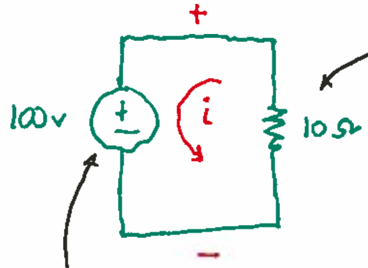
Monday, January 18, 2016
(both L02, L03)

Example revisited



For this current direction i and voltage polarity v.

$$v = -iR, \quad \text{so} \quad i = -\frac{v}{R}$$

$$i = \frac{-100\,V}{10\,\Omega} = -10\,A$$

Passive reference convention

$$p = +vi = 100 \times -10$$
$$= -1000\ W$$

(power delivered)

In resistor,

$$p = -vi$$
$$= -100 \times -10$$
$$= +1000\ W \quad \text{(absorbing)}$$

Example 2

Assume energy cost is \$0.12 per kilowatt-hour (kWh)

- electric bill for 30 days : \$60.00
- power is constant over this time.

(a) Give power in Watts.

(b) Voltage = 120 V, find current

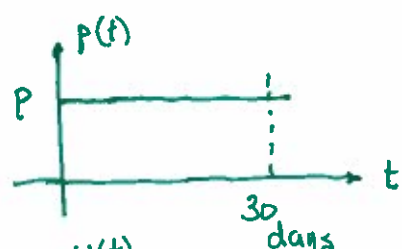
(c) How much energy is saved (in percent) by removing 60 W.

Solution

(a) Total energy consumed in 30 days

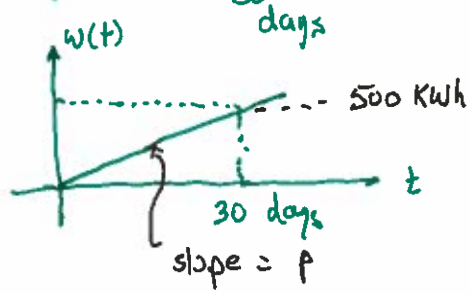
$$w = \$60.00 / \$0.12 = 500\ kWh$$

Constant power implies



and $w(t) = \int_0^t p\,dt$

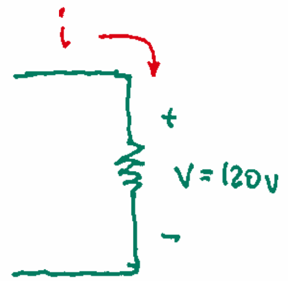
$= pt$



$$P = \frac{500 \text{ KWh}}{30 \text{ days}} = \frac{500{,}000 \text{ Wh}}{30 \times 24 \text{ h}}$$

$$= 694.4 \text{ W}$$

(b)



Assuming house is absorbing energy!

$p = vi$, so $i = \frac{P}{V} = \frac{694.4}{120}$

$= 5.787 \text{ A}$

(c) Reducing power consumption by 60 W.

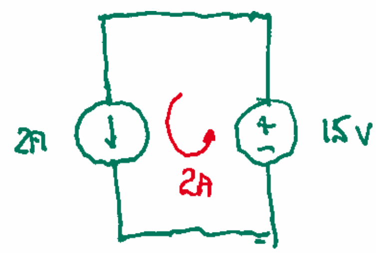
$$\text{reduction} = \frac{60}{694.4} \times 100\% = 8.64\%$$

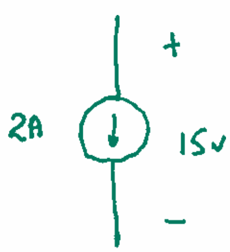
or 8.64% of \$60.00 = \$5.18

<u>Example 3:</u>

Consider the simple circuit

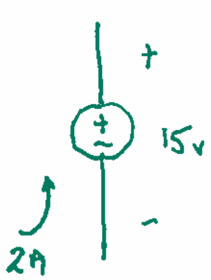
Find the power in each source, and determine if absorbing or delivering.





Note that $p = vi$

$P_{2A} = 15 \times 2 = +30 \text{ W}$ (absorbing)



Here, $P_{15V} = -vi$

$= -15 \times 2 = -30 \text{ W}$ (delivering)

Note energy balance! $-30 \text{ W} + 30 \text{ W} = 0$

Kirchhoff's laws

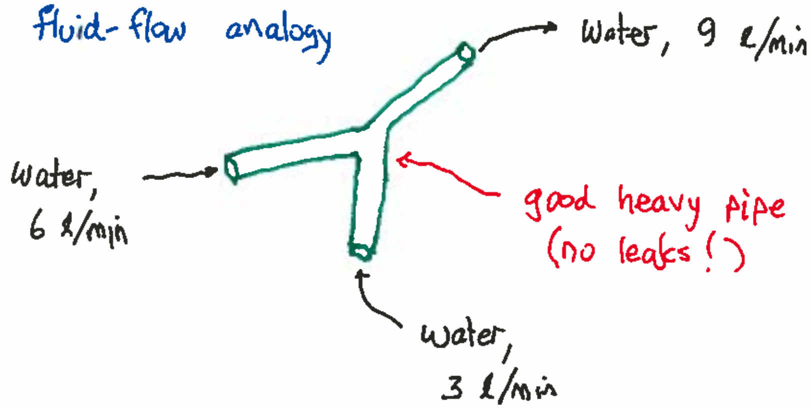
So far, we have reviewed

- fundamental electricals quantities v, i (and p, w)
- basic circuit elements (R, sources, etc.)
    - each has its own important v-i relationship.

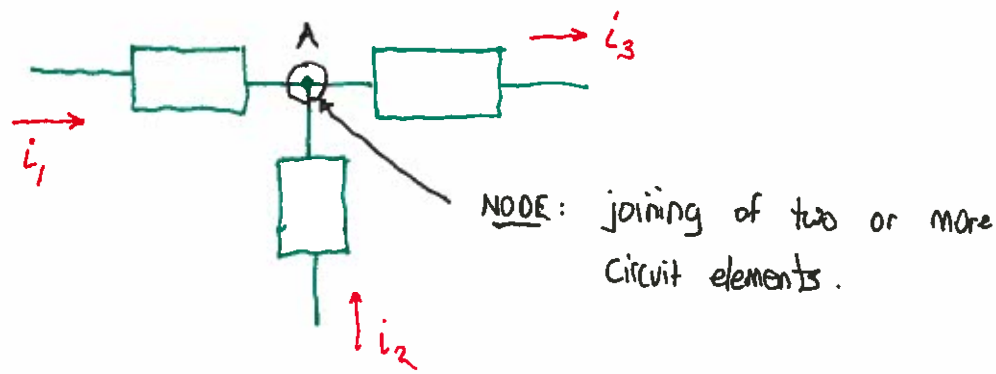
Kirchhoff's laws now define how v, i distribute in a circuit.

Kirchhoff's Current Law (KCL)

KCL fluid-flow analogy



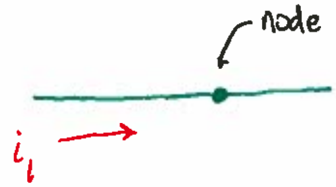
Consider a node in a circuit



KCL states: $\boxed{\text{Algebraic sum of all currents at a node must be zero}}$

Choose a consistent way to distinguish incoming and outgoing currents at a node.

E.g.,



incoming current __adds__

outgoing current __subtracts__

Then, sum currents at node A

$$\underbrace{i_1 + i_2}_{\text{entering node A}} - \underbrace{i_3}_{\text{leaving node A}} = 0$$