1	Explain the characteristics of a series circuit. يشرح خصائص دائرة التوالي.	كما ورد في الكتاب As mentioned in textbook	82

Equivalent resistance of a series circuit From the river model, you know that the height from sea level to the top of the mountain equals the height that the water drops from the top of the mountain to sea level. In an electric circuit, the potential difference across the generator or other energy source (ΔV_{source}) equals the sum of the potential differences across lamps 1 and 2 and is represented by the following equation:

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

To find the potential difference across a resistor, multiply the current in the circuit by the resistance of the individual resistor. Because the current through the lamps is the same, $\Delta V_1 = IR_1$ and $\Delta V_2 = IR_2$. Therefore, $\Delta V_{source} = IR_1 + IR_2$, or $\Delta V_{source} = I(R_1 + R_2)$. The current through the circuit is represented by the following equation:

$$I = \frac{\Delta V_{source}}{(R_1 + R_2)}.$$

The same idea can be extended to any number of resistances in series, not just two. If you replaced all the resistors in a circuit with a single resistor that resulted in the same current, that resistor's value would be the **equivalent resistance** of the circuit. For resistors in series, the same current would exist in the circuit with a single resistor (R) that has a resistance equal to the sum of the individual resistances.

EQUIVALENT RESISTANCE FOR RESISTORS IN SERIES
The equivalent resistance of resistors in series equals the sum of the individual resistances of the resistors.

$$R = R_1 + R_2 + \ldots$$

Notice that the equivalent resistance is greater than that of any individual resistor. Therefore, if the battery voltage does not change, adding more devices in series always decreases the current. To find the current through a series circuit, first calculate the equivalent resistance and then use the following equation.

CURRENT
The current through a series circuit is equal to the potential difference across the power source divided by the equivalent resistance.

$$I = \frac{\Delta V_{source}}{R}$$

(1) In a series circuit, the current in each of the devices is the same, and the sum of the device voltage drops equals the source voltage.

(2) In a parallel circuit, the voltage drop across each device is the same and the sum of the currents through each loop equals the source current.

2	يحل مسائل لإيجاد التيار وفروق الجهد والمقاومات في دائرة توالي. Solve problems to find the current, voltages and resistances in a series circuit.	Example 1 مثال تقويم الوحدة 4- 50،49،45 Unit 4 Assessment- 45,49,50	84 98

EXAMPLE 1

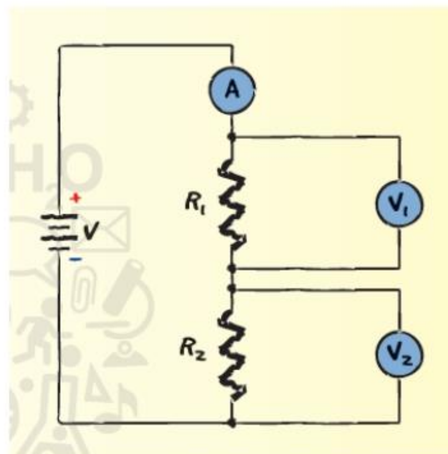
POTENTIAL DIFFERENCE IN A SERIES CIRCUIT Two resistors, 47 Ω and 82 Ω, are connected in series across a 45 V battery.

a. What is the current in the circuit?

b. What is the potential difference across each resistor?

c. If you replace the 47 Ω resistor with a 39 Ω resistor, will the current increase, decrease, or remain the same?

d. What is the new potential difference across the 82 Ω resistor?



45. A series circuit has two voltage drops: 5.50 V and 6.90 V. What is the supply voltage?

$$V = 5.50\ \text{V} + 6.90\ \text{V} = 12.4\ \text{V}$$

49. Ammeter 1 in **Figure 18** reads 0.20 A.

a. What is the total resistance of the circuit?

b. What is the potential difference across the battery?

c. How much power is delivered to the 22 Ω resistor?

d. How much power is supplied by the battery?

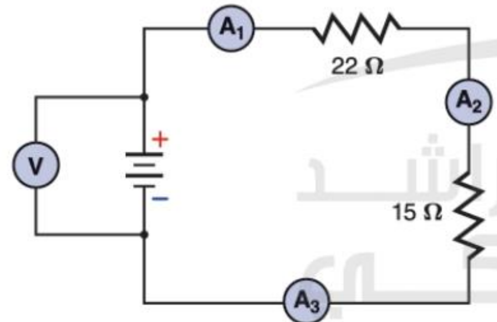


Figure 18

a. What is the total resistance of the circuit?

$R = R_1 + R_2 = 15\ \Omega + 22\ \Omega = 37\ \Omega$

b. What is the battery voltage?

$V = IR = (0.20\ A)(37\ \Omega) = 7.4\ V$

c. How much power is delivered to the 22-Ω resistor?

$P = I^2R = (0.20\ A)^2(22\ \Omega) = 0.88\ W$

d. How much power is supplied by the battery?

$P = IV = (0.20\ A)(7.4\ V) = 1.5\ W$

50. Ammeter 2 in **Figure 18** reads 0.50 A.

a. Find the potential difference across the 22 Ω resistor.

b. Find the potential difference across the 15 Ω resistor.

c. Find the potential difference across the battery.

a. Find the voltage across the 22-Ω resistor.

$V = IR = (0.50\ A)(22\ \Omega) = 11\ V$

b. Find the voltage across the 15-Ω resistor.

$V = IR = (0.50\ A)(15\ \Omega) = 7.5\ V$

c. What is the battery voltage?

$V = V_1 + V_2 = (11\ V) + (7.5\ V) = 19\ V$

3	يحسب المقاومة المكافئة في دائرة توالي يشرح خصائص دائرة التوازي. **Calculate the equivalent resistance and the total current passing through a series circuit** **Calculate the equivalent resistance of a parallel circuit**	تقويم الوحدة (4) 44 و43 Unit 4 Assessment- 43,44	98

43. Calculate the equivalent resistance of these series-connected resistors: 680 Ω, 1.1 kΩ, and 11 kΩ.

44. Calculate the equivalent resistance of these parallel-connected resistors: 680 Ω, 1.1 kΩ, and 10.2 kΩ.

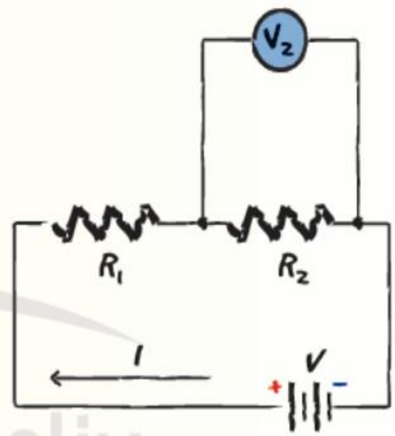
4	يستخدم دائرة مجزئ الجهد كدائرة توالي لحساب المقاومات وانخفاض الجهد عبر مكونات الدائرة. Use the voltage divider circuit as a series circuit to calculate resistances and voltage drop across the components.	مثال2 Examples 2	85

EXAMPLE 2

VOLTAGE DIVIDER A 9.0 V battery and two resistors, 390 Ω and 470 Ω, are connected as a voltage divider. What is the potential difference across the 470 Ω resistor?

1 ANALYZE AND SKETCH THE PROBLEM

Draw the battery and resistors in a series circuit.



KNOWN

$\Delta V_{source} = 9.0$ V

$R_1 = 390$ V

$R_2 = 470$ V

UNKNOWN

$\Delta V_2 = ?$

2 SOLVE FOR THE UNKNOWN

$$R = R_1 + R_2$$

$$I = \frac{\Delta V_{source}}{R}$$

$$= \frac{\Delta V_{source}}{R_1 + R_2}$$ ◀ Substitute $R = R_1 + R_2$

$$\Delta V_2 = IR_2$$

$$= \frac{\Delta V_{source} R_2}{R_1 + R_2}$$ ◀ Substitute $I = \frac{V_{source}}{R_1 + R_2}$

$$= \frac{(9.0\ V)(470\ \Omega)}{390\ \Omega + 470\ \Omega}$$ ◀ Substitute $\Delta V_{source} = 9.0\ V$, $R_1 = 390\ \Omega$, $R_2 = 470\ \Omega$

$$= 4.9\ V$$

5	يذكر قاعدة الحلقة لكيرشوف، ويربطها بقانون حفظ الطاقة. يذكر قاعدة الوصلة لكيرشوف، ويربطه بقانون حفظ الطاقة. State Kirchhoff's loop rule and relate it to the conservation of energy. State Kirchhoff's junction rule and relate it to the conservation of charge.	كما ورد في الكتاب As mentioned in textbook	89 90

The loop rule The loop rule is based on the law of conservation of energy. Imagine you are standing on the side of a hill. You walk around on the side of this hill in a loop, as shown in the top of **Figure 8.** How does your height up the hill before your walk compare to your height up the hill after your walk? Because you begin and end your walk at the same place, your height up the hill after your walk equals your height up the hill before your walk. The sum of increases in height equals the sum of decreases in height during your walk.

A similar situation occurs as an electric charge moves around any loop in an electric circuit. Instead of increases and decreases in height, however, electric charges move through increases and decreases in electric potential. The sum of increases in electric potential around a loop in an electric circuit equals the sum of decreases in electric potential around that loop.

READING CHECK **Explain** how Kirchhoff's loop rule and the conservation of energy are related.

For an application of the loop rule, look at the bottom of **Figure 8.** Picture an electric charge traveling clockwise around the red loop. Electric potential increases by 9 V as this charge travels through the battery, and electric potential drops by 5 V as this charge travels through resistor 1. What will be the change in potential as the charge travels through resistor 2? Because the increases in electric potential around a loop must equal the decreases in electric potential around that loop, the drop in electric potential across resistor 2 must be 9 V − 5 V = 4 V.

Notice that resistor 3 does not affect our answer. Why is this? Resistor 3 is not a part of the loop that includes the battery, resistor 1, and resistor 2.

READING CHECK **State** the loop rule in your own words.

The Loop Rule

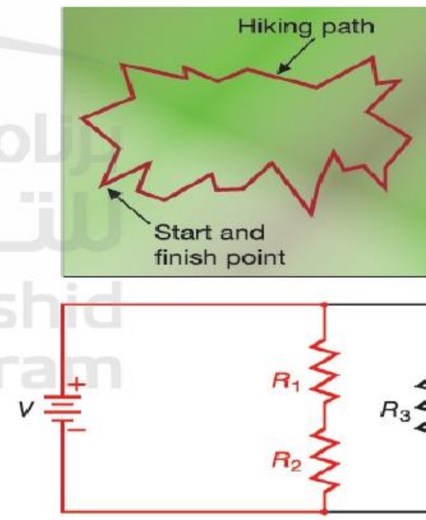


Figure 8 Walking around the side of a hill is similar to electric charges moving around a loop in a circuit.

Key ideas are:

(1) Kirchhoff's Voltage Law (KVL) is conservation of energy applied to electric circuits.

(2) Kirchhoff's Current Law (KCL) is conservation of charge applied to electric circuits.

(3) KVL states that the algebraic sum of voltage drops around a closed loop is zero. In a series circuit there is one closed loop, and the sum of voltage drops in the resistances equals the source voltage. In a parallel circuit, there is a closed loop for each branch, and KVL implies that the voltage drop in each branch is the same.

(4) KCL states that the algebraic sum of currents at a node is zero. In a series circuit, at every point the current in equals current out; therefore, the current is the same everywhere. In a parallel circuit, there is a common node at each end of the branches. KCL implies that the sum of the branch currents equals the source current.

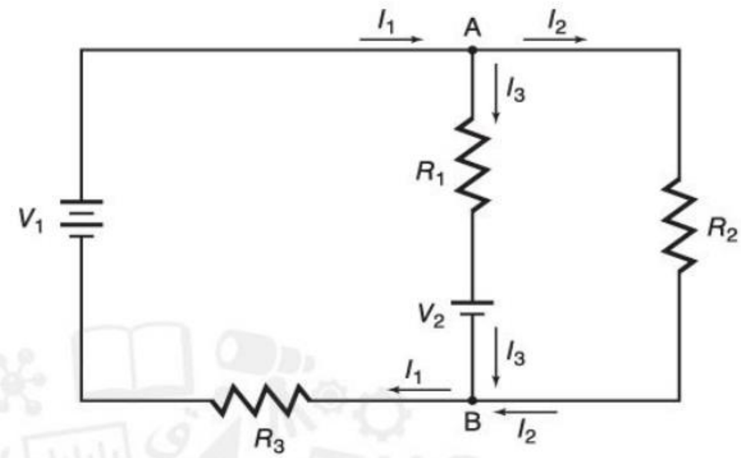


Figure 9 An application of Kirchhoff's junction rule is shown. At junction A the total current entering (I_1) equals the total current leaving ($I_2 + I_3$). At junction B, the total current entering is $I_2 + I_3$, and the total current leaving is I_1.

The junction rule The loop rule describes electric potential differences and is based on the law of conservation of energy. The junction rule describes currents and is based on the law of conservation of charge. Recall that the law of conservation of charge states that charge can neither be created nor destroyed. This means that, in an electric circuit, the total current into a section of that circuit must equal the total current out of that same section.

A junction is a location where three or more wires are connected together. The circuit shown in **Figure 9** has two such junctions–one at point A and another at point B. How does the total current into a junction relate to the total current out of that junction? According to the law of conservation of charge, the sum of currents entering a junction is equal to the sum of currents leaving that junction. Otherwise, charge would build up at the junction. This is Kirchhoff's junction rule. In **Figure 9,** $I_1 = I_2 + I_3$ at junction A, and $I_2 + I_3 = I_1$ at junction B. For example, if $I_2 = 0.3$ A and $I_3 = 0.7$ A, then $I_1 = 1.0$ A.

Key ideas are:

(1) Kirchhoff's Voltage Law (KVL) is conservation of energy applied to electric circuits.

(2) Kirchhoff's Current Law (KCL) is conservation of charge applied to electric circuits.

(3) KVL states that the algebraic sum of voltage drops around a closed loop is zero. In a series circuit there is one closed loop, and the sum of voltage drops in the resistances equals the source voltage. In a parallel circuit, there is a closed loop for each branch, and KVL implies that the voltage drop in each branch is the same.

(4) KCL states that the algebraic sum of currents at a node is zero. In a series circuit, at every point the current in equals current out; therefore, the current is the same everywhere. In a parallel circuit, there is a common node at each end of the branches. KCL implies that the sum of the branch currents equals the source current.

6	Apply Kirchhoff's junction rule to electric circuits. يطبق قاعدة الوصلة لكيرشوف على الدوائر الكهربائية.	كما ورد في الكتاب As mentioned in textbook Section 2 review - مراجعة القسم2 30	90 95

Refer to ***Figure 17*** *for questions 29–33 and 35.*

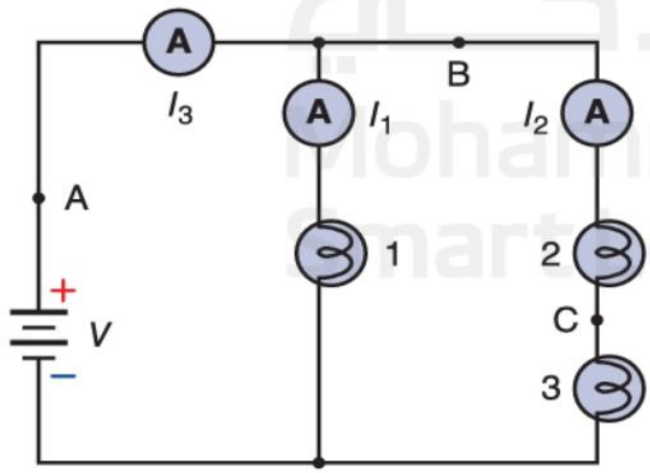


Figure 17

30. Current If I_3 is 1.7 A and I_1 is 1.1 A, what is the current through bulb 2?

$$I_3 = I_1 + I_2$$

$$I_2 = I_3 - I_1 = 1.7\ \text{A} - 1.1\ \text{A} = 0.6\ \text{A}$$

7	يعرف دائرة القصر ويوضح أثرها. Define a short circuit and describe its effects.	كما ورد في الكتاب As mentioned in textbook	91

What is a short circuit? Why is a short circuit dangerous? (23.2)

A short circuit is a circuit that has extremely low resistance. A short circuit is dangerous because any potential difference will produce a large current. The heating effect of the current can cause a fire.

8	يوضح الدائرة الكهربائية المركبة. Describe a combined series-parallel circuit.	كما ورد في الكتاب As mentioned in textbook	93

A combined series-parallel circuit is a circuit configuration that contains both series and parallel connections of electrical components. In such a circuit, some components are connected in series, meaning the current flows sequentially through each component, while others are connected in parallel, allowing the current to split and flow through multiple paths.

9	يذكر خصائص الفولتميتر والأميتر من حيث مقاومة كل منهما. يحدد التوصيل الصحيح لأجهزة الأميتر والفولتميتر في الدائرة الكهربائية. State the properties of voltmeters and ammeters, in terms of their resistance. Identify the correct placements of ammeters and voltmeters in electric circuits	كما ورد في الكتاب As mentioned in textbook	95

An ammeter is connected in series; a voltmeter is connected in parallel.

An ammeter must have low resistance because it is placed in series in the circuit. If its resistance were high, it would significantly change the total resistance of the circuit and thus serve to reduce the current in the circuit, thereby changing the current it is meant to measure.

A voltmeter is placed in parallel with the portion of the circuit whose difference in potential is to be measured. A voltmeter must have very high resistance for the same reason that an ammeter has low resistance. If the voltmeter had low resistance, it would lower the resistance of the portion of the circuit it is across and increase the current in the circuit. This would produce a higher voltage drop across the part of the circuit where the voltmeter is located, changing the voltage it is measuring.

10	Describe the properties of magnets. يوضح خواص المغانط.	كما ورد في الكتاب As mentioned in textbook	107

Opposite poles What's inside a magnet that makes it polarized? You know that when you bring a metal rod near an electric charge, one end of the rod becomes negatively charged and the other end becomes positively charged, polarizing the rod. You might think a magnet is similar, with one half of the magnet positive and the other half negative, but this is not the case. No matter how you cut or break a magnet, a magnet always has two poles. There have been many searches for objects, called monopoles, with only a north pole or only a south pole, but no monopole has ever been found.

Polarized
• **Science usage**
having two opposite ends
All magnets are polarized.
• **Common usage**
broken into opposing factions or groups
Members of Congress were polarized on the issue of Social Security reform.

Poles repel or attract You have likely noticed that forces between two magnets differ depending on how you orient the magnets. When you place the north pole of one magnet next to the north pole of another magnet, the magnets repel each other, as they do in the top of **Figure 2.** The same is true when you bring two south poles together. If, however, you brought the north pole of one magnet next to the south pole of another magnet, the poles would attract each other, as they do in the bottom of **Figure 2.** Like poles repel; unlike poles attract.

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.

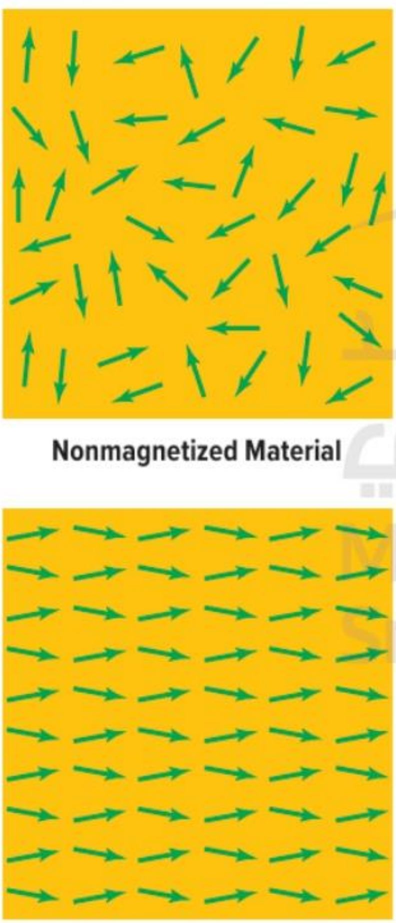
Magnets only attract some metals. Brass, copper, and aluminum are common metals that are not attracted to magnets. Iron, nickel, and cobalt are strongly attracted. Materials containing these elements, called ferromagnetic materials, can become temporary magnets. A steel nail can become a temporary magnet 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.

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

Identify the north and south poles of the nail.

11	يوضح النطاقات المغناطيسية ويربطها بالخصائص المغناطيسية للمواد عالية النفاذية. Describe magnetic domains and relate them to the magnetic properties of ferromagnetic materials.	كما ورد في الكتاب As mentioned in textbook	108

Figure 5 Domains in a nonmagnetized ferromagnetic material point in random directions (top). When a strong magnet is placed near a ferromagnetic material, the domains in that ferromagnetic material align with those of the external magnet (bottom).



Magnetic domains What gives a permanent or temporary magnet its magnetic properties? Each atom in a ferromagnetic material acts like a tiny magnet; each has two poles. Each is part of a **domain,** which is a group of neighboring atoms whose poles are aligned. Look at the arrows in **Figure 5.** Each arrow represents a domain. Although domains can contain as many as 10^{20} individual atoms, they are tiny–usually from 10 to 1000 microns across. Even a small sample of a ferromagnetic material contains a huge number of domains.

In a ferromagnetic material that is not magnetized, each domain points in a random direction, as shown in the top panel of **Figure 5.** But if the ferromagnetic material is next to a strong magnet, most of the object's domains preferentially align to point in the same direction as the poles of the external magnet, as shown in the bottom panel of **Figure 5.** When its domains are aligned in the same direction, the material becomes a temporary magnet.

When an external magnet is removed from a temporary magnet, the domains of the temporary magnet return to a random arrangement, and the material loses its magnetization. How long it takes for a temporary magnet to lose its magnetization depends on the interactions between the atoms, which depend on the microscopic structure of the material.

Creating permanent magnets The only naturally occurring magnet is the mineral magnetite. The lodestones that ancient sailors used were nothing more than pieces of magnetite. If magnetite is the only naturally occurring magnet, how, then, are commercial permanent magnets made?

When an object containing certain ferromagnetic materials is heated in the presence of a strong magnet, thermal energy frees the atoms in each of the object's domains. The domains can rotate and align with the magnet's poles. The object is then cooled while it is still in the presence of the strong magnet. After cooling, the object's atoms are less free to rotate. Therefore, when the strong magnet is removed from the object, the object remains magnetized. A permanent magnet has been created. If this permanent magnet is later reheated or dropped, however, the atoms can jostle out of alignment, reordering the domains and removing the magnetic properties.

12	يعرف التدفق المغناطيسي. Define magnetic flux.	كما ورد في الكتاب As mentioned in textbook	110

Magnetic field lines Scientists visualize magnetic fields using magnetic field lines, such as those shown in **Figure 7.** Like electric field lines, magnetic field lines are not real. They are used to show the direction as well as the strength of a magnetic field. The number of magnetic field lines passing through a surface perpendicular to the lines is the **magnetic flux.** 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.

The direction of a magnetic field line is defined as the direction in which the north pole of a compass points when placed in a magnetic field. Therefore, field lines emerge from a magnet's north pole and enter at its south pole, as in **Figure 7.** The field lines form closed loops, continuing through a magnet from its south pole to its north pole.

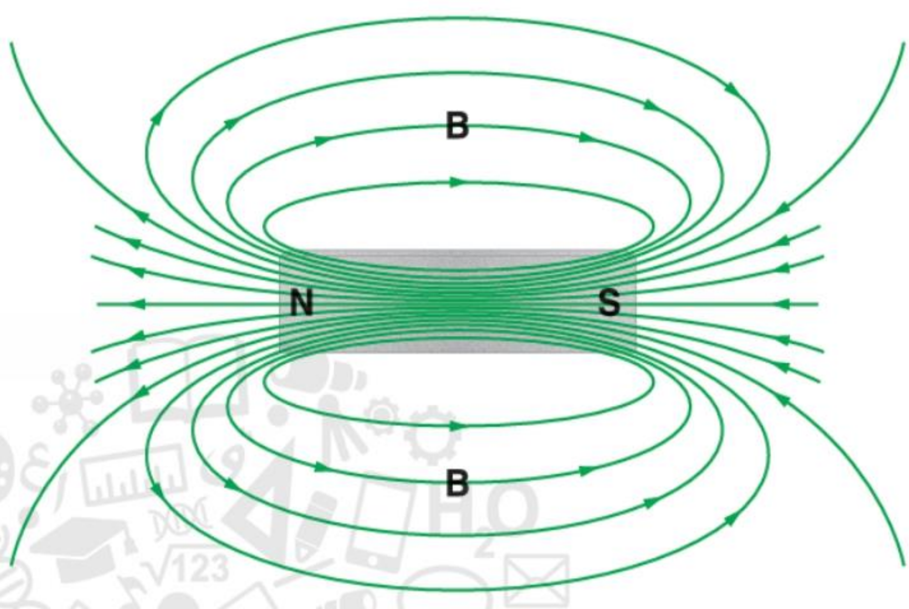


Figure 7 Magnetic field lines can be visualized as lines leaving the north pole of a magnet, entering the south pole, and passing through the magnet, forming closed loops. Magnetic fields are traditionally represented by the letter *B*.

COLOR CONVENTION
Magnetic field lines ⟷ green

14	يرسم خطوط المجال المغناطيسي داخل وحول ملف لولبي يحمل تيارا كهربائيا ويحدد قطبيه. Draw the magnetic field lines inside and around a solenoid carrying current and identify its poles.	كما ورد في الكتاب As mentioned in textbook	112

Magnetic Field in a Solenoid

The magnetic fields of the loops inside a solenoid are all in the same direction.

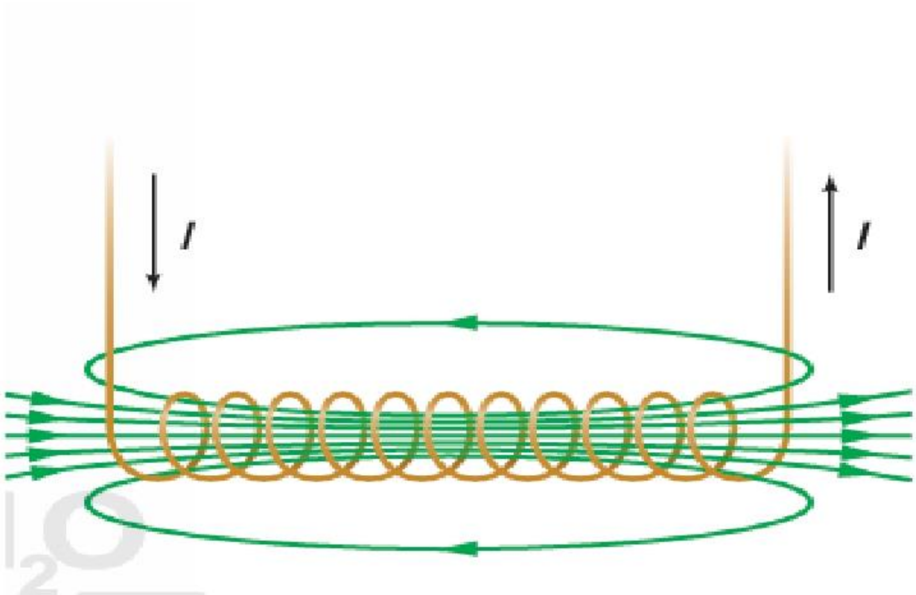
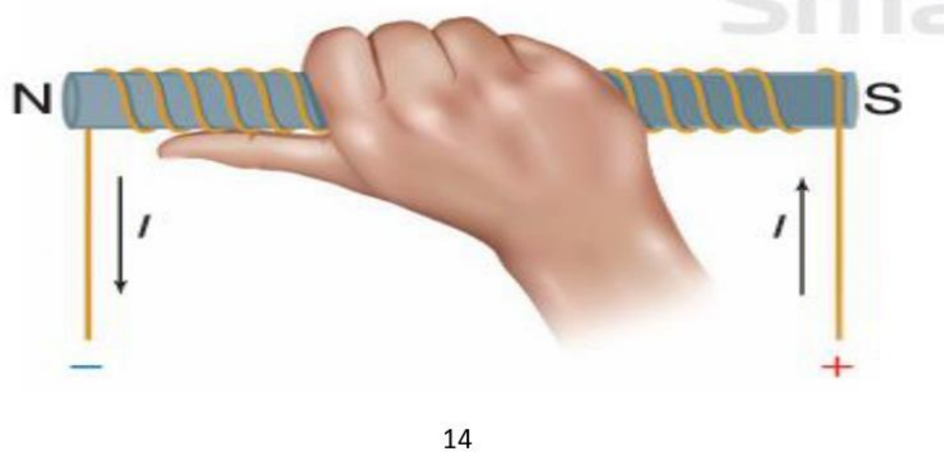


Figure 12 Imagine you are holding the solenoid with your right hand. Your thumb will point toward the solenoid's north pole when you curl your fingers in the direction of the conventional current.

Right-Hand Rule



15	يوضح المغناطيس الكهربائي والعوامل التي تؤثر على شدة مجاله المغناطيسي ومميزاته على المغناطيس الدائم. Describe an electromagnet, the factors affecting its strength, and its advantages over a permanent magnet.	كما ورد في الكتاب As mentioned in textbook	112

Electromagnets You just read that a current in a wire produces a magnetic field encircling that wire. What do you think happens to the magnetic field around a wire formed into a loop? An electric current in a single loop of wire forms a magnetic field all around the loop, as shown in the left panel of **Figure 11.** By applying a right-hand rule to any part of the loop in **Figure 11,** you can see that the direction of the magnetic field inside the loop is always the same.

Now think about a wire with many loops. A wire connected to a circuit and coiled into many spiral loops is a **solenoid.** When current is turned on in a solenoid, each loop produces its own magnetic field. The fields are all in the same direction, as shown in the right panel of **Figure 11,** so the fields add together.

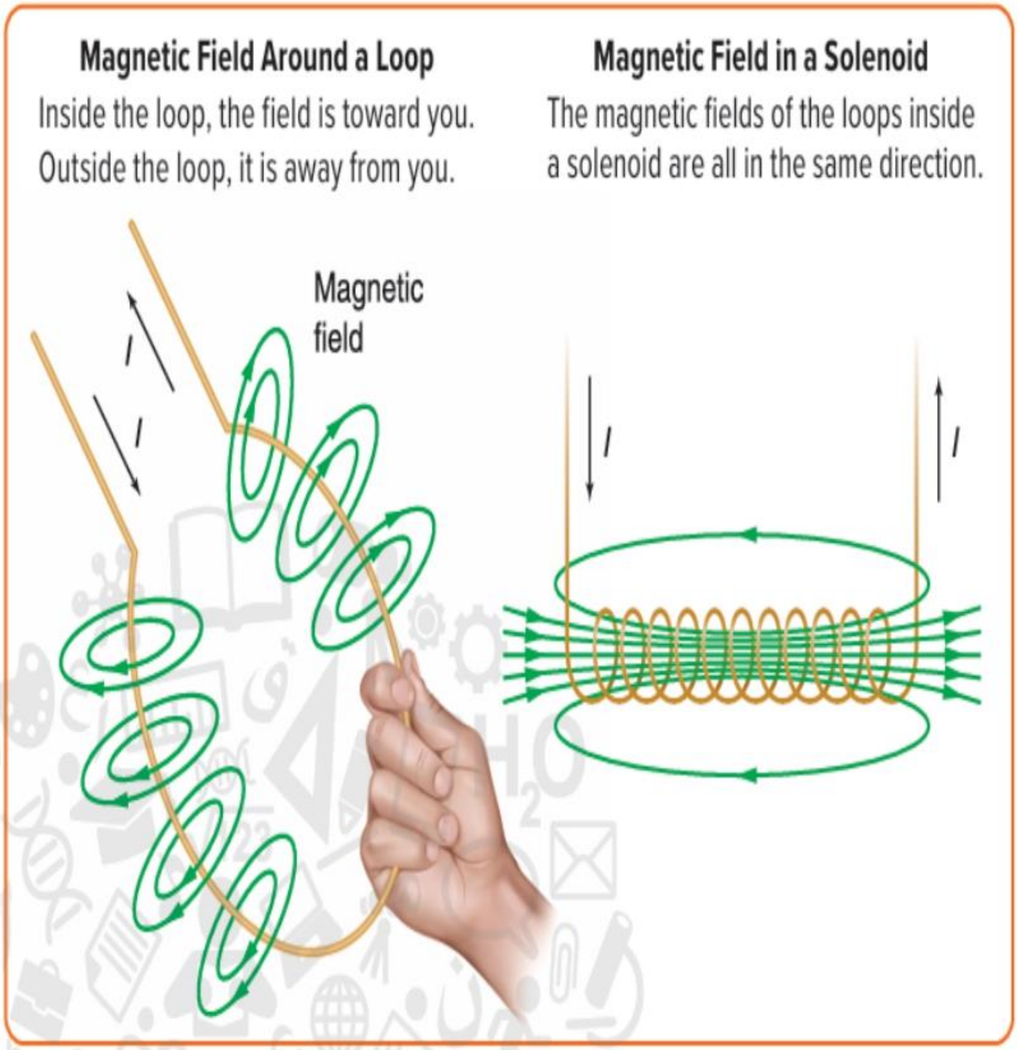
When there is an electric current in a solenoid, the solenoid has a magnetic field similar to the field of a permanent magnet. This kind of magnet is an electromagnet. An **electromagnet** is a magnet whose magnetic field is produced by electric current.

Loops and field strength 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. The more loops there are in a solenoid and the closer they are spaced, the greater the solenoid's magnetic field strength.

The magnetic field strength of a solenoid also can be increased by placing an iron-containing rod inside it. An iron rod strengthens the solenoid's magnetism because the solenoid's field produces a temporary magnetic field in the iron, just as a permanent magnet produces a temporary magnet in a ferromagnetic object.

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?



16	حل مسائل لإيجاد التيار وفروق الجهد والمقاومات في دائرة توازي. Solve problems to find the current, voltages and resistances in a parallel circuit.	مثال 3 Example Ch4 Assessment -59 تقويم-الوحدة 4 - 59	88 99

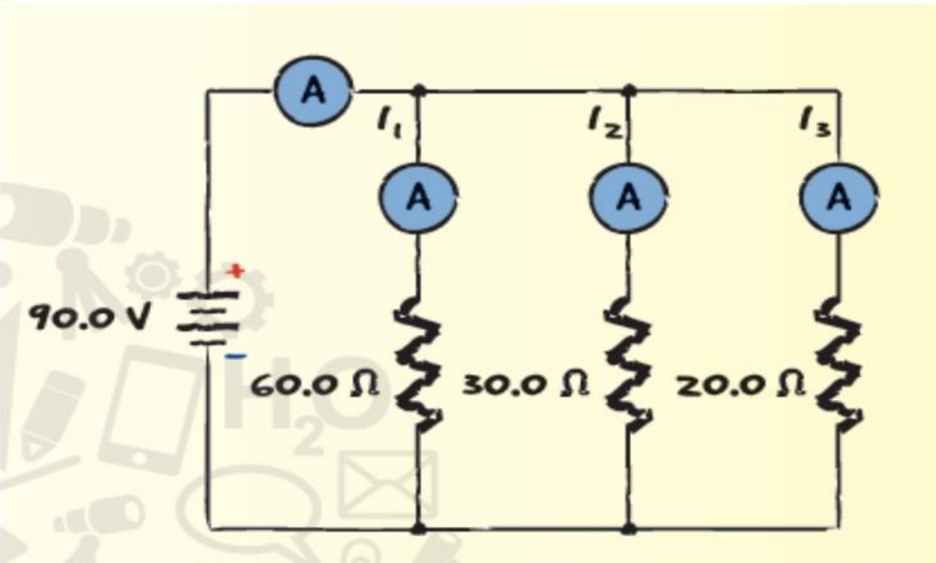
EXAMPLE 3

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.



59. For **Figure 22,** the battery develops 110 V.

a. Which resistor is the hottest?
b. Which resistor is the coolest?
c. What will ammeter 1 read?
d. What will ammeter 2 read?
e. What will ammeter 3 read?
f. What will ammeter 4 read?

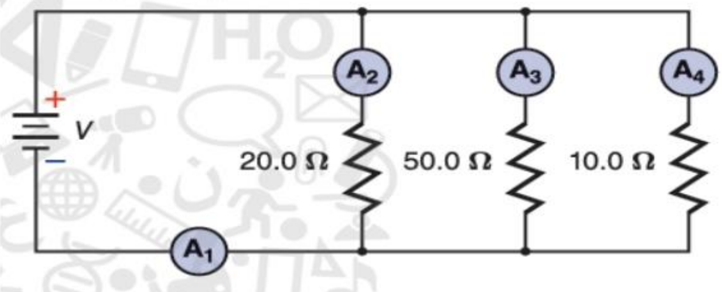


Figure 22

a. Which resistor is the hottest?

10.0 Ω. Since $P = V^2/R$ and V is constant in a parallel circuit, the smallest resistor will dissipate the most power.

b. Which resistor is the coolest?

50.0 Ω. Since $P = V^2/R$ and V is constant in a parallel circuit, the largest resistor will dissipate the least power.

c. What will ammeter 1 read?

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

$$R = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)}$$

$$= \frac{1}{\left(\frac{1}{20.0\ \Omega} + \frac{1}{50.0\ \Omega} + \frac{1}{10.0\ \Omega}\right)}$$

$$= 5.88\ \Omega$$

$$I = \frac{V}{R} = \frac{1.1\times10^2\ \text{V}}{5.88\ \Omega} = 19\text{A}$$

d. What will ammeter 2 read?

$$I = \frac{V}{R} = \frac{1.1\times10^2\ \text{V}}{20.0\ \Omega} = 5.5\ \text{A}$$

e. What will ammeter 3 read?

$$I = \frac{V}{R} = \frac{1.1\times10^2\ \text{V}}{50.0\ \Omega} = 2.2\ \text{A}$$

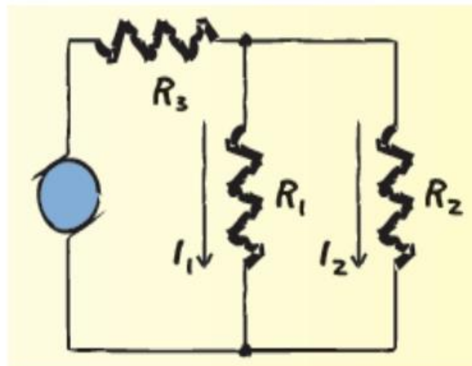
f. What will ammeter 4 read?

$$I = \frac{V}{R} = \frac{1.1\times10^2\ \text{V}}{10.0\ \Omega} = 11\ \text{A}$$

17	يحسب المقاومة المكافئة في دائرة كهربائية مركبة. يحسب فرق الجهد ومقدار التيار الكهربائي المار والقدرة الكهربائية المبددة لكل مقاوم في دائرة كهربائية مركبة Calculate the equivalent resistance of combined series-parallel circuits. Calculate the voltage, current, and power dissipation for any resistor in a combined series-parallel circuit.	مثال 4 Example 4 Ch4 Assessment -73 ,78 تقويم الوحدة 4 - 73و78	94 100

EXAMPLE 4

SERIES-PARALLEL CIRCUIT A hair dryer with a resistance of 12.0 Ω and a lamp with a resistance of 125 Ω are connected in parallel to a 125 V source through a 1.50 Ω resistor in series. Find the current through the lamp when the hair dryer is on.



73. Refer to **Figure 23** and assume that all the resistors are 30.0 Ω. Find the equivalent resistance.

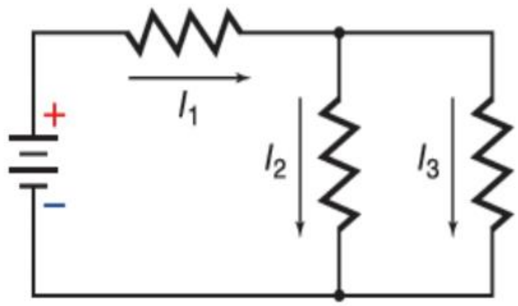


Figure 23

The parallel combination of the two 30.0-Ω resistors has an equivalent resistance of 15.0 Ω.

So $R = 30.0\ \Omega + 15.0\ \Omega = 45.0\ \Omega$

78. Ranking Task Consider the resistors in the circuit in **Figure 24.** Rank them from least to greatest specifically indicating any ties, using the following criteria:

a. the current through each

b. the potential difference across each

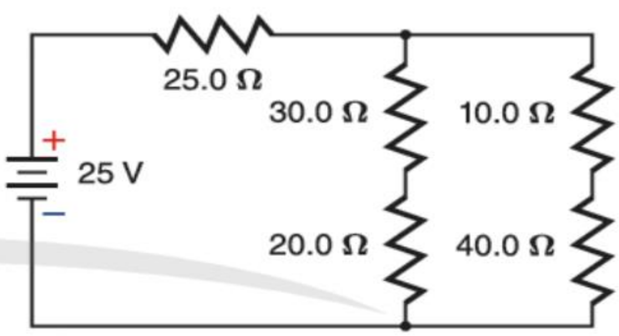
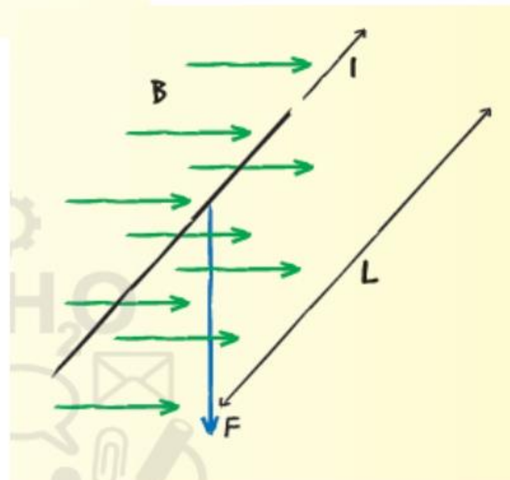


Figure 24

18	يطبق قاعدة اليد اليمنى لتحديد اتجاه القوة المؤثرة على سلك يمر به تيار وموضوع في مجال مغناطيسي. يطبق المعادلة (($F = ILB\sin(\theta)$)لحساب مقدار القوة المؤثرة على جزء مستقيم من سلك يحمل تيارا كهربائيًا في مجال مغناطيسي منتظم. Apply the right-hand rule to find the direction of the force on a current-carrying wire placed in an external magnetic field. Apply the equation $F = ILB\sin(\theta)$ to calculate the magnitude of the force on a straight segment of a current-carrying wire placed in a uniform magnetic field.	مثال 1 Example 1 تطبيقات Applications 21,23 تقويم الوحدة 5 -70 و71 Ch5 Assessment 70, 71	116 126

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)?



21. A wire that is 75 cm long and carrying a current of 6.0 A is at right angles to a uniform magnetic field. The magnitude of the force acting on the wire is 0.60 N. What is the strength of the magnetic field?

$$F = BIL$$

$$B = \frac{F}{IL} = \frac{0.60\ \text{N}}{(6.0\ \text{A})(0.75\ \text{m})} = 0.13\ \text{T}$$

23. How much current would be required to produce a force of 0.38 N on a 10.0 cm length of wire at right angles to a 0.49 T field?

$$F = BIL$$

$$I = \frac{F}{BL} = \frac{0.38\ \text{N}}{(0.49\ \text{T})(0.100\ \text{m})} = 7.8\ \text{A}$$

70. A current-carrying wire is placed between the poles of a magnet, as shown in **Figure 31.** What is the direction of the force on the wire?

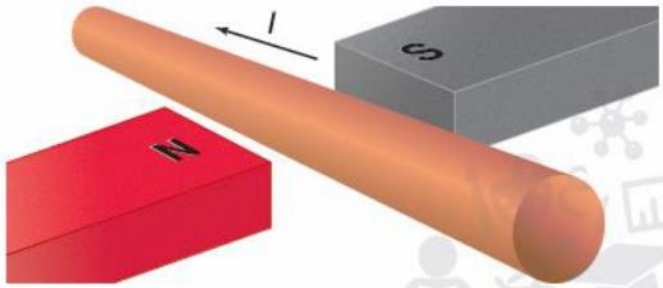
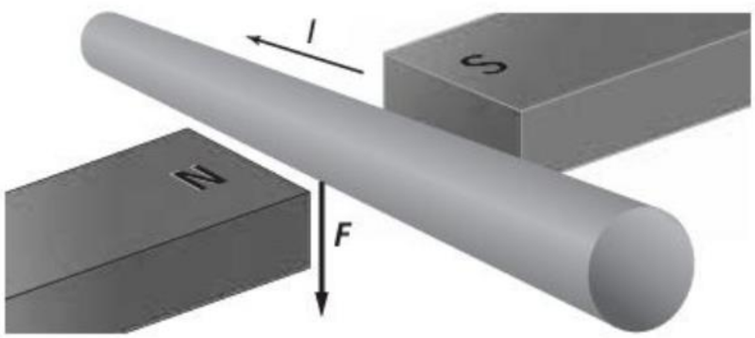


Figure 31



71. The force on a 0.80 m wire that is perpendicular to Earth's magnetic field is 0.12 N. What is the current in the wire? Use 5.0×10^{-5} T for Earth's magnetic field.

$$F = ILB$$

$$I = \frac{F}{BL} = \frac{0.12\ \text{N}}{(5.0\times10^{-5}\ \text{T})(0.80\ \text{m})}$$

$$= 3.0\times10^{3}\ \text{A}$$

$$= 3.0\ \text{kA}$$

19	يشرح أهمية مجزئ الجهد لتوليد فرق الجهد المطلوب. يشرح كيف تعمل المنصهرات وقواطع الدائرة الكهربائية وقاطع التيار بسبب الأعطال على حماية الدوائر الكهربائية Explain how fuses, circuit breakers and ground-fault interrupters protect electric circuits and make them safe to operate. Explain the importance of a voltage-divider circuit to achieve a desired potential difference. Describe the principle and working of a simple electric motor and the energy conversions that occur.	كما ورد في الكتاب As mentioned in textbook	83 91
	يوضح القوى المغناطيسية التي تؤثر عند تقريب مغناطيسين متشابهين او مختلفين في مغناطيسين دائمين من بعضهما (من حيث التفاعل واتجاه خطوط المجال). Describe the forces that occur when like or unlike poles of two permanent magnets are brought close together (in terms of the interaction between the magnetic fields and the orientation of the magnetic field lines).	كما ورد في الكتاب As mentioned in textbook	110

1. **Fuses and Circuit Breakers:**

A **fuse** is a short piece of metal that acts as a safety device by melting and stopping the current when too large a current passes through it. Engineers design fuses to melt before other elements in a circuit are damaged. A **circuit breaker,** shown in **Figure 11,** is an automatic switch that acts as a safety device by stopping the current if the current gets too large and exceeds a threshold value.

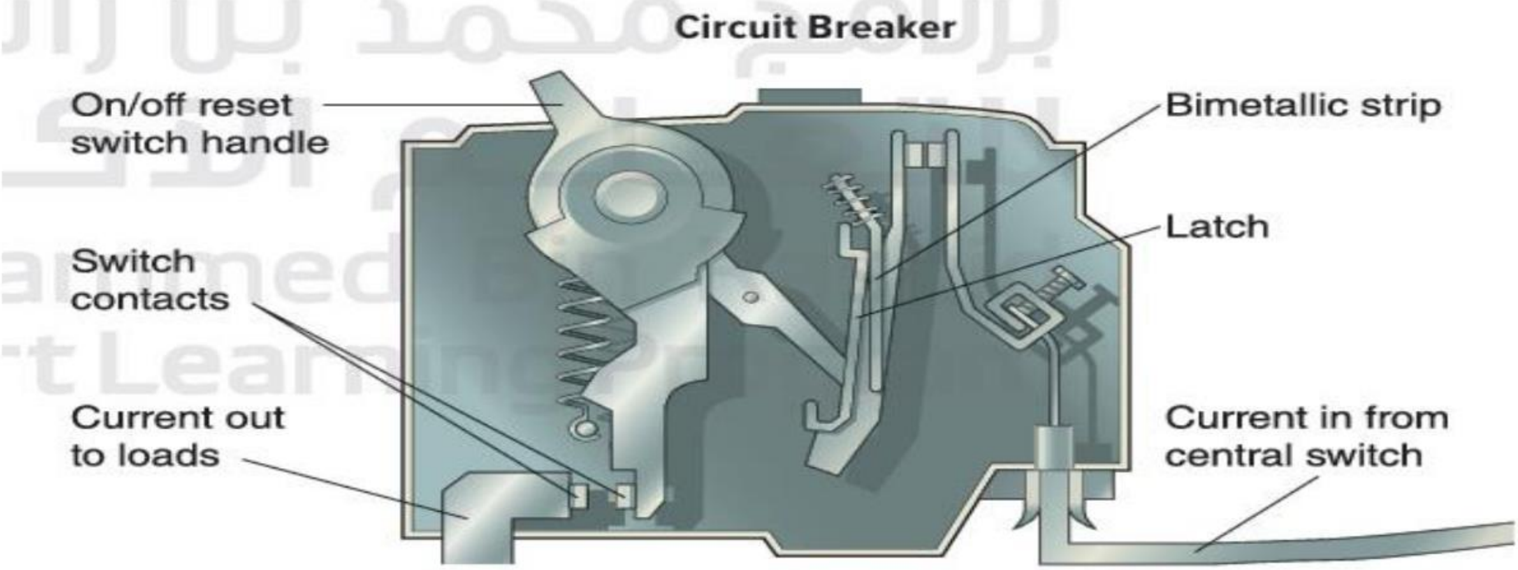


Figure 11 When there is too much current through the bimetallic strip in a circuit breaker, the heat that is generated causes the strip to bend and release the latch. The handle moves to the off position, causing the switch to open and the current to stop.

2. Ground-Fault Interrupters (GFCIs):

Usually, current follows a single path from the power source through an electrical appliance and back to the source. An appliance malfunction or an accidental drop of the appliance into water can result in additional current pathways. A **ground-fault interrupter** (GFI) is a device that contains an electronic circuit that detects small current differences between the two wires in the cord connected to an appliance. An extra current path, such as one through water, could cause this difference. The GFI stops the current when it detects such differences. This often protects a person from electrocution.

voltage divider produces a source of potential difference that is less than the potential difference across the battery.

Consider the circuit shown in **Figure 4.** Two resistors (R_1 and R_2) are connected in series across a battery with potential difference V. The equivalent resistance of the circuit is

$$R = R_1 + R_2.$$

The current is represented by the following equation:

$$I = \frac{\Delta V}{R} = \frac{\Delta V}{R_1 + R_2}$$

The desired voltage (5 V) is the voltage drop (ΔV_2) across resistor R_2: $\Delta V_2 = IR_2$. Substitute the earlier equation into this equation as shown:

$$\Delta V_2 = IR_2 = \left(\frac{\Delta V}{R_1 + R_2}\right)R_2 = \frac{\Delta V R_2}{R_1 + R_2}$$

By choosing the right resistors, you can produce a potential difference of 5 V across a portion of an electric circuit even if you only have a 9 V battery available.

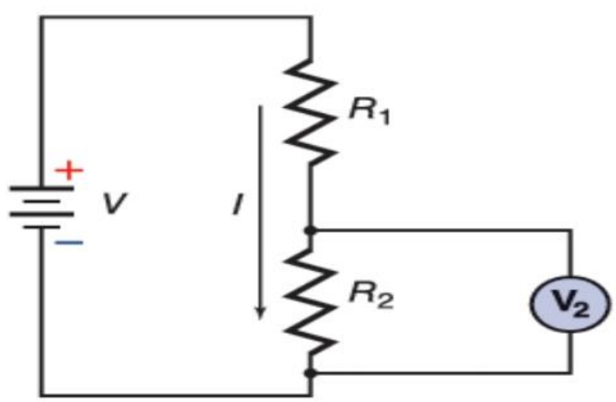


Figure 4 This voltage-divider circuit demonstrates how a voltage of desired magnitude can be achieved by choosing the right combination of resistors.

Explain why the current direction arrow in the diagram is pointing in that direction.

Electric motors

- An electric motor is an apparatus that converts electrical energy into mechanical energy.

- Electric motors rely on a multilooped wire coil called an armature, which is mounted on an axle that rotates in a magnetic field.

- Current enters the armature through a split-ring **commutator**, which reverses the direction of current as the armature turns, as shown in the simple electric motor in the Figure .

Electric motors

- Although only one loop is shown in the Figure, the armature in most electric motors has many loops.

- The total force acting on the armature is proportional to **nILB**, where **n** is the total number of turns on the armature (each completing 360°), I is the current, L is the length of wire in each turn that moves perpendicular to the magnetic field, and B is the strength of the magnetic field.

- The magnetic field is produced either by a permanent magnet or by an electromagnet (called a field coil).

- The torque on the armature is controlled by varying the current through the motor.

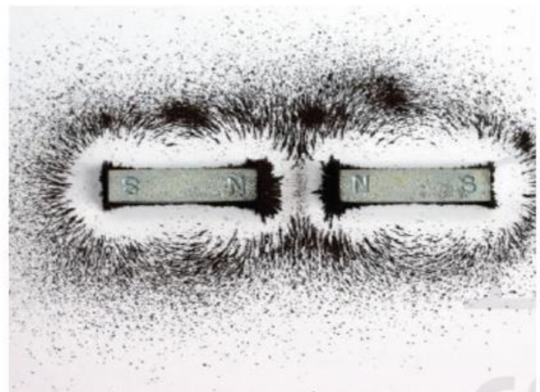
- The larger the torque, the faster the armature turns.

Forces on magnetic fields

Forces on permanent magnets

1. Magnetic fields exert forces on magnets

1. When like poles of two magnets are close together, the fie produced by the north pole of one magnet pushes the north pole of the second magnet away in the direction of the field lines



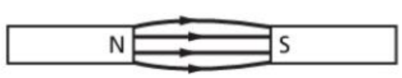
Like poles repel.

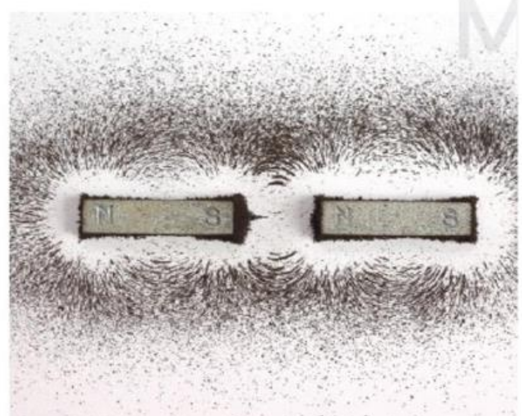
Forces on magnetic fields

Forces on permanent magnets

1. 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.

1. The magnetic field is continuous, forming arcs from one magnet to the other





Unlike poles attract.

20	يطبق المعادلة ($F = qvBsin(\theta)$) لحساب مقدار القوة المؤثرة على جسيم مشحون يتحرك في مجال مغناطيسي. يطبق قاعدة اليد اليمنى لتحديد اتجاه القوة المؤثرة على جسيم مشحون يتحرك في مجال مغناطيسي. Apply the equation $F = qvBsin(\theta)$ to calculate the magnitude of the force acting on a charged particle moving in a magnetic field. Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field.	مثال 2، تطبيق 26 Example2, Exercise 26	120

EXAMPLE 2

FORCE ON A CHARGED PARTICLE IN A MAGNETIC FIELD A beam of electrons travels at 3.0×10^{6} 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?

26. What are the magnitude and direction of the force acting on the proton shown in **Figure 20**?

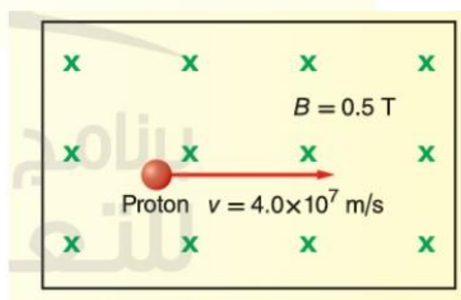


Figure 20