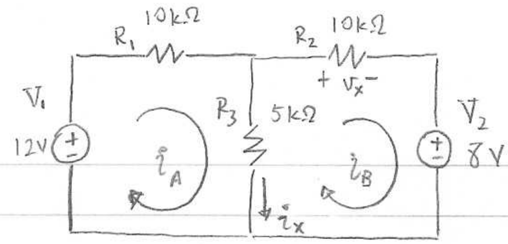
3/9 (a) Formulate mesh equations
(b) Use mesh eqns to find v_x, i_x



(a) KVL A: $R_1(i_A) + R_3(i_A - i_B) = V_1$

$$\Rightarrow \boxed{i_A(R_1+R_3) + i_B(-R_3) = V_1}$$

KVL B: $R_2(i_B) + R_3(i_B - i_A) = -V_2$

$$\Rightarrow \boxed{i_A(-R_3) + i_B(R_2+R_3) = -V_2}$$

$$\therefore \begin{bmatrix} R_1+R_3 & -R_3 \\ -R_3 & R_2+R_3 \end{bmatrix} \begin{pmatrix} i_A \\ i_B \end{pmatrix} = \begin{pmatrix} V_1 \\ -V_2 \end{pmatrix}$$

$$\Rightarrow \begin{bmatrix} 15k\Omega & -5k\Omega \\ -5k\Omega & 15k\Omega \end{bmatrix} \begin{pmatrix} i_A \\ i_B \end{pmatrix} = \begin{pmatrix} 12V \\ -8V \end{pmatrix}$$

$i_A = .7\ mA$

$i_B = -.3\ mA$

(b) $v_x = i_B \times R_2$

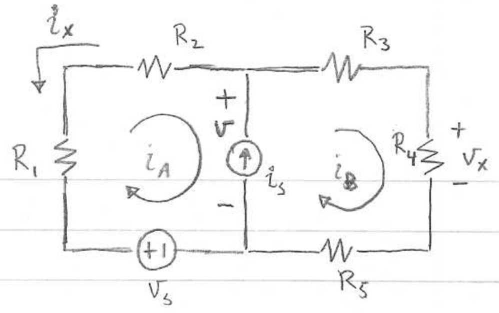
$\boxed{v_x = -3V}$

$i_x = i_A - i_B$

$\boxed{i_x = 1\ mA}$

3/9, 12, 28

3/12 (a) Formulate mesh eqns.
(b) Find v_x, i_x when
$R_1 = 200\Omega$, $R_2 = 300\Omega$,
$R_3 = 50\Omega$, $R_4 = 250\Omega$,
$R_5 = 200\Omega$, $i_s = 50mA$,
$v_s = 15V$



(c) Find total power dissipated by circuit.

(a) Note: Super nodes & super meshes are useful tricks to greatly expedite the solutions of circuit problems, and they have insightful conceptual foundations; however, always remember that they, like establishing equations by inspection, are short-cuts. You can always fall back on just KCL, KVL, and Ohm's Law and a little math to solve any linear circuit problem, so don't spend time remembering how to apply the tricks. Instead, use your time to understand why the tricks work.

KVL @ A: $R_1(i_A) + R_2(i_A) = v_s - v$; $v \triangleq$ voltage gain across i_s

KVL @ B: $R_3 i_B + R_4 i_B + R_5 i_B = v$

combining: $(R_1+R_2)\, i_A + (R_3+R_4+R_5)\, i_B = v_s$

also note that $i_B = i_s + i_A$

$$\therefore (R_1+R_2+R_3+R_4+R_5)\, i_A = v_s - (R_3+R_4+R_5)\, i_s$$

(b) subst. appropriate values $\Rightarrow$ $i_A = \dfrac{v_s - (R_3+R_4+R_5)\, i_s}{R_1+R_2+R_3+R_4+R_5}$

$i_A = -10mA$

$i_B = i_s - i_A = 40mA$

$i_x = -i_A$ $\quad$ $v_x = R_4 i_B$

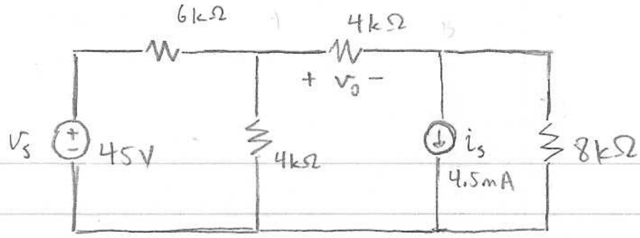
$\boxed{i_x = 10mA}$ $\quad$ $\boxed{v_x = 10V}$

(c) Current is forced through v_s
$\Rightarrow$ v_s dissipates power

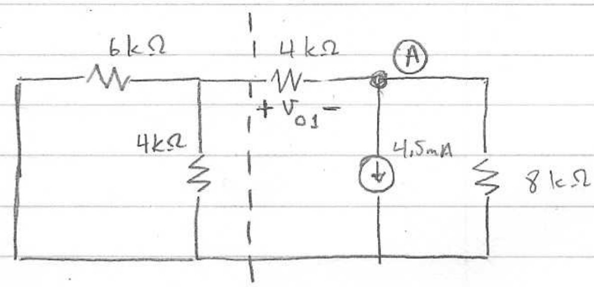
$P = i_A^2 (R_1+R_2) + i_B^2 (R_3+R_4+R_5) - v_s i_A$

$\boxed{P = 1\ W}$

3/28 Use super position
Find v_0



Turn off the voltage source.
⇒ $v_s = 0$ ⇒ short circuit



KCL @ A

$$v_A\left(\frac{1}{2.4+4}+\frac{1}{8}\right)\times 10^{-3} = -4.5\times 10^{-3}$$

$$R_{eq} = \frac{4\times 6}{4+6} = 2.4k\Omega$$

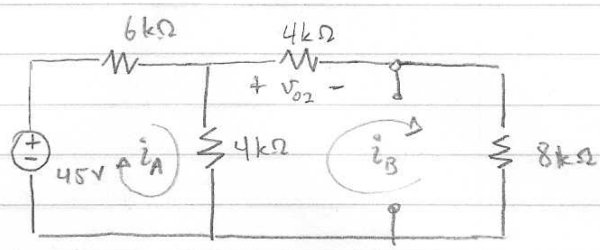
$$v_A = -16\ V$$

$$-v_{01} = v_A - \underbrace{v_A \times \frac{2.4}{4+2.4}}_{\text{voltage divider}}$$

note the minus sign!

$$\boxed{v_{01} = +10\ V}$$

Turn off current source
⇒ $i_s = 0$ ⇒ open circuit



KVL A: $6k\Omega \cdot i_A + 4k\Omega \times (i_A - i_B) = 45V$

KVL B: $4k\Omega(i_B - i_A) + 4k\Omega \times i_B + 8k\Omega \times i_B = 0$

$$10^3 \times \begin{bmatrix} 6+4 & -4 \\ -4 & 4+4+8 \end{bmatrix}\begin{pmatrix} i_A \\ i_B \end{pmatrix} = \begin{pmatrix} 45 \\ 0 \end{pmatrix}$$

$$i_B = 1.25\ mA$$

$$v_{02} = 4k\Omega \times 1.25\ mA$$

$$v_{02} = 5\ V$$

$$\therefore v_0 = v_{01} + v_{02}$$

$$\boxed{v_0 = 15\ V}$$