Use Node-Voltage method to find how much power the 2A source extracts from circuit.

First we use terminology:

- # nodes = 4 (two or more circuit elements join)
- # essential nodes = 2 (three or more circuit elements join; they are nodes for 4Ω resistor, top & bottom)
- paths: 2A → 4Ω, 4Ω → 2Ω → 55V → 3Ω, 2Ω → 55V, 2A → 2Ω → 55V are a few examples (trace of connected circuit elements without passing thru any element twice)
- branch: (path that connect 2 nodes) 2A, 4Ω, 2Ω, 3Ω, 2Ω → 55V, 55V → 3Ω, 3Ω → 55V (either direction okay), 55V, 2Ω → 55V → 3Ω
- essential branch: (path connecting essential node w/o passing thru essential node) 2A, 4Ω, 2Ω → 55V → 3Ω, or 3Ω → 55V → 2Ω
- loops: (path with last node = start node) 2A → 4Ω, 2A → 2Ω → 55V → 3Ω, 4Ω → 2Ω → 55V → 3Ω
- mesh: (loop not enclosing any other loop) 2A → 4Ω, 4Ω → 2Ω → 55V → 3Ω but not 2A → 2Ω → 55V → 3Ω
- planar circuit: (can draw circuit w/o crossover branches) it planar

For Node-V method, we use all but 1 essential nodes after we define a ref node.

Choose node at bottom of 4Ω as ref node (i.e. 0V)

\[ \begin{align*}
\text{Node at top of 4Ω is the other essential node. Label it } V_1 \end{align*} \]
Although we call it the Node-V method, because we get an equation that we solve for voltage, we are writing an equation for sum of currents out of node = 0.

\[ 2A + \frac{V_i - 0V}{4\Omega} + \frac{V_i - 55V}{2\Omega + 3\Omega} = 0A \]

Note that current thru 2A is equal to total V-drop across the 2Ω and 3Ω R's.

or \[ V_i \left( \frac{1}{4\Omega} + \frac{1}{5\Omega} \right) = -2A + 55V \]

or \[ \frac{V_i}{4\Omega \parallel 5\Omega} = 9A \]

or \[ V_i = 9A \cdot \frac{4\Omega}{4\Omega \parallel 5\Omega} = \frac{9A \cdot 4\Omega}{4\Omega + 5\Omega} = 20V \]

Check: \[ \frac{V_i}{4\Omega} = 5A \quad \frac{V_i - 55V}{2\Omega + 3\Omega} = -35V = -7A \]

Calculate power for 2A source: \[ p = i \cdot v = 2A \cdot 2V = 4W \]

p > 0 ⇒ power absorbed.