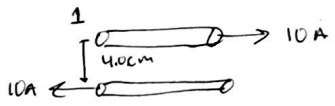
1)



a) repel

b) $|\vec{F}_{12}| = I_1 \ell B_2$ $\qquad F_{12} = I_1 \ell \frac{I_2 \mu_0}{2\pi r} = \boxed{\frac{\mu_0 I_1 I_2 \ell}{2\pi r}}$

$|\vec{B}_2| = \frac{\mu_0 I_2}{2\pi r}$

2) $\vec{F}_B = -\vec{F}_E$

$\rightarrow F_B = F_E \rightarrow \cancel{q} v B = \cancel{q} E \qquad V = \int_0^L d\ell\, E = E \cdot L$

~~$vB = E \cdot L$~~

~~$V = EL$~~

$\int_0^L vB\, d\ell = \int_0^L E\, d\ell \rightarrow vB\ell = E\ell = V$

$\boxed{v = \frac{V}{B\ell}}$

3) $\mathcal{E}mf = \frac{d\Phi}{dt} = \frac{d}{dt}\left(\vec{B} \cdot \vec{A}\right)$

$\vec{B}$ is const, $\vec{A}$ is const, $\vec{r}$ always points tangentially

$\Phi = 0 \rightarrow \frac{d\Phi}{dt} = 0$

4) $\vec{B} = 1\,\hat{z}$ $\quad S(t=0) = 20\,cm^2$

$\frac{dS}{dt} = 1\ cm^2/s$ $\qquad \vec{B}\cdot\vec{A} = BA\cos\theta$

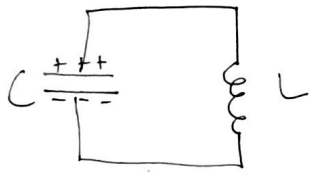
we want $\frac{d\Phi}{dt} = 0$

$$\frac{d\Phi}{dt} = \frac{d}{dt}(\vec{B}\cdot\vec{A}) = B\frac{dA}{dt} + A\frac{dB}{dt} = 0$$

$$A\frac{dB}{dt} = -B\frac{dA}{dt}$$

$$\frac{dB}{dt} = -B\cdot\frac{1}{A}\frac{dA}{dt} \quad (ODE)$$

5)



$\Delta V = 0$

$\Delta V_C + \Delta V_L = 0$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

$$\frac{Q}{C} + L\frac{d^2Q}{dt^2} = 0$$

$$\frac{d^2Q}{dt^2} = -\frac{Q}{LC}$$

$Q(t) = Q_0\cos\omega t$

$\omega = \sqrt{1/LC}$

$C = \frac{Q}{\Delta V_C}$

$\mathcal{E}_{ind} = \frac{d\Phi}{dt} = L\frac{dI}{dt}$

$\frac{dQ}{dt} = -I$

↑ minus sign for direction

$$\boxed{C = L\omega^2}$$

6) $t = 15\,ms$ $\quad \phi = 30° + 180°$

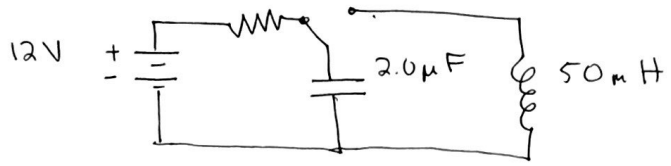
a) $\omega = 2\pi f$ $\quad f = \frac{deg}{sec}$ $\quad \boxed{\omega = 2\pi \cdot \frac{210°}{0.15s}}$

b) $V(t) = V_0 \cos(\omega t)$

~~$V(.15) = 12 \cos(210 \cdot 2\pi \cdot .15s)$~~

$V(15) = -12 \cos(30°) = \boxed{-6\sqrt{3}\ V}$

7)



a) $I(t) = -\frac{dQ}{dt} = \omega Q_0 \sin \omega t$

(Q(t) from prob. 5)

$\omega Q_0 = I_{max}$ $\quad \omega = \sqrt{1/LC}$

Q_0 is capacitor max charge

it's charged up from 12V battery

$C = \frac{Q_0}{\Delta V_C}$ $\quad Q_0 = C \Delta V_C$

$\mathcal{E}mf = IR + V_C = IR + \frac{Q}{C}$

@ switch 1
as $t \to \infty$
$Q_c \to C V_{bat}$

$Q_0 = C V_{battery}$

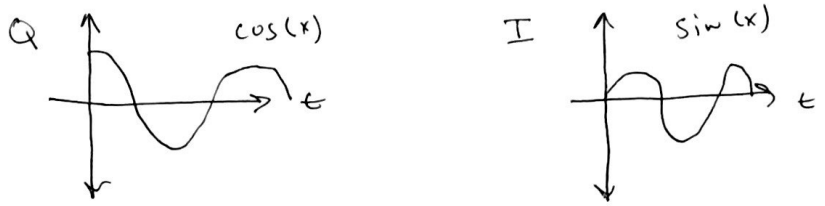
$\rightarrow I_{max} = Q_0 \omega = \boxed{\text{set}\left[\frac{1}{LC}\right] \cdot CV}$

b) $I(t)$ is sine function

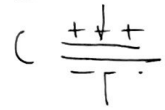
$\sin x = 1$ when $x = \pi/2$

$\rightarrow \omega t = \pi/2$ $\quad t = \frac{1}{\omega}\frac{\pi}{2} = \boxed{\sqrt{LC}\,\frac{\pi}{2}}$

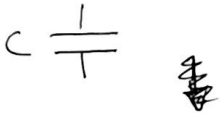
c)



① Capacitor discharges until $I(t) = I_{max}$



$\Rightarrow$ ② Current continues until C has reverse polarity



Inductor doesn't let current end when Cap is neutral

③

Now discharge in opp. direction

④ Continues until initial state is restored $\leftarrow$

8) $1.0\,mT = B_{sol}$ $\quad I = 1\,A$

$$B_{sol} = \frac{\mu_0 N I}{L}$$

$$N = \frac{B \cdot L}{\mu_0 I}$$

$\frac{L}{N}$ = Circumference of each loop

$C = 2\pi r \rightarrow \boxed{2r = \frac{L}{N\pi}}$

9) $I_0 = 10\,m$

a) Emf frequency $\omega = 2\omega_0$

$I(t) = \omega C V_c \sin(\omega t)$

$I_0 = \omega C V_c \qquad V_c = \frac{Q}{C}$

$\boxed{I_f = 2I_i}$

b) $\boxed{I_f = 2I_i}$

$I \propto V_c = \mathcal{E}_{mf}$