CAPA due date extended to Friday night 11:59 PM.

Physics 102

Lecture 15.

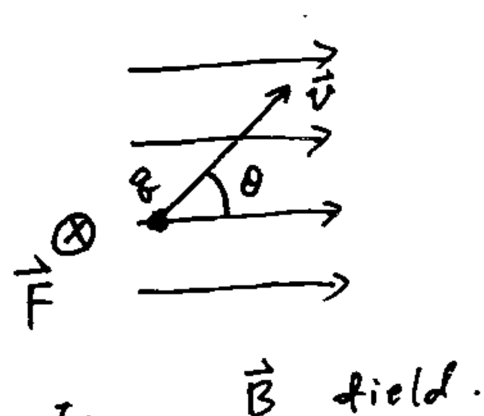
Wed. Oct. 13, 2004

- Magnetic force on a moving charge.

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

Direction: right-hand rule

Magnitude: $F = qvB \cdot \sin\theta$

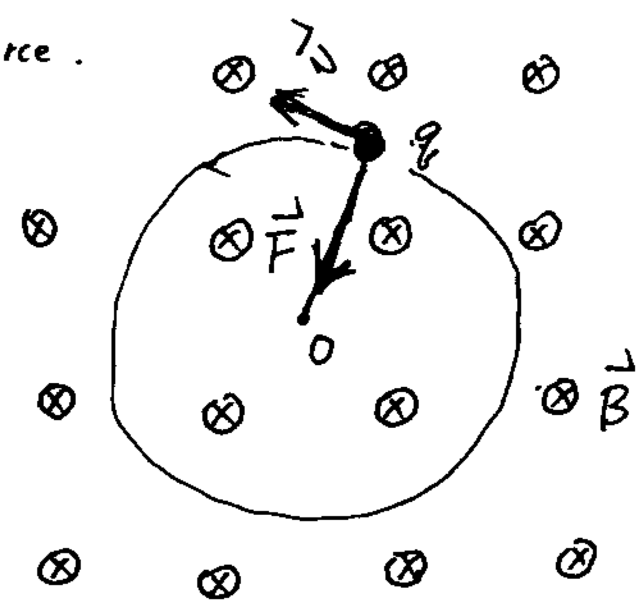


① $\vec{F} \perp \vec{v}$.

The force only changes the direction of motion of the moving charge.

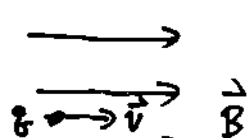
i.e. it does not speed up or slow down the charge.

e.g. centripetal force.



② $\vec{F} \perp \vec{B}$.

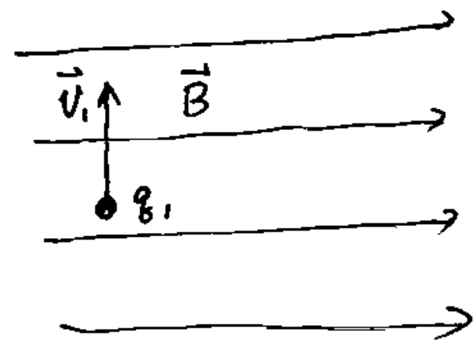
③ $\vec{F} = 0$ when $\vec{v} \parallel \vec{B}$



$\vec{F} = 0$.

e.g. 22-1. p.718.

uniform magnetic field $\vec{B}$.



$q_1 = 3.60 \mu C$

$v_1 = 862$ m/s.

$F_1 = 4.25 \times 10^{-3} N$.

Q1: direction of Force on q_1. — into the page. $\otimes \vec{F}$

Q2: $B = ?$

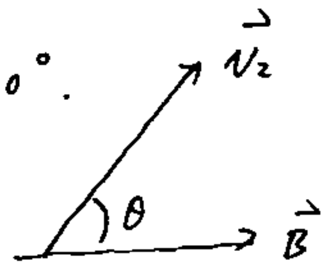
$\vec{v}_1 \perp \vec{B}$: $\theta = 90°$.

$\vec{F} = q_1 \vec{v}_1 \times \vec{B}$. $F = q_1 v_1 B \sin\theta = q v_1 B$.

$$B = \frac{F}{q_1 v_1} = \frac{4.25 \times 10^{-3} N}{3.60 \times 10^{-6} C \times 862 m/s} = 1.37 T$$

Q2: $q_2 = 53.0 \mu C$.

$v_2 = 1.30 \times 10^3$ m/s. Now: $\theta = 55.0°$.



$\vec{F}_2 = ?$

$\vec{F}_2$: direction : still into page. $\otimes$

magnitude:

$$F_2 = q_2 v_2 \cdot B \sin\theta$$

$$= 5.3 \times 10^{-5} \times 1.3 \times 10^3 \times 1.37 \times \sin 55°$$

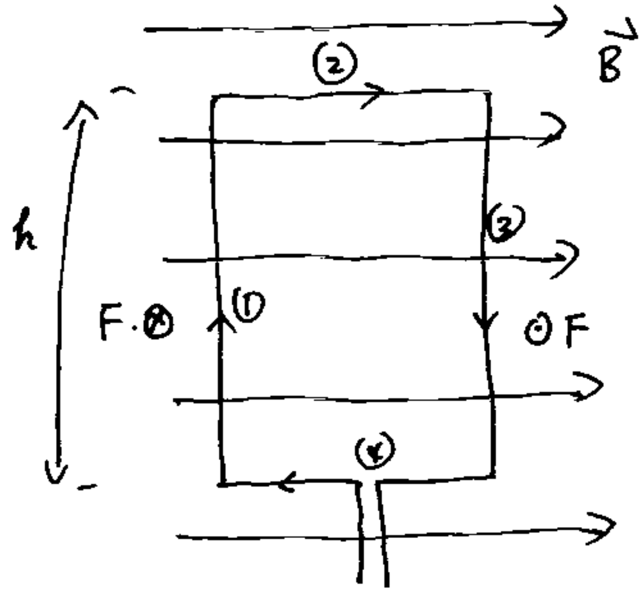
$$= 0.0773 N$$

- Magnetic Torque on a Loop of current.

①. When the loop is in the plane $\parallel \vec{B}$, $\vec{A} \perp \vec{B}$

$\vec{F}_2 = \vec{F}_4 = 0$

$\because \vec{v} \parallel \vec{B}$.



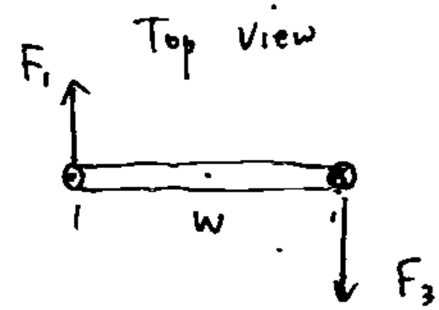
$\vec{F}_3$ — out of page

F_1 — into page.

$F_1 = F_3 = IhB$

$\tau = F_1 \frac{W}{2} + F_2 \frac{W}{2}$.

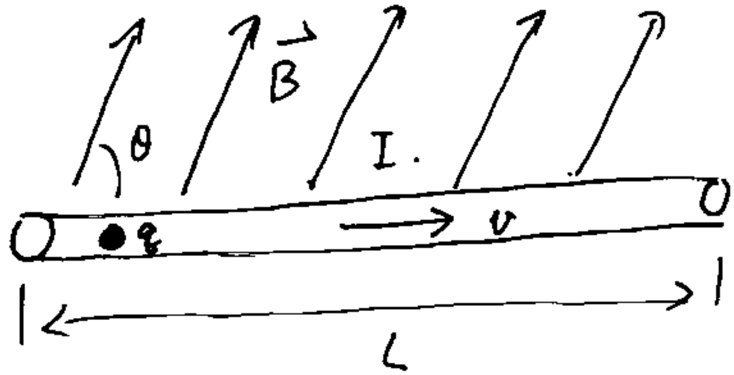
$= IBhW$.



$\tau = IBA$

A — area.

- Magnetic force on a current-carrying wire



In time Δt, charge q has moved by a length of L.

The current: $$I = \frac{q}{\Delta t}.$$

Multiply both sides by L: $$I \cdot L = \frac{q \cdot L}{\Delta t} = q \cdot v.$$

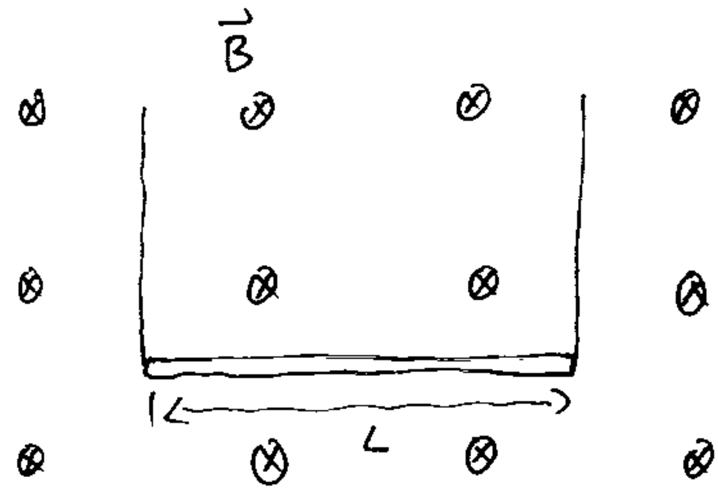
$$(\because\ v = \frac{L}{\Delta t}).$$

$\therefore$ Magnetic force:
$$F = qvB \cdot \sin\theta = ILB \cdot \sin\theta$$

e.g. 22-4. p.727

uniform $\vec{B}$ field.

A copper rod. suspened. from 2 thin wires.



$L = 1.50$ m

$m = 0.05$ kg.

$B = 0.55$ T.

Want : Lift The copper rod. by sending a current I through.

Q1. Direction of current I. $\longrightarrow$.

Q2: magnitude of the current.

$$F = IL \cdot B \cdot \sin\theta = mg.$$

$$I = \frac{F}{L \cdot B \sin\theta} = \frac{mg}{LB \sin\theta} \qquad \theta = 90°.$$

$$I = \frac{mg}{LB} = 5.95\,A.$$