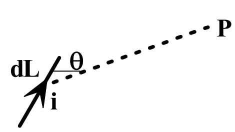
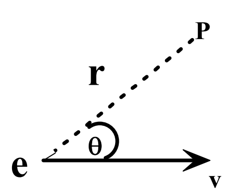
ELECTROMAGNETIC INDUCTION

- **THE ORIGIN OF MAGNETIC FIELDS:** An electric charge at rest produces an electric field only. A moving charge produces not only an electric field but also a magnetic field. A conductor carrying a current produces only a magnetic field. This was proved by the Oersted's experiment.
  A beam of electrons or protons in vacuum produces both electric and magnetic fields.
  Basically all magnetic effects are due to moving charges.
- **OERSTED'S EXPERIMENT**: If a horizontal wire is placed parallel to a freely pivoted magnetic needle above it and carries a current from south to north the needle turns such that the north pole gets deflected towards west.
  The **direction** of deflection can be known from **Ampere's swimming rule.** "Imagine a swimmer going in the direction of current with his face towards the needle, then, the north pole deflects towards his left hand side".
- **CURRENT ELEMENT**:

Current Element

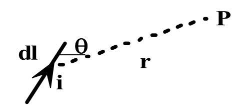


  A short piece of wire of length 'dL' and carrying a current 'i' is called a current element. It behaves like a magnetic pole. With respect to P it acts as a magnetic pole of strength $m = i\,dL\sin\theta$. If P is in the direction of the element $m = 0$ (minimum) and if P is in a direction perpendicular to the element, then $m = i\,dL$ (maximum)
- **MOVING CHARGE:** A moving charge behaves like a magnetic pole. With respect to a point P it acts as a magnetic pole of strength $m = ev\sin\theta$. If P lies on the velocity vector, then the pole strength $m = 0$ (minimum) and if P is in a direction perpendicular to the velocity, then $m = ev$ (maximum)



Moving Charge

- **BIOT – SAVART'S LAW:**
  Magnetic induction due to a current element at any point is directly proportional to the current in the element, directly proportional to the length of the element, directly proportional to the sine of the angle between the element and the position vector of the point with respect to the element and inversely proportional to the square of the distance of the point from the element.



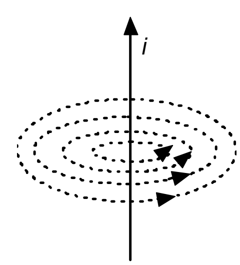
$$dB = \frac{\mu_o}{4\pi}\frac{id\lambda\sin\theta}{r^2}$$

In vector form $d\overline{B} = \dfrac{\mu_o}{4\pi}\dfrac{id\overline{\lambda}\times\overline{r}}{r^3}$

- **THE UNIT OF MAGNETIC INDUCTION "TESLA":** The SI unit of magnetic induction "tesla" can be deduced from the Biot–Savart's law.
  If "i" = 1 ampere, and "r" = 1 meter, and "θ" = 90°, then $dB = 10^{-7} dl$ tesla. The unit tesla can alternately be defined as one weber per square meter (Wb m^{-2}).

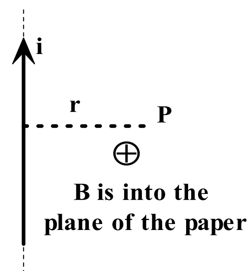
  NOTE: 1 tesla = 10^4 gauss (old cgs unit)

- **MAGNETIC FIELD LINES DUE TO A STRAIGHT CURRENT CARRYING CONDUCTOR:** A straight wire carrying a current produces a magnetic field whose lines of induction are concentric circles in a plane **perpendicular to the wire**.

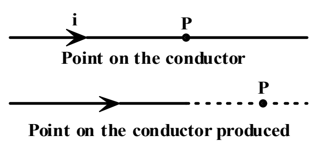


- **FLEMING'S RIGHT HAND GRIP RULE**: The direction of the magnetic field of a current carrying wire can be found by using the Fleming's right hand rule. Grasp the wire in the right hand, with the thumb pointing in the direction of the current. The fingers then circle the wire in the same direction as the magnetic field does.

- **MAXWELLS CORK SCREW RULE:** If a right hand cork screw is advancing in the direction of current, then the direction of rotation of the screw gives the direction of magnetic lines of induction.
- **AMPERE'S LAW:** This gives an alternate method to find the magnetic induction due to a given current distribution. If a closed path is constructed around the conductors, then $\oint \overline{B} \bullet d\overline{\lambda} = \mu_o\, i$, here $\overline{B}$ is the magnetic induction at the element of length and "i" is the total current enclosed by the closed path.
- **MAGNETIC INDUCTION DUE TO A STRAIGHT CURRENT CARRYING CONDUCTOR:**



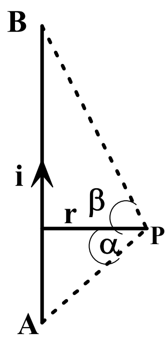
a) When the conductor is infinitely lon g extending on either side of the point P, then $B = \mu_o i / 2\pi r$ (Easily erived from Ampere's law).



b) When the conductor is infinitely long and P is at the one end of the conductor, $B = \mu_o i / 4\pi r$.

c) If the point P lies on the conductor or the conductor produced, then $B = 0$.

d) If a conductor has finite length as shown in the figure, the magnetic induction at the point P is given by



$$B = \frac{\mu_o i}{4\pi r}(\sin\alpha + \sin\beta)$$

- **WORK DONE IN MOVING A NORTH POLE AROUND A STRAIGHT CURRENT CARRYING CONDUCTOR**:
  A north pole of strength "m" is moved around a circle of radius r which lies around a straight conductor carrying a current '*i*',
  then, the work done = Force $\times$ distance

$$= \frac{\mu_o i}{2\pi r} \times m \times 2\pi r = \mu_o im$$

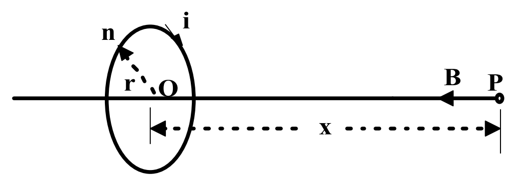
NOTE: This work done is independent of the radius of the circular path.

- **MAGNETIC INDUCTION DUE TO A HOLLOW CYLINDER CARRYING A CURRENT:** The magnetic induction at any point inside is *zero*. Outside there will be a magnetic field.
- **MAGNETIC INDUCTION DUE TO A SOLID CYLINDER CARRYING A CURRENT:** The magnetic induction is produced both inside and outside of the cylinder.
- **MAGNETIC INDUCTION AT THE CENTER OF A CIRCULAR COIL**: A circular coil of wire carrying a current behaves like a magnetic shell (disc shaped magnet). The face on which current flow is clockwise behaves as a south-pole and vice versa. [*Hint*: a**N**ti clock – **N**orth Pole].
  The magnetic induction vector **B** is perpendicular to the plane of the coil and is inwards for a clockwise current and outwards for an anti-clockwise current.

$$B = \frac{\mu_0 in}{2r}$$

(In this "n" is number of turns **which can take fractional values**, "*i*" is electric current and "*r*" is radius)

- **MAGNETIC INDUCTION AT ANY POINT ON THE AXIS OF A CIRCULAR COIL CARRYING A CURRENT:**



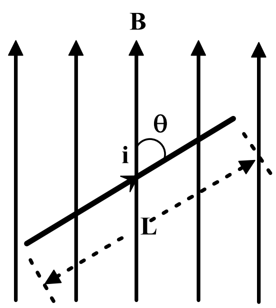
$$B = \frac{\mu_o\, i\, n\, r^2}{2(r^2 + x^2)^{\frac{3}{2}}}$$

n: number of turns
x: distance of the point from the centre of the coil.
r: radius of coil.

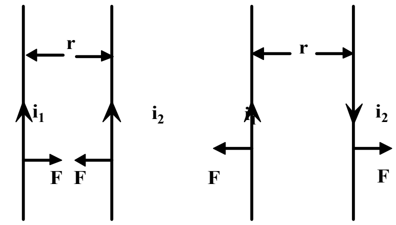
If $x >> r$ then $B = \dfrac{\mu_o\, i\, n\, r^2}{2x^3}$

- **NULL POINT:** If there are two or more magnetic inductions at a point such that their vector sum is zero, then the point is called a null point.
- **MAGNETIC DIPOLE MOMENT DUE TO A CURRENT LOOP**: Any coil of area 'A' having 'n' turns and carrying a current 'i' behaves like a magnetic dipole (i.e., short bar magnet) of moment M = nAi. (Remember a**N**ti clock current **N**orth pole)

- **MEMORY AID:** Clock-in is useful for the field at the center of a circular coil, dipole moment of a current loop, and torque on a current loop.
- **UNWINDING AND REWINDING A COIL:** When a coil of wire is unwound and rewound with a different radius, the length of the wire remains constant $[L = 2\pi rn]$.
  $\therefore 2\pi r_1 n_1 = 2\pi r_2 n_2$ i.e., $n_1 r_1 = n_2 r_2$.
- **SOLENOID:** It is a coil of wire wound on a cylindrical former in which the length of the former is greater than its diameter. A solenoid ( ) carrying a current acts like a bar magnet. It produces a uniform magnetic induction at any point on its axis given by $\mathbf{B = \mu_o \mathit{i}\, n}$ (**n**: number of turns/ unit length and $\boldsymbol{i}$ is the current flowing through it).
  When a current flows through a solenoid the adjacent turns tend to mutually attract each other and hence it exhibits a tendency to shorten.
- **CURRENT CARRYING CONDUCTOR IN A MAGNETIC FIELD:**
  A straight conductor of length 'L' carrying a current 'i' in a uniform magnetic field of induction 'B' placed at an angle 'θ' with the field, experiences a force $F = BiL \sin\theta$
  The direction of the force is given by Fleming's left hand rule.



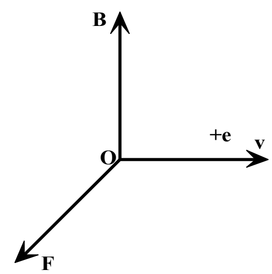
  "If the first three fingers of left hand are held mutually perpendicular to each other, such that **F**ore finger points in the direction of the **F**ield, **C**entral finger points in the direction of **C**urrent, then the thu**M**b gives the direction of **M**otion i.e. force on the conductor."
  NOTE: If the conductor is parallel to the direction of field, force acting on it is zero and if the conductor is perpendicular to the field the force is maximum (BiL).
- **PARALLEL CONDUCTORS:**
  When two straight conductors are arranged parallel to each other and carry currents, they mutually influence each other. **Like** currents **attract** while **unlike** currents **repel**. The mutual force per unit length is given by
  $F/l = \mu_o i_1 i_2 / 2\pi r$



Like currents attract each other **Unlike currents repel each other**

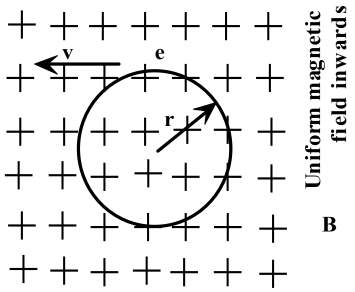
- **DE** ent is the *ampere* (A), defined as that constant current which, if maintained in each of two infinitely long straight parallel wires of negligible cross section placed at one metre apart, in vacuum, will produce between the wires a force of 2×10^{-7} newton per metre length.

- **FORCE ON A MOVING CHARGE IN A MAGNETIC FIELD:**
  A moving charge in a magnetic field experiences a force. The direction of force is given by Fleming's lefthand rule



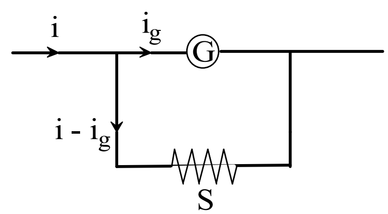
  (The direction of motion of positive charge is the direction of current)
  The magnitude of the force is given by **F = Bev** $\sin\theta$. If v and B are perpendicular to each other F = Bev.
  In vector form $\overline{F} = e(\overline{v} \times \overline{B})$
- **LORENTZ FORCE:** The force acting on a moving charge q in a combined electric and magnetic field. It is given by $\overline{F} = q(\overline{E} + \overline{v} \times \overline{B})$. This is nothing but the vector sum of electric force and magnetic force on the moving charge.

- **MOTION OF A CHARGED PARTICLE IN A UNIFORM MAGNETIC FIELD:** When a charged particle is fired either parallel to or antiparallel to the magnetic field, it experiences no force and hence moves along a straight path.
  When a charged particle is fired at right angles to a uniform magnetic field perpendicular to its motion experiences a sideward force perpendicular to both the field and velocity. This force acts like a centripetal force and hence it describes a **CIRCULAR** path.



Then $Bev = mv^2/r$; i.e., $r = mv/Be$.
This is the principle of working of a **cyclotron**.
The time period $T = 2\pi r/v = 2\pi mv/Bev = 2\pi m/Be$
The frequency of cyclotron $f = 1/T = Be/2\pi m$.
The time period and frequency are independent of the velocity.
If the charged particle is fired in a direction inclined to the field such that the particle has a component of velocity parallel to the field, then it describes a **helical path.**
If the charged particle is fired parallel to the magnetic field, it experiences **zero** force and hence continues to move in a straight line with uniform velocity.
NOTE: In all the above cases the kinetic energy of the particle remains constant. i.e., no work is done by the magnetic field on the charged particle moving through it. [***Reason:*** Force is always perpendicular to the motion].

- **TORQUE ON A CURRENT LOOP**: A current carrying coil in a uniform magnetic field experiences a torque. This is the principle of a moving coil galvanometer.
  The torque is given by τ = **BinA sin**θ, where θ is the angle between the direction of the field and **normal** to the plane of the coil.
  If the field is parallel to the plane of the coil τ_{max} = BinA. [$\because \theta = 90°$]
- **MOVING COIL GALVANOMETER**: In a moving coil galvanometer a horse–shoe type of magnet fitted with cylindrical pole shoes is used. A soft iron cylinder kept in the polar gap produces a special magnetic field called a "radial magnetic field". The coil suspended in a radial magnetic field always experiences a maximum and uniform torque given by
  $\tau_{max} = BinA$
  The coil in a moving coil galvanometer is suspended by phosphor bronze ribbon and it provides the restoring torque. [The elastic modulus of phosphor bronze is independent of temperature]
  The deflections of the coil in a moving coil galvanometer are measured with a lamp and scale arrangement.
  In a moving coil galvanometer **i = [C/ B An]** θ.
  C is couple per unit twist of the suspension fibre.
  i = K θ**,** where K is called the figure of merit or current sensitivity of the galvanometer.
  In a moving coil galvanometer currents of the order of 10^{-9} A can easily be measured.
- **SENSITIVITY OF A MEASURING INSTRUMENT:** For any measuring instrument, the magnitude of the change of the deflection (or indicated value) that is produced by a given change in the measured quantity. For a galvanometer $\frac{d\theta}{di}$ is referred to as its sensitivity.
- **D'ARSONWAAL'S GALVANOMETER**: It is a moving coil type galvanometer with reduced sensitivity (still it can measure currents of the order of 10^{-5} A). It has a pointer moving over a scale, so that lamp and scale arrangement is not required. (It is also known as a table galvanometer or Weston galvanometer).
- **CONVERSION OF A GALVANOMETER INTO AN AMMETER**:



By connecting a low resistance in parallel (i.e., shunting) The required shunt resistance is calculated by using
$G\,i_g = (i - i_g)\,S$ where 'i_g' is full scale deflection current of the galvanometer, 'i' is maximum current to be measured by the ammeter. (It is also called the range).
'G' is the resistance of the galvanometer and 'S' is the shunt resistance.
If $i / i_g = n$, then the shunt resistance is given by
$$S = \frac{G}{n-1}$$
Ammeter is an instrument that measures the current. Therefore an ammeter must be connected in circuit in such a manner that there is one current path, i.e., a **series** connection.
Internal resistance of an ammeter **'r_a'** is low (less than that of the shunt).

$r_a = GS/(G + S)$

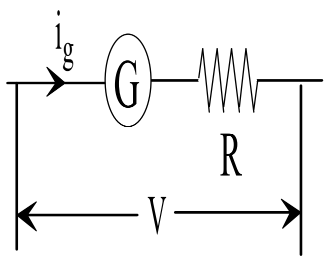
Ideal ammeter should have zero internal resistance.

The p.d. across the terminals of an ammeter is negligible.

By shunting a galvanometer the sensitivity decreases.

The range of an ammeter can be increased by connecting a low resistance in parallel with it (i.e., shunt).

- **SHUNT and its USES:**



It is a low resistance connected in parallel to a sensitive galvanometer to prevent damage due to excess current in the galvanometer. A suitable shunt resistance connected in parallel to a galvanometer converts it into an ammeter.

- **CONVERSION OF A GALVANOMETER INTO A VOLTMETER:** A galvanometer is connected with a high resistance in series. Value of the series resistance is calculated by using

  $\mathbf{V = i_g(G + R)}$.

  R: high resistance in series, V: range of the voltmeter (the maximum voltage that is to be measured) and i_g: full scale deflection current.

  If 'v' = Gi_g, the p.d. across the voltmeter for full scale deflection current, and V/v = n, then the series resistance R = G (n - 1)

  As a voltmeter is an instrument that measures the voltage drop across a circuit element, two terminals of the voltmeter are connected to the two ends of an element so that a **parallel** connection is formed.

  Internal resistance of a voltmeter is high (more than that of the series resistance). $\mathbf{r_v = R + G}$

  Ideal voltmeter should have infinite internal resistance.

  The current drawn by a voltmeter is negligible. An ideal voltmeter draws *zero* current.

  The range of a voltmeter can be increased by connecting a high resistance in series with it.

- **TANGENT GALVANOMETER:** This is also called a "moving magnet galvanometer". It contains a circular coil of wire in a vertical plane coinciding with the magnetic meridian. A compass box with a pivoted magnetic needle and a circular scale calibrated in degrees is arranged in a horizontal plane so that the centre of the magnetic needle and the centre of the circular coil coincide.

  The working principle is the same as that of a deflection magnetometer, namely tangent law: $B = B_o \tan\theta$. Here "B" field is produced by the circular coil.

  The current in the tangent galvanometer is proportional to the tangent of the deflection (θ).

  $i \propto \tan\theta$ or $i = K \tan\theta$.

  Here "K" is a constant of proportionality and is known as the **reduction factor** of the galvanometer.

  $$K = \frac{2 r B_o}{\mu_o n}$$

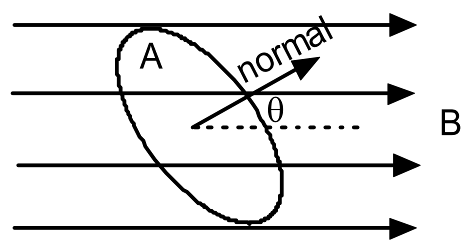
  The unit of K is ampere.

  K value depends on B_o, so it changes from place to place for the same galvanometer.

  The tangent galvanometer is most accurate when the deflections are around 45°.

  NOTE: The less the K value, the more the sensitivity of the tangent galvanometer.

- **MAGNETIC FLUX (φ):**



Consider a coil of area "A" having "n" turns situated in a uniform magnetic field of induction "B" such that the normal to the plane of the coil makes an angle of "θ" with the direction of the magnetic field. Then the product of the area of the coil and the component of the magnetic induction perpendicular to the coil is called the magnetic flux through each turn of the coil. This may be expressed as a dot product $\overline{B}.\overline{A}$. The total magnetic flux ***linked*** with the coil is the flux linked with each turn multiplied by the number of turns. Thus, $\varphi = BAn\cos\theta$

The unit of magnetic flux is weber (Wb). Magnetic flux is a scalar.

- **ELECTRO MAGNETIC INDUCTION:** Whenever there is a change in the magnetic flux through the area surrounded by a loop, an emf is induced. The induced emf exists only during the time the flux through the loop is changing.
- **CHANGING MAGNETIC FLUX:** A changing magnetic flux can be produced in several ways.

i) A coil is fixed and a magnet moves either into the coil or out of the coil. The magnetic flux associated with the coil changes.

ii) A magnet is fixed and a coil moves either into the magnet or out of the magnet. The magnetic flux associated with the coil changes.

iii) Two coils are wound on an iron rod, when current in one is either switched *on* or *off* i.e. current is either increasing or decreasing, the magnetic flux associated with the other coil changes.

iv) Using alternating currents in a coil, changing magnetic flux can be produced.

- **FARADAY'S EXPERIMENTS:** In the Oersted's effect, a current in a conductor produces a magnetic field in the surroundings. The converse of this was found by Faraday. In the Faraday's experiments, a ***changing*** magnetic flux produced an emf and a current in a closed coil.

  A coil of wire was connected to a sensitive galvanometer and a magnet is moved into the coil, thereby changing the magnetic flux linked with the coil and Faraday observed a current in the galvanometer so long as there was a relative motion between the coil and the magnet. The more the speed of the magnet, the more was the current in the galvanometer.

- **FARADAY'S LAWS OF ELECTROMAGNETIC INDUCTION:**

  (i) Whenever the magnetic flux linked with a conducting loop or coil changes, an emf is induced in it.

  (ii) The induced emf is directly proportional to the rate of change of magnetic flux through the coil.

  $\varepsilon = -N \times \dfrac{d\phi}{dt}$. Here E is the induced emf and N is the number of turns and φ is the magntic flux linked with each turn of the coil. The negative sign indicates that the induced emf opposes the cause that produces it. This is also called Neumann's law.

  Note : If the coil is closed, in addition to the induced emf, there will be induced current also.

- Whenever the flux linked with a closed coil changes, the charge that flows through the coil is independent of the time interval in which the change of flux occurs.

- **LENZ'S LAW:** The induced emf and induced current are always in such a direction as to oppose the change that produces them. This is nothing but a consequence of the law of conservation of energy.

- **APPLICATION OF LENZ'S LAW:**

  i) Suppose there is a circular coil of wire in the vertical plane and the North pole of a bar magnet is approaching it horizontally. The induced current in the coil will be in such a direction that it behaves as a North pole to oppose the incoming North pole. i.e. the direction of the induced current will be anticlockwise.

  ii) Suppose there is a circular coil of wire in the vertical plane and the North pole of a bar magnet initially near it is moving away from it. The induced current in the coil will be in such a direction that it behaves as a South pole to oppose the moving away North pole. i.e. the direction of the induced current will be clock wise.

  iii) A freely falling magnet will have an acceleration equal to the acceleration due to gravity like any other object. However, if it were falling into a horizontally arranged coil of wire with the free ends connected together, while the magnet is falling, it induces a current in the coil which according to Lenz's law must flow in such a direction as to oppose the cause. Hence the magnet now falls into the coil with an acceleration less than the acceleration due to gravity.

- **MOTIONAL EMF IN TRANSLATORY MOTION:** When a conductor moves through a magnetic field so as to cut the field lines, an induced emf will exist across its ends, in accordance with Faraday's law.The induced emf in a straight conductor of length "L" moving with a velocity "v" in a direction perpendicular a magnetic field of induction "B" is given by $E = B\,L\,v$.

  The direction of the induced emf and consequent current can be deduced from Fleming's *right hand* rule.

- **MOTIONAL EMF IN ROTATORY MOTION:** A metal rod of length 'L' rotates about one end as axis with an angular velocity 'ω' in a uniform magnetic field of induction 'B', such that the field is perpendicular to the plane in which the rod rotates, the emf induced across the ends of the rod is given by the formula : $e = \frac{1}{2} BL^2\omega$

- **FLEMING'S RIGHT HAND RULE:** Hold the thumb, first finger, and middle of the **right** hand at right angles to one another. Point the thumb in the direction of motion of the conductor, the first finger along the direction of the magnetic field; the middle finger gives the direction of the induced current. (This is also known as dynamo principle, whereas the Fleming's left hand rule is known as motor principle)

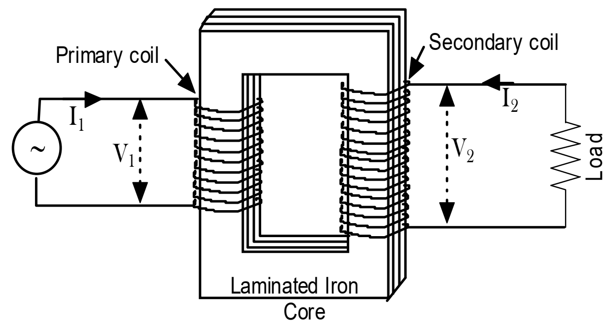
- **SELF INDUCTANCE:** A coil can induce an emf in itself. If the current in a coil changes, the magnetic flux through the coil due to that current also changes. As a result, the changing current in a coil induces an emf in that same coil. This property is called self induction. It is expressed in terms of the coefficient of self induction also known as self inductance (L). The total magnetic flux through a coil is directly proportional to the current that passes through it. $\therefore \varphi \propto i$ or $\varphi = L \times I$, where L is a constant of proportionality known as the coefficient of self induction or simply self inductance, which depends on the geometry of the coil and the number of turns in it.

  From $\varphi = L \times i$ we deduce $(d\varphi/dt) = L \times (di/dt)$, but $(d\varphi/dt) = -E$, where E is the induced emf. $\therefore E = -L \times (di/dt)$. The self inductance "L" may be defined as numerically equal to the induced emf in a coil, when the current in it is changing at the rate of one ampere per second.

  Unit of L : $Wb\,A^{-1}$ or $V\,s\,A^{-1}$ or henry (H).
- **SELF INDUCTANCE OF A SOLENOID:** A solenoid of length "l" having "N" turns of area of cross section "A" has a self inductance $L = \mu_o N^2A/l$. This is valid if the core of the solenoid is air. For any other core replace μ_o with μ.
- **ENERGY STORED IN AN INDUCTOR:** Because of its self induced back emf, work must be done to increase the current through a coil having self inductance (*called inductor*) from zero to a value I. This work will be stored as energy in the magnetic field established in the coil and is given by $U = \frac{1}{2} L I^2$.
- **MUTUAL INDUCTANCE:** If two coils without any electrical connection are near to each other, then the flux from one coil threads through the other coil, an emf can be induced in either one by the other. The coil that contains the power source is called the *primary coil*. The other coil, in which an emf is induced by the changing current in the primary, is called the *secondary coil*. The total flux linked to the secondary is directly proportional to the current in the primary. $\varphi_s \propto i_p$. or $\varphi_s = M \times i_p$, where "M" is a constant of proportionality known as the coefficient of mutual induction or simply mutual inductance, which depends on the geometry of the coil and the number of turns in them and the coupling between the coils.

  From $\varphi_s = M \times i_p$ we deduce $(d\varphi_s/dt) = M \times (di_p/dt)$, but $(d\varphi_s/dt) = -E_s$, where E_s is the induced emf in the secondary coil. $\therefore E_s = -M \times (di_p/dt)$. The mutual inductance "M" may be defined as numerically equal to the induced emf in the secondary coil, when the current in the primary coil is changing at the rate of one ampere per second.

  Unit of M: $Wb\,A^{-1}$ or $V\,s\,A^{-1}$ or henry (H).
- **MUTUAL INDUCTANCE OF A PAIR OF COILS ONE WOUND OVER THE OTHER:** A solenoid of length 'l' having "N_1" turns of area of cross section "A" has a secondary coil wound over it with N_2 turns, the mutual inductance $M = \mu_o N_1N_2A/l$.



- **TRANSFORMER:** A transformer works on the principle of mutual induction. It is a static device that is used to increase or decrease the voltage in an AC ciruit.

  On a laminated iron core two insulated copper coils called primary and secondary are wound. If the primary is connected to an alternating source of emf (AC), by mutual induction, an emf is induced in the secondary.
- **VOLTAGE RATIO:** If V_1 and V_2 are the primary and secondary voltage in a transformer, and N_1 and N_2 are the number of turns in the primary and secondary coils of the transformer, then $\frac{V_1}{V_2} = \frac{N_1}{N_2}$.

  In a transformer the *voltage per turn* is the same in primary and secondary coils.

  The ratio N_2/N_1 is called transformation ratio.

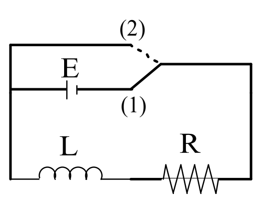
  The voltage ratio is the same as the ratio of the number of turns on the two coils.
- **CURRENT RATIO:** If the primary and secondary currents are I_1 and I_2 respectively, then $\frac{I_1}{I_2} = \frac{N_2}{N_1}$.

  In a transformer the *ampere turns* are the same in primary and secondary coils.

  The current ratio is the *inverse* ratio of the number of turns on the two coils.

- **STEP-UP TRANSFORMER:** The transformer in which the number of turns in the secondary (N_2) is more than the number of turns in the primary (N_1) is called a STEP-UP transformer. The out put voltage is more than the input voltage. They are used in Power generating plants.

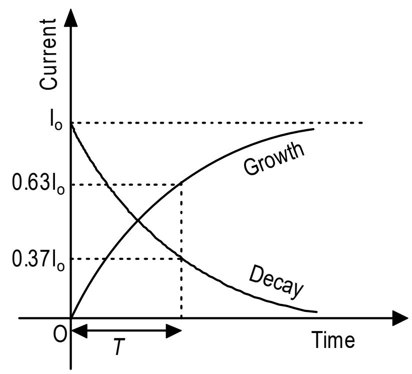
- **STEP-DOWN TRANSFORMER:** The transformer in which the number of turns in the secondary (N_2) is less than the number of turns in the primary (N_1) is called a STEP-DOWN transformer. The out put voltage is less than the input voltage. They are used as distribution transformers.
- **IDEAL TRANSFORMER:** In an ideal transformer the input power is equal to the output power. $V_1 I_1 = V_2 I_2$
  The efficiency of an ideal transformer is 100%.
- **LOSSES IN A TRANSFORMER:** The losses in a transformer are divided in to two types. They are *copper losses* and *iron losses*.
  The loss of energy that occurs in the copper coils of the transformer (i.e. primary and secondary coils) is called 'copper losses'. These are nothing but joule heating losses where electrical energy is converted in to heat energy.
  The loss of energy that occurs in the iron core of the transformer (i.e. hysteresis loss and eddy current loss) is called 'iron losses'.
- **MINIMIZING THE LOSSES IN A TRANSFORMER:** The core of a transformer is laminated and each lamination is coated with a paint of insulation to reduce the 'eddy current' losses. By choosing a material with narrow 'hysteresis loop' for the core, the hysteresis losses are minimized.
- **GROWTH OF CURRENT IN L- R CIRCUIT**:



When an inductance 'L' and a resistance 'R' are connected in series with a battery as shown with a switch and the switch is ON [position (1)] at t = 0, then the current in the circuit exponentially grows from zero value to a final steady state value given by I_o = E/R, where 'E' is the emf of the battery.

At any instant the current in the circuit is given by

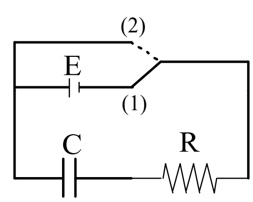
$$i = I_o(1 - e^{\frac{-Rt}{L}})$$



- **DECAY OF CURRENT IN L – R CIRCUIT:** When an inductance 'L' and a resistance 'R' are connected in series with a battery of emf 'E' and the circuit is closed [position (1)], the current reaches a maximum value I_o = E/R after some time. If the circuit is broken at t = 0, with the help of the switch by moving it to position (2), the current exponentially decays to zero value.
  At any instant the current in the circuit is given by

$$i = I_o e^{\frac{-Rt}{L}}$$

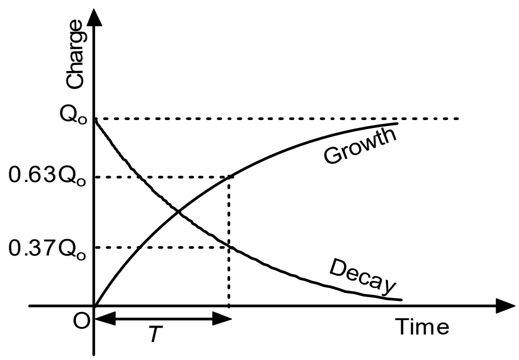
- **TIME CONSTANT OF L-R CIRCUIT:** The time taken for the current to reach 63% of the final steady state value is called the time constant (*or*) the time taken for the current to reach 37% of the initial value. Time constant T = L/R and has the dimensions of time.
- **GROWTH OF CHARGE IN C - R CIRCUIT:**



When a condenser of capacity 'C' and a resistance 'R' are connected in series with a battery as shown with a switch and the switch is ON [position (1)] at t = 0, then the electric charge in the condenser exponentially grows to a final steady state value given by Q_o = EC, where 'E' is the emf of the battery.
At any instant the charge in the condenser is given

by $q = Q_o(1 - e^{\frac{-t}{CR}})$

- **DECAY OF CHARGE IN THE CONDENSER IN C – R CIRCUIT:** When a condenser of capacity 'C' and a resistance 'R' are connected in series with a battery of emf 'E' and the circuit is closed [position (1)], the charge in the condenser reaches a maximum value $Q_o = EC$ after some time. If the circuit is broken at t = 0, with the help of the switch by moving it to position (2), the charge in the condenser exponentially decays to zero value.
At any instant the electric charge on the condenser in the circuit is given by $q = Q_o e^{\frac{-t}{CR}}$



- **TIME CONSTANT OF C-R CIRCUIT:** The time taken for the charge in the condenser to reach 63% of the final steady state value is called the time constant (*or*) the time taken for the charge to reach 37% of the initial value. Time constant T = CR and has the dimensions of time.

CONCEPTUAL QUESTIONS

1. An observer is moving relative to a stationary electric charge. His instruments detect
1) an electric field only 2) an electric field and a magnetic field
3) a magnetic field only
4) any of the above depending upon his velocity
2. Magnetic fields do not interact with
1) stationary electric charges
2) moving electric charges.
3) stationary permanent magnets
4) moving permanent magnets.
3. All magnetic fields in this universe originate in
1) iron atoms
2) permanent magnets
3) magnetic domains
4) moving electric charges
4. Two charged particles in motion exert on each other
1) electric forces only
2) magnetic forces only
3) neither electric nor magnetic forces
4) both electric and magnetic forces
5. According to Biot-Savart's law the magnetic field induction due to a current element at a point near it is given by
1) μ_o i dl sin$\theta/4\pi r$ 2) μ_o i dl cos$\theta/4\pi r^2$
3) μ_o i dl sin$\theta/4\pi r^2$ 4) μ_o i dl sin$\theta/4\pi r^3$
6. Which of the following correctly represents Ampere's circuital law?
1) $\oint \overline{B} \times \overline{d\lambda} = \mu_0 i$ 2) $\oint \overline{B} \times \overline{d\lambda} = \frac{\mu_0}{i}$
3) $\oint \overline{B}.\overline{d\lambda} = \frac{\mu_0}{i}$ 4) $\oint \overline{B}.\overline{d\lambda} = \mu_0 i$
7. A circular coil of one turn and area "A" carrying a current has a magnetic dipole moment "M". The current through the coil is
1) M × A 2) A/ M
3) M/A 4) M/A^2
8. A circular coil of wire carries a current. It's magnetic dipole moment is independent of
1) the current in the coil
2) the radius of the circle
3) the number of turns in the coil
4) the induction of the magnetic field in which the coil lies
9. A current carrying conductor produces
1) a magnetic field but not an electric field
2) an electric field but not a magnetic field
3) both a magnetic and an electric field
4) neither a magnetic field nor an electric field
10. A straight wire is carrying an electric current, then the magnetic lines of force
1) are absent in its neighbourhood
2) concentric circles around the wire
3) straight lines parallel to the wire and in the same direction as the current
4) straight lines parallel to the wire in the direction opposite to the current
11. If a long hollow copper pipe carries a current, the magnetic field produced will be
1) inside the pipe only 2) outside the pipe only
3) neither inside nor outside the pipe
4) both inside and outside the pipe
12. The force acting on a current carrying wire situated in a uniform magnetic field is independent of
1) the induction of the field
2) the magnitude of current
3) the length of the wire
4) the radius of the wire

13. Two long straight wires are parallel and close to each other, but not touching. A steady current is passed through each, the two currents being in the same direction.
1) the wires do not experience any force
2) both wires revolve around each other
3) the wires attract each other
4) the wires repel each other

14. A rectangular coil of wire carrying a current is kept in a uniform magnetic field. The torque acting on the coil will be maximum when
1) the plane of the coil is perpendicular to the field
2) the normal to the plane of the coil is parallel to the field
3) the normal to the plane of the coil is perpendicular to the field
4) the plane of the coil is making an angle of 45° with the field

15. A rectangular coil of wire carrying a current is kept in a uniform magnetic field. The torque acting on the coil will be zero when
1) the plane of the coil is perpendicular to the field
2) the normal to the plane of the coil is making an angle of 45° with the field
3) the normal to the plane of the coil is perpendicular to the field
4) the plane of the coil is parallel to the field

16. The purpose of soft iron cylinder between the pole pieces of the horse-shoe magnet in a moving coil galvanometer is
1) to increase the magnetic induction in the polar gap
2) to evenly distribute the magnetic lines of force
3) to provide a radial magnetic field
4) to reduce the magnetic flux leakage in the polar gap

17. The radial magnetic field is used in a suspended coil galvanometer to provide
1) a uniform torque on the coil
2) maximum torque on the coil in all positions
3) a uniform and maximum torque in all positions of the coil
4) a non uniform torque on the coil

18. The sensitivity of a moving coil galvanometer can be increased by
1) decreasing the number of turns.
2) decreasing the area of the coil.
3) increasing the couple per unit twist of the suspension.
4) increasing the induction of the field.

19. The coil of the moving coil galvanometer is wound over an aluminium frame
1) because aluminium is a good conductor
2) because aluminium is very light.
3) because aluminium is comparatively cheaper
4) to provide electro-magnetic damping.

20. To make a moving coil galvanometer more sensitive, which of the following must be done
1) increase the number of turns of the coil
2) increase the area of the coil
3) decrease the couple per unit twist of the suspension
4) all of the above

21. Inside an ammeter there will always be a galvanometer and
1) a high resistance connected in series with it
2) a low resistance connected in series with it
3) a high resistance connected in parallel with it
4) a low resistance connected in parallel with it

22. Inside a voltmeter there will always be a galvanometer and
1) a high resistance connected in series with it
2) a low resistance connected in series with it
3) a high resistance connected in parallel with it
4) a low resistance connected in parallel with it

23. Regarding the connections of an ammeter and a voltmeter in an electrical circuit, which of the following is true?
1) ammeter is connected in parallel and voltmeter in series
2) ammeter is connected in parallel and voltmeter in parallel
3) ammeter is connected in series and voltmeter in parallel
4) ammeter is connected in series and voltmeter in series

24. A galvanometer is converted into a voltmeter of range V by connecting a high resistance R in series with it. To convert the same galvanometer into a voltmeter reading up to 2 V, the high resistance to be connected in series is
1) 2R 2) R/2
3) > 2R 4) < 2R

25. The resistance of an ideal ammeter and conductance of an ideal voltmeter are respectively
1) zero, infinity 2) infinity, zero
3) infinity, infinity 4) zero, zero

26. If G, r_A and r_V denote the internal resistances of a galvanometer, an ammeter and a voltmeter which of the following relationship is correct?
1) $G < r_A < r_V$ 2) $r_A < r_V < G$
3) $r_A < G < r_V$ 4) $r_V < r_A < G$

27. The internal resistance of which of the following instruments is highest ?
1) Ammeter 2) Galvanometer
3) Voltmeter 4) Milliammetre

28. To increase the range of an ammeter
1) a small resistance is connected in series
2) a small resistance is connected in parallel
3) a large resistance is connected in parallel
4) a large resistance is connected in series

29. To increase the range of a voltmeter
1) a small resistance is connected in series
2) a small resistance is connected in parallel
3) a large resistance is connected in parallel
4) a large resistance is connected in series

30. In an electrical circuit containing a source of emf and a load resistance, the voltmeter is connected by mistake in series with the load across the source and ammeter is connected parallel to the load. Then which meter burns out
1) ammeter 2) voltmeter
3) both ammeter and voltmeter
4) neither ammeter nor voltmeter

31. The potential difference across the terminals of an non-ideal ammeter in an electrical circuit will be
1) small 2) large
3) infinity 4) zero

32. The current drawn by a non-ideal voltmeter in an electrical circuit will be
1) small 2) large
3) infinity 4) zero

33. What would happen to the current in a circuit if a voltmeter, inadvertently mistaken for an ammeter, were inserted in to the circuit? The current
1) increases 2) remains same
3) decreases
4) becomes zero

34. An ammeter and a voltmeter are joined in series to a cell. Their readings are A and V respectively. If a resistance is now joined in parallel with the voltmeter, then
1) both A and V will increase
2) both A and V will decrease
3) A will decrease, V will increase
4) A will increase, V will decrease

35. The reduction factor of a tangent galvanometer may be defined as the current passing through it to produce a deflection of
1) 90° 2) 45°
3) 30° 4) 60°

36. A tangent galvanometer is taken from equator to the north pole. During this the sensitivity of the tangent galvanometer
1) decreases because its reduction factor decreases
2) increases because its reduction factor decreases
3) decreases because its reduction factor increases
4) increases because its reduction factor increases

37. In a tangent galvanometer, the circular coil is unwound and rewound to have twice the previous radius. As a result of this the reduction factor (K) of the tangent galvanometer is
1) unaffected 2) doubled
3) quadrupled 4) halved

38. An electron and a proton travel with equal speed in the same direction at 90° to a uniform magnetic field. The forces experienced by them are
1) equal and in the same direction
2) equal but in opposite directions
3) unequal and in the same direction
4) unequal but in opposite directions

39. Cathode rays passing through an electric field experience maximum force when they move
1) parallel to the field 2) antiparallel to the field
3) perpendicular to the field
4) in any direction, because the force is independent of velocity

40. A proton is speeding down towards earth (cosmic ray proton). Due to the horizontal component of earth's magnetic field, in what direction it will be deflected? Towards
1) North 2) East
3) West 4) South

41. An electron moving along X-positive direction, experiences a magnetic force in the Y-negative direction. The direction of the magnetic field over this region is along the
1) Z negative direction 2) Z positive direction
3) Y positive direction 4) X negative direction

42. A horizontal wire running from east to west carries a westward current. It is situated in a uniform magnetic field of induction B which is acting vertically upwards. Then the conductor experiences a force in the direction of
1) north 2) south
3) east 4) west

43. A proton is projected horizontally eastward in a uniform magnetic field, which is horizontal and southward in direction. The proton will be deflected
1) upward 2) downward
3) northward 4) southward

44. A charged particle moves through a steady magnetic field. The effect of the field is to change the particle's
1) speed 2) direction of motion
3) mass 4) energy

45. A uniform electric field and a uniform magnetic field are produced in the same direction. An electron is projected with its velocity in the same direction, then the
1) electron will turn to its right.
2) electron will turn to its left.
3) electron velocity will increase in magnitude.
4) electron velocity will decrease in magnitude.

46. A uniform magnetic field is obtained using
1) a bar magnet
2) a horseshoe magnet
3) a circular coil carrying a current
4) a cylindrical coil carrying a current

47. A charged particle is found to move with a constant kinetic energy in a field. It could be
1) an electric field only
2) a magnetic field only
3) neither an electric field nor a magnetic field
4) either a magnetic field or an electric field

48. A deuteron is fired into a uniform magnetic field at an angle 45° with the field. The path of the particle in the magnetic field will be a
1) circle 2) parabola
3) straight line 4) helix

49. A test charge at rest in a region experiences no force. Then there is
1) no magnetic field but an electric field may be present
2) no magnetic field
3) no electric field but a magnetic field may be present
4) no electric field

50. An electron is fired in the direction of a uniform magnetic field. It experiences
1) an accelerating force
2) a retarding force
3) no force
4) a centripetal force

51. A charged particle enters a field has its path changed but it is found that its kinetic energy remains unchanged, then the field could be
1) an electric field 2) a magnetic field
3) a combination of electric and magnetic fields parallel to each other.
4) a combination of electric and magnetic fields at right angles to each other.

52. A negatively charged particle is falling freely under gravity. Due to the earths horizontal component of the magnetic field it will be deflected towards
1) west 2) east
3) north 4) south

53. Imagine you are seated in a room. A proton beam is coming towards you horizontally and there is a horizontal magnetic field of uniform induction B towards your left hand side, then the proton beam deflects
1) vertically downwards
2) towards your right hand side
3) vertically upwards
4) away from you

54. A charged particle is fired perpendicular to a uniform magnetic field. The field
1) changes the momentum and kinetic energy of the particle
2) changes the momentum but not the kinetic energy of the particle
3) changes the kinetic energy but not the momentum of the particle
4) neither changes the momentum nor the kinetic energy of the particle

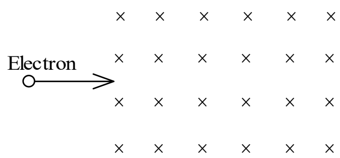
55. A charged particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one point. If a magnetic field is switched on in the vertical direction, the tension in the string
1) will increase 2) will decrease
3) will remain the same
4) may increase or decrease

56. A proton is fired through the origin along the X-positive direction with a certain velocity. A uniform electric field of intensity 'E' exists along the Y-negative direction. A magnetic field of induction 'B' is applied such that the proton goes undeflected with the same velocity. The magnitude of the velocity of the proton and the direction of the magnetic field are respectively
1) E/B, Z-negative direction
2) B/E, Z-negative direction
3) E/B, Z-positive direction
4) B/E, Z-positive direction

57. A proton is fired near a straight conductor carrying a large current in a direction parallel to the conductor and in the direction of the current. The proton tends

1) to move away from the conductor
2) to move towards the conductor
3) to move parallel to the conductor in the original direction
4) to come to rest

58. An electron is fired in to a uniform magnetic field that is directed in to the plane of the paper as shown. The direction of a uniform electric field to be applied in order that the electron may experience no deflection is



1) upwards 2) downwards
3) in to the plane of the paper
4) out of the plane of the paper

59. Charged particles such as α- particles can move in circular orbits in
1) electric fields but not in magnetic fields
2) magnetic field but not in electric fields
3) both electric and magnetic fields
4) neither magnetic fields nor in electric fields

60. A proton is fired through a region of space in which an electric field "E" and a magnetic field "B" exist. If the proton continues to move in the same direction without any change in its speed, which of the following is not possible?
1) $E \neq 0, B \neq 0$ 2) $E = 0, B = 0$
3) $E \neq 0, B = 0$ 4) $E = 0, B \neq 0$

61. When ever the flux linked with a coil changes, then
1) an emf is always induced
2) an emf and a current are always induced
3) an emf is induced but a current is never induced
4) an emf is always induced and a current is induced, when the coil is a closed one

62. When a conductor carrying current is free to move in a magnetic field, the direction in which it will move is given by
1) Fleming's right hand rule
2) Fleming's left hand rule
3) Laplace's rule
4) Cork screw rule

63. Lenz's law is in accordance with the law of conservation of
1) electric current 2) energy
3) electro motive force
4) electric charge

64. The coefficient of self inductance and the coefficient of mutual inductance have
1) same units but different dimensions
2) different units but same dimensions
3) different units and different dimensions
4) same units and same dimensions

65. Choke coil works on the principle of
1) transient currents 2) self induction
3) mutual induction 4) wattles current

66. The direction of the induced e.m.f. is determined by
1) Fleming's left hand rule
2) Fleming's right hand rule
3) Maxwell's right hand screw rule
4) Ampere's rule of swimming

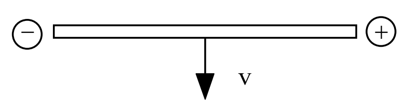
67. When a metallic sphere is moved in a magnetic field, it gets heated due to
1) air resistance
2) induced currents called eddy currents
3) currents in the coil of magnet producing the field
4) None of these

68. A dynamo
1) creates an electric energy
2) converts mechanical energy into electric energy
3) converts electrical energy into mechanical energy 4) creates mechanical energy

69. An inductance stores energy in the
1) electric filed 2) magnetic field
3) resistance of the coil
4) electric and magnetic fields

70. The laws of electromagnetic induction have been used in the construction of a
1) galvanometer 2) voltmeter
3) electric motor 4) electric generator

71. A wire moves with a velocity "v" through a magnetic field and experiences an induced charge separation as shown. What is the direction of the magnetic field?



1) in to the page 2) out of the page
3) towards the bottom of the page
4) towards the top of the page

72. Four solenoids having same area of cross section have the lengths and number of turns as in the choices given below. Which of them has the least coefficient of self induction? The one that is
1) longer with more number of turns
2) shorter with less number of turns
3) shorter with more number of turns
4) longer with less number of turns

73. The core of a transformer is laminated so that
1) energy loss due to eddy currents may be reduced
2) rusting of the core may be prevented
3) change in flux may be increased
4) ratio of voltage in the primary to that in the secondary may be increased

74. A step up transformer is used to
1) increase the current and increase the voltage
2) decrease the current and increase the voltage
3) increase the current and decrease the voltage
4) decrease the current and decrease the voltage

75. A transformer changes the voltage
1) without changing the current and frequency
2) without changing the current but changes the frequency
3) without changing the frequency but changes the current
4) without changing the frequency as well as the current

76. A step up transformer is connected on the primary side to a rechargeable battery which can deliver a large current. If a bulb is connected in the secondary, then
1) the bulb will glow very bright
2) the bulb will get fused
3) the bulb will glow, but with less brightness
4) the bulb will not glow

77. The ratio of primary voltage to secondary voltage in a transformer is 'n'. The ratio of the primary current to secondary current in the transformer is
1) n 2) $1/n$ 3) n^2 4) $1/n^2$

78. In a step down transformer, the number of turns in the primary is always
1) greater than the number of turns in the secondary
2) less than the number of turns in the secondary
3) equal to the number of turns in the secondary
4) either greater than or less than the number of turns in the secondary

79. The transformation ratio of a step up transformer is
1) ratio of turns in secondary to turns in primary and is greater than one
2) ratio of turns in primary to turns in secondary and is less than one
3) ratio of turns in secondary to turns in primary and is less than one
4) ratio of turns in primary to turns in secondary and is greater than one

80. To reduce the iron losses in a transformer, the core must be made of a material having
1) low permeability and high resistivity
2) high permeability and high resistivity
3) low permeability and low resistivity
4) high permeability and low resistivity

01) 2	02) 1	03) 4	04) 4	05) 3	06) 4	07) 3
08) 4	09) 1	10) 2	11) 2	12) 4	13) 3	14) 3
15) 1	16) 3	17) 3	18) 4	19) 4	20) 4	21) 4
22) 1	23) 3	24) 3	25) 4	26) 3	27) 3	28) 2
29) 4	30) 4	31) 1	32) 1	33) 3	34) 4	35) 2
36) 2	37) 3	38) 2	39) 4	40) 2	41) 1	42) 1
43) 2	44) 2	45) 4	46) 4	47) 2	48) 4	49) 3
50) 3	51) 2	52) 1	53) 1	54) 2	55) 4	56) 1
57) 2	58) 2	59) 2	60) 3	61) 4	62) 2	63) 2
64) 4	65) 2	66) 2	67) 2	68) 2	69) 2	70) 4
71) 2	72) 4	73) 1	74) 2	75) 3	76) 4	77) 2
78) 1	79) 1	80) 2				

LEVEL – 1

1. The average self-induced emf in a 25 m H solenoid when the current in it falls from 0.2 A to 0 A in 0.01 second, is
1) 0.05 V 2) 0.5 V 3) 500 V 4) 50 V

2. The rate of change of current needed to induce an emf of 8 V in a 0.1-H coil is
1) 0.8 A/s 2) 0.125 A/s
3) 80 A/s 4) 8 A/s

3. An average emf of 32 V is induced in a coil in which the current drops from 10 A to 2 A in 0.1 s. The inductance of the coil is
1) 0.32 H 2) 0.4 H 3) 4 H 4) 0.04 H

4. A train is moving towards north with a speed of 180 kilometers per hour. If the vertical component of the earth's magnetic filed is 0.2×10^{-4} T, the emf induced in the axle of length 1.5 m is
1) 1.5 mV 2) 15 mV
3) 54 mV 4) 5.4 mV

5. In an inductance coil the current increases from zero to 6 ampere in 0.3 second by which an induced e.m.f. of 60 volt is produced in it. The value of coefficient of self-induction of coil is
1) 1 henry 2) 1.5 henry
3) 2 henry 4) 3 henry

6. A rectangular coil of 200 turns and area 100 cm^2 is kept perpendicular to a uniform magnetic field of induction 0.25 tesla. If the field is reversed in direction in 0.01 second, the average induced emf in the coil is
1) 10^6 V 2) 10^4 V 3) 10^2 V 4) zero

7. A filed of strength $5 \times 10^4/\pi$ ampere turns / meter acts as right angles to the coil of 50 turns of area 10^{-2} m^2. The coil is removed from the field in 0.1 second. Then the induced e.m.f in the coil is
1) 0.1 V 2) 0.2 V
3) 1.96 V 4) 0.98 V

KEY

8. The current decays from 5 A to 2 A in 0.01 s in a coil. The emf induced in a coil nearby it is 30V. The mutual inductance between the coils is
1) 1.0 H 2) 0.1 H
3) 0.001 H 4) 10 H

9. The coefficient of mutual inductance of two coils is 5 H. The current through the primary coil is reduced to zero value from 3 A in 1 millisecond. The induced e.m.f. in the secondary coil will be
1) 30 kV 2) 1.67 kV
3) 15 kV 4) 600 V

10. An ideal transformer has 400 turns in the primary and 200 turns in the secondary. If the primary is connected to a 12 V battery, then the secondary voltage is
1) 6 V 2) 24 V 3) 3 V 4) *zero*

11. A transformer steps up an A.C. voltage from 230 V to 2300 V. If the number of turns in the secondary coil is 1000, the number of turns in the primary coil will be
1) 100 2) 10,000 3) $500\sqrt{2}$ 4) $1000\sqrt{2}$

12. A transformer converts 230 V A.C into 1035 V A.C. If the number of turns in the primary is 200, the number of turns in the secondary is
1) 400/9 2) 900 3) 4050 4) 800/81

13. The transformation ratio of a transformer is 5. If the primary voltage of the transformer is 400 V, 50 Hz, the secondary voltage will be
1) 2000 V, 250 Hz 2) 80 V, 50 Hz
3) 80 V, 10 Hz 4) 2000 V, 50 Hz

14. The efficiency of a transformer is 98%. The primary voltage and current are 200 V and 6 A. If the secondary voltage is 100 V, the secondary current is
1) 11.76 A 2) 12.25 A
3) 3.06 A 4) 2.94 A

15. A coil of inductance 4 H has an internal resistance of 0.75 Ω. The time constant of the coil connected in to a battery will be
1) 3/16 s 2) 16/3 s
3) 3 s 3) 1/3 s

16. Two inductance coils made of different metal wires are having the same inductance. But their time constants are in the ratio 1 : 2. What is the ratio of their resistances?
1) 1 : 2 2) $1:\sqrt{2}$
3) $\sqrt{2}:1$ 4) 2 : 1

17. A condenser of 20 μF is charged to a certain voltage and then discharged through a 4 MΩ resistor. The time taken for the condenser to lose 63% of its charge is
1) 5 s 2) 80 s 3) 8 s 4) 50 s

18. A choke coil has an inductance of 4 H and a resistance of 2 Ω. It is connected to a battery of 12 V and negligible internal resistance. The time taken for the current to become 3.78 A is nearly
1) 8 s 2) ½ s 3) 2 s 4) 4 s

19. A resistance with an inductor of 8 H has the same time constant as it has with a condenser of capacity 2 μF. The value of the resistance expressed in ohms is
1) 500 2) 250 3) 4000 4) 2000

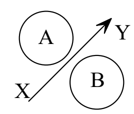
KEY

1) 2	2) 3	3) 2	3) 1	5) 4	6) 3	7) 1
8) 2	9) 3	10) 4	11) 1	12) 2	13) 4	14) 1
15) 2	16) 4	17) 2	18) 3	19) 4		

LEVEL – 2

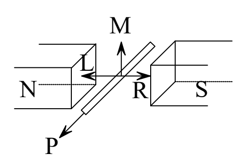
1 An emf of 20, 000V is induced in a secondary coil, when the current breaks in the primary. The mutual inductance is 5 H and the current reaches to zero in 10^{-4} s in primary. The current in the primary before the break is
1) 0.04 A 2) 0.4 A 3) 4.0 A 4) 40 A

2. Consider the situation shown in the figure. If the current I in the long straight conducting wire XY is increased at a steady rate then the induced e.m.f.'s in loops A and B will be



1) clockwise in A, anti clockwise in B
2) anti clockwise in A, clockwise in B
3) clockwise in both A and B
4) anti clockwise in both A and B

3. An electric potential difference will be induced between the ends of the conductor shown in the figure, if the conductor moves in the direction shown by



1) P 2) R 3) L 4) M

4. A transformer with primary to secondary turns ratio of 1 : 2, is connected to an alternator of voltage 200 V. A current of 4 A is flowing though the primary coil. Assuming that the transformer has no losses, the secondary voltage and current are respectively
1) 100 V, 8 A 2) 400 V, 8 A
3) 400 V, 2 A 4) 100 V, 2 A

5. A charged particle moves undeflected in a region of closed electric and magnetic fields. If the electric field is switched off, the particle has an initial acceleration "a". If the magnetic field is switched off, instead of the electric field the, the particle will have an initial acceleration
1) equal to zero 2) > a
3) equal to a 4) < a

6. A charged particle of mass "m" and charge "q" is accelerated through a potential difference of "V" volts. It then enters in to a region of uniform magnetic field of induction "B" which is perpendicular to the direction of motion of the particle. The particle will move in a circular path of radius given by

1) $\sqrt{\frac{Vm}{qB}}$ 2) $\frac{2Vm}{qB^2}$ 3) $\frac{1}{B}\sqrt{\frac{2Vm}{q}}$ 4) $\frac{1}{B}\sqrt{\frac{Vm}{q}}$

7. A rectangular coil is perpendicular to a uniform magnetic field. If the field is reversed in a short time interval of 't', the charge flowing through the coil depends on 't^N', then the value of 'N' is
1) 1 2) – 1 3) zero 4) 2

8. A particle of mass 'm' and charge 'q' is fired perpendicular to a uniform magnetic field of induction 'B'. While the particle moves in a circular path in the filed, its angular momentum about the center of the circle is

1) $\frac{m^2v}{Bq}$ 2) $\frac{Bq}{m^2v^2}$ 3) $\frac{m^2v^2}{Bq}$ 4) $\frac{mv}{Bq}$

9. An annular circular brass disk of inner radius 'r' and outer radius 'R' is rotating about an axis passing through its center and perpendicular to is plane with a uniform angular velocity 'ω' in a uniform magnetic filed of induction 'B' normal to the plane of the disk. The induced emf between the inner and outer edge of the annular disk is

1) $\frac{B\omega(r^2+R^2)}{2}$ 2) $\frac{B\omega(R^2-r^2)}{2}$

3) $\frac{B\omega(r-R)}{2}$ 4) $\frac{B\omega(r+R)}{2}$

10. A voltmeter has an internal resistance 'r' and can measure up to 'v' volts. A high resistance 'R' is connected in series with it and now it is able to measure up to 'V' volts. Then which of the following is the correct relation between the 'r', 'R', 'v' and 'V'?

1) $\frac{v}{r}=\frac{V}{R}$ 2) $\frac{v}{R}=\frac{V}{r}$

3) $\frac{v}{r}=\frac{V-v}{R}$ 4) $\frac{v}{R}=\frac{V-v}{r}$

11. A solenoid of self inductance 1.2 H is in series with a tangent galvanometer of reduction factor 0.9 A. They are connected to a battery and the tangent galvanometer shows a deflection of 53°. The energy stored in the magnetic field of the solenoid is
1) 0.864 J 2) 0.72 J 3) 0.173 J 4) 1.44 J

12. A physicist works in a laboratory where the magnetic field is 2 T. She wears a necklace enclosing an area 100 cm^2 of field and having a resistance of 0.1 Ω. Because of power failure, the field decays to 1 T in a millisecond. Find the electric charge circulated in the necklace assuming that the magnetic field is perpendicular to area covered by the necklace.
1) 0.01 C 2) 0.001 C 3) 0.1 C 4) 1.0 C

13. A proton is fired in to a uniform magnetic field with a velocity $\overline{v} = a\hat{i} + b\hat{j}$. The magnetic field is given by $\overline{B} = c\hat{i} + d\hat{j}$. The condition that the proton many not experience a force is
1) ac = – bd 2) bc = ad
3) ac = bd 4) ab = cd

14. To measure the field 'B' between the poles of an electromagnet, a small test loop of area 1 cm^2, resistance 10 Ω and 20 turns is pulled out of it. A galvanometer shows that a total charge of 2 μC passed through the loop. The value of 'B' is
1) 0.001 T 2) 0.01 T 3) 0.1 T 4) 1.0 T

15. A solenoid is connected to a battery of 12 V emf and negligible internal resistance. The current in the solenoid grows to 63% of its final steady state value in 0.3 s. If the final steady state current is 0.6 A, the inductance of the solenoid is
1) 0.6 H 2) 6.0 H 3) 0.015 H 4) 0.15 H

16. The time constant of an inductor is τ_1. When a pure resistor of R Ω is connected in series with it, the time constant is found to decrease to τ_2. The internal resistance of the inductor is

1) $\frac{R\tau_2}{\tau_1-\tau_2}$ 2) $\frac{R\tau_1}{\tau_1-\tau_2}$ 3) $\frac{R(\tau_1-\tau_2)}{\tau_1}$ 4) $\frac{R(\tau_1-\tau_2)}{\tau_2}$

17. In a transformer in which the losses may be neglected, the ratio of the primary voltage to secondary voltage is found to be 4 : 1. The ratio of the primary to secondary turns and the ratio of the primary current to secondary current are respectively in the ratio of
1) 4 : 1, 1 : 4 2) 1 : 4, 4 : 1
3) 4 : 1, 4 : 1 4) 1 : 4, 1 : 4

18. A transformer has 200 turns in primary and 400 turns in secondary. When a battery of 6 V and negligible internal resistance is connected to the primary a current of 2 A is produced in it. The secondary voltage and current are
1) 12 V, 1 A 2) 12 V, *zero*
3) *zero*, 1 A 4) *zero, zero*

19. A solenoid of inductance 'L' carrying a certain current is linked with a total magnetic flux ϕ. Now it is connected to a condenser with which it shares half of its initial energy. The total flux now linked with the solenoid is
1) $\phi/2$ 2) $\phi/\sqrt{2}$ 3) $\phi/2\sqrt{2}$ 4) $\phi/4$

20. An inductor of 12 mH and a resistor of 4 kΩ are connected in series across a battery of 240 V through a switch. After closing the switch the current in the circuit starts growing. When the current is 15 mA, the potential difference across the inductor will be
1) 60 V 2) 120 V 3) 180 V 4) 240 V

21. The flux linked with a coil is 0.8 Wb when a 2 A current is flowing through it. If this current begins to increase at the rate of 400 A/s, the induced emf in the coil will be
1) 20 V 2) 40 V 3) 80 V 4) 160 V

22. A closed coil with a resistance R is placed in a magnetic field. The flux linked with the coil is ϕ. If the magnetic field is suddenly reversed in direction, the charge that flows through the coil will be
1) $\phi/2R$ 2) ϕ/R 3) $2\phi/R$ 4) *zero*

23. There are two batteries 'A' and 'B' having same emf. A has no internal resistance and B has some internal resistance. A solenoid is connected first to 'A' and the energy in the uniform magnetic field setup inside is 'U'. It is now disconnected from 'A' and reconnected to 'B'. The energy stored in the uniform magnetic field will be
1) U 2) > U 3) < U 4) *zero*

24. A current of 2 A is increasing at the rate of 4 A/s through a coil of inductance 2 H. The energy stored in the inductor per unit time is
1) 2 W 2) 1 W 3) 16 W 4) 4 W

25. A coil of 30 turns of wire each of 10 cm^2 area is placed with its plane perpendicular to a magnetic field of 0.1 T. When the coil is suddenly withdrawn from the field, a galvanometer connected in series with the coil indicated that a 10 μC charge passes around the circuit. The combined resistance of the coil and galvanometer is
1) 3 Ω 2) 30 Ω 3) 300 Ω 4) 3000 Ω

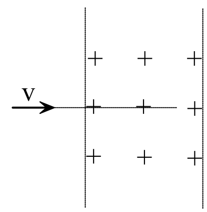
KEY

1) 2	2) 1	3) 4	4) 3	5) 3	6) 3	7) 3
8) 3	9) 2	10) 3	11) 1	12) 3	13) 2	14) 2
15) 2	16) 1	17) 1	18) 4	19) 2	20) 3	21) 4
22) 3	23) 3	24) 3	25) 3			

LEVEL – 3

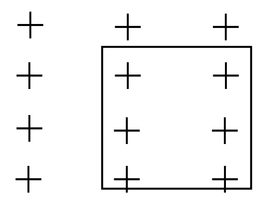
1. A wheel has three spokes and is in a uniform magnetic field perpendicular to its plane, with the axis of rotation of the wheel parallel to the magnetic field. When the wheel rotates with a uniform angular velocity ω, the emf induced between the center and rim of the wheel is 'e'. If another wheel having same radius but with six spokes is kept in the same field and rotated with a uniform angular velocity '$\omega/2$', the emf induced between the center and the rim will be
1) e 2) e/2 3) 2e 4) e/4

2. A particle of mass 'm' and charge 'e' is moving with constant velocity 'v' along the X-axis as shown. Between x = 0 and x = a, there is a region of uniform magnetic field B in to the plane of the diagram.



What is the maximum possible value 'v' can take, so that the particle does not emerge from the other side of the field?
1) Bea/2m 2) 2Bea/m 3) Bea/m 4) Bea/4m

3. A spatially uniform magnetic field of 0.080 T is directed into the plane of the page and perpendicular to it, as shown in the accompanying figure. A wire loop in the plane of the page has constant area 0.010 m^2. The magnitude of the magnetic field decreases at a constant rate of 3.0 $\times$ 10^{-4} T/s. What is the magnitude and direction of the induced emf?



1) 3.0×10^{-6} V clockwise
2) 3.0×10^{-6} V anticlockwise
3) 2.4×10^{-5} V anticlockwise
4) 8.0×10^{-4} V clockwise

4. A coil of some internal resistance 'r' behaves like an inductance. When it is connected in series with a resistance R_1, the time constant is found to be τ_1. When it is connected in series with a resistance R_2, the time constant is found to be τ_2. The inductance of the coil is

1) $\dfrac{\tau_1\tau_2(R_1-R_2)}{(\tau_2-\tau_1)}$ 2) $\dfrac{(\tau_2-\tau_1)}{\tau_1\tau_2(R_1-R_2)}$

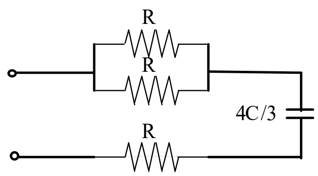
3) $\dfrac{(R_1-R_2)}{(\tau_2-\tau_1)}$ 4) $\dfrac{(\tau_2-\tau_1)}{(R_1-R_2)}$

5. A condenser in series with a resistor is connected through a switch to a battery of negligible internal resistance and having an emf of 12 V. One second after closing

the switch, the condenser is found to have a potential difference of 6 V. The time constant of the system is

1) 2 s 2) $\frac{1}{\log_e 2}$ 3) $\log_e 2$ 4) $\log_e\left(\frac{1}{2}\right)$

6. The time constant of the circuit shown is



1) RC 2) 2RC 3) 3RC 4) 4RC

7. An inductance L and a resistance R are connected in series to a battery of voltage V and negligible internal resistance through a switch. The switch is closed at t = 0. The charge that passes through the battery in one time constant is [*e* is base of natural logarithms]

1) $\frac{eR^2V}{L}$ 2) $\frac{VL}{R}$ 3) $\frac{VL}{eR^2}$ 4) $\frac{eL}{VR}$

8. Two difference coils have self inductance $L_1 = 8$ mH and $L_2 = 2$ mH. The currents in both are increasing at the same constant rate. At a certain instant of time, the power given to the two coils is the same. At this moment the current, the induced voltage and energy stored in the first coil are i_1, V_1 and U_1 respectively. The corresponding values in the second coil are i_2, V_2 and U_2 respectively. Then the values of $\frac{i_1}{i_2}$, $\frac{V_1}{V_2}$ and $\frac{U_1}{U_2}$ are respectively

1) ¼, 4, ¼ 2) 4, ¼, ¼
3) ¼, 4, 4 4) 4, 4, ¼

9. A resistance box, a battery of negligible internal resistance and a galvanometer of resistance 20 Ω are connected in series. The galvanometer is shunted by a 5 Ω coil. The change in the resistance in the box required to maintain the current from the battery unchanged, is

1) decrease by 4 Ω 2) increase by 4 Ω
3) decrease by 16 Ω 4) increase by 16 Ω

KEY

10) 2 11) 3 12) 1
13)1 14) 2 15) 2 16) 3 17) 1 18) 4

ASSERTION & REASON QUESTIONS

In the following questions, a statement of Assertion(A) is followed by a statement of Reason(R). Of these statements, mark the correct answer

1) Both A and R are individually true and R is the correct explanation of A
2) Both A and R are individually true but R is not the correct explanation of A
3) A is true but R is false
4) Both A and R are false

1. Assertion(A): The possibility of an electric bulb fusing is higher at the time of switching on and off.
Reason(R): Inductive effects produce a large current at the time of switch-on and switch-off.
2. Assertion(A) : If changing current is flowing through a machine with iron parts, results in loss of energy.
Reason(R): Changing magnetic flux through an area of the iron parts causes eddy currents.
3. Assertion(A): Only a change in magnetic flux will maintain an induced current in a closed coil.
Reason(R): The presence of large magnetic flux through a coil maintains a current in the coil if the coil is continuous.
4. Assertion(A) : If an electron and proton enter a magnetic field at right angles to it with equal kinetic energy, the path of electron is more curved than that of proton.
Reason(R): Electron has less mass than proton
5. Assertion(A): An electric field changes the velocity and energy of a charged particle, whereas in a magnetic field, it may change its velocity but not its energy
Reason (R): The force on a charged particle due to a magnetic field is perpendicular to its velocity whereas due to on electric field it has a component parallel to its velocity
6. Assertion(A): L/R and CR both have same dimensions.
Reason(R): L/R and CR are time constants
7. Assertion(A): For a given charged particle moving in a given uniform magnetic-field, the radius of circular path is directly proportional to the momentum of particle.
Reason(R): The effect of magnetic field on a charged particle is to change only its path from linear to circular.
8. Assertion(A): Whenever the magnetic flux linked with a coil changes there will be an induced emf as well as an induced current.
Reason(R): According to Faraday, the induced emf is inversely proportional to the rate of change of magnetic flux linked with a coil.
9. Assertion(A): When a charged condenser discharges through a resistor, the time taken for half the charge to be lost is always same, irrespective of the initial value of the charge.
Reason(R): The rate of decay of charge in a CR circuit is a linear function of time.
10. Assertion(A): Lenz's law is a violation of the law of conservation of energy.
Reason(R): Induced emf and induced currents always oppose the magnetic flux that has produced them.

11. Assertion(A): An inductor in a D.C.circuit opposes both a steady current and a changing current
Reason(R): Induced emf is generated only when the flux linked with the inductor remains unchanged.
12. Assertion(A): A current carrying conductor produces only an electric field
Reason(R): Electrons in motion produce only a magnetic field.

KEY

01) 1 02) 1 03) 3 04) 1 05) 1 06) 1
07) 2 08) 4 09) 3 10) 4 11) 4 12) 4

QUESTIONS FORM PREVIOUS EAMCET PAPERS (2003, 2004, 2005)

1. A galvanometer, having a resistance of 50 Ω gives a full scale deflection for a current of 0.05 A. The length in meter of a resistance wire of area of cross-section 2.97×10^{-3} cm^2 that can be used to convert the galvanometer into an ammeter which can read a maximum of 5A current is: (Specific resistance of the wire = 5×10^{-7} Ωm) [2003 ENGG]
1) 9 2) 6 3) 3 4) 1.5
2. A coil has 1, 000 turns and 500 cm^2 as its area. The plane of the coil is placed at right angles to a magnetic induction field of 2×10^{-5} web/m^2. The coil is rotated through 180° in 0.2 seconds. The average emf induced in the coil, in milli volts, is: [2003 ENGG]
1) 5 2) 10 3) 15 4) 20
3. A long straight wire carrying a current of 30 A is placed in an external uniform magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction in tesla at a point 2.0 cm away from the wire is:
($\mu_0 = 4\pi \times 10^{-7}$ H/m) [2003 ENGG]
1) 10^{-4} T 2) 3×10^{-4} T
3) 5×10^{-4} T 4) 6×10^{-4} T
4. Two ions having masses in the ratio 1 : 1 and charges 1 : 2 are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2 : 3. The ratio of the radii of circular paths along which the two particles move is: [2003 ENGG]
1) 4 : 3 2) 2 : 3 3) 3 : 1 4) 1 : 4
5. The scale of a galvanometer of resistance 100 ohms contains 25 divisions. It gives a deflection of one division on passing a current of 4×10^{-4} amperes. The resistance in ohms to be added to it, so that it may become a voltmeter of range 2.5 volts, is: [2003 MED]
1) 100 2) 150 3) 250 4) 300
6. Two coils have self-inductance $L_1 = 4$ mH and $L_2 = 1$ mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then the value of (I_1/I_2) is: [2003 MED]
1) $\frac{1}{8}$ 2) $\frac{1}{4}$ 3) $\frac{1}{2}$ 4) 1
7. The electric current in a circular coil of two turns produced a magnetic induction of 0.2 T at its centre. The coil is unwound and is rewound into a circular coil of four turns. The magnetic induction at the centre of the coil now is, in tesla, (if same current flows in the coil): [2003 MED]
1) 0.2 2) 0.4 3) 0.6 4) 0.8
8. Two ions having equal masses, but charges in the ratio 1 : 2 are projected perpendicular to a uniform magnetic field with speeds in the ratio 2 : 3. The ratio of the radii of the circular paths along which the two ions move is: [2003 MED]
1) 4 : 3 2) 2 : 3 3) 3 : 2 4) 1 : 4
9. Magnetic induction at the center of a circular loop of area π square meter is 0.1 tesla. The magnetic moment of the loop is : (μ_o = permeability of air) [2004 ENGG]
1) $\frac{0.1\pi}{\mu_o}$ 2) $\frac{0.2\pi}{\mu_o}$ 3) $\frac{0.3\pi}{\mu_o}$ 4) $\frac{0.4\pi}{\mu_o}$
10. A wire of length 'l' is bent in to a circular coil of one turn of radius R_1. Another wire of the same material and same area of cross section and same length is bent in to a circular coil of two turns of radius R_2. When the same current flows through the two coils, the ratio of magnetic induction at the centers of the two coils is : [2004 ENGG]
1) 1 : 2 2) 1 : 1 3) 1 : 4 4) 3 : 1
11. A circular coil of radius 2R is carrying a current *i*. The ratio of magnetic fields at the center of the coil and at a point at a distance 6R from the center of the coil on the axis of the coil is : [2004 MED]
1) 10 2) $10\sqrt{10}$ 3) $20\sqrt{5}$ 4) $20\sqrt{10}$
12. A magnetic flux of 500 micro-webers passing through a 200 turns coil is reversed in 20×10^{-3} seconds. The average emf induced in the coil in volts, is : [2004 MED]
1) 2.5 2) 5.0 3) 7.5 4) 10.0
13. Two parallel rails of a railway track insulated from each other and with the ground are connected to a millivoltmeter. The distance between the rails is one metre. A train is traveling with a velocity of 72

kmph along the track. The reading of the millivoltmeter (in m V) is : (Vertical component of the earth's magnetic induction is 2×10^{-5}T)
[2005 ENGG]

(1) 144 (2) 0.72 (3) 0.4 (4) 0.2

14. Magnetic field induction at the centre of a circular coil of radius 5 cm and carrying a current 0.9 A is (in S.I. units) ($\in_0$ = absolute permittivity of air in S.I. units; velocity of light = 3×10^8 ms^{-1})
[2005 ENGG]

(1) $\frac{1}{\in_0 10^{16}}$ (2) $\frac{10^{16}}{\in_0}$ (3) $\frac{\in_0}{10^{16}}$ (4) $10^{16}\in_0$

15. A current carrying circular coil, suspended freely in a uniform external magnetic field orients to a position of stable equilibrium. In this state
[2005 MED]

1) The plane of the coil is normal to the external magnetic field
2) The plane of the coil is parallel to the external magnetic field
3) Flux through the coil is minimum
4) Torque on the coil is maximum

16. A proton is projected with a velocity 10^7 ms^{-1}, at right angles to a uniform magnetic field of induction 100 mT. The time (in seconds) taken by the proton to traverse 90° arc is
(Mass of proton = 1.65×10^{-27} kg and charge of proton = 1.6×10^{-19}C) [2005 MED]

1) 0.81×10^{-7} 2) 1.62×10^{-7}
3) 2.43×10^{-7} 4) 3.24×10^{-7}

KEY

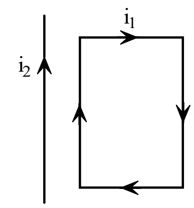
1) 3 2) 2 3) 3 4) 1 5) 2 6) 2
7) 4 8) 1 9) 2 10) 3 11) 2 12) 4
13) 3 14) 1 15) 1 16) 2

QUESTIONS FROM OTHER COMPETITIVE EXAMS

1. A proton and an α-particle, moving with the same velocity, enter into a uniform magnetic field, acting normal to the plane of their motion. The ratio of the radii of the circular paths described by the proton and α-particle is [AIIMS-2004]

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

2. A rectangular loop carrying a current i_1, is situated near a long straight wire carrying a steady current i_2. The wire is parallel to one of the sides of the loop and is in the plane of the loop as shown in the figure. Then the current loop will [AIIMS-2003]



1) move away from the wire
2) move towards the wire
3) remain stationary
4) rotate about an axis parallel to the wire

3. A straight wire of length (π^2) metre is carrying a current of 2 A and the magnetic field due to it is measured at a point distance 1 cm from it. If the wire is to be bent into a circle and is to carry the same current as before, the ratio of the magnetic field, at its centre to that obtained in the first case would be [AFMC-2004]

1) 1 : 100 2) 100 : 1 3) 1 : 50 4) 50 : 1

4 A proton of energy 8 eV is moving in a circular path in a uniform magnetic field. The energy of an alpha particle moving in the same magnetic field and along the same path will be [JAMMU & KASHMIR-2004]

1) 4 eV 2) 2 eV 3) 8 eV 4) 6 eV

5. A one metre long wire is lying at right angles to the magnetic field. A force of 1 kg wt. is acting on it in a magnetic field of 0.98 tesla. The current flowing in it will be [JAMMU & KASHMIR-2004]

1) 100 A 2) 10 A 3) 1 A 4) zero

6. A proton, a deuteron and an alpha particle are accelerated through same potential difference and then they enter a normal uniform magnetic field. The ratio of the radii of their circular paths be [JAMMU & KASHMIR-2005]

1) $\sqrt{2} : 1 : \sqrt{2}$ 2) $1 : \sqrt{2} : \sqrt{2}$
3) $1 : \sqrt{2} : 1$ 4) $\sqrt{2} : \sqrt{2} : 1$

7. For a magnetic field to be maximum due to a small element of current carrying conductor at a point, the angle between the element and the line joining the element to the given point must be [JAMMU & KASHMIR-2005]

1) 0^o 2) $90°$ 3) $180°$ 4) 45^o

8. A circular coil of 20 turns and radius 10 cm is placed in uniform magnetic field of 0.10 T normal to the plane of the coil. If the current in coil is 5 A, then the torque acting on the coil will be [JAMMU & KASHMIR-2005]

1) 31.4 Nm 2) 3.14 Nm 3) 0.314 Nm 4) zero

9. If a charge particle enters perpendiculary in to a uniform magnetic field, then [BHU-2005]

1) energy and momentum both remains constant
2) energy remains constant but momentum changes
3) both energy and momentum changes
4) energy changes but momentum remains constant

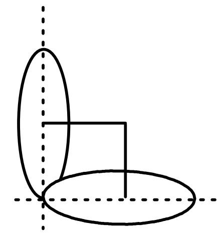
10. The turns ratio of a transformer is given as 2 : 3. If the current through the primary coil is 3 A, thus calculate the current through load resistance. [BHU-2005]

1) 1 A 2) 4.5 3) 2 A 4) 1.5 A

11. Two inductors each of inductance L are joined in parallel. What is their equivalent inductance? [BHU-2005]

1) zero 2) 2L 3) L/2 4) L

12. Two similar current loops are placed with their planes one along X-axis and the other along Y-axis. Then the ratio of resultant magnetic field at a common point to the individual magnetic field produced by each coil is [BHU-2003]



1) 2 : 1 2) 1 : 2 3) $\sqrt{2} : 1$ 4) $1 : \sqrt{2}$

13. The electrons in the beam of a television tube move horizontally from south to north . The vertical component of the earth's magnetic field points down. The electron is deflected towards [KCET-2005]

1) west 2) no deflection
3) east 4) north to south

14. A tangent galvanometer has a reduction factor of 1A and it is placed with the plane of its coil perpendicular to the magnetic meridian. The deflection produced when a current of 1 A is passed through it is [KCET-2005]

1) 60° 2) 45° 3) 30° 4) 0°

15. A vertical circular of coil of radius 0.1 m and having 10 turns carries a steady current. When the plane of the coil is normal to the magnetic meridian, a neutral point is observed at the centre of the coil. If $B_H = 0.314 \times 10^{-4}$ T, the current in the coil is [KCET-2004]

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

16. The magnetic flux linked with a coil at any instant 't' is given by $\phi = 5t^3 - 100\,t + 300$ Wb, the emf induced in the coil at t = 2 second is [KCET-2003]

1) 140 V 2) 300 V 3) –40 V 4) 40 V

17. If the current 3.0 A flowing in the primary coil is made zero in 0.1 sec, the emf induced in the secondary coil is 1.5 volt. The mutual inductance between the coils is [JIPMER-2004]

1) 0.05 H 2) 0.5 H 3) 0.1 H 4) 0.2 H

KEY

01) 1 02) 2 03) 4 04) 3 05) 2 06) 2
07) 2 08) 4 09) 2 10) 3 11) 3 12) 2
13) 3 14) 4 15) 1 16) 4 17) 1