MAGNETISM
This is the ability of substances to attract and/or to repel others.

A magnet is a piece of metal which is able to attract another magnet or a magnetic material.

Lodestone is a naturally occurring magnet. A magnet exerts magnetic forces on magnetic materials.

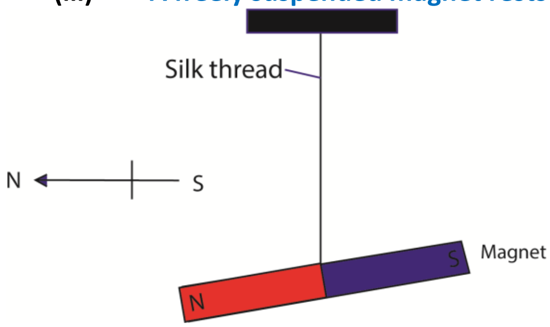
The magnetic forces are:
(i) Forces of attraction.
(ii) Forces of repulsion.

Uses of magnets
- In construction of cycle dynamos, telephones, loud speaker, electric meters, current measuring instruments.
- To remove metal splinters from oil engine
- For door closures
- Electric bell
- Magnetic ink
- Computer memory cards.
- Electric motor
- Magnets are used in hospitals to remove iron pieces from the eye of patient.
- Making magnetic tapes used in audio and video recorders.

Properties of a magnet
(i) It attracts other pieces of metals.
- Materials attracted by magnets are called magnetic materials
- Materials strongly attracted by magnets are called ferromagnetc materials such as iron, nickel steel, cobalt.
- Materials that are not attracted by magnets are non magnetic materials, e.g. copper, brass, aluminium, wood and plastics
- Nonmagnetic material can eith be diamagnetic or pramagnetic materials
- Diamagnetic materials whose atoms have no permanent magnetic dipole moment but when placed in a magnetic field, a weak magnetic dipole moment is induced in the direction opposite the applied field; e,g, copper, bismuth and benzene
- Paramgnetic materials that are weakly attracted to magnets. e.g. platnum

(ii) **It possesses magnetic poles**- theNorth Pole and South Pole at the ends of a magnet. These are places where magnetic forces appear to be concentrated.

(iii) A freely suspended magnet rests in the North-south direction



Explanation; This is because the earth is a magnet having its south pole in the northern hemisphere and its north pole in the southern hemisphere so there is attraction between the poles of freely suspended magnet and the earth's magnet.

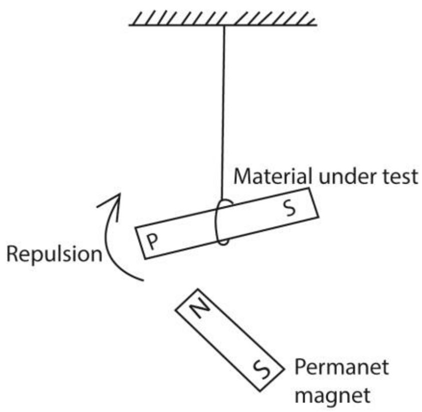
Laws of magnet

- **Like poles of magnets repel;** e.g. when a north pole is brought near a north pole or a south pole brought near the south, repulsion occurs.
- **Unlike poles of magnet attract** e.g. a north pole brought near the South Pole attraction will occur.

Testing for polarity of a pole

A known pole of magnet is brought near the ends of a material suspected to be a magnet. If repulsion occurs then that end of material is a like pole. The poles of a given magnet or magnetized material are tested by repulsion occurring between poles of a known magnet and that of the material whose polarity is to be tested.

NB: Repulsion is a sure test for polarity because repulsion only occurs due to like poles of magnets. While **attraction** is not a sure test because attraction can either result from unlike poles of magnets **or** from magnet and Ferromagnetic material which is not magnetized.

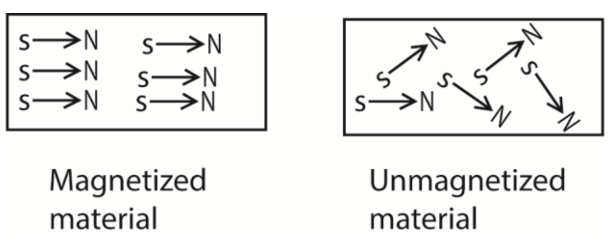


In this case P is a north pole

Magnetic domain theory

A magnet is made us of tiny molecular magnets called dipole arranged in groups called magnetic domains, lined up with their N-poles pointing in the same direction.

In nonmagnetic materials, the domains are randomly mixed and their magnetic effect cancel each out.



Magnetization

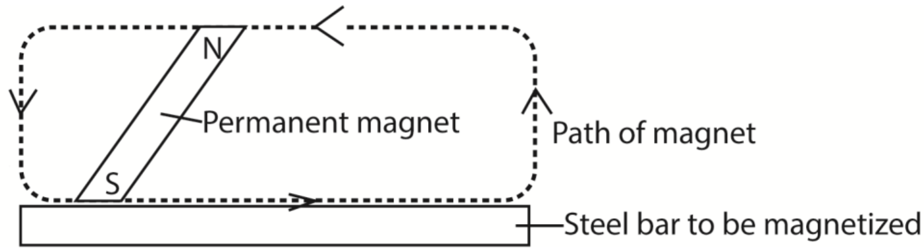
This is a process by which randomly arranged molecular magnet of a ferromagnetic material are arranged to point in one direction.

Methods of magnetization

These include:

- Single touch method.
- Double touch method.
- Electrical method using direct current (d.c.).

Single touch or single stroke method



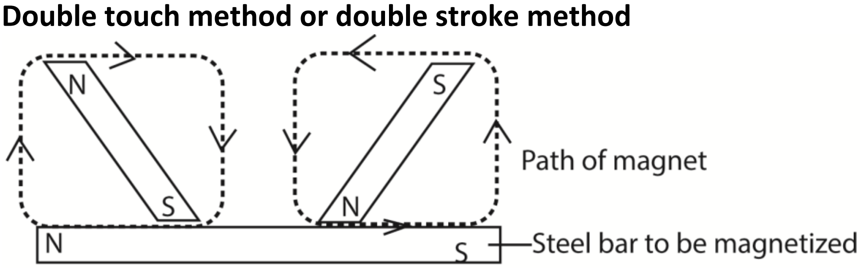
Single stoking
A steel bar (Ferromagnetic material) is stroked several times from end to end using a bar magnet. The stroking is done in the same direction and using the same pole of bar magnet.

Molecular magnets explanation
The stroking of the magnet pulls the randomly molecular magnets to face in one direction thus material becomes magnetic.

Disadvantage of single stroke method
The magnet produced has one pole nearer to the end as compared to the other pole

Identification of a pole
The pole of the bar magnet being used for stroking should be the same pole induced at the end of the steel bar from where stroking starts.

Double touch method or double stroke method

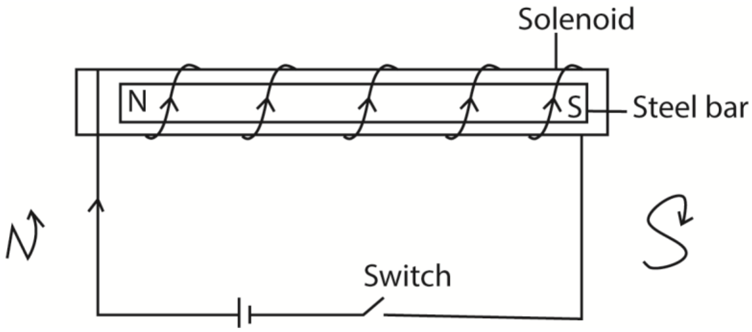


This uses two bar magnets placed at the centre of the steel bar with unlike poles as in the diagram. The stroking begins in the middle of the steel bar and ends at the opposite ends. The magnets are raised high at the end of each stroke before another one begins. This prevents reversing the acquired magnetism.

Molecular magnet
As stroking is done, the molecular magnets are pulled to face in one direction therefore creating poles at the ends of the steel bar.

Advantage of a double touch method over a single touch method
All poles are at both ends while for single touch method one pole is nearer to end than the other.
Disadvantages of double touch method over a single touch method
Double touch method is more expensive and tiresome.

Electrical method



The steel bar to be magnetized is placed inside a solenoid connected to the cells.
When direct current is switched on for some time, the bar will be magnetized

Note that with a.c. current the bar is not magnetized

Polarity of steel bar
The polarity of the steel bar depends on the direction in which the current is flowing. Current flows from positive to negative, so if on looking at the end of solenoid, current is flowing in a clock wise direction, that end will be South Pole but if it is flowing anti clockwise the end will be a north pole.

Induction method
When a magnetic material is kept close to a magnet for long time it gets magnetized.

Magnetic saturation
This is the maximum level of magnetization when the resultant magnetic axes of all domains in magnetic material are aligned with the magnetizing field.

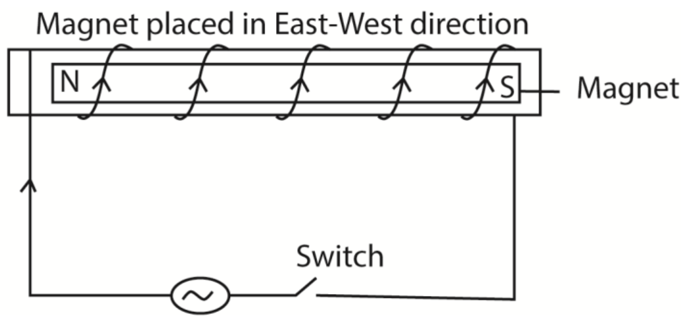
Demagnetization

Demagnetization is the process through which magnets lose their magnetism
Demagnetization result in scattering molecular magnets to face in randomly.

Methods of demagnetization
(i) By Heating:
Heating a magnetized material makes it loses its magnetism. This is because the temperature rise causes the vibrations of molecular magnets to become so great that their ordinary arrangement is destroyed.

(ii) By hammering:
Hammering a magnetized material placed in east-west direction, makes it loses most of its magnetism. This is because when a magnet is hammered, the vibrations of the molecular magnets increase which result in random arrangement.

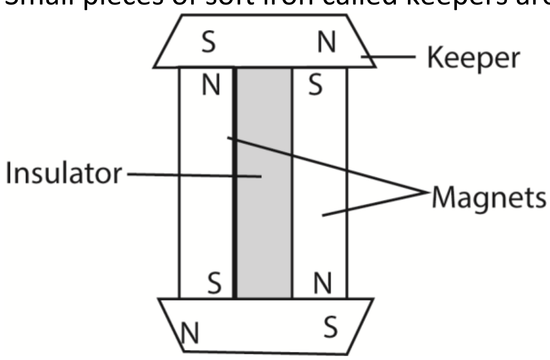
(iii) By electrical method using alternating current



Here an alternating current is supplied to the solenoid in which the magnet is placed in east-west direction.

The alternating current (a.c.) causes the molecular magnet to change from orderly to random arrangement as current changes direction of flow every half cycle.
The demagnetized magnet should be removed from solenoid and stored along east- west direction to avoid magnetization due to earth's field.

Storing magnets
Small pieces of soft iron called keepers are placed across opposite **poles** of two bar magnets



These iron keepers become induced magnets and their poles neutralize the poles of the magnets. This ensures that there is no magnetic loss.

Soft and hard magnetic substances

Soft magnetic materials are substance that are easily magnetized and easily lose magnetism, e.g. soft iron.
Soft magnetic materials are used in making soft-iron core in transformers, dynamos, e.t.c.

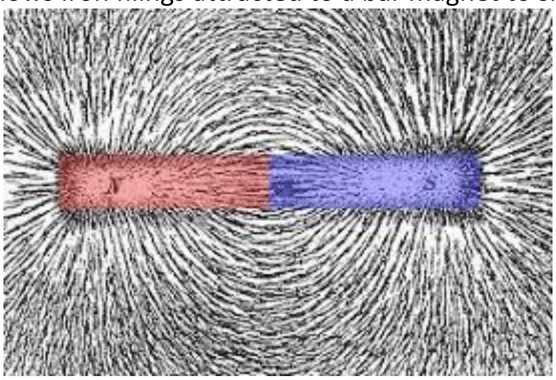
Hard magnetic material are materials that are difficult to magnetize but retair their magnetism for long, e.g. steel.
Hardmagneticmaterials are used in loud spears.

Magnetic field

A mgnetic field is a region around a magnet in which magnetic force is experienced.

An experiment to determine the magnetic field pattern of bar magnet using iron fillings.

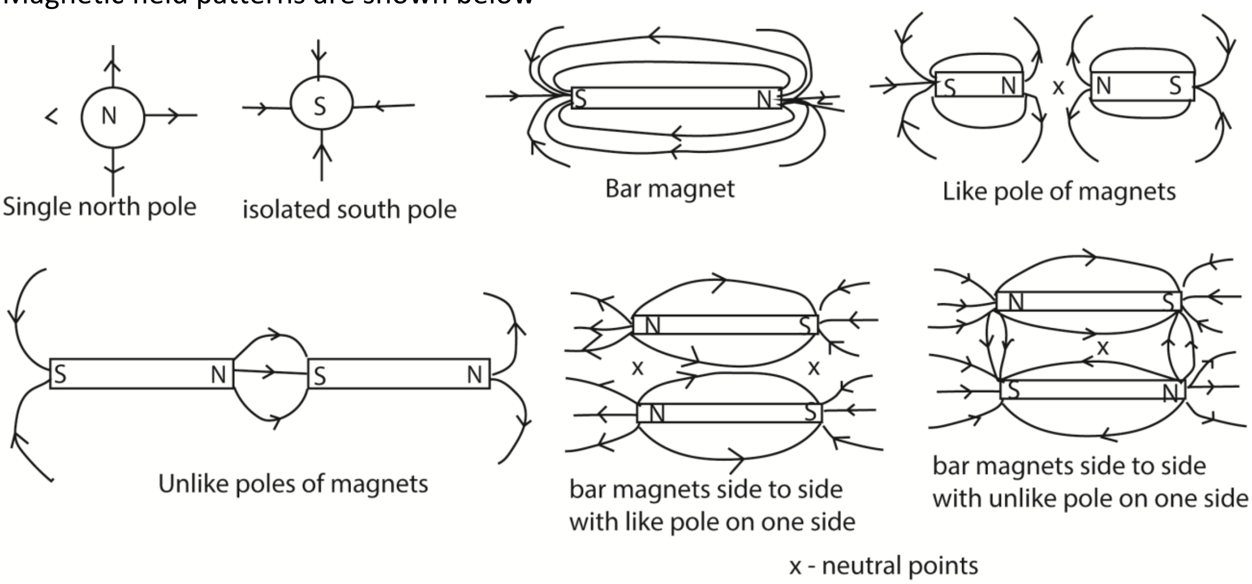
- A cardboard is placed on a magnet and iron fillings sprinkled on the cardboard
- On tapping slightly on the cardboard, the fillings arrange themselves along the magnetic lines.
- The figure below shows Iron filings attracted to a bar magnet to show the magnetic field.

- 

Magnetic field lines

They are lines of forces in magnetic field running from North to south poles of a magnet. The direction of these lines can be shown using a plotting compass.

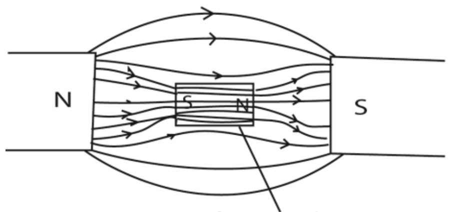
Magnetic field patterns are shown below

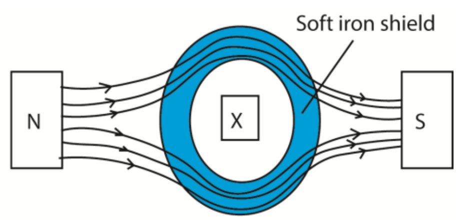


NB: (i) Neutral point are places around magnets where the magnetic field flux is zero; i.e. no magnetic line pass through neutral point

(iii) The more crowded the field lines, the stronger the magnetic force

(iv) Magnetic shielding/screening is the protection of the object against external magnetic fields by enclosing it with soft – iron ring or box





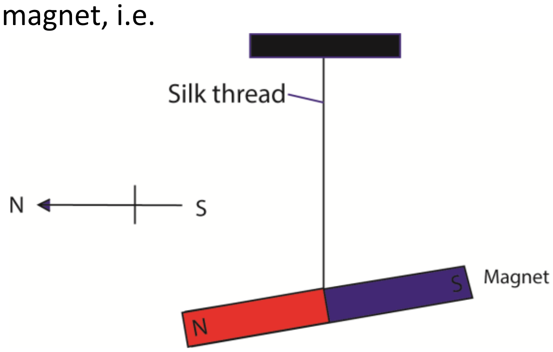
The magnetic field lines are attracted to soft iron ring shielding the region enclosed by the ring or box from magnetic field

Thick-walled soft-iron boxes are used to shield delicate and sensitive electrical instruments from external magnetic fields

The earth as a magnet

Suspending a bar magnet

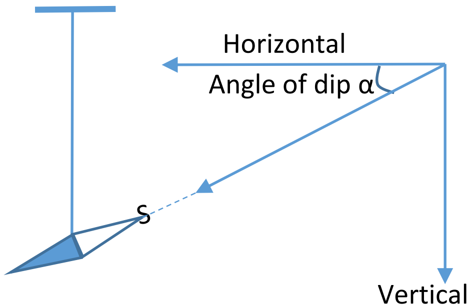
When a bar magnet is freely suspended, it always come to rest in a north-south direction. This is because the earth is a magnet having its north pole in the southern hemisphere and South Pole in the northern hemisphere and these poles attract the poles of the freely suspended magnet, i.e.



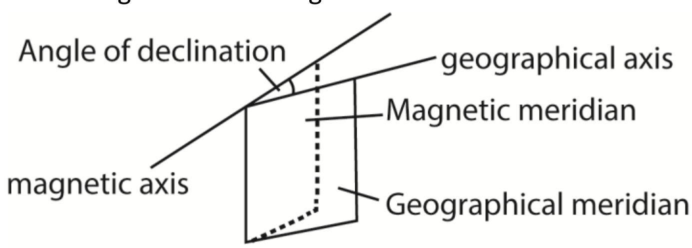
Definitions

1. **Magnetic meridian** is a vertical plane containing magnetic axis of a freely suspended magnet at rest under the action of earth's magnetic field.
2. **Geographical meridian** is the vertical plane passing through the axis of rotation of the earth
3. **Angle of dip /Angle of inclination**

Angle of dip (inclination) α: Angle of dip is the angle that the axis of a freely suspended bar magnet makes with the horizontal when the magnet settles.



4. **Angle of declination** is the angle between the earth's magnetic and geographical meridians. Or the angle between magnetic north and true north.

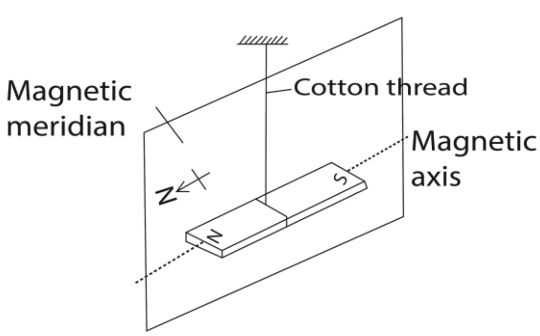


The compass needle:

The compass needle points approximately north because the earth has a magnetic field so the needle always points in the same direction as the earth's magnetic field.

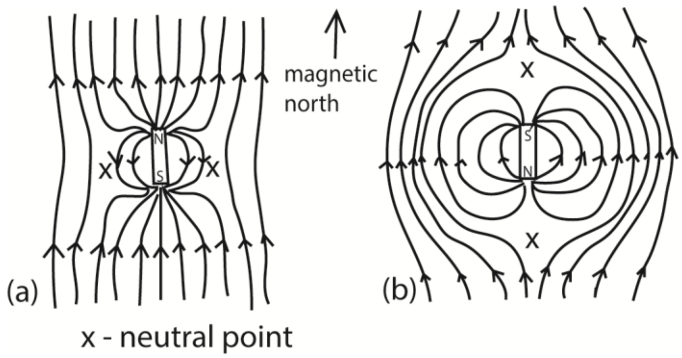
Experiment to determine magnetic meridian

- A permanent bar magnet is suspended on a retort stand using a thread and allowed to settle.
- The vertical plane parallel to the magnetic axis represents the earth's magnetic meridian

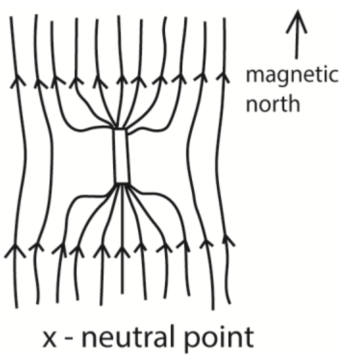


Magnetic flux pattern of a horizontal bar magnet in earth's magnetic field

(a) South Pole, S, of bar magnet facing to north (attraction occurs)
(b) North Pole, N, of bar magnet pointing north (repulsion occurs)



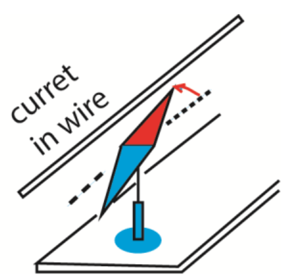
Magnetic flux pattern due to soft iron in earth's horizontal magnetic field



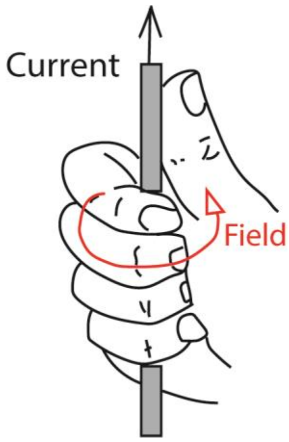
Magnetic Effect of current

When current flows in a conductor placed near a compass needle, the needle deflects depending on the direction of current.

This shows that around a conductor carrying current, there is a magnetic field which depends on the direction of current.

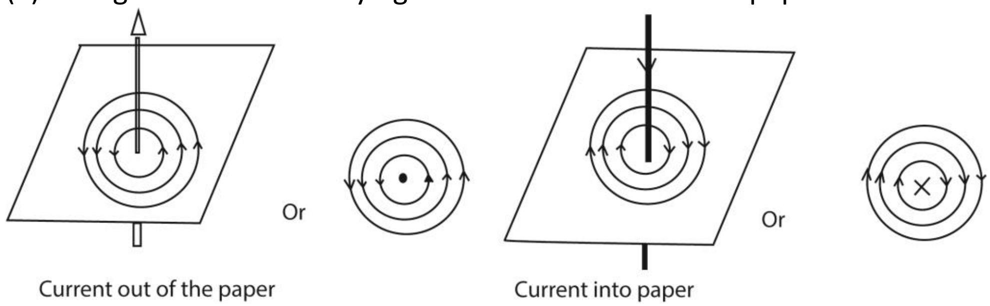


The direction of magnetic field around such a conductor is obtained by right hand grip rule(RHGR)- with the thumb pointing along the direction of current, the direction of fingures gives the direction of the magnetic field

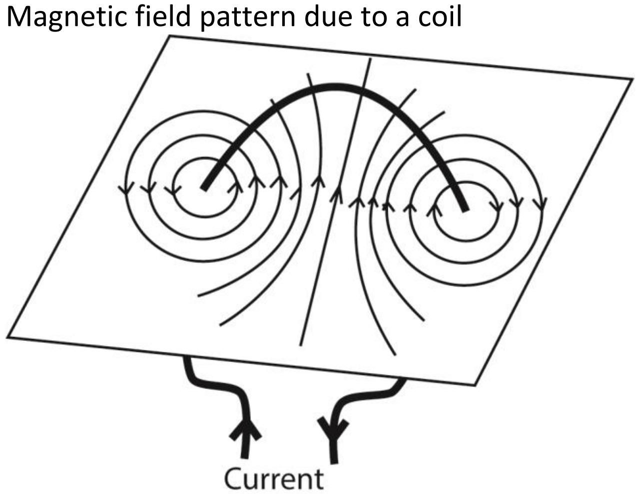


Magnetic field pattern due to current carrying conductors

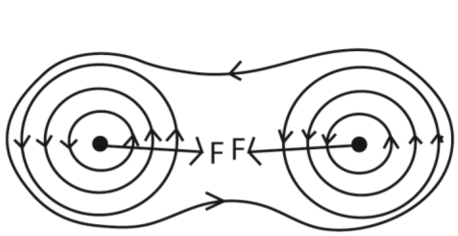
(a) Straight conductor carrying current into or out of the paper



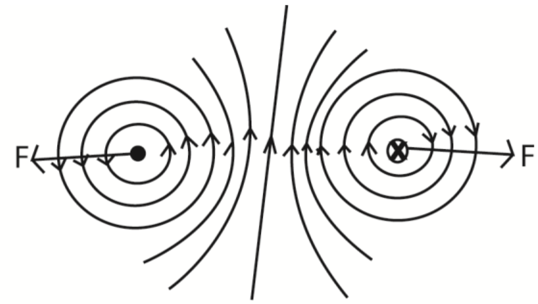
(b) Magnetic field pattern due to a coil



(c) Magnetic field pattern due to parallel conductors



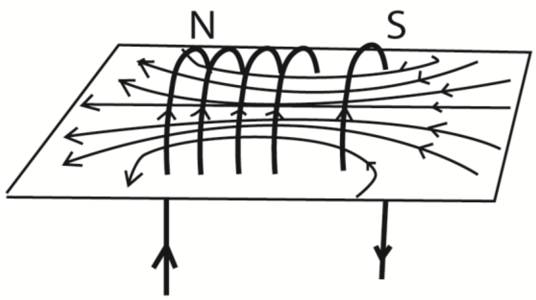
Current in the same direction
(out of paper- attraction)



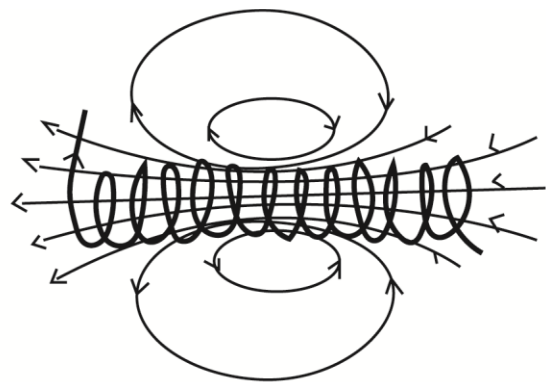
Opposite current
(repulsion)

F- is the force experienced by the conductors.

(d) Magnetic field pattern due to solenoid



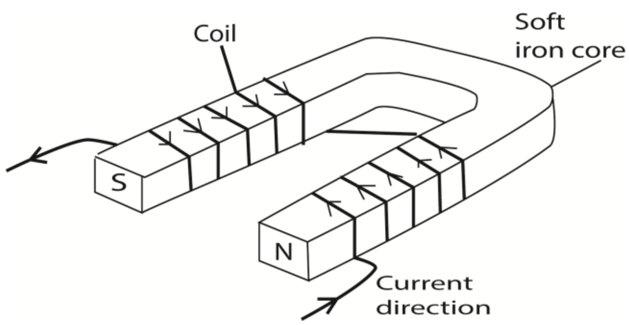
Or



Electromagnets

An electromagnet is a temporary magnet which acquires and loses its magnetism by switching on or off current.

It consists of soft iron core placed inside the solenoid.

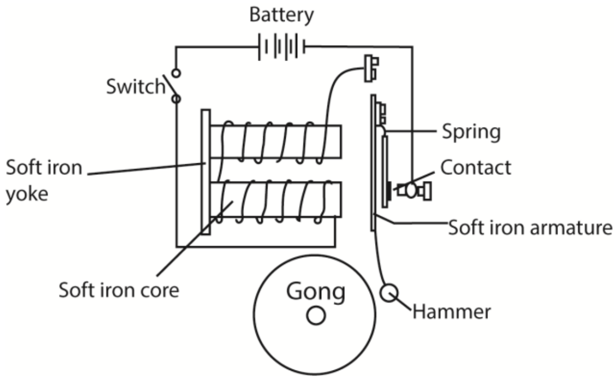


The strength of the electromagnet is increased by

- Increasing current in the coil
- Increasing number of turns (windings) of the coil
- Bringing poles closer

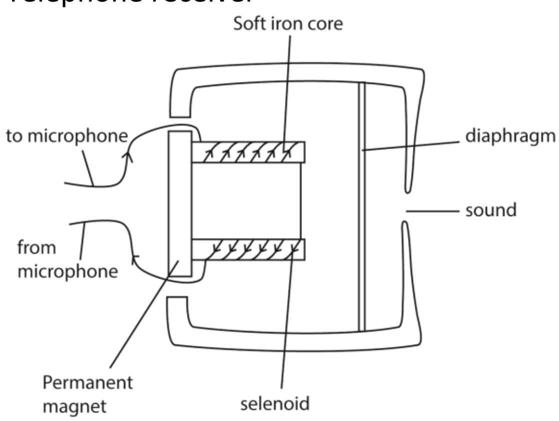
Uses of electromagnet

(a) Electric bell



- When the switch is closed, current flows through the circuit and the core become magnetized
- The iron armature is attracted towards the magnetized core causing hammer to hit the gong and produce sound but this breaks the contact and the circuit.
- When the circuit is broken, the iron core loses magnetism releasing the armature to be returned to the contact by the spring.
- Again the circuit is completed and the process repeats, the hammer making repeated sound.

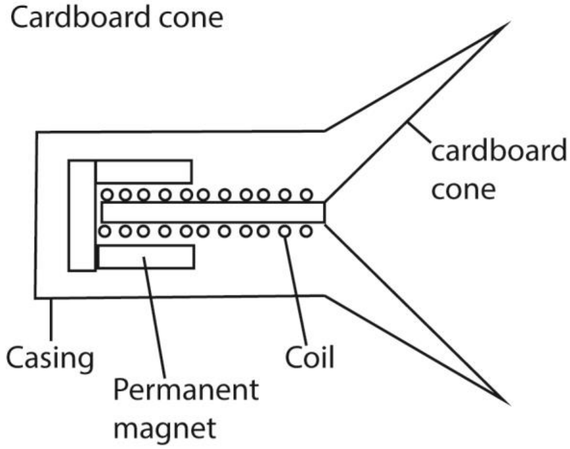
(b) Telephone receiver



- The varying current from the microphone passes through the coil of electromagnets, soft iron gets magnetized and pull the diaphragm to and fro depending on the current from the microphone.
- Vibration of the diaphragm produces sound

(c) Moving coil loud speaker

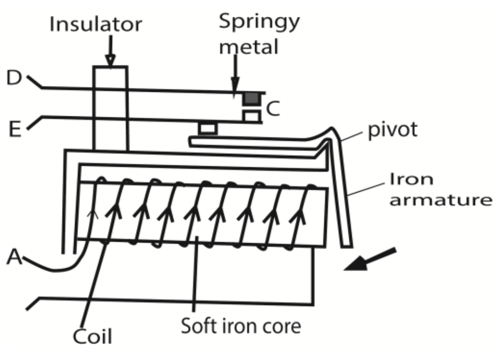
Cardboard cone



- When the varying current is supplied into the coil, the coil is magnetized and vibrates backwards and forwards, with the same frequency as that of the current.
- The motion of the coil in turn causes the cone to vibrate, causing the surrounding air to vibrate, and sound is produced.

(d) This is a switch that is operated by an electromagnet.

- When current flows in the coil, soft iron is magnetized and attracts iron armature which closes the contact at C.
- This completes the circuit connected to DE and current flows in it.



Current carrying conductors in a magnetic field

When a current carrying conductor is placed between poles of a permanent magnet, it experiences a force F.

The strenght of this force depends on

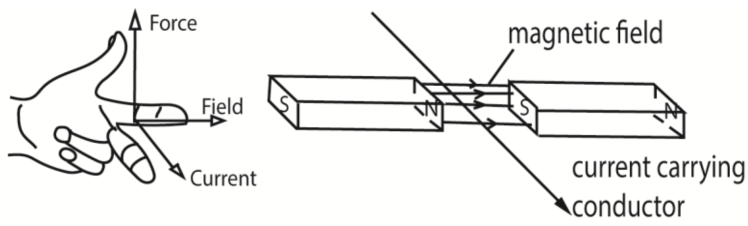
(i) Strenght of the magnet field (B)

(ii) Length of the conductor (L)

(iii) Current (I) through the conductor

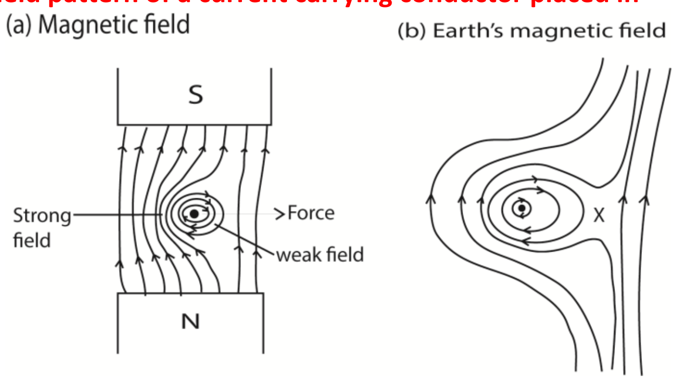
i.e. $F = BIL$

The direction of the force is determined by Fleming's left hand rule- with the first finger pointing to the magnetic field, second finger in the direction of current, the thumb in the direction of the force (motion)



e.g in this figure, the wire moves upward at right angles to the field

Magnetic field pattern of a current carrying conductor placed in



Electromagnetic Induction

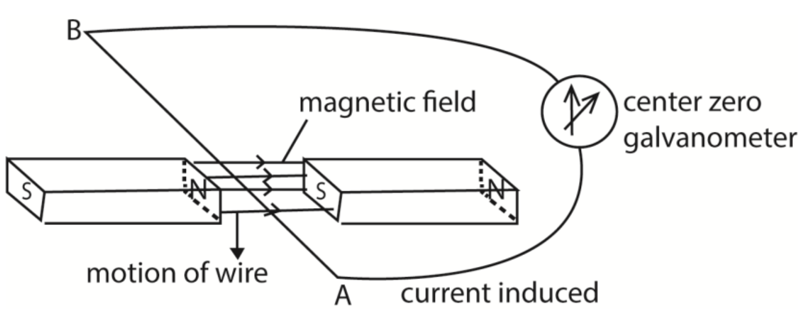
If a wire is moved througha magnetic field in such a way that it cuts the magnetic lines of force, a voltage is created across the wire. An electric current will flow through the wire if the two ends of the wire are connected by a conductor to form a circuit.
This current is called an induced current, and the induction of a current in this manner is callled electromagnetic induction.

It does not matter whether the wire moves of the magnetic field moves provided the wire cuts through lines of force, a current is induced.

This can be observed when

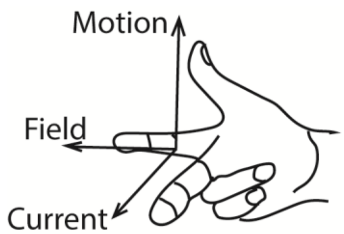
(a) A straight wire AB connected to the galvanometer at right angle to the field

When the wire is moved downwards, the meter deflects to the right. This shows that the current is induced in the wire.

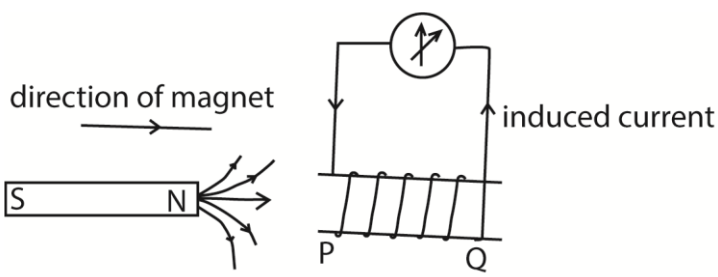


Note

- The relative motion of the wire in a magnetic field leads to induced e.m.f. hence current.
- Thequicker the motion of the wire, the greater the induced current. (Faraday's law)
- The induced current leads to a force acting in the opposite direction to the motion of the wire (Lenz's law)
- The direction of the induced current is determined by Fleming's right hand rule (with the first finger pointing to the direction of the field, the thumb poits in the direction of force (motion), then the second finger points in the direction of current.



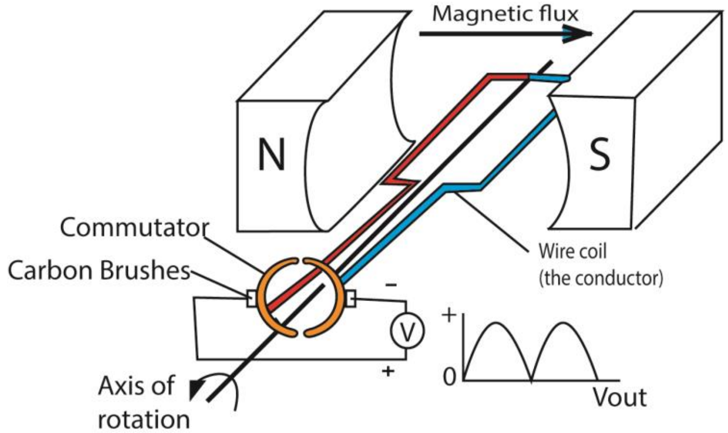
(b) A bar magnet is brought towards the coil (solenoid) connected to galvanometer



When a north pole is approching a solenoid current is iduced in it to oppose the incomining N pole of the magnet. Thus end P of solenoid becomes a north pole.
Note thnat the induced e.m.f. depends on

- Number of turns of the coil
- Area f the coil
- Speed of the magnet
- Strength of the magnt

(c) **The simple d.c. electric motor**



- When the coil is rotated, the magnetic field linking the coil changes and e.m.f is induced.
- When the coil passes the vertical position, the two halves of commutators change contacts with the brushes, e.m.f in the coil reverses but the direction of current in external circuit remains the same.

Note: due to the resistance, R, of the coil

- Power waster in the coil = I^2R
- Power input (power supplied), $P_{in} = I_iV_i$
- Power output, $P_{out} = I_oV_o$ = power supplied – power wasted $=IV - I^2R$
- Efficiency of the motor = $\frac{P_{out}}{P_{in}}\ x\ 100\%$

Example

The armature reistance is 4Ω. If it draws current of 10A when connected to a 200Vsupply, clculate the

(i) Power wasted

Power wasted in the coil, $P = I^2R = 10^2 \times 4 = 400W$

(ii) Efficiency of the motor

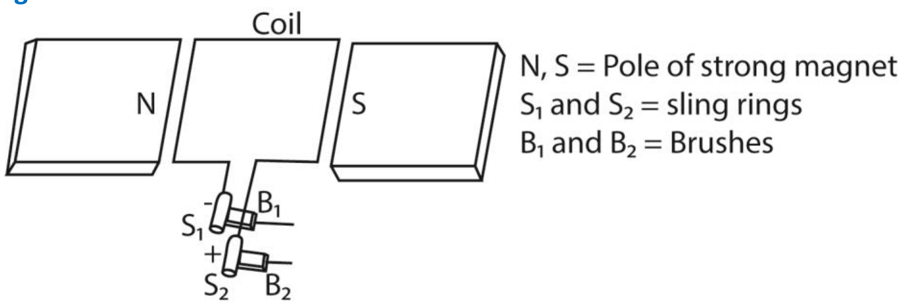
Power input, $P_{in} = IV = 10 \times 200 = 2000W$

Power output $= IV – I^2R = 2000 – 400 = 1600W$

Efficiency $= \frac{P_{out}}{P_{in}}\ x\ 100\%$

$= \frac{1600}{2000}\ x\ 100 = 80\%$

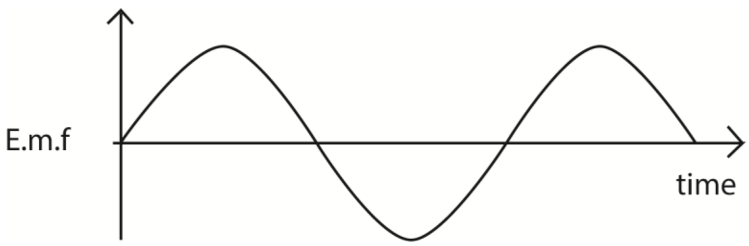
(d) a.c. generator



Mode of action

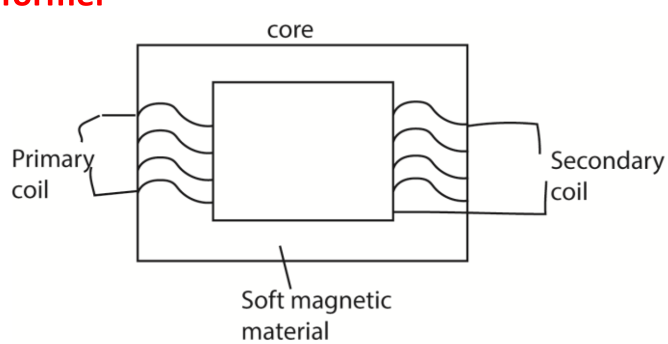
- The coils is turned with uniform speed in magnetic field.
- Because of change in magnetic field linking the coil, an e.m.f is induced in the coil.

The induced e.m.f varies as shown below



The coil, is in horizontal position, the rate of change of magnetic flux linkage is maximum, i.e. maximum induced e.m.f.
In vertical position, the rate of change of flux linkage is zero, i.e. zero e.m.f is induced.
Beyond the vertical position, induced e.m.f reverses because of change in direction of sides.

Transformer



It consists of two coils, the primary coil and secondary coil, wound closely over one another on a laminated soft iron core

When an alternative voltage, V_p, is applied to the primary coil, it causes changing magnetic flux in the soft iron core. This changing flux links the secondary coil so an e.m.f, V_s is induced in the secondary.

$\frac{V_S}{V_p} = \frac{N_S}{N_p}$

Where N_p = number of turns of primary coil

Ns = number of turns of secondary coil

If $N_s < N_p$, then it is a setup transformer.

Ns> N_p, then it is a step down transformer.

Symbols for transformers

Stepup transformer Stepdown transformer

Power losses in a transformer

Power loss	Minimized by
Heat in coils due to their resisitance	Use thick copper coils of low resisitance
Eddy current in soft iron core	Using laminates soft iron core
Leakage of magnetic flus	Winding the same part of the soft iron
Magnetic reversal in the coil due to changing magnetic fields	Using soft iron with low magnetic reversals

Eddy current are currents induced in the core of the armature due to changning magnetic flux or changing conductr cutting uniform magnetic field

In calculations;

- Power in put (power supplied) $P_{in} = I_pV_p$
- $\frac{V_S}{V_p} = \frac{N_S}{N_p}$
- $power\ output\ =\ P_{out}\ =\ I_sV_s$
- Power losts = I^2R = power supplied – power output
- Efficiency = $\frac{P_{out}}{P_{in}}\ x\ 100\%$

Example 1

A transformer has 200 turns in the primary coil; calculate the number of turns in the secondary coil if 240V is stepped up to 415V

Solution

From $\frac{V_S}{V_p} = \frac{N_S}{N_p}$

$\frac{415}{240} = \frac{N_S}{200}$

Ns = 346

Example

A transformer is designed to produce an output of 220V when connected to 25V supply. If its efficiency is 80%, calculate the input current when the output is connected to 220V, 75W lamp

Power input, $P_{in} = I_pV_p$ =?, V_p = 25V, eff = 80%
Power output, $P_{out} = I_sV_s$ = 75W
Efficiency of a transformer = 80 =$\frac{75}{P_{in}}\ x\ 100$
P_{in} = 93.75W
Thus, $I_pV_p = I_p$x 25 = 93.75W
I_p = 3.75A

Example 2

A tranformer of efficiency 80% is connected to a 240V supply to operate a heater of resisitance 240Ω. If the current flowing in the primary circuit is 5A.

(i) Calculate the p.d. across the heater

(ii) If the transformer is cooled by oil of specific heat capacity 2100Jkg^{-1}K^{-1} and the temperature of the oil rises by 20^{0}C in 3 minutes, find the mass of the oil in the transformer

Solution
Vp = 240V, Ip = 5A, Rs = 240Ω, eff = 80%

(i) Power input = IpVp = 5 x 240 = 1200W
Let power output be P_{out}

Efficiency of a transformer = 80% =$\frac{P_{out}}{1200}$
P_{out} = 0.8 x 1200 = 960W
But Pout = $\frac{V_S^2}{R_S}$
960 = $\frac{V_S^2}{240}$
Output voltage, Vs = 480V

(ii) Power lost = 1200- 960 = 240W
240 x 3 x 60 = M x 2100 x 20
M = 1.03kg

Power Transmission

Efficient power transmission requires a step-up transformer at the power generating station to rise voltage and decrease the current. This reduces power loss in the wires, since power loss = I^2R where I is current and R is the resistance of the wires.
Later, appropriate step down transformers are than used to reduce the voltage for local use

Advantages of a.c. over d.c

- a.c. is tepped up or down easily
- a.c. can be transmitted over long distance
- a.c. can easily be converted to direct current
- a.c. is easy to generate

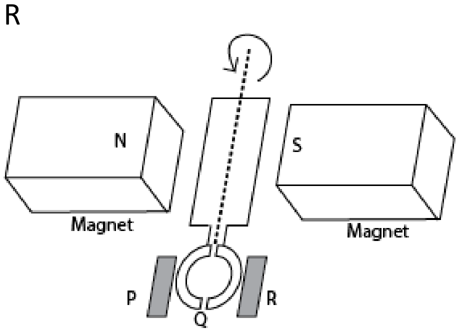
Exercise

Objectives

1. The diagram below a current-carrying coil PQRS pivoted about XY between two magnets. Which of the statements is true about the coil?
   (i) The sides PQ and QR shall experience a force.
   (ii) As seen from X the coil will rotate anticlockwise
   (iii) The force on the coil can be increased by increasing the number of turns
   (iv) The coil will come to rest with PQ at right angles to the magnetic field.
   A. (i), (ii), (iii)
   B. (i) and (iii) only
   C. (ii) and (iv) only
   D. (iv) only

2. The diagram in the figure below shows a simple motor.

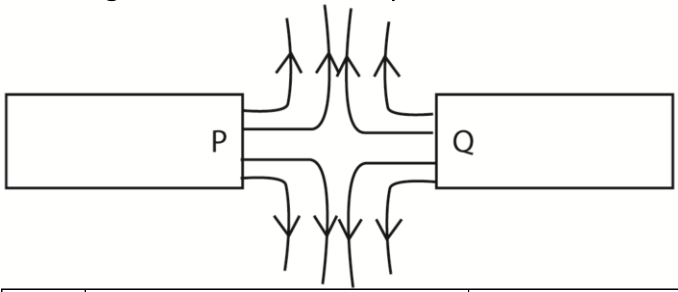
   The coil continues in the same direction because the commutator Q and brushes P and R



   A. Reverses current in the coil every half of revolution
   B. Reverse current every quarter of revolution
   C. Reverse polarity of the field produced by the magnet
   D. Carry the coil past its vertical position every half of a revolution

3. Which of the following statement is not true about magnets?
   A. Magnetic poles cannot be separated
   B. A paramagnetic material is a material from which strong magnet can be made
   C. The neutral point in magnetic field is a point where there is no force experienced
   D. Heating a magnet can reduce its magnetism
4. Which of the following will increase the force on current currying wire?
   (i) Using a large current
   (ii) Using a stronger magnetic field
   (iii) Using a shorter length of wire in the field
   A. (i) only
   B. (i) and (ii) only
   C. (i) and (iii) only
   D. (ii) and (iii) only

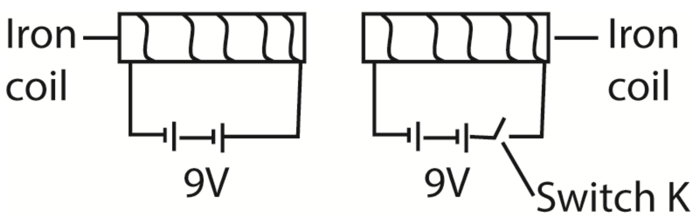
5. In the figure below name the polarities of Q



	P	Q
A	N pole	S pole
B	N pole	N pole
C	S pole	S pole
D	S pole	Un magnetized ioron

6. The arrangement in the figure below is used to produce an e.m.f. what causes the e.m.f.
   A. The attraction between the coil and magnet
   B. The magnet placed close to the coil
   C. The magnetic field outside the coil
   D. The variation of magnetic field lines linking the coil

7. In figure 6, when switch K is closed, the two soft iron core will



   A. Repel each other all the time
   B. Attract each other all the time
   C. Attract each other for just a brief moment
   D. Have no force of attraction or repulsion between then
8. The law of electromagnetic induction states that
   A. Like poles repel and unlike poles attract
   B. Like poles attract while unlike poles repel
   C. Like charges repel and unlike charges attract
   D. Like charges attract and unlike charges repel
9. The strength of magnetic field between the poles of an electromagnet remains the same if the
   (i) Current of the electromagnet windings is doubled
   (ii) Direction of the current in the electromagnetic windings are reversed
   (iii) The number of turns are halved.
      A. (i) only

B. (ii) only
C. (i) and (ii) only
D. (ii) and (iii) only

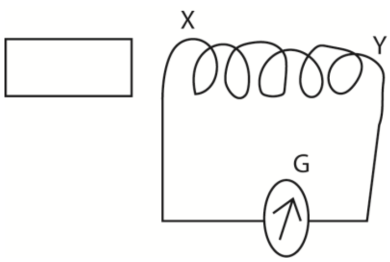
10. A 240V mains transformer has 1000 turns in the primary. The number of turns in the secondary if it is used to supply a 12V, 24W lamps is
A. 2.0×10^4 B. 500 C. 50 D. 20

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\frac{N_s}{1000} = \frac{12}{240}$$

$$N_s = 50 turns$$

11.



The figure above shows a coil connected to a center zero galvanometer, G. The poles produced at end X and Y of the coil when the North Pole of a magnet approaches it is

A. X- North Pole	Y-South pole
B. X- South Pole	Y- North Pole
C. X- North Pole	Y- North Pole
D. X- South Pole	Y- South Pole

Lenz's law: The direction of induced current is always such as to oppose the change producing it. When the N pole of a magnet is plunged into the coil, the induced current must flow in such a direction as to give N polarity to the end of the coil facing the magnet.

12. Which one of the following statements is true about energy transformation?
A. A steam engine changes heat energy into mechanical energy
B. A thermopile changes electrical energy to heat energy
C. A dynamo changes electrical energy to mechanical energy.
D. A microphone changes electrical energy to sound energy

13. When transmitting electrical power over long distance, the voltage is stepped up in order to
A. Transmit it
B. Reduce power loss
C. Increase current transmission
D. Prevent electrical shock

14. Which of these factors affects the magnitude of force on a current carrying conductor in a magnetic field.
(i) The direction of current
(ii) The amount of current

(iii) The direction of magnetic field
(iv) The strength of the magnetic field

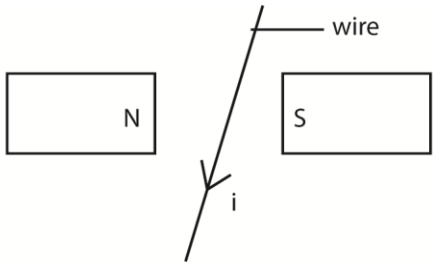
A. (i) and (ii)
B. (ii) and (iii)
C. (i) and (iii)
D. (ii) and (iv)

15. A transformer connected to 240V a.c. mains is used to light a 12V 36W lamp. What current does the lamp draw?
    A. 20.0A
    B. 6.7A
    C. 3.0A
    D. 0.33A

    Power = IV
    36 = I x 12
    I = 3.0A
16. The energy transformation involved in bicycle dynamos is
    A. Electrical to chemical
    B. Potential energy to chemical energy
    C. Chemical to light energy
    D. Kinetic energy to electrical
17. The figure above shows the superposition of the earth's magnetic field due to a magnet. Identify point marked 1, 2, 3 and 4 respectively

A	South Pole	North Pole	Neutral point	Neutral point
B	North Pole	South Pole	Neutral point	Neutral point
C	Neutral point	Neutral point	North Pole	South Pole
D	Neutral point	Neutral point	South Pole	North Pole

18. The direction of induced current in a conductor moving in magnetic field can be predicted by applying
    A. Faraday's law
    B. Maxwell's screw rule
    C. Fleming's left hand rule
    D. Fleming's right hand rule
19. Power loss due to eddy current in the core of a transformer can be minimized by
    A. Laminating the core
    B. Using copper wire in windings
    C. Using a soft iron core
    D. Winding the secondary coil on top of primary coil
20.



When current, i, flows through a wire placed in between the poles of U-magnet as shown above, the wire will move

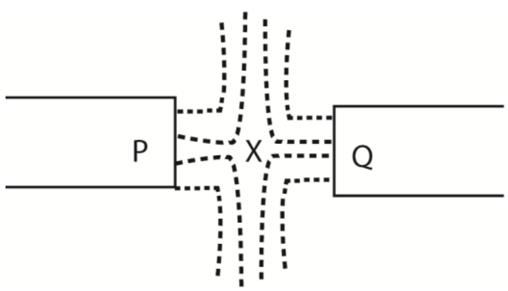
A. Upwards
B. Downwards
C. Towards south pole
D. Towards north pole

21. How long does it take an alternating current p.d. of peak value 10V and frequency 50Hz make one cycle

A. 0.02s B. 0.20s C. 5.00s D. 500.00s

Period = 1/f = 1/50 = 0.02s

22.

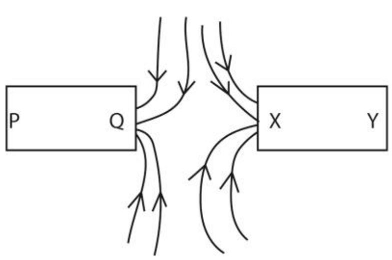


The figure above shows a pattern of iron fillings between two magnetic poles P and Q. Which one of the following is true?

(i) P and Q are like poles
(ii) Pole P is stronger than Q
(iii) X is neutral

A. (i) only
B. (i) and (iii) only
C. (ii) and (iii) only
D. (i), (ii) and (iii)

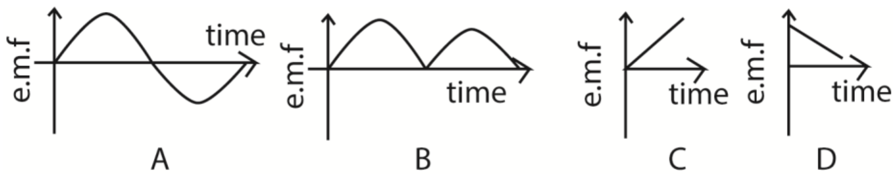
23.



The figure above shows magnetic field lines between two magnetic poles. The poles marked PQXY are respectively

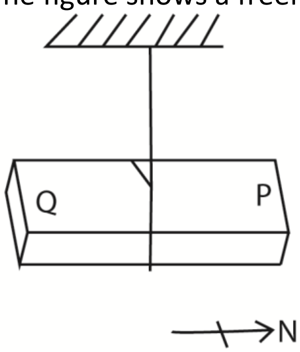
A. North, south, south, north
B. South, north, north, south
C. North, north, south, north
D. South, south, north, north

24. The direction of the force on a current carrying conductor in a magnetic field depends on
    (i) Direction of current
    (ii) Strength of magnetic field
    (iii) Direction of magnetic field
    A. (iii) only
    B. (i) and (ii) only
    C. (i) and (iii) only
    D. (ii) and (iii)only
25. Which of the following graphs shows variation of e.m.f produced by a d.c. generator with time?

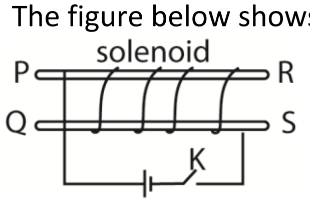


Answer is B

26. The figure shows a freely suspended magnet with poles Q and P.



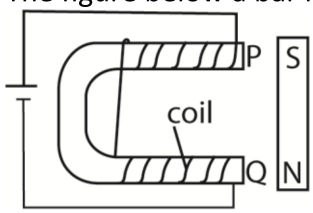
If X of another magnet attracts, P, which of the following is true about polarities of X and Q
A. X is north pole and Q is south pole
B. X is south pole and Q is north pole
C. Both X and Q are south poles
D. Both X and Q are north poles
27. The figure below shows identical rods PR and QS in a solenoid.



When switch K is closed, the rods separate from each other. Which one of the following statements is correct about the polarities of end P, Q, R and S.

A. P and Q are both north, R and S are south
B. P and Q are both south, R and S are north
C. P and S are both north, Q and R are south
D. P and S are south, Q and R are north

28. The figure below a bar magnet placed near an electromagnet with poles P and Q.



Which of the following is/are observed when current flows through the coil?
(i) The magnet is attracted towards P and Q
(ii) The magnet is repelled from P and Q
(iii) The magnet rotates abut its axis
   A. (i) only i.e. P is north and Q is south
   B. (i) and (ii) only
   C. (ii) and (iii) only
   D. (i) and (iii) only

29. When a wire carrying current is placed between the poles of a magnet, it experiences a force due to
   A. Wire being attracted by a magnet
   B. Attraction between the North and South pole
   C. Interaction between the current and magnetic field
   D. Interaction between magnetic field between the poles and the field around the wire

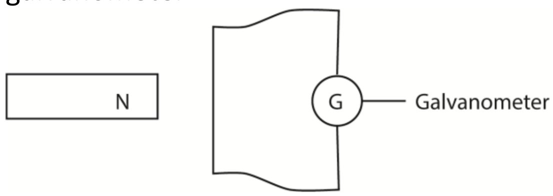
30. Which of the following is correct about step-up transformer? It
   (i) Has more turns of wire in the secondary coil than the primary
   (ii) Changes alternating voltage from lower to higher value
   (iii) Changes alternating voltage from higher to lower value
      A. (i) only
      B. (ii) only
      C. (i) and (iii) only
      D. (i), (ii) and (iii) only

31. The loudness of sound from a loud speaker cab be increased by increasing the
   (i) Surface area of the diaphragm
   (ii) Resistance of the coil
   (iii) Size of current flowing in the coil
   A. (i) only
   B. (i) and (ii) only
   C. (ii) and (iii) only
   D. (i) and (iii) only

32. A step- down transformer give current of 2A at 12V. If the primary voltage is 240V, find the primary current
   A. $\left(\frac{240 \, x \, 2}{12}\right) A$ B. $\left(\frac{240}{12 \, x \, 2}\right) A$ C. $\left(\frac{12 \, x \, 2}{240}\right) A$ D. $\left(\frac{12}{240 \, x \, 2}\right) A$

NB power IV = constant

33. The figure below shows a magnet moved towards a wire connected to a center zero galvanometer



Which of the following is correct about the movement of the pointer?

A. Pointer stays at rest
B. Pointer deflects to the right
C. Pointer deflects to the left
D. The pointer deflects to the right and then to the left

Section B

34. (a) What is a transformer?

A transformer is a device for stepping down or up alternating voltage

(b) A transformer whose efficiency is 80% has an output of 12V. Calculate the input current if input voltage is 240V.

Efficiency = $\frac{power\ out\ put}{power\ in\ put}\ x\ 100\%$

$$\frac{80}{100} = \frac{12\ x\ 100}{(I_p\ x\ 240)100}$$

$I_p = \frac{12\ x\ 100}{240\ x\ 8}$ = 0.065A

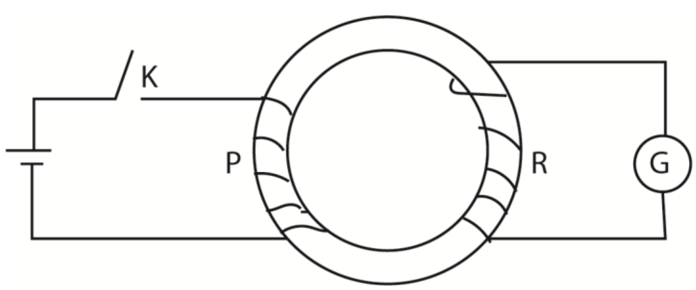
(c) Explain why bulbs in buildings are connected in parallel.

To have the same voltage through each.

35. (a) What is a transformer

A transformer is a device for stepping down or up alternating voltage

(b) The diagram below shows a model of a transformer in which the primary coil P is connected to a d.c. supply, and a secondary coil R is connected to a galvanometer.



Iron ring

(i) What is observed just as switch K is closed?

Momentary deflection of galvanometer i.e. galvanometer deflects and comes back to zero.

(ii) What would be the effect of closing switch K very fast in (i) above?
There will be a larger momentary deflection

(iii) What happens when switch K is left closed?
There will be no deflection

(iv) What is observed just as switch K is opened?
The will momentary deflection in opposite direction to that in (i) above

(v) What would be observed if the d.c. source is replaced by an a.c. source of low frequency?
The galvanometer deflects to and fro continuously

(c) A transformer of efficiency 80% connected to a 240V, a.c. supply operates a heater of resistance 240Ω. If the current flowing in primary coil is 5A

(i) Calculate the potential difference (p.d.) across the heater?

In put power = V_iI_i = 240 x 5 = 1200W

Output power, P_0 = 80% of input power

$= \frac{80}{100}\ x\ 1200$ = 960W

But Po $= \frac{V^2}{R} = \frac{V^2}{240} = 960$

V = 480V

(ii) If the transformer is cooled by oil of specific heat capacity 2100$Jkg^{-1}K^{-1}$ and the temperature of the oil rises by 20^0C in 3 minutes, find the mass of oil in the transformer.

Power lost = $\frac{MC\theta}{time}$

Power lost = power in put – power out put

= 1200 – 960 = 240W

Then

240 x time = MCθ

240 x 3 x 60 = M x 2100 x 20

Mass of oil M = 1.0286kg

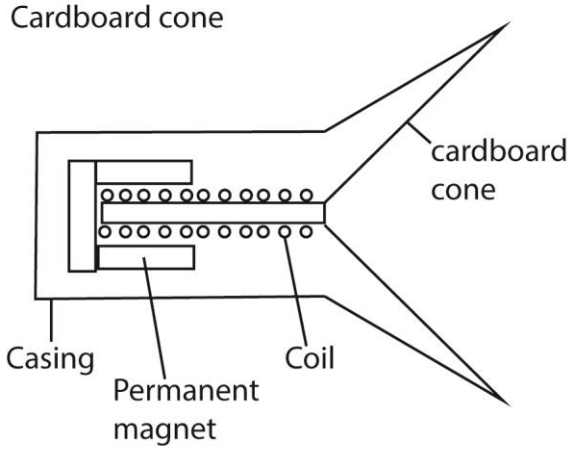
36. (a) State any two factors, which determine the magnitude of force exerted on a current carrying conductor.

- Strength of magnetic field
- current in the conductor
- length of the conductor.

(b) Describe the structure and mode of action of moving coil loudspeaker.

Solution

Cardboard cone



- When the varying current is supplied into the coil, the coil vibrates backwards and forwards, with the same frequency as that of the current.
- The motion of the coil in turn causes the cone to vibrate, causing the surrounding air to vibrate, and sound is produced.

(c) State the factor which determine the pitch and loudness of sound produced by moving coil loud speaker.

- Pitch- rate of vibration of the cone (frequency)
- loudness of sound – amplitude of vibration (amount of current)

(d) a D.C motor has an armature resistance of 4Ω. If it draws a current of 10A when connected to a supply of 200V. Calculate

(i) power wasted in the windings

Power wasted = $I^2R = 10^2 \times 4 = 400Js^{-1}$

(ii) efficiency of the motor.

Power input = IV = 200 x 10 = 2000Js-1

Power output =IV = 2000-400 = 1600Js-1

Efficient = $\frac{Power\ output}{Power\ input}\ x\ 100\%$

= $\frac{1600}{2000}\ x\ 100\%$

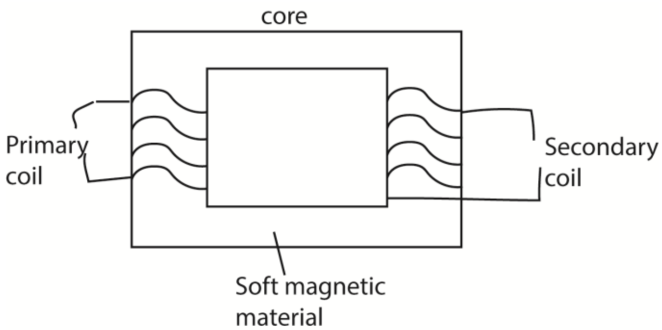
= 80%

37. (a) State any two factors which determine the magnitude of the e.m.f induced in a coil rotating in magnetic field
    - number of turns
    - strength of magnetic field
    - winding the coil on soft iron

(b) Explain why soft iron is preferred to steel in making electromagnet.

Because soft iron gets strongly magnetized and is easily demagnetized.

38. (a) Describe briefly the structure and mode of action of an a.c. transformer



It consists of two coils, the primary coil and secondary coil, wound closely over one another on a laminated soft iron core

When an alternative voltage, V_p, is applied to the primary coil, it causes changing magnetic flux in the soft iron core. This changing flux links the secondary coil so an e.m.f, V_s is induced in the secondary.

$\frac{V_S}{V_p} = \frac{N_S}{N_p}$

Where N_p = number of turns of primary coil
Ns = number of turns of secondary coil
If $N_s < N_p$, then it is a setup transformer.
Ns> N_p, then it is a step down transformer.

(b) (i) State any 3 causes of energy losses in a transformer.
- ordinary current heating losses in windings
- eddy current in the core
- leakage of magnetic flux

(ii) How are these losses reduced in a practical transformer?
- low resistance wires like copper wires are used to minimizes losses due to current in the wire
- Laminated core used to minimize eddy current
- Soft iron core used to minimize hysteresis.
- Secondary is wound directly on the primary coil to reduce leakage of flux.

(C) Explain why it is an advantage to transmit electrical at high voltage.
Power = IV, high voltage and low current reduces power loss since heat = I^2R

(d) Electrical power is generated at 11kV. Transformers are used to raise the voltage to 440kV for transmission over long distances using cables. The output of the transformer is 19.8MW and they are 90% efficient.

Find

(i) The output current to the transformer

$\frac{Power\ in\ output\ (P_0)}{power\ input(P_i)} = \frac{90}{100}$

P_0 = 19.8MW

$P_i = \frac{19.8\ x\ 10^6\ x\ 100}{90}$ = 2.2 x 10^7MW

$P_i = I_i \times V_p$

$I_i = \frac{2.2 \times 10^7}{11 \times 10^3}$ = 2000A

(ii) The output current to cables

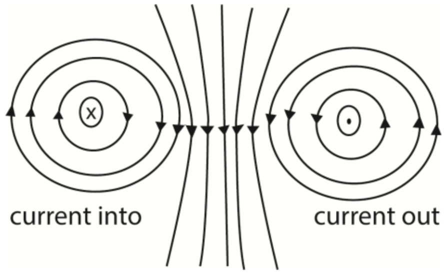
$P_s = I_s \times V_s$

$19.8 \times 10^6 = I_s \times 440 \times 1000$

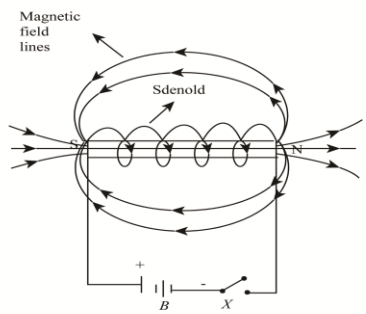
Is = 45A

39. (a)Draw the magnetic flied pattern due to an electric current in

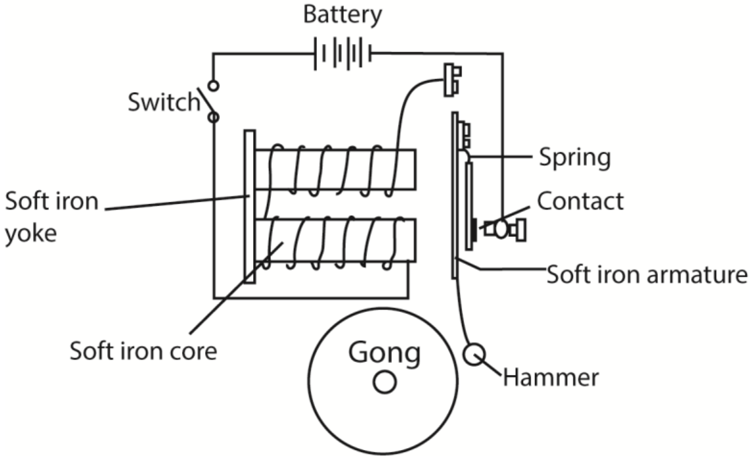
(i) A circular coil



(ii) Solenoid



(b) With the aid of a labelled diagram, describe briefly the action of an electric bell.



- When the switch is closed, current flows through the circuit and the core become magnetized
- The iron armature is attracted towards the magnetized core causing hammer to hit the gong and produce sound but this breaks the contact and the circuit.

- When the circuit is broken, the iron core loses magnetism releasing the armature to be returned to the contact by the spring.
- Again the circuit is completed and the process repeats, the hammer making repeated sound.

(c) What is meant by the following?

(i) magnetic meridian

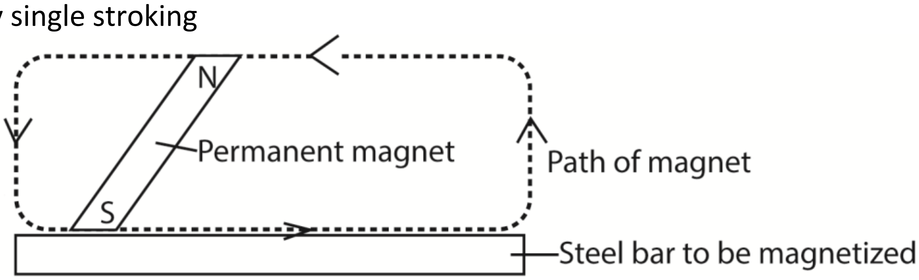
Magnetic meridian is a vertical plane containing a magnetic axis of a freely suspended magnet at rest due to earth's magnetic field.

(ii) neutral point in magnetic field

A neutral point is a point in the magnetic field at which the resultant magnetic force on an imaginary free north pole is zero.

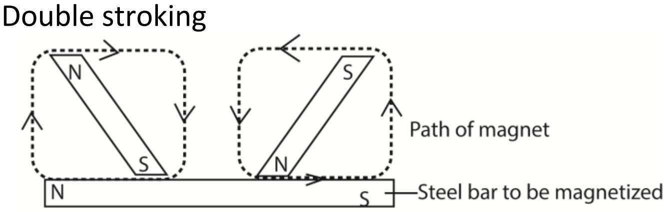
(d) Describe briefly how a steel bar may be magnetized.

(i) By single stroking



- Steel is stroked from end to end several times in the same direction with one pole of a magnet. Between the successive strokes, the pole is lifted high above the bar, otherwise the magnetism already induced in it will be weakened.
- The polarity produced at the end of the bar where the stroking finishes is of opposite kind to that of the stroking pole.

(ii) Double stroking



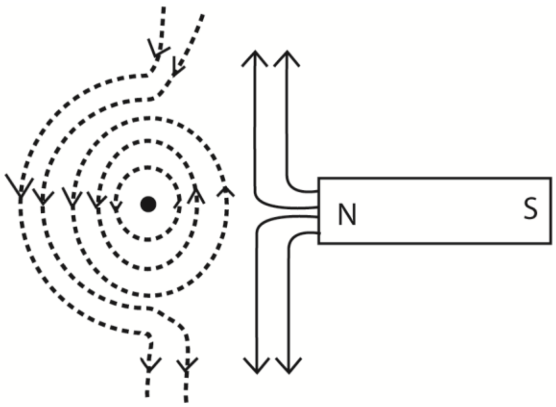
- Stroke the steel bar from the center outwards with unlike poles of two magnets simultaneously several times.
- Lift the magnets high above the steel bar in each stroke
- The polarities produced at the ends are opposite to those of the stroking poles.

40. (a) What is a neutral point in magnetic field?

This is a point where the resultant magnetic flux density is zero in magnetic field.

(b)

The diagram above shows a straight conductor carrying current vertically upwards placed near a bar magnet. Sketch the magnetic field pattern around the wire and the magnet.



41. (a) what do you observe when a magnet is

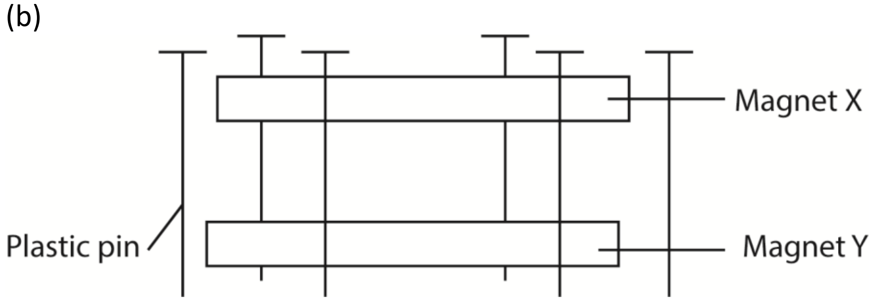
(i) Dipped in iron filling

When a magnet is dipped in iron fillings, the fillings are attracted to the magnet but more attracted to the poles than in the middle because the poles have the highest attractive power.

(ii) Freely suspended in air

The magnet rests in the North- South direction

(b)



Magnet Y is placed on a soft board. Plastic pins are then firmly stuck on the soft board around the magnet. Unidentified magnet X is held in the space surrounded by the pins above the magnet Y. When the magnet X is released it floats above the magnet y.

(i) Explain why X floats above?

Because like poles of X and Y are adjacent. Repulsion between the like poles are equal to the weight of X

(ii) Why are plastic pins used instead of steel pins?

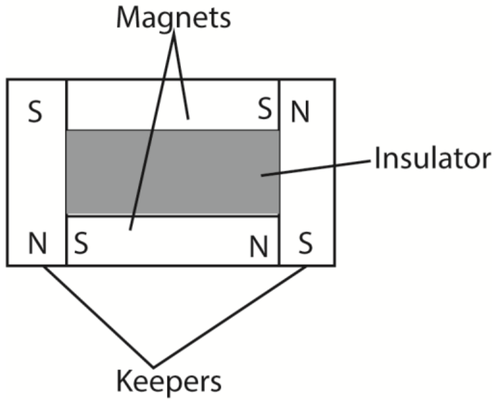
Steel pins would be magnetized and attract X

(iii) What would happen to magnet X if all the pins were removed at the same time?

Magnet X would swing around such that opposite poles of magnet X and Y are adjacent.

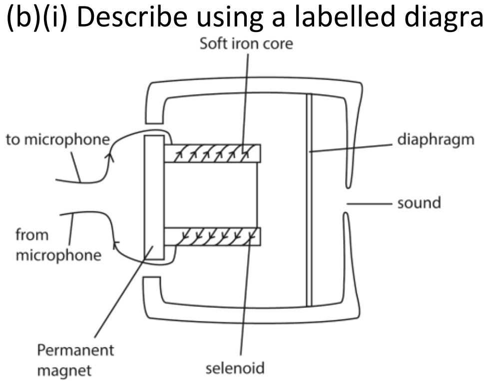
(c) Explain in terms of the domain theory how a steel bar gets magnetized by stroking.
A magnetic material contains tiny magnets (dipoles) in groups known as domains. In un-magnetized material the resultant magnetic axes of the domains point in all direction. When the material is stroked, the resultant magnetic axes are aligned to point in one direction, which is north-south direction, hence becoming magnetized.

42. (a) With the aid of a diagram, explain the use of keeper to store magnets.



- Magnetic keepers are made of soft iron
- Two magnets separated by an insulator are placed side by side with opposite poles adjacent between two keepers.
- The poles opposite those of the magnets are induced on the keepers.
- The keeper become effectively magnets
- Because of attraction between opposite poles of the magnet and keeper, the dipoles maintain their positions.

(b)(i) Describe using a labelled diagram how a telephone receiver works.



- The varying current from the microphone passes through the coil of electromagnets, soft iron gets magnetized and pull the diaphragm to and fro depending on the current from the microphone.
- Vibration of the diaphragm produces sound

(ii) State two ways by which the strength of an electromagnet can be increased.
- Increasing the number of turns on the soft iron
- Increasing current
- Increasing magnetic field.

(c) A bulb is rated12.0V 36W when used on a 12.0V supply.

(i) How much current does it draw from the supply?

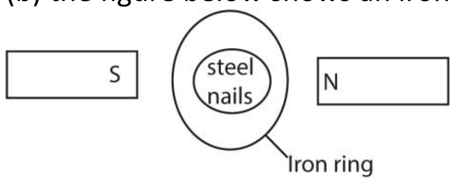
$I = \frac{P}{V} = \frac{36}{12} = 3.0A$

(ii) What is its resistance?

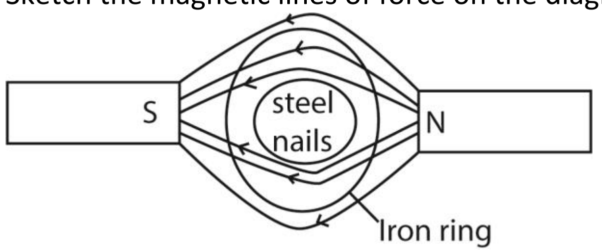
R = $\frac{V}{I} = \frac{12}{3} = 4\Omega$

43. (a) List two ways by which a magnet may lose its magnetic properties

(b) the figure below shows an iron ring between two opposite magnetic poles.



(i) Sketch the magnetic lines of force on the diagram.



(ii) Explain what happens to the steel nails.

Steel nails get magnetized from the surrounding iron ring

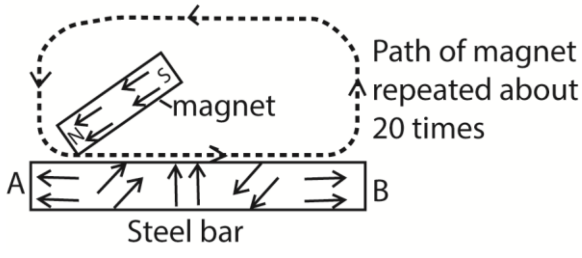
44. (a) (i) What is magnetic field

It is a region of space around a magnet where magnetic force is experienced.

(ii) State laws of magnetism

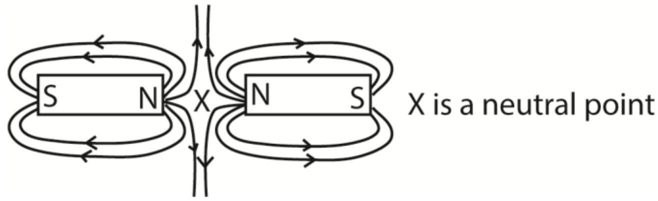
Like poles repel and unlike poles attract.

(b) (i) Explain with the aid of a diagrams how a steel bar can be magnetized by the single touch method

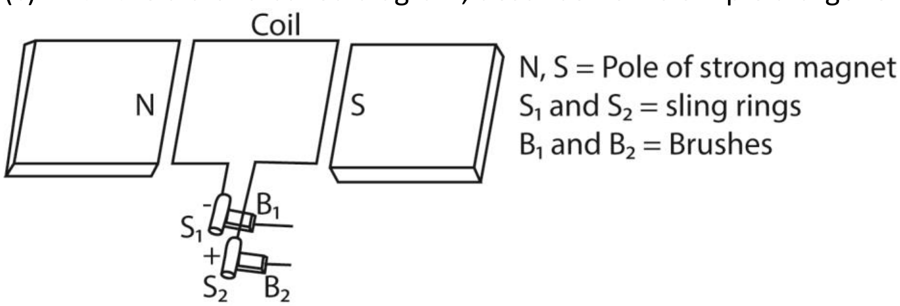


- The steel bar AB is stroked from end A to B about 20 times in one direction only by the same pole of a permanent magnet. This is lifted high at the end B before repeating the stroking. B will be the South Pole. A will be the North Pole.
- The permanent magnet loses hardly any of its magnetism while lining upt he domains of the bar AB.
- The more stroking, the stronger the magnetism in the steel bar.

(ii) Sketch the magnetic field pattern around two bar magnets whose North Poles face each other.



(c) With the aid of a balled diagram, describe how a simple a.c. generator works.

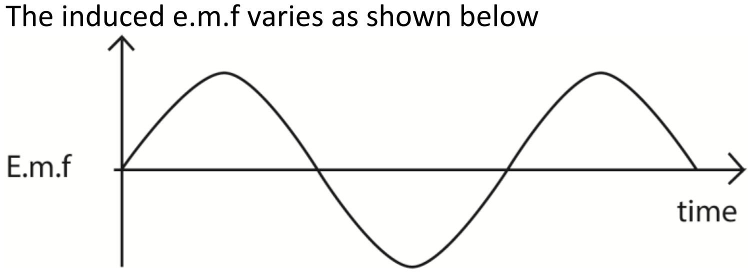


Mode of action

The coils is turned with uniform speed in magnetic field.

Because of change in magnetic field linking the coil, an e.m.f is induced in the coil.

The induced e.m.f varies as shown below



The coil, is in horizontal position, the rate of change of magnetic flux linkage is maximum, i.e. maximum induced e.m.f.

In vertical position, the rate of change of flux linkage is zero, i.e. zero e.m.f is induced.

Beyond the vertical position, induced e.m.f reverses because of change in direction of sides A and B.

45. (a) What is a soft magnetic material?

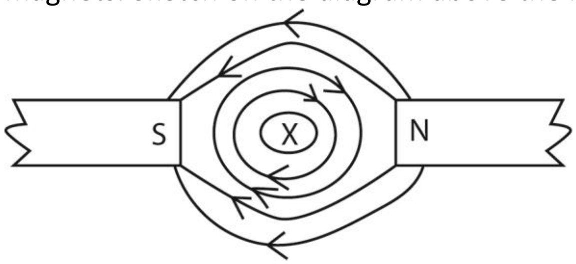
A soft magnetic material is one which can easily be magnetized, and also easily lose it its magnetism

(b) State two ways in which a bar magnet can be demagnetized

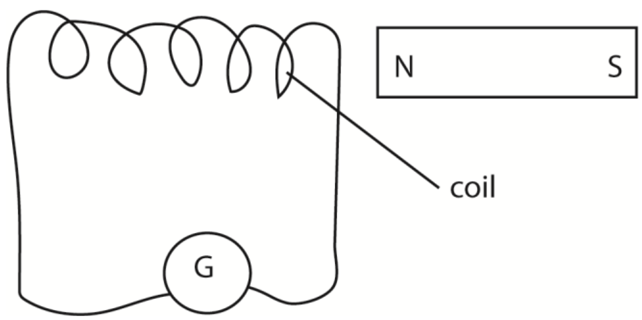
- heating
- hitting
- keeping like poles near each other

(c)

The figure shows a straight conductor carrying current between poles of permanent magnets. Sketch on the diagram above the resultant magnetic field pattern.



46.



A coil is connected to a center zero galvanometer, g, as shown above

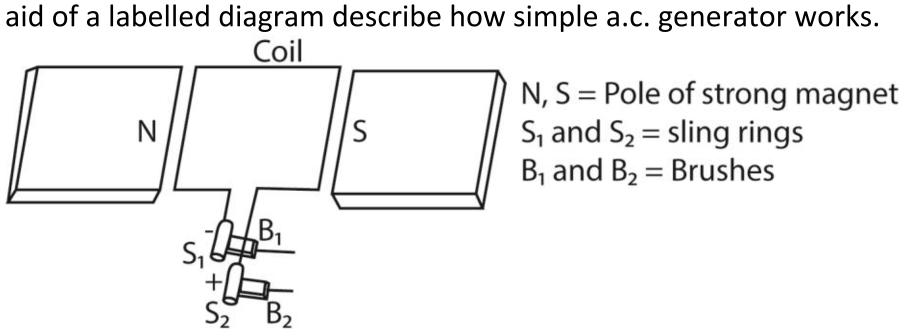
(a) (i) State what is observed when a north pole of a bar magnet is moved toward the coil.

Galvanometer deflects to the right

(ii) State two ways by which the effect observed in (a) can be increased.

- increasing the speed of magnet into and out of the coil
- using a stronger magnet
- increasing the number of turns in the coil

(b)(i) With the aid of a labelled diagram describe how simple a.c. generator works.

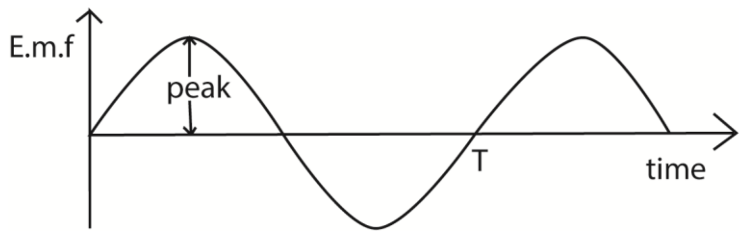


Mode of action

The coils is turned with uniform speed in magnetic field.

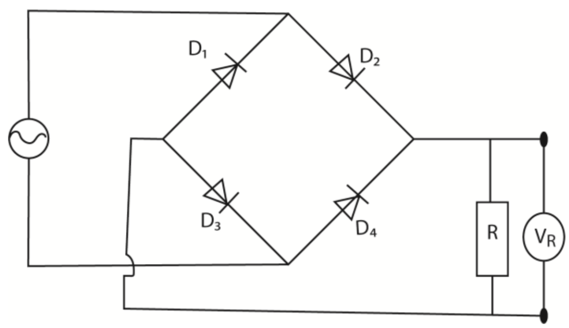
Because of change in magnetic field linking the coil, an e.m.f is induced in the coil.

(ii) Sketch the variation of voltage from a.c. generator and use it to define the terms of peak value and period

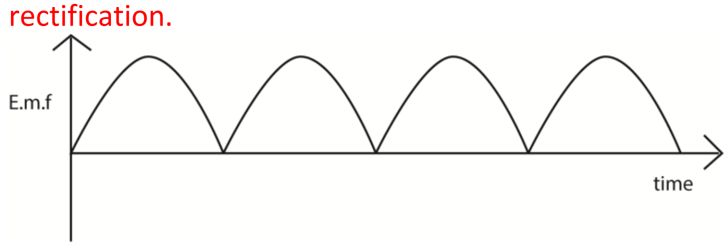


Peak value is the maximum value of e.m.f
Period, T, is the time take for a complete alteration of e.m.f.

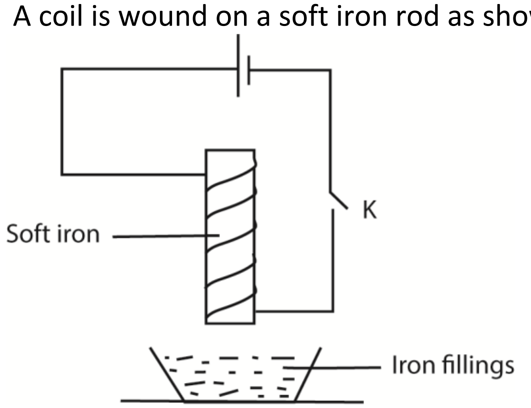
(c) With the aid of a labelled diagram, describe how full wave rectification can be got using four diodes



- During the first half cycle current flows along D_2 and D_4.
- In the second half cycle, current flows along D_3 and D_1
- In both cases current flows through R in the same direction, hence full wave rectification.



47. A coil is wound on a soft iron rod as shown in the figure below



(a) Describe what is observed when K is

(i) Closed
Iron fillings are attracted because soft iron is magnetized

(ii) Closed and then opened
When closed soft iron is magnetized and picks iron fillings, when K is opened soft iron is demagnetized and iron filling fall off although a few remain attracted.

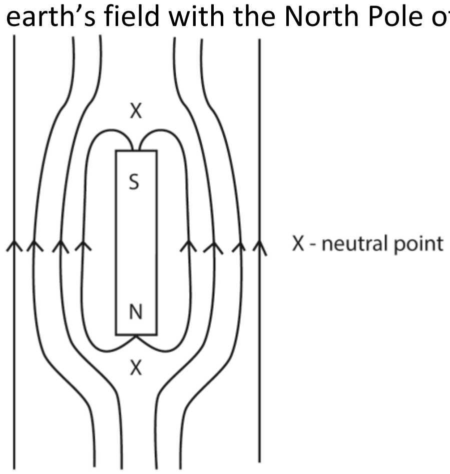
(b) State two ways by which the effect of what is was observed above can be increased
- Using many batteries
- Moving soft iron closer to iron filling
- Using more windings on the soft iron

48. (a) Distinguish between angle of dip (inclination) and angle of declination.

Angle of dip /Angle of inclination is the angle between the magnetic north and geographic north. Or it is the angle between the true north and magnetic north.

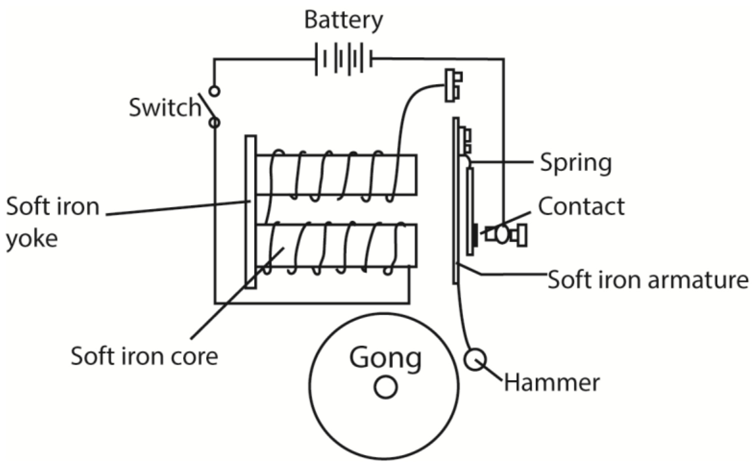
Angle of declination this is the angle between the earth's magnetic and geographical meridians. Or the angle between magnetic north and true north.

(b) Draw a diagram to show the magnetic field pattern around a bar magnet placed earth's field with the North Pole of the magnet pointing to the Earth's south.



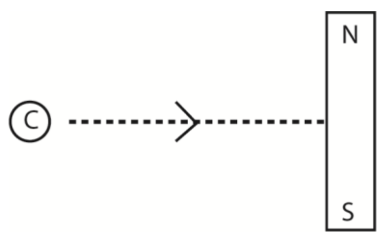
(c) (i) What is electromagnet?
A piece of soft iron that becomes magnetized when electric current passes through the coil surrounding it.

(ii) Describe with the aid of a labelled diagram how an electric bell works



- When the switch is closed, current flows through the circuit and the core become magnetized
- The iron armature is attracted towards the magnetized core causing hammer to hit the gong and produce sound but this breaks the contact and the circuit.
- When the circuit is broken, the iron core loses magnetism releasing the armature to be returned to the contact by the spring.
- Again the circuit is completed and the process repeats, the hammer making repeated sound.

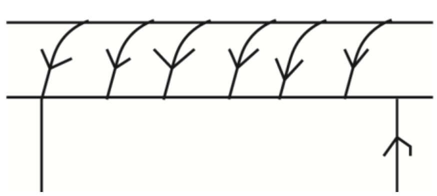
(d)



Describe what happens to compass needle, C, as it is moved closer to the bar magnet along the dotted lines shown in the figure above?

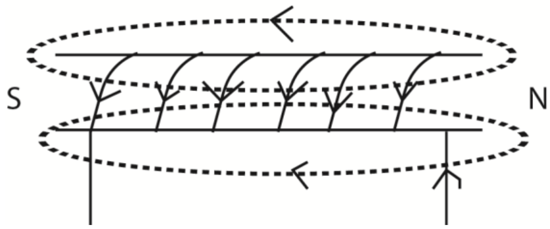
The campus needle rotates to face in the south direction

49. (a) What is magnetic field?
Is an area around the magnet where attraction and repulsion due to magnetism is felt.

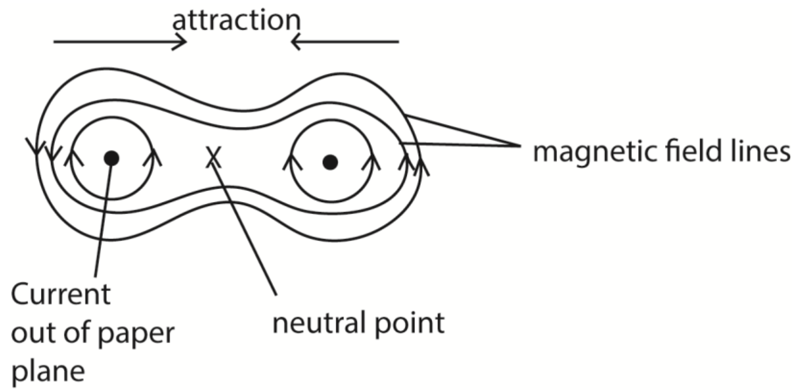


The figure above shows current flowing in a solenoid.

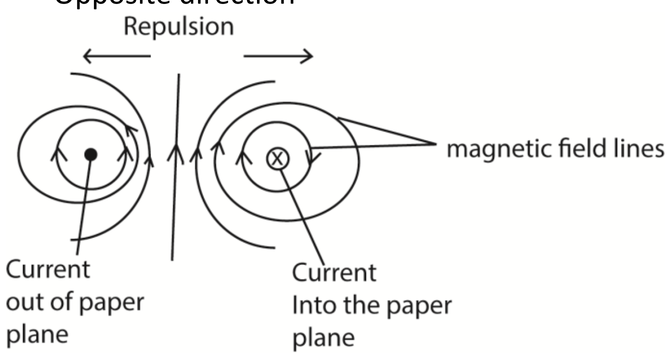
(i) Sketch the magnetic field around the solenoid, clearly label the polarities



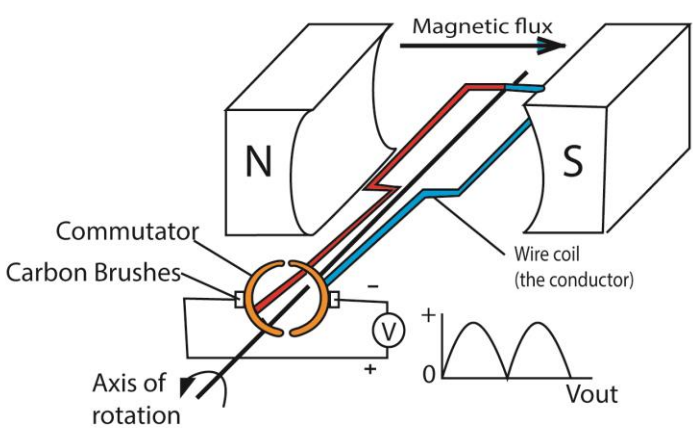
50. (a) What is meant by magnetic field?
    Is space near the magnet where magnetic field is felt.
    (b) Explain with the aid of a diagram, what happens when two vertical parallel conductors are placed near one another and currying current in
        (i) In the same direction



        (ii) Opposite direction



    (c) (i) Describe with aid of a diagram, how a direct current generator works.



- When the coil is rotated, the magnetic field linking the coil changes and e.m.f is induced.
- When the coil passes the vertical position, the two halves of commutators change contacts with the brushes, e.m.f in the coil reverses but the direction of current in external circuit remains the same.

(ii) State three ways of increasing the e.m.f produced by a generator.
- Increasing speed of rotation
- Increasing number of turns in the coil
- Using stronger magnets.

51. (a) Define the following as applied to magnetism

(i) Ferromagnetic material

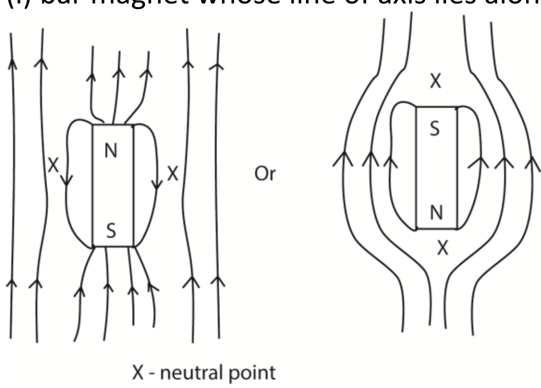
It is a material that is strongly attracted by a magnet

(ii) Neutral point

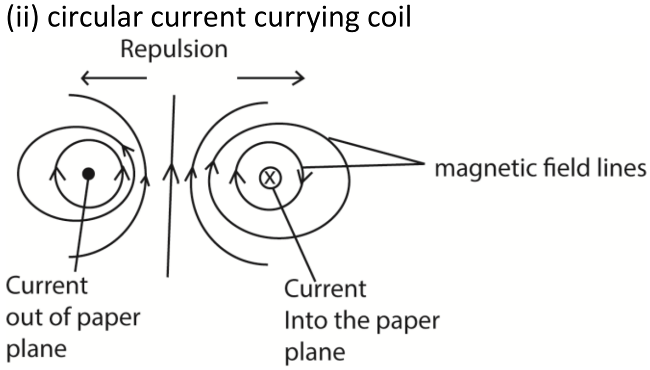
This is a point where the resultant magnetic force is zero

(b) sketch the magnetic field pattern a round

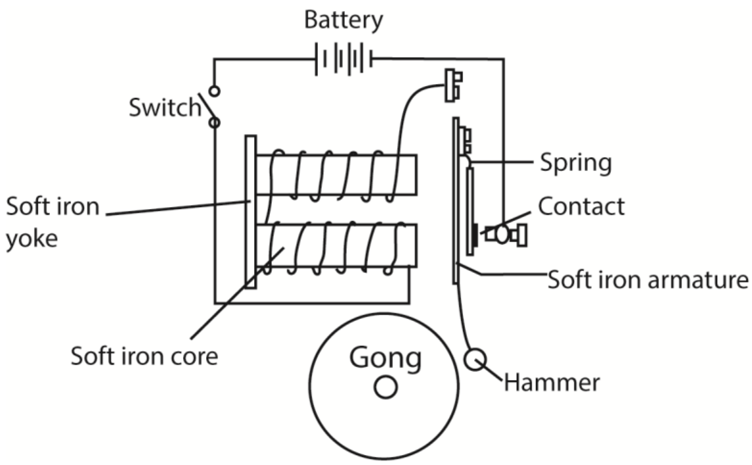
(i) bar magnet whose line of axis lies along the magnetic north



(ii) circular current currying coil



(c) With the aid of a diagram explain how an electric bell works.



- When the switch is closed, current flows through the circuit and the core become magnetized
- The iron armature is attracted towards the magnetized core causing hammer to hit the gong and produce sound but this breaks the contact and the circuit.
- When the circuit is broken, the iron core loses magnetism releasing the armature to be returned to the contact by the spring.
- Again the circuit is completed and the process repeats, the hammer making repeated sound.

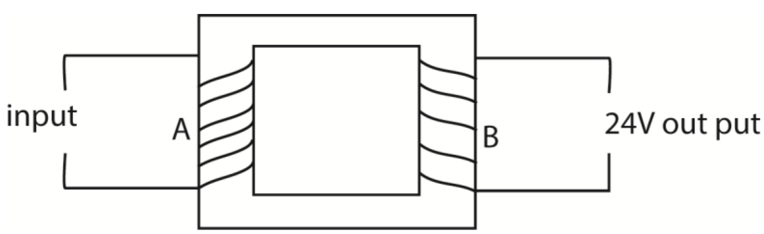
(d) (i) What is meant by a magnetically saturated material

This is when the resultant magnetic axis of all domains in a substance are aligned within the field.

(ii) State one method of demagnetizing a magnet

- Heating
- Hitting/hammering the magnet
- Placing a magnet in a solenoid with a.c. current

52.



The above figure is a step down transformer.

(a) Name the coils marked

A. Primary coil

B. Secondary coil

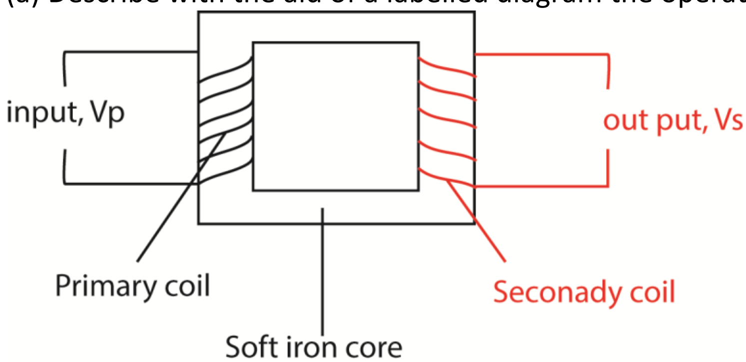
(b) If the transformer is used to step down mains supply from 480V to 24V and A coil has 800 turns, determine the number of turns in coil B.

From $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

$$\frac{480}{24} = \frac{800}{N_S}$$

$$Ns = \frac{800 \ x \ 24}{480} \ 40 \ turns$$

53. (a) Describe with the aid of a labelled diagram the operation of a transformer



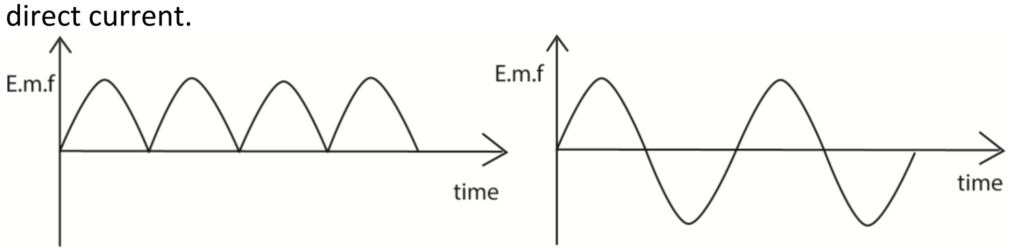
- An input alternating voltage, V_p is applied to the primary coil. It sets up an alternating flux in the soft iron core and induces an alternating voltage, V_s in the secondary coil.
- If the number of turn N_p in primary coil are greater than the number of turns Ns in the secondary coil, then the transformer is a step down transformer
- If the number of turn N_p in primary coil are less than the number of turns Ns in the secondary coil, then the transformer is a step up transformer

(b) A 240V step down mains transformer is designed to light ten 24V, 20W ray box lamps and draw a current of 1A in the primary coil.
Calculate
(i) Power supplied in the primary coil
Power = IV = 240 x 1 = 240W
(ii) Power developed in the secondary coil
Power = 20 x 10 = 200W
(iii) Efficiency of the transformer

$$\text{Efficiency} = \frac{power \ output}{power \ input} \ x \ 100$$

$$= \frac{200}{240} \ x \ 100 = 83\%$$

(c) With the aid of suitable diagrams, distinguish between an alternating current and direct current.



a.c. current oscillates in both positive and negative e.m.f while d.c. oscillates with positive e.m.f only

(d) Explain how a fuse as a safety device achieves its function in house wiring.
A fuse melts and breaks the circuit when a fault develops making the current to exceed the power rating of an appliance.

54. (a) Define the following

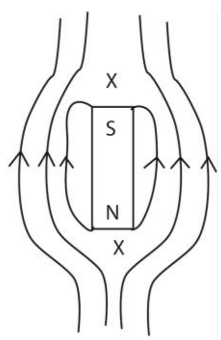
(i) Hard magnetic material
These are materials that are hard to magnetize but retain their magnetism for a long time once magnetized

(ii) Soft magnetic material
These are materials that are magnetized easily and also lose their magnetism easily

(b) (i) describe the electrical method of magnetizing a steel bar
Place a steel bar in a solenoid connected to a d.c. source and switch on

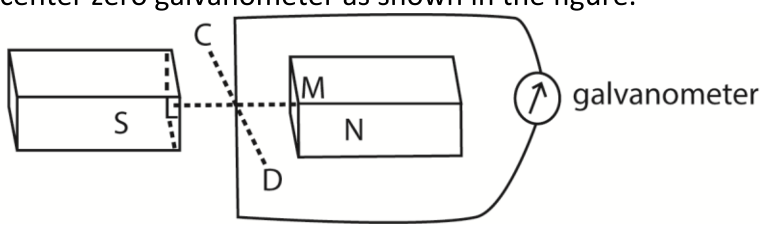
(ii) State any two ways of demagnetizing a bar magnet.

(c) Sketch the magnetic field pattern around a bar magnet with its S-pole pointing North in the magnetic field.



X – is a neutral point

(d) A stiff wire AB is held between opposite pole of two magnets and connected to center zero galvanometer as shown in the figure.



The wire AB is kept vertical and moved horizontally along the line CD

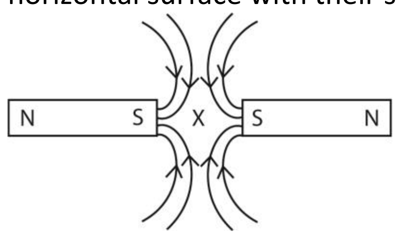
(i) Explain what is would be observed on the galvanometer as the wire AB moves towards C and toward D.
When moved toward C, the wire cuts through a magnetic field inducing current in the wire and the galvanometer deflects to one side.
When moved towards D, the wire cuts through the magnetic field inducing current in opposite direction and the galvanometer deflects in opposite direction.

(ii) Explain what would be observed if the wire were moved along LM

When the wire is moved in direction LM, the galvanometer does not no deflect because no current is induced in a wire the moves parallel to magnetic field.

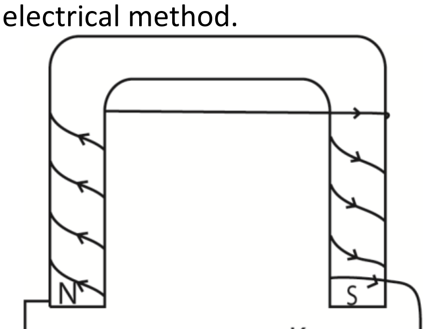
55. (a) What is magnetic field?
A region around a magnet where magnetic forces are experienced.
(b) What is magnetic field saturation?
This is a state where the strength f a magnet cannot be increased further because magnets domains of a material are all aligned.
(c) Explain why a freely suspended bar magnet swings until it points North- South direction.
The earth is a magnet with its south pole in geographical north and its north pole in geographical south. North Pole of suspended magnet is attracted to the south pole of the earth.

56. (a)(i) What is magnetic field?
It is a region around a magnet where magnetic force is experienced.
(ii) Sketch the magnetic field pattern between two bar magnets placed on the horizontal surface with their south poles facing each other.



(b)(i) Explain why the strength of a magnet cannot be increased beyond limits
- in un-magnetized state, the dipoles are the domains of a magnetic material face in random direction, hence neutral.
- When magnetizing it, the dipoles are aligned in the same direction, and once the dipoles are all aligned in the same direction, the material cannot be further magnetized. Hence it is said to be magnetically saturated.

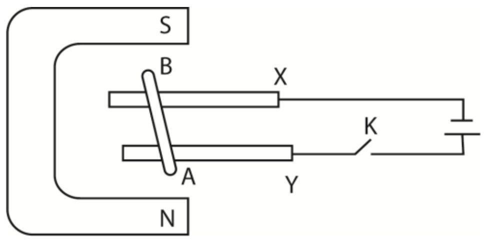
(ii) With the aid of a suitable diagram, show how a U-shaped piece of steel can be magnetized by electrical method.



- A solenoid is wound on to a U-shape steel bar as shown and connected to a d.c. supply and switched on
- The polarity is as shown.

-

(c) A bare copper wire AB lies horizontally over fixed rails X and Y connected to a battery as shown. The rails X and Y are placed between the poles of a U-shaped magnet.



Explain what happens to AB,

(i) When switch K is closed

AB experiences a force. According to Fleming's left hand rule, it will move to the right.

(ii) If two cells are used instead of one cell.

A greater force is experienced and AB moves first.

(d) Name two instrument which use the effect in (c).

- Electric motor
- Moving coil meter
- Moving coil loud speaker.

(e) State two ways of demagnetizing a magnet.

- Hitting
- Using a.c. on magnet
- heating

57. (a) What is meant by

(i) Magnetic saturation

It is a state where a magnetic material acquires magnetism to an extent that it cannot gain any more from magnetizing source.

(ii) Magnetic screening

It is a process of keeping away of magnetic field from a space or an object by enclosing with soft iron box or ring.

(b) (i) Describe the domain theory of magnetism

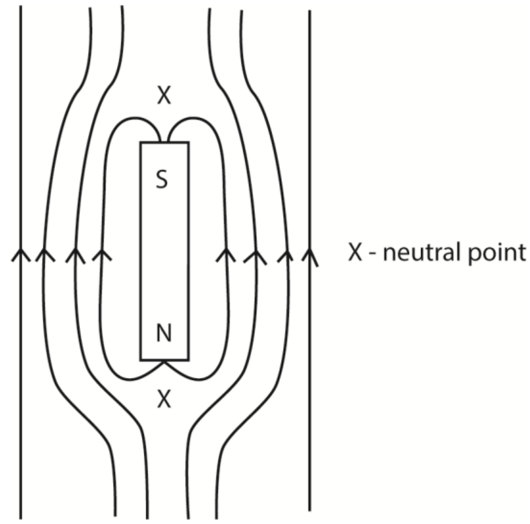
All magnetic materials are made of small molecular magnets called dipoles that are arranged in small groups called domains. When the domains are aligned to face in one direction the substance becomes a magnet.

(ii) use the above theory to explain demagnetization.

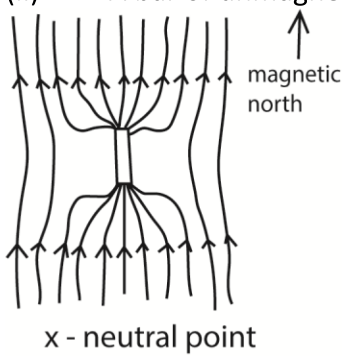
During demagnetization, the aligned domains in a magnetized object are altered to face in random directions

(c) Draw magnetic lines due to

(i) A bar magnet placed horizontally with its axis in the magnetic meridian and its north pointing south.

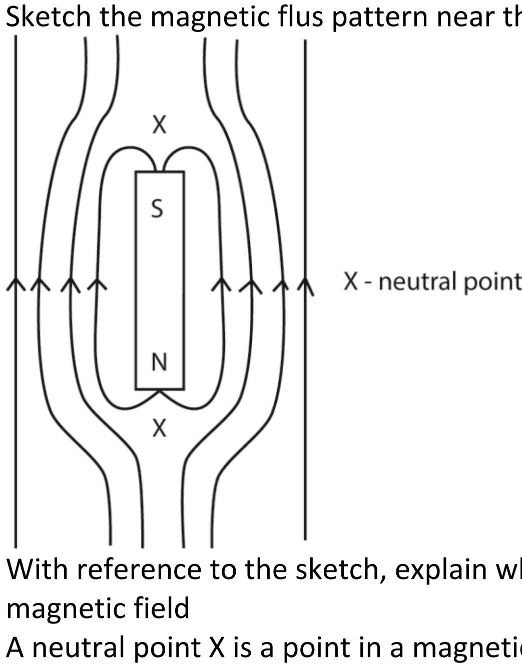


(ii) A bar of unmagnetized iron placed along the axis of the earth's field



58. (a) a bar magnet is places with its axis along the magnetic meridian with its south pole pointing north.

(i) Sketch the magnetic flus pattern near the magnet in the earth's field



(ii) With reference to the sketch, explain what is meant by a neutral point in magnetic field

A neutral point X is a point in a magnetic field where the resultant magnetic field is zero.

(b) (i) Describe an experiment to determine the magnetic field pattern of bar magnet using iron fillings.
   - A cardboard is placed on a magnet and iron fillings sprinkled on the cardboard
   - On tapping slightly on the cardboard, the fillings arrange themselves along the magnetic lines.

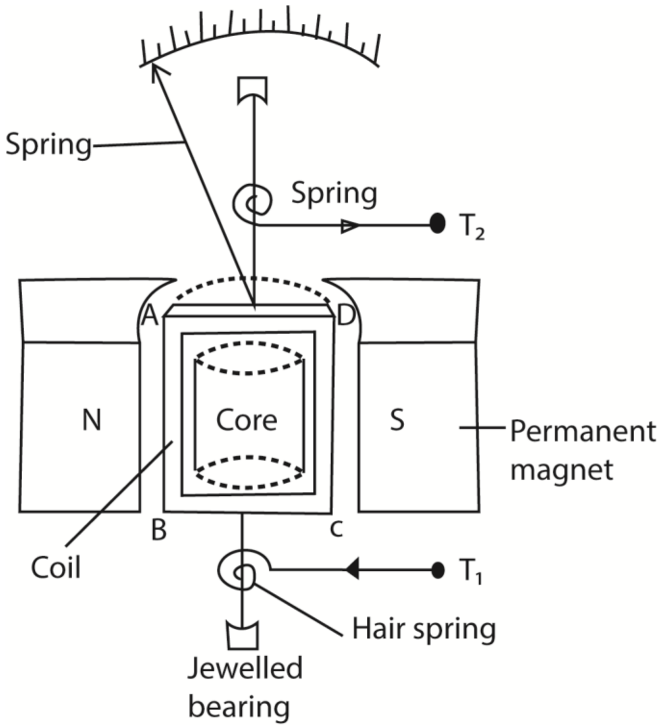
   (ii) State one advantage and one disadvantage of the method in (b)(i) above.
   Advantage: quick
   Disadvantages:- does not show the direction of the field lines
   - Cannot plot weak magnetic field lines

(c) Describe how earth's magnetic meridian can be determined
   - A bar magnet is freely suspended using a string from the middle and allowed to come to rest
   - The vertical plane through the magnetic axis is the magnetic meridian

59. A figure below shows a trolley carrying a magnet and moving at high speed towards the coil. The trolley enters and pass through the coil.

    State and explain what happens to the trolley and galvanometer as the trolley enters the coil.
    - The pointer on the galvanometer deflects, the speed of the trolley reduces.
    - The galvanometer deflects because current is induced through the coil flowing in the direction so as to oppose the change causing it-Lenz's law.
    - The speed of the trolley reduces because of repulsion from the opposite poles induced in the coil.

60. (a) (i) Draw a labelled diagram showing the essential features of moving coil galvanometer.



(ii) Explain why the coil of galvanometer rotates about its axis when current passes through it, and why it settles in a definite position for given values of current.

- When a current flows through the coil, the resultant magnetic field sets up two forces on the vertical sides of the coil that constitutes a couple.
- These forces then cause the coil to rotate about its axis.
- The hair spring set up a control couple which balances the deflecting couple and prevents the coil from further rotation.

(iii) State four factors on which the deflection of the coil of instrument depends.

- Number of turns of the coil
- Strength of magnets used
- Area of the coil
- Current through the coil
- Constant of the hair material

(b) Explain how energy in an a.c. transformer is minimized

- Flux linkage- this minimized by winding the secondary coil on primary coil
- Eddy current tosses – these are minimized by laminating the iron core
- Ohmic losses (I2R losses) – minimized by use of thicker copper wires.
- Hysteresis losses- minimized by use of thicker copper for core.

(c) An a.c. transformer has 200 turns on primary coil. 240V is to be stepped up to 720V, calculate the number of turns on the secondary coil.

From $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$\frac{N_s}{200} = \frac{720}{240}$

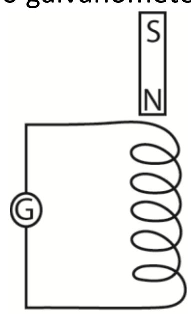
Ns = 600 turns

(d) Explain why thick cables are used for power transmission.
A thick cable offers low resistance owing to its large cross sectional are reducing power loss.

61. (a) What is electromagnetic induction?
This is the generation of e.m.f due to changes in magnetic flux

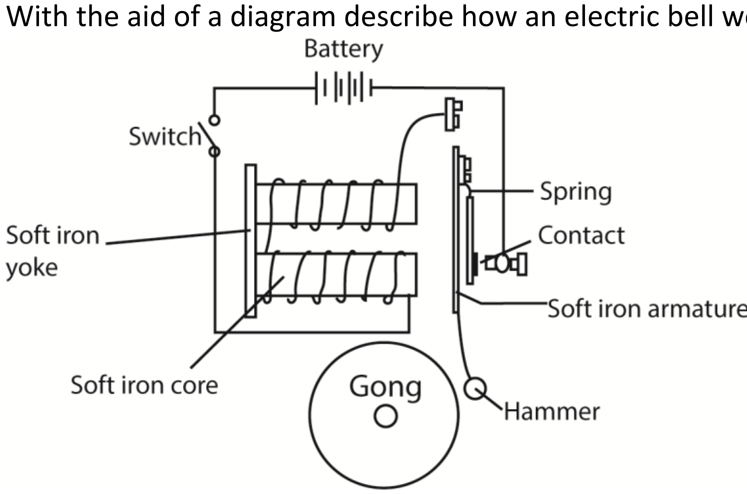
(b) State factors that determine induced e.m.f in electromagnetic induction
- Strength of magnet
- Number of turns in the coil
- Rate of change of magnetic flux

(c) A small magnet is released from above along coil of many turns connected to a center zero galvanometer as shown below



Describe what will be observed on galvanometer as magnet falls through the coil
- As magnet approaches the coil, the galvanometer deflects and attains maximum deflection as the magnet enters the coil
- The deflection decreases as the magnet enters the coil and becomes zero when the magnet is inside the coil.
- The deflection rises again in opposite direction as the magnet leaves the coil and attains maximum deflection when the magnet first exit the coil
- The deflection decreases to zero as the magnet moves far from the coil

(d) With the aid of a diagram describe how an electric bell works

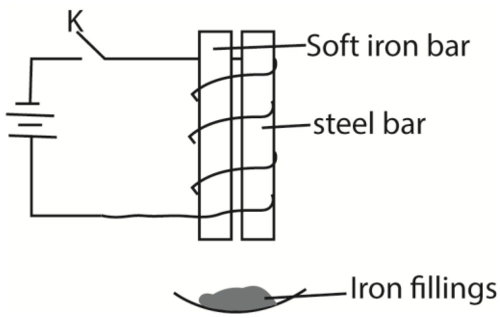


- When the switch is closed, current flows through the circuit and the core become magnetized

- The iron armature is attracted towards the magnetized core causing hammer to hit the gong and produce sound but this breaks the contact and the circuit.
- When the circuit is broken, the iron core loses magnetism releasing the armature to be returned to the contact by the spring.
- Again the circuit is completed and the process repeats, the hammer making repeated sound.

(e) Why is soft iron used in electromagnets instead of steel?
Soft iron is easily magnetized and demagnetized.

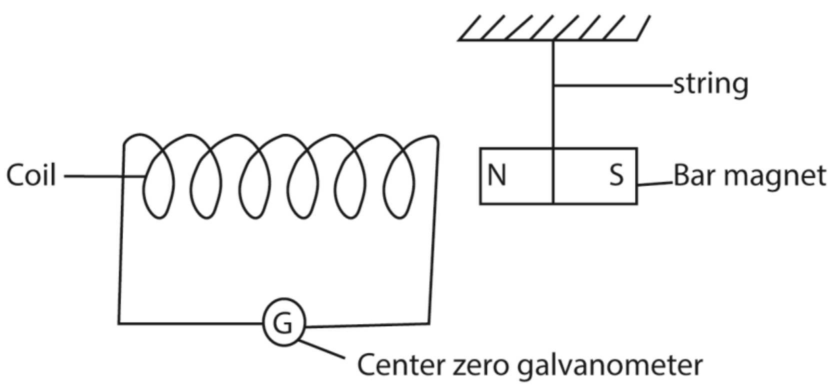
62. (a) What is a hard magnetic material?
Is a substance which is difficult to magnetize and to demagnetize once magnetized
A soft iron bar and steel bar are suspended inside a coil above a container of iron fillings as shown below



Explain what is observed when switch K is closed
More iron filling will be attracted to soft iron than steel because soft iron is easily magnetized.

63. (a) What is a step-down transformer?
This is a device that reduce alternating voltage
(b) State three advantages of alternating current (a.c.) over direct current
  - a.c. can easily stepped up or down but d.c. current cannot
  - a.c. is transmitted with minimum power loss compared to d.c.
  - a.c. is easier to generate

(c)



The figure above shows a bar magnet freely suspended by a string from s clamp near a coil aligned along magnetic meridian. If the bar magnet is slightly displaced away from the coil and then released to swing freely in and out of the coil, describe what is observed on the galvanometer.

- Galvanometer deflects to the maximum as a magnet passes the equilibrium position
- The deflection drops to zero at the maximum displacement and rest momentarily.
- As it swings back, the galvanometer deflects in opposite direction to the maximum as it passes equilibrium position again
- The deflection then drops to zero as it reaches starting point and rest momentarily.

(d) Explain why a transformer in use is usually submerged in oil.
To absorb generated heat and cools the transformer

(e) The number of turns in the primary and secondary coil of a transformer are N and 300 respectively. If the output voltage is 120V when the input is 40V.find the value of N

From $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$\frac{300}{N_p} = \frac{120}{40}$

Np = 100 turns