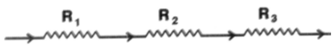
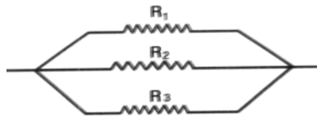
Revision

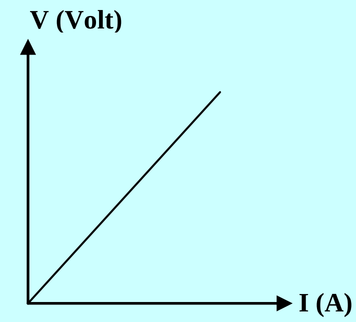
Compare Between

Points of Comparison	Series Connection	Parallel Connection
Drawing		
Total resistance (R_T)	$R_T = R_1 + R_2 + R_3$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
Potential Difference (V)	$V_T = V_1 + V_2 + V_3$	$V_T = V_1 = V_2 = V_3$
Electric Current (I)	$I_T = I_1 = I_2 = I_3$	$I_T = I_1 + I_2 + I_3$

Application

Subject	Application
1. Series connection:	Obtain a large resistance out of a bunch of small resistances.
2. Parallel connection:	Obtain a small resistance out of a bunch of large resistances.
3. Ampere's right hand rule:	It is used to determine the direction of the magnetic field when passing electric current in a straight wire.
4. Right hand screw rule:	It is used to determine the direction of the magnetic field when passing electric current in a circular loop.
5. Flemming's left hand rule:	It is used to determine the direction of motion of a straight wire when passing through it an electric current and placed normally to a magnetic field.

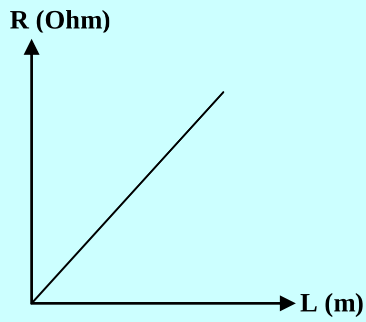
Graphs



$V = I\,R$

$$\text{Slope} = \frac{\Delta V}{\Delta I} = R$$

(R) Resistance of wire

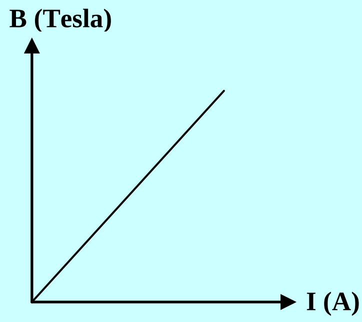


$$R = \rho\left(\frac{L}{A}\right)$$

$$\text{Slope} = \frac{\Delta R}{\Delta L} = \frac{\rho}{A}$$

(ρ) Resistivity of material

(A) Area of wire

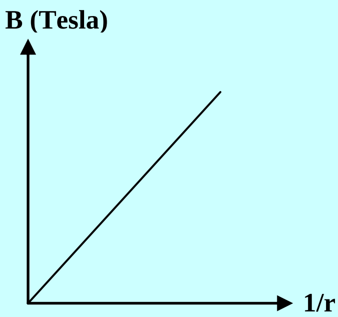


$$B = \frac{\mu I}{2\pi d}$$

$$\text{Slope} = \frac{\Delta B}{\Delta I} = \frac{\mu}{2\pi d}$$

(μ) Permeability of medium

(d) Distance between point and wire



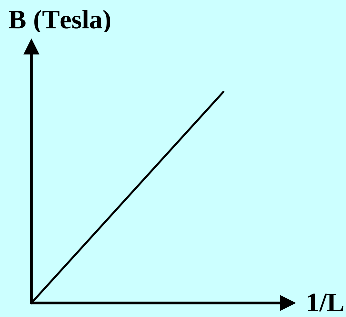
$$B = \frac{\mu N I}{2r}$$

$$\text{Slope} = \frac{\Delta B}{\Delta\left(\frac{1}{r}\right)} = \frac{\mu N I}{2}$$

(μ) Permeability of medium

(N) Number of turns

(I) Electric current intensity



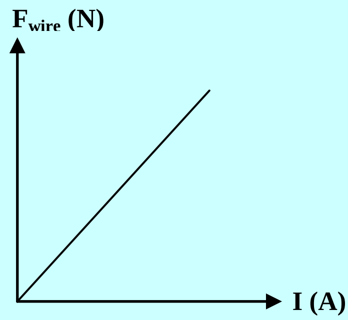
$$B = \frac{\mu N I}{L}$$

$$\text{Slope} = \frac{\Delta B}{\Delta\left(\frac{1}{L}\right)} = \mu N I$$

(μ) Permeability of medium

(N) Number of turns

(I) Electric current intensity



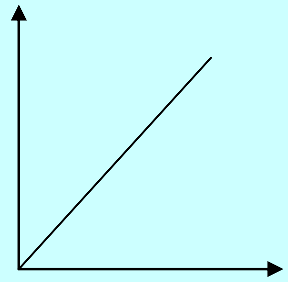
$$F_{wire} = BIL\,\sin\theta$$

$$\text{Slope} = \frac{\Delta F}{\Delta I} = BL\sin\theta$$

(B) Magnetic flux density

(L) Length of wire

(θ) Angle between wire & field

 		
$\tau = BIAN \sin\theta$ $\text{Slope} = \dfrac{\Delta\tau}{\Delta \sin\theta} = BIAN$ (B) Magnetic flux density (I) Electric current intensity (A) Area of coil (N) Number of turns		

Factors Affecting On (Depends On)

Subject	Factors Affecting On (Depends On)
1. Resistance of the conductor: (R) (at same temperature)	Length ($R \propto L$) Area ($R \propto 1/A$) Kind of material (ρ)
2. Magnetic flux density due to straight wire: (B)	Electric current intensity ($B \propto I$) Distance between wire and point ($B \propto 1/d$)
3. Magnetic flux density due to circular coil: (B)	Number of turns ($B \propto N$) Electric current intensity ($B \propto I$) Radius of coil ($B \propto 1/r$)
4. Magnetic flux density due to solenoid: (B)	Number of turns ($B \propto N$) Electric current intensity ($B \propto I$) Length of solenoid ($B \propto 1/L$)
5. Force acting on a wire in a magnetic field:(F)	Magnetic flux density ($F \propto B$) Electric current intensity ($F \propto I$) Length of wire ($F \propto L$) Angle between wire and field ($F \propto \sin\theta$)
6. Torque of couple on a rectangular coil carrying current in a magnetic field: (τ)	Magnetic flux density ($\tau \propto B$) Electric current intensity ($\tau \propto I$) Area of coil ($\tau \propto A$) Number of turns ($\tau \propto N$) Angle between perpendicular to coil and field ($\tau \propto \sin\theta$)

Definitions

Scientific Concept	Definitions	Unit
1. Electric current intensity: (I)	*It is the quantity of charges passed a given cross section in one second.*	Ampere
2. Potential difference between two points: (V)	*It is the work done to transfer unit charge from one point to another.*	Volt
3. Electromotive force: (E.M.F.)	*It is the total work done to transfer unit charge throughout the whole electric circuit outside and inside the source* *OR.* *It is the voltage difference across the source when the current ceases to flow in the circuit.*	Volt
4. Resistance of material: (R)	*The resistance of a material is its opposition to the flow of electric current.*	Ohm Ω
5. Ohm's law:	*The current intensity in a conductor is directly proportional to the potential difference across its terminals at constant temperature.*	
6. Resistivity of a material: (ρ_e)	*It is numerically equal to the resistance of a piece of material of length one meter and cross-sectional area $1m^2$.*	Ω.m
7. The electrical conductivity: (σ)	*It is the reciprocal of the resistivity of the material.*	$Simon.m^{-1}$ $\Omega^{-1}.m^{-1}$
8. Kirchhoff's Law:	*The total voltage (V_T), which is equal to the sum of the voltage differences across the resistors in the series circuit.*	
9. Magnetic flux density: (B)	*It is the number of magnetic flux lines passing normally through a unit area.*	$Weber/m^2$ Tesla N/A.m
10. Tesla: (T)	*It is the magnetic flux density, which will exert a force (1N) on a wire carrying current (1A) of length (1m) perpendicular to the field*	
11. Neutral point:	*It is the point at which the total magnetic flux density is equal to zero. ($B_T = 0$)*	
12. Sensitivity of the galvanometer: (S)	*It is the scale deflection per unit current intensity passing through its coil.*	Degree/A
13. The electromagnetic induction:	*It is a phenomenon in which an induced e.m.f. and also an induced current are generated in the coil on plunging a magnet into or withdrawing out of it.*	
14. Induced electric current: (I_{ind})	*It is the current generated in the conductor in a closed circuit due to the variation of the magnetic flux link with the conductor.*	Ampere
15. Faraday's law:	*The magnitude of the induced electromotive force is proportional to the rate by which the conductor cuts the lines of the magnetic flux linked with it and the number of turns of the conductor which cut the magnetic flux*	

16. Lenz's law:	*The induced current must be in a direction such as to oppose the change producing it.*	
17. Mutual Induction:	*It is the electromagnetic interaction between two coils kept close to each other (or one inside the other). An electric current with time varying intensity passing in one coil (primary coil) will produce in the second one (secondary coil) an induced current in a direction such that to oppose the variations of the current intensity in the primary coil.*	
18. Mutual induction coefficient: (M)	*It is the electromotive force induced in the secondary coil when the current passing through the primary coil changes at a rate equals one ampere per second.*	V.sec/A Ohm.sec Henry
19. Self induction coefficient: (L)	*It is the electromotive force induced in the coil when the current passing through it changes at a rate equals one ampere per second.*	V.sec/A Ohm.sec Henry
20. Henry: (H)	*It is the self-inductance of a coil in which an e.m.f. of one volt is induced when the current passing through it changes at a rate one ampere per second.*	
21. Eddy current:	*They are induced currents that circulate in closed paths due to the change in magnetic flux through a solid conductor associating with heating effect.*	

Give Reason For

(1) When the length of a wire increases its resistance also increases.

- $R = \rho \frac{L}{A}$, *resistance of wire is directly proportional with its length.*

(2) The home electrical devices are not connected in series.

- *As when connected in parallel, the current is divided on them, so when current is cutoff in one device, the other devices is still working, and do not be affected. Also parallel connection decreases the total resistance.*

(3) If the filament of a lamp in the house is cut off, the other lamps still lighten.

- *As the lamps in the house are connected in parallel so the current flowing in each is different and if one of them is cutoff the others will be working.*

(4) When the total power of the electrical instruments used in houses exceeds a certain value the electric current intensity flowing through the fuse increases.

- *As the power ($P = V I$) and since the voltage of the electrical instruments in houses are constant so the total power is directly proportional to the current intensity.*

(5) If the electric circuit is switched off, the potential difference between the two poles of the electric source equals its E.M.F.

- $V = V_B - Ir$, *when circuit is switched off* ($I = 0$), *so* $V = V_B$.

(6) A straight wire carrying a current placed in a magnetic field, wire did not move.

- *Because the straight wire is placed in parallel with the magnetic field. $F = BILSin\theta$, $\theta = 0°$ so F = zero.*

(7) The magnetic flux density along the axis of a solenoid increases if we insert inside it a bar of soft iron.

- *As it increases the permeability of the solenoid and concentrates the magnetic lines inside it, thus the magnetic flux density increases.*

(8) If an electric current flows through both a solenoid and a straight wire coinciding with the axis of the coil, there is no magnetic force acting on the wire.

- *As the wire is placed at the axis of the solenoid parallel to the magnetic flux lines of the solenoid, so there is no force acting on the wire. $F = BILSin\theta$, $\theta = 0°$ and F = zero*

(9) A rectangular coil carrying current is placed in a perpendicular position to a uniform magnetic field, it does not deviate.

- *$\tau = BIAN\ Sin\theta$, so when coil is perpendicular to the field, $\theta = 0^\circ$, $Sin\ 0 = 0$ so $\tau = 0$.*

(10) The couple acting on rectangular coil carrying a current between two magnetic poles, decreases as the coil starts rotating from the position in which the plane of the coil parallel to the magnetic field.

- *$\tau = BIAN\ Sin\theta$ and when coil is parallel to the field, $\theta = 90^\circ$, $Sin\ 90 = 1$ so torque is maximum and as the coil rotates, sine the angle decreases so the torque decrease.*

Proofs

(1) Series Connection

$V_T = V_1 + V_2 + V_3$

But $V_T = IR_T$

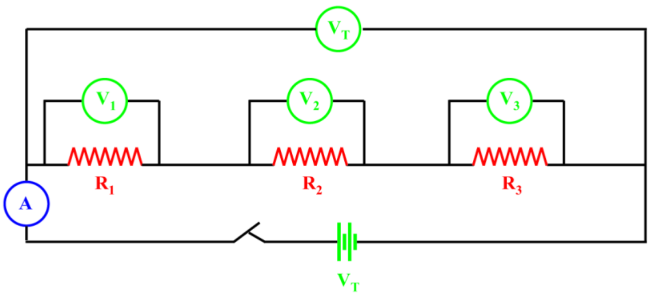
$V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

$IR_T = IR_1 + IR_2 + IR_3$

$$\boxed{R_T = R_1 + R_2 + R_3}$$



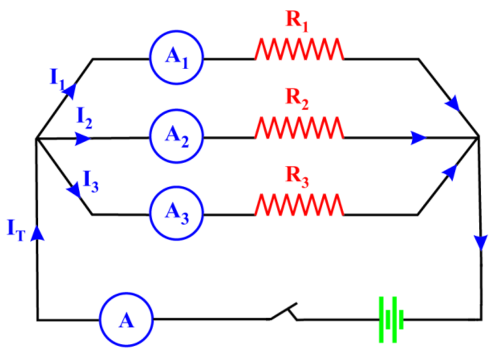
(2) Parallel connection:

$I_T = I_1 + I_2 + I_3$

And $I_T = \frac{V}{R_T}$, $I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$, $I_3 = \frac{V}{R_3}$

$$\frac{V}{R_T} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



(3) Force due to magnetic field acting on straight wire carrying current

Magnetic flux density where ($F \propto B$).

Current intensity passing through the wire where ($F \propto I$).

Length of the wire where ($F \propto L$).

$F \propto BIL$

$\therefore$ F = constant x B I L. (constant equal to unity)

$$\boxed{F = BIL}$$

(4) The force between two parallel wires each carrying current

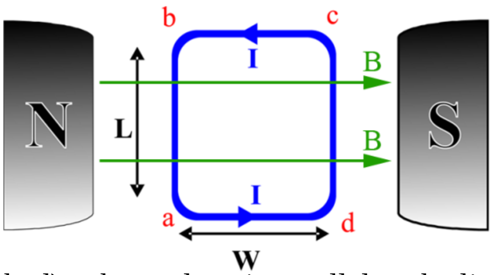
Magnetic flux density of first wire: $B_1 = \frac{\mu I_1}{2\pi d}$

Force acting on second wire: $F_2 = B_1 I_2 L$

Substituting with the magnetic flux density: $F_2 = \left(\frac{\mu I_1}{2\pi d}\right) I_2 L$

$$\boxed{F_2 = \frac{\mu I_1 I_2 L}{2\pi d}}$$

(5) Force and Torque acting on a rectangular coil carrying current placed in a magnetic field



If we have a rectangular coil (abcd), whose plane is parallel to the lines of a uniform magnetic flux, both (bc) and (ad) are parallel to the flux lines. The force acting on each wire is zero.

As to both (ab) and (cd), they are perpendicular to the flux lines. They will be acted upon by two forces equal in magnitude and opposite in direction according to Fleming L.H.R and are parallel, each equal to F = B I L, separated by a perpendicular distance (W). Thus, the coil is acted upon by a **torque** which will cause the coil to rotate around its axis.

The magnitude of the couple (torque) is equal to the force magnitude times the perpendicular spacing between the two equal forces:

Torque (couple of two forces) = force (one of them) x distance (between them)

$$\tau = F \times W$$

$$\tau = BIL \times W$$

But A = L x W, where (A) is the area of the loop

$$\tau = BIA$$

If the loop is replaced with a closely wound coil having (N) turns of wire

$$\boxed{\tau = BIAN = B\left|\overrightarrow{m_d}\right|} \quad \text{(N.m)}$$

Where $\left|\overrightarrow{m_d}\right| = IAN$ is the magnetic dipole moment ($A.m^2$)

Essay

In parallel connection:

$$P = \frac{V^2}{R}$$

$$P \alpha \frac{1}{R} \qquad \text{(V is constant)}$$

The resistances connected in parallel, the **smallest resistance** consume **largest power**.

In series connection:

$$P = I^2R$$

$$P \ \alpha \ R \qquad \text{(I is constant)}$$

The resistances connected in series, the **largest resistance** consume **smallest power**.

Types of Instruments

(1) Analog multi-meter: These instruments use pointers.

(2) Digital multi-meter: These instruments depend on reading numerals.

Conclusion of Faraday's Experiments

(1) Electromotive force induced in the conductor direction depends on the direction of motion of the conductor relative to the field.

(2) The magnitude of the induced electromotive force is proportional to the rate by which the conductor cuts the lines of the magnetic flux linked with it i.e. emf $\alpha \frac{\Delta\phi_m}{\Delta t}$, where (ϕm) is the variation in the magnetic flux intercepted by the conductor through the time interval (Δt).

(3) The magnitude of the induced electromotive force is proportional to the number of turns (N) of the coil which cut (or link with) the magnetic flux. i.e. emf α N

Mutual induction between two coils

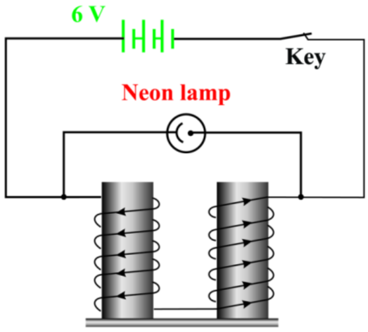
To produce (emf) on secondary coil by mutual induction:

(1) Plunge or take away the primary coil from inside the secondary coil.

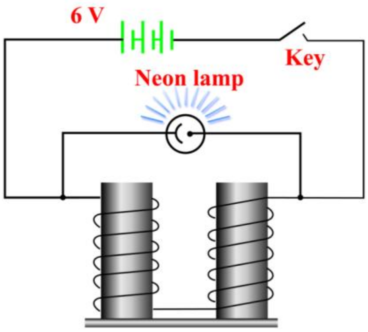
(2) Using rheostat, increase or decrease the intensity of the current in the primary coil.

(3) Using switch, switch-on or switch-off the primary circuit.

Self induction



When the switch is closed, backward induced emf is produced and the lamp will not glow.



When the switch is opened, forward induced emf is produced and the lamp will glow.

Eddy Currents

Disadvantages of eddy currents:

(1) Some of the electric energy is wasted and dissipated as heat.

(2) The spoil of the coil surrounding it, due to this generated heat.

Minimizing eddy currents:

(1) The iron core made of high resistance.

(2) The iron core is made up of thin sheets or wires with an insulating material between them to make the eddy current flow in smaller path and this decreases the heat effect.

What is meant by each of the following

1) A current intensity in a conductor = 100 mA?

It means that an amount of electric charge of 100 milli coulomb passes through the cross-section of the conductor in one second.

2) The potential difference between two points =10 volts?

The work done to transfer a charge of coulomb between the two points =10 Joules.

3) The electromotive force of a battery = 12 volts?

The total work done to transfer a charge of 1 coulomb inside and outside the battery =12 Joules.

4) The resistance of a conductor = 60 Ω?

The ratio between the potential difference across the conductor and the current intensity passing through it is 6 V/A.

5) The work done to transfer 1 coulomb between 2 points in an electric circuit = 4 J.

The potential difference between the two points = 4 volts.

6) The work done to transfer a charge of 3 coulombs between 2 points = 18J.

The potential difference between the two points = 6 volts.

7) The electric resistivity of copper = 1.72×10^{-8} Ω .m?

The resistance of a copper conductor of length 1 m and cross-section area 1 m^2 is 1.72×10^{-8} Ω.m.

8) The electric conductivity-of silver = 6×10^{7} simon.m^{-1}?

The reciprocal of resistivity of silver = 6×10^{-1} simon.m.

OR: The resistance of a silver conductor of unit length and unit cross-section area = $\frac{1}{6x10^{7}}\Omega$

9) A wire of length 1 m and cross-section area 1 m2 has a resistance = 7×10^{-6} Ω?

The resistivity of the wire material = 7×10^{-6} Ω.m.

10) The ratio between the potential difference across a conductor and the current intensity passing through it is 10 V/A?

The resistance of this conductor =10 Ω.

11) The potential difference across an electric cell when no current flows = 9V?

The electromotive force of this cell = 9 volts.

12) Magnetic flux cutting an area = 10 webers?

The total number of magnetic flux lines cutting perpendicular this area =10.

13) Magnetic flux density at a point = 0.2Tesla

The number of magnetic flux lines passing normally through unit cross section area

14) The magnetic flux density = 0.5 N/A. m

a force acting on a wire of length 1 m carrying a current of intensity 1 amp placed $\perp$ to that M.F = 0.5N

15) Ampere's right and rule

It is used to determine the direction of the magnetic field when passing electric current in a straight wire.

16) Right hand screw rule

It is used to determine the direction of the magnetic field when passing electric current in a circular loop.

17) Fleming's left hand rule

It is used to determine the direction of motion of a straight wire when passing through it an electric current and placed normally to a magnetic field.

18) The coefficient of mutual induction between two coils is 0.2 Henry

0.2Volt is the electromotive force induced in the secondary coil when the current passing through the primary coil changes at a rate equals one ampere per second.

19) The coefficient of self induction of a coil is 0.5 Henry

0.5Volt is the electromotive force induced in the coil when the current passing through it changes at a rate equals one ampere per second.

Solved Problems

1) When a current of 2Ampere flows through an unknown resistor, the potential difference across it will be 10volts. Calculate the resistivity and the electrical conductivity of the material of such resistor if its length is 2meters and its cross-sectional area is $0.1cm^2$.

Solution:

$V = I.R$

$10 = 2 \times R$ $\qquad R = 5\Omega$

$\rho_e = \frac{RA}{L} = \frac{5 \times 0.1x10^{-4}}{2}$ $\qquad \rho_e = 2.5\times10^{-5}\Omega.m$

$\sigma = \frac{1}{\rho_e} = \frac{1}{2.5x10^{-5}}$ $\qquad \sigma = 40000\ \Omega^{-1}.m^{-1}$

2) A student made two resistors from the same material; the second is double the first in length and its diameter is equal to the radius of the first. Calculate the ratio of the second resistance to first one.

Solution:

$\rho_1 = \rho_2$ $\qquad \frac{\rho_1}{\rho_2} = 1$

$L_2 = 2L_1$ $\qquad \frac{L_1}{L_2} = \frac{1}{2}$

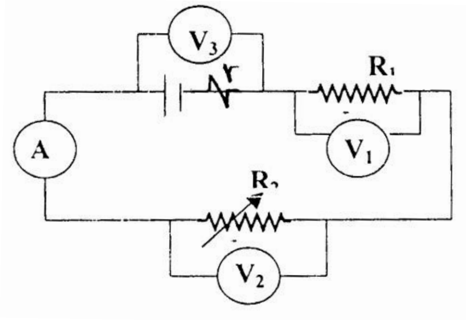
$d_2 = r_1$ $\qquad 2r_2 = r_1$ $\qquad \frac{r_2}{r_1} = \frac{1}{2}$

$$\frac{R_1}{R_2} = \frac{\rho_1}{\rho_2} \times \frac{L_1}{L_2} \times \left(\frac{r_2}{r_1}\right)^2$$

$\frac{R_1}{R_2} = 1 \times \frac{1}{2} \times \left(\frac{1}{2}\right)^2$ $\qquad \frac{R_1}{R_2} = \frac{1}{8}$

$$\therefore \frac{R_2}{R_1} = 8$$

3) In show figure, find the change in the reading of the ammeter and the voltmeters in the circuit when the variable resistance (R_2) increases. (Variable resistance called rheostat)



$$I = \frac{V_B}{(R_T + r)} \qquad I = \frac{V_B}{(R_1 + R_2 + r)}$$

The reading of ammeter (A) decreases

When resistance (R_2) ↑, the current (I) ↓

The reading of the voltmeter (V_1) decreases

$V_1 = I.R_1$

When the current (I) ↓, while (R1) constant, the voltage (V1) ↓

The reading of the voltmeter (V_2) increases

$V_2 = I.R_2$

When the current (I) ↓, while (R2) ↑↑, the voltage (V2) ↑

Ex:

If $R_1 = R_2 = r = 10\ \Omega$. So $R_1 + R_2 + r = 30\ \Omega$

And if **(R_2) increases 4 times** where (R_2) = 40 Ω. So $R_1 + R_2 + r = 60\ \Omega$

When the total resistance increases 2 times, the current **(I) decreases to ½ its value**

The reading of the voltmeter (V_3) increases

$V_3 = V_B - I.r$

When the current (I) ↓, while (VB) constant, (r) constant, the voltage (V3) ↑

4) A cell of E.M.F. 2volts and internal resistance of 0.1Ω is connected to a circuit of external resistance 3.9Ω. Calculate the current flowing through the circuit.

Solution:

$$I = \frac{V_B}{(R_T + r)}$$

$$I = \frac{2}{3.9 + 0.1} \qquad I = 0.5A$$

5) Three resistors of 25Ω, 70Ω and 85Ω are connected in series to a 45volt battery of negligible internal resistance. Calculate the current flowing in each resistor and the terminal potential difference of each.

Solution:

$R_T = 25 + 70 + 85 = 180\Omega$

$$I = \frac{V_B}{(R_T + r)} = \frac{45}{180 + 0}$$

$$I = \frac{45}{(180 + 0)} = 0.25A$$

$I_{battery} = I_{25\Omega} = I_{70\Omega} = I_{85\Omega}$

$V_{25\Omega} = I.R = 0.25 \times 25 = 6.25V$

$V_{70\Omega} = I.R = 0.25 \times 70 = 17.5V$

$V_{85\Omega} = I.R = 0.25 \times 85 = 21.25V$

$V_T = V_{25\Omega} + V_{70\Omega} + V_{85\Omega} = 6.25 + 17.5 + 21.25 = 45V$

6) If the resistors in the previous problem are connected in parallel to the same battery. Calculate:

(a) The total resistance

(b) The current through the circuit

(c) The current flowing in each resistor

Solution:

a) $\frac{1}{R_T} = \frac{1}{25} + \frac{1}{70} + \frac{1}{85}$ $\qquad R_T = 15.14\Omega$

b) $I = \frac{V_B}{(R_T + r)}$

$I = \frac{45}{15.14}$ $\qquad I = 2.972A$

c) $V_{battery} = V_{25\Omega} = V_{70\Omega} = V_{85\Omega}$

$$I_{25\Omega} = \frac{V_B}{R} = \frac{45}{25} = 1.8A$$

$$I_{70\Omega} = \frac{V_B}{R} = \frac{45}{70} = 0.643A$$

$$I_{85\Omega} = \frac{V_B}{R} = \frac{45}{85} = 0.529A$$

$I_T = I_{25\Omega} + I_{70\Omega} + I_{85\Omega} = 1.8 + 0.643 + 0.529 = 2.972A$

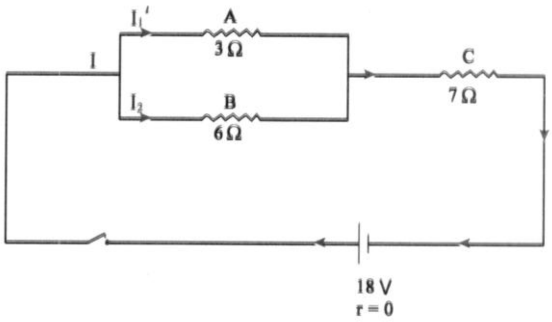
7) In the circuit shown in figure. Calculate:

(a) The total resistance.

(b) The current flowing through the circuit.

(c) The current flowing through each of (A) and (B).

Solution:



a) $R_{(3,6)} = \frac{3\times 6}{3+6} = 2\Omega$

$R_T = 2 + 7 = 9\Omega$

b) $I = \frac{V_B}{(R_T + r)}$

$I = \frac{18}{9+0} = 2A$

c) $V_{3\Omega} = V_{6\Omega} = I.R_{(3,6)}$

$V_{3\Omega} = V_{6\Omega} = 2 \text{ x } 2 = 4V$

$I_{3\Omega} = \frac{V_{3\Omega}}{R}$ $\qquad I_{3\Omega} = \frac{4}{3} = 1.333A$

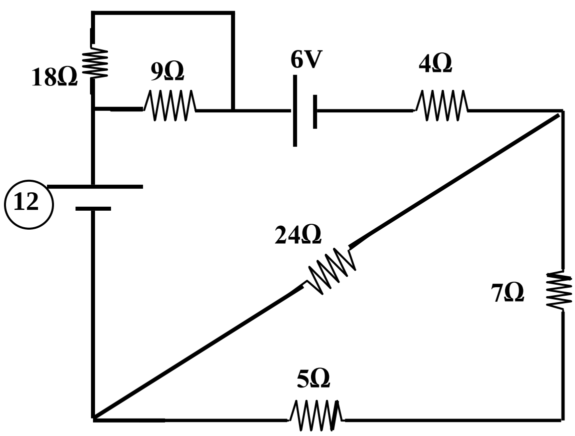
$I_{6\Omega} = \frac{V_{6\Omega}}{R}$ $\qquad I_{6\Omega} = \frac{4}{6} = 0.667A$

OR $\quad I_1 = \frac{R_2}{(R_1 + R_2)} \times I_T$ $\qquad I_{3\Omega} = \frac{6}{(3+6)} \times 2 = 1.333A$

$I_2 = \frac{R_1}{(R_1 + R_2)} \times I_T$ $\qquad I_{6\Omega} = \frac{3}{(3+6)} \times 2 = 0.667A$

8) Find the current through 12V battery.

(Internal resistance of each battery = 3Ω)



Solution:

$$R_{(9,18)} = \frac{9\times18}{9+18} = 6\Omega$$

$$R_{(5,7)} = 5 + 7 = 12\Omega$$

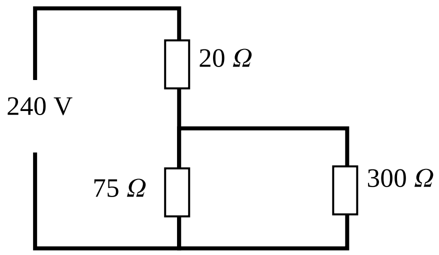
$$R_{(12,24)} = \frac{12\times24}{12+24} = 8\Omega$$

$$R_{(4,6,8)} = 4 + 6 + 8 = 18\Omega$$

$$I = \frac{V_B}{(R_T + r)}$$

$$I = \frac{V_{B_1} - V_{B_2}}{(R_T + r_1 + r_2)} = \frac{12-6}{18+3+3} = 0.25A$$

9) Calculate the current flowing through each resistance and also the potential difference across each of them.



Solution:

$$R_{(75,300)} = \frac{75\times300}{75+300} = 60\Omega$$

$$R_{(60,20)} = 60 + 20 = 80\Omega$$

$$I = \frac{V_B}{(R_T + r)}$$

$$I = \frac{240}{80+0} = 3A$$

$$V_{(80)} = I\,R = 3 \times 80 = 240V$$

$$V_{(20)} = I\,R = 3 \times 20 = 60V$$

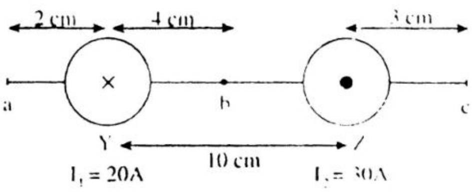
$$V_{(60)} = I\,R = 3 \times 60 = 180V$$

10) Determine the magnetic flux density at a distance of 10cm in air from the center of a long wire carrying a current of 10A (μair = 4πx10-7Wb/Amp.m)

Solution:

$$B = \frac{\mu I}{2\pi d} = \frac{4\pi x10^{-7}\times10}{2\pi\times0.1} = 2x10^{-5}Tesla$$

11) The given figure represents cross-section of two straight parallel conductors carrying currents as shown in the fig. Calculate the total magnetic flux density at the points (a, b and c). ($\mu = 4\pi x10^{-7}$ Weber/Amp.meter).



Solution:

At point (a):

$$B_1 = 2x10^{-7}\frac{I_1}{d_1} = 2x10^{-7}\frac{20}{0.02}$$ $B_1 = 2x10^{-4}$Tesla

$$B_2 = 2x10^{-7}\frac{I_2}{d_2} = 2x10^{-7}\frac{30}{0.12}$$ $B_2 = 5x10^{-5}$Tesla

$B_T = B_1 - B_2 = 2x10^{-4} - 5x10^{-5}$ $B_T = 1.5x10^{-4}$T

At point (b):

$$B_1 = 2x10^{-7}\frac{I_1}{d_1} = 2x10^{-7}\frac{20}{0.04}$$ $B_1 = 1x10^{-4}$Tesla

$$B_2 = 2x10^{-7}\frac{I_2}{d_2} = 2x10^{-7}\frac{30}{0.06}$$ $B_2 = 1x10^{-4}$Tesla

$B_T = B_1 + B_2 = 1x10^{-4} + 1x10^{-4}$ $B_T = 2x10^{-4}$T

At point (c):

$$B_1 = 2x10^{-7}\frac{I_1}{d_1} = 2x10^{-7}\frac{20}{0.13}$$ $B_1 = 3.077x10^{-5}$T

$$B_2 = 2x10^{-7}\frac{I_2}{d_2} = 2x10^{-7}\frac{30}{0.03}$$ $B_2 = 2x10^{-4}$Tesla

$B_T = B_1 - B_2 = 2x10^{-4} - 3.07x10^{-5}$ $B_T = 1.7x10^{-4}$T

12) Determine the magnetic flux density at the center of a circular loop of radius 11cm carrying a current 1.4Amp. If the wire consists of a coil having 20turns and $\mu air = 4\pi x10^{-7}$Wb/A.m.

Solution:

$$B = \frac{\mu NI}{2r} = \frac{4\pi x10^{-7} \times 20 \times 1.4}{2 \times 0.11} = 16x10^{-5}\text{Tesla}$$

13) A long solenoid has 800turns. The current flowing through the wire is 0.7Arnpere. Find the magnetic flux density in the interior of the solenoid. Knowing that is length is 20cm.

Solution:

$$B = \frac{\mu NI}{L} = \frac{4\pi x10^{-7} \times 800 \times 0.7}{0.2} = 3.52x10^{-3}\text{Tesla}$$

14) A solenoid is constructed by winding 800 turns of wire on a 20cm iron core. What current is required to produce a flux density of 0.815Tesla in the center of the solenoid? The permeability of iron is $1.63x10^{-2}$Wb/amp.m.

Solution:

$$B = \frac{\mu NI}{L}$$

$$0.815 = \frac{1.63x10^{-2} \times 800 \times I}{0.2}$$

I = 0.0125A

15) A circular coil of radius 10cm, of 50turns carrying a current of 2A, Calculate the magnetic flux density at its center? If the turns of the coil is a parted from each other regularly such that its length become l00cm. Calculate the magnetic flux density at the axis of the coil? If a bar of iron of permeability (0.02Wb/A.m) is linked with the coil, what is the change in the magnetic flux density at its axis?

Solution:

$$B_{coil} = \frac{\mu NI}{2r} = \frac{4\pi x10^{-7} \times 50 \times 2}{2 \times 0.1} = 6.283x10^{-4}\text{Tesla}$$

$$B_{solenoid} = \frac{\mu NI}{L} = \frac{4\pi x10^{-7} \times 50 \times 2}{1} = 1.256x10^{-4}\text{Tesla}$$

$$B_{solenoid} = \frac{\mu NI}{L} = \frac{0.02 \times 50 \times 2}{1}$$

B = 2Tesla

16) A wire 30cm long supports a current of 4amperes in a direction perpendicular to a magnetic field. If the force on the wire is 6Newton. Find the magnetic flux density.

Solution:

$F = BIL\ Sin\theta$

$6 = B \times 4 \times 0.3 \times Sin90$ $\qquad B = 5Tesla$

17) If the wire in the previous problem makes an angle of 30° with respect to the field. Find the force acting on the wire.

Solution:

$F = BIL\ Sin\theta = 5 \times 4 \times 0.3 \times Sin30 = 3N$

18) A rectangular loop (12 x 10) cm of 40turns carrying a current of 2A. Calculate the torque acting on the loop if it is placed in a magnetic field of density 3T such that:

a) The plane of the coil is parallel to the magnetic flux lines.

b) The plane of the coil is perpendicular to the magnetic flux lines.

c) The plane of the coil makes an angle 60˚ with the magnetic flux lines.

d) The perpendicular to its plane makes an angle 60˚ with the magnetic flux lines.

Solution:

a) $\tau = BIAN\ Sin\theta = 3 \times 2 \times 120\times10^{-4} \times 40 \times Sin90 = 2.88$ Joule

b) $\tau = BIAN\ Sin\theta = 3 \times 2 \times 120\times10^{-4} \times 40 \times Sin0 = zero$

c) $\tau = BIAN\ Sin\theta = 3 \times 2 \times 120\times10^{-4} \times 40 \times Sin30 = 1.44$ Joule

d) $\tau = BIAN\ Sin\theta = 3 \times 2 \times 120\times10^{-4} \times 40 \times Sin60 = 2.494$Joule