Physics Mid term 3 Tanner Barnes

2.1

a. $-\hat{i} = \hat{j} \times (-\hat{k})$ Into the plane of the paper

b. $-\hat{k} = -\hat{j} \times (-\hat{i})$ Along the left side, negative x-axis

c. $\hat{j} = -\hat{i} \times \hat{k}$ Out of the page

2.2 a. Electric Force on charge balances the Lorentz force.

Therefore $qE = qVB\sin\theta \rightarrow \theta = 90°$

Therefore $\cancel{q}E = \cancel{q}VB$

$E = VB$

$$\boxed{V = \frac{E}{B}}$$

b. Electric Field is constant

$\Delta V = (VB)\Delta x$

$\Delta V = B(\Delta x) V$

$V = V_d = \frac{I}{nq_e A}$ Therefore $\rightarrow \Delta V = \frac{B(\Delta x) I}{nq_e A}$

$$\Delta V = \frac{1.33 \times (2\times10^{-2}) \times 10}{2\times10^{28} \times 1.6\times10^{-19} \times (1\times10^{-3})^2}$$

$$\boxed{\Delta V = 8.3125 \times 10^{-5}\ V}$$

2.3

$$\tau = IAB$$

$$= 1.05\times10^{4} \times \pi \times (0.65\times10^{-15})^2 \times 2.50$$

$$= \boxed{3.48 \times 10^{-26}\ N\cdot m}$$

3.1

a. $B = \mu_0 n I$

$$B = (4\pi \times 10^{-7}\ T\text{-}m/A)\times(500\ m^{-1})\times(0.3A) = \boxed{1.88\times10^{-4}\ T}$$

b. Increase By 5000, $B \times 5000 = \boxed{0.942\ T}$

3.2 a. Top Left : Electric Field upwards

Magnetic field out of the page

Velocity ; Right

$$F_{tot} = F_E + F_M = 0$$

$$q[E + V\times B] = 0$$

$$\Downarrow$$

$$F_{tot} = q[E - VB] = 0$$

$$E = VB \rightarrow V = \frac{E}{B} \text{ for } F_{net} = 0$$

b. Centripetal Force mv^2/r

$$qvB = \frac{mv^2}{r} \rightarrow r = \frac{mv}{qB} \quad \left(v = \frac{E}{B}\right) \text{ so } r = \frac{m\frac{E}{B}}{qB} = \frac{mE}{qB^2}$$

mass oxygen = $16 \times 1.67\times10^{-27}$; $1.602\times10^{-19}\,C = q$

$$r = \frac{16\times(1.67\times10^{-27})\times10}{1.602\times10^{-19}\times(0.01)^2} = \boxed{0.0167\,m}$$

4.1

a. Induced Voltage

$$e = \frac{d\phi}{dt} = \frac{d}{dt}(BA)$$

$$e = \frac{A\,dB}{dt}$$

$$e = \pi r^2 \times \frac{B_0}{T_0} \sin(2\pi f t)$$

b. Induced emf at $t=0$

$\sin(2\pi f t)$ $t=0$ so $\sin(0) = 0$

Therefore induced emf at $t=0$ is 0.

c. $$e = \pi \times (0.1)^2 \times \frac{0.1}{1ms} \sin(2\pi \times 10^3 \times 0.16 \times 10^{-3})$$

$$= 3.14 \times \frac{(0.1)^3}{1ms} (\sin(0.32\pi))$$

$$\boxed{e = 0.055\,V}$$

d. Current at t_1 $I = e/R = \frac{0.055V}{5\Omega}$

$$\boxed{I = 0.011A}$$

5.1

L (inductance) = 0.50 H

Emf = 0.150 V

$$\mathcal{E} = -L\frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{-\mathcal{E}}{L} = \frac{-0.150\,V}{0.50\,H} = -0.3\ A/s$$

Rate of change is $-0.3\ A/s$

Magnitude $\left|\frac{dI}{dt}\right| = 0.3\ A/s$

5.2

$$\mathcal{E} = -L\frac{dI}{dt}$$

Magnitude $\mathcal{E} = L\frac{dI}{dt}$

$$500 = 2\times10^{-3}\frac{dI}{dt}$$

$$2.5\times10^{5} = \frac{dI}{dt}$$

$$dI = 2.5\times10^{5}\,dt$$

$$\int dI = \int 2.5\times10^{5}\,dt$$

$$I = 2.5\times10^{5}\,t$$

$$t = \frac{0.100}{2.5\times10^{5}}$$

$$\boxed{t = 4\times10^{-7}\ sec}$$