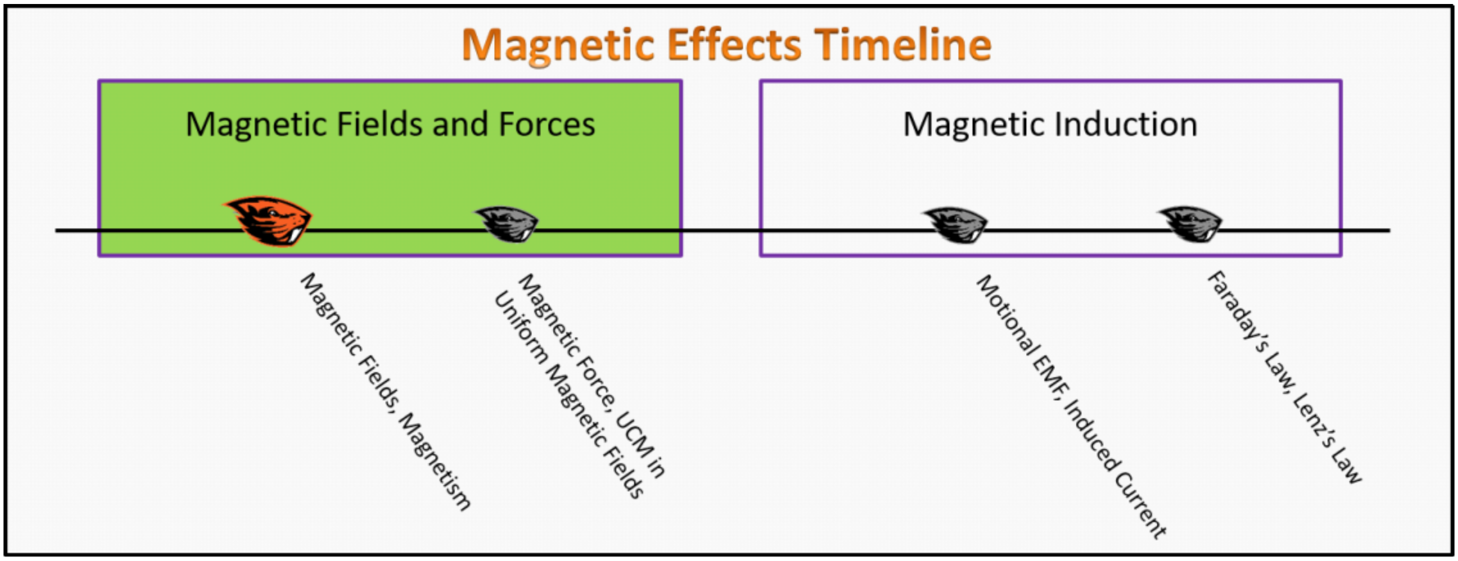
MF.L2.2 - Template

Wednesday, May 29, 2019 7:33 AM

Magnetic Fields and Forces

Foundation Stage (MF.L2.2)

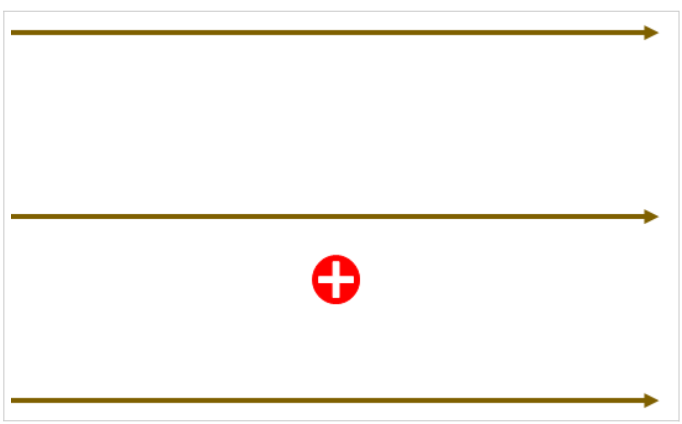
Lecture 2
Magnetic Force, Uniform Circular Motion



Warm up

MF.L1.2-01:

Problem Statement: Consider a positive point charge as shown below. What is the direction of the magnetic force on the charge?



Key Equations

$\vec{F} = q\,\vec{v} \times \vec{B}$	$\left\|\vec{F}\right\| = \|q\|\|\vec{v}\|\left\|\vec{B}\right\| \sin\theta$

Questions

Act I: Magnetic Force on a Point Charge

MF.L2.2-02:

Problem Statement: An electron moves along the -y axis with a speed of 1.0×10^7 m/s. A 0.50 T magnetic field points in the positive x-direction.

(a) What is the magnitude of the force on the electron?

(1) 8×10^{-13} N

(2) 8×10^{-13} N

(3) 7×10^{-12} N

(4) 7×10^{-12} N

(5) 6×10^{-11} N

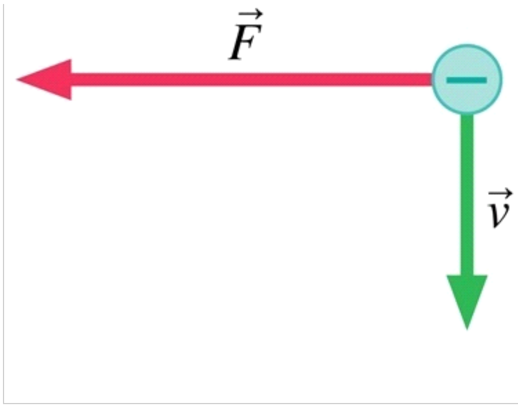
(b) What is the direction of the force on the electron?

(1) negative z-direction
(2) positive z-direction
(3) negative x-direction
(4) positive y-direction
(5) negative z-direction

(c) If the magnetic field were rotated 30^o clockwise, what would the magnitude of the force on the electron be?

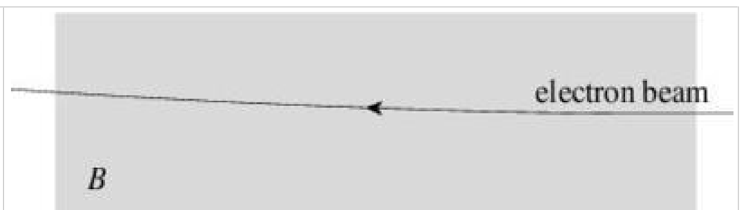
MF.L2.2-03:

Problem Statement: An electron moves perpendicular to a magnetic field. Sketch a vector to represent the direction of the magnetic field.



MF.L2.2-04:

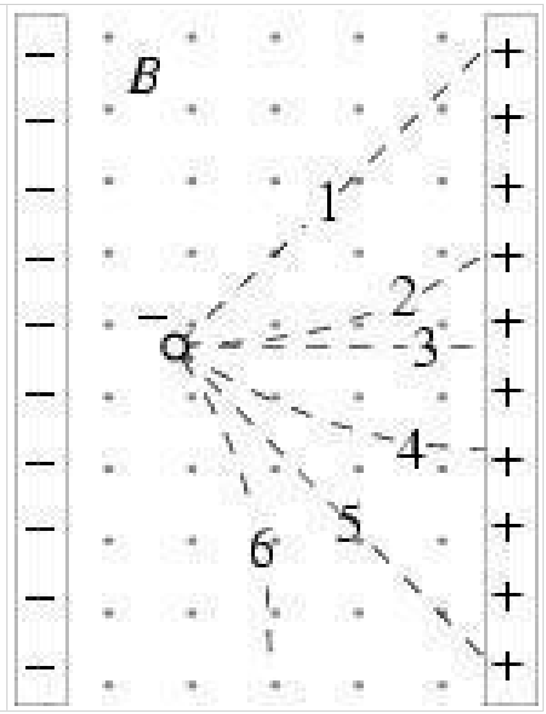
Problem Statement: A beam of electrons enters a region with a magnetic field as shown below. If the beam is deflected upward, the magnetic field must be oriented…

(1) downward. (2) up. (3) into the plane of the drawing. (4) out of the plane of the drawing. (5) to the left. (6) to the right. (7) None of the above - it is at an angle. (8) Need more information to determine.	

MF.L2.2-05:

Problem Statement: A negatively charged particle is released from rest between the plates of a capacitor under the combined influence of a magnetic field B (directed out of page) and the electric field in the capacitor. Which of the paths shown best represents the trajectory of the particle? (ignore gravity)

(1) 1
(2) 2
(3) 3
(4) 4
(5) 5
(6) 6
(7) The particle remains at rest
(8) The particle moves out of the plane of drawing

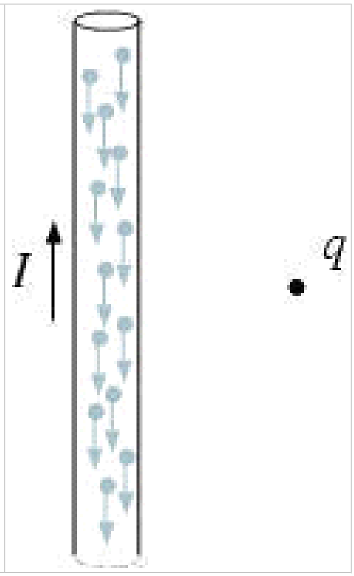


Act II: Magnetic Fields and Forces

MF.L2.2-06:

Problem Statement: A positively charged particle is placed at rest near a wire carrying a steady upward current. The upward current is due to downward motion of negatively charged electrons in the wire. What direction is the magnetic force on the charge?

(1) Up.
(2) Down.
(3) Left.
(4) Right.
(5) Into Page.
(6) Out of Page.
(7) No force.

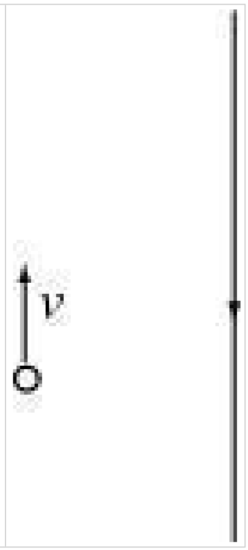


MF.L2.2-07:

Problem Statement: A negatively charged particle moves upward parallel to a wire carrying a downward electric current.

(a) At the location of the charge, in which direction does the magnetic field created by the current point?

(1) up
(2) down
(3) into the plane of the drawing
(4) out of the plane of the drawing
(5) left
(6) right



(b) In which direction is the magnetic force on the charge?

(1) up
(2) down
(3) into the plane of the drawing
(4) out of the plane of the drawing
(5) left
(6) right

MF.L2.2-08:

Problem Statement: Two positive charges move parallel to each other as shown below. At the instant shown…

(a) in which direction is the magnetic force of q_2 on q_1?

(1) The magnetic force is zero (v_1 parallel to v_2)

(2) +x

(3) -x

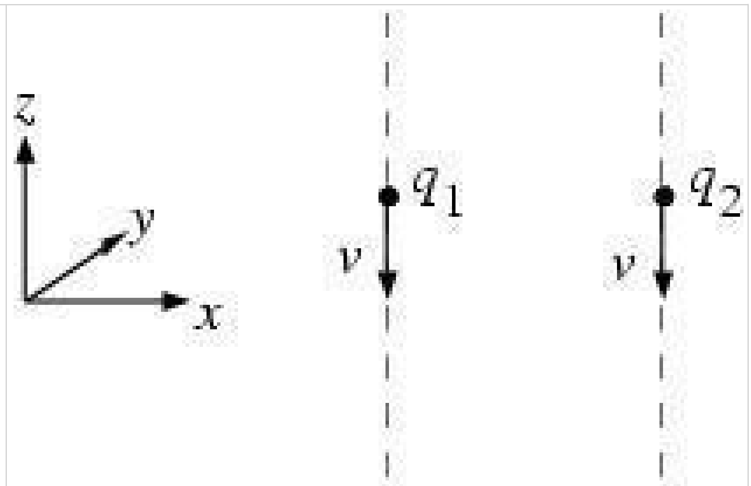
(4) +y

(5) -y

(6) +z

(7) -z

(8) Other



(b) in which direction is the magnetic force of q_1 on q_2?

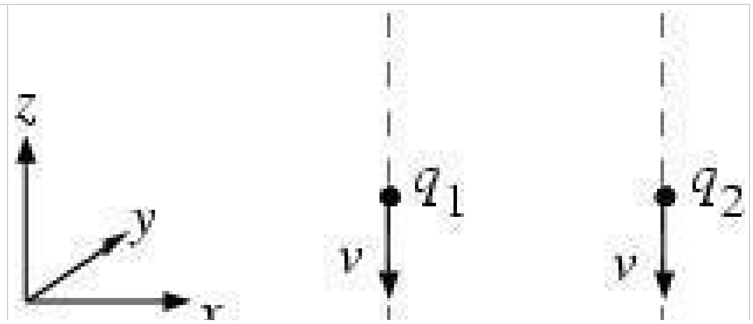
(1) The magnetic force is zero (v_1 parallel to v_2)

(2) +x

(3) -x

(4) +y

(5) -y



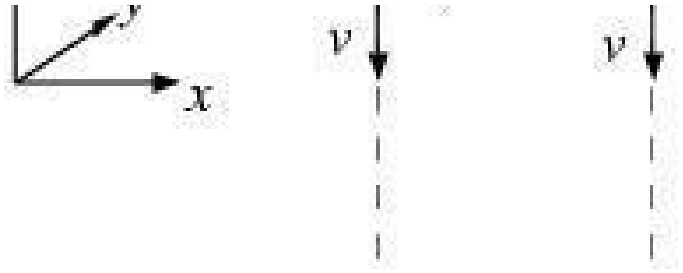
(4) +y

(5) -y

(6) +z

(7) -z

(8) Other



MF.L2.2-09:

Problem Statement: Two positive charges move toward the origin as represented below. At the instant shown, in what direction is the magnetic force of q_2 on q_1?

(1) The magnetic force is zero

(2) +x

(3) -x

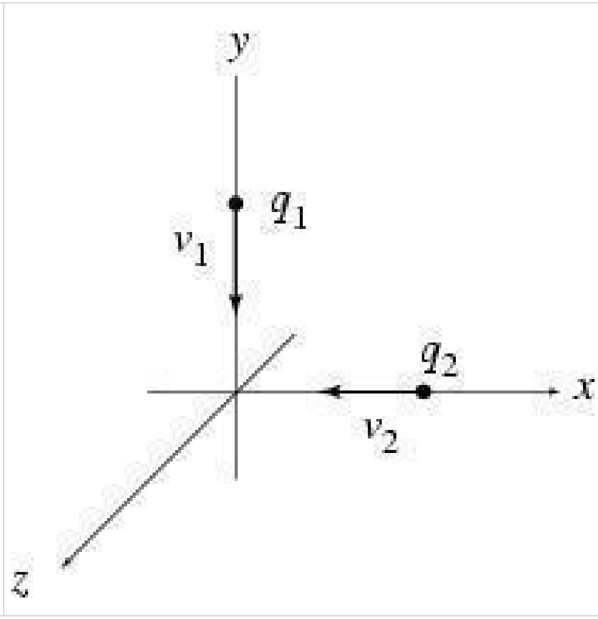
(4) +y

(5) -y

(6) +z

(7) -z

(8) Other



Act III: Magnetic Force Between Wires and Loops

MF.L2.2-10:

Problem Statement: Two parallel current-carrying wires are placed next to each other. When current flows in the opposite direction in the wires, they…

(1) attract each other. (2) repel each other. (3) don't interact.	

MF.L2.2-11:

Problem Statement: Two identical current loops are placed one above other. If the currents flow in the direction indicated by the arrows, the two loops…

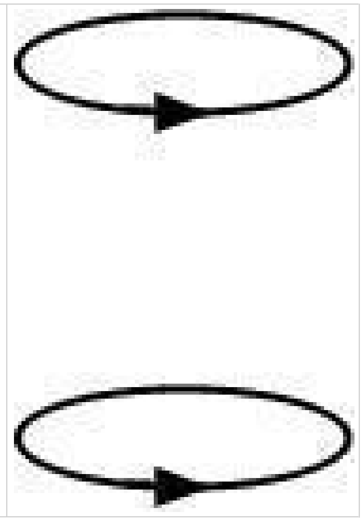
(1) repel.

(2) attract.

(3) do not interact.

(4) exert torques on each other.

(5) push each other sideways.

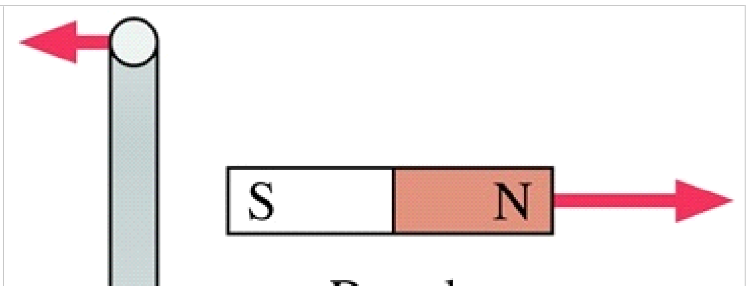


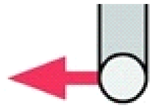
MF.L2.2-12:

Problem Statement: What is the current direction in the loop? (The red arrows are showing the forces on both the magnet and the loop)

(1) Out of the page at the top of the loop, into the page at the bottom

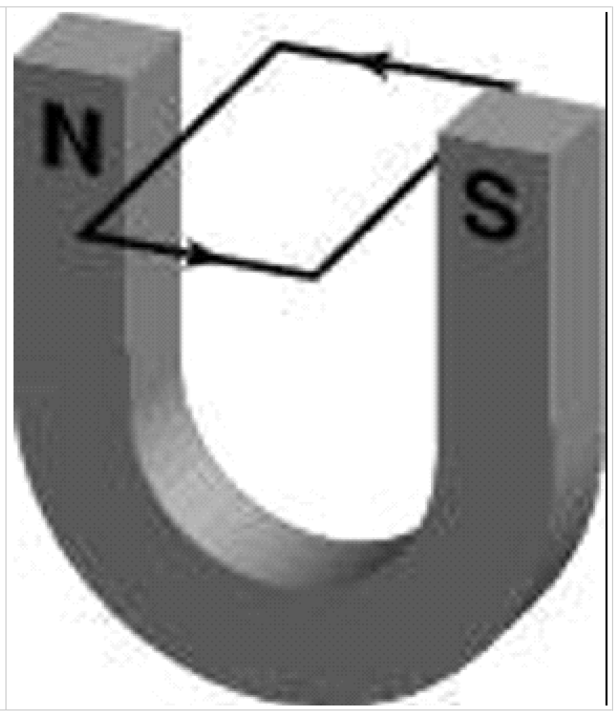
(2) Out of the page at the bottom of the loop, into the page at the top



	 Repel

MF.L2.2-13:

Problem Statement: A current loop is placed between the poles of a horseshoe magnet, as shown below. The loop tends to…

(1) rotate, left side up. (2) rotate, right side up. (3) rotate, front side up. (4) rotate, rear side up. (5) none of the above -- it stays in place. (6) other.	

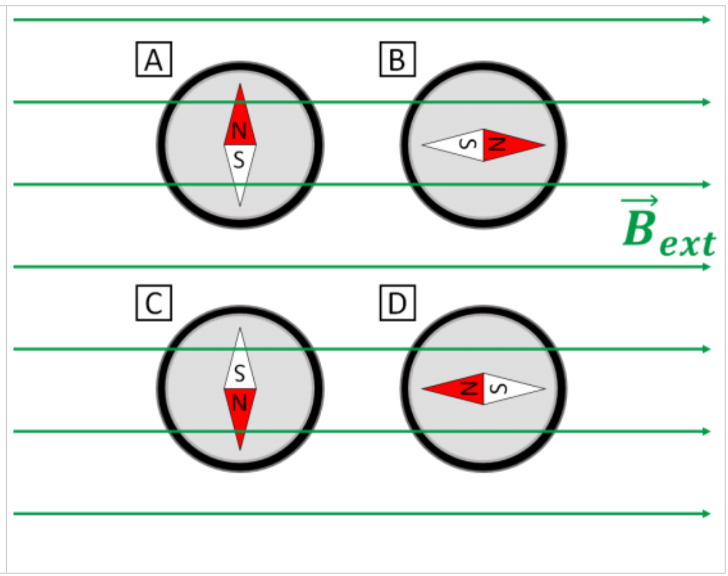
Act IV: Earth's Magnetic Field and the Auroras

MF.L2.2-14:

Problem Statement: The Earth (other planets too!) has a magnetic field created by convection currents in its molten iron core.

(a) A compass is a device that has been used for navigation for almost 1000 years. Compasses contain a magnet which is allowed to spin freely. When placed in a magnetic field as shown, which of the following diagrams best represents how a compass would align itself?

(1) A
(2) B
(3) C
(4) D



(b) The Earth has a very complicated magnetic field, but it can be approximated as a single

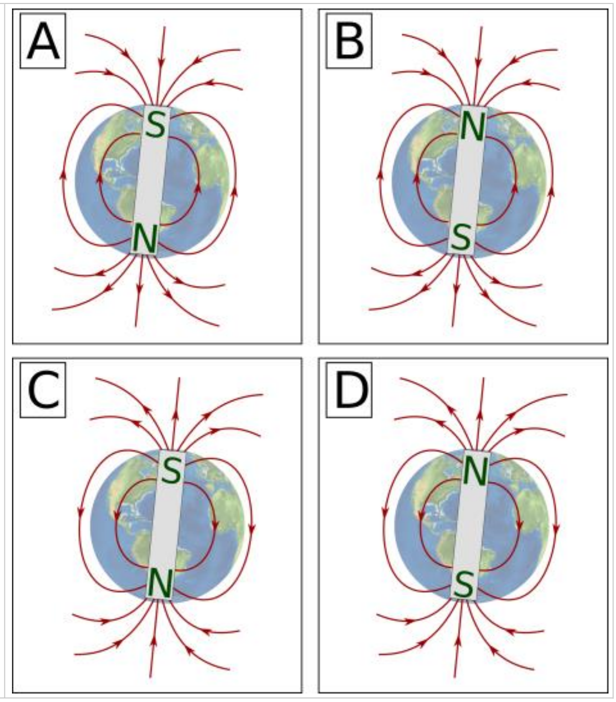
bar magnet. Which of the following figures best represents this approximation of the bar magnet that creates the Earth's magnetic field.
Hint: which way does your compass point?

(1) A

(2) B

(3) C

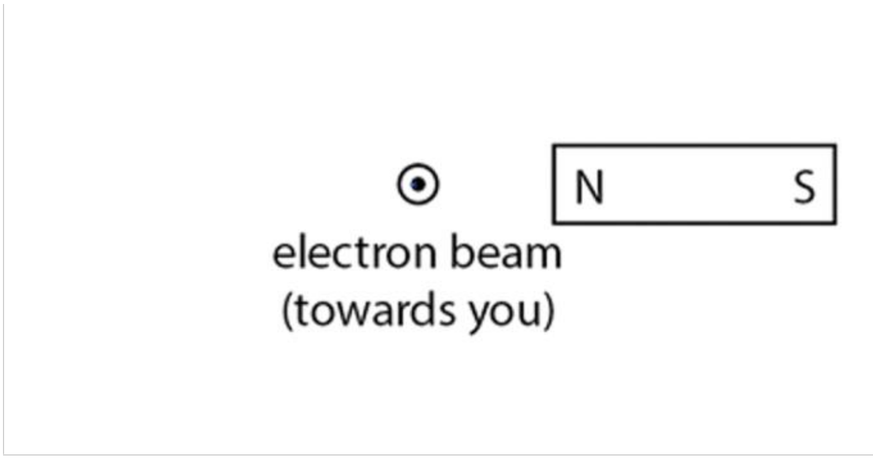
(4) D



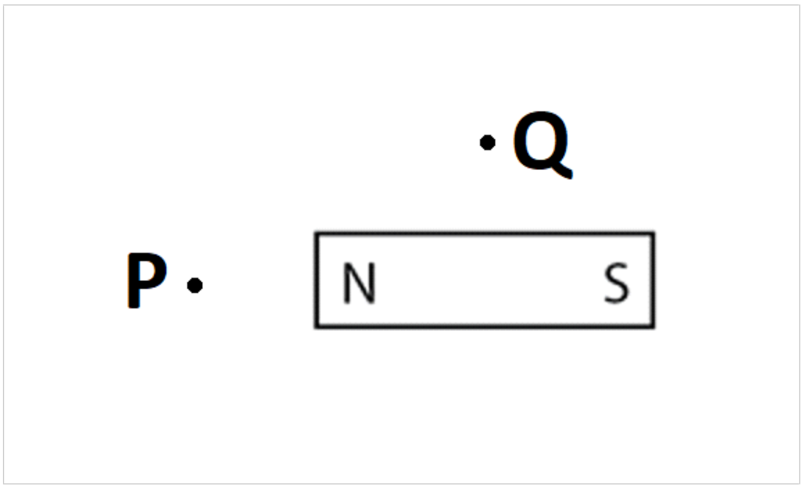
MF.L2.2-15:

Problem Statement: A beam of electrons moves toward you perpendicular to your screen. The North pole of a permanent bar magnet is brought near the beam, pointing toward the beam.

(a) Sketch the direction of the magnetic force on the electrons.



(b) At which point is the magnetic field strength largest?

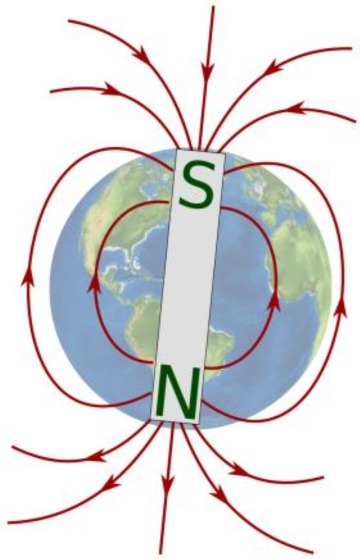


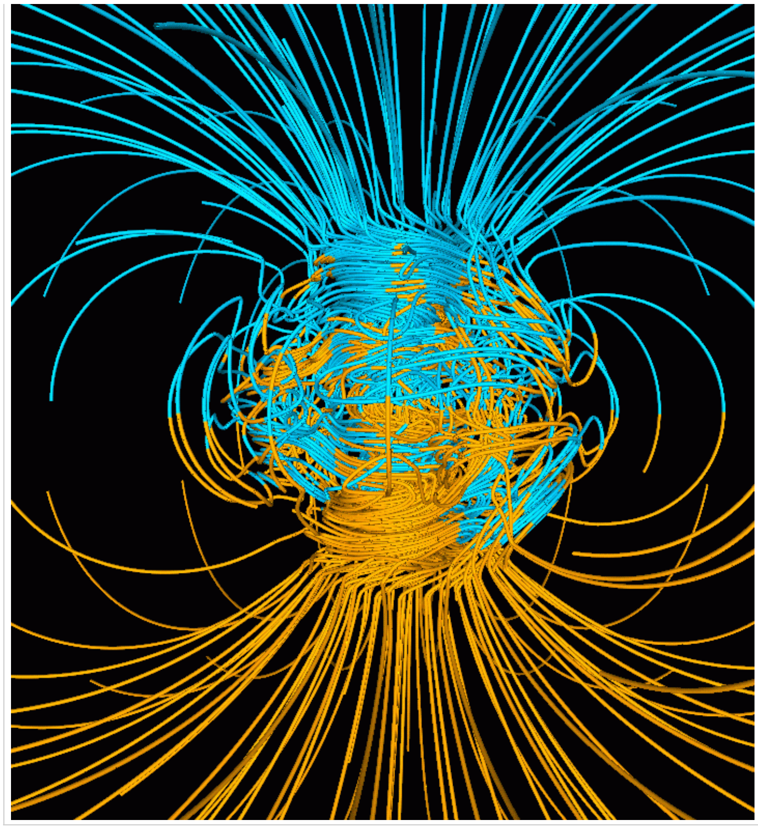
MF.L2.2-16:

Problem Statement: Cosmic rays (atomic nuclei stripped bare of their electrons) and Solar Wind (charged particles emitted by the sun) would continuously bombard Earth's surface if most of them were not deflected by Earth's magnetic field.

Given that Earth is, to an excellent approximation, a magnetic dipole, where above the Earth would such charged particles feel the greatest force?

(1) poles.
(2) mid-latitudes.
(3) equator.





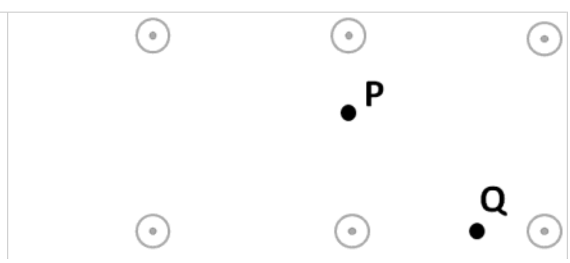
Act V: Magnetic Force and Uniform Circular Motion (UCM)

MF.L2.2-17:

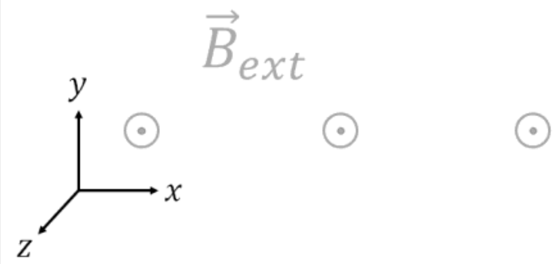
Problem Statement: A positive charge is placed at point **P** in the magnetic field shown below. It is given a velocity, $\vec{v}$, in the positive x direction.

(a) In which direction does the magnetic force on the charge point?

(1) Up.
(2) Down.
(3) Left.
(4) Right.



(5) Into the page.
(6) Out of the page.
(7) The force is zero.



(b) If the charge is placed at point **Q** and given a velocity, $\vec{v}$, in the negative y direction, in which direction is the magnetic force?

(1) Up.
(2) Down.
(3) Left.
(4) Right.
(5) Into the page.
(6) Out of the page.
(7) The force is zero.

(c) In the above scenario, the velocity is perpendicular to the magnetic field. Remember that the net acceleration of anything moving in a circle is $|\vec{a}| = \frac{|\vec{v}|^2}{r}$. Find the symbolic solution for the radius of the circle in which the charge travels in terms of $q, m, |\vec{v}|, |\vec{B}|$.

MF.L2.2-18:

Problem Statement: Two beams of particles enter the same magnetic field with the same velocity, perpendicular to the field. If the mass of particles in beam A is twice that of B and the charge of particles in A are four thirds that of B. What is the ratio of the radius of curvature of A to that of B?