Physics

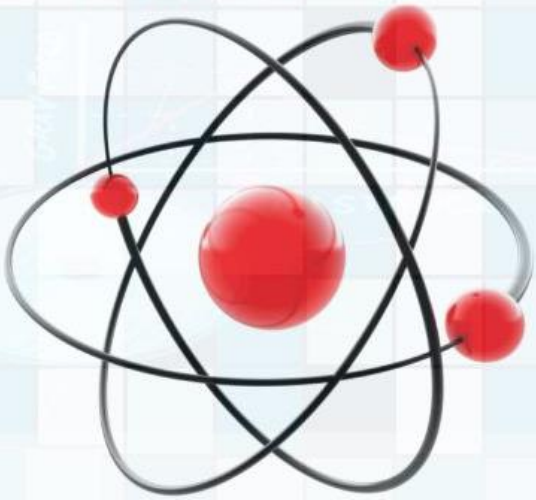
3

Questions & answers

Tips & Tricks

Theory Notes

Previous Year's
Reference Questions

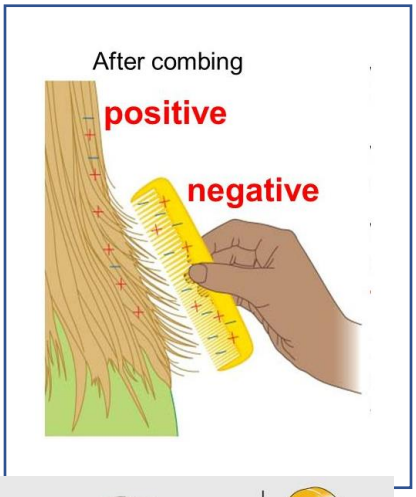


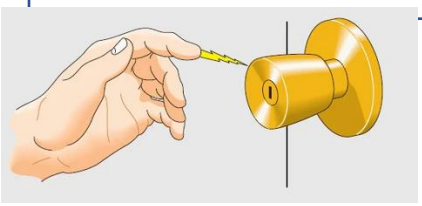
Chapter One

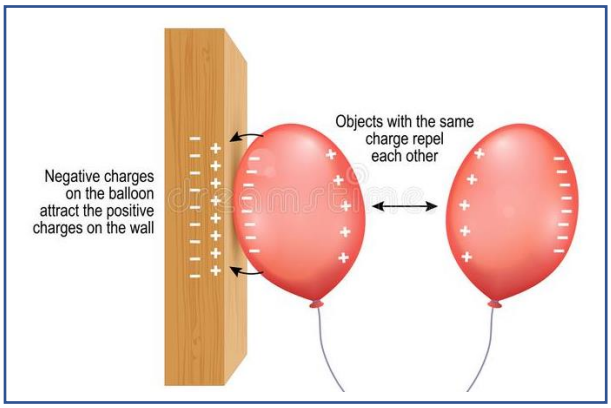
Electrostatic : *phenomena due to attractions or repulsions of electric charges but not moving .*

✓ **Common Observations:**

- Small pieces of paper + plastic material (comb).
- paper pieces + attracted by a balloon.
- A person's hair + attracted by a balloon.
- Wooleen carpet + rubbed (walk).
- touch any part of the body + metal part.
- The slides in parks + clothes.







Electrostatic force: *It is the force of attraction between unlike charges*

or *the force of repulsion between like charges.*

Electric Charge

- Electric charges result from gain or loss of electrons

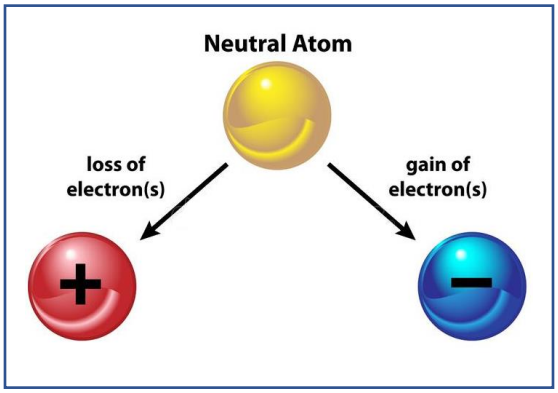
electrically neutral: Number of electrons equals to the number of protons.

Atom
- Electron → negative charge
- Proton → positive charge
- Neutron → neutral

Types of Electrical Charges

negative charge = e

positive charge = p



❖ **There are atoms in material which lose some of their external electrons as a result of external factors.**

number of electrons

- Decreases (loss) ⟹ **positive ion**
- Increases (gain) ⟹ **negative ion**

Notes

1) Coulomb is the unit measurement of electric charge.
2) The charge of proton inside the nucleus of an atom is positive, and it is value equal to the charge of the electron.

$$\mathbf{e = p} = 1.6 \times 10^{-19} C$$

3) 1 C = 6.25×10^{18} electron.
4)

$$\text{Number of electrons} = \frac{\text{the body charge}}{\text{the electron charge}}$$

$$n = \frac{q}{e}$$

UNIT OF CHARGE

MILLI COULOMB	mC	$x10^{-3}$
MICRO COULOMB	μC	$x10^{-6}$
NANO COULOMB	nC	$x10^{-9}$
PICO COULOMB	pC	$x10^{-12}$

Attracting and repelling forces between the electric charges

Activity-1 : Like charges repel each other and unlike charges attract each other

❖ Tools of Activity:

Two identical rods of solid rubber, Two identical rods of glass, Two pieces of cloth, one wool or one fur, and the other silk, Strings of cotton or silk hangers.

❖ Steps

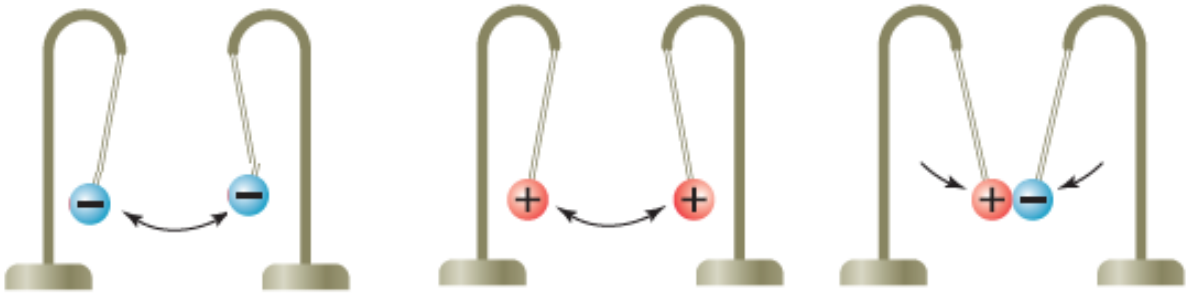
First
- Hang the two rubber rods horizontally by two strings using the holders so that the two rods are close to each other.
- Rub each of the rods individually with the wool. (Each of them will be negatively charged).
- Leave the two rods hanging freely. We see that they repel.

Second
- Hang the two glass rods horizontally and get them close to each other.
- Rub each one individually with the silk. (Each one will be positively charged).
- Leave rods hanging freely. See that they repel each other.

The similar charges repel each other

Third
- Hang a rod of glass and a rod of rubber horizontally and close to each other.
- Rub the glass rod with silk. It will get a positive charge. We rub the rubber rod with wool. It will get a negative charge.
- Leave the two rods hanging freely, we see that they attract each other.

Different charges attract each other

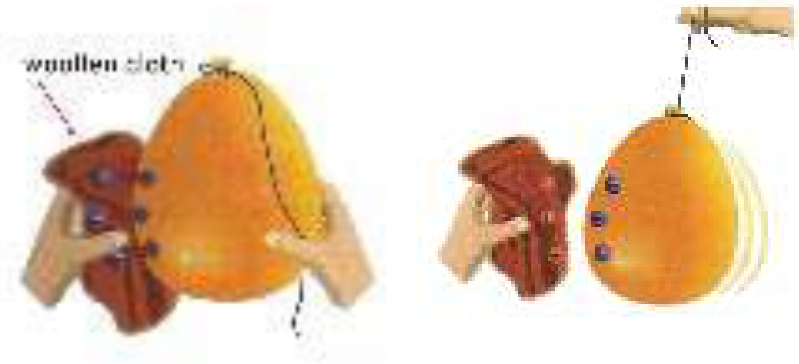


Charging Bodies

1) Charging by Rubbing:

- When a balloon is rubbed by a piece of wool, there will be positive charges on the wool (as it loses some of its electrons) At the same time the balloon will be negatively charged (as it gains some electrons).

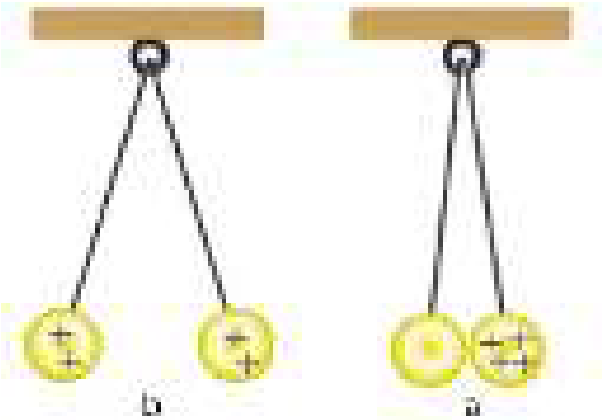
  Now, if you hang the negatively charged balloon with an insulted string and make it close to the piece of wool positively charged; you will find the piece of wool attracts towards the balloon.



2) Charging by contact

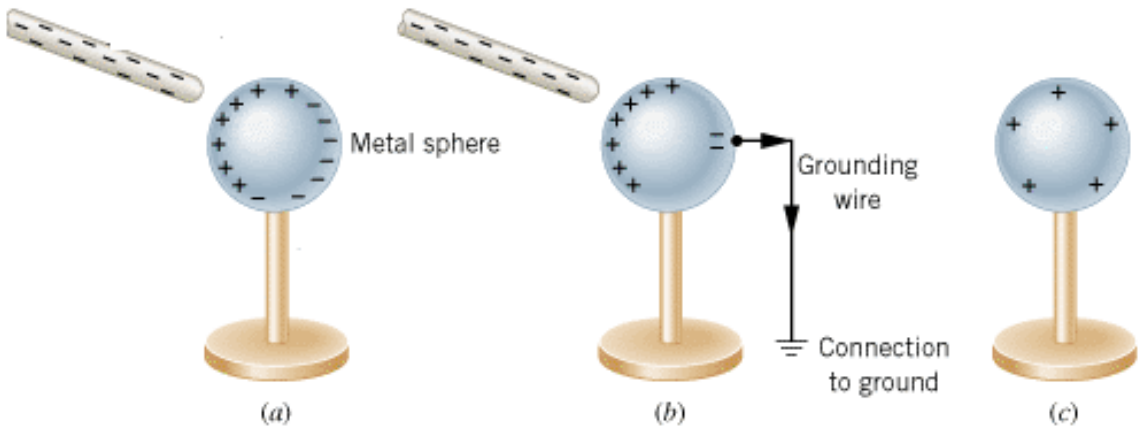
- Hang two balls of balm marrow with two insulated strings from the same point.

  Charge one of the balls by touching it with charged glass rod. with silk. Leave this ball to touch the other ball which is not charged. You will see that the two balls repel each other. This shows that the second ball which was not charged has now gained some of the charges of the first ball by coming into contact.



3) Charging by induction:

- When a negatively charged rod of rubber is approached (negatively charged as a result of rubbing by wool) to the metal ball surface which is neutrally charged and isolated, then the negative charge of the rod in terms of (electrons) will repel the negative charge of the surface ball (electrons) and push it towards the far side of the rod (this is known as a free electron). As a result of a shortage in the number of electrons in the near side of the rod, a positive charge will appear. This is known as a bounded charge.
- Connect a metal ball to the earth by linking its surface by a wire ending at the earth, or by touching its surface by your finger. Keep the charged rod close to the ball.
- We observe that the free electrons have lost to the earth.
- Disconnect the ball connection to the earth (remove your fingers from the ball) and keeping the rod close to the ball. We see that the bounded charge remains at their location
- Move the rod away from the ball. You will find that the bounded charges (which are the positive charges opposing the charges of the rod) distributed evenly on the external surface of the ball.



bound charge: It is the charge produced by Charging by induction and connected with the charging body, cannot move freely and cannot leave the metal ball surface. will not escape to the earth when the conductor is grounded.

free charge: *Can move in the conductors freely and can leave the conductors, and will escape to the earth when the conductor is grounded.*

Ministerial What happens to the charge of a negatively charged body when it is it was connected to the earth?

Electroscope: *An electroscope is an electrical apparatus used in electric experiments*

*1-To **detect** an electrical charge on any surface,*
*2-To **determine** the **kind** of electrical charge on any charged body*

The electroscope consists of:

1. A rod made of metals.
2. metal disc (or metal ball) linked to the upper part of the rod.
3. Two thin leaves (or strips) of gold or aluminum joined to the lower part of the rod.
4. box made of glass or metal or wood with a glass window.
5. A lid made of cork or rubber at the upper part of the box to separate the rod and the two leaves.

Charging an electroscope

1. Charging an electroscope by touching (conducting)

Tools: Electroscope, plastic comb.

Procedure:

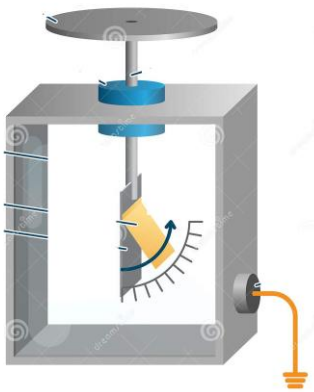
1) rub the comb with a hair.

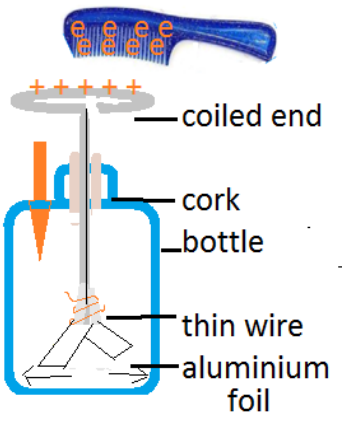
2) Let the comb touch the disc of the electroscope which is electrically neutral.

You will observe that the two leaves of the electroscope will separate.

❖ Conclusion of Activity:

When the charged comb rubbed the electroscope's disc which was neutral, the leaves of the electroscope separate due to the repelling force between them. This is because the leaves gained similar charges.





2. Charging an electroscope by induction

Tools: Electroscope, glass rod, a piece of silk.

Procedure: 1) rub the glass rod by the silk (the rod will gain a positive charge).

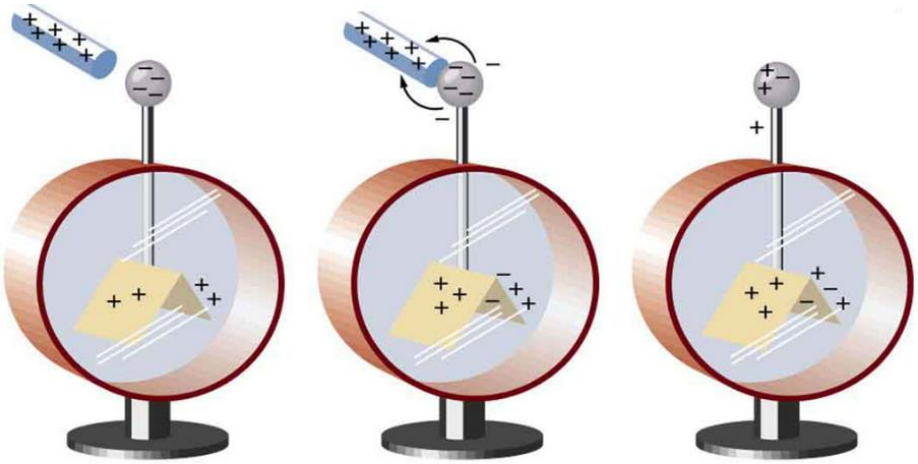
2) Get the charged glass rod close to the electroscope which is electrically neutral. We see that the aluminum leaf and the metal rod of the electroscope repel each other.

This is evidence that the electroscope became charged (The disc of the electroscope will be negatively charged, which is a bounded charge, and the leaf of the aluminum will be positively charged which is a free charge. This means that the disc will always get opposite. This is because the disc's charges attract the influential charge, the leaf and the rod with a similar charge as their charges repel with the influential charge.

3) Connect the electroscope's disc to the earth (by touching the electroscope's disc by your finger keeping the charged glass rod near the electroscope's disc observe that the leaf of the electroscope will be close to the metal rod of electroscope. **The reason is that the electroscope has gained electrons from the earth.**

4) Now disconnect the electroscope's disc from the earth (by moving your finger from the disc) and keeping the charged glass rod close to the electroscope's disc. You will observe that the leaf will remain touching the rod.

5) Now move the glass rod from the electroscope. You will see that the aluminum leaf and the electroscope's rod repel. This gives evidence that the remaining charges which were bounded will be distributed on the electroscope disc, the rod and the leaf.



Q // How can an Electroscope be used to detect an electrical charge?

- *When approaching a charged body to the electroscope disc and touch it. If the body has a charge, then the two leaves of the electroscope also get similarly charged, this leads to a repelling force between the two leaves as charges repel each other, and hence the two leaves separate, this confirms that the body has some charges on it.*

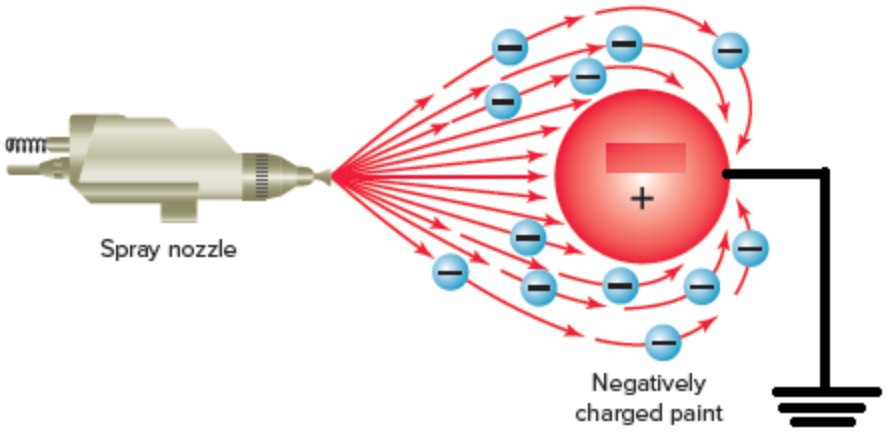
Q// How do you know if an object is positively or negatively charged?

1. We charge We charge the electroscope with a certain charge
2. Bring the body closer to the searchlight
3. If the two **leaves** are separated, that is, the charge of the body is similar to the charge of the electroscope with a certain charge.

Application of Electrostatic

1. Sprayer

Electrostatic used the car painter, the nozzle of the spray will be connected to the positive pole of electricity source. This makes all the drops of painting which come out of the spray positively charged. As a result, they separate from each other they will be connected to the negative poles of the source of electricity or they can be connected to the earth. In this way, the drops of painting will be attracted to the surface of that body, making the painting evenly distributed on the surface.



2. photocopying machines

3. The precipitate systems in cement factories in order to minimize environmental pollution.

4. contact lenses and cosmetic materials.

Different Materials according to its Electrical Conductivity

Conductors: They are materials containing plenty of negative electrical charges, the electrons move through these materials easily (freely),and have weak connections to the nucleus, such as copper, silver and aluminum.

Insulators: They are materials which the electrons do not move freely through, and have strong connections to the nucleus such as (glass, wool, rubber).

Q// Can a copper rod be charged in electrostatics?

Ans // Yes, if a copper rod is rubbed with wool or fur in isolation from the earth, it'll generate electrically charge which are on the copper rod.
But if you're not isolated, the charge will lose to the earth through the body of the person.

Q // Pieces of paper are not attracted to a copper rod that is rubbed with fur or wool if you hold a rod of copper by hand?

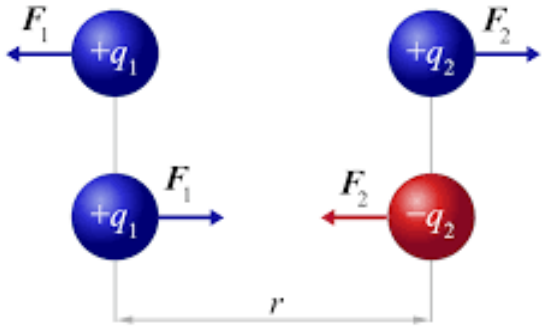
Ans // Because it's lost to the earth through the body of the person.

Coulomb's Law

The mutual electrical force between two electrical charges is direct proportion to the product of the values of their charges and inverse proportion to the square of the distance between them.

$$F = k\frac{q_1 q_2}{r^2}$$

F = The electric force in Newton (N)
q_1, q_2 = the values of each point charge measured in Coulombs(C) r = The distance between the center of two charges in meters (m) k = constant proportion.



Notices

1. يجب تعويض مقدار الشحنة بالوحدات الكبيرة.

$\mu C \Rightarrow C \Rightarrow \times 10^{-6}$

$nC \Rightarrow C \Rightarrow \times 10^{-9}$

2. المسافة (البعد) يقاس بالوحدات الكبيرة (m) ، فاذا أعطيت بالوحدات الصغيرة (cm) يجب تحويلها الى المتر(m), وذلك بالقسمة على (100) أو الضرب مباشرة في (10^{-2}).
3. عند تعويض الشحنة في القانون نعوض فقط مقدار الشحنة بدون إشارة.

Q // What are the units of Coulomb's constant?

$$F = k\frac{q_1 q_2}{r^2}$$

$$N = k\frac{C \times C}{m^2}$$

$$k \cdot C^2 = N \cdot m^2 \Rightarrow k = \frac{N \cdot m^2}{C^2}$$

Q1 // The electrostatic force between two protons placed at distance r is F. If we keep electrons in place of protons, then what would be the effect on electrostatic force?

Charge on proton = Charge on electron

∴ There will be no change in electrostatic force.

∴ Electrostatic force = F

Q2 // If each of the charge's doubles, what happens to the force?

A// Quadruples

Q3 // If the distance doubles, what happens to the force?

A // Reduced by 1/4

Q4 // If the distance doubles, what happens to the value of the charges?

A // Does not affect the value of the charge.

example Two-point charges both positive are ($3 \times 10^{-9}\ C$) and the distance between them is (3 cm). Calculate the repelling force between them.

$$F = k\frac{q_1\, q_2}{r^2}$$

$$F = \frac{9\times10^{9}\times3\times10^{-9}\times3\times10^{-9}}{(3\times10^{-2})^{2}}$$

$$F = \frac{81\times10^{9}\times10^{-18}}{9\times10^{-4}}$$

$$F = 9\times\frac{10^{-9}}{10^{-4}}$$

$$F = 9\times10^{-9}\times10^{+4} \Rightarrow F = 9\times10^{-5}\ N$$

Ministerial Two point charges (q_1= +6 µC) and (q_2 = +2 µC) and the distance between them is (30 cm), Calculate mutual electrical force between two charges, what is its kind?

$$F = k\frac{q_1\, q_2}{r^2} \Rightarrow F = \frac{9\times10^{9}\times6\times10^{-6}\times2\times10^{-6}}{(30\times10^{-2})^{2}}$$

$$F = \frac{108\times10^{-3}}{900\times10^{-4}}$$

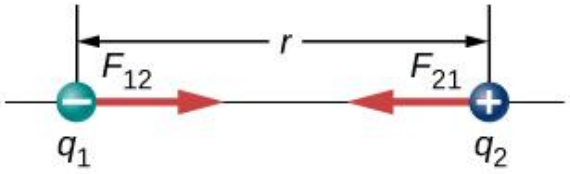
$$F = \frac{108\times10^{-3}}{9\times10^{-2}}$$

$$F = \frac{108}{9}\times10^{-1}$$

$$F = 12\times10^{-1} \Rightarrow F = 1.2\ N$$

example *A positive electric point charge (4×10^{-6} C) is located at a distance of (0.06 m) from another point of electric positive charge of the value (9×10^{-6} C) Calculate the magnitude of:*

1. The force in which the first charge acts on the second charge. What is its kind?
2. The force in which the second charge acts on the first charge. What is its kind?



1- Let F_{12} be the force in which the first charge influences on the second charge

$$F_{12} = k\frac{q_1\, q_2}{r^2}$$

$$F_{12} = 9\times10^{9}\frac{(+4\times10^{-6}\,C)\times(+9\times10^{-6}\,C)}{(0.06m)^2}$$

$$F_{12} = \frac{9\times4\times9\times10^{+9-6-6}}{36\times10^{-4}}$$

$$F_{12} = \boxed{90N}$$ repelling force.

2- Let F_{21} be the force in which the second charge influences on the first charge.

$$F_{21} = k\frac{q_2\, q_1}{r^2}$$

$$F_{21} = 9\times10^{9}\frac{(+9\times10^{-6}\,C)\times(+4\times10^{-6}\,C)}{(0.06m)^2}$$

$$F_{21} = \frac{9\times9\times4\times10^{+9-6-6}}{36\times10^{-4}}$$

$$F_{21} = \boxed{90N}$$

Conclusion

1. These two forces follow Newton's third law ($F_{12} = -F_{21}$).
2. *The force in which the first charge influences on the second charge are equal to the force in which the second charge acts on the first charge in the opposite direction.*

example The repelled force of two identical point electric charges is ($25 \times 10^{-7}\ N$), when the distance between them is (0.003 m). Calculate the charge of each one.

$$F = k \frac{q_1 q_2}{r^2}$$

Let $q_1 = q_2 = q$

$$F = \frac{K \times q \times q}{r^2}$$

$$F = \frac{K \times q^2}{r^2}$$

$$K \times q^2 = F \times r^2$$

$$q^2 = \frac{F \times r^2}{K}$$

$$q^2 = \frac{25 \times 10^{-7} \times (3 \times 10^{-3})^2}{9 \times 10^9}$$

$$q^2 = \frac{25 \times 10^{-7} \times 9 \times 10^{-6}}{9 \times 10^9}$$

$$q^2 = \frac{25 \times 10^{-13}}{10^9}$$

$$q^2 = 25 \times 10^{-22}$$

$$\sqrt{q^2} = \sqrt{25 \times 10^{-22}}$$

$$q = \sqrt{25} \times (10^{-22})^{\frac{1}{2}}$$

$$\therefore q = 5 \times 10^{-11}\ C$$

example

Calculate the distance between two-point charges ($q_1 = 9\ \mu C$) and ($q_2 = 1\ \mu C$) If the force of attraction between them (1000 N).

$$F = k\frac{q_1 \cdot q_2}{r^2}$$

$$r^2 = k\frac{q_1 \cdot q_2}{F}$$

$$r^2 = \frac{9 \times 10^{9} \times 9 \times 10^{-6} \times 1 \times 10^{-6}}{10^{+3}}$$

$$r^2 = \frac{81 \times 10^{9} \times 10^{-12}}{10^{+3}}$$

$$r^2 = \frac{81 \times 10^{-3}}{10^{+3}}$$

$$r^2 = 81 \times 10^{-3} \times 10^{-3}$$

$$r^2 = 81 \times 10^{-6}$$

$$\sqrt{r^2} = \sqrt{81 \times 10^{-6}}$$

$$r = \sqrt{81 \times 10^{-6}}$$

$$r = \sqrt{81} \times (10^{-6})^{\frac{1}{2}}$$

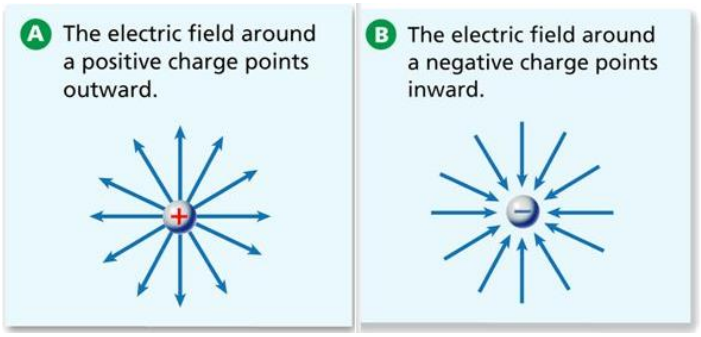
$$r = 9 \times 10^{-3}\ m$$

Electric Field

Electric Field: It's the electric force to unit charge on a test charge (q), measured in units (N/C)

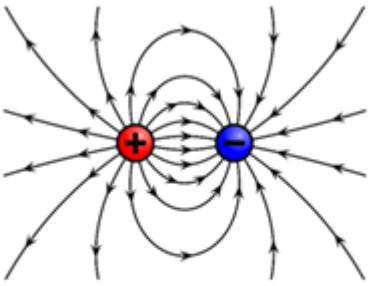
$$\text{Electric field} = \frac{\text{Electric force}}{\text{The value of test charge}}$$

$$E = \frac{F}{q} \qquad E = \frac{N}{C}$$

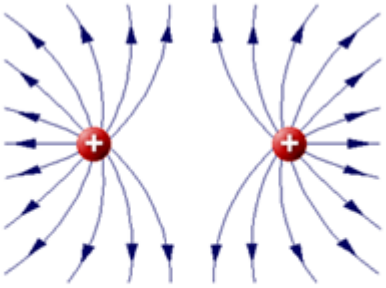


Q // What is electric field lines and its properties?

1. starting from the positive charge and ending at the negative charge.
2. Non visible.
3. Cannot cross each other.

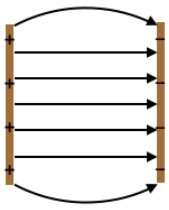


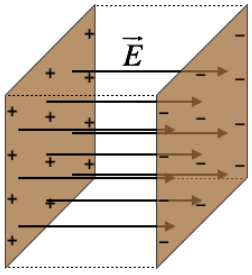
Electric field between two similar charges will be regular



Electric field between two different point charges will be irregular

Regular electric field : generated between two plain metal boards and parallel which are both equally charged in value but different in type.





Irregular electric field: generated between two similar charges.

Min 2019// Draw a diagram explaining the lines of the electric field between two different point charge?

example

A positive point electric charge of ($2 \times 10^{-9}\ C$) located at a point in an electric field. It was acted by a force ($4 \times 10^{-6}\ N$), What is the electrical field at that point?

$$E = \frac{F}{q}$$

$$E = \frac{4 \times 10^{-6}}{2 \times 10^{-9}}$$

$$E = 2 \times 10^{3}\ \frac{N}{C}$$

Ministerial

Draw the regular electric field between two parallel metal plates.

Number of electrons

Q //How many electrons does a body lose for 1 coulomb charge?

$$N = \frac{q}{e}$$

$$N = \frac{1}{1.6 \times 10^{-19}}$$

$$N = \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{+18}\ \text{electrons}$$

Homework

Q1 //The charge of a body (A) is (+6 μC) is located at a distance of (4 cm) from the body (B) has a charge (-3 μC), Calculate the mutual electric force between the two bodies (A and B).

Q2 // The force between two identical charges separated by (**1** cm) is equal to (**90** N). What is the magnitude of the two charges?

Q3 // The repelled force of two identical point electric charges is (**10** N) when the distance between them is (**6** cm). Calculate the charge of each one. (Ministerial)

Q4 // Calculate the distance between two electrons if the repulsive force between them is ($\mathbf{9 \times 10^{-3}}$ $\boldsymbol{N}$).

Q5 // Placing a proton within a uniform electric field that exerts a force of (2×10^{-4} N) on it, what is the magnitude of the electric field at the location of the proton.

Q6 // Suppose that one of oil drops has a charge of (4.8×10^{-19} C). How many excess electrons does the drop contain? (Ans = 3).

وزاري // وضعت شحنة كهربائية موجبة مقدارها (5 μC) على بعد (10 cm) من شحنة كهربائية موجبة أخرى. فأثرت الشحنة الأولى على الشحنة الثانية بقوة مقدارها (36 N) فما مقدار الشحنة الثانية .

QUESTIONS OF CHAPTER ONE

1. An atom is neutral if:
   a. Its contents do not carry any charge.
   b. Number of electrons equals to the number of protons.
   c. Number of electrons is greater than number of protons.
   d. Number of electrons is equal to the number of neutrons.

2. Body becomes positively charged if some of its atom have:
a. Number of electrons greater than the number of protons.
b. Number of electrons less than the number of protons.
c. Number of neutrons in the nucleus is greater than the number of electrons.
d. Number of protons in the nucleus is greater than the number of neutrons.

3. When losing a charge ($1.6 \times 10^{-9}\ N$) from a conducted body which is isolated and neutrally charged, then the number of electrons that was lost from this body will equal

a. 10^{8} electrons
b. 10^{9} electrons
c. 10^{10} electrons
d. 10^{12} electrons

4. The distance between two positive point charges is (10 cm). If one of the charges is replaced by a negative with the same value, then the value of force between them will be:
a. Zero.
b. Less than before.
c. Greater than before.
d. Does not change.

6. Walking on a woollen carpet then touching a metal body such as a door handle, you usually feel a minor electric shock. This is due to the loss of electric charge between the fingers and the metal body. The reason for this is that, electric charges are:
a. Generated by your body.
b. Generated by the carpet.
c. Generated by the metal.
d. Generated as a result of friction between your feet and the carpet

7- The charge of a body (A) is (+2 μC)and the body (B) has a charge (+6 μC), then the mutual electric force between the two bodies (A and B) is:

a- $3F_{AB} = -F_{BA}$

b- $F_{AB} = +F_{BA}$

c- $F_{AB} = -F_{BA}$

d- $F_{AB} = -3F_{BA}$

8. When a positively charged body gets closer to the electroscope disc with two positively charged leaves, this will lead to:

a. The leaves will get apart further.
b. The leaves will get closer.
c. The leaves will get identified (close gap).
d. Nothing changes.

9. When a negatively charged body approached the neutral electroscope's disc which is connected to earth:

a. The leaves open as a result of negative charges on the leaves.
b. The leaves open as a result of positive charges on the leaves.
c. Nothing changes on the leaves in spite of positive electric charge appear on its disc.
d. Nothing changes on the leaves in spite of negative electric charge appear on its disc.

5. Two point charges **(q_1, q_2)** , one of them is positive and the other one is negative. When the distance between them was (**3**cm), the attracting force was (**F_1**). If the distance becomes longer up to (**6**cm) then the force (**F_2**) between them will be equal to:

$a - F_2 = \frac{1}{2}F_1$ $\quad b - F_2 = 2F_1$ $\quad c - F_2 = 4F_1$ $\quad d - F_2 = \frac{1}{4}F_1$

$$F = k\frac{q_1 q_2}{r^2}$$

$$\frac{F_2}{F_1} = \frac{\frac{q_1 q_2}{r_2^2}}{\frac{q_1 q_2}{r_1^2}} = \frac{r_1^2}{r_2^2} = \frac{(3)^2 \times 10^{-4}}{(6)^2 \times 10^{-4}} = \frac{9}{36}$$

$$\frac{F_2}{F_1} = \frac{1}{4} \Rightarrow \therefore F_2 = \frac{1}{4}F_1$$

Q-2 Explain the following:

1) Fuel trails (lorries with fuel) are supplied with metal chains at the back of the trailer touching the ground.

A// *To get rid of the charges generated on the car body due to the friction between the fuel and the car body.*

2) Any positively or negatively charged body would be neutralized if it was connected to earth.

A// *The earth is considered a big store for charges. When a body is connected to the earth, the charges move to and from the earth to equalize the charged body.*

3) The two negatively charged leaves of the electroscope will get apart further if a negatively charged body gets close to its disc.

A// *Because the electrons of a charged body repel the electrons of the electroscope disc and push them away to its farthest position, which is on the two papers, and it increases separate his paper.*

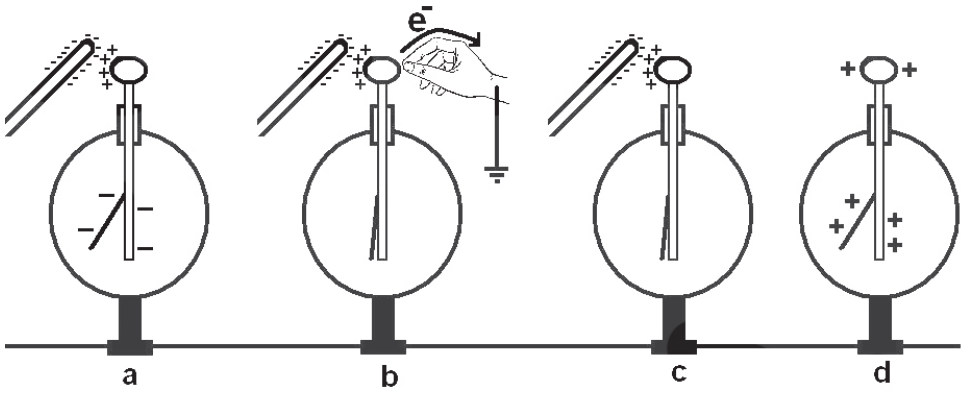
Q3// Explain how the electroscope can be positively charged by using:

A) A positively charged glass rod.

B) A negatively charged rubber rod.

A) *We make the glass rod charged with a positive charge in touch with the electroscope disk and then remove the rod and charge the electroscope with a positive charge.*

B) Charging an electroscope by induction:



Q4 // List the types of the charging methods by electrostatic?

1) *Charging by Rubbing.*
2) *Charging by contact.*
3) *Charging by induction*

Q5// You have used a glass rod which has been rubbed with silk (positive charge) and a metal insulated neutral ball as in the diagram (a,b,c,).

1. Do the electrical charges transfer in the cases (a,b,c)? Explain the method of transferring charges (if any).
2. Determine the kind of electric charges which appear in each case.
3. What happens in the positive charge on the glass rod in each of the three cases?

1) ***Figure (c)*** *Some positive charges are transferred from the rod to the surface of the ball by contact, the rod charges decreases.*
2) ***Figure (a)*** *The surface of the ball opposite the rod shows a negative charge (bound), and the surface of the ball on the other side shows a positive charge (free).*

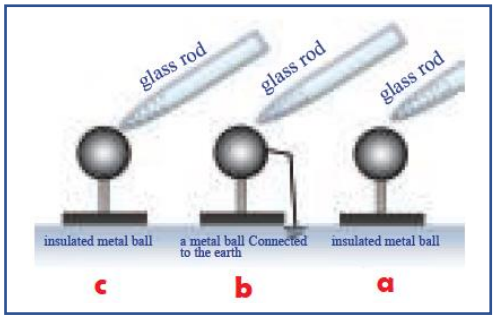
Figure (b) *The surface of the ball opposite the rod shows a negative charge (bound), and the free positive charge is neutralized due to the leakage of electrons from the earth to the ball.*

Figure (c) *The ball is charged with a positive charge.*

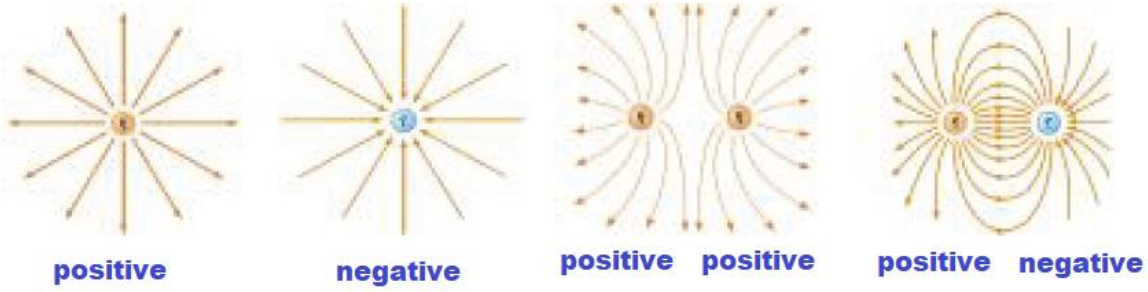
3) ***Figure (a)*** *do not change.*

Figure (b) *do not change.*

Figure (c) *rod charge decreases.*



Q7// Write type of the charge in Figures below?



PROBLEMS

P-l. The repelled force of two identical point electric charges is ($9 \times 10^{-7}\ N$) when the distance between them is (10 cm). Calculate the charge of each one.

$$F = k \frac{q_1 q_2}{r^2}$$

Let $q_1 = q_2 = q$

$$F = \frac{K \times q \times q}{r^2}$$

$$F = \frac{K \times q^2}{r^2}$$

$$K \times q^2 = F \times r^2$$

$$q^2 = \frac{F \times r^2}{K}$$

$$q^2 = \frac{9 \times 10^{-7} \times (10 \times 10^{-2})^2}{9 \times 10^9}$$

$$q^2 = \frac{9 \times 10^{-7} \times 100 \times 10^{-4}}{9 \times 10^9}$$

$$q^2 = \frac{10^{-9}}{10^9}$$

$$q^2 = 10^{-18}$$

$$\sqrt{q^2} = \sqrt{10^{-18}}$$

$$q = (10^{-18})^{\frac{1}{2}}$$

$$\therefore q = 10^{-9}\ C$$

P-2. Two point charges both positive are ($3 \times 10^{-9}\ C$) and the distance between them is (5 cm). Calculate the repelling force between them.

$$F = k\frac{q_1\, q_2}{r^2} \Rightarrow F = \frac{9 \times 10^{9} \times 3 \times 10^{-9} \times 3 \times 10^{-9}}{(5 \times 10^{-2})^2}$$

$$F = \frac{81 \times 10^{-9}}{25 \times 10^{-4}}$$

$$F = \frac{81 \times 10^{-9}}{25 \times 10^{-4}}$$

$$F = \frac{81}{25} \times 10^{-5}$$

$$F = 3.24 \times 10^{-5}\ N$$

P-3. An electric charge of (+ 3 μC) located at a point P in an electric field the electrical field was ($4 \times 10^{6}\ N/C$) .Calculate the influenced electric force.

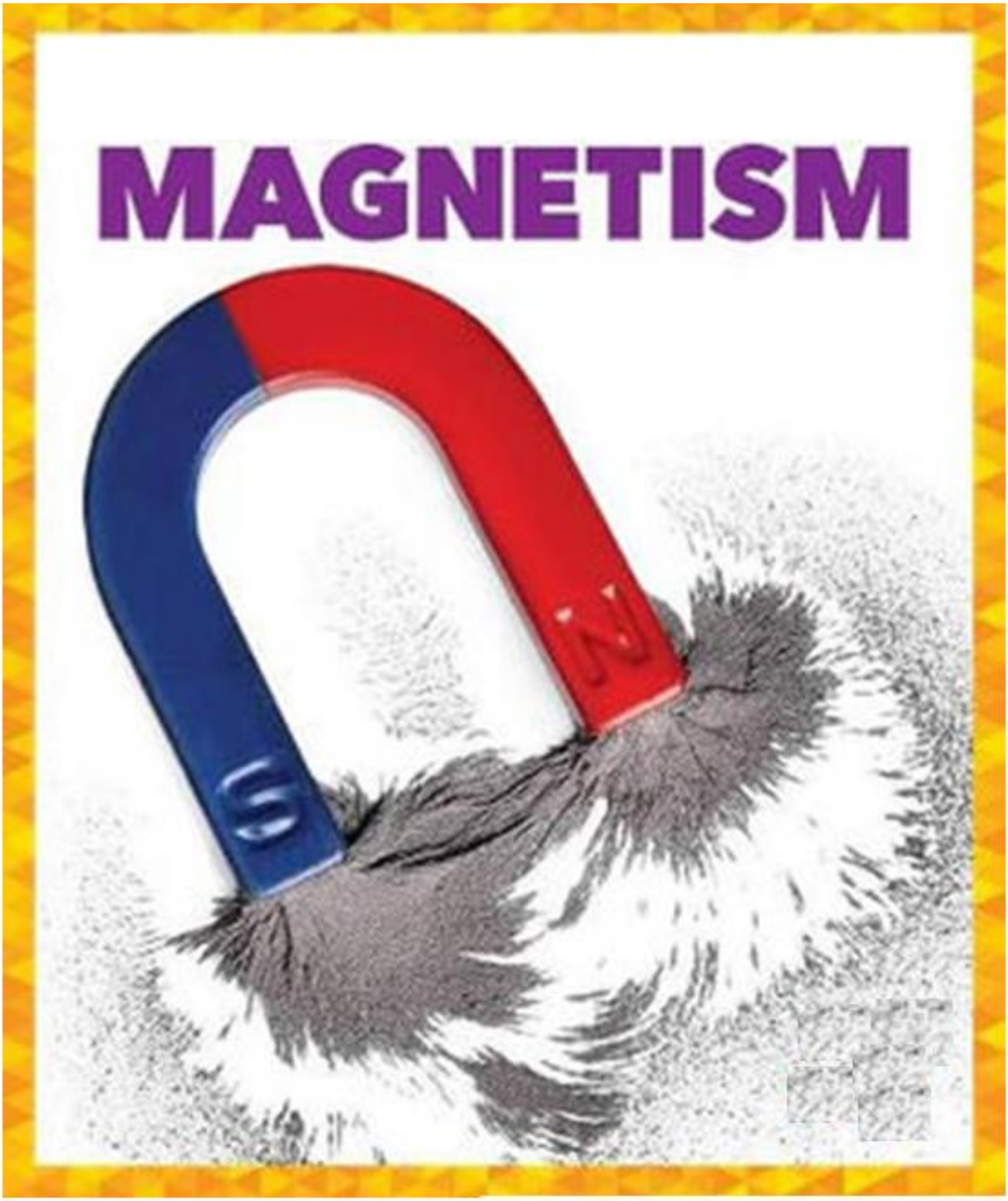
$$E = \frac{F}{q}$$

$$F = E \times q$$

$$F = 4 \times 10^{6} \times 3 \times 10^{-6}$$

$$F = 12\ N$$

MAGNETISM



CHAPTER 2

- Magnet: a metal attracting pieces of iron towards it.
- The pointer of the compass is a small permanent magnet which can rotate freely in a horizontal plane around the vertical axis.
- *Artificial magnets used to*: { lift pieces of steel or scrap metal , loudspeakers, compasses }

Magnetic Materials

01 Diamagnetic
They are the materials which weakly repel with the strong magnets,such as Bizmouth, Antimony, Copper, Silicon, Silver.

02 Paramagnetic
They are the materials which are weakly attracted by strong magnets.
Examples are Aluminun, Calcium, Sodium, Titanium

03 Ferromagnetic
They are the materials which attracted by ordinary magnets.
They have high magnetification capability.
Examples are such as iron,steel, needles, couplet.

Magnet Pole

the areas at which the magnetic forces are strongest.
and they are of two types (north pole and south pole).

- Magnetic poles do not exist individually, but exist as equal pairs in quantity but different in type (north pole and south pole).

Q // What happens when a piece of a magnet is divided (cutting) into some smaller pieces?

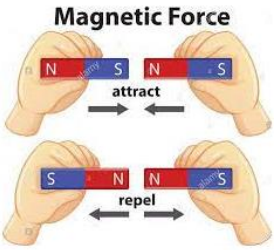
Ans // Magnetic poles do not exist individually, therefore; possessing each piece will have two magnetic poles are (the north and south poles).

- لا يوجد قطب مغناطيسي منفرد، لذلك ستمتلك كل قطعة قطبان (شمالي وجنوبي)

Ministerial // What are different between diamagnetism and Para magnetism material?

Magnetic Forces

Similar magnetic poles **repel** and different magnetic poles **attract**

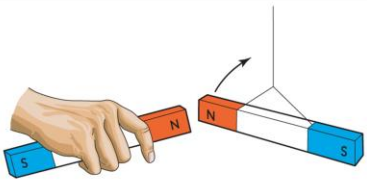


Activity — **Attracting and repelling forces between the magnetic poles.**

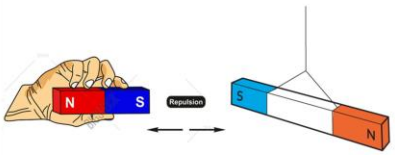
Tools: Two magnetic bars, string, clips, holder (which is not affected by magnets).

Steps:

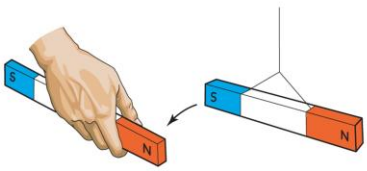
- Hang the magnetic bar from its middle point (center of mass) by a string and a clip and the holder freely in a horizontal position. You will observe that the magnetic bar is taking the direction of (North-South) geographically.
- Hold another magnetic bar by hand letting its north pole (N).
  .
- Get the north pole of the magnet bar which is in your hand close to the north pole of the hanging bar. What do you observe?
- You see that the north pole of the free magnet moves away from the north pole of the one in your hand, which means they repel



- Now let the south poles close to the bar in your hand this time. Then get it close to the south pole of the free magnetic hanging bar. As in What do you observe?
- You will find that the south pole of the free magnetic bar moves away from the bar which is in your hand, which means they repel.



- Repeat the previous procedure by getting the north pole of the bar in your hand approaching the south pole of the hanging bar. What do you observe?
- In this case you will see that the two poles attract to each other. This is the result of the attraction force.



Conclusion

Similar magnetic poles **repel** each other, while the **different** ones **attract** to each other.

Magnetic Fields

Is the space which surrounds the magnet in which the effect of the magnet would be observed

❖ *characteristics of the magnetic field:*

1) Invisible.
2) These are closed lines moving from the north pole to the south pole.
3) cannot cross with each other.
4) repel between each other.

Activity

Determining the magnetic field lines using iron filing:

Tools: Magnetic bar, a glass board, iron filings.

Steps:

- Put the glass board on the magnetic bar at a horizontal level.
- Sprinkle the iron filing over the glass board and gently tip on the board.

What do you observe?

We see that the iron filings has taken the shape of lines which represent the magnetic field lines around the magnetic bar.

Activity

Magnetic field can pass through the human body:

Tools: Collection of paper clips made of steel (Ferromagnetic material).
Powerful magnet.

Steps: Put the magnetic bar on your hand

- Put your palm on a collection of paper clips
- Raise your hand above. What do you observe?

A large number of paper clips will be attracted towards your palm.

How do you explain that?

Answer: The magnetic field can penetrate through the human body.

Question: Does the magnetic field penetrate through the human body, or through some other materials?

Answer: the magnetic field can penetrate through different materials such as carton, glass and water.

Magnetised Materials

1) Rubbing Method:

- A piece of steel, such as a needle, can be become a needle magnetic by rubbing it by one of the magnetic poles. The magnet must be moved over, the steel needle in only one direction and in a slow motion repeatedly. After finalizing this that the needle becomes magnet. The generated magnetic pole at the end of the rubbed part of the needle will always have the opposite pole to the magnet pole used in rubbing.

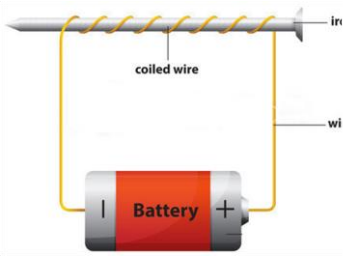
2) Induction Method:

First: Magnetizing by approach:

- When a material of Ferromagnetic is placed near a material which is not magnetized (such as a nail) inside a powerful magnetic field or (near to a powerful magnet without contact between the nail and the magnet), the nail will gain magnetism by induction.

Second: Magnetizing by Direct Electric Current:

- placed the material it inside a hollow coil (A coil is made of an insulated wire rolling in a spiral form). Alternatively, the insulated wire is rolled around the nail or a metal screw the ends of the wire are connected to a battery with a proper voltage. We then get a magnet which is called Electromagnet.



The power of the Electromagnet depends on:

1. The amount of direct electric current in the electric circuit.
2. The number of rolled wires in the coil around the piece of steel.
3. The quality of the material required to magnetism.

Magnets lose their magnetism: 1. Hammering strongly. 2. Powerful heat. (Ministerial)

QUESTIONS OF CHAPTER TWO

Q1// Choose the right statement for the following:

Q1

1-A magnetic compass is used to draw the lines of a magnetic field around a certain magnet because the needle of the compass is:

a. A small permanent magnet which can rotate freely in a horizontal level around a vertical pointed axis.
b. An electromagnet loses its magnetism after a certain period of time once the electric source is cut off.
c. Made of copper.
d. A small permanent magnet with a "U" shape.

Q1

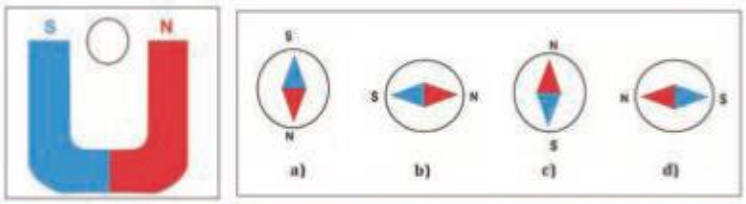
2) Permanent magnets are made of the following material: -

a. Copper
b. Aluminum
c. Soft iron
d. Steel

Q1

3) *A small magnetic compass placed between two poles of a permanent magnet in the shape of a "U" as illustrated in the diagram. Which of the following directions will it take:*

The correct direction which the needle can take inside the magnetic field.



Q1

4) Different materials are classified according to their magnetic properties:

a- Diamagnetic.
b- Paramagnetic
c- Ferromagnetic
d- Diamagnetic ,Paramagnetic and Ferromagnetic.

Q1

5) ***Magnetic field is represented by lines that characterized by being:***

a- Unclosed
b- moving from the north pole to the south pole outside the magnet
c- Cross between them
d-Visible

Q1

6 - When a magnet bar is divided into small pieces:

a. We get small non magnetised pieces.
b. Each piece will have only one magnetic pole either north or south.
c. Each piece will have four magnetic poles, two north poles and two south poles.
d.Each piece will have two magnetic poles, one north and one south.

Q2

Explain why the magnets are used on the wardrobe and fridge doors ?

Ans// The magnet are used on wordrob and fridge to have their door completly closed

Q3

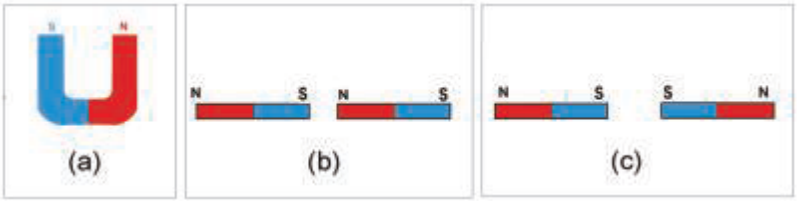
If you were given three identical bars which were aluminium, iron and a permanent magnet explain, how you can distinguish one from the others.

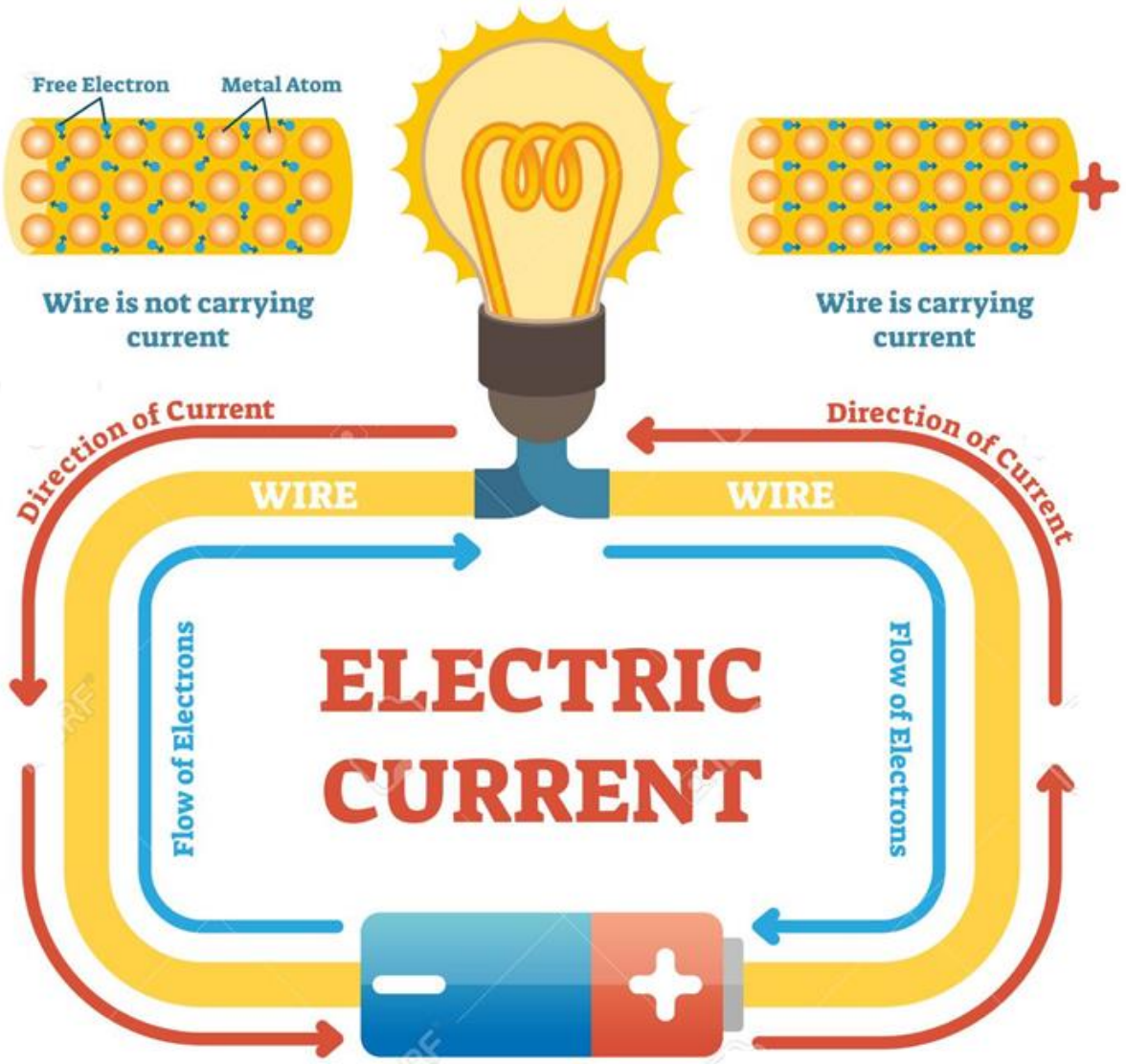
Ans // we close to any two bars of each other. If they attract each other, this means one of them a magnet and the other iron, so we got to know the aluminium bar.

* To distinguish between the magnet bar and the iron bar, we put one of the bars in a horizontal position and bring the end of the other leg close to its middle. If there is attraction, the vertical leg is a magnet and the horizontal leg is iron.

نقرب اي ساقين من بعض فأن تجاذبا فهذا يعني احدهما مغناطيس والاخر حديد وبذلك تعرفنا على ساق الالمنيوم .
للتميز بين ساق المغناطيس وساق الحديد ، نضع احد السيقان بوضع افقي ونقرب من منتصفه طرف الساق الاخر فان حصل التجاذب فالساق العمودي مغناطيس والساق الافقي حديد.

Q5 //




Free Electron
Metal Atom
Wire is not carrying current
Wire is carrying current
Direction of Current
Direction of Current
WIRE
WIRE
Flow of Electrons
Flow of Electrons
ELECTRIC CURRENT

Chapter 3

electric current Quantity of charge passing through a conductor during a certain time, it measured in the unit Ampere (A).

$$I = \frac{q}{t} \qquad I = \frac{C}{sec} = Ampere$$

Ampere (A): represents the passing of one Coulomb of electric charges through conducted section during one second.

Milliampere	$1mA=10^{-3}A$
Microampere	$1\mu A=10^{-6}A$

Q // *What is the physical meaning of* (**2A, 3A, 4A**,…..)?

Ans // that means that the electric charge of (2C) crosses through in one second (s).

$$\frac{2\ C}{1\ sec} = 2A$$

Q// What happens when the charge moves inside the conductor? (ماذا يحدث عندما تتحرك شحنة داخل موصل)

Ans // the electrical current produced.

Q // What causes the movement of charges within conductors? (ما سبب حركة الشحنات داخل الموصل)

Ans // External electric field.

Q // What is the difference between conductors and insulators from were of their ability to conduct electrically?

Ans // Conductors have higher electrical conductivity, because the electrons in the outer orbits of the conductors will be weakly connected to the nucleus. (الموصلات قابليتها عالية للكهربائية لان الالكترونات ارتباطها ضعيف بالنواة)

- insulators, *the force of the connection of its electrons to the nucleus will be very large. Therefore, its electrons which are affected by an external electric field do not move. So the insulators do not allow an electric current to pass through them.*

(العوازل، ستكون قوة اتصال إلكتروناتها بالنواة كبيرة جدًا. لذلك فإن إلكتروناتها التي تتأثر بمجال كهربائي خارجي لا تتحرك. لذا فإن العوازل لا تسمح بمرور تيار كهربائي من خلالها)

Q // Are electrons required to obtain electric current?

Ans // No, any moving charge.

Q // What do we call current that only flows in one direction?

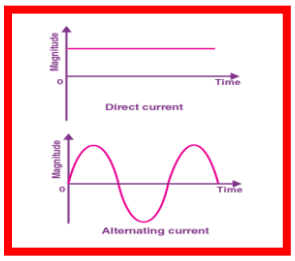
1) AC current 2) DC current.

Electronic current: *The direction of moving electrons (current) will be from the negative pole towards the positive pole.*
electric current will be opposed to the direction of the affected electric field.

Conventional current: *have direction from the positive pole towards the negative pole.*
the electric current which was in the same direction as the electric field.

direct current (DC): Is the current that is constant in amount and direction with time.
the sources of direct current are the batteries.

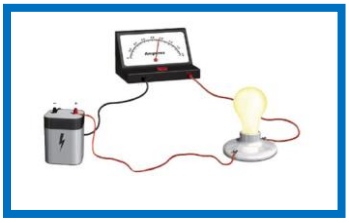
Alternating current (AC): Is the current that variable(changes) in amount and direction with time ,the sources AC generator (in houses).



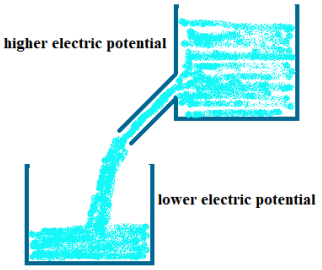
The Ammeter

used to measure the amount of electric current in the electric circuit.
The milli-ammeter device is used to measure the small amount of currents

1. Connecting the Ammeter in series with the required load or device.
2. The resistance of the ammeter will be very small.
3. The positive side of the Ammeter connected to the positive pole of the battery
   The negative side of the Ammeter connected to the negative side of the battery



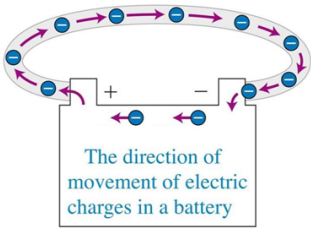
The electric Potential Difference work done to move charge from one point to another point,Measured in units volt (V).



- The direction of electrical current flow from the point with the higher electric potential to the point with lower electric potential.

Q // What is determined by the potential difference between the two points?
Ans // determines the amount of electrical current flow between them.

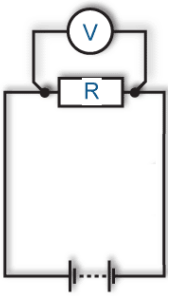
Q // What happens when the potential difference between two points is equal?
Ans // The electrical current flow will stop. (يتوقف سريان التيار)



Voltmeter

Is used to measure the amount of electric potential difference between any two points in the electrical circuit.

1. The voltmeter will be connected in parallel between the two sides of the load.
2. The resistance of the Voltmeter will be very high.
3. The positive end of the Voltmeter is connected to the positive pole of the Battery While its negative side with the negative pole for the battery.



When the electric circuit is opened is called (*emf*)

EXAMPLE The amount of electric charge passing through a cross section of a conductor is given (1.2 C) each minute. Calculate the amount of current through this conductor.

$$I = \frac{q}{t}$$

$$1 \text{ min} = 60 \text{ sec}$$

$$I = \frac{1.2}{60} \longrightarrow I = 0.02 \text{ A}$$

EXAMPLE If the amount of current in a conductor equals to (**0.4 A**) Calculate the amount of charge which passes through the cross section of the conductor during:

a) 2 second. b) 4 minutes.

$$I = \frac{q}{t}$$

$$q = I \times t$$

$$q = 0.4 \times 2$$

$$q = 0.8 \text{ C}$$

$$I = \frac{q}{t}$$

$$4 \text{ min} = 4 \times 60$$

$$4 \text{ min} = 240 \text{ sec}$$

$$q = I \times t$$

$$q = 0.4 \times 240$$

$$q = 96 \text{ C}$$

H.W // A light bulb carries a current of (2 mA) , What is the time required for a charge of (500 μC) to pass?

H.W // Calculate the number of electrons passing in wire in one minute when the current is a (8A).

Min // What are the differences between ammeter and voltmeter of connection method and uses.

Ohm's Ω Law

The Electric Resistance Is the impedance caused by the resistor of the electric current passing through it, the electric resistance is measured by Ohm.

Ohm's Law The quotient of the electric potential difference between the two sides of the resistance in the current which flows inside it is equal to a constant value.

$$R = \frac{V}{I} = \frac{V}{A} = \text{Ohm } (\Omega)$$

Ohm Is the resistance of potential difference conductor between its two sides are one volt and the amount of the current passing through it is one ampere.

❖ *measure the value of electrical resistance by using the "Ohmmeter"*

The Factors on which the Conductor Resistance Depends

1. The temperature T — $R \propto T$
2. Conductor length L — $R \propto L$
3. Cross Section area A — $R \propto \frac{1}{A}$
4. Type of material

1. The resistance will increase as the temperature increases.
2. The resistance will increase as the length increases.
3. The resistance will decrease as the area of the cross section of the conductor increases.
4. Type of material.

1 The pure conducting materials will increase in resistance with increase in the temperature.
(تزداد مقاومة المواد الموصلة النقية مع زيادة درجة الحرارة)

2 The resistance decreases with increasing temperature, as in carbon.

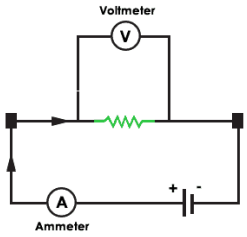
Types of Resistance

1. Constant Resistance
2. Variable quantity resistance

Activity: Measuring a small electric resistance by using an

Tools: Connection Wires, Ammeter (A), Voltmeter (V) battery, electric key, small resistor

Steps:



1. Connect the electric system as in Figure.
   The Ammeter must be connected in series with the resistor that we want to calculate its value, and then connect the voltmeter in parallel between its two ends.
2. Close the electric circuit and write down the reading of the Ammeter and the Voltmeter.
3. Divide the Voltmeter reading value (potential difference) by the Ammeter reading value (current).
   This will give us the value of resistance by Ohm's Law:

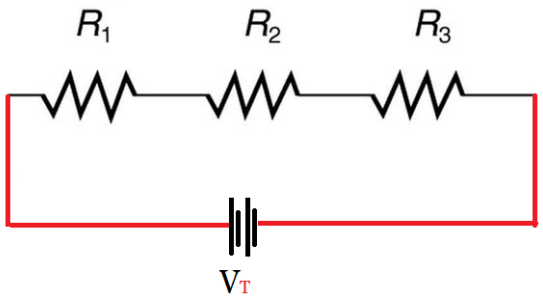
$$R\,(\Omega) = \frac{V}{I}$$

Q // If the Voltage is increased and the resistance stays the same, Current will:

a) Increase. b) Decrease. c) Stay the same.

1 Connection of resistors in series

1. $I_T = I_1 = I_2 = I_3$
2. $V_T = V_1 + V_2 + V_3$
3. $R_T = R_1 + R_2 + R_3$



المقاومة الكلية المكافئة لربط التوالي
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EXAMPLE The two resistances ($R_1 = 3\Omega$, $R_2 = 5\Omega$) are connected in series with each other, Then electric current of (2A) flow in the circuit, Calculate the potential difference of each resistance.

$$R_1 = \frac{V_1}{I_1}$$

$$3 = \frac{V_1}{2} \longrightarrow V_1 = 3 \times 2 \longrightarrow V_1 = 6\ V$$

$$R_2 = \frac{V_2}{I_2}$$

$$5 = \frac{V_1}{2} \longrightarrow V_2 = 5 \times 2 \longrightarrow V_2 = 10\ V$$

$$V_T = V_1 + V_2$$

$$V_T = 6 + 10 = 16 \text{ Volt}$$

Ministerial The two resistances ($R_1 = 2\Omega$, $R_2 = 4\Omega$) are connected in series with each other, they were connected to the two ends of a source of electric potential difference (6V), Calculate:

1. The total current flow in the circuit.
2. potential difference at the two ends of each of the resistance

$R_T = R_1 + R_2$

$R_T = 2 + 4$ ⟹ $R_T = 6\ \Omega$

$R_T = \frac{V_T}{I_T}$

$6 = \frac{6}{I_T}$ ⟹ $6 = \frac{6}{I_T}$ ⟹ $I_T = 1\ A$

❖ Since the connection is in series:

$I_T = I_1 = I_2 = 1\ A$

$R_1 = \frac{V_1}{I_1}$

$2 = \frac{V_1}{1}$ ⟹ $V_1 = 2 \times 1$ ⟹ $V_1 = 2\ V$

$R_2 = \frac{V_2}{I_2}$

$4 = \frac{V_1}{1}$ ⟹ $V_2 = 4 \times 1$ ⟹ $V_2 = 4\ V$

$2\ V + 4\ V = 6\ V$

Ministerial Three resistances ($R_1 = 2\Omega$, $R_2 = 4\Omega$, $R_3 = 6\Omega$), are connected in series with each other, The current flowing through the second resistance was (4A), Calculate:

1. Total voltage. 2. The potential difference at the two ends of each of the resistance.

❖ Since the connection is in series:

$$I_T = I_1 = I_2 = I_3 = 4\ A$$

$R_T = R_1 + R_2 + R_3$

$R_T = 2 + 4 + 6$ ⟹ $R_T = 12\ \Omega$

$R_T = \frac{V_T}{I_T}$

$12 = \frac{V_T}{4}$ ⟹ $V_T = 12 \times 4$ ⟹ $V_T = 48\ V$

$R_1 = \frac{V_1}{I_1}$

$2 = \frac{V_1}{4}$ ⟹ $V_1 = 2 \times 4$ ⟹ $V_1 = 8\ V$

$R_2 = \frac{V_2}{I_2}$

$4 = \frac{V_2}{4}$ ⟹ $V_2 = 4 \times 4$ ⟹ $V_2 = 16\ V$

$R_3 = \frac{V_3}{I_3}$

$6 = \frac{V_3}{4}$ ⟹ $V_3 = 6 \times 4$ ⟹ $V_3 = 24\ V$

$= 48\ V$

Ministerial The two resistances ($R_1 = 3\ \Omega$, $R_2 = 6\ \Omega$) are connected in series with each other, If the potential difference across the two ends of the first resistance (18 V), find:

1. The total current flow in the circuit.
2. Potential difference across the second resistance.
3. Total voltage.

$R_1 = 3\ \Omega$, $V_1 = 18\ V$ ⟹ $I_1 = ?$

$$R_1 = \frac{V_1}{I_1}$$

$$I_1 = \frac{V_1}{R_1} \Rightarrow I_1 = \frac{18}{3} \Rightarrow I_1 = 6\ A$$

❖ *Since the connection is in series:*

$$I_T = I_1 = I_2 = 6\ A$$

$$R_2 = \frac{V_2}{I_2}$$

$$6 = \frac{V_2}{6} \Rightarrow V_2 = 6 \times 6 \Rightarrow V_2 = 36\ V$$

$$R_T = R_1 + R_2$$

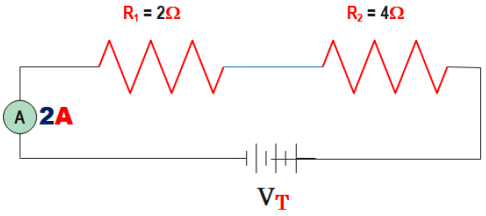
$$R_T = 3 + 6 \Rightarrow R_T = 9\ \Omega$$

$$R_T = \frac{V_T}{I_T}$$

$$9 = \frac{V_T}{6} \Rightarrow V_T = 9 \times 6 \Rightarrow V_T = 54\ V$$

Ministerial By observing the diagram, calculate:

1. The equivalent resistant.
2. The current passing through the first resistance.
3. Battery voltage difference.
4. Potential difference at the two ends of the resistance.



$R_T = R_1 + R_2$

$R_T = 2 + 4$ ⟹ $R_T = 6\ \Omega$

$I_T = I_1 = I_2 = 2\ A$ **(series)**

$R_T = \frac{V_T}{I_T}$

$6 = \frac{V_T}{2}$ ⟹ $V_T = 6 \times 2$ ⟹ $V_T = 12\ V$

$R_1 = \frac{V_1}{I_1}$

$2 = \frac{V_1}{2}$ ⟹ $V_1 = 2 \times 2$ ⟹ $V_1 = 4\ V$

$R_2 = \frac{V_2}{I_2}$

$4 = \frac{V_2}{2}$ ⟹ $V_2 = 4 \times 2$ ⟹ $V_2 = 8\ V$

$= 12\ V$

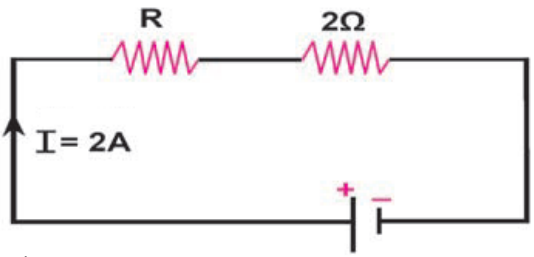
Ministerial

The two resistances (R and 2Ω) are connected in series with each other, then they were connected to the two ends of a source of electric potential difference (12V). Then electric current of (2A) flow in the circuit. Calculate the amount:

1. The unknown resistance **R**.
2. Potential difference at the two ends of the resistance.

نحسب مقدار المقاومة المجهولة R من قانون المقاومة المكافئة (الكلية)

$$V_T = I.R_{eq}$$
$$12 = 2 \times R_{eq}$$
$$\therefore R_{eq} = \frac{12}{2} = \boxed{6\Omega}$$



$I = 2A$

$V_T = 12V$

$$R_{eq} = R_1 + R_2$$
$$R_{eq} = R_1 + 2\Omega$$
$$6\Omega = R + 2\Omega$$
$$R = 6 - 2$$
$$R = \boxed{4\Omega}$$

$$V_1 = IR$$
$$V_1 = 2A \times 4\Omega$$
$$V_1 = \boxed{8V}$$

$$V_2 = I \times 2\Omega$$
$$V_2 = 2A \times 2\Omega$$
$$V_2 = \boxed{4V}$$

$$V_T = V_1 + V_2$$
$$V_T = 8V + 4V = \boxed{12V}$$

EXAMPLE A (9V) battery is in a circuit with three resistors connected in series.

1) If the resistance of one of the resistors increases, how will the equivalent resistance change.
2) What will happen to the current?
3) Will there be any change in the battery voltage?

1. إذا ازدادت مقدار احد المقاومات في الدائرة فان المقاومة الكلية (المكافئة) سوف تزداد .

$$R_T = R_1 + R_2 + R_3$$

2. إذا ازدادت المقاومة فان التيار سوف يقل لان العلاقة عكسية.

$$R_T = \frac{V_T}{I_T}$$

3. فولتية البطارية لا تتغير (لا تتأثر).

Q // If the potential difference across the ends of a conductor is doubled, the current flowing through becomes:

A. doubled
B. halved
C. four times
D. no change.

$$V \propto I$$

الحالة الاولى $V_1 = V_1$

$$\frac{V_2}{V_1} = \frac{I_2}{I_1}$$

الحالة الثانية $V_2 = 2V_1$

$$\frac{2V_1}{V_1} = \frac{I_2}{I_1}$$

$$\frac{2}{1} = \frac{I_2}{I_1} \Rightarrow I_2 = 2\,I_1$$

HOMEWORK

Ministerial

The two resistors (4Ω,8Ω) are connected in series with each other and then connected to a source electrical potential is (24V). Calculate the amount of:

1. The current flow in the electric circuit.
2. Potential difference at the two ends of the resistance.

Ministerial

Three resistors (3Ω,4Ω,5Ω)connected in series and connected the group to an electrical source and the charge passing through the circuit within half a minute was 60 coulombs: Calculate:

1. the potential difference of the source.
2. Potential difference at the two ends of the resistance.

Ministerial

The two resistances (R, 4Ω) are connected in series with each other, then they were connected to the two ends of a source of electric potential difference (18V). Then electric current of (3A) flow in the circuit. Calculate:

1. The unknown resistance R.
2. Potential difference at the two ends of the resistance.

Ministerial

Three resistances (3Ω, R, 4Ω) are connected in series with each other, then they were connected to the two ends of a source of electric potential difference (18V). Then electric current of (2A) flow in the circuit. Calculate:

1. The unknown resistance R.
2. Potential difference at the two ends of the resistance.

Question

An electric lamp that draws a current (4A) when connected to a source of voltage (120 V), Calculate:

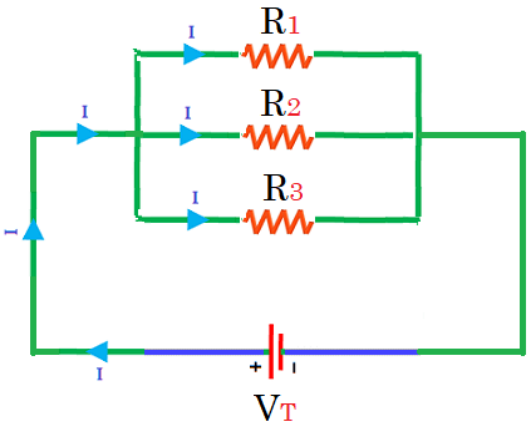
1. The lamp resistance.
2. If a resistance is added to the lamp to reduce the current flowing through it to half its original value, what is the potential difference between the two terminals of the lamp?
3. The amount of resistance added.

Question

- Three resistances (R1 = 2Ω , R_2 , R_3), are connected in series with each other, If the potential difference across the two ends of the second resistance (15 V), and the amount of equivalent resistance for the circuit (18 Ω), then electric current of (5A) flow in the circuit, Calculate the amount the unknown resistance R_2 , R_3 .

2 Parallel Connection of resistors

1. $V_T = V_1 = V_2 = V_3$
2. $I_T = I_1 + I_2 + I_3$
3. $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$



Req is Less than the smallest resistance in the circuit.

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Ministerial The two resistances (3Ω, 6Ω) are connected in parallel with each other, then they were connected to the two ends of a source of electric potential difference (12V). Calculate:

1. The amount of equivalent resistance.
2. The current flow in each resistance.
3. The total current flow in the circuit.

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

$$\frac{1}{R_T} = \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_T} = \frac{2+1}{6} = \frac{3}{6} = \frac{1}{2} \Longrightarrow R_T = 2\Omega$$

❖ Since the connection is in parallel:

$$V_T = V_1 = V_2 = 12\ V$$

$$R_1 = \frac{V_1}{I_1}$$

$$I_1 = \frac{V_1}{R_1} \Rightarrow I_1 = \frac{12}{3} \Rightarrow I_1 = 4\ A$$

$$R_2 = \frac{V_2}{I_2}$$

$$I_2 = \frac{V_2}{R_2} \Rightarrow I_2 = \frac{12}{6} \Rightarrow I_2 = 2\ A$$

$= 6\ A$

$$R_T = \frac{V_T}{I_T}$$

$$I_T = \frac{V_T}{R_T} \Rightarrow I_T = \frac{12}{2} \Rightarrow I_T = 6\ A$$

Ministerial

In the nearby diagram,
there are three resistances ($R_1 = 6\Omega$, $R_2 = 9\Omega$, $R_3 = 18\Omega$). The equivalent resistance for them is connected to an electric potential difference of (18V). Calculate:

1. The amount of equivalent resistance.
2. The current flow in each resistance.
3. The total current flow in the circuit.

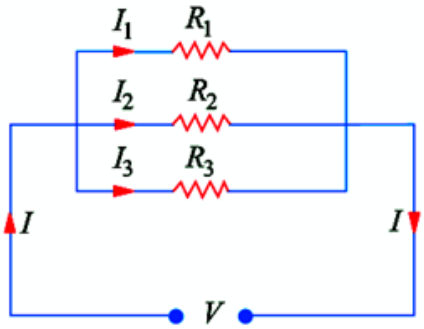
1) $$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18}$$

$$\frac{1}{R_{eq}} = \frac{3+2+1}{18}$$

$$\frac{1}{R_{eq}} = \frac{6}{18}$$

$$R_{eq} = \boxed{3\Omega}$$



2) Since the connection is in parallel

$$V_{total} = V_1 = V_2 = V_3 = \boxed{18V}$$

$$I_1 = \frac{V_1}{R_1} = \frac{18}{6} = \boxed{3A}$$

$$I_2 = \frac{V_2}{R_2} = \frac{18}{9} = \boxed{2A}$$

$$I_3 = \frac{V_3}{R_3} = \frac{18}{18} = \boxed{1A}$$

3) $$I_{total} = I_1 + I_2 + I_3 = 3 + 2 + 1 = \boxed{6A}$$

or $$I_{total} = \frac{V}{R_{eq}} = \frac{18}{3} = \boxed{6A}$$

Ministerial Three resistances ($R_1 = 2\Omega$, $R_2 = 4\Omega$, $R_3 = 6\Omega$), connected in parallel and the group was connected to an electrical source, and a current of (3A) flows in the second resistance Calculate:

1. The amount of equivalent resistance.
2. source of potential difference.
3. The current flowing through the first and third resistances.
4. The total current flow in the circuit.

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

$$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6}$$

$$\frac{1}{R_T} = \frac{6+3+2}{12} = \frac{11}{12}$$

$$R_T = \frac{12}{11}\ \Omega$$

❖ V_2 من المقاومة الثانية نحسب فرق الجهد

$$R_2 = \frac{V_2}{I_2}$$

$$4 = \frac{V_2}{3} \longrightarrow V_2 = 4 \times 3 \longrightarrow V_2 = 12\ V$$

❖ Since the connection is in parallel:

$$V_T = V_1 = V_2 = V_3 = 12\ V$$

$$R_1 = \frac{V_1}{I_1}$$

$$I_1 = \frac{V_1}{R_1} \longrightarrow I_1 = \frac{12}{2} \longrightarrow I_1 = 6\ A$$

$$R_3 = \frac{V_3}{I_3}$$

$$I_3 = \frac{V_3}{R_3} \longrightarrow I_3 = \frac{12}{6} \longrightarrow I_3 = 2\ A$$

EXAMPLE Three equal resistors are connected in parallel, and the total equivalent resistance (1Ω), is connected to its voltage source (6V). Calculate:

1. The amount of each resistance.
2. The total current flow in the circuit.

بـما ان المـقـاومـات مـتسـاوية المـقـدار

نفرض ان مقدار كل مقاومة هـو (R)

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

$$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$$

$$\frac{1}{1} = \frac{1+1+1}{R}$$

$$\frac{1}{1} = \frac{3}{R}$$

$$R = 3\ \Omega$$

$$R_T = \frac{V_T}{I_T}$$

$$I_T = \frac{V_T}{R_T}$$

$$I_T = \frac{6}{1}$$

$$I_T = 1\ A$$

HOMEWORK

Ministerial

The two resistors (4Ω,8Ω) are connected in parallel with each other, If the current flowing through the small resistance (3A), calculate:

1. source of potential difference (Battery).
2. The current through the large resistance (second).
3. The total current flow in the circuit.

Ministerial

The two resistances (R and 6 Ω) are connected in parallel with each other, then they were connected to the two ends of a source of electric potential difference (24V). Then electric current of (2A) flow in unknown resistance, calculate:

1. The unknown resistance R.
2. The total current flow in the circuit.

Ministerial

An electrical circuit whose resistance is (100 Ω) What is the amount of resistance that must be connected in the circuit to make the total resistance of the circuit (60 Ω).

Ministerial

سؤال // دائرة توالي تحتوي مقاومة (20 Ω) ومصباح مقاومته (10 Ω) مربوطان مع بطارية فرق جهدها (6V) احسب :

1. فرق جهد كل من المقاومة والمصباح.

2. لو ربطت مقاومة أخرى مقدارها (5Ω) على التوازي مع المصباح ، فما مقدار التيار المار في هذه المقاومة.

Activity

Connecting electric lamps in series

Tools: Small and identical three lamps (a,b,c), A proper voltage battery, wires and key.

Steps:

1. Connect one of the three lamps in series with the key and battery, close the key and we see the lamp glows.
2. Connect two of the lamps in series together with the key and battery.
3. Close the key and see that both lamps glow. We see that the sharpness of the glow of the two lamps is equaled while the glow of each lamp is less than the glow of lamp if it was connected alone in the circuit.
4. Repeat the same procedure by connecting the three lamps by the conducting wires and the key in series as in Figure.
5. Connect the two ends of the system which is connected series in (the three lamps and the key) between the two poles of the battery.

   Turn the key on and observe the glow of the lamps. What can you see?

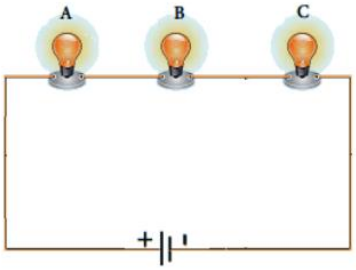
   We find that the amount of the three lamps glowing is equaled and each one glows less than the previous case.

Conclude:

The current of the circuit which has series connection will be equaled in all its parts and its amount will decrease by the increase of the number of the lamps connected in series.

This is because of the increase of the equivalent resistance to the collection in series.

Q // *When connecting three lamps in a series, we observe that the glow of the lamps is less than if one or two lamps are connected?*



Ans // The current of the circuit which has series connection will be equaled in all its parts and its amount will decrease by the increa of the number of the lamps connected in series.

This is because of the increase of the equivalent resistance to the collection in series.

Q // *What happens when you increase the number of lamps in a series?*

Ans // The current decreases with the increase in the number of lamps.

Activity

Connecting electric lamps in Parallel

Tools: Three small and identical lamps (a,b,c), battery, conducting wires and key.

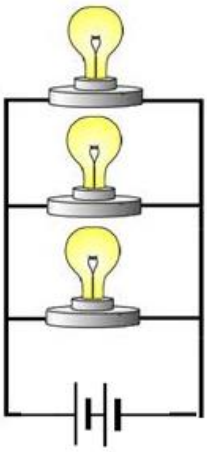
Steps:

1. Connect one of the lamps together with the key and the battery will be connected in series. Switch the key on, we see the lamp's glow.
2. Now we connect two lamps in parallel with each other. Then we connect their system in series with the key and the battery.
3. Switch the key on, we see the lamp's glow equally and at the same level as in the first case.
4. Connect all the three lamps in parallel, by the conducting wires and connect the system of lamps with key in series.
5. Connect the two ends of the total collection to the poles of the battery Figure.
6. Switch the key on, we see the lamp's glow equally and at the same level as in the first and second cases.

Conclude:

The potential difference across the electric parallel circuit parts is equal and the main current in the circuit equals the sum of the currents flowing through the lamps which are connected in parallel.

This current flow will increase with the increase of the number of lamps which are connected in parallel. The equivalent resistance in the parallel circuit decreases with increase of the number of lamps (the resistors) which are connected in parallel.



Q //*When three lamps are connected in parallel, we observe that the glow of the lamps is equal and same to the glow of one or two lamps?*

Ans // The potential difference across the electric parallel circuit parts is equal and the main current in the circuit equals the sum of the currents flowing through the lamps which are connected in parallel. The equivalent resistance in the parallel circuit decreases with increase of the number of lamps.

Q // Why is it better to connect the lamps and the other electric devices in the electric circuits in the house in parallel?

Ans //When one lamp is off (faulty)or removed, the other lamps will not be affected and remain on. This is because the current flow stops only at where the lamp. (From other paths can flow)

- **Compare between the connecting of lamps in parallel and in series**

a) Connecting lamps in series (characteristics)

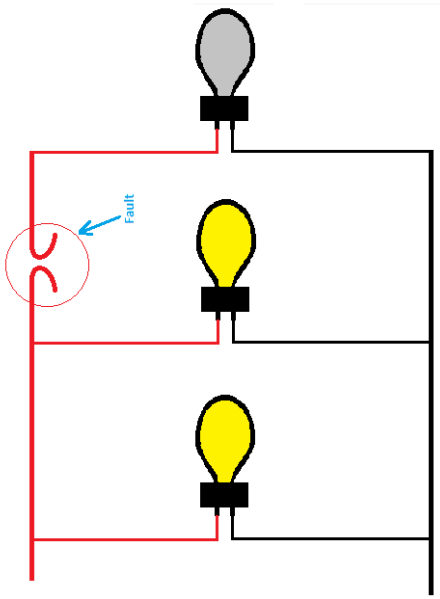
1. when one of the lamps is faulty or disconnected, the other lamps will be off.
2. only one path for the electric charge (current).

Q // *why when one of the lamps is faulty or disconnected, the other lamps will be off ?*

Ans // because there is only one path for the electric circuit .

b) Connecting lamps in parallel (characteristics)

1. when one lamp is off or removed, the other lamps will not be affected and remain on.
2. there are other paths through which the electric charge (current).



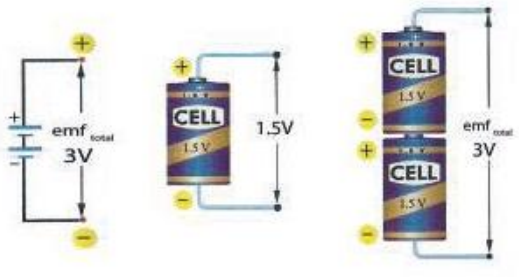
Connecting electric cells in series

Characteristics

1. the positive pole of the first cell will be connected with the negative pole of the second cell. The positive pole of the second cell will be connected to the negative pole of the third cell and so on.
2. To supply higher voltage (largest electromotive force emf).
3. (emf $_{total}$) will be equal to the sum of electromotive force for the cells which are connected in the series.

Q// Battery cells are connected in series to :

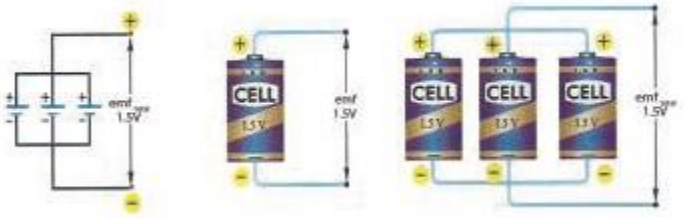
1. Increase voltage output
2. Decrease voltage output
3. Increase current capacity
4. Decrease current capacity



Connecting electric cells in Parallel

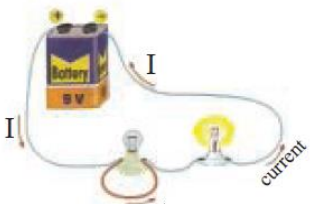
Characteristics

1. All the positive poles will be connected together her and all the negative poles will also be connected together.
2. To supply the electric circuit with a largest current.
3. (emf $_{total}$) is equal to (emf) for the one cell.



✓ Short Circuit

Is a circle generated by placing a thick wire between the ends of the lamp of the current flows through this wire (which has very low resistance).



QUESTIONS OF CHAPTER THREE

Q1

1-The characteristics of connecting lamps in parallel are:

a. When one lamp is off ther lamps will remain on.
b. All lamps are directly connected to the battery.
c. There are many paths through which the current can flow.
d. All the above.

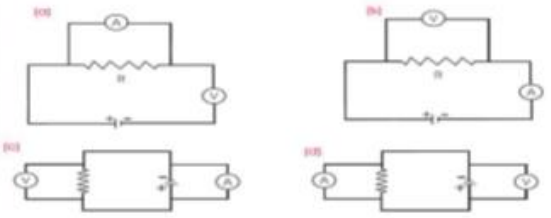
Q1

2-Increasing the number of resistances which are connected in parallel in an electric circuit containing a battery:

a. The amount of electric potential difference between the two ends of each resistance will be equaled.
b. The amount of electric potential difference will increase between the two ends of equivalent resistances.
c. The amount of current flow will be equal in all resistances.
d. The amount equivalent resistance will increase.

Q1

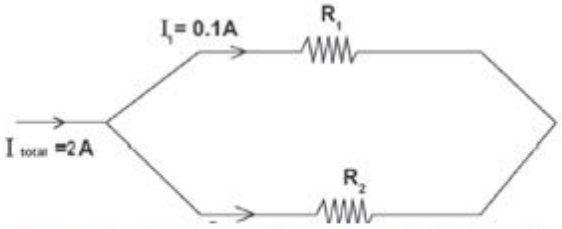
3- Which diagram of the following circuits diagram is regarded as correct when we use it to measure a small resistance, Ammeter (A), Voltmeter (V)



Q1

4-The amount of electric current (I_2) which flows in resistance (R_2) in the electric circuit diagram, given below, equals:

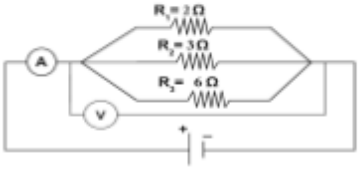
a. 0.1 A
b. 2A
c. 2.1 A
d. 1.9 A



Q1

5- If the reading of the ammeter which is connected to the electric circuit in the diagram is (6A),then the reading of the voltmeter in this circuit equals:

a. 6V b. 12V c. 18V d. 3V



Q1

6- One of the following units is the unit for measuring the electric resistance :

a. $\frac{\text{Amper}}{\text{Volt}}$ b. $\frac{\text{Volt}}{\text{Amper}}$ c. $\text{Volt} \times \text{Amper}$ d. $\frac{\text{Coulomb}}{\text{Second}}$

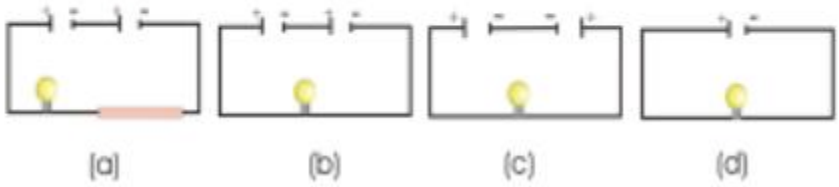
Q1

7-The amount of electric resistance for a conductor wire does not depend on:

a. Wire's diameter
b. Length of the wire.
c. The type of material of the wire.
d. The electric current which flows in the wire.

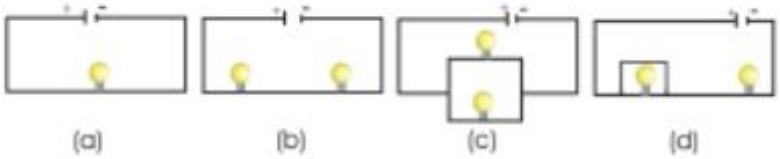
Q1

8- If the batteries in the following electric circuits are similar. Explain in which one the lamp glows sharper.



Q1

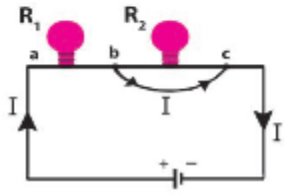
9- If the electric lamps in the following electric circuits are similar. Explain which one lamb or two lamps glows weaker.



Q1

10- In the nearby diagram, a thick wire has been connected between the two ends of the second lamp (between the points c,b), we observe:

a. The second lamp with resistance (R_2)will be off, and at the same time the glow of the first lamp (R_1) will increase.
b. The first lamp with resistance (R_1) will be off and at the same time the glow of the second lamp with resistance (R_2) will increase.
c. No change in the glow of the two lamps (R_1)or (R_2)
b. Both of the lamps will be off (R_1) and (R_2)

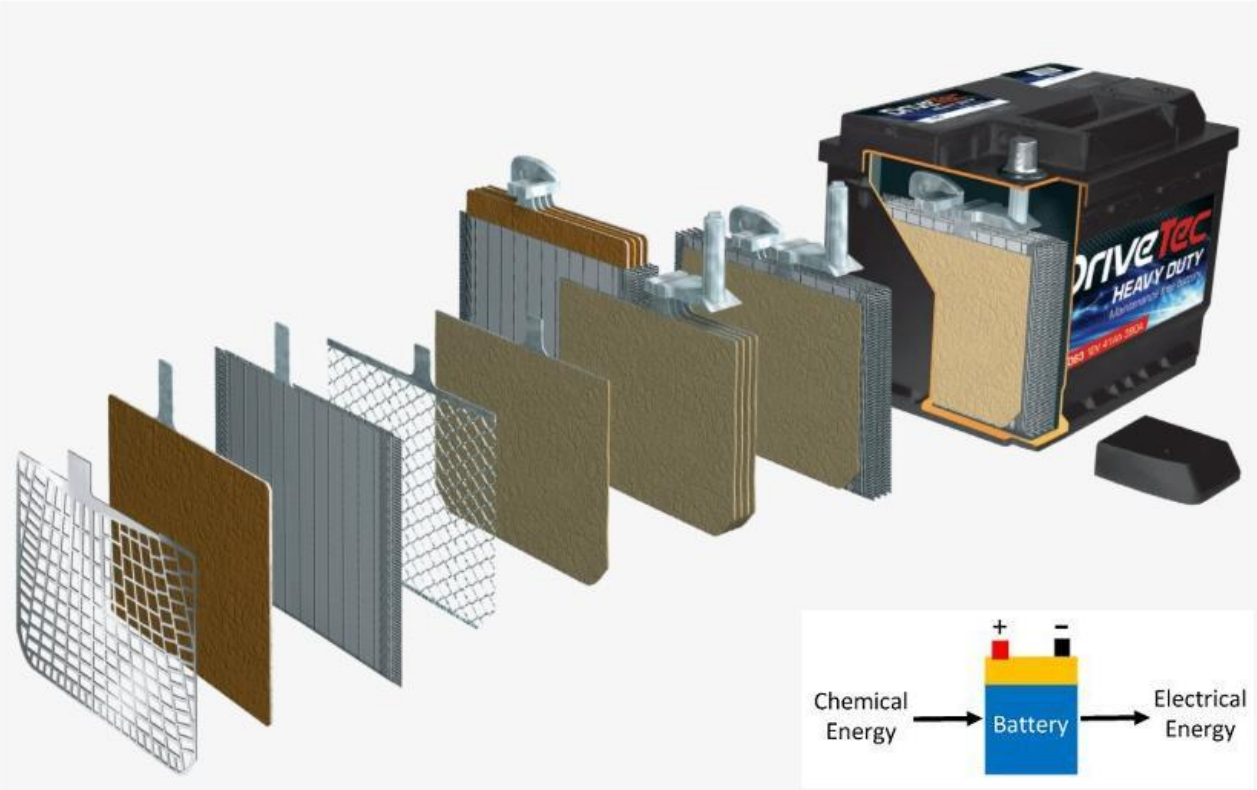


Q2// To measure the electric current flow in a load, by using an ammeter. Do we need to connect the ammeter in the circuit in series or in parallel with load?

Ans // Connecting the Ammeter in series with the required load or device in order to see the current which flows in it, (To allow all the electric charge pass in the part where the Ammeter is located),
The resistance of the ammeter will be very small as related to the resistance of the circuit or related to the system resistance that we want to know the current flow in it.

Q3// Why is it better to connect the lamps and the other electric devices in the electric circuits in the house in parallel?

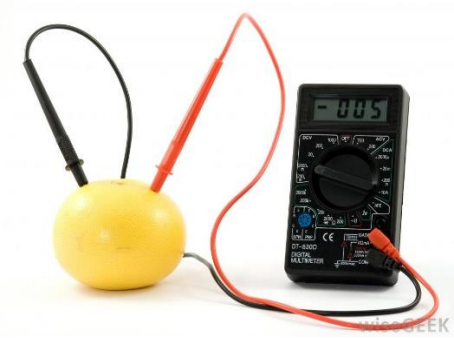
Ans // When one lamp is off (faulty)or removed, the other lamps will not be affected and remain on. This is because the current flow stops only at where the lamp. (From other paths can flow)


DriveTec
HEAVY DUTY
+
−
Chemical Energy
Battery
Electrical Energy

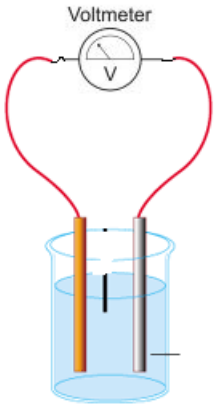

N
AAAA
AAA
AA
PP3
C
D
3R12

CHAPTER:4

❖ **Battery is the source of producing electric energy by the chemical reaction.**



Activity Converting Chemical Energy to Electric Energy



Tools: A plate of copper, a plate of zinc,glass container filled sulphuric acid diluted, Galvano meter (sensitive) and connection wires.

Steps:

•Place both the copper and zinc plates inside the glass container which has sulphuric acid diluted.

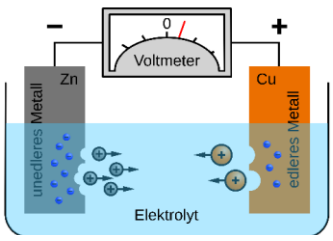
•Join the two plates with wires to the two ends of the Galvanometer Figure 3.

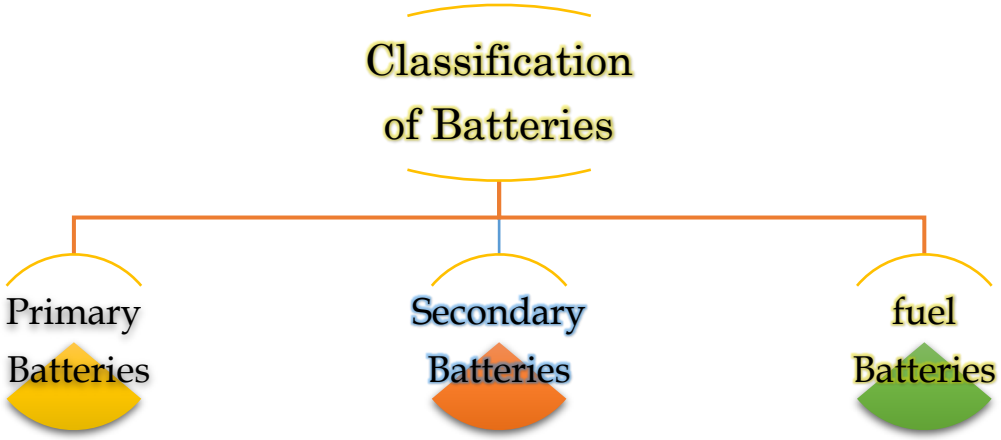
•The pointer of the Galvanometer will move as a result of flowing an electric current in the circuit.

•This system is called a simple electric cell.

Conclusion:

The simple electric cell is two different metal plates (such as copper and zinc). An eclectic potential difference will be generated between the two plates as about one volt. The effort of copper is greater than the effort of zinc. As a result, sufficient energy is generated allowing electric current flow when connected to an external circuit.





✓ Classification of Batteries

1. according to the chemical contents inside them.
2. according to its charging ability.

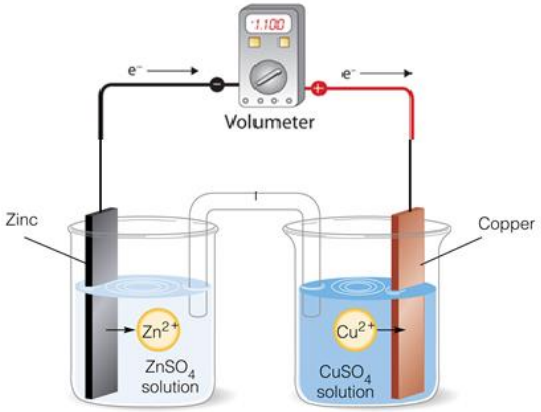
Primary Batteries

Q // What are the characteristics of the primary battery (simple cells)?

Ans // 1) stop working and be expired if one of its chemical components are consumed.
2) cannot be recharged.
3) Examples of this type is the simple Galvano cell and dry cell (carbon-zinc).

The simple Galvano cell

Danial cell

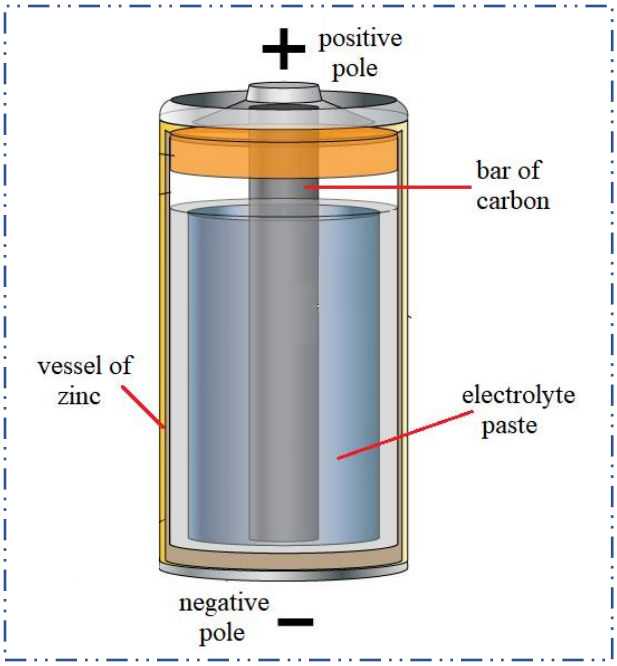


- ✓ consist of two halves cells.
- ✓ One of the boards is zinc (Zu).
- ✓ and the other one is copper (Cu).
- ✓ Each board sinks inside one of its salt solutions (Zinc [illegible] O_4).
- ✓ The atoms leave the electrons on the board and get into the solution as positive ions.
- ✓ Accumulation of electrons on the zinc board (negative pole) will be greater than the accumulation on the copper board (positive pole).

DRY CELL (carbon - zinc)

✓ Consisting of :

- ✓ vessel of zinc, acts as a negative pole.
- ✓ bar of carbon, acts as a positive pole.
- ✓ electrolyte paste, made of:
  1. ammonium chloride.
  2. zinc chloride.
  3. Water.
  4. manganese dioxide.
  5. carbon powder.



Q // How does a dry cell work?

Ans // As a result of chemical reaction a potential difference generates between the two ends of the cell by (1.5 V).

✓ Dry Cells Characteristics:

1. stop working and be expired if ones of its chemical components is consumed.
2. cannot be charged.

Secondary Battery

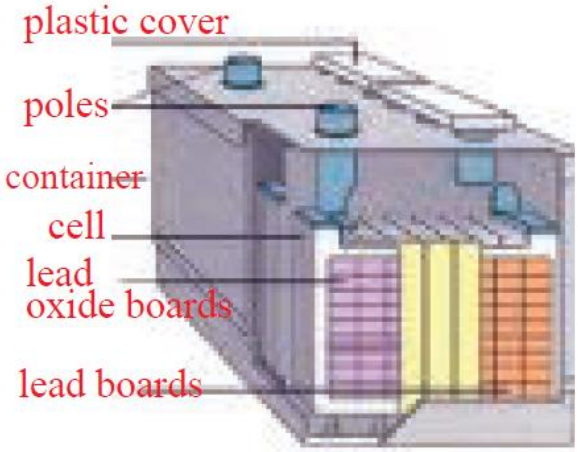
Q // What are the characteristics of the secondary battery?

Ans //

1. Don't stop working and be expired if one of its chemical components are consumed.
2. can be recharged.
3. Examples of this type is the car batteries, and (ion-lithium) batteries.
4. convert the electric energy to chemical energy which will be stored inside the battery.

CAR BATTERIES

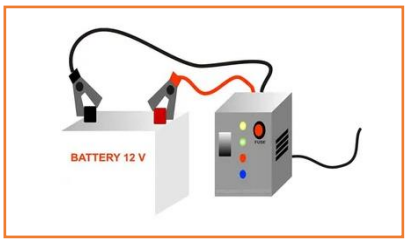
- ✓ The external shape of battery which is made of a plastic or solid rubber container.
- ✓ distilled water. (ماء مقطر)
- ✓ containing (3-6) cells inside with electrolyte solution.
- ✓ Each cell generates a potential difference of (2V).
- ✓ reacts chemically happen, producing a potential difference (12 V).
- ✓ the cells connected to each other in series.
- ✓ convert the chemical energy to electric energy.



❖ CHARGING BATTERY

1. Connect the battery to the source of direct current (charger) and join the positive pole of the source (Charger) with the positive pole of the battery.
   - ❖ Also join the negative pole of the source to the negative of the battery which we want to recharge.
2. The electromotive force amount (emf) for the car battery is (12V), so when it is recharged with an external source, the external source must be slightly higher than the emf of the car battery, about (14V) taking into a consideration the loss potential in the internal resistance of the battery, and in the connection wire.
3. Remove the plastic covers of the battery during the process of charging to get rid of the gases that would be generated as a result of chemical reactions inside the battery.

In the charging process, electrical energy is converted into chemical energy inside the battery.



❖ MAINTAINING THE CAR BATTERIES

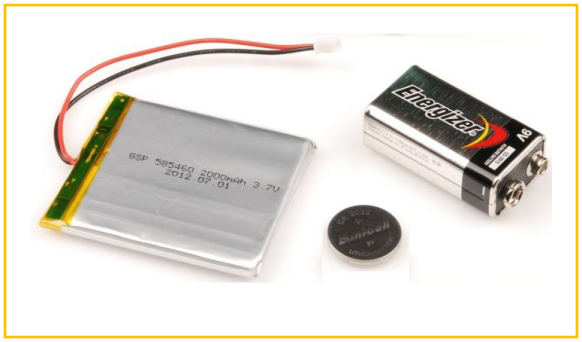
1. *Avoid extracting high current from the car battery for long period of time. Because that will generate a large amount of temperature which damage the battery.*
2. *The level of the acid solution (electrolyte) must be slightly higher than the level of the battery plates. In case the solution is less as a result of evaporation due to using distilled water needs to be added, making sure that the relative density for the solution of the battery is approximately.*
3. *The battery should not be left for a long time without use because that would cause making an insulation layer of sulphate on the boards.*

Q // why must remove the plastic covers of the battery during the process of charging?

Ans // To get rid of the gases that would be generated as a result of chemical reactions inside the battery.

Lithium-Ion Battery

- Can be recharged without any damage.
- can keep the electrical charge more than any other battery.
- Manufactured in different sizes and shapes (similar to dry batteries)
- Lithium-Ion batteries have durable covers.
- specially designed to resist high pressure and the heat generated inside the battery.
- The cover consists of three thin layers wrapped in a spiral way.



✓ **The cover consists:**

1. The positive pole made of (oxide lithium cobalt)
2. Insulator
3. Negative pole made of (carbon).

✓ The thin insulating layer is made of plastic which isolates the positive pole from the negative pole and allowing the ions to pass through them.

Q // What is the benefit of having insulator in Lithium-Ion battery?

Ans // *To isolates the positive pole from the negative pole and allowing the ions to pass through them.*

Q // What acts carbon as poles in: 1) dry cell. 2) Lithium-ion Battery

Fuel Battery

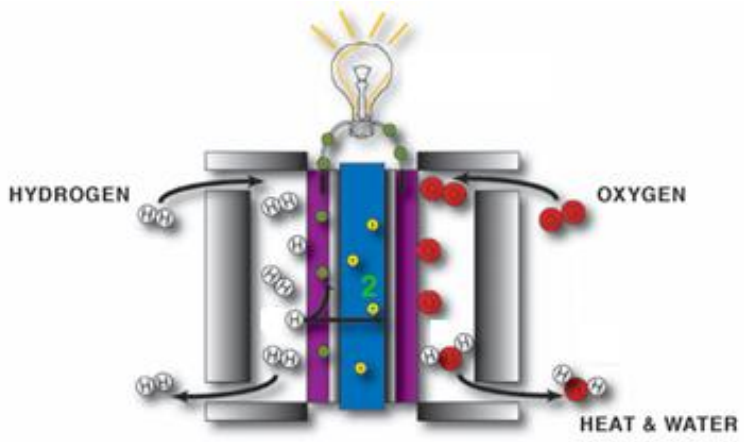
1. It's able to generate an electric current depending on fuel (chemical material) which is supplied by external sources.
2. does not stop working, as long as it is fed by fuel.
3. for example, hydrogen fuel batteries.
4. convert the chemical energy to electric energy.

Hydrogen Fuel Cell (Fuel cell)

- ✓ Convert the chemical energy to electric energy, (depending on chemical reactions)
- ✓ Hydrogen is usually stored as liquid in special containers.
- ✓ the hydrogen and oxygen gases that are obtained from the atmosphere will be converted to water and electric energy.
- ✓ The fuel battery (fuel cell) consists of thin boards.
  Each cell generates an electric potential difference of (1V).
  As the number of boards that are linked to each other in series increases,
  the potential difference will be increased.

❖ Hydrogen Fuel Battery has the following properties:

1. **It does not contaminate the environment.**
2. **does not contain dangerous factors. It is safe to use.**
3. **It has a very high working efficiency. It directly converts the chemical energy to electrical So, there is no loss of energy.**
4. **It lasts very long.**



Dry cell	Car Batteries
Primary Batteries	Secondary Batteries
cannot be charged	can be recharged
Stop working and be expired if ones of its chemical components are consumed	Consumables can be added to re-work
Has a vessel of zinc It acts as a negative pole	a plastic container
dry medium (electrolyte paste) and bar of carbon	Electrolyte medium
a potential difference generates (1.5 V)	Each cell generates a potential difference of (2 V)

Q // What does the positive and negative pole represent in each of the following:

1. Dry cell.
2. Car Batteries.
3. Lithium-Ion Battery.

Battery	Positive pole	Negative pole
Dry cell		
Car Batteries		
Lithium-Ion		

Electromotive Force

emf: The amount of energy supplied by the battery for electric charge units,

It is measured in units of (volt).

OR {Energy (**Work**) per unit charge}

$$emf = \frac{E}{q} = \frac{J}{C} = Volt$$

Q // What do you mean by "emf of a battery is: **1.5V, 9V, 12V** "?

Ans // It means that the energy gained for one coulomb from the battery is (**1.5**) joule.

$$1V = \frac{1.5\ J}{1\ C}$$

Example 1:

An amount of electric charges (q) has flowed (10C) through a battery. The battery gained energy (w) of (20J). Calculate the electromotive force (emf).

$$emf = \frac{E}{q}$$

$$emf = \frac{20}{10} \Rightarrow emf = 2\ Volt$$

Example 2:

Calculate the electrical energy to transfer electric charge (5C) between the poles of a battery, the potential difference between its poles (20 V).

$$emf = \frac{E}{q}$$

$$E = emf \times q$$

$$E = 20 \times 5 \Rightarrow E = 100\ Joule$$

QUESTIONS OF CHAPTER FOUR

Q 1 // Choose the correct statements for the following:

1.The unit of electromotive force (emf) is volt (V) and equals:

a) $\frac{A}{C}$ b) $\frac{J}{C}$ c) $\frac{C}{s}$ d) $\frac{C}{J}$

2.The simple Galvano cell is:

a) Primary battery
b) Secondary battery
c) Fuel battery
d) Rechargeable battery

3.A car battery of (12 V) is consists of six cells connected to each other

a) All in series
b) All in parallel
c) Three cells in parallel and three cells in series
d) Two cells in series and four cells in parallel

4. In (lithium-ion) batteries, the insulation boards between its two poles will carry out:

a) Allow ions to pass through it
b) Allow electrolyte solution to pass through it
c) Allow the ions and electrolyte solution to pass through it
d) Does not allow any of the above to flow

5.When charging a car battery, the amount of:

a) Source voltage must be slightly greater than the electromotive force (emf) for the battery
b) Source voltage must be less than the electromotive force (emf) for the battery
c) The source voltage equals (emf) for the battery
d) The source voltage is much greater than emf for the battery

6.Hydrogen Fuel Cell converts:

a) Electric energy to chemical energy
b) Chemical energy to electrical energy
c) Light energy to chemical energy
d) Electrical energy to light energy

Q2 // What is a secondary battery? Give an example.

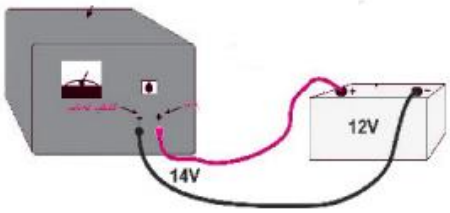
Ans //A cell that can be recharged by passing an electric current in the direction the opposite of the discharge current, (car battery).

Q3 // what is the type of energy stored in a secondary battery?

Ans // Electrical energy is stored in the secondary battery in the form of chemical energy.

Q4// Explain by diagram the process of charging a car battery.

Ans //



Q5// what procedures are needed in order to maintain the car battery?

1. Avoid extracting high current from the car battery for long period of time.
2. The level of the acid solution (electrolyte) must be slightly higher than the level of the battery plates.
3. The battery should not be left for a long time without usage.
4. Always clean the battery terminals and wires.

Q6 // List four pieces of devices in which a dry battery is used.

Ans // torches, remote controls, cameras and children's toys.

Q7// What are the properties of hydrogen fuel?

1. **It does not contaminate the environment.**
2. **does not contain dangerous factors. It is safe to use.**
3. **It has a very high working efficiency. It directly converts the chemical energy to electrical So, there is no loss of energy.**
4. **It lasts very long.**

P1// Calculate the amount of work spent on a moving charge of (2C) in an electrical circuit containing a battery with electromotive force (emf) (1.5V).

$$emf = \frac{W}{q}$$

$$W = (emf) \times q$$

$$W = 1.5 \times 2$$

$$W = 3 \ J$$

P2 // The electromotive force (emf) for a battery 12V and the amount of work supplied by the battery in order to move a charge (q) (120J). Calculate the amount of moving charge (q).

$$emf = \frac{Work}{Charge}$$

$$emf = \frac{W}{q}$$

$$q = \frac{W}{emf}$$

$$q = \frac{120J}{12V} \Rightarrow q = 10C$$

ENERGY & POWER

Chapter 5

Electrical Power

❖ The amount of energy that is consumed by an electrical device in a unit of time.
The unit of the power Watt (W).

$$P = \frac{E}{t} \Rightarrow \frac{\text{Joule}}{\text{sec}} = Watt$$

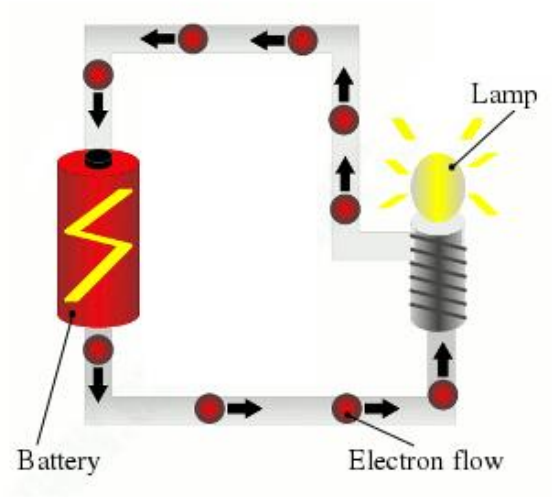
$P \propto E$

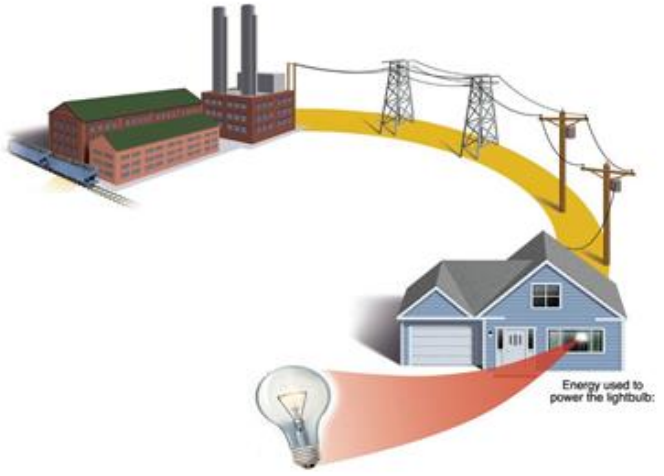
Q // What do we mean lamp with a power of (20 W, 90 W, 100 W) (larger lighting) ?
Ans // The lamp with power of (20W) consumes in one second (1s) is energy of (20 J).
The lamp with power of (90W) consumes in one second (1s) is energy of (20 J).

$$P = \frac{E}{t} = \frac{20\ J}{1\ sec} = 20\ Watt$$

Q // What does electrical power depend on?
Ans // **The electrical power depends on**:

1. the amount of current which flows in that device.
2. the potential difference between its two ends.





Electric Power laws

$$P = \frac{E}{t} \quad \text{---------- (1)}$$

$$P = V \times I \quad \text{---------- (2)}$$

$$R = \frac{V}{I}$$

$$V = I \times R$$

$$P = V \times I$$

$$P = I R \times I$$

$$P = I^2 . R \quad \text{---------- (3)}$$

$$I = \frac{V}{R}$$

$$P = V \times I$$

$$P = V \times \frac{V}{R}$$

$$P = \frac{V^2}{R} \quad \text{---------- (4)}$$

EXAMPLE An electrical heater operated by (220 V) ,resistance of its heating bars (one of three bars is 88Ω)

Calculate:

1. Power consumed by one of the bars.
2. Current flow in one of the bars.

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

$$P = \frac{(220)^2}{88} = 550W$$

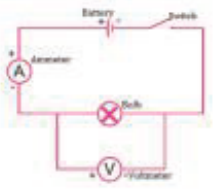
$$I = \frac{V}{R}$$

$$I = \frac{220}{88} = 2.5A$$

Activity : Calculating the electrical power

Tools :

Electrical lamp which works on voltage (6V) and power (2.5W), A battery with voltage (6V),Voltmeter, Ammeter, electrical key, Connection wires.



Steps:

1. Connect the systems in the electrical circuit as in Figure
2. Turn the electrical circuit on and record the reading of the ammeter (the amount of the circuit current). Then record the voltmeter reading (the amount of the potential difference at the ends of the lamp). Then calculate the power by applying the following relationship:

Power consumed = Current (ammeter reading) × potential difference (voltmeter reading)

IMPORTANT NOTICE

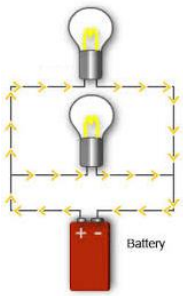
❖ يجب معرفة العلاقـة بين كل من (القدرة و المقاومة و التيار) وحسب العلاقات الرياضية:

$$P \propto \frac{1}{R}$$ inversely

$$R \propto \frac{1}{I}$$ inversely

EXAMPLE The two lamps (4Ω and 2Ω) are connected in parallel with each other, then they were connected to the two ends of a source of electric potential difference (12V), Calculate the amount:

1. The amount of current which flows in each resistance.
2. The consumed power in each lamp.



$$R = \frac{V}{I}$$

$$I_1 = \frac{V}{R} = \frac{12}{4} = 3\ A$$

$$I_2 = \frac{V}{R} = \frac{12}{2} = 6\ A$$

لاحـظ ان المصباح الكبـير يمر به تيار صغـير

وبالعكس: المصباح الصغيرة يمر به تيار كبـير

$$P_1 = \frac{V^2}{R} = \frac{(12)^2}{4} = \frac{144}{4} = 36 \text{ Watt}$$

OR

$$P_1 = V \times I = 12 \times 3 = 36 \text{ Watt}$$

لاحـظ ان المصباح الكبـير قدرتـه اقـل

وبالعكس: المصباح الصغيرة قدرتـه اكبـر

$$P_1 = \frac{V^2}{R} = \frac{(12)^2}{2} = \frac{144}{2} = 72 \text{ Watt}$$

OR $P_2 = V \times I = 12 \times 6 = 72$ Watt

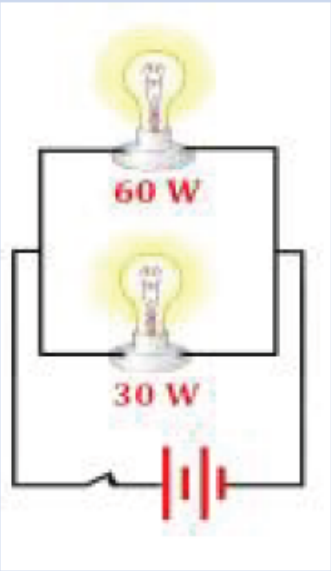


Figure 4

Question:

Two lamps, the first indicated as (60W) and the second is indicated (30W).They were connected in parallel. Both of them were connected in parallel with a battery of a certain voltage as in Figure 4. Fill the blanks in the following sentences by <, >, = :

1- The resistence of the first lamp ..... the resistence of the second lamp.

2- The current flow in the first lamp ..... the current flow in the second lamp.

3- The brightness of the first lamp ..... the brightness of the second lamp.

4- Potential difference between the two ends of the first lamp ..... potential difference between the two ends of the second lamp.

Answer:

1) $R1 < R_2$ (The resistance of the first lamp is **less than** the resistance of the second lamp)

$$P \propto \frac{1}{R}$$

2) $I_1 > I_2$ (The current flow in the first lamp **greater than** the current flow in the second lamp).

$$R \propto \frac{1}{I}$$

3) Bright 1 > Bright 2 (The brightness of the first lamp **greater than** the brightness of the second lamp)

$$P \propto \frac{1}{R}$$

4) $V_1 = V_2$ (connected in parallel)

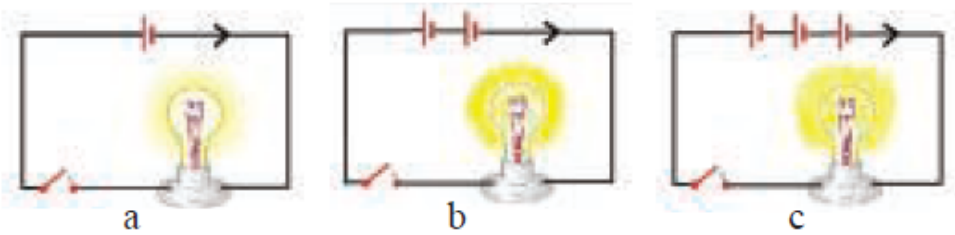
❖ تذكـــر:

ان زيادة عـــدد المصابيـــح على التوالـــي يعني زيادة المقاومة الكلية المكافئـــة فيقل التيار لان العلاقة عكسية.

$$R = \frac{V}{I}$$

Example:

The lamps (a,b,c.) in the diagram are identical. Show which one of the lamps will have more light (brighter). Which one consumes more power ?



Answer:

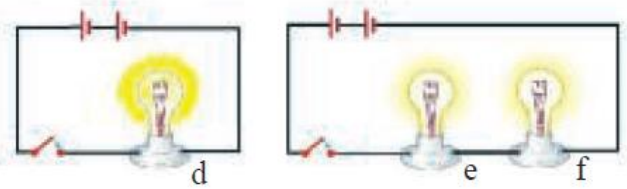
We see that the lamp (c) is brighter than the lamps (a and b). This is because of the increase in the number of battery in the circuite of the lamp (c) that is higher electric potential difference in the lamp .

So the current flow increases in lamp (c).The power which is converted from electrical energy to light energy in lamp (c) is largest

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

Example:

The following identical lamps (d,e,f). Which one of them glows more?
Which one will convert the largest power?



Answer:

The lamp (d) is the brightest. The lamps (e and f) will be less bright because of the increasing of number of lamps in the circuit.

This will lead to an increase of the equivalent resistence in the circuit and decrease in the amount of current flow there. Lamp (d) consumes more power

Electrical energy calculated

electric energy Consummation = electrical power × time

$$E\ (J) = P\ (w) \times t\ (s)$$

EXAMPLE A hair dryer with power (1500W) used for (20 minutes). Calculate the amount of electric energy consumed by the hair dryer.

t = 20 × 60 = 1200 sec

E = P × t

E = 1500(W) × 1200 (s)

E = 1800000 (J)

E = 1800 (kJ) the electric energy consumed.

EXAMPLE An electric teapot uses potential difference of (220V), an electric current of (10A) flows. Calculate:

1. The teapot's power.
2. The electric energy consumed during (20s).

P = I × V

P = 10 × 220

P = 2200 Watt

E = P × t

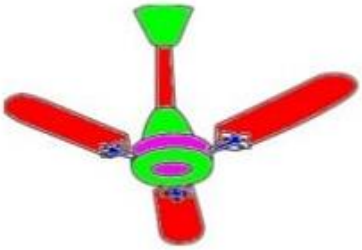
E = 2200 × 20

E = 4400 J

E = 44 kJ

H.W

The ceiling fan with power (100 W) How much energy does it consume when it works for 6 hours.



Cost = power x time x **Unit price**

Cost = Kw x hour x **Dinar kW/h**

1. To convert watts to kilowatts divide by 1000.
2. To convert minutes to hours divide by 60.

EXAMPLE If you can use electric vacuum cleaner for (30 minutes) consuming power of (1000W) and the price if a unit is (100 dinar/(kW-h)). What the price that you should pay?

$$\text{cost} = P\,(\text{kW}) \times t\,(\text{h}) \times \text{Unit price}$$

$$\text{cost} = 1\,(\text{kW}) \times 0.5\ \text{h} \times 100$$

$$\text{cost} = 50 \text{ Dinars}$$

$$P = \frac{1000\ \text{W}}{1000} = 1\ \text{KW}$$

$$t = \frac{30\ \text{min}}{60} = 0.5\ \text{h}$$

EXAMPLE Calculate the cost of using a mobile phone charger power (100W) for (4 hours), If the unit price (100 dinar/(kW-h)).

$$\text{cost} = P\,(\text{kW}) \times t\,(\text{h}) \times \text{Unit price}$$

$$\text{cost} = 0.1 \times 6 \times 100$$

$$\text{cost} = 60 \text{ Dinars}$$

H.W //

A 1200-watt dishwasher was used for two hours, so if the unit price is 50 dinar/(kW-h) who much would it cost to use the dishwasher once a day for a month?

Electricity in our houses

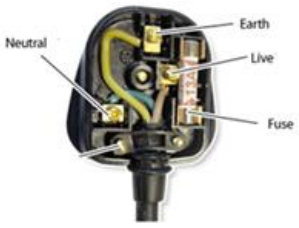
❖ Electric establishments supply us with electricity through two wires and the electric alternating current flows through them with potential difference of (220 V).
The first wire L has a potential difference of (220 V) and is called the live wire (hot).
The second wire(N) is called the neutral wire(cold) which also carries current, but it is earthed at the power station so its voltage is not as higher as in the live wire (L).

✓ **The Earth Wire** (E)

It connected the device to the earth, It is used for safety (safety wire).
If any fault happens in the electric circuit or if the live wire touches the metal cover of any electric device, this will lead to a large amount of current flowing from the live wire to the earth through the earthed wire. This will make the shock less dangerous.

✓ **Plug with Fuse:**

The electric plug consists of the live wire (L) and the neutral wire (N) and the earthed wire (E) and the fuse. Their role is as a safety precaution to avoid an electric shock.



circuit breaker
قاطـع الدورة الكهربائية

✓ Fuse:

A fuse is made of a metal wire, so it has a certain limit to resist an electrical current, If the current is more than that limit, then the metal wire will hot and melt, then the electric current will cut off.

✓ The fuse must be connected in series with the live wire before the current enters the device.
This will cut off the current when there is a current flow more than a certain current flow.

1. The degree of his temperature is low
2. Connected in series with a live wire

✓ Circuit breaker

A device that cuts off the electricity automatically in case the current flow exceeds that which was planned. (Connected in series with the live wire).

Avoiding an electric shock

Q // How to avoid electric shock?

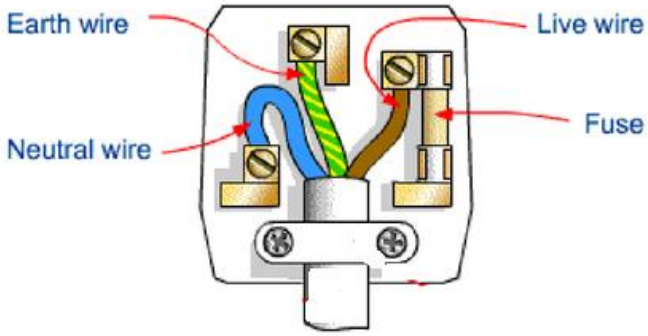
Ans // Electric devices with metal covers are usually earthed to avoid an electric shock and protect the device.

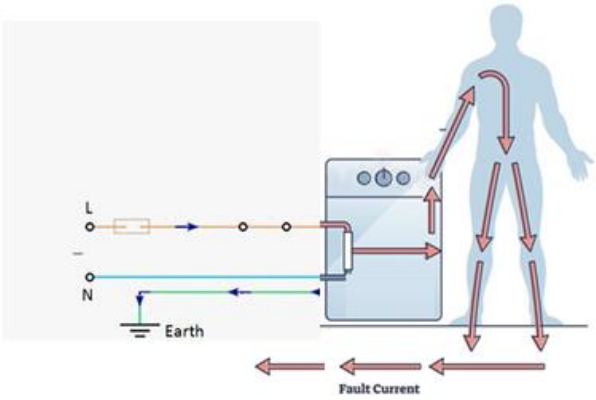
Q // What characterizes the earth wire? How does it work (Reason)?

Ans // The earth wire is normally thick, but its resistance electricity is very weak, less than the human's resistance. Therefore, the current flows in the wire but it doesn't flow in the human body, So, a short circuit with wire is being done avoiding the human body.

Q //The earth wire must be is very weak, less than the human's resistance?

Ans // the current flows in the wire but it doesn't flow in the human body.





✓ To protect yourself follow the following safety procedures.

1. Do not touch anybody who is exposed to an electric shock, except when the person is isolated from electricity.
2. Avoid putting any metal body with hand into the plugs (nail or un insolated wire).
3. Do not leave wires without insulation.
4. Avoid to let your body connect between the live wire and neutral one or between the live wire and earth.

QUESTIONS OF CHAPTER FIVE

Q1

1) The fuse must be connected:

a) In series with the live wire
b) In series with the neutral wire
c) With the earthed wire
d) In parallel with the live wire

Q1

2. (kW-h) is a unit of:

a) Power
b) Potential difference
c) Resistance
d) Electric energy

Q1

3. One of the following is not a unit of electric power:

a) J/sec
b) Watt
c) A × V
d) J × S

Q1

4. A electric teapot uses (1200 W) If the current which flows in the teapot is (5A), what is the voltage which the system works on :

a) 60 V
b)120 V
c) 240 V
d) 600 V

Q1

5.Electrical device consumes energy (18000J) in five minutes. The rate of power consumed

a) 360 Watt
b) 180 Watt
c) 30 Watt
d) 60 Watt

Q-2 Give the reason of the following:

1) The fuse is connected to the electrical circuit of the house in series with the live wire before providing the electric device with electric energy.

Ans // In order to protect the electrical devices, the current of the electrical circuit is automatically cut off in the event of a current flowing greater than the current appropriate for it.

2) Electric device will be earthed, especially the ones with metal covers.

Ans // To avoid electric shock and protect electrical devices, because the earth wire has a very small electrical resistance, less than the resistance of the human body, so a short circuit is formed with the wire without the human body being included in it.

3) A bird can stand on a live wire which has very high power without being shocked?

Ans // Because the resistance of the bird's body is very large between the two points of contact of the bird's legs with the wire in relation to the resistance of this part of the wire, then almost no current flows in the bird's body and flows through the wire.

A short circuit is formed with the wire without the bird's body being within it, so the potential difference will be between the two points of contact with the wire is zero.

الجواب :

((لان مقاومة جسم الطائر كبيرة جداً بين نقطتي تلامس رجلي الطائر بالسلك بالنسبة الى مقاومة هذا الجزء من السلك عندئذ يكاد لاينساب تيار في جسم الطائر وينساب في السلك فتتكون دائرة قصيرة مع السلك من غير ان يكون جسم الطائر ضمنها فيكون فرق الجهد بين نقطتي التلامس بالسلك يساوي صفراً))

Q-3 Is the fuse connected in parallel or in series in the electric circuit of the required device that you want it to be safe? Why?

Ans // It is connected in series because when the circuit becomes overloaded, no current flows in the circuit.

P-1 The nearby diagram represents an electric containing a lamp (L), Voltmeter and Ammeter. If the reading of the Voltmeter is (3V) and the reading of the ammeter is (0.5A) calculate:

a) The lamp resistance.

b) The lamp powers.

$$R_L = \frac{V}{I} = \frac{3}{0.5} = \frac{30}{5} = 6\Omega$$

$$P = I \times V$$

$$P = 3 \times 0.5$$

$$P = 1.5 \text{ watt}$$

P-3 A lamp has the following properties (24 W), (21 V). Calculate in (kW-h) the consumed energy during a time period of (10 hours).

$$P = 24 \text{ watt} = \frac{24}{1000} = 0.024 \text{ kw}$$

$$E = P \times t$$

$$E = 0.024 \text{ kw} \times 10 \text{ hours}$$

$$E = 0.24 \text{ kw - h}$$

$$P = 24 \text{ watt} = 24 \frac{J}{s}$$

$$E = P \times t$$

$$E = 24 \frac{J}{s} \times 10 \text{ h} \times 3600 \text{ s}$$

$$E = 864000 \text{ J}$$

P-4 An electric boiler consumes power of (2kW). It worked for (6 hours). What is the cost of consumed energy if the price of 1 (kWh) is 100 Dinars?

$$\text{cost} = P\,(\text{kW}) \times t\,(\text{h}) \times \text{Unit price}$$

$$\text{cost} = 2 \times 6 \times 100$$

$$\text{cost} = 1200 \text{ Dinars}$$

P-2 Two resistances (180 Ω and 90 Ω) are connected to each other in parallel. The set is connected to a source with a potential difference (36 V). Calculate:

a) The current which flows in each resistance

b) The consumed power in each resistance by two different methods.

$$I_1 = \frac{V}{R_1} = \frac{36}{180} = \frac{2}{10} = 0.2\text{A}$$

$$I = \frac{V}{R_2} = \frac{36}{90} = \frac{2}{5} = 0.4\text{A}$$

$$V = 36 \text{ volt}$$

$$P_1 = I_1 \times V = 36 \times 0.2$$

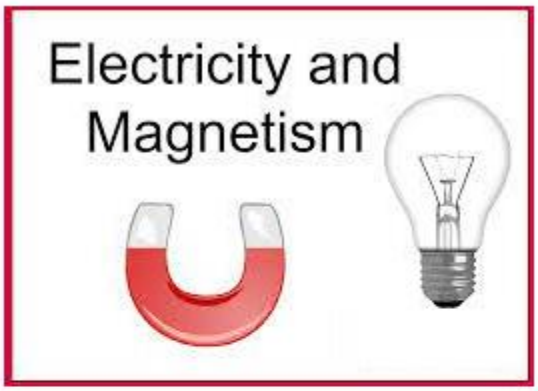
$$= 7.2 \text{ watt}$$

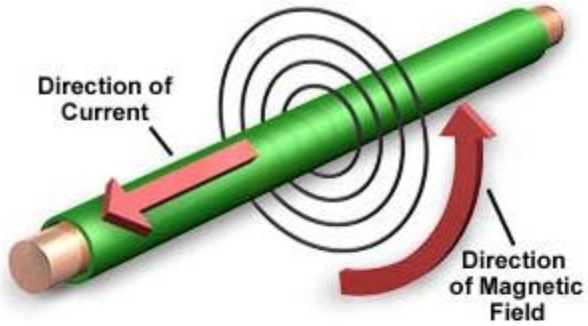
$$P_1 = I_1^2 \times R_1 = (0.2)^2 \times 180$$

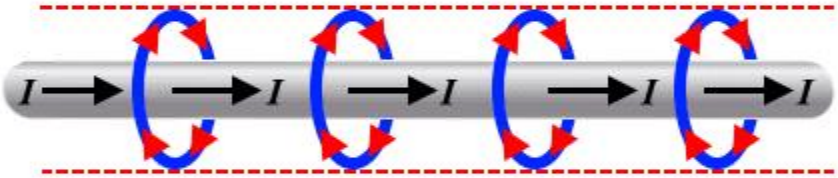
$$= \frac{4}{100} \times 180 = 7.2 \text{ watt}$$

$$P_2 = I_2 \times V = 36 \times 0.4 = 14.4 \text{ watt}$$

$$P_2 = I_2^2 \times R_2 = (0.4)^2 \times 90 = 14.4 \text{ watt}$$







CHAPTER 6

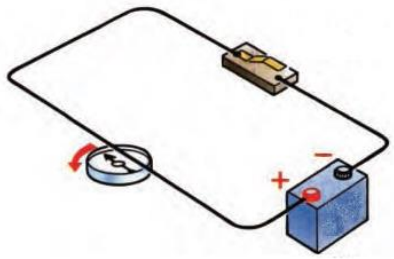
ELECTRICITY AND MAGNETISM

OERSTED EXPERIMENT

- ✓ **The electric current flow in a conducting wire generates a magnetic field around it.**

Activity:

- ✓ Tools: Magnetic needle fixed on tipped holder ,Thick wire of 30 cm, Battery voltage 1.5 V Wires and an electric key.
- ✓ Steps:
- ✓ Leave the electric needle free to direct alongside the line of the magnetic field of the earth
- ✓ Place the thick wire over the magnetic needle so that it will be parallel to its axis
- ✓ Connect the ends of the thick wire to the poles of the battery and through an electric key.
- ✓ Switch the key on for a while, then we will see the magnetic needle deviates and then settle down at a perpendicular position alongside with the wire. Once the current comes off, the needle goes back to its original position.
- ✓ Reverse the direction of the current flow in the thick wire by reversing the poles of the connected battery in the circuit. Then we switch on the electric key for a while. We observe that the magnetic key deviates and then settles down in a perpendicular position with the thick wire and in a reverse position to the first case.
- ✓ repeat the above steps by putting the thick wire under the needle and in a parallel position to the needle. What do you observe in each step?
- ✓ The deviation of the compass needle indicates to its effectiveness for a magnetic force as it is a magnetic field. Also, its return to its original position when the electricity is off shows that the electric current generated this magnetic field



Q // What does the magnetic needle declination of a compass indicate?

Ans // indicates to its effectiveness for a magnetic force as it is a magnetic field.

Q // What is the reason behind switching on the circuit (close the circuit) for a while?

Ans // To make sure that the movement of the compass needle is due to the effect of the magnetic field.

Q // What is the purpose of using a thick wire in this experiment?

Ans // In order for the resistance to be small, a large current flow, and a large magnetic field is generated that affects the compass needle.

Types of magnetic field

1. Straight wire:

Activity

Tools:

Carton, some small magnetic compasses, a thick wire, electrical key, electric battery of reasonable voltage, iron powder.

Steps:

Make a hole in the middle of the carton and thread the wire through the hole and then we connect the electric circuit.

Sprinkle the iron powder around the wire. Then we switch the electric circuit allowing the electric current to flow in the wire. Then we gently tap on the carton.

Repeat the above steps by putting the compass on the carton instead of the iron powder. They form a circle; its center is the wire.

Switch on the key by close the electric circuit, for a while an electric current flow through the wire, direction of the north pole for the magnetic needle.

We conclude:

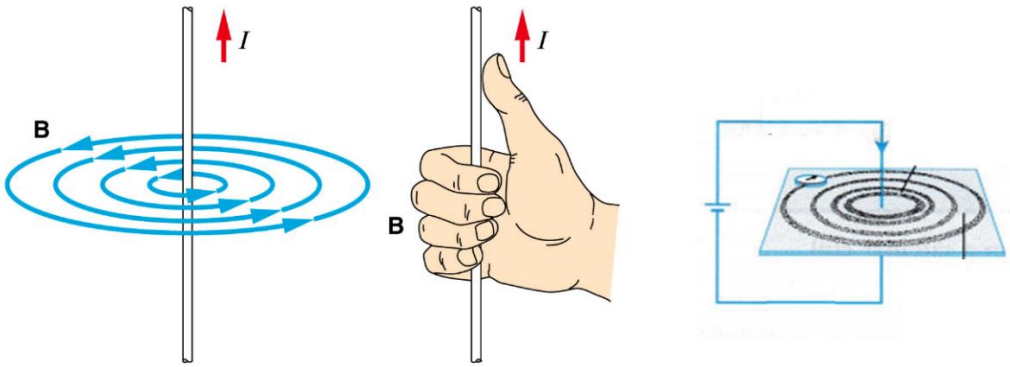
from this activity that the iron fillings are arranged in a co-center circle (circles with the same center). These circles represent the magnetic field lines around the wire as a result of an electric current flow in the wire.

✓ To determine the direction of the magnetic field:

Thumb to the direction of the **electric current.**

fingers bending towards the **magnetic field.**

the direction of the magnetic field will be in circles with the same center around the wire.



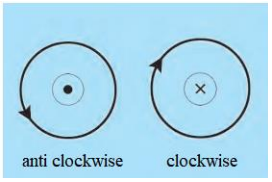
✓ The factors that the magnetic field which creates around a wire, as a result of electric current flow, depends on are as following:

1. The magnetic field increases with the increase in the electric current flow in the wire. It also increases with the number of magnetic lines passing through a certain cross section area.
2. The magnetic field increases as it is approached to the wire and decreases as it is taken away from the wire.
3. The direction of the magnetic field depends on the direction of the direct electric current in the straight wire.

THE DIRECTION DEPENDS ON THE DIRECTION OF THE CURRENT FLOW IN THE WIRE

✓ (•) The dot represents the direction of the current out of paper and the direction of the magnetic field is in an anti clockwise direction.

✓ (x) represents the direction of the current entering the paper and the direction of the magnetic field will be in a clockwise direction.

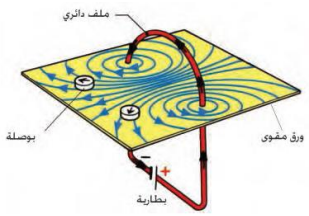


2. Circular ring:

Activity : Planning a magnetic field for an electric direct current flow in a circular ring.

Tools:

carton, a number of magnetic compasses, a ring of thick wire (insulated), electric key, battery with a proper voltage (dry) and iron powder.



Steps:

Fix the circular thick wire in the carton and connect the electrical circuit which consists of a ring connected in series with a battery.

Allow the current to flow free for a few seconds in the wire and put some compasses at various locations from the center of the ring. Observe the deviation in the direction of the magnetic needles of the compasses.

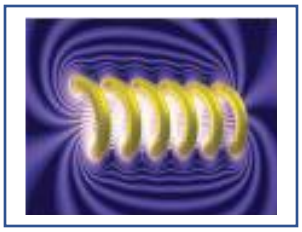
Reverse the direction of the current in the ring and repeat the above procedures.

What will we see?

Conclude

from this activity that the shape of the magnetic field lines as a result of the current flow in the conducted a circular ring , the lines will be elliptic in shape (egg shape) and this will be more condensed inside the ring and it will be perpendicular to the plane of the ring.

3. spiral coil



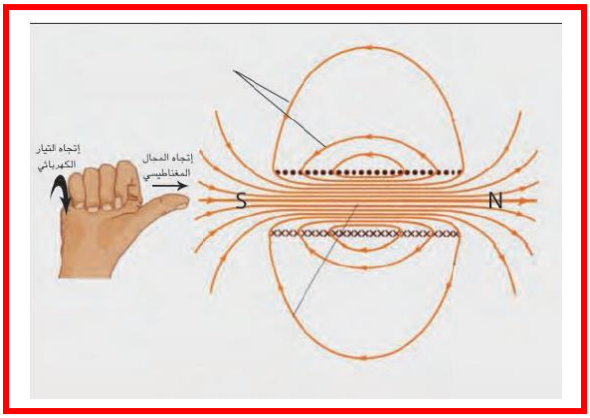
using a spiral coil , we see that the lines of the magnetic field :

1) parallel to each other inside the coil.
2) closed Outside the coil.

✓ closed fingers will determine the direction of the electric currents.
The thumb will have the direction of magnetic field inside the coil.

✓ **magnetic field depends on :**

1. amount of the current
2. the turns number



✓ straight wire

1. thumb : electric current
2. fingers rotate : magnetic field

✓ Circular ring

1. thumb : electric current
2. fingers rotate : magnetic field.

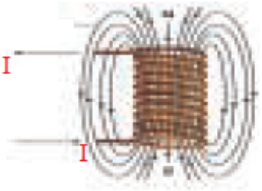
✓ spiral coil

1. thumb : magnetic field.
2. fingers rotate : electric current.

Question

1.Compare between the lines of magnetic field around a magnetic bar and around coil in which a direct electric current flows.

2.Compare between the lines of magnetic field inside the coil and outside it in regard to the direction and quantity.



1. Similar. متماثلة
2. Inside the coil : parallel lines.
   Outside the coil, the lines would be closed.

a magnetic field to be generated around a moving charge as an electron around

Electromagnet

Electromagnet: is a temporary magnet which will disappear when the electric current flow disappears in the wire.

✓ Consist of a core of soft iron when a conducted insulated wire is wrapped around it. This can be in the shape of a straight bar or in the shape of a (U).

Q // Why the direction of wrapping the wire in a magnet is in a (U) shape around the core of iron in two opposite directions?

Ans // To get two magnetic poles, one north and the other south at its two ends.

✓ If we want to get a permanent magnet for a longer period after the disconnection of the electric current, we use steel as instead of soft iron.

✓ The amount of magnetic for any magnet will depend on:

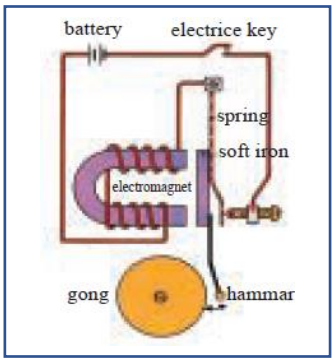
1. The turns number of the coil in unit length.
2. The type of core material.
3. The amount of electric current which flows in the coil.

❖ The magnetic field increases between the two poles when it has a (U) shape

✓ The Electric Bell:

consists of:

1. An electromagnet in a (U) shape.
2. Container made of soft iron
3. Axial nail
4. Hammer
5. Metal Gong



✓ When the bell is connected to electric circuit containing battery and a key, when the key is on, the electromagnet will attract the piece of soft iron then the hammer will move towards the bell making a sound. By then the electric circuit is "off " (the key is open).

✓ As a consequence, the iron bar will lose its magnetism. So the magnet will lose its magnetism and piece of soft iron will move away and a gap will appear between the iron bar and the magnet, then the sound will stop. This procedure will be repeated with an electric current flow in the electric bell.

❖ The Telephone

❖ By speaking into a receiver the amount of current in the electric circuit will change according to the pulses of pressure and shrinking in a similar way to the frequency of the caller's voice (the same frequency). These kinds of frequencies are transmitted through the cables and the other person's receiver. This will pass through the electromagnet which attract a thin disc made of soft iron which generate a frequency. This will generate sound waves in the air, similar to the sound of the caller.

❖ Electromagnet Relay

This is a magnetic key used as a controlling means of switching (on) and (off) in an electric circuit. In a car for example, the relay plays the role of controlling the functioning of a large electric current.

Uses:

1. when turning the car key.
2. the electronic circuits in order to switch (on) and (off) automatically.

Electromagnetic Induction

❖ A phenomena of generating an induced voltage through an electric conductor within a magnetic field which is variable, or by a relative movement between the conductor and the magnetic field in which variation is in the magnetic field is happening.

❖ Induced electromotive force (emf_{ind})
potential difference generated at the two ends of a conductor.

❖ Induced Current (I_{ind})
Its generated in the electrical circuit result changes in the magnet field inspite of the non-existence of a battery.

Faraday's law

Induced emf (ε_{ind}) is generated and an induced current (I_{ind}) if there is change in the magnetic field (for whatever reason)

❖ Reasons:

1. **changes in the magnet field lines.**
2. **relative movement.** حركة نسبية

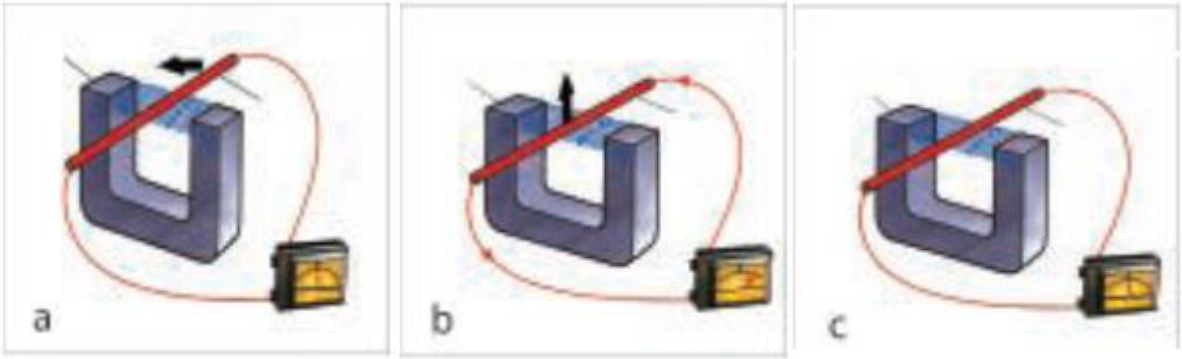
ACTIVITY : *Generating electricity by using a magnetic field*

- Tools: Permanent magnet (U) shaped, galvanometer, insulated conductive wire.
- steps:

1. Connect the two ends of the wire to the two ends of a galvanometer and move the wire in a parallel direction to the lines of the magnetic field. Does the galvanometer pointer move?
   The galvanometer pointer would not move because there is no change in the magnetic field.
2. Move the wire in a vertically to the lines of the magnetic field (up and down). We see that the pointer of the galvanometer moves in two opposite directions around the side of (zero) in the galvanometer. This is due to a change in the magnetic field. When the conductor stops moving, the pointer does not move .

We, therefore, conclude:

The instant electric current which is generated in the wire inspite of the non-existence of a battery in its electric current, is called the Induced Current, as it has been created as a result change in magnetic field.



Q *// What is the reason of generating an induced current?*

Ans // Generating an induced current in the closed circuit is due to an induced potential difference generated at the two ends of a conductor called induced electromotive force (induced emf).

ACTIVITY: Induced emf

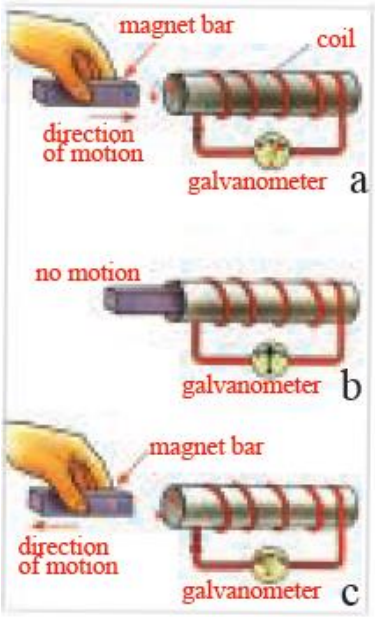
Tools: magnet bar, cylindrical coil, galvanometer.

Steps: Connect both ends of the coil to the two ends of the galvanometer.

- Move the magnet by making it closer to the coil parallel to the coil length. We see the movement of the pointer of the galvanometer which indicates to the current flow.
- Fix the magnet beside the coil and observe it. Does the galvanometer pointer move? Observe that the pointer of the galvanometer is fixed at zero This indicates that no induced electric current has been generated.
- Pull the magnet bar from the inside of the coil. See the deviation of the galvanometer's pointer which is in the direction opposite to the first case.

We, therefore, conclude that:

- The induced electric current in a closed electric circuit is created when the magnet or the coil is moved causing changes in the magnet field lines, whereas no induced current is created if none of these are moved. This is because no change has happened to the magnetic field lines.
  Generating an induced current in the closed circuit is due to an induced potential difference generated at the two ends of a conductor called induced electromotive force (induced emf).



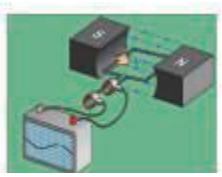
Remember:

- induced current is generated when :
  1. change (variation) in the lines of a magnetic field through a conductor.
  2. a relative motion between the conductor and the magnetic field penetrates the conductor

APPLICATIONS OF INDUCED ELECTROMAGNETISM

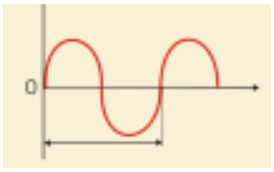
✓ Electric Generator of alternative current (AC)

It is device which converts the mechanical or dynamic energy to electric energy with magnetic field availability.



Consists of the following:

1. A coil of conducted wire, insulated and wrapped around an iron core.
2. Two insulated metal rings.
3. Two carbon brushes.
4. A permanent magnet or electromagnet in a (U) shape



Q // What happens during the rotation of the coil between the magnetic poles?(How works)

Ans // During the rotation of the coil inside the magnetic field in a regular way, it crosses the magnetic force lines causing changes in the magnetic force lines. This will generate an induced electromotive force (induced emf) leading to an induced alternating current flow in the core of coil. This will be transferred across the two metal rings and the brushes which are touching them to the external electric circuit. It is called an alternating current.

✓ The simple generator for direct current (DC)

It is device which converts the mechanical energy to electric energy with magnetic field.

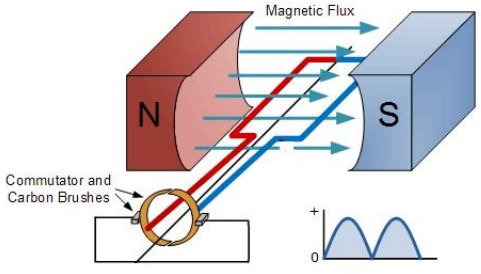
❖ Consists of the following:

1. A coil of conducted wire, insulated and wrapped around an iron core.
2. two halves of the metal ring (exchanger).
3. Two carbon brushes.
4. A permanent magnet or electromagnet in a (U) shape

❖ The current which we get in this case will be in one direction (DC).
It is called a direct current.

Q // What is the function of the exchanger? ما وظيفة المبادل

Ans // Make the current one way in one direction (DC).



Electric motor

- It is a machine which converts electrical energy to mechanical energy.

Consists of the following:

1. The core of the motor.
2. A permanent strong magnet where the coil is placed between its two poles
3. Exchanger: This is the two halves of a metal ring isolated electrically and they are connected to the ends of the wire of the rotated core coil.
4. Two brushes of carbon touching the two halves of the exchanger and they connected to the two poles of electric direct current.

Q // What is the principle of an electric motor?

Ans // electric motor depends on the principle of the magnetic force in the wire in which the direct electric current flows.

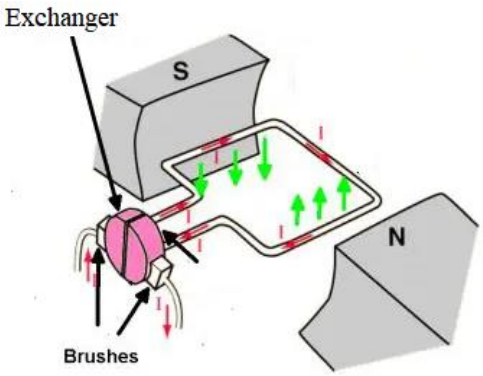
Q// How does an electric motor work?

When the circuit is closed the direct electric current flows from the external circle to the core coil. This will pass through at both two ends of the coil in opposite directions. As a result of a magnetic field effect for the current passes in the core coil and the field which is produced by the permanent magnet, two opposite forces will be generated. These two forces will be equal in amount and opposite in direction on the two sides of the coil. These two forces cause the coil to rotate around its axes inside a magnetic field. The coil will continue rotating in one direction because of the exchanger

Q // What is the function of a the exchanger In electric motor?

ما وظيفة المبادل في المحرك الكهربائي.

Ans // make coil will continue rotating in one direction.



Q // What is the difference between alternating current and direct current generator

Electric Generator of alternative current	The simple generator for direct current
Generates alternating current	Generates direct current
Connect the two ends of the coil with two metal rings	Connect both ends of the coil with two metal ring halves (exchanger)

Q // What is the benefit of exchange in all of the following?

1. The simple generator for direct current.
2. Electric motor

Ans //

1.
2.

Q // How can you convert an AC into a DC generator?

Ans // by replacing the two metal rings of an AC generator with the exchanger of a DC generator. باستبدال الحلقتين المعدنيتين بالمبادل

QUESTIONS OF CHAPTER SIX

Q1

1) Induced electro motive force (emf) is generated as a result of changing in:

a. Electric field.

b. Magnetic field.

c. Electric potential difference.

d. Mechanical force.

Q1

2) The induced electric current in a wire coil circuit increases if:

a. The magnet is moved slowly inside the coil.

b. The magnet is moved faster inside the coil.

c. The magnet is fixed in the coil.

d. The coil is pulled slowly away from the magnet.

Q1

3) An alternating current generator can be transferred to a direct current generator. This is can be done by lifting the two slippery rings away and connecting the two ends of the coil to the:

a)Exchanger. b)Electric lamp. c)Thick wire. d)Voltmeter .

Q1

4) The electric generator convert the mechanical energy to:

a) Chemical energy.

b) Electric energy.

c) Magnetic energy.

d) Lightening energy.

Q1

5) Electric motor converts the electric energy to:

a) Mechanical energy.

b) Chemical energy.

c) Magnetic energy.

d) Light energy.

Q1

6)Which one of the following do not increase the electromagnetic force for the coil:
a) Entering a copper bar inside the coil space.
b) Entering an iron bar inside the coil space.
c) Increase the number of wrapping in the coils per length unit.
d) Increasing the amount of current flow in the coil.

Q1

7) Insulated conducted wire is wrapped around soft iron nail. The two ends of the wire are connected to a battery with a proper voltage. Which one of the following statements is not true for this case:
a)The nail will be a permanent magnet.
b)One end of the nail will be a north pole and the other a south pole.
c)The nail generators magnetism around it.
d)The magnetic field of the nail will disappear after a period of time when the current is cut off.

Q1

7) The moving electric charges generate:
a) An electric field only.
b) Only a magnetic field.
c) An electric and a magnetic field.

Q2 // *In which way does the electromagnet differ from a permanent magnet?*

Ans //

1. It is used to lift and transport scrap steel and iron pieces in factories Because its field disappears when the electric current is cut off, and magnets cannot be used permanent for this purpose.
2. It is possible to reverse the poles of the electromagnet by reverse the connection of the poles of the battery , this is not possible for permanent magnets.
3. To obtain a controllable magnetic field
4. The strength of magnetism can be changed by changing the amount of current flowing through its coil.
5. In electrical machines that depend in their work on the magnetic effect of electric current (temporary magnetization) as in an electric bell.

Q3 // *In the nearby diagram, a magnetic bar is moving inside the coil space?*

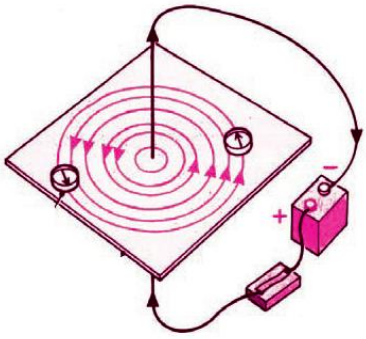
a. Why does the electric current flow in the milli-ammeter which is connected between the two ends of the coil?
b. What is the source of the electric energy generated in the circuit?

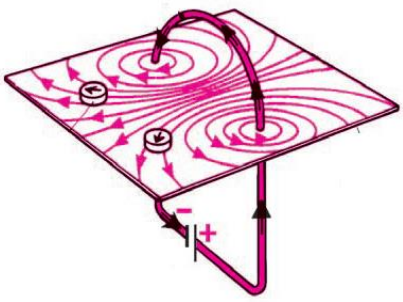
Ans //

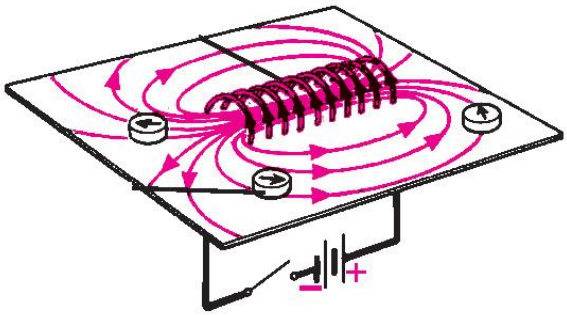
1. Due to the generation of an induced electromotive force (emf) on both ends of the coil in the electrical circuit.
2. The source of electrical energy generated in the electrical circuit from the completion of external work.

Q4 // Draw a diagram illustrating the lines of the magnetic force for a magnetic field produced by electric direct current flow in:

1. A straight conductor wires.
2. A ring conductor wire.
3. A wire coil in a spiral shape.







Q6 // The magnetic field of a coil with electric direct current field increases when A piece of iron is placed inside it. Give your reasons.

Ans // To increase the intensity of the magnetic flux through a piece of iron.

Q5 // Explain (with giving reasons) in which of the following two cases a straight conducted wire with an electric current flow will be affected by a magnetic force when placed inside a regular magnetic field:

1. The length of perpendicular wire to the magnetic field lines.
2. The length of perpendicular wire parallel to the magnetic field lines.

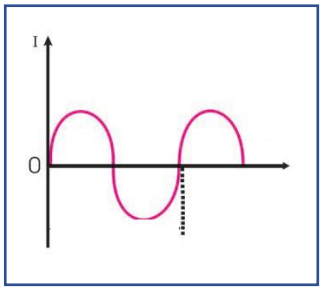
Ans //

a) It is affected by a magnetic force when placed vertically in a uniform magnetic field.

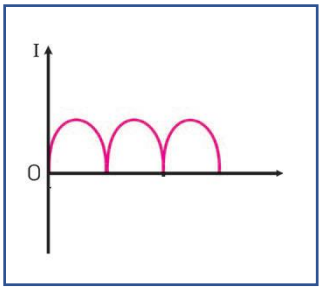
b) The wire is not affected by any magnetic force.

Q9 // What is the difference between the alternating current generator and a direct current generator respect to:

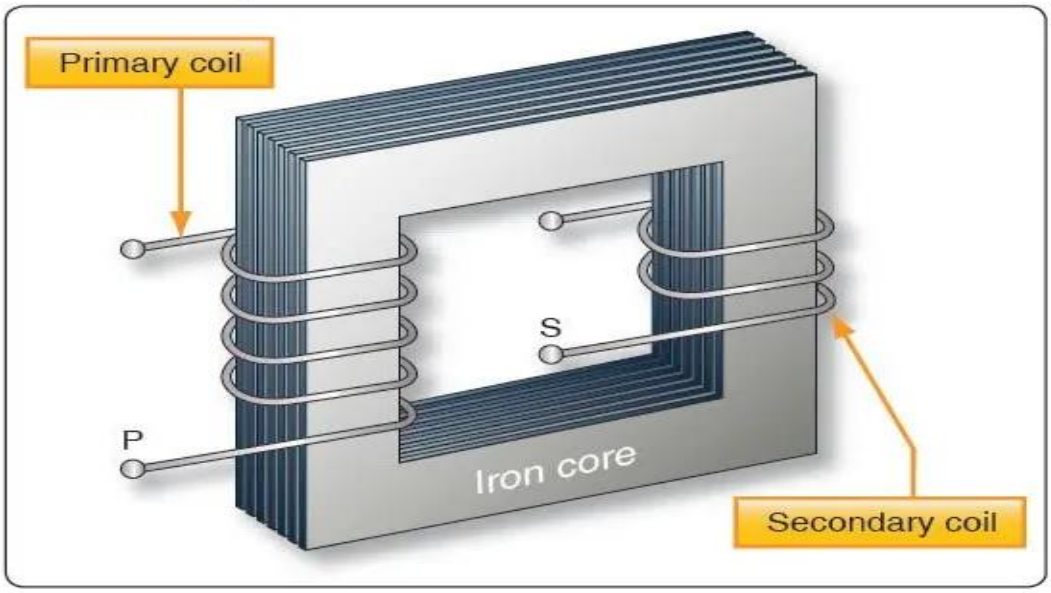
1. The consisting parts. (راجع الملخص)
2. The output current from them.



❖ alternating current generator:
variable in amount and direction during a period of time.



❖ direct current generator
a constant direction and variable amount.



ELECTRIC TRANSFORMER 7

❖ Electric transformers

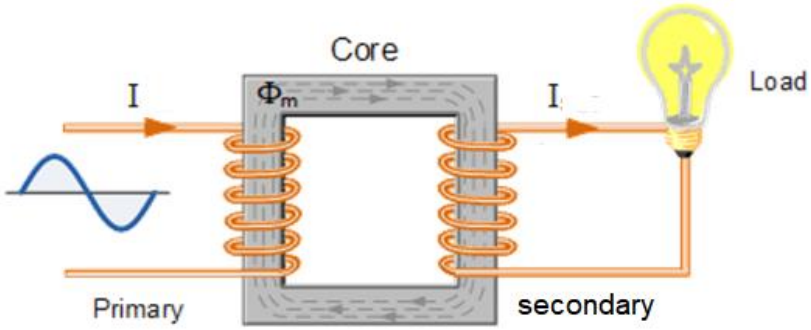
It is a device which operates to rise or reduce the alternative voltage (changing the amount of alternating voltage) and the current decrease or increase.

Mutual induction الحث المتبادل

It is the phenomenon of generating an induced current in a coil as a result of a change in magnetic field to a coil adjacent to it. ظاهرة تولد تيار محتث نتيجة تغير المجال المغناطيسي في ملف مجاور

❖ Electric transformer consists of:

1. two coils made from insulated copper wires (primary coil and secondary coil).
2. core of soft iron.
3. source of alternating voltage.



Q // *How transformers work?*

Ans // When an alternative current flows in the primary coil for the transformer, this will generate a varied magnetic field inside the iron core. This field penetrates the second and the primary coils.

Q // *The electric transformer considers one of the alternating current devices?*

Ans // because the alternating current generates a changing magnetic field an induced current is generated inside the iron core.

Q // *Does the electric transformer operate on battery?*

Ans // No, because there is no an induced current generated in the secondary coil, because no change happens in the magnetic field inside the iron core.

Remember

direct current ⇒ constant magnetic field
alternative current ⇒ varied magnetic field

Activity: Generating induced current in a coil

Tools:

Coil in a hollow cylinder shape (A coil is an insulated wire containing several turns), A ring –shaped coil, electric lamp operating with a proper voltage, a source of alternative voltage and soft iron bar with a suitable length.

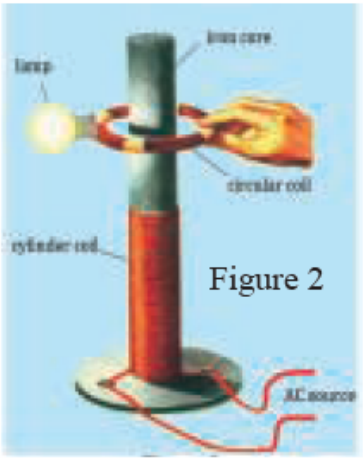


Figure 2

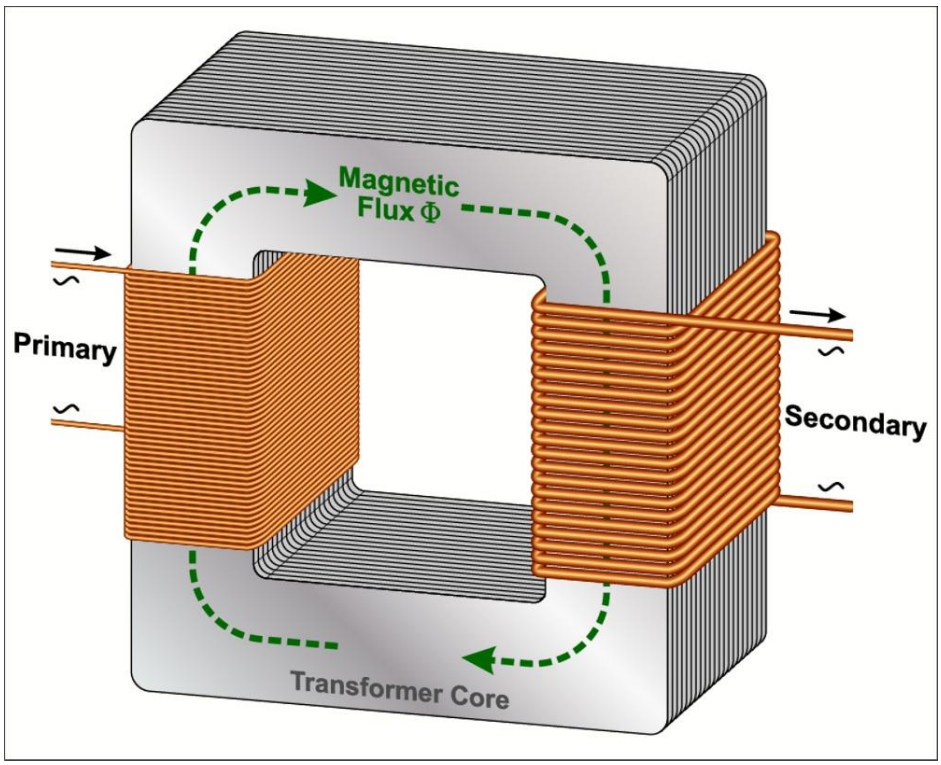
Steps:

- Place a soft iron bar inside the cylindrical coil as in Figure 2.
- Connect the source of alternative voltage and the key in series between the two ends of the cylindrical coil. (This circuit is called a primary coil circuit)
- Connect the electric lamp to the ring coil (called the secondary coil).
- Close the primary coil circuit

(cylindrical coil).we see the lamp which is connected to the secondary coil is glowing.

We conclude from this activity the following:

An induced current generates in the secondary coil as a result of variation in the magnetic field lines in the unit time generated in the primary coil, which was caused by an alternative current flow inside it.



Ideal transformer

The power supply for the primary coil= the output power from the secondary coil.

$$P_{in} = P_{out}$$

$$V_1 \times I_1 = V_2 \times I_2$$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2}$$

The ratio $\frac{N_2}{N_1}$ is called the transfer ratio.

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{N_2}{N_1} = \frac{I_1}{I_2}$$

- The efficiency of transformer (η)

$$\eta = \frac{P_{out}}{P_{in}} \times 100\ \%$$

Ideal transformer

$$\frac{V_2}{V_1} = \frac{I_1}{I_2}$$

$$\frac{N_2}{N_1} = \frac{v_2}{v_1}$$

$$\frac{N_2}{N_1} = \frac{I_1}{I_2}$$

Non- Ideal transformer

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{N_2}{N_1} = \frac{I_1}{I_2}$$

$$\eta = \frac{P_{out}}{P_{in}} \times 100\ \%$$

kinds of transformers

1. Step-down transformer

1. The turns number in its secondary coil (N_2) will be less than the turns number of coils in its primary coil (N_1).
2. The output voltage from the secondary coil (V_2) will be less than the input voltage (V_1) in the primary coil.

$$N_2 < N_1$$

$$V_2 < V_1$$

$$\frac{N_2}{N_1} < 1$$

$$I_2 > I_1$$

2. Step-up-transformer

1. The turns number in the secondary coil (N_2) will be greater than the turns number in the primary coil (N_1).
2. the output voltage from the secondary coil (V_2) will be greater than the input voltage (V_1) in the primary coil.

$$N_2 > N_1$$

$$V_2 > V_1$$

$$\frac{N_2}{N_1} > 1$$

$$I_2 < I_1$$

Remember

The step up voltage transformer will be step down current and vice versa, the step down voltage transformer will be a step up current transformer.

Q // The transfer of electric power to far distances by long wires it is transferred with high voltage and low current.

Ans // To minimized power losses occurs as a result of the high resistance in the wires.

power loss in electric transformers

1. Loss wires resistance:

   This is as a result of Ohm resistance for the wires of the two coils.
   appear as heat energy in the wires of two coils

   To minimize this loss:

   the wires of the two coils are made of material with less resistance (copper)

2. Loss of Eddy Currents:

   This appears as heat energy in the iron core for the transformer during its operation.
   It happens because of the change in the magnetic field lines through the iron core which generates induced currents inside the core called Eddy Current.

   To minimize this loss

   the core of transformer is made in the shape of plates of soft iron and they are insulated from each other, and they are compacted and their level is parallel to the magnetic field

Example:

Electric transformer, its primary coil is connected to a source with alternating voltage of (240 V). The electric system (load) which is connected to its secondary coil operates on alternating voltage of (12V). if the turns number in the primary coil is (500 turn), then:

1. What is the type of transformer.
2. Calculate the turns number of the secondary coil.

1. The transformer is step down because the voltage of its secondary coil (V_2= 12V) is less than the voltage of its primary coil (V_1= 240V).

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{N_2}{500} = \frac{12}{240}$$

$$N_2 = 25\ turn$$

Example

If the input power for the primary coil of transformer is (220W) and the loos of power is (11W), find the efficiency of the transformer.

Solution:

Loss of power in transformer = Input power - output power

$$P_{lost} = P_1 - P_2$$

$$11 = 220 - P_2$$

$$P_2 = 209\,W$$

$$\eta = \frac{P_2}{P_1} \times 100\%$$

$$\eta = \frac{209\,W}{220\,W} \times 100\%$$

$$\eta = 95\%$$

Example

Ideal electric transformer (its loss is neglected) has 4000 turn in the primary coil and the turns number in the secondary coil is 200 turn , and the input alternating power in its primary coil is 2200 W with a voltage of 220V, calculate : voltage and current of the secondary coil.

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{200}{4000} = \frac{V_2}{220}$$

$$\frac{2}{40} = \frac{V_2}{220}$$

$$\frac{1}{20} = \frac{V_2}{220}$$

$$V_2 = \frac{220}{20} \Rightarrow V_2 = 11 \text{ Volt}$$

$$P_1 = V_1 \times I_1$$

$$2200 = 220 \times I_1$$

$$I_1 = \frac{2200}{220} \Rightarrow I_1 = 10 \text{ A}$$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2}$$

$$\frac{11}{220} = \frac{10}{I_2}$$

$$I_2 = 200 \text{ A}$$

QUESTIONS OF CHAPTER SEVEN

Q1// Choose the correct statement for the following:

1. The alternating current flows in the secondary coil of an electric transformer is an induced current is generated by:
   a. A changing electric field.
   b. A changing magnetic field through the iron core.
   c. An iron core of the transformer.
   d. Coil's movement.

2. The ratio between the voltage of a secondary coil and the voltage of a primary coil in an electric transformer does not depend on :
   a. The ratio of the turns number in the two coils.
   b. The resistance of wires in the two coils.
   c. The output voltage from the primary coil.
   d. The output voltage from the secondary coil.

3. If the turns number in a primary coil in an ideal transformer is 800 turn and the secondary coil of 200 turn and the current which flows in the secondary coil is 40 A, then the current which flows in the primary coil is:

   a.10A b.80A c.160A d.8000A

4 An electric transformer has two coil, the turns number of a secondary coil in is 300 turn and the turns number of its primary coil is 6000 turn. If the alternating voltage around its primary coil is 240V, then the output voltage from its secondary coil is:

   a.12V b.24V c.4800V d.80V

5. An ideal electric transformer (its loss is neglected) has 600 turn in the primary coil and the turns number in the secondary coil is 1800 turn and the input alternating power in its primary coil is 720W with a voltage of 240V. Then its secondary coil current is:

   a.1A b.3A c.0.1A d.0.3A

6- The following diagram shows four types of electric transformer. According to the infor mation which given under each Figure, show which one of them will be a step- up trans former.

Q2 // What is the differences between the step - up transformer and the step down transformer?

	step-down transformer	step-up transformer
turns number		
Voltage		
transfer ratio		
Current		

Q3 // What is the basic function of the electric transformer ?

Ans // The principle Mutual induction between two coils.

Q4 // Explain how the electric transformer operates to a change the voltage.

Ans // By change the number of turns of its secondary coil.

Q5 // *Where can the electric transformers be used ?*

1. Step up

1. the transformer which is used in TV to supply high voltage to the electronic shooter of screen.
2. transformer when they transmit electric power to the cities

2. Step down

1. the mobile phone transformers (chargers).
2. the stations which receive power in order to supply cities.
3. the transformers used in electric welding.

Q6 // Explain the economic advantage of transforming electrical power to far distances with a high voltage and low current.

Ans // To minimized power losses occurs as a result of the high resistance in the wires.

Q7 // Why does the electric transformer need alternating current in order to operate ?

Ans // because the alternating current generates a changing magnetic field an induced current is generated inside the iron core.

Q8 // Does the electric transformer operate if a battery is used between the two ends of its primary coil ? Explain that .

Ans // No, because there is no an induced current generated in the secondary coil, because no change happens in the magnetic field inside the iron core.

Q8 // In order to supply a large factory with electric power by a generating station the factory is far from the generating station in a certain distance, what is the kind of electrical trans former used ?

1. At the beginning of the power transforming lines in the generating station.
   - ((step-up-transformer))
2. At the end of the power transforming lines before reaching to the factory.
   - ((step-down transformer))

P-1// A transformer with an efficiency of 100% and the rate of transformation is (1/2) operates on an alternating voltage of 220V. The current which flows in its secondary coil is (1.1A)

calculate: 1. the voltage of the secondary coil.

2 .The primary coil current.

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{1}{2} = \frac{V_2}{220}$$

$$\therefore V_2 = \frac{220}{2} = \boxed{110\ V}$$

$$\frac{N_2}{N_1} = \frac{I_1}{I_2}$$

$$\frac{1}{2} = \frac{I_1}{1.1}$$

$$\therefore I_1 = \frac{1.1}{2} = \boxed{0.55\ A}$$

P-2// An electric transformer has an efficiency of (80%) and the output power is (4.8 kW).

What is the input power in the transformer?

$$\eta = \frac{p_2}{p_1} \times 100\%$$

$$\frac{80}{100} = \frac{4.8}{p_1} \times \frac{100}{100}$$

$$0.8 = \frac{4.8}{p_1}$$

$$\therefore p_1 = \frac{4.8}{0.8}$$

$$P = 6\ kw$$

P-3// An electric transformer with an efficiency of (95%) The input power was (9.5 kw). What is the output power?

$$\eta = \frac{P_2}{P_1} \times 100\%$$

$$\frac{95}{100} = \frac{P_2}{9.5} \times \frac{100}{100}$$

$$0.95 = \frac{P_2}{9.5}$$

$$P_2 = 0.95 \times 9.5$$

$$P_2 = 9 \text{ kw}$$

P4//An electric lamp, its voltage is (6V) and power is (12 W). The lamp is connected with a secondary coil for an electrical transformer. Its primary coil is connected with an alternating voltage source of (240V). If the number of turns in the primary coil is 8000 turn, it glows (you can assume the transformer is ideal) Calculate:

1. The turns number of it's secondary coil.
2. The current which flow in the lamp.
3. The current which flows in the primary coil.

1)

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

$$\frac{N_2}{8000} = \frac{6}{240}$$

$$N_2 = \frac{6 \times 8000}{240}$$

$$N_2 = 200 \text{ Turns}$$

2)

$$p_2 = I_2 \times v_2$$

$$12 = 6 \times I_1$$

$$I_2 = \frac{12}{6} = 2 \text{ A}$$

3)

$$\frac{V_2}{V_1} = \frac{I_1}{I_2}$$

$$\frac{I_1}{2} = \frac{6}{240}$$

$$\therefore I_1 = 0.05A$$

Homework

1. A transformer with an efficiency of 100% and the rate of transformation is (1/4) operates on an alternating voltage of 240V. The current which flows in its secondary coil is (1.2A) calculate: 1. the voltage of the secondary coil.
   2 .The primary coil current.

2. An electric transformer, Its primary coil is connected with an alternating voltage source of (220V), and the device connected with its secondary coil work on (11 volt), If the number of turns in the secondary coil is (100) turn:
   1. What is the type of transformer.
   2. Calculate the turns number of the primary coil.

3. An electric transformer with an efficiency of (95%), the current which flows in its primary coil is (1A) and the current which flows in its secondary coil is (1.9 A) , Calculate:
   1. the rate of transformation.
   2. What is the type of transformer.

CHAPTER EIGHT

8

ENERGY SOURCES TECHNOLOGY

Energy : is the ability to perform work, One of the important units is known as a Joule.

$$W = F \cdot x$$

$$\text{Joule} = N \times m$$

1 Joule = 1 Newton × 1 meter

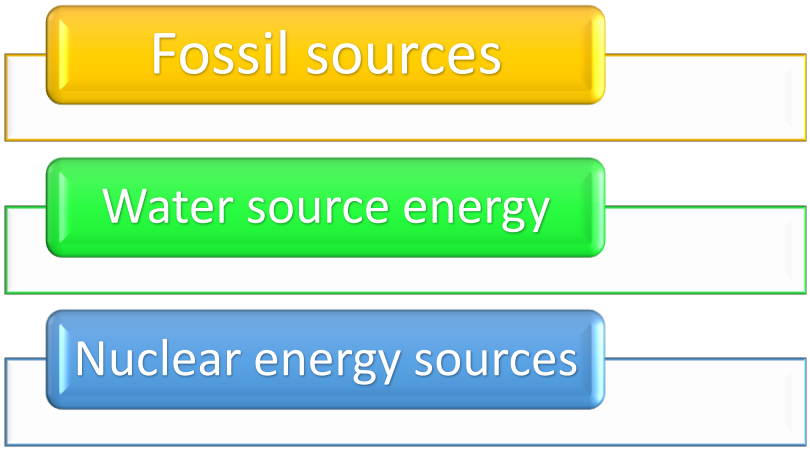
1 (Kilowatt - hour) = 3.6×10^6 Joule

1 (Horse Power-hour) = 2.68×10^6 Joule

electron-volt (eV) : used measured primary particles, such as molecules, atoms and contents.

$$1ev = 1.6 \times 10^{-19}$$

❖ Existing energy sources



1. Fossil Energy Sources:

- ❖ This energy consists of two elements carbon and hydrogen, that means hydrocarbon materials, in addition to materials such as water, sulfur, oxygen, nitrogen, and carbon oxides.
- ❖ This kind fossil energy is known as non-renewable energy. This means the world's reserves are decreasing every day. The rate in which this energy is created is much less than the rate of its consume. Sources of this energy are petrol, coal and natural gas.

Q // Why are fossil energy sources considered non-renewable energy.

Ans // Because its created rate is less than the rate of it consumes.

Q // What are the characteristics of fossil energy sources ?

Ans //

1. Consist of two elements carbon and hydrogen.
2. Its exhaust.
3. contaminate the environment.
4. High production costs.

- The important uses of the fossil fuel are:

a- Generating electricity. We use heat that we got from fire fuel to boil water to produce steam which is used to operate the turbines connected to electric generators

b- Operating various types of transportation.

c- It can be used as direct fuel in order to cook and heat.

2. Water Energy Sources:

Essentially depends on the principle of converting the potential energy of the water stored behind the dams or the high places.

Q // How is electrical energy produced using water sources?

Ans // The water flows either through pipes or streams to water turbines or hydraulic turbines, when water pushes through turbine, the Axis of turbine will rotate and that will lead to rotate large electric generators to generate electric energy.

3. Nuclear energy Sources:

This is used as a nuclear fuel for the reactor. The heat which is produced as a result of nuclear fission in order to convert the water to steam.

Q // How is electrical energy produced using nuclear energy Sources:

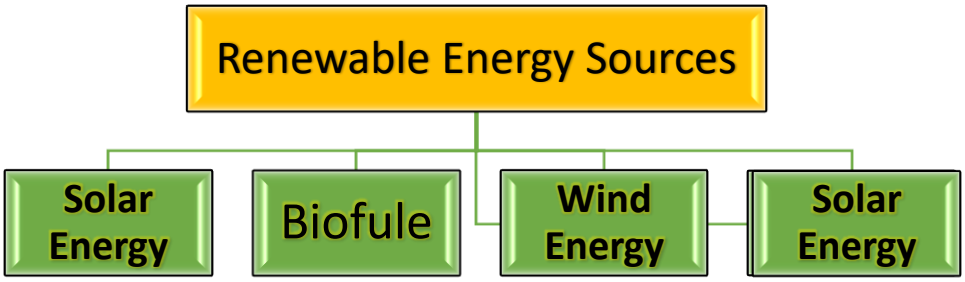
Ans // this way used a nuclear reactor instead of burning fuel. Nuclear reactors produce huge amounts of heat energy by a process known as fission.

The nucleus of heavy element atoms such as uranium (U^{235}).

❖ Renewable Energy Sources

Q // Why renewable energy is preferred to non-renewable energy?

1. it does not exhaust (finish).
2. It is clean energy (not contaminated) contrary to the fossil fuel which has gases when they are burnt and then gases contaminate the environment.
3. It can exist locally on the contrary of fossil fuel.
4. Low production costs.



1. Solar Energy Technology

Q // What are the characteristics of Solar Energy?

1. Is easily available in most parts of the world.
2. It has no negative side effects on the environment, as it has no gases or chemical materials which may harm humans or the environment.

Solar Cell

The fundamental function of the Solar cell is to convert the solar energy to electric energy.

- The solar cell (photovoltaic cell) made of one layer of thin semi-conducting material such as silicone.

- The solar cell is consisting of

1. The upper layer: silicone which is polluted by phosphorous called type N which saves electrons
2. The lower layer: silicone polluted by boron called type P which receives electrons.
3. Thin layer on the surface which prevents the reflection of sunlight.
4. Covered by glass board to protect it from the atmosphere effects.

- The solar cell supplies us with direct electric power DC.
- Each cell generates between (1-2 watt) which is small power.

The cells are connected in series in order to increase the voltage.
The cells are connected in parallel in order to increase the current

Q // What depends on the period of time needed to charge a battery?

Ans // 1) The number of cells.
2) The area of each cell.

Q // What depends on the production of electric energy in the solar cells?

Ans // The production of electric energy in the solar cells varies directly with the intensity of the sun's rays.

كفاءة تحويل الطاقة للخلية الشمسية

The Conversion Efficiency of Solar Cell Energy

Input solar power = incident radiation intensity × solar cell surface area

$$\text{Solar Cell convertion efficiency} = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$\eta = \frac{V_2 \times I_2}{i \times A}$$

i = the incident solar radiation intensity

Example-:

- If you know that the dimensions of a solar cell are (4 cm × 6 cm). Calculate the power received by the solar cell (the input power) if the incident solar radiation intensity on the cell equals

Area = 4 cm × 6 cm

A = 0.04 m × 0.06 m = 0.0024 m^2

$P_{in} = i \times A$

$P_{in} = 1400 \times 0.0024$

$P_{in} = 3.36$ watt.

Example-:

A solar cell in the shape of a square (0.2 m × 0.2m) If the value of the incident solar radiation intensity on the cell equals 1400 W/m^2 and the generated current by the solar cell is 0.16 A and the potential difference is 12V as in the following diagram, calculate the efficiency of the solar cell to convert the solar energy to electric energy?

$P_{out} = V_2 \times I_2$

$P_{out} = 0.16\ A \times 12\ V$

$P_{out} = 1.92$ Watt

$$\eta = \frac{V_2 \times I_2}{\mathcal{i} \times A}$$

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$\eta = \frac{1.92}{1400 \times 0.04} \times 100\%$$

$$\eta = \frac{1.92}{56} \times 100\%$$

$$= 3.42 \times 10^{-2} \times 100\%$$

$\eta = 3.4\%$ solar cell efficiency

Example-:

If the solar cell energy conversion efficiency is 0.12 (i.e.12%) with a surface area of the solar cell of 0.01 m^2. Calculate the output power if the incident solar radiation intensity on this cell is 1400 $\frac{watt}{m^2}$.

Solution:

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$0.12 = \frac{P_{out}}{1400 \frac{watt}{m^2} \times 0.01 m^2}$$

$P_{out} = 1.68 watt$ output power

Solar Cell Heat Applications

1. Warming and heating water technology (solar boiler):

The solar boiler is a complete system and consists of many parts used to collect the incident solar radiation and applied its energy in the heating water, especially when sun is shining.

Q // Solar cell made from materials are anti-rust and painted with a black color ?
Ans // to absorbs the largest amount of solar rays.

- There are other types in which mirrors of parabola are used to get boiling heat

2. Water purification by solar energy technology:

a. Indirect method to purify water with solar energy

This method is based on saving the necessary energy for the purifying units and operating it by using the solar cells to obtain heat, electric or mechanical energy.

b. Direct method to purify water using solar energy

In this method the solar rays are used as a heating source to raise the temperature of impurified water, then evaporate it and convert it to pure water by using a solar dropper.

Wind Energy Technology:

Q // State the basic function of Wind energy technology?
Ans // The basic of wind on the investment of wind power to rotate air fans.

- The fan is connected to an electric generator enabling the core of the generator to rotate, and as a result generates electric energy.

Q // What depends on the wind energy source?

1. The speed of the wind which should not be lower than 5.4 m/s.
2. must continue for long hours in the day.

Biofuel Energy

is the energy obtained from a live creature either plant or animals.

1. **Ethanol Fuel**
   It can be obtained from sugar cane, sweet potato, corn, dates etc.
   This is then processed in certain ratios according to its purposes which include many fields, This fuel can also be used in operating some kinds of cars.

2. **Biodiesel fuel**
   It is extracted from plants which contain oils such as soya bean, palm oil, sunflower etc. They need chemical processing.

Tidal energy

It can be benefit from the obtained by benefit from the tidal movement in the seas and oceans to generate electric energy.

As a result, there will be a large difference between the levels of water.
This forms a large source of energy if we consider millions of cubic meters which are subject to this movement. This can be used in operating turbines in order to generate electric energy.

QUESTIONS OF CHAPTER EIGHT

Q-l Choose the correct statement for each of the following:

1- Some of the non-renewable resources are:

a. Tidal energy b. Wind energy c. Coal energy d. Hydrogen energy

2- Which of the following is a renewable energy:

a.Natural gas. b.Oil c.Solar cell energy d.Nuclear energy

3- A solar cell is made of:

a. Titanium b. Aluminum c. Carbon d. Silicone

4- Solar cell converts:

a. Heat energy to electric energy b. Heat energy to light energy

c. Solar energy to light energy d. Light energy to electric energy

5- A floating generators use in the seas to generate:

a. Hydrogen energy b. Tidal energy c. Wind energy d. Solar energy

6- The best fuel for nuclear reaction is:

a. Cadmium b. Radium c. Thorium d. Uranium

7- The energy generated by movement or falling water is called:

a. Bioenergy b. Water energy c. Solar energy d. Nuclear energy

8- The rate of maximum energy received in one second in each square meter (solar radiation power) over the surface of a solar cell is:

a. 1200 $\frac{\text{watt}}{\text{m}^2}$ b. 1000 $\frac{\text{watt}}{\text{m}^2}$ c. 1400 $\frac{\text{watt}}{\text{m}^2}$ d. 1100 $\frac{\text{watt}}{\text{m}^2}$

9- The converting efficiency of a solar cell is (0.17) for an area of (0.01 m^2). The solar radiation intensity is (1400 $\frac{\text{watt}}{\text{m}^2}$) . The power produced is:-

a. 2.2 Watt b. 1.8 Watt c. 2.38 Watt d. 2 Watt

10-If the current generated by a solar panel is (0.5 A) with a potential difference of (10 V), the output power is:

a. 6 Watt b. 5 Watt c. 8 Watt d. 4 Watt

11-If the output power of a solar cell is (4 Watt) and the input power is (32 Watt), then the efficiency of the solar cell converting energy is:

a. 4.5% b. 12.5% c. 5% d . 5.5%

CHAPTER NINE 9

Atmosphere

The atmosphere is a non-homogenous mass. It consists of layers which are each other over. These layers are determined by their gas depending on their temperature and pressure.

❖ ATMOSPHERIC LAYERS

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere
5. Exosphere

1. Troposphere

Q // What are characteristics of the Troposphere:

1. This is the first layer of the atmosphere close to the surface of the earth.
2. stretch to high approximately 14 km from the surface of the earth.
3. This layer forms 80% of the atmosphere.
4. All climate phenomena take place at this layer.
5. The pressure and the density decrease rapidly within this layer according to the high from the surface of the earth.

2. Stratosphere

Q // What are characteristics of the Stratosphere?

1. sites over the Troposphere.
2. Stretch from high (14 km) to high (50km).
3. It contains the ozone layer.
4. increase its relative temperature by increase the height above Earth's surface.

Ozone layer

1. The largest concentration of ozone at the height of (25km) from the surface of the earth, (91%). It is at about the middle of the stratospheric layer.

Q // How is the ozone layer generated?

Ans // The function of the other two types A and B is to generate Ozone (O_3) so that the ultraviolet which the sun its source, absorbed by (O_2), molecules which is in the atmosphere, and break down into two oxygen atoms (O+ O). After that each atom will merge with a molecule of oxygen (O_2) producing the ozone molecule .

3. Mesosphere

Q // What are characteristics of the Mesosphere?

1. at the middle of the atmosphere.
2. stretch from high (50 km up to 90 km).
3. Its gases are helium and hydrogen.
4. Its pressure and density are low.
5. The temperature decreases in the mesosphere with the increase of height from the surface of the earth. is the lowest which equal to (-120oC).

4. Thermosphere

Q // What are characteristics of the Thermosphere (Ionosphere)?

1. It is a hot layer above the mesosphere.
2. Its height is from (90 km) to(500 km).
3. contains free electrons and ions.
4. The temperature can reach (1000oC) at its highest level.
5. the radio-waves that have a frequency of less than (300 KHz) can be reflected.

5. Exosphere

1. the highest layer in the atmosphere.
2. Its height is from of (500 km) from the surface of the earth.
3. and it represents the external gas cover.
4. The molecules of the gas move very quickly in a way that they possess sufficient dynamic energy to be free of gravity and escape to external space.

Modern Communication Technology

❖ Communication Systems Units

Communication systems consist of three basic units:

1. Transmitting unit

It is responsible for converting signals from the information source (sound, image, data ,etc) to electrical or light signals (electromagnet waves) so that they become suitable to transmit through the communication channels.

2. Communication channel

It is used between the transmitter and receiver. This can be wired or wireless.

3. Receiving unit

It is responsible for extracting information signals which comes from the transmitter and converting it to its original form, as it was before transmission.

❖ Types of Communication Channels

There can be two types of communication channels:

1. Wired Channels:

a. Twisted pairs.

These are two parallel isolated wires which carry signals.

b. Coaxial cables.

It is made of two metal cylinders with the same center. The first cylinder is a flexible cable specially designed to transmit data. This cable is situated inside an insulated material. The next layer i.e. the second cylinder is a metal net which is regarded as the earth wire. The last layer is an insulated material to protect all the inside wires.
This kind of cable is used to transmit signals with relative high frequency

Optical Fibers.

❖ These are designed to direct the light according to inner total reflection phenomena for the light inside the optical fibre.

❖ Optical fiber consists of the following parts: 1. The core 2. Cladding. 3. Coating buffer.

2. Wireless channels

This is a means of communication which depends on the electromagnetic waves between the two ends of the communication points (transmitter and receiver) .

- **PROPAGATION OF WIRELESS WAVES**

Wireless waves spread out in the air in two different ways. They are the earth waves and the sky waves.

1. Earth waves:

These are radio waves travelling close to the surface of the earth. So sometimes they are called surface waves. They travel in short range because they travel in straight lines. Therefore, they are able to provide communication for short distances.

It depends on the nature aerial, the frequency of the transmitted waves and the power of the transmitter. Its frequency will be less than 200 MHz.

2. Sky waves:

These are used in long distance communication. They take different patterns according to their frequencies.

The high frequency waves (HF) have the ability to reflect from the Ionosphere layer.

This enables them to travel for a long-distance transmission, in thousands of kilometers.

- used in the satellite's communications.

- The basic contents of mobile phone

1. Electronic circuit containing a processor and memory chips.
2. Aerial
3. Display screen speaker
4. Keyboared
5. Sound receiver
6. Speaker
7. Battery.

- **SATELLITES**:

1. Communication satellites
    1. designed for telephone communication and the satellite channels .
    2. placed in high locations (36000 Km from the earth.

2. Scientific Satellites
    1. to monitor the weather, meteorology, solar activities and for recognizing international locations (GPS) .
    2. will be at medium heights.

3. Military purpose satellites
    1. to survey and take photographs of military positions for the purpose of spying.
    2. low heights.

QUESTIONS OF CHAPTER NINE

Q-1 Choose the correct statement for each of the following:

1-The atmosphere is composed of a mixture of several gases that exist with each other in percentages:

a. variable. b. fixed. c.equal. d.neutral.

2-The atmosphere layer which contains Ozone is called:

a. Mesosphere. b. Stratosphere. c. Troposphere. d. Exosphere.

3-The highest layer in the atmosphere is:

a. Stratosphere. b.Thermosphere. c. Exosphere. d.Mesosphere.

4-The means of connection between the transmitter and the receiver is called communication channel, and it can be:

a. Wired only. b. Wireless only. c. Wired or optical fibers. d. Wired or wireless.

5- Axial cables consist of:

a. Two metal cylinders with insulation between them.
b. Three cylinders and insulation between them.
c. Metal net surrounded with insulation material.
d. One metal cylinder surrounded by insulation material.

6- Optical fiber consists of:

a. Four layers. b. Three layers. c. Two layers. d. One layer.

7- Sky waves are used for communications which are:

a. Long range. b. Short range. c.Medium range. d. Long and medium ranges.

8- The purpose of scientific satellites is:

a. Take photos for locations on earth.
b. Monitoring the weather and meteorology.
c. Communication.
d. Military purposes.

Q-2 Correct the following statements if they are incorrect without changing the underlined phrases:

1. The atmosphere is mixture of gases which all have various rates.

2. The atmosphere of the earth is a homogenous mass with many layers each one above other.

3. In the troposphere layer, the pressure, density and temperature increases with increasing height from the earth's surface.

4. Stratosphere layer is recognized by its content of free electrons and Ions.

5 .because of the effect of Ultraviolet of type(A,B) on oxygen the ozone is generates.

6. The stratosphere layer exists at the middle of the atmosphere.

7. The thermosphere layer is recognized by its ability to reflect radio waves.

8. A communication system consists of three basic units.

9. The surface radio waves are sometimes called the sky waves.

10. Communications satellites heights are very high from the surface of the earth.

Q-3 State four atmospheric gases?

1. O_2
2. N_2
3. H_2
4. CO_2

Q-4 State the main atmospheric layers?

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere
5. Exosphere.