELECTRICAL ENERGY, POWER DISTRIBUTION FOR SERIES PARALLEL COMBINATION, MAXIMUM POWER

Q.83 Two cells of same emf E and internal resistance r are connected in parallel with a resistance of R. To get maximum power in the external circuit, the value of R is -



(1) $R = \frac{r}{2}$ (2) R = r

(3) R = 2 r (4) R = 4r

Q.84 Two bulbs, one of 50 watt and another of 25 watt are connected in series to the mains, the ratio of the current through them is -

(1) 2 : 1
(2) 1 : 2
(3) 1 : 1
(4) Can't be determined without the p.d. of the main supply

Q.85 Constant voltage is applied between the two ends of a uniform metallic wire. The heatdeveloped is doubled if -

(1) both the length and radius of the wire are halved
(2) both the length and radius of the wire are doubled
(3) the radius of wire is doubled
(4) the length of the wire is doubled

Q.86 Two electric bulbs rated P_1 watt V volt and P_2 watt V volt are connected in parallel across V volt mains then the total power is -

(1) $P_1 + P_2$ (2) $\sqrt{P_1P_2}$

(3) $\frac{P_1P_2}{(P_1+P_2)}$ (4) $\frac{(P_1+P_2)}{P_1P_2}$

Q.87 Lamps used for the house lightening are connected in -

(1) series (2) parallel
(3) mixed grouping (4) arbitrary manner

Q.88 Two electric bulbs whose resistances are in the ratio of 1 : 2 are connected in parallel to a constant voltage source. The power dissipated in them have the ratio -

(1) 1 : 2 (2) 1 : 1 (3) 2 : 1 (4) 1 : 4

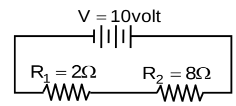
Q.89 An electric bulb is rated 220 volt and 100 watt. The resistance of the filament of the electric bulb is -

(1) 2.2 Ω (2) 2.2×10^4 Ω
(3) 484 Ω (4) 100 Ω

Q.90 Three electric bulbs 40W, 60W and 100W are designed to work on a 220V mains. Which bulb will glow most brightly if they are connected in series across 220V mains -

(1) 100W bulb
(2) 60W bulb
(3) 40 W bulb
(4) All bulbs will glow equally brightly

Q.91 In fig the ratio of power dissipated in resistors R_1 and R_2 is



(1) 1 : 4 (2) 4 : 1 (3) 1 : 2 (4) 2 : 1

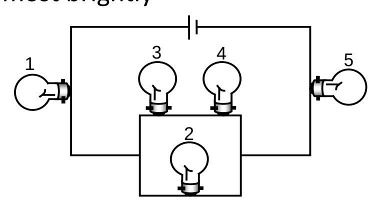
Q.92 A house is served by a 220V supply line. In a circuit protected by a fuse marked 9A. The maximum number of 60W lamps in parallel that can be turned on is -

(1) 44 (2) 20 (3) 22 (4) 33

Q.93 Two bulbs 25 watt, 220 volt and 100 watt, 220 volt are connected in series across a 440 volt line-

(1) only 100 watt bulb will fuse
(2) only 25 watt bulb will fuse
(3) both bulbs will fuse
(4) none of the bulb will fuse

Q.94 All bulbs in figure below are identical, which bulb light most brightly -



(1) 1 only (2) 2 only
(3) 3 and 4 only (4) 1 and 5

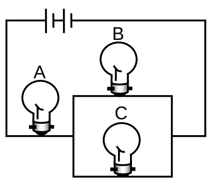
Q.95 The same mass of copper is drawn into two wires 1 mm thick and 2 mm thick. If the two wires are connected in series and the current is passed, the heat produced in the wires will be in the ratio-

(1) 2 : 1 (2) 4 : 1 (3) 1 : 16 (4) 16 : 1

Q.96 Two bulbs of 500 watt and 200 watt are manufactured to operate on 220 volt line. The ratio of heat produced in 500 watt and 200 watt, in two cases, when first they are joined in series and secondly in parallel, will be -

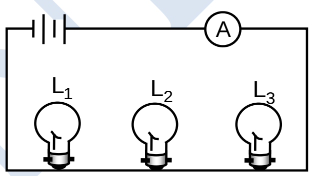
(1) $\frac{5}{2},\frac{2}{5}$ (2) $\frac{5}{2},\frac{5}{2}$ (3) $\frac{2}{5},\frac{5}{2}$ (4) $\frac{2}{5},\frac{2}{5}$

Q.97 The bulbs A, B and C are connected as shown in fig. The bulbs B and C are identical. If the bulb C is fused -



(1) both A and B will glow more brightly
(2) both A and B will glow less brightly
(3) A will glow less brightly and B will glow more brightly
(4) A will glow more brightly and B will glow less brightly.

Q.98 In the circuit below, ammeter (A) reads 0.5A. Bulbs L_1 and L_2 are brightly lit, but L_3 is not lit. What is the reason for L_3 not being lit ?



(1) The ammeter is faulty
(2) The filament of L_3 is broken
(3) The resistance of L_3 is much lower than that of L_1 and L_2
(4) There is a break in the connecting wire between L_2 and L_3

Q.99 How much electrical energy in kilo-watt hour is consumed in operating ten 50 watt bulbs for 10 hours per day in a month of 30 days ?

(1) 1500 (2) 15000 (3) 15 (4) 150

Q.100 Two bulbs 100 W, 250 V and 200 W, 250 V are connected in parallel across a 500 V line. Then-
(1) 100 W bulb will fused
(2) 200 W bulb will fused
(3) Both bulbs will be fused
(4) No bulb will fused

Q.101 A uniform wire connected across a supply produces heat H per second. If the wire is cut into n equal parts and all the parts are connected in parallel across the same supply, the heat produced per second will be -

(1) $\frac{H}{n}$ (2) nH (3) n^2H (4) $\frac{H}{n^2}$

Q.102 Two electric bulbs 40 W, 200 V and 100 W, 200 V are connected in series. Then the maximum voltage that can be applied across the combination, without fusing either bulb is -

(1) 280V (2) 400V (3) 3000V (4) 200V

Q.103 The resistance of 3Ω and 6Ω are joined in series and connected across a battery of emf 10 V and internal resistance 1Ω. The power dissipated by battery is -

(1) 3 W (2) 8 W (3) 9 W (4) 10 W

Q.104 A 24 V battery of internal resistance 4Ω is connected to a variable resistor. The rate of heat production in the resistor is maximum when the current in the circuit is –

(1) 2 A (2) 3 A (3) 4 A (4) 6 A

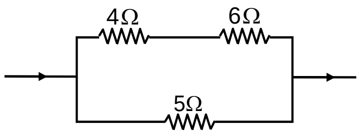
Q.105 An electric kettle has two coils. When one of these is switched on, the water in the kettle boils in 6 minutes. When the other coil is switched on, the water boils in 3 minutes. If the two coils are connected in series, the time taken to boil the water in the kettle is-

(1) 2 min. (2) 3 min. (3) 6 min. (4) 9 min

Q.106 In Question 105, if the two coils are connected in parallel, then the total time taken to boil the water in kettle is -

(1) 2 min. (2) 3 min. (3) 6 min. (4) 9 min

Q.107 In the circuit shown in the figure, heat produced in 5Ω resistor due to a current flowing in it is 10 cal/s. The heat produced in 4 Ω resistor is -



(1) 4 cal/s (2) 1 cal/s (3) 2 cal/s (4)3 cal/s

METER BRIDGE, AMMETER, VOLTMETER

Q.108 A galvanometer having a coil resistance of 60 Ω shows full scale deflection when a current of 1.0 A passes through it. It can be converted into an ammeter to read currents upto 5.0 A by :

(1) putting in parallel a resistance of 240 Ω
(2) putting in series a resistance of 15 Ω
(3) putting in series a resistance of 240 Ω
(4) putting in parallel a resistance of 15 Ω

Q.109 A milli voltmeter of 25 milli volt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be :

(1) 0.001 (2) 0.01 (3) 1 (4) 0.05

Q.110 A galvanometer can be changed into ammeter by connecting :

(1) high resistance in parallel
(3) high resistance in series.
(3) low resistance in parallel
(4) low resistance in series

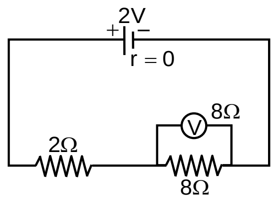
Q.111 There is a voltameter in a circuit. In order to triple its range, the resistance of how much value should be used?

(1) 2R (2) R/2 (3) 3R (4) 4R

Q.112 In Wheat stone's bridge P = 9 ohm, Q = 11 ohms, R = 4 ohm and S = 6 ohms. How much resistance must be put in parallel to the resistance (S) to balance the bridge

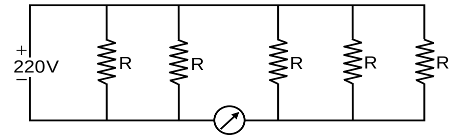
(1) 24 ohms (2) (44/9) ohm
(3) 26.4 ohms (4) 18.7 ohms

Q.113 In the circuit shown in fig, the reading of voltmeter is-



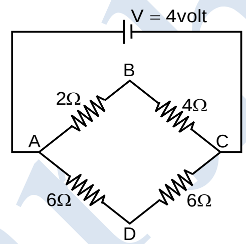
(1) 1.33 V (2) 0.8 V
(3) 2.0 V (4) 1.6V

Q.114 Five identical lamps each resistance R = 1100Ω are connected to 220V as shown in fig. The reading of ideal ammeter (A) is -



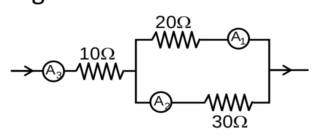
(1) 1/5 A (2) 2/5 A
(3) 3 /5 A (4) 1 A

Q.115 If fig. the difference of potential between (B) and (D) is -



(1) +0.67V (2) –0.67V
(3) 2V (4) 1.33V

Q.116 If the reading of ammeter A_1, in figure is 2.4 A, what will the ammeter A_2 and A_3 read ? (Neglecting the resistances of ammeters) -



(1) 1.6 A, 2.3 A (2) 1.6 A, 4.0 A
(3) 4.0 A, 1.6 A (4) 2.3 A, 1.6 A

Q.117 In a galvanometer 5% of the total current in the circuit passes through it. If the resistance of the galvanometer is G, the shunt resistance S connected to the galvanometer is

(1) 19G (2) G/19
(3) 20G (4) G/20

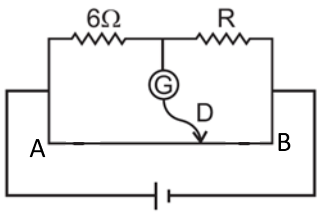
Q.118 A voltmeter has a resistance of G ohm and range V volt. Then the value of resistance used in series to convert it into avoltmeter of range nV volt is

(1) nG (2) (n–1)G
(3) G/n (4) G/(n–1)

Q.119 An ammeter gives full scale deflection with a current of 1A. It is converted into an ammeter of range 10 ampere. Find theratio of the resistance of ammeter to the shunt resistance used

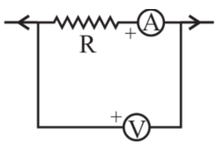
(1) 9 : 1 (2) 9 : 10 (3) 2 : 3 (4) 9 : 5

Q.120 The meter-bridge wire AB shown in figure is 50 cm long. When AD = 30 cm, no deflection occurs in the galvanometer. Find R.



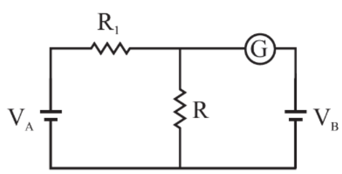
(1) 1 Ω (2) 2 Ω (3) 3 Ω (4) 4 Ω

Q.121 In the following circuit, the resistance of a voltmeter is10,000 Ω and that of an ammeter is 20 Ω. If the reading of anammeter is 0.1 amp. and that of voltmeter is 12 volt, then thevalue of R is:



(1) 122 Ω (2) 100 Ω (3) 118 Ω (4) 116 Ω

Q.122 In the circuit shown below, the cells A and B have negligibleresistance. For V_A = 12 V, R_1 = 500 Ω and R = 100 Ω, thegalvanometer (G) shows no deflection. The value of $V_B$is:



(1) 4 V (2) 2 V (3) 12 V (4) 6 V

POTENTIOMETER

Q.123 The unit of potential gradient is :

(1) volt (2) volt/ampere

(3) volt/meter (4) volt x meter

Q.124 The potential gradient of a potentiometer wire is defined as :

(1) the fall of potential per unit length

(2) the fall of potential per unit area

(3) the fall in potential across the ends of wires

(4) None of the above

Q.125 For the same potential difference, a potentiometer wire is replaced by another one of a high specific resistance. The potential gradient then ($r = R_h = 0$) :

(1) decreases (2) remains same

(3) increases (4) data is incomplete

Q.126 The length of the potentiometer wire is kept larger so that the value of potential gradient may:

(1) increase

(2) decrease

(3) remain uniform all over the length of its wire

(4) None of the above

Q.127 If the current in a potentiometer increases, the position of the null point will :

(1) be obtained at a larger length than the previous one

(2) be equal to the previous length

(3) be obtained at a smaller length than the previous

(4) None of the above

Q.128 The potentiometer wire 10 m long and 20 ohm resistance is connected to a 3 volt emf battery and a 10 ohm resistance. The value of potential gradient in volt/m of the wire will be :

(1) 1.0 (2) 0.2

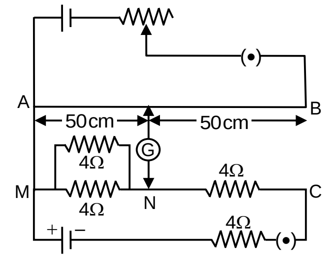
(3) 0.1 (4) 0.02

Q.129 In a potentiometer wire, whose resistance is 0.5 ohm/m, a current of 2 ampere is passing. The value of potential gradient in volt/m will be :

(1) 0.1 (2) 0.5

(3) 1.0 (4) 4

Q.130 In the following figure, the p.d. between the points M and N is balanced at 50 cm length. The balancing length in cm, for the p.d. between points N and C will be



(1) 40 (2) 100

(3) 75 (4) 25

Q.131 The potential gradient of potentiometer is 0.2 volt/m. A current of 0.1 amp is flowing through a coil of 2 ohm resistance. The balancing length in meters for the p.d. at the ends of this coil will be:

(1) 2 (2) 1 (3) 0.2 (4) 0.1

Q.132 It is observed in a potentiometer experiment that no current passes through the galvanometer, when the terminals of the cell are connected across a certain length of the potentiometer wire. On shunting the cell by a 2Ω resistance, the balancing length is reduced to half. The internal resistance of the cell is-

(1) 4Ω (2) 2Ω (3) 9Ω (4) 18Ω

Q.133 The emf of a standard cell is 1.5 volt and its balancing length is 7.5 m. The balancing length in meters for a 3.5 ohm resistance, through which a current of 0.2 A, flows will be :

(1) 3.5 (2) 5.0 (3) 5.7 (4) 6.5

Q.134 Resistance of 100 cm long potentiometer wire is 10 Ω. it isconnected to a battery of 2 volt and resistance R is in series. A source of 10 mV gives null point at 40cm length, thenexternal resistance R is

(1) 490 Ω (2) 790 Ω (3) 590 Ω (4) 990 Ω

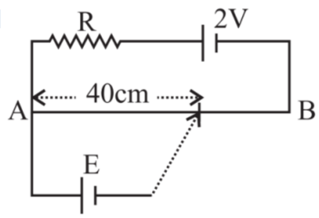
Q.135 A galvanometer of 25 Ω and having full scale deflection fora current of 10 mA is changed into voltmeter of range 100 Vby connecting a resistance R in series with the galvanometer. The resistance R in ohm is

(1) 10000 (2) 975
(3) 10025 (4) 9975

Q.136 An ammeter of resistance 0.2Ω and range 10 mA is to be usedto read potential difference upto 1V. What is to be done?

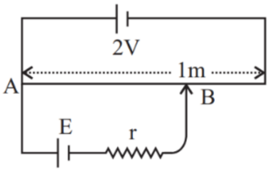
(1) 96 Ω in series (2) 92 Ω in parallel
(3) 99.8 Ω in series (4) 90 Ω in parallel

Q.137 AB is a potentiometer wire of length 100 cm and its resistance is 10 ohm. It is connected in series with a resistance R = 40 ohm and a battery of e.m.f. 2V 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:



(1) 0.8 V (2) 1.6 V
(3) 0.08 V (4) 0.16 V

Q.138 In 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 :



(1) 1 Ω (2) 3 Ω (3) 10 Ω (4) 5 Ω

Q.139 In a potentiometer experiment, the balancing length with a cell in the secondary circuit is found to be 480 cm. When a resistor of 8 ohm is connected in parallel to the cell, the balancing length is found to be 420cm. The internal resistance of the cell is

(1) 1.14Ω (2) 2Ω (3) 4.12Ω (4) 56Ω

Q.140 A potentiometer having a wire of 4m length is connected to the terminals of a battery with a steady voltage. A Leclanche cell has a null point at 1m. If the length of the potentiometerwire is increased by 1m, the position of the null point is

(1) 1.5m (2) 1.25m (3) 10.05m (4) 1.31m

Q.141 In a potentiometer, the balance length with standard cadmiumcell is 509 cm. The emf of a cell which when connected in the place of the standard cell gave a balance length of 750 cm is (emf of standard cell is 1.018V)

(1) 1.5V (2) 0.5V (3) 1.08V (4) 1.2V

EXERCISE-II Analytical Questions

Q.1 Two batteries with e.m.f. 12 V and 13 V are connected in parallel across a load resistor of 10 Ω. The internal resistances of the two batteries are 1 Ω and 2 Ω respectively. The voltage across the load lies between

(1) 11.6 volt and 11.7 V
(2) 11.5 volt and 11.6 V
(3) 11.4 volt and11.5 V
(4) 11.7 volt and11.8 V

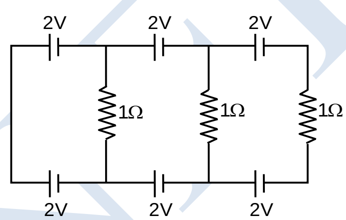
Q.2 In a potentiometer experiment, it is found that no current passes through the galvanometer when the terminals of the cell are connected across 52 cm of the potentiometer wire. If the cell is shunted by a resistance of 5 Ω, a balance is found when the cell is connected across 40 cm of the wire. Find the internal resistance of the cell.

(1) 1 Ω (2) 1.5 Ω (3) 2 Ω (4) 2.5 Ω

Q.3 On interchanging the resistances, the balance point of a metre bridge shifts to the left by 10 cm. The resistance of their series combination is 1 kΩ. How much was the resistance of the left slot before interchanging the resistances ?

(1) 990 Ω (2) 505 Ω (3) 550 Ω (4) 910Ω

Q.4 In the above circuit in each resistance is



(1) 1 A (2) 0.25 A (3) 0.5 A (4) 0 A

Q.5 When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into to voltmeter of range 0 – 10 V is

(1) $1.985 \times 10^3 Ω$ (2) $2.045 \times 10^3 Ω$
(3) $2.535 \times 10^3 Ω$ (4) $4.005 \times 10^3 Ω$

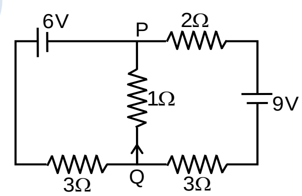
Q.6 A galvanometer having a coil resistance of 100Ω gives a full scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvalnometer into ammeter giving a full scale deflection for a current of 10 A, is :

(1) 0.01 Ω (2) 2 Ω (3) 0.1 Ω (4) 3 Ω

Q.7 When 5 V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is $8\times10^{28} m^{-3}$, the resistivity of the material is close to:

(1) 1.6×10^{-8} Ωm (2) 1.6×10^{-7} Ωm
(3) 1.6×10^{-6} Ωm (4) 1.6×10^{-5} Ωm

Q.8 In the circuit shown, the current in the 1Ω resistor is:



(1) 1.3 A, from P to Q
(2) 0 A
(3) 0.13 A, from Q to P
(4) 0.13 A, from P to Q

Q.9 In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be:

(1) 8 A (2) 10 A (3) 12 A (4) 14 A

Q.10 The supply voltage to room is 120 V. The resistance of the lead wires is 6 ohm. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb ?

(1) Zero (2) 2.9 V
(3) 13.3 V (4) 10.04 V

Q.11 Two electric bulbs of 25 W – 220 V and 100 W – 220 V are connected in series with 440 V source. Which bulb which be fused ?

(1) Both (2) 100 W
(3) 25 W (4) None of these

Q.12 Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then errors in the value of reasistance of the wire is

(1) 6% (2) Zero (3) 1% (4) 3%

Q.13 If a wire is stretched to make it 0.1% longer, its resistance will :

(1) 0.05% increment (2) 0.2% increment
(3) 0.2% decrement (4) 0.05% decrement

Q.14 Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly

(1) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (2) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$

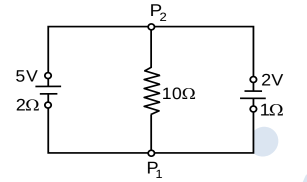
(3) $\alpha_1+\alpha_2, \frac{\alpha_1 \times \alpha_2}{\alpha_1+\alpha_2}$ (4) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$

Q.15 **Statement-I :** The temperature dependence of resistance is usually given as $R = R_0 (1+\alpha \Delta t)$. The resistance of a wire changes from 100 Ω to 150 Ω when its temperature is increased from 27°C to 227°C. This implies that $\alpha = 2.5\times10^{-3}/°C$.

Statement-II : $R = R_0 (1+\alpha \Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R-R_0) << R_0$.

(1) Statement I is true; Statement II is true; Statement II is the correct explanation of Statement I
(2) Statement I is true; Statement II is true; Statement II is not the correct explanation of Statement I
(3) Statement I is false, Statement II is true
(4) Statement II is false, Statement I is true

Q.16 A 5 V battery with internal resistance 2 Ω and a 2 V battery with internal resistances 1 Ω are connected to a 10 Ω resistor as shown in the figure. The current in 10 Ω resistor is



(1) 0.27 A, from P_2 to P_1
(2) 0.03 A, from P_1 to P_2
(3) 0.03 A, from P_2 to P_1
(4) 0.27 A, from P_1 to P_2

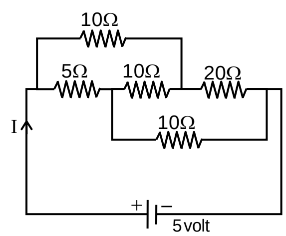
Q.17 The resistance of a wire is 5 ohm at 50 °C and 6 ohm at 100 °C. The resistance of the wire at 0 °C will be

(1) 2Ω (2) 1Ω (3) 4Ω (4) 3Ω

Q.18 A material B has twice the specific resistance of A. A circular wire made of B has twice the diameter of a wire made of A. Then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be

(1) 1/2 (2) 1/4 (3) 2 (4) 1

Q.19 The current I drawn from the 5 volt source will be



(1) 0.5 A (2) 0.67 A (3) 0.17 A (4) 0.33 A

Q.20 The resistance of a bulb filament is 100 Ω at a temperature of 100 °C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of

(1) 400°C (2) 500°C (3) 200°C (4) 300°C

Q.21 In awheatstone's bridge, three resistances P, Q and R are connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be

(1) $\frac{P}{Q} = \frac{R(S_1+S_2)}{S_1S_2}$ (2) $\frac{P}{Q} = \frac{R(S_1+S_2)}{2S_1S_2}$

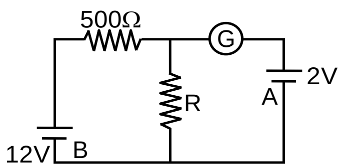
(3) $\frac{P}{Q} = \frac{R}{S_1+S_2}$ (4) $\frac{P}{Q} = \frac{2R}{S_1+S_2}$

Q.22 An electric bulb is rated 220 V – 100 W. The power consumed by it when operated on 110 V will be

(1) 40 W (2) 25 W

(3) 50 W (4) 75 W

Q.23 In the circuit, the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be



(1) 100 Ω (2) 200 Ω

(3) 1000 Ω (4) 500 Ω

Q.24 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

(1) 10^5 (2) 10^3

(3) 9995 (4) 99995

Q.25 Two sources of equal emf are connected to an external resistance 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

(1) $R = R_2 – R_1$

(2) $R = R_2 \times (R_1+R_2)/R_2–R_1)$

(3) $R=R_1R_2/(R_2–R_1)$

(4) $R = R_1R_2/(R_1+R_2)$

Q.26 A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be

(1) four time (2) doubled

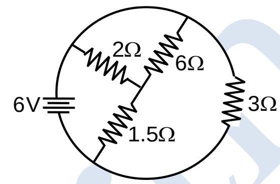
(3) half (4) one-fourth

Q.27 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

(1) 0.5 Ω (2) 1 Ω

(3) 2 Ω (4) 4 Ω

Q.28 The total current supplied to the circuit by the battery is



(1) 1 A (2) 6 A (3) 4 A (4) 2 A

Q.29 The resistance of the series combination of two resistances is S. When they are joined in parallel the total resistance is P. If S = n P then the minimumpossiblevalue of n is

(1) 4 (2) 1

(3) 2 (4) 3

Q.30 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 wires will be

(1) 3 (2) 2 (3) 8/9 (4) 1/3

Q.31 The length of a wire of a potentiometer is 100 cm, and the emf of its stand and cell is E volt. It is employed to measure the emf of a battery whose internal resistance is 0.5 Ω. If thebalance point is obtained at l = 30 cm from the positive end, the emf of the battery is [i is the current in the potentiometer wire]

(1) $\frac{30E}{100.5}$ (2) $\frac{30E}{100-0.5}$

(3) $\frac{30(E-0.5i)}{100}$ (4) $\frac{30E}{100}$

Q.32 A strip of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

(1) each of these decreases

(2) copper strip increases and that of germanium decreases

(3) copper strip decreases and that of germanium increases

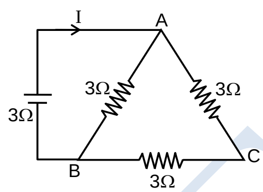
(4) each of these increases

Q.33 The thermo-emf of a thermocouple is 25μV/°C at room temperature. A galvanometer of 40Ω resistance, capable of detecting current as low as 10^{-5} A, is connected with the thermocouple. The smallest temperature difference that can be detected by this system is-

(1) 16°C (2) 12°C

(3) 8°C (4) 20°C

Q.34 A 3 volt battery with negligible internal resistance is connected in a circuit as shown in the fig. The current I in the circuit will be :



(1) 1 A (2) 1.5 A (3) 2 A (4) 1/3 A

Q.35 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 :

(1) 200% (2) 100% (3) 50% (4)300%

Q.36 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 4X against Y ?

(1) 50 cm (2) 80 cm (3) 40 cm (4) 70 cm

EXERCISE-III Previous Year Questions (JEE MAINS)

Q.1 Statement 1: The temperature dependence of resistance is usually given as $R = R_0 (1 + \alpha\Delta t)$. The resistance of a wire changes from 100 Ω to 150 Ω when its temperature is increased from 27°C to 227°C. This implies that $\alpha = 2.5 \times 10^{-3}$/°C.

Statement 2: $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$. **[AIEEE-2009]**

(1) Statement 1 is true, statement 2 is true; Statement 2 is the correct explanation of Statement 1

(2) Statement 1 is true, Statement 2 is true; Statement 2 is not the correct explanation of Statement 1

(3) Statement 1 is false, Statement 2 is true

(4) Statement 1 is true, Statement 2 is false

Q.2 Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly **[AIEEE-2010]**

(1) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$ (2) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$

(3) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (4) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

Q.3 Combination of two identical capacitors, a resistor R and a dc voltage source of voltage 6 V is used in an experiment on a (C – R) circuit. It is found that for a parallel combination of the capacitor the time in which the voltage of the fully charged combination reduces to half its original voltage is 10 second. For series combination, the time needed for reducing the voltage of the fully charged series combination by half is **[AIEEE-2011]**

(1) 2.5 second (2) 20 second

(3) 10 second (4) 5 second

Q.4 The current in the primary circuit of a potentiometer is 0.2 A. The specific resistance and cross-section of the potentiometer wire are 4×10^{-7} ohm metre and 8×10^{-7} m^2 respectively. The potential gradient will be equal to **[AIEEE-2011]**

(1) 0.1 V/m (2) 0.2 V/m

(3) 1 V/m (4) 0.5 V/m

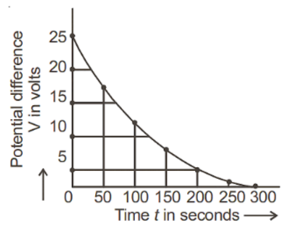
Q.5 If 400 Ω of resistance is made by adding four 100 Ω resistances of tolerance 5%, then the tolerance of the combination is **[AIEEE-2011]**

(1) 15% (2) 20% (3) 5% (4) 10%

Q.6 Two electric bulbs marked 25 W - 220 V and 100 W - 220 V are connected in series to a 440 V are connected in series to a 440V supply. Which of the bulbs will fuse? **[AIEEE-2012]**

(1) 10 W (2) 25 W (3) Neither (4) Both

Q.7



The figure shows an experimental plot for discharging of a capacitor in an R-C circuit. The time constant τ of this circuit lies between **[AIEEE-2012]**

(1) 0 and 50 s (2) 50 sec and 100 s

(3) 100 sec and 150 s (4) 150 sec and 200 s

Q.8 The supply voltage to a room is 120 V. The resistance of the lead wires is 6 Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb? **[AIEEE-2013]**

(1) Zero (2) 2.9 volt

(3) 13.3 volt (4) 10.04 volt

Q.9 This question has Statement I and Statement II. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement - I : Higher the range, greater is the resistance of ammeter.

Statement - II : To increase the range of ammeter, additional shunt needs to be used across it. **[JEE(Main)-2013]**

(1) Statement - I is true, Statement - II is true, Statement - II is the correct explanation of Statement-I.

(2) Statement - I is true, Statement - II is true, Statement - II is not the correct explanation of Statement-I.

(3) Statement - I is true, Statement - II is false.

(4) Statement - I is false, Statement - II is true.

Q.10 In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be **[JEE(Main)-2014]**

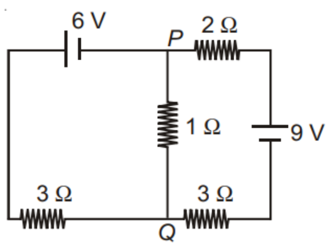
(1) 8 A (2) 10 A (3) 12 A (4) 14 A

Q.11 When 5 V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to **[JEE(Main)-2015]**

(1) 1.6×10^{-8} Ωm (2) 1.6×10^{-7} Ωm

(3) 1.6×10^{-6} Ωm (4) 1.6×10^{-5} Ωm

Q.12 In the circuit shown, the current in the 1 Ω resistor is **[JEE(Main)-2015]**



(1) 1.3 A from P to Q (2) 0 A

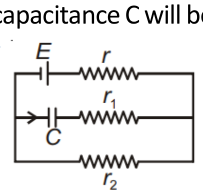
(3) 0.13 A, from Q to P (4) 0.13 A, from P to Q

Q.13 A galvanometer having a coil resistance of 100 Ω gives a full scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10 A, is **[JEE(Main)-2016]**

(1) 2 Ω (2) 0.1 Ω

(3) 3 Ω (4) 0.01 Ω

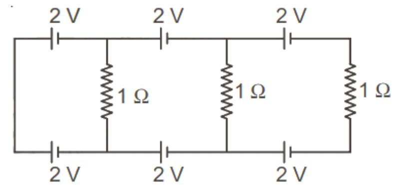
Q.14 In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be **[JEE(Main)-2017]**



(1) CE (2) $CE\frac{r_1}{(r_2+r)}$

(3) $CE\frac{r_2}{(r+r_2)}$ (4) $CE\frac{r_1}{(r_1+r)}$

Q.15



In the above circuit the current in each resistance is **[JEE(Main)-2017]**

(1) 1 A (2) 0.25 A (3) 0.5 A (4) 0 A

Q.16 When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range 0-10 V is **[JEE(Main)-2017]**

(1) 1.985×10^3 Ω (2) 2.045×10^3 Ω

(3) 2.535×10^3 Ω (4) 4.005×10^3 Ω

Q.17 Which of the following statements is false? **[JEE(Main)-2017]**

(1) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude

(2) In a balanced Wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed

(3) A rheostat can be used as a potential divider

(4) Kirchhoff's second law represents energy conservation

Q.18 Two batteries with e.m.f 12 V and 13 V are connected in parallel across a load resistor of 10 Ω. The internal resistances of the two batteries are 1 Ω and 2 Ω respectively. The voltage across the load lies between **[JEE(Main)-2018]**

(1) 11.6 V and 11.7 V (2) 11.5 V and 11.6 V

(3) 11.4 V and 11.5 V (4) 11.7 V and 11.8 V

Q.19 In a potentiometer experiment, it is found that no current passes through the galvanometer when the terminals of the cell are connected across 52 cm of the potentiometer wire. If the cell is shunted by a resistance of 5 Ω, a balance is found when the cell is connected across 40 cm of the wire. Find the internal resistance of the cell. **[JEE(Main)-2018]**

(1) 1 Ω (2) 1.5 Ω (3) 2 Ω (4) 2.5 Ω

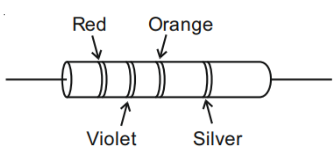
Q.20 On interchanging the resistances, the balance point of a meter bridge shifts to the left by 10 cm. The resistance of their series combination is 1 kΩ. How much was the resistance on the left slot before interchanging the resistances? **[JEE(Main)-2018]**

(1) 990 Ω (2) 505 Ω (3) 550 Ω (4) 910 Ω

Q.21 A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is **[JEE(Main)-2019]**

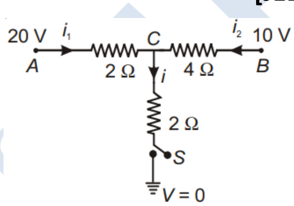
(1) 0.5 % (2) 2.0 %
(3) 2.5 % (4) 1.0 %

Q.22 A resistance is shown in the figure. Its value and tolerance are given respectively by **[JEE(Main)-2019]**



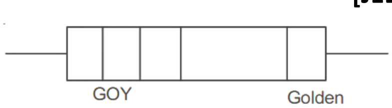
(1) 27 kΩ, 20 % (2) 270 Ω, 5 %
(3) 27k Ω, 10% (4) 270 Ω, 10 %

Q.23 When the switch S, in the circuit shown, is closed, then the value of current i will be **[JEE(Main)-2019]**



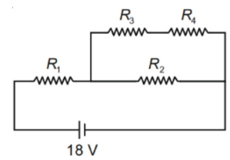
(1) 2 A (2) 5 A
(3) 4 A (4) 3 A

Q.24 A carbon resistance has a following colour code. What is the value of the resistance? **[JEE(Main)-2019]**



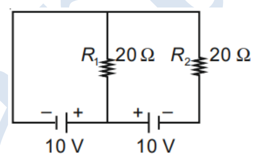
(1) 6.4 MΩ ± 5 % (2) 5.3 MΩ ± 5 %
(3) 64 kΩ ± 5 % (4) 530 kΩ ± 5 %

Q.25 In the given circuit the internal resistance of the 18 V cells is negligible. If R_1 = 400 Ω, R_3 = 100 Ω and R_4 = 500 Ω and the reading of an ideal voltmeter across R_4 is 5 V, then the value of R_2 will be **[JEE(Main)-2019]**



(1) 230 Ω (2) 450 Ω (3) 550 Ω (4) 300 Ω

Q.26 In the given circuit the cells have zero internal resistance. The currents (in amperes) passing through resistance R_1 and R_2 respectively, are **[JEE(Main)-2019]**



(1) 1, 2 (2) 0, 1 (3) 0.5, 0 (4) 2, 2

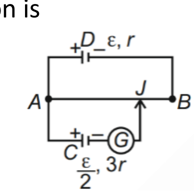
Q.27 A 2 W carbon resistor is color coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is **[JEE(Main)-2019]**

(1) 20 mA (2) 0.4 mA
(3) 100 mA (4) 63 mA

Q.28 A uniform metallic wire has a resistance of 18 Ω and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is **[JEE(Main)-2019]**

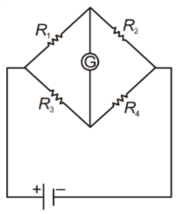
(1) 4 Ω (2) 12 Ω (3) 8 Ω (4) 2 Ω

Q.29 A potentiometer wire AB having length L and resistance 12r is joined to a cell D of emf ε and internal resistance r. A cell C having emf $\frac{\varepsilon}{2}$ and internal resistance 3r is connected. The length AJ at which the galvanometer as shown in fig. shows no deflection is **[JEE(Main)-2019]**



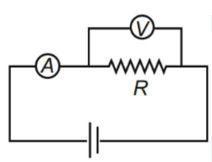
(1) $\frac{11}{12}L$ (2) $\frac{11}{24}L$ (3) $\frac{5}{12}L$ (4) $\frac{13}{24}L$

Q.30 The Wheatstone bridge shown in Fig. here, gets balanced when the carbon resistor used as R1 has the colour code (Orange, Red, Brown). The resistors R_2 and R_4 are 80 Ω and 40 Ω respectively. Assuming that the colour code for the carbon resistors gives their accurate values, the colour code for the carbon resistor, used as R_3, would be **[JEE(Main)-2019]**



(1) Brown, Blue, Black (2) Red, Green, Brown
(3) Grey, Black, Brown (4) Brown, Blue, Brown

Q.31 The actual value of resistance R, shown in the figure is 30 Ω. This is measured in an experiment as shown using the standard formula R = $\frac{V}{I}$, where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is **[JEE(Main)-2019]**



(1) 570 Ω (2) 600 Ω
(3) 350 Ω (4) 35 Ω

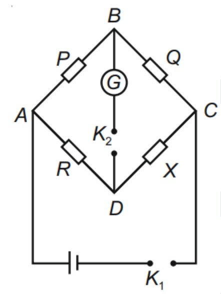
Q.32 A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11 V is connected across it is **[JEE(Main)-2019]**

(1) 11×10^{-5} W (2) 11×10^{5} W
(3) 11×10^{-3} W (4) 11×10^{-4} W

Q.33 Two equal resistances when connected in series to a battery, consume electric power of 60 W. If these resistances are now connected in parallel combination to the same battery, the electric power consumed will be **[JEE(Main)-2019]**

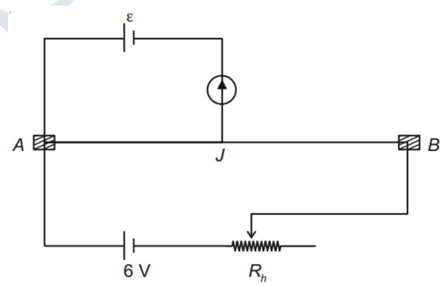
(1) 60 W (2) 30 W
(3) 120 W (4) 240 W

Q.34 In a Wheatstone bridge (see fig.), Resistances P and Q are approximately equal. When R = 400 Ω, the bridge is balanced. On interchanging P and Q, the value of R, for balance, is 405 Ω. The value of X is close to **[JEE(Main)-2019]**



(1) 404.5 ohm (2) 401.5 ohm
(3) 402.5 ohm (4) 403.5 ohm

Q.35 The resistance of the metre bridge AB in given figure is 4 Ω. With a cell of emf ε = 0.5 V and rheostat resistance R_h = 2 Ω the null point is obtained at some point J. When the cell is replaced by another one of emf ε = ε_2 the same null point J is found for R_h = 6 Ω.The emf ε_2 is **[JEE(Main)-2019]**

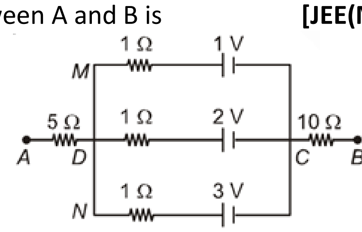


(1) 0.6 V (2) 0.5 V
(3) 0.3 V (4) 0.4 V

Q.36 A galvanometer having a resistance of 20 Ω and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is **[JEE(Main)-2019]**

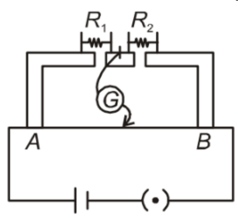
(1) 100 Ω (2) 125 Ω (3) 80 Ω (4) 120 Ω

Q.37 In the circuit shown, the potential difference between A and B is **[JEE(Main)-2019]**



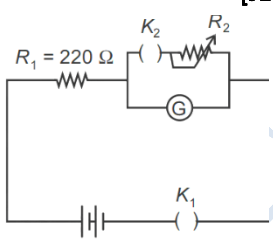
(1) 6 V (2) 3 V (3) 2 V (4) 1 V

Q.38 In the experimental set up of metre bridge shown in the figure, the null point is obtained at a distance of 40 cm from A. If a 10 Ω resistor is connected in series with R_1, the null point shifts by 10 cm. The resistance that should be connected in parallel with $(R_1 + 10)\ \Omega$ such that the null point shifts back to its initial position is **[JEE(Main)-2019]**



(1) 60 Ω (2) 30 Ω (3) 40 Ω (4) 20 Ω

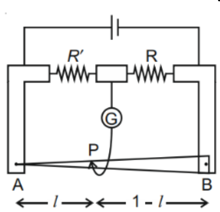
Q.39 The galvanometer deflection, when key K_1 is closed but K_2 is open, equal θ_0 (see figure). On closing K_2 also and adjusting R_2 to 5 Ω, the deflection in galvanometer becomes $\frac{\theta_0}{5}$. The resistance of the galvanometer is, then given by [Neglect the internal resistance of battery] **[JEE(Main)-2019]**



(1) 22 Ω (2) 25 Ω (3) 5 Ω (4) 12 Ω

Q.40 In a meter bridge, the wire of length 1 m has a non-uniform cross-section such that, the variation $\frac{dR}{dl}$ of its resistance R with length l is $\frac{dR}{dl} \propto \frac{1}{\sqrt{l}}$.

Two equal resistances are connected as shown in the figure. The galvanometer has zero deflection when the jockey is at point P. What is the length AP ? **[JEE(Main)-2019]**



(1) 0.2 m (2) 0.35 m (3) 0.25 m (4) 0.3 m

Q.41 An ideal battery of 4 V and resistance R are connected in series in the primary circuit of a potentiometer of length 1 m and resistance 5 Ω. The value of R, to give an potential difference of 5 mV across 10 cm of potentiometer wire, is **[JEE(Main)-2019]**

(1) 480 Ω (2) 490 Ω (3) 495 Ω (4) 395 Ω

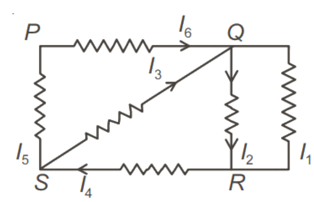
Q.42 Two electric bulbs, rated at (25 W, 220 V) and (100 W, 220 V), are connected in series across a 220 V voltage source. If the 25 W and 100 W bulbs draw powers P_1 and P_2 respectively, then **[JEE(Main)-2019]**

(1) P_1 = 9 W, P_2 = 16 W (2) P_1 = 4 W, P_2 = 16 W
(3) P_1 = 16 W, P_2 = 9 W (4) P_1 = 16 W, P_2 = 4 W

Q.43 A galvanometer, whose resistance is 50 ohm, has 25 divisions in it. When a current of 4×10^{-4} A passes through it, its needle(pointer) deflects by one division. To use this galvanometer as a voltmeter of range 2.5 V, it should be connected to a resistance of **[JEE(Main)-2019]**

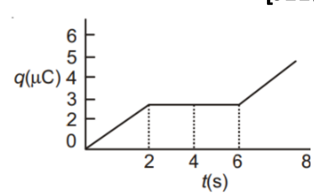
(1) 6250 ohm (2) 250 ohm
(3) 200 ohm (4) 6200 ohm

Q.44 In the given circuit diagram, the currents, $I_1 = -0.3$ A, $I_4 = 0.8$ A and $I_5 = 0.4$ A, are flowing as shown. The currents I_2, I_3 and I_6, respectively, are **[JEE(Main)-2019]**



(1) 1.1 A, 0.4 A, 0.4 A (2) 1.1 A, - 0.4 A, 0.4 A
(3) 0.4 A, 1.1 A, 0.4 A (4) – 0.4 A, 0.4 A, 1.1 A

Q.45 The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure **[JEE(Main)-2019]**



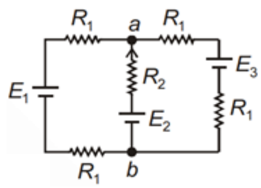
What is the value of current at t = 4 s?

(1) 2 μA (2) Zero (3) 3 μA (4) 1.5 μA

Q.46 A 200 Ω resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be **[JEE(Main)-2019]**

(1) 400 Ω (2) 500 Ω (3) 300 Ω (4) 100 Ω

Q.47 For the circuit shown, with $R_1 = 1.0\ \Omega$, $R_2 = 2.0\ \Omega$, $E_1 = 2$ V and $E_2 = E_3 = 4$ V, the potential difference between the points 'a' and 'b' is approximately (in V) **[JEE(Main)-2019]**



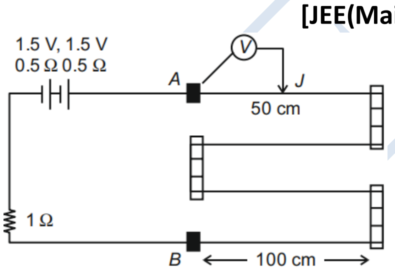
(1) 2.7 (2) 3.7 (3) 2.3 (4) 3.3

Q.48 A cell of internal resistance r drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when : **[JEE(Main)-2019]**

(1) R = 1000 r (2) R = r

(3) R = 2r (4) R = 0.001 r

Q.49 In the circuit shown, a four-wire potentiometer is made of a 400 cm long wire, which extends between A and B. The resistance per unit length of the potentiometer wire is r = 0.01 Ω/cm. If an ideal voltmeter is connected as shown with jockey J at 50 cm from end A, the expected reading of the voltmeter will be: **[JEE(Main)-2019]**

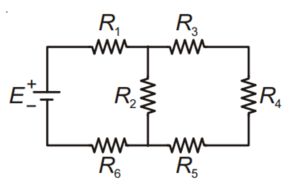


(1) 0.75 V (2) 0.50 V

(3) 0.20 V (4) 0.25 V

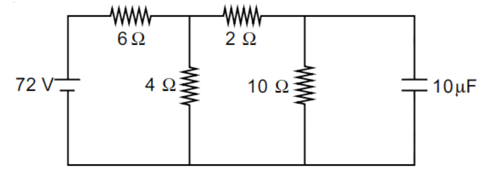
Q.50 In the figure shown, what is the current (in Ampere) drawn from the battery? You are given :

$R_1 = 15\ \Omega$, $R_2 = 10\ \Omega$, $R_3 = 20\ \Omega$, $R_4 = 5\ \Omega$, $R_5 = 25\ \Omega$, $R_6 = 30\ \Omega$, E = 15 V **[JEE(Main)-2019]**



(1) $\frac{13}{24}$ (2) $\frac{9}{32}$ (3) $\frac{20}{3}$ (4) $\frac{7}{18}$

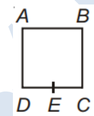
Q.51 Determine the charge on the capacitor in the following circuit. **[JEE(Main)-2019]**



(1) 200 μC (2) 60 μC (3) 10 μC (4) 2 μC

Q.52 A wire of resistance R is bent to form a square ABCD as shown in the figure. The effective resistance between E and C is

(E is mid-point of arm CD) **[JEE(Main)-2019]**



(1) $\frac{3}{4}$R (2) R (3) $\frac{1}{16}$R (4) $\frac{7}{64}$R

Q.53 A moving coil galvanometer has resistance 50 Ω and it indicates full deflection at 4 mA current. A voltmeter is made using this galvanometer and a 5 kΩ resistance. The maximum voltage, that can be measured using this voltmeter, will be close to **[JEE(Main)-2019]**

(1) 10 V (2) 20 V (3) 15 V (4) 40 V

Q.54 A metal wire of resistance 3 Ω is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make a circle. If two points on this circle make an angle 60° at the centre, the equivalent resistance between these two points will be **[JEE(Main)-2019]**

(1) $\frac{5}{3}\Omega$ (2) $\frac{5}{2}\Omega$ (3) $\frac{7}{2}\Omega$ (4) $\frac{12}{5}\Omega$

Q.55 The resistance of a galvanometer is 50 ohm and the maximum current which can be passed through it is 0.002 A. What resistance must be connected to it in order to convert it into an ammeter of range 0 – 0.5 A? **[JEE(Main)-2019]**

(1) 0.2 ohm (2) 0.002 ohm

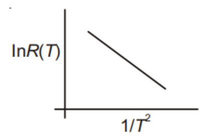
(3) 0.5 ohm (4) 0.02 ohm

Q.56 In a conductor, if the number of conduction electrons per unit volume is $8.5 \times 10^{28}\ m^{-3}$ and mean free time is 25 fs (femto second), its approximate resistivity is ($m_e = 9.1 \times 10^{-31}$ kg) **[JEE(Main)-2019]**

(1) $10^{-5}\ \Omega$m (2) $10^{-6}\ \Omega$m

(3) $10^{-7}\ \Omega$m (4) $10^{-8}\ \Omega$m

Q.57 In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line. **[JEE(Main)-2019]**



One may conclude that :

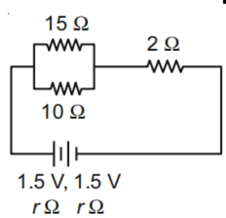
(1) $R(T)=\frac{R_0}{T^2}$ (2) $R(T)=R_0e^{-T_0^2/T^2}$

(3) $R(T)=R_0e^{-T^2/T_0^2}$ (4) $R(T)=R_0e^{T^2/T_0^2}$

Q.58 A moving coil galvanometer allows a full scale current of 10–4 A. A series resistance of 2 MΩ is required to convert the above galvanometer into a voltmeter of range 0 – 5 V. Therefore the value of shunt resistance required to convert the above galvanometer into an ammeter of range 0–10 mA is: **[JEE(Main)-2019]**

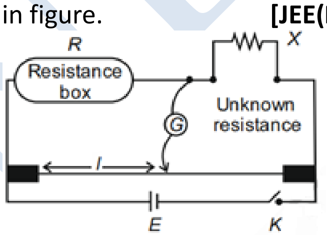
(1) 200 Ω (2) 500 Ω (3) 100 Ω (4) 10 Ω

Q.59 In the given circuit, an ideal voltmeter connected across the 10 Ω resistance reads 2 V. The internal resistance r, of each cell is : **[JEE(Main)-2019]**



(1) 0.5 Ω (2) 0 Ω (3) 1.5 Ω (4) 1 Ω

Q.60 In a meter bridge experiment, the circuit diagram and the corresponding observation table are shown in figure. **[JEE(Main)-2019]**



Sl. No	R(Ω)	I (CM)
1	1000	60
2	100	13
3	10	1.5
4	1	1.0

Which of the readings is inconsistent ?

(1) 3 (2) 2 (3) 1 (4) 4

Q.61 A current of 5 A passes through a copper conductor (resistivity = 1.7×10^{-8} Ω m) of radius of crosssection 5 mm. Find the mobility of the charges if their drift velocity is 1.1×10^{-3} m/s. **[JEE(Main)-2019]**

(1) 1.3 m^2 / Vs (2) 1.8 m^2 / Vs

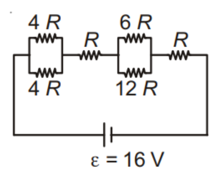
(3) 1.5 m^2 / Vs (4) 1.0 m^2 / Vs

Q.62 Space between two concentric conducting spheres of radii a and b (b > a) is filled with a medium of resistivity ρ. The resistance between the two spheres will be: **[JEE(Main)-2019]**

(1) $\frac{\rho}{4\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$ (2) $\frac{\rho}{2\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$

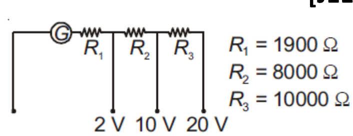
(3) $\frac{\rho}{2\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$ (4) $\frac{\rho}{4\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$

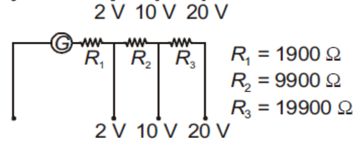
Q.63 The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 watt. The value of R is : **[JEE(Main)-2019]**

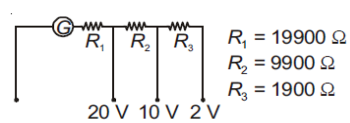


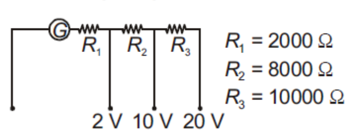
(1) 8 Ω (2) 1 Ω (3) 16 Ω (4) 6 Ω

Q.64 A galvanometer of resistance 100 Ω has 50 divisions on its scale and has sensitivity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0-2 V, 0-10 V and 0-20 V. The appropriate circuit to do so is : **[JEE(Main)-2019]**

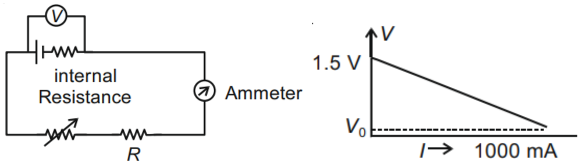
(1) 

(2) 

(3) 

(4) 

Q.65 To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained : **[JEE(Main)-2019]**



If V_0 is almost zero, identify the correct statement :

(1) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω

(2) The emf of the battery is 1.5 V and the value of R is 1.5 Ω

(3) The value of the resitance R is 1.5 Ω

(4) The potential difference across the battery is 1.5 V when it sends a current of 1000 mA

Q.66 A moving coil galvanometer, having a resistance G, produces full scale deflection when a current I_g flows through it. This galvanometer can be converted into (i) an ammeter of range 0 to I_0($I_0 > I_g$) by connecting a shunt resistance R_A to it and (ii) into a voltmeter of range 0 to V($V = GI_0$) by connecting a series resistance R_V to it. Then, **[JEE(Main)-2019]**

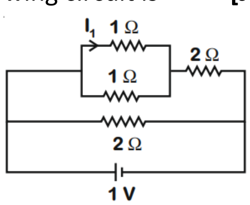
(1) $R_AR_V = G^2$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0 - I_g}\right)^2$

(2) $R_AR_V = G^2\left(\frac{I_g}{I_0 - I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_0 - I_g}{I_g}\right)^2$

(3) $R_AR_V = G^2$ and $\frac{R_A}{R_V} = \frac{I_g}{(I_0 - I_g)}$

(4) $R_AR_V = G^2\left(\frac{(I_0 - I_g)}{I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{(I_0 - I_g)}\right)^2$

Q.67 The current I_1 (in A) flowing through 1 Ω resistor in the following circuit is **[JEE(Main)-2020]**



(1) 0.5 (2) 0.4 (3) 0.25 (4) 0.2

Q.68 In a building there are 15 bulbs of 45 W, 15 bulbs of 100 W, 15 small fans of 10 W and 2 heaters of 1 kW. The voltage of electric main is 220 V. The minimum fuse capacity (rated value) of the building will be **[JEE(Main)-2020]**

(1) 15 A (2) 10 A (3) 20 A (4) 25 A

Q.69 The length of a potentiometer wire is 1200 cm and it carries a current of 60 mA. For a cell of emf 5 V and internal resistance of 20 Ω, the null point on it is found to be at 1000 cm. The resistance of whole wire is **[JEE(Main)-2020]**

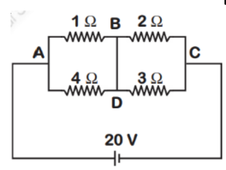
(1) 80 Ω (2) 100 Ω (3) 60 Ω (4) 120 Ω

Q.70 A galvanometer having a coil resistance 100 Ω gives a full scale deflection when a current of 1 mA is passed through it. What is the value of the resistance which can convert this galvanometer into a voltmeter giving full scale deflection for a potential difference of 10 V? **[JEE(Main)-2020]**

(1) 10 kΩ (2) 9.9 kΩ

(3) 8.9 kΩ (4) 7.9 kΩ

Q.71 In the given circuit diagram, a wire is joining points B and D. The current in this wire is **[JEE(Main)-2020]**



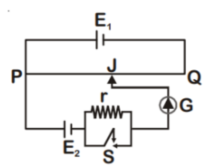
(1) 0.4 A (2) 4 A (3) 2 A (4) Zero

Q.72 Consider four conducting materials copper, tungsten, mercury and aluminium with resistivity ρ_C, ρ_T, ρ_M and ρ_A respectively. **[JEE(Main)-2020]**

(1) $\rho_M > \rho_A > \rho_C$ (2) $\rho_C > \rho_A > \rho_T$

(3) $\rho_A > \rho_M > \rho_C$ (4) $\rho_A > \rho_T > \rho_C$

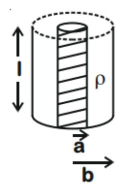
Q.73 A potentiometer wire PQ of 1 m length is connected to a standard cell E_1. Another cell E_2 of emf 1.02 V is connected with a resistance 'r' and switch S (as shown in figure). With switch S open, the null position is obtained at a distance of 49 cm from Q. The potential gradient in the potentiometer wire is **[JEE(Main)-2020]**



(1) 0.04 V/cm (2) 0.01 V/cm

(3) 0.02 V/cm (4) 0.03 V/cm

Q.74 Model a torch battery of length l to be made up of a thin cylindrical bar of radius 'a' and a concentric thin cylindrical shell of radius 'b' filled in between with an electrolyte of resistivity ρ (see figure). If the battery is connected to a resistance of value R, the maximum Joule heating in R will take place for **[JEE(Main)-2020]**



(1) $R=\frac{\rho}{\pi l}\ln\left(\frac{b}{a}\right)$ (2) $R=\frac{2\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(3) $R=\frac{\rho}{2\pi l}\ln\left(\frac{b}{a}\right)$ (4) $R=\frac{\rho}{2\pi l}\left(\frac{b}{a}\right)$

Q.75 Which of the following will NOT be observed when a multimeter (operating in resistance measuring mode) probes connected across a component, are just reversed? **[JEE(Main)-2020]**

(1) Multimeter shows NO deflection in both cases i.e., before and after reversing the probes if the chosen component is capacitor

(2) Multimeter shows NO deflection in both cases i.e., before and after reversing the probes if the chosen component is metal wire

(3) Multimeter shows a deflection, accompanied by a splash of light out of connected component in one direction and NO deflection on reversing the probes if the chosen component is LED

(4) Multimeter shows an equal deflection in both cases i.e. before and after reversing the probes if the chosen component is resistor

Q.76 Two resistors 400 Ω and 800 Ω are connected in series across a 6 V battery. The potential difference measured by a voltmeter of 10 kΩ across 400 Ω resistor is close to **[JEE(Main)-2020]**

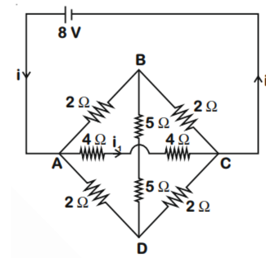
(1) 2.05 V (2) 1.8 V (3) 2 V (4) 1.95 V

Q.77 A battery of 3.0 V is connected to a resistor dissipating 0.5 W of power. If the terminal voltage of the battery is 2.5 V, the power dissipated within the internal resistance is **[JEE(Main)-2020]**

(1) 0.10 W (2) 0.072 W

(3) 0.50 W (4) 0.125 W

Q.78 The value of current i_1 flowing from A to C in the circuit diagram is **[JEE(Main)-2020]**

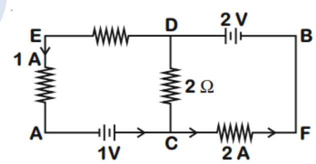


(1) 1 A (2) 4 A (3) 5 A (4) 2 A

Q.79 A galvanometer of resistance G is converted into a voltmeter of range 0 – 1 V by connecting a resistance R_1 in series with it. The additional resistance that should be connected in series with R_1 to increase the range of the voltmeter to 0 – 2 V will be **[JEE(Main)-2020]**

(1) G (2) R_1 (3) $R_1 + G$ (4) $R_1 - G$

Q.80 In the circuit, given in the figure currents in different branches and value of one resistor are shown. Then potential at point B with respect to the point A is **[JEE(Main)-2020]**



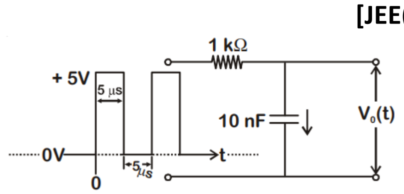
(1) +1 V (2) - 2 V (3) + 2 V (4) - 1 V

Q.81 A galvanometer is used in laboratory for detecting the null point in electrical experiments. If, on passing a current of 6 mA it produces a deflection of 2°, its figure of merit is close to **[JEE(Main)-2020]**

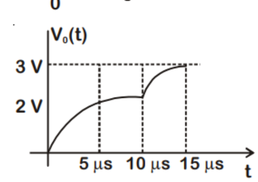
(1) 6×10^{-3} A/div. (2) 666° A/div.

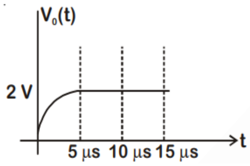
(3) 3×10^{-3} A/div. (4) 333° A/div.

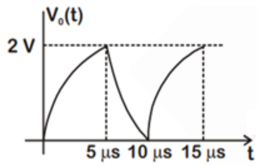
Q.88 For the given input voltage waveform $V_{in}(t)$, the output voltage waveform $V_0(t)$, across the capacitor is correctly depicted by **[JEE(Main)-2020]**

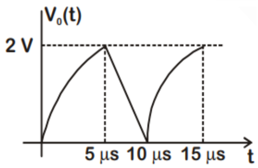


(1)



(2)


(3)


(4)


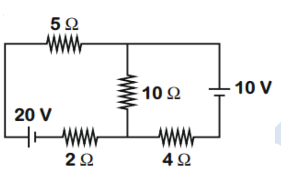
Q.83 A circuit to verify Ohm's law uses ammeter and voltmeter in series or parallel connected correctly to the resistor. In the circuit **[JEE(Main)-2020]**

(1) Ammeter is always connected in series and voltmeter in parallel

(2) Both ammeter and voltmeter must be connected in parallel

(3) Ammeter is always used in parallel and voltmeter is series

(4) Both ammeter and voltmeter must be connected in series

Q.84


In the figure shown, the current in the 10 V battery is close to **[JEE(Main)-2020]**

(1) 0.36 A from negative to positive terminal

(2) 0.42 A from positive to negative terminal

(3) 0.71 A from positive to negative terminal

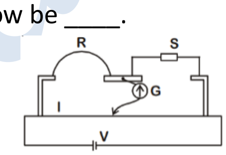
(4) 0.21 A from positive to negative terminal

Q.85 The balancing length for a cell is 560 cm in a potentiometer experiment. When an external resistance of 10 Ω is connected in parallel to the cell, the balancing length changes by 60 cm. If the internal resistance of the cell is $\frac{N}{10}\Omega$, where N is an integer then value of N is _____. **[JEE(Main)-2020]**

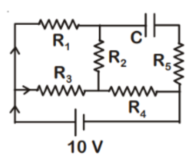
Q.86 Four resistances of 15 Ω, 12 Ω, 4 Ω and 10 Ω respectively in cyclic order to form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10 Ω to balance the network is _________ Ω. **[JEE(Main)-2020]**

Q.87 The series combination of two batteries, both of the same emf 10 V, but different internal resistance of 20 Ω and 5 Ω, is connected to the parallel combination of two resistors 30 Ω and R Ω. The voltage difference across the battery of internal resistance 20 Ω is zero, the value of R (in Ω) is _______. **[JEE(Main)-2020]**

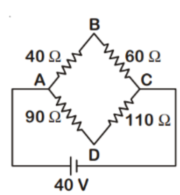
Q.88 In a meter bridge experiment S is a standard resistance. R is a resistance wire. It is found that balancing length is l = 25 cm. If R is replaced by a wire of half length and half diameter that of R of same material, then the balancing distance l′ (in cm) will now be ____. **[JEE(Main)-2020]**



Q.89 An ideal cell of emf 10 V is connected in circuit shown in figure. Each resistance is 2 Ω. The potential difference (in V) across the capacitor when it is fully charged is ______. **[JEE(Main)-2020]**



Q.90 Four resistances 40 Ω, 60 Ω, 90 Ω and 110 Ω make the arms of a quadrilateral ABCD. Across AC is a battery of emf 40 V and internal resistance negligible. The potential difference across BD in V is ______. **[JEE(Main)-2020]**



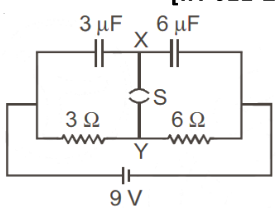
EXERCISE-IV Previous Year Questions(JEE ADVANCE)

Q.1 A resistance of 2 Ω is connected across one gap of a meter-bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2 Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is **[IIT-JEE-2007 (Paper-1)]**

(1) 3 Ω (2) 4 Ω (3) 5 Ω (4) 6 Ω

Q.2 A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is

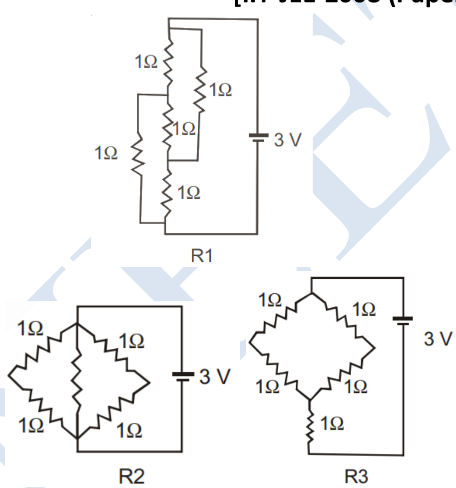
[IIT-JEE-2007 (Paper-1)]



(1) 0 (2) 54 μC (3) 27μC (4) 81 μC

Q.3 Figure shows three resistor configurations R_1, R_2 and R_3 connected to 3 V battery. If the power dissipated by the configuration R_1, R_2 and R_3 is P_1, P_2 and P_3, respectively, Then

[IIT-JEE-2008 (Paper-1)]



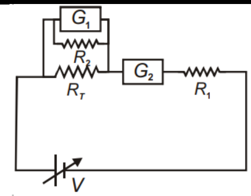
(1) P1 > P2 > P3 (2) P1 > P3 > P2

(3) P2 > P1 > P3 (4) P3 > P2 > P1

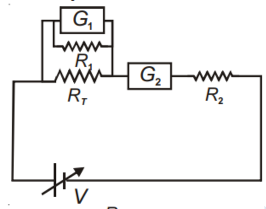
Q.4 To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2, and a variable voltage source V. The correct circuit to carry out the experiment is

[IIT-JEE-2010 (Paper-1)]

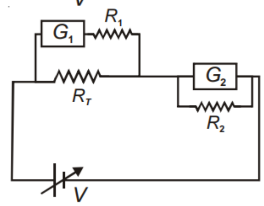
(1)



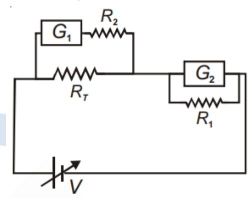
(2)



(3)



(4)

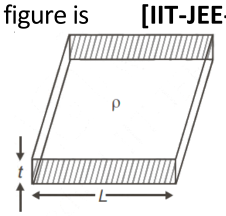


Q.5 Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistance R_{100}, R_{60} and R_{40}, respectively, the relation between these resistance is **[IIT-JEE-2010 (Paper-1)]**

(1) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ (2) $R_{100} = R_{40} + R_{60}$

(3) $R_{100} > R_{60} > R_{40}$ (4) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

Q.6 Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is **[IIT-JEE-2010 (Paper-1)]**



(1) Directly proportional to L

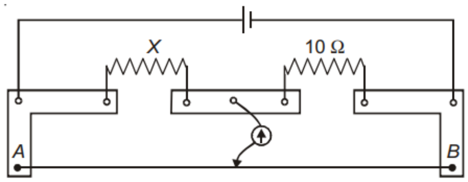
(2) Directly proportional to t

(3) Independent of L

(4) Independent of t

Q.7 A meter bridge is set-up as shown, to determine an unknown resistance X using a standard 10 ohm resistor. The galvanometer shows null point when tapping key is at 52 cm mark. The end corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of X is

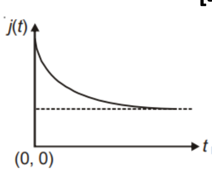
[IIT-JEE-2011 (Paper-1)]

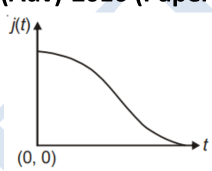


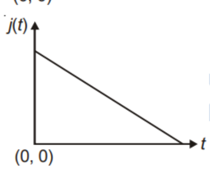
(1) 10.2 ohm (2) 10.6 ohm
(3) 10.8 ohm (4) 11.1 ohm

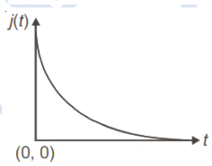
Q.8 An infinite line charge of uniform electric charge density λ lies along the axis of an electrically conducting infinite cylindrical shell of radius R. At time t = 0, the space inside the cylinder is filled with a material of permittivity ε and electrical conductivity σ. The electrical conduction in the material follows Ohm's law. Which one of the following graphs best describes the subsequent variation of the magnitude of current density j(t) at any point in the material?

[JEE (Adv)-2016 (Paper-1)]

(1) 

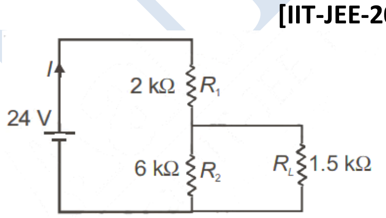
(2) 

(3) 

(4) 

Q.9 For the circuit shown in the figure

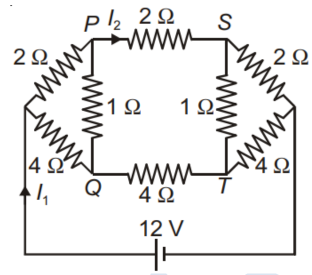
[IIT-JEE-2009 (Paper-1)]



(1) Th current I through the battery is 7.5 mA
(2) The potential difference across R_L is 18 V
(3) Ratio of powers dissipated in R_1 and R_2 is 3
(4) If R_1 and R_2 are interchanged, magnitude of the power dissipated in RL will decrease by a factor of 9

Q.10 For the resistance network shown in the figure, choose the correct option(s).

[IIT-JEE-2012 (Paper-1)]



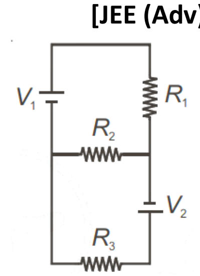
(1) The current through PQ us zero
(2) I_1 = 3 A
(3) The potential at S is less than that at Q
(4) I_2 = 2 A

Q.11 Heater of an electric kettle is made of a wire of length L and diameter d. It takes 4 minutes to raise the temperature of 0.5 kg water by 40 K. This heater is replaced by a new heater having two wires of the same material, each of length L and diameter 2d. The way these wires are connected is given in the options. How much time in minutes will it take to raise the temperature of the same amount of water by 40 K?

[JEE (Adv)-2014 (Paper-1)]

(1) 4 if wires are in parallel
(2) 2 if wires are in series
(3) 1 if wires are in series
(4) 0.5 if wires are in parallel

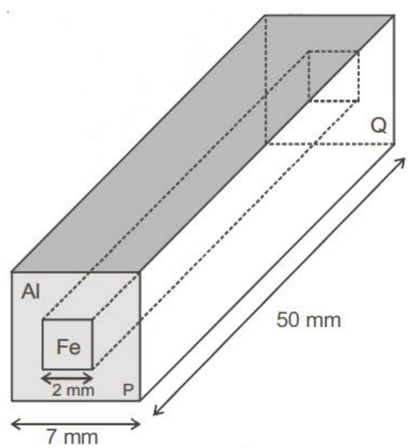
Q.12 Two ideal batteries of emf V_1 and V_2 and three resistances R_1, R_2 and R_3 are connected as shown in the figure. The current in resistance R_2 would be zero if **[JEE (Adv)-2014 (Paper-1)]**



(1) $V_1 = V_2$ and $R_1 = R_2 = R_3$
(2) $V_1 = V_2$ and $R_1 = 2R_2 = R_3$
(3) $V_1 = 2V_2$ and $2R_1 = 2R_2 = R_3$
(4) $2V_1 = V_2$ and $2R_1 = R_2 = R_3$

Q.13 In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are $2.7 \times 10^{-8}\ \Omega$ m and $1.0 \times 10^{-7}\ \Omega$ m, respectively. The electrical resistance between the two faces P and Q of the composite bar is

[JEE (Adv)-2015 (Paper-1)]



(1) $\frac{2475}{64}\mu\Omega$ (2) $\frac{1875}{64}\mu\Omega$

(3) $\frac{1875}{49}\mu\Omega$ (4) $\frac{2475}{132}\mu\Omega$

Q.14 An incandescent bulb has a thin filament of tungsten that is heated to high temperature by passing an electric current. The hot filament emits black-body radiation. The filament is observed to break up at random locations after a sufficiently long time of operation due to non-uniform evaporation of tungsten from the filament. If the bulb is powered at constant voltage, which of the following statement(s) is(are) true?

[JEE (Adv)-2016 (Paper-1)]

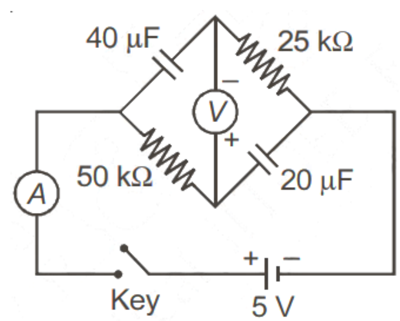
(1) The temperature distribution over the filament is uniform
(2) The resistance over small sections of the filament decreases with time
(3) The filament emits more light at higher band of frequencies before it breaks up
(4) The filament consumes less electrical power towards the end of the life of the bulb

Q.15 Consider two identical galvanometers and two identical resistors with resistance R. If the internal resistance of the galvanometers $R_C < R/2$, which of the following statement(s) about any one of the galvanometers is(are) true?

[JEE (Adv)-2016 (Paper-2)]

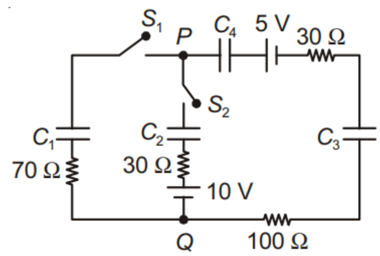
(1) The maximum voltage range is obtained when all the components are connected in series
(2) The maximum voltage range is obtained when the two resistors and one galvanometer are connected in series, and the second galvanometer is connected in parallel to the first galvanometer
(3) The maximum current range is obtained when all the components are connected in parallel
(4) The maximum current range is obtained when the two galvanometers are connected in series and the combination is connected in parallel with both the resistors

Q.16 In the circuit shown below, the key is pressed at time t = 0. Which of the following statement(s) is(are) true? **[JEE (Adv)-2016 (Paper-2)]**



(1) The voltmeter displays –5 V as soon as the key is pressed, and displays +5 V after a long time
(2) The voltmeter will display 0 V at time t = ln 2 seconds
(3) The current in the ammeter becomes 1/e of the initial value after 1 second
(4) The current in the ammeter becomes zero after a long time

Q.17 In the circuit shown, initially there is no charge on capacitors and keys S_1 and S_2 are open. The values of the capacitors are $C_1 = 10\ \mu F$, $C_2 = 30\ \mu F$ and $C_3 = C_4 = 80\ \mu F$. **[JEE (Adv)-2019 (Paper-1)]**



Which of the statement(s) is/are correct?

(1) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage across the capacitor C_1 will be 4 V.

(2) The key S_1 is kept closed for long time such that capacitors are fully charged. Now key S_2 is closed, at this time, the instantaneous current across 30 Ω resistor (between points P and Q) will be 0.2 A (round off to 1^{st} decimal place).

(3) At time t = 0, the key S_1 is closed, the instantaneous current in the closed circuit will be 25 mA.

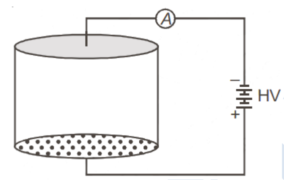
(4) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between point P and Q will be 10 V.

Linked Comprehension Type Questions

Paragraph for Q. Nos. 18 and 19

Consider an evacuated cylindrical chamber of height h having rigid conducting plates at the ends and an insulating curved surface as shown in the figure. A number of spherical balls made of a light weight and soft material and coated with a conducting material are placed on the bottom plate. The balls have a radius r << h. Now a high voltage source (HV) is connected across the conducting plates such that the bottom plate is at $+V_0$ and the top plate at $-V_0$. Due to their conducting surface, the balls will get charged, will become equipotential with the plate and are repelled by it. The balls will eventually collide with the top plate, where the coefficient of restitution can be taken to be zero due to the soft nature of the material of the balls. The electric field in the chamber can be considered to be that of a parallel plate capacitor. Assume that there are no collisions between the balls and the interaction between them is negligible. (Ignore gravity)

[JEE (Adv)-2016 (Paper-2)]



Choose the correct answer :

Q.18 Which one of the following statements is correct?
(1) The balls will execute simple harmonic motion between the two plates
(2) The balls will bounce back to the bottom plate carrying the same charge they went up with
(3) The balls will stick to the top plate and remain there
(4) The balls will bounce back to the bottom plate carrying the opposite charge they went up with

Q.19 The average current in the steady state registered by the ammeter in the circuit will be
(1) Proportional to V_0^2
(2) Proportional to the potential V_0
(3) Zero
(4) Proportional to $V_0^{1/2}$

Paragraph for Q. Nos. 20 and 21

Consider a simple RC circuit as shown in Figure 1.

Process 1: In the circuit the switch S is closed at t = 0 and the capacitor is fully charged to voltage V_0 (i.e., charging continues for time T >> RC). In the process some dissipation (ED) occurs across the resistance R. The amount of energy finally stored in the fully charged capacitor is E_C.

Process 2: In a different process the voltage is first set to $\frac{V_0}{3}$ and maintained for a charging time T >> RC. Then the voltage is raised to $\frac{2V_0}{3}$ without discharging the capacitor and again maintained for a time T >> RC. The process is repeated one more time by raising the voltage to V0 and the capacitor is charged to the same final voltage V_0 as in Process 1.

These two processes are depicted in Figure 2.

[JEE (Adv)-2017 (Paper-2)]

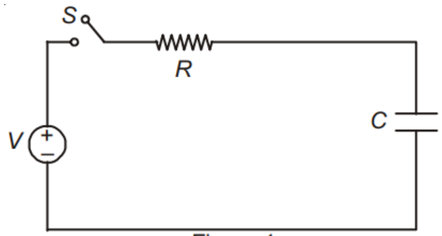


Figure 1

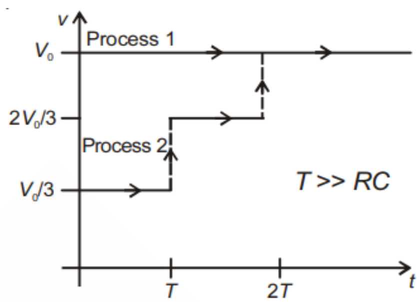


Figure 2

Choose the correct answer :

Q.20 In Process 1, the energy stored in the capacitor E_C and heat dissipated across resistance E_D are related by :

(1) $E_C = E_D \ln 2$ (2) $E_C = E_D$

(3) $E_C = 2E_D$ (4) $E_C = \frac{1}{2} E_D$

Q.21 In Process 2, total energy dissipated across the resistance E_D is :

(1) $E_D = \frac{1}{3}\left(\frac{1}{2}CV_0^2\right)$ (2) $E_D = 3\left(\frac{1}{2}CV_0^2\right)$

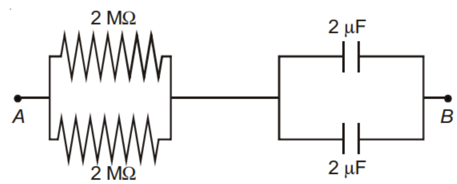
(3) $E_D = 3CV_0^2$ (4) $E_D = \frac{1}{2}CV_0^2$

Integer / Numerical Value Type Questions

Q.22 When two identical batteries of internal resistance 1 Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25\ J_2$, then the value of R in Ω is **[IIT-JEE-2010 (Paper-1)]**

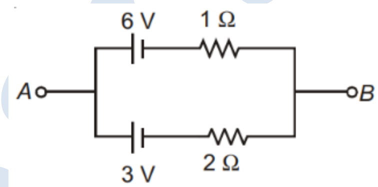
Q.33 At time t = 0, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in seconds) does the voltage across them become 4 V? [Take : ln 5 = 1.6, ln 3 = 1.1]

[IIT-JEE-2010 (Paper-2)]



Q.24 Two batteries of different emfs and different internal resistance are connected as shown. The voltage across AB in volts is

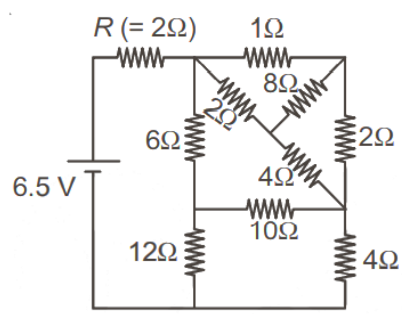
[IIT-JEE-2011 (Paper-2)]



Q.25 A galvanometer gives full scale deflection with 0.006 A current. By connecting it to a 4990 Ω resistance, it can be converted into a voltmeter of range 0 – 30 V. If connected to a $\frac{2n}{249}\Omega$ resistance, it becomes an ammeter of range 0 - 1.5 A. The value of n is **[JEE (Adv)-2014 (Paper-1)]**

Q.26 In the following circuit, the current through the resistor R (= 2 Ω) is I amperes. The value of I is

[JEE (Adv)-2015 (Paper-2)]



ANSWER KEY

EXERCISE-I

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	3	4	2	3	1	3	2	4	2	3	3	2	2	4	4
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	1	4	1	2	1	3	3	3	3	3	4	3	3	4	3
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	3	1	4	2	3	2	2	2	4	3	4	2	3	2	1
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	3	4	1	2	2	2	4	3	3	1	1	3	2	1	3
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**
Ans.	1	3	1	3	3	4	3	2	3	2	1	3	2	1	3
Que.	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
Ans.	4	1	3	1	4	3	3	1	3	2	1	2	3	3	3
Que.	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**
Ans.	1	4	2	4	4	3	3	3	4	3	3	1	4	2	4
Que.	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	1	3	4	1	3	1	3	1	3	1	2	2	2	2	4
Que.	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**
Ans.	2	2	3	1	2	2	3	2	3	2	2	2	1	2	4
Que.	**136**	**137**	**138**	**139**	**140**	**141**									
Ans.	3	4	1	1	2	1									

EXERCISE-II

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	2	2	3	4	1	1	4	3	3	4	3	1	2	4	3
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	3	3	3	1	1	1	2	1	3	1	2	3	3	1	4
Que.	**31**	**32**	**33**	**34**	**35**	**36**									
Ans.	4	3	1	2	4	1									

EXERCISE-III

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	1	1	3	2	3	4	4	3	4	3	4	3	4
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	1	2	2	2	3	4	3	2	4	4	3	1	1	4	4
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	1	1	4	3	3	3	3	1	1	3	4	4	3	1	2
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	2	4	2	4	2	1	4	2	1	1	4	2	BONUS	1	4
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**
Ans.	4	1	1	1	1	1	4	3	2	2	3	1	3	3	1
Que.	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
Ans.	4	1	1	3	1	3	1	1	4	12	10	30	40	8	2

EXERCISE-IV

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	3	3	4	3	2	4	1,4	1,2,3,4	2,4	1,2,4	2	4	2,3
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**				
Ans.	1,2,3,4	1,3	4	1	2	1	4	2	5	5	1				

JEE Module Details

(Total = 24)

CLASS - XII : 12 MODULES

PHYSICS

Ch. No.	Chapter Name
Module - 1	
1.	Electrostatics
2.	Capacitor & R-C Circuit
3.	Current Electricity
Module - 2	
1.	MEC
2.	Magnetic Materials
3.	Bar Magnets & Earth Magnetism
4.	EMI
5.	AC
6.	EMW
Module - 3	
1.	Ray Optics
2.	Wave Optics
Module - 4	
1.	Modern Physics
2.	Nuclear Physics
3.	Electronics - Semiconductor
4.	Principles of Communication System

CHEMISTRY

Ch. No.	Chapter Name
Module -1 (Physical)	
1.	The Solid State
2.	Solutions
3.	Electrochemistry
4.	Chemical Kinetics
5.	Surface Chemistry
Module -2 (Inorganic)	
1.	The p -Block Elements
2.	General Principles and Processes of Isolation of Elements (Metallurgy)
3.	The d - and f Block Elements
4.	Coordination Compounds
Module -3 (Organic)	
1.	Halogen Derivatives
2.	Oxygen Containing Compound
3.	Nitrogen Containing Compound
4.	Biomolecules, Polymers & Chemistry Every Day Life

MATHEMATICS

Ch. No.	Chapter Name
Module - 1	
1.	Functions
2.	Inverse Trigonometric Functions
3.	Matrix
4.	Determinants
Module - 2	
1.	Limit
2.	Continuity & Differentiability
3.	MOD
4.	AOD
Module - 3	
1.	Integration
2.	Area Under Curve
3.	Differential Equations
Module - 4	
1.	Vectors
2.	3 - Dimensional Geometry
3.	Probability
Module - 5	
1.	H & D
2.	M. Reasoning
3.	Linear Programing
4.	Statistics

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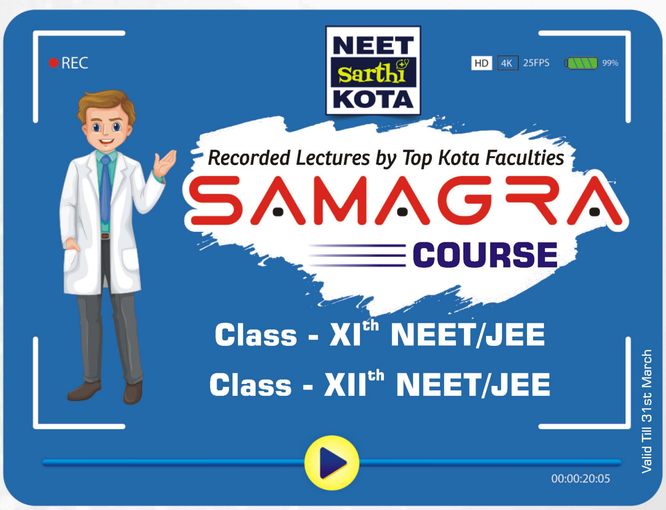

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