30.5

(a) $M = \frac{N_2 \phi_{B_2}}{i_1} = \frac{(400)(0.0320 \text{ Wb})}{6.52 \text{ A}} = 1.96 \text{ H}$

(b) When $i_2 = 2.54$ A, $\phi_{B_1} = \frac{i_2 M}{N_1} = \frac{(2.54\text{A})(1.96\text{H})}{700}$

$= 7.11 \times 10^{-3}$ Wb

30.11

(a) $|\varepsilon| = L\left(\frac{di_1}{dt}\right) = (0.260 \text{ H})(0.0180 \text{ A/s})$

$= 4.68 \times 10^{-3}$ V

(b) "a" is at a higher potential since the coil pushes current from b to a, and if replaced by a battery it would have the + terminal at "a".

30.22

(a) $u = \frac{U}{\text{vol}} = \frac{B^2}{2\mu_0} \Rightarrow \text{Volume} = \frac{2\mu_0 U}{B^2}$

$= \frac{2\mu_0 (3.60 \times 10^6 \text{ J})}{(0.600\text{T})^2} = 25.1 \text{ m}^3$

(b) $B^2 = \frac{2\mu_0 U}{\text{Vol}} = \frac{2\mu_0 (3.60 \times 10^6 \text{ J})}{(0.400 \text{ m}^3)} = 141.4 \text{ T}^2$

$\Rightarrow B = 11.9$ T

30.28

(a) At $t = 0$, $v_{ab} = 0$ and $v_{bc} = 60$ V

(b) As $t \to \infty$, $v_{ab} \to 60$ V and $v_{bc} \to 0$

(c) When $i = 0.150$ A, $v_{ab} = iR = 36.0$ V

and $v_{bc} = 60.0\text{V} - 36.0\text{V} = 24.0$ V

30.35

(a) $T = \frac{2\pi}{\omega} = 2\pi\sqrt{LC}$

$= 2\pi\sqrt{(1.50\,H)(6.00\times10^{-5}F)}$

$= 0.0596\,s$

$\omega = 105\ rad/s$

(b) $Q = CV = (6.00\times10^{-5}\,F)(12.0\,V)$

$= 7.20\times10^{-4}\,C$

(c) $U_0 = \frac{1}{2}CV^2 = \frac{1}{2}(6.00\times10^{-5}\,F)(12.0\,V)^2$

$= 4.32\times10^{-3}\,J$

(d) At $t=0$, $q = Q = Q\cos(\omega t + \phi) \Rightarrow \phi = 0$

$t = 0.0230\,s$, $q = Q\cos(\omega t)$

$= (7.20\times10^{-4}\,C)\cos\left(\frac{0.0230\,s}{\sqrt{(1.50\,H)(6.00\times10^{-5}F)}}\right)$

$= -5.43\times10^{-4}\,C$

Signs on plates are opposite to those at $t=0$.

(e) $t = 0.0230\,s$, $i = \frac{dq}{dt} = -\omega Q\sin\omega t$

$i = -\frac{7.20\times10^{-4}\,C}{\sqrt{(1.50\,H)(6.00\times10^{-5}H)}}\sin\left(\frac{0.0230\,s}{\sqrt{(1.50H)(6.00\times10^{-5}H)}}\right)$

$= -0.0499\,A$

Positive charge flowing away from the plate that had positive charge at $t=0$.

(f) Capacitor: $U_C = \frac{q^2}{2C} = \frac{(5.43\times10^{-4}C)^2}{2(6.00\times10^{-5}F)} = 2.46\times10^{-3}\,J$

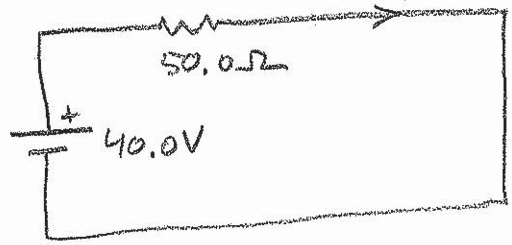
Inductor: $U_L = \frac{1}{2}Li^2 = \frac{1}{2}(1.50\,H)(0.0499\,A)^2 = 1.87\times10^{-3}\,J$

30.65

(a) Initially, the capacitor behaves like a short circuit and the inductor like an open circuit.

The simplified circuit becomes

$i = 40/50 = 0.8\ A$



So $V_1 = 40.0\ V$

$V_2 = 0$

$V_3 = 0$

$A_2 = 0$

$A_1 = 0.8\ A$

$A_3 = 0$

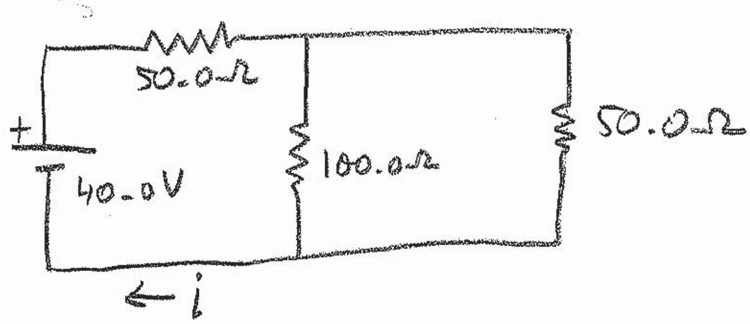
$V_5 = 0$

$A_4 = A_1 = 0.8\ A$

$V_4 = 0$

(b) Long after S is closed, the capacitor stops the current through A_4 and $\frac{di}{dt} \to 0$.

So the simplified circuit becomes



And therefore $i = \dfrac{V}{R}$ where

$$R = 50.0\,\Omega + \frac{1}{\dfrac{1}{100.0\,\Omega} + \dfrac{1}{50.0\,\Omega}}$$

$$= 83.3\,\Omega$$

so $i = \dfrac{40.0\text{ V}}{83.3\,\Omega} = 0.48\text{ A}.$

Thus,

$$V_1 = (50.0\,\Omega)(0.48\text{ A}) = 24.00\text{ V}$$

$$V_2 = 0$$

$$A_1 = 0.48\text{ A}$$

$$V_5 = V - V_1 = 16.0\text{ V}$$

$$A_4 = 0$$

$$A_2 = \tfrac{1}{3} A_1 = 0.16\text{ A}$$

$$A_3 = \tfrac{2}{3} A_1 = 0.32\text{ A}$$

$$V_3 = (100\,\Omega)(0.16\text{ A}) = 16\text{ V}$$

$$V_4 = (500\,\Omega)(0.32\text{ A}) = 16\text{ V}$$