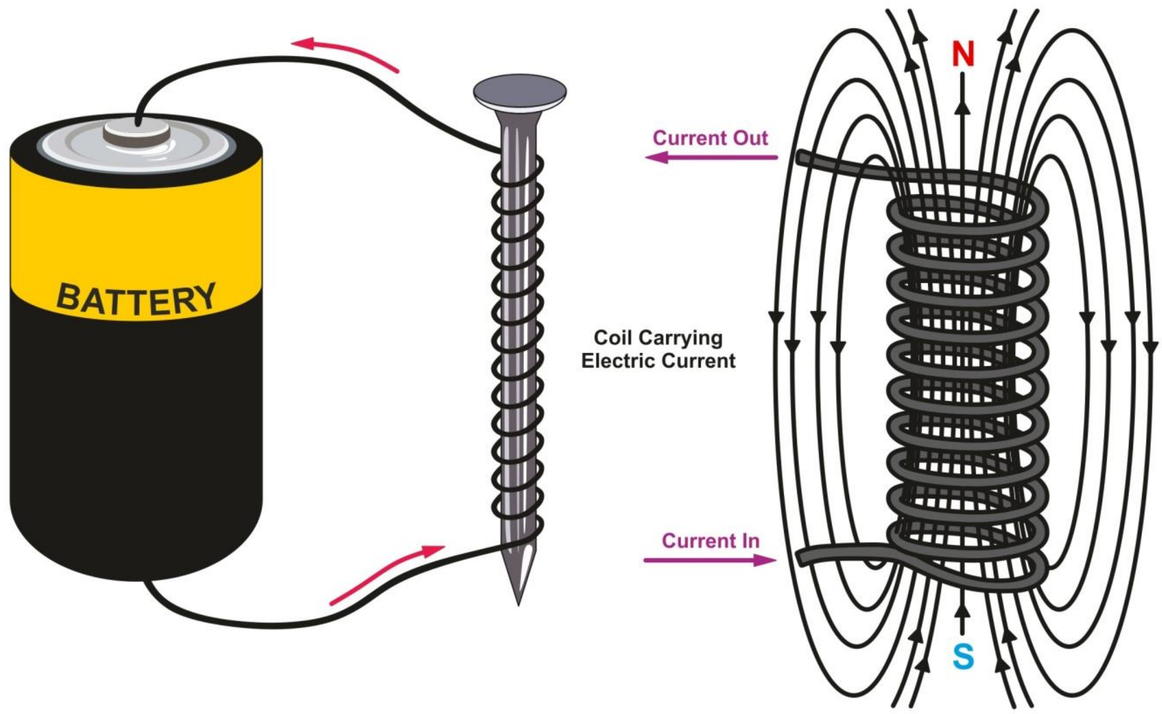
S4 New Curriculum Physics

Theme: Magnetism

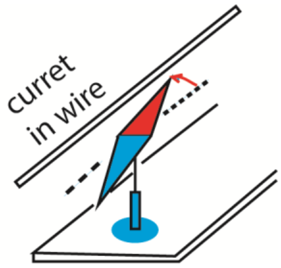
Chapter 3 – Electromagnetic effects



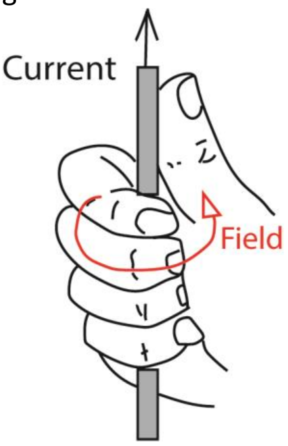
Magnetic Effect of current

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.

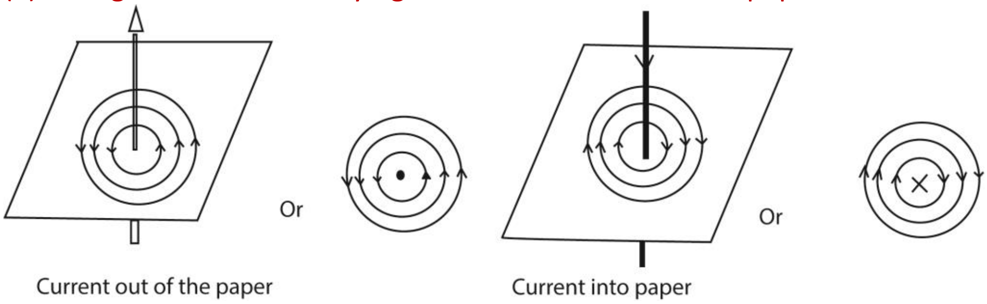


The direction of magnetic field around such a conductor is obtained by right hand grip rule(RHGR)- with the thumb pointing along the direction of current, the direction of fingures gives the direction of the magnetic field

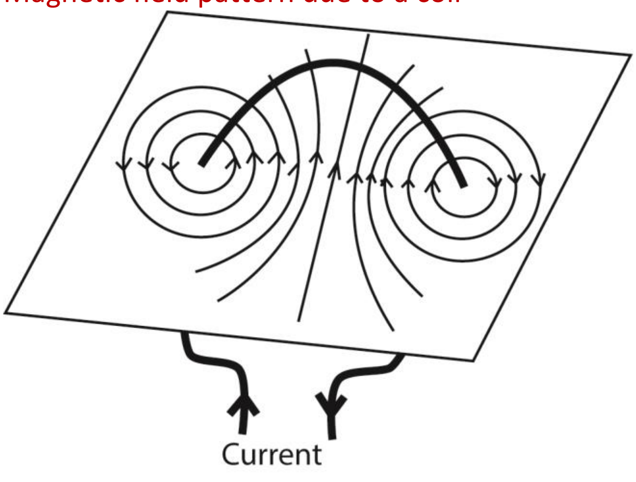


Magnetic field pattern due to current carrying conductors

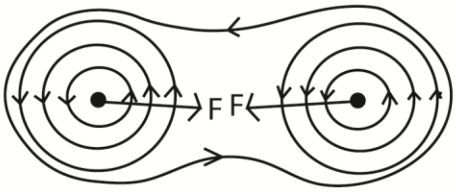
(a) Straight conductor carrying current into or out of the paper



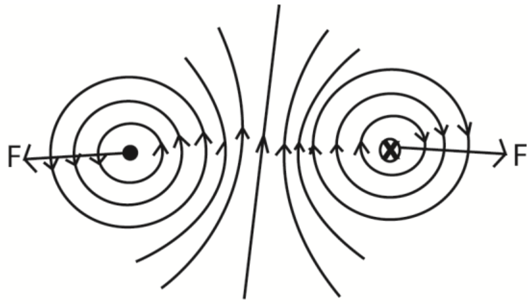
(b) Magnetic field pattern due to a coil



(c) Magnetic field pattern due to parallel conductors



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



Opposite current
(repulsion)

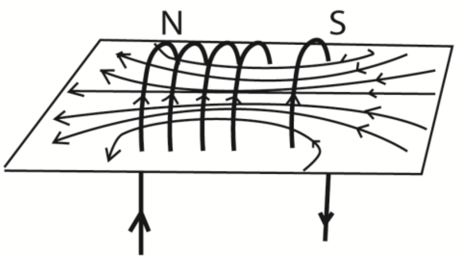
F- is the force experienced by the conductors.

(d) Magnetic field pattern due to solenoid

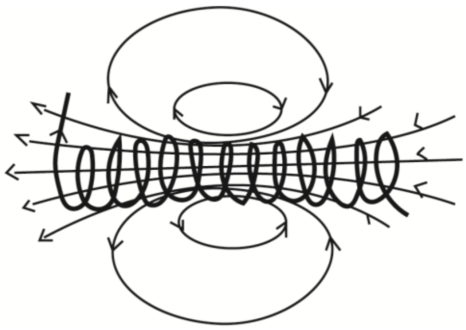
To find the direction of electric field of a solenoid

(i) **Curl the fingers of your right hand** in the direction of the current flowing through the coils of the solenoid.

(ii) **Point your thumb straight out** — it will point toward the solenoid's **north pole**.



Or



Trial 1

(a) Define the following as applied to magnetism

(i) Ferromagnetic material

(ii) Neutral point

(b) Sketch the magnetic field pattern a round

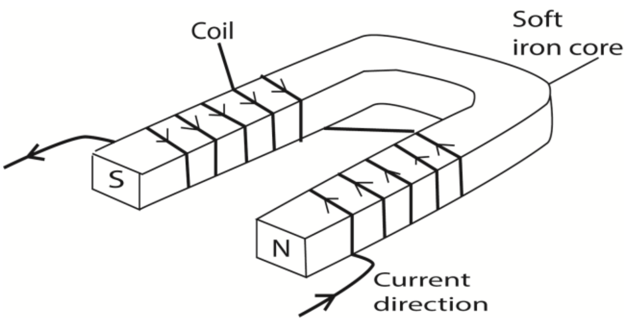
(i) bar magnet whose line of axis lies along the magnetic north

(ii) circular current currying coil

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

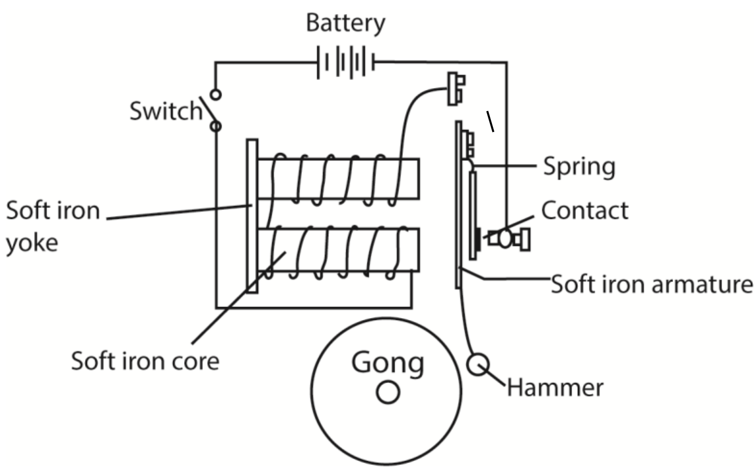
- Increasing current in the coil
- Increasing number of turns (windings) of the coil
- Bringing poles closer

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.

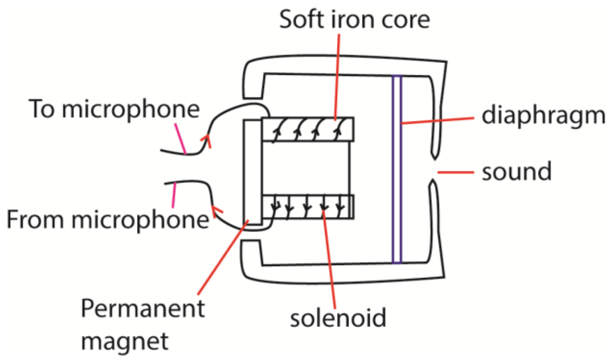
Uses of electromagnet

(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.

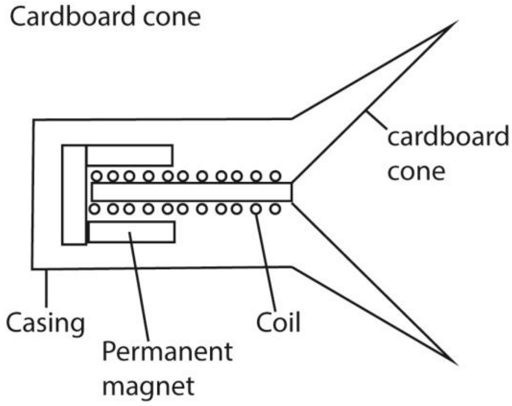
(b) Telephone receiver



- The varying current from the microphone passes through the coils 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

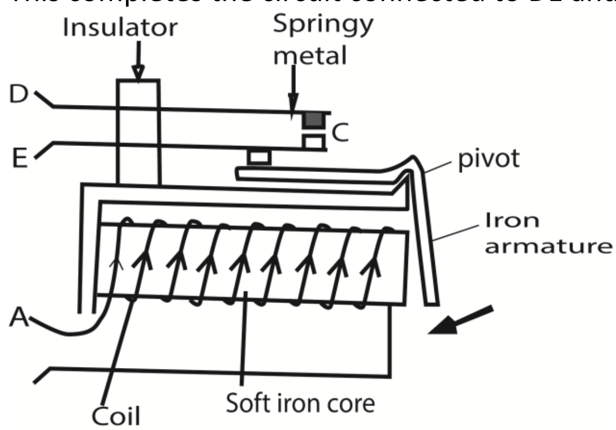
Cardboard cone



- 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) Relay switch

- 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.



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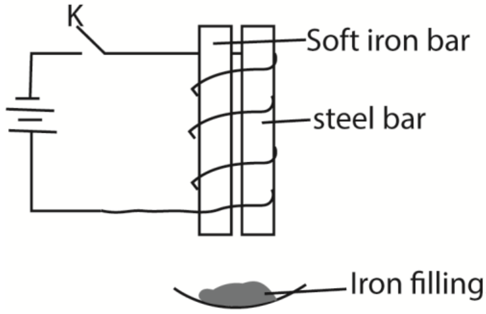
Example 1

1. (a) What is a hard magnetic material?

   It 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

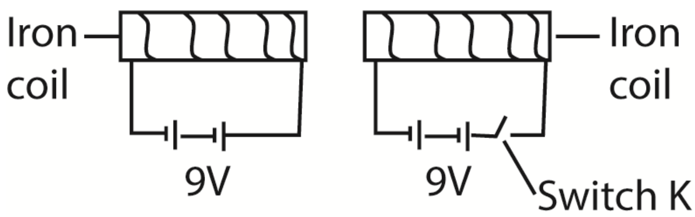


   Explain what is observed when switch K is closed

   More iron filling will be attracted to soft iron than steel because soft iron is easily magnetized.

Trial 2

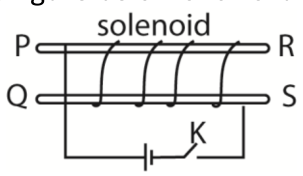
1. In figure 6, when switch K is closed, the two soft iron core will



   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 them [B]

2. 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 [B]

3. The figure below shows identical rods PR and QS in a solenoid.

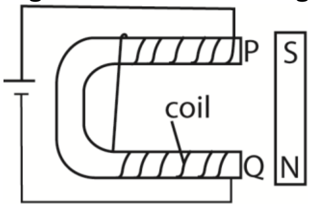


   When switch K is closed, the rods separate from each other. Which one of the following statements is correct about the polarities of end P, Q, R and S.

   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 [A]

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

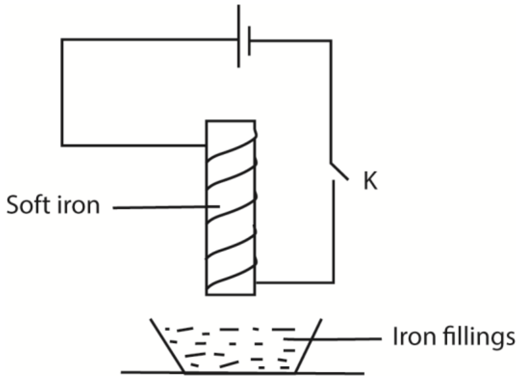


Which of the following is/are observed when current flows through the coil?
(i) The magnet is attracted towards P and Q
(ii) The magnet is repelled from P and Q
(iii) The magnet rotates abut its axis
A. (i) only
B. (i) and (ii) only
C. (ii) and (iii) only
D. (i) and (iii) only [A i.e. P is north and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

5. 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[D}

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

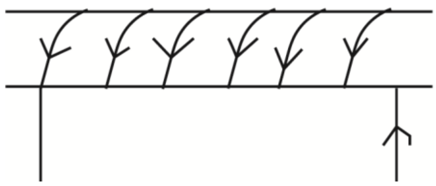
7. A coil is wound on a soft iron rod as shown in the figure below



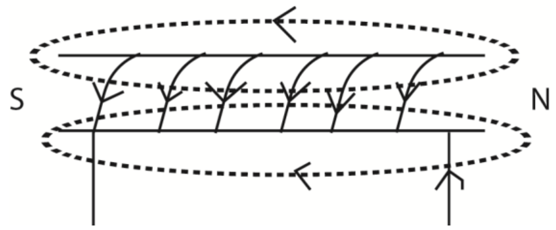
(a) Describe what is observed when K is
(i) Closed
Iron fillings are attracted because soft iron is magnetized
(ii) Closed and then opened
When closed soft iron is magnetized and picks iron fillings, when K is opened soft iron is demagnetized and iron filling fall off although a few remain attracted.

(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

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



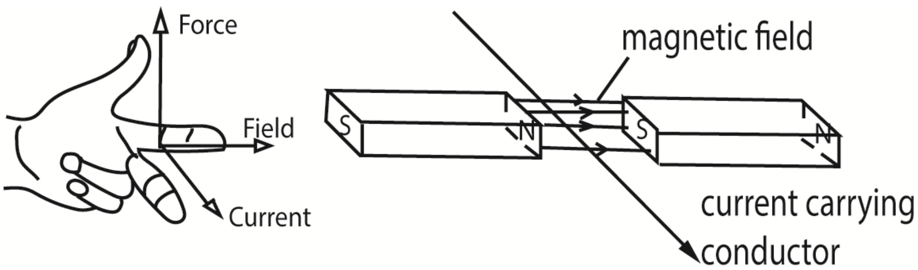
The figure above shows current flowing in a solenoid. Sketch the magnetic field around the solenoid, clearly label the polarities



Force on a current carrying conductor

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)

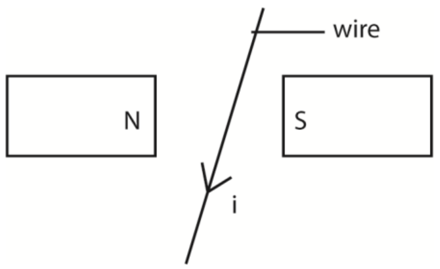


e.g in this figure, the wire moves upward at right angles to the field

Trial 3

1. Which of the following will increase the force on current currying wire?
(i) Using a large current

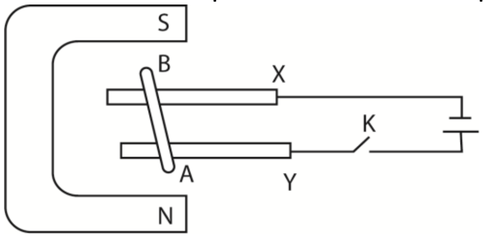
(ii) Using a stronger magnetic field
(iii) Using a shorter length of wire in the field
A. (i) only
B. (i) and (ii) only
C. (i) and (iii) only
D. (ii) and (iii) only [B]

2.


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 [A]

3. 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 [C]

4. 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 [D]

5. 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.

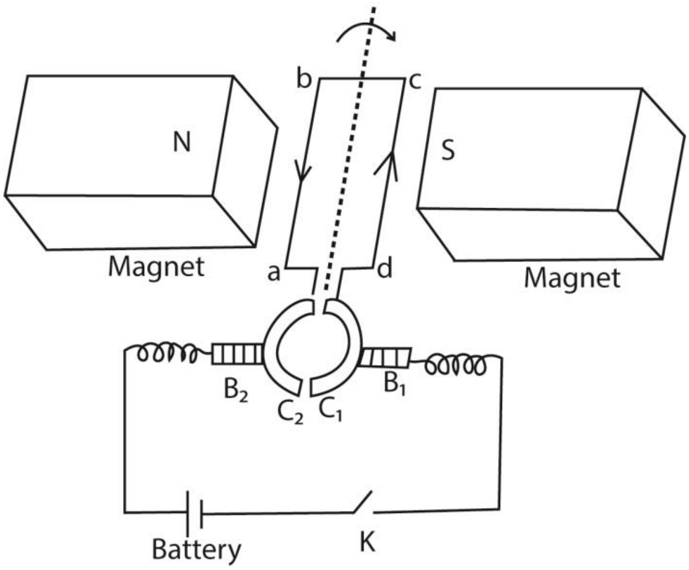
(c) Name two instrument which use the effect in (c).
- Electric motor
- Moving coil meter
- Moving coil loud speaker.

(d) State two ways of demagnetizing a magnet.
- Hitting
- Using a.c. on magnet
- heating

D.C. motor

A **DC motor** (Direct Current motor) is an electrical machine that converts electrical energy into mechanical energy

Structure



It consists of a rectangular coil abcd of wire pivoted between curved poles of a strong magnet and free to rotate about its axis with a uniform velocity.

The ends of the coil are connected to two halves of sprit ring or commutators (C_1 and C_2) which press lightly against the carbon brushes, B_1 and B_2 respectively.

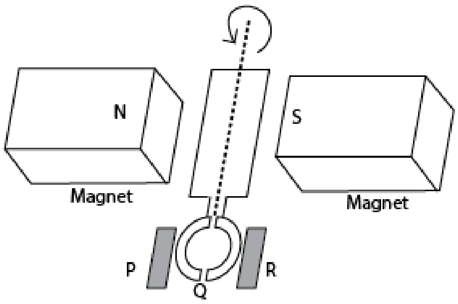
Mode of operation

- The switch K is closed and current flows in the coil in the direction shown

- Applying Fleming's left hand rule, side ab experiences an upward force and side cd a downward force. The two forces constitute a couple which rotates the coil in a clockwise direction.
- When the coil passes over the vertical position, the commutators change contact with the carbon brushes and current in the coil is immediately reversed. The force acting on the sides thus change and the coil continues to rotate in the same direction.
- The axis of rotation of the coil is connected to a system of gears, which transfer the rotational motion to run other equipment.

Trail 4

1. The diagram in the figure below shows a simple motor. The coil continues in the same direction because the commutators 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 [A]
2. Describe with aid of a diagram, how a direct current motor works.

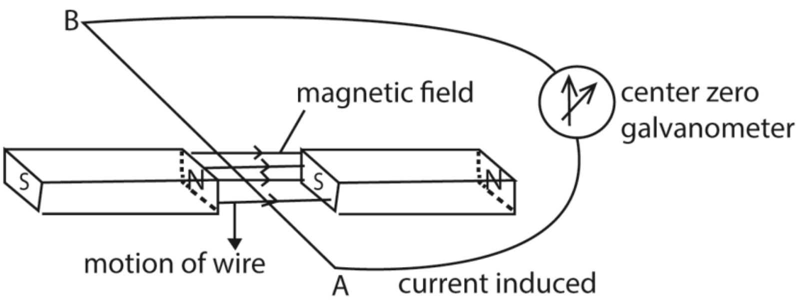
Electromagnetic Induction

Electromagnetic insuction is a the process of generating an electric current through a conductor by changing magnetic field. It occurs when a conductormoves through a magnetic field or when the magnetic field around a conductor changes. As a result, an electromotive force is induced in the conductor, causing curren to flow.

Demonstration of electromagnetic induction

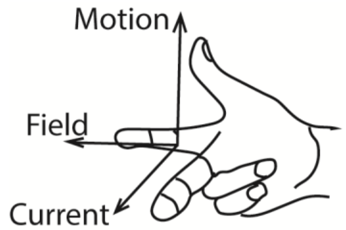
(a) A straight wire AB connected to the galvanometer at right angle to the field

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



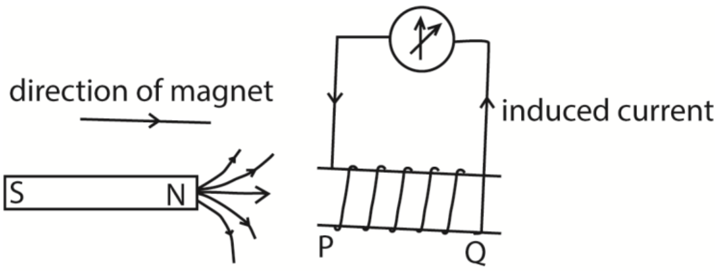
Note

- The relative motion of the wire in a magnetic field leads to induced e.m.f. hence current.
- The faster 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.



Faaday's law of electromagnetism states that:
The magnitude of the emf induced in a coil is directly proportional to the rate of change of magnetic flux density through the coil

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



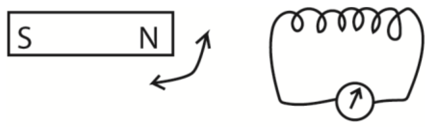
When a north pole is approaching a solenoid current is induced in it to oppose the incoming N pole of the magnet. Thus end P of solenoid becomes a north pole.

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.
Note that the induced e.m.f. depends on

- Number of turns of the coil
- Area of the coil
- Rate of change of the magnetic flux
- Strength of the magnet

Trial 5

1.



The diagram in the figure above, a bar magnet is moved near a coil. Which of the following ways can be used to increase the size of induced e.m.f in the coil

(i) Using a strong magnet

(ii) Moving the magnet at higher speed

(iii) Reducing the number of turns

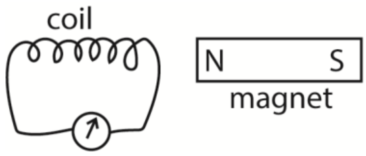
A. (i) and (ii) only

B. (i) and (ii) only

C. (ii) and (iii) only

D. (i), (ii) and (iii) [A]

2. The arrangement in the figure below is used to produce an e.m.f. What causes the e.m.f.



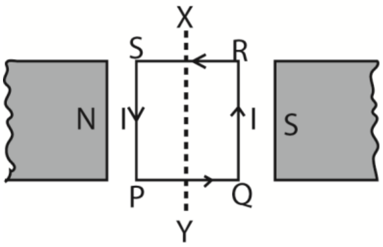
A. The attraction between the coil and magnet

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 [D]

3. 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.

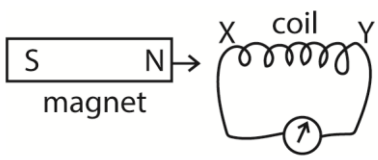
A. (i), (ii), (iii)

B. (i) and (iii) only

C. (ii) and (iv) only

D. (iv) only [C]

4.

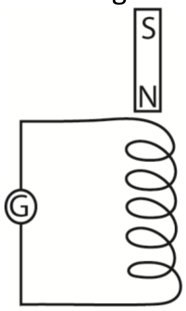


The figure above shows a coil connected to a center zero galvanometer, G. The poles produced at end X and Y of the coil when the North Pole of a magnet approaches it is

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 [A]

5. 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 [D]

6. (a) What is electromagnetic induction?
   This is the generation of e.m.f in a conductor 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

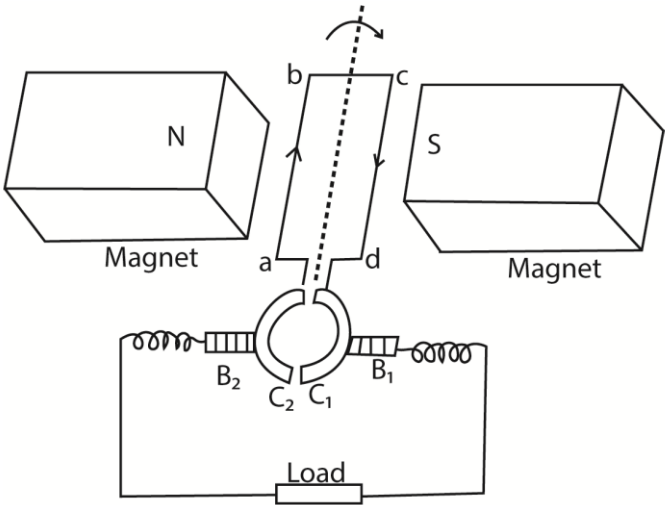


Describe what will be observed on galvanometer as magnet falls through the coil
   - As magnet approaches the coil, the galvanometer deflects and attains maximum deflection as the magnet enters the coil
   - The deflection decreases as the magnet enters the coil and becomes zero when the magnet is inside 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) Why is soft iron used in electromagnets instead of steel?
   Iron easily get magnetized and demagnetised when current is on or off than steel

Application of electromagnetic induction

(a) d.c. generator



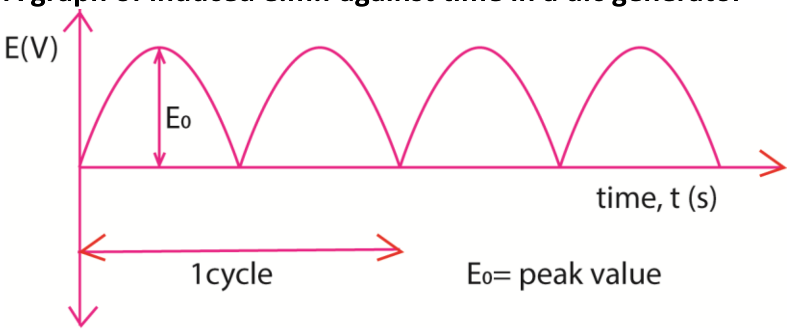
It consists of a rectangular coil abcd of wire pivoted between curved poles of a strong magnet and free to rotate about its axis with a uniform velocity.

The ends of the coil are connected to two halves of sprit ring (commutators) which press lightly against the carbon brush.

Mode of action

- When the coil rotates at uniform velocity in magnetic field, e.m.f is induced in it.
- When the coil is in vertical position, the commutators change brushes C_1 to B_2 and C_2 to B_1.
- E.m.f reverses direction but the current does not change direction. Hence current flows in the same direction in a resistor.

A graph of induced e.m.f against time in a d.c generator



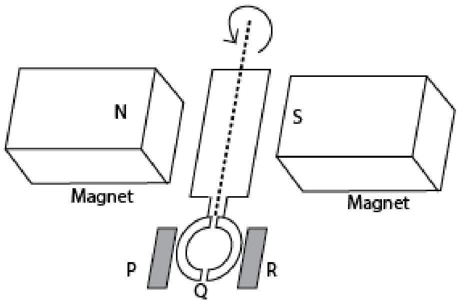
The peak value of induced e.m.f increases with increase in

- The number of turns in the coil
- The area of the coil
- The strength of the magnetic field
- The frequency of rotation of the coil

Trial 6

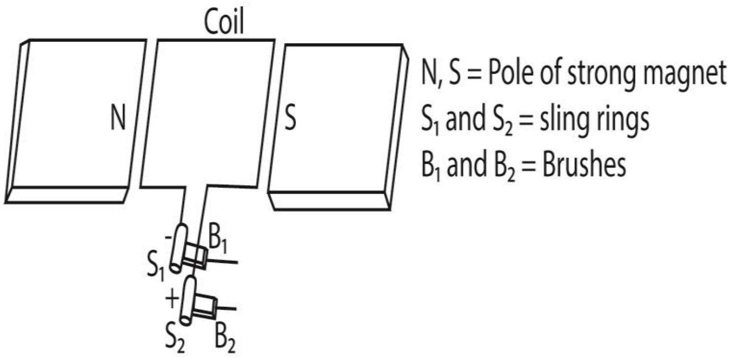
1. The diagram in the figure below shows a simple motor.

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



   E. Reverses current in the coil every half of revolution
   F. Reverse current every quarter of revolution
   G. Reverse polarity of the field produced by the magnet
   H. Carry the coil past its vertical position every half of a revolution [A]
2. With aid of a diagram expalainhow a d.c. generator/dynamo works
3. The armature resistance 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 $= \frac{P_{out}}{P_{in}} x\ 100\%$
   $= \frac{1600}{2000} x\ 100 = 80\%$

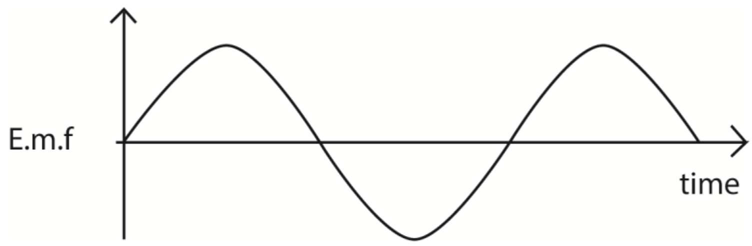
(b) a.c. generator



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.

Advantages of alternating current, a.c

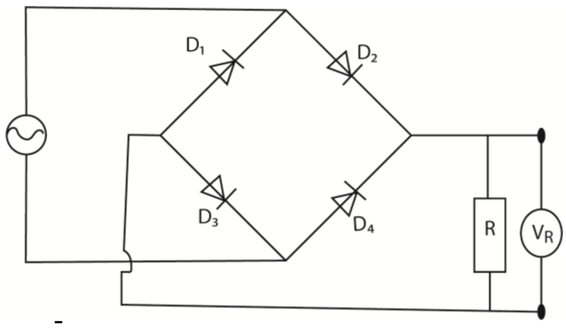
- Cheaper to generate and distribute
- Cheaper to transmit over long distance at high voltage
- Easier Voltage Transformation using step up and set down transformers
- **Compatibility with Household Appliances** like TVs, refrigerators, and microwaves—are designed to run on AC. Powering them with DC would require additional (often bulky) converters.

Advantages of direct current (d.c)

- DC provides a steady voltage flow in one direction, which is ideal for sensitive electronics like laptops, LED lighting, and medical equipment.
- DC is generally considered safer and easier to manage, especially for DIY electronics and low-power environments like IoT devices.
- DC is easier to store in Batteries
- DC systems lose less energy and are more efficient compared to their AC counterparts.
- Ideal for Renewable Energy Sources such as solar panels and fuel cells, generate DC electricity. Using DC directly can reduce energy loss that occurs during conversion to AC.

Rectification of a.c. current

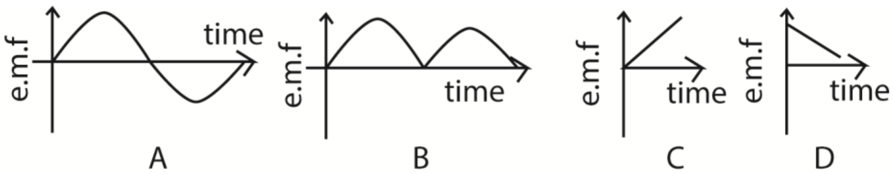
Rectifiers are electric devices that convert alternating current (a.c.)to direct current DC. Full wave rectification can be done using the arrangement of of diodes as show in the diagram below.



-
- 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.

Trial 7

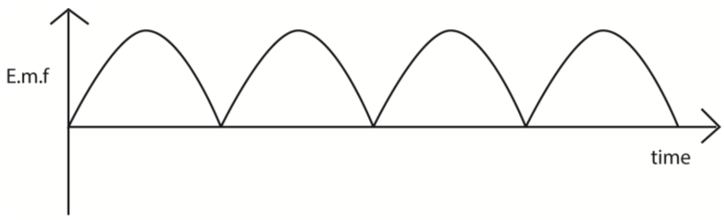
1. Which of the following graphs shows variation of e.m.f produced by a.c. generator with time?



[A]

2. With the aid of a diagram explain how a.c. generator work

3. With the aid of a labelled diagram, describe how full wave rectification can be got using four diodes



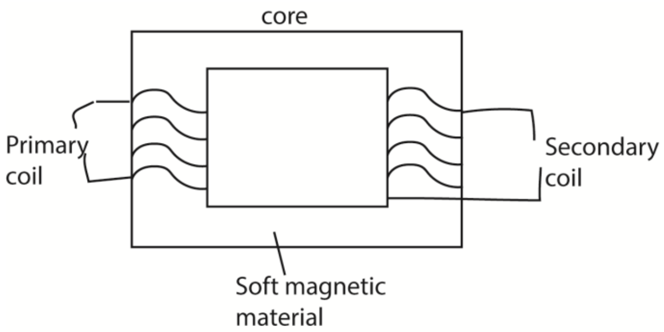
Inverters

Inverters are electronic devices that are used to convert direct current (d.c) into alternating current (a.c)

Application of inverters

Inverters are used solar system, Uninterruptible Power Supplies (UPS), Electric Vehicles (EVs), in power backups etc.

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

A transformer is not 100% due to powers losses

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 3

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 4

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 5

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 20^0C 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

Example 6

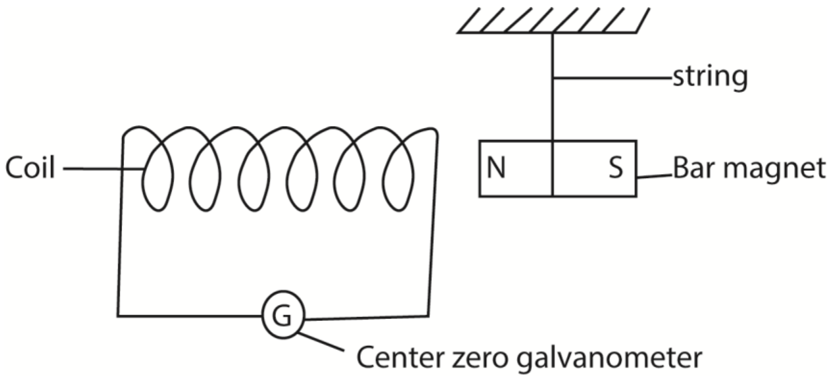
(a) What is a step-down transformer?

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

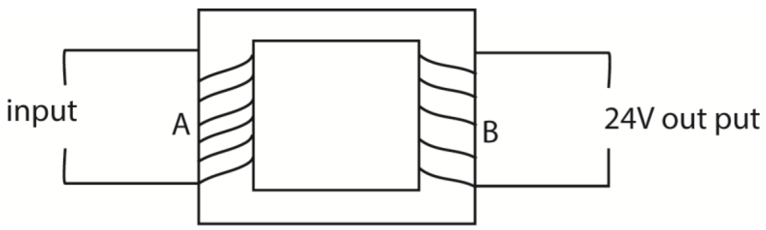
Trial 8

1. 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 [50]
2. A transformer connected to 240V a.c. mains is used to light a 12V 36W lamp. What current does the lamp draw? [3.0A]

3. (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.
   (iii) State four factors on which the deflection of the coil of instrument depends.
   (b) Explain how energy in an a.c. transformer is minimized
   (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. [600]
   (d) Explain why thick cables are used for power transmission.
4. (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
   (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
5. (a) Describe with the aid of a labelled diagram the operation of a 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 [240W]
   (ii) Power developed in the secondary coil [200W]
   (iii) Efficiency of the transformer [83%]
   (c) With the aid of suitable diagrams, distinguish between an alternating current and direct current.
   (d) Explain how a fuse as a safety device achieves its function in house wiring.
6.



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

7. (a) What is meant by magnetic field?

(a) 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

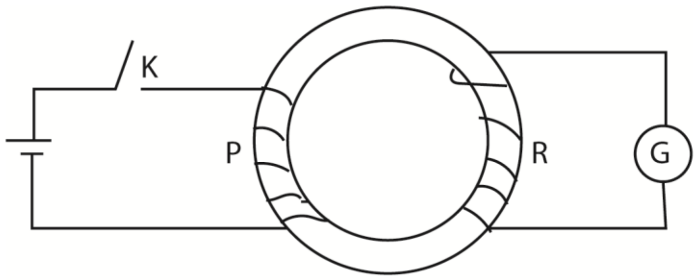
(b) (i) Describe with aid of a diagram, how a direct current generator works.

(ii) State three ways of increasing the e.m.f produced by a generator.

8. (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 $2100Jkg^{-1}K^{-1}$ 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

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Thanks

Dr. Bbosa Science