Unit 25 – Homework Solution

29-1

a) $\vec{F}_m = q\,\vec{v} \times \vec{B}$ $\quad |\vec{F}_m| = q v B \sin\theta$

$|\vec{F}_m| = (+3.2 \times 10^{-19}\,C)(550\,m/s)(0.045\,T)\sin 52^\circ$

$= 6.2 \times 10^{-18}\,N$

b) $a = \dfrac{F_m}{m} = \dfrac{6.2 \times 10^{-18}\,N}{6.6 \times 10^{-27}\,kg} = 9.4 \times 10^{8}\,m/s^2$

c) Since magnetic force is perpendicular to the velocity, it doesn't change the magnitude of velocity, so it remains the same. This force is a centripetal force which changes the direction of $\vec{v}$.

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$\vec{v} = (2.0 \times 10^{6}\,m/s)\,\hat{i} + (3.0 \times 10^{6}\,m/s)\,\hat{j}$

$\vec{B} = (0.030\,T)\,\hat{i} - (0.15\,T)\,\hat{j}$

a) $\vec{F}_m = -e\,\vec{v} \times \vec{B} = (-1.6 \times 10^{-19}\,C)\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2\times10^{6} & 3\times10^{6} & 0 \\ 0.03 & -0.15 & 0 \end{vmatrix}$

$= (-1.6 \times 10^{-19})(-0.3\times10^{6} - 0.09\times10^{6})\,\hat{k}$

$= (6.24 \times 10^{-14}\,N)\,\hat{k}$

b) $q = +e \Rightarrow \vec{F}_m = (-6.24 \times 10^{-14}\,N)\,\hat{k}$

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$q = +2e$

$m = 4(1.66E{-27})\,kg$

$r = 0.045\ m$

$B = 1.20\,T$

a) The circular motion is the result of the magnetic force which is perpendicular to velocity.

$$F_m = \frac{mv^2}{r} \Rightarrow q\cancel{v}B = \frac{m v^{\cancel{2}}}{r}$$

$$\Rightarrow V = \frac{qBr}{m} = \frac{(2\times10^{-19}\times1.6)(1.20)(0.045)}{4\times1.66\times10^{-27}}$$

$$\Rightarrow V = 2.60\times10^{6}\ m/s$$

b) $$V = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{V} = \frac{2\pi\times0.045}{2.60\times10^{6}} = 1.08\times10^{-7}\,(S)$$

c) $$K = \frac{1}{2}mv^2 = \frac{1}{2}\times4\times1.66\times10^{-27}\times(2.60\times10^{6})^2 = 2.24\times10^{-14}\,J$$

$$= 1.4\times10^{5}\ eV$$

d) When a charged particle moves from two points with a potential difference of ΔV, its potential energy changes by $\Delta U = q\,\Delta V$

If $\Delta U = 1.4\times10^{5}$ $$\Rightarrow \Delta V = \frac{\Delta U}{q} = \frac{1.4\times10^{5}\,eV}{2} =$$

$$\Delta V = 7.0\times10^{4}\ V$$

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$\vec{B} = (-2.5\ mT)\hat{i} \qquad \vec{V} = (2000\ m/s)\hat{j}$

a) $\vec{E} = (4.0\ V/m)\ \hat{k}$

$$\vec{F} = q(\vec{E} + \vec{V} \times \vec{B}) = (1.6 \times 10^{-19} c)(4\hat{k} + 5\hat{k})$$

$$= (1.44 \times 10^{-18}\ N)\ \hat{k} \qquad |\vec{F}| = 1.44 \times 10^{-18}\ N$$

b) $\vec{E} = (4.0\ V/m)\ \hat{i}$

$$\vec{F} = (1.6 \times 10^{-19} c)(4.0\hat{i} + 5\hat{k})$$

$$= (6.4 \times 10^{-19}\ N)\hat{i} + (8.0 \times 10^{-19}\ N)\ \hat{k}$$

$$|F| = \sqrt{(6.4 \times 10^{-19})^2 + (8.0 \times 10^{-19})^2} = 1.02 \times 10^{-18}\ N$$

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$\vec{L} = (0.5\ m)\hat{i}$, $I = 0.50\ A$, $\vec{B} = (0.0030T)\hat{j} + (0.0100T)\hat{k}$

$$\vec{F}_m = I\ \vec{L} \times \vec{B} = (0.50\ A)(0.5\hat{i}) \times (0.003\hat{j} + 0.01\hat{k})$$

$$= 0.00075\ \hat{k} - 0.0025\ \hat{j} = (-2.5 \times 10^{-3}\ N)\hat{j} + (7.5 \times 10^{-4}\ N)\hat{k}$$

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The tension in the supporting leads is due to the weight of the wire. If magnetic force cancels the weight of the wire, tension will be removed.

$\vec{F}_m$ should be upward $\Rightarrow$ current is from left to right.

$$F_m = mg \Rightarrow ILB = mg \Rightarrow I = \frac{mg}{lB}$$

$$I = \frac{(13 \times 10^{-3}\ kg)(9.8\ N/kg)}{(0.62\ m)(0.440\ T)} = 0.467\ A$$

SP1 a) Using the right hand rule, you can find that the direction of the force is into the page.

b) $L = \pi r = \pi(6.5\ cm) = 20.4\ cm$, $I = 0.15\ A$

$\Delta L = \frac{L}{15} = \frac{20.4}{15} = 1.36\ cm$, $B = 40.0\ T$

$\Delta\theta = \frac{180}{15} = 12°$

$\vec{\Delta F} = I\ \vec{\Delta L} \times \vec{B} \Rightarrow |\vec{\Delta F}| = I(\Delta L) B \sin\theta$ $\qquad \Delta L = R\Delta\theta$

$\Rightarrow |\vec{\Delta F}| = IRB \sin\theta\ \Delta\theta$