اسم الطالب: .....

EINSTEIN In Physics



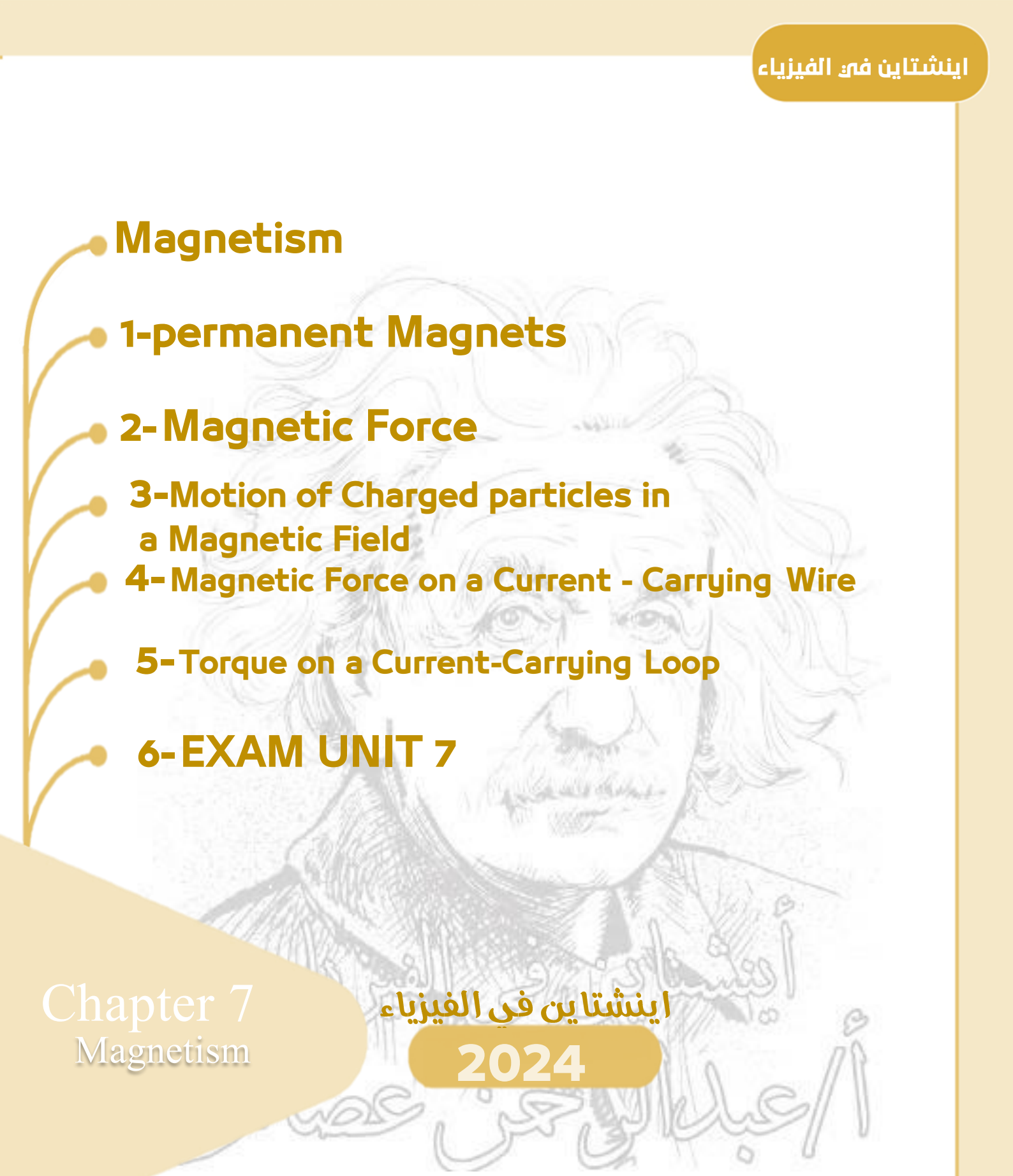
قديما كانت تمثل الفيزياء رعبا للطالب أما الآن

اسلوب جديد لعرض الفيزياء بعيدا عن التعقيد

UNIT 7

Magnetism

- 1-permanent Magnets
- 2- Magnetic Force
- 3-Motion of Charged particles in a Magnetic Field
- 4- Magnetic Force on a Current - Carrying Wire
- 5- Torque on a Current-Carrying Loop
- 6- EXAM UNIT 7



Chapter 7
Magnetism

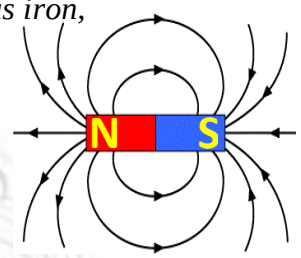
اينشتاين في الفيزياء

2024

permanent Magnets 1

A magnet is a material or object that produces a magnetic field.

This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets.

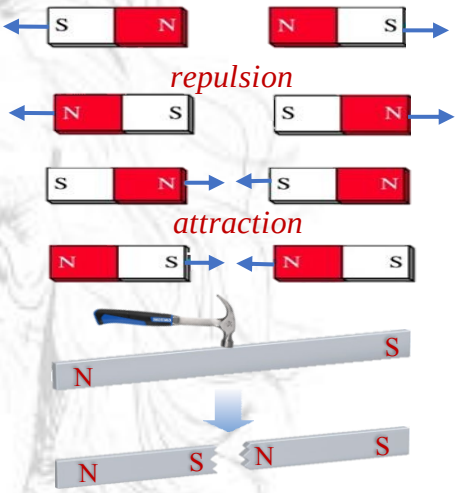


Magnetic Poles :

All magnets have two poles (North) and (south).
A magnetic mono pole cannot exist.

Properties Magnetic :

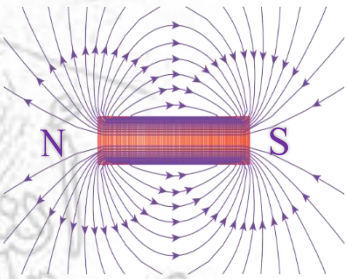
1. *Magnets exert magnetic force on each other:*
   - *Alike poles repel each other.*
     (Same repel)
   - *Unlike poles attract each other.*
     (Different attract)
2. *If a magnet is broken, each piece.*



each piece will have two poles North and South.
each of the broken pieces will act perfectly as individual magnets.

Magnetic Field (B): *the region where magnetic forces exist around a magnet.*

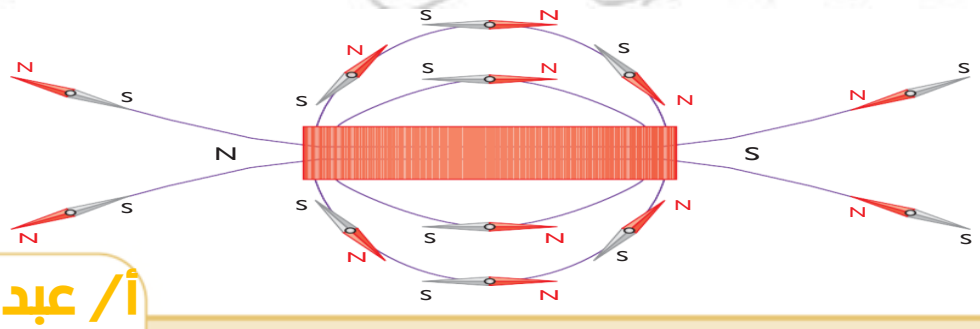
Properties Magnetic Field



1. *Imaginary lines show the strength and direction of magnetic field.*
2. *Magnetic field is a vector quantity.*
3. *Start from the north pole and end in south pole, outside the magnet.*
4. *Move from south pole to north pole, inside the magnet.*
5. *Magnetic Field lines are loops.*
6. *The strongest magnetic field around the poles where lines concentrated.*
7. *Magnetic Field is decreased with distance (inverse proportional).*

A compass : *is just a small magnet that is free to rotate .*

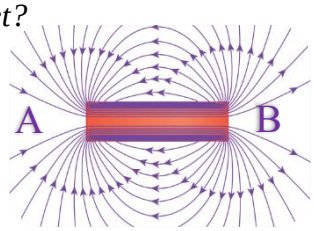




أ/ عبدالرحمن عصام
0509886279

Check your understanding:

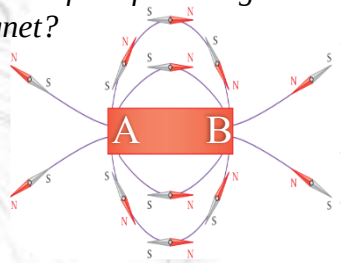
1. *The figure shows the magnetic field lines of a permanent magnet. Which of the following is correct when determining the north pole and south pole of the magnet?*



ⓐ *B is the north pole* ⓒ *B is the south pole*

ⓑ *A is the north pole* ⓓ *There isn't enough data to determine the poles*

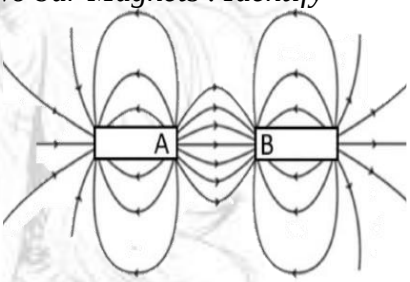
2. *The figure shows the magnetic field lines of a permanent magnet. Which of the following is correct when determining the north pole and south pole of the magnet?*



ⓐ *B is the north pole* ⓒ *B is the south pole*

ⓑ *A is the north pole* ⓓ *There isn't enough data to determine the poles*

3. *The diagram below represents the magnetic field lines around two bar Magnets . Identify the poles at positions A and B.*



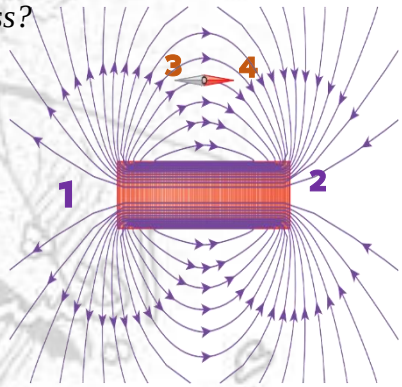
ⓐ *pole A=north*
pole B=south

ⓒ *pole A=south*
pole B=south

ⓑ *pole A=south*
pole B=north

ⓓ *pole A=north*
pole B=north

4. *The figure shows a compass close to a magnet. Which of the following rows show the correct positions of the magnetic poles of the magnet and compass?*



	North Pole of Magnet	*South Pole o f Magnet*	*North Pole of Compass*	*South Pole of Compass*
ⓐ	1	2	3	4
ⓑ	1	2	4	3
ⓒ	2	1	3	4
ⓓ	2	1	4	3

نصيحتي نظم وقت فكل دقيقه تمر خساره لك

1. اصنع جدول لاعمالك المهم
2. ابدء يومك بالصلاه فصلاه عماد الدين واهم شي في الحياه
3. بعد ما ترجع من المدرسه استريح من المدرسه والارهاق
4. ابدء بالمواد السهله ثم الصعب ثم المتوسطة
5. احرص علي ان تكون متميز عن من حولك فالتاريخ لايعرف الا العظماء

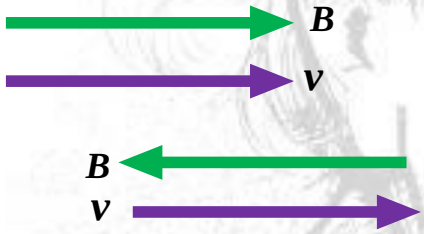
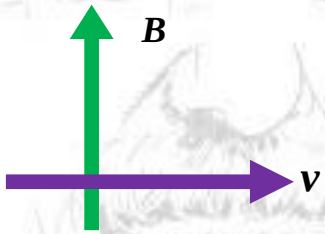
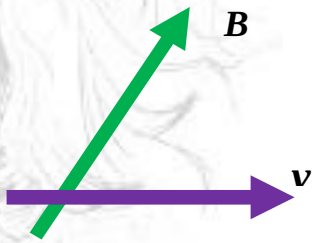
أ/ عبدالرحمن عصام
0509886279

Magnetic Force 2

"When a charged particle moves velocity in a magnetic field, a force is generated."

$$F = qvB\sin\theta$$

F: magnetic force (N)
q: electric charge (C)
v: velocity of charge (m/s)
B: magnetic field (T ≡ Tesla)
θ: angle between field and velocity (charge)

Magnetic field is parallel or antiparallel to velocity (charge)	Magnetic field is perpendicular or normal to velocity (charge)	Magnetic field is **diagonal to** velocity (charge)
$\theta = 0^o \Longrightarrow F_{min} = 0$ $\theta = 180^o \Longrightarrow F_{min} = 0$	$\theta = 90^o \Longrightarrow F_{max} = qvB$	$0^o < \theta < 90^o$ $or 90^o < \theta < 180^o \Longrightarrow F$ Between min and max
		

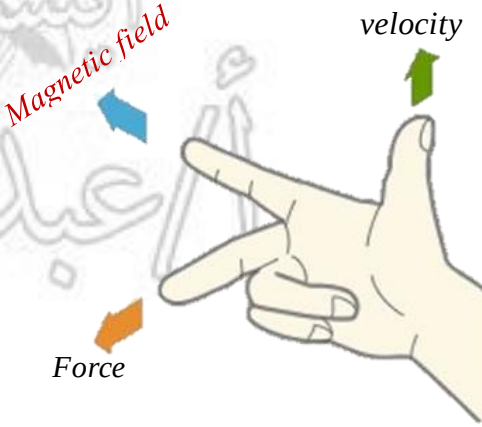

into page

Direction Magnetic field


out of page

The right-hand rule : (positive charge)

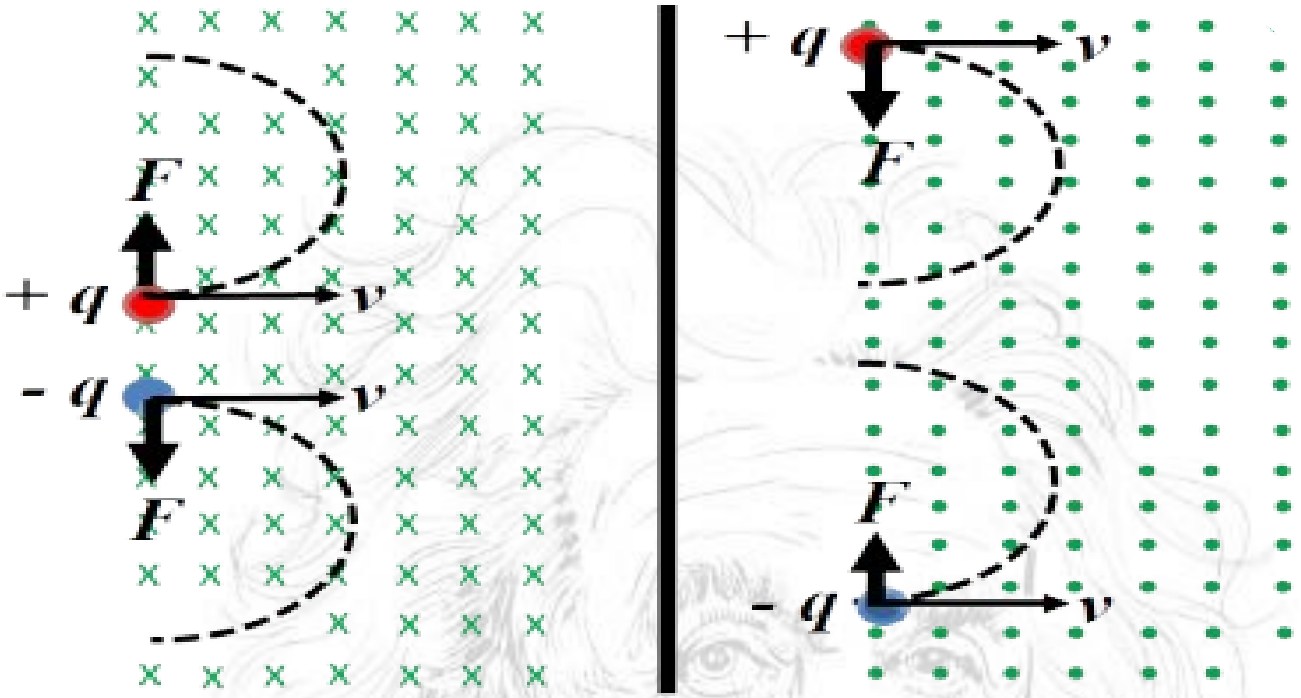
Thumb: first vector after equality sign (v)
Fingers: second vector after equality sign (B)
Palm: vector before equality sign (F)



NOTES:
positive charge Same Direction
Negative charge Opposite Direction

أ/ عبدالرحمن عصام
0509886279

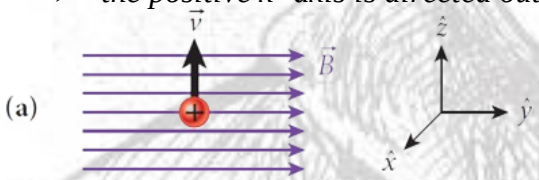
Check your understanding:



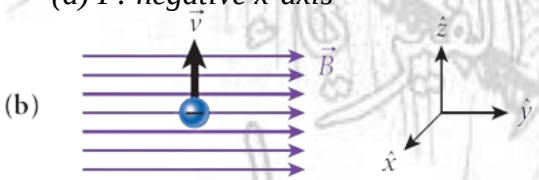
1. *Draw on the x y z coordinate system and specify (in terms of the unit vectors(x, y, z) the direction of the magnetic force on each of the moving particles shown in the figures.*

Note:

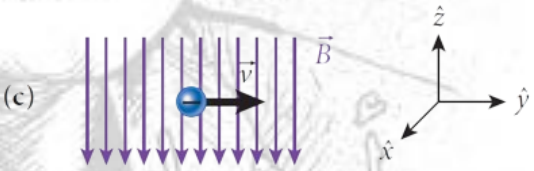
- *The positive y-axis is toward the right,*
- *the positive z-axis is toward the top of the page.*
- *the positive x- axis is directed out of the page.*



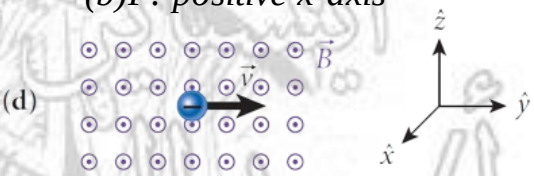
(a) F: negative x-axis



(c)F: positive x-axis



(b)F: positive x-axis



(d)F: positive z-axis

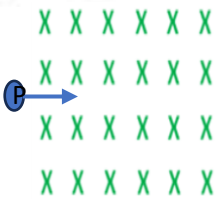
2. *According to the figure, in what direction the proton (p) will be deflected as it enters the constant magnetic field (B) ?*

ⓐ *Toward y positive*

ⓑ *Toward y negative*

ⓒ *Into the page*

ⓓ *Out of the page*

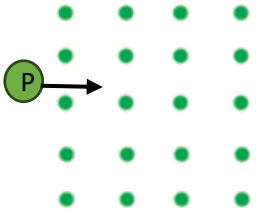


أ/ عبدالرحمن عصام
0509886279

3. *According to the figure, in what direction the proton (p) will be deflected as it enters the constant magnetic field (B) ?*

ⓐ *Toward y positive* ⓒ *Into the page*

ⓑ *Toward y negative* ⓓ *Out of the page*



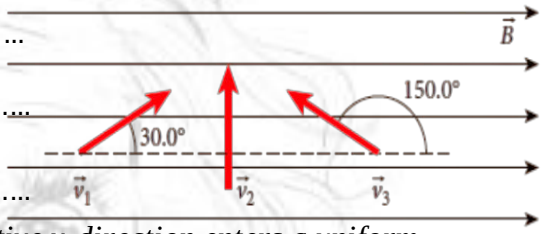
4. *Three particles, each with charge q = 6.0 μC and speed v = 400 m/s, enter a uniform magnetic field with magnitude B = 0.2 T (see the figure). What is the magnitude of the magnetic force on each of the particles?*

Slove : $F = qvB\sin\theta$

……

……

……



5. *A proton moving with a speed of 4×10^5 m/s in the positive y-direction enters a uniform magnetic field of 0.4 T pointing in the positive x-direction.*
Calculate the magnitude of the force on the proton.
Slove :

……

……

……

6. *The magnitude of the magnetic force on a particle with charge –2e moving with speed $v = 1\times10^5$ m/s is 3.0×10^{-18} N. What is the magnitude of the magnetic field component perpendicular to the direction of motion of the particle?* $e = 1.6\times10^{-19}c$
Slove :

……

……

……

7. *A particle with charge q is at rest when a magnetic field is suddenly turned on. The field points in the z-direction. What is the direction of the net force acting on the charged particle?* notes at rest Velocity zero

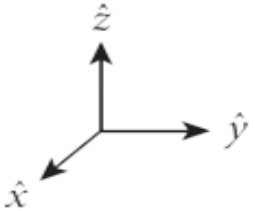
ⓐ *in the x-direction* ⓒ *the net force is zero*

ⓑ *in the z-direction* ⓓ *in the y-direction*

8. *In which direction does a magnetic force act on an electron that is moving in the positive x-direction in a magnetic field pointing in the positive z-direction?*

ⓐ *To the direction of +y axis* ⓒ *To the direction of +x axis*

ⓑ *To the direction of -y axis* ⓓ *To the direction of -x axis*



أ/ عبدالرحمن عصام
0509886279

9. *A particle with charge (q=+3.2μC) and speed (v=520m/s), enters a uniform magnetic field of (B=0.2T) as seen in the figure.*
What is the magnitude of the magnetic force on the particle?

ⓐ $332.8\mu N$ ⓒ $3.2\mu N$

ⓑ $166.4\mu N$ ⓓ $520\mu N$

10. *Which of the following is an equivalent unit of Tesla?*

ⓐ $\frac{N.s}{C.m}$ ⓒ $\frac{N}{A.m}$

ⓑ $\frac{N.C}{s.m}$ ⓓ A+ C are correct

11. *By analyzing the units:*
What does the tesla unit equal to in terms of newtons, amperes, and meters?
Slove :

.....

.....

.....

.....

12. *An electron enters a uniform magnetic field at a velocity of* $\mathbf{2.0 \times 10^{6}\ m/s}$ *at right angle as shown in the figure. The field exerts a force of* $\mathbf{5 \times 10^{-15}\ N}$ *on the electron.*



a-What is the magnetic field strength?
The charge of the electron is (qe) = -1.6 × 10−19 C
b- What is the direction of the force acting on the electron?

.....

.....

.....

.....

نصيحتي

"الحياة فرص، والفرص نادرة ولا تتكرر، ومن المهم استثمارها"

فرص الحياة كثيرة بعدد الأيام والساعات واللحظات، تزداد كلما اجتهدنا وتقل كلما توقفنا،

والزمن الحاضر هو الأثمن في صناعة الفرص، فلا يقلقنا مستقبل ولا يحزننا ماض،

فالحاضر هو السبيل للخروج من عقدة انتظار الفرص إلى صناعتها.

الوقت اهم فرص الحياه فاذا ضاع لان يعود يبقي يالندم فاتقي حسره الندم وقوم ذاكر .

moving charge in magnetic field 3

The magnetic force of charge q and mass m moves with velocity.

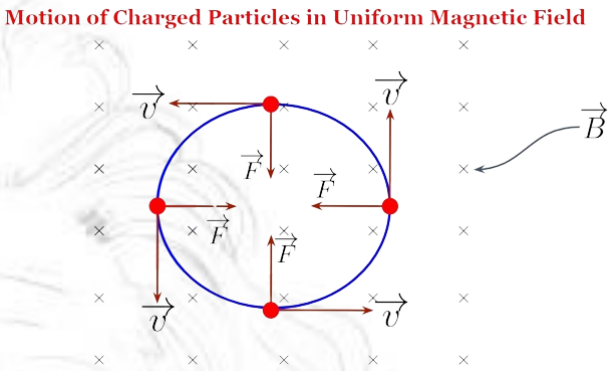
$$F = qvB$$

For circular motion:

$$F = \frac{mv^2}{r}$$

$$F = qvB = \frac{mv^2}{r}$$

$$qB = \frac{mv}{r}$$



FORMALA

NOTES :	
1. the magnetic field magnitude B	$B = \frac{mv}{qr}$
2. the orbital radius r	$r = \frac{mv}{qB}$
3. the momentum of the particle	$P = mv = \frac{r}{qB}$
4. Newton's second law	$F = ma = qvB$
5. Acceleration	$a = \frac{F}{m} = \frac{qvB}{m}$

Check your understanding:

1. *A small aluminum ball with a mass of 5.063 g and a charge of 11.03 C is moving northward at 3079 m/s. You want the ball to travel in a horizontal circle with a radius of 2.137 m and in a clockwise direction when viewed from above. Ignoring gravity, what is the magnitude of the magnetic field ?*

……

……

……

2. *A small aluminum ball with a charge of 11.17 C is moving northward at 3131 m/s. You want the ball to travel in a horizontal circle with a radius of 2.015 m and in a clockwise direction when viewed from above. Ignoring gravity, the magnitude of the magnetic field that must be applied to the aluminum ball to cause it to move in this way is B = 0.8000 T. What is the mass of the ball?*

……

……

……

3. *A small, charged aluminum ball with a mass of 3.435 g is moving northward at 3183 m/s. You want the ball to travel in a horizontal circle with a radius of 1.893 m and in a clockwise direction when viewed from above. Ignoring gravity, the magnitude of the magnetic field that must be applied to the aluminum ball to cause it to move in this way is B = 0.5107 T.*
What is the charge on the ball?

……

……

……

4. *An electron is moving at $v = 6.00\times10^{7}$ m/s perpendicular to the Earth's magnetic field. If the field strength is 0.500×10^{-4} T, what is the radius of the electron ?*

……

……

……

5. *As shown in the figure, an electron moving at a velocity of ($v = 720$ m/s) ,enters a uniform magnetic field of ($B = 2.4 \times 10^{-10}$ T)*
(Ignore the effect of earth gravitation)



A. *Calculate the acceleration of the electron.*

B. *What is the direction of the force acting on the electron?*

……

……

……

6. *The radius of the circular trajectory a particle is following is r = 2.300 m. The magnitude of the magnetic field in the TPC is B = 0.5000 T. We can assume that the particle has charge $|q| = 1.6 \times 10^{-19}$ C. What is the component of the particle's momentum that is perpendicular to the magnetic field?*

……

……

……

7. *An electron moves in a circular trajectory with radius r_i in a constant magnetic field. What is the final radius of the trajectory when the magnetic field is doubled?*

ⓐ *ri/4* ⓒ *2ri*

ⓑ *ri/2* ⓓ *4ri*

أ/ عبدالرحمن عصام

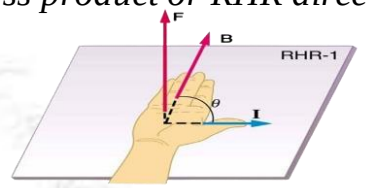
أ/ عبدالرحمن عصام
0509886279

force on wire 4

$$F = I\,l\,b\,\sin(\theta)$$

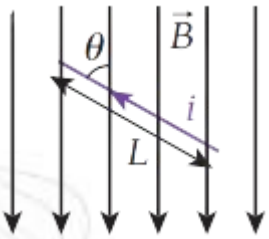
F: magnetic force on wire (N)
I: conventional electric current (A)
L: length of affected wire (m)
B: magnetic field strength (T)

Cross product or RHR direction



Check your understanding:

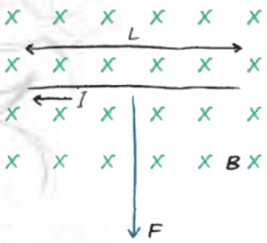
1. *An isolated segment of wire of length L = 4.50 m carries a current of magnitude i = 35.0 A at an angle θ = 50.3° with respect to a constant magnetic field of magnitude B = 6.70×10^{-2} T (see the figure).*
What is the magnitude of the magnetic force on the wire?



ⓐ 2.66 N ⓒ 3.86 N

ⓑ 5.60 N ⓓ 8.12 N

2. *According to the figure, an isolated segment of wire of length (L=8.3m) carries a current of magnitude (i=1.5A) at an angle (θ=60.0°) with respect to a constant magnetic field of magnitude (B=5.4×10 T).*
What is the magnitude of the magnetic force on the wire?



ⓐ 054 N ⓒ 2.16 N

ⓑ 0.29 N ⓓ 0.33 N

3. *A wire of length 5 m, placed in a magnetic field of strength 0.80 T, experiences a force of 12 N. If the current through the wire is 6 A, what approximate angle does the wire make with the magnetic field?*

ⓐ 30° ⓒ 60°

ⓑ 15° ⓓ 30°

4. *A straight wire carrying a 5.0A 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)?

……
……
……

5. *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?

……
……

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

……

……

……

7. *A straight wire of length 2.00 m carries a current of 24.0 A. It is placed on a horizontal tabletop in a uniform horizontal magnetic field. The wire makes an angle of 30.0° with the magnetic field lines. If the magnitude of the force on the wire is 0.500 N*

What is the magnitude of the magnetic field?

……

……

……



أ/ عبدالرحمن عصام

أ/ عبدالرحمن عصام
0509886279

Torque 5

$$\tau = NiAB\sin(\theta)$$

N: number of loops
I: Area loop (m^2)
L: length of affected wire (m)
B: magnetic field strength(T)

NOTES

1. *circular loop* $A = \pi r^2$
2. *square loop* $A = L^2$
3. rectangle *loop* $A = L \times W$

Check your understanding:

1. *A coil is composed of circular loops of radius r = 5.13 cm and has N = 47 windings. A current, i = 1.27 A, flows through the coil, which is inside a homogeneous magnetic field of magnitude 0.911 T. What is the maximum torque on the coil due to the magnetic field?*

ⓐ *0.148 N.m* ⓒ *0.662 N.m*

ⓑ *0.450 N.,m* ⓓ *0.350 N.m*

2. *A coil (X) consists of (400) loop and a coil (Y) consists (900) loop, If the torque on each loop of the coil (X) is equal to the torque on each loop of the coil (Y).*
What is the ratio of the torques (τ_X/τ_Y) *?*

ⓐ 2/3 ⓒ 9/4

ⓑ 4/9 ⓓ 3/2

3. *A rectangular coil with 20 windings carries a current of 2.00 mA flowing in the counterclockwise direction. It has two sides that are parallel to the y-axis and have length 8.00 cm and two sides that are parallel to the x-axis and have length 6.00 cm. A uniform magnetic field of 50.0 μT acts in the positive x-direction.*
What torque must be applied to the loop to hold it steady?

……
……
……

4. *A circular coil with a radius of 10.0 cm has 100 turns of wire and carries a current, i = 100. mA. It is free to rotate in a region with a constant horizontal magnetic field given by B= (0.0100 T)^x. If the unit normal vector to the plane of the coil makes an angle of 30.0° with the horizontal, what is the magnitude of the net torque acting on the coil?*

……
……
……