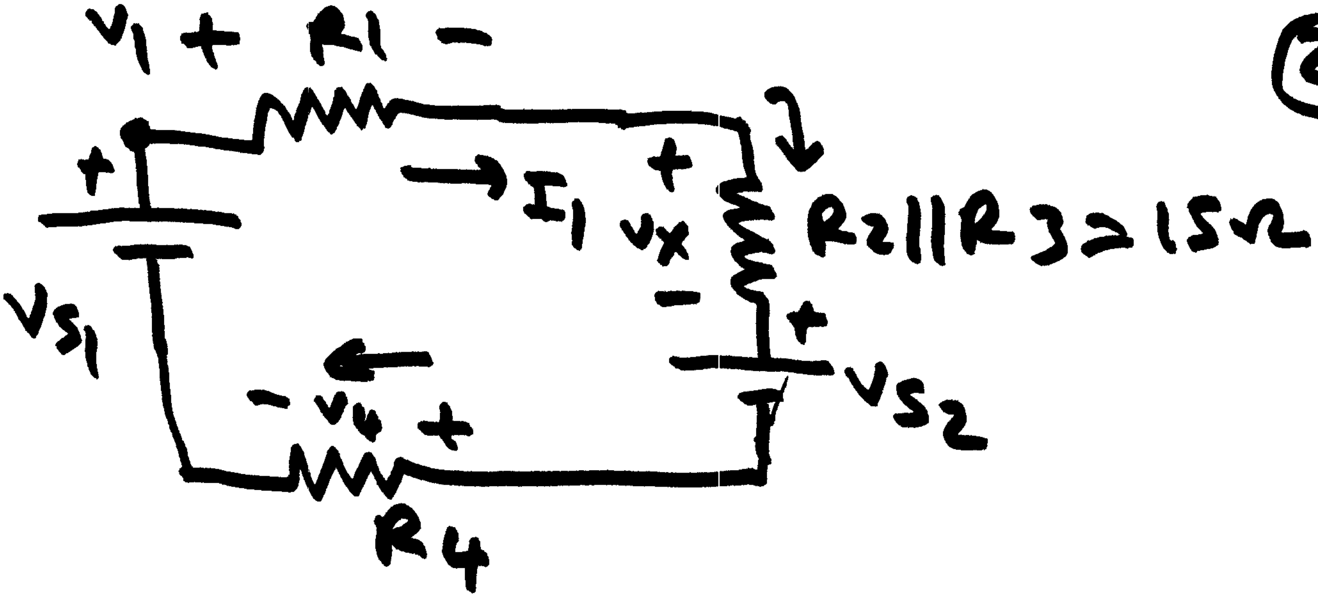


KVL:: $+V_1 + V_x + V_{S_2} + V_4 - V_{S_1} = 0$

$$I_1 \cdot R_1 + I_1 R_2\|R_3 + V_{S_2} + I_1 R_4 - V_{S_1} = 0$$

$$I_1 \left[R_1 + R_2\|R_3 + R_4\right] = V_{S_1} - V_{S_2}$$

$$I_1 = \frac{V_{S_1} - V_{S_2}}{\left[10+15+30\right]} = \frac{120-65}{55} = 1A$$

Compute I_2, I_3

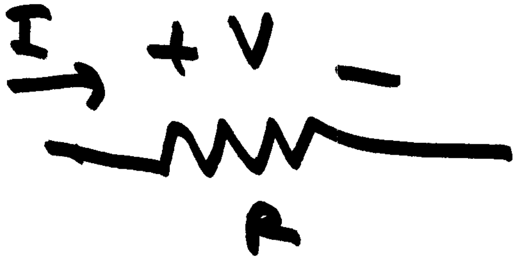
$$I_2 = I_1 \cdot \frac{R_3}{R_2+R_3}, \quad I_3 = I_1 \frac{R_2}{R_2+R_3}$$

$I_2 = \frac{3}{4} A$ // $\quad I_3 = \frac{1}{4} A$ //

Power in Resistors

1-16-02

25



Power: $P = V \cdot I$ since $I = \frac{V}{R}$

$$\Rightarrow \quad P = \frac{V^2}{R} = I^2 R \ (W)$$

$$\text{Energy} = \int_{t_1}^{t_2} p(t)\, dt$$

$$= P \cdot (t_2 - t_1) \text{ if}$$

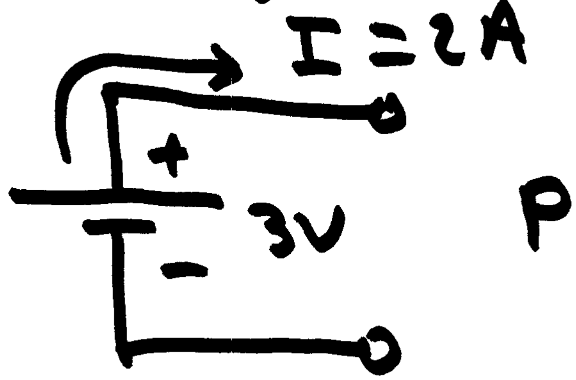
$$P = \text{constant}$$

Electrical energy is usually measured by Power Companies in KWh

Conservation of energy (or power)

(input energy) = (output energy)

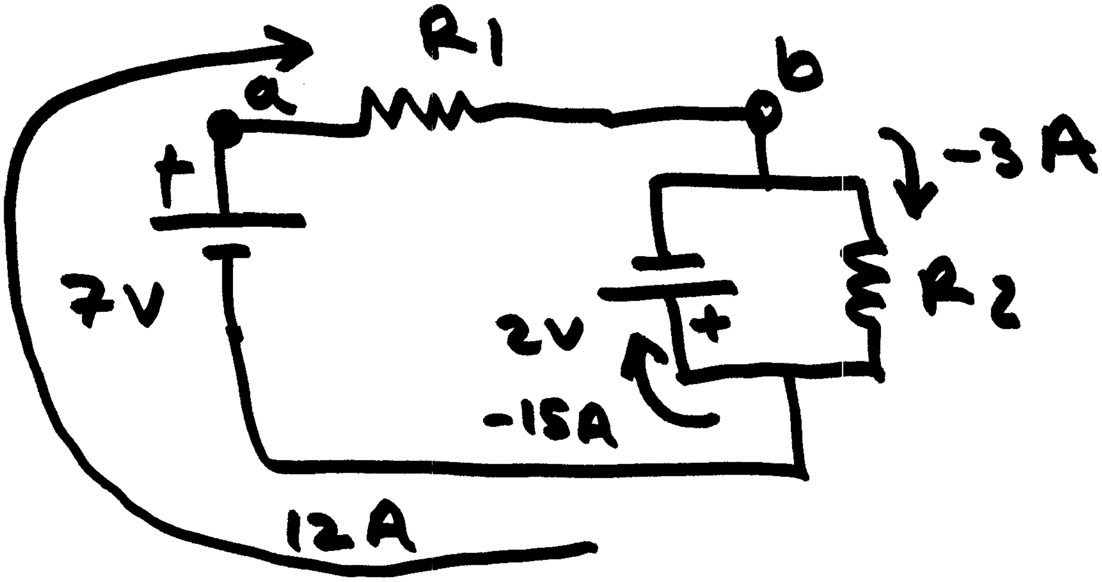
Power from voltage Sources



A voltage source **delivers** power to the outside world if the current flows out of the (+) terminal

Agreement: we will call power **delivered** from a source positive.

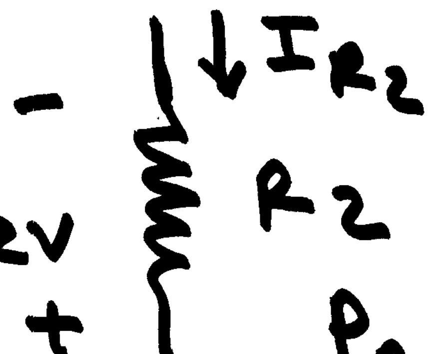
Example: Prob 1.19



$V_{ab} = 9V$

$$P_{R_1} = V_{R_1} \cdot I_{R_1} = V_{ab} \times 12\,A$$
$$= 9V \times 12A = 108\,W$$

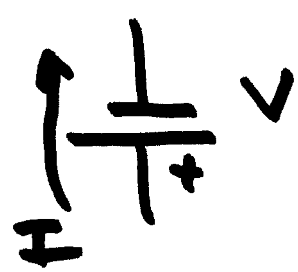
P_{R2}



$$P_{R_2} = -I_{R_2} \cdot 2V$$

$$P_{R2} = -(-3)\,2 = 6W$$

2V source



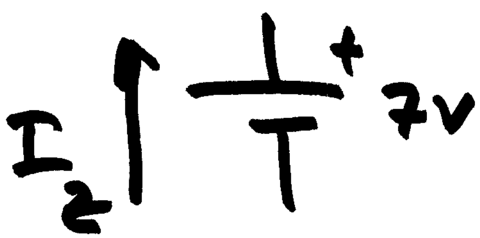
$$|P| = 2V \times 15\,A$$
$$= 30W$$

Actually

$$P_{delivered} = -VI = -(-15)\times 2$$
$$= 30W$$

The 30W is delivered to the circuit

Power from 7V source



$$P_{delivered} = I_2 \cdot 7V$$
$$= 7 \times 12V = 84\,W$$

Power delivered to circuit $\left.\right\}$ $P_{7V} + P_{2V}$

$84 + 30 = 114W$

Power lost $= P_{R_1} + P_{R_2} = 108W + 6W$

Power delivered = 114 w

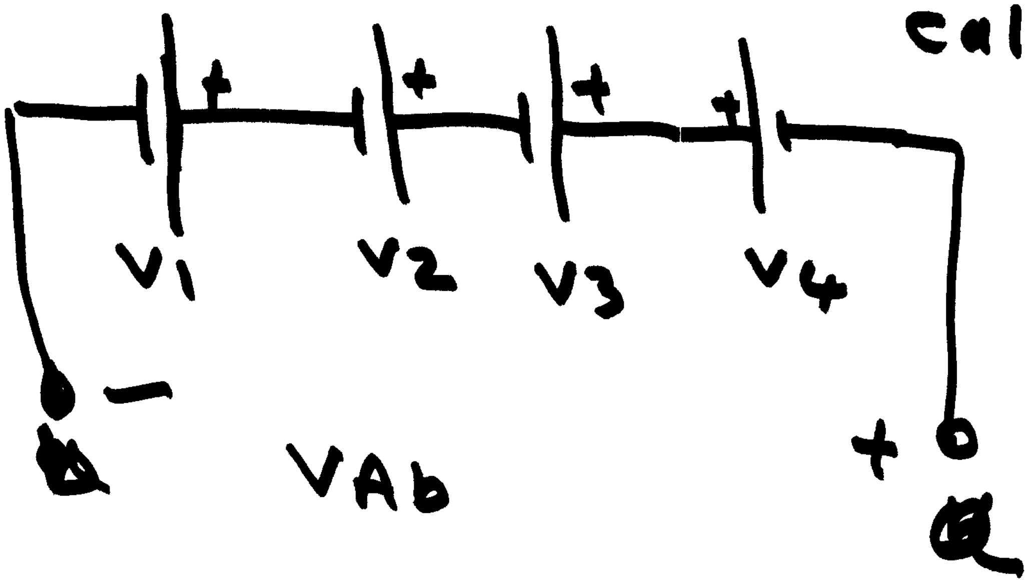
Power lost = 114W

Connections of Sources

a) voltage sources

1) series connection

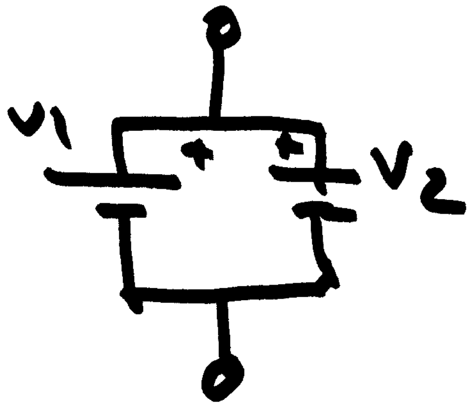
voltages add algebraically



$$V_{ab} - V_1 - V_2 - V_3 + V_4 = 0$$

$$V_{ab} = V_1 + V_2 + V_3 - V_4$$

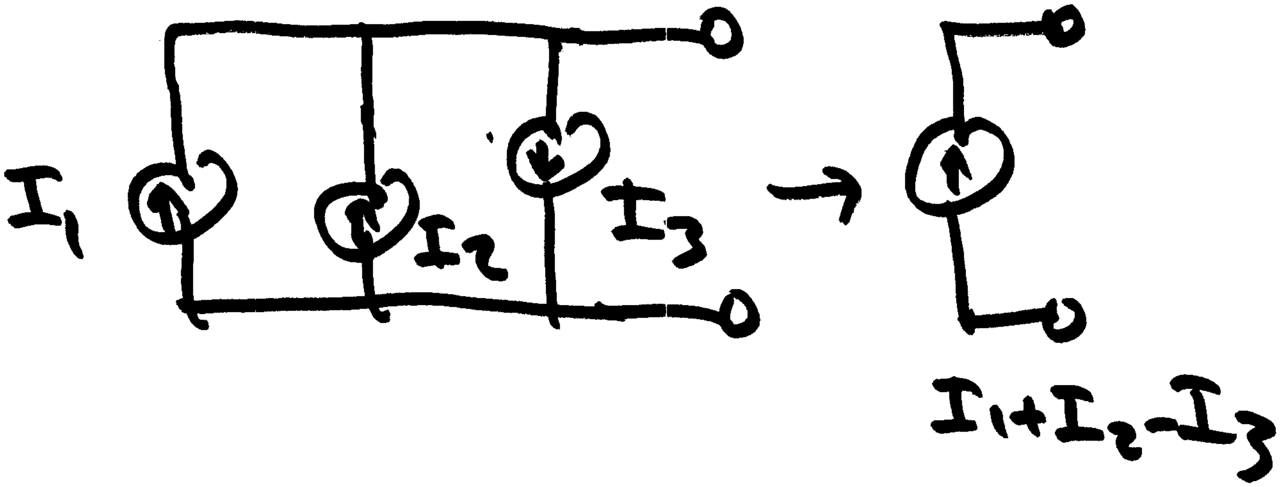
2) Parallel



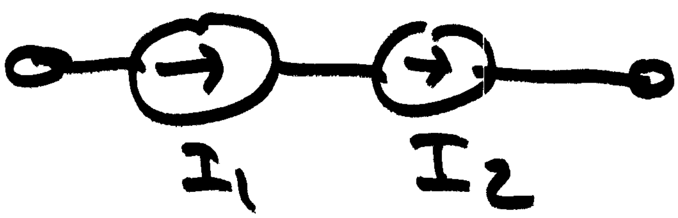
SOS!! when connecting voltage sources in parallel they **MUST** have the same voltage, otherwise they will explode

b) Current Sources

1) Paralle



2) Serial Connection

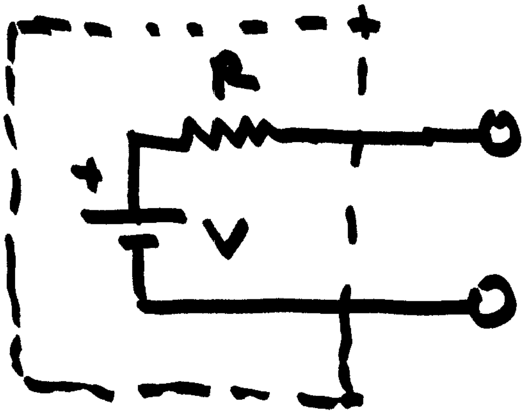


I_1 must be equal to I_2

Equivalent (Internal) Resistance of Sources

A) Voltage Source

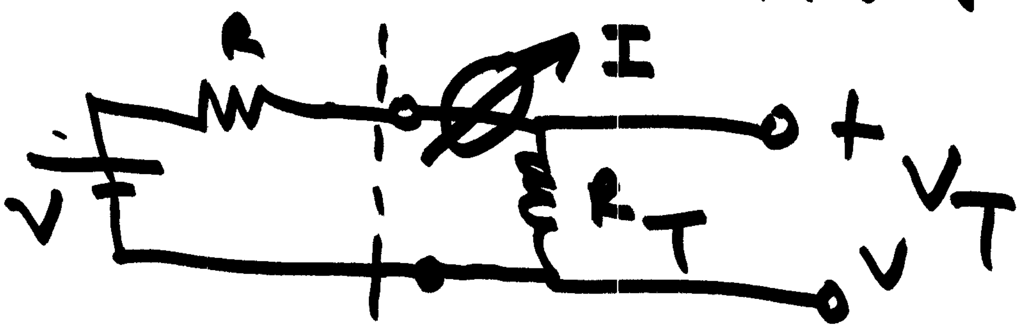
Non-ideal Source



Measure R

1) Measure open-circuit voltage. $V_{oc} = V$

2) Connect a test Resistor at it's terminals



Apply voltage divider

$$\underset{\text{known}}{V_T} = \underset{\substack{V_{oc} \\ \text{known}}}{V} - \underset{\text{known}}{I} \cdot R$$

$$R = \frac{V - V_T}{I - 0} = \frac{\Delta V}{\Delta I}$$

$$\Rightarrow \quad R = \frac{\Delta V}{\Delta I}$$

known

$$\rightarrow \quad V_T = V \cdot \frac{R_T}{R_T + R}$$

measured   solve

Return $R = \dfrac{\Delta V}{\Delta I}$

In ideal source

$\Delta V = 0 \Rightarrow R = 0$

when V becomes zero, the ideal voltage source looks like a short circuit