PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

Section 1 **Quiz 7** **28 March 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An open plastic soda bottle with an opening diameter of *3 cm* is placed on a table. A uniform *2.25 T* magnetic field directed upward and oriented 37^o from vertical encompasses the bottle.

What is the total magnetic flux through the plastic of the soda bottle?

(Cos 37^o 0.8= , Sin 37^o = 0.6. Take π=3)

Solution: The total flux through the bottle is zero because it is a closed surface. The total flux is the flux through the plastic and plus the flux through the open cap, so the sum of these must be zero. $\Phi_{plastic} + \Phi_{cap} = 0$

$$\Phi_{plastic} = -\Phi_{cap} = -BA\cos\phi = -B(\pi r^2)\cos\phi$$

by substituting the numbers gives $\Phi_{plastic} = -(2.25)\pi(0.015\text{ m})^2\cos 37^\circ$

$$\Rightarrow \Phi_{plastic} = 1.215 \times 10^{-3}\ Wb$$

It would be difficult to calculate the flux through the plastic directly, because of the complex shape of the bottle, but with a little thought we can find this flux through a simple calculation.

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Section 2 Quiz 7 28 March 2013

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

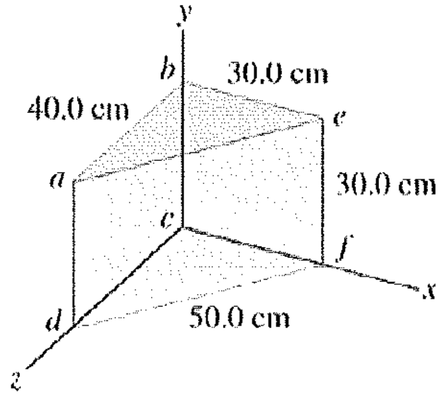
The magnetic field $\vec{B}$ in a certain region is *0.200 T*, and its direction is that of the +*z* axis as shown in the figure.

a) What is the magnetic flux across the surface abcd in the figure?

b) What is the magnetic flux across befc?

c) What is the magnetic flux across the surface aefd?

d) What is the net flux through all five surfaces that enclose the shaded volume?



Solution: When $\vec{B}$ is uniform across the surface, $\Phi_B = \vec{B} \cdot A$

$\Phi_B = \vec{B} \cdot \vec{A} = BA\cos\phi$. $\vec{A}$ is normal to the surface and is directed outward from the enclosed surface. For surface abcd, $\vec{A} = -A\hat{i}$.
For surface befc, $\vec{A} = -A\hat{k}$. For surface aefd, $\cos\phi = \frac{3}{5}$ and the flux is positive.

part a) $\Phi_B(abcd) = \vec{B} \cdot \vec{A} = 0$

part b) $\Phi_B = \vec{B} \cdot \vec{A} = -(0.2T)(0.300m)^2 = -0.018$ Wb

part c) $\Phi_B(aefd) = \vec{B} \cdot \vec{A} = BA\cos\phi = \frac{3}{5}(0.2T)(0.500)(0.300) = +0.018$ Wb

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Section 3 **Quiz 7** **28 March 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A flat square surface with side length *6.10 cm* is in the *xy*-plane at *z=0*. Calculate the magnitude of the flux through this surface produced by a magnetic field $\vec{B} = (0.400T)\hat{i} + (0.100T)\hat{j} - (0.200T)\hat{k}$.

Solution: Knowing the area of a surface and the magnetic field it is in, we want to calculate the flux through it.

$d\vec{A} = dA\,\hat{k}$, so $d\Phi_B = \vec{B}\cdot d\vec{A} = B_z\,dA$

$\Phi_B = B_z A = (-0.200T)(0.0610\,m)^2 = -7.44\times10^{-4}\,T\cdot m^2$.

$|\Phi_B| = 7.44\times10^{-4}\,Wb$

Since the field is uniform over the surface, it is not necessary to integrate to find the flux.

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Section 4 **Quiz 7** **28 March 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A group of particles is traveling in magnetic field of unknown magnetic and direction. You observe that a proton moving at 1.00 km/s in the $+x$-direction experience a force of 2.00 $\times 10^{-16} N$ in the $+y$-direction, and an electron moving at 4.50 km/s in the $-z$-direction experiences a force of 8.00×10^{-16}N in the $+y$-direction.

(a)What are the magnitude and direction of the magnetic field?

(b)What are the magnitude and direction of the magnetic force on an electron on an electron moving in the $-y$-direction at 3.00 km/s? ($e = 1.60x10^{-19} C$)

Solution: apply $\vec{F} = q\vec{v} \times \vec{B}$ to the force on the proton and to the force on the electron, solve for the components of $\vec{B}$ and use them to find its magnitude and direction.

$\vec{F}$ is perpendicular to both $\vec{v}$ and $\vec{B}$. Since the force on the proton is in the $+y$-direction, $B_y = 0$ and $\vec{B} = B_x\hat{i} + B_z\hat{k}$. for the proton, $\vec{v}_p = (1 km/s)\hat{i} = v_p\hat{i}$ and $\vec{F}_p = (2 \times 10^{-16} N)\hat{j} = F_p\hat{j}$. for the electron, $\vec{v}_e = (4.50 \ km/s)\hat{k} = -v_e\hat{k}$ and $\vec{F}_e = (8 \times 10^{-16} N)\hat{j} = F_e\hat{j}$. The magnetic force is $\vec{F} = q\vec{v} \times \vec{B}$

part a) for the proton, $\vec{F}_p = q\vec{v}_p \times \vec{B}$ gives $F_p\hat{j} = ev_p\hat{i} \times (B_x\hat{i} \times B_z\hat{k}) = -ev_pB_z\hat{j}$. Solving for B_z gives $B_z = -\frac{F_p}{ev_p} = -\frac{2 \times 10^{-16} N}{(1.60 \times 10^{-19} C)(1000 m/s)} = -1.25 T$. For electron, $\vec{F}_e = -e\vec{v}_e \times \vec{B}$, which gives $F_e\hat{j} = (-e)(-v_e\hat{k}) \times (B_x\hat{i} + B_z\hat{k}) = ev_eB_x\hat{j}$. Solving for B_x gives $B_x = \frac{F_e}{ev_e}$

$$B_x = \frac{F_e}{ev_e} = \frac{8 \times 10^{-16}}{(1.60 \times 10^{-19} C)(4500 m/s)} = 1.111 T$$

Therefore $\vec{B} = 1.111 T\hat{i} - 1.25 T\hat{k}$. So the magnitude of the field is $B = \sqrt{B_x^2 + B_z^2} = \sqrt{(1.111 T)^2 + (-1.25 T)^2} = 1.63 T$

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Section 5 **Quiz 7** **28 March 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A particle with charge 7.00μC is moving with velocity $\vec{V}$ =-(3.00 × 10^3 $^m/_s$) $\hat{j}$. The

magnetic force on the particle is measured to be $\vec{F}$=+(7.00× $10^{-3}N$) $\hat{i}$ - (5.00× $10^{-3}N$) $\hat{k}$.
(a) Calculate all the components of the magnetic field you can from this information.
(b)Are there components of the magnetic field that are not determined by the measurement of the force? Explain.
(c)Calculate the scalar product $\vec{B}.\vec{F}$. What is the angle between $\vec{B}$ and $\vec{F}$?

Solution: First apply $\vec{F} = q\vec{v}\times\vec{B}$

set up: $\vec{v} = v_y\hat{j}$, with $V_y = -3.00 \times 10^{+3}$ m/s and $F_x = 7.00 \times 10^{-3}$ N, $F_y = 0$

and $F_z = -5.00 \times 10^{-3}$ N

part a) $F_x = q(v_y B_z - V_z B_y) = q v_y B_z \longrightarrow B_z = F_x / q v_y$

so $B_z = (7 \times 10^{-3} N) / [(7\times10^{-6} c)(-3\times10^{3} m/s)] = -0.333$ T

$F_y = q(V_z B_x - V_x B_z) = 0$, which is consistent with $\vec{F}$ as given in the problem. There is no force component along the direction of the velocity.

$F_z = q(V_x B_y - V_y B_x) = -q v_y B_x$. $B_x = -F_z / q v_y \Rightarrow B_x = -\frac{F_z}{q v_y} = -\frac{(+5\times10^{-3} N)}{[(7\times10^{-6} c)\times(-3\times10^{3})]}$

$\Rightarrow B_x = -0.238$ T

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Section 6 **Quiz 7** **28 March 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A particle with charge -5.00 nC is moving in a uniform magnetic field $\vec{B}$=-(1.50T)$\hat{k}$. The magnetic force on the particle is measured to be $\vec{F}$=-(3.00× $10^{-7}N$) $\hat{\imath}$ + (7.00× $10^{-7}N$) $\hat{\jmath}$.

(a)Calculate all the components of the velocity of the particle that you can from this information .

(b) Are there components of the velocity that are not determined by the measurement of the force? Explain.

(c)Calculate the scalar product $\vec{v}.\vec{F}$. What is the angle between $\vec{v}$ and $\vec{F}$?

Solution: $\vec{F} = q\vec{v}\times\vec{B} = qB_z[v_x(\hat{i}\times\hat{k}) + v_y(\hat{j}\times\hat{k}) + v_z(\hat{k}\times\hat{k})] = qB_z[v_x(-\hat{j}) + v_y(\hat{i})]$

part a) set the expression for $\vec{F}$ equal to the given value of $\vec{F}$ to obtain:

$$v_x = \frac{F_y}{-qB_z} = \frac{(7\times10^{-7}N)}{-(-5\times10^{-9}c)(-1.50T)} = -93.3\ \frac{m}{s}$$

$$v_y = \frac{F_x}{qB_z} = \frac{-(3\times10^{-7}N)}{-(-5\times10^{-9}c)(-1.5T)} = -40\ \frac{m}{s}$$

part b) v_z does not contribute to the force, so is not determined by a measurement of $\vec{F}$.

part c) $\vec{v}.\vec{F} = v_xF_x + v_yF_y + v_zF_z = \frac{F_y}{-qB_z}F_x + \frac{F_x}{+qB_z}F_y = 0 \Rightarrow \theta = 90°$

So easily we can know the force is perpendicular to both $\vec{v}$ and $\vec{B}$