2.2: Magnetic Forces & EM Induction

3. Two long straight current-carrying wires run parallel to each other. The current in one of the wires is 4.6 A, their separation is 4.2 cm and they repel each other with a force per unit length of 2.9×10^{-4} N/m.

    1. Determine the current in the other wire.

    $$I_2 = \frac{2\pi(4.2 \times 10^{-2})(2.9 \times 10^{-4})}{(4\pi \times 10^{-7})(4.6)}$$

    $$\boxed{13.24}$$

    2. Determine if the currents are in the same or opposite direction.

    Since the two currents are repelling each other according to the right-hand rule, they are in opposite directions.

    3. Determine what will happen if the direction of one current is reversed and tripled.

    Using the equation

    $$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

    We conclude that the when any current is tripled, the force per unit length also is tripled. Additionally, since the current is reversed, the wires are now attracted to each other rather than repelled.

4. A 0.150 m radius, 510-turn coil is rotated one-fourth of a revolution in 4.17 ms, originally having its plane perpendicular to a uniform magnetic field. Find the magnetic field strength needed to induce an average emf of 10,000 V.

$$|\varepsilon| = |-N\frac{\Delta\phi}{\Delta t}|$$

$$B = \frac{10000 \cdot 4.17 \times 10^{-3}}{(510)(0.150)} = \boxed{1.16}$$

6. A conducting rod of length $L = 28.0$ slides over two horizontal metal bars with a constant speed v to the left through a distance Δx in time Δt. The entire setup is in a region of uniform magnetic field of magnitude 1.65 T that is directed perpendicular to the rods and out of the page.

    1. If the induced emf has a magnitude 1.00 V, what is the speed with which the rod moves?

    $$v = \frac{1}{(0.28)(1.65)} = \boxed{2.16}$$

    2. What is the direction of the induced current in the resistor R?

    Using the right-hand rule, we find that the current flows counterclockwise; from b to a.

10. A single turn coil of radius 4.50 cm is held in a vertical plane and a magnet is rapidly moved relative to the coil as shown in the diagram below.

$$I = \frac{S\frac{db}{dt}}{R}$$

$$I = \frac{\pi(0.045)^2 \times 0.245}{(2.90)(0.120)} = \boxed{4.48}$$

From the right hand rule, I concluded that the direction is counterclockwise