حل تجمبعة أسئلة مراجعة نهائية منهج انسباير

Grade 10 ADV Physics

UNITED ARAB EMIRATES
MINISTRY OF EDUCATION
الإمارات العربية المتحدة
وزارة التربية والتعليم

EOT2 Sample Questions

2024/2025 Exam coverage

Mutasem Jarwan

$I = \frac{q}{t}$		$E = Pt$	$F_{gravitation} = mg$
$R = \frac{\Delta V}{I}$		$I = \frac{\Delta V_{source}}{R}$	$F_{magnetic} = ILB(\sin\theta)$
$P = I\Delta V$		$\Delta V_2 = \left(\frac{\Delta V_{source}}{R_1+R_2}\right) R_2$	
$P = I^2R$	In Series	$R = R_1 + R_2 + \cdots$	$F_{magnetic} = qvB(\sin\theta)$
$P = \frac{(\Delta V)^2}{R}$	In Parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$	● Out of the page ✕ Into the page

Whenever necessary, use the following physical constants

كلما كان ذلك ضرورياً، استخدم الثوابت الفيزيائية التالية

$g = 9.81\ m/s^2$	$q_{proton} = +1.6 \times 10^{-19}\ C$	$q_{elecrton} = -1.6 \times 10^{-19}\ C$

MCQ Questions

LO:

Sate Ohm’s law and applies it to simple circuits (ΔV=IR) and define a resistor as a device designed to have a specific resistance and identify its SI unit as ohms (Ω).

RF:

Student Book
P.(93 - 94)

EX:

P.96
Q.(13 - 18)

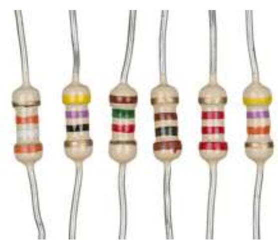
Ohm's law: *The current through a resistor is directly proportional to the potential difference across it*.

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

Unit of $(R) = \frac{V}{A} = \Omega$ Ohm's

Resistor: a device designed to have a specific resistance.

Resistors are used to Control the current in a circuit.



13. An automobile panel lamp with a resistance of 33 Ω is placed across the battery shown in Figure 10. What is the current through the circuit?

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

$$I = \frac{\Delta V}{R} \qquad = \frac{12}{33} = 0.36\ A$$

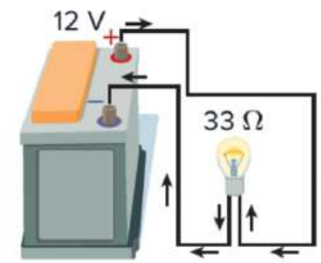


Figure 10

14. A sensor uses $2 \times 10^{-4} A$ of current when it is operated by the battery shown in Figure 12. What is the resistance of the sensor circuit?

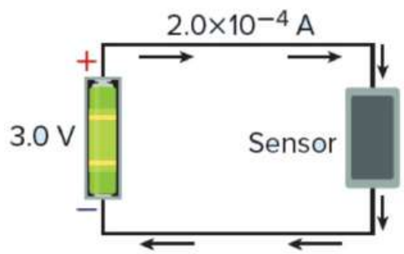


Figure 11

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

$$R = \frac{3}{2 \times 10^{-4}} = 1.5 \times 10^{4}\ \Omega$$

15. A motor with the operating resistance of $32\ \Omega$ is connected to a voltage source as shown in Figure 12. What is the voltage of the source?

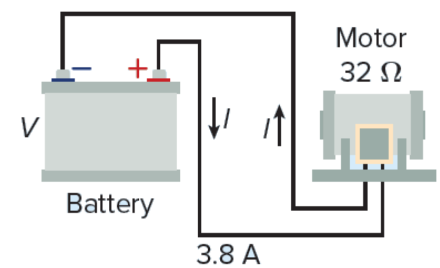


Figure 12

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

$$\Delta V = IR$$

$$\Delta V = (3.8)(32) = 121.6\ V$$

16. A lamp draws a current of 0.50 A when it is connected to a 120 V source.

a. What is the resistance of the lamp?

$$R = \frac{\Delta V}{I} \quad = \frac{120}{0.5} = 240\ \Omega$$

b. What is the power consumption of the lamp?

$$P = I\Delta V \quad = (0.5)(120) = 60\ W$$

17. A 75 W lamp is connected to 125 V.

a. What is the current through the lamp?

$$I = \frac{P}{\Delta V} \quad = \frac{75}{125} = 0.6\ A$$

b. What is the resistance of the lamp?

$$R = \frac{\Delta V}{I} \quad = \frac{125}{0.6} = 208.3\ \Omega$$

18. CHALLENGE A resistor is added to the lamp in the previous problem to reduce the current to half its original value.

a. What is the potential difference across the lamp?

$$\Delta V = IR \qquad = (0.3)(208.3) = 62.5\ V$$

b. How much resistance was added to the circuit?

$$R_{total} = \frac{\Delta V}{I} \qquad = \frac{125}{0.3} = 416.6\ \Omega$$

$$R_{total} = R_{lamp} + R_{new}$$

$$416.6 = 208.3 + R_{new}$$

$$R_{new} = 416.6 - 208.3 = 208.3\ \Omega$$

C. At what rate does the lamp transform electrical energy into radiant and thermal energy?

$$P = I\Delta V \quad = (0.3)(62.5) = 18.75\ W$$

The figure shows two lamps (A) and (B), connected to the same voltage.

Which one has the higher electric resistance value?

يُبيّن الشكل مصباحين (A) و (B) ، تم توصيلهما بفرق الجهد نفسه.

أي منهما لديه قيمة مقاومة كهربائية أعلى؟

Lamp (A)	المصباح (A)
Lamp (B)	المصباح (B) ✓
They are equal	مُتساويان
Insufficient information	المعلومات غير كافية

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

Low resistence

high power

الأقل مقاومة تكون القدرة أعلى

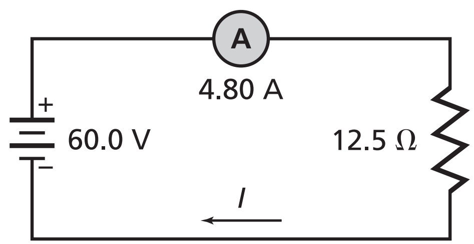
2

LO: Analyze simple electrical circuits that contain combinations of resistors and batteries and evaluate the current passing each resistor and the potential difference across it.

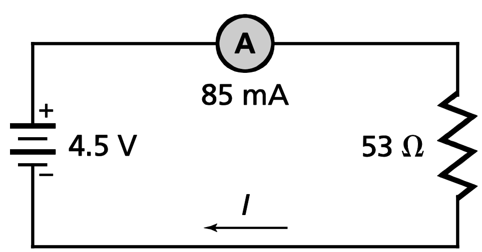
RF: Student Book
P.(91 - 92)

EX: P.92
Q.(8 – 12)

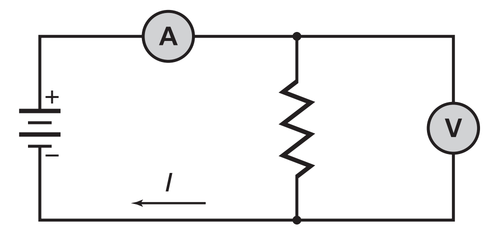
8. Draw a circuit diagram to include a 60.0 V battery, an ammeter, and a resistance of 12.5 Ω in series. Draw arrows on your diagram to indicate the direction of the current.



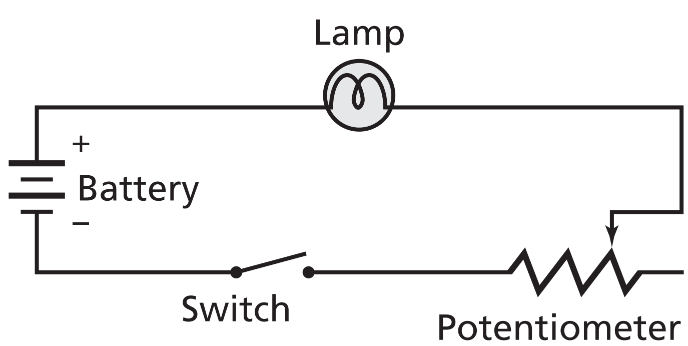
9. Draw a circuit diagram showing a 4.5 V battery, a resistor, and an ammeter that reads 85 mA. Show the direction of the current using conventional rules and indicate the positive terminal of the battery.



10. Add a voltmeter to measure the potential difference across the resistors in the previous two problems. Label the voltmeters.

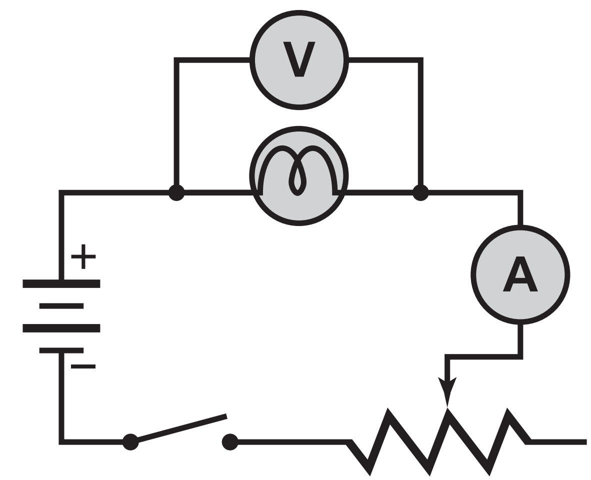


11. Draw a circuit using a battery, a lamp, a potentiometer to adjust the lamp's brightness, and an on-off switch.



https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html

12. CHALLENGE Repeat the previous problem, adding an ammeter and a voltmeter across the lamp.



LO:

Sate Ohm's law and identify devices which obey Ohm's law and apply it to simple circuits (ΔV=RI).

RF:

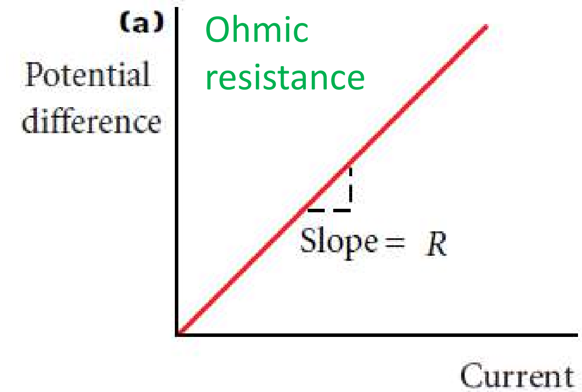
Student Book
P.(93 - 94)

EX:

P.94; P.97
Get it; Q.21

Ohm's law: *The current through a resistor is directly proportional to the potential difference across it.*

A device having constant resistance independent of the potential difference obeys Ohm's law.



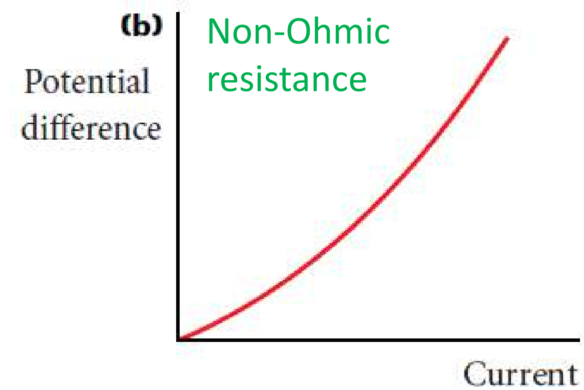
Get It?

Explain which devices obey Ohm's law.

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

Most metallic conductors obey Ohm's law, at least over a limited range of voltages.

Many important devices, however, such as a phone or calculator, contain transistors and diodes, which do not obey Ohm's law.



Ohmic resistance: resistance which obeys ohms law, it is constant (linear). ex: most conductors.

Non-ohmic resistance: resistance which does not obey ohms law it is varying (nonlinear). ex: transistors and diodes in electrical devices.

The two figures below show a graph of the changes in potential difference with electric current for two electrical resistors, where figure (a) is for a metal resistor, and figure (b) is for a lamp resistor.

يبين الشكل ادناه رسما بيانيا لتغير فرق الجهد مع التيار الكهربائي لمقاومتين كهربائيتين حيث ان الشكل (a) لمقاومة فلزية والشكل (b) لمقاومة مصباح.

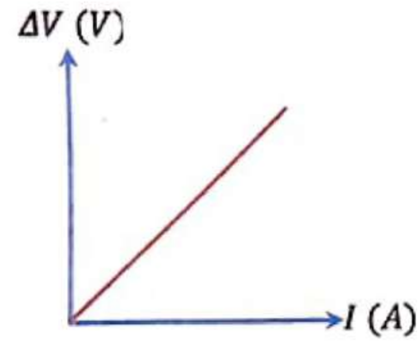


Figure (a) الشكل

#- Which of the two figures obeys Obama's law (Ohmic resistance)? Justify your answer.

أي من الشكلين يخضع لقانون اوم (مقاومة اومية) برر اجابتك؟

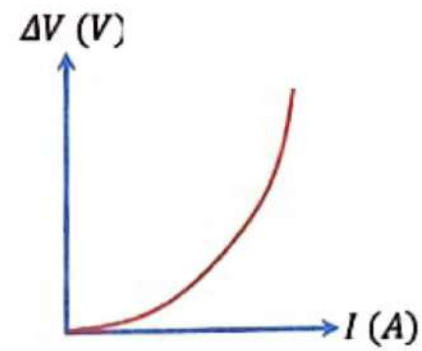


Figure (b) الشكل

Because the intensity of the electric current is directly proportional to the potential difference between its ends, which achieves a constant value of the electrical resistance.

لأن شدة التيار الكهربائي تتناسب طردياً مع فرق الجهد بين طرفيه بما يُحقق ثبات قيمة المقاومة الكهربائية.

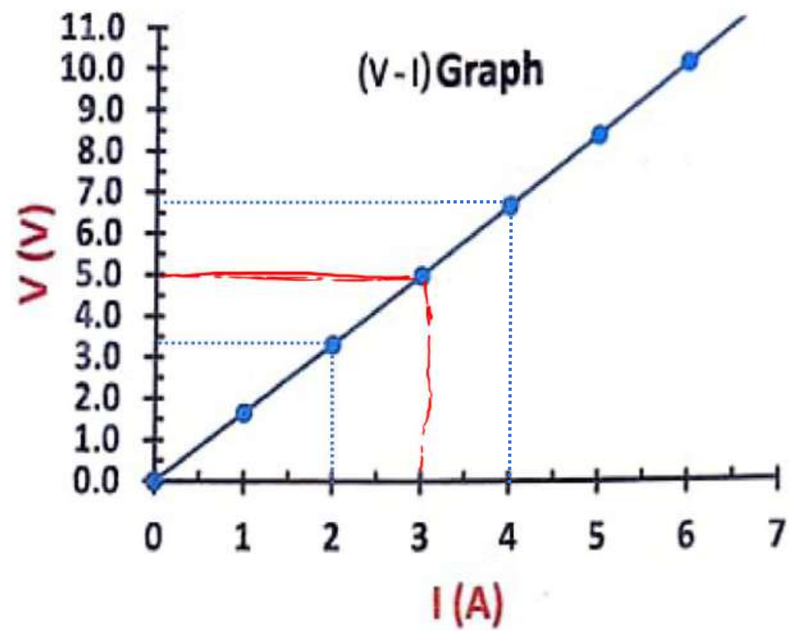
The electric current as a function of voltage of a wire is presented by the (V, I) graph. Use the graph below to answer items that follows:

يتم تمثيل التيار الكهربائي كدالة لجهد السلك من خلال الرسم البياني (V, I). استخدم الرسم البياني ادجناه للإجابة عما يلي:

#- Find the resistance of the wire.

اوجد مقدار مقاومة السلك؟

$$R = \text{slope} = \frac{6.7 - 3.4}{4 - 2} = 1.65\ \Omega$$



#- What is the power dissipated in the resistor when the applied voltage is 5 V?.

ما القدرة المبددة في المقاومة عندما يكون الجهد المطبق 5V؟

$$P = I^2 R = (3)^2 (1.65) = 14.85\ W$$

21. **Resistance** Joe states that because $R = \frac{\Delta V}{I}$, if he increases the voltage, the resistance will increase. Is Joe correct? Explain.

No;

resistance depends on the device. When V increases, so will I.

LO:

Explore connecting resistors in series and in parallel and determine the properties and uses of each kind of connection by studying the electric current and the potential difference across each resistor.

RF:

Student Book
P.97
P.(104 – 105)
P.(109 – 111)

EX:

P.105 Q.(42 – 46)
P.109 Q.(52 – 54)
P.112 Q.(55 – 58)

Series circuit: a circuit in which there is only one path for the current

- *In sires circuit the current across each resistor is the same*

$$I_{total} = I_1 = I_2 = I_3 \ldots$$

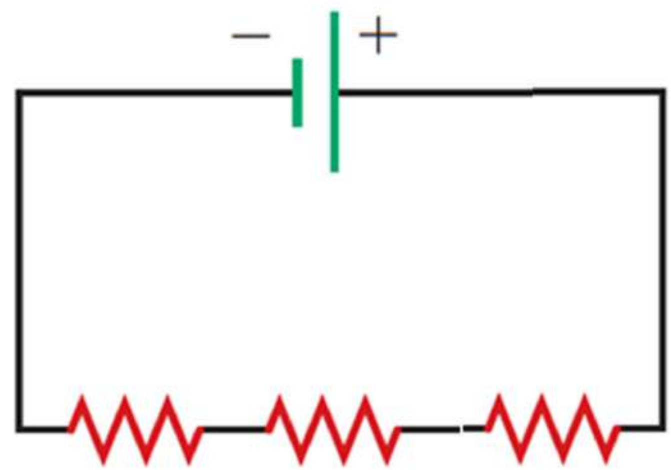
- *In sires the potential difference divide between the resistors*

$$\Delta V_{total} = \Delta V_1 + \Delta V_2 + \Delta V_3 \ldots$$

- *Calculating equivalent resistance*

$$I_{total} R_{total} = I_1 R_1 + I_2 R_2 + I_3 R_3 \ldots$$

$$R_{total} = R_1 + R_2 + R_3 + \cdots$$

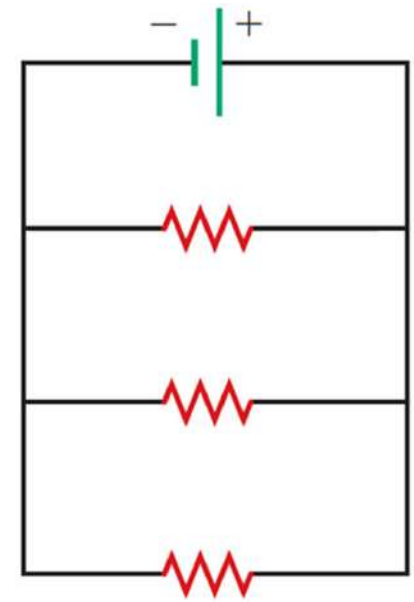


$$\Delta V = IR$$

The equivalent resistance is always greater than any individual resistance.

If one of the components is broken, then all the other components will be off.

Parallel circuit: A circuit in which there are several paths for the current to flaw.



- *In parallel the potential difference across each resistor is the same*

$$\Delta V_{total} = \Delta V_1 = \Delta V_2 = \Delta V_3$$

- *In parallel the current from the source divide between the resistors*

$$I_{total} = I_1 + I_2 + I_3$$

- *Calculating equivalent resistance*

$$\frac{\Delta V_{total}}{R_{total}} = \frac{\Delta V_1}{R_1} + \frac{\Delta V_2}{R_2} + \frac{\Delta V_3}{R_3}$$

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

When using calculator

$$R_{total} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

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

A student is deriving an equation for the equivalent resistance of resistors in series. He writes the following steps but does not justify them.

Which step is justified using conservation of charge?

يستنتج الطالب مُعادلة المقاومة المكافئة للمقاومات الموصلة على التوالي. يكتب الخطوات التالية لكنه لا يبررها.

ما هي الخطوة التي يمكن تبريرها باستخدام مبدأ حفظ الشحنة؟

Step 1 $V = V_1 + V_2$

Step 2 but $V = IR$

Step 3 so $IR = I_1R_1 + I_2R_2$

Step 4 but $I = I_1 = I_2$

Step 5 Therefore $R = R_1 + R_2$

Step 1	الخطوة 1
Step 2	الخطوة 2
Step 3	الخطوة 3
Step 4	الخطوة 4

42. Three 22 Ω resistors are connected in series across a 125 V generator.

(a) What is the equivalent resistance of the circuit?

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

$$R_{eq} = 22 + 22 + 22 = 66\ \Omega$$

(b) What is the current in the circuit?

$$\Delta V = IR_{eq}$$

$$I = \frac{\Delta V}{R_{eq}} = \frac{125}{66} = 1.9\ \text{A}$$

43. A 12 Ω, a 15 Ω, and a 5 Ω resistor are connected in a series circuit with a 75 V battery.

(a) What is the equivalent resistance of the circuit?

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

$$R_{eq} = 12 + 15 + 5 = 32\ \Omega$$

(a) What is the current in the circuit?

$$\Delta V = IR_{eq}$$

$$I = \frac{\Delta V}{R_{eq}} = \frac{75}{32} = 2.34\ \text{A}$$

44. A string of lights has ten identical bulbs with equal resistances connected in series. When the string of lights is connected to a 117 V outlet, the current through the bulbs is 0.06 A. What is the resistance of each bulb?

$R_{eq} = R_1 + R_2 \dots + R_{10}$ $\quad$ $R_{eq} = 10R \dots (1)$

$\Delta V = IR_{eq}$

$$R_{eq} = \frac{\Delta V}{I} = \frac{117}{0.06} = 1950\ \Omega \dots (2)$$

Substitute 2 into 1:

$1950 = 10R$ $\quad$ $R = 195\ \Omega$

45. A 9 V battery is in a circuit with three resistors connected in series.?

a. If the resistance of one of the resistors increases, how will the equivalent resistance change?

It will increase.

b. What will happen to the current

$I = \frac{\Delta V}{R}$, so it will decrease.

c. Will there be any change in the battery voltage?

No. It does not depend on the resistance.

46. CHALLENGE Calculate the potential differences across three resistors, 12 Ω, 15 Ω, and 5 Ω, that are connected in series with a 75 V battery. Verify that the sum of their potential differences equals the potential difference across the battery.

$$\Delta V_1 = IR_1 = 2.3\,(12) = 28\text{ V}$$

$$\Delta V_2 = IR_2 = 2.3\,(15) = 35\text{ V}$$

$$\Delta V_3 = IR_3 = 2.3\,(5) = 12\text{ V}$$

$$\Delta V_{tot} = \Delta V_1 + \Delta V_2 + \Delta V_3 = 75\text{ V}$$ = voltage of battery

52. A 22 Ω resistor and a 33 Ω resistor are connected in series and are connected to a 120 V power source.

a. What is the equivalent resistance of the circuit?

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

$$R_{eq} = 22 + 33 = 55\ \Omega$$

b. What is the current in the circuit?

$$I = \frac{\Delta V}{R_{eq}} = \frac{120}{55} = 2.2\ \text{A}$$

c. What is the potential difference across each resistor?

$$\Delta V_1 = IR_1 = (2.2)(22) = 48.4\ V$$

$$\Delta V_2 = IR_2 = (2.2)(33) = 72.6\ V$$

53. Three resistors of 3.3 kΩ, 4.7 kΩ, and 3.9 kΩ a reconnected in series across a 12 V battery.

a. What is the equivalent resistance?

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

$$R_{eq} = 3.3 + 4.7 + 3.9 = 11.9\ k\Omega$$

b. What is the current through the resistors?

$$I = \frac{\Delta V}{R_{eq}} = \frac{12}{11900} = 0.001\ \text{A}$$

c. Find the total potential difference across the three resistors.

$$\Delta V_{tot} = IR_{tot} = (0.001)(11900) = 11.9\ V$$

54. CHALLENGE Select a resistor to be used as part of a voltage divider along with a 1.2 kΩ resistor. The potential difference across the 1.2 kΩ resistor is to be 2.2 V when the supply is 12 V.

$$\Delta V_2 = \frac{\Delta V R_2}{R_1 + R_2}$$

$$2.2 = \frac{(12)(1200)}{R_1 + (1200)}$$

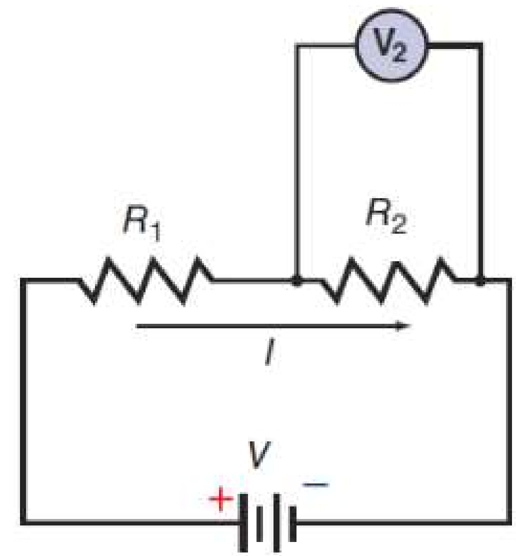
$$(2.2)(R_1 + 1200) = 14400$$

$$(R_1 + 1200) = \frac{14400}{2.2}$$

$$(R_1 + 1200) = 6545.45$$

$$R_1 = 6545.45 - 1200 = 5345.45\ \Omega$$

$$= 5.3\ \text{k}\Omega$$



55. You connect three 15.0 Ω resistors in parallel across a 30.0 V battery.

(a) What is the equivalent resistance of the parallel circuit?

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$R_{eq} = \left(\frac{1}{15} + \frac{1}{15} + \frac{1}{15}\right)^{-1}$$

$$R_{eq} = 5\ \Omega$$

(b) What is the current through the entire circuit?

$$\Delta V = I R_{eq}$$

$$I = \frac{\Delta V}{R_{eq}} = \frac{30}{5} = 6\ \text{A}$$

(c) What is the current through each branch of the circuit?

$$\Delta V_1 = \Delta V_2 = \Delta V_3 = 30\ \text{V}$$

$$I_1 = \frac{\Delta V}{R_1} = \frac{30}{15} = 2\ \text{A}$$

$$I_2 = \frac{\Delta V}{R_2} = \frac{30}{15} = 2\ \text{A}$$

$$I_3 = \frac{\Delta V}{R_3} = \frac{30}{15} = 2\ \text{A}$$

56. Suppose you replace one of the 15.0 Ω resistors in the previous problem with a 10.0 Ω resistor.

(a) How does the equivalent resistance change?

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$R_{eq} = \left(\frac{1}{10} + \frac{1}{15} + \frac{1}{15}\right)^{-1}$$

$$R_{eq} = \frac{30}{7}\ \Omega$$

(b) How does the current through the entire circuit change?

$$\Delta V = IR_{eq}$$

$$I = \frac{\Delta V}{R_{eq}} = \frac{30}{30/7} = 7\ \text{A}$$

(c) How does the current through one of the 15.0 Ω resistors change?

$$\Delta V_1 = \Delta V_2 = \Delta V_3 = 30\ \text{V}$$

$$I_1 = \frac{\Delta V}{R_1} = \frac{30}{10} = 3\ \text{A}$$

$$I_2 = \frac{\Delta V}{R_2} = \frac{30}{15} = 2\ \text{A}$$

$$I_3 = \frac{\Delta V}{R_3} = \frac{30}{15} = 2\ \text{A}$$

57. You connect a 120.0 Ω resistor, a 60.0 Ω resistor, and a 40.0 Ω resistor in parallel across a 12.0 V battery.

(a) What is the equivalent resistance of the parallel circuit?

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$R_{eq} = \left(\frac{1}{120} + \frac{1}{60} + \frac{1}{40}\right)^{-1}$$

$$R_{eq} = 20\ \Omega$$

(b) What is the current through the entire circuit?

$$\Delta V = IR_{eq}$$

$$I = \frac{\Delta V}{R_{eq}} = \frac{12}{20} = 0.6\ \text{A}$$

(c) What is the current through each branch of the circuit?

$$\Delta V_1 = \Delta V_2 = \Delta V_3 = 12\ \text{V}$$

$$I_1 = \frac{\Delta V}{R_1} = \frac{12}{120} = 0.1\ \text{A}$$

$$I_2 = \frac{\Delta V}{R_2} = \frac{12}{60} = 0.2\ \text{A}$$

$$I_3 = \frac{\Delta V}{R_3} = \frac{12}{40} = 0.3\ \text{A}$$

58.CHALLENGE You are trying to reduce the resistance in a branch of a circuit from 150 Ω to 93 Ω. You add a resistor to this branch of the circuit to make this change. What value of resistance should you use, and how should you connect this resistor?

to reduce the resistance, a parallel resistor should be added.

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

$$\frac{1}{93} = \frac{1}{150} + \frac{1}{R_2}$$

$$\frac{1}{R_2} = \frac{1}{93} - \frac{1}{150} = \frac{19}{4650}$$

$$R_2 = \frac{4650}{19} = 245\ \Omega$$

LO:

Analyze simple electrical circuits that contain combinations of resistors and batteries and evaluate the current passing each resistor and the potential difference across it.

RF:

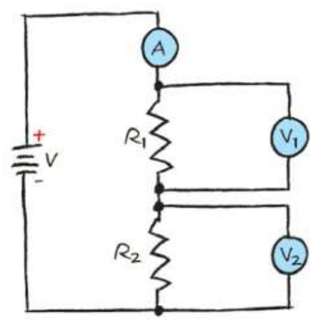
Student Book
P.(104 – 112)

EX:

P.,105 Q.(42 - 46)
P.(108 - 109) Q.(47 - 54)
P.112 Q.(55 - 58)

Calculate the equivalent resistance and the total current passing through a series circuit

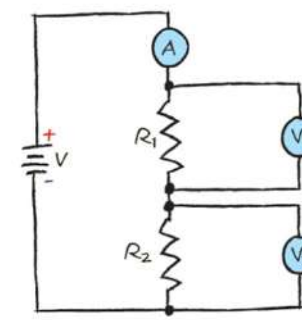
47. The circuit shown in Example Problem 4 is producing these symptoms: the ammeter reads 0 A, ΔV_1 reads 0 V, and ΔV_2 reads 45 V. What has happened?



R_2 has failed. It has infinite resistance, and the battery voltage appears across it.

49. Holiday lights often are connected in series and use special lamps that short out when the voltage across a lamp increases to the line voltage. Explain why. Also explain why these light sets might blow their fuses after many bulbs have failed.

If not for the shorting mechanism, the entire set would go out when one lamp burns out. After several lamps fail and then short, the reduced total resistance of the remaining working lamps results in an increased current that is sufficient to blow the fuse.



48. Suppose the circuit shown in (Example Problem 4) has these values: $R_1 = 255\ \Omega$, $R_2 = 290\ \Omega$ and $\Delta V_1 = 17\ V$. No other information is available.

a. What is the current in the circuit?

$$I_1 = \frac{\Delta V_1}{R_1} = \frac{17}{255} = 0.067\ \text{A}$$

The current in the circuit is the same Series connection

b. What is the potential difference across the battery?

$$\Delta V_1 = IR_1 = (0.067)(255) = 17V$$

$$\Delta V_2 = IR_2 = (0.067)(290) = 19.5\ V$$

$$\Delta V_{tot} = \Delta V_1 + \Delta V_2 = 17 + 19.5 = 36.5\ V$$

c. What is the total power used in the circuit, and what is the power used in each resistor?

$$P_{tot} = I\Delta V_{tot} = (0.067)(36.5) = 2.45\ W$$

$$P_1 = I^2R_1 = (0.067)^2(255) = 1.15\ W$$

$$P_2 = I^2R_2 = (0.067)^2(290) = 1.3\ W$$

d. Does the sum of the power used in each resistor in the circuit equal the total power used in the circuit? Explain.

Yes. The law of conservation of energy states that energy cannot be created or destroyed; therefore, the rate at which energy is converted, or power dissipated, will equal the sum of all parts.

50. The circuit in Example Problem 4 has unequal resistors. Explain why the resistor with the lower resistance will operate at a lower temperature.

The resistor with the lower resistance will dissipate less power, and thus will be cooler.

51. CHALLENGE A series circuit is made up of a 12 V battery and three resistors. The potential difference across one resistor is 1.2 V, and the potential difference across another resistor is 3.3 V. What is the voltage across the third resistor?

$$\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_3$$

$$12 = 1.2 + 3.3 + \Delta V_3$$

$$\Delta V_3 = 12 - 1.2 + 3.3$$

$$\Delta V_3 = 7.5 \text{ V}$$

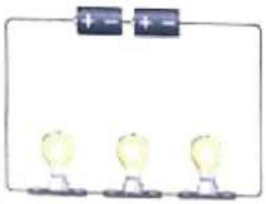
Schematic diagrams (a) and (b), each showing one method of connecting three identical lamps in an electrical circuit to a similar power supply line. Based on the schematic diagrams, answer the following:

الرسمان التخطيطيان (a) و (b) يوضح كل منهما احدى طرق التوصيل لثلاثة مصابيح متماثلة في دائرة كهربائية بمصدر امداد للطاقة، استنادا الى الرسمين التخطيطيين، اجب عما يلي:

What is the name of the way the three lamps are connected in each of the schematic diagrams?

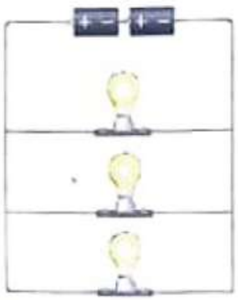
ما اسم الطريقة التي تم فيها توصيل المصابيح الثلاثة في كل من الرسمين التخطيطين؟

(a)



Schematic diagrams (a) Series connection
(a) الرسم التخطيطي التوصيل على التوالي

(b)



Schematic diagrams (b) Parallel connection
(b) الرسم التخطيطي التوصيل على التوازي

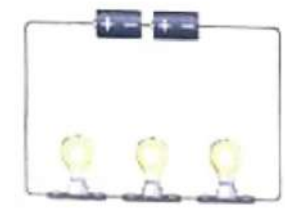
Schematic diagrams (a) and (b), each showing one method of connecting three identical lamps in an electrical circuit to a similar power supply line. Based on the schematic diagrams, answer the following:

الرسمان التخطيطيان (a) و (b) يوضح كل منهما احدى طرق التوصيل لثلاثة مصابيح متماثلة في دائرة كهربائية بمصدر امداد للطاقة، استنادا الى الرسمين التخطيطيين، اجب عما يلي:

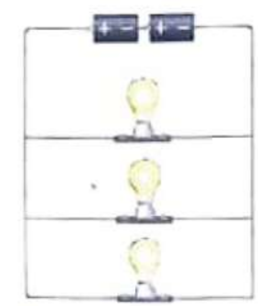
" Study each schematic diagram (a) and (b) well, determine which one of them fits each question in the table, by putting a sign (√).

ادرس كلا من الرسمين التخطيطيين (a) و(b) ثم حدد أي منهما يناسب كل سؤال في الجدول وذلك بوضع إشارة (√).

(a)



(b)



	Question السؤال	Schematic diagrams الرسم التخطيطي	
		a	b
1	Which diagram would have the highest voltage across each lamp? أي مخطط سيكون له اعلى جهد عبر كل مصباح؟		√
2	In which diagram would the lamps be brighter? في أي مصباح ستكون المصابيح اكثر سطوعا؟		√
3	In which diagram if one lamp, blows out, all others will stop glowing? في أي مخطط اذا انفجر احد المصابيح، توقفت المصابيح الأخرى عن التوهج؟	√	
4	Which diagram would have less electric current in it? أي مخطط سيكون به تيار كهربائي اقل؟	√	

LO: Explain how current in transmission lines is altered to reduce thermal energy transformations.

RF: Student Book
P. (101)

EX: P.102
Q.(31 – 41)

Explain how current in transmission lines is altered to reduce thermal energy transformations.

Providing Electrical Energy:

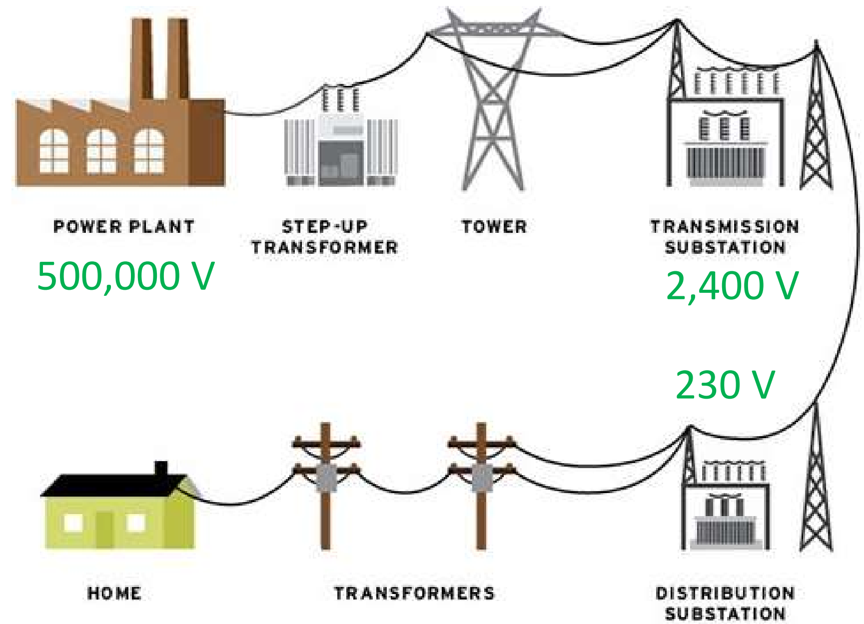
Power plants produce huge electric energy for a whole city by using generators.

Generators: devices convert mechanical energy into electric energy.

National grid is the network of power plants, powerlines and electricity infrastructure that allows electricity to be generated, transported and used across the country.

Transformers: devices change the voltage.

Transmission lines are used to transfer electric energy from generators to homes.



Electric companies provide electric energy (not power).

Electrical Energy Transmission

Explain how current in transmission lines is altered to reduce thermal energy transformations.

How can the energy be transmitted over long distances with as little transformation to thermal energy as possible?

The energy transform at a rate of ($P = I^2 R$):

To reduce the loss by transmission lines, there are two ways

1. Resistance reduced: all cables have small resistance, that depends on its length and the thickness of the wire.

Cables of high conductivity and large diameter (and therefore low resistance) are expensive and heavy.

2. Current reduced: by voltage increasing to keep power ($P = I\Delta V$) constant.

Increasing the voltage reduces the current without changing the power.

The resulting unwanted thermal energy the Joule heating loss, or $I^2 R$ loss.

An electric heater with a resistance (R) works with a voltage difference of (120 volt), if the amount of thermal energy produced by the heater during (10.0 s) is $(2.0 \times 10^4 J)$.What is the resistance of the heater?

مدفأة مقاومتها (R) تعمل بفرق جهد مقداره (120 volt) إذا كان مقدار الطاقة الحرارية التي تنتجها المدفأة خلال (10.0 s) تساوي $(2.0 \times 10^4 J)$ ما مقدار مقاومة المدفأة؟

$\Delta V = 120\ v$

$t = 10\ s$

$E = 2 \times 10^4\ J$

$R = ??$

$E = Pt$

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

$P = \frac{2 \times 10^4}{10}$

$P = 2 \times 10^3\ W$

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

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

$R = \frac{(120)^2}{2 \times 10^3} = 7.2\ \Omega$

31. An electric space heater draws 15.0 A from a 120 V source. It is operated, on the average, for 5.0 h each day.

(a) How much power does the heater use?

$$P = I\Delta V = (15)(120) = 1800\ \mathrm{W}$$

(b) How much energy in kWh does it consume in 30 days?

$$E = Pt = (1800)(30 \times 5 \times 60 \times 60)$$

$$E = 972 \times 10^{6}\ \mathrm{J}$$

Convert the energy

$$E = \frac{972 \times 10^{6}}{3.6 \times 10^{6}} = 270\ \mathrm{kWh}$$

(c) At $0.12 per kWh, how much does it cost to operate the heater for 30 days?

$$¢ = E \times \text{price} = (270)(0.12) = \$\ 32.4$$

32. A digital clock has a resistance of 12,000 Ω and is plugged into a 115 V outlet.

(a) How much current does it draw?

$$I = \frac{\Delta V}{R} = \frac{115}{12000} = 9.6 \times 10^{-3}\text{A}$$

(b) How much power does it use?

$$P = \frac{\Delta V^2}{R} = \frac{115^2}{12000} = 1.1\text{ W}$$

(c) If the owner of the clock pays AED 0.12 per kWh, how much does it cost to operate the clock for 30 days?

$$E = Pt = (1.1)(30 \times 24 \times 60 \times 60) = 2{,}851{,}200\text{ J}$$

$$E = \frac{2851200}{3.6 \times 10^6} = 0.8\text{ kWh}$$

$$¢ = E \times \text{price} = (0.8)(0.12) = 0.1\text{ AED}$$

33. An automotive battery can deliver 55 A at 12 V for 1.0 h and requires 1.3 times as much energy for recharge due to its less-than-perfect efficiency. How long will it take to charge the battery using a current of 7.5 A? Assume the charging voltage is the same as the discharging voltage.

$I_{discharge} = 55A$

$\Delta V = 12\ V$

$t_{discharge} = 1\ h$

$E_{charge} = 1.3E_{discharge}$

$t_{charge} = ?$

$I_{charge} = 7.5A$

$P_{discharge} = I_{discharge}\Delta V$

$P_{discharge} = 55(12) = 660\ W$

$E_{discharge} = Pt$

$E_{discharge} = 660(1 \times 60 \times 60)$

$E_{discharge} = 2376000\ J$

$E_{charge} = 1.3E_{discharge}$

$E_{charge} = 1.3(2376000) = 3088800\ J$

$P_{charge} = I_{charge}\Delta V$

$P_{charge} = 7.5(12) = 90\ W$

$$t_{charge} = \frac{E_{charge}}{P_{charge}} = \frac{3088800}{90} = 34320\ s$$

$$= 9.5\ h$$

34. CHALLENGE Rework the previous problem by assuming the battery requires the application of 14 V when it is recharging.

$I_{discharge} = 55A$

$\Delta V_{discharge} = 12\ V$

$t_{discharge} = 1\ h$

$E_{charge} = 1.3E_{discharge}$

$t_{charge} =?$

$I_{charge} = 7.5A$

$\Delta V_{charge} = 14\ V$

$P_{discharge} = I_{discharge}\Delta V_{dis}$

$P_{discharge} = 55(12) = 660\ W$

$E_{discharge} = Pt$

$E_{discharge} = 660(1 \times 60 \times 60)$

$E_{discharge} = 2376000\ J$

$E_{charge} = 1.3E_{discharge}$

$E_{charge} = 1.3(2376000) = 3088800\ J$

$P_{charge} = I_{charge}\Delta V_{charge}$

$P_{charge} = 7.5(14) = 105\ W$

$$t_{charge} = \frac{E_{charge}}{P_{charge}} = \frac{3088800}{105} = 29417\ s$$

$= 8.17\ h$

Practice Problems

Apply the equation of power ($P = I^2 R = \frac{\Delta V^2}{R}$) to solve numerical problems

35. Energy Forms A car engine drives a generator, which transfers electrical energy to the car's battery. The headlights use the energy stored in the car battery to produce light. List the forms of energy in these three operations.

Mechanical energy from the engine converted to electrical energy in the generator; electrical energy stored as chemical energy in the battery; chemical energy converted to electrical energy in the battery and distributed to the headlamps; electrical energy converted to light and thermal energy in headlamps.

36. Resistance A hair dryer operating from 120 V has two settings, hot and warm. In which setting is the resistance likely to be smaller? Why?

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

Voltage is constant.

Hot: $T\uparrow, P\uparrow, R\downarrow$

Warm : $T\downarrow, P\downarrow, R\uparrow$

Power is inversely proportional to resistance

Power is directly proportional to temperature (Joule heat loss)

Hot draws more power, P = IV, so the fixed voltage current is larger. Because I = V/R the resistance is smaller.

Practice Problems

Apply the equation of power ($P = I^2 R = \frac{\Delta V^2}{R}$) to solve numerical problems

37. Efficiency Evaluate the impact of research to improve power transmission lines on society and the environment.

Research to improve power transmission lines could benefit society. If less power was lost during transmission, some possible benefits include lower cost of electricity and less coal and other power-producing resources would have to be used, which would improve the quality of our environment.

38. Voltage Why would an electric range and an electric hot-water heater be connected to a 240-V circuit rather than a 120-V circuit?

For the same power, at twice the voltage, the current would be halved. The I 2R loss in the circuit wiring would be dramatically reduced because it is proportional to the square of the current.

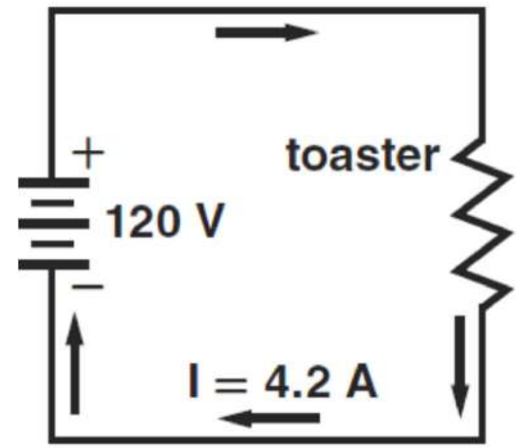
39. Energy Cost A consumer uses 3098 kWh in29 days. She is charged \$0.077592 per kWh for the electricity plus \$0.029998 per kWh for its distribution. What is the bill for the 29 days?

$$¢ = E \times \text{price} = 3098 \times 0.1075572 = 333.2\ \$$$

Practice Problems

Apply the equation of power ($P = I^2 R = \frac{\Delta V^2}{R}$) to solve numerical problems

40. Resistance and Power A toaster is connected to the circuit shown in **Figure 17.**



a. What is the resistance of the toaster?

$$R = \frac{\Delta V}{I} = \frac{120}{4.2} = 29\ \Omega$$

b. At what rate does the toaster transform energy?

$$P = \frac{\Delta V^2}{R} = \frac{(120)^2}{29} = 496.5\ W$$

41. Critical Thinking When demand for electric power is high, power companies sometimes reduce the voltage, thereby producing a “brown-out.” What is being saved?

Power, not energy; most devices will have to run longer.

6

LO:

State Kirchhoff's loop / junction rule and relate it to the conservation of energy / charge and apply Kirchhoff's loop / junction rule to electric circuits.

RF:

Student Book
P.(112 - 113)

EX:

P.113
Q.(60 – 65)

Kirchhoff's Rules

State Kirchhoff's loop rule and relate it to the conservation of energy

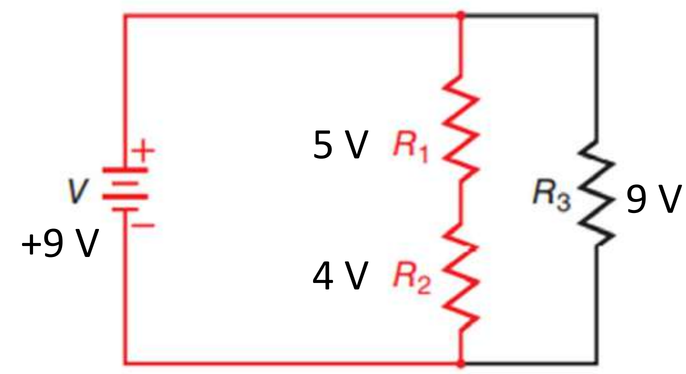
The loop rule:

the sum of increases in electric potential equals the sum of decreases in electric potentials around a loop.

$\Sigma\Delta V = 0$ loop rule

$\Delta V + -\Delta V_1 + -\Delta V_2 = 0$ $\Delta V = \Delta V_1 + \Delta V_2$

Batteries in same direction increase the electric potential but resistors decrease the electric potential (voltage drop).



Kirchhoff's loop rule is based on conservation of energy.

The black-blue path in the circuit above shows:

electric potential increases by 9 V as this charge travels through the battery

electric potential decreases (drops) by 5 V as this charge travels through first resistor.

the drop in electric potential across the second resistor must be 9 V − 5 V = 4 V.

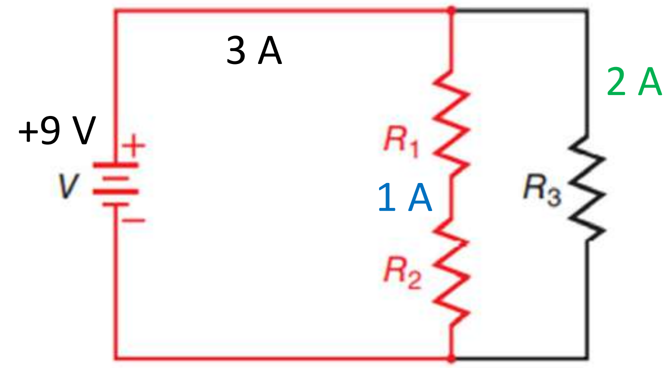
Kirchhoff's Rules

The junction rule:

the sum of current entering a junction equals the sum of current leaving the junction.

$\Sigma I_{\text{in}} = \Sigma I_{\text{out}}$ junction rule

$I = I_1 + I_2$



Kirchhoff's junction rule is based on conservation of charge.

Junction: a point where three or more wires are connected together.

The circuit above shows a red point which represents a junction:

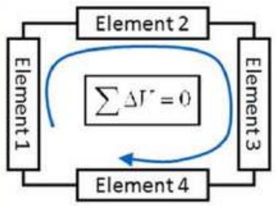
dark arrow is the current enterers the junction 3 A.

blue and green arrows are the currents leave the junction (1 A and 2A).

the currents enter equal to current leave (3 A = 2 A + 1 A).

conservation laws for basic scientific quantities.

What is the name of the physical quantity on which the <u>loop rule</u> in Kirchhoff's rules is based?



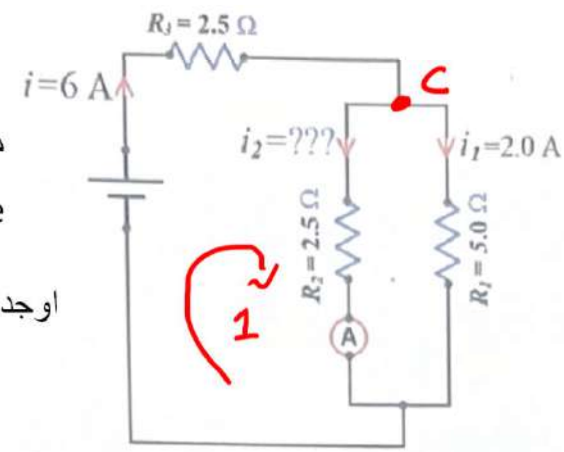
اكتشف العالم العبقري جوستاف كيرشوف عام 1845، قاعدتين من أهم قواعد تحليل الدوائر الكهربائية المركبة وهما: قاعدة الحلقة the loop rule، وقاعدة العقدة (الوصلة) the junction rule، وكان عمره فقط ٢١ سنة. كل قاعدة من القاعدتين مبني على قوانين حفظ لكميات علمية أساسية.

ما اسم الكمية الفيزيائية التي بُنيت عليها قاعدة الحلقة في قاعدتي كيرشوف؟

Energy	الطاقة
Momentum	كمية الحركة (الزخم)
charge	الشحنة
Speed	السرعة

Based on the information written on the figure that represents a closed electric circuit.

معتمدا على البيانات المدونة على الشكل الذي يمثل دائرة كهربائية مغلقة



A- What is the reading of the ammeter (A) in the figure?

ما مقدار قراءة الأميتر (A) المبين في الشكل؟

at point C

$$I_{in} = I_{out}$$

$$I = I_1 + I_2$$

$$6 = 2 + I_2$$

$$I_2 = 4\ A$$

B- What is the potential difference across the battery.

اوجد مقدار فرق الجهد بين قطبي البطارية؟

Loop 1

$$\Delta V_{batt} - \Delta V_{R_3} - \Delta V_{R_2} = 0$$

$$\Delta V_{batt} - I R_3 - I_2 R_2 = 0$$

$$\Delta V_{batt} - (6)(2.5) - (4)(2.5) = 0$$

$$\Delta V_{batt} = 15 + 10 = 25\ V$$

Practice Problems

Solve problems to find the current, voltages and resistances in circuits

60. Total Current A parallel circuit has four branch currents: 120 mA, 250 mA, 380 mA, and 2.1 A. How much current passes through the power source?

$$I_1 = 120 \times 10^{-3} = 0.12$$

$$I_2 = 250 \times 10^{-3} = 0.25$$

$$I_3 = 380 \times 10^{-3} = 0.38$$

$$I_4 = 2.1$$

$$I = I_1 + I_2 + I_3 + I_4$$

$$I = 0.12 + 0.25 + 0.38 + 2.1$$

$$I = 2.85\ \text{A}$$

Practice Problems

Solve problems to find the current, voltages and resistances in circuits

61. Total Current A series circuit has four resistors. The current through one resistor is 810 mA. What current passes through the power source?

810 mA. Current is the same everywhere in a series circuit.

62. Circuits You connect a switch in series with a 75-W bulb to a 120-V power source.

a. What is the potential difference across the switch when it is closed (turned on)?

0 V because the switch act like a wire with R=0 $\Delta V = IR = 0$

b. What is the potential difference across the switch when it is opened (turned off)?

0 V because the switch act like a wire with R=0 $\Delta V = IR = 0$

Practice Problems

Solve problems to find the current, voltages and resistances in circuits

63. Loop Rule Compare Kirchhoff's loop rule to walking around in a loop on the side of a hill.

When you walk around in a loop on the side of a hill and return to the starting point, the sum of the increases in height up the hill and the sum of the decreases in height down the hill are equal. When an electric charge travels around a loop in an electric circuit, the sum of the increases in electric potential equals the sum of decreases in electric potential.

64. Junction Rule Explain how Kirchhoff's junction rule relates to the law of conservation of charge.

The total number of charges is conserved. In an electric circuit, the total number of charges into a section of that circuit must equal the total number of charges out of that same section of circuit.

Practice Problems

Solve problems to find the current, voltages and resistances in circuits

65. Critical Thinking The circuit in **Figure 27** has four identical resistors. Suppose that a wire is added to connect points A and B. Answer the following questions and explain your reasoning.

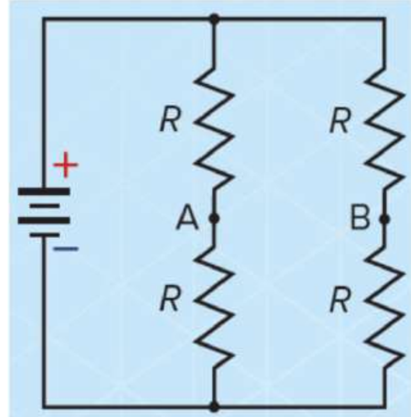


Figure 27

a. What is the current through the wire?

0 A; the potentials of points A and B are the same.

b. What happens to the current through each resistor?

nothing

c. What happens to the current through the battery?

nothing

d. What happens to the potential difference across each resistor?

nothing

LO:

1.Explain the importance of a voltage-divider circuit to achieve a desired potential difference.

2.Identify a type of variable-value resistor, whose value depends on the presence of certain factors such as heat, light, etc.

RF:

Student Book
P. 106

EX:

P. 106
Figure 22

Series Circuit

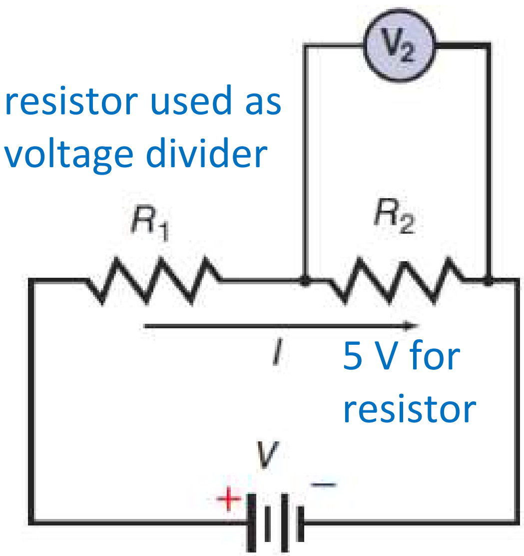
Use the voltage divider circuit as a series circuit to calculate resistances and voltage drop across the components

Series circuit of two resistors is also called a voltage divider, it produces a source of potential difference that is less than the potential difference across the battery.

R_2: unknown resistor

$$\Delta V_2 = \frac{\Delta V R_2}{R_1 + R_2}$$

The law is derived from series circuit laws.



LO:

1. Relate the electric power or rate of energy transfer to current and potential difference ($P=I\Delta V$).

2. Identify the appropriate current rating of a fuse in a circuit

RF:

Student Book
P.(114 – 116)

EX:

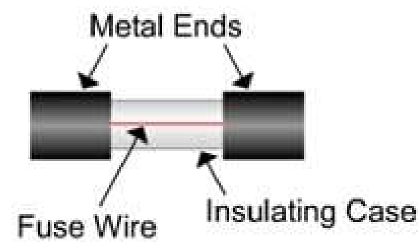
P.115
Figure 29

Fuse: short piece of metal melting when a current is too large to cause open circuit.

Fuses are designed to melt before other elements in a circuit are damaged.

To know the required fuse for a circuit:

- Calculate the current passes through each resistor ($P = I\Delta V$).
- Calculate current passes through the circuit ($I = I_1 + I_2 + \cdots$).
- Compare current to fuse value (current should be smaller).



Common fuse rating:
1A, 2A, 3A, 5A, 10A, 13A, 15A and 30A.

2. Why is it dangerous to replace the 15 A fuse used to protect a household circuit with a fuse that is rated at 30 A?

When current increases to more than 16 A. 15 A fuse melts and opens circuit but 30 A fuse allows current to pass which could damage devices.

LO:

1. Describe the properties of magnets.

2. 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).

RF:

Student Book
P. (125 - 126)
P.(128 – 130)

EX:

P.128
Practice Problems
Q.(1 - 4)

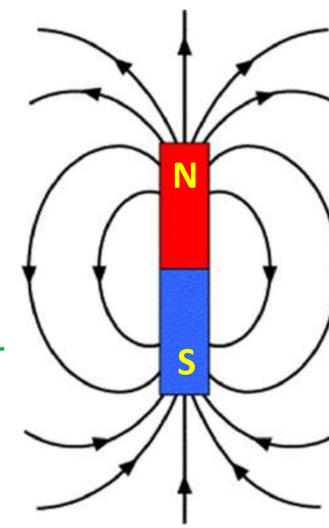
Properties of magnets:

- All magnets are polarized, has two poles, conventionally north and south.

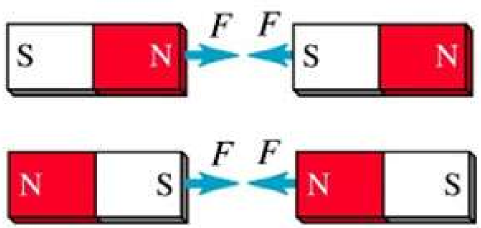
- No matter how a magnet is cut or broken, the magnet always has two poles (no monopoles), because every atom acts as a magnet.

- Magnets exert magnetic force on each other:

polarized

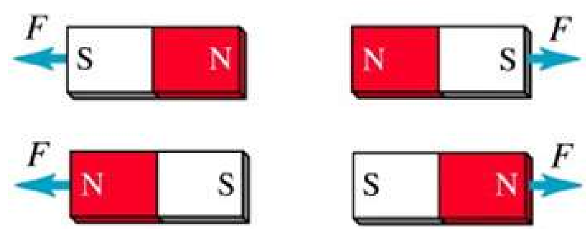


Unlike poles attract each other.



attraction

Alike poles repel each other



repulsion

Properties of magnets

Describe the properties of magnets

1. If you hold a bar magnet in each hand and bring your hands close together, will the force be attractive or repulsive if the magnets are held in the following ways?

a. The two north poles are brought close together.

Repel

b. A north pole and a south pole are brought together.

Attract

2. Figure 5 (at left) shows five disk magnets floating above one another. The north pole of the top-most disk faces up. Which poles are on the top side of each of the other magnets?

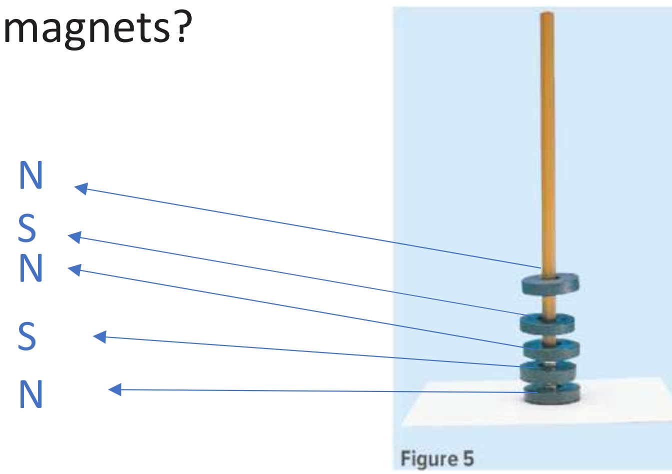


Figure 5

3. The ends of a compass needle are marked N and S. How would you explain to someone why the pole marked N points north? A complete answer should involve Earth's magnetic poles.

Earth is like a giant magnet.

Earth's geographic North Pole is actually its magnetic south pole.

The north end of a compass needle, therefore, points to Earth's magnetic south pole.

4. CHALLENGE When students use magnets and compasses, they often touch the magnets to the compasses. Then they find that the compasses point south. Explain why this might occur.

When students bring compasses near magnets, the magnetization of the compass flips.

11

LO:

1. Describe how magnetic materials can be turned into temporary magnets.

2. Describe magnetic domains and relate them to the magnetic properties of ferromagnetic materials.

RF:

Student Book
P.(127 - 128)

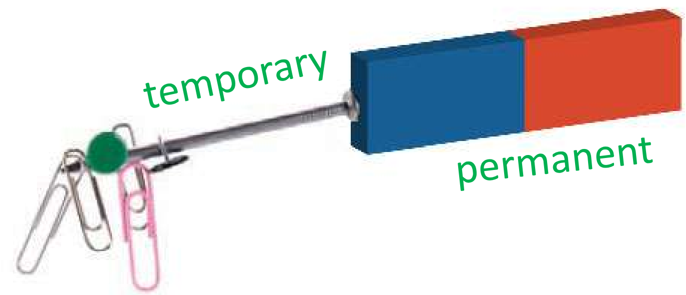
EX:

P.127 Figure 4
P.133 Q.(17, 18)

Describe how magnetic materials can be turned into temporary magnets

Temporary magnets:

Magnet: is any material produces a magnetic field.

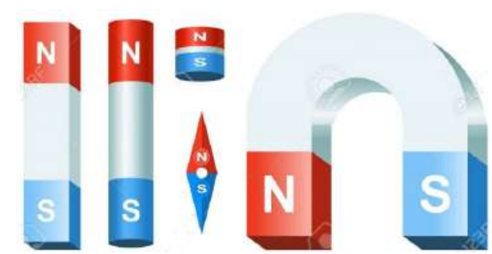


Permanent magnet:
produces its own magnetic field.

Temporary magnet:
act like permanent magnets when they are in magnetic field.

When a magnet touches an object, such as the nail in **Figure 3,** the magnet polarizes the object, making it a temporary magnet. This process is called magnetization by induction.

There are different shapes for magnets: disc, ball, bar, horseshoe and cylinder.



Magnetic Material: any material can gain magnetic field permanently or temporarily.

Ferromagnetic Material: any material can become temporary magnetic. e.g., iron, cobalt, nickel and some alloys (lodestone).

Magnetic domains:

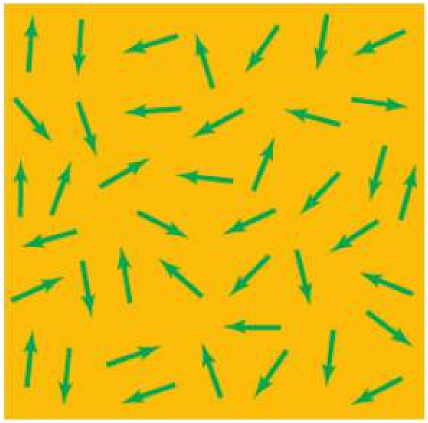
What gives a permanent or temporary magnet its magnetic properties?

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.

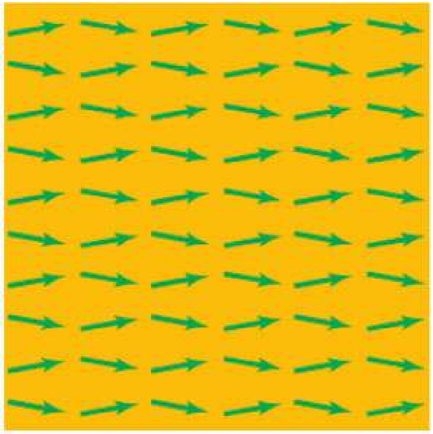
Look at the arrows In **Figure 5.** Each arrow represents a domain. Although domains can contain as many as 10^{20} individual atoms

When its domains are aligned in the same direction, the material becomes a temporary magnet.



Nonmagnetized Material

In a ferromagnetic material that is not magnetized, each domain Points in a random direction,



Magnetized Material

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

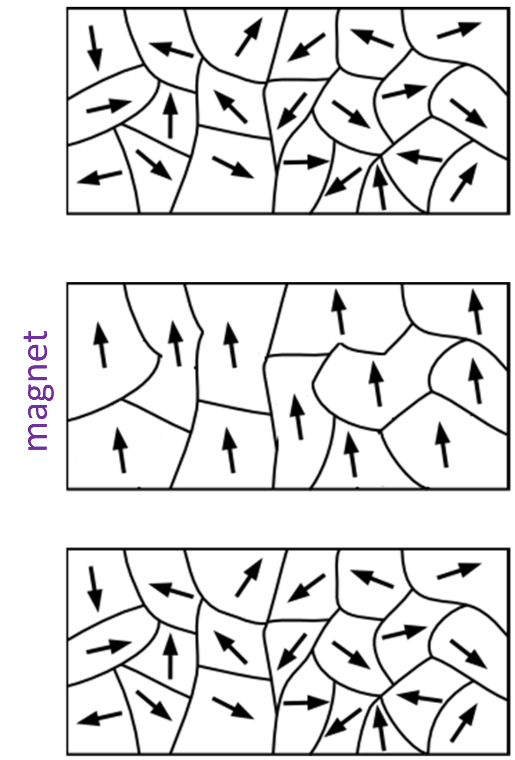
Properties of magnets

Describe how magnetic materials can be turned into temporary magnets

Temporary magnets are produced by magnetization by induction.

As the ferromagnetic material is next to a strong magnet, most of the domains align in the same direction as the poles of the external magnet (magnetization by induction). Finally, the material becomes a temporary magnet.

After removing the magnet, domains return to point in a random direction.



Properties of magnets

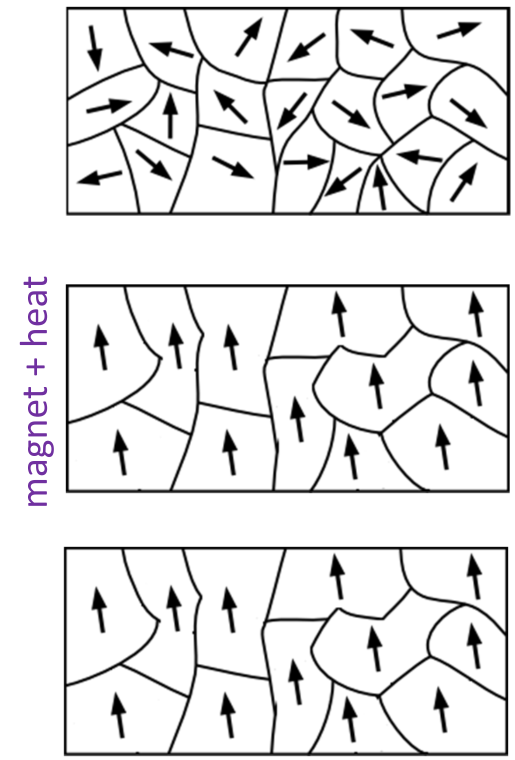
Describe how permanent magnets are created and how they are destroyed

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?



1- An object containing certain ferromagnetic materials is heated in the presence of a strong magnetic field

A- Thermal energy frees the atoms in each of the object's domains.

B- The domains can rotate and align with the magnet's poles.

2- 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.

Permanent magnet has been created.

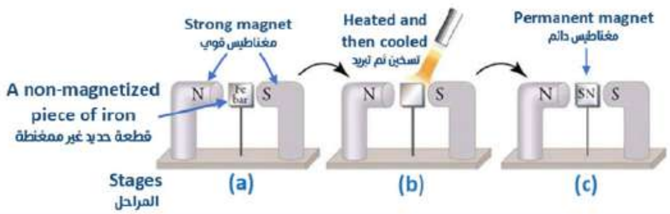
If this permanent magnet is later reheated or dropped, however, the atoms can jostle out of alignment, reordering the domains and removing the magnetic properties.

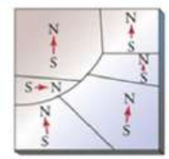
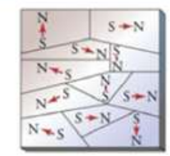
To obtain permanent magnets, an unmagnetized piece of iron is placed between two magnets, heated, and then cooled, or simply tapped when cold. The iron becomes a permanent magnet with the poles aligned as shown in the figures below.

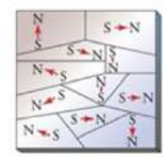
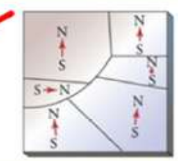
Which of the following pairs of figures correctly represents the magnetic domains in stage (a) and stage (c), respectively?

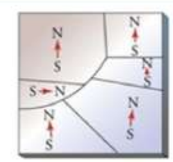
للحصول على مِغناطيس دائم، يتم وضع قطعة حديد غير مُمَغْنطة بين مِغناطيسين، ويتم تسخينها ثم تبريدها، أو ببساطة النقر عليها عندما تكون باردة. يصبح الحديد مغناطيسًا دائمًا مع محاذاة القطبين كما هو موضح في الأشكال أدناه.

أي من الأزواج التالية من الأشكال، تُمثِّل بشكل صحيح النطاقات المغناطيسية في المرحلة (a)، والمرحلة (c) على الترتيب؟



Stage (a) المرحلة	Stage (c) المرحلة
	

Stage (a) المرحلة	Stage (c) المرحلة
	

Stage (a) المرحلة	Stage (c) المرحلة
	

Magnetic domains have nothing to do with the magnetization process	لا علاقة للنطاقات المغناطيسية بعملية التمغنط

17. Magnetic Domains Explain what happens to the domains of a temporary magnet when the temporary magnet is removed from a magnetic field.

Before : random domains

During : aligned domains

After : random domains

The domains return to a random arrangement because they no longer align with the domains of the field of the permanent magnet.

18. Critical Thinking Imagine a toy containing two parallel, horizontal metal rods, one above the other. The top rod is free to move up and down.

a. The top rod floats above the lower rod. When the top rod’s direction is reversed, however, it falls down onto the lower rod. Explain how the rods could behave in this way.

The metal rods could be magnets with their axes parallel. If the top magnet is positioned so that its north and south poles are above the north and south poles of the bottom magnet, it will be repelled and float above. If the top magnet is turned end-for-end, it will be attracted to the bottom magnet.

b. Assume the toy’s top rod was lost and another rod replaced it. The new rod falls on top of the bottom rod no matter its orientation. What type of material is in the replacement rod?

ferromagnetic

LO:

Describe a magnetic field and develop a tool, sketches, qualitative description or presentation to describe the morphology of the magnetic field lines around a magnet or around an infinite straight wire, a circular coil, or a solenoid passed by an electric current.

RF:

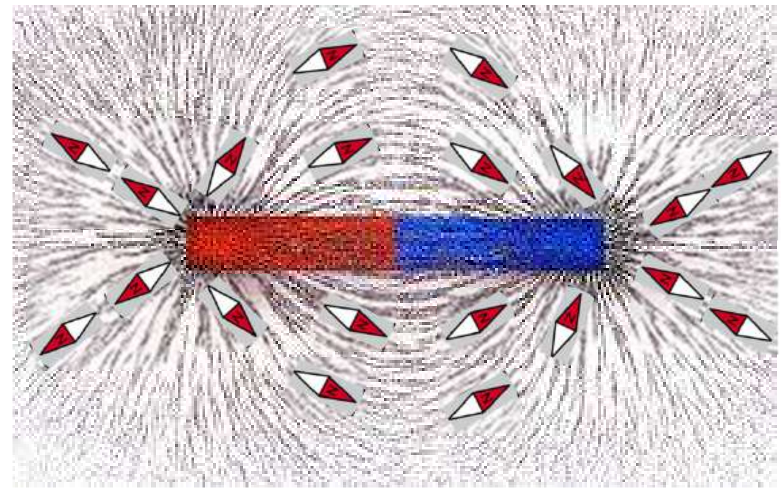
Student Book
P.131

EX:

P.131 Figure 10
P.133 Q.(5 – 9, 14 - 18)

Describe the characteristics of magnetic fields and sketch the field lines around a permanent magnet

Visualize magnetic fields:



Magnetic field lines: imaginary lines (not real) that shows strength and direction of magnetic field.

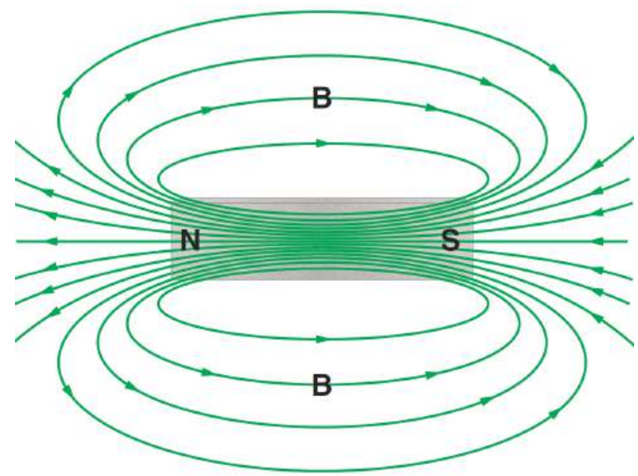
The direction of a magnetic field line is defined as the direction in which the north pole of a compass points when placed in a magnetic field.

The field lines form closed loops

start from north pole and end in south pole, outside the magnet.

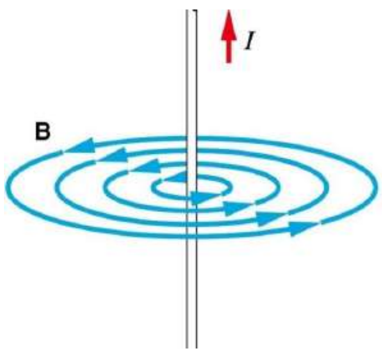
Why???

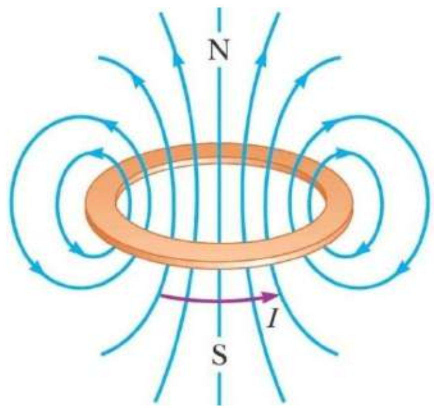
move from south pole to north pole, inside the magnet.

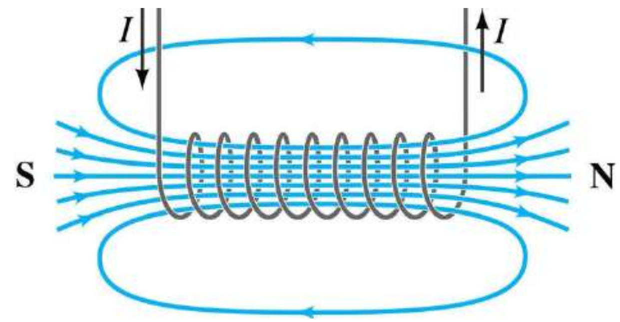


Electromagnetism

Apply the right-hand rule to indicate the direction of the magnetic field in and around a solenoid carrying current







wire

magnetic field
closed loops normal
to wire.

loop

magnetic field
outside: weak
inside: strong

solenoid

magnetic field
outside: very weak
inside: strong and uniform

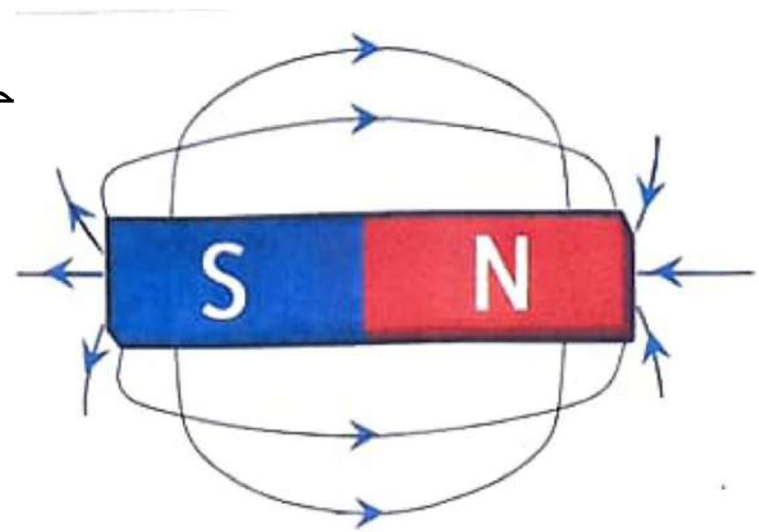
If the current's direction reversed, the magnetic field's direction reversed.

In his science notebook, a student drew the magnetic field lines of a magnet, as shown in the figure:

رسم طالب في كراسة العلوم خطوط المجال المغناطيسي لقطعة مغناطيسية ، كما في الشكل:

Identify two different mistakes (errors) made by the student that violated two different properties of magnetic field lines.

حدد خطأين مختلفين قام بهما الطالب مخالفا خاصيتين مختلفتين من خواص خطوط المجال المغناطيسي.



First mistake: Magnetic field lines must leave the North Pole and enter the South Pole, not the other way around.	الخطأ الأول: خطوط المجال المغناطيسي يجب ان تخرج من القطب الشمالي، وتدخل في القطب الجنوبي، وليس العكس.
Second mistake: Magnetic field lines cannot intersect.	الخطأ الثاني: خطوط المجال المغناطيسي لا يمكن لها أن تتقاطع.

Sketch the magnetic field lines around a long current-carrying wire and apply the right-hand rule to indicate the direction

5. How does the strength of a magnetic field that is 1 cm from a current carrying wire compare with each of the following?

a. the strength of the field 2 cm from the wire

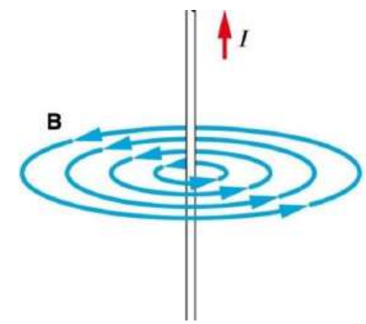
twice as strong

b. the strength of the field 3 cm from the wire

three times as strong

6. A long, straight current-carrying wire lies in a north south direction.

a. The north pole of a compass needle placed above this wire points toward the east. In what direction is the current?



from south to north

b. If a compass were placed underneath this wire, in which direction would the compass needle point?

west

7. A student makes a magnet by winding wire around a nail and connecting it to a battery, as shown in **Figure 13.** Which end of the nail—the pointed end or the head—is the north pole?

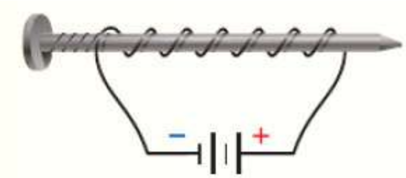


Figure 13

The pointed end

8. You have a battery, a spool of wire, a glass rod, an iron rod, and an aluminum rod. Which rod could you use to make an electromagnet that can pick up steel objects? Explain.

Use the iron rod. Iron would be attracted to a permanent magnet and take on properties of a magnet, whereas aluminum or glass would not.

This effect would support the magnetic field in the wire coil and thus make the strongest electromagnet.

9. CHALLENGE The electromagnet in the previous problem works well, but you would like to make the strength of the electromagnet adjustable by using a potentiometer as a variable resistor. Is this possible? Explain.

Yes. Connect the potentiometer in series with the power supply and the coil.

Adjusting the potentiometer for more resistance will decrease the current and the field strength.

Sketch the magnetic field lines around a long current-carrying wire and apply the right-hand rule to indicate the direction

14. Magnetic Fields Two current-carrying wires are close to and parallel to each other and have currents with the same magnitude. If the two currents were in the same direction, how would the magnetic fields of the wires be affected? How would the fields be affected if the two currents were in opposite directions?

If the currents were in the same direction, the magnetic field would be approximately twice as large; if the currents were in opposite directions, the field would be approximately zero.

15. Direction of the Field Describe how to use aright-hand rule to determine the direction of a magnetic field around a straight, current- carrying wire.

If you grasp the wire with your right hand with your thumb pointing in the direction of the conventional current, your fingers curl in the direction of the field.

Sketch the magnetic field lines around a long current-carrying wire and apply the right-hand rule to indicate the direction

16. Electromagnets A glass sheet with iron filings sprinkled on it is placed over an active electromagnet. The iron filings produce a pattern. If this scenario were repeated with the direction of current reversed, what observable differences would result? Explain.

None; the filings would show the same field pattern. However, a compass would show that the magnetic polarity had reversed.

17. Magnetic Domains Explain what happens to the domains of a temporary magnet when the temporary magnet is removed from a magnetic field.

Before : random domains

During : aligned domains

After : random domains

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b. Assume the toy's top rod was lost and another rod replaced it. The new rod falls on top of the bottom rod no matter its orientation. What type of material is in the replacement rod?

ferromagnetic

LO:

Defines magnetic flux, and its relation to the number of magnetic field lines that cut perpendicularly through a unit area.

RF:

Student Book
P.(128 – 129)

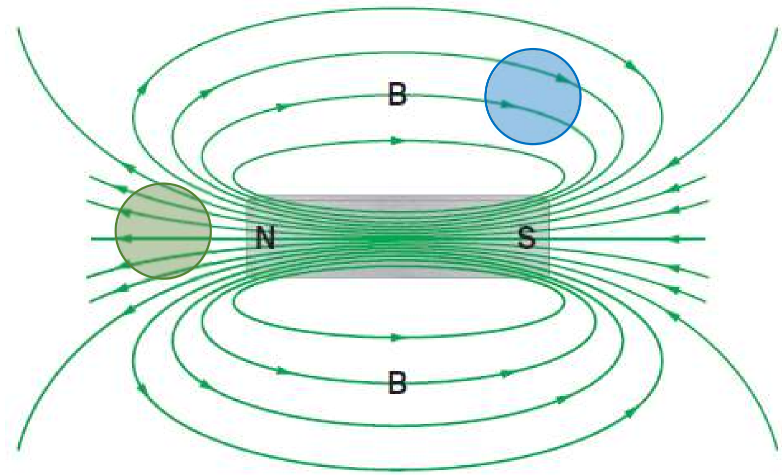
EX:

P.133
Q. 11

Magnetic Flux

Define magnetic flux

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



As the number of magnetic field lines increased the magnetic flux is higher and the magnetic force is stronger.

The flux per unit area is proportional to the strength of the magnetic field.

The strongest magnetic field around the poles where lines concentrated, and it is decreased with distance.

field lines ↑
field ↑
force ↑
flux ↑

The object experiences a greater force and has a higher flux because the lines of magnetic filed are concentrated.

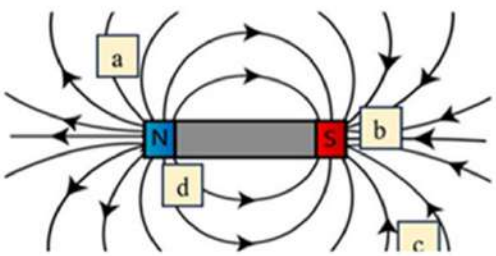
The object experiences a smaller force and has a lower flux because the lines of magnetic field are diverted.

The figure shows the magnetic field lines around a magnet, where each square is a unit area.

In the figure, which expression correctly represents magnetic flux (Let's denote magnetic flux by ϕ)?

يُبيّن الشكل خطوط المجال المغناطيسي حول مغناطيس، حيث كل مُربع عبارة عن وحدة المساحة.

في الشكل، أي من العبارات تُعبّر عن التدفق المغناطيسي (الرمز للتدفق المغناطيسي بالرمز ϕ) بشكل صحيح؟



- $\phi_b > \phi_d > \phi_a > \phi_c$ ✓
- $\phi_c > \phi_a > \phi_d > \phi_a$
- $\phi_d > \phi_a = \phi_c > \phi_a$
- $\phi_b = \phi_d = \phi_a = \phi_c$

Sketch the magnetic field lines around a long current-carrying wire and apply the right-hand rule to indicate the direction

11. Magnetic Fields What two things about a magnetic field can magnetic field lines represent?

Field lines represent the strength and the direction of a magnetic field.

14

LO:

Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field.

RF:

Student Book
P.(141 - 140)

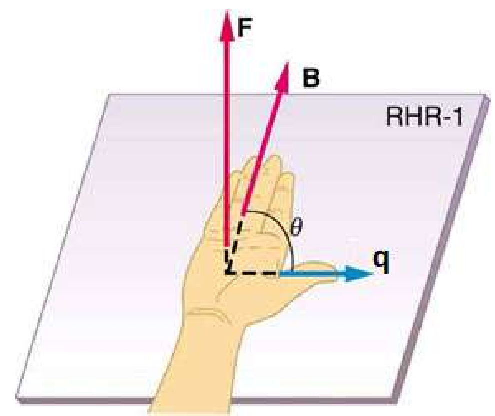
EX:

P.141
Q.(25 - 30)

Force on a charged particle

Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field

The direction of magnetic force can be determined by right hand rule (positive charge).



If the charge is (+):

1- Fingers point in the direction of the magnetic field

2- Thumb points to the direction of the velocity (direction of motion)

3- Palm points in the direction of the magnetic force

$$F = qvB \sin\theta$$

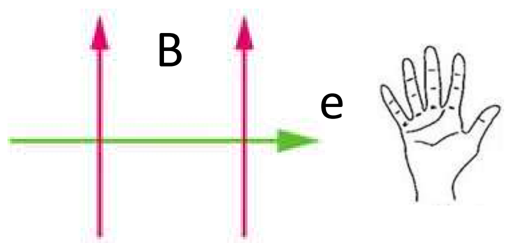
$$F \perp qv \text{ and } B$$

If the charge is (-):

The palm points opposite to the direction of the magnetic force

Force is perpendicular to both magnetic field and velocity (charge).

25. In what direction is the force on an electron if that electron is moving east through a magnetic field that points north?



Thumb: (velocity) (East)

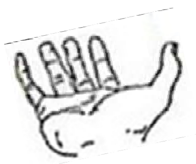
Fingers: (filed) (upward)

Palm: (force) (into the page) negative object

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

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

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



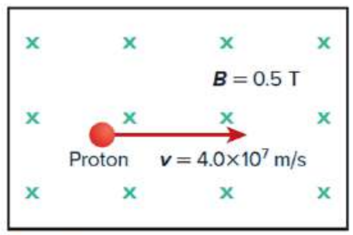


Figure 20

$$F = qvB\sin\theta$$

$$F = (1.6 \times 10^{-19})(4 \times 10^{7})(0.5)\sin 90$$

$$F = 3.2 \times 10^{-12}\ \mathrm{N}$$ (upward)

27. A stream of doubly ionized particles (missing two electrons and thus carrying a net positive charge of two elementary charges) moves at a velocity of 3.0×10^{4} m/s perpendicular to a magnetic field of 9.0×10^{-2} T. How large is the force acting on each ion?

$$F = qvB\sin\theta$$

$$F = (2)(1.6 \times 10^{-19})(3 \times 10^{4})(9 \times 10^{-2})\sin 90$$

$$F = 8.64 \times 10^{-16}\ \mathrm{N}$$

28. Triply ionized particles in a beam carry a net positive charge of three elementary charge units. The beam enters a magnetic field of 4.0×10^{-2} T. The particles have a speed of 9.0×10^{6} m/s and move at right angles to the field. How large is the force acting on each particle?

$$F = qvB\sin\theta$$

$$F = (3)(1.6\times10^{-19})(4\times10^{-2})(9\times10^{6})\sin 90$$

$$F = 1.7\times10^{-13}\ \text{N}$$ (upward)

29. A singly ionized particle experiences a force of 4.1×10^{-13} N when it travels at a right angle through a 0.61 T magnetic field. What is the particle's velocity?

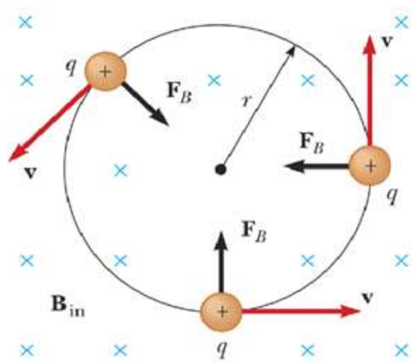
$$F = qvB\sin\theta$$

$$v = \frac{F}{qB\sin\theta}$$

$$v = \frac{4.1\times10^{-13}}{(1.6\times10^{-19})(0.61)\sin 90} = 4.2\times10^{6}\ m/s$$

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

30. CHALLENGE Doubly ionized helium atoms (alpha particles) are traveling at right angles to a magnetic field at a speed of 4.0×10^4 m/s. The force on each particle is 6.4×10^{-16} N. What is the magnetic field strength?



$$F = qvB\sin\theta$$

$$B = \frac{F}{qv\sin\theta}$$

$$B = \frac{6.4\times10^{-16}}{(2)(1.6\times10^{-19})(4\times10^{4})\sin 90}$$

$$B = 0.05\ T$$

LO:

Explain how a current-carrying conductor placed in an external magnetic field experiences a magnetic force.

RF:

Student Book
P.(134 – 136)

EX:

P.137
Q24

Force on a current-carrying loop

Indicate the direction of magnetic forces on a current-carrying rectangular loop of wire in a magnetic field, and determine how the loop will tend to rotate as a consequence of these forces

24. CHALLENGE You are making your own loudspeaker. You make a 1 cm diameter coil with 20 loops of thin wire. You use hot glue to fasten the coil to an aluminum pie plate. The ends of the wire are connected to a plug that goes into the earphone jack on an MP3 music player. You have a bar magnet to produce a magnetic field. How would you orient the magnetic field to make the plate vibrate and produce sound?

One pole should be held as close to the coil as possible so that the field lines are perpendicular to both the wires and the direction of motion of the plate.

Technological devices differ in their operation based on physical principles.

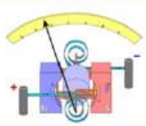
Which of the following technological devices mainly <u>does not</u> depend in its operation on the magnetic force resulting from the passage of an electric current through a conductor placed in a magnetic field?

الأجهزة التكنولوجية تختلف في اعتماد عملها على مبادئ فيزيائية.

أي الأجهزة التكنولوجية الآتية لا تعتمد بشكل أساسي في عملها على القوة المغناطيسية الناتجة عن مرور تيار كهربائي في موصل موضوع في مجال مغناطيسي؟

loudspeakers  مُكبرات الصوت

Radar  رادار

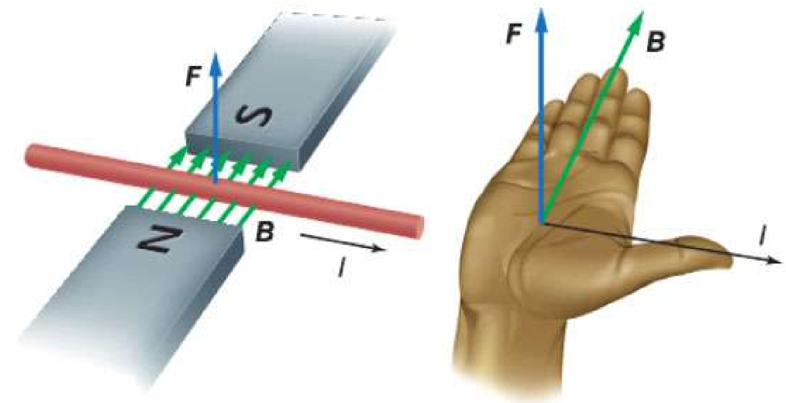
Galvanometer  جلفانوميتر

Headphone
Earphone  سماعة الرأس
سماعة الأذن

Force on a current-carrying wire

Apply the right-hand rule to find the direction of the force on a current-carrying wire placed in an external magnetic field

The direction of magnetic force can be determined by right hand rule (positive charge).



Thumb: first vector after equality sign (IL)
Fingers: second vector after equality sign (B)
Palm: vector before equality sign (F)

Force is perpendicular to both magnetic field and wire (current).

$$F \perp IL \text{ and } B$$

$$F = ILB \sin\theta$$

One vector on x-axis: either right or left
One vector on y-axis: either upward or downward
One vector on z-axis: either into page or out of page

out of page   into page

FRQ Questions

Q1

LO:

Part A: Determine the magnitude of the current in terms of the rate of flow of electric charge (I=q/t).

Part B:

1. Use analogy and models to explain and understand an electrical circuit.

2. Identify the direction of conventional current as the direction of motion of positive charges or opposite to the flow of electrons.

RF:

Student Book	P.89	P.103
Figure 3	P.89	
Figure 18	P.103	

EX:

10, 11, & 12

Electric Current

Electric current: the flow of electrons in a conductor in one direction.

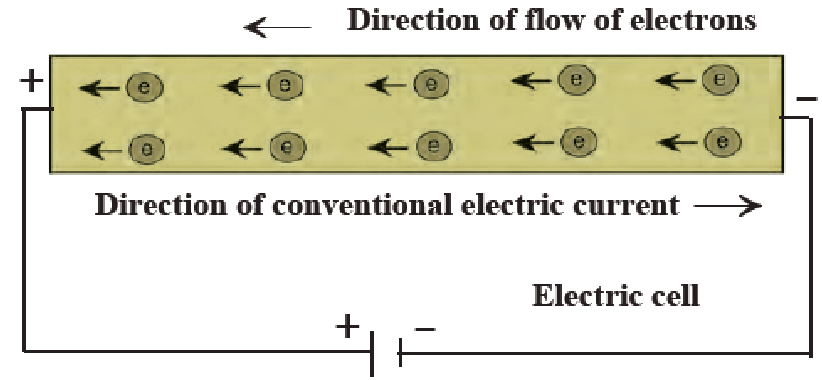
Conventional electric current the flow of positive charges from the positive terminal (high voltage) to the negative terminal (low voltage).

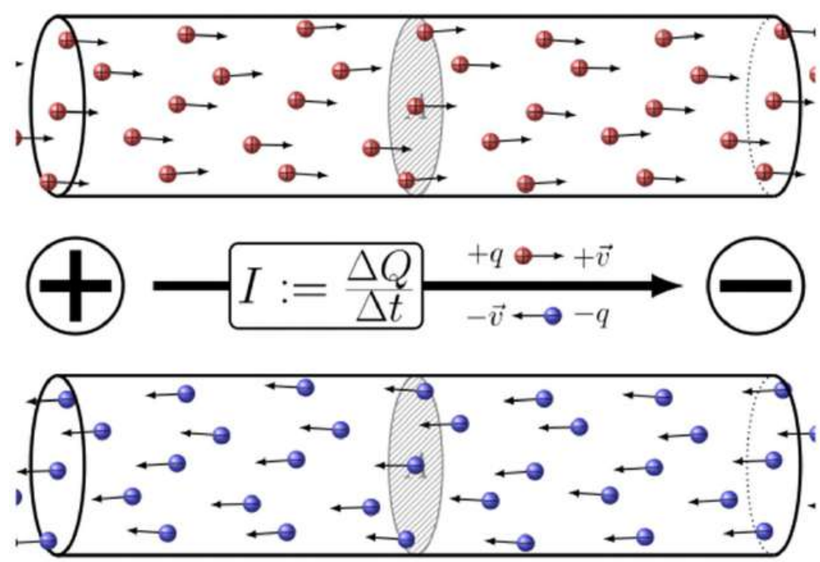
Direction of electron current is opposite to the direction of conventional current.

$$I = \frac{\Delta Q}{\Delta t}$$

Unit $I = \frac{Coloumbs\ (C)}{second\ (s)} = Ampere\ (A)$

$$Q = nq_e$$



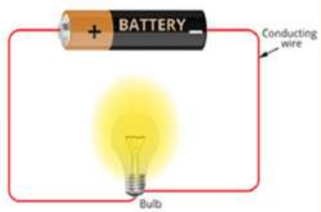


The **diagram** shows a simple electrical circuit consisting of a battery, a bulb, and connecting wires.

What is the direction of the conventional current passing through a light bulb?

المُخطط يُبيّن دائرة كهربائية بسيطة مُكونة من: بطارية، مصباح، أسلاك توصيل.

ما هو اتجاه التيار الاصطلاحي المار في المصباح الضوئي؟



- →
- ← ✓
- ⊗
- •

1. An amount of charge of 50.0 μC passes through a sectional area of a conductor in 0.01 ms. Calculate the intensity of electric current in that conductor?

$$I = \frac{\Delta Q}{\Delta t}$$

$$I = \frac{50 \times 10^{-6}}{0.01 \times 10^{-3}} = 5.0\ \text{A}$$

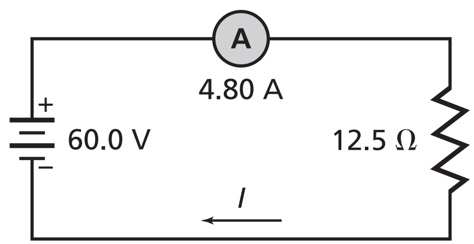
2. An electric current with intensity of 4 mA flows in a metal conductor. Find the amount of charge that passes through the sectional area of that conductor in 1 min.

$$I = \frac{\Delta Q}{\Delta t}$$

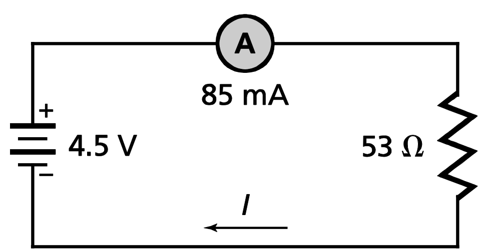
$$\Delta Q = I \Delta t$$

$$\Delta Q = (4 \times 10^{-3})(1 \times 60) = 0.24\ \text{C}$$

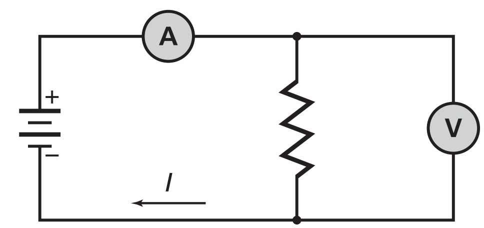
8. Draw a circuit diagram to include a 60.0 V battery, an ammeter, and a resistance of 12.5 Ω in series. Draw arrows on your diagram to indicate the direction of the current.



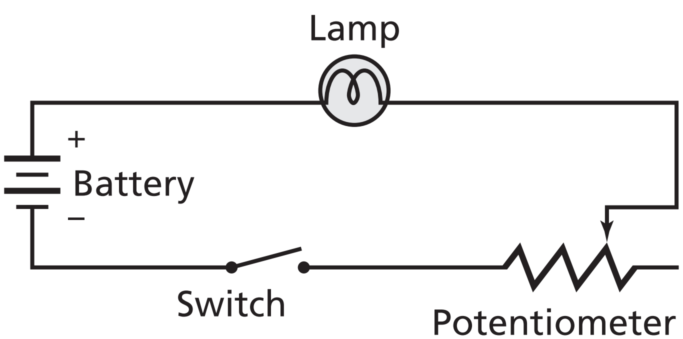
9. Draw a circuit diagram showing a 4.5 V battery, a resistor, and an ammeter that reads 85 mA. Show the direction of the current using conventional rules and indicate the positive terminal of the battery.



10. Add a voltmeter to measure the potential difference across the resistors in the previous two problems. Label the voltmeters.

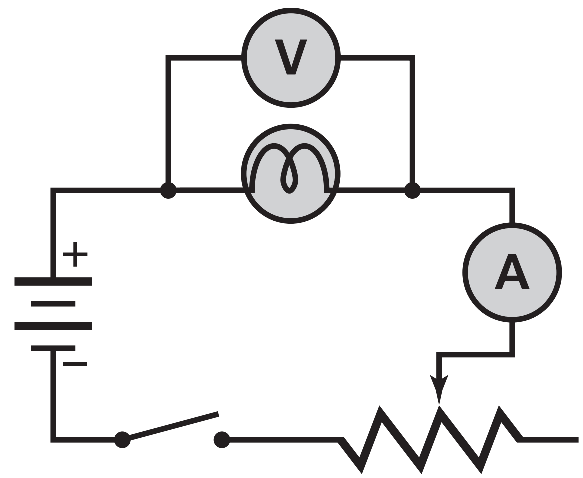


11. Draw a circuit using a battery, a lamp, a potentiometer to adjust the lamp's brightness, and an on-off switch.



https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html

12. CHALLENGE Repeat the previous problem, adding an ammeter and a voltmeter across the lamp.



Q2

LO:

Part A:

1. Define resistance and identify its SI unit as ohms (Ω).

2. Sate Ohm's law and apply it to simple circuits ($\Delta V = RI$).

Part B: **Calculate the equivalent resistance and the total current passing through a series circuit.**

RF:

Student Book

P.(93 – 95)

P.(104 – 105)

P.(109 – 111)

EX:

P.95	**Health Connection**
P.96	**Q.(13 – 18)**
P.105	**Q.(42 – 46)**
P.109	**Q.(52 – 54)**
P.112	**Q.(55 – 58)**

HEALTH Connection The human body acts as a variable resistor. Dry skin's resistance is high enough to keep currents that are produced by small and moderate voltages low. If skin becomes wet, however, its resistance is lowered, and an electric current can rise to dangerous levels. A current as low as 1 mA can be felt as a mild shock, while currents of 15 mA can cause loss of muscle control, and currents of 100 mA can cause death. For safety reasons you should be careful with any electric current, even from a lantern battery.

A. The human body acts as a variable resistor. The resistance value of a dry skin (body) is (10000 Ω) high enough to keep the resulting currents low, acceptable, and within safety limits. Study the table below that explains the value of electric current and its effects on the human body, then answer the following.

يعمل جسم الانسان كمقاوم متغير تكون قيمه المقاومة للجسم الجاف عالية (10000 Ω) بما يكفي للحفاظ على التيارات الناتجة منخفضة ومقبولة وضمن حدود السلامة. ادرس الجدول ادناه والذي يوضح قيمة التيار الكهربائي وتأثيراته على جسم الانسان ثم اجب عما يلي؟

Current (mA) شدة التيار(mA)	Possible effect on the human body التأثيرات المحتملة على جسم الانسان
1 mA	Mild electric shock can be felt يمكن الشعور بصدمة كهربائية خفيفة
5 mA	Electric shock is painful الصدمة الكهربائية مؤلمة
10 mA	causes involuntary muscle contraction (spam) يسبب تقلصات عضلية لا ارادية (تشنجات)
15 mA	causes loss of muscle control يتم فقدان التحكم في العضلات
100 mA	Death can occur ممكن ان يؤدي الى الموت

When you take a shower, your body will get wet, the skin will become moist, the resistance of the body will decrease to (1000 Ω). If you want to use an electrical device with a plug connected to a (120 V) electrical source.

عندما تستحم سوف يبتل جسمك ويصبح الجلد رطبا وستنخفض مقاومة الجسم الى (1000 Ω) اذا كنت ترغب في استخدام جهاز كهربائي مزود بقابس متصل بمصدر كهربائي (120 V).

- Calculate the amount of current you receive.

• احسب مقدار التيار الذي تستقبله.

$R = 1000$

$\Delta V = 120\ V$

$$I = \frac{\Delta V}{R} = \frac{120}{1000} = 0.12\ A$$

120×10^{-3}

$120\ mA$

Current (mA) شدة التيار(mA)	Possible effect on the human body التأثيرات المحتملة على جسم الانسان
1 mA	Mild electric shock can be felt يمكن الشعور بصدمة كهربائية خفيفة
5 mA	Electric shock is painful الصدمة الكهربائية مؤلمة
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15 mA	causes loss of muscle control يتم فقدان التحكم في العضلات
100 mA	Death can occur ممكن ان يؤدي الى الموت

- Based on the amount of current you calculated and the table above, what effect might this have on your body?

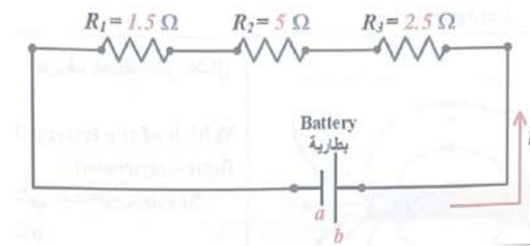
•بناء على مقدار التيار الذي حسبته والجدول أعلاه ما هوة التأثير المحتمل لذلك على جسمك؟

Death can occur

ممكن ان يؤدي الى الموت

Three resistors connected together as in the figure. Answer the following questions?

ثلاث مقاومات متصلة معا كما في الشكل، أجب عن الأسئلة التالية؟



A- What is the type of connection between the resistors in this electric circuit?

ما هي طريقة توصيل المقاومات في هذه الدارة الكهربائية؟

Series

B- Which of the resistors has greater protentional difference across it?

أي المقاومات الثلاثة يكون بين طرفيها اكبر فرق جهد ؟

$\Delta V = IR$

The highest resistance

المقاومة الأعلى

$R_2 = 5\ \Omega$

C- What is the sign of the battery pole labelled with the letter (a) on the figure?

ما نوع إشارة قطب البطارية المعنون بالحرف (a) على الشكل؟

negative (−)

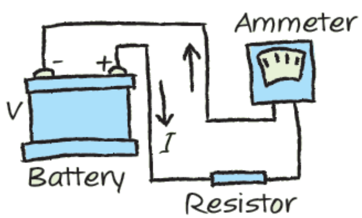
D- What is the equivalent resistance for this electrical circuit?

ما مقدار المقاومة المكافئة لهذه الدارة الكهربائية؟

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

$= 1.5 + 5 + 2.5 = 9\ \Omega$

CURRENT THROUGH A RESISTOR A 30.0 V battery is connected to a 10.0 Ω resistor. What is the current in the circuit?



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

$$I = \frac{\Delta V}{R} = \frac{30}{10} = 3\ A$$

13. An automobile panel lamp with a resistance of 33 Ω is placed across the battery shown in Figure 10. What is the current through the circuit?

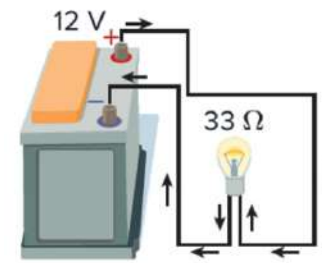


Figure 10

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

$$I = \frac{\Delta V}{R} = \frac{12}{33} = 0.36\ A$$

14. A sensor uses $2 \times 10^{-4} A$ of current when it is operated by the battery shown in Figure 12. What is the resistance of the sensor circuit?

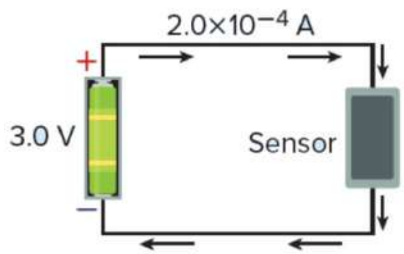


Figure 11

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

$$R = \frac{3}{2 \times 10^{-4}} = 1.5 \times 10^{4}\ \Omega$$

15. A motor with the operating resistance of 32 Ω is connected to a voltage source as shown in Figure 12. What is the voltage of the source?

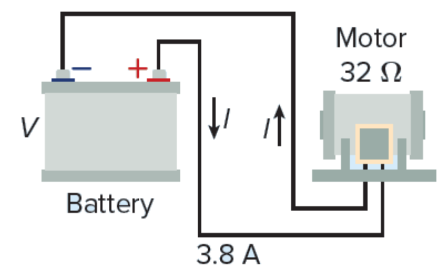


Figure 12

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

$$\Delta V = IR$$

$$\Delta V = (3.8)(32) = 121.6\ V$$

16. A lamp draws a current of 0.50 A when it is connected to a 120 V source.

a. What is the resistance of the lamp?

$$R = \frac{\Delta V}{I} \quad = \frac{120}{0.5} = 240\ \Omega$$

b. What is the power consumption of the lamp?

$$P = I\Delta V \quad = (0.5)(120) = 60\ W$$

17. A 75 W lamp is connected to 125 V.

a. What is the current through the lamp?

$$I = \frac{P}{\Delta V} \quad = \frac{75}{125} = 0.6\ A$$

b. What is the resistance of the lamp?

$$R = \frac{\Delta V}{I} \quad = \frac{125}{0.6} = 208.3\ \Omega$$

18. CHALLENGE A resistor is added to the lamp in the previous problem to reduce the current to half its original value.

a. What is the potential difference across the lamp?

$$\Delta V = IR \qquad = (0.3)(208.3) = 62.5\ V$$

b. How much resistance was added to the circuit?

$$R_{total} = \frac{\Delta V}{I} \qquad = \frac{125}{0.3} = 416.6\ \Omega$$

$$R_{total} = R_{lamp} + R_{new}$$

$$416.6 = 208.3 + R_{new}$$

$$R_{new} = 416.6 - 208.3 = 208.3\ \Omega$$

C. At what rate does the lamp transform electrical energy into radiant and thermal energy?

$$P = I\Delta V \quad = (0.3)(62.5) = 18.75\ W$$

Q3

LO:

1. Identify the commonly used circuit symbols.

2. State the properties of voltmeters and ammeters, in terms of their resistance.

3. Identify the correct placements of ammeters and voltmeters in electric circuits.

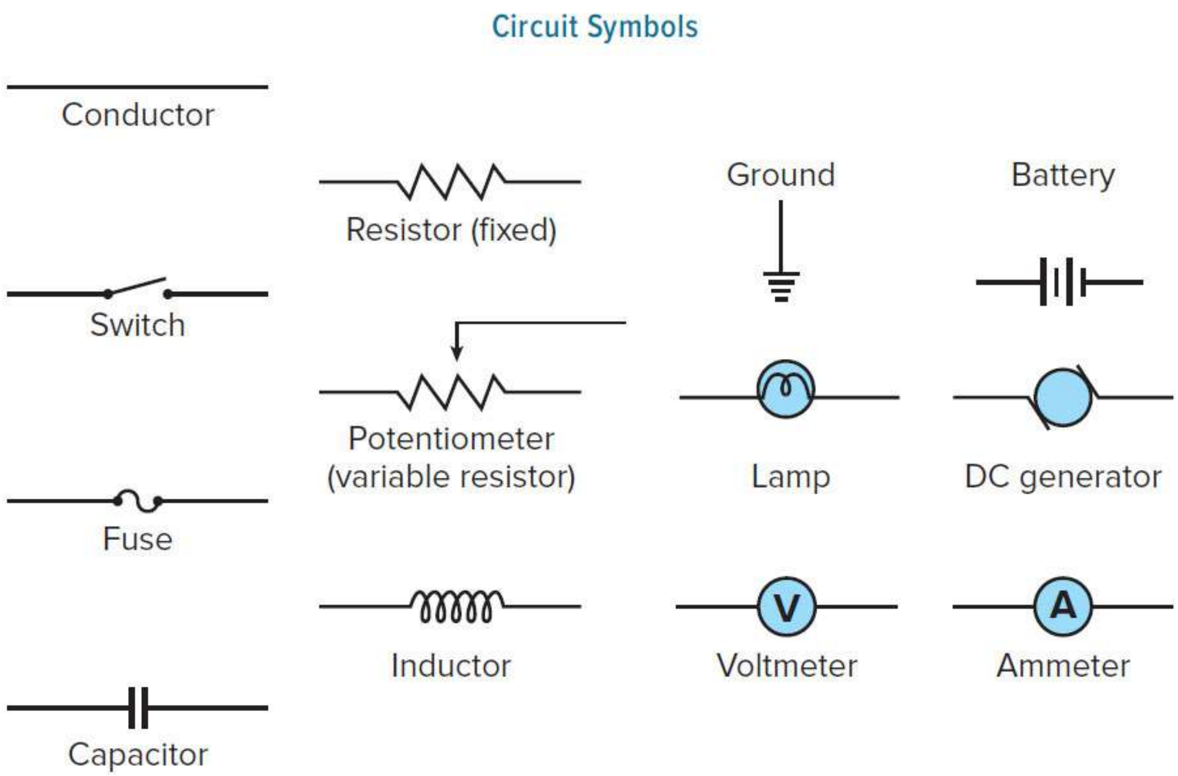
RF:

Student Book
P.(117 – 119)

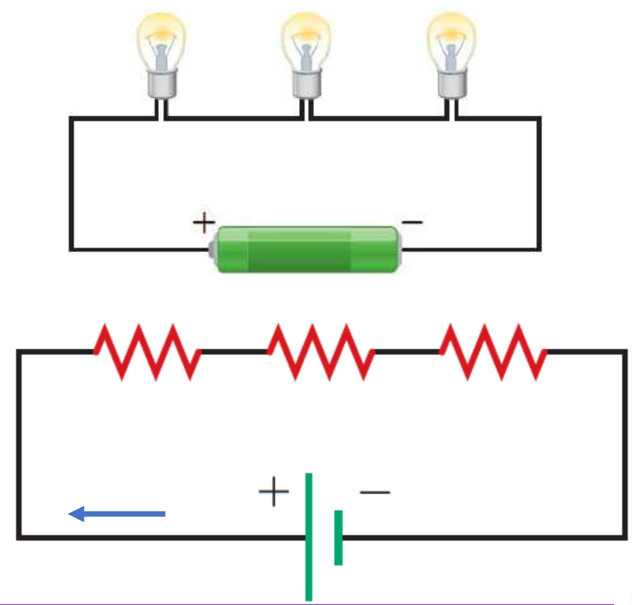
EX:

P.117 Figure 31
P.119 Figure34

Symbols of main components in electric circuit:

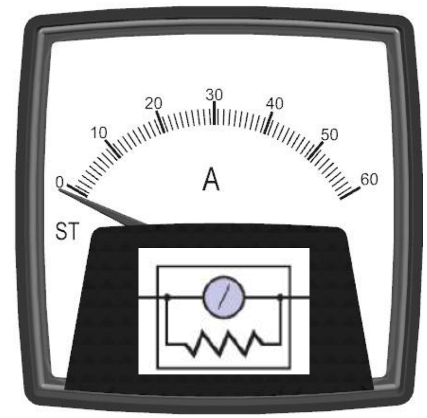


1. An artist's drawing of an electric circuit is shown in the figure below. Draw a schematic of the electric circuit. Indicate the direction of the conventional current in your drawing.



State the properties of voltmeters and ammeters, in terms of their resistance

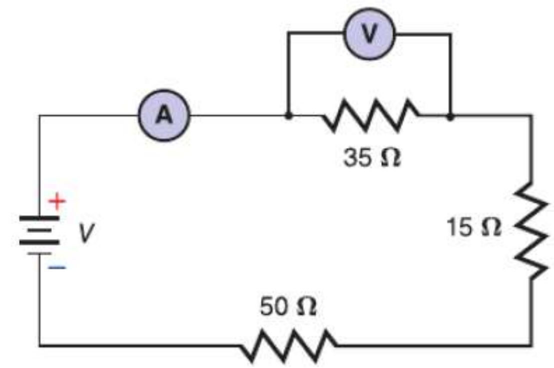
Ammeter:



Its a device that is used to measure the current in any branch or part of a circuit.

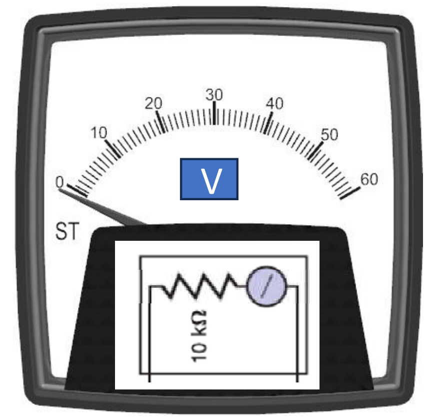
Ammeter is connected in series in the circuit.

ammeter is designed to have a very low resistance as possible so that the ammeter will not affect the current in the circuit



State the properties of voltmeters and ammeters, in terms of their resistance

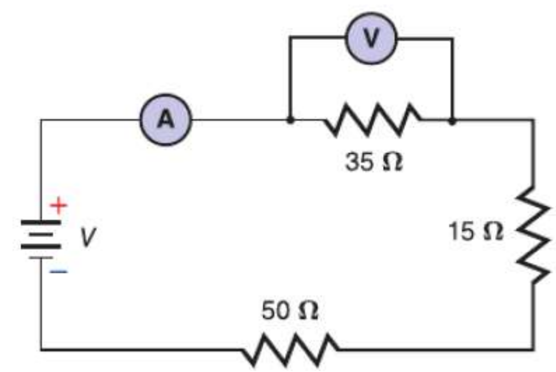
Voltmeter:



Its a device that is used to measure the potential difference across a portion of a circuit

To measure the potential difference across a resistor, a voltmeter is connected in parallel with the resistor.

Voltmeters are designed to have a very high resistance to cause the smallest possible change in currents and voltages in the circuit.

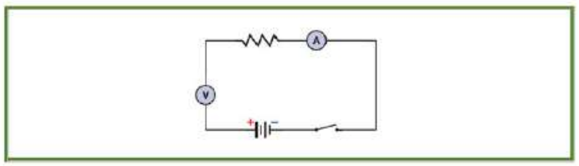


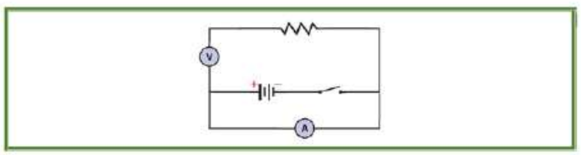
A group of physics students performs an experiment with electric circuits, to study Ohm's law.

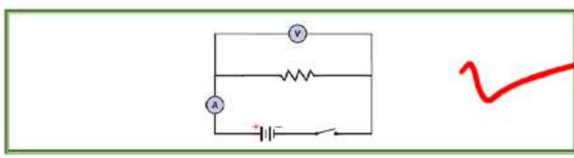
Which of the following circuits can be used to measure the electric current and voltage?

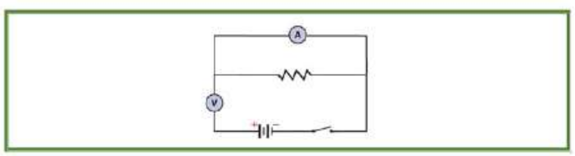
تقوم مجموعة من طلاب الفيزياء بإجراء تجربة على الدوائر الكهربائية، وذلك لدراسة قانون أوم.

أي الدوائر التالية يُمكن استخدامها لقياس التيار والجهد الكهربائي؟









Q4

LO:

Part A: **Describe the properties of magnets, how magnetic materials can be turned into temporary magnets, the Earth's magnetism, the characteristics of magnetic fields and sketch the field lines around a permanent magnet.**

Part B:

1. Describe how magnetic materials can be turned into temporary magnets.

2. Describe the characteristics of magnetic fields and sketch the field lines around a permanent / temporary magnet.

3. Apply the right-hand rule to indicate the direction of the magnetic field in and around a solenoid carrying current

RF:

Student Book
P.(125 - 130)
P.(128 – 130)

EX:

P.(125 - 130)	**Text**
P.129	**Figure 7**

Properties of magnets

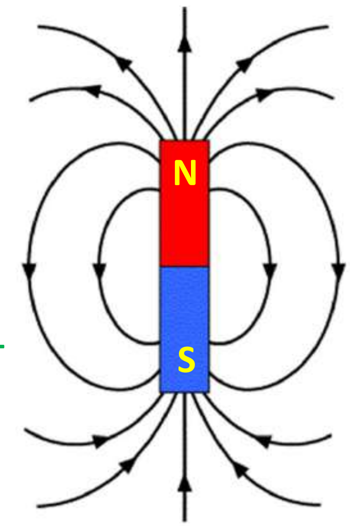
Describe the properties of magnets

Properties of magnets:

- All magnets are polarized, has two poles, conventionally north and south.

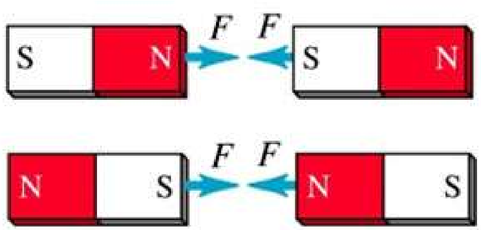
- No matter how a magnet is cut or broken, the magnet always has two poles (no monopoles), because every atom acts as a magnet.

polarized



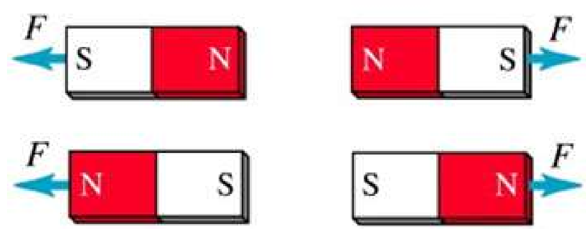
- Magnets exert magnetic force on each other:

Unlike poles attract each other.



attraction

Alike poles repel each other



repulsion

Earth's Magnetic Field

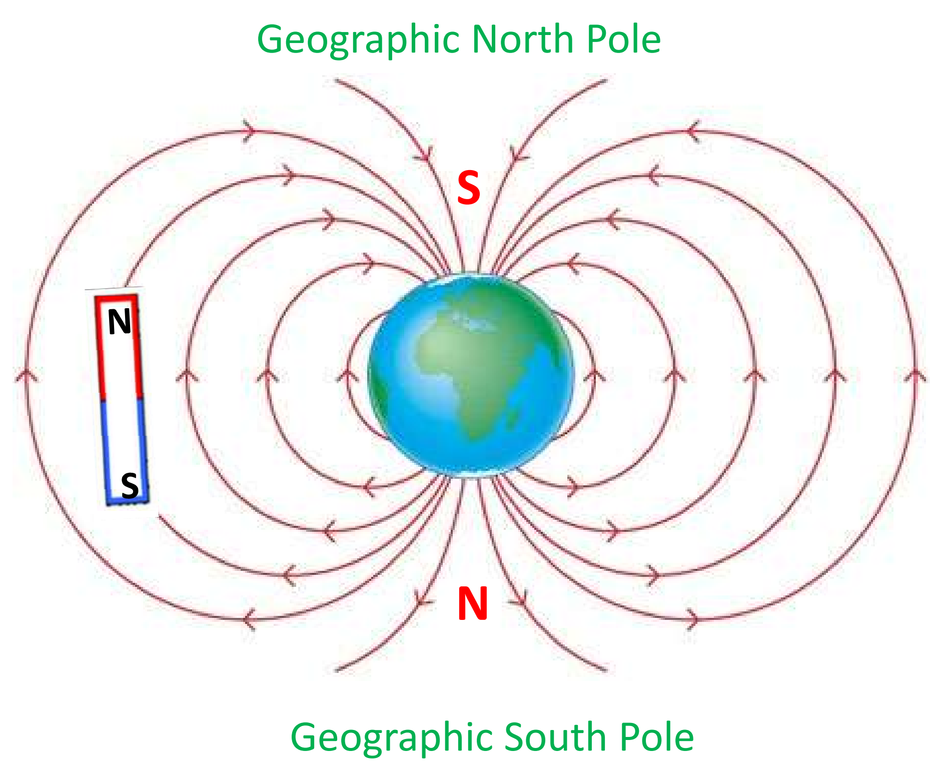
The core of the Earth is composed of an iron, nickel and other elements.

The Earth is considered as a huge magnet which has:

Magnet north pole known as geographic south pole.

Magnet south pole known as geographic north pole.

The Earth's magnetic field lines start from geographic south pole and end in geographic north pole.

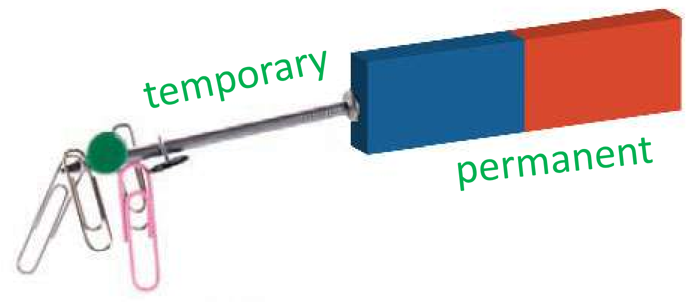


Properties of magnets

Describe how magnetic materials can be turned into temporary magnets

Temporary magnets:

Magnet: is any material produces a magnetic field.

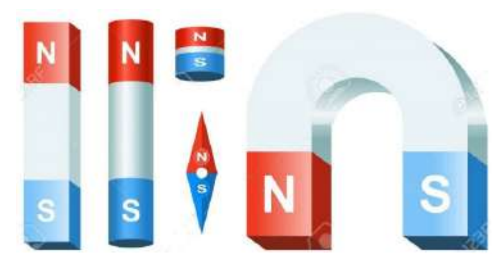


Permanent magnet:
produces its own magnetic field.

Temporary magnet:
act like permanent magnets when they are in magnetic field.

When a magnet touches an object, such as the nail in **Figure 3,** the magnet polarizes the object, making it a temporary magnet. This process is called magnetization by induction.

There are different shapes for magnets: disc, ball, bar, horseshoe and cylinder.



Magnetic Material: any material can gain magnetic field permanently or temporarily.

Ferromagnetic Material: any material can become temporary magnetic. e.g., iron, cobalt, nickel and some alloys (lodestone).

Magnetic domains:

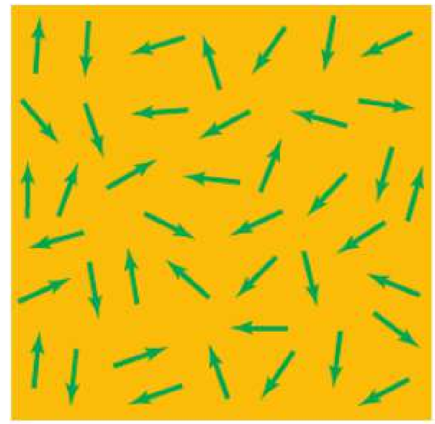
What gives a permanent or temporary magnet its magnetic properties?

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.

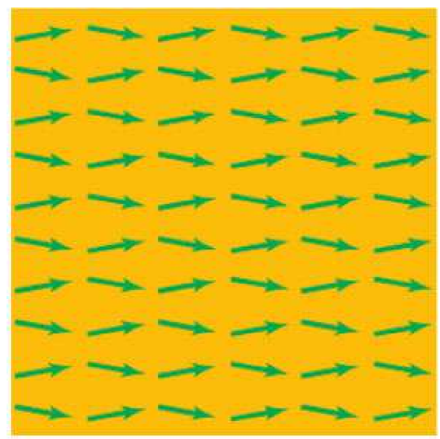
Look at the arrows In **Figure 5.** Each arrow represents a domain. Although domains can contain as many as 10^{20} individual atoms

When its domains are aligned in the same direction, the material becomes a temporary magnet.



Nonmagnetized Material

In a ferromagnetic material that is not magnetized, each domain Points in a random direction,



Magnetized Material

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

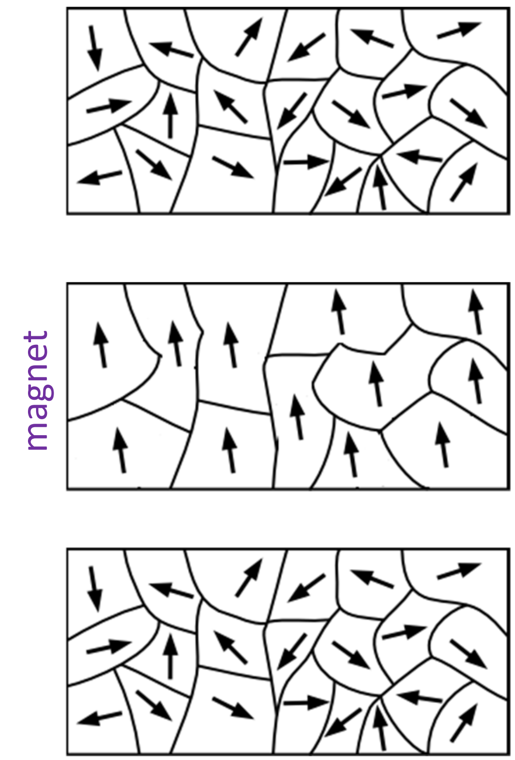
Properties of magnets

Describe how magnetic materials can be turned into temporary magnets

Temporary magnets are produced by magnetization by induction.

As the ferromagnetic material is next to a strong magnet, most of the domains align in the same direction as the poles of the external magnet (magnetization by induction). Finally, the material becomes a temporary magnet.

After removing the magnet, domains return to point in a random direction.



Properties of magnets

Describe how permanent magnets are created and how they are destroyed

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?

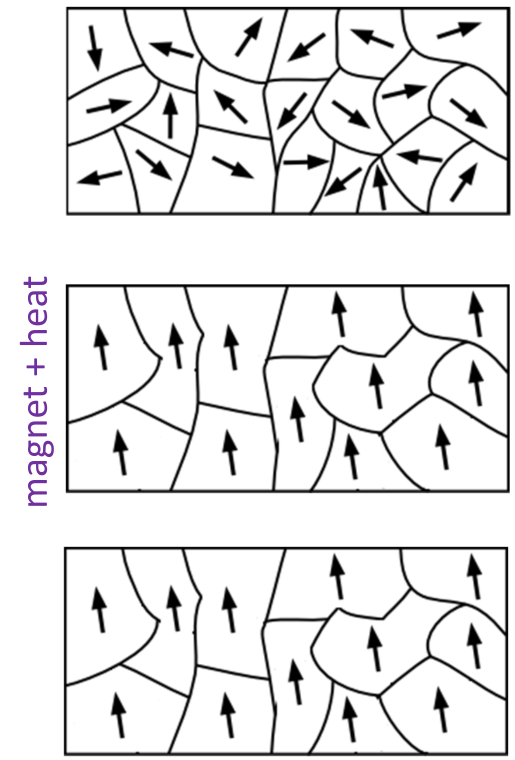
1- An object containing certain ferromagnetic materials is heated in the presence of a strong magnetic field

A- Thermal energy frees the atoms in each of the object's domains.

B- The domains can rotate and align with the magnet's poles.

2- 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.

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.

A student wrote in his science notebook statements for the lesson on the properties of magnets, as follows:

كتب طالب في دفتر ملاحظات العلوم الخاص به عبارات خاصة بالدرس المتعلق بخصائص المغناطيس، كما يأتي:

Science Notebook دفتر ملاحظات العلوم

Properties of Magnets خصائص المغانط

1- A magnet has two opposite ends, called poles, a north pole, and a south pole. ✓

1- المغناطيس يمتلك نهايتان متقابلتان، تُسمى الأقطاب، قطب شمالي وقطب جنوبي. ✓

2- When the magnet is suspended freely by a string, and after it is at rest, its north pole points to the north geomagnetic pole, which is the geographic north pole. ✗

2- عند تعليق المغناطيس بخيط بشكل حر ، وبعد سكونه، فإن قطبه الشمالي يشير إلى القطب المغناطيسي الأرضي الشمالي، وهو القطب الشمالي الجغرافي. ✗

3 - A magnetic monopole (north or south pole) can be obtained by cutting (breaking) a magnet. ✗

3 - يمكن الحصول على قطب أحادي مغناطيسي (قطب شمالي او قطب جنوبي) بتقطيع المغناطيس. ✗

4- Like poles of magnets repel each other, and unlike poles attract. ✓

4- الأقطاب المتشابهة للمغانط تتنافر، والأقطاب المختلفة تتجاذب. ✓

5- When a magnet touches a metal clip, it turns it into a temporary magnet. This process is called magnetization by conduction. ✗

5- عند ملامسة مغناطيس لمشبك معدني، فإنه يجعل منه مغناطيسا مؤقتا، هذه العملية تدعى المغنطة بالتوصيل. ✗

The student submitted his work to his teacher to get feedback, and then received (√) or (×) marks, with the wrong part underlined as shown above.

قام الطالب بتقديم عمله لمعلمه للحصول على التغذية الراجعة، وحصل بعدها على إشارات (√) او(×) مع وضع خط تحت الجزء الخاطئ منها، كما هو موضح أعلاه.

Help the student to correct each wrong statement by writing the correct scientific alternative.

ساعد الطالب في تصحيح كل عبارة خاطئة بكتابة البديل العلمي الصحيح.

2- When the magnet is suspended freely by a string, and after it is at rest, its north pole points to the north geomagnetic pole, which is the geographic north pole. ✗

2- عند تعليق المغناطيس بخيط بشكل حر ، وبعد سكونه، فإن قطبه الشمالي يشير إلى القطب المغناطيسي الأرضي الشمالي، وهو القطب الشمالي الجغرافي. ✗

3 - A magnetic monopole (north or south pole) can be obtained by cutting (breaking) a magnet. ✗

3 - يُمكن الحصول على قطب أحادي مغناطيسي (قطب شمالي أو قطب جنوبي) بتقطيع المغناطيس. ✗

5- When a magnet touches a metal clip, it turns it into a temporary magnet. This process is called magnetization by conduction. ✗

5- عند ملامسة مغناطيس لمشبك معدني، فإنه يجعل منه مغناطيسا مؤقتا، هذه العملية تدعى المغنطة بالتوصيل. ✗

(2nd Statement العبارة الثانية) ___	2nd Statement: to the south geomagnetic pole	العبارة الثانية: إلى القطب المغناطيسي الأرضي الجنوبي	1
(3ed Statement العبارة الثالثة) ___	3rd Statement: cannot be obtained	العبارة الثالثة: لا يُمكن الحصول	1
(5th Statement العبارة الخامسة) ___	5th Statement: By Induction	العبارة الخامسة: بالحث	2

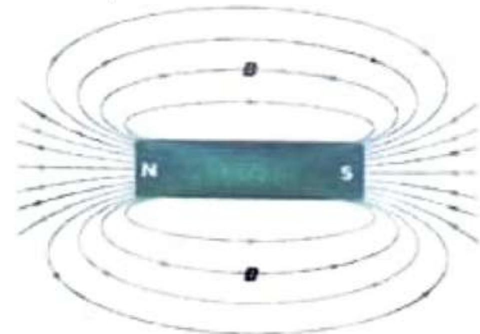
The magnetic field lines of a magnetic bar and a Solenoid coil are similar in general shape, as is clear in Figures (1) and (2) below. Answer the following:

خطوط المجال المغناطيسى لقطعة مغناطيسية ولملف حلزوني تتشابه في الشكل العام . كما هو موضح في الشكلين (1) و(2) ادناه. اجب عما يلي:

One of the differences between the magnetic field in the magnetic bar and the Solenoid is that in (1) its magnetism is permanent, while in (2) case its magnetism is related with an existence to the passage of electric current. Give another difference between them.

احدى الاختلافات بين المجال المغناطيسي في القطعة المغناطيسية والملف الحلزوني انه في (1) مغناطيسيته دائمة، اما في (2) فمغناطيسيته مرتبطة بوجود التيار الكهربائي، اعط فرقا اخر بينهما.

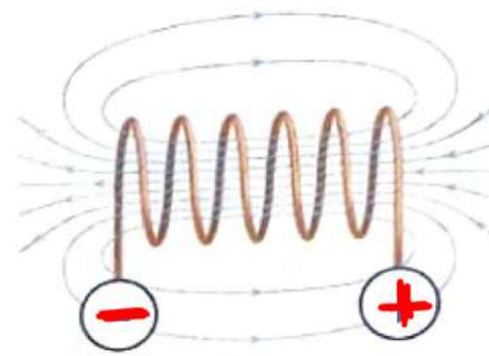
In (1), the magnetic bar, the strength of the magnetic field cannot be controlled, it is a constant value; while in (2), the solenoid, the strength of the magnetic field can be controlled by increasing or decreasing.	في (1)، القطعة المغناطيسية، لا يُمكن التحكم بشدة المجال المغناطيسي، فهي ثابتة القيمة؛ بينما في (2)، الملف الحلزوني، فيمكن التحكم بشدة المجال المغناطيسي بالزيادة أو النقصان.



(1)

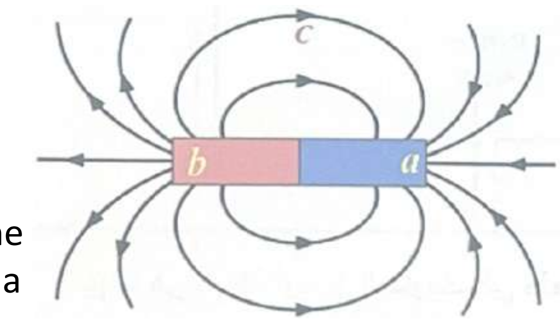
Determine in the two circles on the diagram (2) the polarity of the battery (+ and -), which indicates the direction of the current in the wire.

حدد في الدائرتين على الرسم (2) قطبية البطارية (+,-)، والذي يشير الى اتجاه التيار في السلك.



(2)

The figure shows the magnetic field diagram of a straight magnetic bar



يبين الشكل تخطيط المجال المغناطيسي لساق مغناطيسي مستقيم.

A- Which of the letters shown in the figure represents:
أي من الحروف المبينة على الشكل يمثل:

- North pole of magnet القطب الشمالي للمغناطيس b
- South pole of magnet القطب الجنوبي للمغناطيس a

B- In which of the areas (a,b,c) labelled on the figure the magnetic force is the weakest?
في أي من المناطق (a,b,c) المبينة على الشكل تكون قوة المغناطيس اقل ما يمكن:

C

C- If the pole indicated by the letter (a) is brought close to a similar pole of another magnet, what is the type of force between the two poles?

اذا قرب القطب المشار اليه بالحرف (a) من قطب مماثل له من مغناطيس اخر، ما نوع القوة المتبادلة بينهما؟

repalsive
تنافر

B- Which of the following materials, if placed next to the magnet, would not be attracted to it?
أي المواد التالية اذا وضعت بجانب المغناطيس لا تنجذب اليه؟

(Aluminum الالمنيوم ، Nickle النيكل ، Cobalt الكوبالت)

Q5

LO:

Part A:

1. 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.

2. Apply the right-hand rule to find the direction of the force on a current-carrying wire placed in an external magnetic field.

Part B: **Apply the equation ($F=qvB\sin\theta$) to calculate the magnitude of the force and apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field.**

RF:

Student Book
P.(134 - 135)
P.(140 - 141)

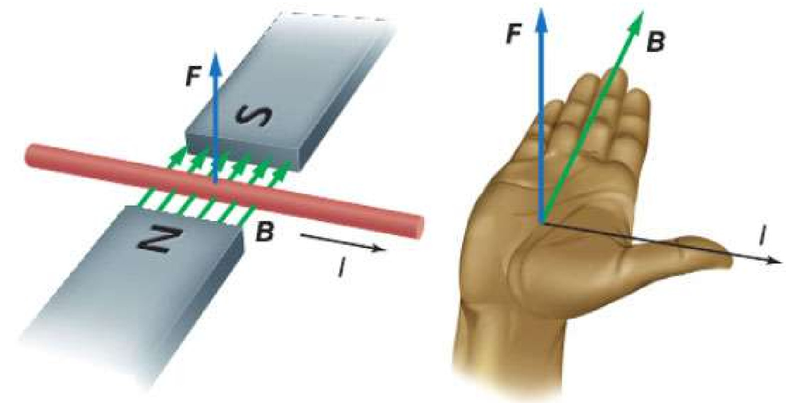
EX:

P.139 Q.(19 - 24)
P.141 Q.(25 – 30)

Force on a current-carrying wire

Apply the right-hand rule to find the direction of the force on a current-carrying wire placed in an external magnetic field

The direction of magnetic force can be determined by right hand rule (positive charge).



Thumb: first vector after equality sign (IL)
Fingers: second vector after equality sign (B)
Palm: vector before equality sign (F)

Force is perpendicular to both magnetic field and wire (current).

$$F \perp IL \text{ and } B$$

$$F = ILB \sin\theta$$

One vector on x-axis: either right or left
One vector on y-axis: either upward or downward
One vector on z-axis: either into page or out of page

$\odot$ out of page

$\otimes$ into page

A copper wire of insignificant resistance is placed in the center of an air gap between two magnetic poles, as shown in Figure below. The magnetic field is confined to the gap and has a strength of (1.9 T):

تم وضع سلك نحاسي ذو مقاومة ضئيلة في وسط فجوة هوائية بين قطبين مغناطيسيين، كما هو موضح في الشكل ادناه. المجال المغناطيسي محصور في الفجوة وشدته (1.9 T).

Determine the magnitude and direction of the magnetic force on the wire when the switch is closed.

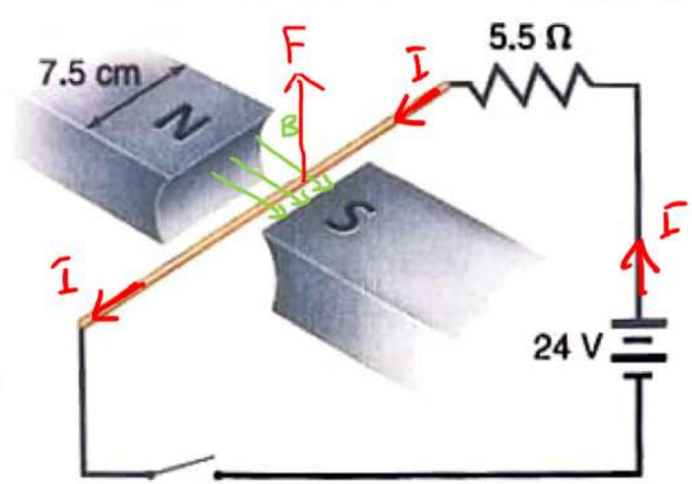
حدد مقدار واتجاه القوة المغناطيسية المؤثرة على السلك عنما يكون المفتاح مغلقا.

$$F = ILB\sin\theta$$

$$= (4.36)(7.5\times10^{-2})(1.9)\sin 90$$

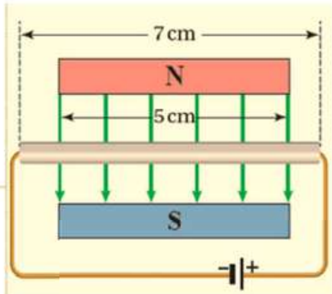
$$= 0.62\ N \quad \text{UP}$$

$$I = \frac{\Delta V}{R} = \frac{24}{5.5} = 4.36\ A$$



a current of $5.2\ A$, part of which is placed in a uniform magnetic field of $250\ mT$, and perpendicular to it, as shown in the figure.

What is the magnitude and direction of the magnetic force acting on the wire?



سلك من الألومنيوم طوله $7\ cm$، يحمل تياراً مقداره $5.2\ A$، يُوضع جُزءٌ منه داخل مجال مغناطيسي مُنتظم شدته $250\ mT$، وعمودي عليه، كما هو مُوضَّح في الشكل.

ما مقدار و اتجاه القوة المغناطيسية المؤثرة في السلك؟

- $9.1 \times 10^{-2}\ N$, ×
- $9.1 \times 10^{-2}\ N$, •
- $6.5 \times 10^{-2}\ N$, ×
- $6.5 \times 10^{-2}\ N$, • ✓

$F = I L B \sin\theta$

$= (5.2)(5\times10^{-2})(250\times10^{-3})\sin 90$

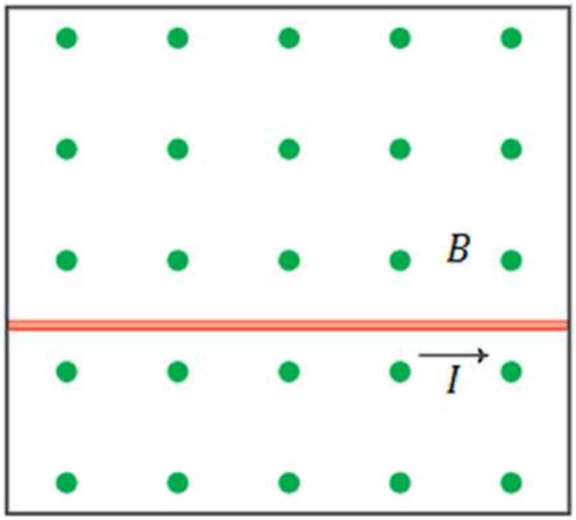
$= 0.065$

$= 6.5\times10^{-2}$ (•)

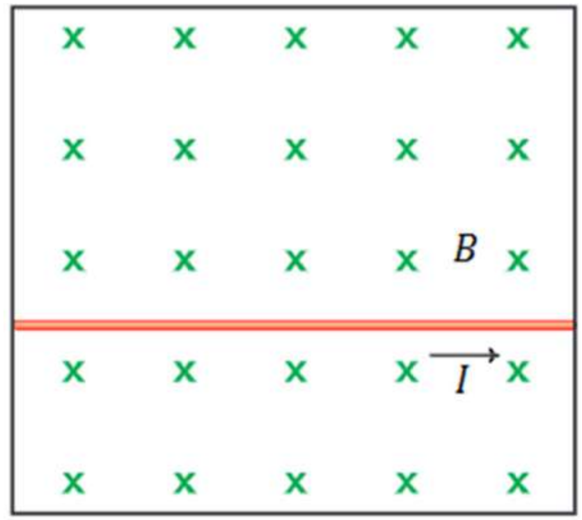
Force on a current-carrying wire

Apply the right-hand rule to find the direction of the force on a current-carrying wire placed in an external magnetic field

1. For the two figures besides, indicate the direction of magnetic force.



Thumb: right
Fingers: out of the page
Palm (force): down (-Y)

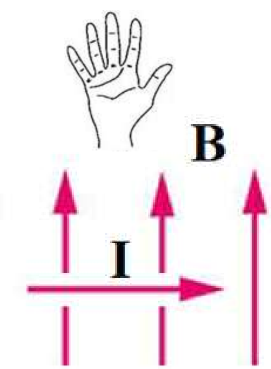


Thumb: right
Fingers: into the page
Palm (force): Up (+Y)

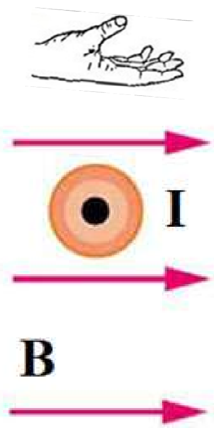
Force on a current-carrying wire

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

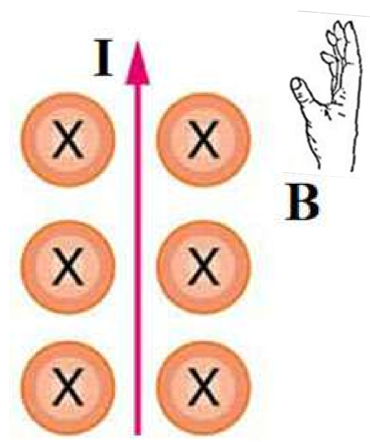
2. indicate the direction of the magnetic force or current for each graph



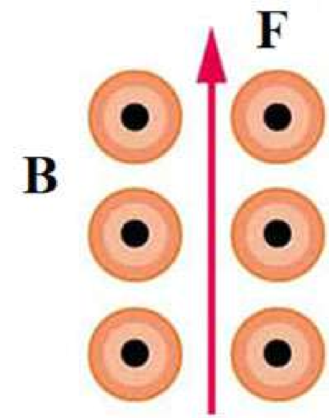
F: out of page



F: upward



F: left



I: left

F: downward

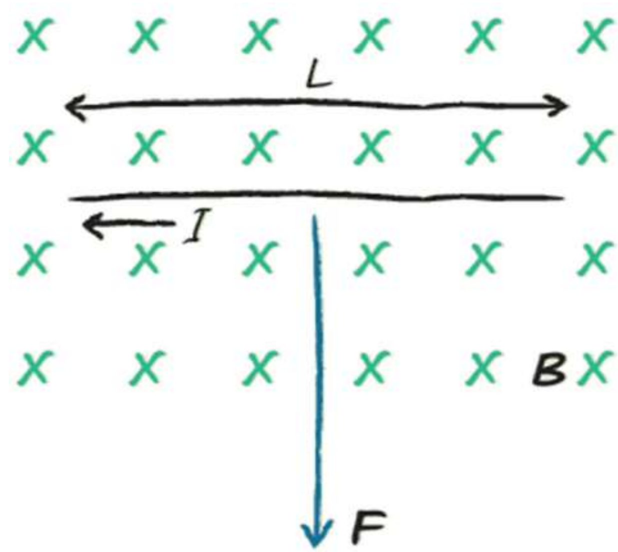
Apply the equation ($F = ILB \sin \theta$) to calculate the magnitude of the force on a straight segment of a current carrying wire placed in a uniform magnetic field

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*)?

$$F = ILB \sin \theta$$

$$B = \frac{F}{IL \sin \theta}$$

$$B = \frac{0.2}{(5)(0.1) \sin 90} = 0.4\ T$$



20. A wire that is 0.50 m long and carrying a current of 8.0 A is at right angles to a 0.40 T magnetic field. How strong is the force that acts on the wire?

$$F = ILB\sin\theta$$

$$F = (8)(5)(0.4)\sin 90$$

$$F = 16\ N$$

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?

$$F = ILB\sin\theta$$

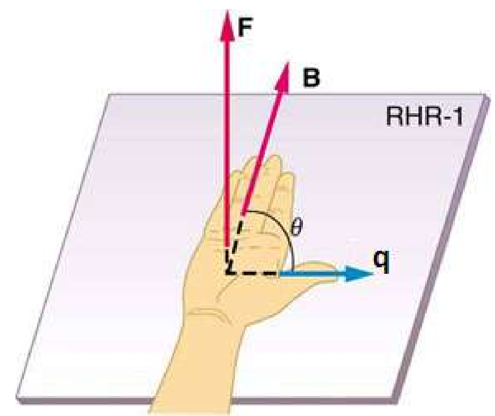
$$B = \frac{F}{IL\sin\theta}$$

$$B = \frac{0.6}{(6)(0.75)\sin 90} = 0.13\ T$$

Force on a charged particle

Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field

The direction of magnetic force can be determined by right hand rule (positive charge).



$$F = qvB\sin\theta$$

$$F \perp qv \text{ and } B$$

If the charge is (+):

1- Fingers point in the direction of the magnetic field

2- Thumb points to the direction of the velocity (direction of motion)

3- Palm points in the direction of the magnetic force

If the charge is (-):

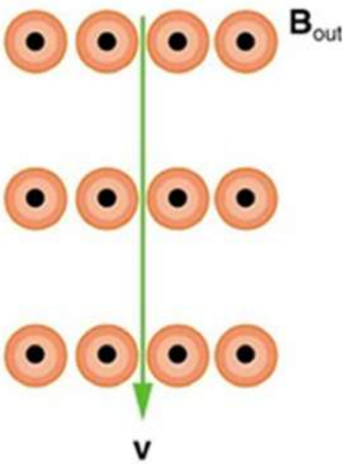
The palm points opposite to the direction of the magnetic force

Force is perpendicular to both magnetic field and velocity (charge).

Force on a charged particle

Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field

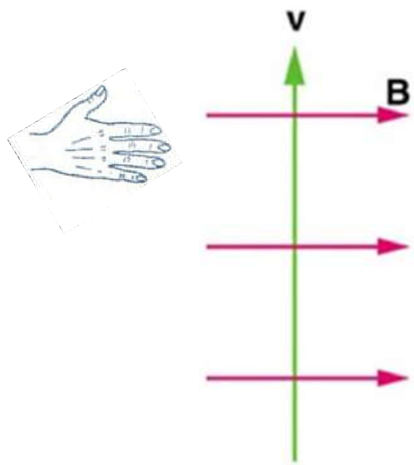
1. indicate the direction of the magnetic force on a charge for each graph:



(a)

+ charge (F: left)

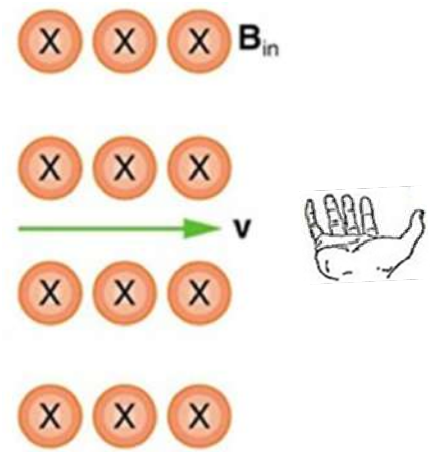
- charge (F: right)



(b)

+ charge (F: into page)

- charge (F: out of page)



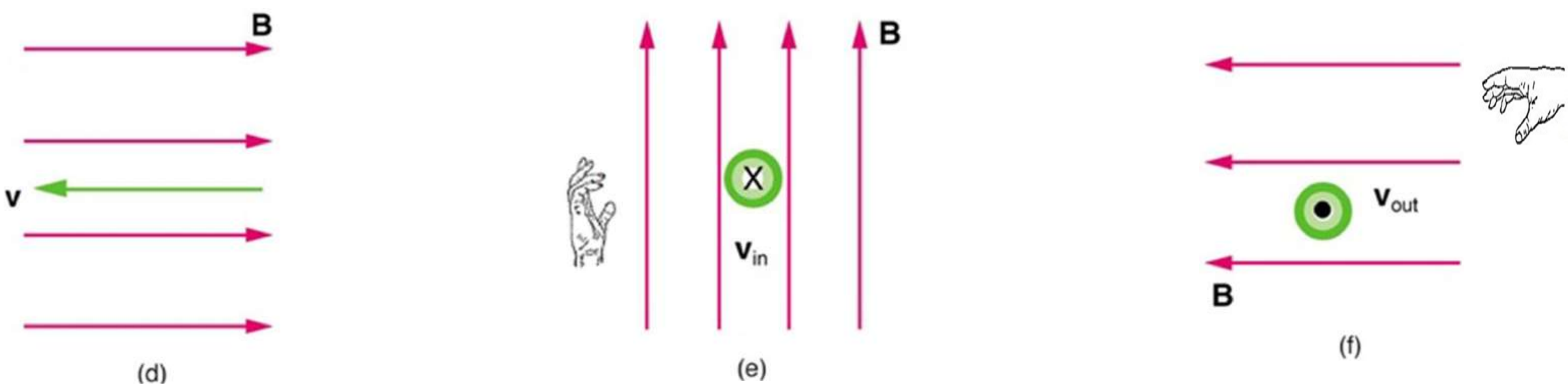
(c)

+ charge (F: upward)

- charge (F: downward)

Apply the right-hand rule to determine the direction of the force acting on a charged particle moving in a magnetic field

2. indicate the direction of the magnetic force on a charge for each graph:



+ charge (F: zero)

- charge (F: zero)

+ charge (F: right)

- charge (F: left)

+ charge (F: downward)

- charge (F: upward)

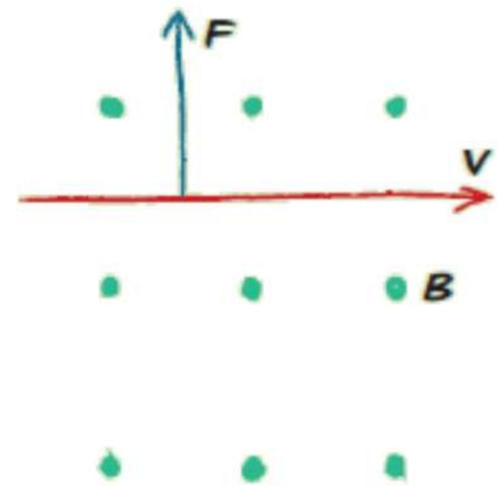
FORCE ON A CHARGED PARTICLE IN A MAGNETIC FIELD A beam of electrons travels at 3.0×10^6 m/s through a uniform magnetic field of 4.0×10^{-2} T at right angles to the field. How strong is the force acting on each electron?

$v = 3 \times 10^6$
$B = 4 \times 10^{-2}$
$\theta = 90$
$q = 1.6 \times 10^{-19}$
$F = ?$

$$F = qvB\sin\theta$$

$$F = (1.6 \times 10^{-19})(3 \times 10^6)(4 \times 10^{-2})\sin 90$$

$$F = 1.9 \times 10^{-14}\ \text{N}$$

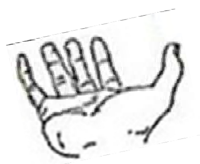


Force on a current-carrying wire

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

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

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



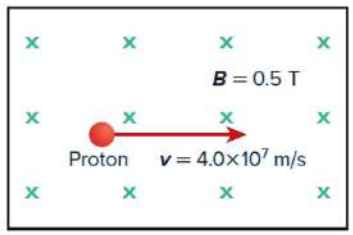


Figure 20

$F = qvB\sin\theta$

$F = (1.6 \times 10^{-19})(4 \times 10^{7})(0.5)\sin 90$

$F = 3.2 \times 10^{-12}$ N (upward)

27. A stream of doubly ionized particles (missing two electrons and thus carrying a net positive charge of two elementary charges) moves at a velocity of 3.0×10^{4} m/s perpendicular to a magnetic field of 9.0×10^{-2} T. How large is the force acting on each ion?

$F = qvB\sin\theta$

$F = (2)(1.6 \times 10^{-19})(3 \times 10^{4})(9 \times 10^{-2})\sin 90$

$F = 8.64 \times 10^{-16}$ N