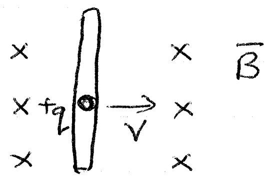
HOMEWORK 8 SOLUTIONS

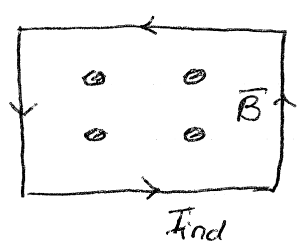
1\. (29.20) a) $\mathcal{E} = vB\ell = (5\,m/s)(0.75\,T)(1.5\,m) = 5.6\,V$

b) (i)



$\bar{F} = q(\bar{v} \times \bar{B})$, which points upward. This force pushes the current in a counterclockwise direction through the circuit.

(ii) The flux through the circuit is increasing, so the induced current must cause a magnetic field out of the paper to oppose this increase. Hence this current must flow in a counterclockwise sense.



c) $\mathcal{E} = Ri$

$i = \mathcal{E}/R = \frac{5.6}{25} = 0.22\,A$

2\. (29.58) a) According to example 29.6 the induced emf is $\mathcal{E} = BLv = (8 \times 10^{-5}\,T)(0.004\,m)(300\,m/s) = 96\,\mu V \simeq 0.1\,mV$.

Note that L is the size of the bar measured in a direction that is perpendicular to both the magnetic field and velocity of the bar. Since a positive charge moving to the east would be deflected upward, the top of the bullet will be at a higher potential.

b) For a bullet that travels south, induced emf is zero.

c) In the direction parallel to the velocity, the induced emf is zero.

3. (30.13) $U = \frac{1}{2} L I^2 = \frac{\mu_0 N^2 A I^2}{4\pi r}$

$\Rightarrow N = \sqrt{\frac{4\pi r U}{\mu_0 A I^2}} = 2850$ turns

4. (30.71) a) Immediately after S_1 is closed, $i_0 = 0$, $V_{ac} = 0$ and $V_{cb} = 36V$, since the inductor stops the current flow.

b) After a long time, $i_0 = \frac{\mathcal{E}}{R_0 + R} = 0.18A$

$V_{ac} = i_0 R_0 = 9V$, $V_{cb} = 36V - 9V = 27V$

c) $i(t) = \frac{\mathcal{E}}{R_{total}} \left(1 - e^{-(R_{total}/L)t}\right)$

$\Rightarrow i(t) = (0.18A)\left(1 - e^{(50s^{-1})t}\right)$

$V_{ac}(t) = i(t) R_0 = 9V\left(1 - e^{-(50s^{-1})t}\right)$ and

$V_{cb}(t) = \mathcal{E} - i(t) R_0 = 90V\left(3 + e^{-(50s^{-1})t}\right)$.

5. (32.07) a) $\lambda = c/f = 361m$

b) $k = 2\pi/\lambda = 0.0174 m^{-1}$

c) $\omega = 2\pi f = 5.21 \times 10^6$ rad/s

$E_{max} = c B_{max} = 0.0145$ V/m

6. (32.39) a) The Laser intensity $I = P/A = \frac{4P}{\pi D^2} = 652 W/m^2$

But $I = \frac{1}{2}\epsilon_0 c E^2 \Rightarrow E = \sqrt{\frac{2I}{\epsilon_0 c}} = 701 V/m$

and $B = E/c = 2.34 \times 10^{-6} T$

b) $u_{B_{av}} = u_{E_{av}} = \frac{1}{4}\epsilon_0 E_{max}^2 = 1.09 \times 10^{-6} J/m^3$

(Note the extra factor of $\frac{1}{2}$ since we are averaging)

c) In one meter of the Laser beam, the total energy is:

$E_{tot} = u_{tot} Vol = 2u_E (AL) = 2u_E \pi D^2 L/4$

$\Rightarrow E_{tot} = 1.07 \times 10^{-11} J$