PHYS 102: General Physics - KOÇ UNIVERSITY
College of Sciences
Quiz 10 Dec 16, 2016

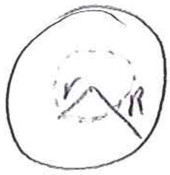
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
Name: ID #: Signature:

Q. An airplane in an intercontinental flight can have a wing span of 60 m. and fly at a speed of 1080 km/h. If the Earth's magnetic field is 0.5 G (5.0×10^{-5} T), what is the maximum potential difference induced between the opposite tips of the wings?

$$\mathcal{E} = vBl = 1080 \times \frac{1000}{3600} \times 5 \times 10^{-5} \times 60 = 90 \text{ V}$$

Q. A long, think solenoid has $n = 1000$ turns per meter and a radius of $R = 4.0$ cm. The current in the solenoid is increasing at a uniform rate of $di/dt = 1.0$ A/s. Find the magnitude of the induced electric field one a wire loop with radius $r = 2.0$ cm at the center of the solenoid and perpendicular to the solenoid's axis. (Use $\pi = 3$ and $\mu_0 = 4\pi \times 10^{-7}$ Tm/A.)

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$$



$$\begin{cases} \oint \vec{E} \cdot d\vec{l} = E(2\pi r) & ① \\ \Phi_B = B(\pi r^2) \Rightarrow \left| -\frac{d\Phi_B}{dt} \right| = \pi r^2 \left| \frac{dB}{dt} \right| & ② \end{cases}$$

$$①, ② \Rightarrow E = \frac{1}{2} r \left| \frac{dB}{dt} \right|$$

$$B = \mu_0 n i \rightarrow \frac{dB}{dt} = \mu_0 n \frac{di}{dt}$$

$$\Rightarrow E = \frac{1}{2} r \mu_0 n \frac{di}{dt} = \frac{1}{2} \times 2 \times 10^{-2} \times 4 \times 3 \times 10^{-7} \times 1000 \times 1 = 1.2 \times 10^{-5} \ \frac{V}{m}$$

Q. A 2.0 cm by 10.0 cm rectangular wire loop with resistance $R = 1.0\ \Omega$ is being pulled to the right out of a region of uniform magnetic field directed into the page and with magnitude $B = 2.0$ T. At the instant when the speed is 3.0 m/s and it is still partially in the field region, what force (magnitude and direction) does the magnetic field exert on the loop?

$$I = \frac{\mathcal{E}}{R} = \frac{vBl}{R}$$

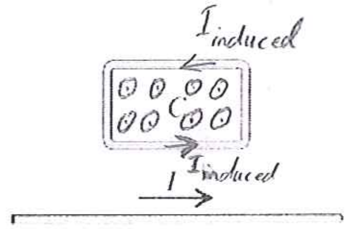
$$F_B = IlB = \frac{vl^2B^2}{R} = \frac{3 \times (2 \times 10^{-2})^2 \times (2)^2}{1} = 4.8 \times 10^{-3}\ N$$

$\vec{B}$ into the page, Φ_B decreasing, field of the induced current in into the page, the induced current is clockwise

$$\vec{F} = I\vec{l} \times \vec{B}$$

Force on the left-hand end of the loop to be to the left.

Q. A closed loop C is near a long wire carrying a current $I = I_0 e^{-bt}$ where $b > 0$. Find the direction (clockwise or counterclockwise) of the current induced in the loop for $t > 0$. If the loop is stationary at $t = 0$, describe its motion for $t > 0$ (and give an explanation for your answer).



Lenz's law: the induced current flows to oppose the flux change that caused it.

current I is decreasing ⇒ the flux is decreasing

The magnetic field of the long wire is directed out of the page at C and decreases.

⇒ the induced current in C is counterclockwise.

The flux through C is decreasing, so it will be pulled toward the long wire to oppose this decrease.

like two parallel wires carry current in the same direction. ⇐

⇓

They attract each other!