21F-PHYSICS1C-1 Phys 1C Section 1 Quiz 2

QUAN DO

TOTAL POINTS

6 / 6

QUESTION 1

1 Magnetic force between 2 wires **5 / 5**

✓ **+ 1 pts Correct for 1a**

+ **0.5 pts** Partially correct for 1a
+ **0 pts** Incorrect for 1a

✓ **+ 1 pts Correct for 1b**

+ **0.5 pts** Partially correct for 1b
+ **1 pts** "Correct for 1b", the error is carried out from part 1a
+ **0 pts** Incorrect for 1b

✓ **+ 1 pts Correct for 1d**

+ **0 pts** Incorrect for 1d

✓ **+ 1 pts Correct for 1c Ans: B= mu_0 I/(2pi d)**

+ **0.5 pts** Partially correct for 1c
+ **0 pts** Incorrect for 1c

✓ **+ 1 pts Correct for 1e Ans: +y or upwards. Use right hand rule or dF= I dl x B**

+ **0.5 pts** Partially correct for 1e
+ **0 pts** Incorrect for 1e
+ **0.5 pts** Partially correct for 1d

QUESTION 2

2 Long solenoid and Ampere's Law **1 / 1**

✓ **+ 1 pts Correct. Ans: The field remains the same when we change the shape from circular to rectangular as the wire is tightly wound and wire diameter<<cross section<<dimensions of coil shape<<solenoid length**

+ **0 pts** Incorrect

(1) The field remains same as long as the wire is tightly wound and wire diameter<<cross section<<dimensions of coil shape<<solenoid length

Quan Do

[redacted]

Physics 1C Section 1, Fall 2021

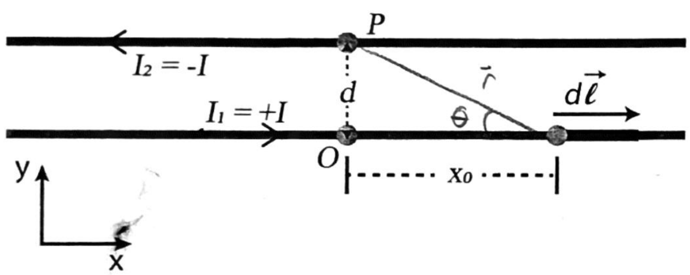
Quiz #2: Ch. 28, Young and Freedman

October 11, 2021

Quiz rules: Please write your name and student ID on the front of the exam! No electronic gadgets of any kind, and the quiz is closed book and closed notes. Write your solutions directly in the spaces provided on the exam sheets.

On completion of the quiz, scan your work and convert to pdf using a smart phone scanning app such as Adobe Scan, Scannable, or Tiny Scanner. Then upload the converted document to Gradescope. Gradescope is accessible to you on the CCLE page, under Course apps.

Question 1. Magnetic force between 2 straight, parallel wires, each carrying current I, but in opposite direction ($I_2 = -I_1$). The x, y axes are labeled in the diagram. The condition $L \gg d$ applies, where L is the length of the wires, and d is the distance between them. Wire #1 passes through the origin (O). (5 points total)



$d\ell \cdot \sin\theta$ → $d\ell \cdot \frac{d}{r}$

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\, d\vec{\ell} \times \hat{r}}{r^2}$$

r^2 → $d^2 + x_0^2$

$$= \frac{\mu_0 I}{4\pi} \cdot \frac{d\ell \cdot d}{(d^2+x_0^2)^{3/2}}$$

a. Consider first the magnetic field produced by the current I_1 in wire #1: write down the contribution to the magnetic field ($d\mathbf{B}_1$) at **P** that results from the current in the segment $d\vec{\ell}$. Your answer should be written in terms of μ_0, I, d, x_0, $d\vec{\ell}$.

$$dB_1 = \frac{\mu_0 I}{4\pi} \cdot \frac{d\ell \cdot d}{(d^2+x_0^2)^{3/2}}$$

b. Using the answer for (a), express *in integral form* the total field at **P** produced by the current in wire #1. Note: **do not solve the integral!**

$$B_1 = \frac{\mu_0 I}{4\pi} \int_{-L/2}^{L/2} \frac{d}{(d^2+x^2)^{3/2}}\, dx$$

c. Write down Ampère's Law, then apply it to this case to find the magnetic field at **P** resulting from the current in wire #1. Your answer should be written in terms of I, μ_0, d.

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{encl}$$

At radius d: $\oint \vec{B} \cdot d\vec{\ell} = B \cdot 2\pi d = \mu_0 I$

$$B = \frac{\mu_0 I}{2\pi d}$$

d. What is the direction of **B** at **P**, resulting from I_1?

Out of page

e. What is the direction of the magnetic force on wire #2 resulting from the current I_1?

up

Question 2. We have found that the magnetic field inside a long solenoid from Ampère's Law, as

$$B = \mu_0 n I,$$

where n is the number of turns per unit length. Does the answer change if the shape of the solenoid cross-section changes from circular to rectangular? As briefly as possible, explain your reasoning. (1 point total)

When we used Ampere's Law, we only cared about $\oint \vec{B} \cdot d\vec{\ell}$ and the total current through it. The current does not change with the solenoid shape. With $\oint \vec{B} \cdot d\vec{\ell}$, we had 4 segments. The outside segment is still $B = 0$, as well as the $\perp$ segments. So the inside segment must be the same as before. So B is still $= \mu_0 n I$.

1

1 Magnetic force between 2 wires **5 / 5**

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c. Write down Ampère's Law, then apply it to this case to find the magnetic field at **P** resulting from the current in wire #1. Your answer should be written in terms of I, μ_0, d.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{encl}$$

At radius d: $\oint \vec{B} \cdot d\vec{l} = B \cdot 2\pi d = \mu_0 I$

$$\boxed{B = \frac{\mu_0 I}{2\pi d}}$$

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