Ch 21 ex.

1) $\mathcal{E} = -\dfrac{d\Phi}{dt}$ = negative slope

Seg. 1 → $\mathcal{E} = -\left(\frac{-6}{1}\right) = 6\,V$

Seg. 2 → $\mathcal{E} = -\left(\frac{6}{1}\right) = -6\,V$

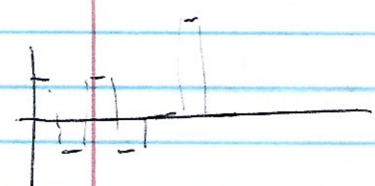
Seg 3 → $\mathcal{E} = \left(-\frac{-6}{1}\right) = 6\,V$

Seg 4 → $\mathcal{E} = -\left(\frac{6}{1}\right) = -6\,V$

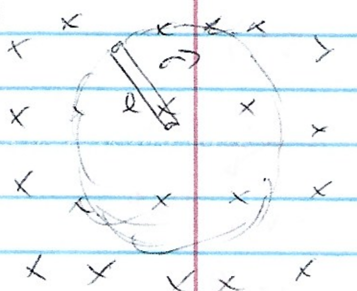
Seg 5 → $\mathcal{E} = 0$

Seg 6 → $-\left(\frac{-6}{0.25}\right) = +24\,V$

Seg 7 → $\mathcal{E} = 0$



2)



charges go to the outside of the rod

$v = r\omega$ $\quad F = qvB\sin\theta,\ \theta = 90$

$F = qvB$

$= qr\omega B$

$eE = evB$

$E = vB = r\omega B$

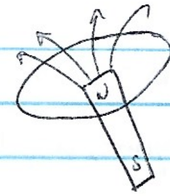
$E = -\omega B \vec{r}$

$\Delta V = -\int_i^f \vec{E}\cdot d\vec{r}$

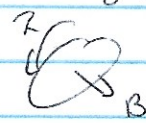
$= -\int_0^l (-\omega B\vec{r})\cdot d\vec{r}$

$= \omega B \cdot \frac{1}{2} r^2 \Big|_0^l = \boxed{\dfrac{\omega B l^2}{2}}$

3)

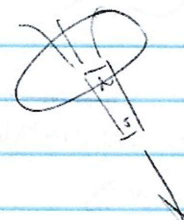


B in the loop → opposite to B entering the loop;



rhr, current

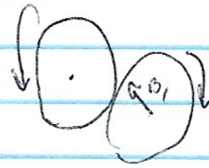
4)



ΔB is ⇓, so B_{ind} is ↑

rhr, current

5) when the switch is closed,

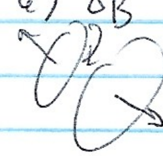


ΔB is ↑

B_{ind} ⇓

I_{ind}

6) ΔB



B_{ind}

7) $\Phi = nB\cdot A = nBA\cos\theta$

a) $\mathcal{E} = \dfrac{d\Phi}{dt} = \dfrac{(50)\left(60\,cm^2 \times \frac{1m}{100cm} \times \frac{1m}{100cm}\right)\cos(30)\,(2.0\,T - 0\,T)}{1.50\,s}$

$= \boxed{-0.346\,V}$ $\quad -0.34\,V$

$I = \dfrac{\Delta V}{R} = \dfrac{-0.34\,V}{0.20\,\Omega} = -1.7\,A$

$+1.7\,A$

8) AC, $f = 60.0\,Hz$ $B = 0.150\,T$

$V_{max} = 170V$ Square, $a = 0.01\,m^2$

$V(t) = NBA\omega \sin(\omega t)$

$= 2\pi NBAf \sin(2\pi f t)$

at V_{max} $\sin\theta = 1$

~~$170V = 2\pi N \cdot 0.150T \cdot 0.01m^2 \cdot 60Hz$~~

$N = \frac{V_{max}}{2\pi BAf} = \frac{170V}{2\pi(0.150T)(0.01m^2)(60Hz)}$

$= \boxed{300 \text{ turns}}$

9) $\lambda = \frac{c}{v} = \frac{3e8\,m/s}{89.1 \times 10^6\,Hz} = \boxed{3.37\,m}$

10) $L = \frac{\Phi}{I} = \frac{B \cdot A}{I}$

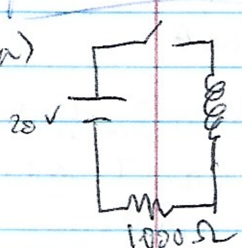
$= \frac{\mu_0 n \cancel{I} A}{\cancel{I}}$

$\boxed{L = \mu_0 nA}$

$\Phi = NBA \cdot l$

$\boxed{L = \mu_0 n^2 A l}$

11) a)



$I(t) = \frac{V_0}{R} e^{-\frac{Rt}{L}} = \frac{20V}{1000\Omega} \cdot e^0$

$= \boxed{0.02\,A}$

$I(t) = \frac{V_0}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$

$I_0 = 0$

b) after a while, I becomes constant,

$I = \frac{V}{R} = \frac{20V}{1000\Omega} = \boxed{0.02\,A}$

b) (ii - V) $V = L\frac{dI}{dt}$

$20V = (10 \times 10^{-3}H)\frac{dI}{dt}$

$\frac{dI}{dt} = \frac{20V}{10 \times 10^{-3}H} = 2 \times 10^3\,A/s$

$I = \frac{V_0}{R}\left(1 - e^{-\frac{R}{L}t}\right)$

$\frac{dI}{dt} = \frac{V_0}{L} e^{-\frac{R}{L}t}$

c) $V_R(t) = I(t) \cdot R$

$V_R(t) = V_0\left(1 - e^{-\frac{R}{L}t}\right)$

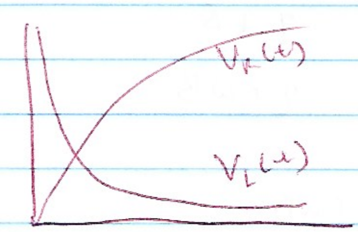
$V_L(t) = L\frac{dI}{dt} = \cancel{L}\frac{V_0}{\cancel{L}} e^{-\frac{R}{L}t}$

$= V_0 e^{-R/L\, t}$

Voltages add up to 0

d) $\tau = \frac{L}{R} = \frac{10 \times 10^{-3}H}{1000\Omega} = \boxed{1 \times 10^{-5}\,\frac{H}{\Omega}}$

e)



12) energy dens $= \frac{1}{2}\frac{B^2}{\mu_0}$

$$B = \sqrt{2(\text{en. den})\mu_0}$$

$$= \sqrt{2(1.0\ \text{J/m}^3)(4\pi \times 10^{-7}\ \text{H/m})}$$

$$= \boxed{1.6 \times 10^{-3}\ T}$$

13) $\omega = \frac{1}{\sqrt{LC}}$

$$2\pi f = \frac{1}{\sqrt{LC}}$$

$$4\pi^2 f^2 = \frac{1}{LC}$$

$$LC = \frac{1}{4\pi^2 f^2}$$

$$C = \frac{1}{L 4\pi^2 f^2} = \frac{1}{4\pi(15\times10^{-3}\ H)^2(540\times10^3\ Hz)}$$

$$= \boxed{3.13\ \mu F}$$

$$C = \frac{1}{4\pi^2(15\times10^{-3}\ H)(540\times10^3)^2}$$

$$= 5.8\ pF$$

14) $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{14\,500\ V}{120\ V} = 121$

$$N_2 I_2 = -N_1 I_1$$

$$I_1 = -\frac{N_2}{N_1} \cdot I_2$$

$$= -\left(\frac{1}{121}\right)(300A)$$

$$= \boxed{-2.48\ A}$$