Midterm Exam No. 02 (2014 Summer)

PHYS 203B: College Physics

Date: 2014 Jul 3

Solutions

(Name) (Signature)

1. **(10 points.)** A charge of $-7.1\,\mu$C is traveling at a speed of 7.1×10^6 m/s in a region of space where there is a uniform magnetic field of magnitude 1.3×10^{-4} T. What is the magnitude of the magnetic force acting on the charge if the angle between the velocity of the charge and the field is 50°.

2. **(10 points.)** A magnetic field has a magnitude of 1.20×10^{-3} T, and an electric field has a magnitude of 4.40×10^3 N/C. Both fields point in the same direction. A positive $1.8\,\mu$C charge moves at a speed of 3.00×10^6 m/s in a direction that is perpendicular to both fields. Determine the magnitude of the net force that acts on the charge.

3. **(10 points.)** A 1.5 m long straight wire carries a current of 0.66 A. This wire makes an angle of 58° with respect to a magnetic field of magnitude 5.60×10^{-5} T. What is the magnitude of the magnetic force experienced by the wire?

4. **(10 points.)** A wire has a length of 4.80×10^{-2} m and is used to make a circular coil of one turn. There is a current of 4.40 A in the wire. In the presence of a 1.50 T magnetic field, what is the maximum torque that this coil can experience?

5. **(10 points.)** A square loop of wire consisting of a single turn is perpendicular to a uniform magnetic field. The square loop is then re-formed into a circular loop, which consists of two turns and is also perpendicular to the same magnetic field. The magnetic flux that passes through the square loop is 3.9×10^{-3} Wb. What is the flux that passes through the circular loop?
   Caution: Note that the circular loop has two turns.

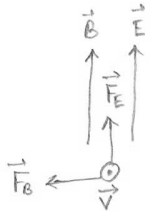
6. **(10 points.)** The coil of a generator has a radius of 0.20 m. When this coil is unwound, the wire from which it is made has a length of 5.4 m. The magnetic field of the generator is 0.29 T, and the coil rotates at an angular speed of 30 rad/s. What is the peak emf of this generator?

7. **(20 points.)** Figure 1 shows a conducting a rod being pulled along horizontal, frictionless, conducting rails at a constant speed v. A uniform magnetic field $\mathbf{B}$ fills the region in which the rod moves. Assume $L = 10$ cm, $v = 4.0$ m/s, $B = 1.4$ T, and $R = 0.40\,\Omega$.

MTE-02, Prob. 1

$$F = qvB\sin\theta = 7.1\times10^{-6}\times 7.1\times10^{6}\times 1.3\times10^{-4}\sin 50$$
$$= 5.02\times10^{-3}\ N$$

MTE-02, Prob. 2



$$F_E = qE = 1.8\times10^{-6}\times 4.40\times10^{3}$$
$$= 7.92\times10^{-3}\ N$$

$$F_B = qvB\sin\theta = 1.8\times10^{-6}\times 3.00\times10^{6}\times 1.20\times10^{-3}\times\sin 90$$
$$= 6.48\times10^{-3}\ N$$

$$F = \sqrt{F_E^2 + F_B^2} = \sqrt{7.92^2 + 6.48^2}\times10^{-3}\ N$$
$$= 1.02\times10^{-2}\ N$$

MTE-02, Prob. 3

$$F = ILB\sin\theta = 0.66\times 1.5\times 5.6\times10^{-5}\times\sin 58$$
$$= 4.7\times10^{-5}\ N.$$

MTE-02, Prob. 4

$$2\pi R = 4.80\times10^{-2}$$
$$R = 7.64\times10^{-3}\ m$$

$$A = \pi R^2 = \pi\times(7.64\times10^{-3})^2 = 1.83\times10^{-4}\ m^2.$$

$$\tau = NIAB\sin\theta \quad \text{(for maximum)}$$
$$= 1\times 4.40\times 1.83\times10^{-4}\times 1.50\times\sin 90$$
$$= 1.21\times10^{-3}\ Nm$$

MTE-02, Prob. 5

Area of square loop = $A_s = L^2$

$2\pi R \times 2 = 4L$

$L = \pi R$

$R = \frac{L}{\pi}$

Area of circular loop = $A_c = \pi R^2$

$= \pi \left(\frac{L}{\pi}\right)^2 = \frac{L^2}{\pi}$

$$\frac{\phi_c}{\phi_s} = \frac{N_c B A_c}{N_s B A_s} = \frac{2}{1} \frac{\left(\frac{L^2}{\pi}\right)}{L^2} = \frac{2}{\pi}$$

$$\phi_c = \frac{2}{\pi} \phi_s = \frac{2}{\pi} \times 3.9 \times 10^{-3} = 2.48 \times 10^{-3} \text{ Wb.}$$

MTE-02, Prob 6

$$N = \frac{5.4 \text{ m}}{2\pi \times 0.20 \text{ m}} = 4.3 \text{ turns}$$

$$V_{max} = N B A \omega = 4.3 \times 0.29 \times \pi \times (0.2)^2 \times 30$$

$$= 4.7 \text{ V}$$

MTE-02, Prob 7

(a) decreasing.

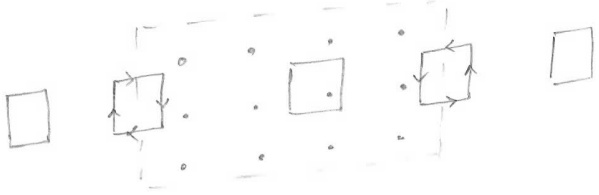
(b) counterclockwise.

(c) $I = \frac{B v L}{R}$

$= \frac{1.4 \times 4 \times 0.1}{0.4}$

$= 1.4 \text{ A}$

MTE-02, Prob 8



I=0 clockwise I=0 counter clockwise I=0