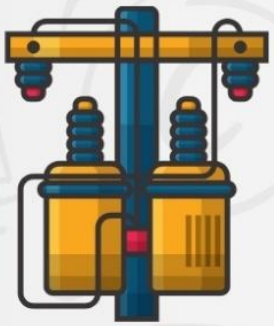
فيزياء
الثالث المتوسط

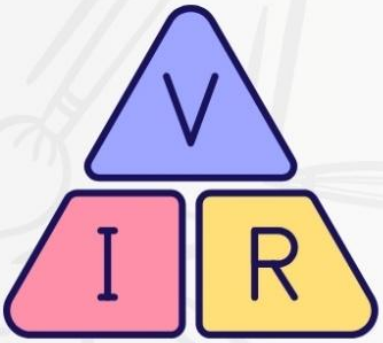
Sajjaj
PHYSICS

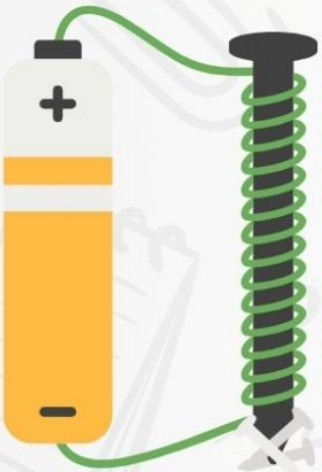
منهج المتميزين

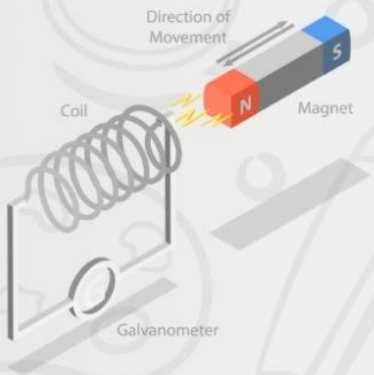
2025-2026

Part 1









الأستاذ: حكم باسل

@Hakam_Basil

Chapter (1) Electrostatic

Introduction

This chapter talks about electrostatic, where it can be observed, how we obtain it, how to detect it, what force exists between it and some other details.

المقدمة

هذا الفصل يتحدث عن الكهربائية الساكنة، اين يمكن ملاحظتها، كيف نحصل عليها، كيفية الكشف عنها، ماهي القوة التي تكون بينها، لأي قانون تخضع وبعض التفاصيل الأخرى.

Common Observations

- ✓ The paper attracted towards a plastic material such as a comb when the comb is rubbed by hair

انجذاب قصاصات الورق الصغيرة الى مادة بلاستيكية مثل المشط بعد دلكه بالشعر

- ✓ the water drops are attracted towards the comb after rubbing it with hair

انجذاب الماء باتجاه المشط بعد دلكه بالشعر

- ✓ The balloon sticks to the wall after rubbing the balloon with a piece of wool

التصاق البالون بالجدار بعد دلك البالون بقطعة صوف

- ✓ Hair is attracted to a balloon after rubbing the balloon with a piece of wool

انجذاب الشعر للبالون بعد دلك البالون بقطعة من الصوف

NOTE:
All these observations occur because the rubbed object will be getting electrostatic charges.

جميع هذه المشاهدات (الحالات) تحدث بسبب اكتساب الجسم الذي يتم دلكه شحنات كهربائية ساكنة

- ❖ Feeling a slight electric shock when touching a metal object after walking on carpets

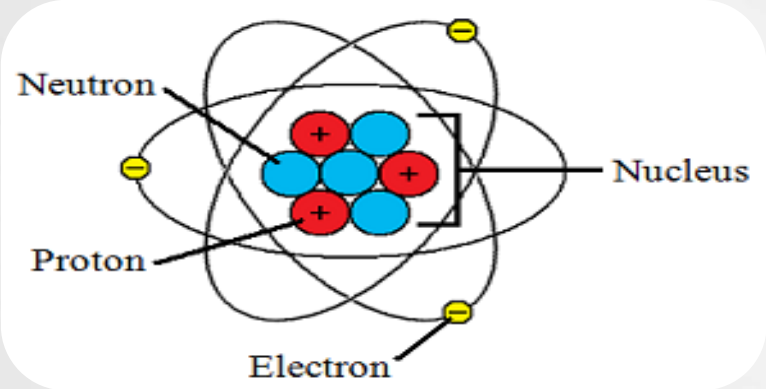
الشعور بصعقة كهربائية خفيفة عند ملامسة جسم معدني بعد السير على السجاد

NOTE:
This observation occurs due to the discharge of electrostatic which generated by walking on carpets

هذا يكون بسبب تفريغ الشحنات الكهربائية الساكنة المتولدة نتيجة الاحتكاك اثناء السير على السجاد

The atom has three types of charges:

1- Electrons (e): negative charged (e-)
2- Protons (p): positively charged (p+)
3- Neutrons (n): which are free of charge (neutral)



تمتلك الذرة ثلاث أنواع من الشحنات:
الالكترونات: سالبة الشحنة
البروتونات: موجبة الشحنة
النيوترونات: وتكون متعادلة الشحنة

NOTE:

- If the number of electrons equals the number of protons The atom called (**natural atoms**).

الذرة المتعادلة يكون عدد الالكترونات يساوي عدد البروتونات.

- If the number of electrons of an atom decreases as a result of releasing some of them to the outside of the atom, then the atom transfers to a (**positive ion**).

تتحول الذرة المتعادلة الى ايون موجب إذا فقدت الكترون (عدد الالكترونات أقل عدد من البروتونات).

- If the number of electrons of an atom increases as a result of gain electrons from some other atoms, then the atom converts to a (**negative ion**).

تتحول الذرة المتعادلة الى ايون موجب إذا اكتسبت الكترون (عدد الالكترونات أكبر عدد من البروتونات).

? **Q**2022 T 4m

Answer the following question:

When is an atom electrically neutral?

Activity (1): Like charges repel each other and unlike charges attract each other.

Tools:
1) Two identical rods of solid rubber.
2) Two identical rods of glass.
3) Two pieces of cloth, one wool and the other silk.
4) Strings of cotton and holders

أدوات النشاط:
1) قطعتين متماثلتين من المطاط
2) قطعتين متماثلتين من الزجاج
3) قطعتين من الملابس احداهما من الصوف والأخرى من الحرير
4) خيط من القطن وحاملان

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

- نعلق ساق المطاط بوضع افقي بواسطة الخيوط والحاملان
- ندلك كل منهما بشكل منفرد بواسطة قطعة من الصوف (فيكتسب شحنة سالبة)
- نترك الساقين معلقين بحرية، نلاحظ تنافرهما عن بعضهما البعض.

Second
- Hang the two glass rods horizontally by two strings using the holders.
- Rub each of the rods individually with the silk. (Each of them will be positively charged).
- Leave the two rods hanging freely. We see that they repel each other.

- نعلق ساق الزجاج بوضع افقي بواسطة الخيوط والحاملان
- ندلك كل منهما بشكل منفرد بواسطة قطعة من الحرير (فيكتسب شحنة الموجبة)
- نترك الساقين معلقين بحرية، نلاحظ تنافرهما عن بعضهما البعض.

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

- نعلق ساق الزجاج والمطاط بوضع أفقي
- ندلك الزجاج بواسطة قطعة الحرير (فتشحن بالشحنة الموجبة)
- ندلك المطاط بواسطة قطعة الحرير (فتشحن بالشحنة الموجبة)
- نترك الساقين معلقتين بحرية، نلاحظ تجاذبهما مع بعضهما البعض

Conclusion
- Different electrical charges attract each other.
- Similar electrical charges repel each other.

- الشحنات الكهربائية المختلفة **تتجاذب** مع بعضها البعض
- الشحنات الكهربائية المتشابهة **تتنافر** مع بعضها البعض

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 (1.6×10^{-19} Coulomb).

مقدار شحنة الالكترون تساوي مقدار شحنة البروتون وهي تساوي (1.6×10^{-19} Coulomb)

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

الكولوم الواحد شحنته تساوي شحنة (6.25×10^{18})

- Coulomb is the measurement unit of electric charge.

الكولوم: هو وحدة قياس الشحنة.

- Coulomb is a large unit. It is commonly used parts are:
  Nano Coulomb ($1nC = 10^{-9}\ C$), Micro Coulomb ($1\mu\ C = 10^{-6}\ C$).

الكولوم وحدة قياس كبيرة جدا لذا نستخدم:
النانو كولوم ($1nC = 10^{-9}\ C$) والمايكرو كولوم ($1\mu\ C = 10^{-6}\ C$).

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

ان شحنة أي جسم مشحون تساوي مضاعفات صحيحة لمقدار شحنة الالكترون.

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

$Q_{2019\ 3R\ 8m}$ / The losing a charge from a conducted body which is isolated and neutrally charged equal $(1.6 \times 10^{-9} C)$. Calculate the number of electrons that was lost from this body.

Answer/

Q2019 3R 4m

Fill the blanks with the term that completes each statement:

The similar charges _____ each other and different charges _____ each other.

Q2023 1R 2m

Fill the blanks with the term that completes each statement:

The unit measurement of electric charge is _____ and is equivalent to the charge of _____ electrons.

Q2022 1R 3m

Choose the correct answer:

One coulomb charge is equivalent to the charge of a number of electrons equal to:

$(1.6\times10^{-19}$ electrons, 1.6×10^{18} electrons, 6.25×10^{18} electrons$)$

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

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

هنالك ثلاث طرق لشحن الاجسام بالكهربائية الساكنة، وهي:

1) الشحن بطريقة الدلك.
2) الشحن بطريقة التوصيل.
3) الشحن بطريقة الحث.

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

الشحن بطريقة الدلك
إذا دلكت بالون بقطعة من الصوف سوف تتولد شحنات كهربائية موجبة على الصوف (نتيجة فقدان الكترونات)، ويكتسب البالون شحنات سالبة (نتيجة اكتساب الكترونات)

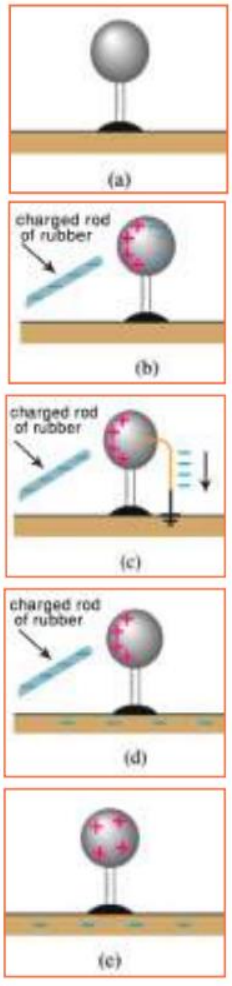
2) **Charging by contact**
Hang two balls of balm marrow with two insulated strings from the same point. One of them positively charged and the other free of charge. Leave them touch each other. You will see that the two balls repel each other. This shows that the second ball which was not charged has now gained some of the charges of the first ball by coming into contact.

الشحن بطريقة التماس
علق كرتين من نخاع البيلسان بواسطة خيط من مادة عازلة من نقطة واحدة، احداهما مشحونة بشحنة موجبة والأخرى غير مشحونة، ثم اتركهما في حالت تماس، سوف تلاحظ ان الكرتين تتنافر بين بعضها البعض، وهذا يثبت ان الكرة الثانية الغير مشحونة اكتسبت بعض الشحنات من الكرة الأولى عن طريق التماس

3) **Charging by induction**

a) The metal surface ball which is neutrally charged and isolated.

كرة معدنية متعادلة كهربائيا ومعزولة



b) Make the negatively charged rod of rubber close to the ball, then th
negative charge of the rod will repel the negative charge and attrac
the positive charge.

نقرب منها ساق من المطاط سالبة الشحنة، لذا الشحنات السالب
داخل الكرة سوف تتنافر مع الساق والشحنات الموجبة تنجذب نحوها

c) Connect a metal ball to the earth by wires, Keep the charged rod cl
to the ball. We observe that the positive charges have lost to the ea

نصل الكرة الأرض بالأسلاك مع بقاء الساق قريب، نلاحظ انتقال
الشحنات السالبة الى الأرض من خلال الاسلاك

d) Disconnect the ball connection to the earth and keeping the rod clo
the ball. We see that the bounded charge remains at their location

نقطع اتصال الكرة بالأرض مع بقاء الساق، نلاحظ الشحنات الموجبة لا تزال في موقعها

e) Move the rod away from the ball. You will find that the bounded charges distributed evenly on the external surface of the ball.

نزيل الساق بعيدا، نلاحظ ان الشحنات الموجبة تتوزع على سطح الكرة.

NOTE:

- When we charge an object by contact, the body gets a charge similar to the source charge.
  عند الشحن بطريقة التماس يكتسب الجسم المشحون شحنة مشابهة لشحنة المصدر.

- When we charge an object by induction, the body gets a charge different from the source charge.
  عند الشحن بطريقة الحث يكتسب الجسم المشحون شحنة مخالفة لشحنة المصدر.

Electroscope

An electroscope: is an electrical apparatus used in electrostatic experiments.

الكشاف الكهربائي: هو جهاز يستعمل في تجارب الكهربائية الساكنة.

The electroscope is used for the following purposes:

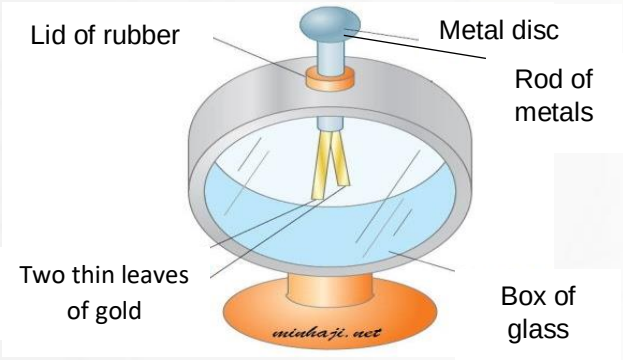
1) To detect an electrical charge on any surface.
2) To determine know the kind of electrical charge on any charged body.

الكشاف الكهربائي يستخدم للأغراض التالية:

1) الكشف عن الشحنات الكهربائية على سطح اي جسم.
2) لمعرفة نوع الشحنة الكهربائية على الجسم المشحون.

The electroscope consists of:

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



الكشاف الكهربائي يتكون من:

1) ساق موصل
2) قرص معدني متصل بأعلى الساق
3) ورقتين رقيقتين من الذهب او الالمنيوم متصلة بأسفل الساق
4) صندوق زجاجي
5) سداد من المطاط يفصل بين الصندوق والساق الموصل

Activity (2): Charging an electroscope by touching (conducting)

Tools:

1) Electroscope.
2) plastic comb.

أدوات النشاط

1) كشاف كهربائي
2) مشط من البلاستك

Steps:

- rub the comb with a hair
- Let the comb touch the disc of the electroscope which is electrically neutral
- You will observe that the two leaves of the electroscope will

الخطوات:

- أدلك المشط بالشعر
- نجعل المشط يلامس قرص الكشاف
- نلاحظ تنافر ورقتي الكشاف نتيجة الشحن

Conclusion:

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

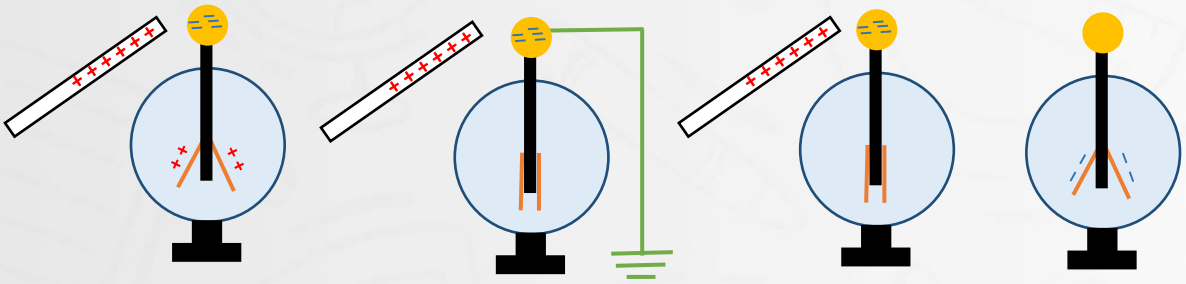
الاستنتاج:

عندما يلامس مشط مشحون قرص الكشاف الكهربائي تتباعد ورقتي الكشاف نتيجة قوى التنافر لاكتساب الورقتين النوع نفسه من الشحنات

Activity (3): Charging an electroscope by induction

Tools:

1) Electroscope.
2) glass rod.
3) a piece of silk.



Steps:

a) Rub the glass rod with silk, then make it close to the electroscope which is electrically neutral. We see that the aluminum leaf and the metal rod of the electroscope repels each other.

b) Connect the electroscope's disc to the earth, 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

c) Now disconnect the electroscope's disc from the earth and keeping the charged glass rod close to the electroscope's disc. You will observe that the leaf will remain touching the rod.

d) Now move the glass rod from the electroscope. You will see that the aluminum leaf and the electroscope's rod repel

Conclusion:

When the charged glass rod gets close to the electroscope's disc which was neutral, the leaves of the electroscope separate due to the repelling force between them. This is because the remaining charges which were bounded will be distributed on the electroscope disc, the rod and the leaf.

Q2019 R2 4m+2018 1R 5m

What are uses of (Electroscope)?

Answer/

Q2022 1R 4m

Fill in the blanks with the term that completes each statement:

The electroscope charging by two methods _____ and _____.

Q2023 1R 2m

Choose the correct answer:

What happens to the two positively charged leaves of electroscope if a positively charged body gets closer to the electroscope disc?

(the two leaves will get closer, the two leaves will get apart further, the two leaves will be neutral**).**

Q2014 1R 4m

Answer the following question: What happens to the charge of a negatively charged object when it is connected to the ground?

Answer/

Application of Electrostatic

تطبيقات الكهربائية الساكنة

Electrostats are used in the following:

1) Sprayer
2) photocopying machines.
3) In contact lenses
4) cosmetic materials.

تستثمر الكهربائية الساكنة فيما يلي:

1) المرذاذ
2) أجهزة الاستنساخ
3) العدسات اللاصقة
4) مواد التجميل

Application of Electrostatic

Sprayer is a device used in painting any conducting body such as a car, chair and so on…. 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. The conducted bodies which you want to paint, will be connected to the negative poles of the source of electricity. In this way, the drops of painting will be attracted to the surface of that body, making the painting evenly distributed on the surface

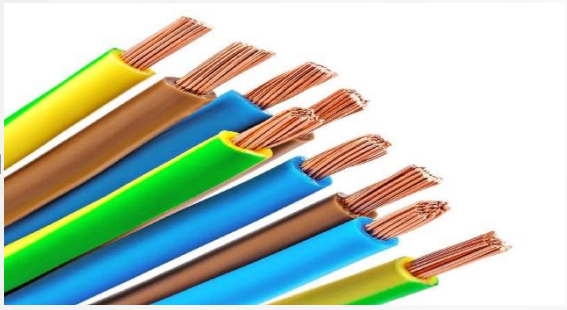
المرذاذ هو جهاز يستخدم لصبغ الاجسام الموصلة مثل السيارة الكرسي .... الخ. توصل فوهة المرذاذ بالقطب الموجب للمصدر الكهربائي وهذا يجعل جميع قطرات الصبغ الخارجة من فوهة المرذاذ مشحونة بشحنة موجبة فتتباعد عن بعضها البعض بسبب قوى التنافر. الجسم الموصل المراد طلائه يوصل بالقطب السالب للمصدر الكهربائي بهذه الطريقة قطرات الصبغ الموجبة سوف تنجذب الى الشحنات السالبة على سطح الجسم مما يجعل الطلاء موزع بالتساوي على السطح

Different Materials according to its Electric Conductivity

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

Conductors:

- It has plenty of negative electrical charges
- The electrons weakly connect to the nucleu
- The electrons move freely through it
- Such as: copper, silver and aluminum.



الموصلات

- لديها وفرة من الشحنات الكهربائية السالبة (الالكترونات)
- الالكترونات ضعيفة الارتباط بالنواة
- الالكترونات تتحرك بحرية خلالها
- مثل: النحاس الفضة الالمنيوم

Insulator:

- It doesn't have plenty of negative electrical charges
- The electrons strongly connect to the nucleus
- The electrons move cannot freely through it
- Such as: glass, wool and rubber.

العوازل

- لا تملك شحنات كهربائية سالبة (الالكترونات) حرة
- الالكترونات قوية الارتباط بالنواة
- الالكترونات لا تتحرك (مقيدة) بسهولة خلالها
- مثل: الزجاج، الصوف والمطاط

Coulombs law

The electrical force between two electrical charges 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 Coulombs law given by:

قانون كولوم ينص على انه القوة بين شحنتين تتناسب طرديا مع حاصل ضرب الشحنتين وعكسيا مع مربع المسافة بينهما ويعطى بالعلاقة التالية:

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

Example: A positive electric point charge $(+4 \times 10^{-9}\ C)$is located at a distance of (0.06 m) from another point of electric positive charge of the value $(+9 \times 10^{-9} C)$, 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:

$$q_1 = +4 \times 10^{-9} C\ , \qquad q_2 = +9 \times 10^{-9} C, \qquad r = 0.06\ m, \qquad k = 9 \times 10^9 \frac{N \times m^2}{C^2},$$

$$F = ?$$

1) F_{12} be the force in which the second charge influences on the first charge.

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

$$F_{12} = 9 \times 10^9 \frac{(+4 \times 10^{-9}) \times (+9 \times 10^{-9})}{(0.06)^2}$$

$$F_{12} = \frac{9 \times 4 \times 9 \times 10^{+9-9-9}}{36 \times 10^{-4}}$$

$$F_{12} = 9 \times 10^{-5} N$$

2) F_{21} (Home Work)

$Q_{2014\ 1R\ 10m}$/Two-point charges one of them (4×10^{-6} C) and the other (9×10^{-6} C) the repelling force between them 90 N. Calculate the distance between them. $k = 9\times10^{9}\ (N.m2)/C^{2}$

Answer/

?

$Q_{2019\ R2\ 10m}$

Two-point charges (+6μc) and (+2μc) the repelling force between them 12×10^{-1} N. Calculate the distance between them. k = 9×10^{9} $(N.m^2)/C^2$

Answer/

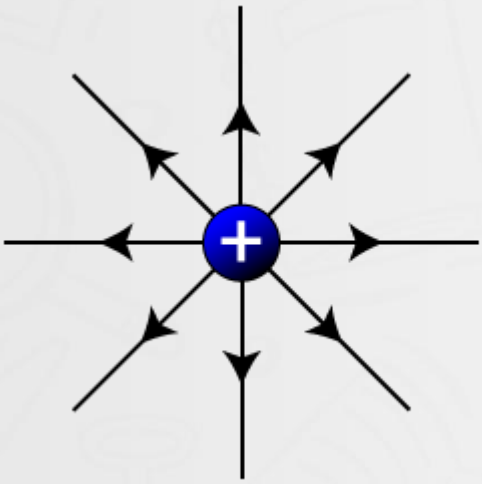
The electrical field:

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 ($\dot{q}$) located at that point, The value of the electric field can be found from the following relationship:

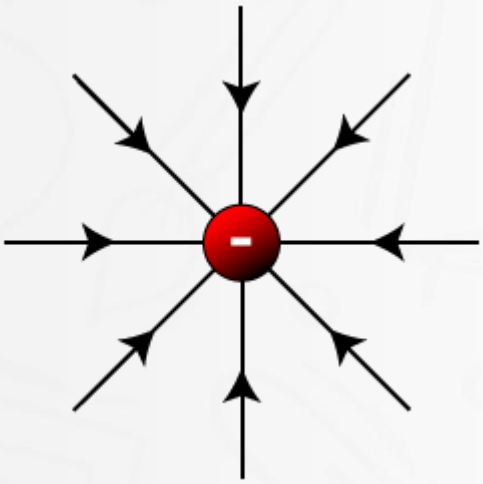
المجال الكهربائي في اية نقطة في الفضاء يعرف بانه:

القوة الكهربائية لوحدة الشحنة المؤثرة في شحنة اختبارية صغيرة موجبة (q) موضوعة في تلك النقطة.

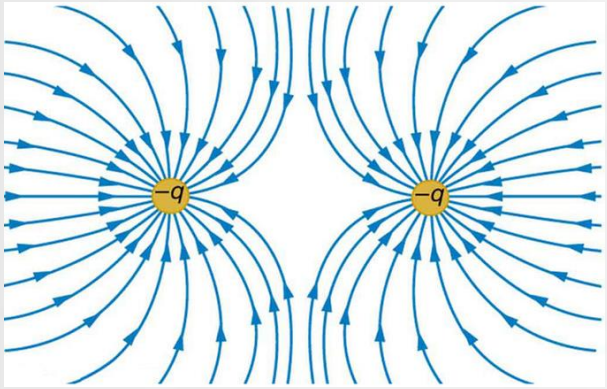
$$Electric\ field\ (E) = \frac{Electric\ force}{The\ value\ of\ test\ charge} = \frac{F}{\dot{q}}$$



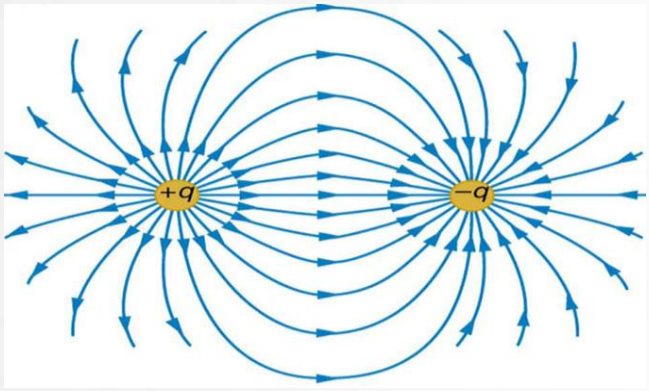
The electric field of positive charge



The electric field of negative charge



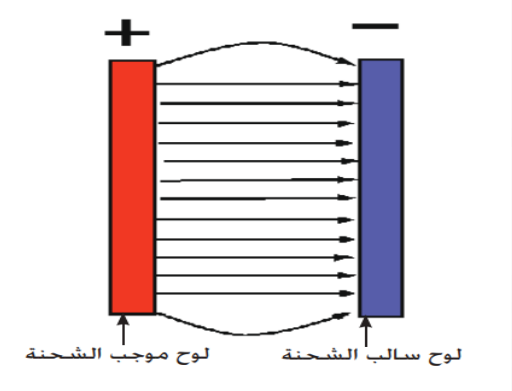
The electric field of two similar charges



The electric field of two different 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, equal-distance between them and perpendicular to the boards.



المجال الكهربائي المنتظم المتولد بين لوحين معدنيين مستويين متوازيين مشحونين بشحنتين متساويتين مقدارا ومختلفتين في النوع فتكون خطوط هذا المجال متوازية مع بعضها وتبعد عن بعضها بأبعاد متساوية وتكون عمودية على اللوحين.

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

Solution:

$$F = 4 \times 10^{-6} N, \quad q = +2 \times 10^{-6} C$$

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

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

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

Q2019 2R 5m/Answer the following question:

What is the electric field? What is the mathematical relationship through which the electric field can be calculated?

Answer/

$Q_{2022\ T\ 5m}$/Give the reason: 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.

Answer/

$Q_{2019\ 1R\ 5m}$

Draw the regular electric field between two parallel metal plates.

$Q_{2014\ 2R\ 5m}$/ Draw a diagram explaining the lines of the electric fields between two similar point charges.

Solution of the question of chapter (1)

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. If the distance becomes longer up to (6cm) then the force 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 woolen 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 $(+2\mu\ C)$and the body (B) has a charge $(+6\mu\ C)$, 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/ 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.

Answer/

To discharge electrostatic charges generated from the friction of the oil with the walls of the tank and accumulated at the outer surface of the tank and on the chassis of the car, which may cause a disaster when an electrical discharge occurs.

لتفريغ الشحنات الكهربائية الساكنة الناتجة عن احتكاك الوقود بجدران الخزان والمتراكمة على السطح الخارجي للخزان وعلى هيكل السيارة مما قد يسبب كارثة عند حدوث تفريغ كهربائي.

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

Answer/

Because the earth is a large store to exhaust the electrical charges which move easily to and from the earth, so any charged object is connected to the earth, it is known as grounded. Then its charges will be neutralized.

لأن الأرض عبارة عن مخزن كبير لتصريف الشحنات الكهربائية التي تنتقل بسهولة من وإلى الأرض، لذلك فإن أي جسم مشحون يكون متصلاً بالأرض يعرف بأنه مؤرض. ثم تكون شحنته متعادلة.

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

Answer/

Because the electrons of the charged body repel the electrons of the electroscope disk and push them away to their farthest location, which is on the two leaves, so the separation of the two leaves increases.

لأن إلكترونات الجسم المشحون تطرد إلكترونات قرص المكشاف الكهربائي وتدفعها بعيداً إلى أبعد مكان لها وهو على الورقتين، فيزداد الانفصال بين الورقتين.

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

A) A positively charged glass rod.

Answer/

By using contact method (make the glass rod in contact with the disc of electroscope)

B) A negatively charged rubber rod.

Answer/

By using induction method (make the rubber rod close to the disc of the electroscope)

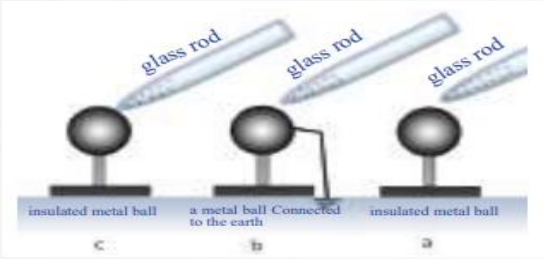
Q4/ List the types of the charging methods by electrostatic?

Answer/

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

a) Charging by Rubbing.
b) Charging by contact.
c) Charging by induction.

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).

Answer/

a) The charges do not move because there is no connection with any external source.
b) The ball acquires a negative charge due to its contact with the ground.
c) Some positive charges will be flow to the ball surface, because attraction force between different charge.

2) Determine the kind of electric charges which appear in each case.

Answer/

a) The surface of the ball opposite the rod shows a negative charge and another surface of the ball from the second side shows a positive charge and the ball is still neutral.
b) The surface of the ball opposite the rod shows a negative charge and another surface of the ball from the second side shows a positive charge and the charge of ball will be negative.
c) The ball is positively charged.

3) What happens in the positive charge on the glass rod in each of the three cases.

Answer/

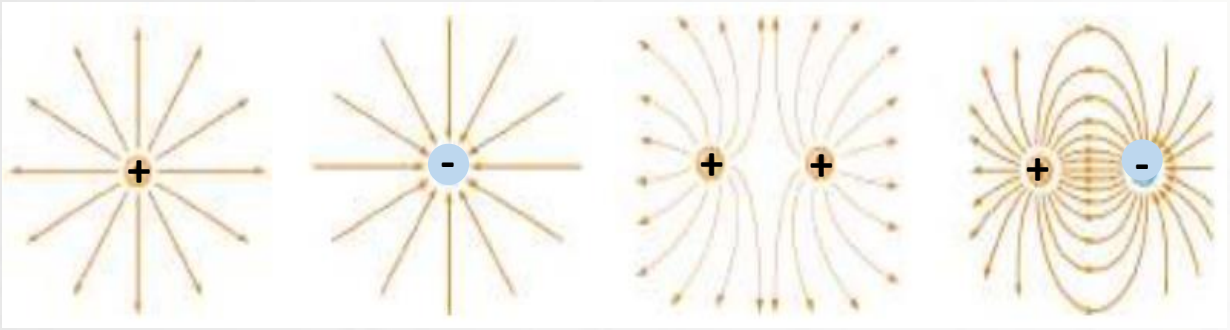
a) does not change.
b) does not change.
c) The charge of rod will be decrease because part of it moves to the surface of the ball

Q-6 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?

Answer/

Because the student moved the rod before moving his finger therefore the addition charges discharged to earth.

Q-7 Write type of the charge in Figures below



Problems

Q1/ The repelled force of two identical point electric charges is ($9 \times 10^{-7} N$) when the distance between them is (10 cm). Calculate the charge of each one.

Solution:

$$q_1 = ?\ , q_2 = ?\ , F = 9 \times 10^{-7} N, k = 9 \times 10^{9} \frac{N \times m^2}{C^2}, r = 10 \times 10^{-2}\ m$$

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

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

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

$$q^2 = 100 \times 10^{-7-4-9} = 100 \times 10^{-20} = 10^{-18}\ C^2$$

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

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

Q2/ Two-point charges both positive are ($3 \times 10^{-9}\ C$) and the distance between them is (5 cm). Calculate the repelling force between them.

Solution:

$$q_1 = q_2 = 3 \times 10^{-9}\ C\ , F = ?\ , k = 9 \times 10^{9}\ \frac{N \times m^2}{C^2}\ , r = 5 \times 10^{-2}\ m$$

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

$$F\ = \frac{9 \times 10^{9} \times 3 \times 10^{-9} \times 3 \times 10^{-9}}{(5 \times 10^{-2})^2} = \frac{81 \times 10^{-9}}{25 \times 10^{-4}}$$

$$F\ = \frac{81 \times 10^{-9+4}}{25} = 3.24 \times 10^{-5}\ N$$

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

Q3/ An electric charge of ($+3\mu\ C$) located at a point P in an electric field the electrical field was ($4 \times 10^{6}\ N/C$). Calculate the influenced electric force.

Solution:

$$q = 3 \times 10^{-6}\ C\ , \qquad F = ?, \qquad E = 4 \times 10^{6}\ N/C$$

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

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

$$F = 12\ N$$

CHAPTER (2)
MAGNETISM

Introduction

This chapter talks about the magnetic in general, the uses of magnets, the difference among the magnetic properties of materials (diamagnetic, paramagnetic, and ferromagnetic), Describe the shape of magnetic field lines and Compare between the two ways of magnetism, rubbing and induction methods.

هذا الفصل يتحدث عن المغناطيس، استخدامات المغناطيس، الفرق بين الخصائص المغناطيسية للمواد (الدايامغناطيسية، البارامغناطيسية، الفيرومغناطيسية), يصف شكل خطوط المجال المغناطيسي ويوضح الفرق بين المغناطيس المتولد بطريقة الدلك وطريقة الحث.

The uses of magnets

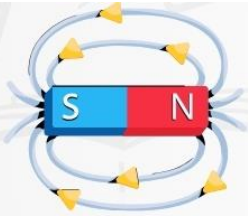
Magnets are used in:

The generators, Electric engines, Televisions, sound recording devices, printer machine, navigating compasses (the pointer of the compass is a small permanent magnet which can rotate freely in a horizontal plane around the vertical axis).

يستخدم المغناطيس في المولدات، مكائن الكهربائية، التلفزيون، مسجلات الصوت، الطابعات، بوصلات الملاحة (إبرة البوصلة هي مغناطيس دائمي صغير يمكنه الدوران بحرية في مستوى افقي حول محور شاقولي مدبب)

Q 2019 3R 4m+2014 1R 4m

What does it mean? The needle of the compass



Magnetic Materials

Materials can be classified according to its Magnetic properties for three types:

تقسم المواد من حيث خصائصها المغناطيسية الى ثلاث انوع:

1- Diamagnetism

They are the materials which weakly repel with the strong magnets.
Such as: Bismuth, antimony, copper, silicon and silver.

المواد الدايامغناطيسية
هي مواد تتنافر مع المغناطيس القوي تنافر ضعيف
مثل: بزموث، الانتيمون، النحاس، السليكون والفضة

2- Paramagnetism

They are the materials which are weakly attracted by strong magnets.
Such as aluminum, calcium, sodium and titanium

المواد البارامغناطيسية
هي مواد تتجاذب مع المغناطيس القوي تجاذبا ضعيفاً
مثل: الالمنيوم، الكالسيوم، الصوديوم والتيتانيوم

3- Ferromagnetism

They are the materials which attracted by ordinary magnets. They have high magnetization capability.
Such as: iron, steel, nickel, cobalt

المواد الفيرومغناطيسية
هي مواد تنجذب بالمغناطيس لها قابلية تمغنط عالية
مثل: الحديد، الفولاذ، النيكل والكوبلت

Q 2019 2R 4m

What does it mean? Paramagnetism.

Q2022 1R 6m+2018 2R 5m

What are differences between the following?

Diamagnetism and Paramagnetism materials.

Q2023 1R 5m**/Compare between the following?**

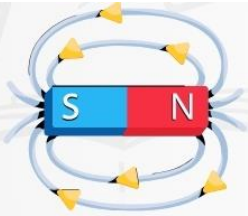
Ferromagnetism and Diamagnetism materials.

Q2022 T 2m

Fill the blanks with the term that completes each statement:

Materials that are weakly repel with the strong magnet are called ---------- and materials that are attracted by ordinary magnets are called ----------.

Chapter two Magnetism



Magnetic poles

1- Magnetic poles :are the areas at which the magnetic forces are strongest.

الأقطاب المغناطيسية هي المناطق التي يكون عندها مقدار القوة المغناطيسية بأعظم ما يمكن.

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

الاقطاب المغناطيسية لا يمكن ان توجد بشكل منفرد، بل توجد بشكل ازواج متساوية بالمقدار مختلفة بالنوع (قطب شمالي وقطب جنوبي)

3- If a piece of the magnet is divided into small pieces, you will find each piece will have two magnetic poles which are the north and south poles.

فاذا قُطع المغناطيس إلى عدة قطع كبيرة أو صغيرة ومهما كان عددها، نجد أن كل قطعة تمتلك قطبين مغناطيسيين هما (قطب شمالي وقطب جنوبي)

? **Q2012 2R 3m**

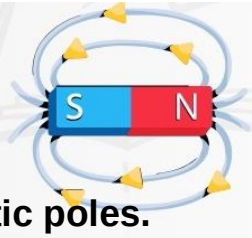
What does it mean? Magnetic Poles.

? **Q2018 2R 5m / Choose the correct answer:**

When a magnet bar is divided into small pieces: (We get small non magnetized pieces, each piece will have two magnetic poles, one north and one south, each piece will have only one magnetic pole either north or south)

Q **2019 2R 4m+2014 1R 4m**

State the characteristics of the following: Magnetic poles.



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

Tools:

1- Two magnetic bars. 2- String. 3- Clips. 4- Holder.

أدوات النشاط:

1- ساقان من المغناطيس 2- خيوط 3- كلاب 4- حامل

Steps:

1- Hang the magnetic bar by string and a clip and the holder freely. You will observe that the magnetic bar is taking the direction of (North - South) geographically.

نعلق الساق المغناطيسي بواسطة الخيط، الكلاب والحامل نلاحظ ان الساق المغناطيسي يتجه بموازاة خط (الشمال – الجنوب) الجغرافي

2- Hold another magnetic bar by hand and get the north pole of the magnet bar which is in your hand close to the north pole of the hanging bar (we will see they repel each other).

نحمل الساق المغناطيسية الأخرى باليد ونجعل القطب الشمالي للمغناطيس الممسوك باليد قريب من القطب الشمالي للمغناطيس المعلق (سوف نلاحظ انهما يتنافران مع بعضهما البعض)

3- Let the south pole close to the bar in your hand close to the south pole of the free magnetic hanging bar (we will see they repel each other again)

نجعل القطب الجنوبي للمغناطيس الممسوك باليد قريب من القطب الجنوبي للمغناطيس المعلق (سوف نلاحظ انهما يتنافران مع بعضهما البعض)

4- Let the north pole of the bar in your hand close to the south pole of the hanging bar (we will see they will attract each other).

نجعل القطب الشمالي للمغناطيس الممسوك باليد قريب من القطب الجنوبي للمغناطيس المعلق (سوف نلاحظ انهما يتجاذبان مع بعضهما البعض)

Conclusion:

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

الاستنتاج:

الأقطاب المغناطيسية المتشابهة تتنافر بينما الأقطاب المغناطيسية المختلفة تتجاذب

Magnetic field

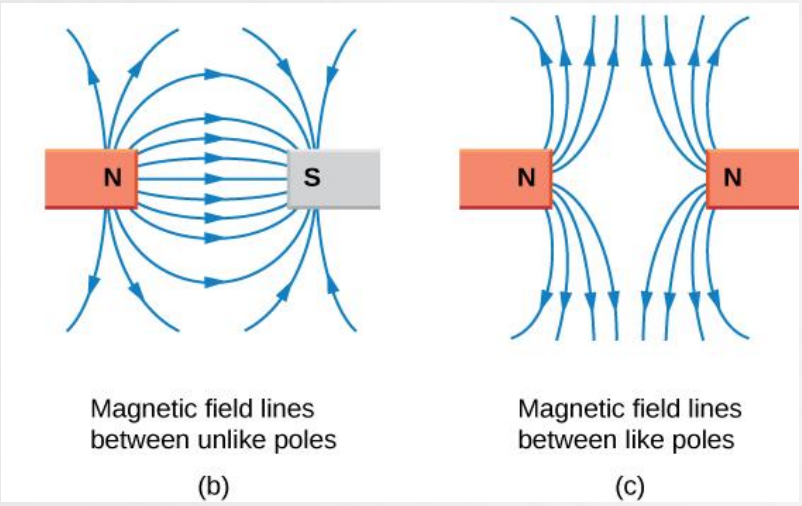
Magnetic field is the space which surrounds the magnet in which the effect of the magnet would be observed.

المجال المغناطيسي: هو الحيز الذي يحيط بالمغناطيس والذي يظهر فيه تأثير القوى المغناطيسية.

The properties of magnetic field lines

closed lines (invisible) heading from the north pole to the south one and completing its circle inside the bar.

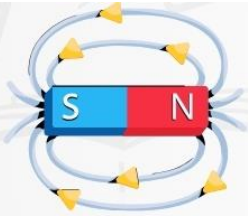
خطوط مقفلة غير مرئية تتجه من القطب الشمالي نحو القطب الجنوبي خارج المغناطيس ومكملة دورتها داخله.



Q2018 2R 5m

Answer the following:

What is the magnetic field? What are the characteristics of magnetic field lines?



Activity (2): Determining the magnetic field lines using iron filing

Tools:

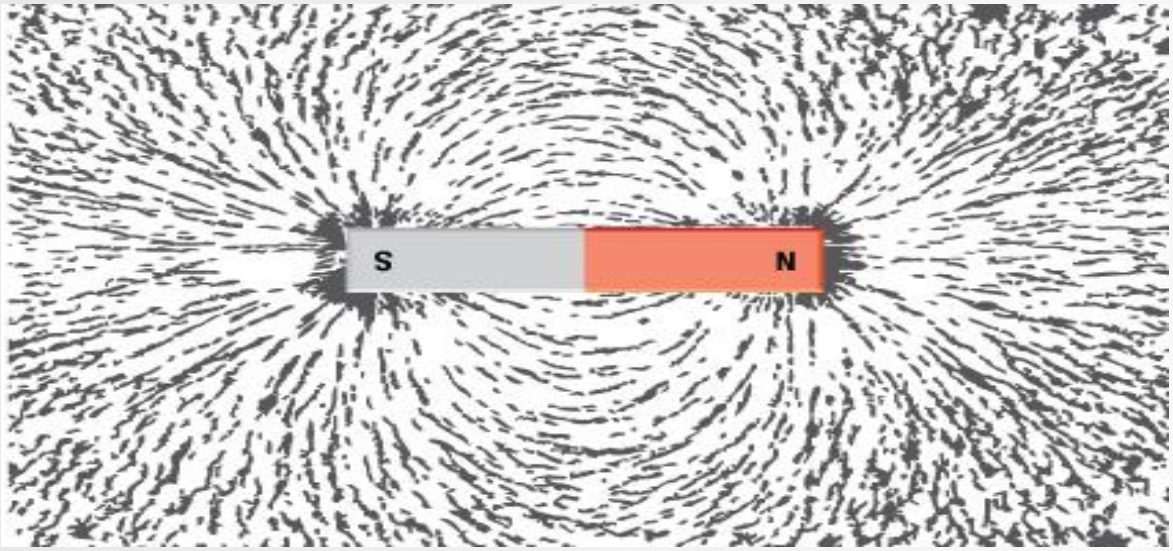
1- Magnetic bar. 2- a glass board. 3- iron filings.

أدوات النشاط:

1- ساق من المغناطيس. 2- لوح من الزجاج 3- برادة حديد

Steps:

- Put the glass board on the magnetic bar at a horizontal level.
- نضع اللوح الزجاجي فوق المغناطيس بمستوى افقي.
- Sprinkle the iron filing over the glass board and gently tip on the board.
- ننثر برادة الحديد فوق اللوح الزجاجي ثم ننقر اللوح بلطف.



Conclusion:

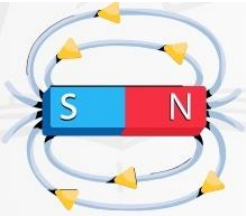
The iron filings have taken the shape of lines which represent the magnetic field lines around the magnetic bar.

الاستنتاج:

برادة الحديد تترتب بشكل خطوط هذه الخطوط تمثل خطوط المجال المغناطيسي حول الساق المغناطيسية.

Q2017 3R 10m

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



Activity (3): Magnetic field can pass through the human body

Tools:

1- Paper clips made of steel. 2- Powerful magnet.

أدوات النشاط:

1- مثبتات ورق مصنوعة من الفولاذ. 2- مغناطيس قوي.

Steps:

- Put the magnetic bar on your hand.
- نضع الساق المغناطيسية فوق يدنا.
- Put your palm on a collection of paper clips
- نضع راحة يدنا على مجموعة من مثبتات الورق.
- Raise your hand above a large number of paper clips will be attracted towards your palm
- نرفع كف يدنا الى الأعلى نجد ان عدد كبير من مثبتات الورق انجذبت الى راحة كف يدنا.

Conclusion:

The magnetic field can penetrate through the human body.

الاستنتاج:

المجال المغناطيسي يمكنه النفاذ خلال جسم الانسان.

Q2019 3R 12m

Explain in activity the magnetic field can pass through the human body.

Activity (4): Magnetic field penetrates through piece of carton

Tools:

1- Magnetic bar. 2- Piece of carton. 3- Set of nails.

أدوات النشاط:

1- ساق من المغناطيس. 2- لوح الكارتون 3- مجموعة مسامير

Steps:

- Hold the magnetic bar vertically by hand.

نحمل الساق المغناطيسية عاموديا بواسطة

- Put some nails on the piece of carton.

نضع المسامير فوق قطعة الكارتون.

- Hold the piece of carton by the other hand and put it on the upper pole of the magnet.

نحمل قطعة الكارتون باليد الأخرى ثم نضعها فوق القطب

- Move the magnet bar underneath the carton in a circular or linear path.

نحمل قطعة الكارتون باليد الأخرى ثم نضعها فوق القطب

- You will see the nails move wherever you move the magnet.

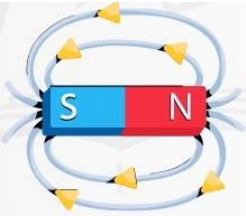
سوف نلاحظ ان المسامير بالأعلى تتحرك بنفس المسار الذي يسلكه

Conclusion:

the magnetic field can penetrate through different materials such as a piece carton,

الاستنتاج:

المجال المغناطيس يمكنه النفاذ من خلال قطعة من الكارتون



Q2015 T 8m

Explain in activity the magnetic field can pass through a piece of carton.

Activity (5): Magnetic field penetrates through glass and water.

Tools:

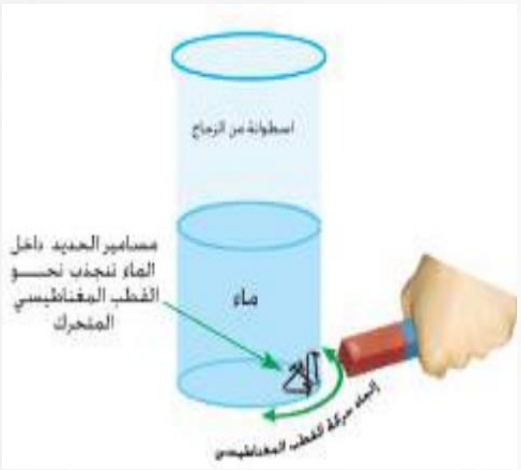
1- Magnetic bar. 2- A glass cylinder 3- Water 4- Set of nails.

أدوات النشاط:

1- ساق من المغناطيس. 2- أسطوانة من الزجاج 3- ماء 4- مجموعة من المسامير.

Steps:

- Put some nails inside a glass cylinder.
- نضع المسامير داخل الأسطوانة الزجاجية.
- Then add some water inside the cylinder.
- ثم نضيف بعض الماء داخل الأسطوانة.
- Get one of the poles of the magnetic bar close to the wall of the cylinder.
- نقرب أحد قطبي الساق المغناطيسية من جدار



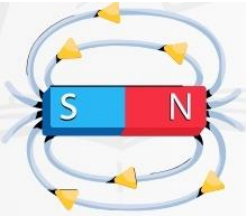
- You will find that the nails are attracted to the nearest pole of the magnetic bar.
- نجد ان المسامير تنجذب الى نحو القطب المغناطيسى الأقرب منها.
- Move the magnetic the pole of the bar around the cylinder. You will find the nails are moving following the path in which the magnetic pole moves.
- نحرك القطب المغناطيسي للساق حول الأسطوانة نلاحظ ان المسامير تتحرك أيضا وبنفس المسار الذي تسلكه الساق المغناطيسية.

Conclusion:

the magnetic field can penetrate through different materials such a glass and water.

الاستنتاج:

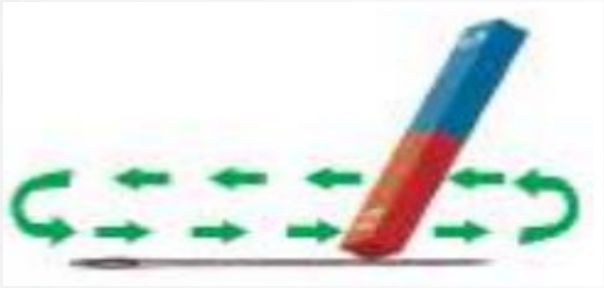
المجال المغناطيس يمكنه النفاذ من خلال أسطوانة زجاجية والماء.



Methods of materials magnetization:

We can get temporary or permanent magnets in two ways:

1- Rubbing method (permanent magnet)



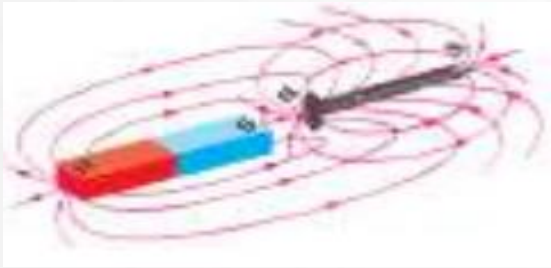
A piece of steel, such as a needle, can be become a needle magnetic by rubbing it by one of the poles. The magnet must be moved over, the steel needle in one direction and in a slow motion. The generated magnetic pole at the end of the rubbed part of the needle will always have the opposite pole to the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

1- طريقة الدلك (مغناطيس دائمي)

يتم مغنطة قطعة فولاذ (مثال ابرة الخياطة) وذلك بدلكها بأحد قطبي مغناطيس، ويجب تحريك القطب المغناطيسي للساق المغناطيسية فوق إبرة الفولاذ باتجاه واحد فقط وبحركة بطيئة وتكرر بمرات عدة. وبعد الانتهاء من العملية تصير إبرة الفولاذ مغناطيسا القطب المغناطيسي المتولد في نهاية جهة الدلك لإبرة الفولاذ يكون دائما بنوعية مخالفة للقطب المغناطيسي الدلك

2- Induction method:

a) Magnetizing by approach (permanent magnet)

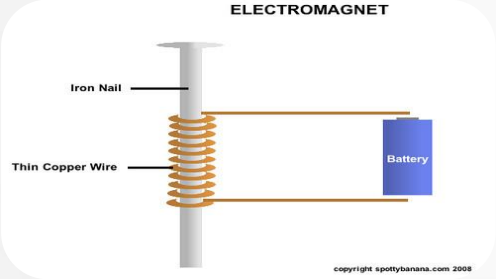


When a material of Ferromagnetic is placed near a material which is not magnetized (such as a nail) inside a powerful magnetic field or the nail will gain magnetism by induction. The nail will have two magnetic poles and the end of the nail which is close to the magnet will gain magnet opposite to the magnetic bar.

عند وضع مادة فيرومغناطيسية غير ممغنطة (مثل مسمار من الحديد) داخل مجال مغناطيسي قوي أو بالقرب من مغناطيس قوي من غير حدوث تماس بين مسمار الحديد والمغناطيس، المسار سوف يكتسب قطبان مغناطيسيان ونهاية المسمار القريبة من المغناطيس سوف تكتسب قطب مخالف لقطب المغناطيس القريب منها.

2- Induction method:

b) Magnetizing by direct electric current (temporary magnet)
Rolled a wire around the nail and the ends of the wire connect them to a battery with a proper voltage.
We then get a magnet which is Called an Electromagnet.



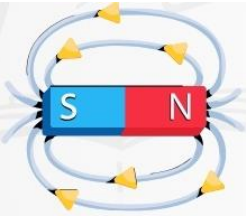
قم بلف سلك حول المسمار وأطراف السلك ربطهما ببطارية ذات جهد مناسب. بذلك نحصل على مغناطيس يسمى المغناطيس الكهربائي.

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.

قوة المغناطيس الكهربائي تعتمد على:
1- مقدار التيار المنساب في الدائرة
2- عدد لفات السلك حول قطعة الفولاذ
3- نوع المادة المراد تحويلها الى مغناطيس.

Magnets lose their magnetism in two ways:
a) Hammering strongly.
b) Powerful heat.

يفقد المغناطيس مغناطيسيته بطريقتين:
a) الطرق القوي.
b) التسخين الشديد.



Q2019 2R 4m

Fill in the blanks with the term that complete each statement:

We can get temporary or permanent magnets in two ways,

_____and _____method.

Q2019 1R 5m+2012 2R 5m

Choose the correct answer:

Permanent magnets are made of the following material

(Copper, Soft iron, Steel, Aluminum).

Q2018 1R 5m

Explain how to magnetize ferromagnetic materials by approach?

Q2014 1R 5m

Is it possible? Explain that.

Magnetizing a piece of steel using a direct current.

Q2022 1R 6m

List the factors on which the power of the electromagnet depends?

Q2023 1R 5m **Answer the following questions:**

Can the magnets lose their magnetism? Explain.

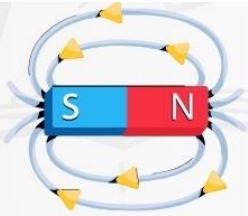
Q2022 T 5m

Define the following: Magnetic protector.

Answer/

Magnetic protector: is a ferromagnetic material using in protect devices from external magnetic effects 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.

الحافظة المغناطيسية: هي مادة فيرومغناطيسية تستعمل لحماية الاجهزة من التأثيرات المغناطيسية الخارجية (كالساعات) ولحفظ المغانط الدائمة من زوال مغناطيسيتها بمرور الوقت.



Solution of the question of chapter (2)

1- A magnetic compass is used the 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 horizontal plane around a vertical pointed axis.
b) An electric magnet loses it magnetism after certain period of time once the electric source is cut off.
c) Made of copper.
d) A permanent magnet with a “U” shape.

1- A magnetic compass is used the draw the lines of a magnetic field around a certain magnet because the needle of the compass is:
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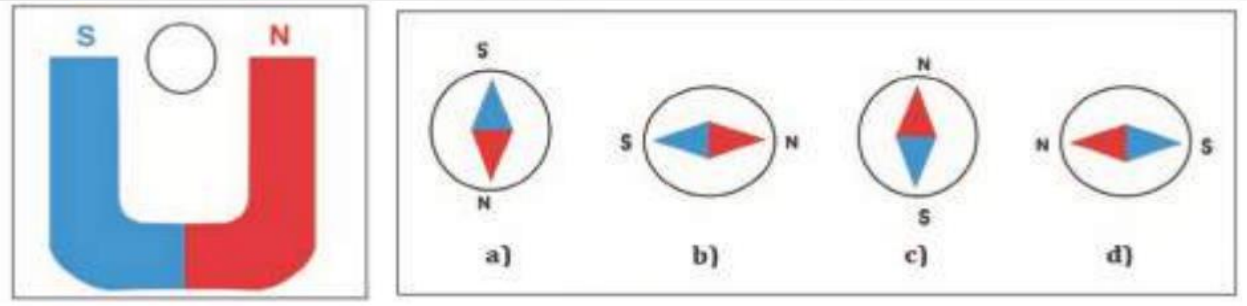
d) A permanent magnet with a “U” shape.

3- A small magnetic compass placed between the two poles of permanent magnet in the shape of “U” as illustrated in the diagram.
Which of the following directions will it take the right 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 cut into small pieces:
a) We get small non-magnetized pieces.
b) Each piece will have only one magnetic pole either north or south.
c) Each piece will have four magnetic poles, two north poles and two south poles.
d) Each piece will have two magnetic poles, one north and one south.

Q2/ Explain, why the magnets are used on the wardrobe and fridge doors?
Answer/
In order to close the wardrobe and fridge automatically and very well.

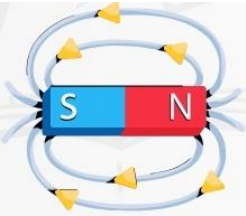
الجواب
من أجل غلق أبواب الخزانات والثلاجات تلقائيا وبشكل مُحكم جدا

Q3/ If you were given three identical bars which were aluminum, iron and a permanent magnet explain how you can distinguish one from the other?
Answer/

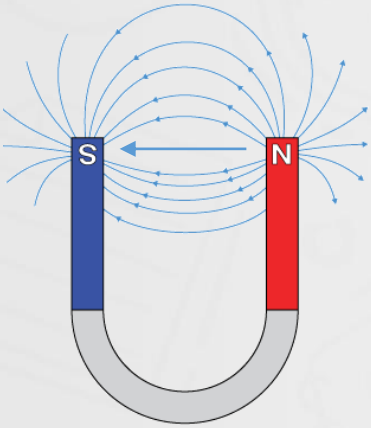
- Put tree bars together with them, we observed that two bars attracted to each other they are iron and magnet, but third bar was not attracted to them it is aluminum.

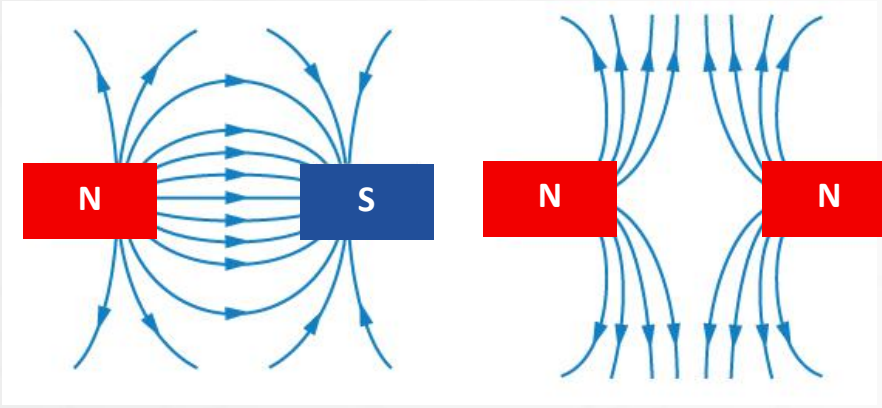
- Put one of the two attracted bars at horizontal level and near another bar to meddle of the first what do you observe?

- If the bars attracted, then the first horizontal bar is iron and other is magnet. If the bars do not attract, then the first horizontal bar is magnet and other is iron.



Q4/ Draw a diagram explaining the lines of magnetic fields 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 (3)
ELECTRIC CURRENT

Introduction

This chapter talks about Electric Charge Movements, distinguishing between the electronic current and conventional current, explain what the electric resistance means, listed the factors which the resistance value of conductor depends on, write Ohm's law in a physical symbol, conclude the favorite way to connect the devices at home and some other details.

هذا الفصل يتحدث عن الشحنات الكهربائية المتحركة، يميز بين التيار الإلكتروني والتيار الاصطلاح، يشرح ما المقصود بالمقاومة الكهربائية يعبر عن قانون أوم بصيغة رمزية رياضية، يعدد العوامل التي تتوقف عليها مقدار مقاومة موصل يستنتج الطريقة المفضلة لربط الاجهزة الكهربائية في المنزل.

The electric source generators are:

1- electric generators. 2- batteries. 3- solar cells.

مصادر توليد الطاقة الكهربائية:

1- المولدات الكهربائية. 2- البطاريات. 3- الخلايا الشمسية.

NOTE:

Electrostatic charges do not produce work

الشحنات الكهربائية الساكنة لا تنتج شغلاً

Q2014 3R 4m

could the electrostatics to produce work?

Chapter three
Electric Current

The electric current

The electric current: the total electric charges passing through the cross section of a conductor during a certain time.

$$\text{Electric current (I)} = \frac{quantity\ of\ charge}{time} = \frac{q}{t}$$

التيار الكهربائي: هو مقدار الشحنات الكهربائية الكلية التي تعبر المقطع الموصل في وحدة الزمن.

NOTE:

- ✓ The electric current is measured in the unit ($\frac{coulomb}{second}$) it is called Ampere (A)
- ✓ Amper (A): represents the passing of one Coulomb of electric charges through a conducted section during one second.

- ✓ التيار الكهربائي يقاس بوحدة ($\frac{\text{كولوم}}{\text{ثانية}}$) وتدعى بالأمبير ويرمز لها (A)
- ✓ الأمبير: يمثل تدفق كولوم واحد من الشحنات الكهربائية في مقطع موصل خلال ثانية واحدة.

Ex: Electric charges passing through a cross-section of a conductor of (1.2 C) each minute, calculate the amount of current flowing in the conductor?

Answer/ $q = 1.2C, \quad t = 1\ min \times 60 = 60\ s, \quad I = ?$

$$Electric\ current\ (I) = \frac{Quantity\ of\ charge\ (q)}{Time\ (t)}$$

$$I = \frac{1.2\ C}{60\ s} = 0.02\ A$$

Ex: If the amount of current flowing in a conductor is equal to (0.4A), calculate the amount of charge that passes through a section of the conductor through:

a) 2s b) 4 minutes

Answer/

a)	b)
$I = 0.4A, \quad t = 2s, \quad q = ?$ $I = \frac{q}{t} \rightarrow q = I \times t$ $q = 0.4 \times 2$ $q = 0.8\ C$	$I = 0.4A, \quad t = 4\ min \times 60 = 240\ s, \quad q = ?$ $I = \frac{q}{t} \rightarrow q = I \times t$ $q = 0.4 \times 240$ $q = 96\ C$

Q2012 2R 5m

Answer the following question:

Electric charges passing through a cross-section of a conductor of (1.2 C) per (30) second, calculate the amount of current flowing in the conductor?

Q2019 3R 12m

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.

Q2022 1R 4m

What does it mean? Ampere

Q2023 1R 5m

Answer the following question:

What do we mean by the amount of electric current through a conducted section equal (3A)?

Answer/

That means the electric charge of (3C) crosses through a cross section of this wire in one second (s).

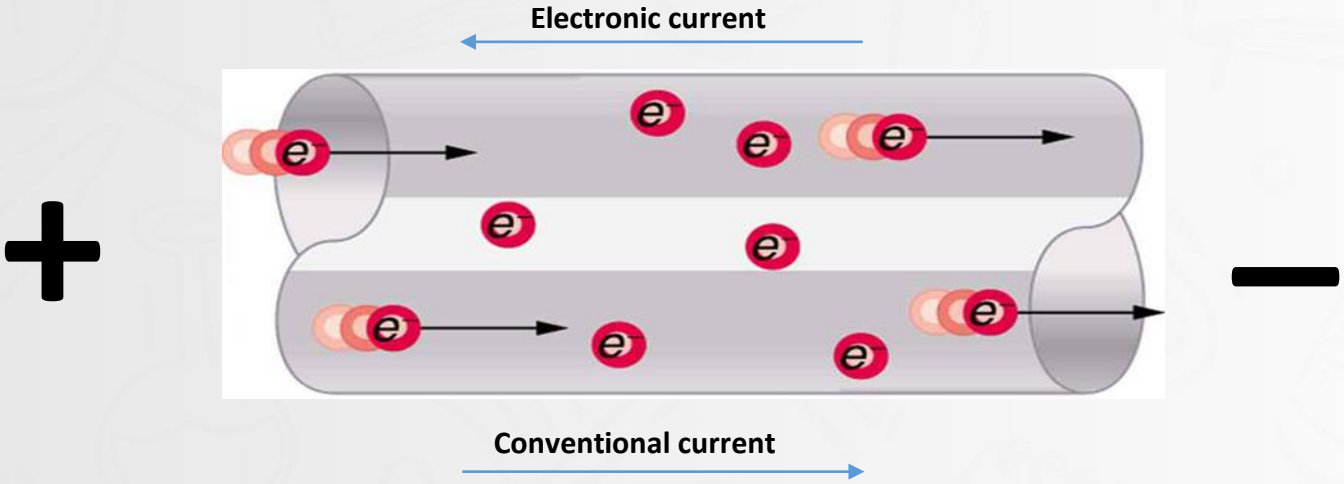
There are two types of electric current:

1- **Electronic current:** It is the current produced when the electrons move from the negative pole towards the positive pole (The direction of electronic current is opposite to the direction of the electric field (E)).

التيار الإلكتروني: هو التيار الذي يتولد نتيجة حركة الالكترونات من القطب السالب الى القطب الموجب
(يكون اتجاه التيار الإلكتروني عكس اتجاه المجال الكهربائي)

2- **Conventional current:** the conventional current will have direction from the positive pole towards the negative pole (The direction of the conventional current is the same direction as the electric field (E)).

التيار الاصطلاحي: هو التيار الذي يكون اتجاهه من القطب الموجب الى القطب الى سالب
(يكون اتجاه التيار الاصطلاحي بنفس اتجاه المجال الكهربائي)



Q2014 1R 2m

what does it mean? conventional current.

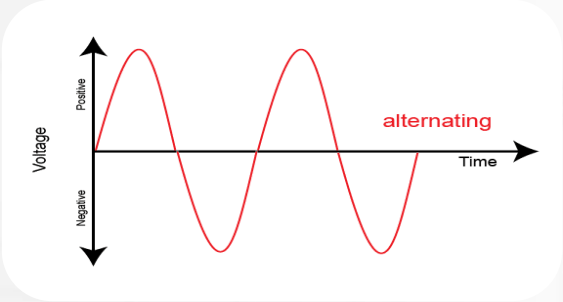
NOTE:

- ✓ The electric current may be resulted from the movement of positive ions and the negative ions inside the acidic electrolytic solutions.
- ✓ The electric current through the connection wires is produced by the movement of electrons only
- ✓ The electric current is traced by the movement of positive ions and electrons in ionized gas inside florescent lamps.

- ✓ قد يكون التيار الكهربائي ناتجا عن حركة الايونات الموجبة والأيونات السالبة داخل المحاليل الكتروليتية
- ✓ التيار الكهربائي خلال اسلاك التوصيل ناتج عن حركة الإلكترونات فقط
- ✓ ينساب التيار الكهربائي بوساطة حركة الايونات الموجبة والإلكترونات في غاز النيون المتأين الموجود في مصباح الفلورسنت.

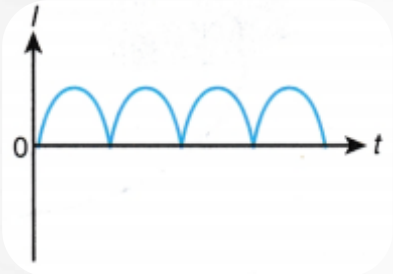
➢ The current leaving an electric battery is a direct current and it has a constant amount and direction (regarded as Ideal)

التيار الخارج من بطارية الكهربائية يكون ثابت المقدار والاتجاه (يعد مثالياً)



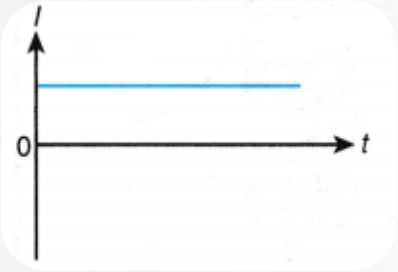
➢ The current from the simple generators is direct current and it has a constant direction and variable amount
(not regarded as ideal)

التيار الخارج من المولد الكهربائية البسيط يكون ثابت الاتجاه ومتغير المقدار (لا يعد مثالياً)



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

إذا كان التيار متغير المقدار والاتجاه خلال الزمن يدعى التيار المتناوب (AC)



Chapter three
Electric Current

The electric circuit:

A simple electric circuit consists of a lamp, connection wires, key, battery, with a proper voltmeter.

الدائرة الكهربائية البسيطة تتألف من مصباح، اسلاك توصيل، مفتاح وبطارية فولطيتها مناسبة.

الشكل (9)

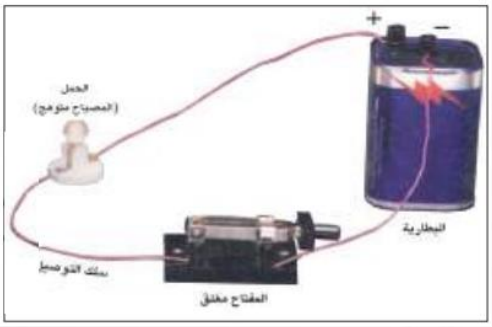
- ✓ **When the key of circuit is “open”**
  the electrons don’t move through the connected wires and through the lamp. Then the lamp is off.

عندما يكون مفتاح الدائرة "مفتوح" لا يوجد الكترونات تتحرك خلال الاسلاك والمصباح. لذا يكون المصباح مطفئ.

الشكل (10)

- ✓ **When the key of circuit is “closed”**
  the electrons will keep moving through the connected wires and through the lamp. Then the lamp will glow

عندما يكون مفتاح الدائرة "مغلق" الكترونات تتحرك خلال الاسلاك والمصباح. لذا يكون المصباح متوهج.

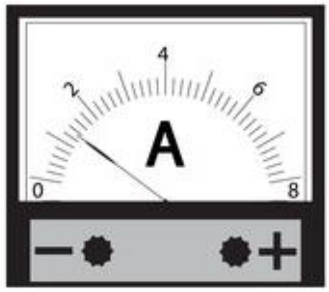


Q2023 1R 4m

What does it mean? Electric circuit

Measuring electric current

The Ammeter: is used to measure the amount of electric current in the electric circuit (millimeter is used to measure the small electric current)



الاميتر: يستعمل جهاز الأميتر لقياس مقدار التيار الكهربائي المنساب في الدائرة الكهربائية (الملميتر جهاز يستخدم لقياس التيارات الصغيرة).

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

عند استعمال جهاز الأميتر لقياس التيار الكهربائي في الدائرة الكهربائية، من الضروري مراعاة ما يأتي:

1- Connecting the Ammeter in series with the device or the circuit.

يربط الاميتر على التوالي مع الجهاز او الدائرة.

2- The resistance of the ammeter will be very small as related to the resistance of the circuit.

مقاومة الاميتر يجب ان تكون صغيرة بالمقارنة مع مقاومة الدائرة.

3- The positive side of the Ammeter will be connected to the positive pole of the battery and the negative side of the Ammeter to the negative side of the battery.

يربط الطرف الموجب لجهاز الأميتر مع القطب الموجب للنضيدة (البطارية) بينما يربط طرفه السالب من جهة القطب السالب للنضيدة (البطارية).

Q2014 2R 5m

What is the practical benefit of: Ammeter?

Activity (1): Measuring the electric current by using the ammeter

Tools:
Ammeter, wires, electric lamp, battery, variable resistor, electric key.

أدوات النشاط:
جهاز الأميتر، أسلاك توصيل، مصباح كهربائي، بطارية، مقاومة متغيرة، مفتاح كهربائي.

Steps:

- Connect the Ammeter, the electric lamp, electric key, battery and the variable Resistor at the highest value by the connection wires with each other in series.

نربط كل من جهاز الأميتر والمصباح الكهربائي والمفتاح والبطارية والمقاومة المتغيرة عند اعلى قيمة لها بواسطة أسلاك التوصيل مع بعضها على التوالي.

- 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, Record the reading.

نغلق مفتاح الدائرة نلاحظ توهج المصباح وانحراف مؤشر جهاز الأميتر مشيرا إلى انسياب تيار كهربائي في الدائرة، سجل هذه القراءة.

- Change the amount of the resistance (using the Rheostat), then the circuit current will change we obtain a new reading in the ammeter.

نغير مقدار مقاومة فيتغير تيار الدائرة، فنحصل على قراءة جديدة للأميتر

- We repeat this procedure and, in each case, we get a new value of the current flow in the circuit.

ثم نكرر العملية وفي كل مرة نحصل على مقدار جديد للتيار المنساب في الدائرة.

Conclusion:
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.

الاستنتاج: قراءة الأميتر تتغير بتغير مقدار التيار المنساب في الدائرة الكهربائية فهي تشير دائما الى مقدار التيار المنساب في الدائرة.

Q2019 2R 10m

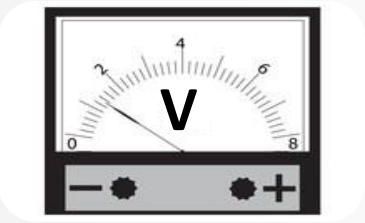
Explain by activity measuring the electric current in circuit had a lamp by using the ammeter.

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

مقدار فرق الجهد بين نقطتين داخل المجال الكهربائي يحدد مقدار التيار الكهربائي المنساب بينهما، فيكون اتجاه انسياب التيار الكهربائي من النقطة ذات الجهد الكهربائي الأعلى الى النقطة ذات الجهد الكهربائي الأوطأ.

Voltmeter: is used to measure the amount of electric potential difference between any two points in the electrical circuit. (millivolt-meter is used to measure the small electric potential difference)

الفولطميتر: هو جهاز يستخدم لقياس فرق الجهد الكهربائي
(ملي الفولطية يستخدم لقياس فرق الجهد الصغير جدا).



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

عند استعمال جهاز الفولطميتر في قياس فرق الجهد الكهربائي من الضروري معرفة ما يأتي

1- Connecting the voltmeter in parallel with the device or the circuit.

يربط الفولطميتر على التوازي مع الجهاز او الدائرة.

2- The resistance of the voltmeter will be very high as related to the resistance of the circuit.

مقاومة الفولطميتر يجب ان تكون كبيرة بالمقارنة مع مقاومة الدائرة.

3- The positive side of the voltmeter will be connected to the positive pole of the battery and the negative side of the voltmeter to the negative side of the battery.

يربط الطرف الموجب لجهاز الفولطميتر مع القطب الموجب للنضيدة (البطارية) بينما يربط طرفه السالب من جهة القطب السالب للنضيدة (البطارية).

Activity (2): Measuring the potential difference between two points in the electric circuit using a Voltmeter

Tools:
Voltmeter, wires, electric lamp, battery, electrical key.

أدوات النشاط:
جهاز الفولطميتر، أسلاك توصيل، مصباح كهربائي، بطارية، مصباح كهربائي.

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 the lamp.

نربط بواسطة اسلاك التوصيل المصباح الكهربائي والمفتاح بين قطبي البطارية، ثم نربط جهاز الفولطميتر على التوازي مع المصباح.

- Look at the deviation of the pointer of Voltmeter showing that there is electric potential difference between the two sides of the lamp.

لاحظ انحراف مؤشر جهاز الفولطميتر مشيرا إلى وجود فرق جهد كهربائي بين طرفي المصباح.

Conclusion:
The reading of the Voltmeter represents potential difference between the two sides of the lamp.

الاستنتاج: قراءة الفولطميتر تشير مقدار فرق الجهد بين طرفي المصباح.

Q2022 1R 6m

What are the differences between the following? Ammeter and Voltmeter

---

Electric resistance

Electric resistance is the impedance caused by the resistor of the electric current passing through it, its unit is Ohm (Ω).

المقاومة: هي الإعاقة التي يبديها السلك للتيار المار خلاله وتقاس بوحدة ألاوم.

NOTE:

* The electric resistance is measured directly by using the **Ohmmeter**.

المقاومة الكهربائية تقاس بجهاز **الأوميتر**.

There are two types of resistances

- ✓ Constant resistance: the amount of resistance is constant and can be observed by the colors of the rings on its surface.

المقامة الثابتة: مقدار هذه المقاومة ثابت ويمكن معرفته من خلال الحلقات الملونة على سطح المقاومة

- ✓ Variable resistance (Rheostat): is a variable resistor which used to change the current in a circuit.

المقامة المتغيرة (الريوستات): مقاومة متغيرة المقدار تستخدم لتغيير مقدار التيار في الدائرة

Q 2022 1R 6m

What are the differences between the following? Ammeter and Voltmeter

---

Ohm's Law:

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

قانون اوم: لقد صاغ العالم أوم العالقة بين فرق الجهد الكهربائي والتيار المنساب خلال المقاوم بالعالقة الاتية:

$$\boldsymbol{Resistance\ (R) = \frac{potential\ difference\ (V)}{current\ (I)}}$$

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.

الأوم: مقاومة موصل فرق الجهد بين طرفيه فولطا واحداء ومقدار التيار المار خلاله أمبير واحد.

Q2018 1R 5m

What is the practical benefit of an ohmmeter?

Q2022 T 5m

Define the following: Ohm

Activity (3): Measuring a small electric resistance by using an Ammeter and Voltmeter

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

أدوات النشاط:
جهاز الأميتر، أسلاك توصيل، فولطميتر، بطارية، مفتاح كهربائي، مقاومة متغيرة.

Steps:

- Connect the electric system as in Figure. (The Ammeter is connected in series and voltmeter in parallel)

مخطط للدائرة الكهربائية

نربط الدائرة الكهربائية كما موضح بالشكل (نربط الأميتر على التوالي والفولطميتر على التوازي)

- Close the electric circuit and write down the reading of the Ammeter and the Voltmeter.

نغلق مفتاح الدائرة ثم نسجل قراءة الأميتر والفولطميتر.

- Divide the Voltmeter reading by the Ammeter reading value.

This will give us the value of resistance by Ohm's Law:

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

نقسم مقدار قراءة الفولطميتر على مقدار قراءة الأميتر نحصل على مقدار المقاومة طبقا لقانون أوم

Conclusion:
We can Measure a small electric resistance by using an Ammeter and Voltmeter, we can also measure the value of electrical resistance by using the "Ohmmeter"

الاستنتاج: يمكن قياس مقاومة كهربائية صغيرة المقدار باستعمال الأميتر والفولطميتر، ويمكن قياس مقدار المقاومة الكهربائية بطريقة مباشرة وذلك باستعمال جهاز الأوميتر

The Factors on which the Conductor Resistance Depends

1- **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).
   - 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 Manganic and Constantan)

درجة الحرارة: يتغير مقدار مقاومة بعض المواد باختلاف درجة الحرارة التي تتعرض لها:
- فالمواد الموصلة النقية تزداد مقاومتها مع ارتفاع درجة حرارتها مثل النحاس.
- توجد مواد مثل الكاربون حيث تقل مقاومتها الكهربائية بارتفاع درجة الحرارة.
- وهناك مواد اخرى تبقى مقاومتها ثابتة تقريبا مهما اختلفت درجة حرارتها (كالمنكانين والكونستنتان)

2- **Conductor length:** the conductor resistance is directly proportion with its length ($R \propto L$).

طول الموصل: مقاومة الموصل تتناسب طرديا مع طول الموصل.

3- **The area of the cross section of the conductor:** the conductor resistance is inversely proportion with its cross-section area ($R \propto 1/A$).

مساحة المقطع العرضي: مقاومة الموصل تتناسب عكسيا مع مساحة المقطع العرضي

4- **Type of material:** 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 the cross section at the same temperature.

تختلف المقاومة الكهربائية باختلاف نوع المادة بثبوت العوامل الأخرى. مثال مقاومة سلك من الفضة أصغر من مقاومة سلك من الحديد مساوٍ له بالطول والمقطع العرضي وعند درجة الحرارة نفسها.

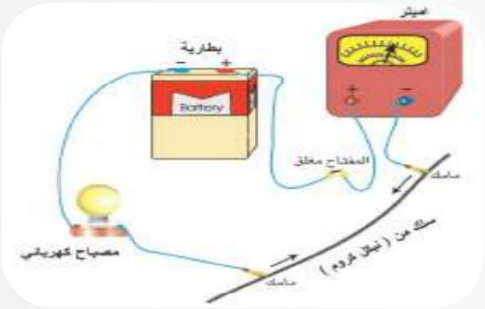
Q 2022 T 4m+2014 1R 4m

List the Factors on which the Conductor Resistance Depends.

Activity (4): The relationship between the resistance of a material and its length

Steps:

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



أدوات النشاط: بطارية، سلك موصل (مصنوع من مادة النيكل)، مصباح كهربائي، أميتر، اسلاك توصيل، ماسكين من مادة موصلة، مفتاح كهربائي.

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

نضع الماسكين بين طرفي الاسلاك ونلاحظ توهج المصباح ونسجل قراءة الأميتر

- Moving the two clips on the cable gradually close to each other. To make the length of the cable is shorter.

نحرك الماسكين على السلك نحو بعضهما تدريجيا (لتصغير طول السلك المستعمل في

- We observe that the lamp glows more and the reading of the ammeter increases.

نلاحظ حصول ازدياد تدريجي في توهج المصباح وازدياد تدريجي في قراءة الأميتر في الوقت نفسه.

Conclusion:

The resistance (R) varies directly with the length (L) when the factors remain unchanged.

الاستنتاج: مقاومة الموصل (R) تتناسب طرديا مع طوله (L) بثبوت العوامل الأخرى.

Activity (5): The relationship between the resistance of a conductor and the area of its cross section.

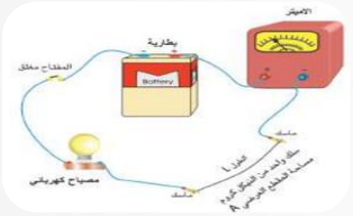
Tools:

Battery, two cables of (nickel chrome), electric lamp, ammeter, connection wires, two clips of conducting material, electric key.

أدوات النشاط: بطارية، سلكين موصلين (من مادة النيكل كروم)، مصباح كهربائي، أميتر، اسلاك توصيل، ماسكين من مادة موصلة، مفتاح كهربائي

Steps:

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

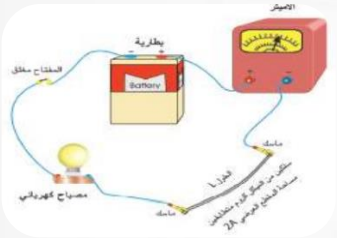


نربط دائرة كهربائية عملية متوالية الربط تحتوي الأميتر والبطارية والمصباح وسلك واحد من النيكل كروم

- Place the two clips between the two ends of the cable and record the reading of the ammeter.

نضع الماسكين بين طرفي السلك ونلاحظ توهج المصباح ونسجل قراءة الأميتر.

- Take the two identical cables (nickel chrome) and join them together to make them one thick cable with a cross section of (2A).



نأخذ السلكين المتماثلين (من النيكل كروم) ونربط طرفيهما ببعض ونجعلهما كسلك واحد، لنحصل على سلك غليظ مساحة مقطعه العرضي تساوى (2A)

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

نضع الماسكين بين طرفي السلكين (بين طرفي السلك الغليظ)

- Observe the reading of the ammeter will increase, due to the decreases of resistance when we duplicate the cross-section area of the wires

نلاحظ ازدياد قراءة الأميتر نتيجة لنقصان المقاومة عند مضاعفة مساحة المقطع العرض

Conclusion:

The resistance is inversely proportion with its cross-section area ($R \propto 1/A$) when the other factors remain the same.

الاستنتاج: مقاومة الموصل تتناسب عكسيا مع مساحة المقطع العرضي بثبوت العوامل الأخرى.

Methods of connecting the electric resistors

طرق ربط المقاومات الكهربائية

Series connection	Parallel connection
Total current: $I_{total} = I_1 = I_2$	Total current: $I_{total} = I_1 + I_2$
Total potential difference: $V_{total} = V_1 + V_2$	Total potential difference: $V_{total} = V_1 = V_2$
The equivalent resistance: $R_{eq} = R_1 + R_2$	The equivalent resistance: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

Compare between connecting of lamps in parallel and in series:

- ✓ **Connecting lamps in series**
  - When one of the lamps is faulty or disconnected, the other lamps will be off.
  - There is only one path for the electric charge movement through the electric circuit.

- ✓ ربط المصابيح على توالي
  - عند عطب أو رفع أحد المصابيح، فإن جميع المصابيح الأخرى المربوطة معها على التوالي تنطفئ
  - يوجد مسرب واحد لحركة الشحنات الكهربائية خلال الدائرة الكهربائية.

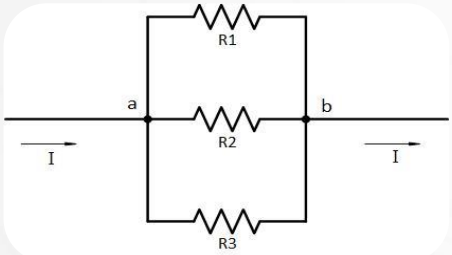
- ✓ **Connecting lamps in parallel**
  - When one of the lamps is off or remove, the other lamps will not be affected.
  - There are other paths through which the electric charge can flow.

- ✓ ربط المصابيح على توازي
  - عند عطب أو رفع أحد المصابيح فإن جميع المصابيح الأخرى المربوطة معه على التوازي تبقى متوهجة
  - توجد عدة مسارب لحركة الشحنات الكهربائية خلال الدائرة كهربائية الكهربائية.

Q2019 2R 4m+2014 2R 5m/ State the characteristics of the following:
Connecting lamps in series.

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

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



Solution / $R1 = 6\Omega,\ R2 = 9\Omega,\ R3 = 18\Omega,\ V_T = 18V$

1)

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18}$$

$$\frac{1}{R_{eq}} = \frac{3+2+1}{18} = \frac{6}{18} = \frac{1}{3}$$

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

2)

$$V_T = V_1 = V_2 = V_3 = 18V$$

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

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

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

3)

$$I_T = I_1 + I_2 + I_3 = 3 + 2 + 1 = 6A$$

or

$$I_T = \frac{V_T}{R_{eq}} = \frac{18}{3} = 6A$$

Q2014 1R 12m/Three resistances (4Ω, Ω, 3Ω) Connected in series with each other. The equivalent resistance for them is connected to a potential difference of (18V), then electric current of (2A) flow in the circuit. Calculate:

1. The amount unknown resistance (R).
2. The potential difference for each resistance.

Solution /$R_1 = 4\Omega, R_2 = ?, R_3 = 3\Omega, V_{total} = 18V,\ I = 2A, V_1 = ?, V_2 = ?, V_3 = ?$

1)

$$R_{eq} = \frac{V_{total}}{I}$$

$$R_{eq} = \frac{18\ V}{2\ A} = 9\ \Omega$$

$$R_{eq} = R_1 + R_2 + R_3$$

$$R_2 = R_{eq} - R_1 - R_3$$

$$R_2 = 9\Omega - 4\Omega - 3\Omega$$

$$R_2 = 2\Omega$$

2)

$$I_{total} = I_1 = I_2 = I_3 = 2\ A \Leftarrow Since\ the\ connection\ is\ in\ series$$

$$V_1 = I_1 \times R_1 = 2A \times 4\Omega = 8V$$

$$V_2 = I_2 \times R_2 = 2A \times 2 = 4V$$

$$V_3 = I_3 \times R_3 = 2A \times 3\Omega = 6V$$

Short Circuit

Short circuit: It is connected a thick conducting wire to two ends of one of the lamps, we see that this lamp will be turned off.

الدائرة القصيرة: على طرفي مقاومة هي ربط سلك غليظ مقاومته صغيرة جدا فيؤدي ذلك الى انسياب جميع الشحنات في السلك الغليظ فتنطفئ المقاومة وهذا ما يسمى بدائرة القصيرة.

NOTE:

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

تجنب ربط الأميتر مباشَرة مع المصدر من غير وجود حمل في الدائرة لان هذا يؤدي إلى تلفه وتلف البطارية معا إذا كان المصدر ذو قدرة عالية وذلك لتعرضها إلى دائرة قصيرة ينتج عنها مرور تيار عالي المقدار.

Connecting Electric Cells

- ✓ **Connecting electric cells in parallel**
  - all the positive poles will be connected together and all the negative poles will also be connected together.
  - The special characteristic of connecting cells in parallel is to supply higher electric current.
  - the total voltages will be equal to the voltage (emf) for the one cell.

- ✓ **ربط الخلايا على التوالي:**
  - القطب الموجب للخلية الاولى يربط مع القطب السالب للخلية الثانية، والقطب الموجب للخلية الثانية مع القطب السالب للخلية الثالثة وهكذا...
  - من مميزات ربط الخلايا على التوالي تجهيز فرق جهد عالي.
  - فرق الجهد (الفولتية) الكلي يساوي مجموع فرق جهد كل خلية مربوطة في الدائرة.

? **$Q_{2019\ 2R\ 4m+2014\ 2R\ 5m}$/ State the characteristics of the following:**
Connecting lamps in parallel.

Connecting Electric Cells

- ✓ **Connecting Electric Cells in series**
  - 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
  - the total voltages will be equal to the sum of voltages for the cells which are connected in the series.

Q 2019 2R 4m+2014 2R 5m

State the characteristics of the following:

Connecting lamps in series.

Solution of the question of chapter (3)

1- Increasing the number of connected resistances which are connected in parallel between the two poles of a battery in an electric circuit, then one of the statements will be correct:

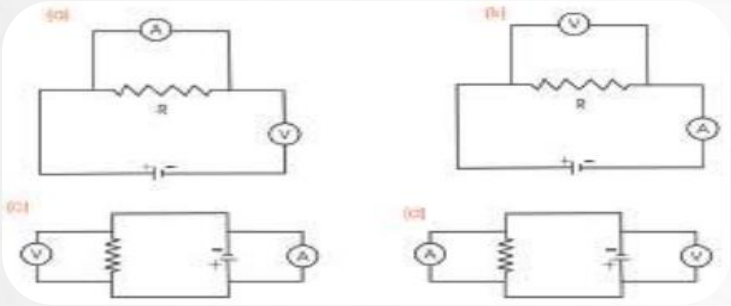
a) The total potential difference will decrease across each resistance.
b) The current flow will increase in all resistance.
c) The equivalent resistance will decrease.
d) The total potential difference will increase through each resistance.

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

a) The amount of potential difference will be same each resistance.
b) The amount of potential difference will increase of equivalent resistance.
c) The amount of current flow will be equal in all resistance.

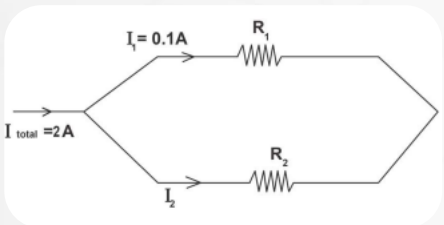
The equivalent resistance will decrease

3- Which one of the following circuits in regarded as correct when used to measure small resistance by connecting an Ammeter and Voltmeter.
Look at the indicated figure:



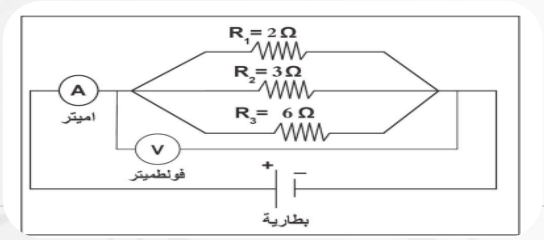
4- The electric current flow (I_2) in resistance (R) in the electric circuit diagram given below equals:

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



4- If the reading of the Ammeter connected to the circuit in the diagram is (6A) the reading of the Voltmeter in this circuit equals:

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



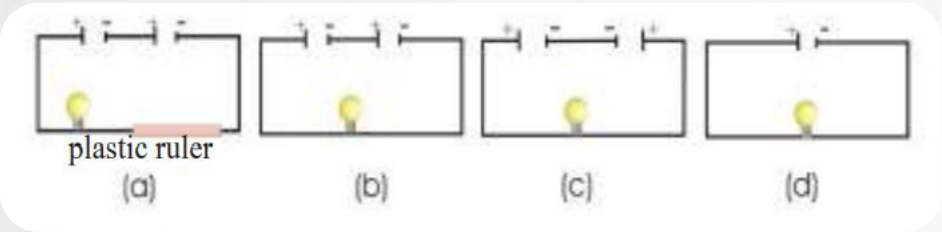
6- One of these is the unit for measuring the electric resistance:

a) $\frac{Ampere}{Volt}$ b) $\frac{Volt}{Ampere}$ C) $Volt \times Ampere$ d) $\frac{Coulomb}{second}$

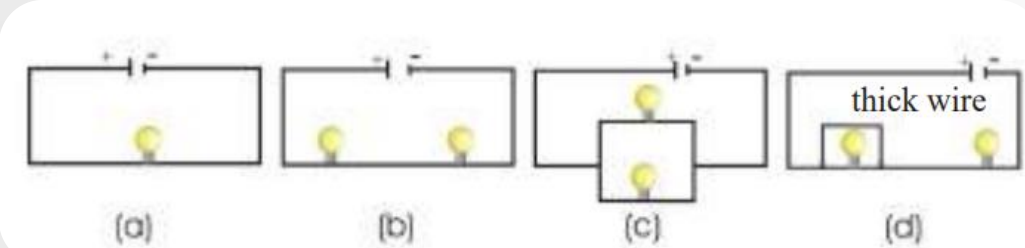
7- Electric resistance for a conductor cable does not depend on:

a) Cable's diameter.
b) Length of the cable.
c) The type of material of the cable.
d) The electric current flow in the cable.

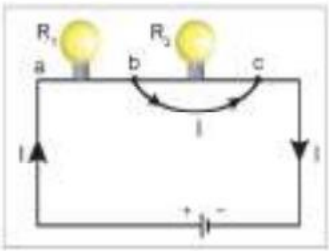
8- The batteries in the following electric circuit are identical. Explain in which one the lamp glow sharper:



9- The electric lamps in a circuit are identical. Which of the lamps glow weaker?



10- In this diagram a thick cable has been connected to the sides of the second lamp (between the points c, b):



a) The second light will be off with the resistance (R) increasing the flow of the first light of resistance (R).
b) The second lamp is off (Resistance R) will increase the glow of the second lamp with resistance R.
c) No difference in the glow of the tow lamps $R1$ or $R2$.
d) Both of the lamps they will be off $R1$ and $R2$.

Q2 / To measure the electric current flow in a circuit/circle, an Ammeter is required. Is the Ammeter connected in series or in parallel in this circuit? Explain.

Answer/

The Ammeter must be connected in series, to allow all the electric charge pass in the part where the Ammeter is located.

الجواب:

يربط جهاز الأميتر على التوالي ليسمح لجميع الشحنات المنسابة في ذلك الجزء من الدائرة بالمرور خلال الأميتر المربوط معه.

Q3/ Why is the preferable to connect the lamps and the other equipment in the electric circuit in the house in parallel?

Answer/ The reason is:

- All the lamps will get the same electric potential difference.
- When one of the lamps is off or remove, the other lamps will not be affected.
- There are other paths through which the electric charge can flow.

الجواب:

- جميع المصابيح تجهز بنفس فرق الجهد الكهربائي.
- عند عطب أو رفع أحد المصابيح فإن جميع المصابيح الأخرى المربوطة معه على التوازي تبقى متوهجة
- توجد عدة مسارب لحركة الشحنات الكهربائية خلال الدائرة كهربائية

Problems

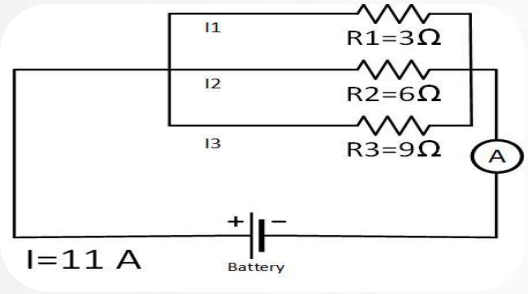
P-1 What is the amount of current which flows through a cross section in a conductor which electrical charges of $(9\ \mu C)$ in time $(3\ \mu s)$ passing through.

Solution/ $q = 9\ \mu C,\ t = 3\ \mu s$

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

$$I = \frac{q}{t} = \frac{9\ \mu C}{3\ \mu s} = 3\ A$$

P-2 By observing the diagram, calculate:



1. The amount of equivalent resistance for all the resistances which are connected in the electric circuit.
2. The amount of potential difference at the two ends of each of the resistance
3. The amount of current which flows in each resistance.

Solution/

1)

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{6} + \frac{1}{9} = \frac{6+3+2}{18} = \frac{11}{18}$$

$$R_{eq} = \frac{18}{11}\ \Omega$$

2) ∵The connection is parallel $\therefore V_1 = V_2 = V_3 = V_{total}$

$$V_T = R_{eq} \times I_T = \frac{18}{11} \times 11 = 18\ V = V_1 = V_2 = V_3 = 18\ V$$

3)

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

$$I_2 = \frac{V_2}{R_2} = \frac{18}{6} = 3\ A$$

$$I_3 = \frac{V_3}{R_3} = \frac{18}{9} = 2A$$

P-3 The two resistances $(R, 2\Omega)$ 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.
2. The potential difference for each resistance.

Solution/ $R_1 = ?\,\Omega,\ V_{total} = 12\ V,\ I = 2\ A,\ R_2 = 2\Omega,\ V_1 = ?,\ V_2 = ?$

1-

$$R_{eq} = \frac{V_{total}}{I} = \frac{12\ V}{2\ A} = 6\ \Omega$$

$$R_{eq} = R_1 + R_2$$

$$R_1 = R_{eq} - R_2$$

$$R_1 = 6\Omega - 2\Omega$$

$$R_1 = 4\Omega$$

2-

$$I_{total} = I_1 = I_2 = 2\ A \Leftarrow Since\ the\ connection\ is\ in\ series$$

$$V_1 = I_1 \times R_1 = 2A \times 4\Omega$$

$$V_1 = 8V$$

$$V_2 = I_2 \times R_2 = 2A \times 2\Omega$$

$$V_2 = 4V$$

CHAPTER (4)
BATTERY & ELECTROMOTIVE

Introduction

This chapter talks about the simple cell, explain how it works, Contents of dry cells, explain why the amount of voltage for the charger source is bigger somehow than the amount of battery electromotive force and the types of cells.

يتحدث هذا الفصل عن الخلية البسيطة، كيفية عملها، محتوياتها، سبب كون مقدار الجهد لمصدر الشاحن أكبر بطريقة أو بأخرى من مقدار القوة الدافعة الكهربائية للبطارية، وأنواع الخلايا.

The Battery

It is the source of producing energy by the chemical reaction, it's made from an electrical cell, one or more cells, each cell contains chemical materials and other contents which enable the cell to produce electric current

البطارية: هي مصدر لتوليد الطاقة بواسطة التفاعلات الكيميائية، وتتكون البطارية من خلية واحدة او أكثر، كل خلية داخلها تراكيب كيميائية ومحتويات أخرى تمكن الخلية من انتاج تيار كهربائي.

Q 2019 3R 4m

State the basic function of: Batteries.

Activity (1): How does a battery made with lemon work

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

أدوات النشاط:
ملي أميتر، مسمار، قطعة من النحاس، حبة ليمون حامض، اسلاك توصيل.

Steps:

- Fix separately the nail and the piece of copper inside the lemon
- 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 Mille-ammeter.
- We see that the pointer moves.

الخطوات:
- نغرس المسمار وقطعة من النحاس، في الليمون.
- يعمل النحاس كقطب كهربائي موجب والمسمار كقطب كهربائي سالب، يؤدي الى توليد فرق جهد بين القطبين.
- نوصل القطبين بسلكي توصيل الى طرفي مقياس للتيار الكهربائي (ملي الأميتر)
- نلاحظ انحراف انحراف مؤشر المقياس.

Conclusion
When the pointer moves, we conclude 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.

الاستنتاج: نلاحظ انحراف مؤشر المقياس وهذا دلالة على انسياب تيار كهربائي في الدائرة الخارجية نتيجة انطلاق الالكترونات من المسمار بتأثير المحلول الحامضي متجهة نحو النحاس.

Activity (2): Converting Chemical Energy to Electric

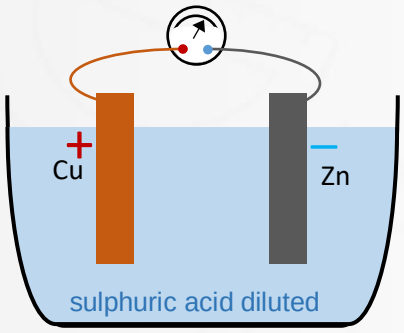
Tools:

A plate of copper and zinc, glass container sulphuric acid, Galvano meter and wires.

أدوات النشاط:

صفيحة من النحاس والخارصين، وعاء من الزجاج، حامض الكبريتيك كلفانوميتر، اسلاك.

Steps:



- Place both the copper and zinc plates inside the glass container filled with sulphuric acid diluted.
- Join the two plates with wires to the two ends of the Galvanometer
- 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.**

الخطوات:

- نضع صفيحتا النحاس والخارصين داخل وعاء الزجاج المملوء بحامض الكبريتيك المخفف.
- نصل الصفيحتين بسلكي توصيل الى طرفي جهاز الكلفانوميتر
- نلاحظ انحراف مؤشر الكلفانوميتر، دلالة على انسياب تيار كهربائي في الدائرة.
- يدعى هذا الجهاز باسم **الخلية الكهربائية البسيطة**

Conclusion

An electric potential difference will be generated between the two plates as about one volt. As a result, sufficient energy is generated allowing electric current flow when connected to an external circuit.

الاستنتاج: يتولد بين الصفيحتين المعدنيتين فرق جهد كهربائي يقدر حوالي فولطاً واحدا، ونتيجة لذلك تتولد طاقة كافية تسمح بانسياب تيار كهربائي عند ربطها بدائرة خارجية.

Classification of Batteries:

Batteries can be classified into three typed:

1- Primary Batteries 2- Secondary Battery 3- Fuel Battery

تقسم البطاريات الى ثلاث أنواع:

1- بطارية أولية 2- بطارية ثانوية 3- بطارية الوقود.

Primary Batteries

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

البطارية الأولية

- الخلايا البسيطة، يتوقف عملها وينتهي مفعولها بعد استهلاك أحد المواد الكيميائية المكونة لها
- لا يمكن إعادة شحنها، لذا يتطلب التخلص منها.
- مثل الخلية الكلفانية البسيطة والخلية الجافة (كاربون – خارصين).

$Q_{2018\ R1\ 4m}$/ Choose the right statement for the following:

The simple Galvano cell is:

(Primary battery, Secondary battery, Fuel battery)

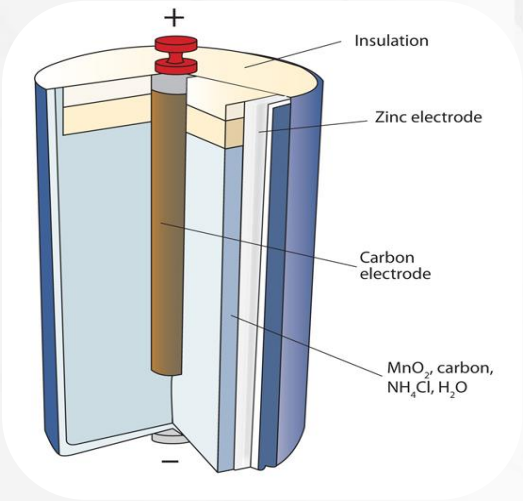
$Q_{2019\ R2\ 2m}$/ Choose the right statement for the following:

The simple Galvano cell is:

(Primary battery, Secondary battery, Fuel battery, Rechargeable battery)

Chapter four
Battery

Dry cell (carbon- zinc)



It consists of a vessel of zinc as a negative pole, A bar of carbon inside as a positive pole which is surrounded by electrolyte paste (Made of ammonium chloride, zinc chloride, water, manganese dioxide and carbon powder). 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, (Carbon- zinc) cells have many uses such as torches, generating electric pulse units for remote controls, cameras and electric children's toys.

البطارية الجافة: تتكون من وعاء من الخارصين يعمل كقطب سالب، في وسطه عمود من الكاربون يعمل كقطب موجب محاط بعجينة الكتروليتية (تتكون من كلوريد الأمونيوم وكلوريد الخارصين والماء وثنائي أوكسيد المغنيسيوم ومسحوق الكاربون). ونتيجة لحدوث تفاعل كيميائي يتولد فرق جهد بين طرفي الخلية مقداره (V1.5) عندها ينساب تيار كهربائي عند ربط طرفيها بحمل خارجي مناسب، تستعمل الخلايا الجافة في الكشافات الضوئية اليدوية، أجهزة التحكم عن بعد، آلة التصوير وألعاب الأطفال.

Q2019 1R 5m+2014 1R 4m+2014 2R 3m

What are the basic components of? Dry cell.

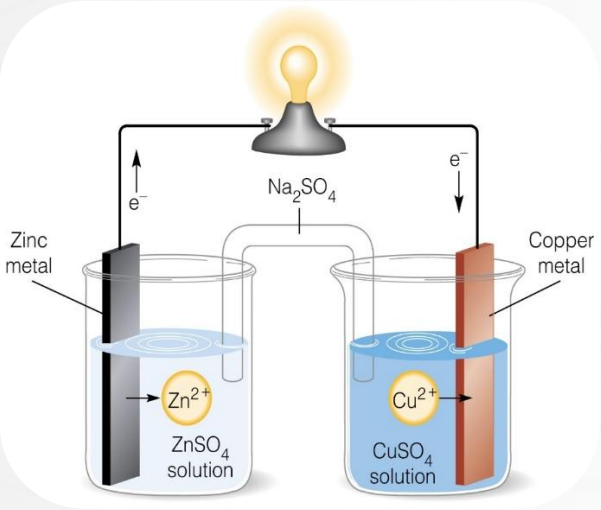
The Galvano cell

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 salts solutions ($ZnSO_4$) and the copper board sinks in ($CuSO_4$).

The atoms of the metal inside the cell leaves 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**

تتكون الخلية الكلفانية من نصفي خليتين، يغمر في كل واحدة منها لوح معدني، أحدهما من الخارصين والأخر من النحاس. ويغمر كل منهما في محلول لأحد أملاحه لوح الخارصين يغمر في محلول كبريتات الخارصين ولوح النحاس يغمر في محلول كبريتات. ذرات المعدن تترك الالكترونات على اللوح وتدخل المحلول على هيئة أيونات موجبة الشحنة. إن تراكم الالكترونات على لوح الخارصين (القطب السالب) يكون أكبر من تراكمها على لوح النحاس (القطب الموجب) وهذا النظام سمي باسم المخترع الأول دانيال فتسمى تلك الخلية **خلية دانيال.**

$Q_{2018\ 2R\ 5m}$/Answer the following question:

What are the components of simple Galvano cell? And how it works?

Secondary Battery

- This is a kind of electric battery which can be recharged
- the chemicals material inside it reacts, 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.

البطارية الثانوية

- هي نوع من البطاريات الكهربائية، يمكن إعادة شحنها
- تتفاعل المواد الكيميائية التي تحتويها فتتحول الطاقة الكيميائية المخزونة فيها إلى طاقة كهربائية
- لإعادة شحنها يتطلب إمرار تيار كهربائي في الاتجاه المعاكس لتيار التفريغ وذلك لتحويل الطاقة الكهربائية إلى طاقة كيميائية تخزن في البطارية
- مثال: بطارية السيارة وبطارية (أيون الليثيوم) التي تستعمل في الأجهزة الالكترونية مثل (الحاسبة).

Car Batteries

These kinds of batteries can be recharged. It is used to Switch on the engine of the car. 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 (PbO2), where all of them sink in the solution of (H2 SO4)

بطارية السيارة:

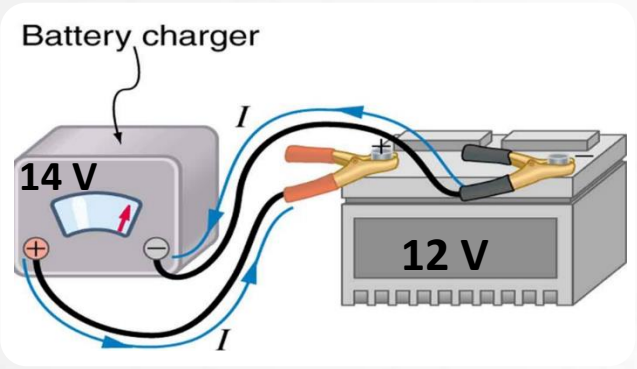
هي نوع من البطاريات الكهربائية التي يمكن إعادة شحنها. تعمل على بدء تشغيل محرك السيارة. فبطارية السيارة المكونة من (6) خلايا مربوطة مع بعضها على التوالي تعطي (V12) عندما تكون تامة الشحن. وتتركب بطارية الرصاص من ألواح الرصاص متقابلة مع ألواح أوكسيد الرصاص وكلاهما مغمور في محلول حامض الكبريتيك

$Q_{2018\ 1R\ 5m}$/ Fill in the blanks with the term that complete each statement:

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

----------.

Charging Battery



1) Connect the battery to the source of direct current (join the positive pole of the source with the positive pole of the battery, and the negative with negative).
2) The external source must be slightly Higher than the electromotive force amount (emf) of the car battery.
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.

شحن البطارية:

1) نربط البطارية بمصدر تيار مستمر (نصل القطب الموجب للمصدر الشاحن مع القطب الموجب للبطارية والقطب السالب مع السالب).
2) يجب أن يكون مقدار فولطية المصدر الشاحن أكبر بقليل من مقدار القوة الدافعة الكهربائية للبطارية.
3) ترفع الأغطية البلاستيكية للبطارية في أثناء عملية شحن البطارية للتخلص من الغازات المتولدة نتيجة التفاعلات الكيميائية التي تحصل داخلها

Maintaining the car batteries

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

العناية ببطارية السيارة:

1. تجنب سحب تيار عالي من بطارية السيارة ولفترة زمنية طويلة.
2. أن يكون مستوى المحلول ألحامضي (الإلكتروليت) دائما أعلى من مستوى صفائح البطارية بقليل.
3. عدم ترك البطارية الحامضية لمدة طويلة من غير استعمالها.

$Q_{2019\ 1R\ 5m}$ /Draw only a diagram of the process of charging a car battery.

Chapter four
Battery

Components of the lithium-ion battery

1- A solid cover especially designed to resist high pressure and the heat which generated inside the battery.
2- The cover contains three thin layers wrapped in a spiral way:
   a) The positive pole, (of oxide lithium cobalt)
   b) Insulation, (of plastic material), allowing the ions to pass through.
   c) Negative pole, (made of carbon).
3- The three layers are sunk in electrolyte solution (mostly Ether).

1- غالف متين يتحمل الضغط ودرجة الحرارة المتولدة داخل البطارية.
2- يحتوي الغلاف بداخله على ثالث شرائح رقيقة ملفوفة بشكل لولبي وهذه الشرائح تمثل:
   a) القطب الموجب (من أوكسيد كوبالت الليثيوم).
   b) العازل (من مادة البلاستك) تسمح للأيونات بالمرور خلالها.
   c) القطب السالب (مصنوع من الكاربون).
3- تكون الشرائح الثالثة مغمورة في محلول الكتروليتي وفي الاغلب هو الاثير

Q2018 2R 5m/Answer the following question:
How to maintaining the car batteries?

Q2019 2R 2m /Answer by (True) or (False) and correct the wrong statements without changing underline words:

- **<u>In (lithium – ion) batteries, the insulation boards between its two poles</u> will allow ions to pass through it.**

Q/ The difference between the battery (ion - lithium) and dry cell

Dry Battery (dry cell)	Lithium-ion Battery
Primary battery بطارية أولية	Secondary battery بطارية ثانوية
It Can't be recharged لا يمكن اعادة شحنها	It can be recharged يمكن اعادة شحنها
It doesn't have insulator ليس لها مادة عازلة	It has insulator that separates the positive pole from the negative pole. لها مادة عازلة تفصل بين القطب الموجب والسالب
Dry medium (electrolyte paste). لها وسط جاف	Electrolyte liquid medium. لها وسط سائل
You lose (20%) of its charge in a month when it is not used. تفقد ( ) من شحنتها خلال شهر	Lose only (5%) of its charge in month if it is not used. تفقد ( ) من شحنتها خلال شهر

$Q_{2012\ 2R\ 5m}$/Compare between the following:

The primary battery and the secondary battery in terms of the type of chemical medium included in each.

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.

بطارية الوقود

1. وهي خلية قادرة على توليد التيار الكهربائي باعتمادها على الوقود (مواد كيميائية) الذي يجهز من مصدر خارجي.
2. لا ينتهي مفعولها فهي تعمل باستمرار عند تجهيزها بالوقود.
3. مثال، بطارية وقود الهيدروجين.

Hydrogen fuel batteries

1- Hydrogen fuel cells convert the chemical energy to electric energy.
2- During the operation, the hydrogen and oxygen gases which are obtained from the atmosphere will be converted to water and electric energy
3- The fuel battery consists of thin boards. Each cell generates electric potential difference of (1V). linked to each other in series.
4- Fuel batteries are used in many modern applications such as computers, operating modern cars.

مميزات بطارية الوقود

1- ان خلية وقود الهيدروجين تعمل على تحويل الطاقة الكيميائية إلى طاقة كهربائية.
2- أثناء عمل خلية الوقود يتم تحويل غاز الهيدروجين وغاز الأوكسجين المأخوذ من الجو إلى ماء وطاقة كهربائية.
3- إن بطارية الوقود هي عبارة عن شرائح رقيقة تولد كل خلية منها فرق جهد كهربائي قدره فولطاً واحدا ومربوطة ببعضها البعض على التوالي
4- تستعمل بطارية الوقود في كثير من التطبيقات الحديثة منها في تشغيل الحاسوب والمركبات الحديثة

The properties of hydrogen fuel batteries

1- It does not contaminate the environment.
2- Hydrogen technology does not contain dangerous factors. It safe to use.
3- It has a very high working efficiency.
4- It lasts very long compared to the other kinds of batteries.

مميزات بطارية الوقود

1- عدم حصول تلوث.
2- تكنلوجيا الهيدروجين ليس فيها خطورة، امنة للاستخدام.
3- كفاءة تشغيلها عالية جدا
4- عمرها طويل جدا بالمقارنة مع باقي البطاريات.

$Q_{2012\ 2R\ 4m}$/ Choose the right statement from the following:
Hydrogen fuel cells convert:
(the electric energy to chemical energy, the chemical energy to electric energy, the electric energy to light energy)

$Q_{2018\ 2R\ 5m}$/What are the properties of Hydrogen Fuel Battery? And what its uses?

Electromotive force (emf)

It is the electric potential difference between the negative and positive poles for any battery when the electric circuit is opened, given by:

القوة الدافعة الكهربائية: هي فرق الجهد الكهربائي بين القطب السالب والقطب الموجب ألي بطارية عندما تكون الدائرة الكهربائية مفتوحة، وتعطى بالعلاقة:

$$Electromotive\ Force\ (emf) = \frac{Work\ (w)}{charge\ (q)}$$

Ex: 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.

Solution: $q = 10C,\ W = 20J$

$$emf = \frac{W}{q} = \frac{20}{10} = 2\ Volt$$

$Q_{2022\ 1R\ 8m}$/An amount of electric charges (2.5C) has flowed through a battery with electromotive force (1.5V). Calculate the amount of energy spent on a moving charge.

Solution: $emf = 1.5V,\ \dot{q} = 2.5C$

$$emf = \frac{W}{\dot{q}} \quad \rightarrow \quad W = emf \cdot \dot{q} = 1.5 \times 2.5 = 3.75\ J$$

$Q_{2023\ 1R\ 10m}$/An amount of electric charges has flowed (20C) through a battery. The battery gained energy of (60J). Calculate the electromotive force (emf). i.e., the energy gained by one coulomb.

QUESTIONS OF CHAPTER FOUR

Q1/ Choose the correct statements for the following:

1.The unit of electromotive force (emf) is volt (V) and equals:
a) A/C
b) J/C
c) C/s
d) 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

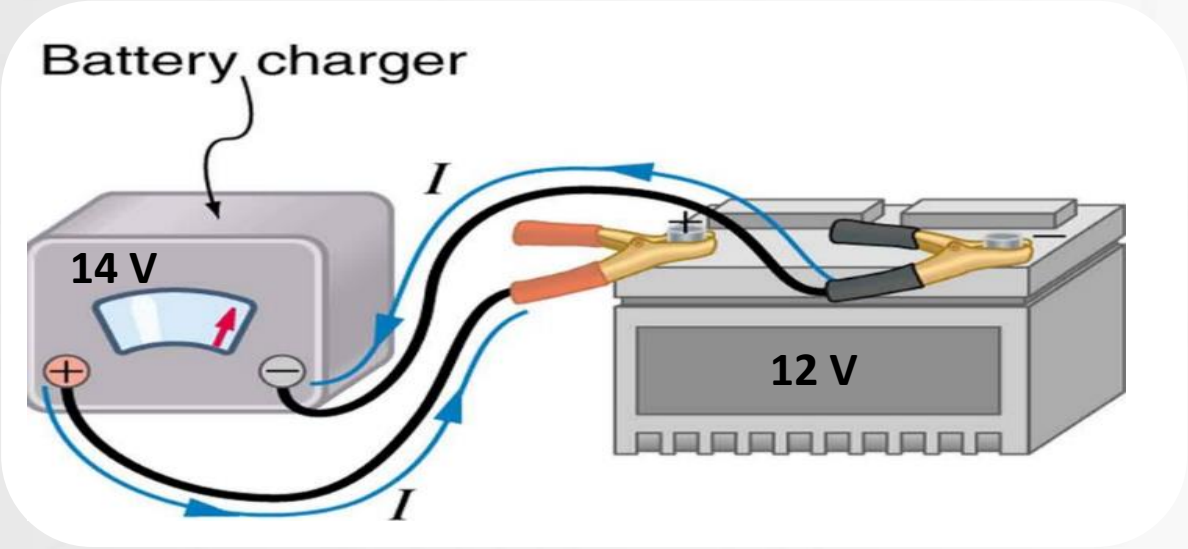
5.When charging a car battery, the amount of:
a) Source voltage must be slightly greater than the electromotive force (emf) for the battery
b) Source voltage must be less than the electromotive force (emf) for the battery
c) The source voltage equals (emf) for the battery
d) The source voltage is much 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.
Answer/
This is a kind of electric battery which can be recharged, to recharge it an electric current is needed to flow in the opposite direction to the discharge current, examples are the car batteries, and (ion-lithium) batteries.

Q-3 what is the type of energy stored in a secondary battery?
Answer/
the electric energy in a secondary battery stored as chemical energy inside the battery.

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



Q-5 what procedures are needed in order to maintain the car battery?
Answer/
Maintaining the car batteries
1. Avoid extracting high current from the car battery for long period of time.
2. The level of the acid solution (electrolyte) must be slightly higher than the level of the battery plates.
3. The battery should not be left for long time without usage.

Q-6 List four pieces of devices in which a dry battery is used.
Answer/
(Carbon- zinc) cells have many uses such as torches, generating electric pulse units for remote controls, cameras and electric children's toys.

Q-8 what are the contents of
a) Dry battery
Answer/
It consists of a vessel of zinc as a negative pole, A bar of carbon inside as a positive pole which is surrounded by electrolyte paste (Made of ammonium chloride, zinc chloride, water, manganese dioxide and carbon powder).

b) Lithium-ion battery
Answer/
1) A solid cover especially designed to resist high pressure and the heat which generated inside the battery.
2) The cover contains three thin layers wrapped in a spiral way:
   a- The positive pole, (of oxide lithium cobalt)
   b- Insulation, (of plastic material), allowing the ions to pass through.
   c- Negative pole, (made of carbon).
3) The three layers are sunk in electrolyte solution (mostly Ether).

PROBLEMS

Q1/ Calculate the amount of work spent on a moving charge of ($2C$) in an electrical circuit containing a battery with electromotive force(emf) ($1.5V$).

Solution/ $q = 2C$, $emf = 1.5\,V$, $w = ?$

$$emf = \frac{w}{q} \rightarrow w = emf \times q = 2 \times 1.5 = \boxed{3\,J}$$

Q2/ The electromotive force (emf) for a battery ($12V$) and the amount of work supplied by the battery in order to move a charge (q) ($120\,J$). Calculate the amount of moving charge (q).

Solution/ $q = ?$, $emf = 12\,V$, $w = 120\,J$

$$emf = \frac{w}{q} \rightarrow q = \frac{w}{emf} = \frac{120}{12} = \boxed{10\,C}$$

CHAPTER (5)
ENERGY & POWER

Introduction

This chapter talks about Electric power, electrical energy and how to calculate it, Electricity in our houses, explaining importance of earthen the electric devices with metal cover. showing importance of rationalizing of using electric energy.

المقدمة

هذا الفصل يتحدث عن القدرة الكهربائية، الطاقة الكهربائية وكيفية حسابها، الكهرباء في بيوتنا، يوضح أهمية تأريض الاجهزة الكهربائية ذات الغلاف المعدني، يبين أهمية الترشيد في استعمال الطاقة الكهربائية

Electrical Power

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

القدرة الكهربائية المستهلكة: هي مقدار الطاقة التي يستهلكها او يستثمرها الجهاز الكهربائي في وحدة الزمن

$$\boldsymbol{Power\ (P) = \frac{Energy\ (E)}{time\ (t)}}$$

NOTE:

- Power is measured in units ($Joule\ /\ second$) and is called $\boldsymbol{Watt}$

القدرة تقاس بوحدة (جول \ ثانية) وتدعى واط

- As the power consumption of a lamp increases, the amount of light produced increases.

كلما زادة قدرة المستهلكة للمصباح، زادة كمية الضوء التي ينتجها.

Electrical Power

Electrical Power: equals the current multiply and Electric Potential Difference, it's given by:

القدرة الكهربائية: هي حاصل ضرب التيار الكهربائي وفرق الجهد الكهربائي.

$$Power\ (P) = current\ (I) \times Potential\ difference\ (V)$$

$$P = I \times V \quad or \quad P = I^2 \times R \quad or \quad P = V^2/R$$

Example:

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

1- Power consumed by one of the heating wires.

2- Current flow in one of the heating wires.

Solution/ $P = 220V,\quad R = 88\Omega,$

1- $P = \frac{V^2}{R} = \frac{(220)^2}{88} = \frac{48400}{88} = 550\ W$

2- $I = \frac{V}{R} = \frac{220}{88} = 2.5\ A$

$Q_{2019\ 2R\ 9m}$/Electric device consumed energy $(18000\ J)$ in (5 minutes). Calculate the power consumed.

Solution/ $E = 18000\ J,\qquad T = 5\ min = 300\ seconds$

$$P = \frac{E}{T} = \frac{18000\ J}{300\ seconds} = 60\ watts$$

$Q_{2014\ 1R\ 12m}$/ An electric lamp operated by (12V) and its power (24 w) calculate:

1. **The current flowed in this device.**
2. **The electric energy consumed during (2 hours).**

Electrical energy and how to calculate it

Electrical energy depends on the amount electrical power of device. According to relationship:

الطاقة الكهربائية تعتمد على القدرة الكهربائية للجهاز وحسب العلاقة:

$$Electric\ energy\ (E) = Power\ (P) \times time\ (t)$$

NOTE:

- Energy is measured in units of ($Joule$).

الطاقة تقاس بوحدة (الجول)

- We can calculate the cost of electricity used by operating a device for a certain period time:

يمكننا حساب تكلفة الطاقة الكهربائية المستهلكة في الأجهزة لمدة من الزمن من خلال

$$Cost = Energy\ (E) \times unit\ price\ of\ unit\ Energy\ (u.p)$$

$$Cost = Power\ (P) \times time(t) \times unit\ price\ of\ Energy\ (u.p)$$

Example:

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

Solution/ $P = 1500\ W,\ E = ?,\ t = 20\ min = 1200s$

$$E = P \times t = 1500 \times 1200 = 1800000\ J = 1800\ KJ$$

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/ $V = 220V,\ I = 10A,\ P = ?,\ t = 20s,\ E = ?$

1- $P = I \times V = 10 \times 220 = 2200\ W$

2- $E = P \times t = 2200 \times 20 = 44000\ J = 44\ KJ$

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/

$$P = 1000W = 1KW,\ t = 30s = 0.5h,\ unit\ price = 100\ \frac{dinar}{KW-h}\ , cost = ?$$

$$Cost = Power\ (P) \times time(t) \times unit\ price\ of\ Energy\ (u.p)$$

$$Cost = 1KW\ \times 0.5\ h \times\ 100 \frac{dinar}{KW-h} = \mathbf{50\ Dinars}$$

$Q_{2019\ 1R\ 10m}$/An electric boiler consumes power of (2000W). It worked for (45 minutes). What is the cost of consumed energy if the price of 1(kWh) is 100 Dinars?

Electricity in our houses

Electricity in our houses consist of two wires:

- The first wire (L) has a potential difference of (220 V) and is called the live wire (hot).

السلك الأول (L) جهده يساوي (220v) يسمى السلك الحي(الحار)

- The second wire (N) is called the neutral wire (cold) it has low potential difference, because it is earthed.

السلك الثاني (N) يدعى بالسلك المتعادل (البارد) له فرق جهد واطي بسبب اتصاله بالأرض.

Earthed circuits

- The earthed wire (E): It 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.

السلك المؤرض: يكون متصل بالأرض يستخدم للحماية، ففي حالة حدوث أي خلل في الدائرة الكهربائية أو حدوث تماس بين السلك الحي والغلاف المعدني للجهاز. فسوف يؤدي إلى انسياب معظم التيار الكهربائي من السلك الحي إلى الارض من خلال السلك المؤرض. مما يقلل خطر الصعقة الكهربائية.

- Plug with fuse: the electric plug consists of the live wire (L), the neutral wire (N), the earthed wire (E) and the fuse. It is used to avoid an electric shock.

القابس ذو الفاصم: يتكون من السلك الحي (L), السلك المتعادل (N), السلك المؤرض (E) والفاصم. يستخدم للحماية من الصعقة الكهربائية.

- Fuse: is made of a metal wire, connected in series with the live wire before the current enter the device If the current is more than that limit, then this metal wire will hot and melt, then the electric current will cut off

الفاصم: هو سلك فلزي يربط مع الدائرة على التوالي قبل انه يدخل الكهرباء على الجهاز وإذا كان التيار أكبر من المقدار المحدد سوف يسخن السك يذوب السلك فيقطع الدائرة الكهربائية.

- Disconnect device (Cut Over device): It is an electric device disconnects the electric current automatically in case the current flow exceeds that which was planned.

قاطع الكهربائي (قاطع الدورة): هو جهاز كهربائي يقوم بقطع التيار الكهربائي تلقائيا إذا انساب تيار أكبر من التيار المصمم له

$Q_{2019\ 2R\ 4m}$/ What are uses of (Earthed wire)?

$Q_{2022\ 1R\ 3m + 2019\ 3R\ 8m}$/What are uses of Fuse?

$Q_{2014\ 1R\ 4m}$/Give the reason of the following:

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.

Avoiding an electric shock

We can avoid the electric shock by using the earth wire is normally thick, but its resistance against electricity is very weak, less than the human's resistance. Therefore, the current flows in the wire but it doesn't flow in the human body.

ممكن تجنب الصعقة الكهربائية من خلال استعمال السلك المؤرض وهو عادة يكون غليظ ومقاومته النوعية صغيرة جدا اقل من مقاومة جسم الانسان، لذلك التيار الكهربائي ينساب في السلك (المقومة الصغيرة)

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

لكي تحمي نفسك من مخاطر الكهرباء يجب توخي الحذر وإتباع إجراءات السالمة الآتية:

1- عدم ملامسة شخص متعرض إلى صعقة كهربائية إلا بعد فصله عن مصدر الكهرباء
2- تجنب وضع جسم معدني ممسوك باليد في نقطة كهربا
3- عدم ترك الاسلام متهرئة (بدون عازل)
4- تجنب ان يتصل جسمك بين السلك الحي والمتعادل أو أن يتصل جسمك بين السلك الحي والأرض.

$Q_{2023\ 1R\ 5m}$/Give the reason of the following:

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

Answer:

Because resistance of bird body (between the bird legs) is very large (big) compare to the resistance of these part of wire. So that the current flows in the wire and doesn't flow in the bird body.

QUESTIONS OF CHAPTER FOUR

Q1/ Choose the correct statements for 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) J
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) 20 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

Q2/ Give the reason of the following:

1. The fuse is connected to the electrical circuit of the house in series with the live wire before providing the electric device with electric energy.
Answer:
The Fuse is connected in series with the live wire before the current enter the device If the current is more than that limit, then this metal wire will hot and melt, then the electric current will cut off

2. Electric device will be earthed, especially the ones with metal covers.
Answer:
To protect the usage from the electric shock when a damage happened in the device.

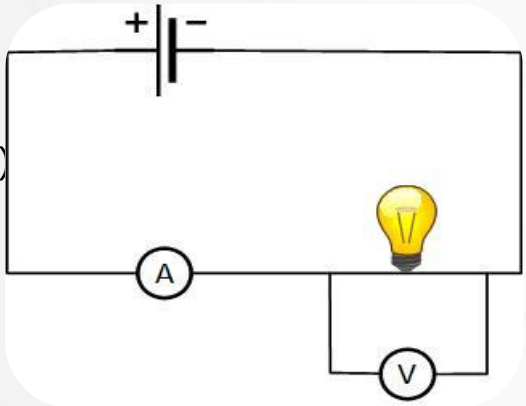
3. A bird can stand on a live wire which has very high power without being shocked
Answer:
Because resistance of bird body (between the bird legs) is very large (big) compare to the resistance of these part of wire. So that the current flows in the wire and doesn't flow in the bird body.

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?
Answer:
Fuse is connected in series with the live wire before the current enter the device If the current is more than that limit, then this metal wire will hot and melt, then the electric current will cut off

PROBLEMS

P-1/ The near figure represents an electrical circuit containing a lamp (L), a voltmeter, and an ammeter. If you know that the voltmeter reading is (3 V) and the ammeter reading is (0.5 A) calculate the amount:

1. The resistance of the lamp.
2. The power of the lamp.



Solution/ $I = 0.5\ A\ ,\ V = 3\ V\ ,\ R = ?,\ P = ?$

1- $R = \frac{V}{I} = \frac{3}{0.5} = 6\Omega$

2- $P = I \times V = 0.5 \times 3 = 1.5\ watt$

P-2/ Two resistances ($180\ \Omega\ and\ 90\ \Omega$) 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

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

Solution/ $R_1 = 180\ \Omega,\ R_2 = 90\ \Omega,\ V = 36\ V,\ I = ?,\ P_1 = ?,\ P_2 = ?$

a) $I_1 = \frac{V}{R_1} = \frac{36}{180} = 0.2\ A\ ,\quad I_2 = \frac{V}{R_2} = \frac{36}{90} = 0.4\ A$

b)

1- $P_1 = I_1 \times V = 36 \times 0.2 = 7.2\ Watt,$

$P_2 = I_2 \times V = 36 \times 0.4 = 14.4\ Watt$

2- $P_1 = (I_1)^2 \times R_1 = (0.2)^2 \times 180 = 7.2\ Watt,$

$P_1 = (I_2)^2 \times R_2 = (0.4)^2 \times\ 90\ = 14.4\ Watt,$

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

Solution/ $P = 24\ Watt = 0{,}024\ KW\ ,\ V = 24\ V,\ t = 10\ h,\ E = ?$

$$E = P \times t = 0.024\ \times 10 = 0.24\ (KW - h)$$

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 (kWh) is 100 Dinars?

Solution/ $P = 2\ KW\ ,\ t = 6\ h,\ unit\ price = 100\ \frac{KW-h}{Dinars}\ ,\ cost = ?$

$$COST = P \times t \times unit\ price = 2 \times 6 \times 100 = 1200\ Dinars$$