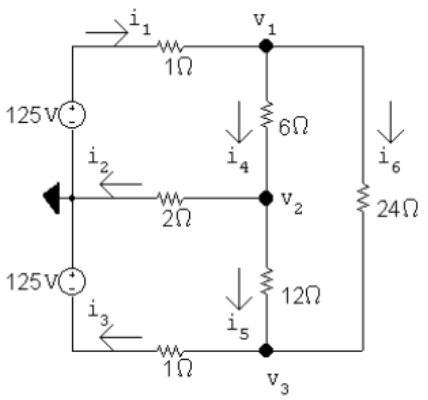
P 4.12 [a]



$$\begin{aligned}
\frac{v_1 - 125}{1} + \frac{v_1 - v_2}{6} + \frac{v_1 - v_3}{24} &= 0 \\
\frac{v_2 - v_1}{6} + \frac{v_2}{2} + \frac{v_2 - v_3}{12} &= 0 \\
\frac{v_3 + 125}{1} + \frac{v_3 - v_2}{12} + \frac{v_3 - v_1}{24} &= 0
\end{aligned}$$

In standard form:

$$\begin{aligned}
v_1\left(\frac{1}{1} + \frac{1}{6} + \frac{1}{24}\right) + v_2\left(-\frac{1}{6}\right) + v_3\left(-\frac{1}{24}\right) &= 125 \\
v_1\left(-\frac{1}{6}\right) + v_2\left(\frac{1}{6} + \frac{1}{2} + \frac{1}{12}\right) + v_3\left(-\frac{1}{12}\right) &= 0 \\
v_1\left(-\frac{1}{24}\right) + v_2\left(-\frac{1}{12}\right) + v_3\left(\frac{1}{1} + \frac{1}{12} + \frac{1}{24}\right) &= -125
\end{aligned}$$

Solving, $v_1 = 101.24$ V; $\quad v_2 = 10.66$ V; $\quad v_3 = -106.57$ V

Thus, $\quad i_1 = \dfrac{125 - v_1}{1} = 23.76$ A $\qquad i_4 = \dfrac{v_1 - v_2}{6} = 15.10$ A

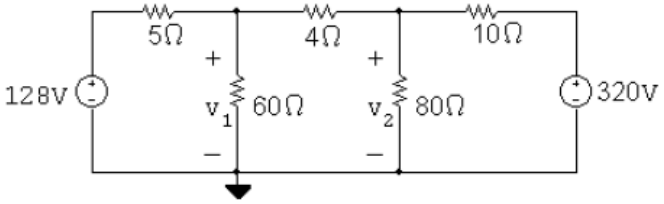
$$i_2 = \frac{v_2}{2} = 5.33 \text{ A} \qquad i_5 = \frac{v_2 - v_3}{12} = 9.77 \text{ A}$$

$$i_3 = \frac{v_3 + 125}{1} = 18.43 \text{ A} \qquad i_6 = \frac{v_1 - v_3}{24} = 8.66 \text{ A}$$

[b] $\sum P_{\text{dev}} = 125i_1 + 125i_3 = 5273.09$ W

$$\sum P_{\text{dis}} = i_1^2(1) + i_2^2(2) + i_3^2(1) + i_4^2(6) + i_5^2(12) + i_6^2(24) = 5273.09 \text{ W}$$

P 4.13 [a]



$$\frac{v_1 - 128}{5} + \frac{v_1}{60} + \frac{v_1 - v_2}{4} = 0$$

$$\frac{v_2 - v_1}{4} + \frac{v_2}{80} + \frac{v_2 - 320}{10} = 0$$

In standard form,

$$v_1\left(\frac{1}{5} + \frac{1}{60} + \frac{1}{4}\right) + v_2\left(-\frac{1}{4}\right) = \frac{128}{5}$$

$$v_1\left(-\frac{1}{4}\right) + v_2\left(\frac{1}{4} + \frac{1}{80} + \frac{1}{10}\right) = \frac{320}{10}$$

Solving, $v_1 = 162$ V; $\quad v_2 = 200$ V

$$i_{\mathrm{a}} = \frac{128 - 162}{5} = -6.8 \text{ A}$$

$$i_{\mathrm{b}} = \frac{162}{60} = 2.7 \text{ A}$$

$$i_{\mathrm{c}} = \frac{162 - 200}{4} = -9.5 \text{ A}$$

$$i_{\mathrm{d}} = \frac{200}{80} = 2.5 \text{ A}$$

$$i_{\mathrm{e}} = \frac{200 - 320}{10} = -12 \text{ A}$$

[b] $p_{128V} = -(128)(-6.8) = 870.4$ W (abs)
$p_{320V} = (320)(-12) = -3840$ W (dev)
Therefore, the total power developed is 3840 W.

P 4.17 [a] $-25+\dfrac{v_1}{40}+\dfrac{v_1}{160}+\dfrac{v_1-v_2}{10}=0 \quad \text{so} \quad 21v_1-16v_2+0i_\Delta=4000$

$$\frac{v_2-v_1}{10}+\frac{v_2}{20}+\frac{v_2-84i_\Delta}{8}=0 \quad \text{so} \quad -16v_1+44v_2-1680i_\Delta=0$$

$$i_\Delta=\frac{v_1}{160} \quad \text{so} \quad v_1+(0)v_2-160i_\Delta=0$$

Solving, $v_1=352$ V; $\quad v_2=212$ V; $\quad i_\Delta=2.2$ A;

$$i_{\text{depsource}}=\frac{212-84(2.2)}{8}=3.4 \text{ A}$$

$p_{84i_\Delta}=84(2.2)(3.4)=628.32$ W(abs)

$p_{25\text{A}}=-25(352)=-8800$ W(del)

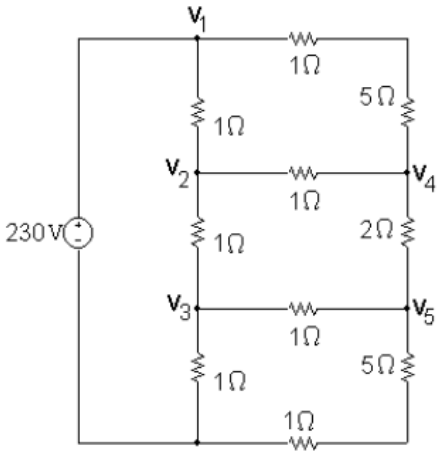
$\therefore \quad p_{\text{dev}}=8800$ W

[b] $\sum p_{\text{abs}}=\dfrac{(352)^2}{40}+\dfrac{(352)^2}{160}+\dfrac{(352-212)^2}{10}+\dfrac{(212)^2}{20}$

$$+(3.4)^2(8)+628.32=8800 \text{ W}$$

$\therefore \quad \sum p_{\text{dev}}=\sum p_{\text{abs}}=8800$ W

P 4.23 [a]



$$\frac{v_2-230}{1}+\frac{v_2-v_4}{1}+\frac{v_2-v_3}{1}=0 \qquad \text{so} \qquad 3v_2-1v_3-1v_4+0v_5=230$$

$$\frac{v_3-v_2}{1}+\frac{v_3}{1}+\frac{v_3-v_5}{1}=0 \qquad \text{so} \qquad -1v_2+3v_3+0v_4-1v_5=0$$

$$\frac{v_4 - v_2}{1} + \frac{v_4 - 230}{6} + \frac{v_4 - v_5}{2} = 0 \qquad \text{so} \qquad -12v_2 + 0v_3 + 20v_4 - 6v_5 = 460$$

$$\frac{v_5 - v_3}{1} + \frac{v_5}{6} + \frac{v_5 - v_4}{2} = 0 \qquad \text{so} \qquad 0v_2 - 12v_3 - 6v_4 + 20v_5 = 0$$

Solving, $v_2 = 150$ V; $v_3 = 80$ V; $v_4 = 140$ V; $v_5 = 90$ V

$$i_{2\Omega} = \frac{v_4 - v_5}{2} = \frac{140 - 90}{2} = 25 \text{ A}$$

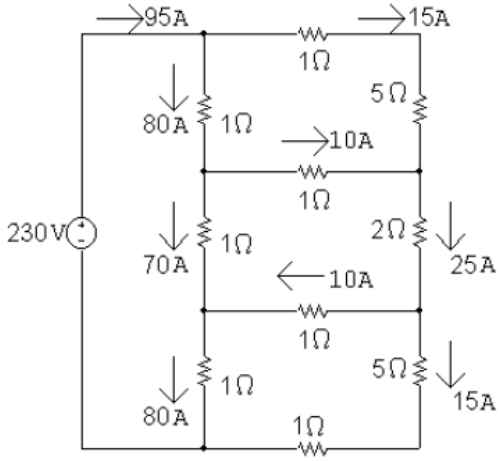
$$p_{2\Omega} = (25)^2(2) = 1250 \text{ W}$$

[b] $$i_{230\text{V}} = \frac{v_1 - v_2}{1} + \frac{v_1 - v_4}{6}$$

$$= \frac{230 - 150}{1} + \frac{230 - 140}{6} = 80 + 15 = 95 \text{ A}$$

$$p_{230\text{V}} = (230)(95) = 21{,}850 \text{ W}$$

Check:



$$\sum P_{\text{dis}} = (80)^2(1) + (70)^2(1) + (80)^2(1) + (15)^2(6) + (10)^2(1)$$
$$+(10)^2(1) + (25)^2(2) + (15)^2(6) = 21{,}850 \text{ W}$$