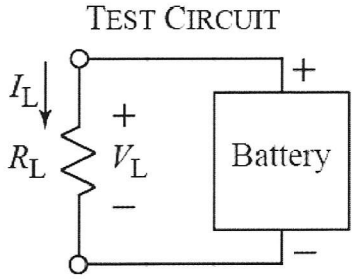
4. a) Given the following data for a battery, find an appropriate model for the battery.

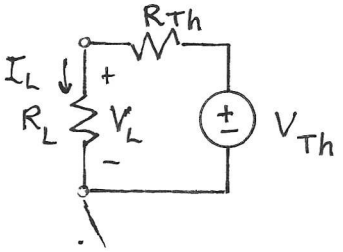


DATA

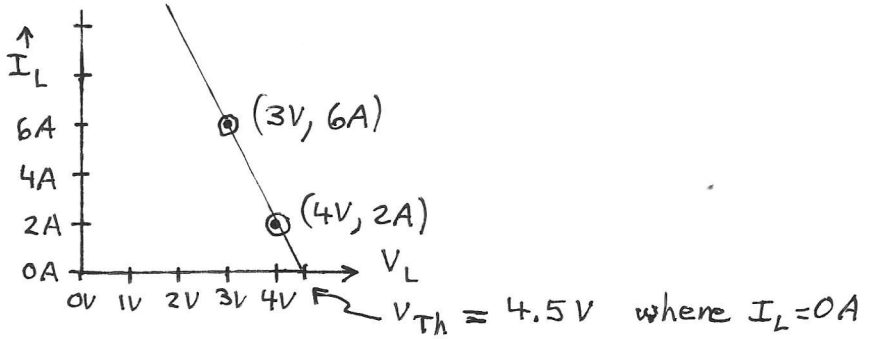
R_L	V_L	I_L
0.5 Ω	3 V	6 A
2 Ω	4 V	2 A

b) If the battery is placed in a charger that delivers 5V to the battery, how much power must the recharger supply to the battery?

soln: a) The battery acts like a V-source with an internal resistance, so we use a Thevenin equivalent.



We can use a graph to help us find the values of V_{Th} and R_{Th}.



From the graph it appears $V_{Th} = 4.5V$. We can use the slope to precisely determined V_{Th} and R_{Th}.

$$\text{slope } \frac{\Delta V_L}{\Delta I_L} = \frac{4V - 3V}{2A - 6A} = -\frac{1V}{4A}$$

Note that we use $\Delta V/\Delta I$ because it gives us R_{Th}.

$$R_{Th} = -\text{slope}\ \frac{\Delta V}{\Delta I} = -\left(-\frac{1V}{4A}\right) = 0.25\,\Omega$$

because R_{Th} from $V_L = V_{Th} - V_{RTh}$

To compute V_{Th}, we use $I_L = 0$ (open circuit for R_L). $(V_{Th}, 0)$ is another point on the line.

$$\text{slope}\ \frac{\Delta V_L}{\Delta I_L} = \frac{V_{Th} - 4V}{0A - 2A} = -\frac{1}{4}\,\Omega$$

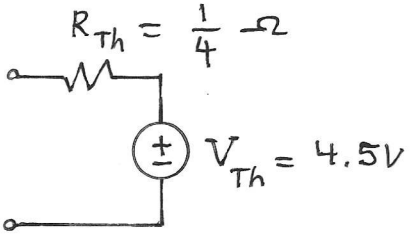
or

$$V_{Th} - 4V = -\frac{1}{4}\,\Omega(-2A) = \frac{1}{2}\,V$$

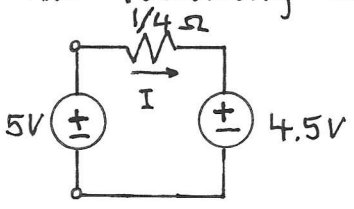
or

$$V_{Th} = 4V + \frac{1}{2}V = 4.5\,V$$

Battery Model:



b) We have 5V on the output of the battery. The following is a circuit model.



Current $I = \frac{5V - 4.5V}{1/4\,\Omega} = 2A$

The power is the voltage (5V) times the current.

$$P = VI = 5V \cdot 2A = 10W$$