Welcome to the Physics class

Principles of Physics II

Lecture 23

Problems

Chapter 29: Magnetic Fields due to current

••**36** In Fig. 29-64, five long parallel wires in an xy plane are separated by distance $d = 8.00$ cm, have lengths of 10.0 m, and carry identical currents of 3.00 A out of the page. Each wire experiences a magnetic force due to the currents in the other wires. In unit-vector notation, what is the net magnetic force on (a) wire 1, (b) wire 2, (c) wire 3, (d) wire 4, and (e) wire 5?

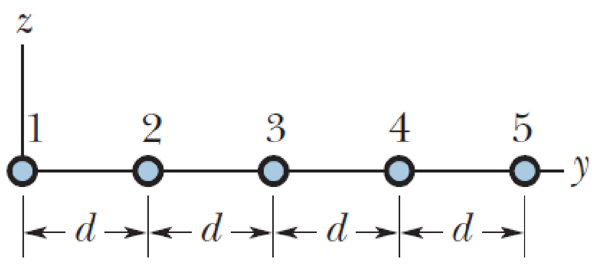

Figure 29-64 Problems 36 and 39.

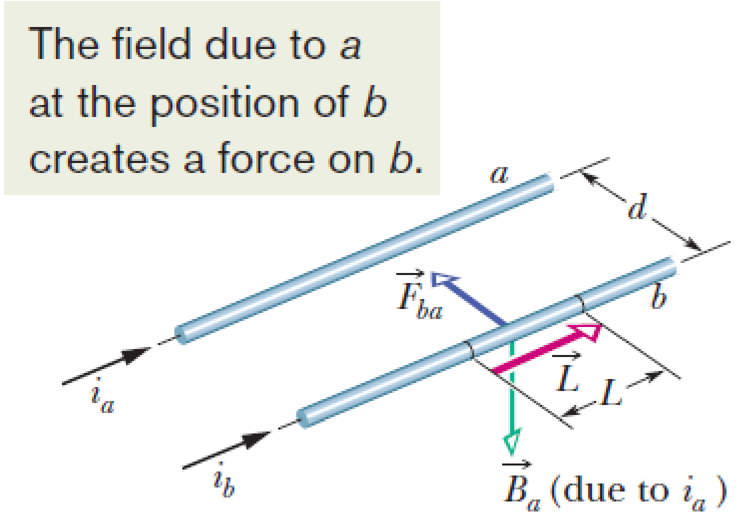

Figure 29-10 Two parallel wires carrying currents in the same direction attract each other. $\vec{B}_a$ is the magnetic field at wire b produced by the current in wire a. $\vec{F}_{ba}$ is the resulting force acting on wire b because it carries current in $\vec{B}_a$.

$$F_{ba} = i_b L B_a \sin 90° = \frac{\mu_0 L i_a i_b}{2\pi d}. \quad (29\text{-}13)$$

(36) The wires are labelled as 1 … 5.

We know $F_{ba} = i_b L B_a \sin 90^\circ$

$$F_{ba} = \frac{\mu_0 L i_a i_b}{2\pi d}$$

(a) Magnetic force on wire 1 is for remaining 4 and they all add as their magnetic fields at location 1 are all in the same direction along y-axis

$$\therefore \vec{F}_1 = \frac{\mu_0 i^2 l}{2\pi}\left(\frac{1}{d} + \frac{1}{2d} + \frac{1}{3d} + \frac{1}{4d}\right)\hat{j}$$

$$= \frac{25\mu_0 i^2 l}{24\pi d}\hat{j} = \frac{25 \times 4\pi \times 10^{-7} \times 3^2 \times 10}{24\pi \times 8 \times 10^{-2}}\hat{j}$$

$$= (4.69 \times 10^{-4}\ N)\hat{j}$$

(b) For wire 2 contributions from 3 and 1 cancel out. Wire 1 will attract along ~~+y~~ −y and 3 will attract along +y

$$\therefore F_2 = \frac{\mu_0 i^2 l}{2\pi}\left(\frac{1}{2d} + \frac{1}{3d}\right) = \frac{5\mu_0 i^2 l}{12\pi d}\hat{j}$$

$$= 1.88 \times 10^{-4}\ N\hat{j}$$

(c) $\vec{F}_3 = 0$ symmetric location of wire 3

(d) $\vec{F}_4 = -F_2 = (-1.88 \times 10^{-4}\ N)\hat{j}$

(e) $\vec{F}_5 = -\vec{F}_1 = -4.69 \times 10^{-4}\ N\hat{j}$

ments from (x, y, z) coordinates $(4d, 0, 0)$ to $(4d, 3d, 0)$ to $(0, 0, 0)$ to $(4d, 0, 0)$, where $d = 20$ cm?

•43 Figure 29-67 shows a cross section across a diameter of a long cylindrical conductor of radius $a = 2.00$ cm carrying uniform current 170 A. What is the magnitude of the current's magnetic field at radial distance (a) 0, (b) 1.00 cm, (c) 2.00 cm (wire's surface), and (d) 4.00 cm?

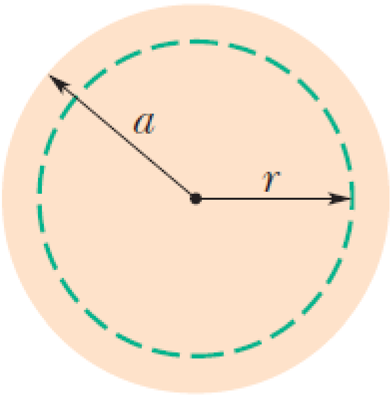

Figure 29-67 Problem 43.

$$B = \frac{\mu_0 i}{2\pi r} \quad \text{(outside straight wire).} \qquad (29\text{-}17)$$

$$B = \left(\frac{\mu_0 i}{2\pi R^2}\right) r \quad \text{(inside straight wire).} \qquad (29\text{-}20)$$

43) Magnetic field inside the wire itself is given by $B = \frac{\mu_0 i}{2\pi R^2} r$ (inside wire) ①

& $B = \frac{\mu_0 i}{2\pi r}$ (outside wire) ②

ⓐ at $r = 0$, $B = 0$ equation ①

ⓑ at $r = 0.01\,m$ $B = \frac{\mu_0 i}{2\pi a^2} r$ equation ①

$$B = \frac{(4\pi \times 10^{-7})(170)(0.01)}{2\pi (0.02m)^2}$$

$$= 8.5 \times 10^{-4}\,T.$$

ⓒ At $r = a = 0.02\,m$

$$B = \frac{\mu_0 i r}{2\pi a^2} = \frac{4\pi \times 10^{-7} \times 170 \times 0.02}{2\pi \times (0.02)^2}$$

$$= 1.70 \times 10^{-3}\,T.$$

ⓓ At $r = 0.04\,m$ $B = \frac{\mu_0 i}{2\pi r}$ (eqn 2)

$$B = \frac{4\pi \times 10^{-7} \times 170}{2\pi \times 0.04} = 8.50 \times 10^{-4}\,T$$

••53 A long solenoid has 100 turns/cm and carries current i. An electron moves within the solenoid in a circle of radius 2.30 cm perpendicular to the solenoid axis. The speed of the electron is $0.0460c$ (c = speed of light). Find the current i in the solenoid.

$$|q|vB = \frac{mv^2}{r},$$

from which we find the radius r of the circle to be

$$r = \frac{mv}{|q|B}.$$

$$B = \mu_0 in \quad \text{(ideal solenoid)},$$

$$B = \mu_0 i n \quad \text{(ideal solenoid)}, \quad r = \frac{mv}{|q|B}.$$

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We use $r = \frac{mv}{|q|B}$ &

$B = \mu_0 n i$ (for ideal solenoid)

$\therefore \quad r = \frac{mv}{qB}$ and $B = \mu_0 n i$

$\therefore \quad r = \frac{mv}{eB} = \frac{mv}{e \mu_0 n i}$ $\quad n = \frac{100}{.01}$ turns/m.

$\cancel{r = \frac{9.11 \times 10^{-31} \times 0.046 \times 3 \times 10^{8} \text{ m/se}}{1.6 \times 10^{-19} \times 4\pi \times 10^{-7}}}$

$\therefore \quad i = \frac{mv}{e \mu_0 n r} = \frac{9.11 \times 10^{-31} \times .046 \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 4\pi \times 10^{-7} \times \frac{100}{.01} \times 2.3 \times 10^{-2}}$

$\cancel{1.6 \times 10^{-19} \times 4\pi \times 10^{-7}}$

$\therefore \quad i = \frac{mv}{e \mu_0 n r} = \frac{9.11 \times 10^{-31} \times .046 \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 4\pi \times 10^{-7} \times \frac{100}{.01} \times 2.3 \times 10^{-2}}$

$= 0.272$ Amp

PHY 112 (4) Summer Semester 2023

Exam on 7th September, 2023 at 11:00 am in room no UB 20204

Syllabus for TERM FINAL Examination

Chapter 25 to Chapter 30 and, Chapter 37
Capacitance to Maxwell's Equations and Relativity
HRW 10 Edition Extended

PHY112	04	Professor Dr. A. F. M. Yusuf Haider	YUH	UB20204	ST DAY 2 Friday	08-09-2023	11:00 am	12:30 pm

1125 PHY112 4 8-Sep-23 11:00 AM 1:00 PM UB20204

Thank you very much

Good Luck to you all.

Please pray for me.