Lecture 9
Node Analysis – 2 of 7

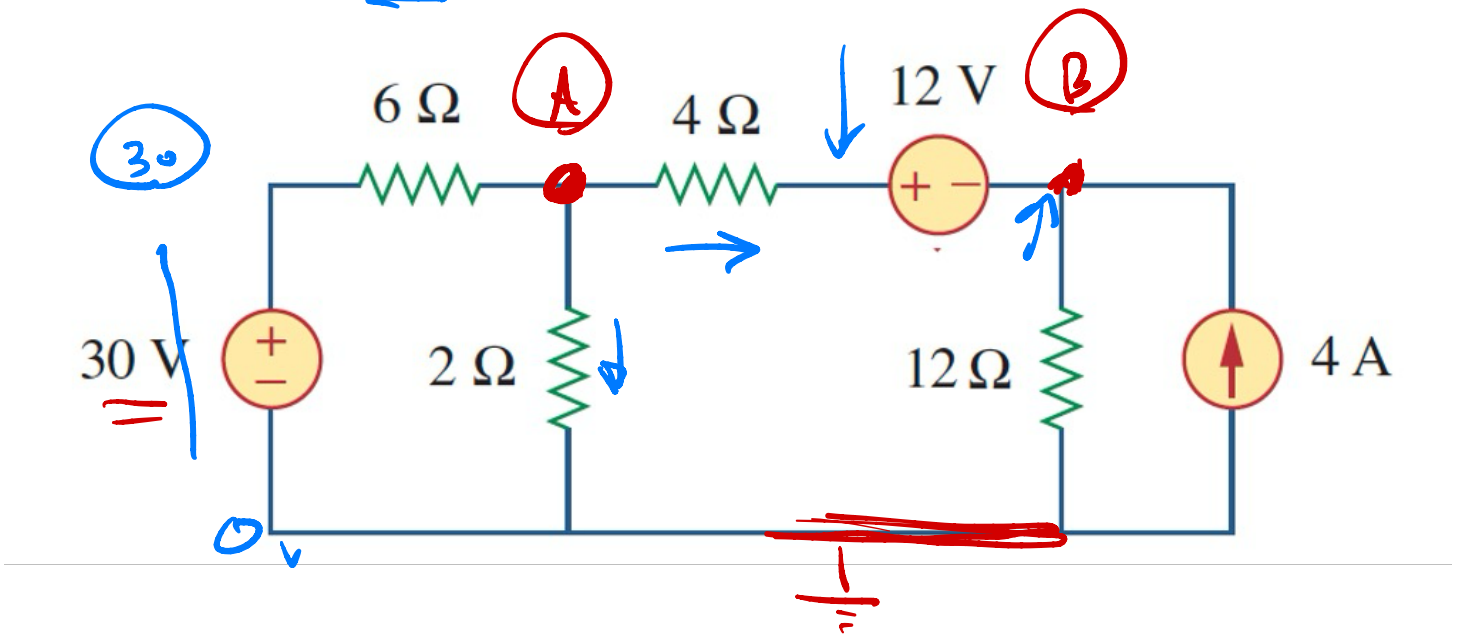
more complex branches

$$A:\ \frac{A}{2} + \frac{A-30}{6} + \frac{A-(B+12)}{4} = 0$$

Extension #2 – V + R branches

1 – label nodes

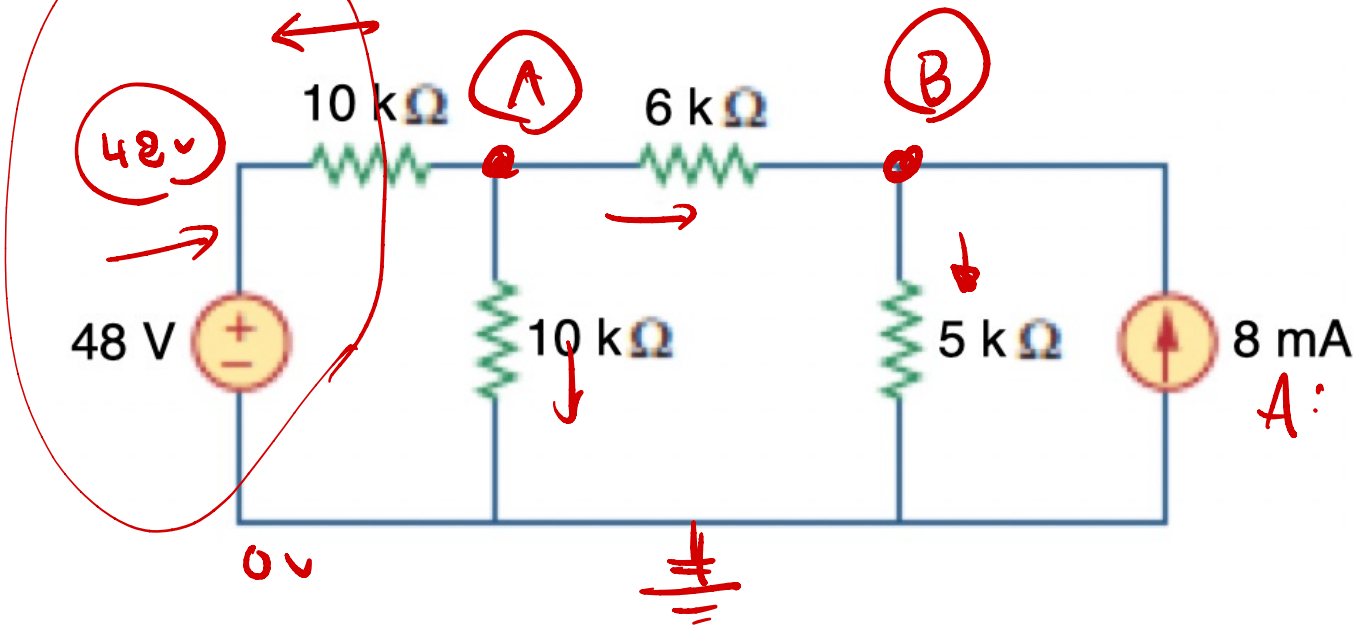
- Consider:



- Solution: Modify the Ohm's Law expression(s) for the individual branch current(s)

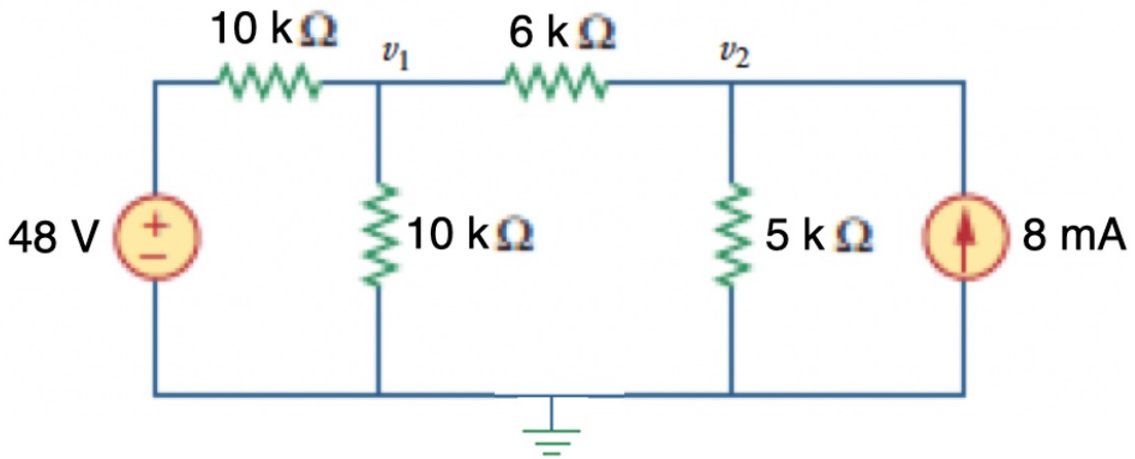
$$B:\ -4 + \frac{B}{12} + \frac{B+12-A}{4} = 0$$

Example (solved on next slide)



B: $\frac{B}{5000} + \frac{B-A}{6000} - 0.008 = 0$

A: $\frac{A-B}{6000} + \frac{A}{10000} + \frac{A-48}{10000}$



$$\frac{v_1}{10k} + \frac{v_1 - 48}{10k} + \frac{v_1 - v_2}{6k} = 0$$

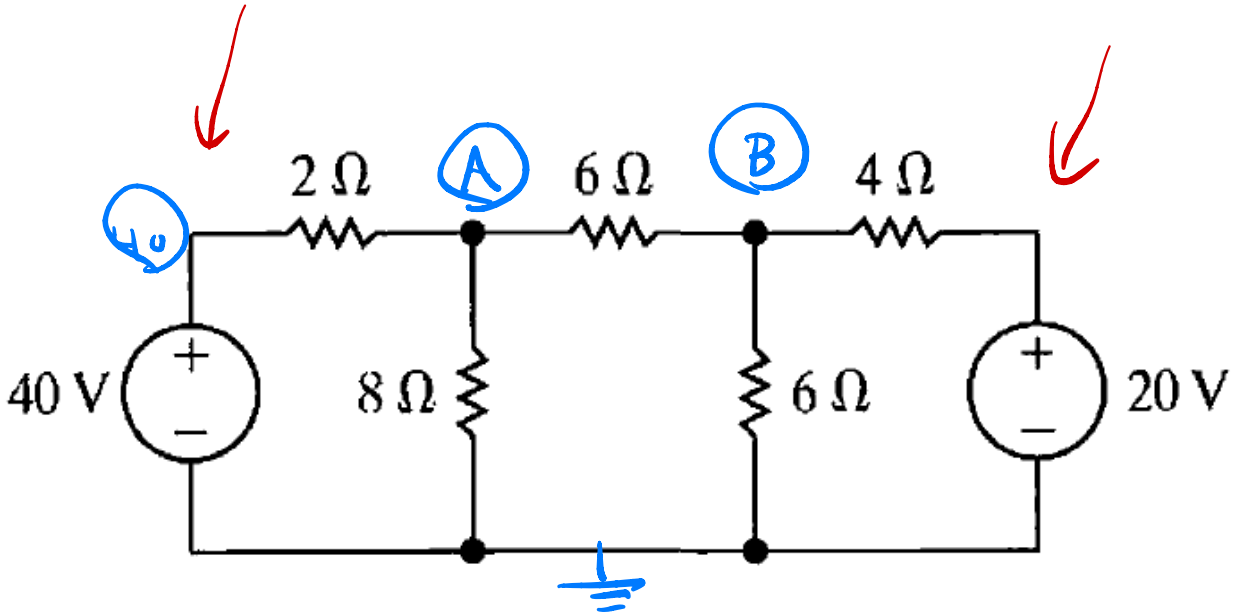
$$\frac{v_2}{5k} + \frac{v_2 - v_1}{6k} - .008 = 0$$

$$3v_1 + 3v_1 + 5v_1 - 5v_2 = 144$$

$$6v_2 + 5v_2 - 5v_1 = 240$$

$$\begin{aligned} 11v_1 - 5v_2 &= 288 \\ -5v_1 + 11v_2 &= 240 \end{aligned} \Rightarrow \begin{aligned} v_1 &= 29\ V \\ v_2 &= 35\ V \end{aligned}$$

Example



1 - label

2 - KCL

$$A: \quad \frac{A}{8} + \frac{A-B}{6} + \frac{A-40}{2} = 0 \quad \Big\} 24$$

$$B: \quad \frac{B}{6} + \frac{B-A}{6} + \frac{B-20}{4} = 0 \quad \Big\} 12$$

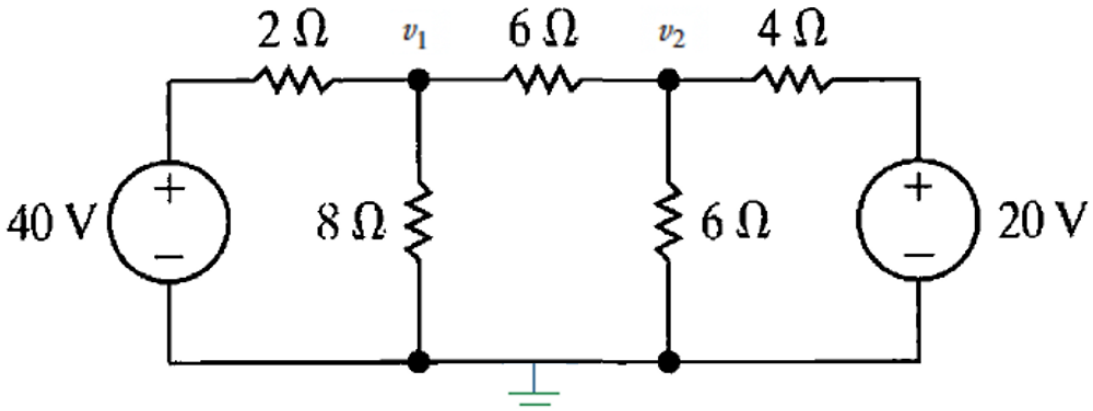
$$3A + 4A - 4B + 12A - 480 = 0$$

$$19A - 4B = 480$$

$$2B + 2B - 2A + 3B - 60 = 0$$

$$-2A + 7B = 60$$

$$A = \frac{\begin{vmatrix} 480 & -4 \\ 60 & 7 \end{vmatrix}}{\begin{vmatrix} 19 & -4 \\ -2 & 7 \end{vmatrix}} = \frac{3600}{125} = 28.8$$



$$\frac{v_1}{8}+\frac{v_1-40}{2}+\frac{v_1-v_2}{6} = 0$$
$$\frac{v_2}{6}+\frac{v_2-v_1}{6}+\frac{v_2-20}{4} = 0$$

$$3v_1+12v_1+4v_1-4v_2 = 480$$
$$2v_2+2v_2-2v_1+3v_2 = 60$$

Fixed

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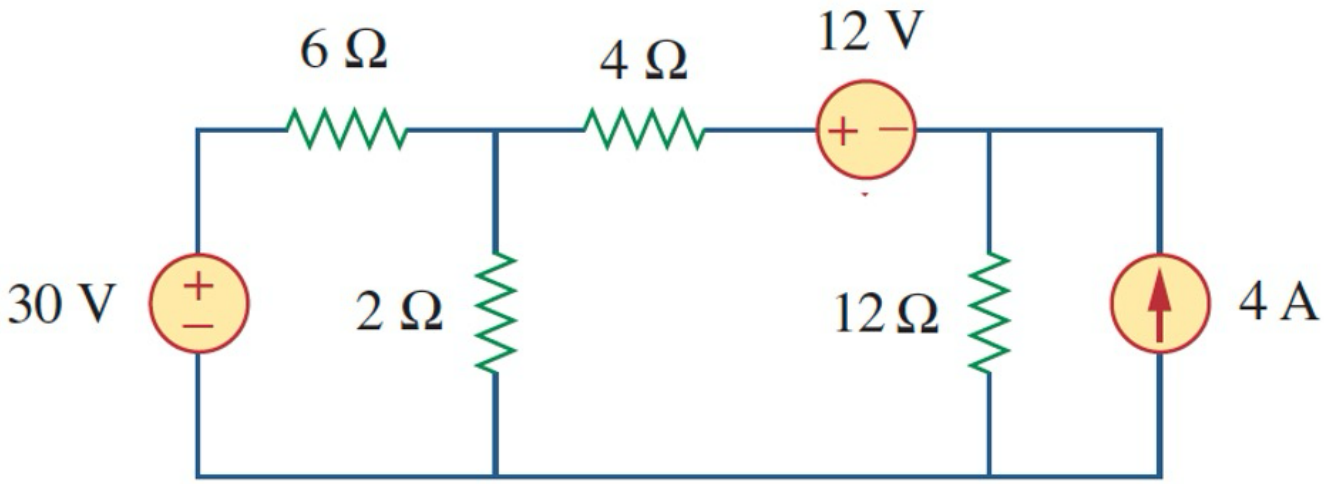
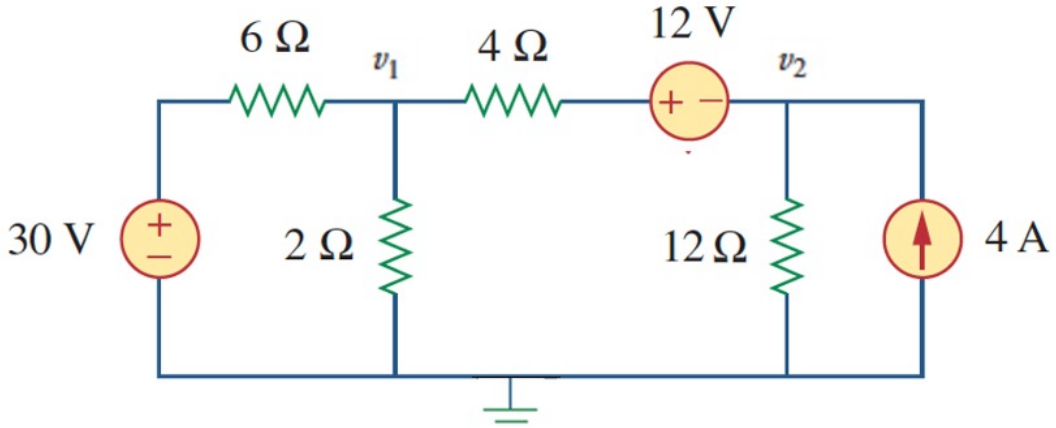
19 W

$$17v_1-4v_2 = 480$$
$$-2v_1+7v_2 = 60$$
$$\Rightarrow \quad v_1 = 27.5\ \text{V}, \quad v_2 = 10.4\ \text{V}$$

28.8
16.8

Example: find the power of the current source





$$\frac{v_1}{2} + \frac{v_1 - 30}{6} + \frac{v_1 - v_2 - 12}{4} = 0$$

$$\frac{v_2}{12} + \frac{v_2 + 12 - v_1}{4} - 4 = 0$$

$$P = (-4\ A) * (12\ V) = -48\ W$$

$$6v_1 + 2v_1 + 3v_1 - 3v_2 = 60 + 36$$

$$v_2 + 3v_2 - 3v_1 = -36 + 48$$

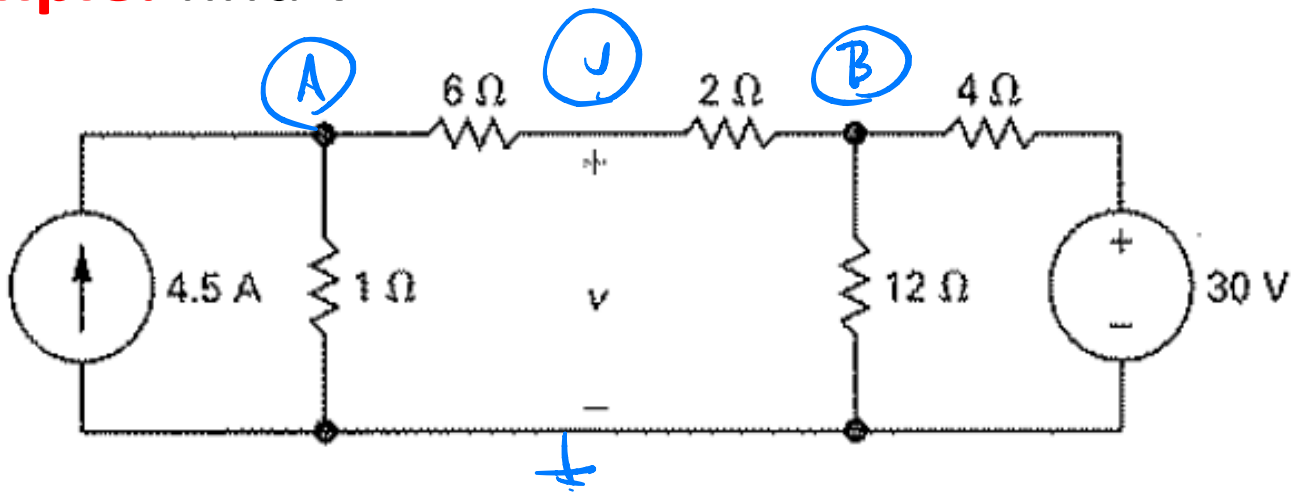
$$11v_1 - 3v_2 = 96$$

$$-3v_1 + 4v_2 = 12$$

$$\Rightarrow \quad v_1 = 12\ V, \quad v_2 = 12\ V$$

15 V

Example: find v



$$\frac{A}{1} - 4.5 + \frac{A-V}{6} = 0$$

$$\frac{B}{12} + \frac{B-30}{4} + \frac{B-V}{2} = 0$$

$$\frac{V-A}{6} + \frac{V-B}{2} = 0$$

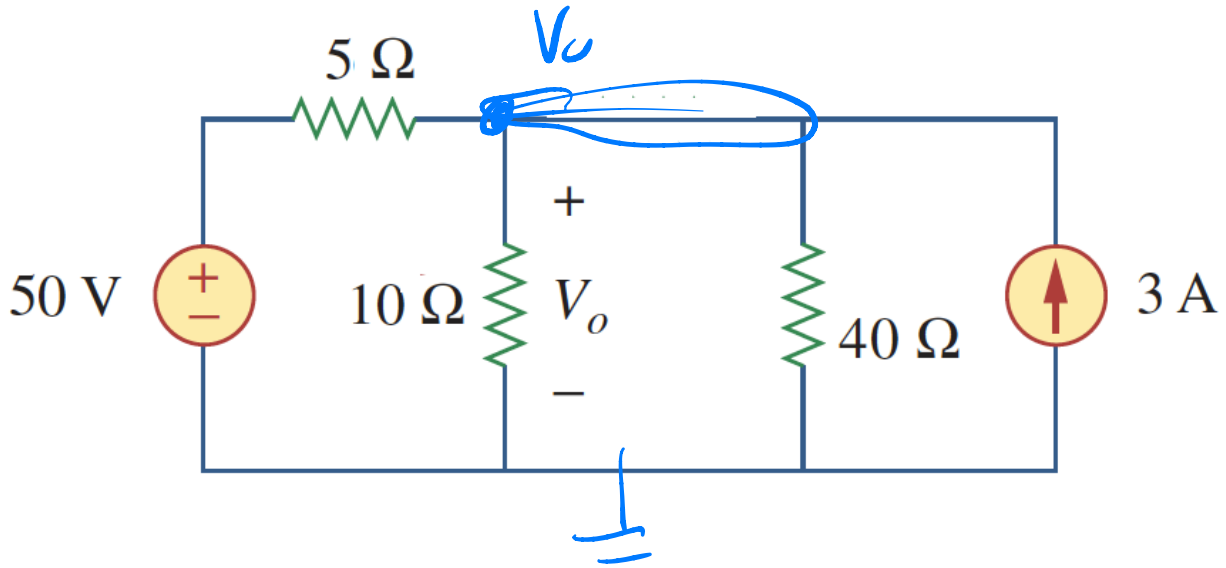
$$A\left(\frac{7}{6}\right) - V\left(\frac{1}{6}\right) - \quad - 4.5$$

$$-V\left(\frac{1}{2}\right) \quad B\left(\frac{1}{12}+\frac{1}{4}+\frac{1}{2}\right) = \frac{30}{4}$$

$$A\left(-\frac{1}{6}\right) + V\left(\frac{1}{6}+\frac{1}{2}\right) - B\left(\frac{1}{2}\right) = 0$$

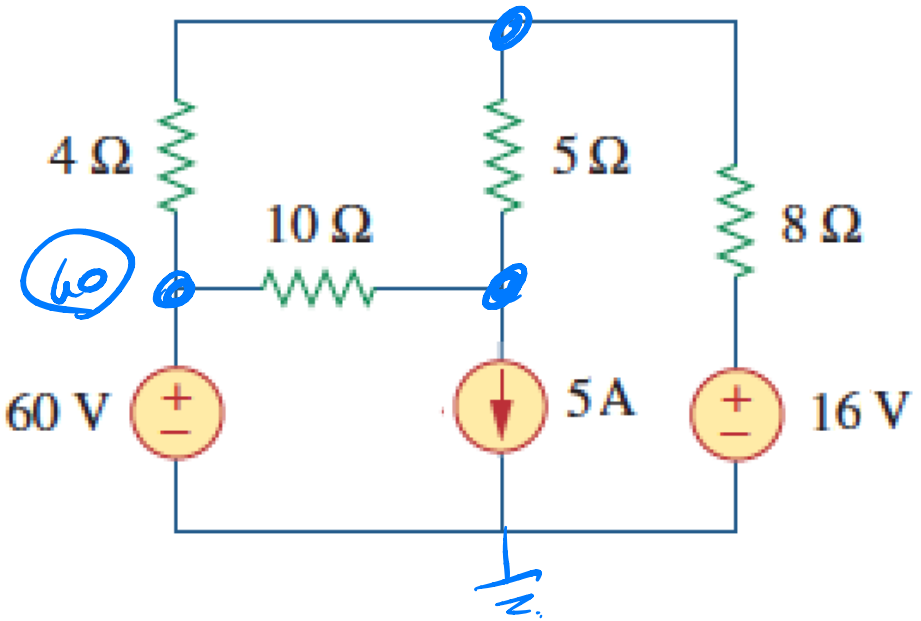
$40\ V$

Practice problem: find V_o



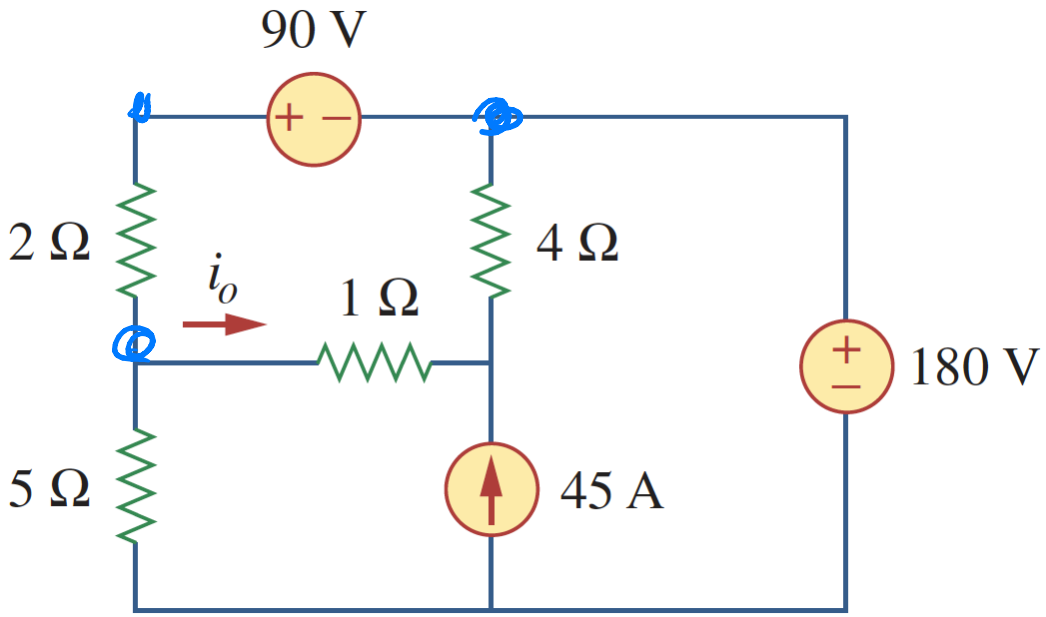
$v_T = 40\ V, v_M = 30\ V$

Practice problem: find the node voltages to the top and bottom of the 5 Ω resistor relative to the bottom



$-26\ A$

Practice problem: find i_o



$-26\ A$

Practice problem: find i_o