مراجعة لهيكل الفيزياء ثاني عشر عام

اعداد الاستاذ محمد ابو محفوظ

و

الاستاذ مروان ابو محفوظ

اهداء

لله الحمد في البداية والختام....له الحمد في السراء والضراء وفي كل وقت وحين ...نحمد الله على هذا الفضل ونرجو رضاه اما بعد اهدي هذا العمل البسيط الى كل من يسعى جاهدا في طلب العلم ولم يستسلم للظروف او للفشل .... الى من سهرت لراحتي الى سيدتي الاولى والاخيرة امي الى صاحب الفضل والسيادة والدي صاحب البهجة والسعادة الى الى عائلتي والاهل والاصدقاء اهدي لكم كلماتي وجهدي واجتهادي لكم خالص شكري وارجو لكم من الله التوفيق والعلم والعمل نضع بين ايديكم هذا العمل نفعنا الله واياكم بما فيه من علم

وَقُل رَّبِّ زِدْنِي عِلْمًا

Parallel Circuits: A circuit in which there are several current paths is called a parallel circuit.

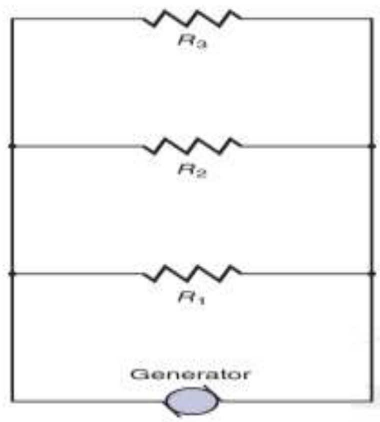


Figure 6 The parallel paths for current in this diagram are analogous to the multiple paths that a river might take down a mountain.

The three resistors are connected in parallel; both ends of the three paths are connected together.

Current in a parallel circuit:

$$I = I_1 + I_2 + I_3.$$

Voltage in a parallel circuit:

$V_S=V_1=V_2=V_3=....$

EQUIVALENT RESISTANCE FOR RESISTORS IN PARALLEL:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

- In parallel connected we get Req smaller than the smallest resistance.
- If we remove any resistance in parallel connected Req increase and is Is decrease.
- If there is a break in part of the circuit, the rest of the circuit is working

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

EXAMPLE 3

EQUIVALENT RESISTANCE AND CURRENT IN A PARALLEL CIRCUIT Three resistors, 60.0 Ω, 30.0 Ω, and 20.0 Ω, are connected in parallel across a 90.0 V battery.

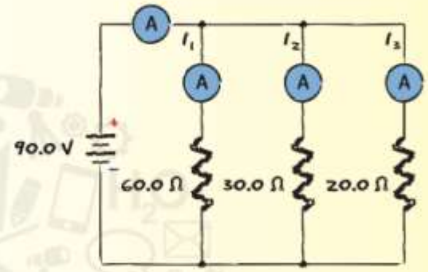
a. Find the current through each branch of the circuit.

b. Find the equivalent resistance of the circuit.

c. Find the current through the battery.

1 ANALYZE AND SKETCH THE PROBLEM

- Draw a schematic of the circuit.
- Include ammeters to show where you would measure each of the currents.



KNOWN	UNKNOWN	
$R_1 = 60.0\ \Omega$	$I_1 = ?$	$I = ?$
$R_2 = 30.0\ \Omega$	$I_2 = ?$	$R = ?$
$R_3 = 20.0\ \Omega$	$I_3 = ?$	
$\Delta V = 90.0$ V		

Q:

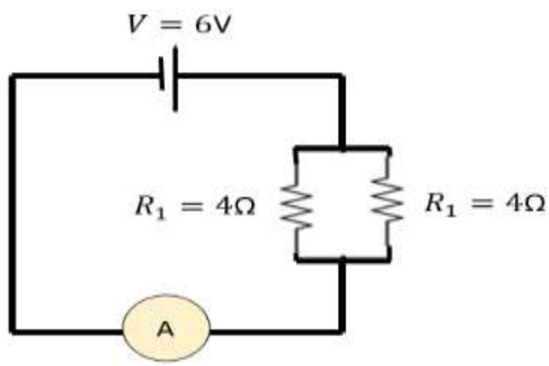
في الشكل أدناه دائرة تتكون من مقاومتين

$$R_1 = R_2 = 4\Omega$$

تم وصلهما ببطارية

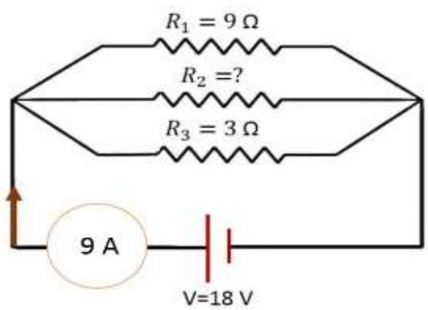
$$V = 6V$$

فإن قراءة الأميتر تعادل

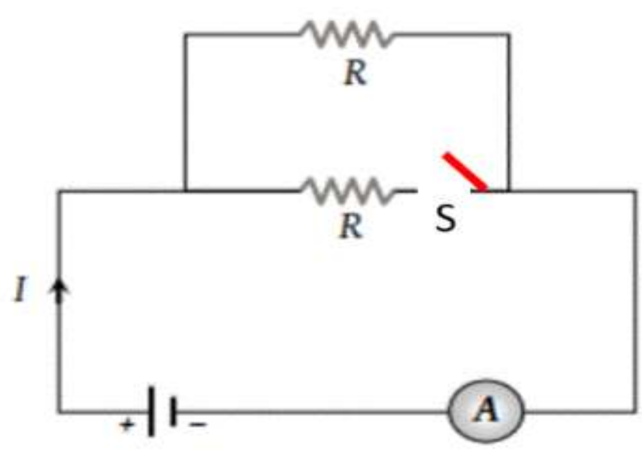


ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

ثلاث مقاومات متصلة كما في الشكل أدناه ببطارية جهدها (18 v)
تم قياس شدة التيار المار في الدائرة فكانت شدة التيار (9 A)
وقيم المقاوم الأول والثالث موضحة على الشكل
فإن قيمة المقاوم الثاني تعادل



مقاومتين متساويتين عند توصيل المفتاح (S)
في الدائرة أدناه فإن قراءة الأميتر في الدائرة

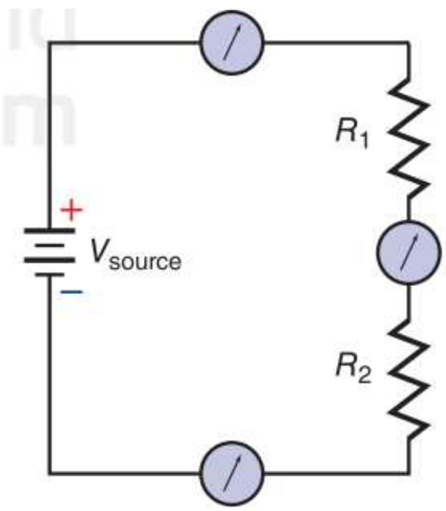


ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

series circuit: "A circuit such as this, in which there is only one path for the current".

Voltmeter: device used to measure the voltage (V) in the circuit.

Ammeter: device used to measure the current (I) in the circuit .



$$\Delta V_{source} = \Delta V_1 + \Delta V_2.$$

$I_{source} = I_1 = I_2$

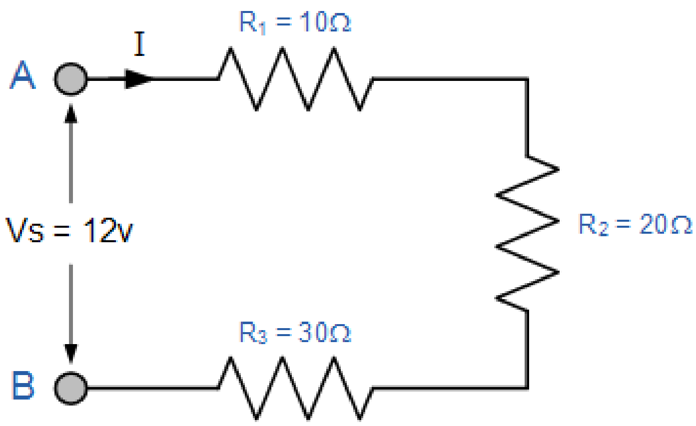
$R_{eq} = R_1 + R_2$

$P = I\Delta V$.... (POWER)

- In series connected we get Req greater than the largest resistance.
- If we remove any resistance in series connected Req decrease and Is increase.
- If we cut any part of the circuit the current stop at all in the circuit.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Example :



In the circuit find :
1- Req
2- ISOURCE
3- V1,V2,V3

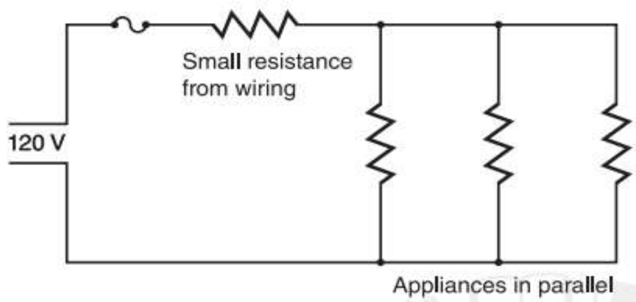
أحد الإجابات التالية لا تعتبر من ميزات التوصيل على التوالي

a-We get a greater equivalent resistance than any resistance.
b-The current in the resistors is equal.
c-If there is a break in part of the circuit, the rest of the circuit is working.
d- A larger resistor needs more potential difference. Lkm

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Combined Series-Parallel Circuits

Circuits that contain series and parallel branches are called combination series-parallel circuits.

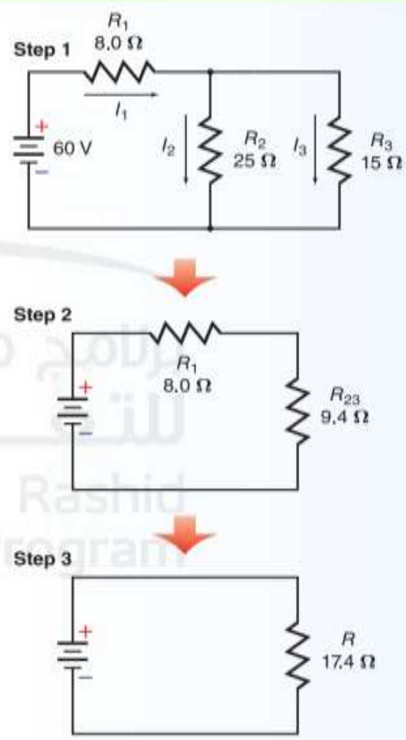


PROBLEM-SOLVING STRATEGIES

SERIES-PARALLEL CIRCUITS

When analyzing a combination series-parallel circuit, use the following steps to break down the problem.

1. Draw a schematic diagram of the circuit.
2. Find any parallel resistors. Resistors in parallel have separate current paths. They must have the same potential differences across them. Calculate the single equivalent resistance of a resistor that can replace them. Draw a new schematic using that resistor.
3. Are any resistors (including the equivalent resistor) now in series? Resistors in series have one and only one current path through them. Calculate a single new equivalent resistance that can replace them. Draw a new schematic diagram using that resistor.
4. Repeat steps 2 and 3 until you can reduce the circuit to a single resistor. Find the total circuit current. Then go backward through the circuits to find the currents through and the potential differences across individual resistors.

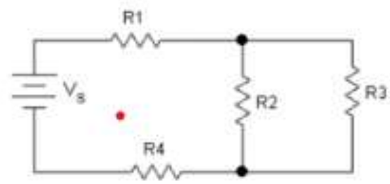


ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

أربع مقاومات متساوية تم توصيلها كما في الشكل ادناه تم حساب المقاومة المكافئة فكانت

5 Ω

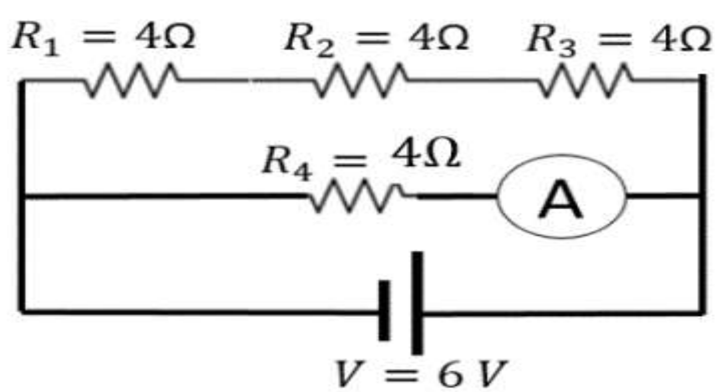
فإن مقاومة كل مقاوم تعادل



أربع مقومات متساوية مقاومة كل منها (4 Ω)

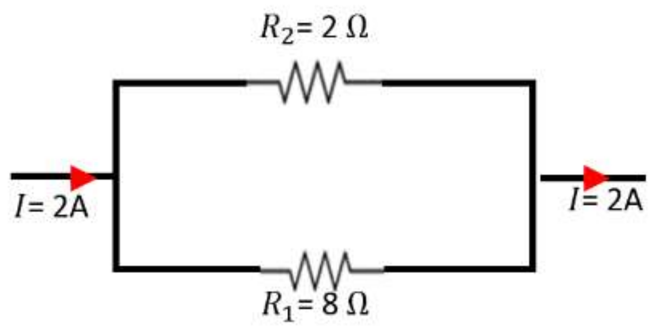
تم توصيلها ببطارية فرق جهدها (6 V)

كما في الشكل ادناه فإن قراءة الأميتر تعادل



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

في الشكل أدناه أحسب شدة التيار المار في المقاومة (8 Ω)

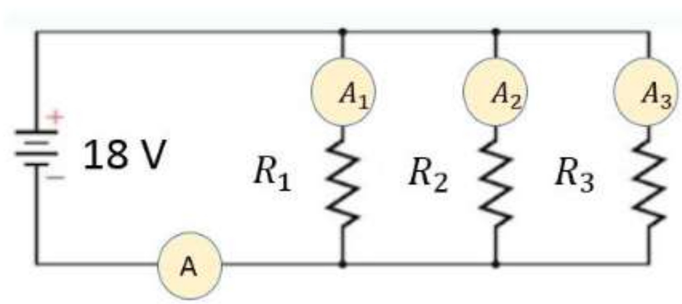


ثلاث مقاومات

$$R_1 = 8\Omega, R_2 = 10\Omega, R_3 = 15\Omega$$

تم وصلها ببطارية جهدها (18 V)

متصلة ببعضها كما في الشكل أدناه



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

- أحد الإجابات التالية لا تعتبر من ميزات التوصيل على التوازي

a- The larger resistor has a larger current.
b- If there is a break in part of the circuit, the rest of the circuit is working.
c- We get a smaller equivalent resistance than any resistance.
d- Equal potential difference in resistors

Ammeters and Voltmeters

Ammeters

- ammeter is a device that is used to measure the current in any branch or part of a circuit.
- An ammeter is connected in series with the resistor.
- the use of an ammeter should not change the current in the circuit.
- the resistance of an ammeter is designed to be as low as possible.

Voltmeter

- a device that is used to measure the potential difference across a portion of a circuit.
- a voltmeter is connected in parallel with the resistor.
- Voltmeters are designed to have a very high resistance.

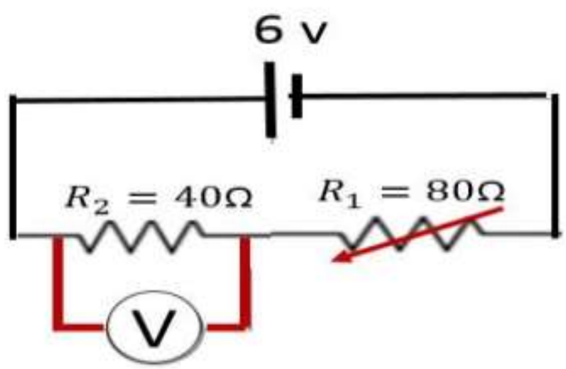
ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

في الشكل أدناه دائرة تتكون من مقاومتين

$R_1 = 80\Omega, R_2 = 40\Omega$

متصلة بمصدر تيار مستمر فرق جهده (6 .0 V)

فإن قراءة الفولتميتر تعادل

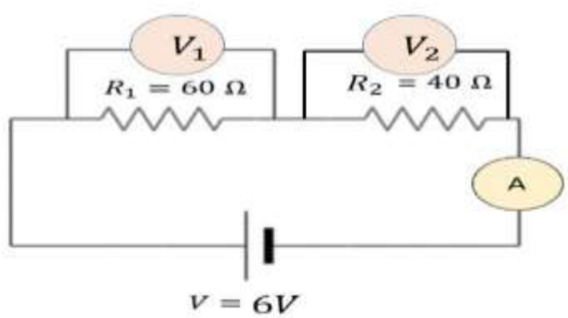


في الشكل أدناه دائرة تتكون من مقاومتين

$R_1 = 40\Omega, R_2 = 60\Omega$

متصلة بمصدر تيار مستمر فرق جهده (6 .0 V)

فإن قراءة أجهزة الأميتر و الفولتميتر تعادل



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Magnetic Fields

Properties of Magnets:

- Magnets have two opposite ends, called **poles.** (Magnets are polarized)
- A magnet that is free to rotate always comes to rest pointing in the north-south direction.
- The pole pointing north is called the north-seeking pole or (the north pole),the opposite pole is the south pole.

Earth as a magnet the needle of a compass points in a north-south direction because Earth itself is agiant magnet. A compass's north pole points to Earth's geographic North Pole. As you will read,
however, a magnet's north pole is always attracted to a magnetic south pole. Therefore, what we call
the North Pole is near Earth's magnetic south pole, and the South Pole is near Earth's magnetic north pole.

A.Z physics

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Poles repel or attract forces between two magnets differ depending on how you orient the magnets." Like poles repel; unlike poles attract"

Like poles repel.

Unlike poles attract.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

a magnet always has two poles: No matter how you cut or break a magnet, a magnet always has two poles. There have been many searches for objects, called mono poles, with only a north pole or only a south pole, but no monopole has ever been found.

Temporary magnets Magnets also attract nails, paper clips, tacks, and other metal objects. These objects have no poles, and both the north and south poles of a magnet attract them. When a magnet touches one of these objects, such as the nail in Figure 3, the magnet polarizes the object, _making it a temporary magnet. This process is called **magnetization by induction**.

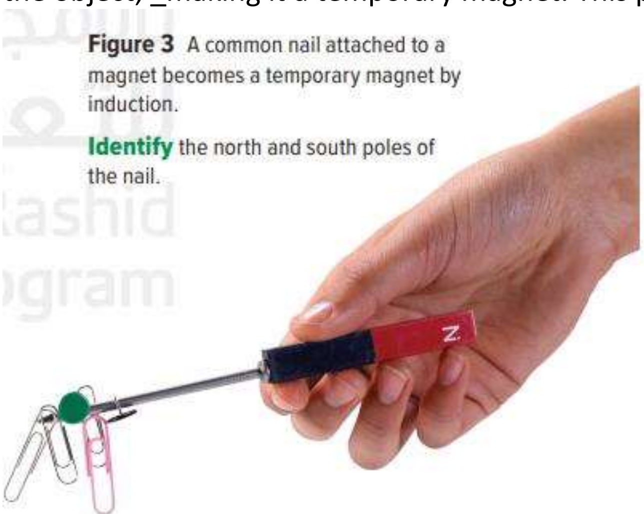


Figure 3 A common nail attached to a magnet becomes a temporary magnet by induction.

Identify the north and south poles of the nail.

Magnets only attract some metals. Brass, copper, and aluminum are common metals that are not attracted to magnets. Iron, nickel, and cobalt are strongly attracted. Materials containing these elements, called **ferromagnetic materials**, can become temporary magnets. A steel nail can become a temporary magnet because it is made of iron with tiny amounts of carbon and other materials.

- When you remove a nail from a magnet, the nail gradually loses most of its magnetism.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Magnetic Fields Around Magnets

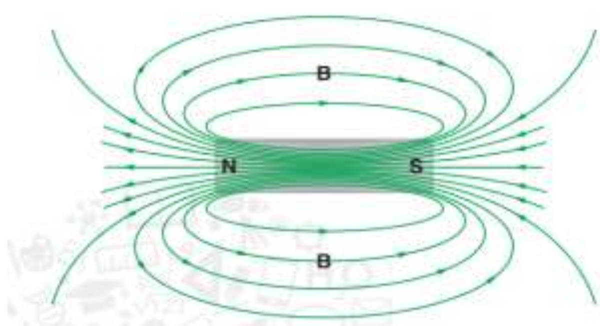
Magnetic fields: are fields that exist in space where magnets would experience a force.

- Magnetic fields are traditionally represented by the letter B.
- They are vector quantities because they have magnitude and direction.
- The needle of a compass in Earth's magnetic field aligns in the direction of Earth's field" When in a stronger magnetic field, the needle realigns in the direction of the stronger field."
- the forces between magnets are present without needing touch.

<u>Magnetic field lines:</u> lines used to show the direction as well as the strength of a magnetic field.

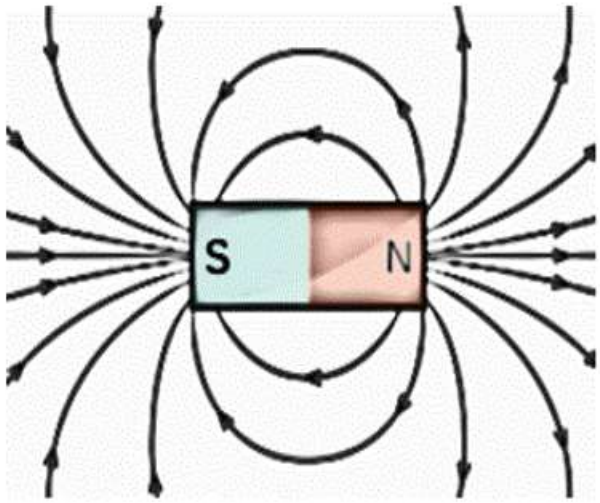
N: "Magnetic field lines are not real!"

- field lines emerge from a magnet's north pole and enter at its south pole.
- The field lines form closed loops, continuing through a magnet from its south pole to its north pole.
- The direction of the field at any point is the tangent to the field line at that point.
- At poles magnetic field strength is the highest.
- The density of magnetic field line represent its strength.



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

أحد الإجابات التالية لا تمثل صفات خطوط المجال المغناطيسي



a- Field lines go from south pole to north inside the magnet.
b- The direction of the field at any point is the tangent to the field line at that point.
c- Field lines condense at the poles and as little as possible at the center.
d- It is possible that the field lines intersect at the poles.

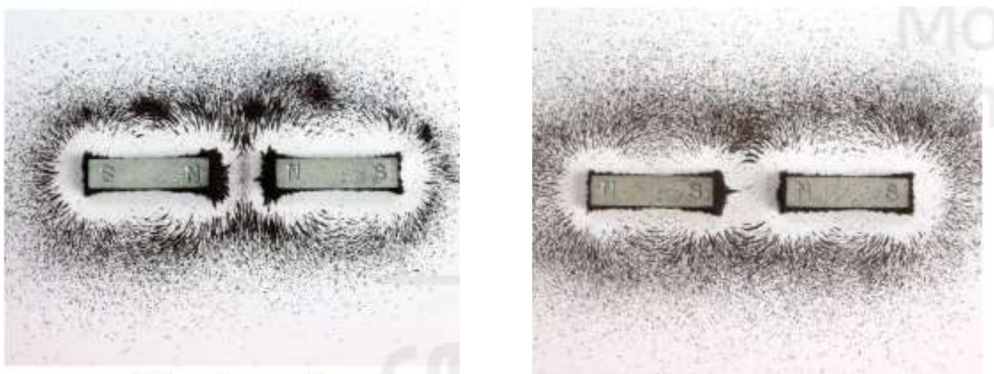
magnetic flux: The number of magnetic field lines passing through a surface perpendicular to the lines.

- The flux per unit area is proportional to the strength of the magnetic field.
- Magnetic flux is most concentrated at magnetic poles, where magnetic field strength is the highest.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Forces on objects in magnetic fields :

Forces on permanent magnets: Magnetic fields exert forces on magnets. When like poles of two magnets are close together, the field produced by the north pole of one magnet pushes the north pole of the second magnet away in the direction of the field lines, as shown by the iron filings in the top panel of Figure 8. Now look at the bottom panel of Figure 8. The field from the north pole of one magnet now acts on the south pole of the second magnet, attracting it in a direction opposite the field lines. The magnetic field is continuous, forming arcs from one magnet to the other.



Like poles repel.

Unlike poles attract.

Figure 8 Iron filings can be used to visualize the magnetic field around two like poles (top) and around two unlike poles (bottom). The iron filings help us understand how like poles repel and unlike poles attract.

Forces on temporary magnets: Magnetic fields exert forces not only on other magnets. They also exert forces on ferromagnetic materials. When an object containing a ferromagnetic material is placed in the field of a permanent magnet, field lines leave the magnet's north end and enter the end of the object that is closest to the magnet. The field lines pass through the object and loop back to the magnet's south pole. The domains in the object align their poles along the field lines, making the end of the object closest to the magnet's north pole the object's south pole. The object's new south pole is then attracted to the magnet's north pole, and the object's new north pole is repelled.

A.Z physics

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Magnetic fields from current-carrying wires:

- The magnetic field around a current-carrying wire is always perpendicular to that wire.
- Just as field lines around permanent magnets form closed loops.
- the field lines around current-carrying wires also form closed loops.
- The strength of the magnetic field around a long, straight wire is proportional to the current in that wire.
- Magnetic field strength also varies inversely with distance from the wire.

Magnetic Field Around a Wire

Direction of the magnetic field from current-carrying wires:

_ Scientists use right-hand rules to describe how the directions of electric and magnetic properties relate.

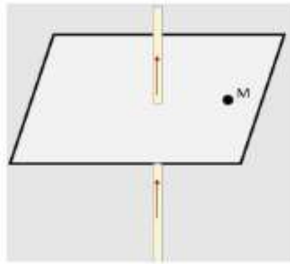
right-hand rules:

1) imagine holding a length of wire with your right hand.
2) If your thumb points in the direction of the current.
3) the fingers of your hand encircling the wire will point in the direction of the magnetic field.

A.Z physics

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

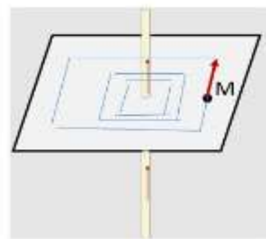
سلك عمودي على الورقة و يمر به تيار نحو الأعلى كما في الشكل أدناه



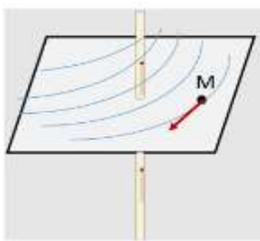
فإن شكل المجال المغناطيس حول السلك

و اتجاه المجال عند النقطة(M)

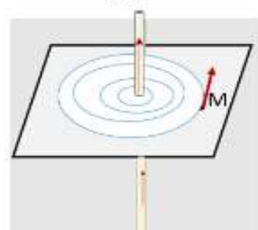
يعبر عنه الشكل



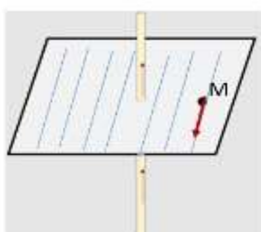
A



C



B

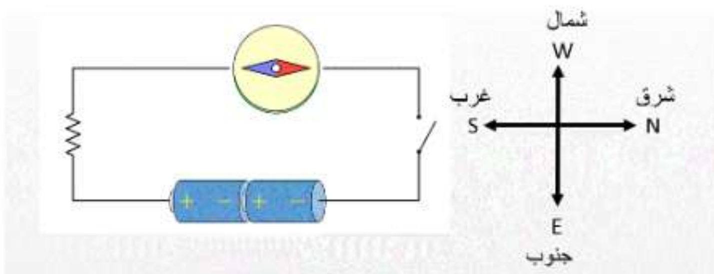


D

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

- **To Determind the direction of the needle of the compass under-wire or up-wire we use right hand rule:**
  _ your thumb points in the direction of the current, the fingers of your hand encircling the wire will point in the direction of the magnetic field.
  Example:

عند اغلاق الدائرة والبوصلة فوق السلك فإن رأس الإبرة ينحرف نحو الموقع



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Solenoid

- An electric current in a single loop of wire forms a magnetic field all around the loop.
- a wire with many loops called “solenoid”.
  - solenoid: A wire connected to a circuit and coiled into many spiral loops.
- When current is turned on in a solenoid, each loop produces its own magnetic field. The fields are all in the same direction.
  _ When there is an electric current in a solenoid, the solenoid has a magnetic field similar to the field of a permanent magnet. This kind of magnet is an electromagnet.
  - electromagnet: is a magnet whose magnetic field is produced by electric current.
- Solenoids can be exceptionally strong electromagnets, producing magnetic fields much stronger than those around permanent magnets.
- The strength of the magnetic field in a solenoid is proportional to the current in the solenoid’s loops.
- It is also proportional to the number and spacing of loops.
- “<u>The more loops there are in a solenoid and the closer they are spaced, the greater the solenoid’s magnetic field strength</u>.”
- Magnatic field is greater inside solenoid.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

- The magnetic field strength of a solenoid also can be increased by placing an iron-containing rod inside it.

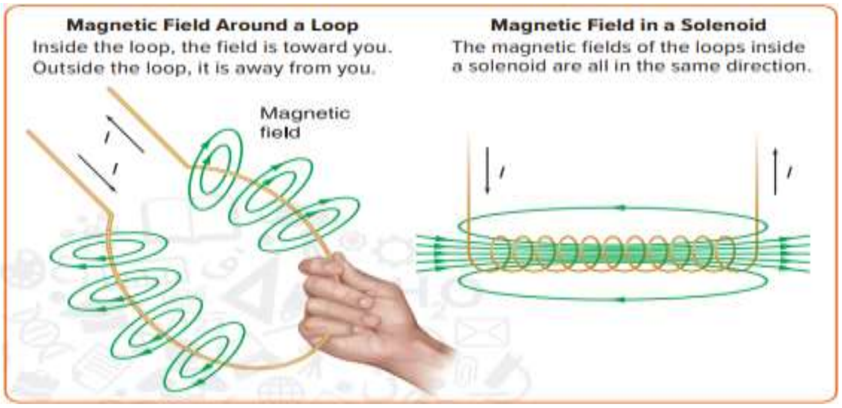


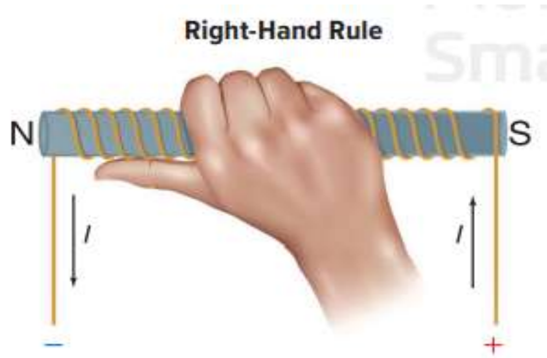
Figure 11 You can model the direction of the magnetic field around a loop of current-carrying wire and around a solenoid.

Assess Is the magnetic field greater inside or outside the solenoid?

Direction of the magnetic field from solenoid:

Right-hand rule for a solenoid:

1. Imagine holding a solenoid with your right hand.
2. curl your fingers around the solenoid in the direction of current.
3. your thumb will point toward the solenoid's north pole.



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Forces on Single Charged Particles

FORCE OF A MAGNETIC FIELD ON A MOVING CHARGED PARTICLE
The amount of force from a magnetic field on a particle equals the product of the particle's charge, its speed, the magnetic field strength, and the sine of the angle between the particle's velocity and the magnetic field.

$$F = qvB(\sin \theta)$$

F: force in newton(N)

q: charge is measured in coulombs (C)

V: velocity in meters per second (m/s)

B: magnetic field strength in teslas (T)

Θ: angle between velocity& magnetic field

_ The direction of the force on a charged particle is perpendicular to that particle's velocity and to the magnetic field.

_ To find the direction of force, you can use the same right-hand rule you use for finding the direction of the force on a current-carrying wire, where the moving charge is the current.

N:" ***If the moving particle is an electron (with a negative charge), the direction of force is reversed*.**"

EXAMPLE 2

FORCE ON A CHARGED PARTICLE IN A MAGNETIC FIELD A beam of electrons travels at 3.0×10^{5} m/s through a uniform magnetic field of 4.0×10^{-2} T at right angles to the field. How strong is the force acting on each electron?

- magnets can be used to ***direct a charged particle's path*** such as "Synchrotrons".
- the magnets in the LHC use superconducting wires.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

direction of force (right-hand rule) of Forces on Single Charged Particles

1- your thumb points in the direction of the velocity (where the moving charge).(V)
2- the fingers of your hand will point in the direction of the magnetic field. (B)
3- your hand back will show the force(F) if the charge is negative (-).
4- your Palm face will show the force(F) if the charge is positive (+).

جسيم مشحون بشحنة مقدارها(8×10^{-9} C)

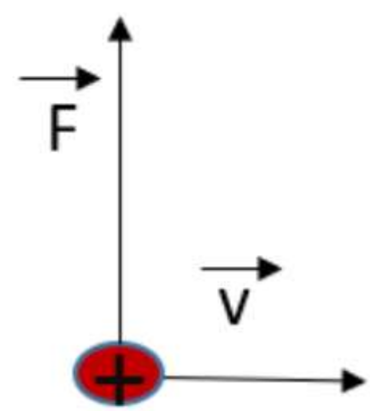
دخل منطقة مجال مغناطيسي

و بسرعة نحو الشرق مقدارها

5×10^{6}m/s

فتأثر بقوة مغناطيسية اتجاهها نحو الشمال و مقدارها (0.02 N)

فإن أقل مقدار واتجاه للمجال المغناطيسي الذي يحقق هذه القوة يعادل



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Forces on Current-Carrying Wires

FORCE ON A CURRENT-CARRYING WIRE IN A MAGNETIC FIELD

The magnitude of the force on a current-carrying wire in a magnetic field is equal to the product of the current, the length of the wire, the field strength, and the sine of the angle between the current and the magnetic field.

$$F = ILB(\sin \theta)$$

F: force in newtons (N)

I: current in amperes (A)

L: length of the wire in meter (m)

B: the strength of a magnetic field (B) in teslas (T).

_One T equals 1 N/(A·m)

θ : the angle between current and the magnetic field

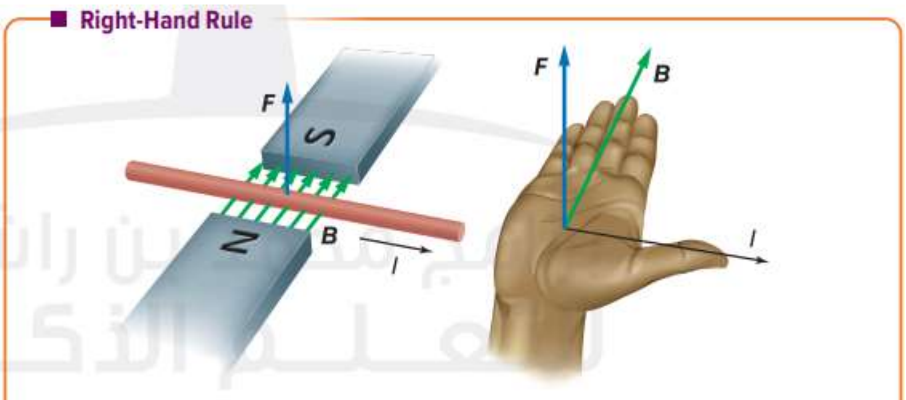
- the magnitude of the force (F) on a current carrying wire is proportional to the wire's current (I), the wire's length (L), the strength of the magnetic field (B), and the sine of the angle between the current and the magnetic field (sin θ).
- sin 0° = 0, when the current and the magnetic field are parallel to each other, the force on a current-carrying wire is zero.
- sin 90° = 1, The force on the wire is greatest when the current and the magnetic field are perpendicular to each other.

A.Z physics

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Direction of force: (right-hand rule)

- Point the fingers of your right hand in the direction of the magnetic field
- Point your thumb in the direction of the wire's current.
- The palm of your hand will face in the direction of the force acting on the wire.
- "When current changes direction, so does the force".



View an **animation of the right-hand rule for magnetic force on a wire.**

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Arrows in three dimensions: The relationship among magnetic field, electric current, and force is three-dimensional.

- Imagine an archer shooting an arrow toward you.
- The arrow looks like a dot. **Field out of Page** ●
- imagine the same arrow going away from you,The arrow looks like a cross. **Field into Page** x

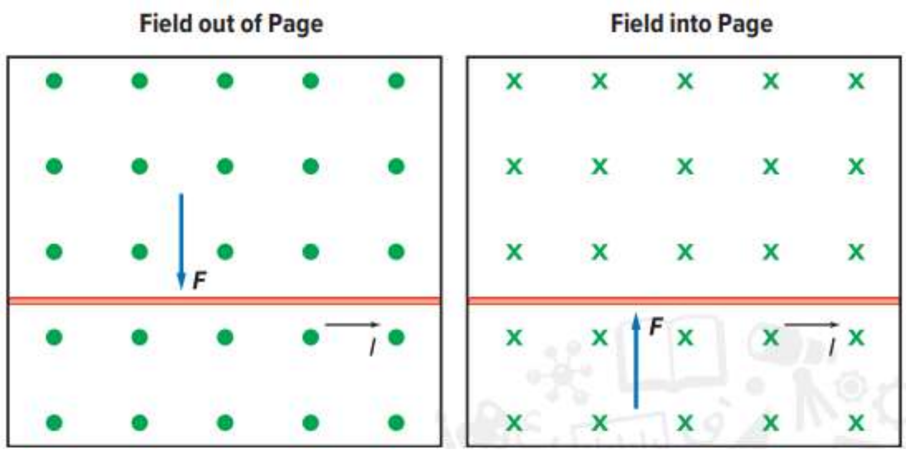


Figure 15 Dots represent a magnetic field coming out of the page, toward you (left). Crosses represent a magnetic field going into the page, away from you (right). Note that the force on each wire is perpendicular to both the magnetic field and the current.

EXAMPLE 1

CALCULATE THE STRENGTH OF A MAGNETIC FIELD A straight wire carrying a 5.0 A current is in a uniform magnetic field oriented at right angles to the wire. When 0.10 m of the wire is in the field, the force on the wire is 0.20 N. What is the strength of the magnetic field (B)?

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

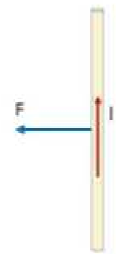
سلك يمر به تيار شدته (0.5 A)

نحو الأعلى وضع في منطقة مجال مغناطيسي منتظم وبشكل طولة عمودي على المجال

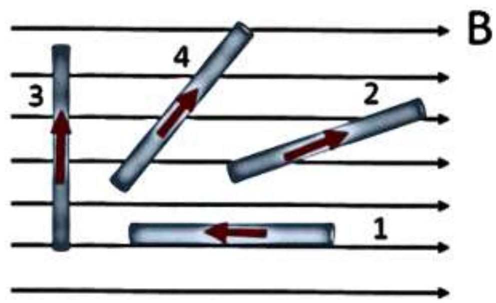
فإذا كان طول السلك الخاضع للمجال المغناطيسي (0.3 m)

فتأثر السلك بقوة مغناطيسه مقدارها (0.2 N)

نحو الغرب فإن مقدار واتجاه المجال المغناطيسي الذي أثر على السلك يعادل



أربعة أسلاك وضعت في مجال مغناطيسي منتظم كما في الشكل لها نفس الطول ويمر بها نفس التيار أحد الاسلاك يتأثر بأكبر قوة مغناطيسية

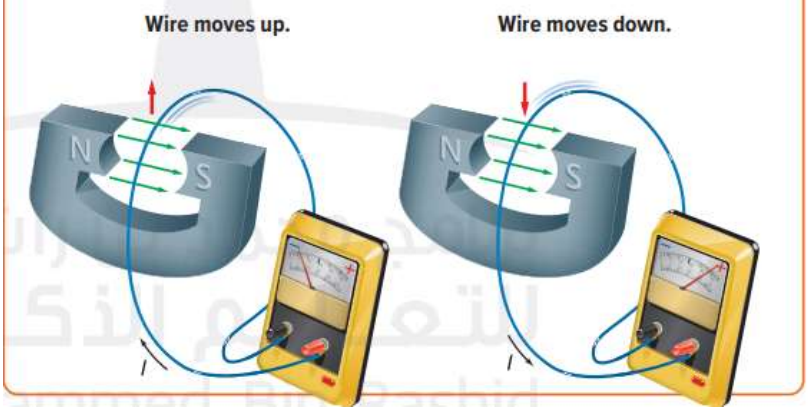


ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Inducing Currents

Figure 1 illustrates a modern version of one of Faraday's and Henry's experiments. A loop of wire that forms a circuit crosses a magnetic field.

Figure 1 The direction of current induced in a wire moving through a magnetic field depends on the direction the wire moves. When motion stops, so does the current.



_When the wire is held stationary or moved parallel to the field, nothing happens

_When the wire is moved perpendicular to the field, there is a current.

_When the perpendicular wire is moved in the other direction, the current reverses direction.

Relative motion An electric current can be generated in a wire in a circuit when at least part of the wire moves through, and cuts, magnetic field lines. Field lines can be cut when a segment of wire moves through a stationary magnetic field, as the wire does in Figure 1. Field lines also can be cut when a magnetic field moves past a stationary wire or when the strength of a magnetic field changes around a wire. It is the relative motion between a wire and a magnetic field that can cut field lines and produce current

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Electromagnetic induction: is the process of generating current through a wire in a circuit in a changing magnetic field.

Electromotive force :

When a wire moves perpendicular to a magnetic field, there is a force on the charges in the wire.

1- The force causes negative charges to move to one end of the wire, leaving positive charges at the other end.
2- This separation of charge produces an electric field and therefore a potential difference across the length of the wire.
3- This potential difference is called the induced electromotive force, or induced EMF.

_The magnitude of an induced EMF in a wire in a magnetic field depends on the strength of the magnetic field (B), the length of the wire within the field (L), and the component of the velocity of the length of wire that is perpendicular to the field (v(sin θ)).

INDUCED ELECTROMOTIVE FORCE IN A WIRE

EMF is equal to the strength of the magnetic field times the length of the wire times the component of the velocity of the wire in the field that is perpendicular to the field.

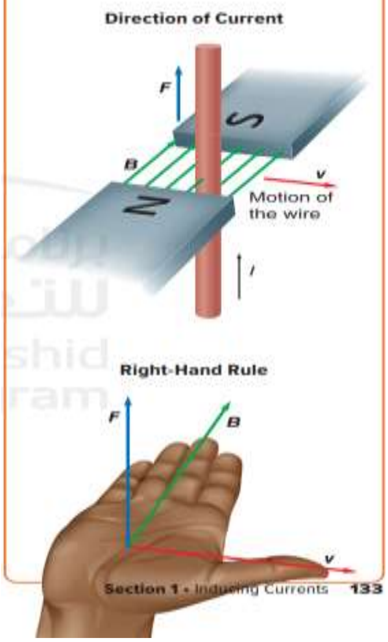
$$EMF = BLv(\sin\theta)$$

Magnitude of current:

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

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Figure 2 The direction of current in a wire moving through a magnetic field can be found using a right-hand rule. Note that the direction of current is the same as the direction of the force on the charges in the wire.



Direction of current How do you determine the direction of an induced current in a wire? As a wire moves through a magnetic field, a force is exerted on the charges in the wire, and they move in the direction of that force, as shown in the top image of **Figure 2.** To find this direction, use the right-hand rule illustrated in the bottom of **Figure 2.** Point your thumb in the direction the wire moves and your fingers in the direction of the magnetic field. Your palm points in the direction of the force on the positive charges and, thus, in the direction of current.

EXAMPLE 1

INDUCED *EMF* A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T.

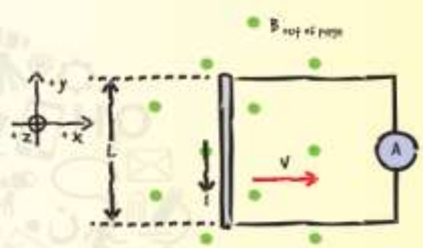
a. What *EMF* is induced in the wire?

b. What is the current through the wire?

c. If a different metal were used for the wire, increasing the circuit's resistance to 0.78 Ω, what would the new current be?

1 ANALYZE AND SKETCH THE PROBLEM

- Draw a straight wire of length L. Connect an ammeter to close the circuit so that there will be a current.
- Show a direction for the magnetic field (B) that is perpendicular to the wire length.
- Show a direction for the velocity (v) that is perpendicular to both the length of the wire and the magnetic field.
- Use the right-hand rule to determine the direction of the current, and show it on the diagram.



KNOWN

$v = 7.0$ m/s

$L = 0.20$ m

$B = 8.0\times10^{-2}$ T

$R_1 = 0.50$ Ω

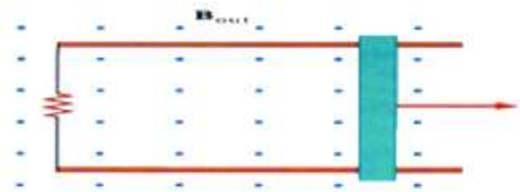
UNKNOWN

$EMF = ?$

$I = ?$

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

سلك موصل طوله (0.2 m)
تم تحريكه بشكل يقطع خطوط المجال المغناطيسي وبسرعة عمودية على المجال مقدارها
20 m/S
على سكة بدون احتكاك ومتصلة بمقاومة مقدارها
5 Ω
فإذا كان شدة المجال المغناطيسي يعادل (0.2 T)



Electric Generators

electric generator: converts mechanical energy to electrical energy.

- It consists of a number of wire loops in a magnetic field.
- The wire is wound around an iron core, which concentrates the magnetic flux through the wire.
- The iron and wire make up the generator's armature, also called a rotor.

Current from a generator:

- the armature in a generator can rotate freely in a magnetic field.
- As the armature is turned, its wire loops cut through magnetic field lines.
- This induces an EMF in each loop.
  _Recall that EMF depends on wire length, magnetic field strength, and speed. Therefore, increasing the number of loops increases wire length and thus increases the total induced EMF. The larger the EMF, the stronger the resulting current.

Orientation of loop

-when a loop rotate in a magnetic it induced EMF which produces a current in the loop.

- As the loop rotates, the strength and the direction of the current change as the orientation of the loop's motion relative to the magnetic field changes.
- only the component of the wire's velocity perpendicular to a magnetic field can induce an EMF.
- Therefore, the current is strongest when the motion of the loop is perpendicular to the field, that is, when the loop is horizontal

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

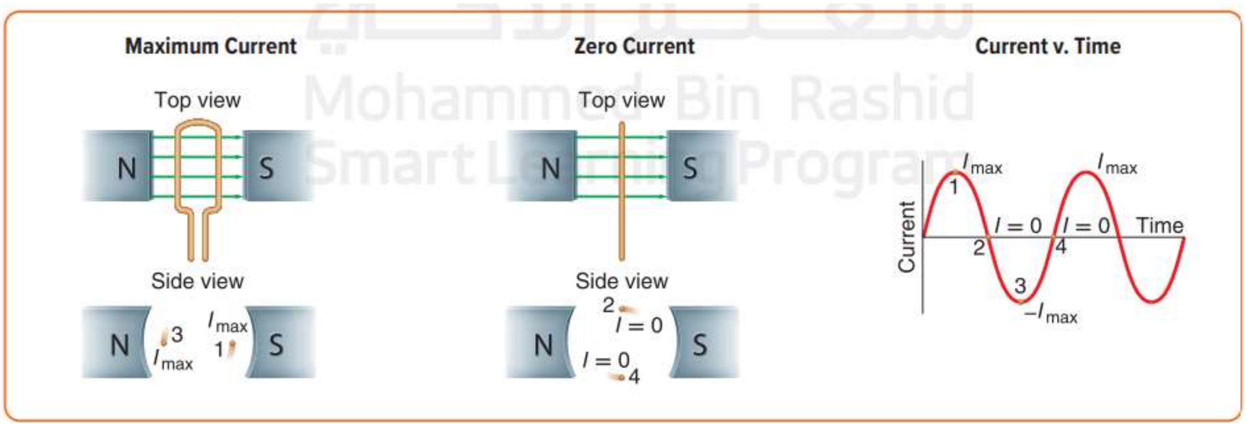
abstract

- When loop in horizontal position(the motion of the loop is perpendicular to the field), we get greater maximum value of current in the loop.
- When loop is perpendicular(the motion of the loop is horizontal to the field) we get greater maximum value of current in the loop.

Figure 4 An electric current is induced in a rotating wire loop in a circuit that is in a magnetic field. Direction and strength of the induced current change as the loop rotates.

Determine What is the direction of the current when the loop is horizontal to the field, as shown?

Current reversals: As the loop in Figure 5 rotates to the vertical position, it moves through the magnetic field lines at an ever-decreasing angle. Thus, it cuts through fewer magnetic field lines per unit of time, and the current decreases. When the loop is in the vertical position, as it is in the middle image of Figure 5, current is zero because the wire moves parallel to the magnetic field.
As the loop continues to rotate, the current changes sinusoidally from zero to some maximum value and back to zero during each half-turn. Current reverses each time the loop turns through 180°. A graph of current versus time is shown in the far right of Figure 5.



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Figure 5 Maximum current is generated when the rotating loop is horizontal to the magnetic field (left). When the loop is vertical to the field (middle), the current is zero. The graph shows that current varies regularly with time as the loop rotates. The numbers on the graph correspond to positions of the loop in the side views. A graph of the variation of *EMF* with time (not shown) would be similar.

Q: what is the difference between generator and motor?

Ans:

A generator converts mechanical energy to electrical energy, <u>while a</u> **motor** converts electrical energy to mechanical energy.

Alternating currents and generators:

_ There are two main types of generators:

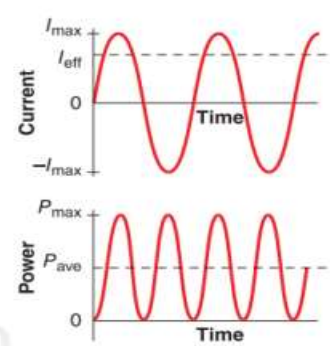
1- direct current (DC) generators.
2- alternating current (AC) generators.

Direct current (DC) generators:

- In direct current (DC) generators, charges move in a single direction, as they do in batteries. Current is in one direction because the wires of the armature connect to a circuit by means of a commutator.

Alternating current (AC) generators:

- The current alternates from positive to negative.
- In a consistently turned generator, the current alternates at a fixed rate and varies sinusoidally



ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL

+962 7 8769 5012
+971 50 727 0623

Average power

To find average power we have three equation:

1- PAC, is half the maximum power; thus, PAC = 1/ 2 PACmax

2- $P_{AC} = I_{eff}^2 R.$

Where **Effective current" Ieff"** calculate as:

EFFECTIVE CURRENT

Effective current is equal to $\frac{\sqrt{2}}{2}$ times the maximum current.

$$I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max} = 0.707 I_{max}$$

3- $P = \frac{V^2}{R}$, where V the effective potential difference.

Where **Effective potential difference"Veff":**

EFFECTIVE POTENTIAL DIFFERENCE

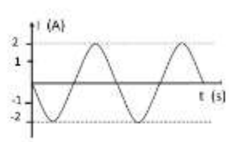
Effective potential difference is equal to $\frac{\sqrt{2}}{2}$ times the maximum potential difference.

$$V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max} = 0.707 V_{max}$$

- Effective potential difference is commonly referred to as RMS (root mean square) potential difference.

مولد تيار متردد تم رسم العلاقة بين شدة التيار والزمن فنتج الخط البياني التالي

من خلال بيانات الشكل

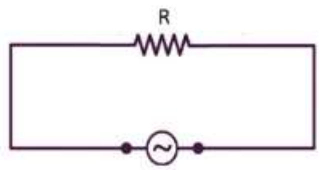


فإن القيمة الفعالة لشدة التيار تعادل

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL

+962 7 8769 5012
+971 50 727 0623

تيار متردد شدته العظمى (I(max)= 4 A)
ويمر من خلال مقاوم مقداره (R=10 Ω)
فإن القدرة المتوسطة التي يصرفها المقاوم تعادل

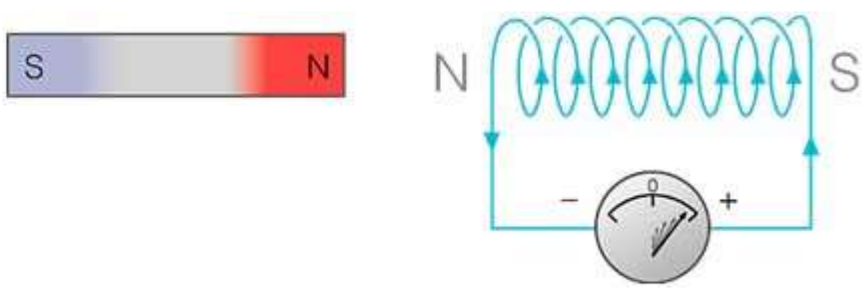


Lenz’s Law

Opposing change

The current in the loop produces its own magnetic field. The right-hand rule shows that the direction of this induced field inside the loop is into the paper. That is, it is in the direction that opposes the change in the field that caused it. Thus, Lenz's law.

Lenz's law says that the magnetic field produced by the induced current is in the direction that is opposite the original field.



Bmagnet increase _EMFinduce(inverse)_I induce (inverse)_ Binduce (inverse)

- The meaning of inverse that the direction of Binduce opposite the direction of Bmagnet.
- Inverse to opposes the change in the field that caused it

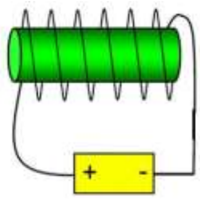
ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL

+962 7 8769 5012
+971 50 727 0623

Bmagnet derease _EMF induce(direct)_I induce (direct)_Binduce(direct)

- The meaning of direct that the direction of Binduce with the same the direction of Bmagnet.
- direct to opposes the change in the field that caused it.

Self-inductance: An EMF can be induced in a wire when the magnetic field in the region of the wire changes. The field can be external, or it can be generated by the current in the wire itself.



Is increacs _ Bmagnet increase _EMFinduce(inverse)_I induce (inverse)

Inverse to opposite the change in current”Is"

Is decrease _ Bmagnet decrease _EMFinduce(direct)_I induce (direct)

direct to opposite the change in current”Is"

- When the current reaches a constant final value, the current change is zero, so the induced EMF is also zero.
- If the coil were suddenly disconnected from the battery, the induced EMF could be large enough to produce a spark
- The property of a wire, either straight or in a coil, to create an induced EMF that opposes the change in the potential difference across the wire is called self-inductance.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

<u>**Transformers**</u>

Transformers: are devices that increase or decrease potential differences with relatively little waste of energy.

- Only alternating current (AC) can be sent through a transformer.

Direct current (DC) cannot pass through a transformer.

- mutual inductance: An EMF and current in one coil due to changing current in another coil .
- secondary potential difference: The EMF induced in the secondary coil.
- The secondary potential difference depends on what is called the turns ratio.
- The turns ratio: is the number of turns of wire in the secondary coil divided by the number of turns in the primary coil

$$\frac{\text{primary potential difference}}{\text{secondary potential difference}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

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

We have two type of transformers:

1- step-up transformer: the secondary potential difference is larger than the primary potential difference.

2- step-down transformer: the secondary potential difference is smaller than the primary potential difference.

■ Transformers

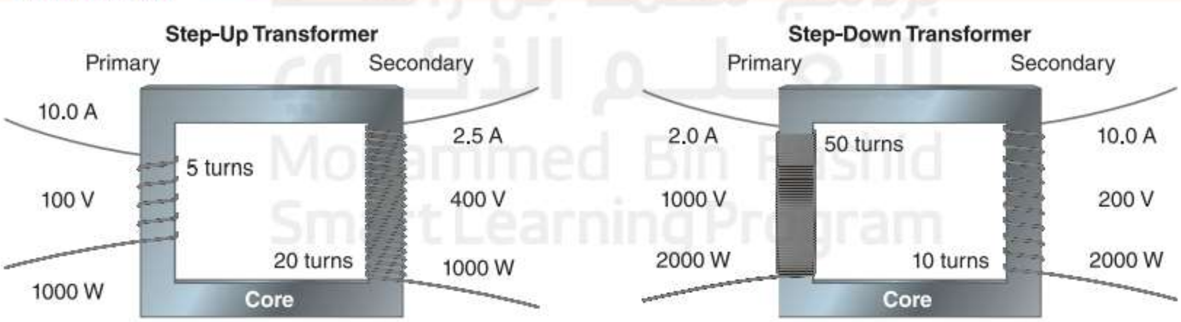


Figure 15 The ratio of primary potential difference to secondary potential difference in a transformer depends on the ratio of the number of turns on the primary coil to the number of turns on the secondary coil. Secondary potential difference can be greater than the primary (left) or less than the primary (right).

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL

+962 7 8769 5012
+971 50 727 0623

The ideal transformer : In an ideal transformer, the electrical power delivered to the secondary circuit equals the power supplied to the primary circuit.

- Ideal transformers do not convert any electrical energy to thermal energy.

$$P_p = P_s$$
$$V_p I_p = V_s I_s$$

TRANSFORMER EQUATION

The ratio of the current in the secondary coil to the current in the primary coil is equal to the ratio of the potential difference in the primary coil to the potential difference in the secondary coil, which is also equal to the ratio of the number of turns on the primary coil to the number of turns on the secondary coil.

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

CONNECTING MATH TO PHYSICS

Inequalities Study the following expressions to help you understand the relationships among potential difference (V), current (I), and the number of coils in transformers (N) in primary and secondary circuits.

Step-Up Transformer	Step-Down Transformer
$V_p < V_s$	$V_p > V_s$
$I_p > I_s$	$I_p < I_s$
$N_p < N_s$	$N_p > N_s$

Isolation transformers: , the primary and secondary coils have the same number of turns, so the input and output potential differences are identical.(for safety uses).

A.Z physics

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623

Real transformers

- In real transformers, however, some of the electrical energy they deliver to the primary circuit is converted into thermal energy, heating the transformer and the air around it.
- The power that can be delivered by the secondary circuit is thus reduced.
- The efficiency of a transformer is given by the ratio of the output power to the input power.
- typical transformers are 95 to 98 percent efficient.

EXAMPLE 2

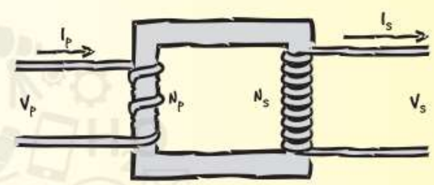
STEP-UP TRANSFORMERS A step-up transformer has a primary coil consisting of 200 turns and a secondary coil consisting of 3000 turns. The primary coil is supplied with an effective AC potential difference of 90.0 V.

a. What is the potential difference in the secondary circuit?

b. The current in the secondary circuit is 2.0 A. What is the current in the primary circuit?

1 ANALYZE AND SKETCH THE PROBLEM

- Draw an iron core that has turns of wire on either side.
- Label the variables *I*, *V*, and *N*.



KNOWN		UNKNOWN
$N_p = 200$	$V_p = 90.0$ V	$V_s = ?$
$N_s = 3000$	$I_s = 2.0$ A	$I_p = ?$

N: long-distance transmission of electrical energy is economical only if very high potential differences are used.

ENG.MOHAMMAD JAMAL & ENG.Marwan JAMAL
+962 7 8769 5012
+971 50 727 0623