Lesson 7.3- Magnetic Force on a Charge

Unit 7: Magnetism

Charge in Magnetic Field Sim and one in 3D

Learning Intentions:

- I can use right-hand and left-hand rules to predict the direction of force and motion of charged particles in a magnetic field.
- I can calculate the magnetic force on a moving charge.
- I can explain and calculate how charged particles move in circular paths by connecting magnetic force to centripetal force.

Magnetic Force and Magnetic Field Strength:

A moving charged particle that enters a **magnetic** field at any direction other than **parallel** will experience a **force** (**F_B**)

Since $\vec{F} \propto Q$ and $\vec{F} \propto \vec{v}$, $\vec{F} \propto Q\vec{v}$

$$\therefore \frac{F}{Q\vec{v}} = 1\frac{N}{C\frac{m}{s}} = 1\frac{N}{Am} = 1T\ (\vec{B})$$

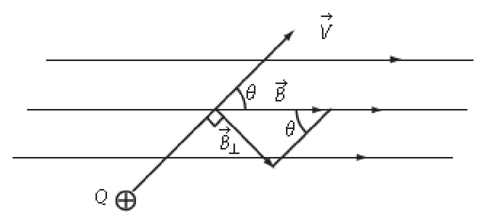
$$\vec{F} = \vec{B}Q\vec{v}$$

Magnetic force depends on:

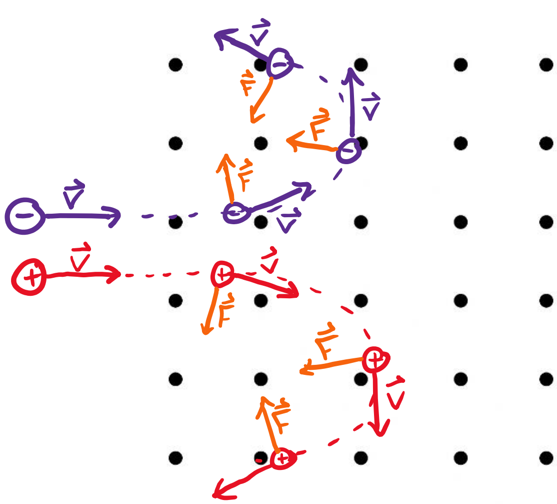
- Q – charge, Q (C)
- v – Particle Velocity, v (m/s)
- B – Magnetic field strength (T)

*Only consider $\vec{B} \perp$ to $\vec{v}$

$$\vec{F} = \vec{B}Q\vec{v}\sin\theta$$



Charged Particles in a Magnetic Field (use sim)



Similar to the charge in a **wire** causing force, but since the charge is free to move, its **direction** constantly **changes**; therefore, so does the **force** vector.
Result: the particle moves in a **circular** path

Rules:
(+) charge: use 2nd right-hand rule with thumb pointing with velocity

(-) charge: Left-handed version of the (+) charge rule

$\vec{v}$ $\vec{F}$

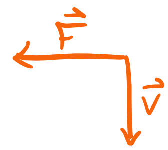
Example 1: A proton with speed 3.0 x 10^5 m/s in a magnetic field experiences a force of 8.0 x 10^{-14} N west when moving downward. What is the magnitude and direction of the magnetic field?

$\vec{B}$?

$$\vec{F} = \vec{B}Q\vec{v}$$

$$\vec{B} = \frac{\vec{F}}{Q\vec{v}} = \frac{(8.0\times10^{-14})}{(1.6\times10^{-19})(3.0\times10^{5})}$$

$$\boxed{= 1.67\,T \odot}$$



Describing the Circular Path of a Charge in a Magnetic Field:

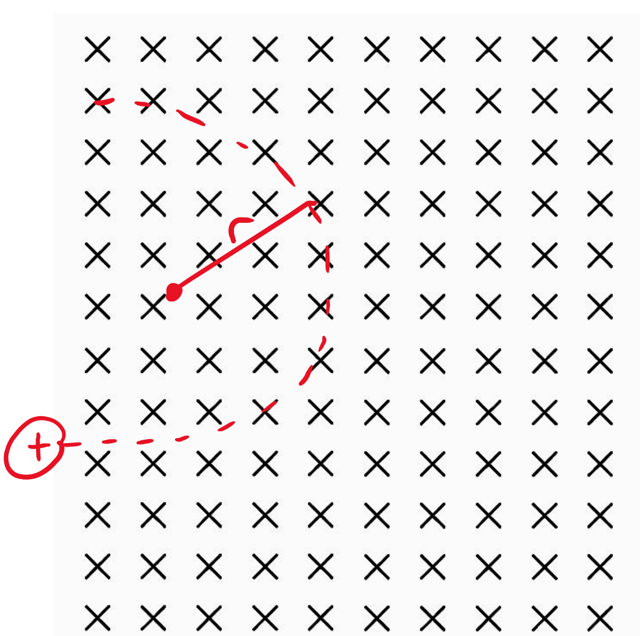
* Recall forces that produce circular motion are types of centripetal forces.

$$F_B = F_c$$

$$\vec{B}Q\cancel{\vec{v}} = \frac{m\vec{v}^{\cancel{2}}}{r}$$

$$r = \frac{m\vec{v}}{\vec{B}Q}$$

Example 2: A proton travelling at 1.2 x 10^6 m/s enters a 0.60 T field at a right angle. Find the radius of the path and draw it below.



$$\vec{F}_B = \vec{F}_c$$

$$\vec{B}Q\vec{v} = \frac{m\vec{v}^2}{r}$$

$$r = \frac{m\vec{v}}{\vec{B}Q}$$

$$r = \frac{(1.67\times10^{-27})(1.2\times10^{6})}{(1.6\times10^{-19})(0.6)}$$

$$\boxed{r = 0.021\,m}$$

Assignments: BC Physics 12 Pg. 224 #'s 1-2 | Pg. 232 #1, 6 | Pg. 243 #'s 1 |WS 7.3