Week 6 Homework

Physics 1B

February 15, 2007

1 Serway C19.3

Using the right hand rule a bunch of times, we see that the particle will move in a circle upwards until gets to the end of the region of the magnetic field. At this point it ceases to feel a magnetic force, and continues in a straight line away from the field region. An electron traverses a similar path, except instead of an upward circle, it makes a circle beneath the point of entry, in the clockwise direction.

2 Serway C19.4

Magnetic forces act in a direction perpendicular to the velocity of charged particles. However, if charges move along the direction of the magnetic field, there is no magnetic force. Therefore if we orient the current along the direction of the external magnetic field, there will be no magnetic force on the charge carriers.

3 Serway C19.5

The simplest test to differentiate between a magnetic and electric force is to look at the direction of the force. The direction of a force caused by an electric field is always in the same direction (the direction of the electric field), whereas a magnetic force always acts perpendicular to the velocity of a particle (except when the particle moves in the direction of the magnetic field).

Week 6 HW

4. Using the right hand rule:

$\vec{F} = q\,\vec{v}\times\vec{B}$ ($\vec{v}\times\vec{B}$ just means $vB\sin\Theta$, pointing in the direction given by the right hand rule)

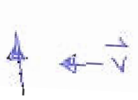
a)

Direction of $\vec{v}\times\vec{B}$: $\uparrow$

" " $q\vec{v}\times\vec{B}$: $\uparrow$

$\boxed{\text{Deflection: } \uparrow}$

b)



Direction of $\vec{v}\times\vec{B}$: $\otimes$ (into page)

" " $q\vec{v}\times\vec{B}$: $\odot$ (out of page)

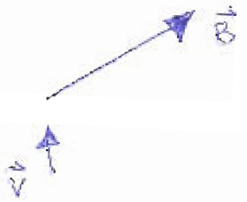
$\boxed{\text{Deflection: } \odot}$

c)

Direction of $\vec{v}\times\vec{B}$: 0 ($\vec{v}\times\vec{B} = \vec{0}$)

$\boxed{\text{No Deflection}}$

d)

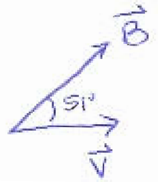


Direction of $\vec{v}\times\vec{B}$: $\otimes$

" " $q\vec{v}\times\vec{B}$: $\otimes$

$\boxed{\text{Deflection: } \otimes}$

Week 6 HW

10. 

- $F_{mag} = qvB\sin\Theta$ force on one Na^+ ion

$$= \underbrace{(1.60\times10^{-19}\ C)(0.851\ m/s)(0.254\ T)}_{3.458\times10^{-20}}\ \underbrace{\sin(51.0^\circ)}_{0.777}$$

$$= 2.687\times10^{-20}\ N$$

- Number of sodium ions in arm:

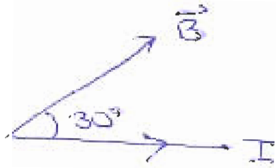
$$n = \frac{3.00\times10^{20}\ Na^+}{cm^3} \times \frac{100\ cm^3}{1\ arm}$$

$$= 3.00\times10^{22}\ Na^+$$

- $F_{mag} = n\,F_{mag1}$

$$\boxed{F_{mag} = 806\ N}$$

15. $F = BI\ell\sin\Theta$



$I = 10.0\ A$

$B = 0.300\ T$

$\Theta = 30.0^\circ$

$\ell = 5.00\ m$

$$F = (0.300\,T)(10.0\ A)(5.00\,m)\sin(30.0^\circ)$$

$$\boxed{F = 7.50\ N}$$

Week 6 HW

19. For the wire to move, the magnetic force must be at least as large as the gravitational force:

$$F_{min} = F_g$$
$$= mg$$

$$F_{mag} = I \ell B \sin\Theta$$

$$mg = I \ell B \sin\Theta$$

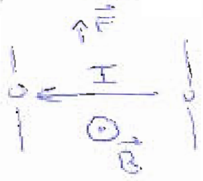
$$B = \frac{mg}{I \ell \sin\Theta}$$

B smallest when $\sin\Theta$ biggest possible (1)

$$B = \frac{(0.015\ kg)(9.8\ m/s^2)}{(5.0\ A)(0.15\ m)}$$

$$\boxed{B = 0.2\ T}$$

Since current is to the left and, by convention, current is thought of as the motion of positive charge carriers, for the force to be up $\vec{B}$ must be out of the page.



Week 6 HW

21. The right hand rule demonstrates that current parallel to the y axis experiences no magnetic force.

$\therefore F_{ab} = 0$

$F_{bc} = I \ell B \sin\theta$

$\theta = 90°$

$B = 0.0200\,T$

$\ell = 0.400\,m$

$I = 5.00\,A$

$\boxed{F_{bc} = 4.00 \times 10^{-2}\,N \text{ in } -\hat{x} \text{ direction}}$

$F_{cd} = I \ell B \sin\theta$

$\theta = 45°$

$B = 0.0200\,T$

$\ell = 0.566\,m$ (using Pythagorean theorem)

$I = 5.00\,A$

$\boxed{F_{cd} = 4.00 \times 10^{-2}\,N \text{ in } -\hat{z} \text{ direction}}$

$F_{da} = I \ell B \sin\theta$

$\theta = 90°$

$B = 0.0200\,T$

$\ell = 0.566\,m$

$I = 5.00\,A$

$\boxed{F_{da} = 5.66 \times 10^{-2}\,N}$ in xz plane (deflected 45° from both +x and +z axes)