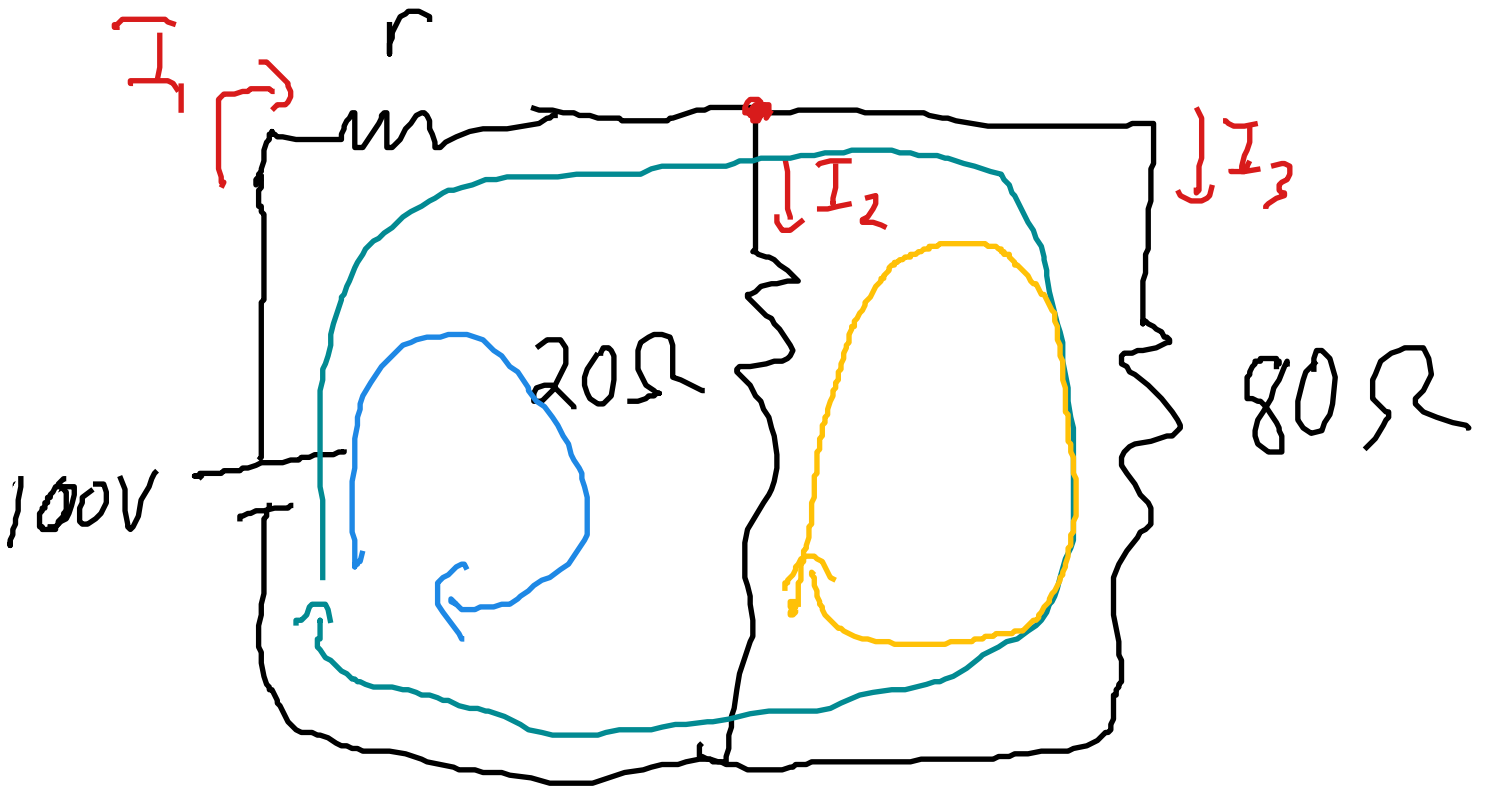


Junction: $\underset{\text{in}}{I_1} = \underset{\text{out}}{I_2 + I_3}$

Loop: $100 - I_1 r - 20 I_2 = 0$

$100 - I_1 r - 80 I_3 = 0$

$20 I_2 - 80 I_3 = 0$

$$20 I_2 - 80 I_3 = 0$$

$$20 I_2 = 80 I_3$$

$$I_2 = 4 I_3$$

$$I_1 = I_2 + I_3$$

$$= 4 I_3 + I_3$$

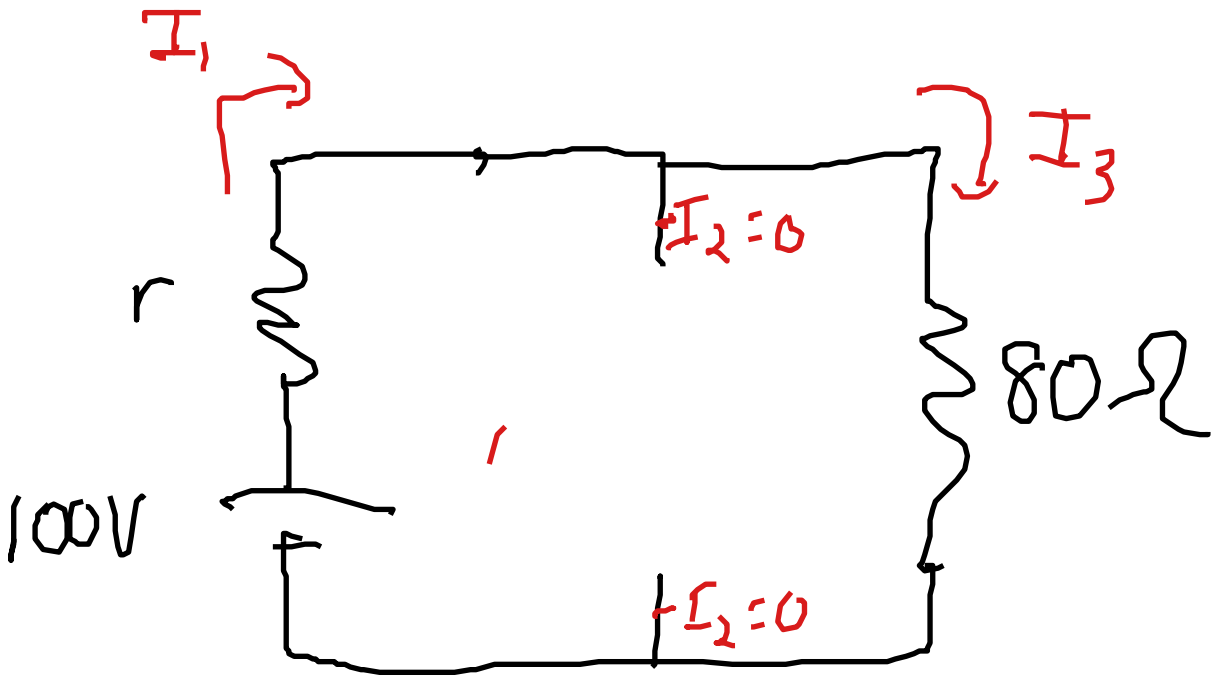
$$I_1 = 5 I_3$$

$$100 - r(5 I_3) - 20(4 I_3) = 0$$

$$\overset{20}{\cancel{100}} = I_3 (5r + \overset{16}{\cancel{80}})$$

$$I_3 = \frac{20}{16 + r} \qquad I_1 = \frac{100}{16 + r}$$

$$I_2 = \frac{80}{16 + r}$$



$$I_1 = I_3$$

$$100 - I_1 r - 80 I_3 = 0$$

$$100 - I_1 r - 80 I_1 = 0$$

$$100 = I_1 (80 + r)$$

$$I_3 = I_1 = \frac{100}{80 + r}$$

with 20Ω

$$I_3 = \frac{20}{16+r}$$

without 20Ω

$$I_3 = \frac{100}{80+r} \quad \text{1/5}$$

$$= \frac{20}{16+(r/5)}$$

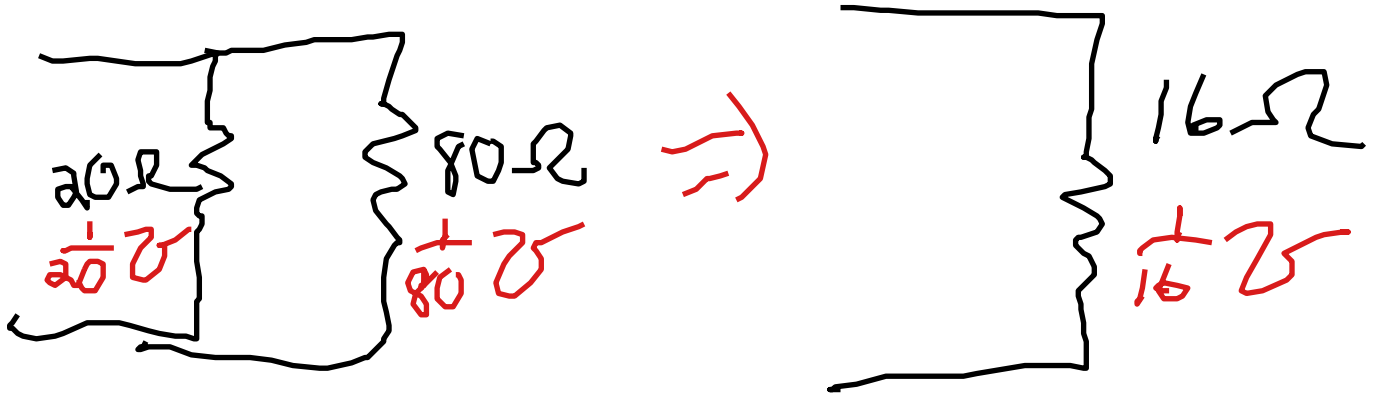
If r is tiny $(r \to 0)$

then these two currents

are roughly the same

If $r \ll 16\Omega$ then

internal resistance doesn't matter



If $r << R_{eq}$ of parallel resistors, then it doesn't matter

$$R_{eq} < R_1, R_2, \ldots$$

if $r << R_1, R_2, \ldots$

then we're probably OK.

So house wiring works well (all devices are independent) so long as all resistors are much greater than the internal resistance.

But low-resistance devices

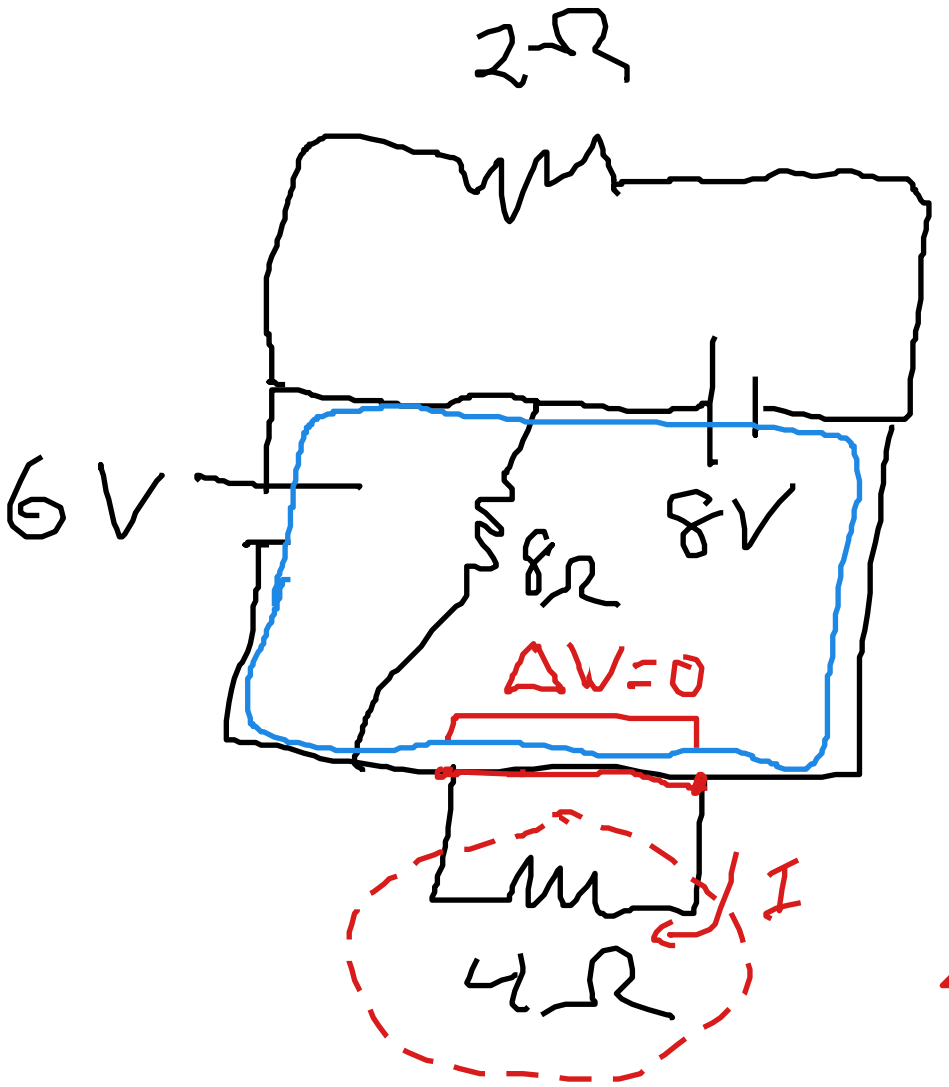
can mess this up

high $\rightarrow P = \frac{(\Delta V)^2}{R}$ (ΔV ← const; R ← low)

vacuum cleaners

microwaves

space heaters



$\Delta V = IR$

$0 = I(4)$

resistor is "short-circuited" - gets no current

$I = 0$

$+6 - 8 = 0$

$-2 = 0$?!?!?

short-circuiting the batteries

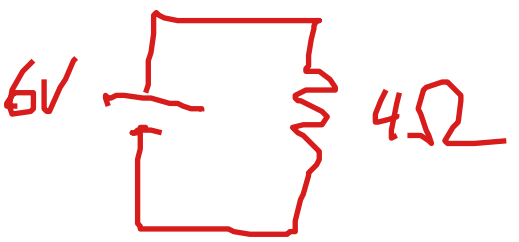
(huge, tiny)

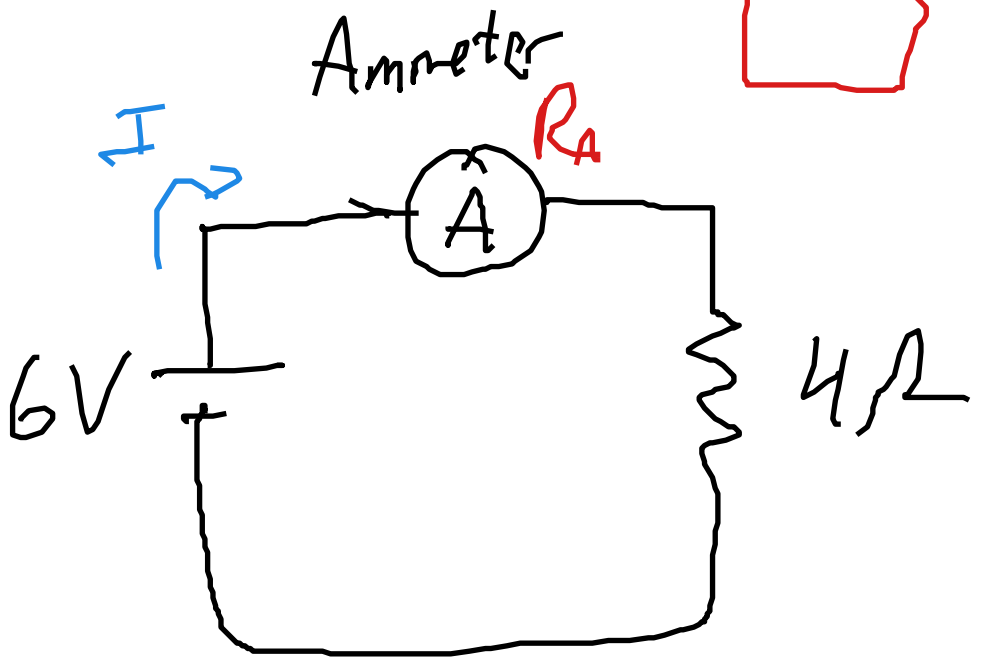
$+6 - 8 - I\,r_{wire} = 0$

Ammeters & Voltmeters

measure current

measure ΔV





placed in series with the current they're measuring

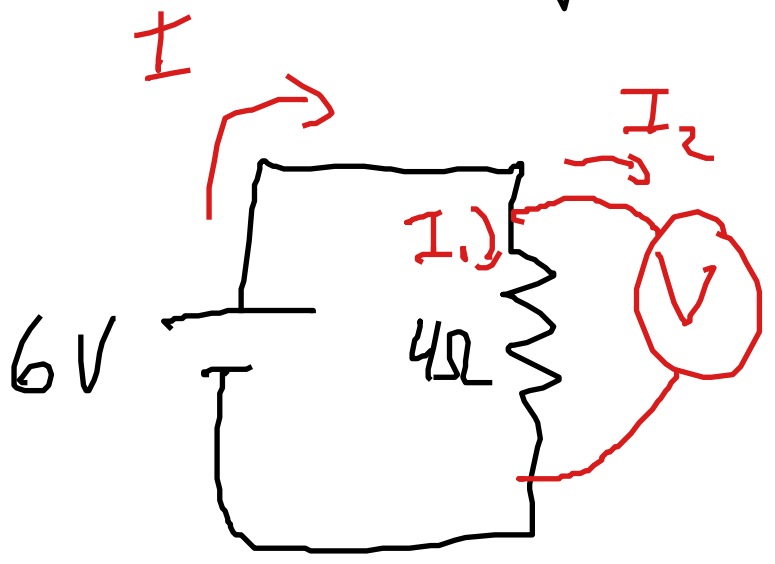
$$6 - IR_A - 4I = 0$$

$$I = \frac{6}{4 + R_A}$$

ammeters have tiny resistance

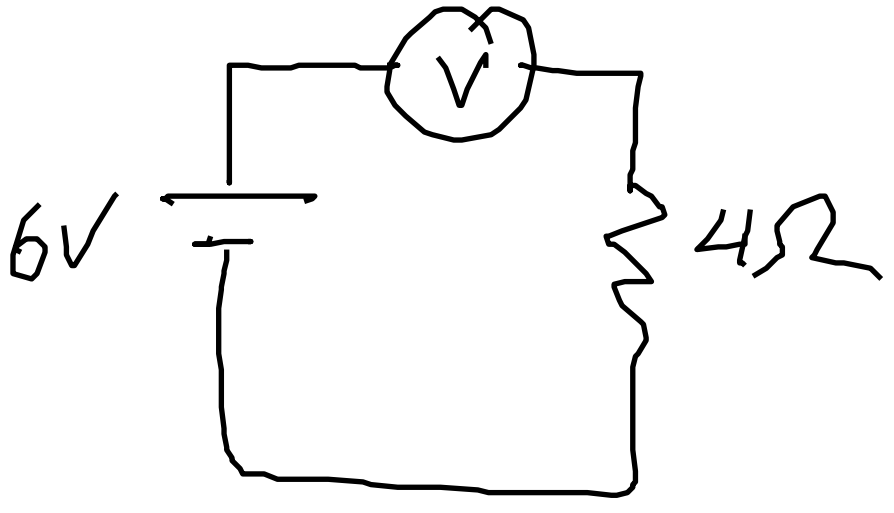
behave like a wire

Voltmeter

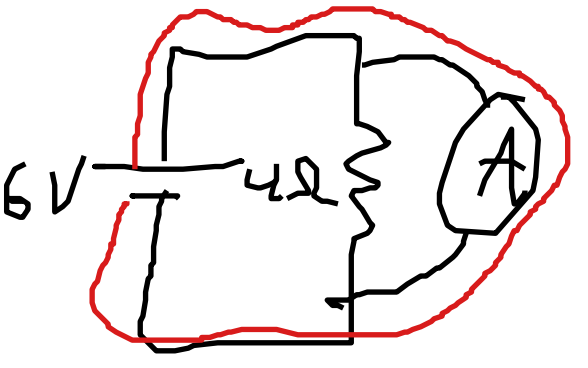


is placed in parallel with the device it's measuring

voltmeters have huge resistance to avoid interference



no current



short-circuits the battery (fuse is blown)