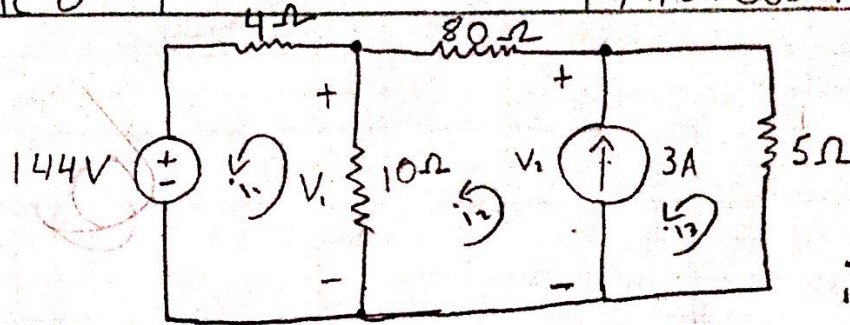


Q1)



$$i_2 - i_3 = 3A$$

KVL₁

$$0 = 4\Omega(i_1) + 144V + 10(i_1 - i_2) = 0$$

$$4i_1 + 144V + 10i_1 - 10i_2 = 0$$

$$14i_1 - 10i_2 + 144V = 0 \quad -144V$$

KVL₂

$$80(i_2) + 10(i_2 - i_1) - V_2 = 0$$

$$80(i_2) + 10i_2 - 10i_1 - V_2 = 0$$

$$-10i_1 + 90i_2 - V_2 = 0$$

KVL₃

$$V_2 + 5(i_3) = 0$$

$$\begin{bmatrix} i_1 & i_2 & i_3 & V_2 \\ 14 & -10 & 0 & 1 \\ -10 & 90 & 0 & -1 \\ 0 & 0 & 5 & 1 \\ 0 & 1 & -1 & 0 \end{bmatrix} \quad \begin{matrix} i_1 \\ i_2 \\ i_3 \\ V_2 \end{matrix} = \begin{bmatrix} -144 \\ 0 \\ 0 \\ 3 \end{bmatrix} \quad \left. \begin{matrix} i_1 = -11A \\ i_2 = -1A \\ i_3 = 4A \\ V_2 = 20V \end{matrix} \right\}$$

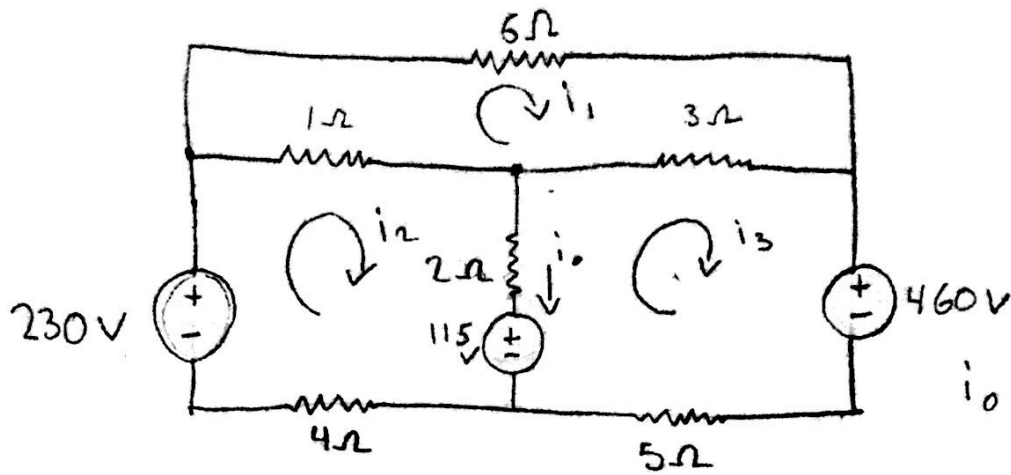
$$V = IR$$

$$V_1 = (i_1 - i_2)10$$

$$= (-11 - (-1))10$$

$$= -100V$$

Q2)



$$i_0 = i_2 - i_3$$

$$4.4 - (-36.8)$$

$$= 42.1$$

KVL 1

$$6i_1 + 3(i_1 - i_3) + 1(i_1 - i_2) = 0$$

$$\underline{6i_1} + \underline{3i_1} - 3i_3 + \underline{1i_1} - 1i_2 = 0$$

$$10i_1 - 1i_2 - 3i_3 = 0$$

KVL 2

$$1(i_2 - i_1) + 2(i_2 - i_3) + 115V + 4i_2 - 230V = 0$$

$$\underline{i_2} - i_1 + \underline{2i_2} - 2i_3 + \underline{-115V} + \underline{4i_2} = 0$$

$$-i_1 + 7i_2 - 2i_3 = 115V$$

KVL 3

$$3(i_3 - i_1) + 460V + 5i_3 - 115V + 2(i_3 - i_2)$$

$$\underline{3i_3} - 3i_1 + 460V + \underline{5i_3} - 115V + \underline{2i_3} - 2i_2$$

$$-3i_1 - 2i_2 + 10i_3 = -345V$$

$$\begin{bmatrix} 10 & -1 & -3 \\ -1 & 7 & -2 \\ -3 & -2 & 10 \end{bmatrix} = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 115 \\ -345 \end{bmatrix}$$

$$i_1 = -10.6A$$

$$i_2 = 4.4A$$

$$i_3 = -36.8A$$

$$P = VI$$

$$P = i^2 R$$

$$P = \frac{V^2}{R}$$

$$P_{230} = -230(4.4) = \underline{-1012 \text{ W}}$$

$$P_{115} = (41.2) 115 = \underline{4738 \text{ W}}$$

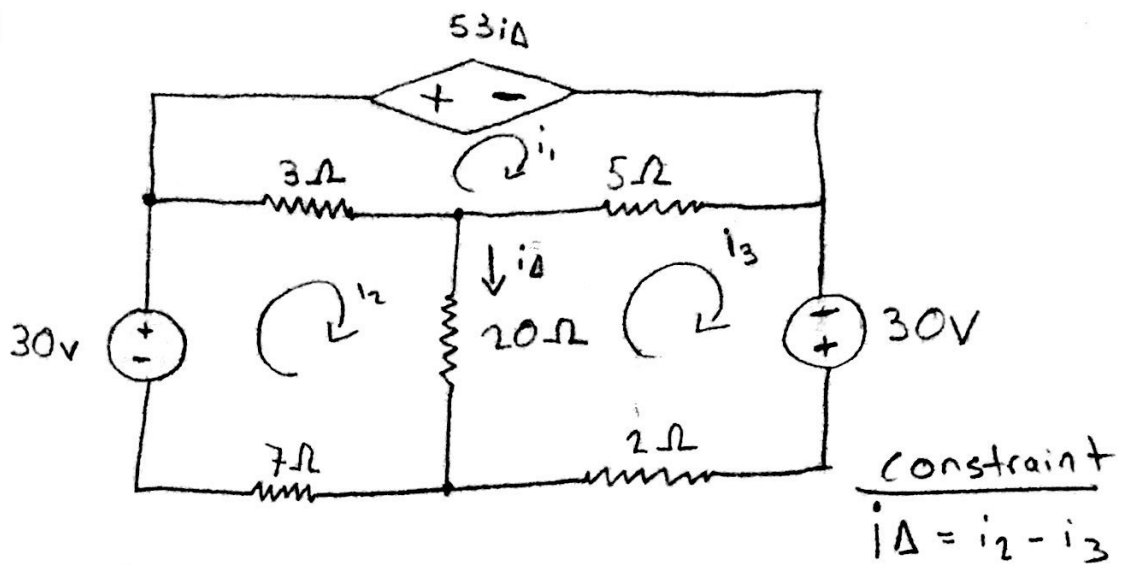
$$P_{460} = (460)(-36.8) = \underline{-16928 \text{ W}}$$

$$P_{\text{total}} = \underline{-13202 \text{ W}}$$

Checking power

$$P_{\text{total}} = 6(-10.6 \text{ A})^2 + 3(26.2)^2 + 1(-15^2) + 2(41.2)^2 + 4(4.4)^2 + 5(36.8)^2 = \underline{-13202 \text{ W}}$$

Q3)



KVL₁

$$53i_{\Delta} + 5(i_1 - i_3) + 3(i_1 - i_2) = 0$$

$$53i_{\Delta} + 5i_1 - 5i_3 + 3i_1 - 3i_2 = 0$$

$$53i_{\Delta} + 8i_1 - 5i_3 - 3i_2 = 0$$

KVL₂

$$3\Omega(i_2 - i_1) + 20\Omega(i_2 - i_3) + 7i_2 - 30V = 0$$

$$3i_2 - 3i_1 + 20i_2 - 20i_3 + 7i_2 - 30V = 0$$

$$+ 30\Omega i_2 - 3\Omega i_1 - 20\Omega i_3 = 30V$$

$$-3\Omega i_1 + 30\Omega i_2 - 20\Omega i_3 = 30V$$

KVL₃

$$5\Omega(i_3 - i_1) - 30V + 2\Omega i_3 + 20\Omega(i_3 - i_2)$$

$$5i_3 - 5i_1 - 30V + 2i_3 + 20i_3 - 20i_2$$

$$-5\Omega i_1 - 20\Omega i_2 + 27\Omega i_3 = 30V$$

$$\begin{bmatrix} 8 & -3 & -5 & -53 \\ -3 & 30 & -20 & 0 \\ -5 & -20 & 27 & 0 \\ 0 & 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_{\Delta} \end{bmatrix} = \begin{bmatrix} 0 \\ 30 \\ 30 \\ 0 \end{bmatrix} = \begin{bmatrix} i_1 = 110 \\ i_2 = 52 \\ i_3 = 60 \\ i_{\Delta} = -8A \end{bmatrix}$$

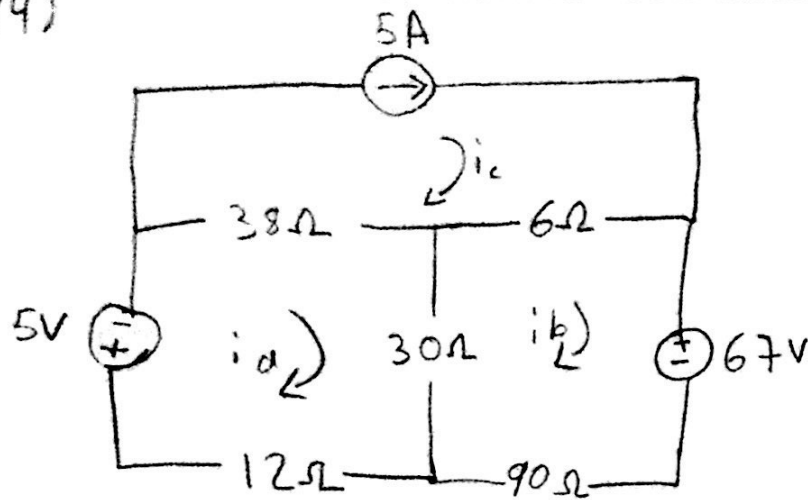
$$P = VI$$

$$P_{30} = 30(52) = \underline{1560}$$

$$P_{30} = 30(60) = \underline{1800}$$

$$P_{dep} = 110(53(-8)) \\ = \underline{-46640 \text{ W}}$$

Q4)



$$i_c = 5A$$

$$\text{KVL A: } 5V + (i_a - i_c)38\Omega + (i_a - i_b)30\Omega + 12i_a = 0$$

$$80i_a - 30i_b = 185$$

$$\text{KVL B: } (i_b - i_a)30 + (i_b - i_c)6 + 67 + 67 + 40i_b = 0$$

$$76i_b - 30i_a = -37$$

$$\begin{bmatrix} 80 & -30 \\ -30 & 76 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \end{bmatrix} = \begin{bmatrix} 185 \\ -37 \end{bmatrix}$$

$$i_a = 2.5A$$

$$i_b = .5A$$

$$\text{KVL C: } V_c + (i_c - i_b)6 + (i_c - i_a)38 = 0$$

$$V_c = 122V$$

Power dissipated

$$38(i_a - 5)^2 + 6(i_b - 5)^2 + 40(.5)^2 + 12(2.5)^2 + 30(.5 - 2.5)^2$$

$$\Sigma P = 564W, \quad \Sigma P_d = 564 + 33.5 + 12.5$$

$$P_{SA} = -122(5)$$

$$= -610W$$

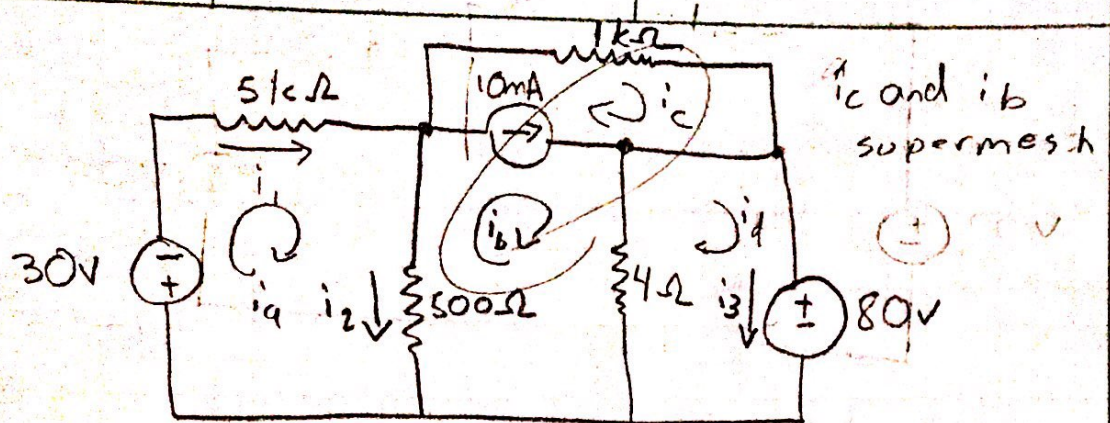
$$P_{SV} = 5(2.5) = 12.5W$$

$$= 12.5W$$

$$P_{67V} = 67(.5)$$

$$= 33.5W$$

Q5)



KVLA:

$$30 + 5k\Omega i_a + (i_a - i_b) \cdot 5k\Omega = 0$$

$$5.5i_a - .5i_b = -30$$

KVL D:

$$80 + (i_d - i_b) 4k\Omega = 0$$

$$4i_d - 4i_b = -80$$

Super:

$$5k\Omega (i_b - i_a) + 1k\Omega i_c + 4(i_c - i_b) = 0$$

$$-.5i_a + 4.5i_b + i_c - 4i_d = 0$$

Constraint:

$$i_b - i_c = 10mA$$

$$\begin{bmatrix} 5500 & -5000 & 0 & 0 \\ 0 & -4000 & 0 & 4000 \\ -500 & 4500 & 1000 & -4000 \\ 0 & 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \\ i_d \end{bmatrix} = \begin{bmatrix} -30 \\ -80 \\ 0 \\ .01 \end{bmatrix}$$

$$\begin{aligned} i_a &= -.01A \\ i_b &= -.05A \\ i_c &= -.06A \\ i_d &= -.07A \end{aligned}$$

$$\begin{aligned} i_1 &= -.01A \\ i_a - b &= .04A \\ i_2 &= .04A \end{aligned}$$

$$i_3 = -.07A$$