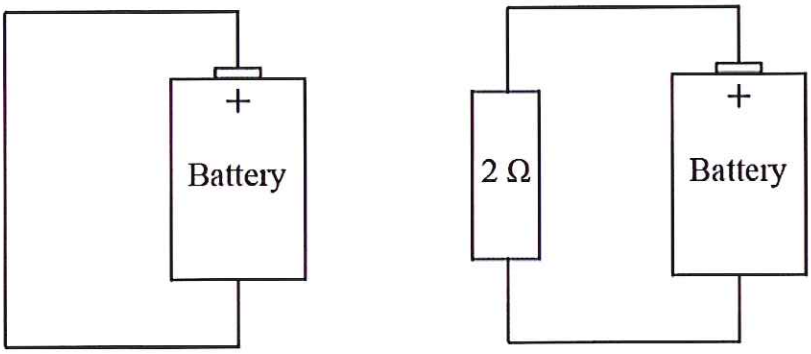
3. (25 points)



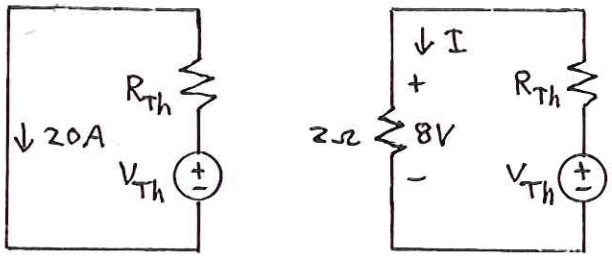
When the above battery is shorted out by a wire, it delivers 20 A of current.

When a 2 Ω resistor is connected across the battery, the voltage across the resistor is 8 V.

a) Find a Thevenin equivalent model of the battery.

b) How much power is dissipated by the resistance in the battery when the battery is shorted out?

soln: a) We have the following circuits.



From the first circuit, we have

$$20A = \frac{V_{Th}}{R_{Th}}.$$

From the second circuit, we have

$$I = \frac{8V}{2\Omega} = 4A = \frac{V_{Th}}{R_{Th} + 2\Omega}$$

So

$$20A R_{Th} = V_{Th} = 4A\,(R_{Th} + 2\Omega)$$

$$20A\,(R_{Th}) = 4A\,(R_{Th}) + 4A\,(2\Omega)$$

or

$$20A\,(R_{Th}) = 4A\,(R_{Th}) + 8V$$

or

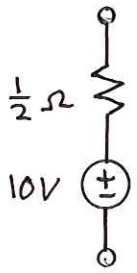
$$16A\,(R_{Th}) = 8V$$

or

$$R_{Th} = \frac{8V}{16A} = \frac{1}{2}\,\Omega$$

And $V_{Th} = 20A\,R_{Th} = 20A \cdot \frac{1}{2}\,\Omega = 10V$

Battery Model:



b) When shorted out, the current is 20A (from problem statement). The power in the $\frac{1}{2}\,\Omega$ is I^2R where $R = \frac{1}{2}\,\Omega$.

$$p = I^2R = (20A)^2 \cdot \frac{1}{2}\,\Omega = 200\,W$$