Republic of Iraq
Ministry of Education
General Directorate of curricula

PHYSICS

3

Authors

Prof. Dr. Qasim Azeez Mohammed
Prof. Deyaa Abd Ali Twig
Prof. Dr. Mohammed Salah Mahdi
Dr.Shafaa Maggied Jassem
Mohammed Hamd Al-Ajaili
Saeed Maggied Al-Obeidi
Abbas Nagaye Al- Baghdadi

Eleventh Edition(translated)

2023-1445

Scientific Supervisor :Susan yaseen saleh

Design Supervisor : Khalil mohmmed Khalil

الموقع والصفحة الرسمية للمديرية العامة للمناهج

www.manahj.edu.iq
manahjb@yahoo.com
Info@manahj.edu.iq
manahjb
manahj

المديرية العامة للمناهج
قسم التحضير الطباعي

Introduction

Most gracious most merciful

This book – dear student- is physics for the third grade of secondary schools, which we hope will be congruent with the educational development plan based on the objectives of the educational philosophy and implementing the project of developing and modernizing the education system.This will contribute to create a generation of educated capable of dealing with modern information and communication, and employ them correctly with clear visions.

The style and the presentation of the book comes in a way that encourages the student to interact directly with the material and scientific activities which are based on modern teaching strategies and it contains many of the drawings and illustrations, in addition to the modern scientific applications that enrich the subject of the lesson and link with life, community and terms.

It also includes anew show of the content , such as the writing of symbols and equations which have a relation with the English digits . It is anew step by which we hope to achieve a harmony in study in preparatory school and university.

The book presents its topics in nine chapters. Each chapter includes behavioral purposes, vocabulary and scientific terminology. The languages of the book stimulate the student to remind and encourage him to interact with the scientific material by asking questions under the title: Think, a question or remember. It also contains a combination of relevant enrichment information. Which comes under the title (do you know) their proposals in a way that scientific and educational objectives.

We also extend our thanks and appreciation to Dr. Anmar Zaki Saleh and Buthaina Mahdi Mohammed for their help in scientific review of the book.

Authors

Review in Mathematics: Basic rules for exponents

When dealing with very large numbers or very small numbers in mathematics. We find it difficult to perform some calculations, so we use a method depend on the power of the number (10) or (the exponents) as in the examples:

$$10^0=1$$
$$10^1=10$$
$$10^2=100$$
$$10^3=1000$$
$$10^4=10000$$

And (10^1)means that (1) as the power and (10) is the basis, which determines the number of zeros, for example, writes the speed of light which amounts equals to 300000000 in the form of (3×10^8 m/s).

$$250000=2.5\times10^5$$
$$10^{-1}=\frac{1}{10}=0.1$$
$$10^{-2}=\frac{1}{10\times10}=0.01$$
$$10^{-3}=\frac{1}{10\times10\times10}=0.001$$
$$10^{-4}=\frac{1}{10\times10\times10\times10}=0.0001$$
$$2\times10^{-2}=\frac{2}{10\times10}=0.02$$
$$5\times10^{-5}=\frac{5}{10\times10\times10\times10\times10}=0.00005$$

For example, we write: 0.0054 on the form 5.4×10^{-3}
and when we multiply:

$$10^2\times10^3=10^{2+3}=10^5$$
$$4\times10^5\times0.5\times10^3=4\times0.5\times10^{5+3}=2\times10^8$$
$$10^4\times10^{-3}=10^{4+(-3)}=10^{+1}$$
$$10^9\times10^{-18}=10^{9+(-18)}=10^{-9}$$
$$\frac{10^3}{10^2}=10^3\times10^{-2}=10^{3+(-2)}=10^1$$

In the case of finding the square root, for example:

$$\sqrt{4}=2$$
$$\sqrt{9}=3$$
$$\sqrt{4\times10^{16}}=\sqrt{2\times2\times10^3\times10^3}=2\times10^3$$
$$\sqrt{16\times10^{-8}}=\sqrt{4\times4\times10^{-4}\times10^{-4}}=4\times10^{-4}$$

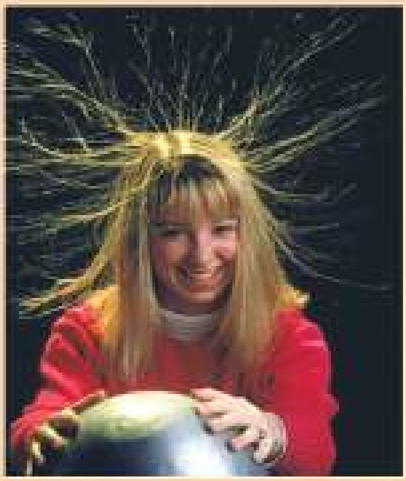
CHAPTER

ONE

1

ELECTROSTATIC

Contents



Behavior Targets

After finishing this chapter, we expect student to be able to:

- Define Electrostatic.
- Distinguish between positive and negative Charges.
- Explain Methods of charging materials with electrostatic.
- Listed the parts of Electroscope.
- Explain by experiments the charging of electroscope.
- State applications of electrostatic.
- Explain difference of materials according to their electric conduction.
- Use Coulomb's Law to solve physical problems.

Scientific Terms	
Electrostatic	الكهربائية الساكنة
Electroscope	الكشاف الكهربائي
Conductor	الموصل
Insalator	العازل
Electric charge	الشحنة الكهربائية
Coulomb's Law	قانون كولوم
Electric Field	المجال الكهربائي
Charging by Induction	الشحن بالحث
Force of attraction	قوة تجاذب
Force of repulsion	قوة تنافر

Introduction

The Greek scientist Arsto Talius found in 600 BC that the electrical material attracts small particles such as (small pieces of paper, pieces of hay) when it is rubbed down with a piece of woollen cloth. William Gilbert the British scientist found in 1600 that there are many different materials with this property of attracting small materials when rubbed by a piece of woollen cloth. So this was called electricity. This originated from the word “Electron” which was named as “Amber”.

1.1 Electrostatic

Common Observations

-Small pieces of paper will be attracted towards a plastic material such as a comb when the comb is rubbed by hair. This is because the rubbed comb will be getting electrostatic (provided that the hair is dry and without grease), as in Figure 1. These paper pieces will be attracted by a balloon when the balloon is rubbed by a piece of woollen cloth (This balloon will get electrostatic charge). A persons hair will be attracted by a balloon which has been rubbed by a piece of woollen cloth, when this balloon is close to the head of a person as in Figure (2).


Figure(1)


Figure(2)

-If you push the charged balloon towards the wall, you will find it sticks to the wall and remains stuck on it for many hours if the weather is dry. (The damp air discharges the electric charges quickly) as in Figure (3).


Figure(3)

-When you walk on a woollen carpet your feet get rubbed by the carpet and become electrostatic. You can feel the generated electric charge on your body as a slight electric shock when you touch a metal door handle as these electric charges discharge as in Figure (4).


Figure(4)

-A similar thing happens when you get out of car after turning it off and you touch any part of the body of the car, you feel a slight electric shock; or if you touching the metal part of a car with an edge of a key, an electric spark appears as in Figure (5).


Figure(5)

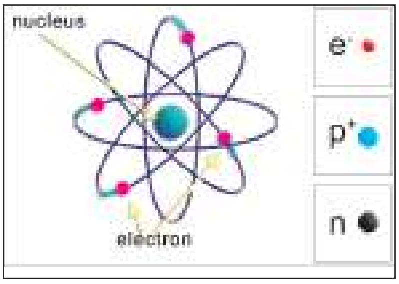
-If you rub a comb or any rod of plastic by your hair, or rub them with wool and make them close to an open tap of dripping water, you will see that the water drops are attracted towards the comb, as in Figure (6).


Figure(6)

Figure(7)

The slides in parks are made of plastic as shown in Figure7. When the children slide down, their clothes will be attracted by the surface of the slide and their body will be charged with electrostatic charges. Then if the child approaches a metal part, he will get a slight electric shock as a result of discharging his electric charges already gained by the friction .

1.2 Electric Charge



Figure(8)

It is well known that all material consists of small particles called atoms. Atoms contain electrons with negative charge (e-) which rotate with a very high speed around the nucleus which contains protons positively charged (p+) and neutrons (n) which are free of charge (neutral). Look at Figure 8.

Electrons are connected to the nucleus of atoms by a force varying with their distance from the nucleus. The majority of the atoms will be electrically neutral. (Number of electrons equals to the number of protons) Figure (9a).

The Two Types of Electrical Charges

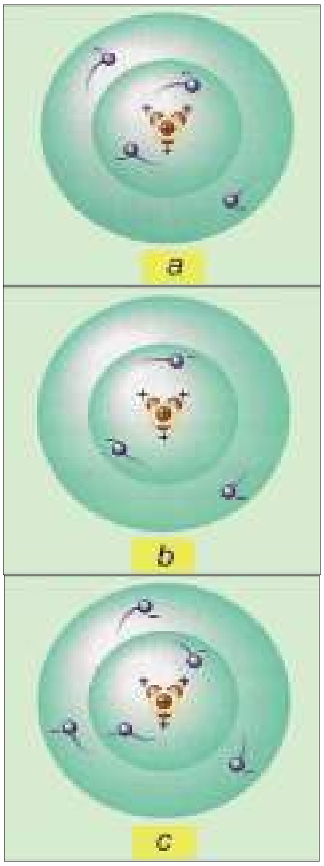


Figure (9)

There are atoms in material which lose some of their external electrons as a result of external factors. If the number of electrons of an atom decreases as a result of releasing some of them to the outside of the body, then the atom transfers to a positive ion. This will result in the body becoming positively charged (+q) Figure (9b). Those bodies which gain electrons from some other bodies, their atoms convert to negative ions, then the body will be negatively charged (-q) Figure (9c).

The following information is important to know:

-The charge of proton inside the nucleus of an atom is positive, and it is value equal to the charge of the electron.

-The charge of an electron and proton is regarded as the smallest unit of charge.

- The charge of any charge body is equal to the multiple of an electron charge.

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

-Experiments showed that the charge of an electron is equal to (1.6×10^{-19} Coulomb) ; and Coulomb is the measurement unit of electric charge.

-One Coulomb is equivalent to charge of 6.25×10^{18} electron.

-Coulomb is a large unit. It is commonly used parts are:

Nano Coulomb ($1nC = 10^{-9}C$) , Micro Coulomb ($1\mu C = 10^{-6}C$)

Do You Know:
The electrostatic with very high intensity can be as a lightning. This can be very dangerous and can kill if it hits someone. thunderbolt can also cause forests to burn when discharged on to trees. Look at the Figure below.

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.

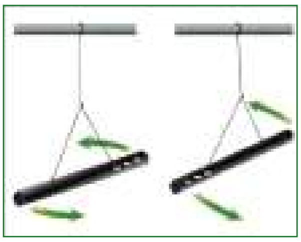
Steps

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 Figure 10-a.



Figure(10-a)

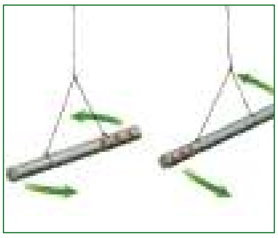
-The similar charges repel each other.

Second

• Hang the two glass rods horizontally and get them close to each other.

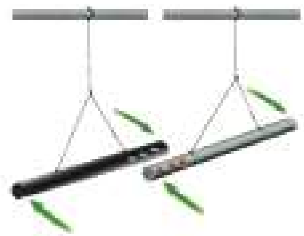
• Rub each one individually with the silk. (Each one will be positively charged).

• Leave rods hanging freely. See that they repel each other. Figure10-b.



Figure(10-b)

- Similar charges repel each other.



Figure(10-c)

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.

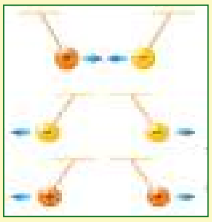
• Leave the two rods hanging freely, we see that they attract each other. see the Figure 10-c.

-Different charges attract each other.

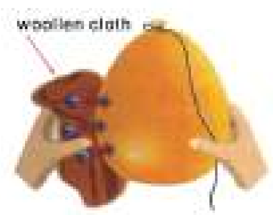
Remember

-Different electrical charges attract each other.

-Similar electrical charges repel each other.



1.3 Charging Material with Electrostatic



Figure(11-a)

There are three methods of charging bodies with Electrostatic, which are the following:

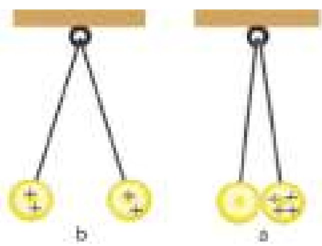
A) Charging by Rubbing

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), Figure 11-a.

Figure(11-b)

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. (Figure 11-b)

B) Charging by contact



Figure(12)

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 as in Figure 12a. 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. This is why the balls repel as in Figure 12b.

Do you know:

A charged isolated body loses its electric charge when it is left in the air.

Also the rate of losing its charges increase with the increase of wet air.

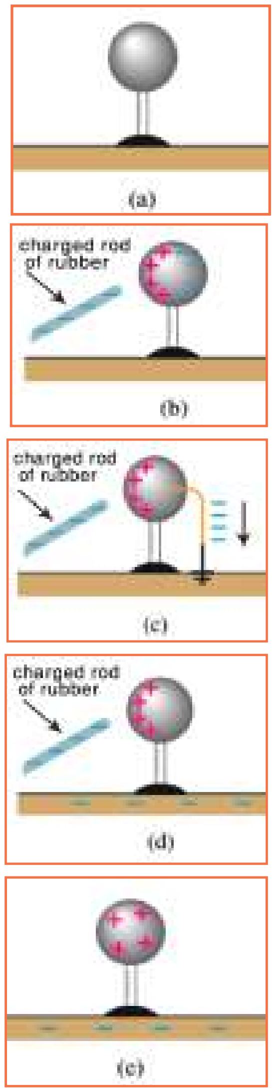
C) Charging by induction

-When a negatively charged rod of rubber is approached (negatively charged as a result of rubbing by wool) to the metal surface ball which is neutrally charged and isolated, then the negative charge of the rod in terms of (electrons) will reple the negative charge of the surface ball (electrons) and push it towards the far side of the rod (this is known as a free electrons). 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 charges as in Figure(13-b).

-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 in Figure (13-c).

-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 remain at their location Figure (13-d).

-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. Look at Figure 12-e. To conclude whether charges exist on a body or not, use an electroscope.



Figure(13)

1.4 Electroscope

An electroscope is an electrical apparatus used in electrostatic experiments for the following purposes:

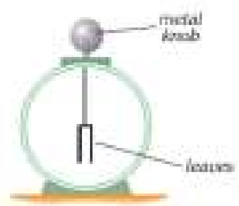
1-To detect an electrical charge on any surface,

2-To determine know the kind of electrical charge on any charged body,

Electroscopes are classified by different types. Look at Figure 14.

<u>The electroscope consists of:</u>

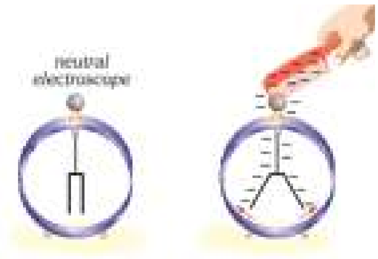
- A rod made of metals.
- A metal disc (or metal ball) linked to the upper part of the rod.
- Two thin leaves (or strips) of gold or aluminium joined to the lower part of the rod (or one thin leaf of gold or aluminium joined at the lower side of the rod). These are fixed to the middle axis at the end of the rod so that the leaves may be free to move.
- A box made of glass or metal or wood with a glass window, look at Figure 14.
- A lid made of cork or rubber at the upper part of the box to separate the rod and the two leaves from the box.



Figure(14)

1.5 Charging an electroscope

Activity(a): Charging an electroscope by touching (conducting)



Figure(15)

Tools:

Electroscope, plastic comb.

Steps:

-rub the comb with a hair (when the hair is dry without any kind of cream).

-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 (Figure 15).

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.

Activity-b: Charging an electroscope by induction

Tools:

Electroscope, glass rod, a piece of silk.

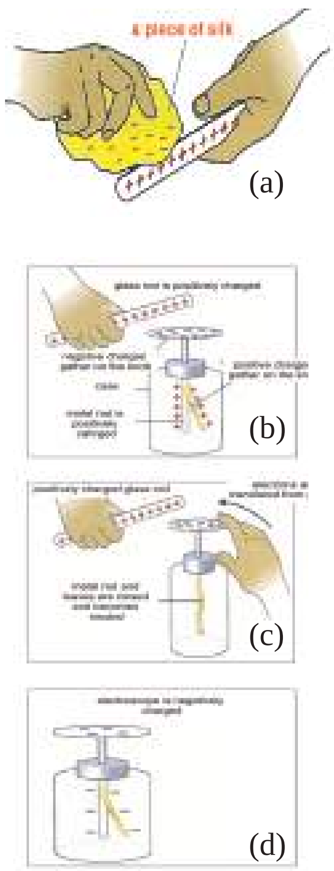
Steps:

-rub the glass rod by the silk (the rod will gain a positive charge. See Figure (16-a)

-Get the charged glass rod close to the electroscope which is electrically neutral. We see that the aluminium leaf and the metal rod of the electroscope repel each other. See Figure (16-b)

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 aluminium 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.

-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 as in Figure (16-c).



Figure(16)

The reason is that the electroscope has gained electrons from the earth.

-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.

-Now move the glass rod from the electroscope. You will see that the aluminium 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. Look at Figure (16-d).

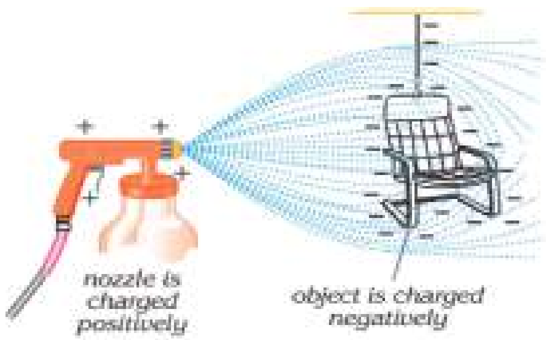
1.6 Application of Electrostatic

Electrostats are used in the following:

Sprayer:

As an example the car painter (or painting any conducting body such as a chair Figure 17. The nozzle of the sprayer 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. With regard to the conducted bodies which you want to paint, such as a car or a chair, 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.

Electrostatic is also used in many other areas such as photocopying machines, and in the precipitate systems which are used in cement factories in order to minimize environmental pollution. It is also used in contact lenses and cosmetic materials.

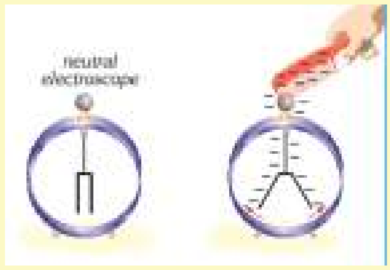


Figure(17)

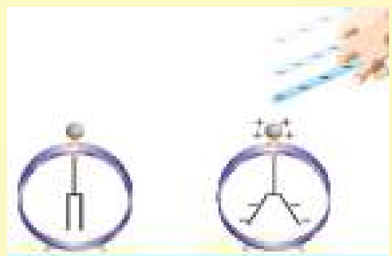
Do you know
When a charged conductor is connected to the earth with a metal wire, it is known as grounded. Then its charges will be neutralized as the earth is a large store to exhaust the electrical charges which move easily to and from the earth.

Remember

The electroscope which is charged by contacting (touching) will have its leaves separated from each other. This is because they gain charges which are similar to the charge of the touching body.



The electroscope which is charged by induction will get its leaves separated as they receive charges opposite to the charge of the body close to it from the electroscope's disc.



1.7 Different Materials according to it's Electric Condectivey

Materials are classified in respect to their abilities to electrically conduct the following:

1-Conductors They are materials containing plenty of negative electrical charges (such as they which have weak connections to the nucleus), such as copper, silver aluminium, etc. The electrons move through these materials easily because they consider as good conductors Figure 18.

Figure(18)

Insulators

They are materials which the electrons do not move freely through, such as glass, wool, rubber, etc.Figure 19

Figure(19)

Things need to be justified.

If you hold a rod of copper by hand at one of its ends, and rubbed it by wool or fur and close it to small pieces of paper, you will observe small pieces do not attract towards the rod. You may believe that the copper is not charged. But the fact is that the generated electrical charges which are generated on the copper rod by rubbing and held by hand have been lost to the earth through the body of the person.

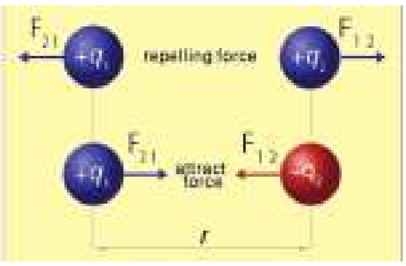
Now if you hold a copper rod itself at one of its ends using an insulated material as gloves, as in Figure (20) and started rubbing the rod with wool, or fur and approached it to the small pieces of paper you will see that they will be attracted to the rod. We conclude that the copper rod can be electrostatically charged and can keep the charges for a short period of time, if it was isolated.

Figure(20)

Do you know
There are substances called semiconductors that have electrical conductivity under certain conditions and Have insulator behavior under other conditions.

1.8 Coulomb's Law

We have known that similar electrical charges repel each other and that different electrical charges attract to each other. This means there is an electrical force between the charges making them either to repel or attract. See Figure 21



Figure(21)

The scientist Coulomb found that the mutual electrical force between two electrical charges (both still) is direct proportion to the product of the values of their charges and indirect proportion to the square of the distance between them. Mathematical formula for Coulomb›s law can be given as:

$$\text{Electric force} = \text{Constant} \times \frac{(\text{Value of first charge} \times \text{Value of the second charge})}{(\text{Square of the distance between them})}$$

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

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 depends on the media between the two charges. Its value in the vacuum is given by:

$$k = 9\times10^9 \frac{(N.m^2)}{C^2}$$

Example:

A positive electric point charge($+4\times10^{-6}$C)is located at a distance of (0.06 m) from another point of electric positive charge of the value($+9\times10^{-6}$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?

Solution:

Using Coulomb's Law $F = k\frac{q_1\, q_2}{r^2}$

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

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

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

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

$$F_{12} = 90N$$

Since the electric force is positive that mean it is a repelling force.

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

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

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

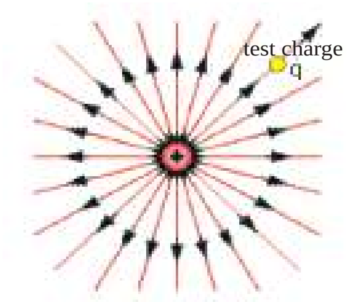
$$F_{21} = \frac{9\times9\times4\times10^{+9-6-6}}{36\times10^{-4}}$$

$$F_{21} = 90N$$

Since the force is mutual one between the electric charges. These two forces follow Newton's third law which is: $F_{21} = -F_{12}$

This means that the force in which the first charge influences on the second charge is equal to the force in which the second charge acts on the first charge in the opposite direction.

1.9 Electric Field

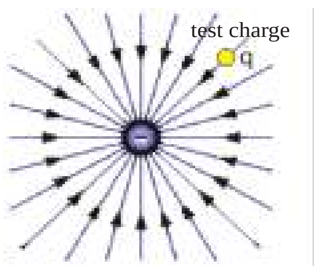


Figure(22-a)

What is the electric field? How do you know its existence.

Let's have a positive point charge (q) at a certain point. This charge influences surroundings and is called an electric field. The electric field is tested at any point by a small positive charge called the "test charge". This is placed at that point and the force is measured to know the quantity of the electric field.

Figure (22a) shows that a positive point charge (+q) generates an electric field. Its charge (q́) is the test charge.



Figure(22-b)

Figure (22b) represents an electric field for a negative electric charge (-q). This means that the electric field at any point is known by the electric force that acts on the Test charge which is located at that point. So the value of the electrical field at any point in the space is known to be the electrical force for the unit charge which acts on a small positive test charge (q́) located at that point. The value of the electric field can be found from the following relationship:

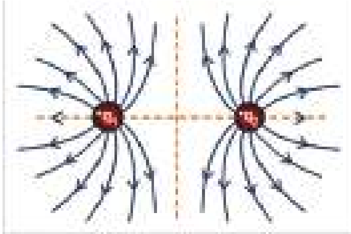
$$\text{Electric field} = \frac{\text{(Electric force)}}{\text{(The value of test charge)}}$$

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

E: is the value of electric field measured in units $\frac{N}{C}$.

F: is the value of electric force measured in units (N).

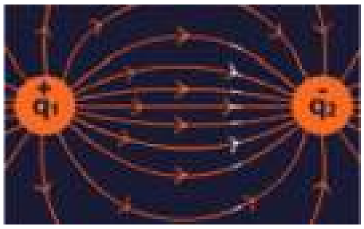
q: Positive test charge measured in units of Coulombs (C).



Figure(23-a)

Electric field between two similar point charges

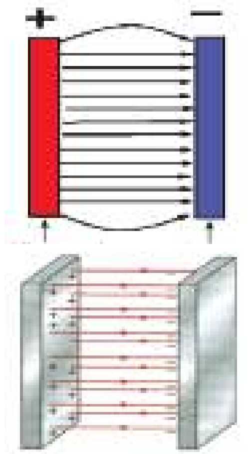
It is significant to mention that the electric field is represented by force lines (non visible) starting from the positive charge and ending at the negative charge. Figure (23-a) show the electric field between two similar point charges and Figure(23-b). show the electric field between two different point charges.



Figure(23-b)
Electric field between two different point charges

Regular electric field

The Regular electric field generated between two plain metal boards and parallel which are both equally charged in value but different in type, the lines in this field will be parallel with each other and equi-distance between them. These will be perpendicular to the boards (constant value and direction at all its points). Figure (24)



Figure(24)

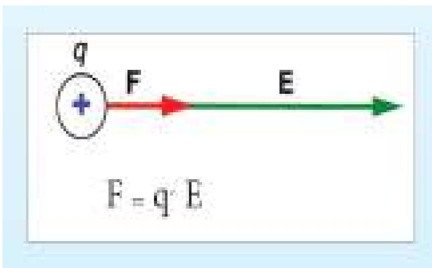
Example:

A positive point electric charge of $(+2\times10^{-9}C)$ located at a point in an electric field. It was acted by a force $(4\times10^{-6}N)$.

What is the electrical field at that point?

Solution:

The following information is given:



$$F=4\times10^{-6}N$$

$$q'=+2\times10^{-9}C$$

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

$$E=\frac{4\times10^{-6}N}{2\times10^{-9}C}$$

$$E=2\times10^{3}\frac{N}{C}$$ The electric field value,

QUESTIONS OF CHAPTER ONE

Q-l Choose the correct statement for each of the following:

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 ($1.6 \times 10^{-9}C$) 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^{10} electrons .

c. 10^{9} 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 .

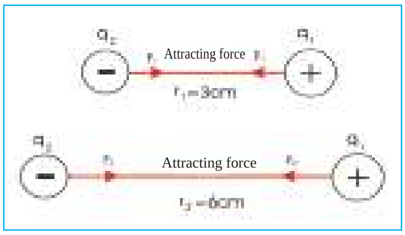
b. Less than before.

c. Greater than before.

d. Does not change.

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 (3cm), the attracting force was (F_1) . If the distance becomes longer up to (6cm) then the force (F_2) between them will be equal to:

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



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

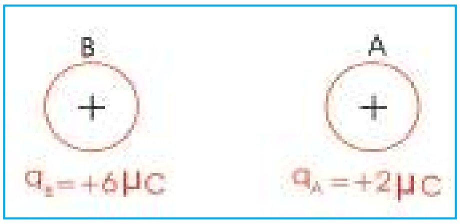
7- The charge of a body (A) is (+2 μC)and the body (B) has a charge (+6 μC), then the mutual electric force between the two bodies (A and B) is:

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.

Q-2 Give reason for the following:

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

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

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

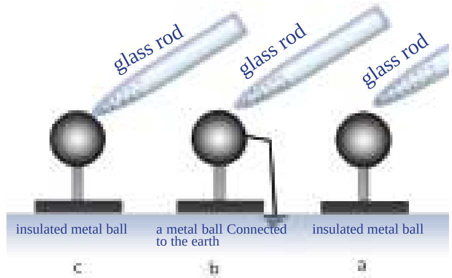
Q-3 Explain how the electroscope can be positively charged by using:

A) A positively charged glass rod.

B) A negatively charged rubber rod.

Q-4 List the types of the charging methods by electrostatic?

Q-5 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,).



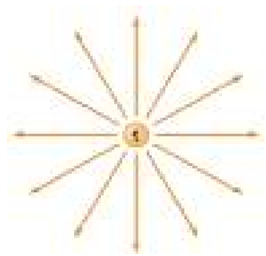
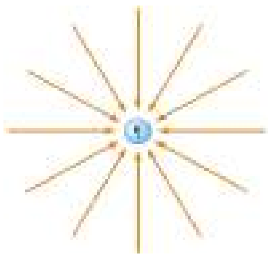
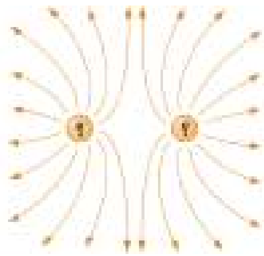
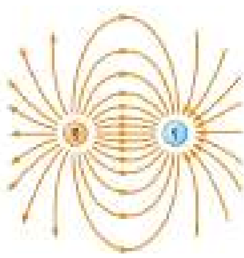
1-Do the electrical charges transfer in the cases (a,b,c)? Explain the method of transferring charges (if any).

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.

Q-6 A student wanted to charge of an electroscope which is neutralized by using the method of induction so he approached a glass rod which is positively charged and touched the electroscope's disc with his finger while the glass rod was still close to the disc. Then he removed the rod away from the disc. Subsequently, the student found that the leaves are closed. What is your explanation for this?

Q-7 Write type of the chrage in Figures below

PROBLEMS

P-l The repelled force of two identical point electric charges is $(9\times10^{-7}\,N)$ when the distance between them is (10 cm). Calculate the charge of each one.

Answer: $1\times10^{-9}C$

P-2 Two point charges both positive are $(3\times10^{-9}C)$ and the distance between them is (5 cm). Calculate the repelling force between them. Answer: $3.24\times10^{-5}N$

P-3 An electric charge of +3μC located at a point P in an electric field the electrical field was $4\times10^{6}\,\frac{N}{C}$ .Calculate the influenced electric force. Answer: 12N

It is expected that teacher will explain the method of solution in advance.

CHAPTER

TWO

2

MAGNETISM

Contents

Behavior Targets

After studying this chapter, we expect that student will be able to:

-Explain the difference among the magnatic properties of materials (diamagnetic, paramagnetic, and ferromagnetic).

-Describe the shape of magnatic field lines.

-Conclude that the magnatic field can be pass through various materials.

-Compare between the two way of magnetism, rubbing and induction methods.

Scientific Terms	
Magnet	المغناطيس
Magnetic field	المجال المغناطيسي
Magnetic materials	المواد المغناطيسية
Magnetic induction	الحث المغناطيسي
Magnetic bar	ساق مغناطيسية
Lode stone	الحجر المغناطيسي
Magnetic Compass	البوصلة المغناطيسية
Compass Needle	إبرة البوصلة

2-1 The Concept of Magnetism

Before 25 centuries, the Greeks discovered a metal attracting pieces of iron towards it. They called this metal a magnet which is made of (Fe_3O_4). It was commonly known as the Lode Stone. Observe Figure1.


Figure(1)

There are different types of artificial magnets, some of them are magnetic bars and others like letter (U) shape.

Magnetism has an essential role in our everyday life. In industry, huge electric magnets are used to lift pieces of steel or scrap metal. Figure 2.


Figure(2)

Magnets are also used in the loudspeakers Figure 3. They are also used in generators, Electric anginens, televisions and sound recording devices. Magnets use also in the letters of printr machine, Figure 4.


Figure(3)


Figure(4)

Magnets are used in navigating compasses Figure 5. The pointer of the compass is a small permanent magnet which can rotate freely in a horizontal plane around the vertical axis.

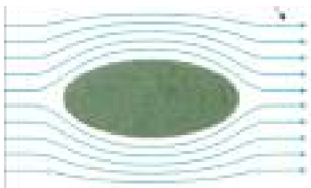

Figure(5)

2-2 Magnetic Materials

Materials can be classify according to its Magnetic properties for three types.

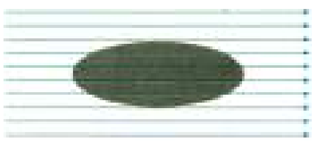
1. Diamagnetism

They are the materials which weakly repel with the strong magnets, such as Bismouth, Antimony, Copper, Silicon, Silver... etc. Figure 6a.


Figure(6a)

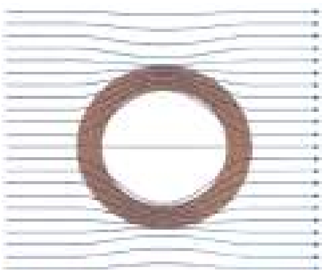
2. Paramagnetism

They are the materials which are weakly attracted by strong magnets. Examples are Aluminun, Calcium, Sodium, Titanium etc. Figure 6b.


Figure(6b)

3. Ferromagnetism

They are the materials which attracted by ordinary magnets. They have high magnetization capability. Examples are such as iron, steel, nickel, cobalt, etc. Figure 6c.


Figure(6c)

Some of the materials which are made of Ferromagnets are attracted very strongly towards magnets. Examples are such as, paper clips, pins, needles, etc. However, the pencil, the chalk, rubber, and sharpener are not attracted to magnets.

Figure 7a explains accumulating the iron filling with high concentration at the magnet poles.

Figure 7b a magnet as a straight bar.

Figure 7c accumu -lating the iron filling with a high concentration at the poles of a magnet with a“U” shape.

Magnetic poles

Each magnet contains two magnetic poles. One of them is called “North magnetic pole”, or the pole searching for the north. The other is called the “South magnetic pole” or the pole searching for the south.

The Poles of a Magnet are the areas at which the magnetic forces are strongest. Magnetic poles do not exist individually, but exist as equal pairs in quantity but different in type (north pole and south pole). If a piece of magnet is divided into a number of smaller pieces no matter how many they are, you will find each piece will have two magnetic poles which are the north and south poles. Figure7.

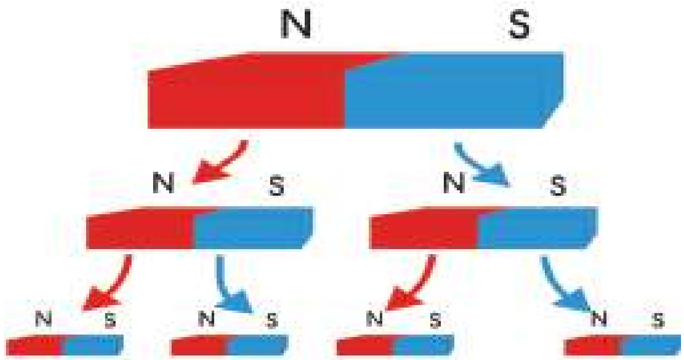


Figure 7d In spite of cutting the magnet into a number of pieces each piece is a magnet possessing two poles one of them north and the other one south.

The Forces between the magnetic poles

Magnets affect each other by forces similar to those between the electric charges. As in the previous chapter, similar electric charges repel and different electric charges attract. Similar magnetic poles repel and different magnetic poles attract. Figure (8a) and (8b).

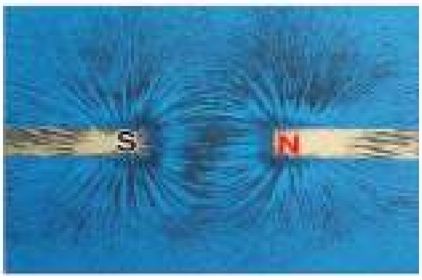


Figure (8a) different poles attract

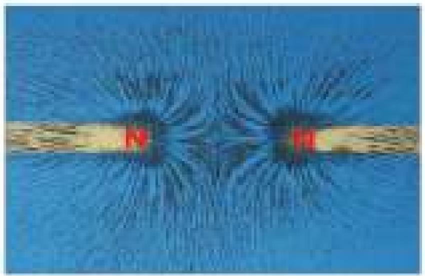


Figure (8b) Similar poles repel

Activity-1: Attracting and repelling forces between the magnetic poles.

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

Steps:

-Hang the magnetic bar from its middle point (centre 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. Figure 9

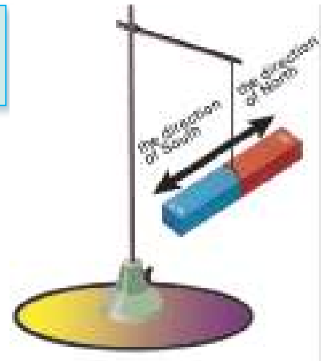


Figure 9

-Hold another magnetic bar by hand letting its north pole (N) visible.

-Get the north pole of the magnet bar which is in your hand close to the north pole of the hanging bar as in Figure 10a. 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 pole 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 Figure 10b.**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 as in Figure 10c. **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.

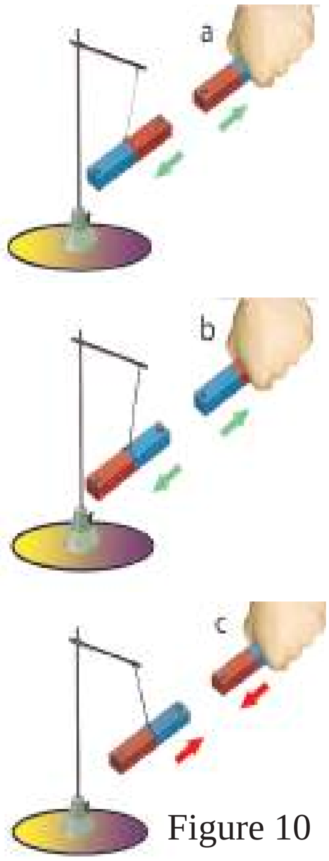


Figure 10

Conclusion

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

2-3 Magnetic Fields

The magnetic field in any region is the space which surrounds the magnet in which the effect of the magnet would be observed. Figure (11)

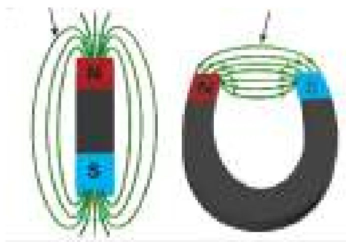


Figure 11

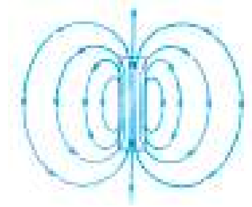


Figure 12

Figure 13

Magnetic Field representation

The magnetic field is represented in drawing by lines . These are closed lines (invisible) heading from the north pole to the south one and completing its circle inside the bar Figure 12.

Magnet field lines can be drawn around a magnet by using a magnetic compass or a set of small magnetic compasses and discovered by using iron filings. Figure 13 .

Activity-2: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.

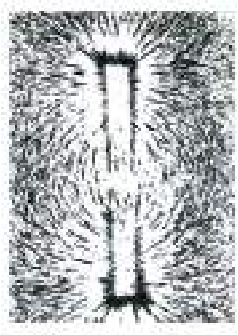


Figure 14

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. Figure14.

Question: Does the magnetic field penetrate through the human body, or through some other materials? The answers will be shown in the following two activities:

Activity-1: 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?

Figure 15

A large number of paper clips will be attracted towards your palm as in Figure 15.

How do you explain that?

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

Activity-2: Magnetic field penetrates through different materials

Tools: Magnetic bar, piece of carton or piece of wood or glass, set of nails, a glass cylinder, water.

Steps Part (a)

- Hold the magnetic bar vertically by hand.
- Put some nails on the piece of carton.
- Hold the piece of carton by the other hand and put it on the upper pole of the magnet.
- Move the magnet bar underneath the carton in a circular or linear path. What do you observe? You will see the nails move accordingly, i.e. they move wherever you move the magnet.See Figure16a.

Figure 16a

Part (b).

- Put some nails inside a glass cylinder. Then pour some water inside the cylinder. Figure 16 b.
- Get one of the poles of the magnetic bar close to the wall of the cylinder. What do you see? You will find that the nails are attracted to the nearest pole of the magnetic bar.
- Move the magnetic the pole of the bar around the cylinder. You will find the nails are moving following the path in which the magnetic pole moves.

Figure 16b

We conclude from this activity that the magnetic field can penetrate through different materials such as carton, glass and water.

2-4 Magnetised Materials

We can get temporary or permanent magnets in two ways:

A.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. Figure 17.

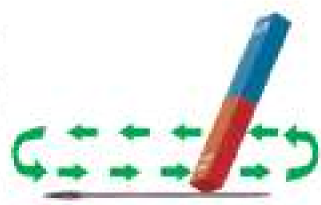


Figure 17

B.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), as in Figure 18, the nail will gain magnetism by induction. The nail will have two magnetic poles, one of them is north and the second is south. The end of the nail which is close to the magnet will gain magnetization opposite to the magnetic bar. The far end will have the same type of magnetic pole.

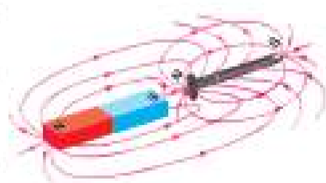


Figure 18

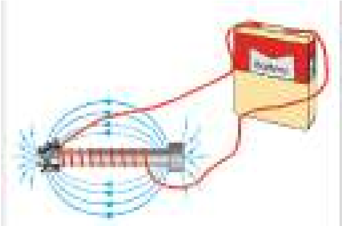


Figure 19

Second: Magnetizing by Direct Electric Current

The favorite way for magnetising Ferromagnetic material such as steel is to place 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 as in Figure 19.
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 in different ways as in Figure 20:

a. Hammering strongly
b. Powerful heat

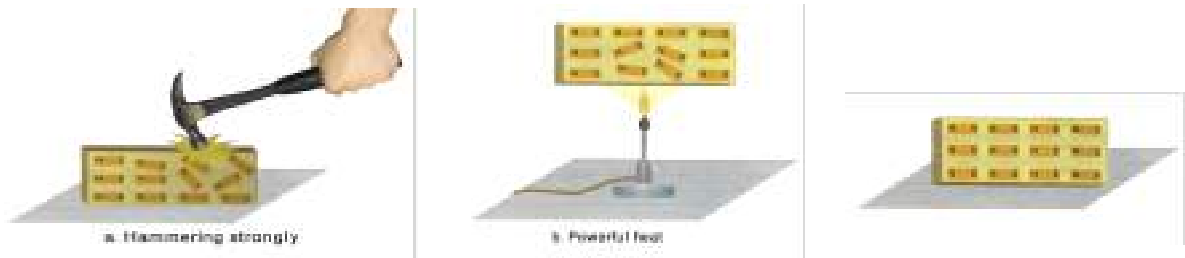


Figure 20

Do you know?
Magnetic protector is a ferromagnetic material using in protect devices from external magneticeffects such as in watches.
They are also used to keep the magnetic property of magnets, preventing the loss of magnetism throughout a period of time.

QUESTIONS OF CHAPTER TWO

Q-l Choose the right statement for the following:

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.

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

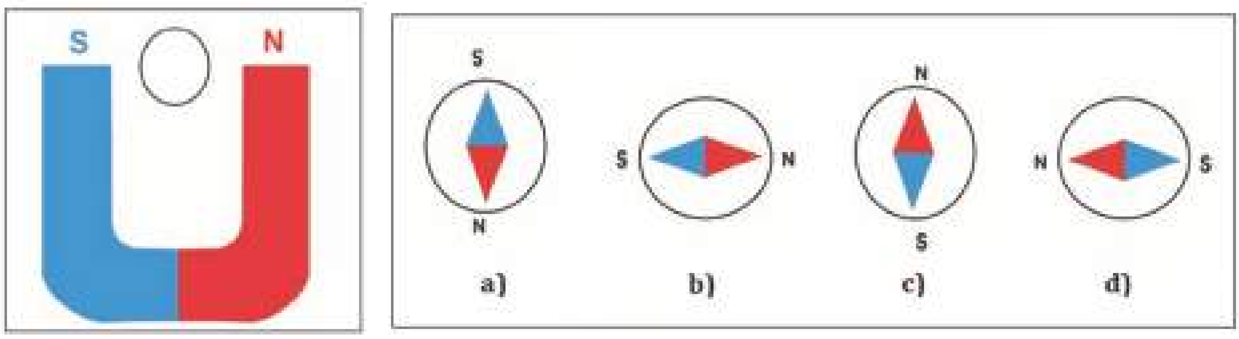
a. Copper

b. Aluminium

c. Soft iron

d. Steel

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.



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

a- Diamagnetic.

b- Paramagnetic

c- Ferromagnetic

d- Diamagnetic ,Paramagnetic and Ferromagnetic.

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

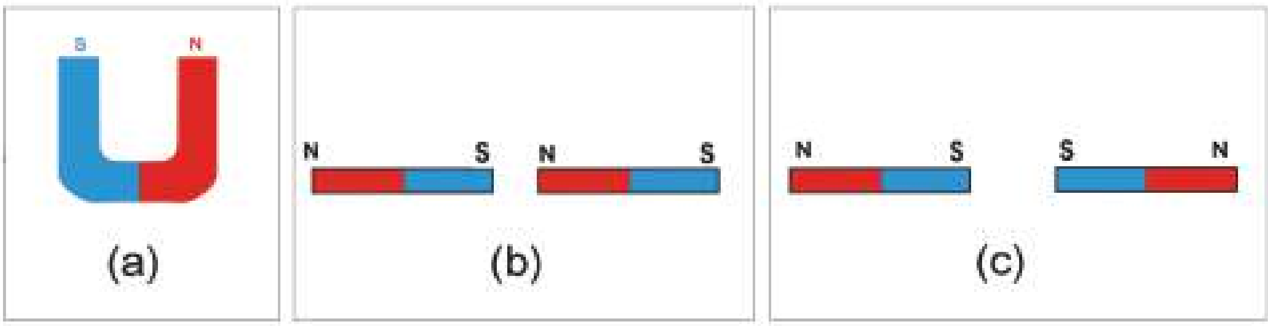
d-Visible

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.

Q-2 Explain why the magnets are used on the wardrobe and fridge doors.

Q-3 If you were given three identical bars which were aluminium, iron and a permanent magnet explain, how you can distinguish one from the others.

Q-4 Draw a diagram explaining the lines of magnetic field for the following diagrams:



Q-5 Explain an activity which enables you to see the lines of magnetic fields by using iron filing of a straight magnetic bar .

CHAPTER THREE

3

ELECTRIC CURRENT

Contents

Behavior Targets

After studying this chapter, we expect student will be able to:

1-Distinguishing between the electronic current and conventional current.

2-Explain the difference between the two connecting ways of Ammeter and Voltmeter with electric circuit with load.

3-Explain what the electric resistance means.

4-Write Ohm’s law in a physical symbols.

5-Listed the factors which the resistance value of conductor depends on.

6-Conclude the favorite way to connect the devices at home.

7-Design electric circuit which has more than one connected electric cell to provide the electric circuit with the largest current.

Scientific Terms	
Electric charge	شحنة كهربائية
Electric current	التيار الكهربائي
Conventional current	التيار الاصطلاحي
Ampere	أمبير
Electronic current	التيار الالكتروني
Potential difference	فرق الجهد
Resistance	مقاومة
Resistance in parallel	المقاومات على التوازي
Resistance in series	المقاومات على التوالي
Ohm’s law	قانون اوم
Electric energy	الطاقة الكهربائية
Electric circuit	الدوائر الكهربائية
Electric lamp	مصباح كهربائي
Volt	فولط
Conductors	الموصلات
Insulators	العوازل

3.1 Electric Charge Movements

Our studies for electric phenomena were restricted in Chapter One to Electrostatic. In this chapter we will cover dynamical electric charges through the conductors in order to study the electric current.

Electrostatic charges do not produce work but they produce work if they move through connection wires which link any electric device to the source of suitable electric energy. It helps that device to work. The electric current is regarded as a means of transferring electric energy from the source generators (electric generators, batteries, solar cells) to the electric devices which invest this energy. Examples are when the electric lamp is 'on' as a result of the current running through it. All devices such as the washing machine, electric oven, toaster, electric kettles, etc, work when there is an electrical current running through them. Figure1.

Figure 1

3.2 Electric Current

It is known that the electrons in the outer orbits (valance electrons) of the conductors will be weakly connected to the nucleus.

If these electrons are exposed to an external electric field, they will move between the atoms of the conductors in the opposite direction to the affected electrical field (E). This is because the electrons have a negative charge.

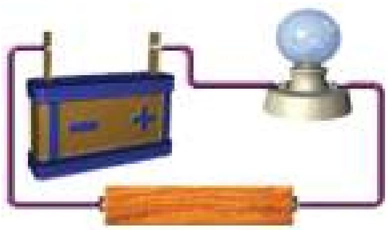


Figure 2

With regard to the 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 pass through them (examples are dry wood, plastic, rubber, glass etc.). Figure 2

When the two ends of the load are connected (such as a lightlamp) by connecting wires between the two poles of an electric battery, the direction of moving electrons will be from the negative pole towards the positive pole (through the connection wires), and this current is called the electronic current. Figure 3.

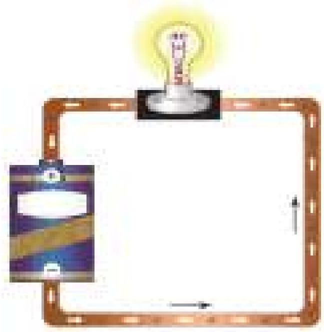


Figure 3

So the direction of the electronic current will be oppose to the

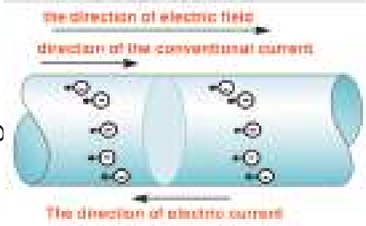


Figure 4

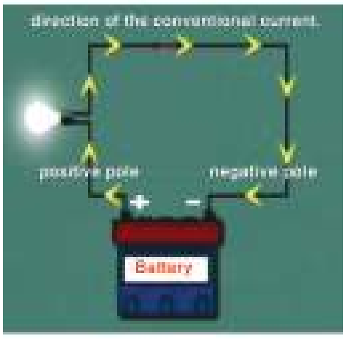


Figure 5

Figure 6


Figure 7

Figure 8

direction of the affected electric field, Figure 4. The electric current which was in the same direction as the electric field is called conventional current. (The conventional current will have direction from the positive pole towards the negative pole through the connection wires).

It is worth to be mention that all the electric circuits in our study, the conventional current uses to determine the direction of the electric current, Figure 5. The electric current may be resulted from the movement of positive ions and the negative ions inside the acidic electrolytic solutions. However the electric current through the connection wires is produced by the movement of electrons only Figure 6.

Also in the operation of ionization of gases (as in the ionization of neon gas inside florescent lamps under low pressure), the electric current is traced by the movement of positive ions and electrons in ionized gas inside these pipes. Figure 7

Consider a cross section of a conductor with area A, where the electric charges are flowing through it, then the total electric charges passing through this cross section during a certain time is the quantity of the electric current, Figure 8.

$$\text{Electric current} = \frac{\text{Quantity of charge}}{\text{Time}}$$

The electric current is measured in the unit $\left(\frac{\text{coulomb}}{\text{second}}\right)$ and denoted by $(\frac{C}{s})$ and it is called Ampere (A).

Ampere represents the passing of one Coulomb of electric charges through a conducted section during one second. When it is said that electric current of (2A) passes through a conducted wire, that means that electric charge of (2C) crosses through a cross section of this wire in one second (s).

$$\text{Current (Ampere)} = \frac{\text{Charge (Coulomb)}}{\text{Time (Second)}}$$

$$\text{Current (A)} = \frac{\text{Charge (C)}}{\text{Time (s)}}$$

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

The small current are measured in parts of Ampere.

Milliampere $1mA=10^{-3}A$

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

Example-1

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.

Solution:

$$\text{Current (A)} = \frac{\text{Charge (C)}}{\text{Time (s)}}$$

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

$$I=\frac{1.2\ C}{60\ s}$$

$$I=0.02A$$

Example-2 If the amount of current in a conductor equals to (0.4A) Calculate the amount of charge which passes through the cross section of the conductor during: a) 2 second b) 4 minutes

$$\text{Current (A)} = \frac{\text{Charge (C)}}{\text{Time (s)}}$$

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

a) $q=I\times t$

$q=0.4A\times 2s=0.8C$

b) $q=I\times t$

$q=0.4A\times(4\times 60)s$

$q=96C$

If the current through a conductor was constant in direction during a period of time, this is called Direct Current and denoted by (DC). The sources of direct current are the generators and batteries.

3.3 Electric Circuit

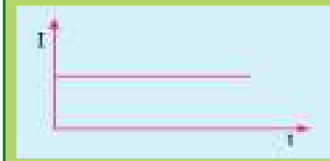
The closed path in which the electrons keep moving is called an electric circuit. A simple electric circuit consists of a lamp, connection wires, key , battery, with a proper voltmeter. Figure 9.

In the case which the key of the circuit is unlocked in the circuit, we observe that the lamp does not glow. This means there is a disconnection in the circuit. This kind of circuit is called an open electric circuit, Figure 10.

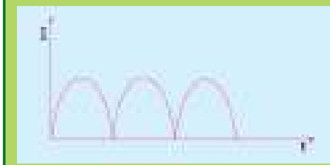
When the key of circuit is “closed”, the electrons will keep moving through the connected wires and through the lamp. Then thelamp will glow. This kind of circuit is known as a “closed electric circuit”, Figure 11.

Do You Know

-The current leaving an electric battery is a direct current and it has a constant amount and direction (regarded as Ideal)



-The current from the simple generators is direct current and it has a constant direction and variable amount (not regarded as ideal



-If the current was variable in amount and direction during a period of time it is called an alternating current (AC)

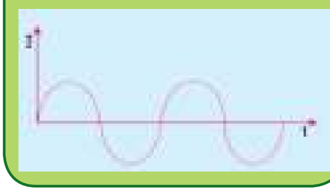


Figure 9

Figure 10

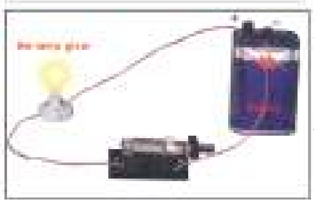


Figure 11

3.4 Measuring electric current

The Ammeter

Figure 12

The Ammeter is used to measure the amount of electric current in the electric circuit (or any part of it). The milli-ammeter device is used to measure the small amount of currents (measured in milliamperes in mA), See Figure 12.

The following points should be taken into account when the ammeter is used in order to measure the electric current.

1-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),Figure 13.

2-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.

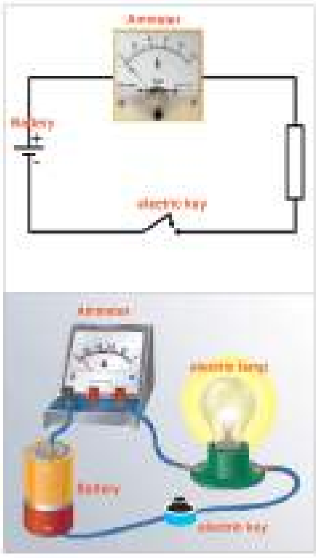


Figure 13

3-The positive side of the Ammeter will be connected (usually it is coloured in red, or marked with “+” sign) to the positive pole of the battery(the point with higher electric potential).

The negative side of the Ammeter coloured in black or marked as sign to the negative side of the battery (the point with lower electric potential).

Attention is required when any activity is carried out (practical experiment) in the electric circuits. The key of the circuit must be kept open before starting the measurement. When you make sure all the connections are correct and make sure about the positive and negative ends of the Ammeter and Voltmeter in the circuit then close the circuit key.

Activity: Measuring the electric current by using the ammeter

Tools: Ammeter, connection wires, electric lamp,battery with suitable volt, variable resistor (Rheostat)and electric key.

Steps:

-Connect the Ammeter , the electric lamp, electric key, battery and the variable Resistor (Rhostat) at the highest value by the connection wires with each other in series, We should pay attention to the type of poles for the battery and the ammeter, Figure 14.

Figure 14

-Close the circuit key, then see the light glows and the pointer of the Ammeter deviates, referring to the flow of electric current in the circle. What does the reading of the ammeter point to? Record the reading. What are the units of this reading?

-Change the amount of the resistance (using the Rheostat), then the circuit current will change. We obtain a new reading in the ammeter and we observe the glow of the lamp. We repeat this procedure and in each case we get a new value of the current flow in the circuit.

We conclude from the activity that: The reading of the Ammeter will alter with the alteration of the value of the current flow in the electrical circuit which always refers to the amount of current flow in the circuit.

3.5 The electric Potential Difference:

The amount of potential difference between two points inside the electrical field determines the amount of electrical current flow between them.

Then, the direction of electrical current flow will be from the point with higher electric potential to the point with lower electric potential.

When the potential amount of the two points are equaled, then the electrical current flow will stop. The unit of measurement of the electric potential difference between two points is the volt. The mean of measurement is called Voltmeter Figure 15.

Figure 15

3.6 Electric Potential Difference Measurement

Voltmeter

Voltmeter, is used to measure the amount of electric potential difference between any two points in the electrical circuit Figure 16.

It is also used to measure the amount of electric potential difference between the poles of a battery. In order to measure small voltages, we use measurement units called millivolt (mV) and the device used in this case is called millivoltmeter.

Figure 16

When a voltmeter is used to measure the electrical potential difference, it is important to be aware of the following:

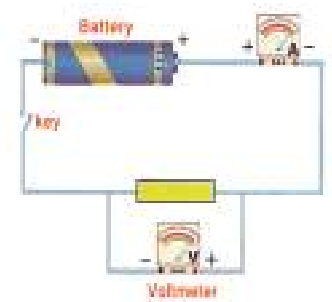


Figure 17a

1-The voltmeter will be connected in parallel between the two sides of the load that we need to know the electric potential difference between its two sides (between the two points which you need to measure the electric potential difference in the electric circuit). Figure 17 a.

2-The resistance of the Voltmeter will be very high as relative to the resistance of the circuit or relative to the resistance of the required apparatus which the potential difference is needed to be measured between its two ends.

3-The positive end of the Voltmeter (normally red colour) is connected to the positive pole of the battery (its potential is higher). While its negative side (which is normally blue) with the negative pole for the battery (which has lower potential).

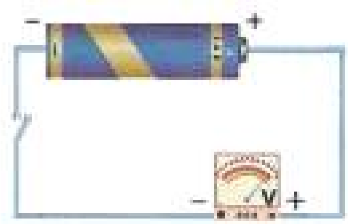


Figure 17b

It should be clear that the potential difference between the two sides, when the electric circuit is opened (current = zero) is called (emf). We use Voltmeter which is directly connected between two poles to measure it ,as in Figure (17b).

Activity: Measuring the potential difference between two points in the electric circuit using a Voltmeter

Tools: Voltmeter, connection wires, electric lamp, battery with a suitable voltage, electrical key.

Steps:

-Using the electric wires, we connect the electric lamp and the key between the two poles of the battery. Then we connect the Voltmeter in parallel with thelamp Figure 18.

-Look at the deviation of the pointer of Voltmeter showing that there is electric potential difference between the two sides of the lamp.What does the reading of the Voltmeter represent? Record this reading.

Figure 18

3.7 Electric resistance and its measurement unit

Electric Potential difference is regarded essential in order to generate electric current in the conductors and the movement of electrons face resistance during their transfer inside the resistance conductors. This resistance is caused by a collision of electrons with each other and with the atoms of the conductor. This will lead to the raising of the temperature of the conductor. This means that the conductor generated a resistance to the electric current, which means that the conductor has electric resistance. Look at Figure 19.

Figure 19

The Electric Resistance: is the impedance caused by the resistor of the electric current passing through it, The electric resistance is measured by Ohms according to the scientist George Simon Ohm.

Types of Resistance

a-Constant Resistance: It is possible to know its amount by observing the colours of the rings on its surface using special tables. Figure 20.

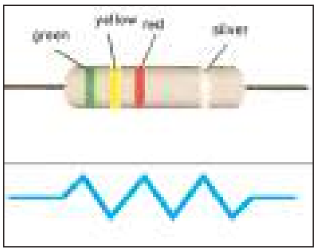


Figure 20

b-Variable quantity resistance: Figure 21

A Rheostat is a variable resistor. It is used to change the current in a circuit.

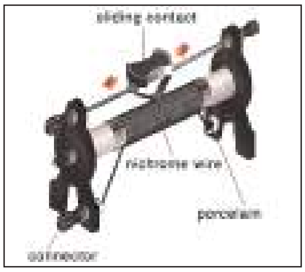


Figure 21

3.8 Ohm's Law

The scientist Ohm found that 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 within a certain limits. He called this constant the electrical resistance. It is measured in Ohms and denoted by (Ω).

The scientist Ohm formulated the relationship between the electric potential difference and the current which passes through the resistor as follows:

$$\text{Resistance} = \frac{\text{Potential difference}}{\text{Current}}$$

$$R(\Omega) = \frac{V(\text{volt})}{I(\text{Ampere})}$$

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

Activity: Measuring a small electric resistance by using an Ammeter and Voltmeter

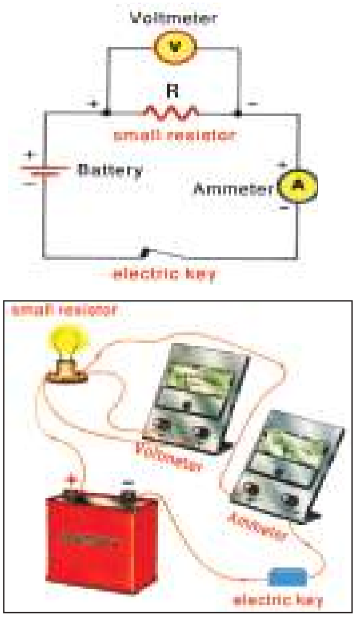


Figure 22

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

Steps:

1-Connect the electric system as in Figure 22. 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:

$$\text{Resistance } (\Omega) = \frac{\text{Voltmeter reading value (V)}}{\text{Ammeter reading value (A)}}$$

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

Figure 23

We can also measure the value of electrical resistance by using the "Ohmmeter". Figure (23)

When using the Ohmmeter, the resistance which you want to measure should not be linked to the electric circuit Figure (24).

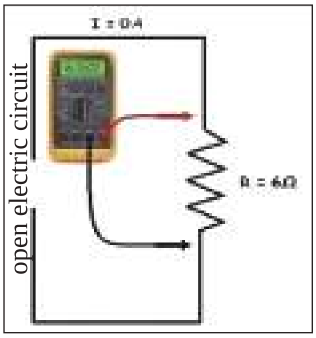


Figure 24

The Factors on which the Conductor Resistance Depends:-

1-The temperature: The resistance of some material varies with variation of the temperature which that material is exposed to. The pure conducting materials will increase in resistance with increase in the temperature (copper is an example). When a copper bar, which is connected in series with an electric lamp is heated, we observe that the glare of the lamp decreases as the temperature of the copper increases as a result of decrease in the electric current in the circuit, Figure 25. This shows the increase of the resistance of conductor with the increase of the temperature.

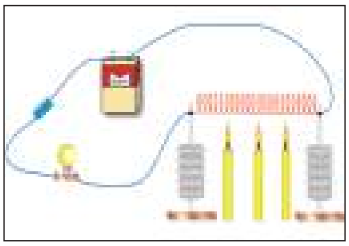


Figure 25

It is important to mention that when the great decrease in the temperature of some material happens, they become superconductors and ideal in transferring the electric energy. Materials such as carbon will have less electrical resistance as the temperature rises. There are other materials with constant resistance regardless of the temperature (such as Manganen and Constantan).

2-Conductor length: The conductor resistance direct proportion with its length (The resistance will increase as the length increases). Figure 26.

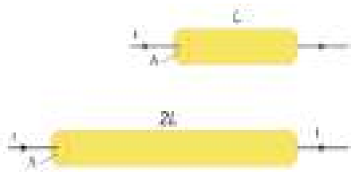


Figure 26

Activity: The relationship between the resistance of a material and its length

Tools: Battery with suitable voltage, conductor cable (made of Nickel Chrome) with proper length, electric lamp, ammeter, connecting wires, two conducting clips and electric key.

Steps:

-Connect a practical electric circuit containing Ammeter, battery, lamp, wire and the electric key. Figure 27.

-Place the two clips between the two ends of the cable. We see that the lamp glows . We record the reading of the ammeter.

-Moving the two clips on the cable gradually close to each other. To make the length of the cable is shorter. We observe that the lamp glows more and the reading of the ammeter increases. That is explained as increase in the current which passes in the circuit as the resistance of the conductor decreases.

We conclude from this activity that: The resistance (R) varies directly with the length (L) when the factors remain unchanged.

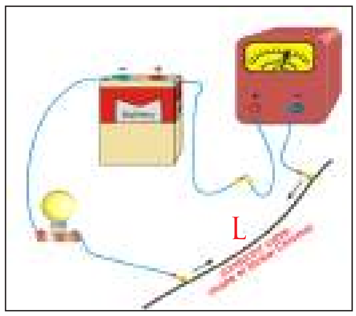


Figure 27

3-The Area of the Cross Section of the Conductor

The resistance of a conductor decreases as the area of the cross section of the conductor increases Figure 28.

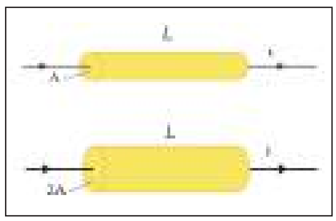


Figure 28

Activity: The relationship between the resistance of a conductor and the area of its cross section

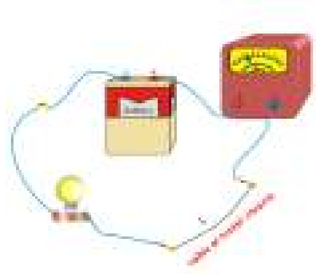


Figure 29

Figure 30

Tools: Proper voltage battery, two cables of (nickel chrome) equal in length and cross section, electric lamp, ammeter, connection wires, two clips of conducting material, electric key.

Steps:

-Connect a practical electrical circuit in series containing ammeter, battery, lamp and a cable made of nickel chrome, Figure 29.

-Place the two clips between the two ends of the cable and observe the lamp glowing and we record the reading of the ammeter.

-Take the two identical cables in length and cross section (nickel chrome) and join them together to make them one thick cable with a cross section of (2A) i.e. twice the cross section of the previous cable, Figure 30.

-Place the two clips between the two ends of the two cables (at the two ends of the thick cable).

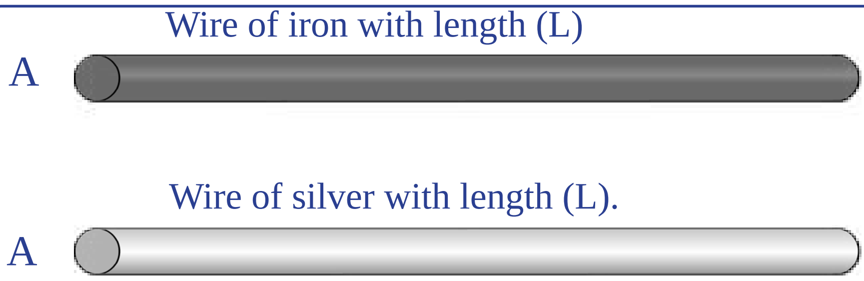
-Observe the lamp glows sharper than the first case (before putting the two cables together). At the same time the reading of the ammeter will increase. This means that the electric current flows in the circuit has been increased by doubling the cross section of the cable. The explanation of that is when the cross section area is doubled, the resistance has decreased compared to the first case, so the electric current flows has increased.

The conclusion of this activity is that the resistance of a conductor (R) inversely proportion with the area of the cross section (A) when the other factors remain the same.

Do you Know
In the petrol tank of vehicles, there is a float which changes the resistance which controls the amount of current flow in petrol measurement. When the level of the petrol is high, a larger current flows causing a larger deviation for the petrol meter and vice versa.

4-Type of material

Electric resistance is a physical property for the material showing its retardation to the electric current flow which passes through it. The electric resistance differs according to the type of the material when the other factors remain the same. As an example, the resistance of a wire of silver is less than the resistance of a wire of iron which equals in length and also equal to the cross section at the same temperature look at Figure 31.



The cross section area (A) is equaled to both of the wires at the same temperature.

The resistance of the iron wire (R_{Fe}) is greater than the resistance of silver wire (R_{Ag}).

Figure 31

We can now say that:

Resistance is directly proportional to wire length and inversely proportion to the cross section area.

$$\text{Resistance} \propto \frac{\text{Wire Length}}{\text{Cross Section Area}}$$

$$R \propto \frac{L}{A}$$

3.9 Methods of Connecting the electric resistors:

a) Connection of resistors in series

Figure 32 shows two electric resistances. Their resistances are (R_1 and R_2) connected in series with each other. This kind of connection provides only one flow in the electrical circuit.

V_1 represents the electric potential difference between the two ends of the resistance R_1

V_2 represents the elecrtic potential difference between the two ends of the resistance R_2

$$I=I_1=I_2 \quad ....(1)$$

(I) represents the current flow in the electrical circuit.

(V_{Total}) represents the total potential differences

$$V_{total}=V_1+V_2 \quad ....(2)$$

Substitute for $V=I\times R$ in equation (2)

$$I\times R_{eq}=I\times R_1+I\times R_2$$

$$I\times R_{eq}=I\times(R_1+R_2)$$

(R_{eq}) represents the equivalent resistance for the collection of resistances which are connected in series.

Now cancelling (I) from both sides of the equation, we get

$$R_{eq}=R_1+R_2 \quad ....(3)$$

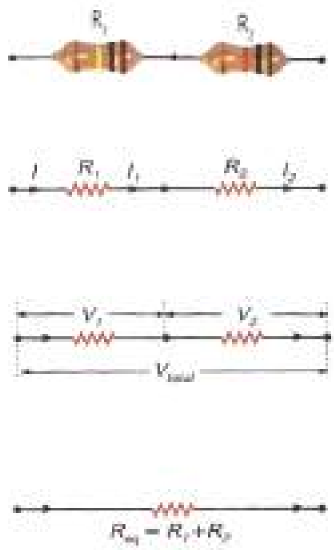


Figure 32

Activity: Connecting electric lamps in series

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

Steps:

-Connect one of the three lamps in series with the key and battery, close the key and we see the lamp glows.

-Connect two of the lamps in series together with the key and battery.

-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.


Figure 33

-Repeat the same procedure by connecting the three lamps by the conducting wires and the key in series as in Figure 33.

-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.

We conclude from this activity that 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.

b)Parallel Connection of resistors

Figure (34a,b), shows two electrical resistances (R_1 and R_2)connected in parallel with each other. This kind of connection provides many routes for the electric current flow in the electric circuit.

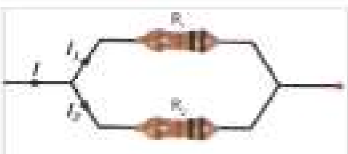


Figure 34a

(V_1) represents potential difference between the two ends of resistance R_1

(V_2) represents potential difference between the two ends of resistance R_2

$$V = V_1 = V_2 \quad ....(1)$$

$$I_{total} = I_1 + I_2 \quad ....(2)$$

Where (I_{total}) represents the total current flowing in the electric circuit

(I_1) represents the current flow in resistance (R_1)

(I_2) represents the current flow in resistance (R_2)

The equivalent resistance can be calculated as follows:

Substitute $I=\frac{V}{R}$ in equation (2).

(R_{eq})represents the equivalent resistance

$$\frac{V}{R_{eq}}=\frac{V}{R_1}+\frac{V}{R_2}$$

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

Cancelling (V) from both sides of equation, we get:

$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2} \quad \text{............(3)}$$

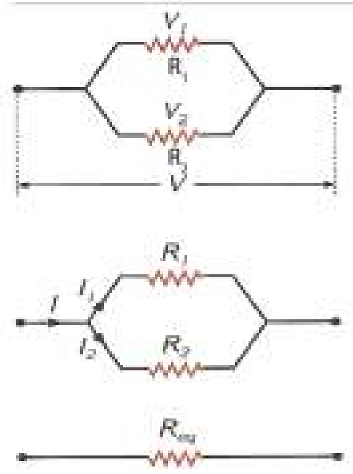


Figure 34b

Activity: Connecting electric lamps in parallel

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

Steps:

- 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.

-Now we connect two lamps in parallel with each other. Then we connect their system in series with the key and the battery.

- Switch the key on, we see the lamp's glow equally and at the same level as in the first case.

-Connect all the three lamps in parallel, by the conducting wires and connect the system of lamps with key in series.

-Connect the two ends of the total collection to the poles of the battery Figure 35.

-Switch the key on, we see the lamp's glow equally and at the same level as in the first and second cases.

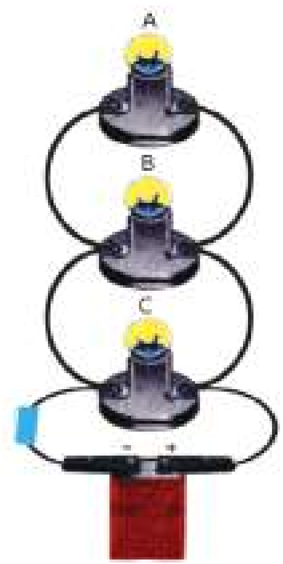


Figure 35

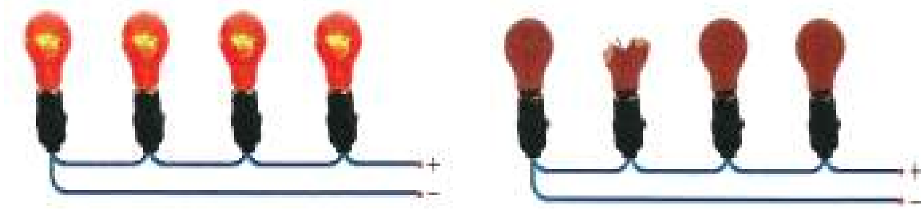
We conclude that: The potential difference Across the parts of the parallel connected electric circuit is equal and the main current in the circuit equals the sum of the currents flowing through the lamps which are connected in parallel. This current flow will increase with the increase of the number of lamps which are connected

in parallel. The equivalent resistance in the parallel circuit decrease with increase of the number of lamps (the resistors) which are connected in parallel.

Compare between the connecting of lamps in parallel and in series

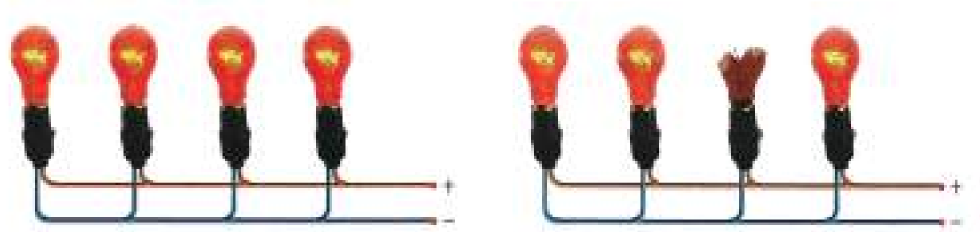
One of the characteristics of connecting lamps in series is that when one of the lamps is faulty or disconnected, the other lamps will be off. Figure (36a,b).

The reason is that when the lamps are connected in series, the current will flow from one lamp to the next one. That means that there is only one path for the electric charge movement throughout the electric circuit.



a Figure 36 b

The characteristics of connecting lamps in parallel is that when one lamp is off or removed, the other lamps will not be affected and remain on. This is because the current flow stops only at where the lamp is off Figure 37. All the other lamps are directly connected to the battery. In other words, there are other paths through which the electric charge can flow. For that reason, in most of the electric circuits the connection in parallel is used. All electric device in the houses are connected in parallel.



a Figure 37 b

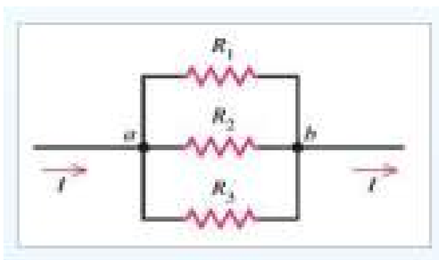
Example: In the nearby diagram, there are three resistances.

$R_1=6\Omega$, $R_2=9\Omega$, $R_3=18\Omega$ The equivalent resistance for them is connected to a 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.



Solution: The diagram shows that the connection is in parallel. The equivalent resistant R_{eq} is calculated as:

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

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

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

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

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

2) Since the connection is in parallel

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

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

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

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

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

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

3.10 Short Circuit

When two lamps of equal resistances are connected in series with each other and connect their group to the poles of a battery, we see that both of the lamps glow equally. Figure 38a. This is because they get the same current flow.

Now if we connect a thick conducting wire to two ends of one of the lamps, as in Figure 38b we see that this lamp will be turned off. The reason for this is that this thick wire generated a short circuit for the lamp, and make the majority of the current flows through this wire (which has very low resistance). while the small proportion of the current flows through the lamp which is insufficient to glow the lamp.

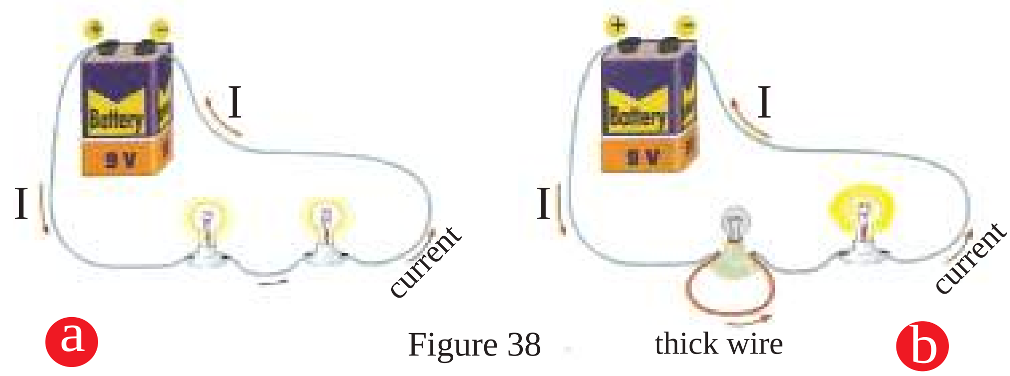


Figure 38

For the other lamp in the circuit, we find that its glowing is stronger than the first case. It is because of the increase in the electric circuit current in the second case as a result of decrease in the equivalent resistance (The electric circuit in the second case has one lamp connected with the battery instead of two lamps connected in series).

Attention :

Avoid connecting the Ammeter directly with the source (without any extra load in the circuit) because that would cause damage to the ammeter and the battery (if the source has high power). The reason is that it exposed by a short circuit and causes a very high current flow.

3.11 Connecting Electric Cells

Many electric circuits need more than one cell in order to work. So the electric cells are connected with each other in series or in parallel, or they will be connected differently to supply the circuit with a proper current or a proper voltage.

a.Connecting electric cells in series

In this kind of connecting cells, 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.

The characteristics of connecting electric cells in series is to supply higher voltage (largest electromotive force emf). This is a result of adding the voltages of the cells, the total electromotive force (emf_{total}) will be equal to the sum of electromotive force for the cells which are connected in the series.

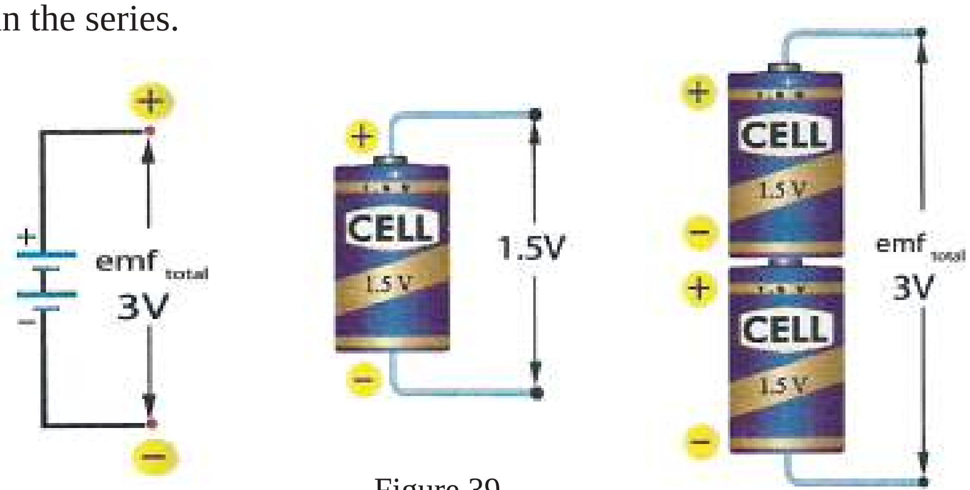


Figure 39

When two identical cells are connected to each other. Each one has emf of (1.5 V) in series. The total voltage for the two cells (emf_{total}) equals (3 V) i.e. twice the voltage of each one individually, Figure 39 .

b. Connecting electric cells in parallel:

In this kind of connecting cells, all the positive poles will be connected together and all the negative poles will also be connected together, Figure 40.

The special characteristic about connecting cells in parallel is to be able to supply the electric circuit with a largest current. The total voltage for the connected cells in parallel, the total electromotive force (emf_{total}) is equal to (emf) for the one cell.

When two identical cells (emf) are connected with each other in parallel, each one of them has (1.5V) in parallel, then the total voltage for the two cells (emf_{total}) equals (1.5V) which is equal to the voltage of each one of them, Figure 40.

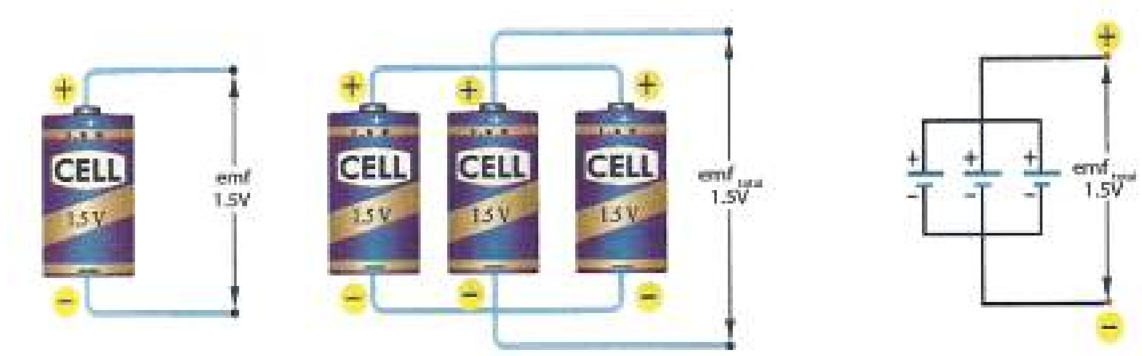


Figure 40

QUESTIONS OF CHAPTER THREE

Q-l Choose the correct statement for the following:

1-The characteristics of connecting lamps in parallel are:

a. When one lamp is off other 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.

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

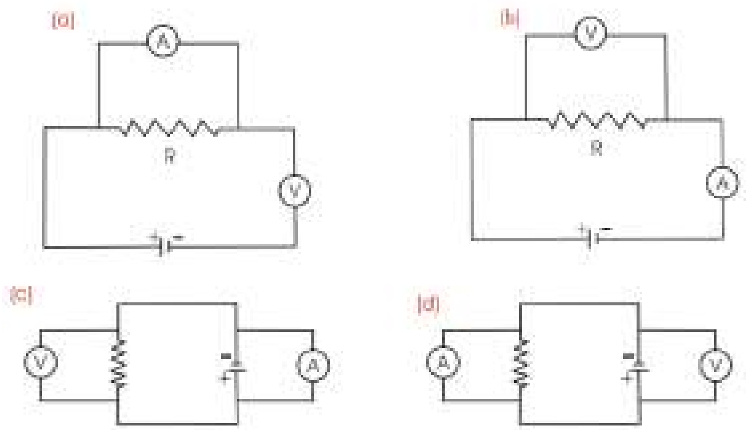
a. The amount of electric potential difference between the two ends of each resistance will be equaled.

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.

3-Which diagram of the following circuits diagram is regarded as correct when we use it to measure a small resistance by connecting an ammeter and voltmeter. Look at the Figure:



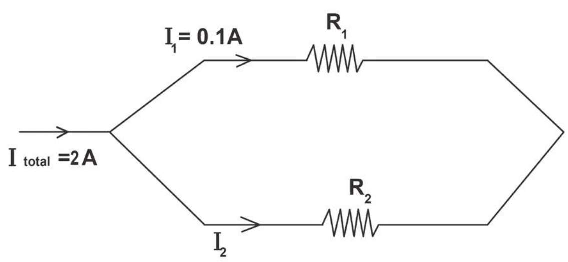
4-The amount of electric current (I_2) which flows in resistance (R_2) in the electric circuit diagram, given below, equals:

a. 0.1 A

b. 2A

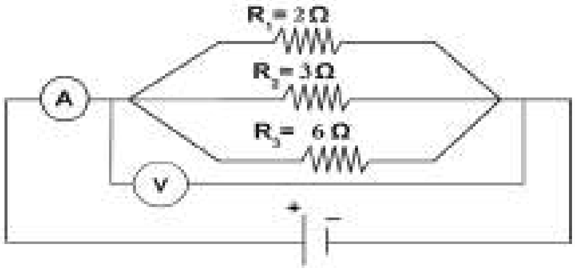
c. 2.1 A

d. 1.9 A



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



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. Volt × Amper d. $\frac{\text{Coulomb}}{\text{Second}}$

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

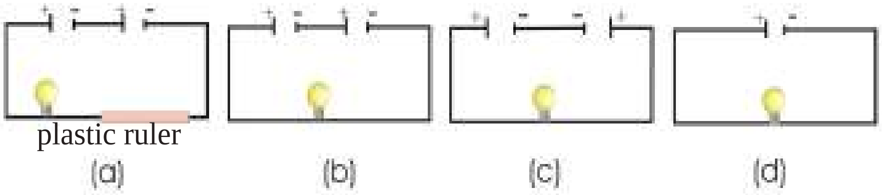
a. Wire's diameter

b. Length of the wire.

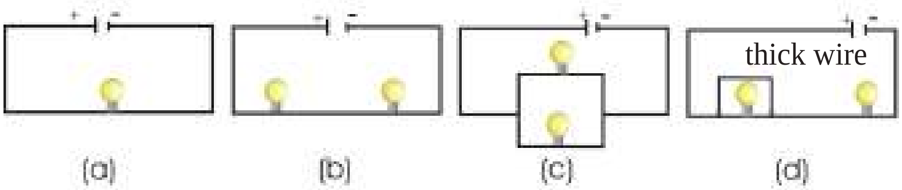
c. The type of material of the wire.

d. The electric current which flows in the wire.

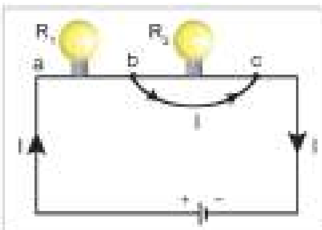
8- If the batteries in the following electric circuits are similar. Explain in which one the lamp glows sharper.



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



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)

d. Both of the lamps will be off (R_1) and (R_2)

Q-2 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 ? Explain.

Q-3 Why is it better to connect the lamps and the other electric devices in the electric circuits in the house in parallel?

PROBLEMS

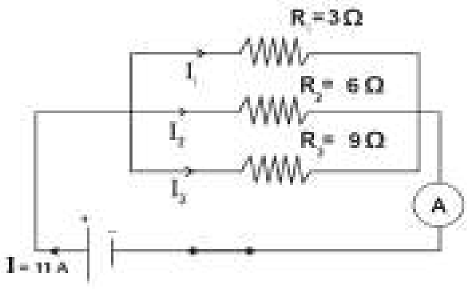
P-1 What is the amount of current which flows through a cross section in a conductor which electrical charges of $(9\mu C)$ in time $(3\mu s)$ passing through. Ans:(3A)

P-2 By observing the diagram, calculate:

a. The amount of equivalent resistance for all the resistances which are connected in the electric circuit

b. The amount of potential difference at the two ends of each of the resistance

c. The amount of current which flows in each resistance.



Ans: $1-R_{eq}=1.6\Omega$

$2-V_1=V_2=V_3=18V$

$3-I_1=6A$

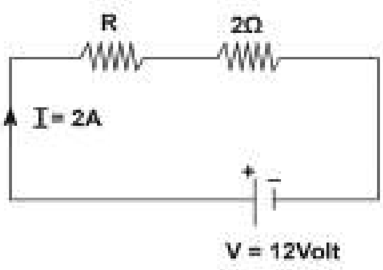
$I_2=3A$

$I_3=2A$

P-3 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



Ans:

$1-R=4\Omega$

$2-V_2=4V$ Potential difference at (2Ω) the two ends of resistance

$V_R=8V$ Potential difference at the two ends of resistance(R)

CHAPTER FOUR

4

THE BATTERY AND ELECTROMOTIVE FORCE

Contents

Behavior Targets

After finishing this chapter, we expect that student will be able to:

- define the simple cell
- explain how the simple Galvano cell works
- Showing Contents of dry cell (carbon-zinc)
- distinguish between Secondary battery and car one
- explain why the amount of voltage for the charger source is bigger somehow than the amount of battery electromotive force
- Showing how (Lithium - Ion) battery works
- Explain the contents of hydrogen - fuel cell
- Calculate the characteristics of hydrogen - fuel battery

Scientific Terms	
Battery	بطارية
primary battery	البطارية الاولية
The simple Galvano cell	الخلية الكلفانية البسيطة
Dry cell	الخلية الجافة
Secondary battery	البطارية الثانوية
Lithium - Ion battery	بطارية (أيون - الليثيوم)
Hydrogen Fuel Cell	خلية وقود الهيدروجين
Electromotive force (emf)	القوة الدافعة الكهربائية

4.1 Introduction


Figure 1

Battery is the source of producing electric energy by the chemical reaction. A battery consists of one electrical cell, or more. Each cell contains chemical materials and other contents which enable the cell to generate the electric current. Batteries were invented by an Italian scientist called Alessandro Volta.

Batteries are made in various shapes. Some batteries are very small such as the ones used in watches. There are huge batteries which provide power to the ships, and their mass are approximately (910kg). The producers of batteries make them at certain standard volumes .Figure 1

Activity 1 How does a battery made with lemon work

Tools: Milli-ammeter, galvanized nail, piece of copper, lemon, wires for connection.

Steps:

• Fix separaty the galvanized nail (iron and zinc) and the piece of copper inside the lemon Figure2.

• The copper will act as a positive electric pole, and the galvanized nail will act as a negative electric pole, thus generating a potential difference between the two poles.

• Join the wires from these two poles to the two ends of Milli-ammeter .We see that the pointer moves to show that electric current flows in the external circuit as a result of releasing electrons from the nail towards the copper under the influence of acid solution.


Figure 2

Activity 2 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.

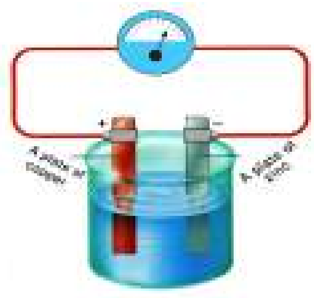


Figure 3

> Do you know
> 1.We refer to Galvano meter by (G) and it is sensitive to the very small electric currents (μA) and its pointer is reflected according to the current flowing.
> 2.We refers to Milli-ammeter by (mA) to measure the small electric currents (parts of amper).

Conclusion:

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

4.2 Classification of Batteries

There are various kinds of batteries according to the chemical contents inside them, such as batteries with liquid inside (car batteries). There are also batteries which are solid inside such as powders or putty materials (such as dry cells).There are also batteries with gas inside (such as fuel batteries), or classify according to it's charging ability, so batteries can be classify into three typed:

Battery Classification

- Primary Batteries
- secondary Batteries
- fuel Batteries

4.2.1 Primary Batteries

Figure 4

These are known as simple cells. Some of dry cells stop working and be expired if ones of its chemical components is consumed. They cannot be charged, so they need to be replaced. Figure 4. An example of this type is the simple Galvano cell and dry cell (carbon- zinc).

The simple Galvano cell

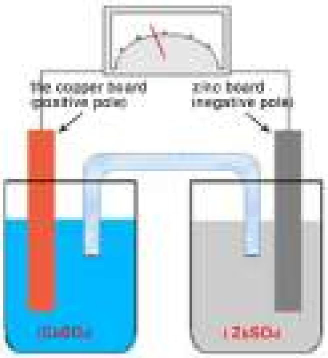


Figure 5

The Galvano cell consist of two halves cells. In each one there is a metal board sank inside. One of the boards is zinc (Zn) and the other one is copper (Cu). Each board sinks inside one of its salt solutions (Zinc sinks in $ZnSO_4$) and the copper board sinks in ($CuSO_4$). The atoms of the metal inside the cell 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). This system was named according to its first inventor Danial. So it is called Danial cell Figure 5.

> Do you know
> The bridge of salt in the simple Galvano cell connects the solution of two containers in an indirect way and help in leaving the positive and negative Ions.

Dry cell (carbon- zinc)

It is a cell which is dry medium. It consists of a vessel of zinc. It acts as a negative pole. There is a bar of carbon inside it which acts as a positive pole which is surrounded by electrolyte paste (made of ammonium chloride, zinc chloride, water, manganese dioxide and carbon powder).The vessel is closed with an insulated lid. Figure 6. As a result of chemical reaction a potential difference generates between the two ends of the cell by (1.5 V), then the electric current flows when the two ends of the cell are connected by proper external resistance Figure7.

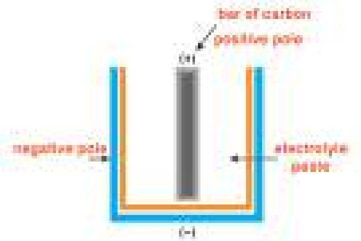


Figure 6

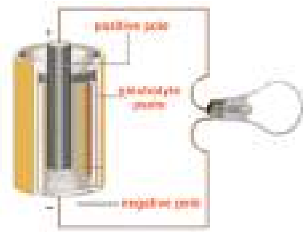


Figure 7

(Carbon- zinc) cells have many uses such as torches, generating electric pulse units for remote controls, cameras and electric children's toys.

4.2.2 Secondary Battery

This is a kind of electric battery which can be recharged. During its function, the chemicals material inside it react, and then the chemical energy stored in the battery will be converted into electric energy.

To recharge it an electric current is needed to flow in the opposite direction to the discharge current in order to convert the electric energy to chemical energy which will be stored inside the battery. Examples are the car batteries, and (ion-lithium) batteries which are used in electronic device such as computers.

> Do you know
>
> Exhausting a large quantity of electric current in a short time will shorten the age of the cell, so it is preferable to use it to supply small currents in intervals.
>
> At the same time storing it for a long time will make it less efficient.

Car Batteries

These kinds of batteries can be recharged. It is used to Switch on the engine of the car. Figure 8, shows the external shape of battery which is made of a plastic or solid rubber container (compartment) containing three to six cells.Each cell has plates inside with electrolyte solution consists of sulfuric acid(H_2SO_4)and distilled water-with a relative density of (1.3) when it is fully charged . Figure 9.

Figure 8

Each cell of the acid lead cell generates a potential difference of (2V), so the car battery of six cells which are connected in series will supply twelve volts (12V), when the battery is fully charged.

The lead battery consists of lead boards (Pb) facing boards lead dioxide boards(PbO_2),where all of them sink in the solution of (H_2SO_4) Figure 9.

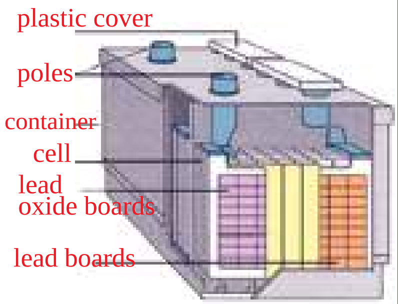


Figure 9

This system reacts chemically, producing a potential difference between the lead boards (negative pole) and lead dioxide board (positive pole),enabling electric current to flow when the two poles of the battery are connected to the cars electrical circuit after close the circuit.

Charging Battery

Remember
The car battery will supply a high electric current, so they must be connected with think wires.

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 pole of the battery which we want to recharge Figure 10.
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.

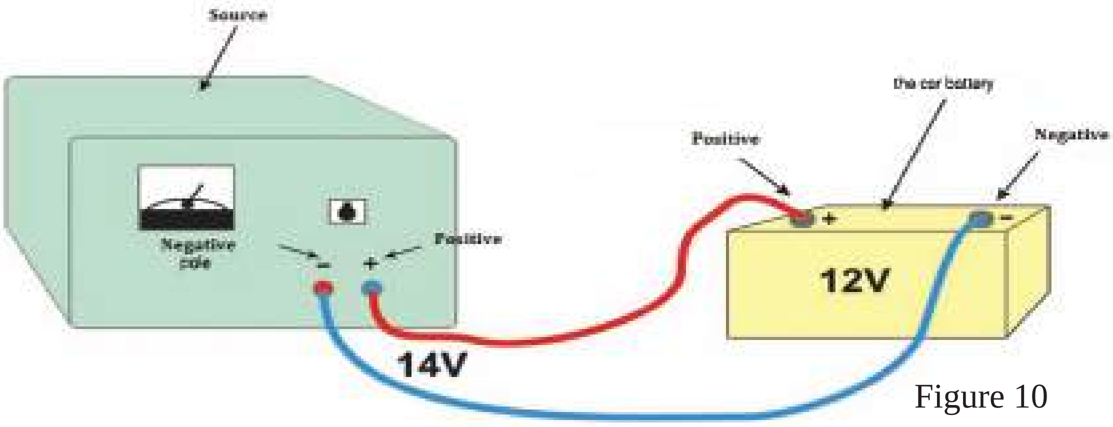


Figure 10

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.

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 (1.3).
3)The battery should not be left for long time without usage because that would cause making an insulation layer of sulphate on the boards.

Lithium-Ion Battery

The developing technical devices such as laptops, mobiles, MP3, cameras, etc makes our depending on the batteries increase more and more especially those kind of batteries that can be recharged without any damage.The lithium-ion batteries are similar to the size and shape of normal dry batteries. Figure 11.

Figure 11

Lithium-Ion batteries have durable covers, especially designed to resist high pressure and the heat which generated inside the battery. The cover contains a valve for security. The cover contain three thin layers wrapped in a spiral way as in Figure 12.

Figure 12

These layers represent:

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

The three layers are sunk in electrolyte solution (mostly Ether). 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.

Lithium-ion batteries can keep the electrical charge more than any other battery. For example the lithium-ion batteries lose only (5%) of their charge in a month if it is not used compared to the dry battery which lose (20%) of its charge in a month when it is not used.

4.2.3 Fuel Battery

This is a cell which is able to generate an electric current depending on fuel (chemical material) which is supplied by external sources. This kind of battery does not stop working, as long as it is fed by fuel, for example hydrogen fuel batteries.

Figure 13

Hydrogen Fuel Cell

Hydrogen fuel cells convert the chemical energy to electric energy, (depending on chemical reactions). Hydrogen is usually stored as liquid in special containers. Figure 13

During the operation of the fuel cell, the hydrogen and oxygen gases which are obtained from the atmosphere will converted to water and electric energy shows the mechanism of the reaction in order to produce electric energy Figure 14.

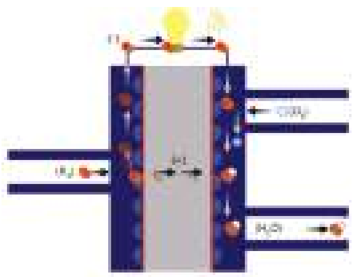


Figure 14

The fuel battery (fule cell) consists of thin boards. Each cell generate electric potential difference of (1V). As the number of boards which are linked to each other in series increases , the potential difference will be increased. Figure 15

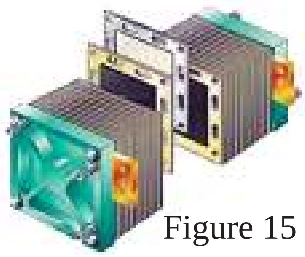


Figure 15

Fuel batteries are used in many modern applications such as computers, operating modern cars Figure 16.

Figure 16

Hydrogen Fuel Battery has the following properties:

1. It does not contaminate the environment or the consumption of ordinary fuel which can affect the human health because hydrogen is extracted from water by oxidation, and returns to water again.
2. Hydrogen technology 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 one. So there is no loss of energy.
4. It lasts very long compared to the other kinds of batteries.

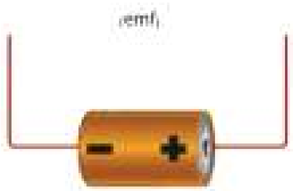


Figure 17

4.3 Electromotive Force (emf)

The electric potential difference between the negative and positive poles for any battery when the electric circuit is opened is called the electromotive force (emf). Figure 17. In order to move the electrons within an electric circuit, it would be necessary to give these electrons energy obtained from the battery. The amount of energy supplied by the battery for electrical charge units is called (emf) of the battery.Voltmeter is used to measure units. Figure 18

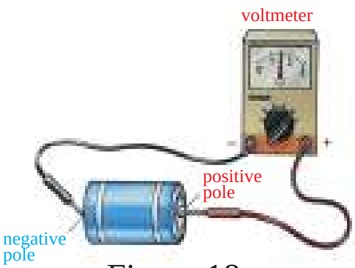


Figure 18

The unit of emf is $\left(\frac{\text{Joule}}{\text{Coulomb}}\right)$ =Volt

Example:

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

Think
What do we mean by the electromotive force for a battery (emf) is 1.5 Volt.

Solution:

$$\text{Electromotive Force} = \frac{\text{Gained Energy}}{\text{Charge Quantity}}$$

$$\text{emf (V)} = \frac{W}{q} \frac{\text{Joule}}{\text{Coulomb}}$$

$$\text{emf (V)} = \frac{20}{10} = 2V$$ electromotive force.

The internal resistance of a battery

The retraction caused by the media material (chemical compounds) inside a battery for the electrical charges movement is called the internal resistance of the battery and denoted (r) Figure 19

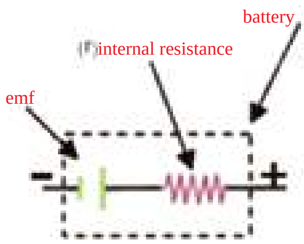


Figure 19

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) Dose 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

Q-2 what is a secondary battery? Give an example.

Q-3 what is the type of energy stored in a secondary battery?

Q-4 Explain by diagram the process of charging a car battery.

Q-5 what procedures are needed in order to maintain the car battery?

Q-6 List four pieces of device's in which a dry battery is used.

Q-7 what are the properties of hydrogen fuel?

Q-8 what are the contents of
a) Dry battery
b) Lithium-ion battery

PROBLEMS

P-1 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).

(Ans: 3J)

P-2 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) .

(Ans: 10C)

CHAPTER FIVE

5

ENERGY AND ELECTRICAL POWER

Contents

Behavior Targets

After finishing this chapter ,We expect students will be able to:

- Knowing the consumed electric power in any device.
- Explaining the difference between the light of two lamps, 20W and l00W.
- Expressing the relationship of electric power with electric energy and time in a mathematical formulation.
- Using the law of electric energy cost which invests in calculating fees we pay when using an apparatus for a certain time.
- Calculating the parts of plug with fuse.
-Giving the resone of connecting of fuse to the active wire circuit before entering the electric current into apparatus.
- Explaining importance of earthing the electric devices with metal cover.
- Showing importance of rationalizing of using electric energy.

Scientific Terms	
Electrical energy	الطاقة الكهربائية
power	القدرة
Earth wire	سلك التأريض
Live wire	السلك الحي
Neutral wire	السلك المتعادل
Earthing connection	التوصيل بالارض (التأريض)
plug	القابس الكهربائي

5-1 Electrical Power

Why does the lamp with a power of (100W) glow more than similar lamp of (20 W) what these numbers mean? Figure 1.

Operating any Electrical device needs a certain amount of electric energy consumption and converts that energy to another kind of energy for example energy can be converted to dynamic energy (as in machines) or to heat energy (as in case in heaters) or can be converted to light (as in lamps) and other kinds of energy.

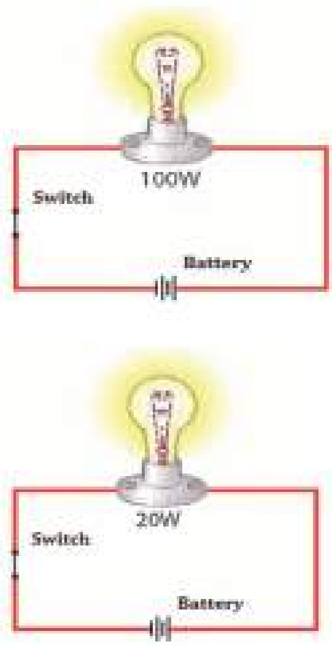


Figure 1

The consumed electrical power in any device is defined as :

The amount of energy which is consumed or used by an electrical device in a unit of time is given by :

$$Power=\frac{Energy}{Time}$$

$$P=\frac{E}{T}$$

The unit of the power is $\frac{Joule}{Second}$ which is called Watt (W)

$$Watt=\frac{Joule}{Second}$$

The lamp with power of (20W) consumes in one second (1s) an energy of (20 J), While the lamp with power of (100 W) consumes energy of (100 J) in one second (1s), So it has larger lighting than the lamp of (20W) has.The electrical power for any device depends on the amount of current which flows in that device and the potential difference between its two ends.

Electrical power = Current × Electric Potential Difference .

P= I × V .... (1)

If the amount of current flows in an electric device (1A) and the potential difference between its two ends is 1V then the consumed power in the apparatus equals 1W .

1W = 1 Ampere × 1 Volt :

Now applying Ohms law : $R=\frac{V}{I}$, we get :

$$P=I\times V$$

$$P=I\times (IR)$$

$$P=I^2\times R \quad ....(2)$$

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

$$P=\frac{V^2}{R} \quad ....(3)$$

Remember:
Electric energy equals Electric power multiply and time
(E = P × t)

The electrical devices in the houses are connected in Parallel with each other's

Activity : Calculating the electrical power

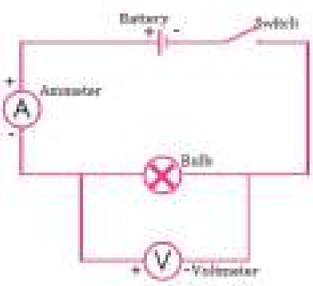


Figure 2

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.
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 × potential difference
(ammeter reading) (voltmeter reading)

$$P = I \times V$$

Example:

In the near by diagram, an electrical heater operated by 220 V, resistance of its heating bars (one of three bars is 88 Ω) Calculate:

1- Power consumed by one of the heating wire

2- Current flow in one of the heating wire

Solution: 1- $$P=\frac{V^2}{R}$$

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

2- $$I\frac{V}{R}$$

$$I=\frac{220}{88}=2.5A$$ amount of current


Figure 3

Electrical power has many applicatins in our everyday life situation. It is consumed in our houses, factories, business shops, hospitals for the purpose of lighting, heating, cooling and operating devices, Figuer 3.

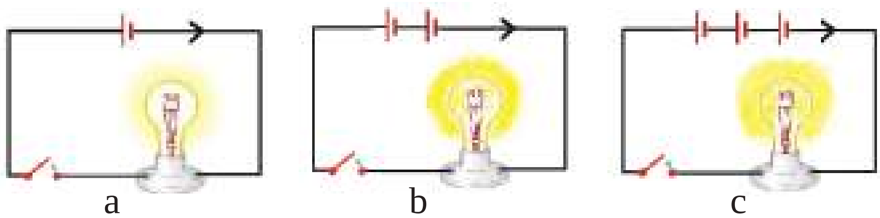
Activity: Knowing power and voltage of electric some devices in houses

According to the data which is written on devices (voltage and electrical power), calculate the amount of current is needed by each device during operation . then calculate the ammount of the total current? Follow the table below:

Device	Power(W)	Voltage(V)	Current(A)
Heater	1600W	220V	
Electric Iron	1000W	220V	
Washing Maching	500W	220V	
Electric Lamp	100W	220V	
Kitchen Hood	200W	220V	

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:

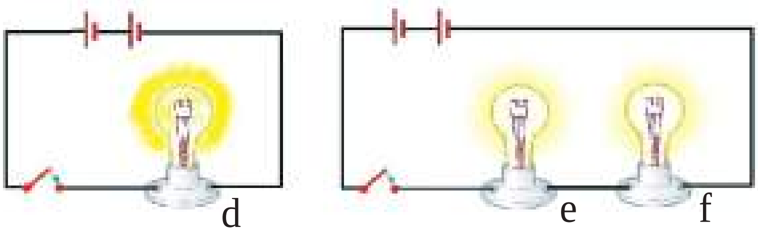
We see that the lamp (c) is brighter than the lamps (a and b). This is because of the increase in the number of battery in the circuite of the lamp (c) that is higher electric potential difference in the lamp So the current flow increases in lamp (c).

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

Remember:

-The best glowing of any lamp depends on the amount of current which flows in the lamps .

- the electric current is affected by the flowing factors:

1- The electric potential differnece between the two ends of the circuit.

2-The number of lamps which is used in the circuit (circuit's resistence) and its connection.

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 **<, >, = :**

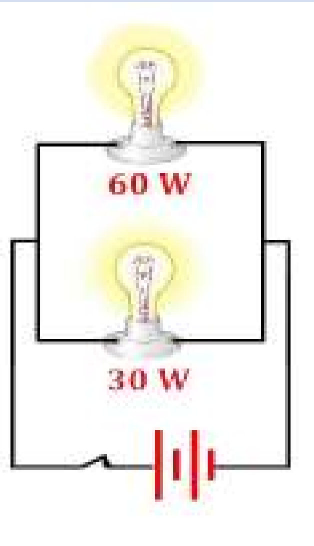


Figure 4

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.

5-2 Electrical energy and how to calculate it.

Figure 5

We use different kinds of electrical devices in our houses. The Ministry of Electricity is supplying us with electrical energy in order to operate these devices. So it sets a meter in each house to record how much electricity has been consumed, then we received an invoice to pay monthly Figure 5.

Measuring the amount of electrical energy consumed by each electrical device during a certain period of time can be calculated by using the following equation:

electric energy Consumation = electrical power × time

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

Example :

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

Solution:

$t = 20 \times 60 = 1200$ s

$E = P \times t$

$E = 1500(W) \times 1200\ (s) = 1800000\ (J)$

$E = 1800$ (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).

Solution:

1- $P = I \times V$

$P = 10 \times 220$

$= 2200$ W the power of the teapot

2- $E = P \times t$

$E = 2200\ (W) \times 20\ (s)$

$E = 44$ kJ the amount of energy consumed.

> **Think:**
> On what does the amount of consumed electrical energy depend?

We can calculate the cost of the electricity used by operating a device for a certain period of time, if we know the price of the unit of electricity (kW-h) by using the following equation:

The cost of consumed electric energy = electric energy (kW-h) × price of the unit in Dinar for each (kW-h).

i.e

Cost of Electricity = Electric Energy Consumed × Unit price .

Since: the electric energy = electrical power × time

$$E = P \times t$$

therfore:

the cost of electricity = Power (kW)× time(h)×unit price ($\frac{\text{Dinar}}{\text{kW}-\text{h}}$)

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?

Solution:

$P = 1000 \div 1000 = 1$ kW

$t = 30$ minutes $= 0.5$ h

Unit price $= 100\ \frac{\text{Dinar}}{\text{kW}-\text{h}}$

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

cost $= 1(\text{kW}) \times 0.5\text{h} \times 100(\frac{\text{Dinar}}{\text{kW}-\text{h}})$

$= 50$ Dinars the cost of electricity

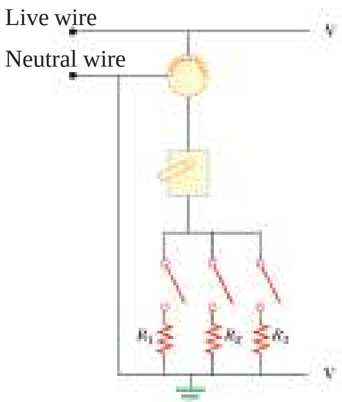


Figure 6

5.3 Electricity in our houses

The use of electric energy is an essential part of our daily lives. However, electricity can be dangerous. An electric shock can be powerful and can cause death. So how can we use electricity safely. 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) . Figure 6

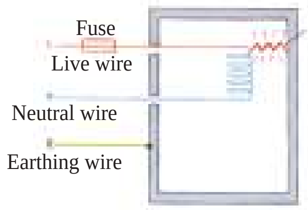


Figure 7

5.4 Earthed circuits

the Earth Wire

As you notice in Figure 7 the earthed wire (E) is connected to earth. It is used for the 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 to flow from the live wire to the earth through the earthed wire. This will make the shock less dangerous.

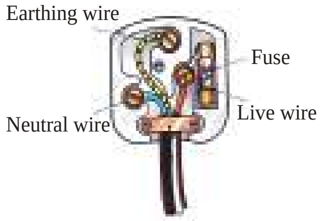


Figure 8

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. Figure 8


Figure 9

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 this 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 enter the device. This will cut off the current when there is a current flow more than a certain current flow. Figure 9

Another means of safety is the disconnect device. This disconnects the electric current automatically in case the current flow exceeds that which was planned for Figure10

.


Figure 10

5.5 Avoiding an electric shock

The earthing connection is denoted by (⏚) and is one of the safety precautions Electric device with metal covers are usually earthed to avoid an electric shock and protect the device.

Figure 11

The earth wire is normally thick, but its resistence against electricity is very Small, less than the human's resistance. Therfore, the current flows in the wire but it dosen't flow in the human body. So a short circuit with wire, is being done avoiding the human body, Figure 11.
Look at the Figure 12a . Suppose a fault has happend to the washing machine (which is connected to the electricity point through the binary plug) and suppose that this made the live wire touch the metal body of the washing machine.
In the event, if someone touches the external cover of the washing machine then the electric circuit will be produced in which the current flows from the live wire through the washing machine then through the human body to the earth. This will cause a dangerous electric shock for human Figure 12b.
If the washing machine is connected to the electricity point through a triple plug containing an earth wire, Figure 12c, and if there was contact between the live wire and the washing machine's cover (metal),there would not be any electric shock to the human (person).

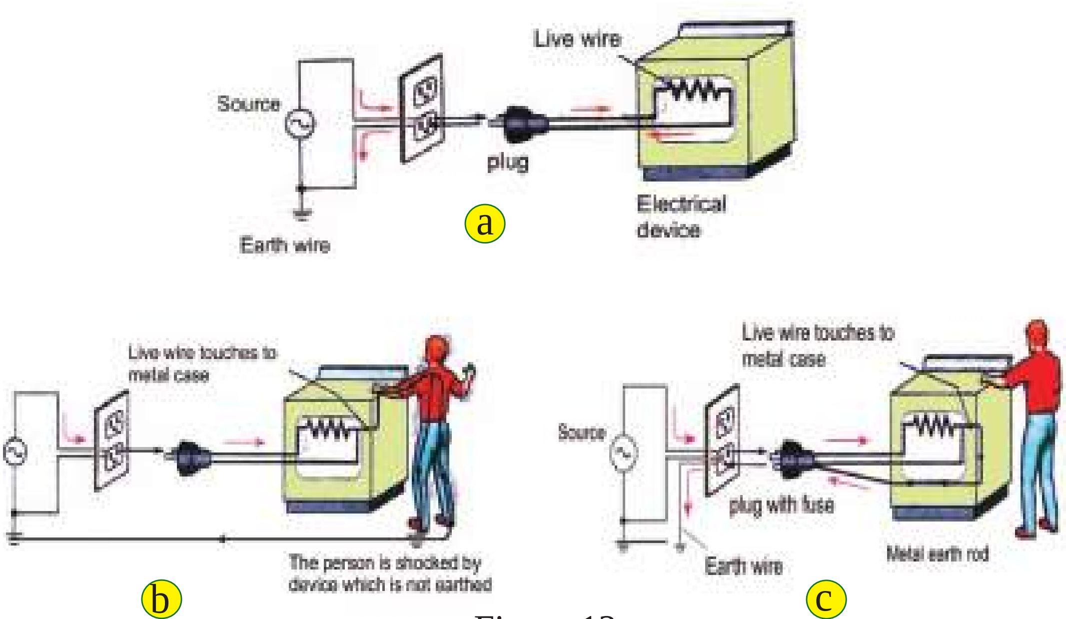


Figure 12

Do you know

The electric shock causes different damage to the human body especially to the function of the cells and the nervous system. For example, a current flow of (0.005 A) causes minor pain, however, a current flow of (0.01A) makes the muscles shrink. A current flow of (0.1A) for even a few seconds may cause death Figure 13.

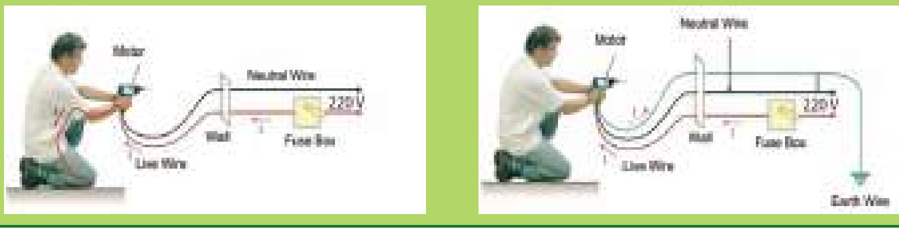


Figure 13

To protect yourself from danger you must be careful and 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. Figure(14)

Figure 14

Dear students:

The rationalization of electric energy means the best way of using electric energy of using natural light and minmising the use of electric lights during the day. Also stop using air conditioners and cooling devices in unused rooms. Economic lamps should be encouraged such as florescent lamps.

QUESTIONS OF CHAPTER FIVE

Q-1 Choose the correct statement in the following:

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

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

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

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

a) $\frac{J}{s}$
b) Watt
c) A × V
d) J × s

4. An 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

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

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

Q-2 Give the reasone of the following:

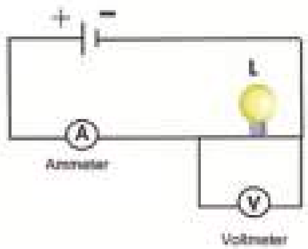
1.The fuse is connected to the electrical circuit of the house in series with the live wire before providing the electric device with electric energy.

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

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

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?

PROBLEMS



P-1 The nearby diagram represents an electric circuit 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 power

Ans:
1- 6Ω
2- 1.5 Watt

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

- Compare between the two quantities of consumed power in each resistance. What can you conclude?

Ans:
1- 0.4A ,0.2A
2-14.4 Watt,7.2Watt

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)

Ans:
0.24(kW-h)

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 (kW-h) is 100 Dinars?

Ans:
1200 Dinar

CHAPTER

SIX

6

ELECTRICITY AND MAGNETISM

Contents

Behavior Targets

After finishing this chapter ,We expect student will be able to:

- Say the conclusion of Oerested experiment.
- Explain by experiment magnetic effect of electric current.
- Distinguish the shap of magnetic field lines around straight wire , circular ring and spiral coil when an electric cuurrent flows .
-List some of the practical applications for the magnetic effect of the electric currnet.
- Mention the right - hand rule to determine the direction of magnetic field
- Define the Electromagnetic.
- Calculate the practical applications for electromagnet.
- Explain the phenomena of Electromagnetic Induction.
- Compare between the parts of simple generator for alternative current and the parts of simple generator for direct current.
- Explain the electric motor working.

Scientific Terms	
Magnetic Field	المجال المغناطيسي
Electromagnet	المغناطيس الكهربائي
Electromagnetic Relay	المرحل الكهرومغناطيسي
Electric Generator	المولد الكهربائي
Electric charge	شحنة كهربائية
Electric motor	المحرك الكهربائي
Electromagnetic Induction	الحث الكهرومغناطيسي
Electromotive Force	القوة الدافعة الكهربائية
Wire	سلك

Introduction

In 1820 the scientist Oersted observed deviation of magnetic needle which was located beside a wire during the flow of constant electric current. This was done by a simple experiment showed that the electric current has a magnetic effect. In this chapter we will study the magnetic effects of on the electric current which flows in a conductor, and some practical examples.

6.1 Magnetic Field of Electric Current

To understand the magnetic effect of electric current we do the following activity:

Activity -1: Oersted experiment

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 magnetic needle free to direct along side 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. Figure 1.

• 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 needle 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, Figure 2, so we can say that: **The electric current flow in a conducting wire generates a magnetic field around it. (This is what Oersted concluded in the above experiment).**

Figure 1

Think
•What is the purpose of using a thick wire in this experiment.
•What is the reason behind switching on the circuit (close the circuit) for a while.

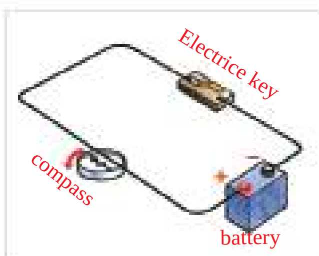


Figure 2

6.2: The electric field around a conductor straight wire with a direct electric current flow

If the electric current flows in a conductive wire generates a magnetic field around it. What is the type of this field and how do we determine its position?
What are the factors which depend on? To answer all these questions we give the following activity:

Activity -2: Planning the magnetic field for a direct electric current flow in a straight wire

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

Steps:

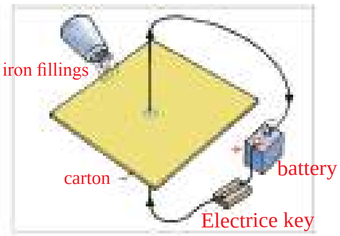


Figure 3


Figure 4

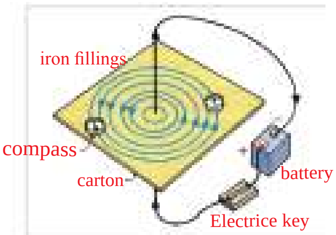


Figure 5


Figure 6

•Make a hole in the middle of the carton and thread the wire through the hole and then we connect the electric circuit Figure 3
•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. What do you observe Figure 4?
•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 flows through the wire, direction of the north pole for the magnetic needle, Figure 5
•Reverse the poles of the battery to reverse direction of the current flow in the wire, and repeat the above steps. What do you observe?
We conclude from this activity that the iron fillings is arranged in a co-centre circles (circles with the same center). The center will be the wire and in perpendicular to the wire. These circles represent the magnetic field lines around the wire as a result of an electric current flow in the wire.
With regard to the north poles of the compass needles, they represent the direction of the magnetic field at the point where the compass is , see Figure 6.
•Imagine you are holding the wire with your right hand, and your thumb is pointing at the direction of the electric current flow in the wire.

Do the directions of the north poles for the compasses take the direction of the other fingers, see Figure 7


Figure 7

In order to determine the direction of the magnetic field around a straight wire in which a constant electric current flows, we apply the right hand principle as follows:

Hold the wire with the right hand so that the thumb points to the direction of the electric current, while the direction of the other fingers bending will be towards the magnetic field Figure 8.

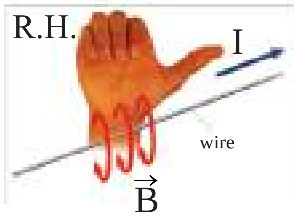


Figure 8

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. If there was a direct electric current flow in a wire perpendicular to a horizontal card, then the direction of the magnetic field will be in circles with the same center around the wire. Their direction depends on the direction of the current flow in the wire. If the direction of the current was out of the card then the direction of the magnetic field and the direction of the current will be as in Figure 9a.

However if the current flow in the wire was moving away, the direction of the magnetic field will be,as in Figure 9b.

Figure 9a (.) The dot represents the direction of the current out of paper and the direction of the magnetic field is in an anti clockwise direction.

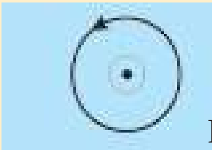


Figure 9

Figure 9b (x) represents the direction of the current entering the paper and the direction of the magnetic field will be in a clockwise direction

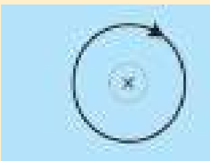


Figure 9

6.3 Magnetic field produced as a result of electric current flow in a conducted circular ring:

We learned in the previous section about the magnetic field around a conducted straight wire in which direct electric current flow. Do the properties of the magnetic field vary as the shape of the wire vary. To answer this question we have the following activity.

Activity 3:Planning a magnetic field for an electric direct current flow in a circular ring

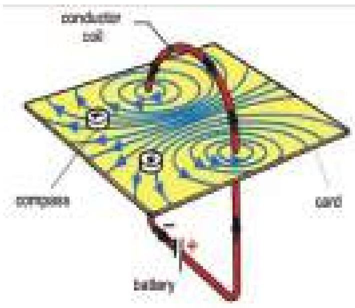


Figure 10

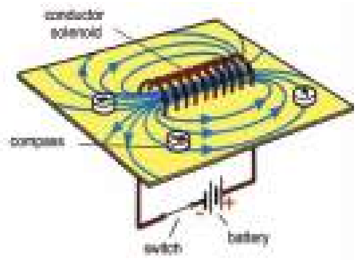


Figure 11

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 as in Figure 10 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?

• Repeat the activity by using iron powder and watch its arrangement.

We 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.

• Repeat activity 3 by using a spiral coil (many rings or coil) refer to Figure 11 instead of a ring, we see that the lines of the magnetic field are similar as Figure 10, but they will be parallel to each other inside the coil.

From this activity we conclude that:

The shape of the magnetic field inside a coil (spiral) is a set of parallel lines.Outside the coil, the lines would be closed as in Figure 12. (This would similar to a magnetic bar) as you have learned in Chapter 2. The amount of the magnetic field depends on the amount of the current and the turns number in the length cell unit, which direct proportion with them.

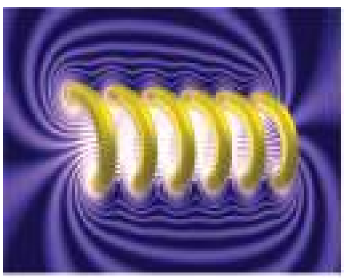


Figure 12

With regard to the direction of the magnetic field inside the coil, this is determined by the right hand rule of the coil. The direction of the closed fingers will determine the direction of the electric currents .The thumb will have the direction of magnetic field inside the coil (this will point towards the north pole).as Figure 13.

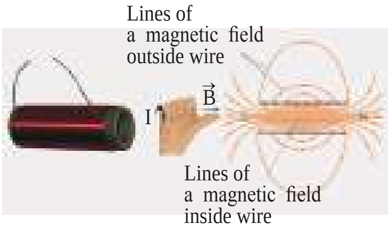


Figure 13

Question

1.Compare between the lines of magnetic field around a magnetic bar and around coil in which a direct electric current flows. Refer to Figure 14a and 14b

2.Compare between the lines of magnetic field inside the coil and outside it in regard to the direction and quantity. Look at Figure14b.

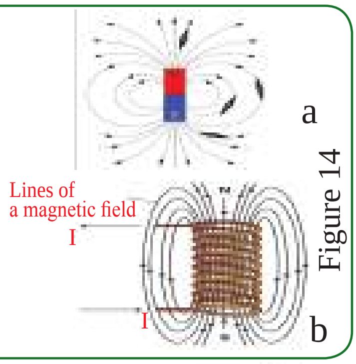


Figure 14

It would also possible for a magnetic field to be generated around a moving charge as an electron around the nucleus of the atom Figure 15.

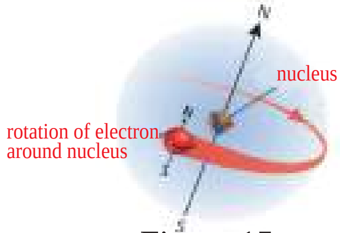


Figure 15

6.4 Electromagnet

Recalling the activity (3) and showing the effect of a piece of soft-iron (iron nail) when it is placed inside a spiral conducted wire:

The piece of soft iron will get magnetised when a direct electric current flow in the conducted spiral wire.When the electric current is cutoff, the iron bar will lose its magnetic property. By now you should have made an electromagnet. This means that the electro-magnet is a temporary magnet which will disappear when the electric current flow disappears in the wire. It is possible to take advantage of this point in making electromagnet Refer to Figure 16.


Figure 16

The electromagnet is 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) Figure (17) The direction of wrapping the wire in a magnet is in a (U) shape around the core of iron in two opposite directions in order to get two magnetic poles, one north and the other south at its two ends, the two ends of the wire will be connected to source of an electric current.

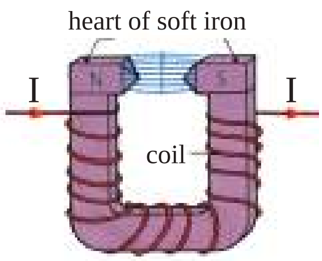


Figure 17

When the electric circuit is closed, the electromagnet will be generated. When the electric circuit is open (disconnection of electric current) the magnet field will disappear quickly in the piece of iron. This means we have a temporary magnet Figure (18).


Figure 18

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.

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

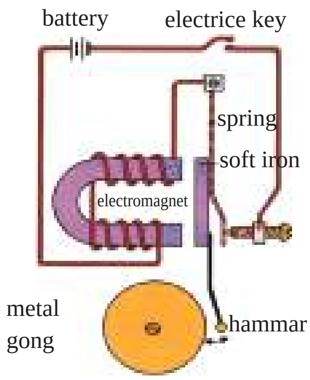


Figure 19

6.5 The Use of Electriomagnet

The Electric Bell:

This is a well-known device for alarming. An electromagnet is used in operating the electric bell, which consists of:

1.An electromagnet in a (U) shape. Figure 19
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 metal gong 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.


Figure 20

The Telephone:

This is a wire communication method from a distance which is used to transmit and receive sound waves between two people or more, commonly used in houses, as Figure 20 .It is operated through transmitting electric signals through a telephone network which facilitates communication from one person to another.

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 Figure 21.

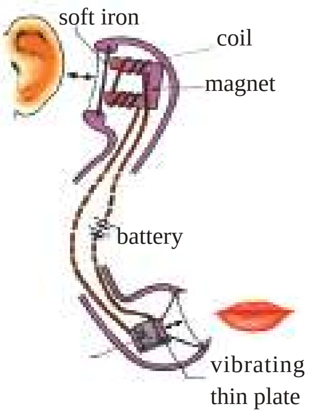


Figure 21

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. This is initiated by a small current when turning the car key. It is also used at the electronic circuits in order to switch (on) and (off) automatically. Figure 22

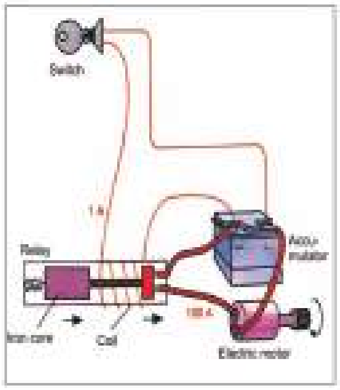


Figure 22

6.6 Electromagnetic Induction and Induced Electromotive Force

As you knew the electric current flow in any wire will generate a magnetic field around it. But is it possible to generate an electric current as a result of a magnetic field? To answer the question we will do the following activity:

Activity -4: Generating electricity by using a magnetic field

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

steps:

•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? Refer to Figure 23a.

The galvanometer pointer would not move because there is no change in the magnetic field.

•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. Refer to Figure 23b.

When the conductor stops moving, the pointer does not move Figure 23c.

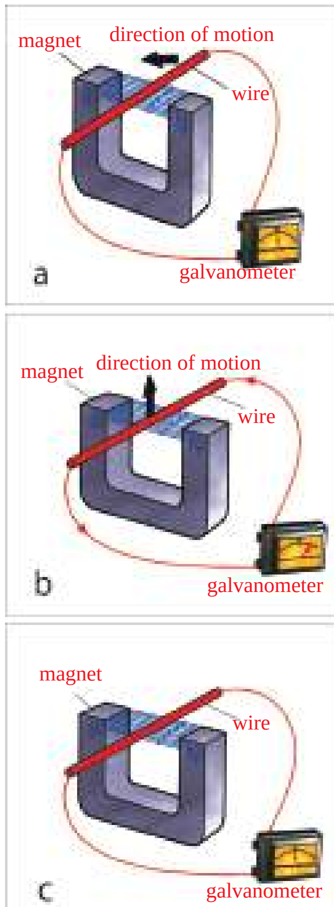
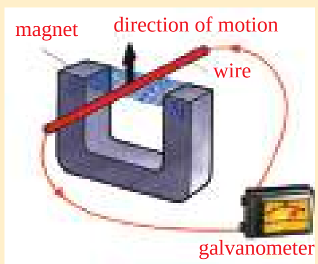


Figure 23

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 of magnetic field.

Remember: The induced current is generated in the electrical circuit which is closed when the wire crosses the magntic field. (When there is a change in the number of lines of magnrtic force in unit time). This current will not be created when we keep moving the wire in a parallel way to the lines of the magnetic fields.



We have studied in (Chapter Three) that the electric current in an electric circuit (closed) which is created as a result of connecting it to a battery (or any source of voltage). Now what is the reason of generating an induced current in the above activity in the absence of a battery?

To answer this question we do the following activity

Activity-5: Induced emf

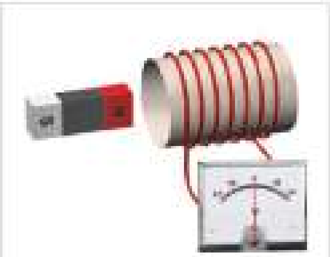


Figure 24

Tools: magnet bar, cylindrical coil, galvanometer

Steps:

• Connect both ends of the coil to the two ends of the galvanometer , Figure(24).

• 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. Figure (25a)

• Fix the magnet beside the coil and observe it. Does the galvanometer pointer move? Figure (25b) Observe that the pointer of the galvanometer is fixed at zero , Look at Figure 25c. 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.

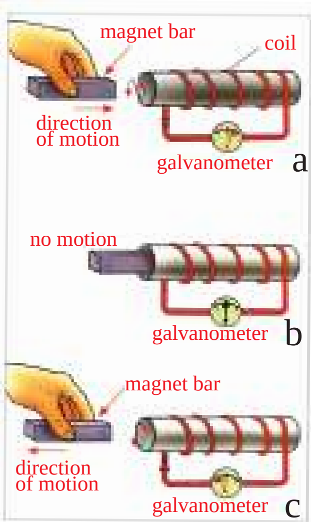


Figure 25

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). This is measured in volts. This was first carried out by the scientist Faraday in 1831.

According to the above information, the electromagnetic induction is a phenomena of gnerating 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 .

The induced magnetic phenomena is the basis for operating many electric devices especially the generators.

Do you know?
In the direct current generators (in everyday life).
•A set of coils are used, not only one.
•The magnets rotate and the coil remains fixed.

6.7 Applications of Electromagnetic Induction

The discovery of electromagnetism by induction led to develope the means of generating, transferring and distributing the electric energy through transport networks is regarded as a basis for modern technology.

Electric Generator of alternative current

This is device which converts the mechanical or dynamic energy to electric energy with magnetic field availability. It is regarded as the main source which is used to produce electric energy. It works on the foundation of electromagnetic induction.

The generator, in its simplest form, consists of the following:

- A coil of conducted wire, insulated and wrapped around an iron core.
- Two insulated metal rings.
- Two carbon brushes.
- A permanent magnet or electromagnet in a (U) shape Look at Figure 26 .

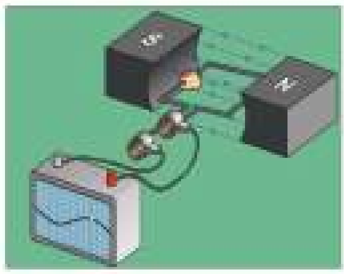


Figure 26

What happens during the rotation of the coil between the magnetic poles?

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 electric 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. Figure (27).

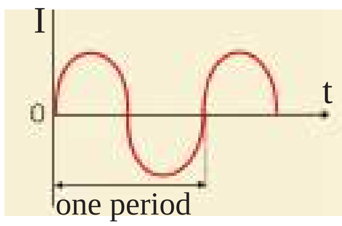


Figure 27

The simple generator for direct current

The direct current generator consists of the same parts as in the generator of alternating current. The difference is that the use of the two halves of the metal ring is electrically isolated from each other, and they join the two ends of the core coil, which is called the commutator, Figure (28) .

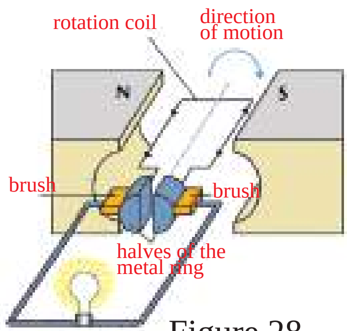


Figure 28

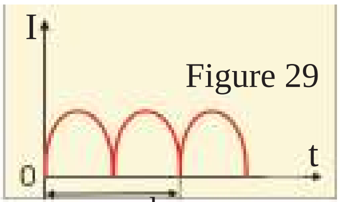


Figure 29

The current which we get in this case will be in one direction (DC). It is called a direct current. Look at Figure (29).

Electric motor

This is a machine which converts electrical energy to mechanical energy with the existence of a magnetic field. That means, it works in a contrary way to the electric generator Figure (30). The function of the electric motor depends on the principle of the magnetic force in the wire in which the direct electric current flows Figure (31).


Figure 30

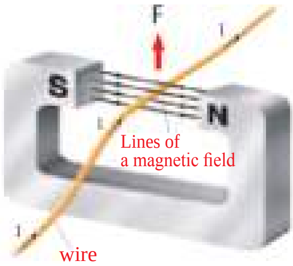


Figure 31

Electric motors are used in many electric devices such as (the electric vacuum cleaner, electric drill, mixers, fans, etc).The volume and the capacity of the electric motors can be different Figure (30). Small machines such as mixers and most of the kitchen devices need very small as they need less power, however trains need very large and complicated motors.

The electric motors which work in direct current consist of the following parts:

•The core of the motor. This is made of a coil of isolated copper wire contained a piece of iron Figure(32).

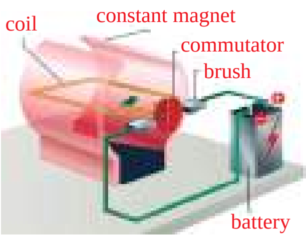


Figure 32

•A permanent strong magnet where the coil is placed between its two poles

•Commutator: 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.

•Two brushes of carbon touching the two halves of the exchanger and they connected to the two poles of electric direct current

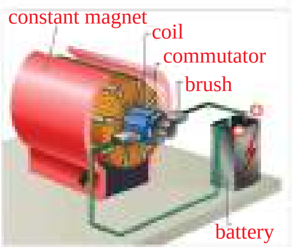
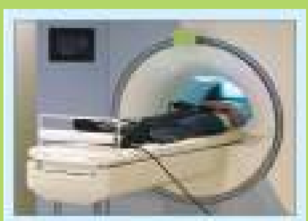


Figure 33

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 commutator. Figure (33).

Do you know?
MRI (magnetic resonance imaging) is one of the important application of electromagnetism



QUESTIONS OF CHAPTER SIX

Q-1 Choose the correct statement for the following:

1)Induced electromotive force (emf) is generated as a result of changing in:
a)Electric field.
b)Magnetic field.
c)Electric potential difference.
d)Mechanical force.

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.

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 .

4)The electric generator convert the mechanical energy to:
a)Chemical energy.
b)Electric energy.
c)Magnetic energy.
d)Light energy.

5)Electric motor converts the electric energy to:
a)Mechanical energy.
b)Chemical energy.
c)Magnetic energy.
d)Light energy.

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.

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 generates magnetism around it.

d)The magnetic field of the nail will disappear after a period of time when the current is cut off.

8)The moving electric charges generate:

a)An electric field only.

b)A magnetic field only.

c)An electric and a magnetic field.

Q -2 In which way does the electromagnet differ from a permanent magnet?

Q-3 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?

Q-4 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 wire.

2.A ring conductor wire.

3.A wire coil in a spiral shape .

Q-5 Explain (with giving reasons) in which of the following two cases a straight conducting wire with an electric current flow will be affected by a magnetic force when placed inside a regular magnetic field:

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

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

Q-6 The magnetic field of a coil with electric direct current increases when a piece of iron is placed inside it. Give your reasons.

Q-7 What are the basic components of:

a)An electric generator.

b)An electric motor.

Q-8 What are the principles of the functioning of each of the following:

a)An electric motor.

b)An electric generator.

Q-9 What is the difference between the alternating current generator and a direct current generator respect to:

a)The consisting parts.

b)The outbut current from them.

CHAPTER SEVEN

7

ELECTRIC TRANSFORMER

Contents

Behavior Targets

After finishing this chapter, We expect the student will be able to:

- know the Electric Transformer.
- Say the parts of Electric Transformer .
- Apply the law of Saving energy of the ideal electric transformer.
- Apply the law of transformer efficiency to solve physical prolems.
- Compare between step-up and step-down transformers.
- Listed power loses in electric transformer.

Scientific Terms	
Electrical Transformer	المحولة الكهربائية
Step-up TransformerStep-	المحولة الرافعة
Step-down Transformer	المحولة الخافضة
power Station	محطات القدرة
Load	حمل
primary Coil	الملف الابتدائي
Secondary Coil	الملف الثانوي
High Voltage	الفولطية العالية
Source of AC Voltage	مصدر الفولطية المتناوبة
Soft iron Core	قلب من الحديد المطاوع

Introduction

Electric energy is regarded as the most common energy used in houses. It is used in light, heating and operating all electric devices. It is also used in electric devices in hospitals, factories,etc. You have learned in chapter six how the induced current is generated in conductors. You have also learned that the induced current is generated when there is a variation in the lines of a magnetic field through a conductor in the unit of time, or as a result of a relative motion between the conductor and the magnetic field penetrates the conductor a accompanied with a variation in the magnetic flow. Sometimes, We need to change the alternative voltage either by raising it to a higher value, or decreasing it to a lower value. Electric transformers are used to alter the voltage which goes out of any alternative source. Look at Figure 1. We use electric transformers to raise the voltage, as in TV or they also use to reduce the voltage, as in radio and recorder.

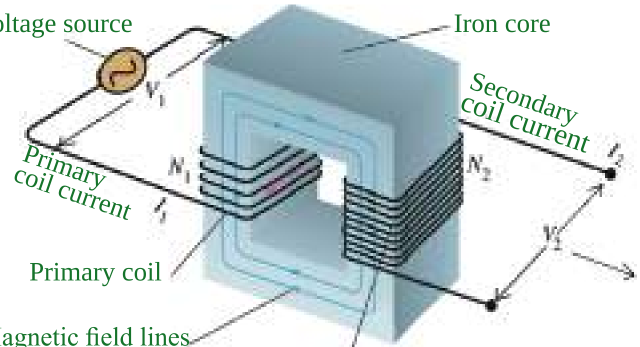


Figure 1

7.1 Induced current

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.

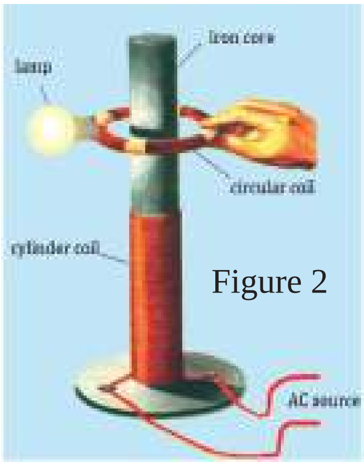


Figure 2

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.

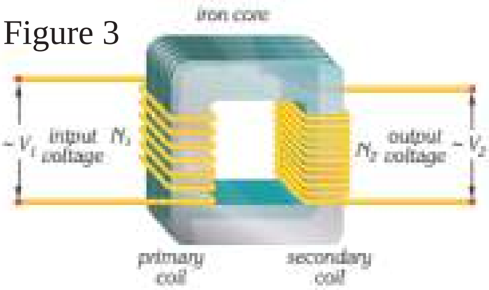
We conclude from this activity the following:

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.

7.2 Electric Transformer and it's Types

Electric transformers

Figure 3



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.

Electric transformer consists of two coils made from insulated copper wires wrapped around a closed core of soft iron. Figure 3

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. So the electric transformer considers one of the alternating current devices that is becuse does not operate on the direact current. That is because there is no an induced current generated in the secondary coil, because no change happens in the magnetic field inside the iron core.

The coil connected to the source of alternating voltage (the supply of voltage to the transformer)which its turns number of coils is (N_1) is called the primary coil. while the coil which is connected to the load (the system which works on the transformer) which has (N_2) turns number is called the secondary coil.

Since the electric power (P) is equels the result of multiplying voltage (V) with current (I) and is measured by watt i.e.

$$P = I \times V$$

The input power in the primary coil (P_1) =The current of primary coil (I_1) × voltage of the primary coil (V_1)

$$P_1 = I_1 \times V_1$$

The output power from the secondary coil (P_2)= Secondary coil current (I_2) × Voltage of secondary coil (V_2)

$$P_2 = I_2 \times V_2$$

According to the energy conservation law, we find that the amount of the supplied power for the primary coil equals the amount of the output power in the secondary coil (assuming that the transformer is ideal) this means neglecting the loss in energy through the wires of the two coils and through the iron core of the transformer during its operation. Then we can apply this equation:

The power supply for the primary coil= the output power from the secondary coil.

That means:

$$P_1 = P_2$$

Then we have : $I_1 \times V_1 = I_2 \times V_2$

All transformers will have loos of power during their operation. The output power will be less than the input power. So the efficiency of any transformer is measured by applying the following relationship:

The efficiency of transformer (η)

$$= \frac{\text{(the output power in secondary coil } (P_2))}{\text{(the input power in Primary coil } (P_1))} \times 100\%$$

Then $\eta = \frac{P_2}{P_1} \times 100\%$

$$\frac{\text{Output voltage from secondary coil } (V_2)}{\text{input voltage in Primary coil } (V_1)} = \frac{\text{turns number of coils in secondary coil } (N_2)}{\text{turns number of coils in Primary coil } (N_1)}$$

$$\frac{N_2}{N_1} = \frac{V_2}{V_1}$$

The ratio $\frac{N_2}{N_1}$ is called the transfer ratio in the transformer, or the ratio of the turns number.

It is important to mention that during the transfer of electric power to far distances by long wires it is transferred with high voltage and low current, so that the loss can be minimized. The loss occurs as a result of the high resistance in the wires.

There are two kinds of transformers.

The first type: step-down transformer

In this kind of transformer, the turns number in its secondary coil (N_2) will be less than the turns number of coils in its primary coil (N_1) as in Figure (4). So the output voltage from the secondary coil (V_2) will be less than the input voltage (V_1) in the primary coil.

There are numerous usages for this type of transformer. Most of the transformers which are used in the input voltage of the houses, are from this type of transformer. It is also the same with the stations which receive power in order to supply cities Figure(5a). Also the transformers used in electric welding Figure (5b) and the mobile phone transformers (chargers),Figure (5c) .

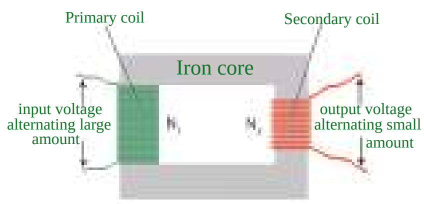


Figure 4

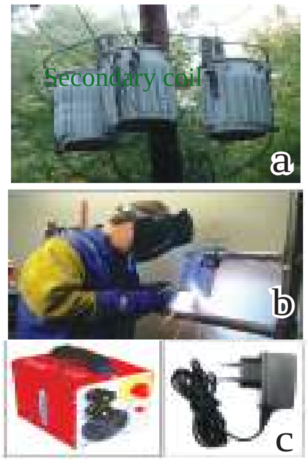
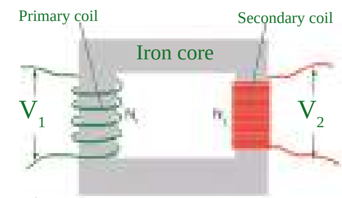


Figure 5

The secondary type-step-up-transformer

In this kind of transformer the turns number in the secondary coil (N_2) will be greater than the turns number in the primary coil (N_1), Figure 6. So the output voltage from the secondary coil (V_2) will be greater than the input voltage (V_1) in the primary coil. It is like the transformer which is used in TV to supply high voltage to the electronic shooter of screen Figure (7a). Electricity power generators also use this kind of transformer when they transmit electric power to the cities Figure (7b).



$V_2 > V_1$ Figure 6

a b

Figure 7

$$\frac{\text{(the output voltage from secondary coil } (V_2))}{\text{(the input voltge in Primary coil } (V_1))} = \frac{\text{turns number in secondary coil } (N_2)}{\text{turns number in primary coil } (N_1)}$$

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

If the power loss is neglected in the transformer, then the transformer is called ideal one , and in which the output power will be equal to the input power: $P_2 = P_1$

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

This means that the step up voltage transformer will be a step down current at the same time. The voltage inversely (indirectly) varies with the current. There is a relationship between the turns number in the coil and the current in the ideal electric transformer.

$$\frac{N_2}{N_1} = \frac{I_1}{I_2} \longrightarrow \frac{V_2}{V_1} = \frac{N_2}{N_1}$$

If the transfer rate in any transformer $\frac{N_2}{N_1}$ is greater than one, then the transformer is step-Up voltage transformer. Then we have: V_2 greater that V_1 and step- down current (I_2 less than I_1). If the transfer rate in any transformer $\frac{N_2}{N_1}$ is less than one, then the transformers step-down voltage and we have V_2 less than V_1 and step- up current. (I_2 greater than 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.

7.3 power loss in electric transformers

The types of loss are:

1. Loss as a result of wires resistance of the two coils: This loss will appear as heat energy in the wires of two coils (primary and secondary) during the operation of the transformer. This is as a result of Ohm resistance for the wires of the two coils.

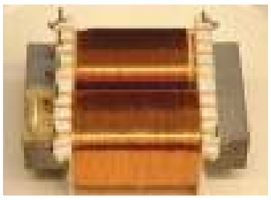


Figure 8

To minimize this loss, the wires of the two coils are made of material with less resistance (copper) Figure 8.

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 parallal to the magnetic field. Look at Figure 9.

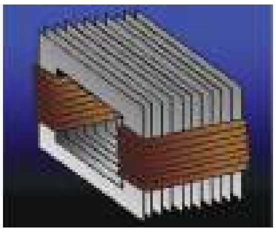


Figure9

Example (1) 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.

Solution

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).

2. V_1=240V, N_1=500 turn V_2=12V, N_2=?

Apply the formula $\frac{V_2}{V_1}=\frac{N_2}{N_1}$

$$\frac{12}{240}=\frac{N_2}{500}$$

N_2=25turn

Example (2)

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

$$P_{lost}=P_1-P_2$$

$$11=220-P_2$$

therefore P_2=209W

$$\eta=\frac{P_2}{P_1}\times100\%$$

$$\eta=\frac{209W}{220W}\times100\%$$

η=95%

QUESTIONS OF CHAPTER SEVEN

Q-1 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, the turns number of a secondary coil in is 300

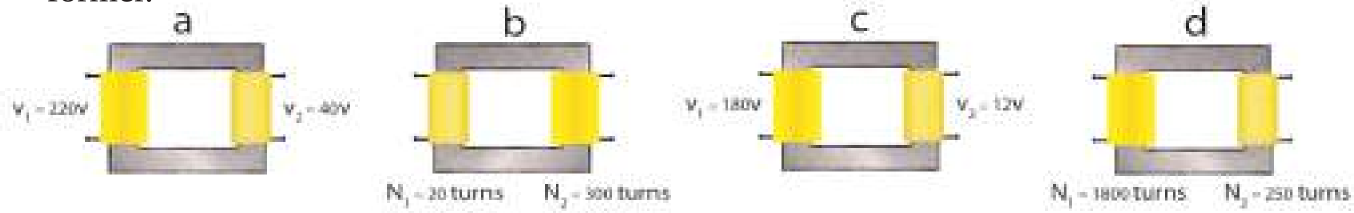
turn and the turns number of its primary coil is 6000 turn. If the alternating voltage around its primary coil is 240V, then the output voltage from its secondary coil is:

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.



Q-2What is the differences between the step up transformer and the step down transformer?

Q-3What is the basic function of the electric transformer ?

Q-4Explain how the electric transformer operates to a change the voltage.

Q-5Where can the electric transformers be used ? 1. Step up 2. Step down

Q-6Explain the economical advantage of transforming electrical power to far distances with a high voltage and low current.

Q-7 Why does the electric transformer need alternating current in order to operate ?

Q-8 Does the electric transformer operate if a battery is used between the two ends of its primary coil ? Explain that .

Q-9 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.

2- At the end of the power transforming lines before reaching to the factory.

Problems

P-1 A transformer with an efficiency of 100% and the rate of transformation is ($\frac{1}{2}$) 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.

Ans 1- 110V
2- 0.55A

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 transerformer?

Ans 6 kW

P-3 An electric transformer with an efficiency of (95%) The input power was (9.5 kW). What is the output power?

Ans 9.025 kW

P-4 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

Ans 1. 200 turn
2. 2A
3. 0.05A

CHAPTER EIGHT

8

ENERGY SOURCES TECHNOLOGY

Contents

Behavior Targets

After finishing this chapter, we expect student will be able to:

- Explain the importance of Energy in our life.
- Know the concept of Energy.
- Determine types of energies invested by people.
- List types of Non-Renewable energies.
- List types of Renewable energies.
- Explain the difference between Non-Renewable and Renewable energies.
- Determine the benefits of Renewable energies applications.
- Say the importance of using different types of Renewable energy.
- Illustrate the benefits of Solar energy applications.
- Say the benefits and applications of Solar Cells.

Scientific Terms	
Energy	الطاقة
Hydropower energy sources	المصادر المائية للطاقة
Nuclear energy Sources	مصادر الطاقة النووية
Non-Renewable energy Sources	مصادر الطاقة غير المتجددة
Renewable energy Sources	مصادر الطاقة المتجددة
Solar Cell	الخلية الشمسية
Wind energy	طاقة الرياح
Biofuel energy	طاقة الوقود الحيوي
Tidal energy	طاقة المد والجزر
Alternating current (AC)	التيار المتناوب
Direct current (DC)	التيار المستمر

8. 1 Energy in our Life

Figure 1

Energy is one of the basic principles in civilized societies. We need energy in everyday life. It is used to operate a large number of factories, transportation and household devices, etc .Figure 1

Obviously, there are different kinds of energy Look at Figure2, such as light, heat, sound and mechanized energy which keeps machines working. Also the chemical energy stored in bands of atoms, molecules and nuclear energy which can be converted into electric energy.We have known in previous chapters, it is possible to convert the energy from one form to another, and the energy is the ability to perform work. We use different kinds of units to measure energy depending on the form of energy used. One of the important units is known as a Joule.

1 Joule = 1 Newton × 1 meter

There are some other kinds of units,

1 (Kilowatt - hour) = 3.6×10^6 Joule

1 (Horse Power-hour) = 2.68×10^6 Joule

Figure 2

There are other kinds of energy which are used in the case of primary particles, such as molecules, atoms and other contents such as electron-volt, eV and 1 eV= 1.6×10^{-19} Joule.

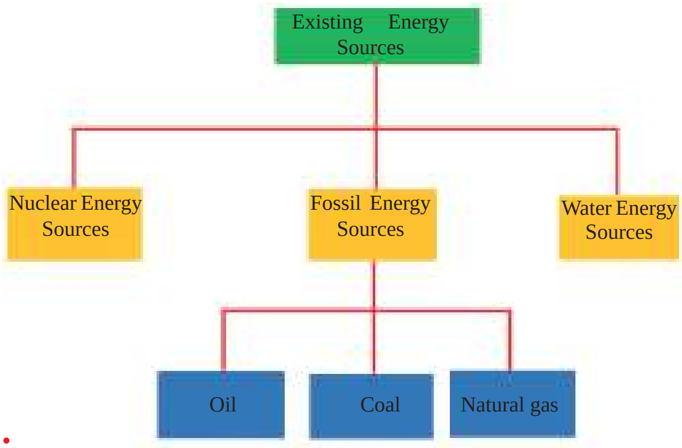
8.2 The sources of energy Nowadays :

Human beings have been trying to invest in various types of energy. Energy has been obtained from water or from the wind or solar energy. Even now people use wood in order to overcome energy problems such as heat. Existing energy sources are divided into three types, these are:

1- Fossil sources.

2- Water source energy.

3-Nuclear energy sources .



8.2.1 Fossil Energy Sources:

The sources of fossil energy consist of two elements carbon and hydrogen, that means hydrocarbons 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. Figure 3

Figure 3

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.

8.2.2 Water Energy Sources

The concept of water energy sources, essentially depends on the principle of converting the potential energy of the water stored behind the dams or the high places, to mechanical energy during the water fall. The water flows either through pipes or streams to water turbines or hydraulic turbines. Figure 4.When water pushes through turbine, the Axis of turbine will rotate and that will lead to rotate large electric generators to generate electric energy.

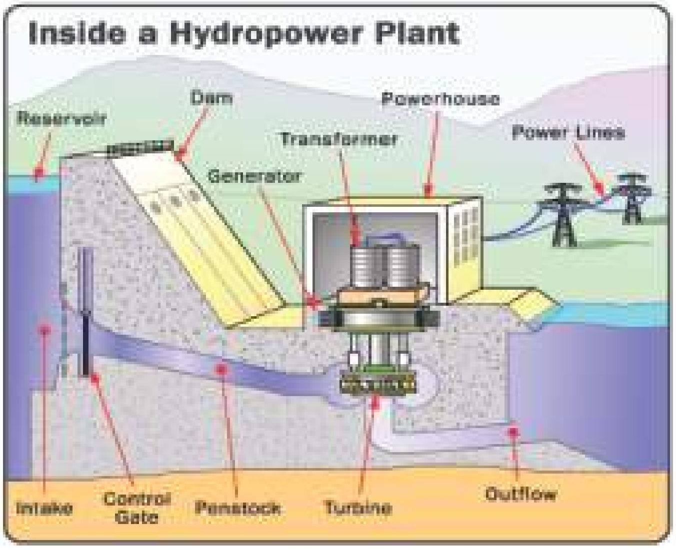
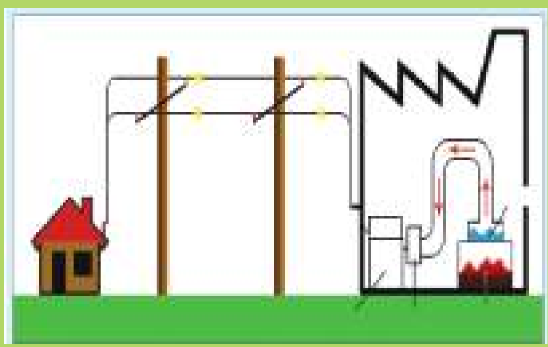


Figure 4
(See only)

Do You Know

There are steam (heat) stations which generate electric energy. They are burning fuel to operate The heat which produce due to that will convert water into steam in huge boilers, then this steam which has a very high pressure rotates the turbines. These huge turbines rotate the generators which produce electricity. Refer to the diagram.



8.2.3 Nuclear energy Sources:

Nuclear energy stations produce electric energy in a similar way to those in the steam stations. However, they use 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 (^{235}U).

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. The steam rotates the turbine, Figure 5, which rotates the electric generator that generates electricity.

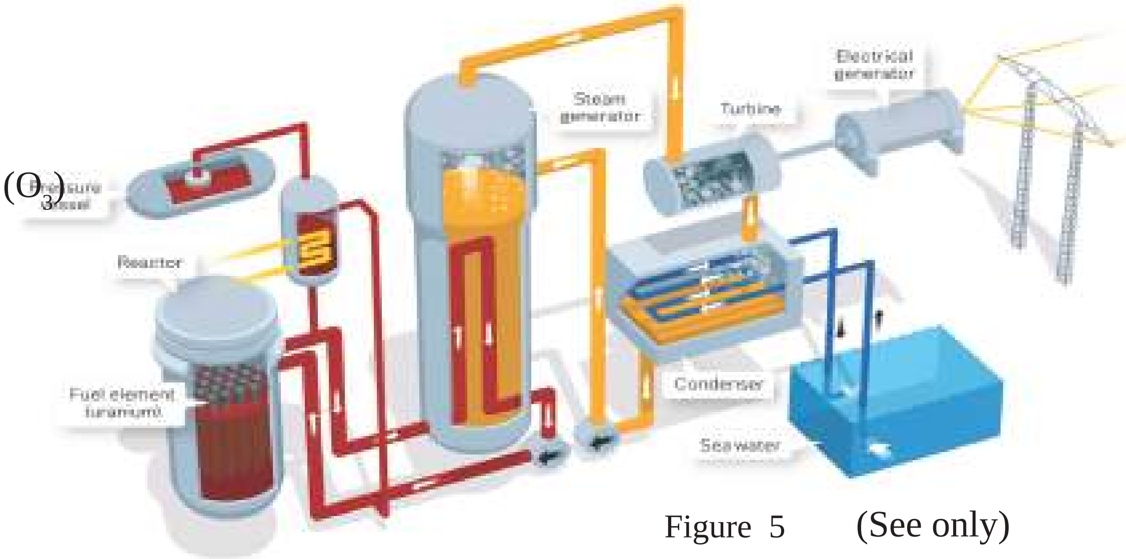


Figure 5 (See only)

8.3 Renewable Energy Sources:

Now, we live in stage of countdown as related to decrease of the fossil energy sources coal, gas and petrol. These sources have contributed effectively in our lifestyle. However, these sources also have problems in use. These problems are in terms of increasing pollution as a result of using these resources.

Efforts have been made in order to find alternative resources. The following issues made the use of renewable energy preferable.

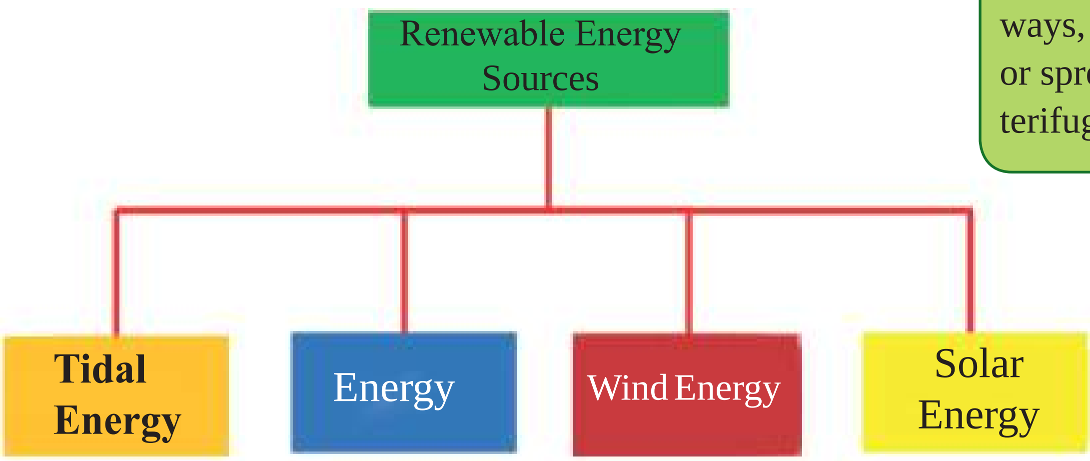
1- Because it does not exhaust (finish).

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.

Some of the important sources of renewable energy (alternative energy) is given in the following diagram:



Do you know

Uranium is a radiated element denoted by (U). It consists of (U-238,U-235and U-234). U-238 is widely available in nature as 99.3.% from crude uranium. While U-235 is an important, effective and fissionable counterpart and its ratio is less than 1%. The process is separated and assembled in a process called enrichment and is done in several ways, including laser or spread gas or centerifuge.

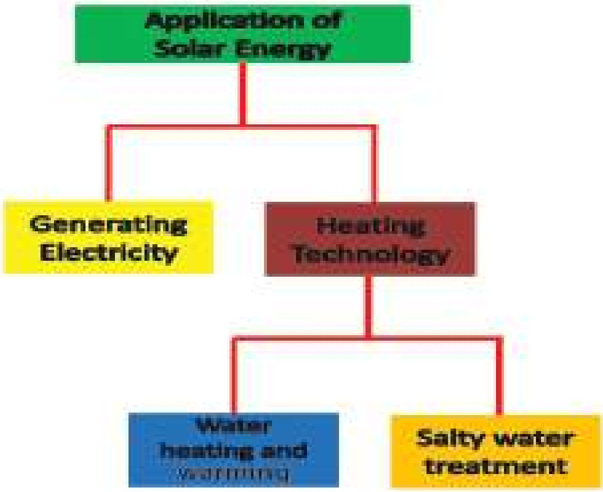
Figure 6

8.3.1 Solar Energy Technology

Solar energy, received by earth, is the main source of life on the earth's surface. It is regarded as a direct and indirect source for various types of energies. Look at Figure 6. Solar Energy Technology is regarded as one of the important means of supplying world demand with daily energy sources.

This sector witnessed important designs and technical developments which have enabled it to be an important source of renewable energy, and is easily available in most parts of the world. It has no negative side effects on the environment, as it has no gases or chemical materials which may harm humans or the environment.

The fields of investing solar energy can be illustrated in our life in the following diagram:



Solar Energy Investment in Electricity

Solar Cell

Figure 7

Figure 8

The solar cells which are also called photovoltaic cells is derived from the function of the solar cell. The word (photo) means light while the word (voltaic) means the electric potential difference.

On this base , the fundamental function of the Solare cell is to convert the solar energy to electric energy. Look at Figure7. The solar cell (photovoltaic cell) made of one layer of thin semi-conducting material such as silicone, in addition to some impurities, such as phosphorous or boron at certain rates in order get acertain combination to convert the light to electric energy.From Figure 8 we see that the upper layer in the solar cell is consists of silicone which is polluted by phosphorous called type N which saves electrons. The lower layer is silicone polluted by boron called type P which receives electrons. The solar cell has a very thin layer on the surface which prevents the reflection of sunlight. The cell is covered by glass board to protect it from the atmosphere effects .

There are two points for the outward connection of the external circuit. It is worth to be to mentioned that the solar cell supplies us with direct electric power DC, as is that when we use dry battery which provides us a direct current but the difference between them is the dry battery works on an electro-chemical reaction which converts to an electric current. However the solar cell works on the sun rays energy in order to obtain an electric current. Figure (9.a,b).

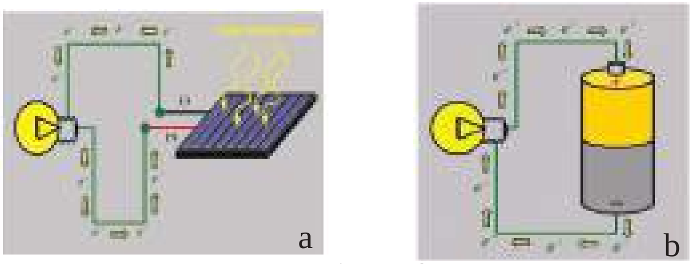


Figure 9

The electric potential and current generated from one cell is insufficient to supply enough electric power. Each cell generates between (1-2 watt) which is small power. So many cells will be combined and used forming panels. Figure 10.

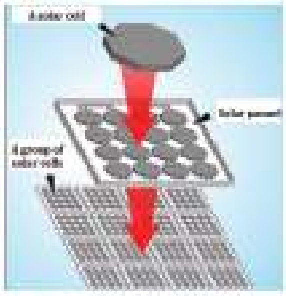


Figure 10

The cells are usually connected in series in order to increase the voltage from the system or in parallel in order to increase the current produced Figure(11a), Figure(11b). The voltage supplied by the panel varies with the variation of the resistance of the load which used, such as the electric lamp or electric motor work with direct current.

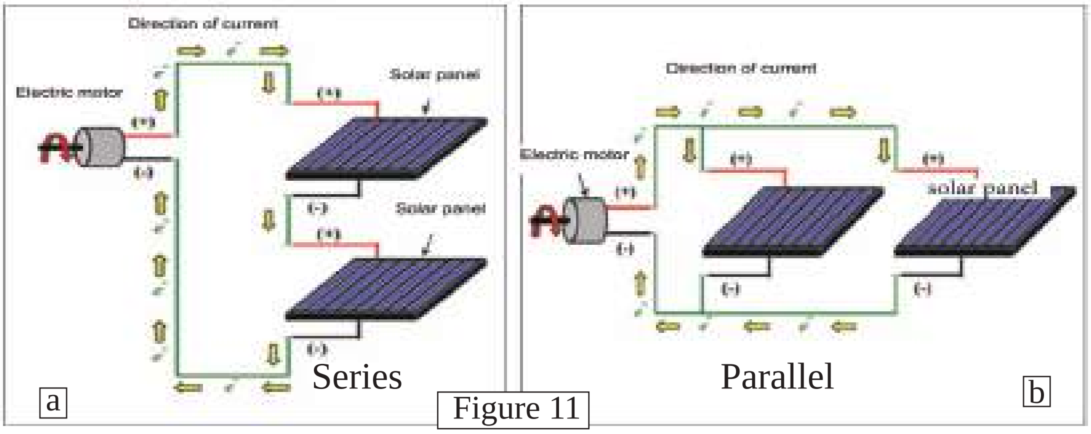


Figure 11

We therefore conclude that the direct power which we are supplied by the solar cell is given by the following relationship.

DC Power(Watt) = current (Ampere)× voltage (volt)

or $P = I \times V$

Solar cells can be used to recharge batteries, and they can be used whenever we need electricity Refer to Figure 12 in which we see that the circuit consists of a system called an inverter which converts DC electric current supplied by the charged battery to alternating current AC in order to operate the electric devices at home.

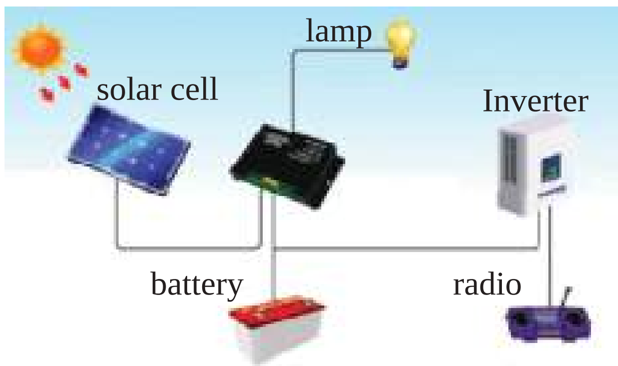


Figure 12

The period of time needed to charge a battery depends on the power of the solar panels with respect to the number of its cells and area. Figure 13

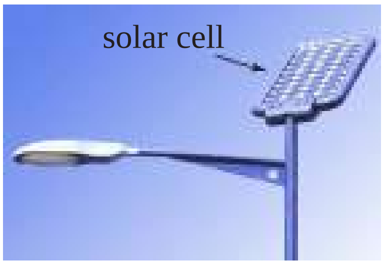


Figure 13

The production of electric energy in the solar cells varies directly with the intensity of the sun's rays to a certain degree. To find out the solar power intensity on a solar cell, this is done by multiplying the solar cell area (A) in units (m^2) by the intensity of incident solar radiation on that cell which is in the range of $1400 \ \frac{watt}{m^2}$. Figure 14.


Figure 14

The solar power (the input power) = Incident solar radiation intensity×solar cell surface area

The Conversion Efficiency of Solar Cell Energy

The efficiency of converting the solar cell energy is the ratio between the output power to the input power, that means:

$$\text{Solar cell energy conversion efficiency} = \frac{(\text{Output Power})}{(\text{Input Power})} \times 100\%$$

$$\text{Solar cell energy conversion efficiency} = \frac{\text{Output Power}}{\text{Incident solar radiation intensity} \times \text{solar cell surface area}} \times 100\%$$

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

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 $1400 \ \frac{watt}{m^2}$.

Solution

Area= 4 cm × 6 cm= 0.04 m × 0.06 m= 0.0024 m^2

The input power =Incident solar radiation intensity×solar cell surface area

$$\text{Input power} = 1400 \ \frac{watt}{m^2} \times 0.0024 \ m^2$$

$$= 3.36 \text{ watt.}$$

Example-:

A solar cell in the shape of a square (0.2m × 0.2m) If the value of the incident solar radiation intensity on the cell equals $1400 \ \frac{watt}{m^2}$ 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.

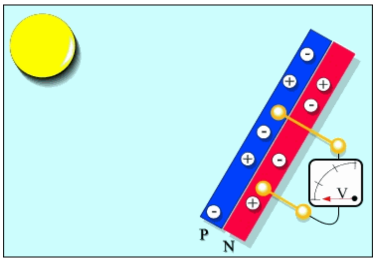
Solution:

Output electric power = current × voltage

$= 0.16\ \text{A} \times 12\ \text{V}$

$= 1.92\text{Watt}$

Solar cell energy conversion efficiency $= \dfrac{(\text{Output Power})}{(\text{Input Power})} \times 100\%$



$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$\eta = \frac{1.92}{1400 \times 0.2 \times 0.2} \times 100\%$$

$$\eta = \frac{1.92}{56} \times 100\%$$

$$= 3.42 \times 10^{-2} \times 100\%$$

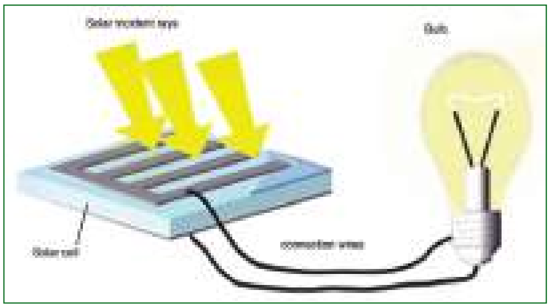
$$\eta = 3.4\%$$

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 $\dfrac{\text{watt}}{m^2}$.

Solution:

Solar cell energy conversion efficiency $= \dfrac{(\text{Output Power})}{(\text{Input Power})} \times 100\%$



$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$0.12 = \frac{P_{out}}{1400 \dfrac{\text{watt}}{m^2} \times 0.01 m^2}$$

$$P_{out} = 1.68\text{watt}$$

Solar Cell Heat Applications

Heat energy is one of the main energy uses in human life, and is very common in the use of solar cell energy. Some of the applications are listed below:

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, Figure 15.Certain metals are used in this system.

Figure 15

Figure 16

These materials are anti-rust and painted with a black color so that it absorbs the largest amount of solar rays such as oxides of chrome and cobalt.There are other types in which mirrors of parabola are used to get boiling heat as in Figure 16.

Water purification by solar energy technology

The following are some of the means currently used to purify water by solar energy:

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 as in Figure 17.

Figure 17

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. Look at Figure 18.

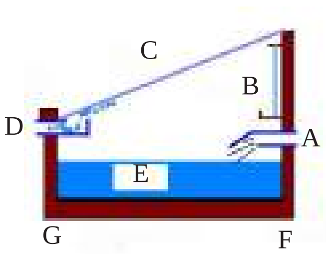


Figure 18

A:enter impurified water B:mirror C:glass cover
D:exit puer water E:impurified water F:special layer
G:black plate

8.3.2 Wind Energy Technology

The basic operation of wind technology depends on the investment of wind power to rotate air fans, therefore a strong wind will make the fan rotate. The fan is connected to an electric generator enabling the core of the generator to rotate, and as a result generate electric energy, Figure 19. The speed of wind varies according to the locations it is generally faster at the seaside and in the desert.

The wind energy source depends on the speed of the wind which should not be lower than 5.4 m/s and must continue for long hours in the day .Figure 20.

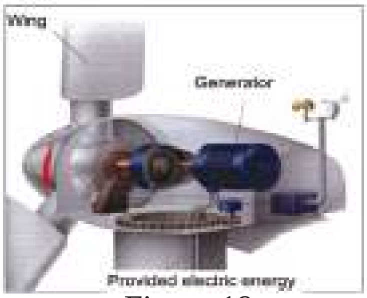


Figure 19

Figure 20

Do you know?
Solar cells are used to generate electric power and generated energy can be used to raise the well water.

8.3.3 Biofuel Energy

Biofuel energy is the energy obtained from a live creatures either plant or animals. It is one of the important renewable energy resources. The liquid biofuel occupies the first place to be are one of the most important sources of producing this kind of fuel energy. Liquid fuel is available in two types:

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, Figure 21. This fuel can also be used in operating some kinds of cars.

Figure 21

> Do you know?
> It is possible to get gas biofuel (methane gas) from the chemical decom position of plants, animal waste, garbage, and animal carcasses by non-arial digesting.

2. Biodiesel fuel

It is extracted from plants which contain oils such as soya bean, palm oil, sunflower etc. They need chemical processing. Figure 22.

Figure 22

8.3.4 Tidal energy

It can be benefit from the obtained by benefit from the tidal movement in the seas and oceans to generate electric energy. Refer to Figures 23 .a and 23.b. 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.

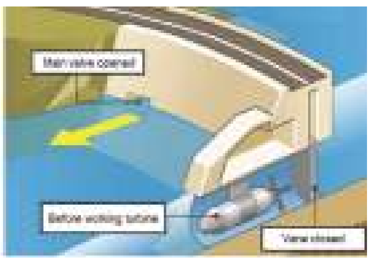


Figure 23 a

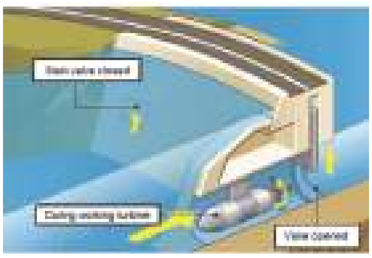


Figure 23 b

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. $1200 \frac{watt}{m^2}$ b. $1000 \frac{watt}{m^2}$ c. $1400 \frac{watt}{m^2}$ d. $1100 \frac{watt}{m^2}$

9- The converting efficiency of a solar cell is (0.17) for an area of ($0.01\ m^2$). The incident solar radiation intensity is ($1400 \frac{watt}{m^2}$) . 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%

Q-2 If the number of solar cells which are connected in series are increased, explain how the amount of the output voltage is varied?

Q-3 A glass layer is placed on the solar panel when it is manufactured. What is the advantage of that?

Q-4 Renewable energy is preferred to non-renewable energy. Explain.

Q-5 State the basic function of:

a. Solar cell technology b. Wind energy technology

CHAPTER

NINE

9

PHYSICS OF ATMOSPHERE AND MODERN COMMUNICATION TECHNOLOGY

Contents

Behavior Targets

After finishing this chapter, we expect student to be able to:

- Explain the contents of atmosphere.
- State the layers of atmosphere.
- Define Ozon layer.
- List types of Wired Channels.
- Say the contents of optical fibers.
- Distinguish between the land waves and atmosphere ones.
- List the contents of mobile phone.
- Determine the usages of satellites.

Scientific Terms	
Atmosphere and its contents	جو الارض ومكوناته
Atmosphere Layers	طبقات الغلاف الجوي
Modern Communications Technology	تقنية الاتصالات الحديثة
Wired Channels	قنوات الاتصال السلكية
Wireless Channels	قنوات الاتصال اللاسلكية
propagation of wireless wares	انتشار الموجات اللاسلكية
Mobile phone	الهاتف النقال
Satellites	الاقمار الصناعية

9.1 The atmosphere and its contents

The word atmosphere is referred to the air cover which completely surrounding the earth. The thickness of this cover is very small compared to the diameter of the earth. It is seen from space as a thin layer of dark blue light on the horizon, Look at Figure1.

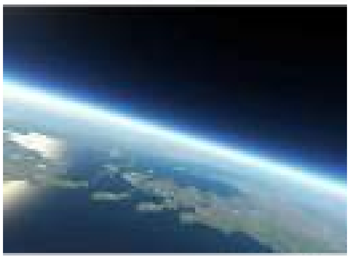


Figure 1

The atmosphere of a mixture of many gases surrounding the earth which connected to it because of the gravity. The mixture has constant ratio of gases such as dry air, which contain a constant percentage as shown in Table 1.

The unbalanced activities of humans cause the pollution of atmosphere due to the changing of natural percentage of atmosphere gases which cause the global warming. Accordingly, climate changes, floods, melting of ice in north and south poles and un natural hurricanes happened, Look at Figure 2.

Do You Know
The global warming is a phenomena in which the heat remains in the atmosphere more than its natural rate and doesn't flow out of the atmosphere as a result of a absorbing the carbon dioxide which is produced by factories and human activities.

Figure 2

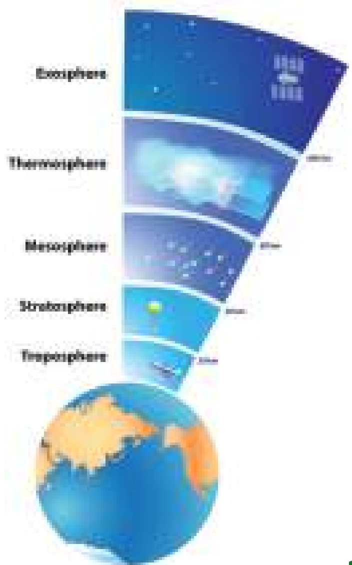
Table 1

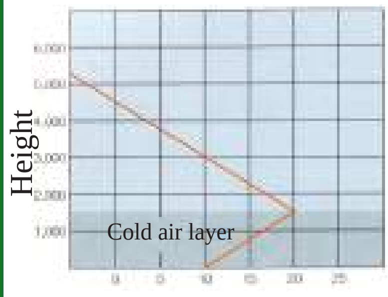
Chemical Symbol	Percentage in the atmosphere(see only)
N_2	78.8
O_2	20.94
Ar	0.9325
CO_2	0.036
Ne	0.0018
He	0.0005
Kr	0.0001
CH_4	0.00017
H_2	0.00005
N_2O	0.00003
O_3	0.000004
Xe	0.000009

9.2 Atmospheric layers

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. These layers change according to their height from the surface of the earth. Each layer is different from the other. There are five important layers in the atmosphere which are:

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere
5. Exosphere





Air temperature
Figure 3

(see only)

1. Troposphere

This is the first layer of the atmosphere close to the surface of the earth. Its stretch to high approximately 14 km from the surface of the earth. This layer forms 80% of the atmosphere. It is the most upset layer. All climate phenomena and weather changes take place at this layer.

The pressure and the density decrease rapidly within this layer according to the high from the surface of the earth. The temperature also decreases at this layer at a constant rate called fixed decrease. For instance, the temperature decreases about 6.5°C for each kilometer Figure 3.

2. Stratosphere

This layer sites over the Troposphere as in Figure 4. Stretch from high (14 km) to high (50km). It contains the ozone layer. 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. The stratosphere characterizes by increase its relative temperature by increase the height above Earth's surface which increase about (-60°C)at the lower edge to(-15°C)at the higher edge for this layer.

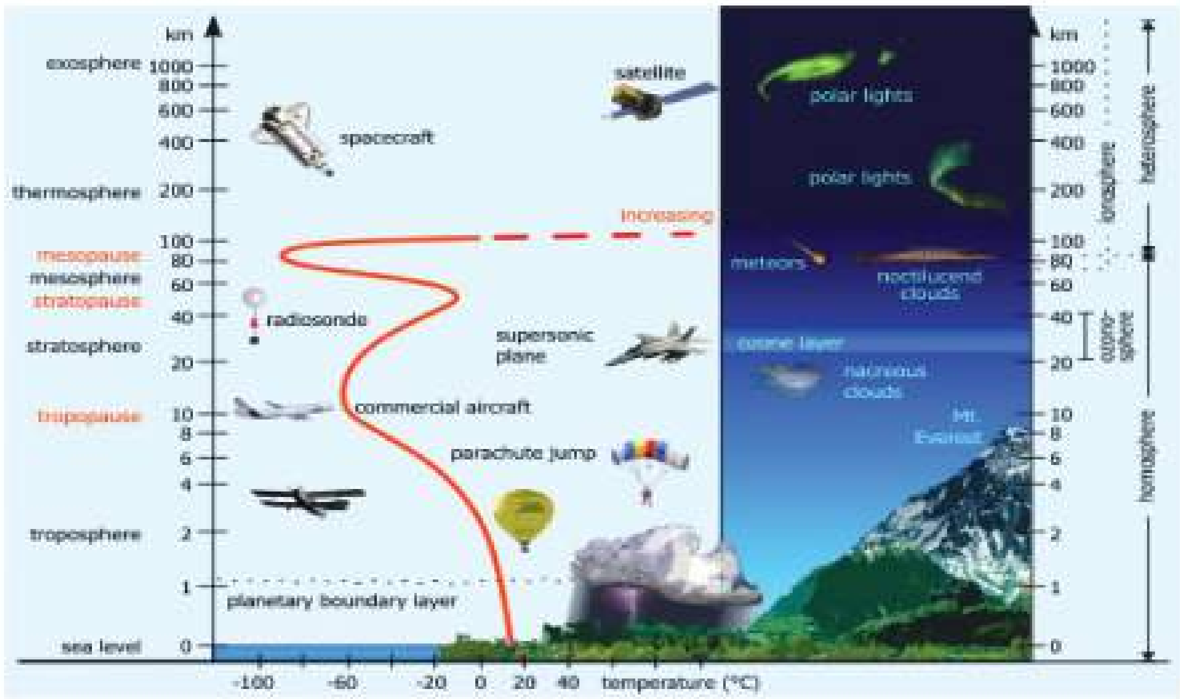


Figure 4

Ozone layer

Ozone in the stratosphere is generated by ultraviolet rays which originate from the sun. In Figure 5, the ultraviolet can be classified into three types which are A, B, and C. The negative effects of these three types concentate in type C which affects living creatures on the surface of the earth. The ozone layer is regarded as a protection for living creatures on the earth's surface.

This Layer prevents the harmful radiation type C from reaching to the surface of the earth.

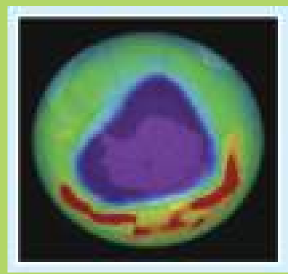
The function of the other two types A and B is to generate Ozone (O_3) so that the ultraviolet ,which the sun its source, absorbed by (O_2), molecules which is in the atmosphere, and break down into two oxygen atoms (O+O). After that each atom will merge with a molecule of oxygen (O_2) producing the ozone molecule (O_3) as in the following equations:

$O_2 + UV \rightarrow O + O$

$O + O_2 \rightarrow O_3$

It is important to mention that exposure to type B ultraviolet for a long time can have negative effects. It may result in burning the skin and in some cases it may cause skin cancer.

Do you know?
The ozone hole means that the ozone concentration is reduced (its percentage is reduced). The hole can be seen at the region surrounding the north and south poles of the globe with larger areas of these poles.



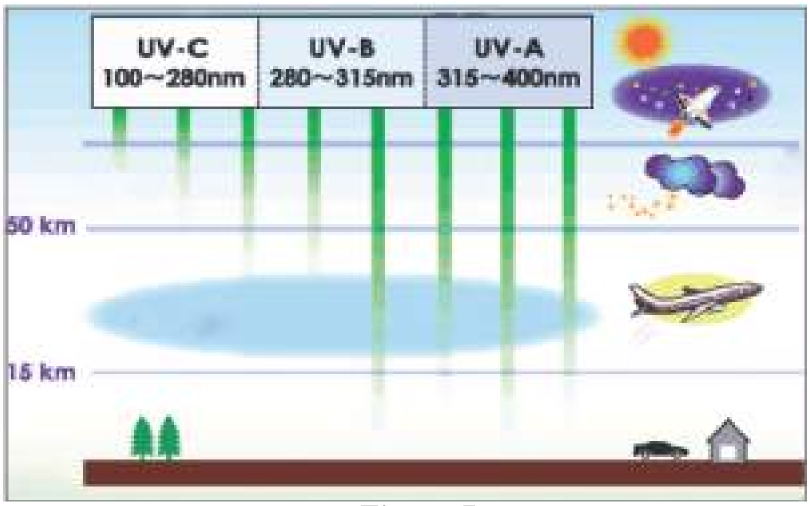


Figure 5

3. Mesosphere

This layer is situated at the middle of the atmosphere stretch from high (50 km up to 90 km). Its gases are helium and hydrogen. Its pressure and density are low. The temperature decrease in the mesosphere with the increase of height from the surface of the earth. At the highest region of the mesosphere, the temperature is the lowest which equal to (-120^{o}C) Figure 4.

4. Thermosphere

It is a hot layer above the mesosphere and is called the hot layer. Its height is from(90 km) to(500 km). It contains free electrons and ions and it is also called the Ionosphere. This layer has higher temperature as moved up away from the surface of the earth. The temperature can reach (1000^{o}C) at its highest edge. Figure (4)

In this layer the radio-waves that have a frequency of less than (300 KHz) can be reflected. Look at Figure 6.

Figure 6 : Every layer in the atmosphere has an advantage for humans. The Ionsphere, for example, reflects the radio waves which are transmitted from a certain centre to the earth. This can allow the transmission to the far distances.

Figure 7

5. Exosphere

This is the highest layer in the atmosphere at a distance of (500 km) from the surface of the earth, and it represents the external gas cover Figure 7. The molecules of the gas move very quickly in a way that they possess sufficient dynemic energy to be free of gravity and escape to external space.

9.3 Modern Communication Technology

Modern communication systems expand all over the world and transmit sound, data and images and various information. The fast development of computers and electronics led to the development of communication. Now communication and exchange of information are automatic and very speedy such as the internet application. Look at Figure 8.

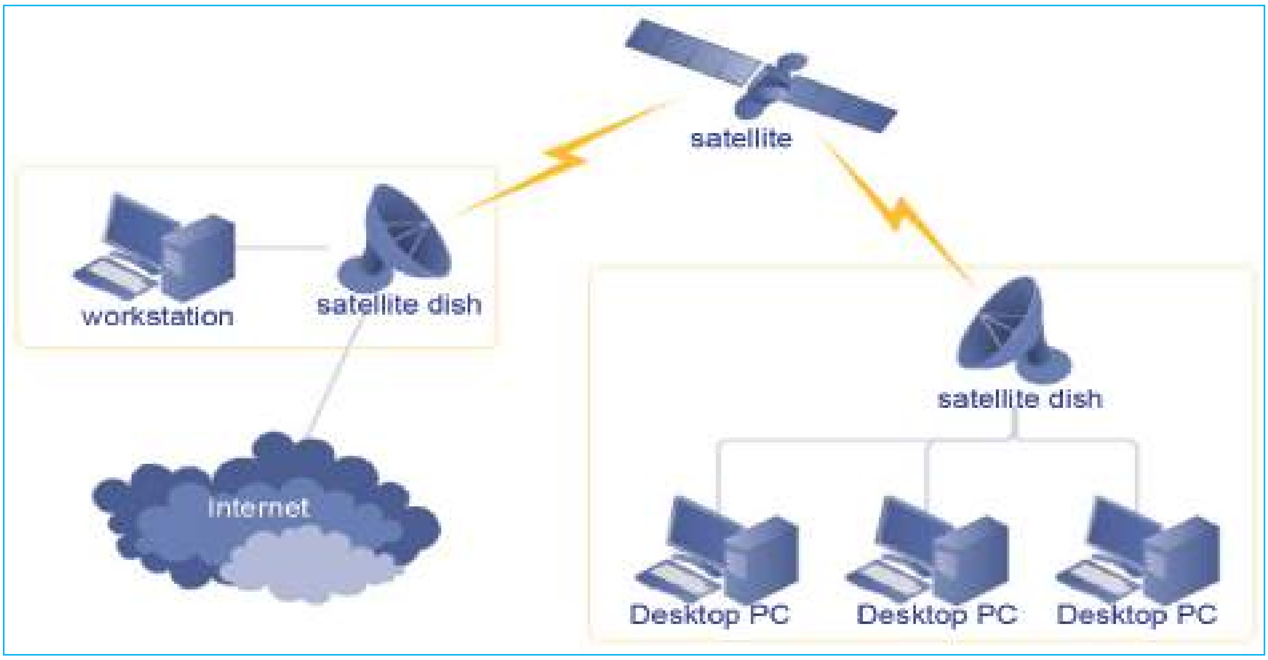


Figure 8

9.3.1 Communication Systems Units

Communication systems consist of three basic units, Figure (9) as follows:

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.

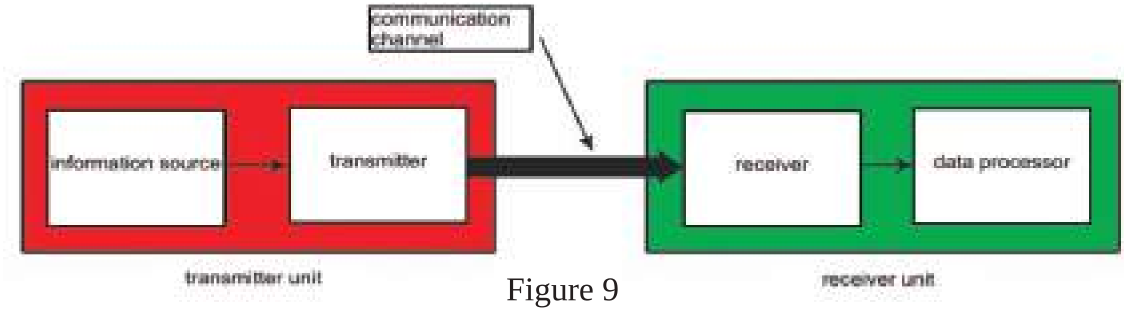
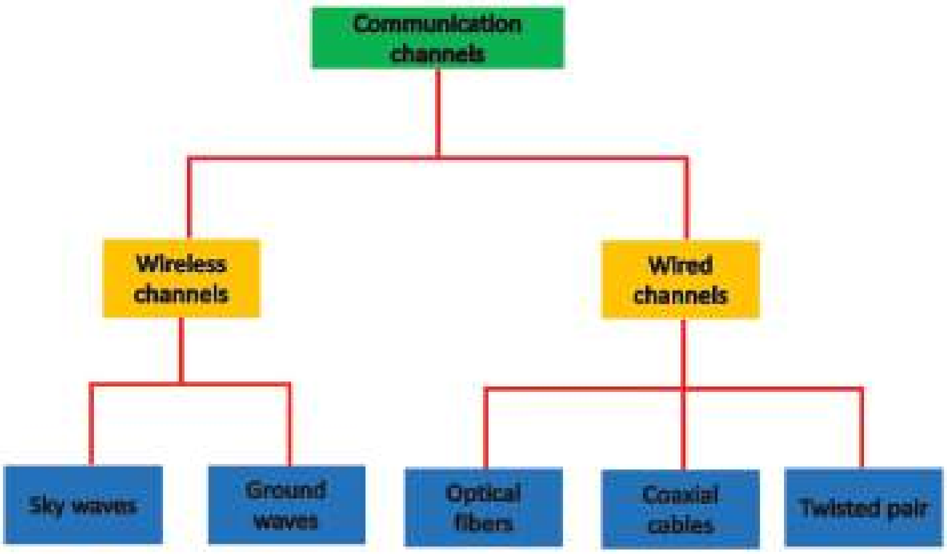


Figure 9

9.3.2 Types of Communication Channels

There can be two types of communication channels:



1. Wired Channels

Wired channels are regarded as a physical means between the two sides of communication and these are, the source (transmission) and the destination (receiver) . Its contents are as follows:

a. Twisted pairs:

These are two parallel isolated wires which carry signals Look at Figure 10

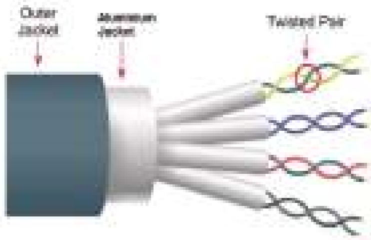


Figure 10

b .Coaxial cables :

Figure 11

It is made of two metal cylinders with the same centre. 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. Look at Figure 11. This kind of cable is used to transmit signals with relative high frequency.

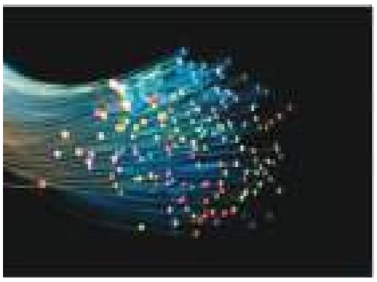


Figure 12

c.Optical Fibres: These are designed to direct the light according to inner total reflection phenomena for the light inside the optical fibre. This is widely used in optical communication which enables transmission of signals for long distances. Look at Figure 12.

Optical fibre consists of the following parts: Figure 13

1. The core. It is a glass or flexible thin transparent material in which the light is transmitted.

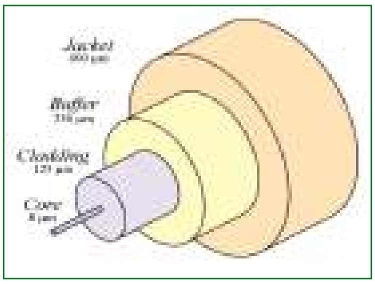


Figure 13

2. Cladding: It surrounds the core of glass and reflects the light to the centre of the optical fibre
3. Coating buffer: It is a cover which encloses the optical fibre to protect it from the damage, breakage and humidity.

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 recever) . It travels in straight lines and in a speed which equals to the speed of light.

9.4 Propagation of wireless waves:

Wireless waves spread out in the air in two different ways. They are the earth waves and the sky waves.

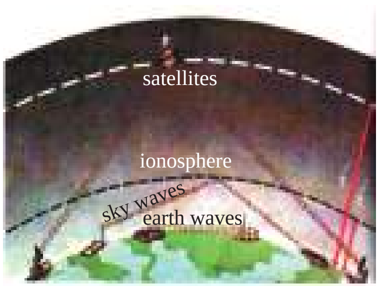


Figure 14 a

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, as a result of the crust of the earth surface. 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.

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. Figure (14-a-b)

While to the waves which have frequencies higher than HF is the microwaves. These waves have the ability to penetrate the Ionosphere layer, and travel into outer space. So they are used in the satellites communications. These satellites receive the waves, and strengthens them, and sends them back to the earth. Look at Figure (14-b). These are used in the mobile phones.

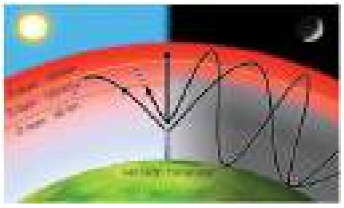


Figure 14 b

9.5 Mobile phone:

Mobile phones is one of complex technical devices due to accumulation of electronic circuits within a small area, Figure 15.

It is a wireless communication means

Figure 15

The basic contents of mobile phone

The mobile phones consist of the following as Figure 16

1. Electronic circuit containing a processor and memory chips.
2. Aerial
3. Display screen
4. Key boared
5. Sound receiver
6. Speaker
7. Battery

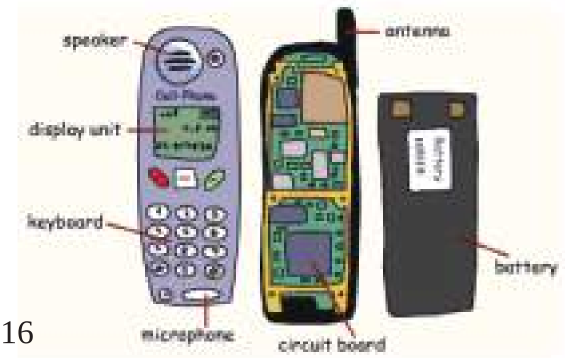


Figure 16

9.6 Satellites:

The satellite rotate around the earth carrying electric devices. They are used in communication and scientific purposes, Figure 17.

They are used for the following purposes:

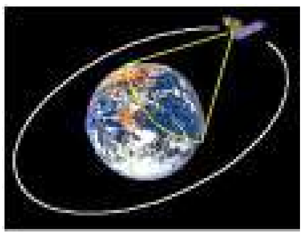


Figure 17

1. Communication satellites: These are specially designed for telephone communication and the satellite channels and to transmit data. They are usually placed in high locations (36000 Km) from the earth surface which is higher than the other satellites. Figure 18.

Figure 18

2. Scientific Satellites: The purpose of these satellites is to monitor the weather, meteorology, solar activities and for recognizing Global position system (GPS) .These will be at medium heights Figure 19.

Figure 19

3. Military purpose satellites: These satellites rotate in special orbits at relatively low heights to survey and take photographs of military

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?

Q-4 State the main atmospheric layers?

Q-5 State the characteristics of the following layers:
1. Troposphere.
2. Stratosphere.
3. Mesosphere.

Q-6 what is Ozone? Where does it exist? How does it form?

Q-7 from what are the contents of the modern communication systems and what is the function of each one?

Q-8 State the types of wired communication channels?

Q-9 what are the main contents of mobile phone?

Q-10 state three satellite uses?

Index