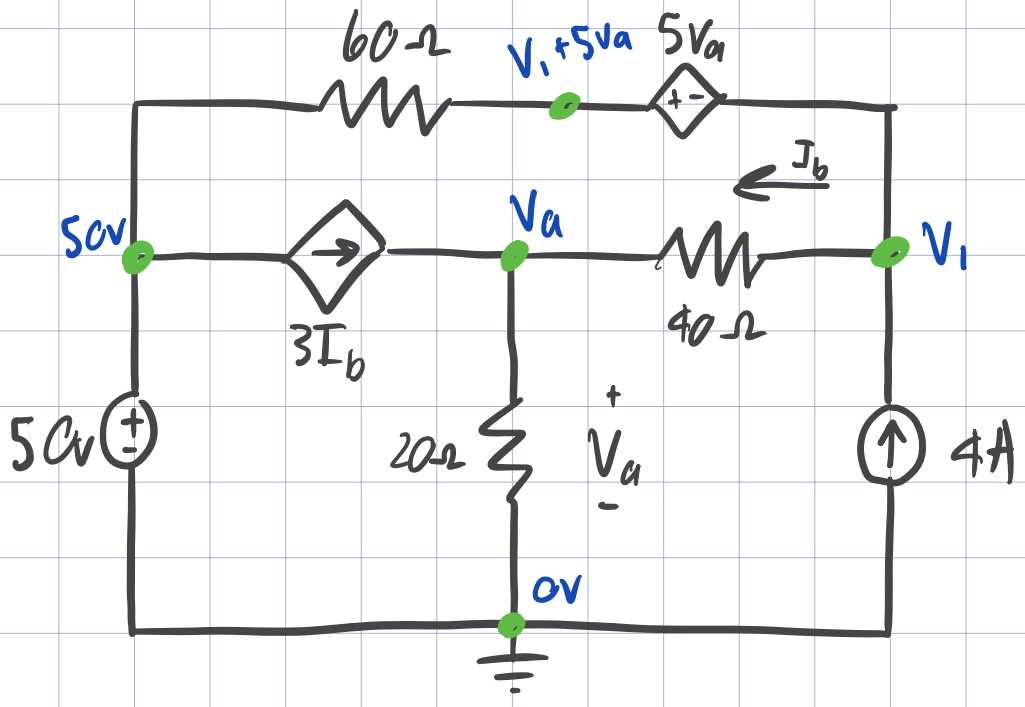


5 nodes - 1 ref - 2 voltage sources = 3 unknowns

Kcl at V_1

$$-4 + \frac{V_1 - V_a}{40} + \frac{V_1 + 5V_a - 50}{60} = 0$$

$$-480 + 3(V_1 - V_a) + 2(V_1 + 5V_a - 50) = 0$$

$$-480 + 3V_1 - 3V_a + 2V_1 + 10V_a - 100 = 0$$

$$5V_1 + 7V_a = 580$$

Kcl at V_a

$$-3I_b + \frac{V_a}{20} - I_b = 0$$

$$-4I_b + \frac{V_a}{20} = 0$$

$$-4\left(\frac{V_1 - V_a}{40}\right) + \frac{V_a}{20} = 0$$

$$\frac{V_a - V_1}{10} + \frac{V_a}{20} = 0$$

$$2V_a - 2V_1 + V_a = 0$$

$$3V_a - 2V_1 = 0$$

$$V_1 = \frac{3}{2}V_a$$

$$5\left(\frac{3}{2}V_a\right) + 7V_a = 580$$

$$15V_a + 14V_a = 1160$$

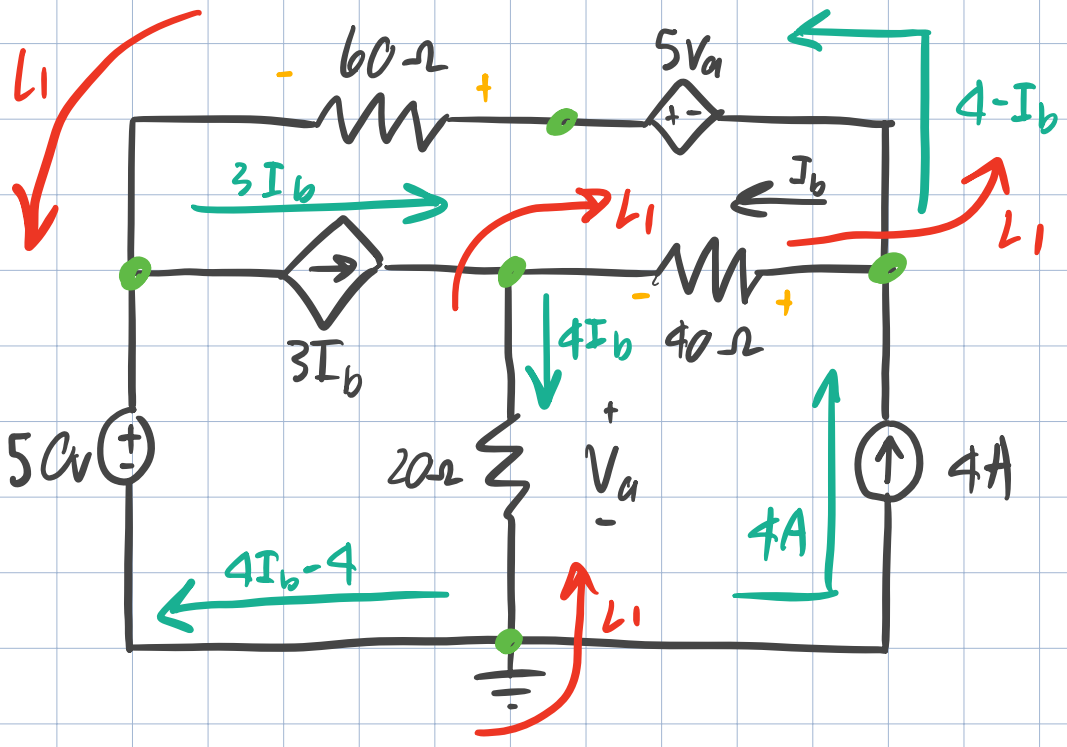
$$29V_a = 1160$$

$$V_a = 40\,V$$

$$V_1 = 60\,V$$

$$I_b = \frac{V_1 - V_a}{40}$$

$$= \frac{1}{2}\,A$$



3 backyards - 2 current source = 1 unknowns

kvl on L_1

$$50 - V_a - 40I_b - 5V_a + 60(4 - I_b) = 0$$

$$50 - 6V_a - 40I_b + 240 - 60I_b = 0$$

$$290 - 6V_a - 100I_b = 0$$

$$V_a = 4I_b \cdot 20$$

$$V_a = 80I_b$$

$$I_b = \frac{1}{80} V_a$$

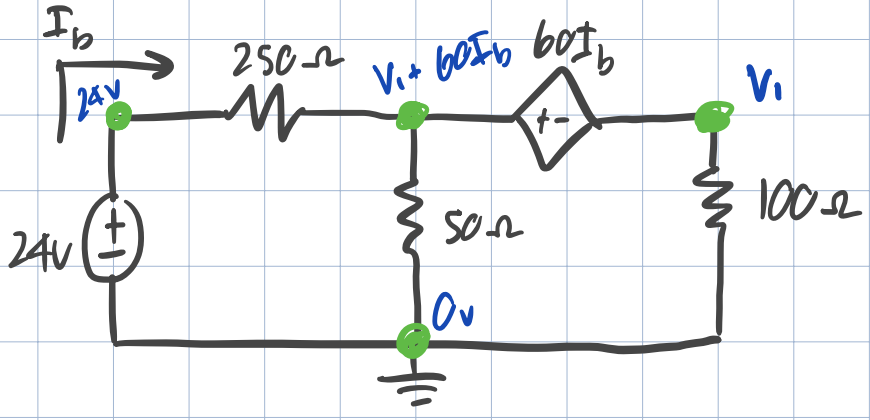
$$290 - 6V_a - \frac{5}{4} V_a = 0$$

$$1160 - 24V_a - 5V_a = 0$$

$$29V_a = 1160$$

$$V_a = 40\,V$$

$$I_L = \frac{1}{2}\,A$$



4 nodes - 1 ref - 2 voltage sources = 1 unknown

KCL at $V_1 + 60I_b$

$$\frac{V_1 + 60I_b - 24}{250} + \frac{V_1 + 60I_b - 0}{50} + \frac{V_1 - 0}{100} = 0$$

$$2(V_1 + 60I_b - 24) + 10(V_1 + 60I_b) + 5V_1 = 0$$

$$2V_1 + 120I_b - 48 + 10V_1 + 600I_b + 5V_1 = 0$$

$$17V_1 + 720I_b = 48$$

$$I_b = \frac{24 - (V_1 + 60 I_b)}{250}$$

$$250 I_b = 24 - V_1 - 60 I_b$$

$$310 I_b = 24 - V_1$$

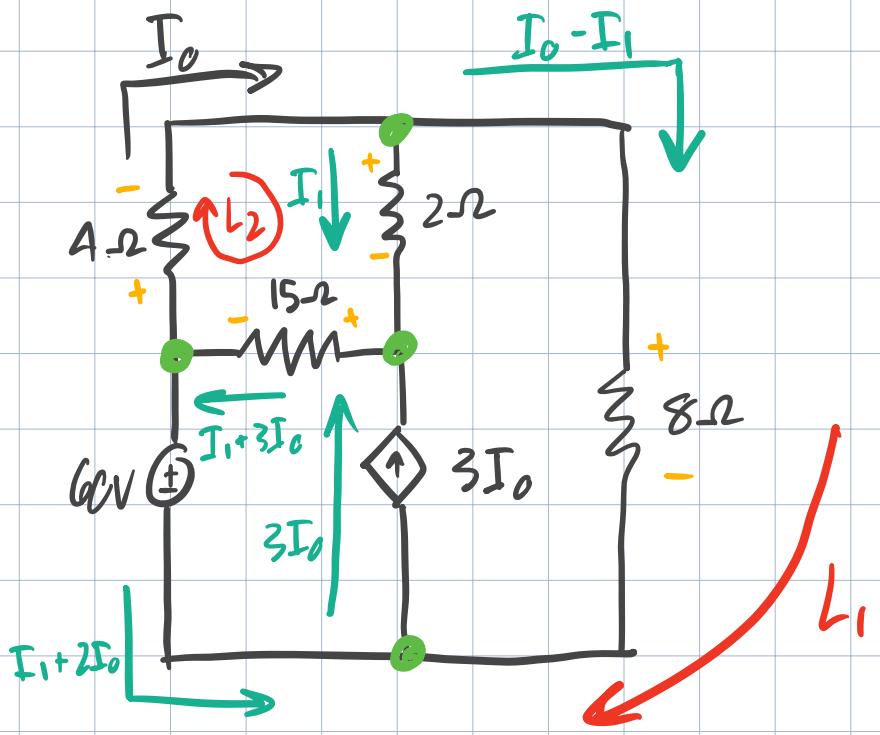
$$V_1 = 24 - 310 I_b$$

$$17(24 - 310 I_b) + 720 I_b = 48$$

$$408 - 5270 I_b + 720 I_b = 48$$

$$4550 I_b = 360$$

$$I_b = \frac{36}{455} \text{ A}$$



3 backyards - 1 current source = 2 unknowns

KCL on L_1

$$-60 + 4I_0 + 8I_0 - 8I_1 = 0$$

$$12I_0 - 60 - 8I_1 = 0$$

$$3I_0 - 15 - 2I_1 = 0$$

$$I_0 = 5 + \frac{2}{3}I_1$$

KCL on L_2

$$4I_0 + 2I_1 + 15(I_1 + 3I_0) = 0$$

$$4I_0 + 2I_1 + 15I_1 + 45I_0 = 0$$

$$49I_0 + 17I_1 = 0$$

$$17I_1 = -49I_0$$

$$I_1 = -\frac{49}{17} I_0$$

$$I_0 = 5 + \frac{2}{3}\left(-\frac{49}{17} I_0\right)$$

$$I_0 = \frac{255}{149} A$$