4.1-Simple phenomena of magnetism

Key terms:

- **Magnetic substances**: Substances that are attracted by magnets are called as magnetic substances.

Examples of magnetic substances: Iron , steel ,nickel and cobalt.

- **Non-magnetic substances**: Substances that are not attracted by magnets are called as non-magnetic substances
  Examples;wood, plastic, copper, paper, aluminium, rubber, stone.

- **Ferromagnetism:** It is the basic mechanism by which certain materials such as iron form permanent magnets or are attracted to magnets.
- **Magnetic field:** It is a region in which a magnetic pole experiences a force

Properties of magnets:

- Magnets can attract another magnet.
- Magnets can attract unmagnetised magnetic substances.
- Magnets attract magnetic substances like iron, cobalt, nickel and steel.
- The ends of magnets are called as the poles of the magnets, namely the north and the south poles. The poles are of equal strength.
- A freely suspended magnet always points in the north south direction.
- Like poles repel and unlike poles attract. Hence South-South poles and North -North poles repel; whereas North-South poles attract.

Magnetically hard and magnetically soft substances

Magnetically hard substances:

- Substances that are hard to magnetise and retain their magnetism are said to be magnetically hard substances.
- These are often alloys of iron, nickel and cobalt.

Magnetically soft substances:

- Substances that are easy to magnetise but lose their magnetism easily are said to be magnetically soft substances.
- They lose their magnetic properties very quickly once they have left a magnetic field.
- Alloys with less iron, nickel or cobalt will be magnetically soft and have a weaker magnetic field

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Types of magnets:

- **Permanent magnets:**

Magnets that retain their magnetism once magnetised are called as permanent magnets.

Ferromagnetic materials such as iron, nickel, cobalt, some alloys of rare earth and some naturally occurring minerals such as loadstone are permanent magnets.

Use: In electric motors, compasses, fridge doors etc

- **Temporary magnets:**

These are magnets that act as magnets in the presence of magnetic fields but lose their magnetism in the absence of magnetic field.

Example: Electromagnets

Use: Junk yards to lift the scrap

- **Electromagnets:**

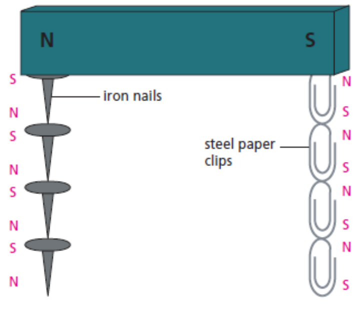
They are wound coils of wire that act like magnets when an electric current is passed through them .The electromagnets can be made stronger either by passing a large current or using a metal such as iron in the core of the coil.

Use: Junk yards to lift the scrap

Note:

- Substances that can be permanently magnetised are magnetically hard substances.
- Substances that can only be temporarily magnetised are described as magnetically soft substances.

Magnetic induction:



- When a magnetic substance is brought near a magnet , an opposite pole is induced in the side of the substance touching the magnet.

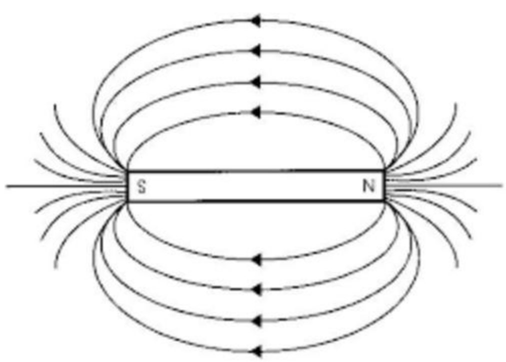
Core of electromagnets

Material used in the core is related to its use: Steel core cannot be used to separate magnetic substances from non-magnetic substances as steel forms a permanent magnet.

Magnetic field

- The region around a magnet where the magnet attracts other magnetic substances is called as a magnetic field.
- The field lines have arrows on them
- The magnetic field lines always point from the north to the south poles of the magnet.
- The magnetic field is are more concentrated at the poles
  and hence is the strongest at the poles.

Pattern and the direction of magnetic field lines around a bar magnet



The direction of the magnetic field at a pointis the direction of the force on the N pole of a magnet at that point

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Plotting of magnetic field lines and finding their direction

Magnetic field lines can be plotted with a compass or with the help of iron filings .A magnetic compass can be used to determine the direction of the magnetic field lines.

Method of plotting the magnetic field lines using a compass:

1. The bar magnet should be placed on a flat surface and then a magnetic compass should be placed close to one of the poles of the magnet.
2. In the diagram below, the blackened part of the needle is the north pole.
3. Mark a small dot as shown in the second diagram.
4. Lift the compass and place it ahead of the previous dot and repeat the entire procedure till the other pole of the magnet is reached.
5. The pole which has the neele pointing outward is the North pole and that which has the needle pointing inwardis the South pole.
6. The magnetic field lines always run from North to South
7. You may then colour the magnet to indicate the North and the South pole and label it too.

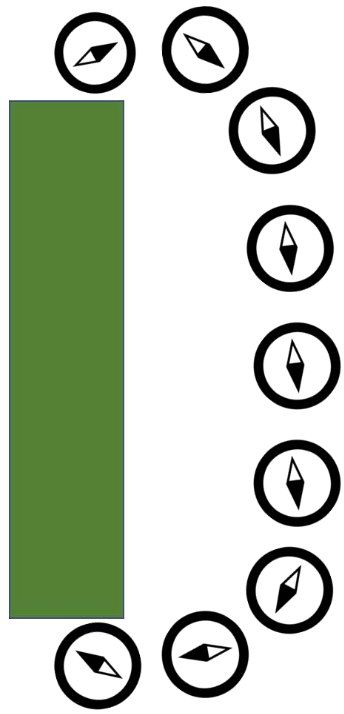


Diagram 1

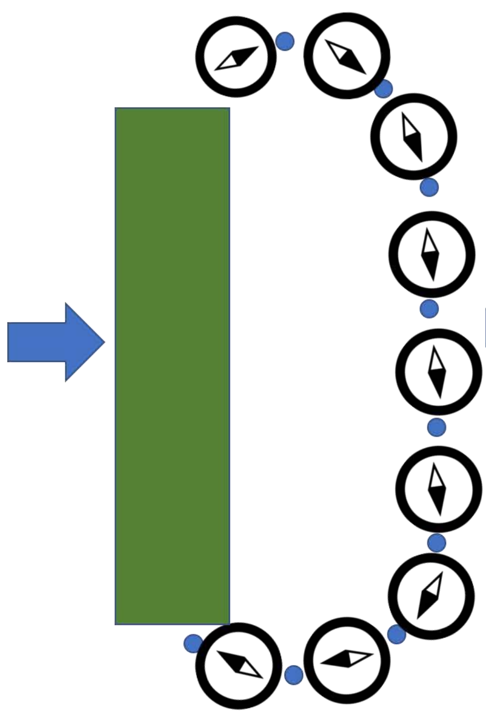


Diagram 2

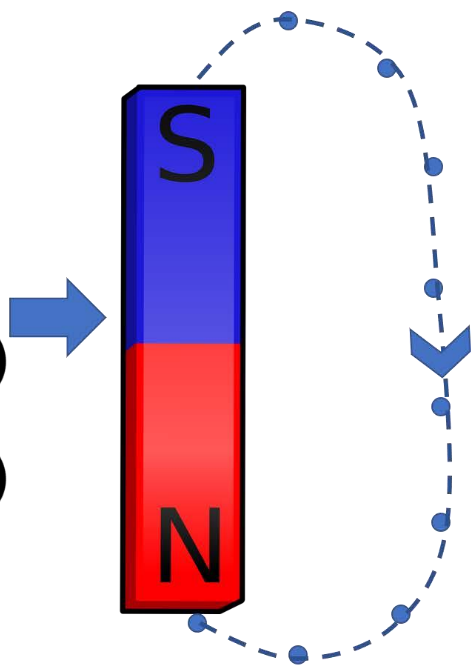
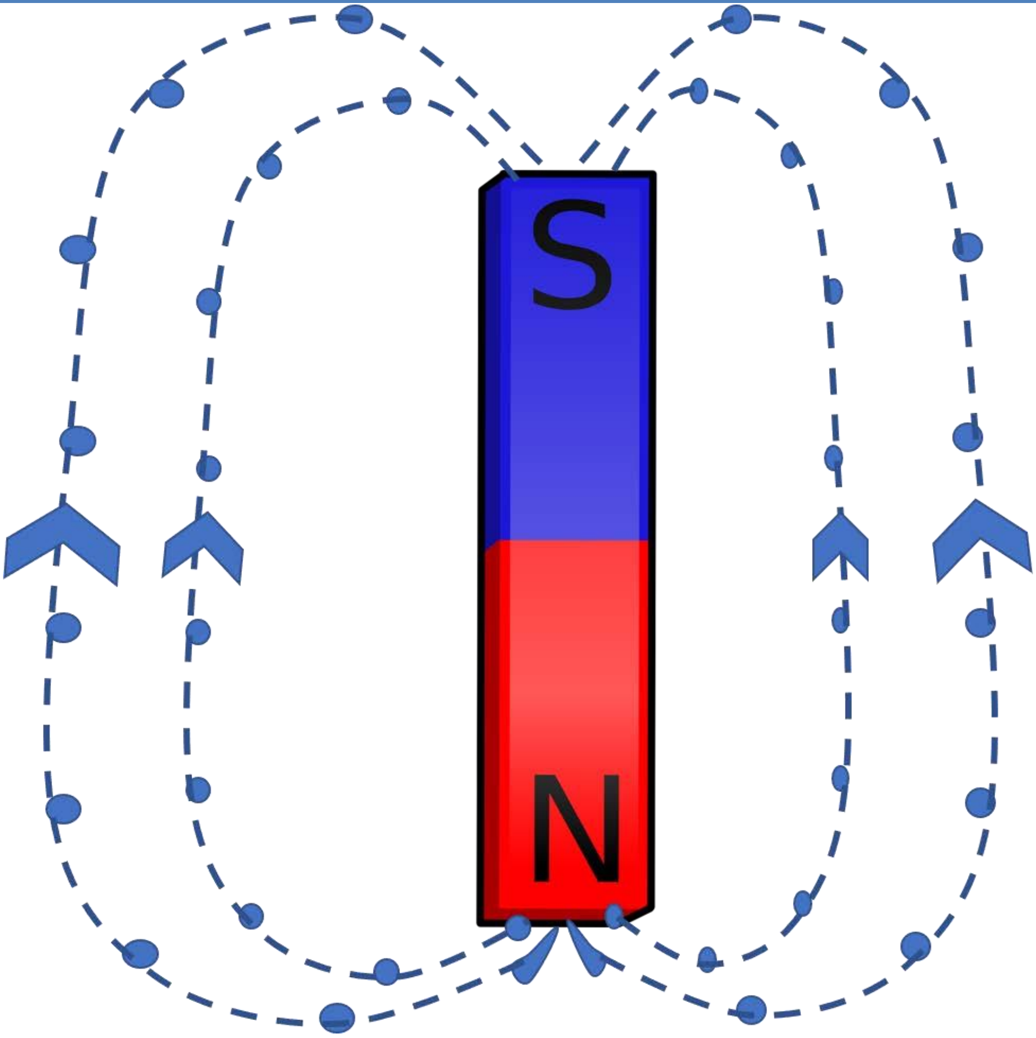


Diagram 3

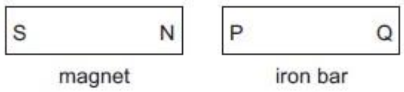


The relative strength of the magnetic field is represented by the spacing of the magnetic field lines. The farther the lines, the weaker is the strength of the field and vice-versa.

Application based past paper questions:

1. Identify the poles induced in a magnetic material

25 The north pole of a bar magnet is placed next to end P of an iron bar PQ, as shown. As a result, magnetic poles are induced in the iron bar.



What are the magnetic poles induced at P and at Q?

0625/11/M/J/09

	magnetic pole at P	magnetic pole at Q
A	north	north
B	north	south
C	south	north
D	south	south

2. Identify the suitable material for the core of an electromagnet

26 An electromagnet is used to separate magnetic metals from non-magnetic metals.

Why is steel unsuitable as the core of the electromagnet?

0625/11/M/J/09

A It forms a permanent magnet.

B It has a high density.

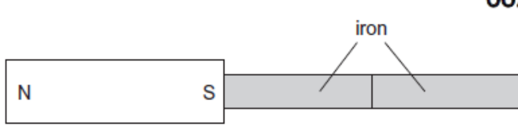
C It has a high thermal capacity.

D It is a good conductor of electricity.

3. Identify the induced poles

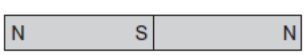
26 A magnet attracts two pieces of iron.

0625/11/M/J/10

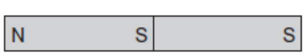


What is the arrangement of the induced poles in the pieces of iron?

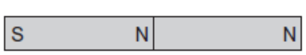
A



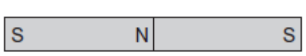
B



C



D



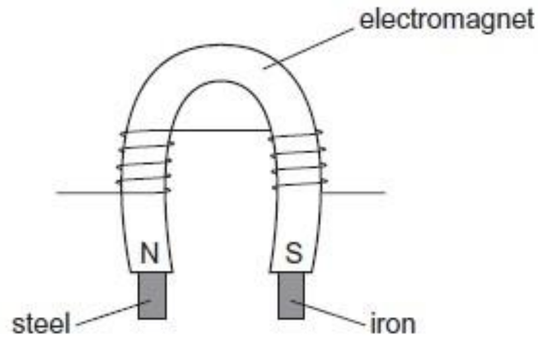
208

4. Identify the behaviour of magnetically hard and soft substances

210

27 A piece of iron and a piece of steel are picked up by an electromagnet as shown.

0625/11/M/J/10



The current to the electromagnet is switched off.

What happens?

A Both the iron and the steel remain magnetised.

B Neither the iron nor the steel remain magnetised.

C Only the iron remains magnetised.

D Only the steel remains magnetised.

---

5. Identify the induced poles of a magnet

219

25 Which test could be used to find which end of a magnet is the north pole?

0625/11/M/J/11

A putting it near a compass needle

B putting it near a ferrous metal

C putting it near a non-ferrous metal

D putting it near a steel spoon

---

6 .Ways of de-magnetising steel

25 Which action will demagnetise a magnetised piece of steel?

0625/13/M/J/15

A Cool it in a freezer for several hours.

B Hit it repeatedly with a hammer.

C Put it in a coil carrying a direct current (d.c.).

D Put it near an unmagnetised piece of iron.

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7. Ways to demagnetise permanent magnets

0625/11/O/N/13

27 How can a permanent magnet be demagnetised?

A cool the magnet for a long time

B hit the magnet repeatedly with a hammer

C leave the magnet in a coil which is connected to a battery

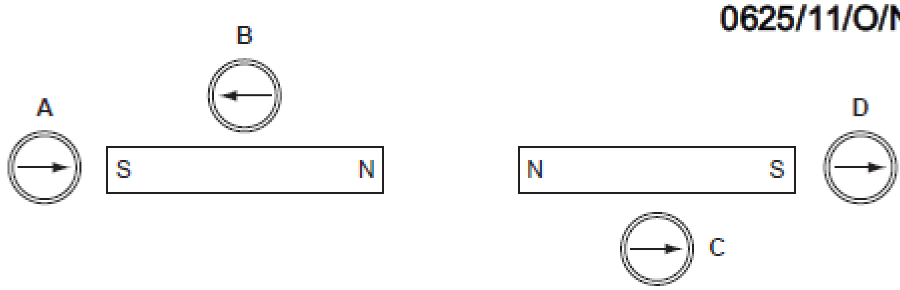
D shine bright light onto the magnet

8. Direction of the magnetic field lines

26 Four plotting compasses are placed in the magnetic field of two identical bar magnets as shown in the diagram.

Which compass is shown pointing in the wrong direction?

0625/11/O/N/09



9 **25** A permanent magnet is brought near to a piece of copper. The copper is not attracted by the magnet.

Why is there no attraction?

0625/11/O/N/09

A Copper is ferrous but is only attracted by an electromagnet.

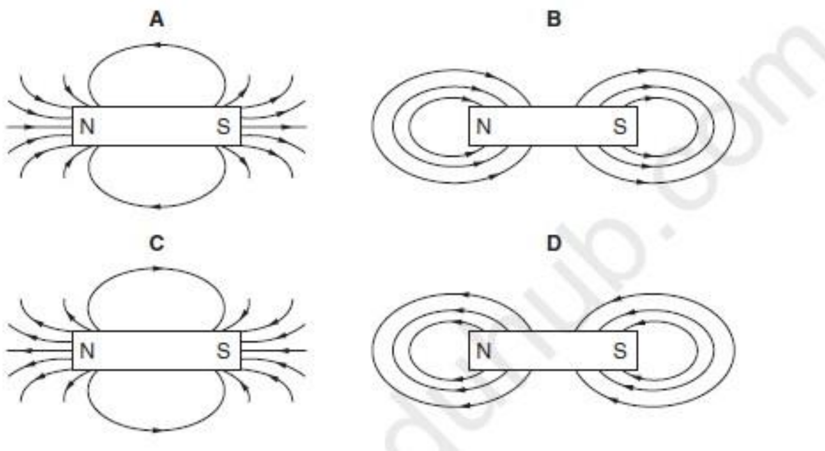
B Copper is ferrous but is not attracted by any type of magnet.

C Copper is not ferrous and is only attracted by an electromagnet.

D Copper is not ferrous and is not attracted by any type of magnet.

10 26 Which diagram best shows the pattern of field lines around a bar magnet?

0625/1/M/J/02



MARK SCHEME:

1-C
2-A
3-B
4-D
5-A
6-B
7-B
8-D
9-D
10-C

EXTENDED THEORY QUESTIONS

M/J/15-P32-Q7

A physics teacher suspends two pointers in a magnetic field. One pointer is made of brass and the other is a magnet.

She holds the pointers in the initial positions shown in the two upper circles of Fig. 7.1. She then releases the pointers.

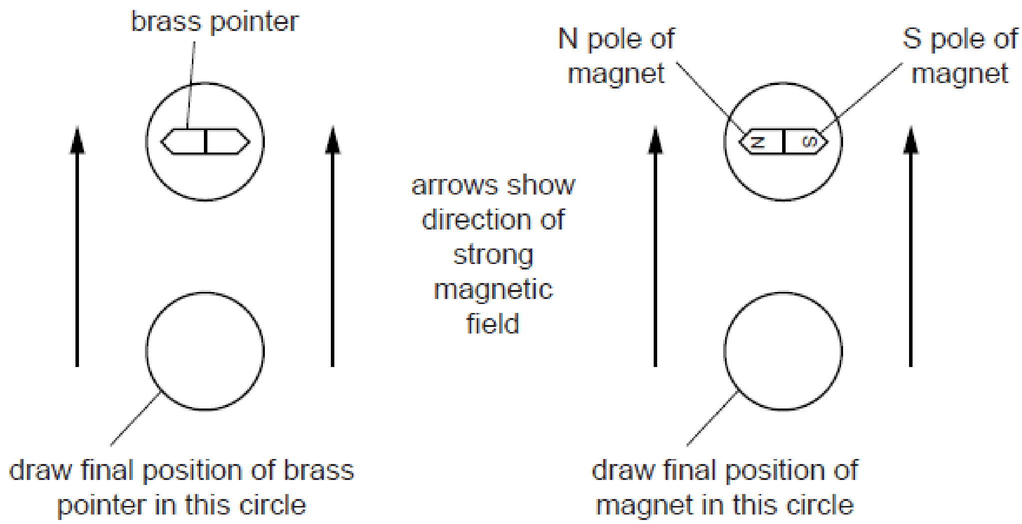


Fig. 7.1

(a) In the lower circles of Fig. 7.1, draw the settled final positions of the two pointers. [2]

(b) (i) Explain the final position of the brass pointer.

....

....

....

(ii) Explain the final position of the magnet.

....

....

....
[2]

(c) Suggest a material from which the magnet is made.

....[1]

[Total: 5]

:MARK SCHEME:

(a) brass:	needle horizontal	B1
magnet:	needle vertical, N pole up	B1
(b) **(i)**	no forces/effect on needle	B1
(ii)	needle aligns with field OR N or S pole attracted along field line or to (magnetic) S or N NOT points to N of Earth	B1
(c)	steel, accept cobalt, nickel, ferrite, Magnadur, Alnico NOT iron	B1

O/N/2015-P32-Q10

10 **(a)** Fig. 10.1 shows the gap between the N-pole and the S-pole of a magnet.

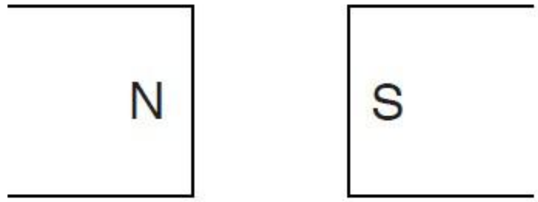


Fig. 10.1

The magnetic field in the gap is uniform.

On Fig. 10.1, draw four field lines to show the pattern and direction of the magnetic field in the gap. [2]

MARK SCHEME:

(a) ≥ 3 horizontal lines in gap by eye B1
≥ 4 evenly spaced horizontal lines filling ¾ of width of gap AND arrows L to R B1

4.2 Electrical quantities

Following subtopics will be covered in this unit:

- ✓ Electric charge
- ✓ Electric current
- ✓ Electromotive force and potential difference
- ✓ Resistance
- ✓ Electrical energy and electrical power

Electric charge

- There are 2 kinds of charges; namely the positive and the negative charge
- The positive charges repel other positive charges
- The negative charges repel other negative charges
- The positive charges attract negative charges
- Charge is measured in coulombs.
- The direction of an electric field at a point is the direction of the force on a positive charge at that point

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Electric field:

An electric field is a region in which an electric charge experiences a force

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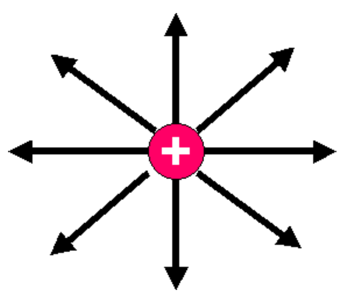
DIRECTION OF ELECTRIC FIELD AROUND A POINT CHARGE



Electric field around a positive charge: The electric field is radially outward from a positive charge

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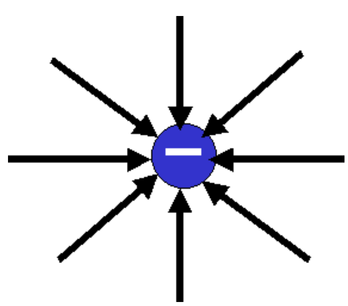
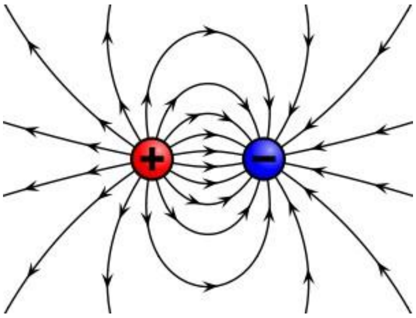


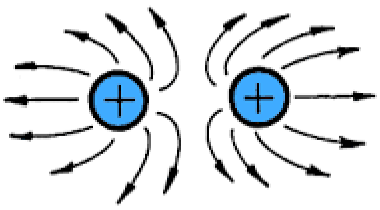
Electric field around a negative charge: The electric field is radially in towards a negative point charge.

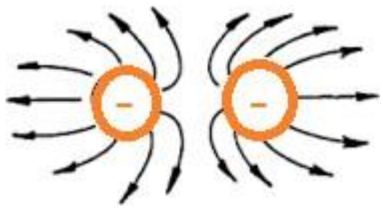
DIRECTION OF ELECTRIC FIELD BETWEEN 2 POINT CHARGES



Electric field between unlike charges: The electric field lines originate from the positive point charge and travel towards the negative point charge.

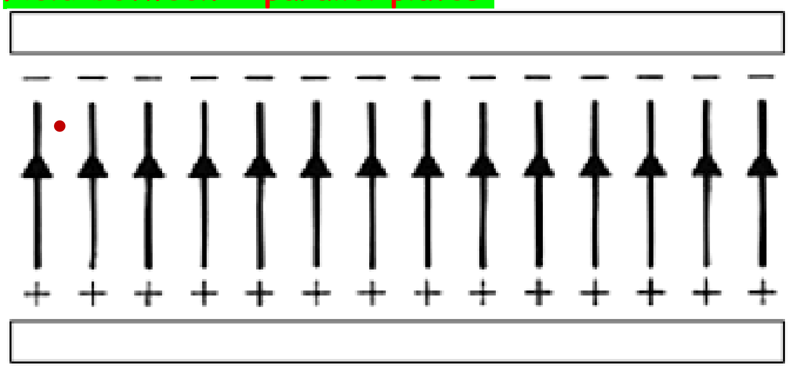
Electric field between like charges: The lines of force radiate away from the individual charges. There is no field between the two charges. This region of no field is indicated by the absence of the electric field lines.,





ELECTRIC FIELD BETWEEN TWO OPPOSITELY CHARGED CONDUCTING PLATES

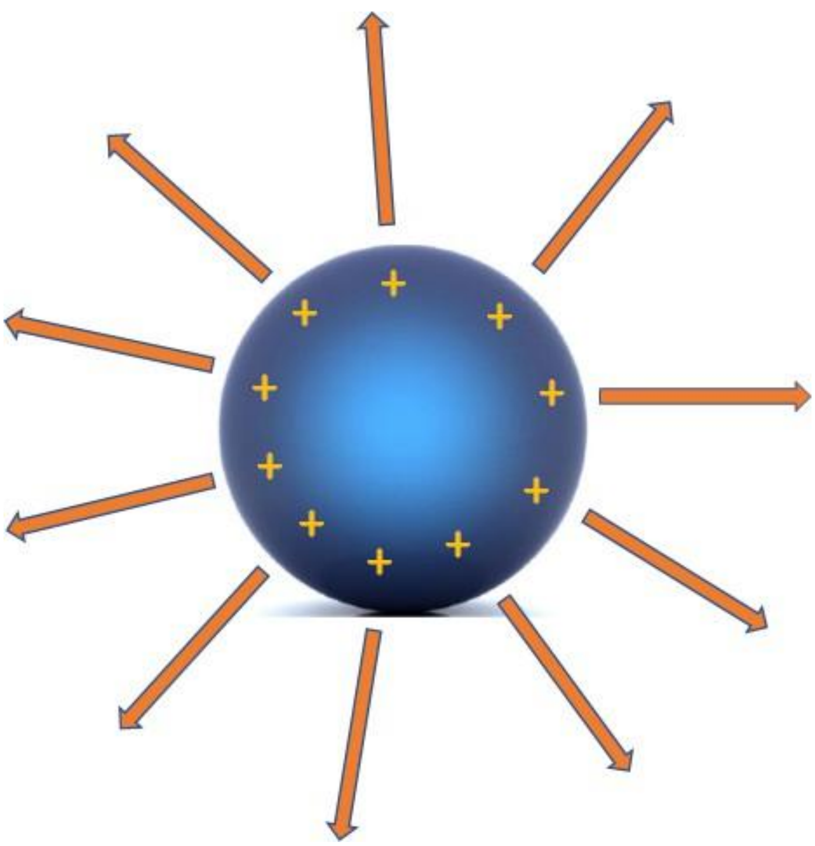
Field between 2 parallel plates:



The direction of field lines are from the positively charged plate to the negatively charged plate.

NOTE: The direction of an electric field at a point is the direction of the force on a positive charge at that point

ELECTRIC FIELD AROUND A CONDUCTING SPHERE



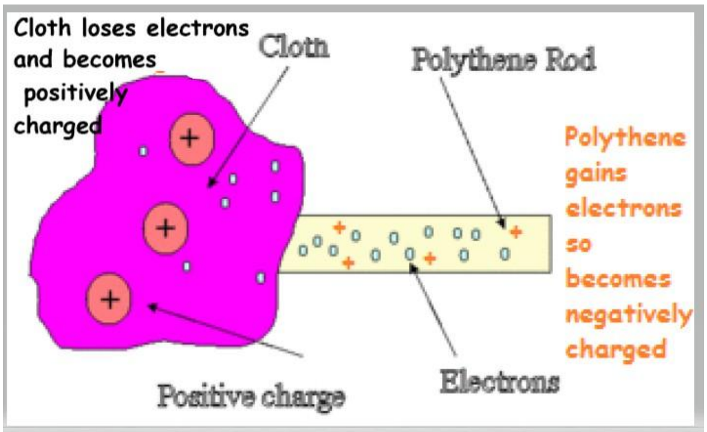
THE DIRECTION OF THE ELECTRIC FIELD IS FROM POSITIVE TO NEGATIVE

Electrostatic charges:

Production of electrostatic charges by friction:

When two insulators are rubbed on each other, electrons are transferred from one insulator to the other. Hence charges are produced on the insulators. These charges stay on the insulators. Hence these charges are called as electrostatic charges.

Example:



When the polythene rod is rubbed on a cloth, some electrons leave the cloth and move to the polythene rod.So the polythene rod has more electrons than protons so it develops a negative charge. Similarly, the cloth loses electrons so it becomes positively charged.

Note: **Charging of solids by friction involves only a transfer of negative charge (electrons)**

Detection of electrostatic charges:

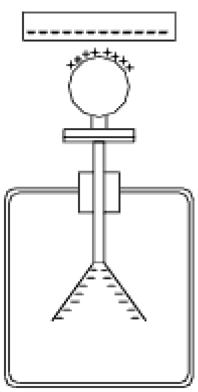
Electrostatic charges can be detected by a gold leaf electroscope.

An electroscope is a device that detects static electricity by using thin metal or plastic leaves, which separate when charged.

A metal disc is connected to a narrow metal plate and a thin piece of gold leaf is fixed to the plate. The whole of this part of the electroscope is insulated from the body of the instrument. A glass front prevents air draughts but allows you to watch the behaviour of the leaf.

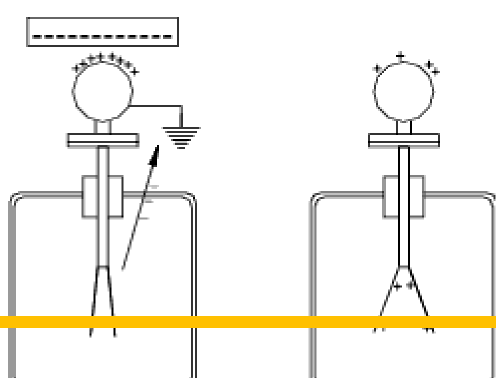
(b)By induction - a charged rod is brought up to the disc and then the electroscope is earthed, the rod is then removed.

- Imagine a charged rod; say a negavitely charged rod is brought close to the conducting surface of the electroscope.



- Separation of charges takes place and the part of the conducting sphere close to the rod develops a positive charge.Negative charges are repelled they flow to the leaves of the electroscope. Since the leaves have the same charge, they repel.

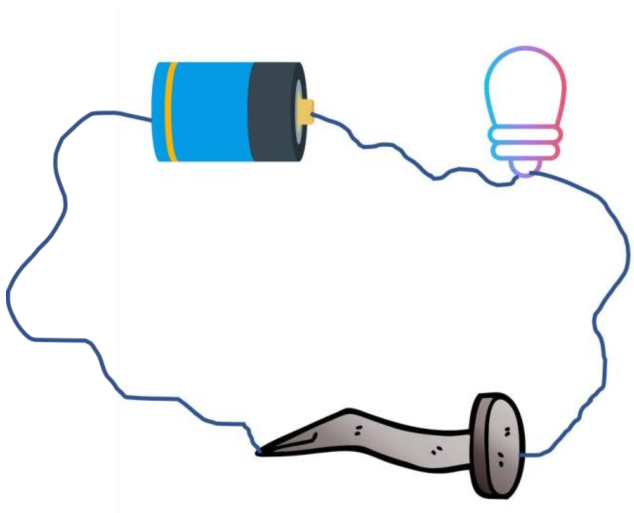
- But if the electroscope is earthed, the electrons flow through the earth and the sphere becomes positively charged.



ELECTRICAL CONDUCTORS AND INSULATORS

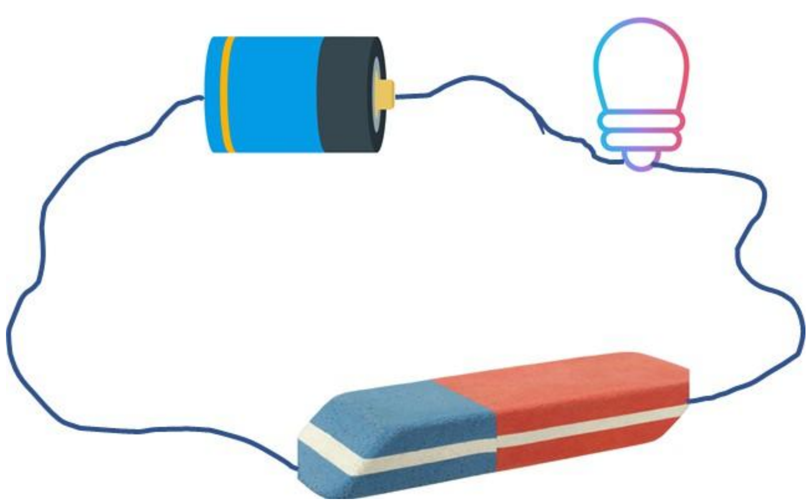
Electrical conductors are aterials that allow electric current to pass through them
Examples :copper utensils, iron nail, safety pin, water, human body etc.
Electrical insulators are materials that do not allow electric current to pass through them
Examples : rubber, plastic, glass, air,etc
Conductors are mainly metallic while insulators are non-metallic.Graphite is a non-metal and it is the only non-metal that can conducts electricity

EXPERIMENT TO IDENTIFY ELECTRICAL CONDUCTORS AND INSULATORS



->Connect an iron nail,a cell and a lamp by using a conducting wire as shown in the adjoining figure.
->It is found that the bulb lights up .
>This indicates that the iron nail is an electrical conductor.
->Other substances can be tested for electrical conductivity in a similar way

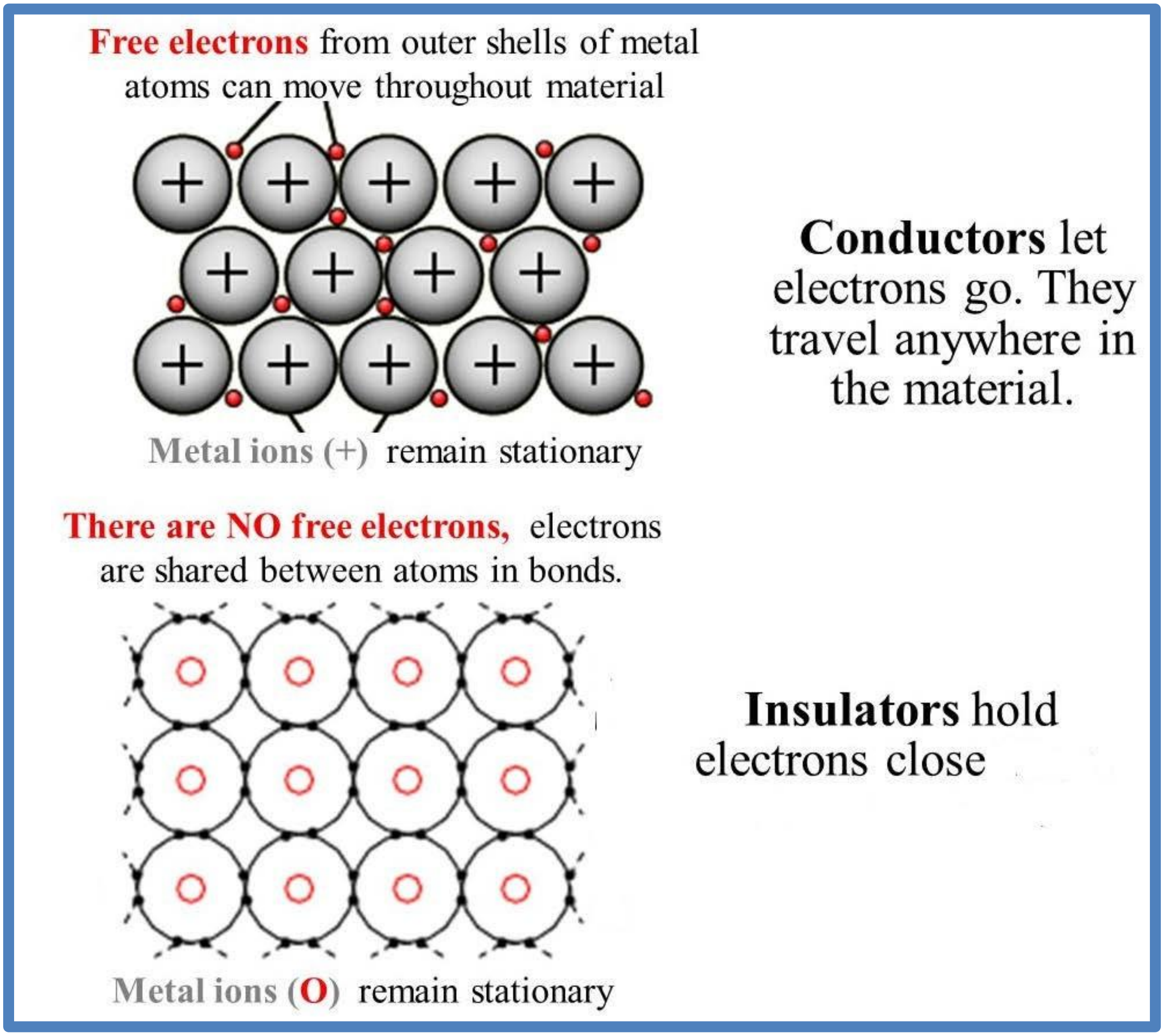
->Connect a pencil , a cell and a lamp by using a conducting wire as shown in the adjoining figure.
->It is found that the bulb does not light up.
->This indicates that the iron nail is an electrical insulator.
->Other substances can be tested for electrical conductivity in a similar way



Difference between electrical conductors and insulators

Electrical conductors	Electrical insulators
Substances that allow electricity to pass through them are called as conductors	Substances that do not allow electricity to pass through them are called as insulators
Electrical resistances of conductors are very low	Electrical resistances of insulators are very high
They contain large number of free electrons	They do not contain free electrons
Generally metals are conductors. Example, copper, silver, gold etc	Generally non- metals are insulators. Example: plastics, rubbers, polystyrene etc

Simple electron model to distinguish between conductors and insulators

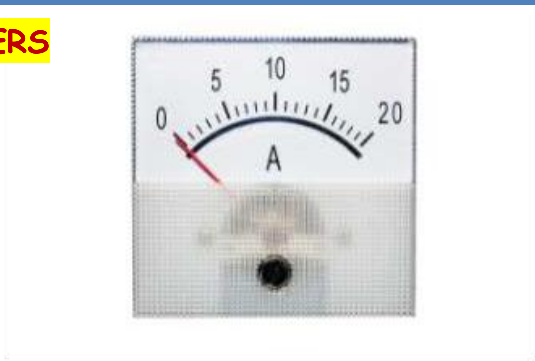


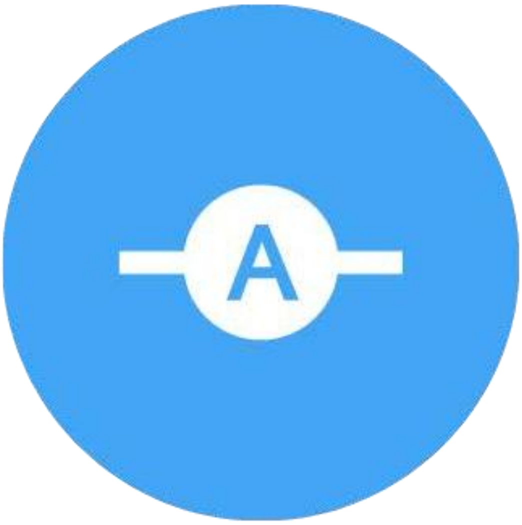
Electric current:

- Current is related to the flow of charge (electrons).
- Ammeter is used to measure electric current.
- Ammeter can be analogue or digital.
- Ammeter is always connected in series with the component whose current needs to be measured.
- Metals conduct electricity because they have free(mobile) electrons.
- Electrons flow from the negative terminal of the power supply to the positive.
- Conventional current flows from positive terminal of the power supply to the negative.
- Current is the charge passing a point per unit time .$I=Q/t$

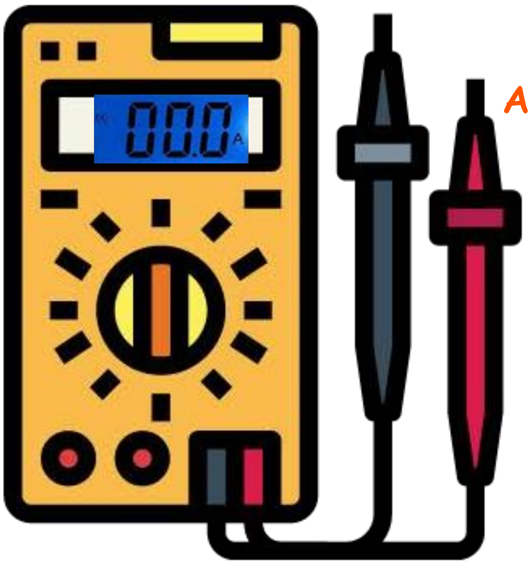
USING ANALOGUE AND DIGITAL AMMETERS

Analogue ammeter with each division=1A

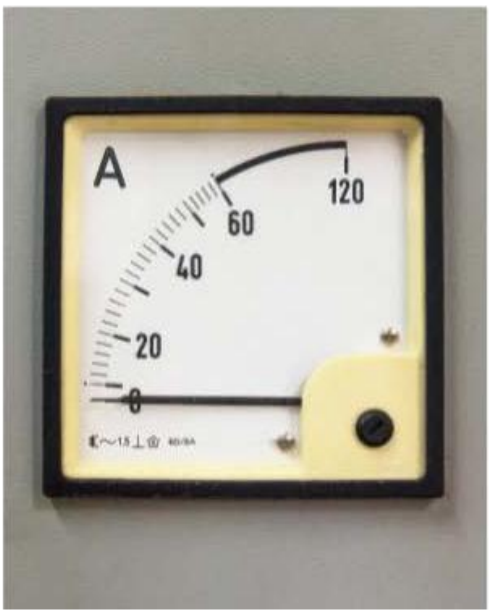




Symbol for an ammeter



A three digit digital ammeter



Analogue ammeter with each division=2A

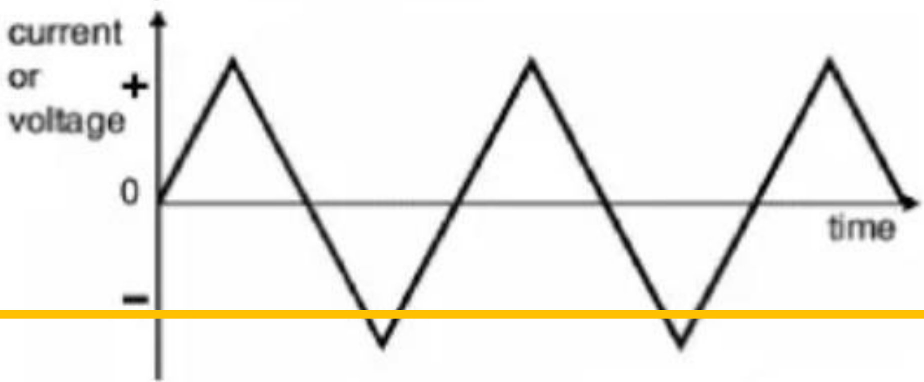
ELECTRICAL CONDUCTION IN METALS:

->The electrical conduction in metals is due to the movement of free electrons.
->The flow of free electrons is from negative to positive

Direct current (d.c.) and alternating current (a.c.)

ALTERNATING VOLTAGE FORMS

DIRECT VOLTAGE



ALTERNATING CURRENT	DIRECT CURRENT
The electrons keep switching directions- forward and backwards	The electrons keep moving steadily- forwards or backwards
It is the current of magnitude that varies with time	It is the current of constant magnitude
It is caused due to a magnet that rotates along a wire	It is caused due to steady magnetism along a wire
It reverses its direction while flowing through the circuit	It flows in one direction through the circuit
The alternating current frequency is 50Hz or 60Hz depending on the country	The direct current frequency is zero
It is obtained from AC generator and mains	It is obtained from a cell or a battery
It is safe to transfer AC current over long distances and provides more power	Direct current cannot travel too far.

ELECTROMOTIVE FORCE AND POTENTIAL DIFFERENCE

Electromotive force:

- Electromotive force is measured across the power supply using a voltmeter
- It is measured in volts
- Emf is defined as the electrical work done by a source in moving a unit charge around a complete circuit
  Emf=W/Q
- **Emf (E)=W/Q**

Potential difference :

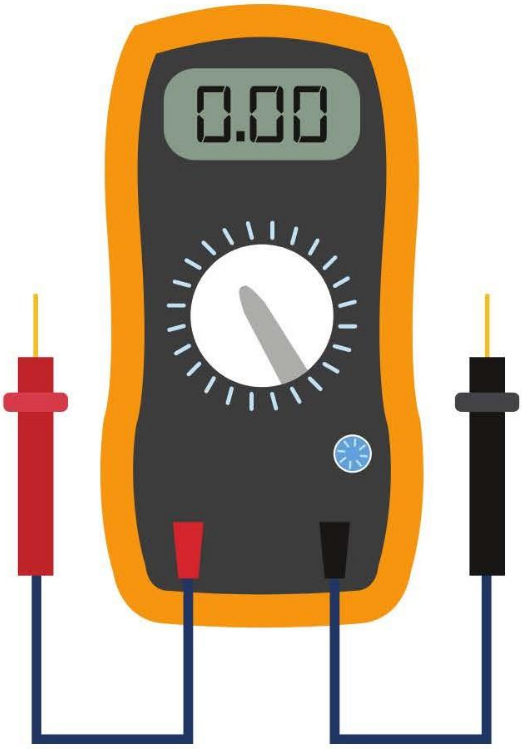
- Potential difference is measured across the electrical components using a voltmeter
- Unit of potential difference is volts(V).
- Voltage is measured using an analogue or digital voltmeter.

  $11V = 1J/1C$

- **Emf is defined as the work done by a unit charge passing through acomponent**
- **p.d.(V)=W/Q**

->Voltmeters come in analogue and in difital form
->Based on the scale of the voltmeters, the value of one division varies

Digital voltmeter using three digits



Symbol for a voltmeter

Analogue voltmeter with one division=1V

Digital voltmeter with one division=10V

Resistance:

- A resistor is a component designed to offer a particular resiustance .
- Resistors are usually made from metal wires or carbon.
- Resistance= $\frac{Potential\ difference}{Current} \Longrightarrow R = \frac{V(volts)}{I(\ amperes)}$
- Unit of resistance is ohms (ΩΩ)
- Resistance is measured using an ohmmeter

Uniform wire: A wire that has the same diameter all along its length is said to be a uniform wire.
The resistance of a uniform wire depends upon the following factors

- material- e.g. copper has lower resistance than steel
- length - longer wires have greater resistance
- thickness - smaller diameter wires have greater resistance
- temperature - heating a wire increases its resistance

Note:
=>The resistance of a metallic wire to its length and to its cross-sectional area
=>for a metallic electrical conductor:
(a) resistance is directly proportional to length
(b) resistance is inversely proportional to cross-sectional area

- -

Current -voltage characteristic of:

- an ohmic resistor
- filament lamp
- diode

==

Ohm's law:

Statement: The current in a resistor at constant temperature is proportional to the potential difference across the resistor

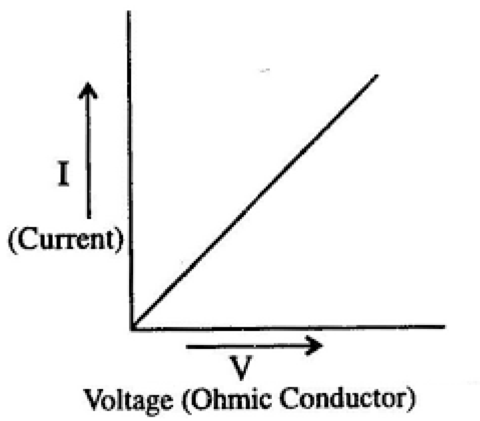
==

Conductors that follow ohms law are called as ohmic conductors. Those that do not follow are called as non-ohmic conductors.

==

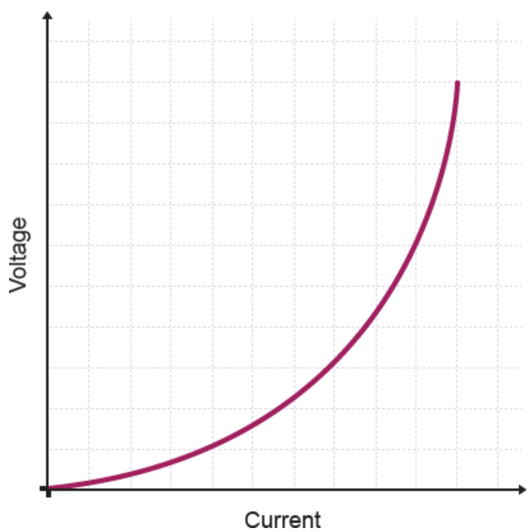
==

Ohmic conductor:



- A linear resistor is ohmic conductor.
- Ohmic examples include all metals like Cu and Al.
- Graph for a ohmic conductor

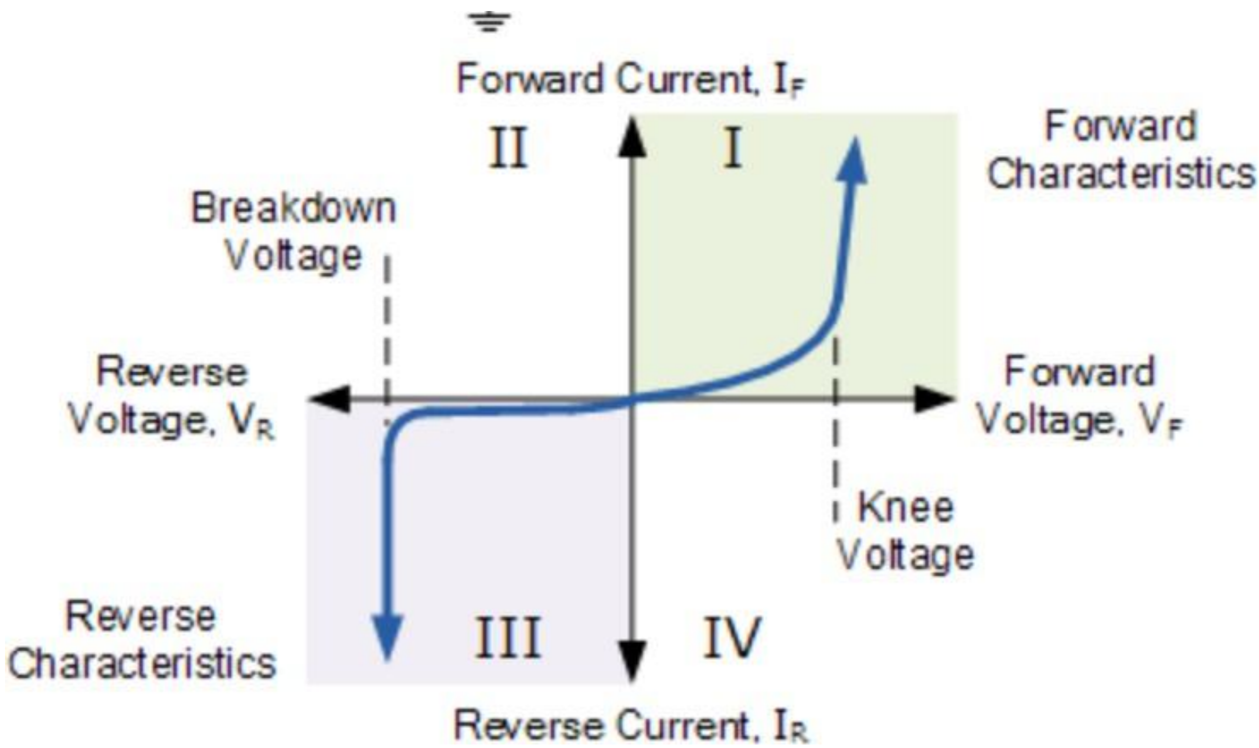
Non-ohmic conductor:



- A light-bulb is a non-ohmic conductor.
- It's voltage-current graph does not follow a straight line.
- A lightning arrestor, a diode are non ohmic conductors
- Graph for a non ohmic conductor

==

Current -Voltage graph of a diode



Forward biased diode:

->The anode is positive with respect to the cathode
-> A forward or positive current passes through the diode
-> The diode operates in the top right quadrant of its I-V characteristics curves

Reverse biased diode:

->The cathode is positive with respect to the anode

->The diode blocks current except for an extremely small leakage current, and operates in the lower left quadrant of its I-V characteristic curves.

ELECTRICAL ENERGY AND POWER

Electrical energy supplied and potential difference: Electical energy supplied= **power x time**

Electrical energy supplied= **current x potential difference** x time

= IVt

where; I = current in amperes

V=potential difference

t= time taken in seconds

Note:

- For a resistor of resistance R, the pd across it, V=IR when the current in it is I.
- In time t, the electrical energy developed in the resistor $=I^2Rt$

Note:

->Electric circuits transfer energy from a source of electrical energy, such as an electrical cell or mains supply, to the circuit components and then into the surroundings

->Electrical power ; P = IV

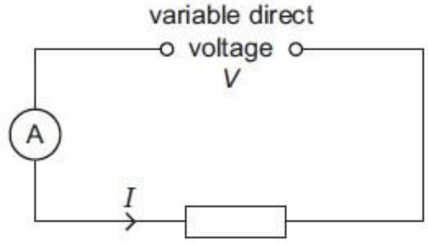
->Electrical energy E = IVt

-A kilowatt-hour is a unit of energy that is equal to the energy provided by a thousand watts in one hour.The energy unit is the kWh

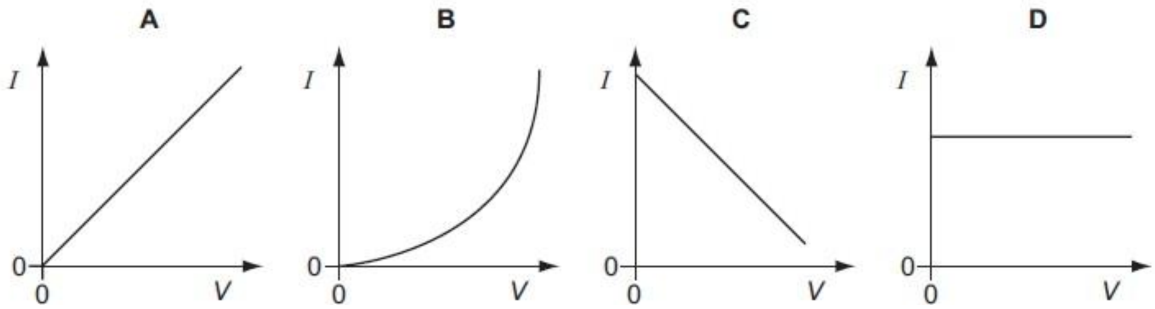
APPLICATION BASED QUESTIONS

1 **28** Using the circuit shown, the current I is found for various voltages V. The temperature of the resistor does not change.

0625/11/M/J/09

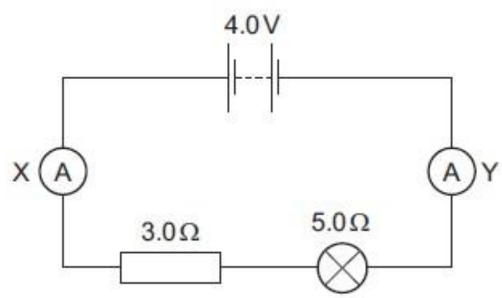


Which graph shows the results obtained?



2 **29** In the circuit shown, ammeter X reads 0.5 A.

0625/11/M/J/09



What does ammeter Y read?

A 0 **B** 0.5 A **C** 3.5 A **D** 4.0 A

3

28 The table shows the lengths and diameters of four copper wires.

Which wire has the **least** resistance?

0625/11/M/J/10

	length/m	diameter/mm
A	0.50	1.0
B	0.50	2.5
C	0.75	1.0
D	0.75	2.5

4

28 A polythene rod repels an inflated balloon hanging from a nylon thread.

What charges must the rod and the balloon carry?

0625/11/M/J/11

A The rod and the balloon carry opposite charges.

B The rod and the balloon carry like charges.

C The rod is charged but the balloon is not.

D The balloon is charged but the rod is not.

5

29 In which unit is potential difference measured?

0625/13/M/J/12

A ampere

B ohm

C volt

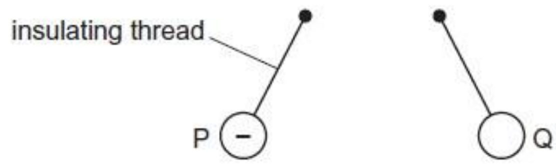
D watt

6

28 Three charged balls, P, Q and R are suspended by insulating threads. Ball P is negatively charged.

0625/11/M/J/13

Ball Q is brought close to ball P.



Ball Q is now brought close to ball R.

What are the charges on ball Q and on ball R?

	ball Q	ball R
A	positive	positive
B	positive	negative
C	negative	positive
D	negative	n

7

27 The diagram shows a piece of metal resistance wire.

0625/11/M/J/15

Which wire, made of the same metal, has a smaller resistance?

A a wire of the same length with a larger diameter

B a wire of the same length with a smaller diameter

C a wire of greater length with the same diameter

D a wire of greater length with a smaller diameter

8

28 What is the unit of electromotive force (e.m.f.)? **0625/11/M/J/15**

A ampere

B joule

C volt

D watt

MARK SCEME:

1-A
2-B
3-B
4-B
5-C
6-C
7-A
8-C

APPLICATION BASED QUESTION-EXTENDED THEORY

1

10 Fig. 10.1 shows two parallel conducting plates connected to a very high voltage supply.

M/J/15-P31

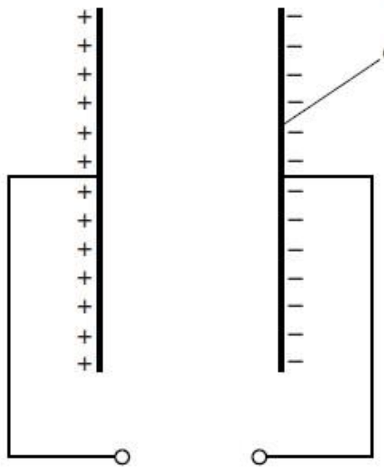


Fig. 10.1

The left-hand plate is positively charged and the right-hand plate is negatively charged.

(a) On Fig. 10.1, draw the electric field pattern produced between the charged plates. Use arrows to show the direction of the field. [2]

(b) A light, conducting ball is suspended by an insulating string. Fig. 10.2 shows the ball in the middle of the gap between the plates.

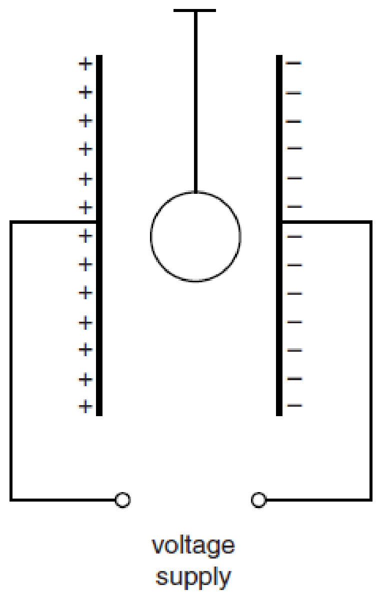


Fig. 10.2

On Fig. 10.2, show the distribution of charge on the ball. [2]

(c) The ball is displaced to the left and then oscillates backwards and forwards between the two plates.

The ball touches a plate once every 0.05 s. Every time it touches a plate, a charge of 2.8×10^{-8} C (0.000 000 028 C) is transferred.

Calculate the average current produced by the repeated transfer of charge.

current = ... [2]

[Total: 6]

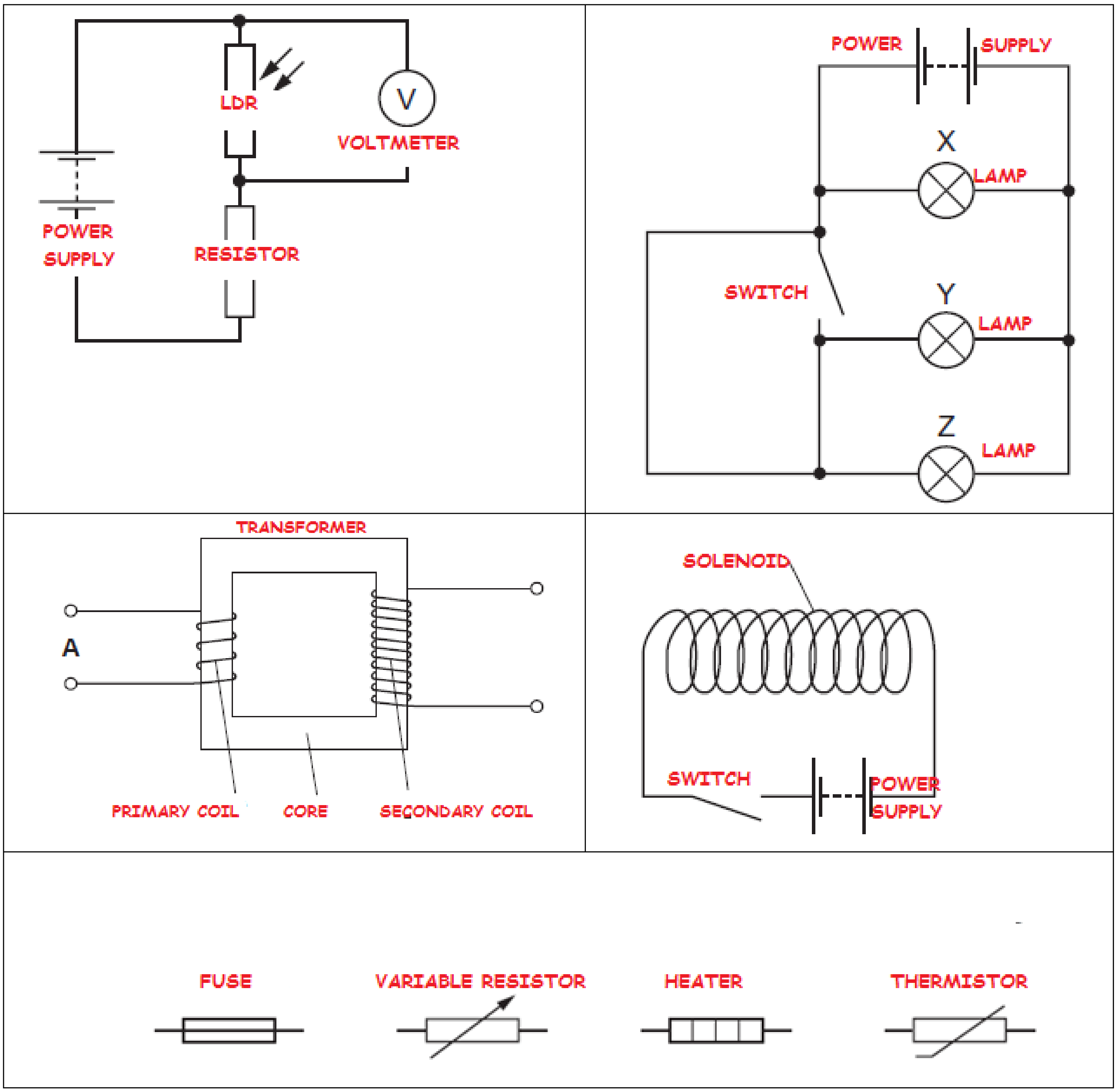
MARKSCHEME:

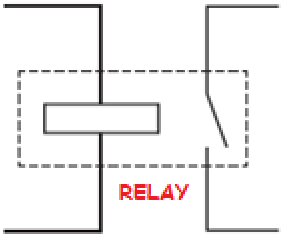
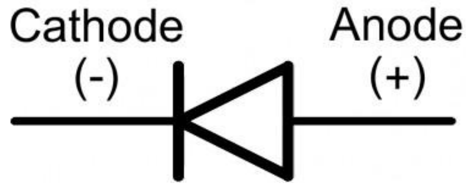
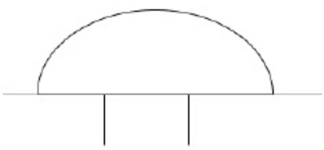
(a)	**(i)** at least three horizontal, parallel lines evenly spaced (ignore edge effects)	B1
	arrows pointing left to right	B1
(b)	right hand half of ball has more + signs than – signs AND left hand half of ball has more – signs than + signs	M1
	equal numbers of + and – signs	A1
(c)	$Q = It$ in any form OR ($I =$) $Q \div t$ OR $2.8 \times 10^{-8} \div 0.05$	C1
	5.6×10^{-7} A OR C/s	A1

[Total: 6]

4.3-Electric circuits

KNOW THE ELECTRICAL COMPONENTS:



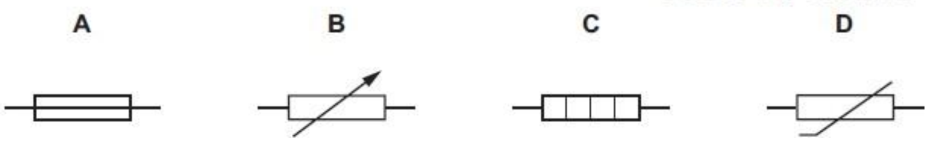
	 Diode
 electric bell	 Center zero galvanometer

APPLICATION BASED QUESTIONS:

MCQ:

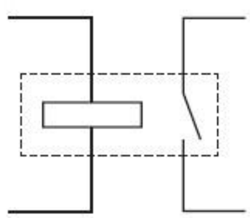
1

30 What is the circuit symbol for a variable resistor? **0625/11/O/N/15**



2

31 Which component is represented by this circuit symbol? **0625/13/M/J/15**



A a bell

B a fuse

C a relay

D a transformer

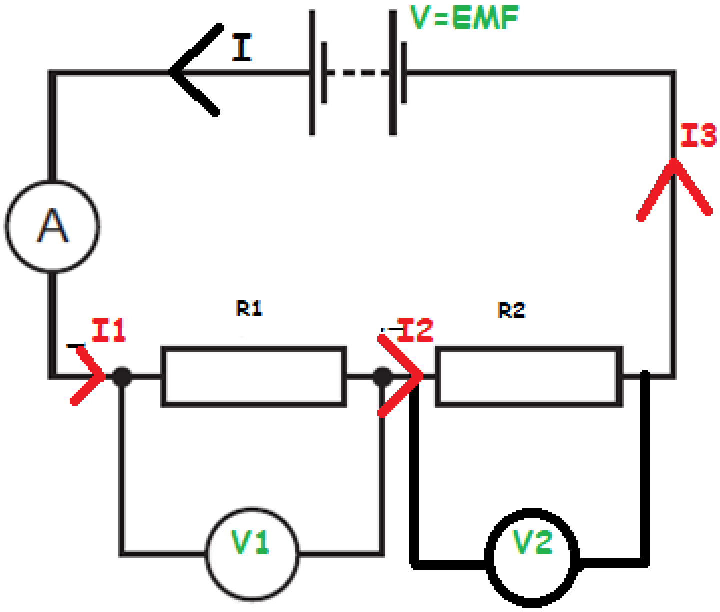
3 **27** Which symbols are used for the units of current and of resistance?

	unit of current	unit of resistance
A	A	W
B	A	Ω
C	C	W
D	C	Ω

0625/11/O/N/11

MARK SCHEME:
1-B
2-C
3-B

Series circuits



Currrent: Current at every point in a series circuit is the same.

$I = I_1 = I_2 = I_3$

Potential difference:

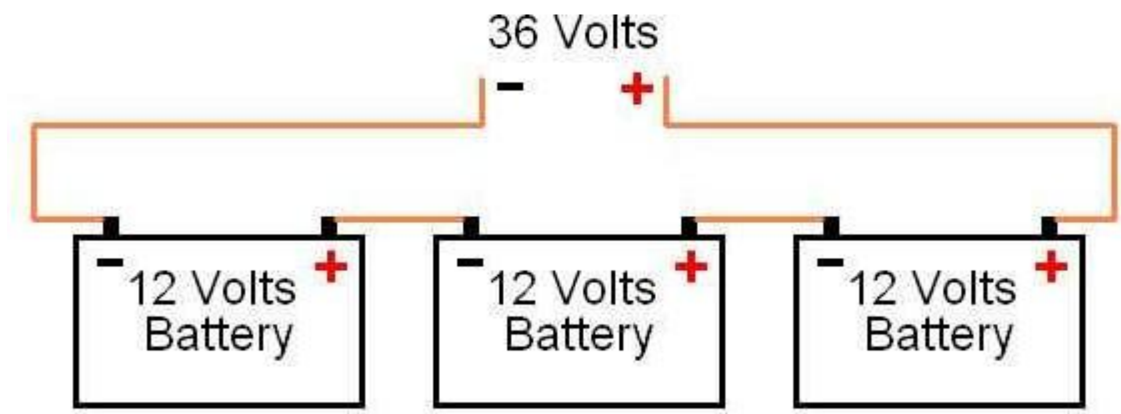
Sum of the pd's across the components in a series circuit is equal to the total pd(emf) across the

$V = V_1 + V_2$

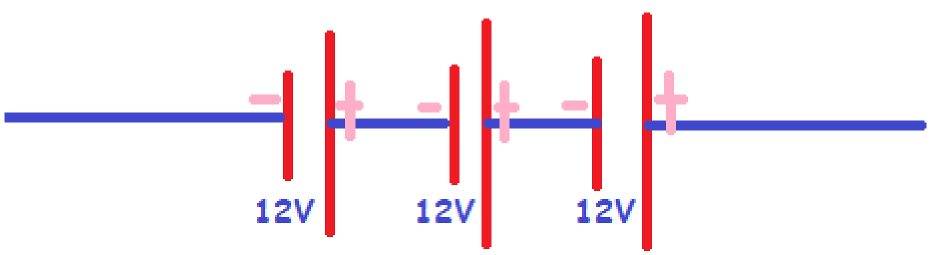
Combined resistance : Total resistance in a series circuit is equal to the sum of individual resistances of the resistors.

$R = R_1 + R_2$

Combined emf of several sources in series:

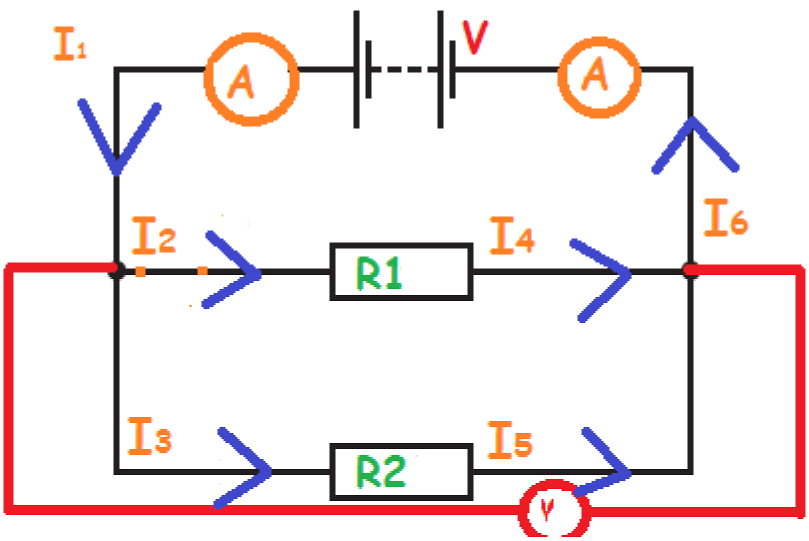


The above diagram can be represented as:



The combined emf= 36V

Parallel circuits



Current:

$I_1=I_2+I_3$

$I_1=I_6$

$I_6=I_4+I_5$

$I_2+I_3= I_4+I_5$

$I_2=I_4$

$I_3=I_5$

Voltage:

The voltage across the power supply is the same as the voltage across each branch in a parallel circuit.

Hence :

The voltage across Resistor R_1 = The voltage across Resistor R_2
= Emf of the power supply

Resistance:

The total resistance (R) in a parallel circuit is given by:

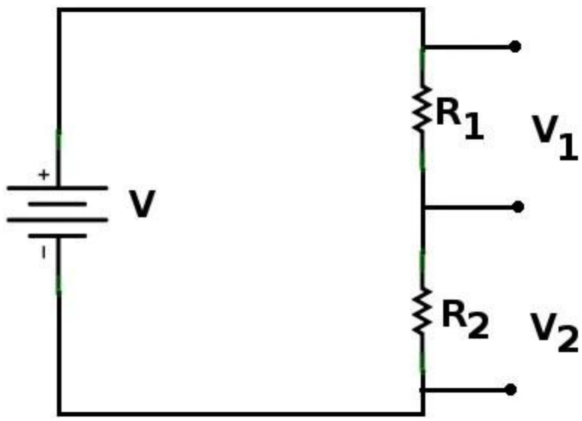
$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_{22}}$$

Advantages of connecting lamps in parallel in a lighting circuit:

- All lamps will work at the same brightness.
- If one lamp breaks, the others will continue to light.

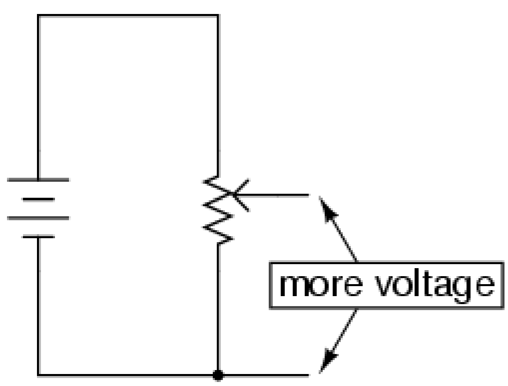
Action and use of circuit components:

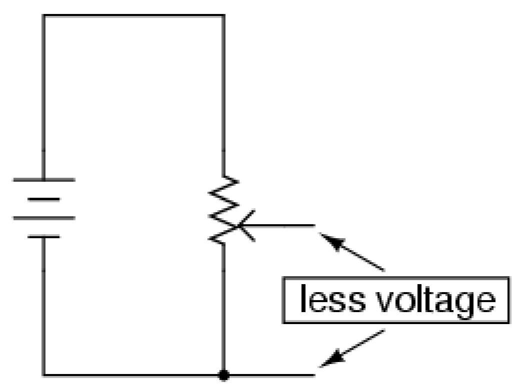
Action of a potential divider: A potential divider consists of 2 or more resistors connected in series across a power supply.



Because the resistors are in series so the same current flows through them. The emf of the power source is shared between the two resistors R_1 and R_2.

Action of a variable potential divider-potentiometer:





A potentiometer is a kind of potential divider. There is a sliding contact that can help to change the potential.

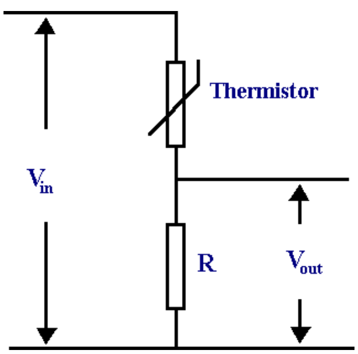
- The voltmeter reading increases when more wires are brought in contact.
- The voltmeter reading decreases when less wires are brought in contact.
- Thus the pd between the sliding contact and either fixed contact depends on the position of the sliding contact.

Action of Thermistors (TDR) and light dependent resistors (LDR) and their use as input transducers

Transducers: A sensor circuit is also called as a transducer.LDR and TDR are used in sensor circuits

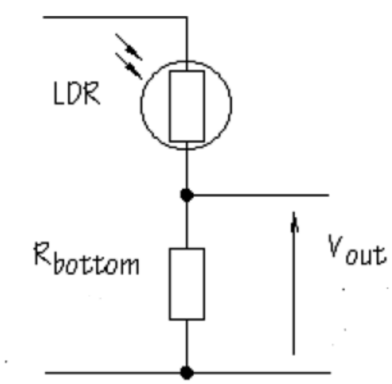
Thermistor:

- A thermistor is a temperature dependent resistor.
- Its resistance decreases as its temperature increases.



When the temperature of the thermistor increases, its resistance decreases, so its share of battery pd decreases. as a result its share of battery pd across resistor R increases so the output pd increases.

Light dependent resistor:



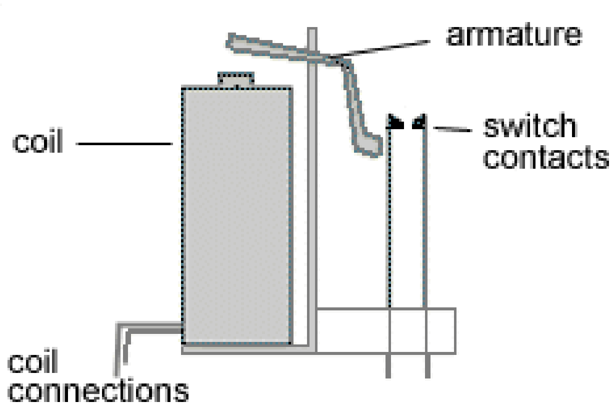
When the brightness of the incident light increases, its resistance decreases, so its share of battery pd decreases. as a result its share of battery pd across resistor R inc

---

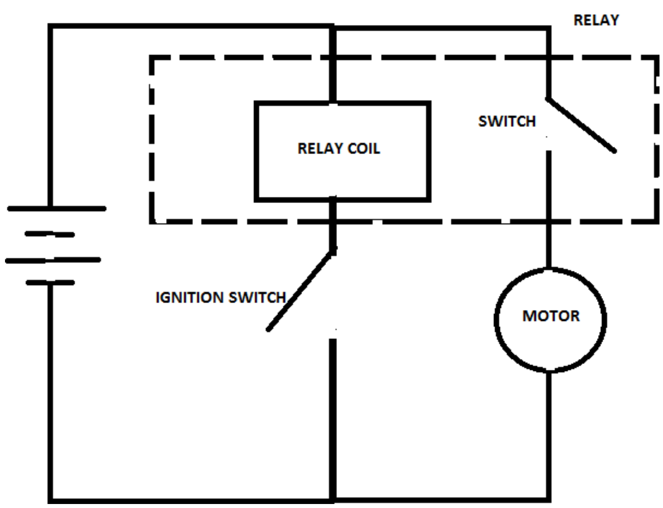
Action of relay and their use in switching circuits:

Relay:

A relay is a special type of switch turned on and off by an electromagnet.



When a current flows through the coil an electro-magnetic field is set up. The field attracts an iron armature, whose other end pushes the contacts together, completing the circuit. When the current is switched off, the contacts open again, switching the circuit off.



When the ignition car switch is turned on, a small current passes through the coil of the electromagnet and the iron armature is attracted to the electromagnet. The armature turns about the pivot and closes the gap. This allows a much larger current to pass through the car motor.

Working of diode and its use as a rectifier:

A diode allows the current to flow in one direction only. This direction is referred to as the forward direction. Its resistance in the forward direction is very low. Its resistance in the reverse direction is very high.

Solved Examples:

8 (a) A piece of wire has a resistance of 0.45 Ω. **O/N/13-P32** ƆUO

Calculate the resistance of another piece of wire of the same material with a third of the length and half the cross-sectional area.

the resistance of another piece of wire of the same material with a third of the length and half the cross-sectional area.

$=(0.45 \times 2/3)$

$= 0.3(0)\,\Omega$

(b) Fig. 8.1 shows a circuit with three resistors, a power supply and four voltmeters.

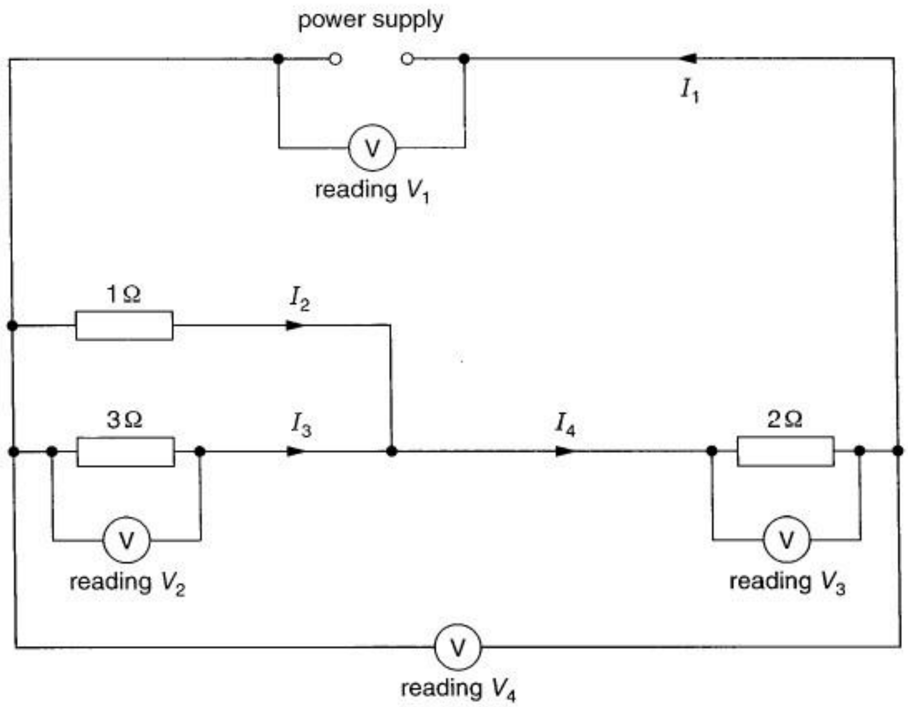


Fig. 8.1

(i) Calculate the combined resistance of the three resistors.

combined reisistance$= 1/\{(1/1+ 1/3)\}+ 2$

$=2.75$ *ohm*

(ii) Write down **two** relationships for the currents in the circuit.

$I_1 = I_4$ *and* $I_1 = I_2 + I_3$

(iii) Write down **two** relationships for the voltmeter readings in the circuit.

$V_1 = V_4$ *and* $V_1 = V_2 + V_3$

10 The circuit shown in Fig. 10.1 uses a 12V battery. A and B are identical lamps, each designed to work from a 6V supply.

M/J/2009-P32

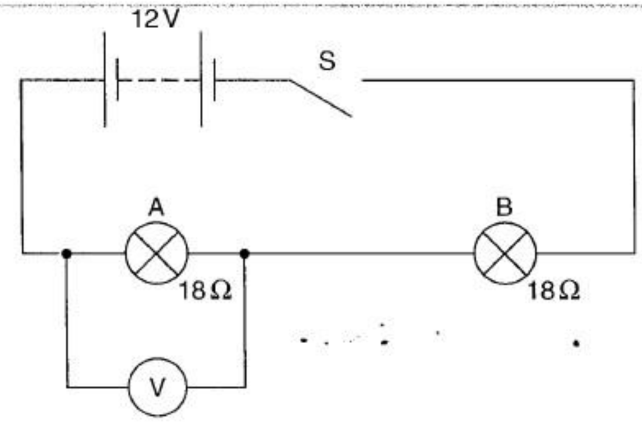


Fig. 10.1

(a) Switch S is open, as shown in Fig. 10.1.

(i) State the value of

1. the potential difference (p.d.) across S,

12V

2. the reading on the voltmeter.

0V

(ii) Comment on the brightness of the two lamps.

Both lamps off

(b) Switch S is now closed.

(i) State the new reading on the voltmeter.

6V

(ii) Comment on the brightness of the two lamps.

Normal brightness

(iii) Under these conditions, each lamp has a resistance of 18Ω.

Calculate the current in each lamp.

$V = IR$

$6 = I \times 18$ $\Rightarrow I = \frac{6}{18} = \frac{1}{3} = 0.3A$

(c) With switch S open, lamp B is connected in parallel with lamp A. With no current, each lamp has a resistance of 1.8 Ω.

(i) Calculate the value of the combined resistance of A and B.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \therefore \frac{1}{R} = \frac{1}{1.8} + \frac{1}{1.8} \Rightarrow \frac{1}{R} = \frac{2}{1.8} \Rightarrow R = \frac{1.8}{2}$$

$$= 0.9\,\Omega$$

(ii) State why it would not be wise to close S when A and B are connected in parallel.

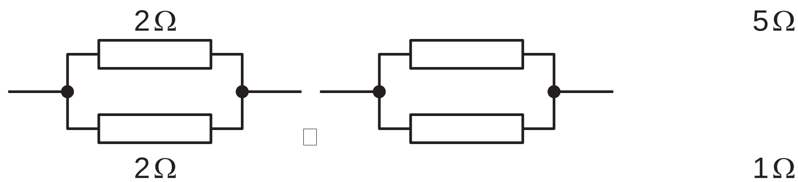
Because the lamps would blow off due to too much voltage.

APPLICATION ABSED QUESTIONS: MCQ:

1 A student connects various resistors in parallel pairs.
Underneath each diagram is a statement about the total resistance of each pair of resistors.

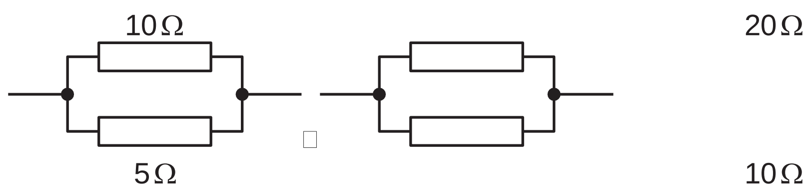
Which statement is correct?

A **B**



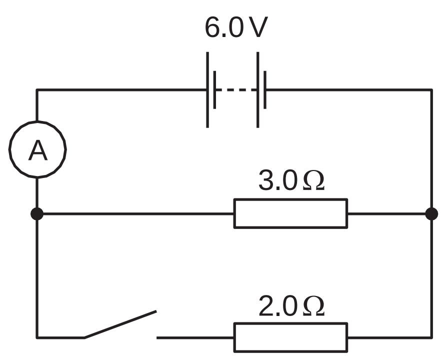
The total resistance is 4Ω. The total resistance is between 1Ω and 5Ω.

C **D**



The total resistance is less than 5Ω. The total resistance is more than 20Ω.

2 The diagram shows a circuit with a 3.0Ω resistor and a 2.0Ω resistor connected in parallel.



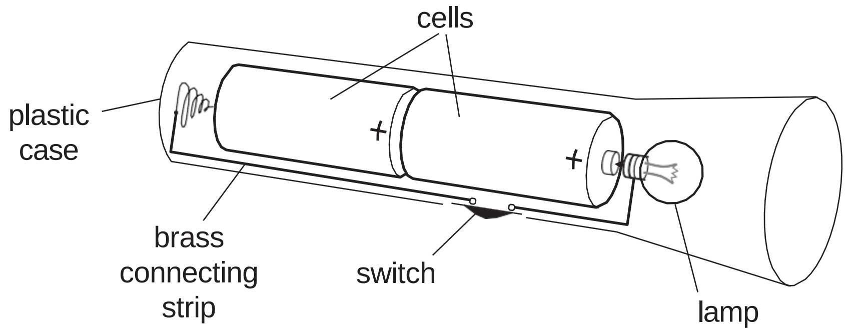
The switch is open, and the ammeter reads 2.0A.

The switch is now closed and the ammeter reads the total current in both resistors.

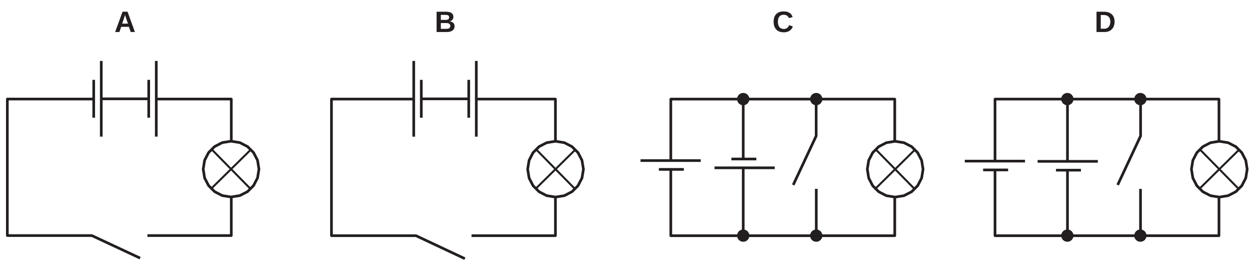
What is the ammeter reading with the switch closed?

A 1.2A B 3.0A C 4.0A D 5.0A

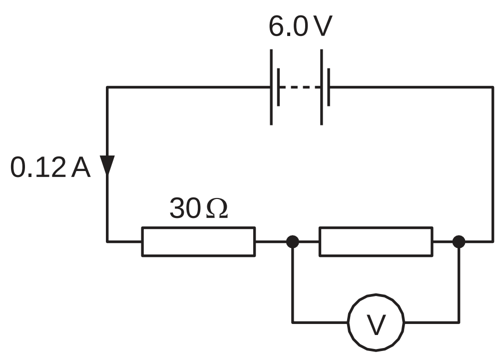
3 The diagram shows a torch containing two cells, a switch and a lamp.



Which is the circuit diagram for the torch?



4 A 30 Ω resistor is connected in series with another resistor and a 6.0V battery. The current in the circuit is 0.12 A. A voltmeter is connected across the other resistor.

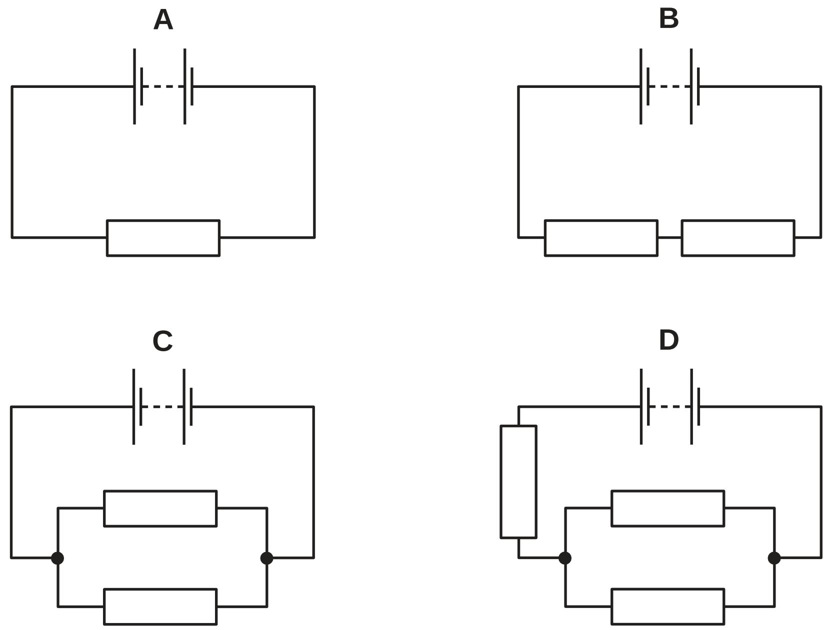


What is the reading on the voltmeter?

A 2.4 V B 3.6 V C 6.0 V D 9.6 V

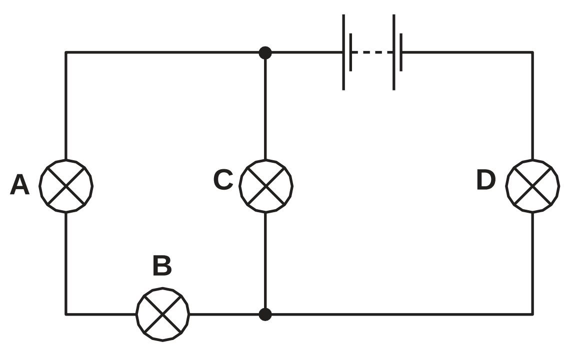
5 In the circuits shown, all the resistors are identical.

Which circuit has the least resistance?

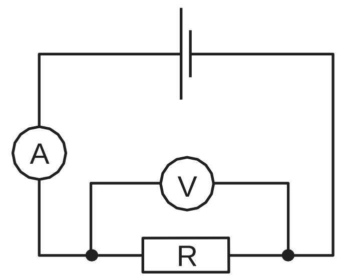


6 In the circuit below, one of the lamps breaks, causing all the other lamps to go out.

Which lamp breaks?



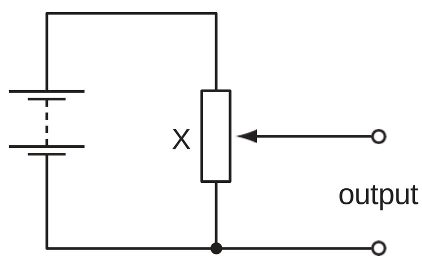
7 A circuit is set up to measure the resistance of a resistor R. The meter readings are 2.0 A and 3.0 V.



What is the resistance of the resistor R?

A 0.67 Ω B 1.5 Ω C 5.0 Ω D 6.0 Ω

8 The circuit shown is a potential divider.



What is component X?

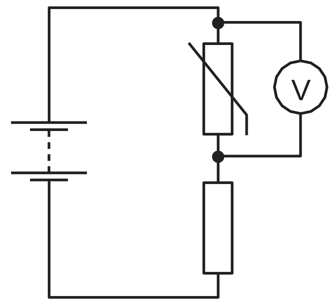
A a light-dependent resistor

B a relay

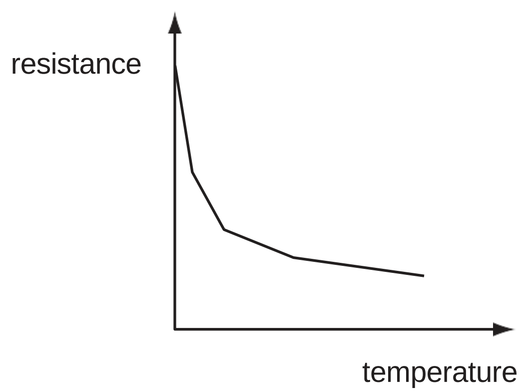
C a thermistor

D a variable resistor

9 The diagram shows a thermistor in a potential divider. A voltmeter is connected across the thermistor.



The graph shows how the resistance of the thermistor changes with temperature.



As the thermistor becomes warmer, what happens to its resistance and what happens to the reading on the voltmeter?

	resistance	voltmeter reading
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

10 An electric current can produce a heating effect and a magnetic effect.
Which row shows the effect that a relay uses, together with one application of a relay?

	effect used by a relay	one application of a relay
A	heating effect	allowing a small current to switch on a large current
B	heating effect	changing the voltage of an alternating current
C	magnetic effect	allowing a small current to switch on a large current
D	magnetic effect	changing the voltage of an alternating current

11 A thermistor is used in a circuit to control a piece of equipment automatically.
What might this circuit be used for?

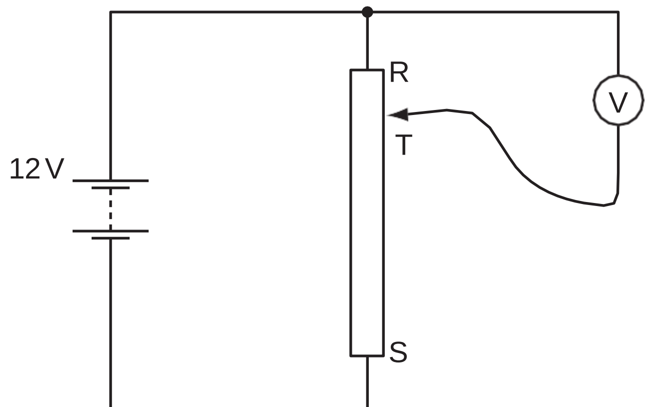
A lighting an electric lamp as it becomes darker

B ringing an alarm bell if a locked door is opened

C switching on a water heater at a pre-determined time

D turning on an air conditioner when the temperature rises

12 A student connects a variable potential divider (potentiometer) circuit.



What happens to the reading on the voltmeter as the sliding terminal T is moved from R to S?

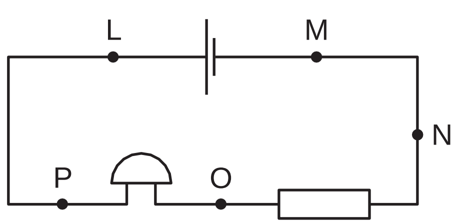
A It decreases from 12 V to 0 V.

B It increases from 0 V to 12 V.

C It remains at 0 V.

D It remains at 12 V.

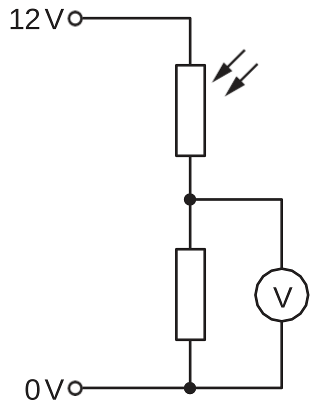
13 The diagram shows an electrical circuit.



Between which two points must a voltmeter be connected to find the potential difference across the bell?

A L and M B M and N C N and O D O and P

14 The diagram shows part of an electric circuit.



The light falling on the light-dependent resistor (LDR) increases in brightness.

What happens to the resistance of the LDR and what happens to the reading on the voltmeter?

	resistance of LDR	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

MARK SCHEME:

1-C
2- D
3-A
4-A
5-C
6-D
7-B
8-D
9- A
10-C
11-D
12-B
13-D
14-D

APPLICATION BASED QUESTIONS-EXTENDED THEORY

1 **(a)** Fig. 9.1 shows an a.c. supply connected in series to a diode and a resistor.

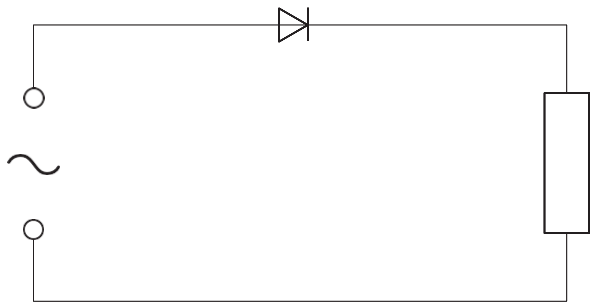


Fig. 9.1

On the axes of Fig. 9.2, draw a graph showing the variation of the current in the resistor. [1]

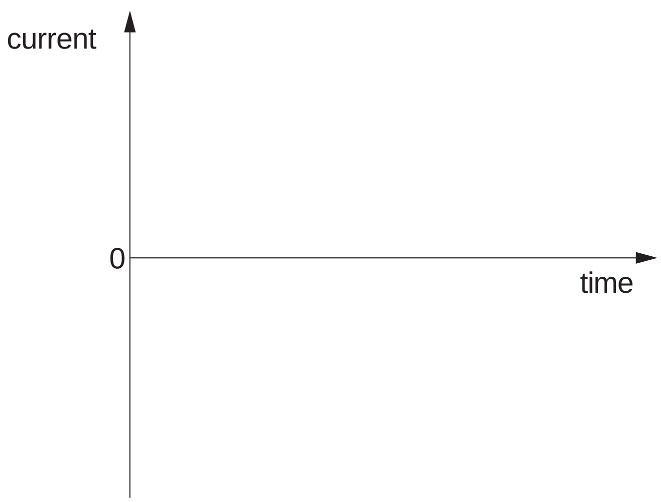


Fig. 9.2

(b) Fig. 9.3 shows four attempts, **A**, **B**, **C** and **D**, to connect a circuit known as a bridge rectifier.

The circuit is connected to a 12V a.c. supply.

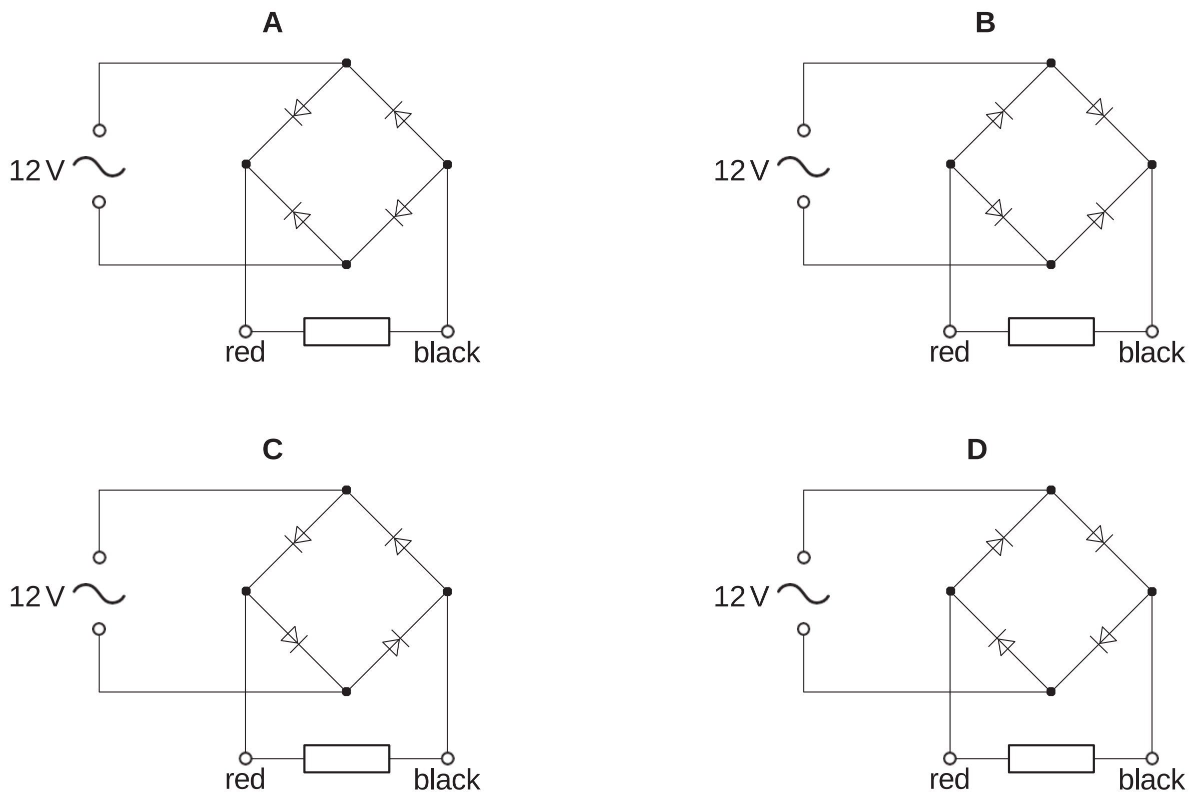


Fig. 9.3

(i) In which circuit will the direction of the conventional current in the resistor always be from red to black?

....[1]

(ii) On the circuit you chose in **(b)(i)**, clearly indicate with arrows the path of the conventional current in the circuit when the upper terminal of the a.c. supply is positive with respect to the lower terminal. [2]

[Total: 4]

MARK SCHEME:

(a) half-wave rectification clearly indicated (any wave shape, repeated):
at least 2 humps with all spaces more than half width of hump, by eye. B1

(b) (i) A (c.a.o.) M1

(ii) For answers A and B only in (i), not C or D:
Route to resistor: correct arrow on one downwards diode and nothing wrong on this route B1
Route from resistor: correct arrow on one downwards diode and nothing wrong on this route B1 [4]

2 A battery charger includes a transformer and a rectifier.

Fig. 11.1 represents the transformer, consisting of an iron core with two coils P and Q wound on to the core.

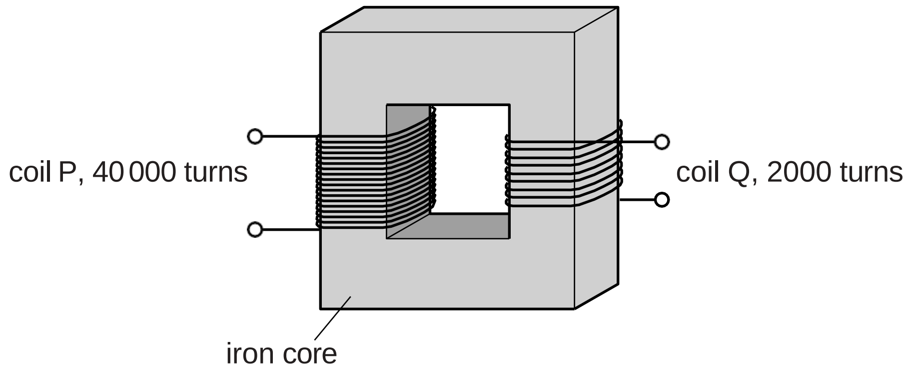


Fig. 11.1

P consists of 40 000 turns and Q consists of 2000 turns.

When P is connected to a 230 V a.c. supply, there is an e.m.f. across the terminals of Q.

(a) **(i)** Calculate the size of this e.m.f.

e.m.f. = ... [2]

(ii) Explain how this e.m.f. is generated.

....

....

....

....

.... [3]

(b) The output of Q is connected to the rectifier circuit.

State

(i) the name of the circuit component that is used in a rectifier circuit to rectify the a.c. (alternating current),

.... [1]

(ii) the property of this component that is used to rectify the current.

.... [1]

[Total: 7]

MARK SCHEME:

(a) (i) $(V_2=)V_1N_2/N_2$ OR 230 × 2000 / 40 000[00]

11 / 11.5 / 12 V — A1

(ii) any three from:
alternating / changing magnetic field (in core)
(magnetic field) transferred (allow conducted) to coil Q
changing flux linkage / in Q
e.m.f. / voltage induced in Q — B3

(b) (i) diode — B1

(ii) it conducts in (only) one direction — B1

[Total: 7]

4.4-ELECTRICAL SAETY

Dangers of high voltage:

- Anyone touching a bare wire or a high voltage terminal will receive a fatal electric shock.
- A current of 20mA (0.02A) is enough to electrocute a person. Also the resistance of a human body=1000ΩΩ. Thus it is dangerous to touch a terminal of about 20V.[Calculated using ohm's law]

Dangers of low voltage:

Low voltage cables can overheat and cause fires. The overheating may happen due to a fault in the low voltage circuit.

Short circuit of low voltage circuits can also cause over-heating.

Short circuit: A low-resistance connection between two points in an electric circuit through which the current tends to flow rather than along the intended path.

This results in excessive current flow in the power source through the 'short,' and may even cause the power source to be destroyed as it might get overheated and catch fire

----

Hazards of:

- **Damaged insulation:**

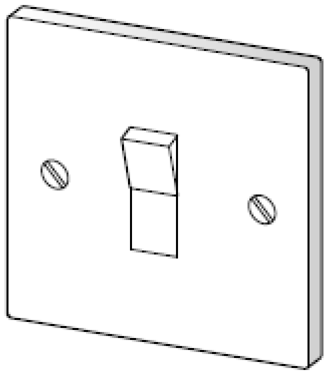
The layer of insulation around a wire or a cable may wear away. The plug or the socket may become chipped or broken exposing a bare wire or terminal in a plug.

- Overheating of cables can melt the insulation. Thus the wires may become bare. There are also chances of a short circuit.
- Damp or wet conditions: Dampness inside a device , socket or a plug can cause short circuit or it could provide a conducting path for the outer surface.
- Excess current from overloading a plug, extension leads, single and multiple sockets when using mains supply.

A socket with more than one appliance connected to it may become overloaded if too much current flows through it

OVERLOADED SOCKETS

Some precautions to be taken while handling electrical equipment in electrically unsafe conditions:



If such kind of switches are being used in damp and hot conditions:

- The switch should be set on or off using a long chord of insulated material.
- The switch must have an insulating cover on it.
- Such switches must be placed outside workrooms with such atmospheric conditions.

Fuses and trip switches:

Fuses and trip switchesprevent electrical appliances

Fuse:

- A fuse consists of a thin wire that heats up and melts when an excess current flows through it.
- Every fuse has a rating. This is the maximum current that can flow through it without melting its wire
- If the rating is too large then the fuse will not blow when it should and there can be a fire due to overheating. Hence a fuse should be chosen carefully.
- Once a fuse blows out , it needs to be replaced.

The fuse rating:

The fuses in plugs come in various ratings – 3A, 5A or 13A. Each rating is designed to allow enough current to reach a device to allow it to operate normally, but to melt if the current becomes excessive before the device is damaged.

The fuse rating is found by finding the current required by device and rounding up to the next fuse rating.

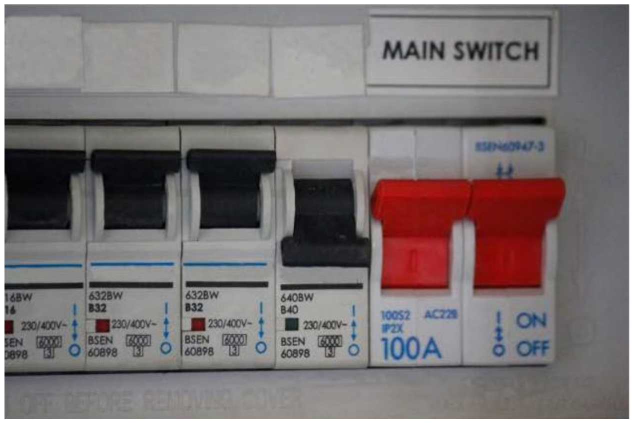
Suppose for example that a device has a power rating of 800W. We can find the current requirement using the equation[Note that the three pin plug is used in the UK for every electrical device run off the 240V mains supply.] Hence:

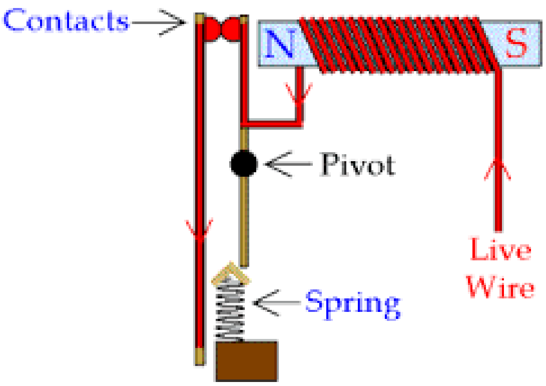
$$Current = \frac{PoPPer}{Voltage}$$

$$Current = \frac{PoPPer}{Voltage} = \frac{888888}{222288} = 22.4444A.$$

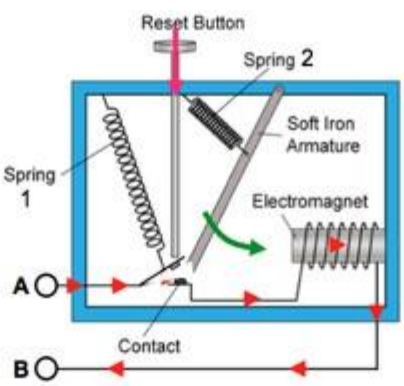
Then for this appliance we should use a fuse of 5A

Trip switches:

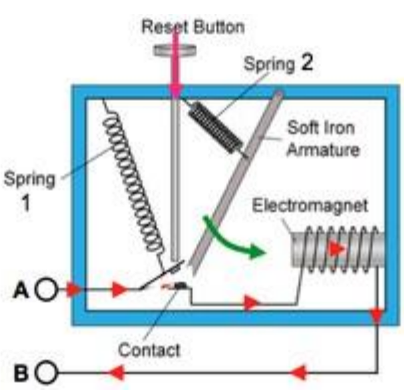




- It is a safety switch that automatically stops electricity from flowing to a machine if a dangerously large current is created by the machine failing to operate as it should



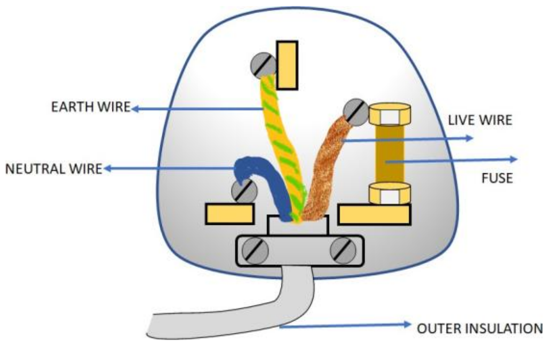
When the current in the live wire exceeds the prescribed limit, the electromagnet pulls the switch open. As a result the rest button pops up and the current is cut off.



Once the fault that made it is put right, the switch is reset by pressing the reset button .As a result the soft iron armature again establishes contact with the electromagnet and the circuit is complete and the current begins to flow.

Benefits of earthing metal cases:

- Earthing provides additional safety to electrical appliances with metal frames and panels.
- Three pin plugs:

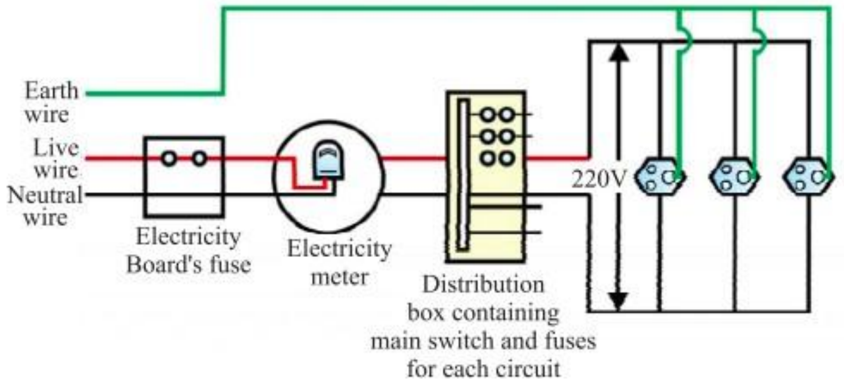


- Three pin plugs contain an additional cable called as the earth wire. This wire carries the excess current to the earth thus making the appliance and its user safe.
- The earth pin is longer which ensures that the appliance is first earthed while being plugged into the socket

==

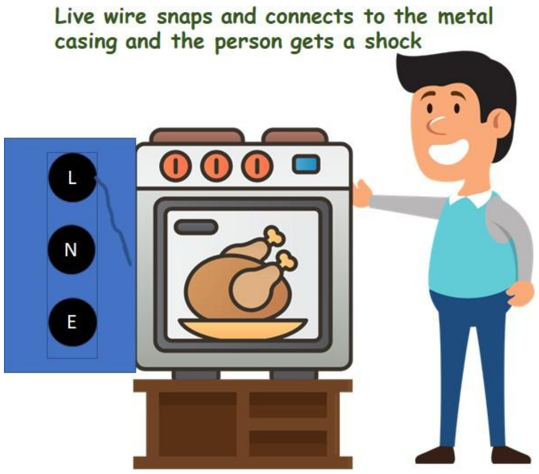
->A mains circuit consists of a live wire (line wire), a neutral wire and an earth wire
->A switch must be connected to the live wire for the circuit to be switched off safely

The circuit wiring from the distribution board also includes an earth wire in addition to the live and neutral wire. The earth wire is connected to the ground outside the building.



To prevent electrocution, the earth wire is connected to the casing of appliances.

The outer casing of an electrical appliance must be either non-conducting(double-insulated) or earthed



If the live wire snaps and touches the casing, the casing will become alive. So anyone touching the casing would be electrocuted. The earth wire however will provide a path for the flow of electricity from the appliance to the ground. So anyone touching the appliance will not be electrocuted.

Will the excess current blow the fuse?

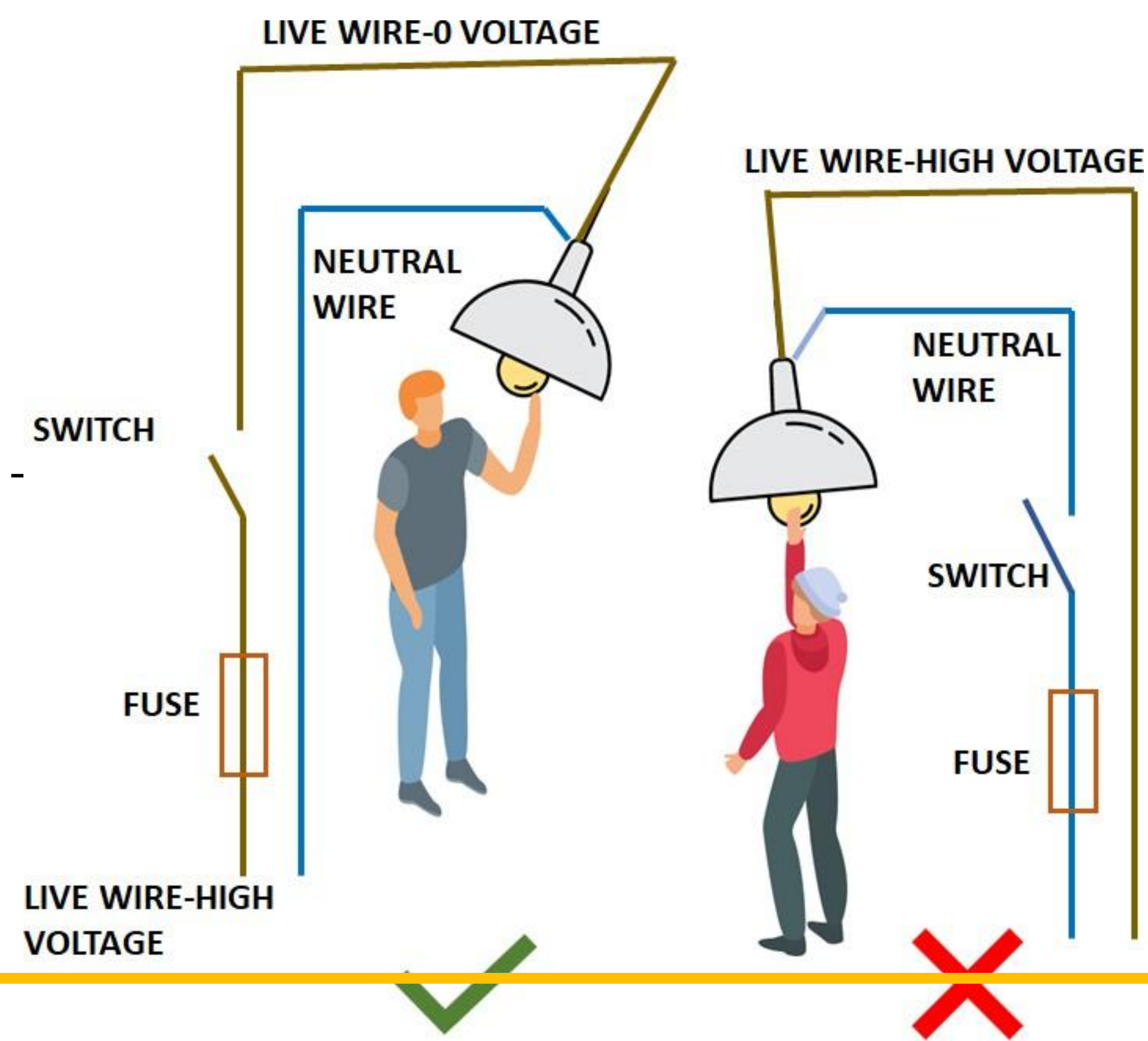
Yes: The extra current will blow the fuse if it exceeds the fuse rating and switch off the appliance, keeping the user safe.

No: If however the current is not large enough to blow off the fuse, the appliance will still become unsafe as the excess current will lead to overheating of the device and a possible fire.

Fuse in the live wire of electrical appliances:

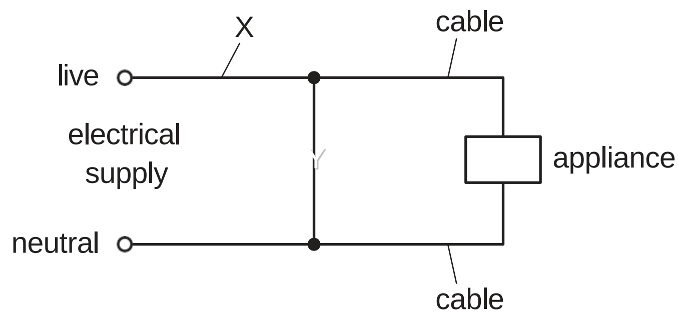
The fuse should be present in the live wire, so that the circuit is broken when excess current flows through it and prevents electrical shocks.

->A fuse without an earth wire protects the circuit and the cabling for a double-insulated appliance



APPLICATION BASED QUESTIONS:

1 Either a fuse or a circuit-breaker can be used to protect electrical cables from large currents that could cause overheating.



If a fuse is used, in which position in the circuit should it be connected, and if a circuit-breaker is used, in which position should it be connected?

	position of fuse	position of circuit-breaker
A	X	X
B	X	Y
C	Y	X
D	Y	Y

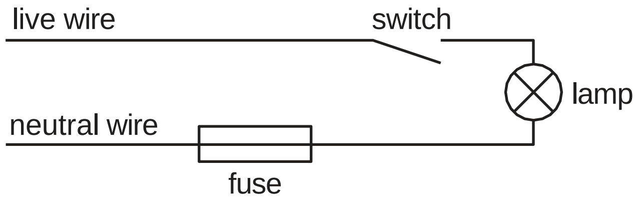
2 The current in a lamp at full brightness is 0.25 A. The flexible cable to the lamp is designed for currents up to 5.0 A, so it can safely carry the 0.25 A taken by the lamp.

Which fuse should be inserted in the plug at the other end of the flexible cable?

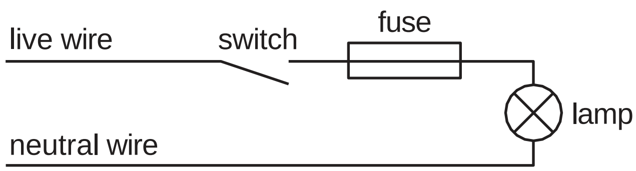
A 0.2 A B 1.0 A C 5.0 A D 10.0 A

3 Which diagram shows the correct positions for both the switch and the fuse?

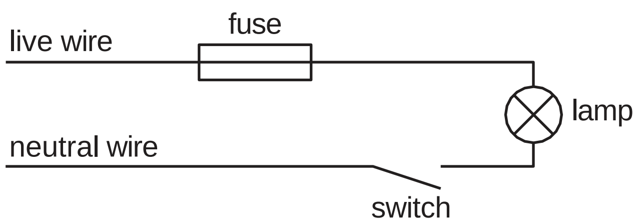
A



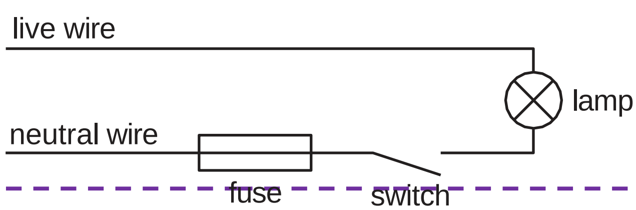
B



C



D



MARK SCHEME:

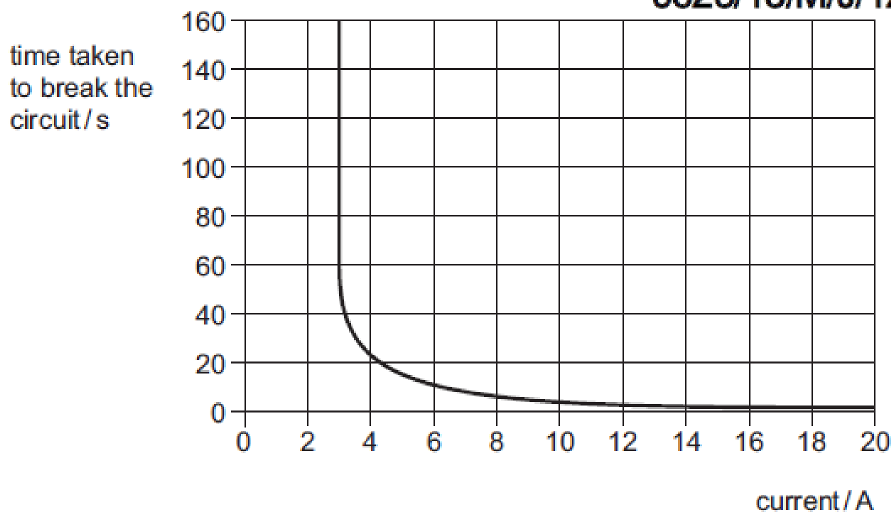
1-A
2-B
3-B

4

31 A circuit-breaker is designed to protect a circuit which usually carries a current of 2 A.

The time taken to break the circuit depends on the current, as shown in the graph.

0625/13/M/J/12



What happens when the current in the circuit is 2 A and what happens when the current 18 A?

	when the current is 2 A	when the current is 18 A
A	the circuit breaks in less than 5 seconds	the circuit breaks in less than 5 seconds
B	the circuit breaks in less than 5 seconds	the circuit does not break
C	the circuit does not break	the circuit breaks in less than 5 seconds
D	the circuit does not break	the circuit does not break

MARK SCHEME:

EXTENDED THEORY

1 The manufacturer's label on an electric heater is as shown in Fig. 5.1.

C.I.E. Electrical Company
Suitable for use on 110 V, 60 Hz supply
1 kW/2 kW
This appliance must be earthed when in use

Fig. 5.1

(a) State what electrical quantity is represented by

(i) 110 V, ...

(ii) 60 Hz, ...

(iii) 1 kW. .... [1]

(b) **(i)** Which part of the electric heater must be earthed?

.... [1]

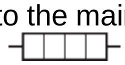
(ii) Explain what the hazard might be if the heater is not earthed.

....

....

.... [2]

(c) The heater has two 110V heating elements, with two switches, so that either one or both elements may be switched on.

In the space below, draw a circuit diagram showing how the heating elements and switches are connected to the mains supply.
Use the symbol  for each heating element.

[2]

[Total: 6]

MARK SCHEME:

(a) (i)	potential difference OR e.m.f. OR voltage ignore volts	all 3	B1
(ii)	frequency accept cycles/s ignore waves/s		
(iii)	power accept energy/s		
(b) (i)	case/frame/outside/base/parts that can be touched ignore metal parts		B1
(ii)	electric shock/electrocution/death by electricity o.w.t.t.e. ignore anything else		B1
	live wire touches case		B1

(c) heaters in parallel with any supply
(M0 if no supply, clear break in circuit, short across supply or heater) M1
one switch controlling both heaters and one switch controlling one heater
OR one switch in series with each element A1

special case: heaters in series with supply and one switch shorting out one
resistor AND another switch in series with supply B2 [6]

4.5-Electromagnetic Effects

This topic covers the following sub-topics:

1. Electromagnetic induction
2. The A.C. generator
3. Magnetic effect of a current
4. Force on a curren-carrying conductor
5. The D.C. motor
6. The transformer

Once a current has been induced in the coil, you need to know :

1. How to find the direction of the induced current
2. How to increase/decrease the induced current.
3. Ways of changing the direction of the induced current.
4. That the Lenz's law is used to find the direction of the induced current in the coil.
5. That the 'Right hand thumb rule " is used to find the direction of the induced current when a wire is moved in between the poles of a magnet.

ELECTROMAGNETIC INDUCTION

1. **Electromagnetic induction: [2]**

When a magnetic field is cut by a conductor(wire /coil or solenoid), a current (or an e.m.f.) is induced by it. This is called as electromagnetic induction

or

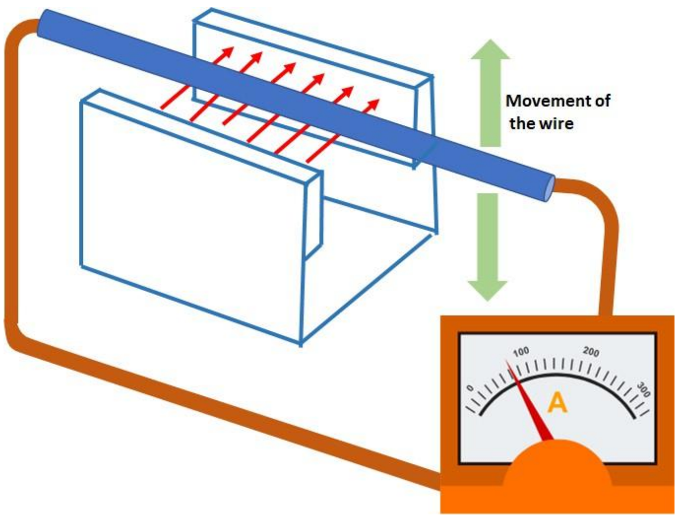
A changing magnetic field in the coil induces a current or an e.m.f. in it. This is said to be electromagnetic induction.

EXPERIMENT TO DEMONSTRATE ELECTROMAGNETIC INDUCTION

1 by moving a wire in a magnetic field.

2 by moving magnet steadily into a solenoid

Method:1:ELECTROMAGNETIC INDUCTION BY MOVING A WIRE IN A MAGNETIC FIELD



Steps to induce an e.m. f. and current.

Step 1: Take 2 magnets. Then take a wire and connect it to a galvanometer as shown.

Step 2: Move the wire between the poles of the magnet.

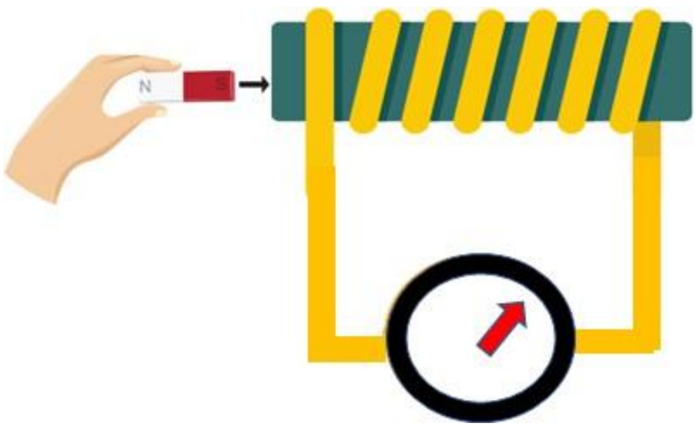
Observation:

- When the wire is moved up, the galvanometer needle points in one direction.
- When the wire is moved down, the galvanometer moves in the opposite direction.
- When the wire is held stationary , the galvanometer points to zero.

Note:A conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an e.m.f. in the conducto

Method:2:ELECTROMAGNETIC INDUCTION BY MOVING A MAGNET INSIDE A STEADY COIL (SOLENOID)

Step 1: Take a bar magnet and push it into a solenoid connected to a galvanometer as shown above.



When the bar

- magnet is moved in , the galvanometer needle points in one direction.

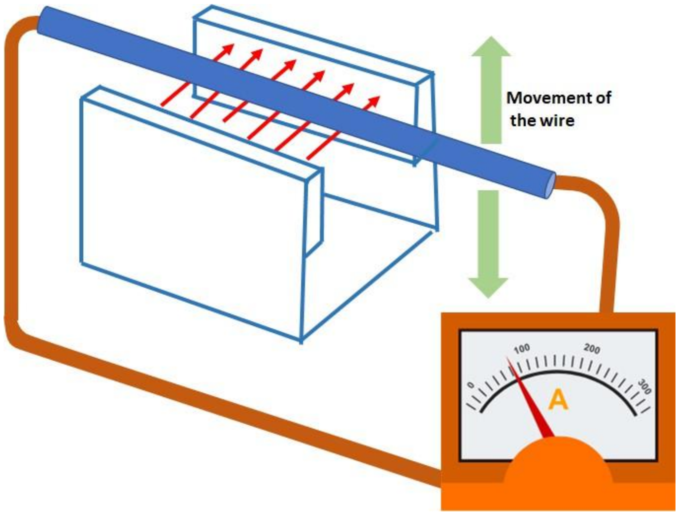
- When the bar

magnet is moved out , the galvanometer moves in the opposite direction.

- When the bar magnet is held stationary , the galvanometer points to zero (shows no deflection)

FACTORS AFFECTIG THE MAGNITUDE OF AN INDUCED EMF

Different ways of increasing the magnitude of the induced e.m.f. and current.

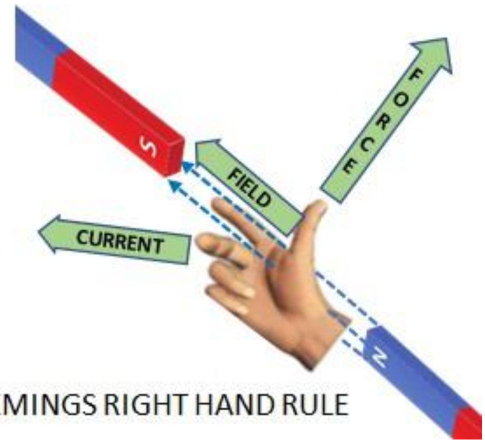


1. Move the wire faster.
2. Use a stronger magnet.
3. Increase the length of the wire in the magnetic field.

Ways of changing the direction of the induced e.m.f .and current.

1. Move the wire in the opposite direction.
2. Turn the magnet around so that the poles of the magnet are reversed.

Finding the direction of the induced current



FLEMINGS RIGHT HAND RULE

When a straight wire is moved perpendicular to the magnetic field, the direction of the induced e.m.f. can be found by using Flemings Right Hand Rule.

Note :

- The first finger always points in the north south direction as shown.
- The thumb points in the direction of the current.
- The second finger points in the direction of the induced current.

Different ways of increasing the magnitude of the induced e.m.f. and current.

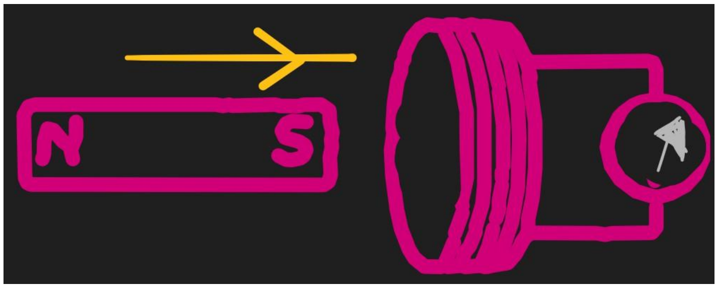
1. Move the magnet faster.
2. Use a stronger magnet.
3. Increase the number of turns of the coil of the wire in the magnetic field.

Ways of changing the direction of the induced e.m.f .and current.

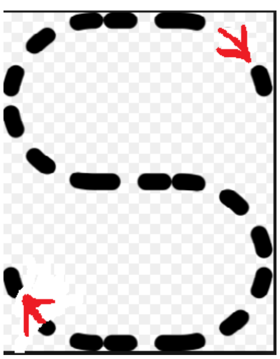
1. Pull the magnet out of the solenoid if earlier you had pushed it in.
2. Push the North pole of the magnet in the solenoid instead of the South pole
3. Turn the magnet around so that the poles of the magnet are reversed.

Finding the direction of the induced current -Lenz's law

Lenz's law states that
" An induced current always flows in a direction so as to oppose the change that created it"



For example: When a magnet approaches a coil with its south pole facing the coil, a current is induced in the coil. This induced current turns the coil into a weak electromagnet with an induced south pole as shown in the diagram .



To find the direction of the current:

Step 1: Check the polarity induced in the coil: In our example , it is the South pole.

Step 2: Write the alphabet S as as shown above along with the arrows.

Step 3: The direction of the arrows shows the direction of current in the coil

Hence When the South pole of a magnet approaches a coil , a current in the clockwise direction is induced in the coil and that part of the coil develops a South pole on it.

The table on the next page summarises all the possible directions and polarites that can be induced in the coil

The following table will help you identify the polarity induced and the direction of flow of the current in the coil.

	Bar magnet	What will the coil try to do as per Lenz's law	Polarity induced in the coil	Direction of current in the coil
1	Enters the coil with its North pole facing the coil	Stop it from entering the coil by offering it repulsion	North	Anticlockwise 
2	Enters the coil South pole facing the coil	Stop it from entering the coil by offering it repulsion	South	Clockwise 
3	Leaves the coil with its North pole facing the coil	Stop it from leaving by attracting it towards it	South	Clockwise 
4	Leaves the coil with its South pole facing the coil	Stop it from leaving by attracting it towards it	North	Anticlockwise 

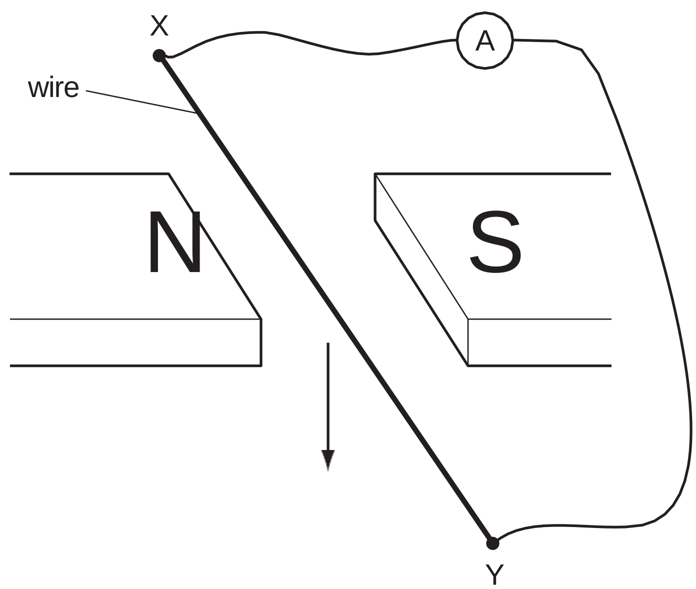
[As like poles repel, so as per lenz's law, the direction of the induced e.m.f. tried to stop the approaching magnet from moving towards it and hence developed a South pole on it]

Type of application based questions asked so far:

MCQ's:

1. **Know that e.m.f. and current can only be induced in conductors and not in insulators like nylon.**

37 The diagram shows an experiment to demonstrate electromagnetic induction.



X and Y are joined, in turn, by four wires, each made of a different material.

Each wire is then moved quickly downwards between the magnets.

Which material will not give rise to an induced current in the wire?

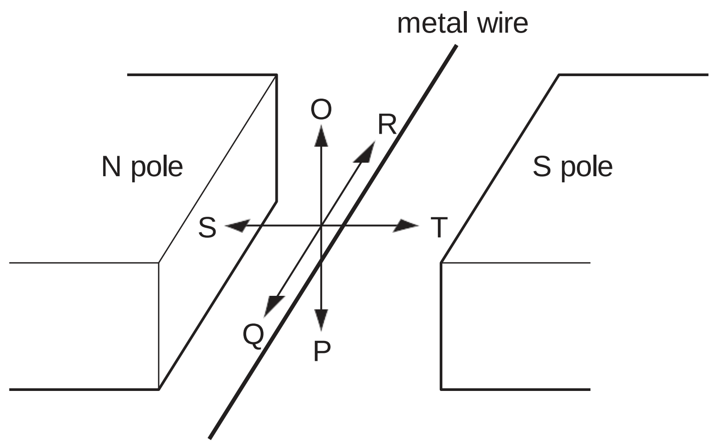
A aluminium
B copper
C iron
D nylon

D

2. Know that a current is induced only when the wire is moved perpendicular to the magnetic field

35 A metal wire is placed between the poles of a magnet.
The wire can be moved in each of three directions OP, QR and ST.

A



In which direction or directions must the wire be moved to induce an e.m.f. across the ends of the wire?

A OP only B OP or ST C QR D ST only

---

3. Know that if an alternating force is applied on the wire in a magnetic field , then the current keeps changing about a fixed value

MARKING SCHEME:

1-D
2-A

Extended theory:

1 Electromagnetic induction may be demonstrated using a magnet, a solenoid and other necessary apparatus.

(a) Explain what is meant by *electromagnetic induction*.

....

....

....

....[2]

(b) In the space below, draw a labelled diagram of the apparatus set up so that electromagnetic induction may be demonstrated. [2]

(c) Describe how you would use the apparatus to demonstrate electromagnetic induction.

....

....

....

.... [2]

(d) State two ways of increasing the magnitude of the induced e.m.f. in this experiment.

1. ....

....

2. ....

.... [2]

[Total: 8]

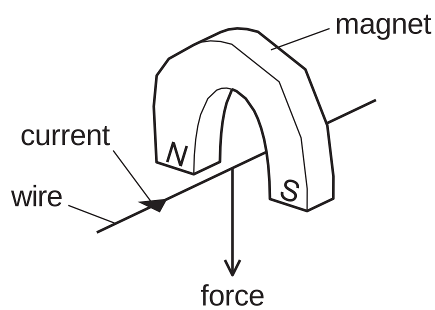
MARK SCHEME:

(a)	when magnetic field cuts/cut by conductor/wire/coil/solenoid OR change in magnetic field linked with coil etc.	B1
	current/e.m.f caused	B1
(b)	solenoid ends connected to meter/lamp note: any sign of a cell gets B0	B1
	magnet indicated in suitable position on axis of solenoid	B1
(c)	insert/withdraw/move magnet into/out of solenoid	B1
	meter gives reading (as magnet moves) OR watch the meter OR lamp glows	B1
(d)	move magnet faster) increase strength of magnet) any 2 more turns on solenoid) closer to solenoid)	B1+B1

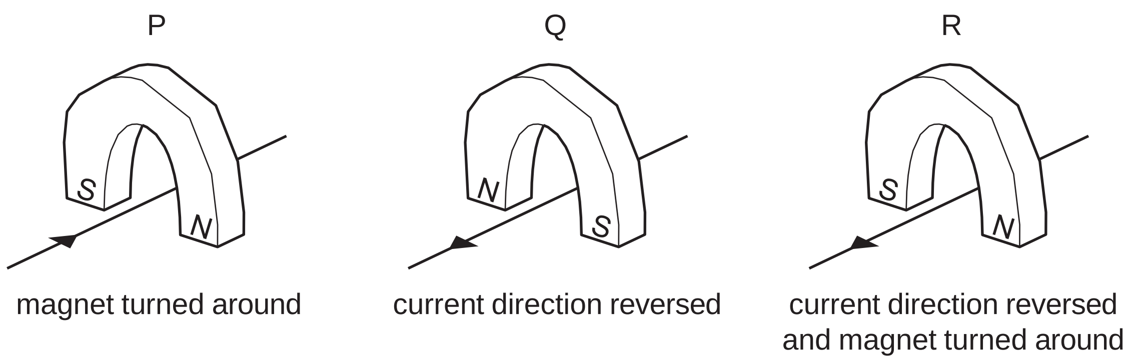
[Total: 8]

MULTIPLE CHOICE QUESTIONS

1 A wire passes between the poles of a horseshoe magnet. There is a current in the wire in the direction shown, and this causes a force to act on the wire.



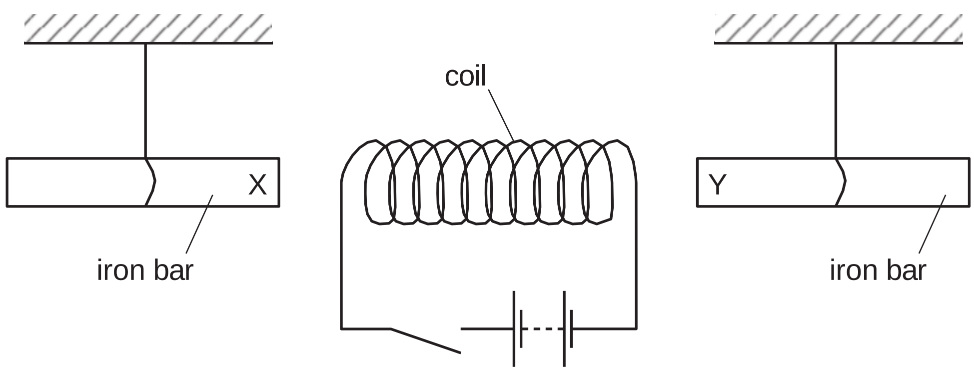
Three other arrangements, P, Q and R, of the wire and magnet are set up as shown.



Which arrangement or arrangements will cause a force in the same direction as the original arrangement?

A P, Q and R B P and Q only C P only D R only

2 The diagram shows a coil connected to a battery and a switch. Two unmagnetised iron bars hang freely near opposite ends of the coil.



What happens to the iron bars when the switch is closed?

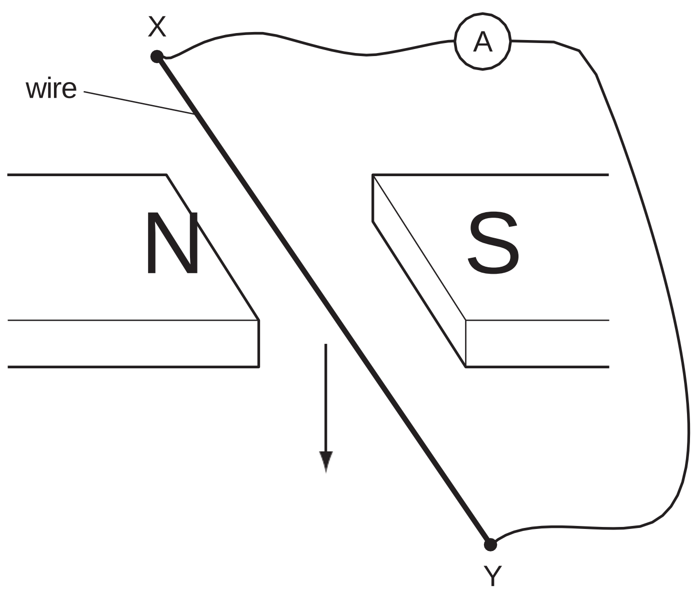
A Both X and Y move away from the coil.

B Both X and Y move towards the coil.

C X moves towards the coil, Y moves away from the coil.

D Y moves towards the coil, X moves away from the coil.

3 The diagram shows an experiment to demonstrate electromagnetic induction.



X and Y are joined, in turn, by four wires, each made of a different material.

Each wire is then moved quickly downwards between the magnets.

Which material will not give rise to an induced current in the wire?

A aluminium

B copper

C iron

D nylon

MARK SCHEME:

1-D
2-B
3-D

APPLICATION BASED QUESTION-EXTENDED THEORY

1 Fig. 9.1 shows apparatus used to investigate electromagnetic effects around straight wires.

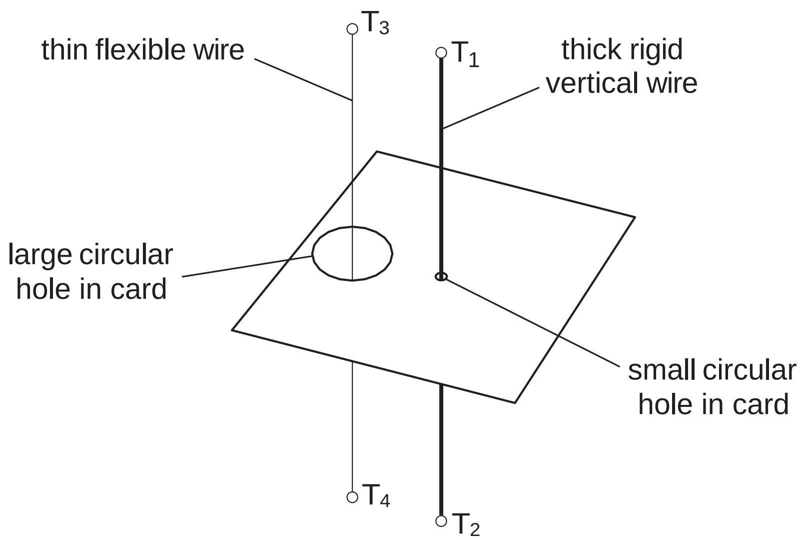


Fig. 9.1

Fig. 9.2 is a view looking down on the apparatus shown in Fig. 9.1.

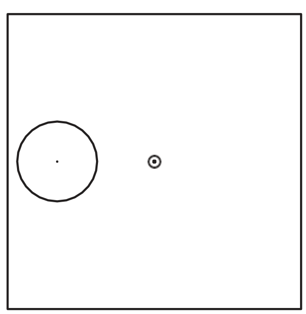


Fig. 9.2

(a) A battery is connected to T_1 and T_2 so that there is a current vertically down the thick wire.

On Fig. 9.2, draw three magnetic field lines and indicate, with arrows, the direction of all three. [2]

(b) Using a variable resistor, the p.d. between terminals T_1 and T_2 is gradually reduced.

State the effect, if any, that this will have on

(i) the strength of the magnetic field,.. [1]

(ii) the direction of the magnetic field. .... [1]

(c) The battery is now connected to terminals T_3 and T_4, as well as to terminals T_1 and T_2, so that there is a current down both wires. This causes the flexible wire to move.

(i) Explain why the flexible wire moves.

....

....

....

.... [2]

(ii) State the direction of the movement of the flexible wire.

.... [1]

(iii) The battery is replaced by one that delivers a smaller current.

State the effect that this will have on the force acting on the flexible wire.

....

.... [1]

[Total: 8]

MARK SCHEME:

(a)		3 complete circles about thick wire, roughly concentric on wire	B1
		clockwise or anticlockwise arrows on any 2 correct circles, and no contradictions	B1
(b)	(i)	reduced	B1
	(ii)	same OR none	B1
(c)	(i)	thin wire is a current-carrying conductor in a magnetic field	B1
		field produced by current in thick wire	B1
		OR alternative approach:	
		(both wires produce a magnetic field	B1)
		(fields interact	B1)
	(ii)	inwards/towards thick wire/to right/towards T_1T_2	B1
	(iii)	smaller force	B1

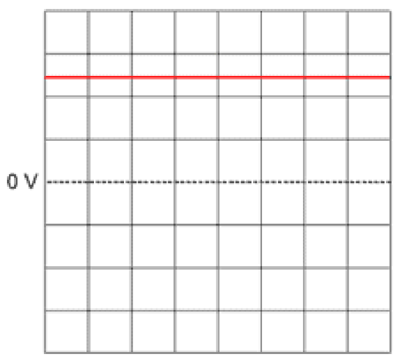
[8]

4.5.2-AC generator

Difference between DC and AC:

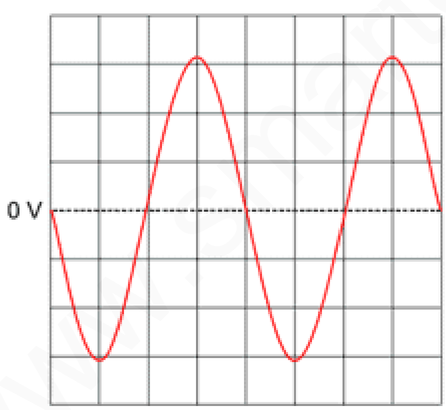
DC stands for direct current and AC stands for alternating current.

DIRECT CURRENT:



- A direct current flows in one direction only.
- Components that supply direct current are batteries and cells.
- The signal from a DC power supply looks like the following picture:

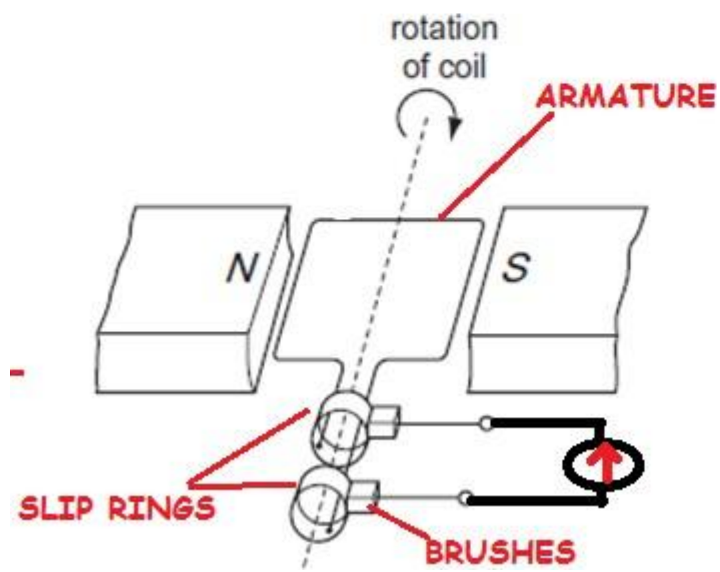
ALTERNATING CURRENT:



- Alternating current changes direction continuously.
- Mains electricity is an example of AC current. In India it is 230V AC
- The signal from a AC source looks like the following picture:

AC generator:

Construction and working



The Ac generator consists of an armature, slip rings, magnet, a suitable output.

Working:

When a conductor is moved through a magnetic field, it cuts the magnetic field lines and an emf is induced in the coil.

The coil is connected to a center zero galvanometer via the metal brushes. The brushes press against the slip rings and provide a connection between the coil and meter.

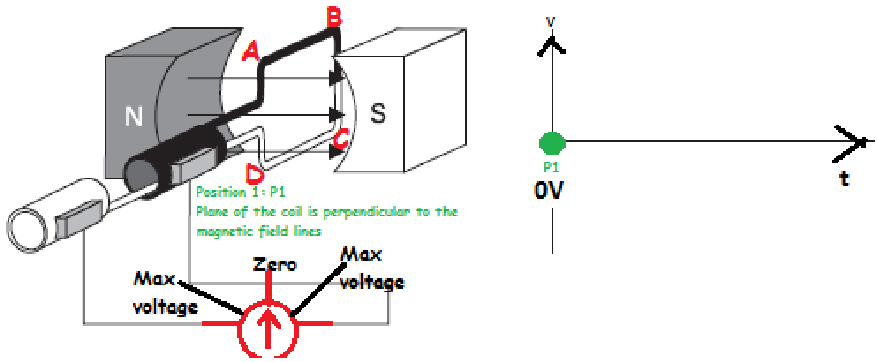
When the coil moves in one direction, the needle deflects in one direction and vice versa. This continues as long as the coil keeps rotating.

The direction of the induced emf changes constantly hence the direction of the current keeps changing after every half turn. Hence an alternating emf and an alternating current are produced.

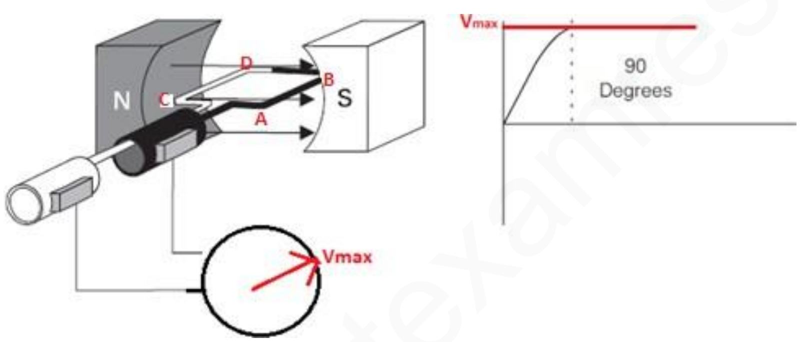
Interpreting the graph of the induced emf against time:

Working:

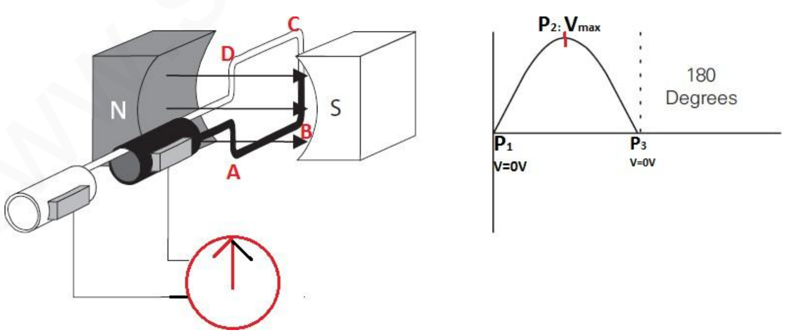
P1: The plane of the coil is perpendicular to the magnetic field lines, the armature conductors sides AB and CD are parallel to the magnetic field. Since no magnetic field lines are cut, the induced emf is 0V. So the needle points to 0V.



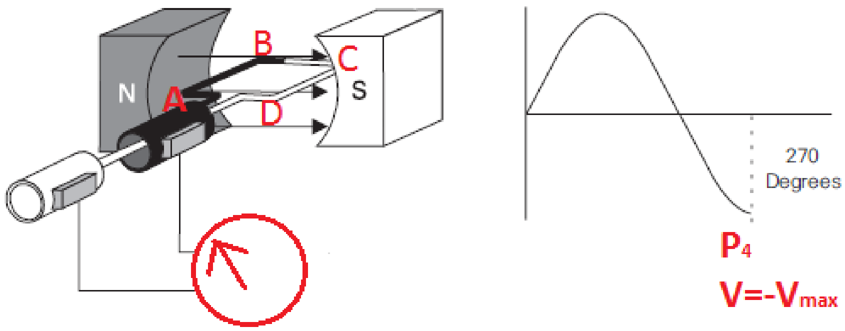
P2: When the coil rotates from 0 to 90^0, the sides AB and CD cut the magnetic field lines so the induced emf increases . It becomes maximum when the plane of the coil is parallel to the magnetic field lines. This is because in this position the sides AB and CD cut the magnetic field lines directly and needle points to one side giving maximum deflection.



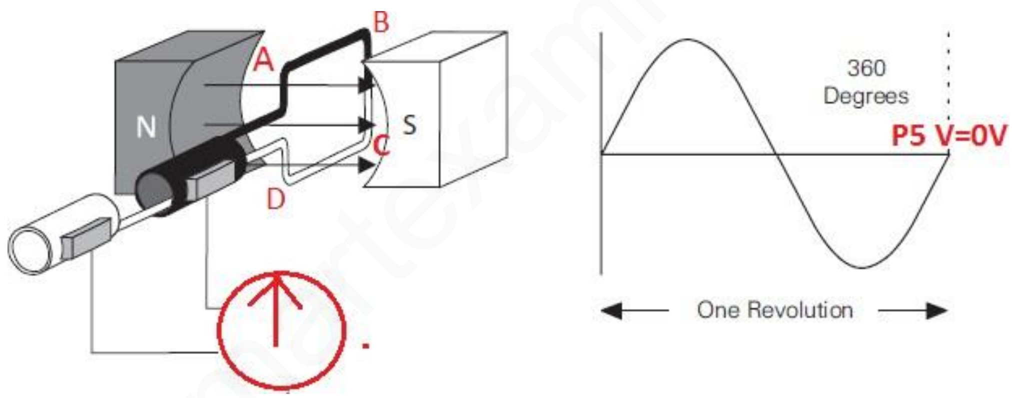
P3: The armature continues to rotate from 90^0 to 180^0. The induced emf decreases from maximum to zero volts where the plane of the coil is again perpendicular to the magnetic field lines. Note that the coil is upside down compared to its starting position(P1).



P4: When the coil rotates from 180⁰ to 270⁰,the sides AB and CD cut the magnetic field lines so the induced emf increases from 0 to negative maximum. It becomes negative maximum when the plane of the coil is parallel to the magnetic field lines once again but this time the coil is upside down compared to its original position.



P5: The armature further continues to rotate from 270⁰ to 360⁰. It is seen that that the emf increases from negative max to zero volts. This completes one cycle.



Note:

- **Role of slip rings:**

The slip rings help to maintain electrical contact between the coil and the external circuit(example , the meter)

- **Brushes:**
- The brushes are made of carbon

Difference between DC motors and AC generators:

Sr. No	Basis of comparison	DC motor	AC Generator
1	Type of energy conversion	Electrical to mechanical	Mechanical energy to electrical energy
2	Electricity	It uses electricity	It generates electricity
3	Principle	It is based on the principle: Current carrying conductor placed in a magnetic field experiences a force	Based on the principle of electromagnetic induction
4	Fleming's rule	Fleming's Left Hand rule	Fleming's Right Hand rule
5	Current	In a motor ,the current is supplied to the armature windings	In the generator, the current is produced in the armature windings
6	Commutator	DC motors use a split ring commutator	AC generators use a slip ring commutator

EXTENDED THEORY PRACTISE QUESTION

1 Fig. 10.1 shows a coil of wire rotating steadily in the magnetic field between the poles of a

permanent magnet. The current generated in the coil is to pass through resistor R.

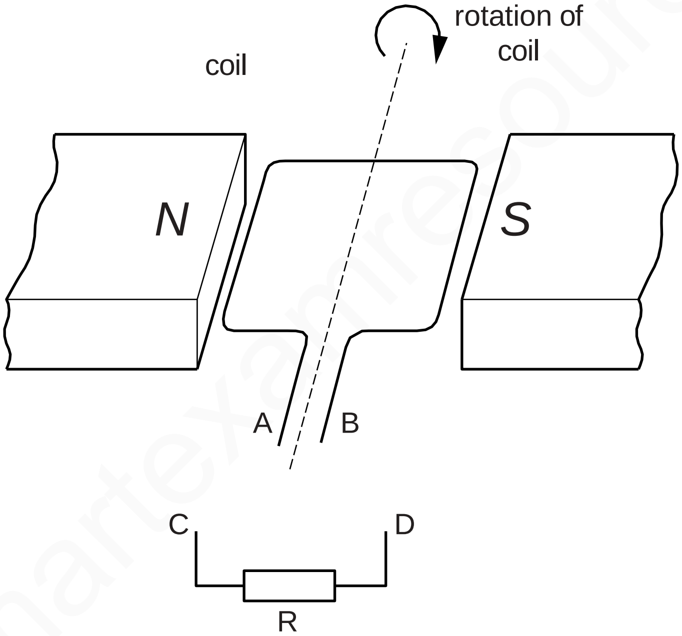


Fig. 10.1

(a) The apparatus in Fig. 10.1 is part of an a.c. generator. What is connected between the ends A and B of the coil and the connections C and D?

.... [1]

(b) **(i)** On Fig. 10.2, sketch a graph to show the variation with time of the current through R. [1]

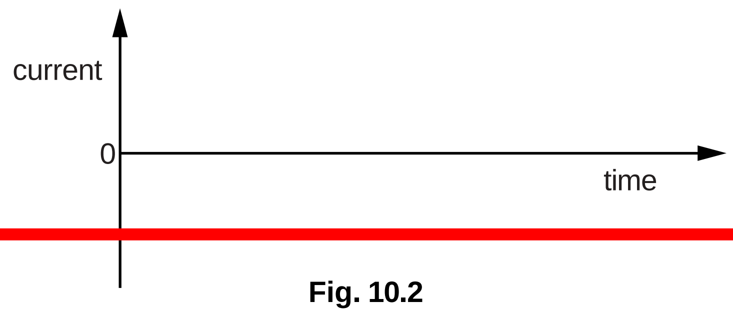


Fig. 10.2

(ii) On Fig. 10.2, show the time *T* corresponding to one complete rotation of the coil. [1]

(iii) State **two** ways in which the graph would be different if the coil spins at a faster rate.

1. ....

2. .... [2]

(c) Suggest what could be connected between C and R so that the current in R is always in the same direction.

.... [1]

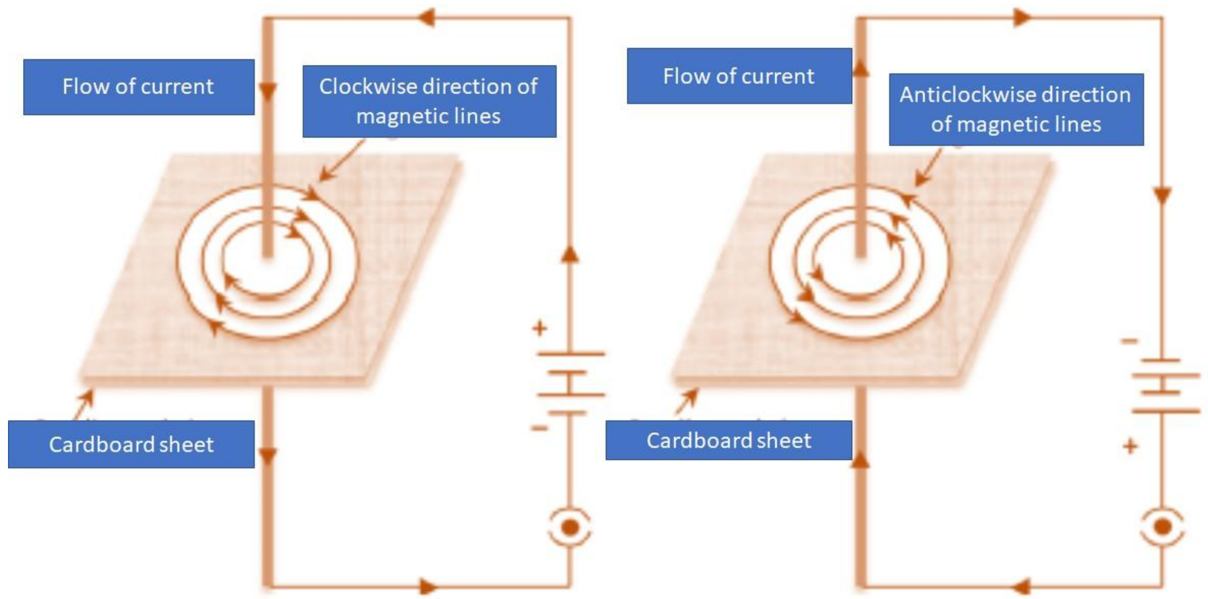
[Total: 6]

MARK SCHEME:

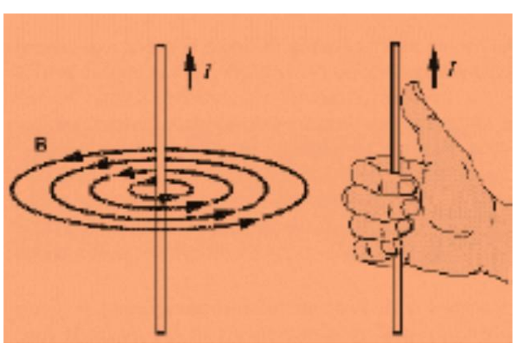
(a)	slip-rings (and brushes)	B1
(b) (i)	sinusoidal curve, any value at t = 0	B1
(ii)	appropriate T value indicated on graph	B1
(iii)	smaller T / time of one cycle OR higher frequency	B1
	higher maximum current / greater amplitude / higher peaks / higher peak-to-peak	B1
(c)	diode / rectifier	B1
		[Total: 6]

4.5.3
Magnetic effect of a current

Pattern of a magnetic field due to currents in straight wires:
When an electric current passes along a wire, a magnetic field is set up around the wire. the following is the pattern of the magnetic field lines around a straight current carrying wire.



Ampere's right-hand grip rule (also called *right-hand screw rule, coffee-mug rule* or the *corkscrew-rule*)



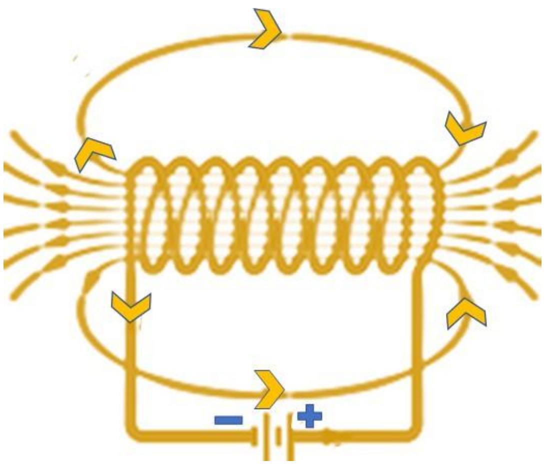
Point the thumb of your right hand in the direction of the conventional current and curl your fingers up as shown.
The magnetic field lines are circles around the wire pointing in the same direction as your fingers.

The direction of the magnetic field lines can be reversed by reversing the direction of the conventional current.

Pattern of magnetic fields in a current carrying solenoid:

Solenoid: A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.

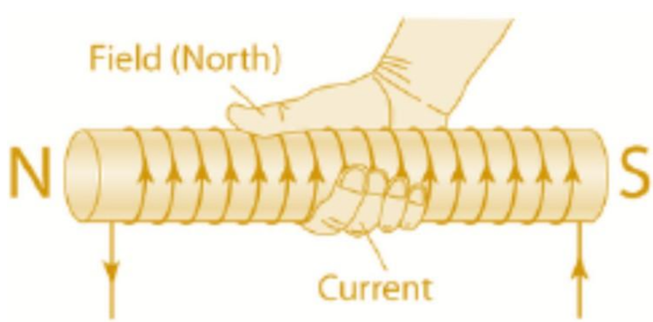
- Current in solenoid produces a stronger magnetic field inside the solenoid than outside.



- The field lines are concentrated at the ends of the solenoid.
- The field lines are uniform inside the solenoid. Hence the magnetic field has the same strength and direction inside the solenoid.
- The field lines spread out beyond the ends of the solenoid.
- Field lines outside the solenoid are similar to that of a bar magnet, and it behaves in a similar way – as if it had a north pole at one end and south pole at the other end. The side where magnetic field lines emerge is the North pole and vice-versa.
- Strength of the field diminishes with distance from the solenoid.
- Strength of the magnetic field can be increased by:

1. increasing the magnitude of the current in the coil
2. increasing the number of coils in the solenoid; and
3. using a soft iron core within the solenoid.

Finding the direction of the induced magnetic field:



Right-hand rule can be used to find the direction of the magnetic field.

In this case, point the wrapped fingers (along the coil) in the direction of the conventional current. Then, the thumb will point to the direction of magnetic field within the solenoid.

Application of the magnetic effect of current:

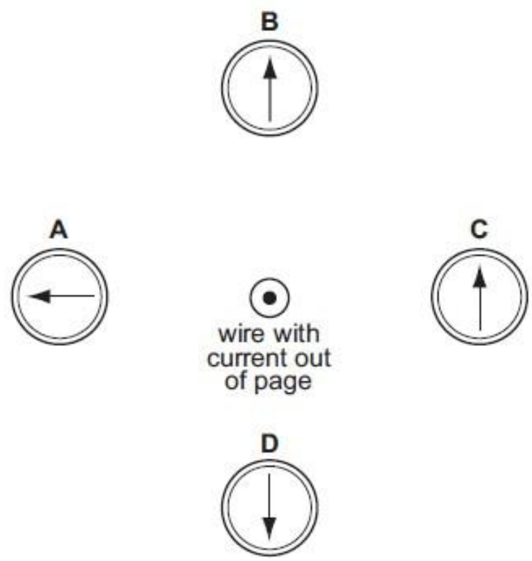
- **The magnetic field inside the solenoid is used in applications ranging from cathode ray TV tubes, magnetic resonance(MR) brain scanner.**
- **The magnetic field outside the solenoid is used to make electromagnets in the scrap-yard, to make small electromagnets to be used in relays.**

APPLICATION BASED QUESTIONS:

1 **34** A wire perpendicular to the page carries an electric current in a direction out of the page. There are four compasses near the wire.

Which compass shows the direction of the magnetic field caused by the current?

0625/11/M/J/09

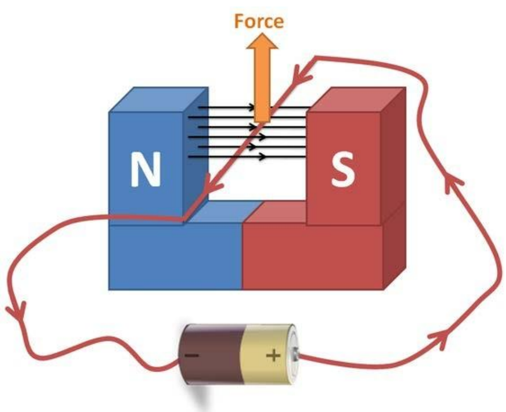


MARK SCHEME:

1-C

4.5.4-4.5.5
Force on a current carrying conductor

Motor effect: A force is exerted on a current carrying conductor placed in a magnetic field. This effect is called as the motor effect.



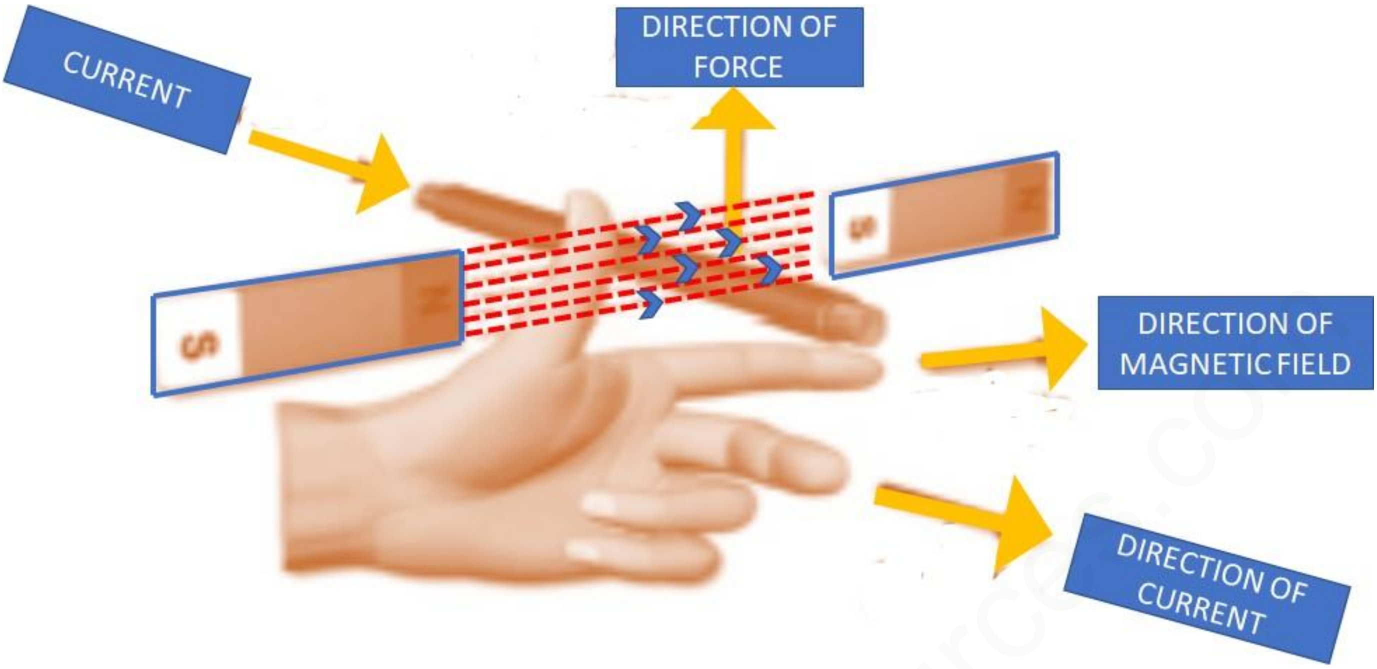
Factors affecting the force on the wire:

1. Force can be increased by :
   Increasing the current
   Using a stronger magnet

2. The direction of the force can be reversed by:
   Changing the direction of the current
   Reversing the direction of the magnetic field

3. The maximum and minimum value of the force:
   The force is greatest when the wire is perpendicular to the magnetic field lines.
   Zero when the wire is parallel to the magnetic field lines.

4. The direction of the force:
   The direction of the force is always perpendicular to the direction of the wire and magnetic field lines.



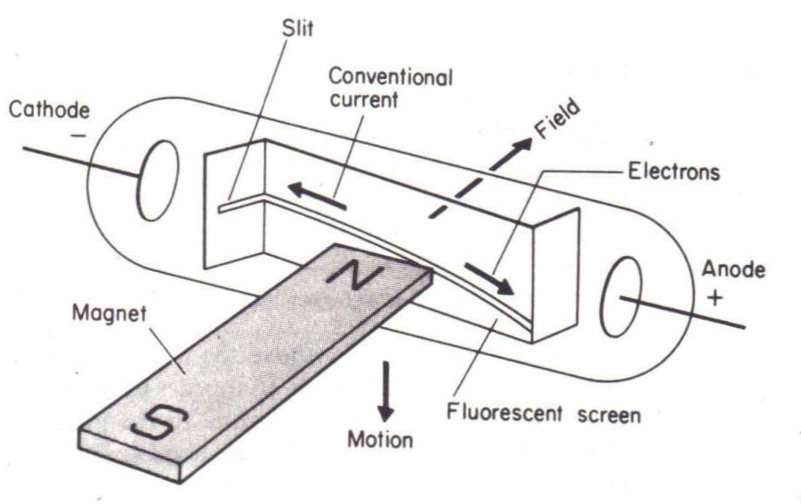
Flemings left hand rule:

The direction of the force can be found out by Flemings left hand rule:

Spread your left thumb, forefinger (index finger) and second finger so that they are all at 90° to one another. Point your forefinger (index finger) in the direction of the magnetic field (north to south)

and your second finger in the direction of the conventional current (positive to negative). Then your thumb will point in the direction of the force.

Force on the beam of charged particles in a magnetic field:



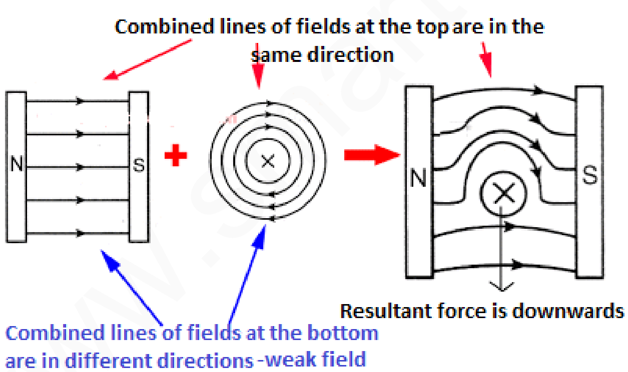
Cathode rays are a beam of negatively charged electrons. In the adjoining picture, they appear to go from left to right. Hence the direction of the conventional current is from right to left.

Also a magnet is brought close to it as shown. Hence the direction of the bending of the cathode rays can be found by Flemings Left Hand Rule. Hence the rays bend downwards.

Note:

- If an electromagnet instead of a permanent magnet will produce the same result
- If the Current in the electromagnet is increased, the magnetic field strength also increases, thus pushing the electron beam further down.

The combined effect of the magnetic fields:



A current carrying wire had its own magnetic field. A magnetic field also exists in between the poles of a magnet. The adjoining diagram shows what happens when the two magnetic fields interfere.

The magnetic field lines of the wire and the magnet cancel out each other on one side and reinforce on the other side. Consequently, the wire is pushed to the weakest part of the field.

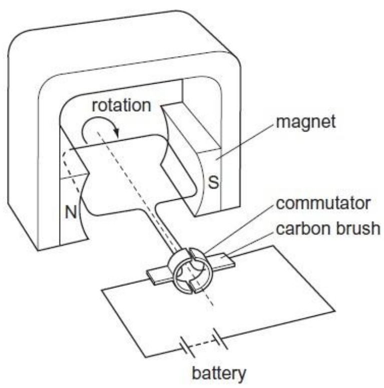
DC Motor:

Principle: A current carrying coil in a magnetic field experiences a turning effect.

This turning effect can be increased by:

- Increasing the number of turns of the coil.
- Increasing the current
- Increasing the strength of the magnetic field.

Working of a DC motor:



Constrution:

- The DC motor consists of a rectangular coil of insulated wires(armature) between two poles of a magnet.
- The coil is connected to the battery via two metal or graphite brushes.
- The brushes press onto a metal split ring commutator fixed to the coil.

Working:

When a current is passed through the coil, the coil rotates because:

- A force acts on each side of the coil due to the motor effect.
- The force on one side of the coil is opposite to the force on the other

Role of the split ring commutator:

The brushes connect to the other split ring after every half turn. Thus they reverse the direction of the current every half turn. Also the sides of the coil also swap after every half turn. Thus the coil continues to move in the same direction .

Type of energy conversion:

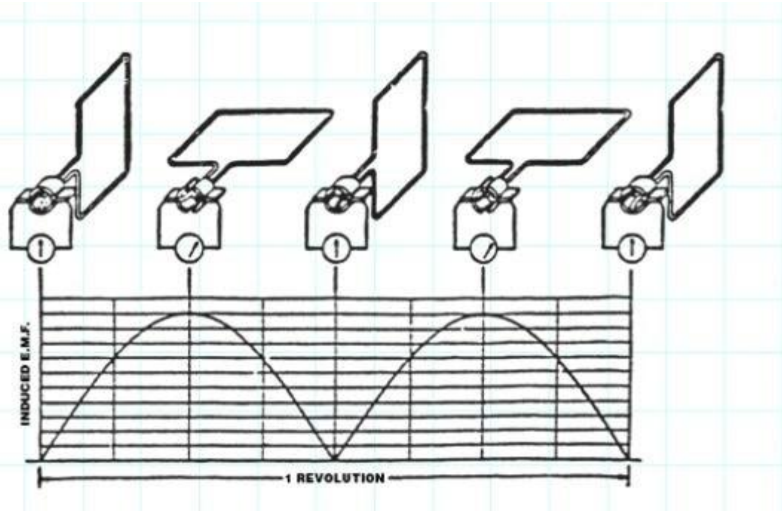
The DC motor converts electrical energy to kinetic energy

Controlling the speed of the motor:

Speed of the motor can be controlled by controlling the magnitude of the current.

Changing the direction of the rotation of the motor: This can be done by changing the direction of the current.

Voltage-time graph for the DC motor:



The force on the coil is the largest when the plane of the coil is parallel to the magnetic field lines.
The force on the coil is zero when the plane of the coil is perpendicular to the magnetic field lines. The coil comes down due to its own momentum.

Structure (Split rings vs. Slip rings)

AC generators use slip rings (advantage)

- They have smooth, continuous surfaces which the brushes are constantly in contact with.
- This means they do not wear down quickly, require little maintenance and are quite reliable.

DC generators use split-rings (disadvantage)

- This means the brushes are constantly striking the edges of the commutator causing them to wear quickly and require regular maintenance.
- As they wear, they also do not maintain proper contact reducing its efficiency.
- Conductive objects may also become lodged in the gaps between half-rings causing sparking and reducing the quality of the output signal.

APPLICATION BASED QUESTIONS

1 **(a)** Fig. 9.1 shows a wire, held between the poles of a magnet, carrying a current in the direction of the arrow.

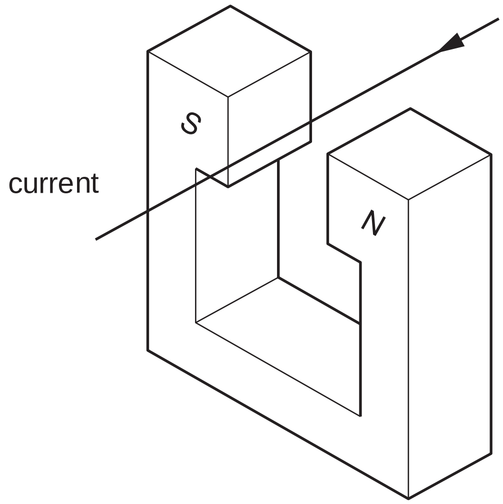


Fig. 9.1

(i) On Fig. 9.1, draw an arrow, labelled *F*, to show the direction of the force acting on the wire. [1]

(ii) Explain why the force *F* acts on the wire.

....

.... [1]

(iii) The directions of the current and the magnetic field are both reversed. State the effect on the force *F*.

.... [1]

(b) Fig. 9.2 shows a negatively charged particle travelling, in a vacuum, into a region where a magnetic field acts. The magnetic field, shown by the crosses, is acting **into** the paper.

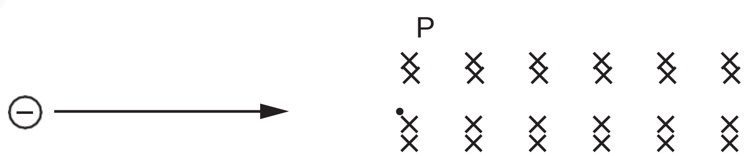


Fig. 9.2

(i) Draw an arrow, labelled *F*, to show the direction of the force on the particle at point P where it enters the field.

(ii) Describe the path of the particle as it continues to move through the magnetic field.

.... [2]

MARK SCHEME:

(a) (i) arrow pointing vertically downwards B1

(ii) <u>magnetic</u> fields due to current and magnet interact with each other
OR current produces <u>magnetic</u> field.
OR wire contains moving charges which experience a force in a <u>magnetic</u> field B1

(iii) direction of force unchanged B1

(b) arrow at P pointing down the page B1
curved path B1 [5]

(a) Fig. 9.1 illustrates the left hand rule, which helps when describing the force on a current-carrying conductor in a magnetic field.

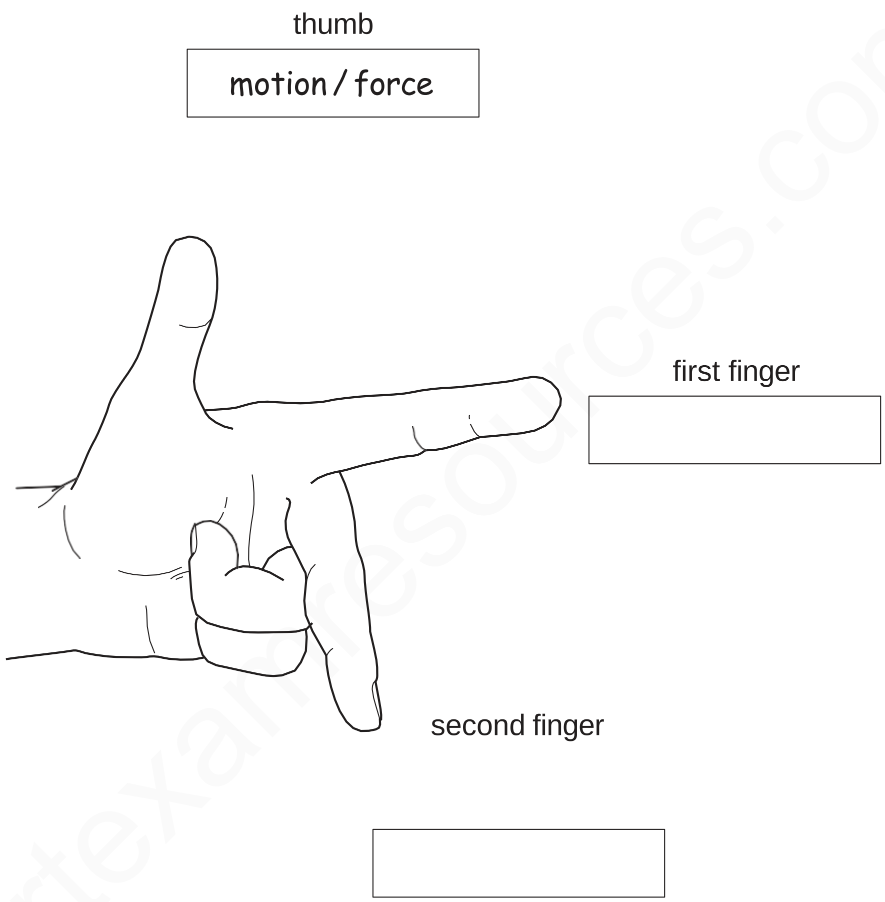


Fig. 9.1

One direction has been labelled for you.

In each of the other two boxes, write the name of the quantity that direction represents.
[1]

(b) Fig. 9.2 shows a simple d.c. motor connected to a battery and a switch.

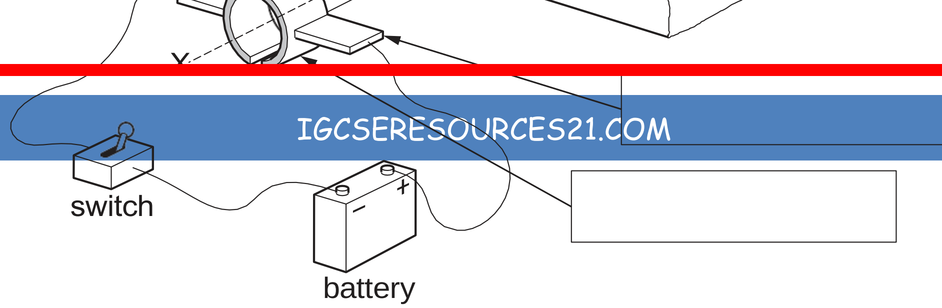


Fig. 9.2

(b) Fig. 9.2 shows a simple d.c. motor connected to a battery and a switch.

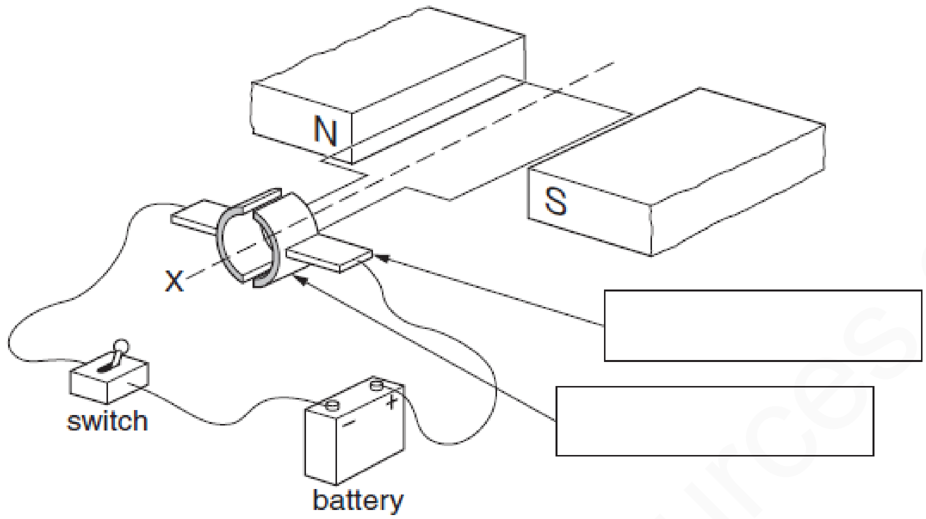


Fig. 9.2

(i) On Fig. 9.2, write in each of the boxes the name of the part of the motor to which the arrow is pointing. [2]

(ii) State which way the coil of the motor will rotate when the switch is closed, when viewed from the position X.

.... [1]

(iii) State two things which could be done to increase the speed of rotation of the coil.

1. ....

2. .... [2]

[Total: 6]

MARK SCHEME:

(a) first finger – field / magnetism / flux)
second finger – current / charge flow (NOT electron flow)) both B1

(b) (i) brush OR contact OR sliding connector B1
split ring OR commutator NOT slip ring B1

(ii) clockwise OR right side down OR left side up OR correct arrows on figure NOT turn to the right B1

(iii) more current / more voltage / "stronger battery" / more power)
more turns on coil / more coils)
stronger magnet Ignore bigger magnets)
closer magnet / magnetic poles) any 2 B1, B1
more magnets)
iron core) [6]

10 (a) Fig. 10.1 shows the cross-section of a wire carrying a current into the plane of the paper.

Fig. 10.1

On Fig. 10.1, sketch the magnetic field due to the current in the wire. The detail of your sketch should suggest the variation in the strength of the field. Show the direction of the field with arrows. [3]

(b) Fig. 10.2 shows part of a model of a d.c. motor.

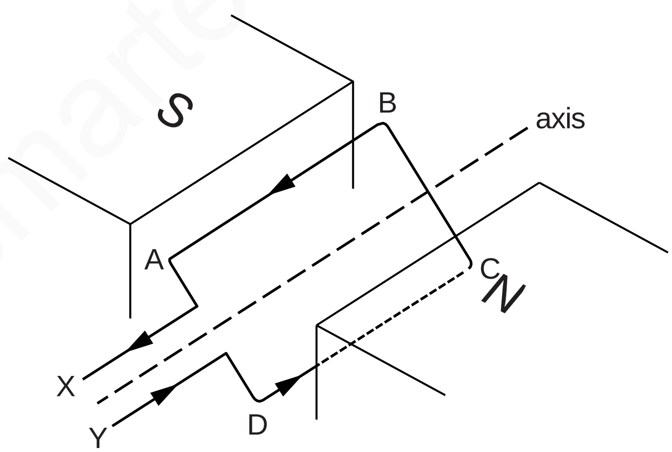


Fig. 10.2

A loop of wire ABCD is placed between the poles of a magnet. The loop is free to rotate about the axis shown. There is a current in the loop in the direction indicated by the arrows.

(i) On Fig. 10.2, draw arrows to show the directions of the forces acting on side AB and on side CD of the loop. [1]

(ii) With the loop in the position shown in Fig. 10.2, explain why the forces on AB and CD cause the loop to rotate about the axis.

....

....

....

....[1]

(iii) The ends X and Y of the loop are connected to a battery using brushes and a split-ring commutator.

State why a split-ring commutator is used.

....

....

....

....[2]

[Total: 7]

MARK SCHEME:

(a)	at least 3 concentric circles centred on wire	B1
	arrows clockwise on each circle / at least one circle	B1
	spacing of circles increasing as radius increases	B1
(b) (i)	arrow pointing down on side AB, up on side CD	B1
(ii)	forces on AB and CD are opposite OR up and down and separated / not in same line (so cause rotation) OR have moments in same sense / direction OR cause couple / torque	B1
(iii)	to reverse current in loop or keep current in AB or CD in the same direction OR keep current on side near a pole in the same direction when (plane of) coil is vertical OR every half turn OR when AB and CD swap sides	B1
	so that: rotation continues (in same direction) OR so that rotation doesn't reverse its direction OR to maintain sense/direction of moments/couple OR coil turns more than half a revolution	B1

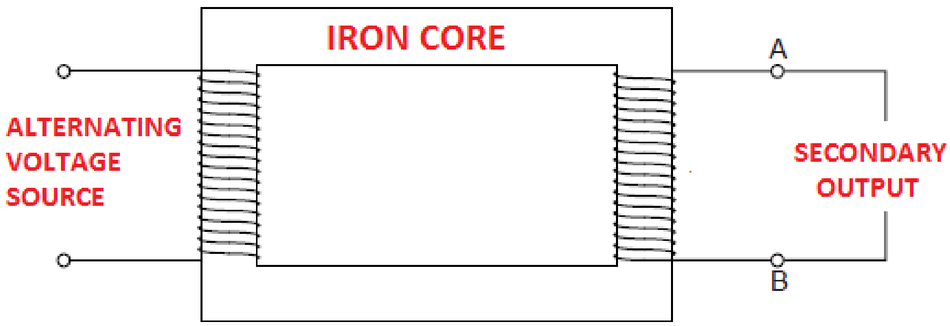
[Total 7]

4.5.6-The transformers

Transformers:

Transformers are electrical devices consisting of two or more coils of wires used to transfer electrical energy by means of a changing magnetic field.

Construction and working of a transformer in general:



A transformer consists of two coils of insulated wires. Both the wires are wound around the same soft iron core. The coil connected to the alternating voltage source is referred to as the primary coil. The coil connected to the output is called as the secondary coil.

Working:

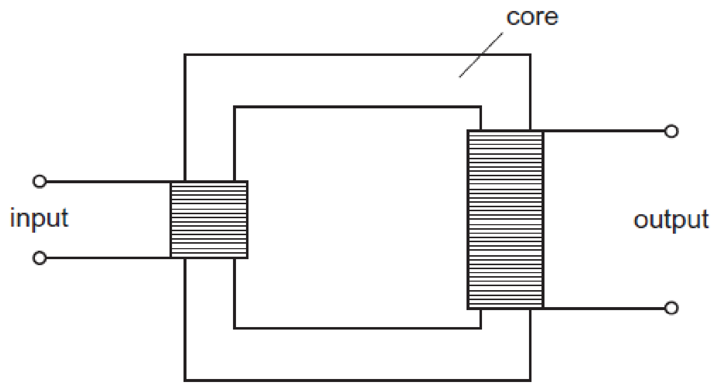
- **When a voltage is applied across the primary coil, an alternating current is induced in the primary coil.**
- **This alternating current induces an alternating magnetic field in the soft iron core.**
- **These alternating magnetic field lines from the iron core cut the secondary coil and induce an alternating voltage across it.**
- **Thus electrical energy is transferred from the primary to the secondary coil. It is to be noted that the two coils are not connected to each other.**
- **If the core of the transformer is split and are separated by a considerable distance then the transformer does not work because the magnetic field does not get transferred from the primary to the secondary coil.**

The transformer does not work on a DC voltage: **This is because a constant voltage cannot cause electromagnetic induction.**

There are 2 types of transformers:

- Step up transformers
- Step down transformers

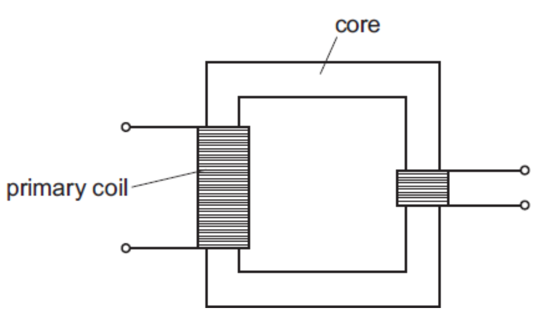
Step up transformer: A step up transformer steps up the primary voltage. As a result the secondary voltage is greater than the primary voltage.



For a step up transformer:
The number of turns of secondary (N_s) are greater than the number of turns of the primary (N_p), so The voltage of the secondary(V_s) > the voltage of the primary(V_p)

$N_s > N_p$ and $V_s > V_p$

Step down transformer: A step down transformer steps down the primary voltage. As a result the secondary voltage is lesser than the primary voltage



For a step down transformer:
The number of turns of secondary (N_s) are lesser than the number of turns of the primary (N_p), so the voltage of the secondary(V_s) < the voltage of the primary(V_p)

$N_s < N_p$ and $V_s < V_p$

Uses of transformers:

- Transformers are used in low voltage supply units such as mobile phone charges to step down the alternating voltage from the mains down to the required voltage.

The transformer equation:

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

Where;

V_P = vvvvvvvvvvvvvvv vvaaaavvaavvaa vvvv vvttvv aappaappvvpppp ccvvaavv

V_{SS} = vvvvvvvvvvvvvvv vvaaaavvaavvaa vvvv vvttvv ssvvccvvssaavvpppp ccvvaavv

N_P = ssnnppnnvvpp vvoo vvnnppssss vvoo vvttvv aappaappvvpppp ccvvaavv

N_{ss} = ssnnppnnvvpp vvoo vvnnppssss vvoo vvttvv ssvvccvvssaavvpppp ccvvaavv

Equation to use when a transformer is 100% efficient:

$$I_P V_P = I_S V_S$$

Thus if a transformer is 100% efficient, the input power=output power.

Energy losses in the transformer may be due to:

- Heating up of the coil or the wires.
- Eddy current in the core or heat losses in the core
- Sound from the core or the coil.

Advantages of high voltage transmission:

High voltage transmission is much more efficient than transmission at much lower voltages. This is because by operating the grid at a high voltage, we can reduce the current in the cables and transfer the same amount of electrical energy every second through them. Thus less energy is wasted in the form of heat.

Note: The greater the efficiency, the lower is the energy wasted in the cables.

A step up or a step down transformer does not change the frequency of the output current.

Disadvantages of using transformers:

- **It has led to increased dependence on electricity**
- **It has led to the automation of industry, reducing demand for unskilled labour – loss of jobs**
- **Increased risk of electrocution**
- **Increased demand – increased burning of fossil fuels, causing decreased air quality and causing respiratory irritation.**

NUMERICALS:

(d) A 100% efficient transformer is used to step up the voltage of a supply from 100 V to 200 V. A resistor is connected to the output. The current in the primary coil is 0.4 A.

Calculate the current in the secondary coil.

O/N/05-P3-Q10

current = ... [2]

Solution:

Given:

- **The transformer is 100% efficient.**
- **Transformer is a step -up transformer.**
- **V_p=100V ; V_s=200V ; I_p=0.4A ; I_s=?**

$$I_P V_P = I_s V_s$$

$$I_S = \frac{I_P V_P}{V_S} = \frac{00.44 XX 10000}{220000} = 00.22A$$

---

11 A battery charger includes a transformer and a rectifier.

Fig. 11.1 represents the transformer, consisting of an iron core with two coils P and Q wound on to the core.

M/J/14-P33

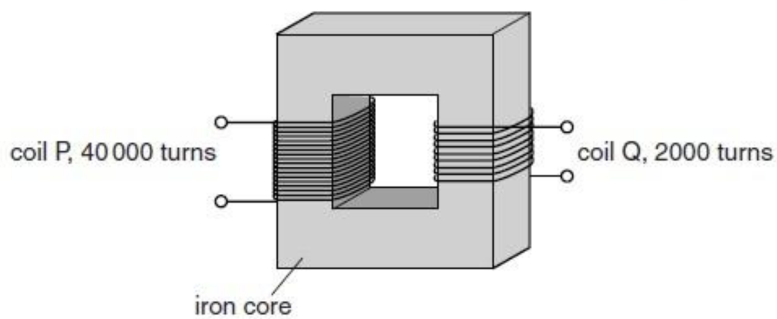


Fig. 11.1

P consists of 40000 turns and Q consists of 2000 turns.

When P is connected to a 230V a.c. supply, there is an e.m.f. across the terminals of Q.

(a) (i) Calculate the size of this e.m.f.

11 (a) (i)	(V_2=)V_1N_2/N_2 **OR** 230 × 2000/40000
	11/11.5/12 V

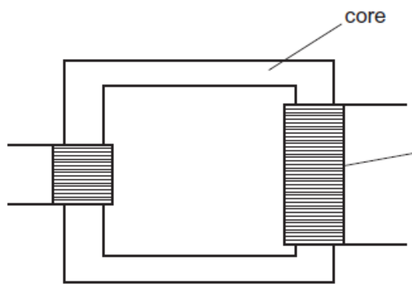
APPLICATION BASED QUESTIONS:

MCQ:

1

35 The diagram shows a transformer.

0625/13/O/N/13

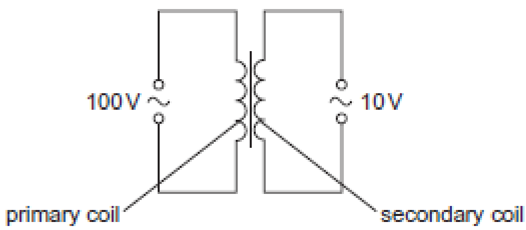


Which materials are suitable to use in its construction?

	core	wire coil
A	copper	iron
B	iron	copper
C	steel	copper
D	steel	iron

2

35 A transformer is to be used to provide a 10 V output from a 100 V supply.

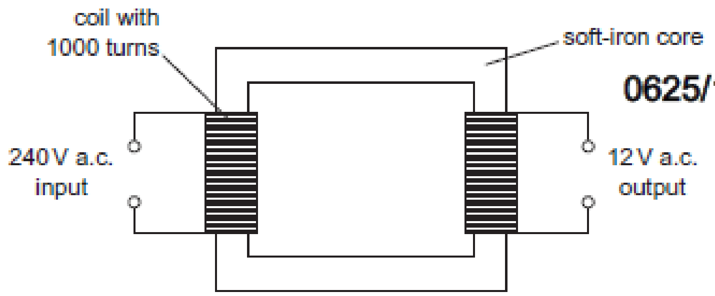


What are suitable numbers of turns for the primary coil and for the secondary coil?

	number of turns on the primary coil	number of turns on the secondary coil
A	100	1000
B	200	110
C	400	490
D	800	80

0625/11/O/N/09

3 **35** The diagram shows a mains transformer that has an output voltage of 12V.



0625/13/M/J/13

How many turns of wire are in the secondary coil?

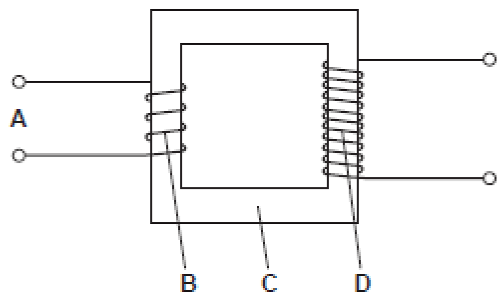
A 12 **B** 20 **C** 50 **D** 20000

---

4 **34** The diagram shows a simple step-down transformer used to decrease a voltage.

Which part is the primary coil?

0625/12/M/J/11



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5 **35** A transformer has 15 000 turns on its primary coil and 750 turns on its secondary coil.

Connected in this way, for what purpose could this transformer be used?

A to convert the 8000 V a.c. output of a power station to 160 000 V for long-distance power transmission

B to convert the 160 000V d.c. supply from a power line to 8000V for local power transmission

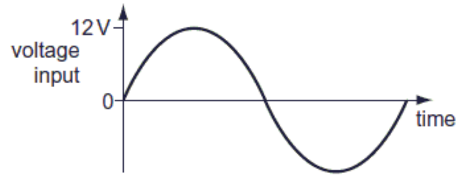
C to use a 12V d.c. supply to operate a 240V razor

D to use a 240 V a.c. mains supply to operate a 12 V motor

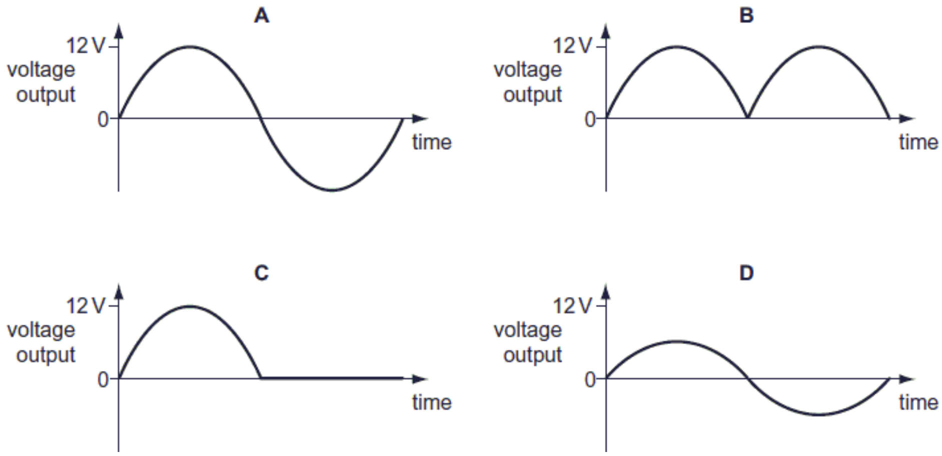
0625/11/M/J/10

6

35 The graph shows the voltage input to a step-down transformer. 0625/01/O/N/06



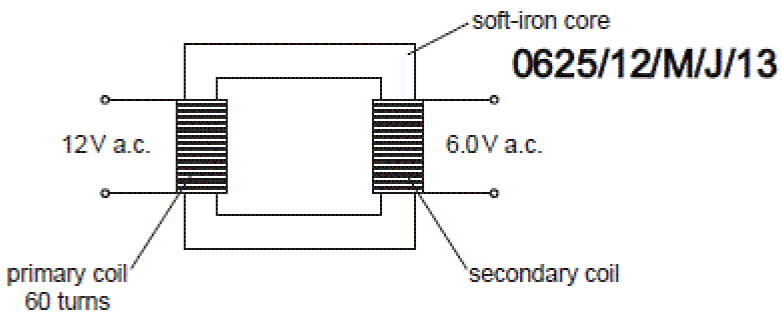
Which diagram shows the voltage output from the transformer?



7

35 A student wants to make a transformer to step 12 V down to 6.0 V.

She winds 60 turns of wire around an iron core as shown in the diagram.



How many turns of wire should she wind on the secondary coil of her transformer?

A 5 **B** 30 **C** 60 **D** 120

8 **36** In the construction of a transformer, which items must be included? **0625/13/O/N/12**

A an iron core and a permanent magnet

B an iron core and two coils of wire

C a steel core and a permanent magnet

D a steel core and two coils of wire

---

9 **34** A step-up transformer is used before electricity is transmitted by overhead cables.

Which statement explains why the step-up transformer is used?

A It increases the current to increase the speed at which the electricity travels.

B It increases the current to reduce energy loss in the cables. **0625/11/O/N/15**

C It increases the voltage to increase the speed at which the electricity travels.

D It increases the voltage to reduce energy loss in the cables.

MARKING SCHEME

1-B
2-D
3-C
4-D
5-D
6-D
7-B
8-B
9-D

EXTENDED THEORY:

1 **8** **(a)** The transformer in Fig. 8.1 is used to convert 240 V a.c. to 6 V a.c.

M/J/10-P31

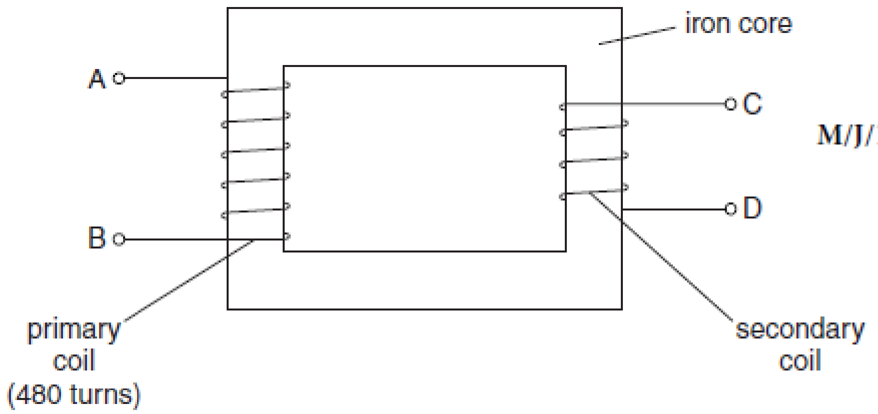


Fig. 8.1

(i) Using the information above, calculate the number of turns on the secondary coil.

number of turns = ... [2]

(ii) Describe how the transformer works.

....

....

....

....

.... [3]

(iii) State one way in which energy is lost from the transformer, and from which part it is lost.

.... [1]

(b) Fig. 8.2 shows a transformer. P is the primary coil. S is the secondary coil. The coils are wound on an iron core.

O/N/11-P31-Q8

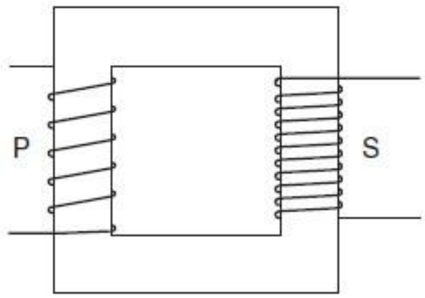


Fig. 8.2

P has 200 turns and S has 800 turns. The e.m.f. induced across S is 24V. The current in S is 0.50A. The transformer operates with 100% efficiency.

Calculate

(i) the voltage of the supply to P,

voltage = ...[2]

(ii) the current in P.

current = ...[2]

[Total: 7]

MARK SCHEME:

(a) any three from:
use a strong(er) magnet
increase the number of coils in the solenoid / turns of solenoid closer together
move the magnet fast(er).
place iron core in the solenoid
use thick(er) wire / low(er) resistance wire for solenoid — max B3

(b) **(i)** $N_P/N_S = V_P/V_S$ OR $200/800 = V_P/24$ OR $V_P = N_P V_S/N_S$
OR $V_P = 200 \times 24/800$ — C1
6.0 V — A1

(ii) $I_p V_p = I_s V_s$ OR $I_p N_p = I_s N_s$ OR $I_P = I_S V_S/V_P$ OR $I_P = I_S N_S/N_P$
OR $I_P = (0.5 \times 24)/6$ OR $I_P = (0.5 \times 800)/200$ — C1
2(.0) A
allow ecf from **(b)(i)** — A1 [7]

2 12 Overhead power cables supply electrical power to a town that is a considerable distance from the power station.

The voltage at which the power is transmitted in the cables is very much greater than the voltage at the power station and the voltage of the mains supply in the town.

M/J/14-P33

(a) Explain the advantage of transmitting electrical power at a very high voltage.

....

....

....

....

.... [3]

(b) It is suggested that the resistance of the cables can be changed by doubling their diameter.

(i) Explain the effect of this change on the resistance of the cables.

....

....

.... [2]

(ii) Suggest one disadvantage of doubling the diameter of the cables.

....

.... [1]

[Total: 6]

NOTE:Until 2015, all extended theory papers were numbered as Paper 1/ 3 and 6 From 2016, they were renumbered as Paper 2/4 and 6. So even if you see questions from Paper 1 or 3 upto 2015, they still have been taken from the extended papers only

MARK SCHEME:

(a)		(high voltage allows) low/less reduced current	B1
		$(P=)I^2R$ **OR** IV OR $(E=)I^2Rt$ **OR** IVt **OR** depends on current heating effect owtte	B1
		low / less / reduced heating effect / heat generated (allow lost) / more efficient / cheaper etc. (**NOT** with reduced resistance)	B1
(b)	**(i)**	(cross-sectional) area 4× larger **OR** resistance inversely proportional to area **OR** smaller resistance	C1
		reduced to ¼	A1
	(ii)	cables heavier **OR** more / stronger pylons or more material in cable	B1
			[Total: 6]