Physics 142 – Homework 10

Ch. 31, Examples: 31.4, 31.5, 31.6
Ch. 31, Q: 7, 9, 13
Ch. 31, P: 5, 10, 20, 22, 28, 30, 39

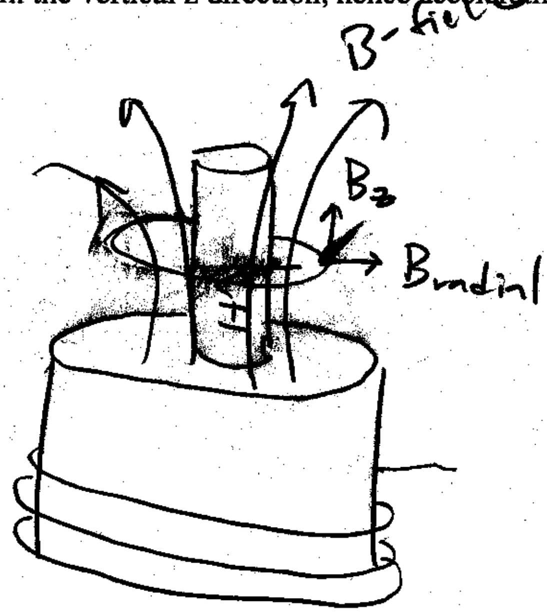
The example problems should be turned in along with the rest of the homework, however since they are written out in the book, solutions will not be provided here.

Questions

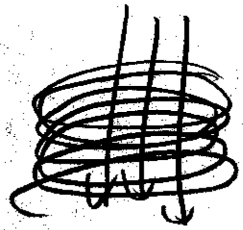
7) Its generally a bad idea to wear a bracelet in a magnetic field because unless you are standing still and unless the magnetic field does not change, a current will be created in the bracelet.

9) As the water falls it accelerates and gains kinetic energy, when the water hits a turbine some of this energy is transferred to move a coil of wire with respect to a magnet or a magnet with respect to a coil of wire. This motion creates a current in the wire that generates electricity.

13) When you close the switch this generates a current in the coil, which in turn generates a magnetic field up along the axis of the coil. As the current increases (it starts at zero and increases until it reaches its maximum) the B-field is increasing, and the flux through the ring is increasing. A counterclockwise current is setup in the ring to oppose this increase in flux. Now, the B-field at the ring is not just along the z-axis, there are also radial components. These components interact with the current in the ring to create a force in the vertical z direction, hence accelarating the ring.



31-5



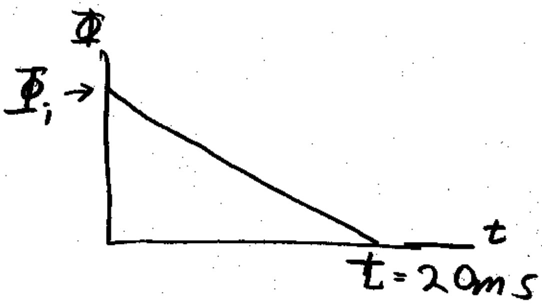
← 1.6T field with an area 0.2 m²

← 200 turn coil

we kno the initial flux $\Phi_i = B_i A = 1.6\,T \cdot 0.2\,m^2$
$= 0.32\ Tm^2$

+ final flux $\Phi_f = 0$

Over a time $\tau = 20.0\,ms$



there for $\frac{d\Phi}{dt} = \frac{0 - 0.32\ Tm^2}{0.020\ 0\ ms}$
$= -16\ V$

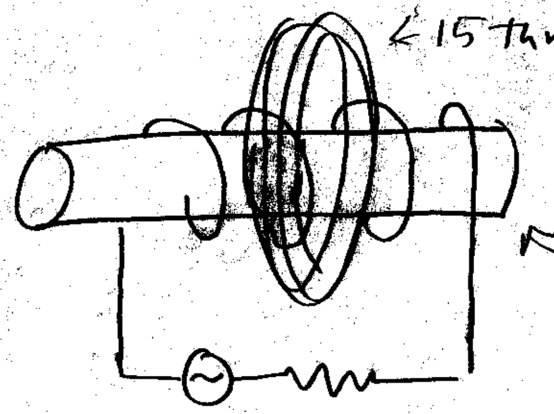
faradays law tells us

$$\mathcal{E} = -N \frac{d\Phi}{dt} = -200 \cdot (-16V) = 3\,200\ V$$

↑
EMF

$$I = \frac{\mathcal{E}}{R} = \frac{3\,200\,V}{20\,\Omega} = 160\,A$$

31-10



$I_{solenoid} = 5.00A \cdot \sin(120\frac{1}{s} t)$

first, we want to find the B-field in the solenoid (remember there's practically no field outside the solenoid)

$B = \mu_0 n I_{solenoid}$, next find the flux

$\Phi = \mu_0 n I_{solenoid} (\pi r_{solenoid}^2)$

then find the induced EMF by faraday's law

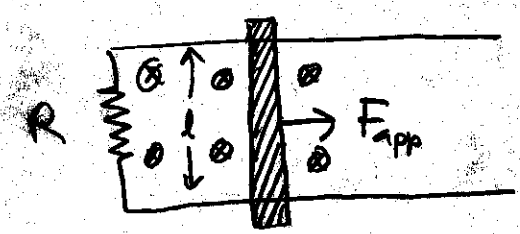
$$\mathcal{E} = -N \frac{d\Phi}{dt} = -N_{coil} \mu_0 n_{solenoid} \pi r_{solenoid}^2 \frac{dI_{solenoid}}{dt}$$

$$\frac{dI_{solenoid}}{dt} = 600 \frac{A}{s} \cos(120\frac{1}{s} t)$$

$$\mathcal{E} = -15 \left(4\pi \times 10^{-7} \frac{Tm}{A}\right)\left(10^3 \frac{1}{m}\right) \pi (0.1m)^2 \, 600 \frac{A}{s} \cos(120\frac{1}{s} t)$$

$$= -(0.014 V) \cos(120\frac{1}{s} t)$$

31-20



$R = 6\Omega$
$l = 1.2m$
$B = 2.5T$ into page

we want to find v s.t. $I = 0.5A$

following the discussion in the book we can use eq 31.6 to fin v

$$I = \frac{Blv}{R}$$

$$V = \frac{IR}{Bl} = \frac{(0.5A)(6\Omega)}{(2.5T)(1.2m)} = 1 \text{ m/s}$$

31-22 Same picture except $F_{app} = 1N$ ← constant
$R = 8\Omega$ $v = 2$ m/s ↙

a) For the velocity to be constant, the drag force must equal the applied force

eq 29.3 → $F_{drag} = -IlB = -F_{app} = \ldots$
↑ opposite direction

but we don't know B, but we know $I = \frac{Blv}{R}$ ← eq. 31.6

$B = \frac{IR}{lv}$, plug in to above equation

$$Il\left(\frac{IR}{lv}\right) = F_{app}$$

31-22 cont

$$I^2 = \frac{F_{app} \cdot V}{R}$$

$$I = \sqrt{\frac{(1 \cdot N)(2\frac{m}{s})}{8\Omega}} = 0.5A$$

b) power delivered to resistor $= I^2R$

$$= (0.5A)^2 \cdot 8\Omega = 2W$$

c) Recall power = force x velocity

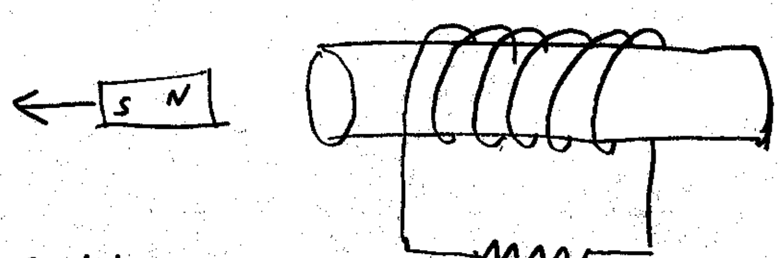
$$= F_{app} \cdot V$$

$$= 1N \cdot 2\frac{m}{s}$$

$$= 2W$$

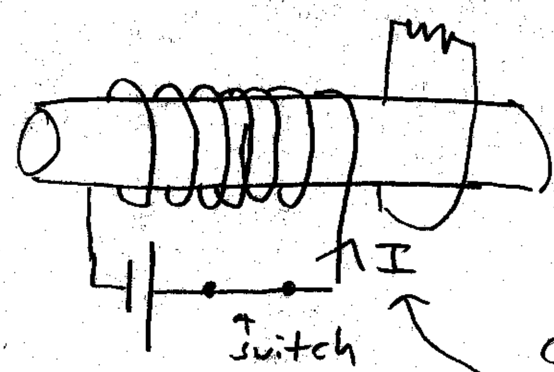
They are the same

31-28 a



the B-field from the magnet in the solenoid is to the right, as the magnet moves to the left, the B-field weakens, so the current will be set up to increase the field to the right, so the current is counter clockwise, thru the resistor to the ~~left~~ right

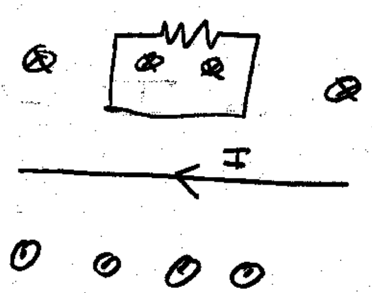
1-28 b)



immediately after the switch is closed the current is as shown

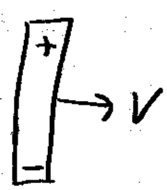
Therefore the B field is to the left and is getting stronger, so the current in the loop must be clockwise to create a B-field to the right. Since the current is clockwise it must be going to the right through the resistor.

c)



as I rapidly decreases the B-field in the rectangle (which is into the page) decreases. So the current must be clockwise to create additional B-field into the page. Therefore to the right

d)



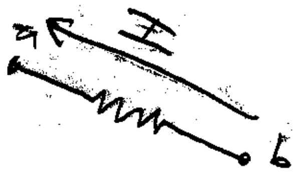
the B-field must be into the page by the right hand rule.

← thumb in direction of force

← fingers in direction of B

palm must be into the page.

31-30| Magnetic field lines point toward the South pole of a magnet, as the magnet moves closer the B-field gets stronger, So the current through the loop must be counterclockwise



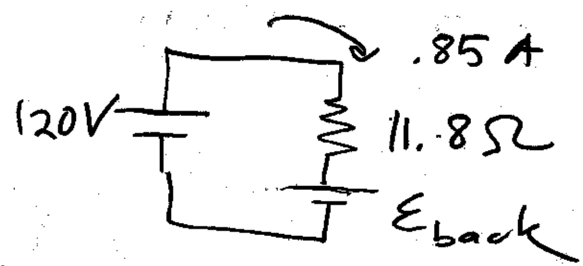
There for $V_A - V_B$ must be ~~negative~~

31-39|

$I_{DC} = .85A$

$V = 120V$

$R = 11.8\Omega$



$120V - \mathcal{E}_{back} = 11.8\Omega \cdot .85A$

$\mathcal{E}_{back} = 110V$

b| rate of energy is power $= I^2R = (.85A)^2(11.8\Omega)$
$= 8.53W$

c| when broken $\mathcal{E}_{back} = 0$

$120V = I_{new}\,11.8\Omega \rightarrow I_{new} = 10.2A$

$P = (10.2A)^2(11.8\Omega) = 1220W$