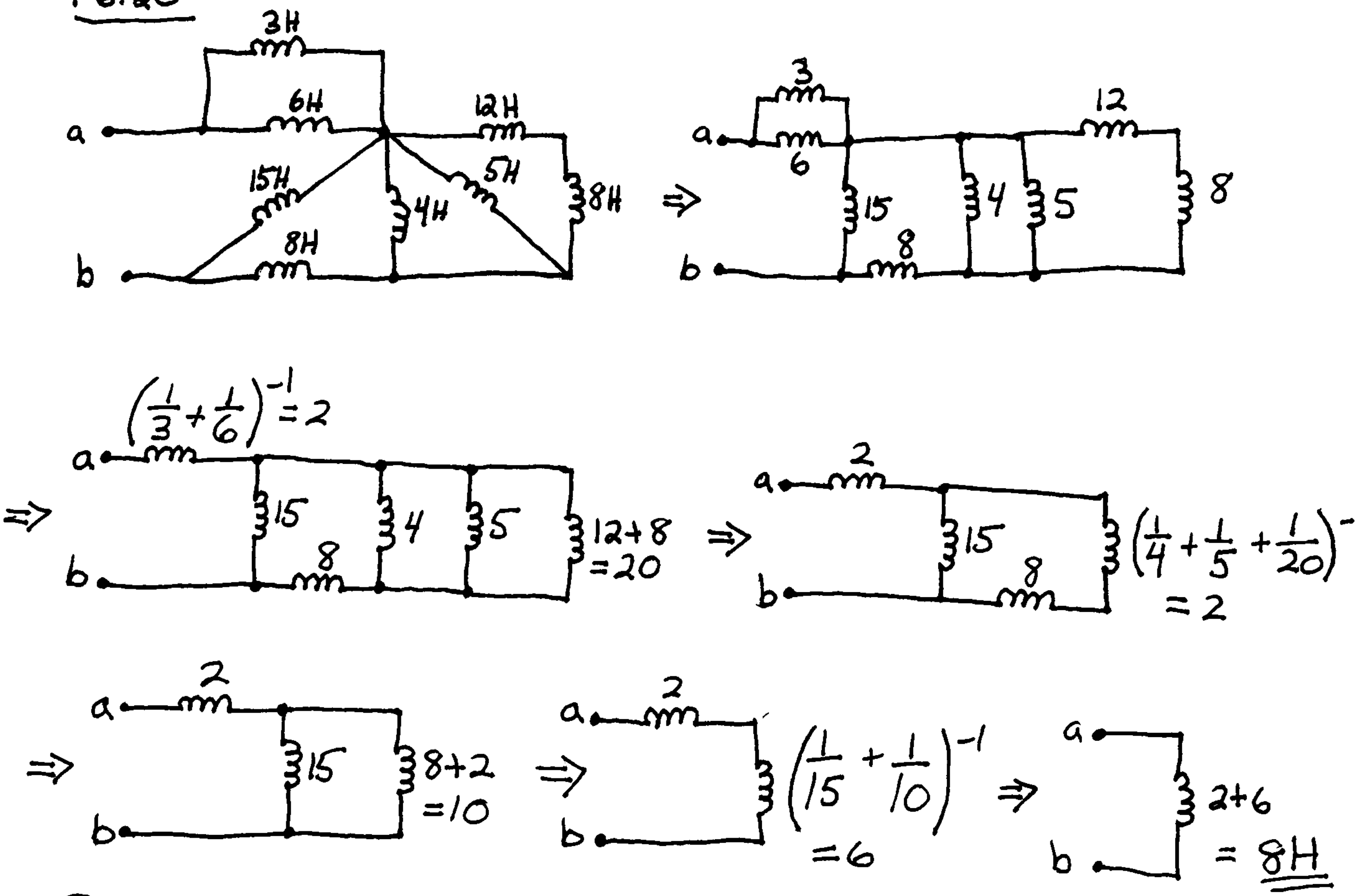
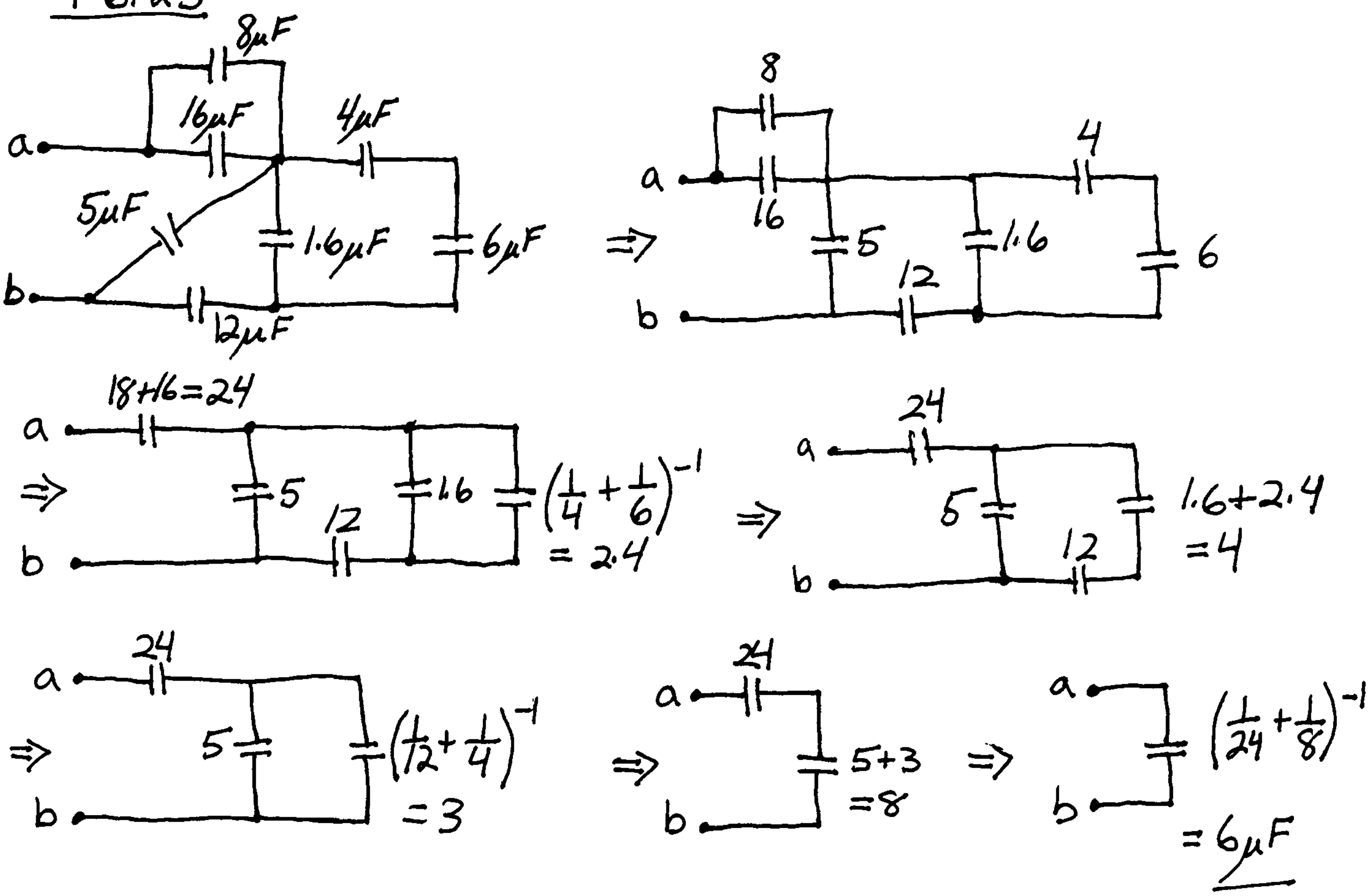
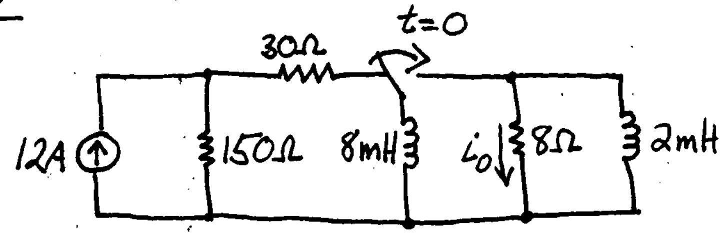
P6.20


3H
6H
12H
15H
5H
4H
8H
8H
a
b
3
6
12
15
8
4
5
8
$\left(\frac{1}{3}+\frac{1}{6}\right)^{-1}=2$
12+8
=20
$\left(\frac{1}{4}+\frac{1}{5}+\frac{1}{20}\right)^{-1}$
= 2
8+2
=10
$\left(\frac{1}{15}+\frac{1}{10}\right)^{-1}$
=6
2+6
= 8H

P6.25

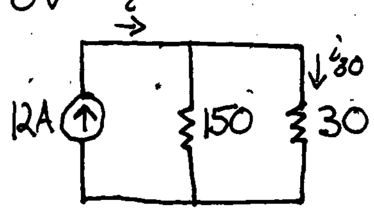

8μF
16μF
4μF
5μF
1.6μF
6μF
12μF
a
b
8
16
4
5
1.6
6
12
18+16=24
$\left(\frac{1}{4}+\frac{1}{6}\right)^{-1}$
= 2.4
24
1.6+2.4
=4
$\left(\frac{1}{12}+\frac{1}{4}\right)^{-1}$
=3
5+3
=8
$\left(\frac{1}{24}+\frac{1}{8}\right)^{-1}$
= 6μF

P 7.8



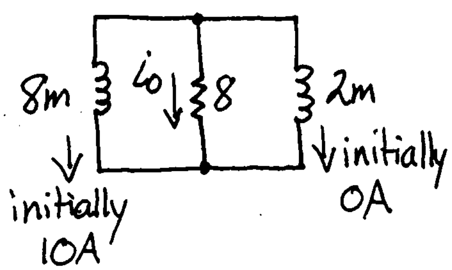
a) $i(t) = i(0)e^{-(R/L)t}$

– voltage across 8mH inductor just before switch is flipped is 0V

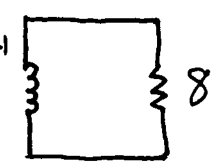


$$i_{30} = \frac{R_{eq}}{R_{30}} i = \frac{\left(\frac{1}{150} + \frac{1}{30}\right)^{-1}}{30}(12) = 10A$$

– current in 8mH inductor just after switch is flipped is 10A



$\Rightarrow$ $\left(\frac{1}{8} + \frac{1}{2}\right)^{-1} = 1.6m$



$i_o(0) = -10A$ in 8Ω resistor $= I_o$

$$i_o(t) = -10e^{-(8/1.6m)t} = -10e^{-5000t} \text{ A}$$

b) $w = \frac{1}{2} L I_o^2 (1 - e^{-2(R/L)t})$

$= \frac{1}{2}(1.6m)(-10)^2(1 - e^{-2(5000)t})$

$= 0.08(1 - e^{-10,000t})$

$w_{TOT} = 0.08(1 - e^{-10000t}) \big|_{t=\infty}$

$= 0.08(1 - 0)$

$= 0.08 J$

c) $.95 = \frac{0.08(1-e^{-10,000t})}{0.08}$

$.95 = 1-e^{-10,000t}$

$e^{-10,000t} = 0.05$

$-10,000t = \ln(0.05)$

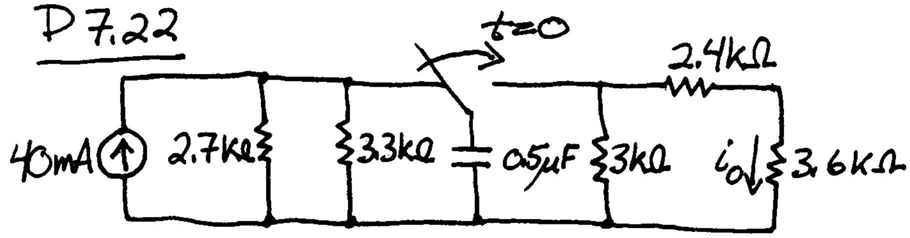
$t = 2.995732274 \times 10^{-4} s$

$\tau = \frac{L}{R} = \frac{1.6m}{8} = 2\times10^{-4}$

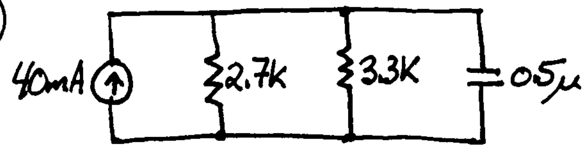
$\frac{2.995732274\times10^{-4}}{2\times10^{-4}} = 1.497866137$

it takes $\sim 1.5\tau$ to deliver 95% of the energy

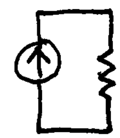
P7.22



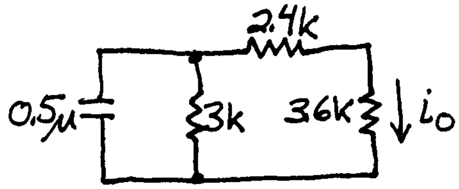
a)



The capacitor acts like an open

∴  $\left(\frac{1}{2.7}+\frac{1}{3.3}\right)^{-1} = 1.485k\Omega$

$V_o = 40m\,(1.485k) = 59.4V$ across the capacitor initially



$R_{eq} = \left(\frac{1}{3} + \frac{1}{2.4+3.6}\right)^{-1} = 2k\Omega$

$i_o = \frac{V_o}{R} = \frac{59.4}{(2.4+3.6)k} = 0.0099A = 9.9mA$

$i_o(t) = 9.9e^{-t/(2k\cdot 0.5\mu)} = 9.9e^{-1000t}\,mA$

b) initial energy $w_i = \frac{1}{2}CV_o^2 = \frac{1}{2}(0.5\mu)(59.4)^2 = 8.8209\times10^{-4}J$

$w = \int_0^t I_o^2 R e^{-2t/\tau}dt$

I_o through 3k resistor

$I_o = \frac{V_o}{R} = \frac{59.4}{3k} = 0.0198A$

$= \int_0^t (0.0198)^2(3k)e^{-2t/\tau}dt$

$= 3.9204\times10^{-4}(3k)\int_0^t e^{-2t/\tau}dt$

$= 1.17612\left(\frac{-\tau}{2}\right)e^{-2t/\tau}\Big|_0^t$

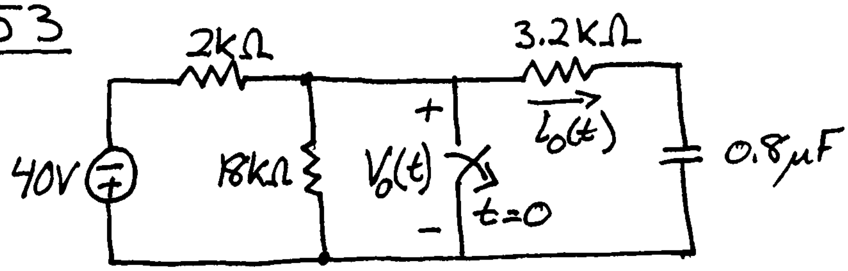
$= -0.58806\tau\left(e^{-2t/\tau}-1\right)$

$w(t=500\mu s) = -0.58806(2k\cdot0.5\mu)\left(e^{-2(500\mu)(1000)}-1\right)$

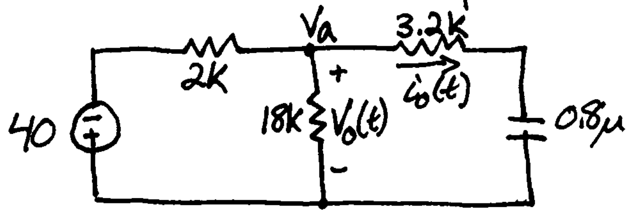
$= -5.8806\times10^{-4}(e^{-1}-1) = 3.717248158\times10^{-4}J$

% energy delivered $= \frac{3.717248158\times10^{-4}}{8.8209\times10^{-4}} = 42.14137059\,\%$

P7.53



a) after switch is opened



capacitor acts like a short

$$\frac{-40-V_a}{2k} = \frac{V_a}{18K} + \frac{V_a}{3.2K}$$

$$-0.02 - \frac{V_a}{2k} = \frac{V_a}{18k} + \frac{V_a}{3.2K}$$

$$-0.02 = \frac{V_a}{18k} + \frac{V_a}{3.2k} + \frac{V_a}{2k}$$

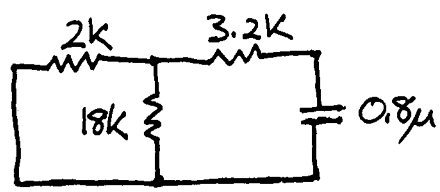
$$-0.02 = 0.000868056\,V_a$$

$$\Rightarrow V_a = -23.04V \qquad \Rightarrow i_o(0) = \frac{-23.04}{3.2k} = -0.0072A$$

$$= 7.2mA$$

b) $i_o(t=\infty) = 0A$

c) $\tau = RC$



$$R_{th} = \left(\frac{1}{2k} + \frac{1}{18k}\right)^{-1} + 3.2k$$

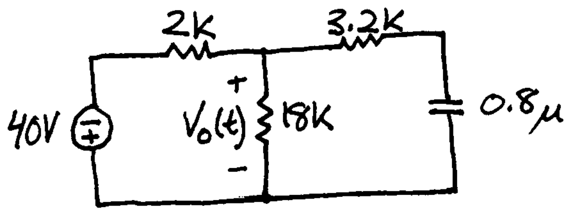
$$= 1.8k + 3.2k$$

$$= 5k\Omega$$

$$\tau = 5k(0.8\mu)$$

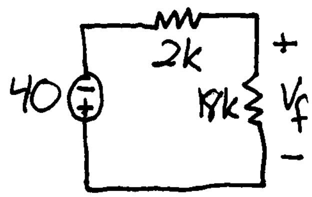
$$= 0.004\,s^{-1}$$

d) $i_o(t) = \left(\frac{V_f}{R} - \frac{V_o}{R} \right) e^{-t/\tau}$



capacitor acts like an open at $t = \infty$

$\Rightarrow$



$V_f = \frac{18k}{2k + 18k} \cdot (-40) = -36V$

$i_o(t) = \left(\frac{-36}{5k} - \frac{0}{5k} \right) e^{-t/0.004}$

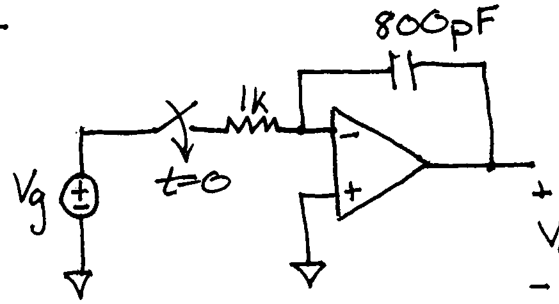
$= -7.2 e^{-250t}$ mA

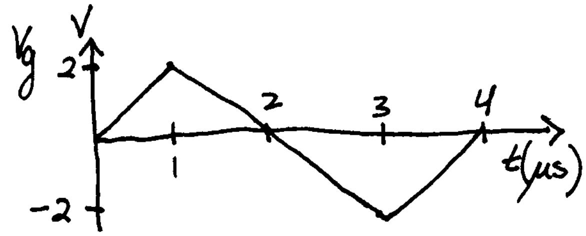
e) $V_o(t) = V_f + (V_o - V_f) e^{-t/\tau}$

$= -36 + (0 - 36) e^{-250t}$

$= -36 + 36 e^{-250t}$ V

P 7.96





a) $0 \le t \le 1\mu s$

$$V_o(t) = -\frac{1}{R_s C_f}\int_{t_o}^{t} V_s\,dt + V_o(t_o)$$

$$t_o = 0,\ V_o(t_o) = 0,\ V_s = \frac{2t}{1\mu} = 2\times10^6 t$$

$$V_o(t) = -\frac{1}{1k(800p)}\int_0^t 2\times10^6 t\,dt$$

$$= -2.5\times10^{12}\frac{t^2}{2}\Big|_0^t$$

$$= -1.25\times10^{12}t^2\,V$$

$1 \le t \le 3\mu s$

$$t_o = 1\mu s,\ V_o(t_o) = -1.25V,\ V_s = \frac{-4}{2\mu s}t + 4 = -2\times10^{-6}t + 4$$

$$V_o(t) = \frac{-1}{1k(800p)}\int_{1\mu}^{t}(-2\times10^6 t + 4)\,dt - 1.25$$

$$= \left(1.25\times10^{12}t^2 - 5\times10^6 t\right)\Big|_{1\mu}^{t} - 1.25$$

$$= 1.25\times10^{12}t^2 - 5\times10^6 t - \left(1.25\times10^{12}(1\mu)^2 - 5\times10^6(1\mu)\right) - 1.25$$

$$= 1.25\times10^{12}t^2 - 5\times10^6 t - (1.25 - 5) - 1.25$$

$$= 1.25\times10^{12}t^2 - 5\times10^6 t + 2.5V$$

$3\mu s \le t \le 4\mu s$

$t_0 = 3\mu s$, $V_o(t=3\mu s) = -1.25V$, $V_s = \frac{2}{1\mu}t - 8 = 2\times10^6 t - 8$

$$V_o(t) = \frac{-1}{1k(800p)}\int_{3\mu}^{t}(2\times10^6 t - 8)\,dt - 1.25$$

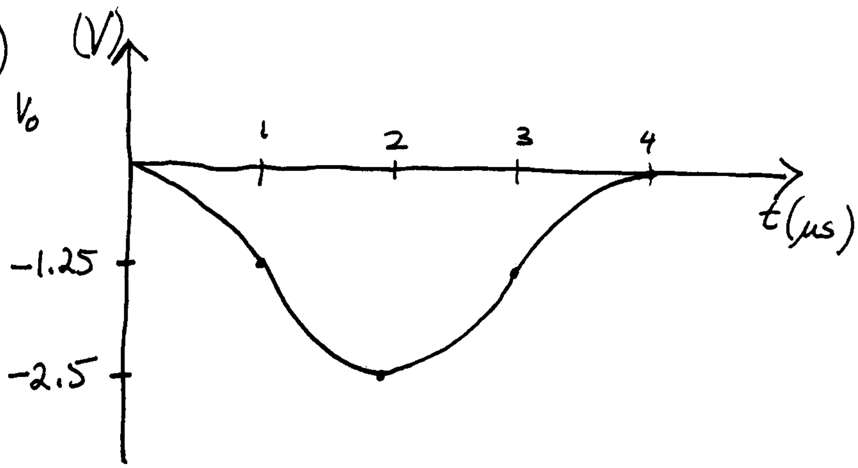
$$= \left(-1.25\times10^{12}t^2 + 10\times10^6 t\right)\Big|_{3\mu}^{t} - 1.25$$

$$= -1.25\times10^{12}t^2 + 1\times10^7 t - \left(-1.25\times10^{12}(3\mu)^2 + 1\times10^7(3\mu)\right) - 1.25$$

$$= -1.25\times10^{12}t^2 + 1\times10^7 t - 18.75 - 1.25$$

$$= -1.25\times10^{12}t^2 + 1\times10^7 t - 20V$$

b)



$V_o(0) = 0$, $V_o(1\mu s) = -1.25V$, $V_o(2\mu s) = -2.5V$

$V_o(3\mu s) = -1.25V$; $V_o(4\mu s) = 0V$

c) repeats