Physics II

Magnetic Force

Force on a charge moving in a magnetic field: $F = Bqv\sin\angle_B^v$

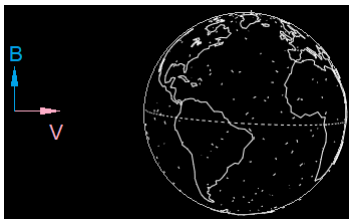
$\vec{F} = q\vec{v}\times\vec{B}$

Force on a wire carrying a current *I*: $F = BIl\sin\angle_B^\ell$

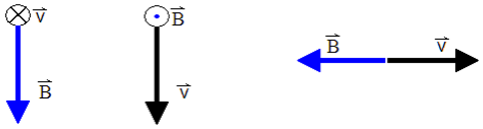
$\vec{F} = I\vec{l}\times\vec{B}$

Magnetic field produced by a long wire: $B = \dfrac{\mu_0 I}{2\pi r}$, where $\mu_0 = 4\pi\times10^{-7}\,\dfrac{\text{Tm}}{\text{A}}$

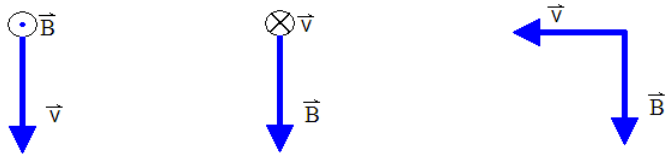
Problem 1.- Find the magnetic force on a proton coming towards our planet at a speed of 4×10^5m/s if the magnetic field of the Earth is 1.5×10^{-5}T at that point and it is perpendicular to the velocity of the proton (as shown in the figure).Answer with magnitude and direction of the force.



Problem 2.- Find the magnitude and indicate the direction of the force on a charge of 6.25 μC for each diagram shown, if *B* = 1.5 T and *v* = 29,979 m/s:



Problem 2a.- Find the magnitude and direction of the force on a positive charge of 2.5 μC for each diagram shown, if *B* = 0.8 T and *v* = 1,200 m/s:

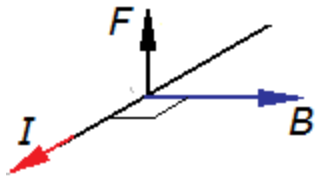


Problem 3.- If two adjacent parallel wires carry electric current in the same direction, are they attracted to each other or repelled from each other? Give a short explanation.

Problem 3a.- Calculate the magnitude of the force on one meter of wire due to another identical parallel wire. Take the currents to be 25A and the distance between the wires 0.8m

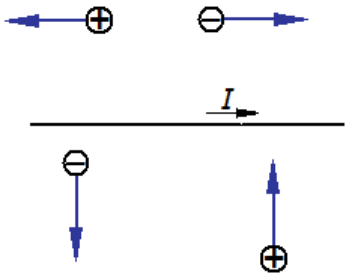
Problem 3b.- Determine the magnitude and direction of the force between two parallel wires 2.0 m long and 2.8cm apart, each carrying a current of 35A in opposite directions.

Problem 4.- A 2-meter-long wire has a mass of 0.0035 kg and it is in a place where the magnetic field is horizontal, perpendicular to the wire and has a magnitude B = 0.9 T. Calculate the current needed so the wire will levitate due to the magnetic force.

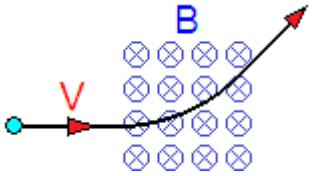


Problem 4a.- How much current is necessary to produce a force of 0.55 N in a 3.8m long wire that is perpendicular to a magnetic field of 0.85T.

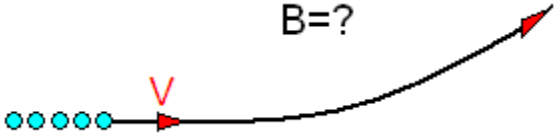
Problem 5.- The following charged particles are moving in the proximity of a current carrying wire. The sign of the charges is indicated (+ or -) as well as their velocity (with arrows).
For each charge, indicate the direction of the magnetic force due to the magnetic field produced by the wire.



Problem 6.- The particle shown in the figure enters a region of magnetic field and is deflected upward. Is the charge of the particle positive or negative? Explain.



Problem 6a.- You want to steer a beam of electrons (charge = -1.6×10^{-19}C) as shown in the figure. Indicate the direction of the magnetic field that will do this for you.



Problem 7.- Determine the magnitude and direction of the force on an electron traveling at a speed of 5.75×10^{5} m/s horizontally to the east in the presence of a vertically upward magnetic field of 0.85T.

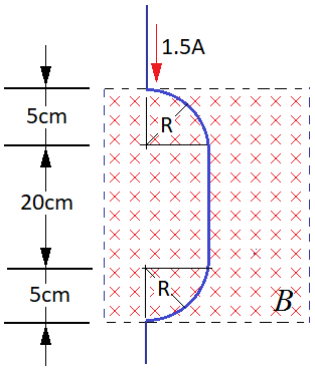
Charge of the electron $q_e = -1.6\times10^{-19}$ C

Problem 7a.- Find the magnitude and direction of the force on a positively charged cloud (charge = 1.5C) moving towards the East with a speed of 3m/s due to the magnetic field of the Earth that points North with a value of 45 μT.

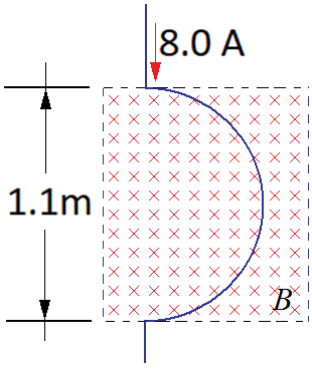
Problem 8.- Describe the trajectory of an electron that enters a region of constant magnetic field at right angles (the angle between the field and the velocity is 90º).

Problem 9.- Determine the radius of the circular motion of a carbon-12 ion in a region of magnetic field B = 0.85T if its speed is 5.75×10^{6} m/s perpendicular to the magnetic field.
Charge of the carbon-12 ion = 1.6×10^{-19} C,
Mass of the ion = 2.0×10^{-26}kg

Problem 10.- Calculate the net force on the conductor, due to the magnetic field B = 0.25 T shown in the figure.



Problem 11.- Calculate the net force on the conductor, due to the magnetic field B = 0.25 T shown in the figure.



Problem 12.- Two transmission lines of length 75 m transport 150 A of current in opposite directions and are separated 0.8 m. Calculate:

a) The magnetic field produced by one line at the position of the other.

b) The magnitude of the magnetic force between them. Is it repulsive or attractive?

c) Do you think this force should be considered when designing the structure to support the transmission lines?

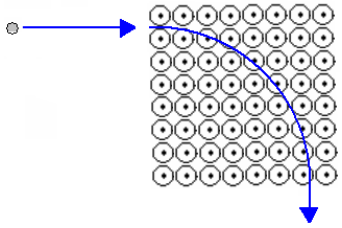
d) During a short circuit, the current is 100 times the normal value. Is it important to consider the force in this case?

Problem 13.- Can you set a resting electron into motion with a magnetic field? Why?

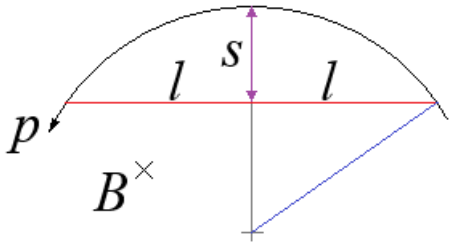
Problem 14.- If a positively charged particle enters a region of uniform magnetic field which is perpendicular to the particle's velocity, will the kinetic energy of the particle increase, decrease or stay the same? Why?

Problem 15.- Find the force acting on a particle that has a charge of 3.2×10^{-19}C if its velocity is given by $\vec{v} = (3\hat{i} + 4\hat{j} + 2\hat{k})\times10^{3}$ m/s and the magnetic field is $\vec{B} = 0.35\hat{k}$ T

Problem 16.- A proton enters a region of magnetic field at a speed of 3×10^{6} m/s. The field and the velocity are at right angles. Calculate the radius of the circle described by the trajectory of the particle if the magnetic field is 1.5×10^{-3}T.
Proton mass = 1.67×10^{-27} kg and charge q = 1.6×10^{-19}C

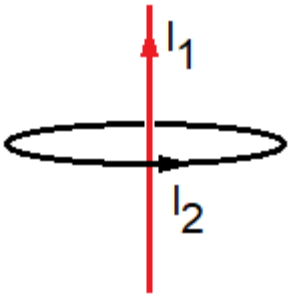


Problem 17.- A particle with charge q and linear momentum p moves in a plane under the force of a uniform magnetic field B. Measurements determined the values s and l in the trajectory of the particle as shown in the figure. Which of the following expressions is the linear momentum of the particle in terms of q, B, s and l if $s << l$?



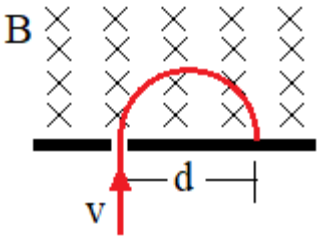
(A) $\frac{qBs^2}{2l}$ (B) $\frac{qBs^2}{l}$ (C) $\frac{qBl}{s}$ (D) $\frac{qBl^2}{2s}$ (E) $\frac{qBl^2}{8s}$

Problem 18.- A long conducting wire transports a current I_1 upward as indicated in the figure. This wire is perpendicular to the plane of a conducting ring and passes through its center. The ring carries a constant current I_2 in the direction indicated in the figure.
Which of the following sentences is correct about the magnetic force of the wire on the ring?



(A) The force is radially outward, trying to expand the ring.
(B) The force is radially inward, trying to shrink the ring.
(C) The force is upward.
(D) The force is downward.
(E) There is no force.

Problem 19.- In a mass spectrometer, a charged particle with speed v enters a region of uniform magnetic field B and describes a circular trajectory as shown in the figure hitting the detector at a distance d. What will be the distance for a particle with the same mass and velocity, but twice the charge?



(A) $\frac{d}{2}$ (B) $\frac{d}{\sqrt{2}}$ (C) d (D) $\sqrt{2}d$ (E) $2d$

Problem 20.- A particle with charge q that was initially at rest is released in a region where there are electric and magnetic fields that are constant and parallel to each other. What will be the trajectory of the particle?

(A) A parabola
(B) A circle
(C) A spiral
(D) A straight line
(E) A helix