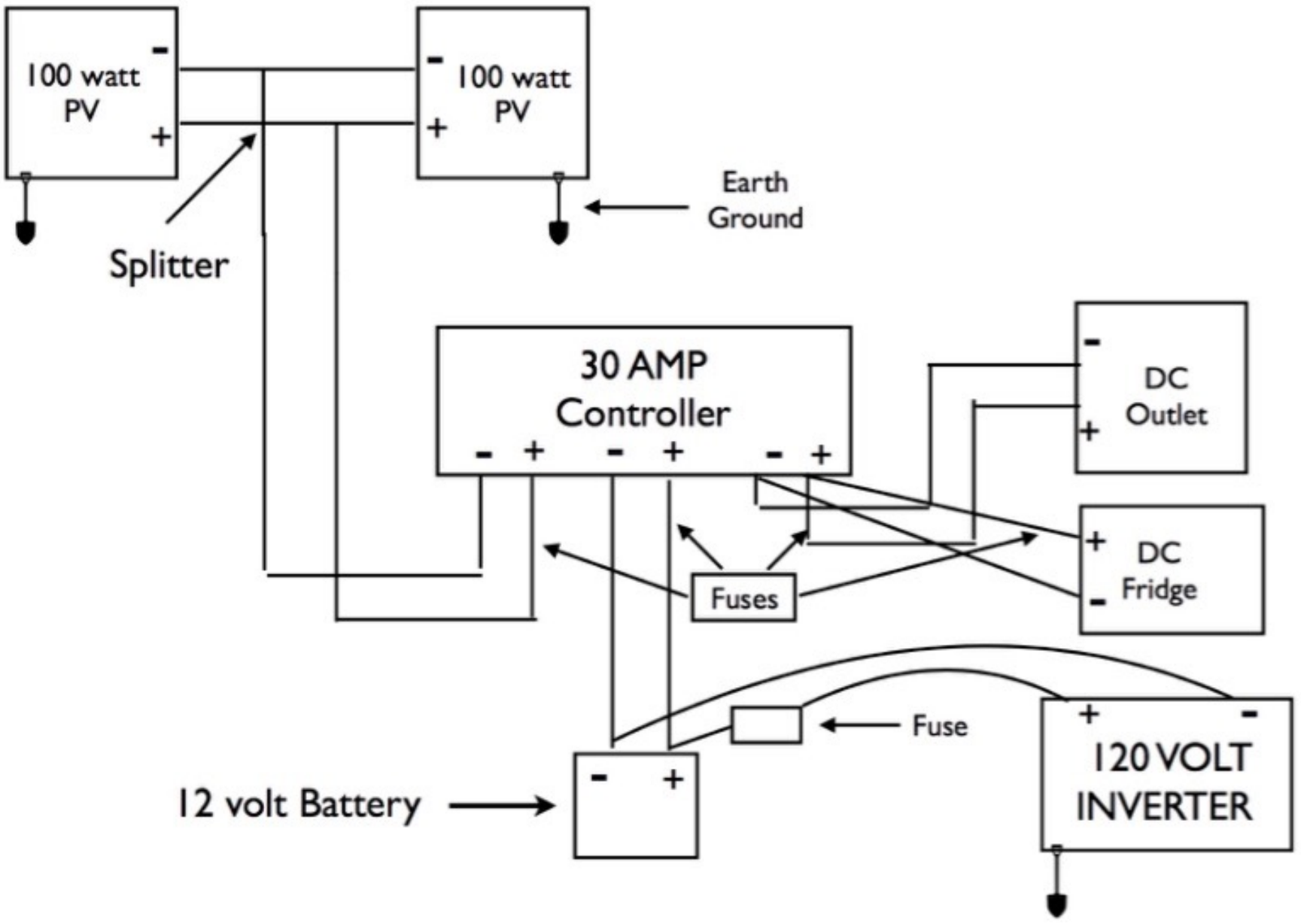
this will be yours

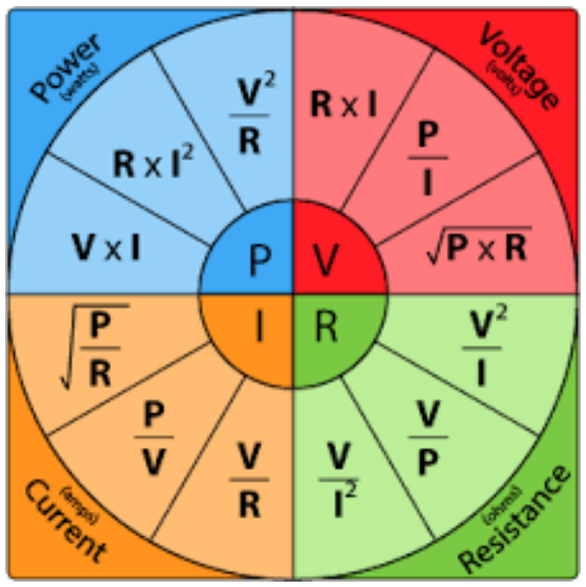
Gallup Solar's 12Volt Hogan System



but first you have to get the math

electricity basics

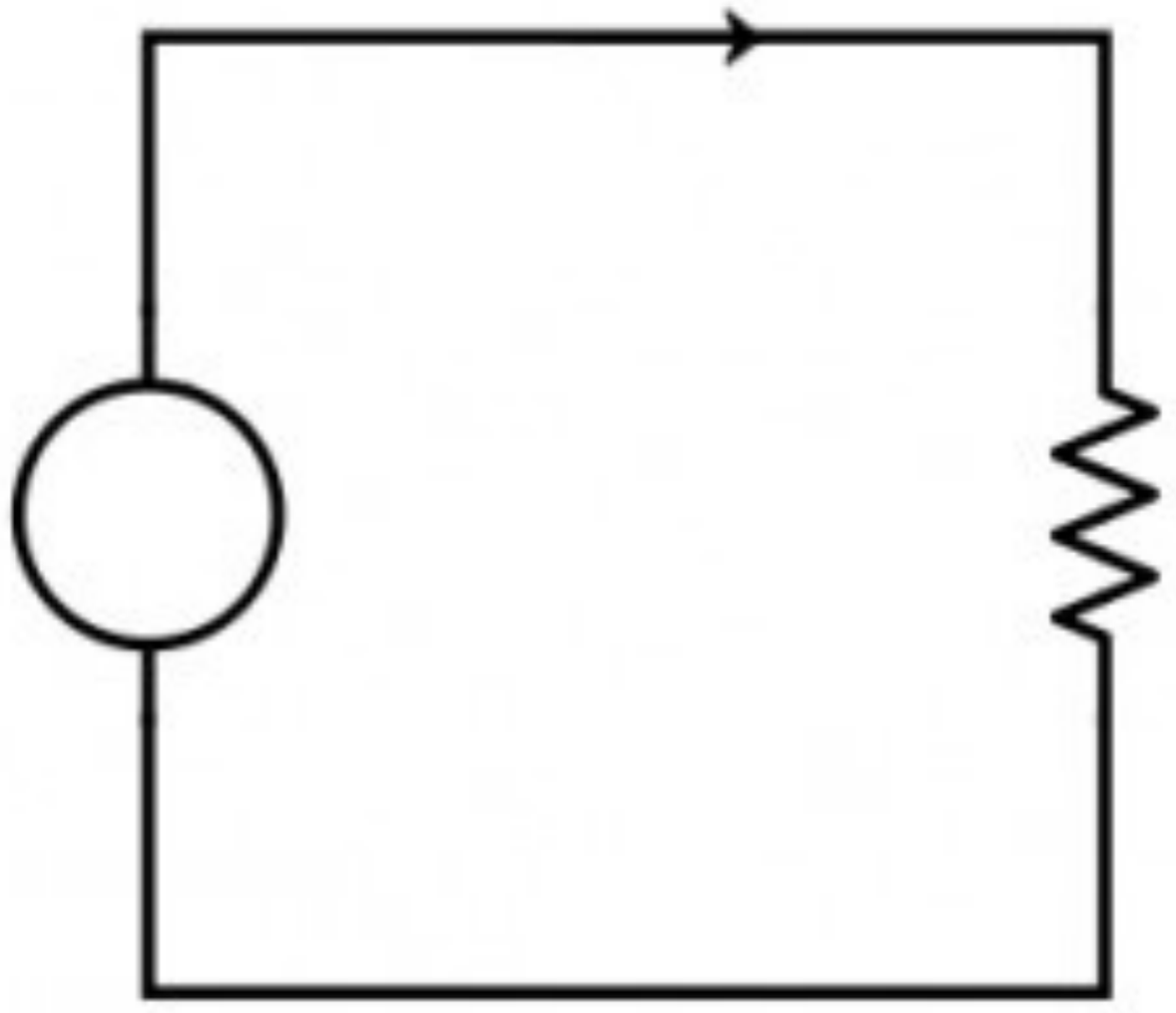
class 2 for Gallup Solar Team 4



All together now: Love and Marriage

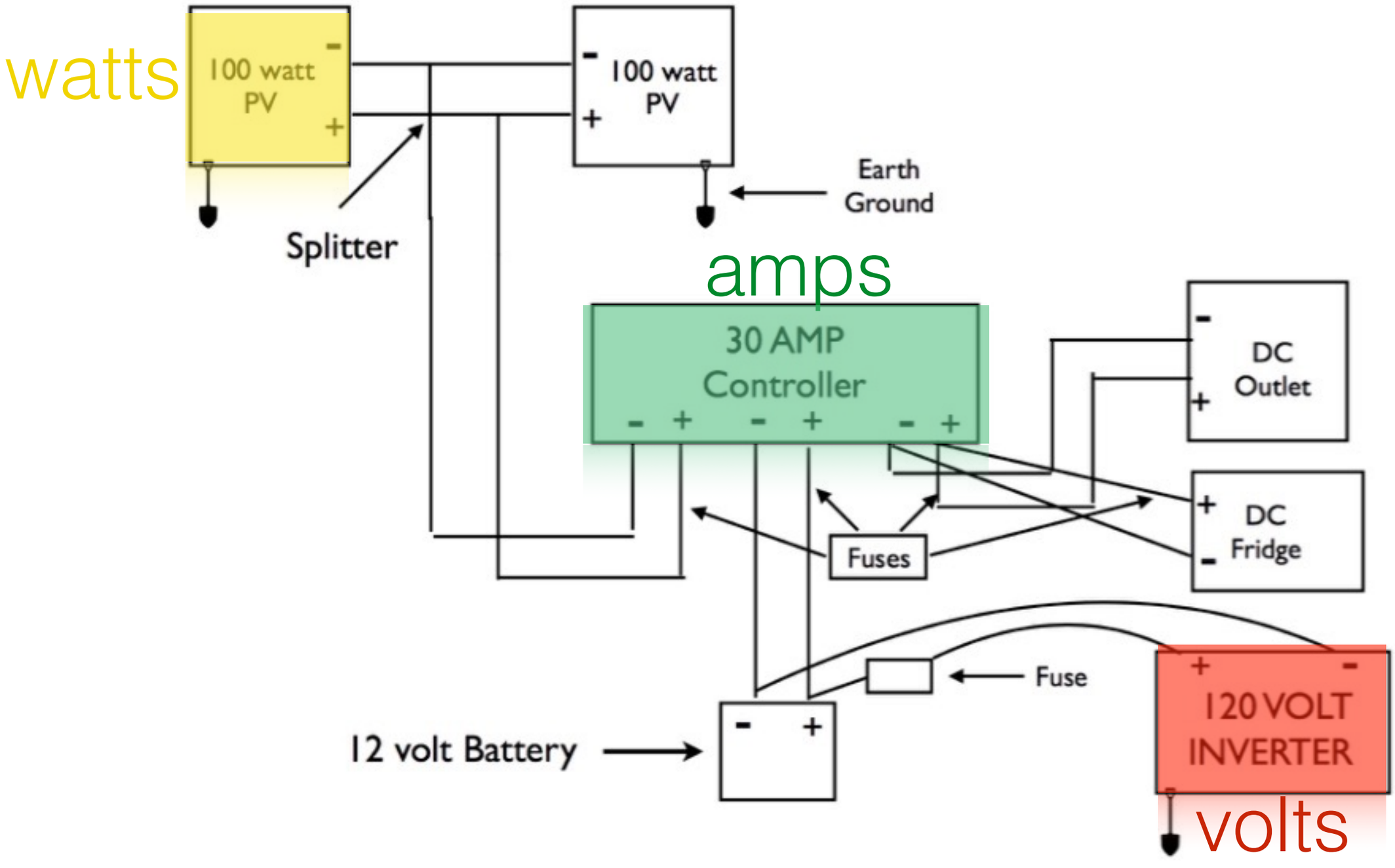
ohms times amperage
amps times voltage
all together they result in wattage
intimately entwined forever
you can’t have one
without the others

and you have to have a circuit

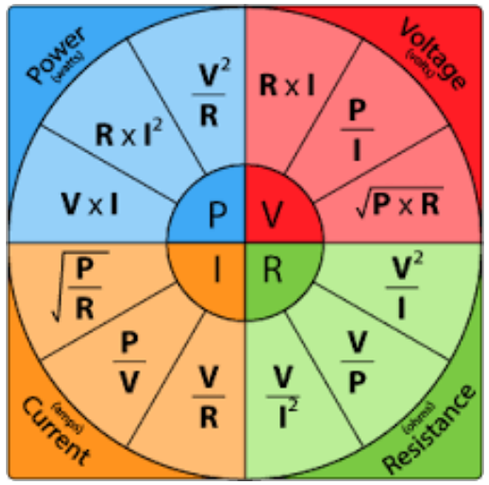


and remember closed circuit means on
and open circuit means off

Gallup Solar's 12Volt Hogan System



Defining Electricity



Watts = Volts x Amps

Watts(W)/Power(P) = Volts **x** Amps(A)/Current(I)

Volts = Ohms x Amps

Volts(V)=Ohms(Ω)/Resistance(R) **x** Amps(A)/Current(I)

Amps

Amps(A) same as Current(I)

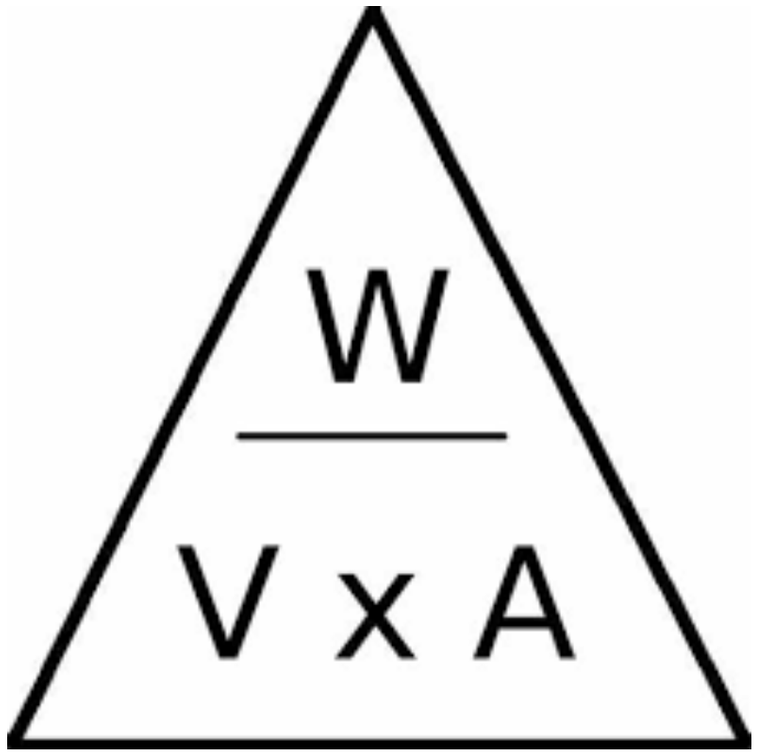
Ohms

Ohms(Ω) same as Resistance(R)

one at a time now

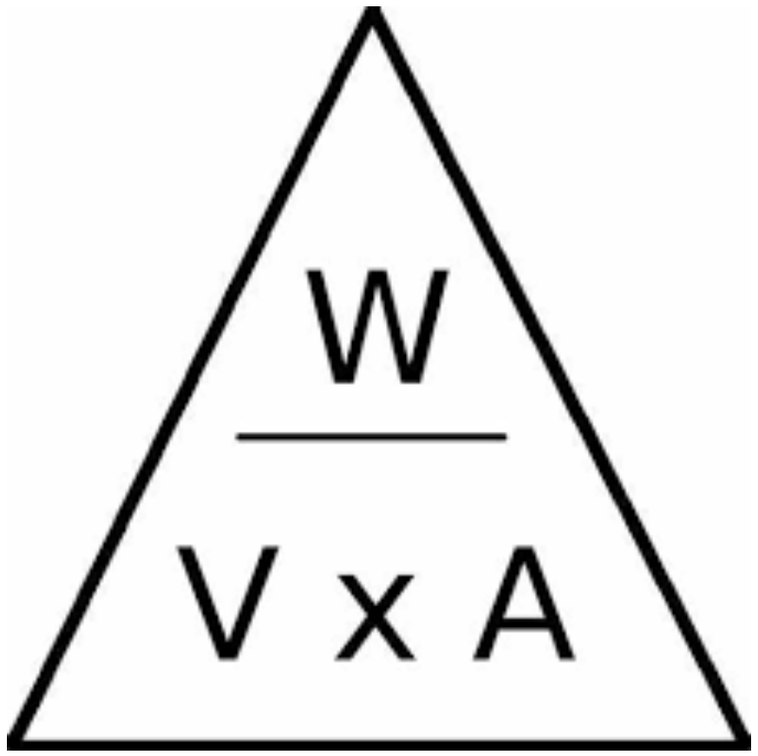
Watts =Volts x Amps

Watts' Law



Watts divided by Amps = Volts

Watts divided by Volts = Amps



Watts (W) are measurements of Power (P)

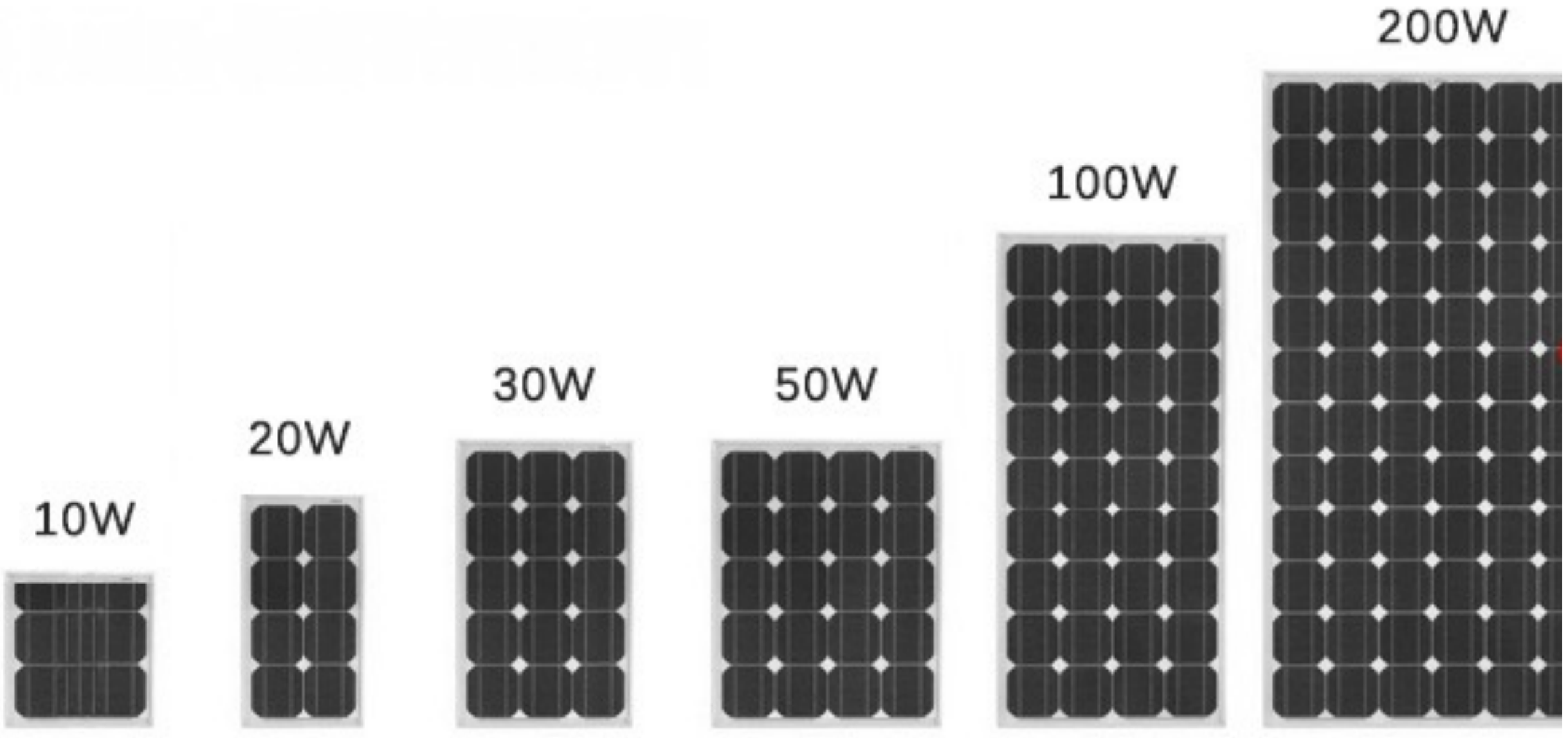
Watts are produced by solar panels

& used by appliances.

Watt / Hours (WH) number of watts

produced per hour or used per hour

Producing Electricity



solar panels of different wattages

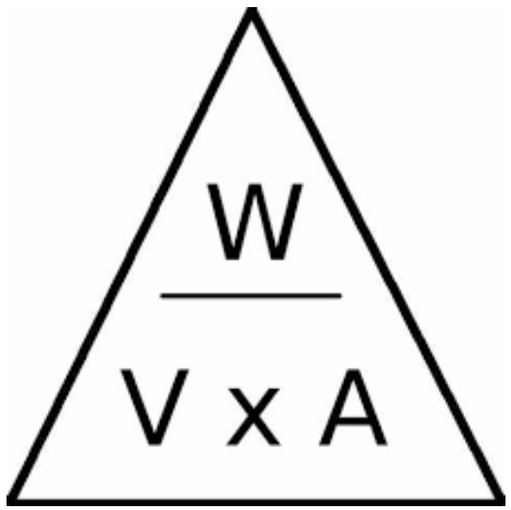
Using Electricity

light bulbs of different wattages

Appliance / Power tools	Average Running Watts	Average Start Up Watts
Induction Motor 370W (1/2 HP)	500	1480
Induction Motor 550W (1/2 HP)	740	2200
Induction Motor 750W (1HP)	1000	3000
Induction Motor 1500W (2HP)	2000	6000
Induction Motor 2200W (3HP)	2950	8500
Air Conditioner (2HP)	4000	6000
Angle Grinder 100mm	1200 - 1800	4000
Angle Grinder 230mm	2400	8000
Laptop	150 - 300	
Concrete Mixer	1200 - 2400	4000
Drill	450 - 800	2000
Drill Hammer	650 - 1400	3000
Lighting LED	10	
Large Floodlights	500 - 1500	
Refrigerator (4 Star)	150 - 650	1350
Vacuum	1000 - 2400	
Welder 140 Amp	6000	6500
Welder 170 Amp	7000	9000
Welder 200 Amp	10000	13000

tools of different wattages

Volts
Volts x Amps =Watts



Voltage (V) is pressure differential

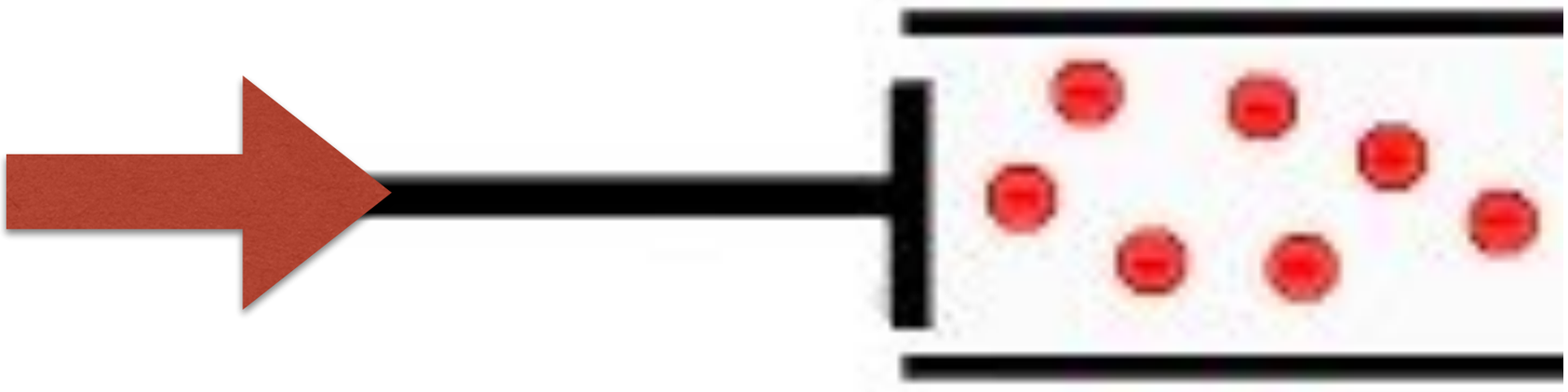
that a solar cell or battery creates.

It is the defining pressure of your system.

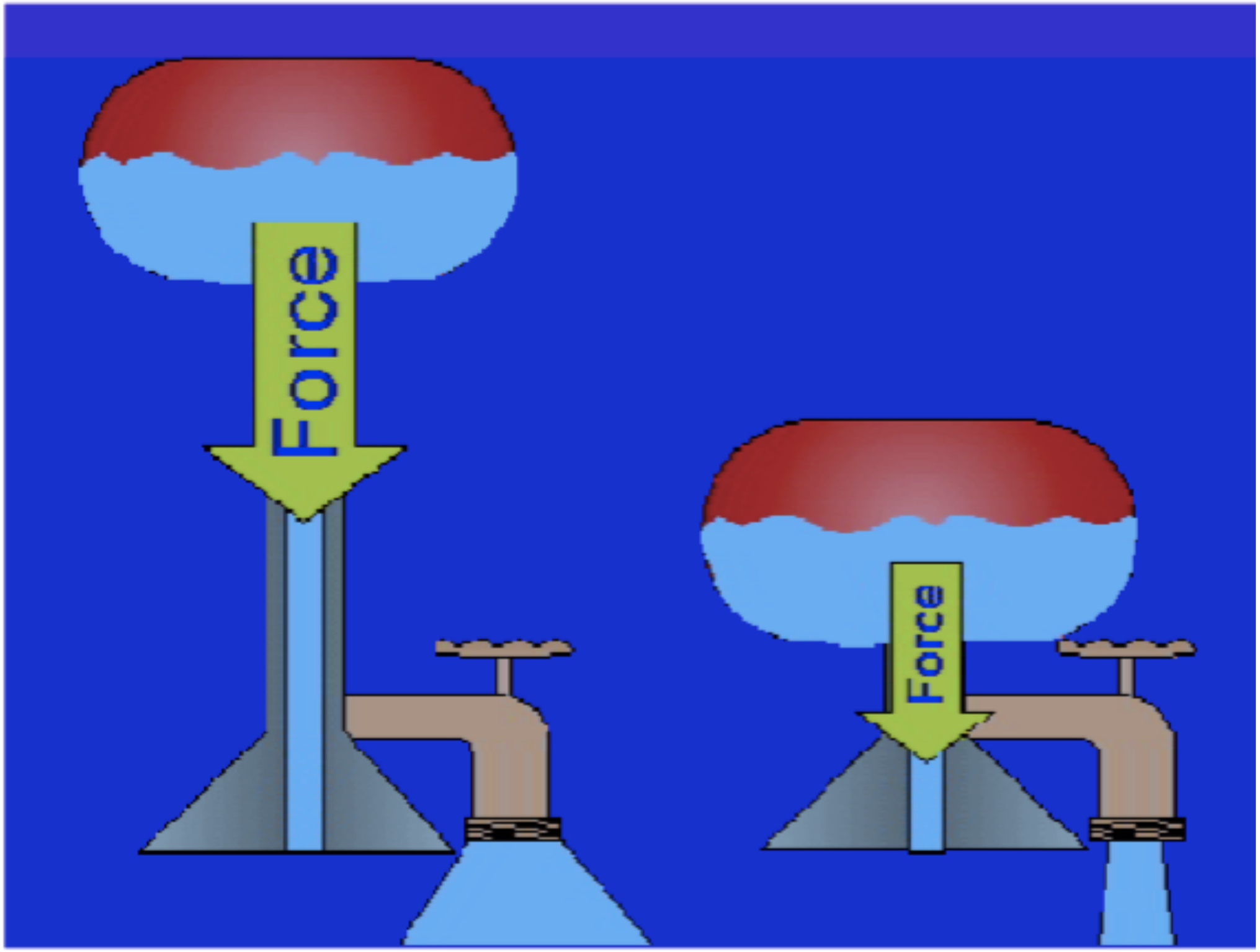
All components and appliances must be

compatible with the voltage of your system.

low voltage = low pressure on electrons



high voltage = high pressure on electrons



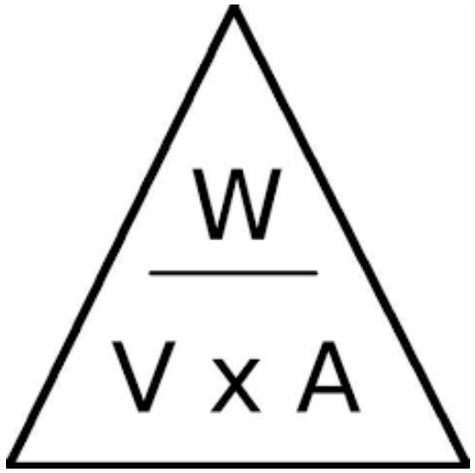
voltage is often compared to water pressure

Some Common Voltages

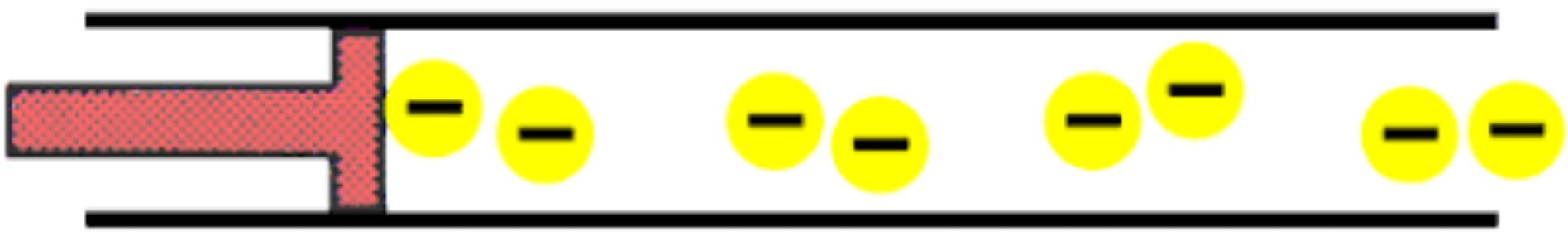
One solar cell any size **.3 -.5V**
Single-cell, rechargeable battery **1.2V**
Single-cell, non-rechargeable battery **1.5V–1.56V**
USB **5V**
Automobile battery **2.1V per cell**
Electric vehicle battery **400V**
Off-Grid Hogan System **12V or 24V**
Household outlet (Japan) **100V**
Household outlet (North America) **120V**
Household outlet (Europe, Asia, Africa, Australia) **230V**
Rapid transit third rail **600V–750V**
High-voltage electric power lines **110,000V**
Lightning **100,000,000V**

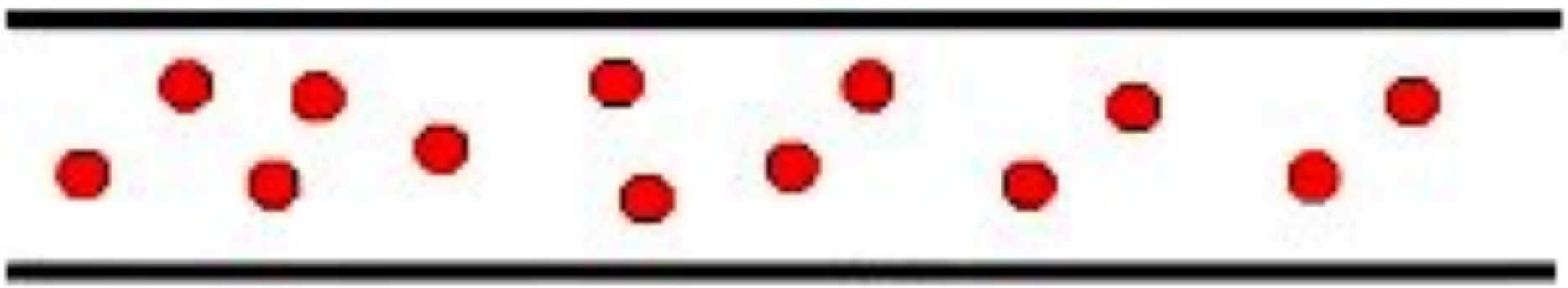
Amps/Amperes/Current

Amps x Volts =Watts

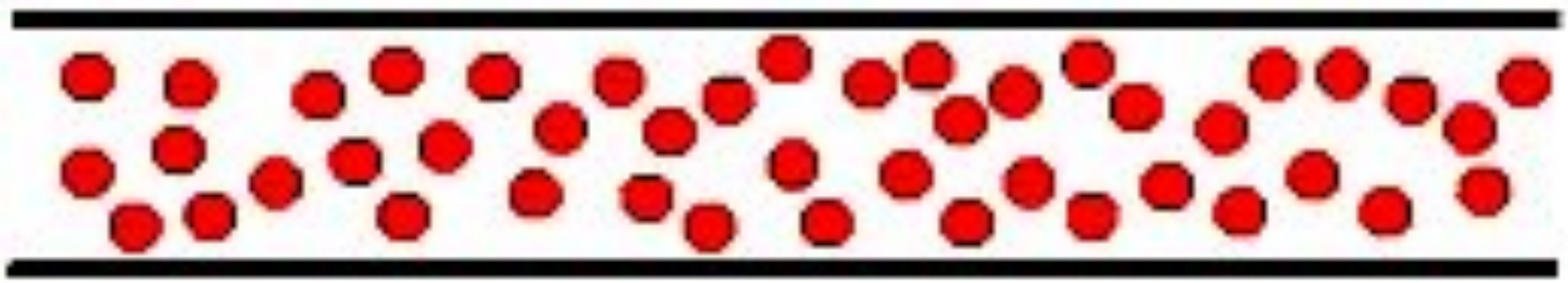


Amperage, also known as Current (I) is the number and speed of electrons pushed by voltage through a circuit.



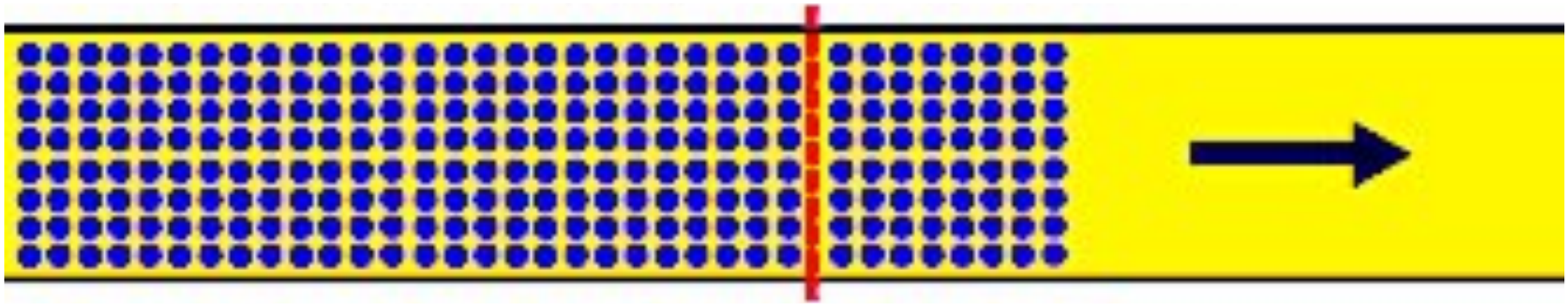


low amperage= few electrons flowing



high amperage= many electrons flowing

a wire carrying 1 ampere carries about...



6,241,000,000,000,000,000 electrons across it per second

stoves and heaters use the most amps

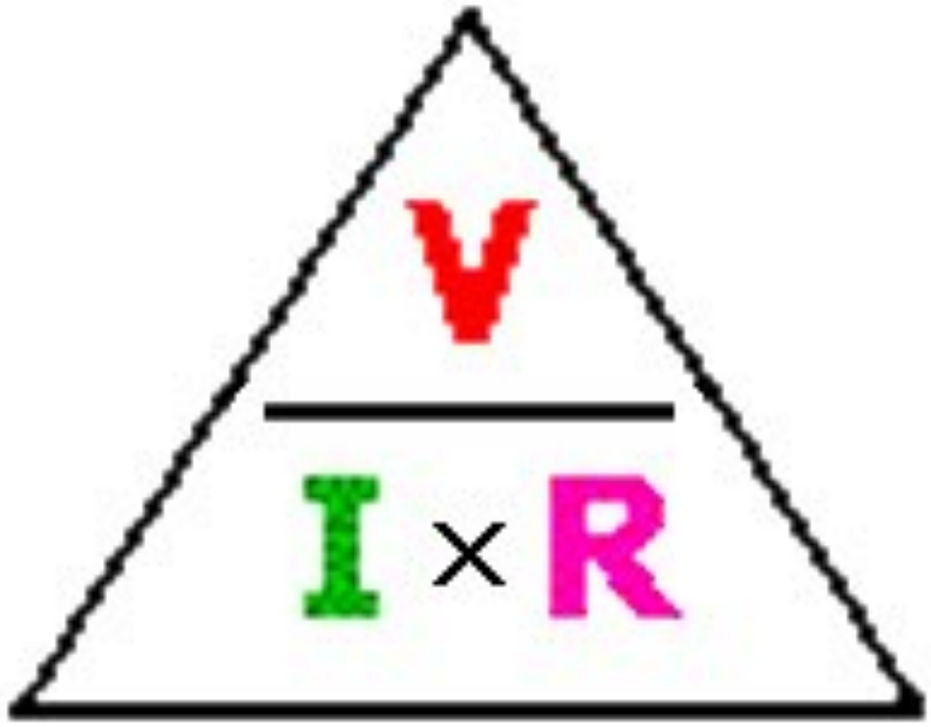
Batteries store Amp/Hours (AH)

Your 110AH battery
can deliver 1 amp for 110 hours
or 10 amps for 11 hours and so on.

(but don't run it down more than halfway, next lesson)

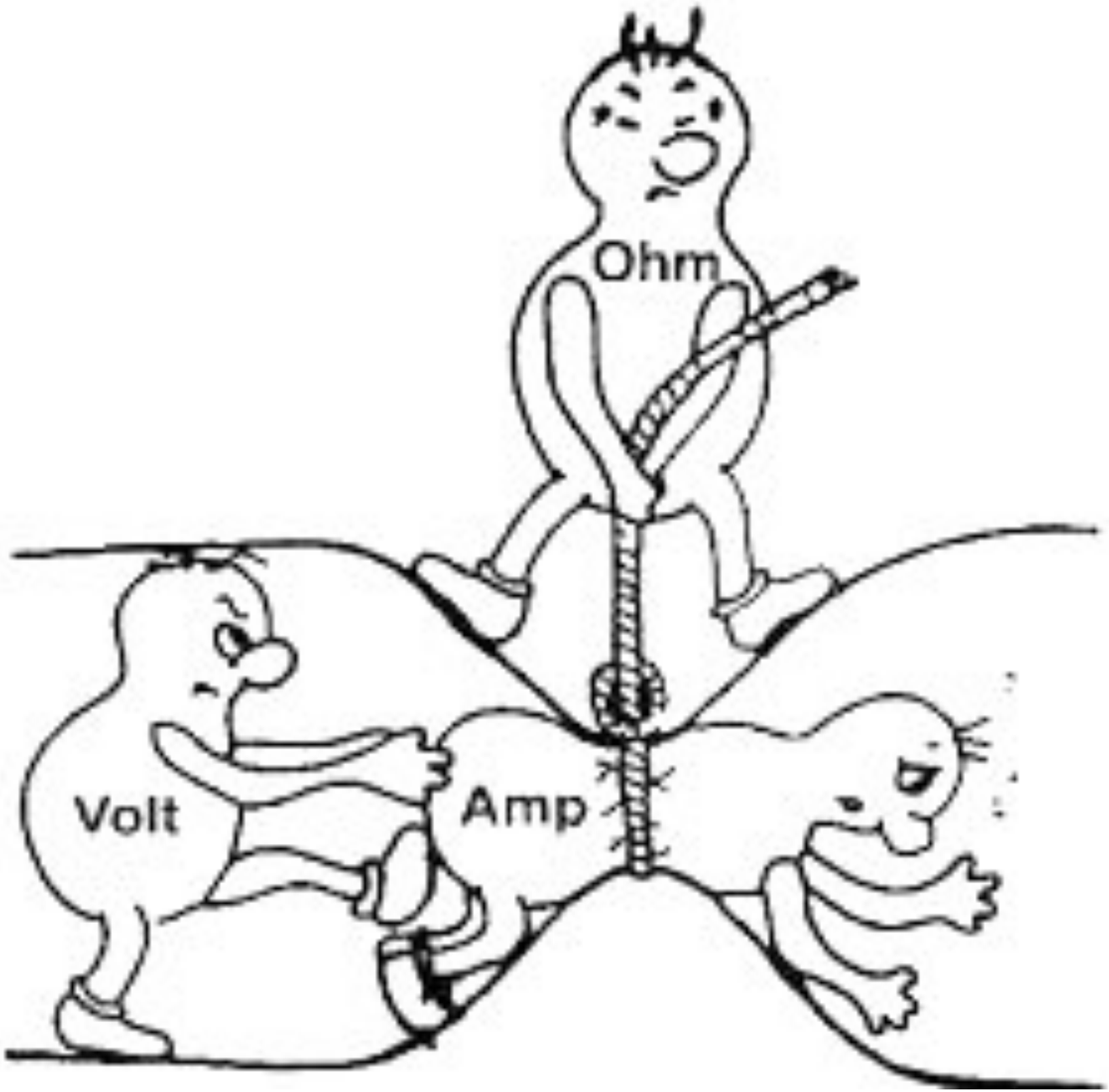
Ohm's Ω Law

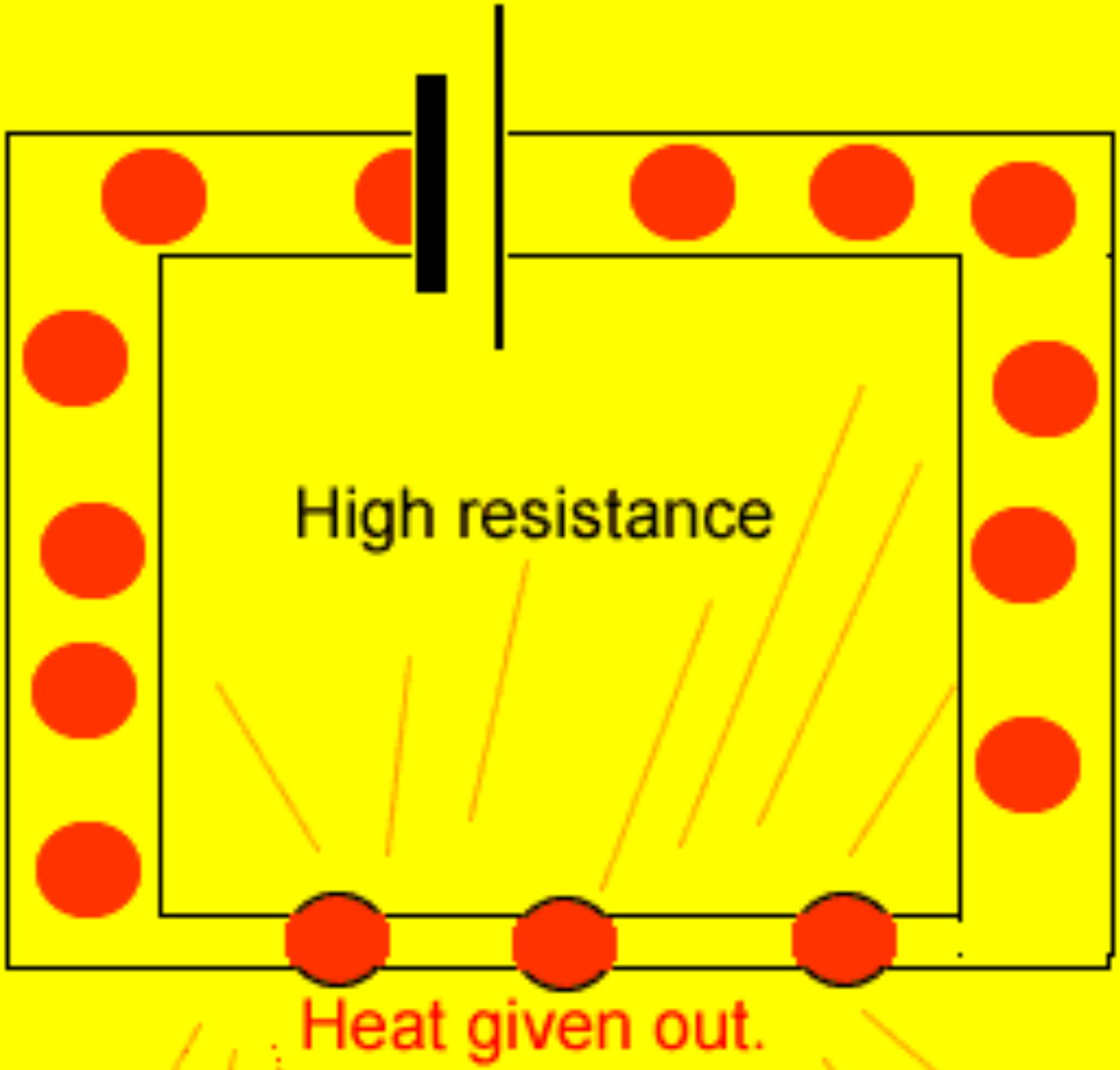
Volts = Amps x Resistance



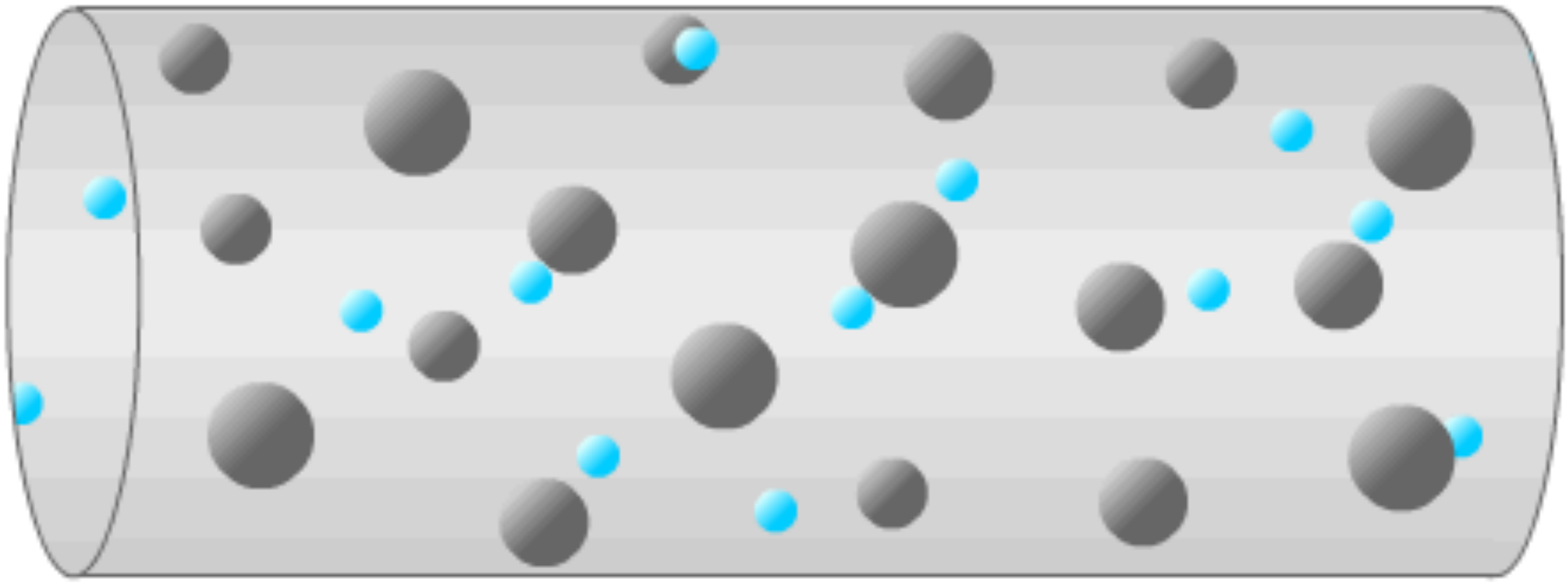
don't forget! amps(A) are the same as current(I)

Ohms Ω / Resistance




High resistance
Heat given out.

Ohms Ω / Resistance



Resistance is in wire

To calculate the resistance of a wire,
we need to know three things:

Length

The longer the wire, the greater its resistance.

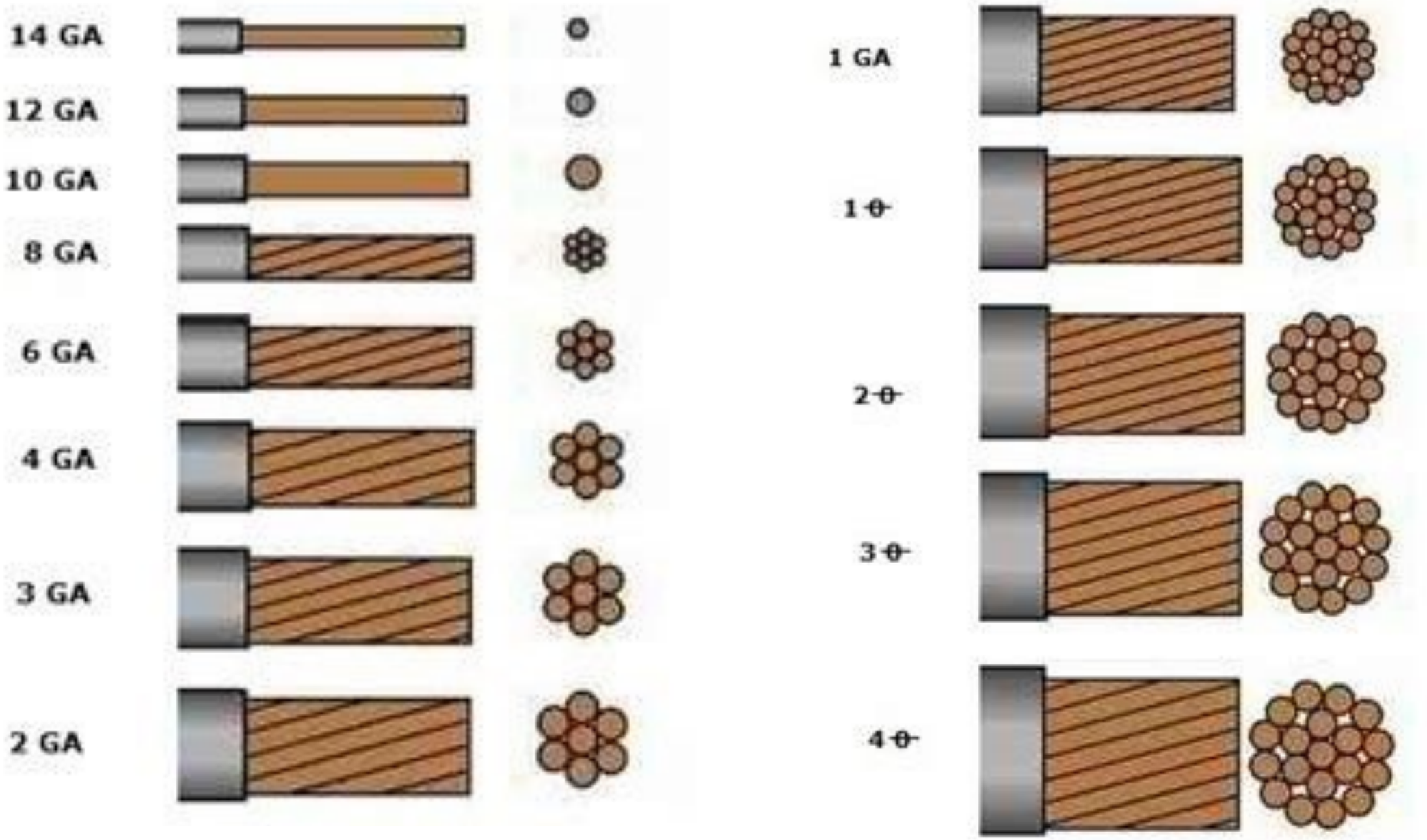
Cross-sectional area

The greater the area, the less its resistance.

Resistivity of the material

The greater the resistivity, the greater its resistance.

Resistance in a circuit is necessary.
Without resistance a huge electrical current would flow
until your source was empty.

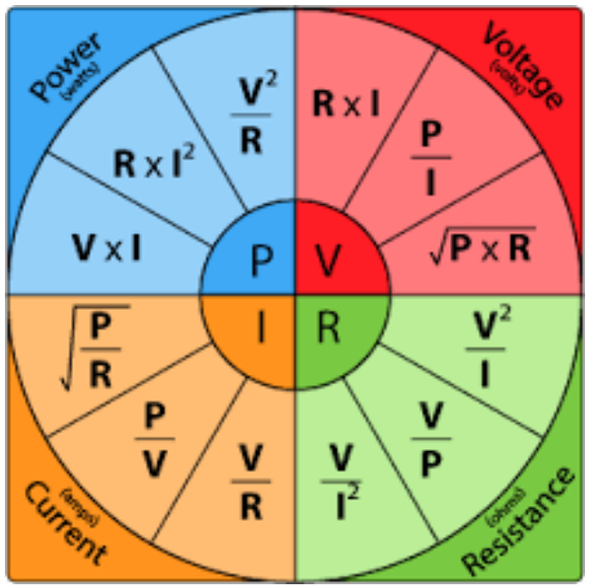


fatter wires have less resistance,
amps flow more freely
fatter wires have lower gauges, just to confuse us

resistance (Ω's)

Resistance is what heats up stoves and heaters and requires more amps to run them.

Managing Electricity in series and parallel



Watts

Volts

Amps

Ohms

Understanding when to use series wiring
and when to use parallel
will help you design solar systems.

When you need more voltage,
more pressure to run bigger equipment
you will wire in series.

When you need more amperage,
amp/hours to fill your battery
you will wire in parallel.

Wiring in Series

When components of an electrical system are wired in series, negative to positive, voltage adds up, amperage stays constant.

Wiring in Parallel

When components of an electrical system are wired in parallel, negative to negative, positive to positive, amperage adds up, voltage stays constant.

Solar Panels

Panels in series

negative to positive

Voltage adds up

Amperage stays constant

12VDC = 12 Volts Direct Current

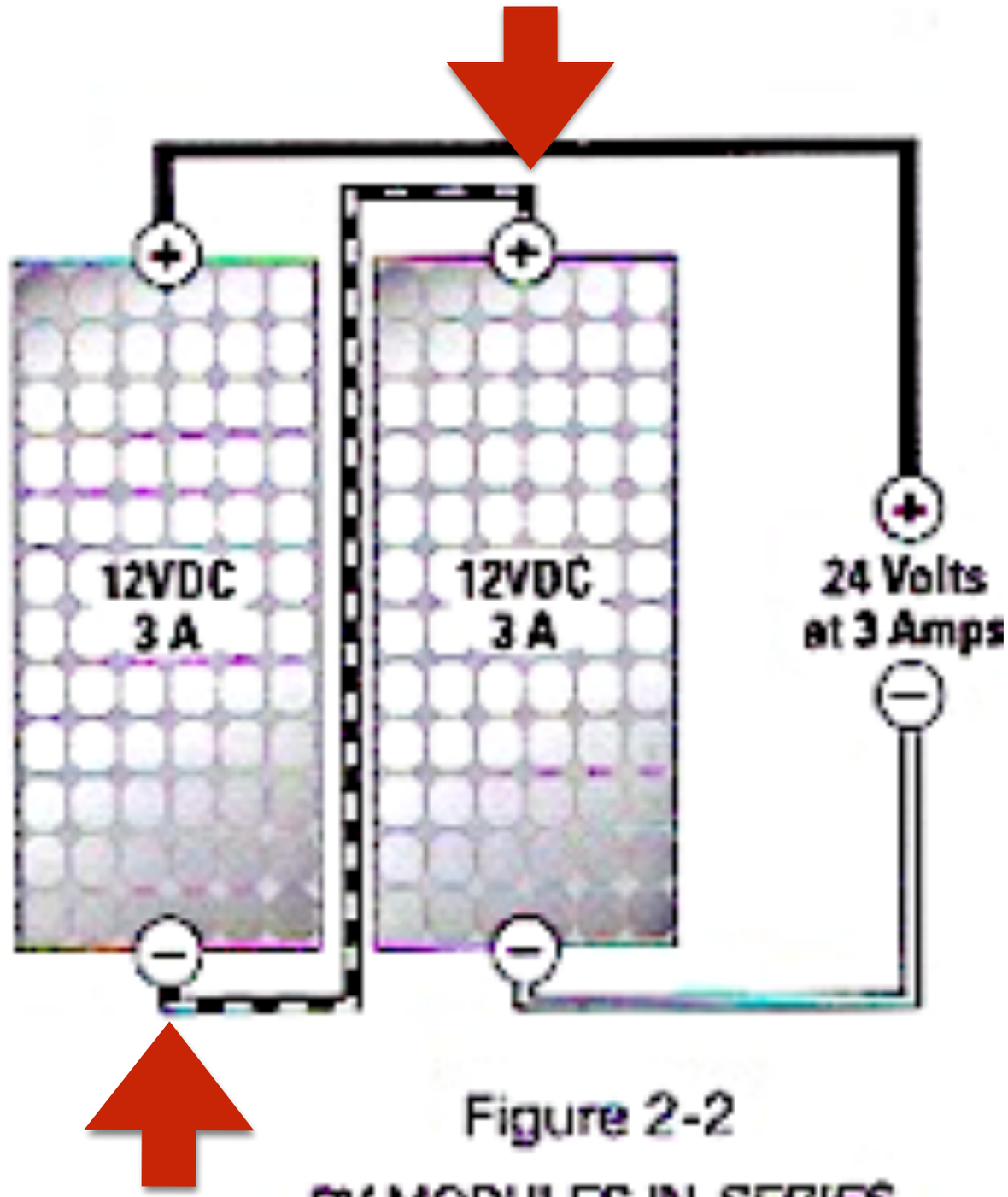


Figure 2-2

PV MODULES IN *SERIES*

Solar Panels

Panels in parallel,

positive to positive

negative to negative

Amperage adds up

Voltage stays constant

12VDC = 12 Volts Direct Current

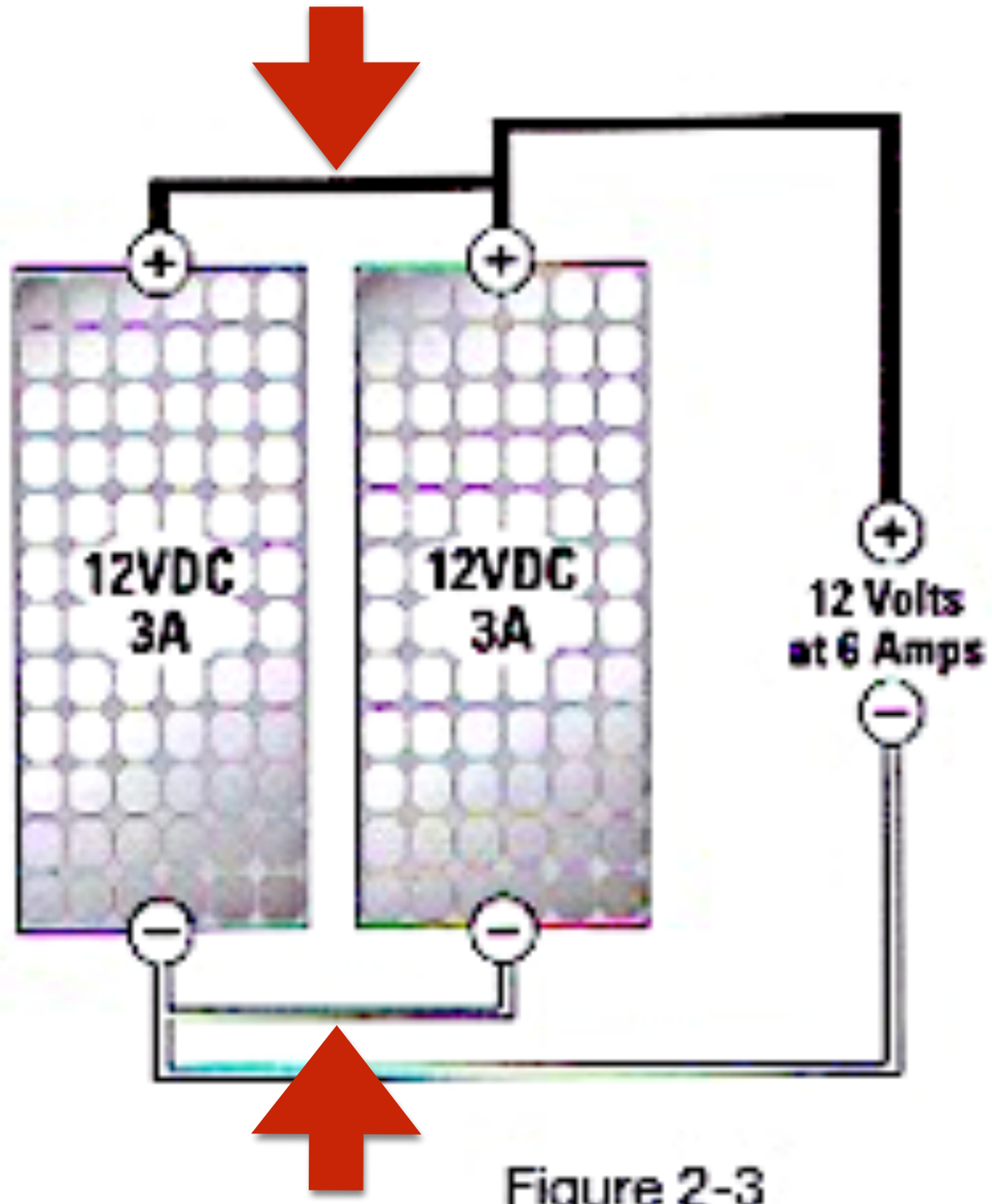
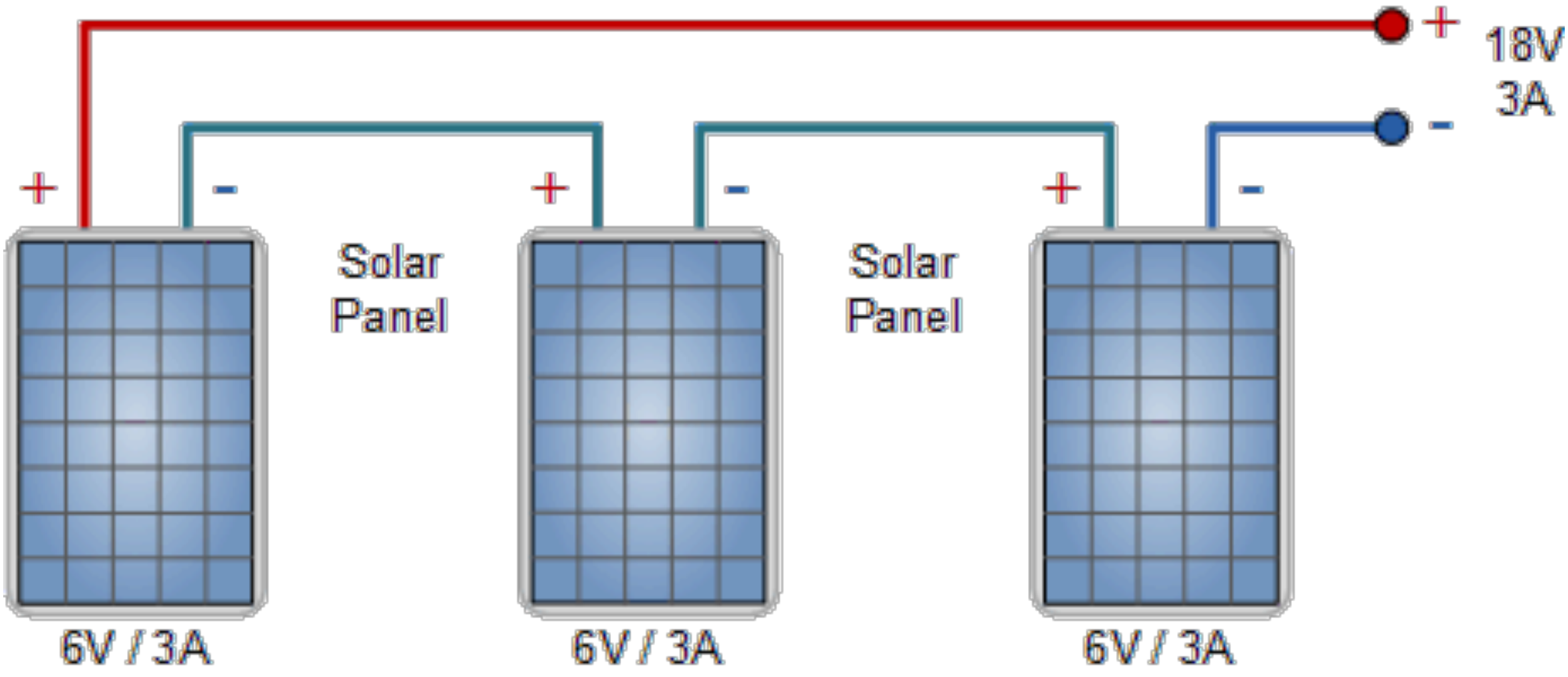


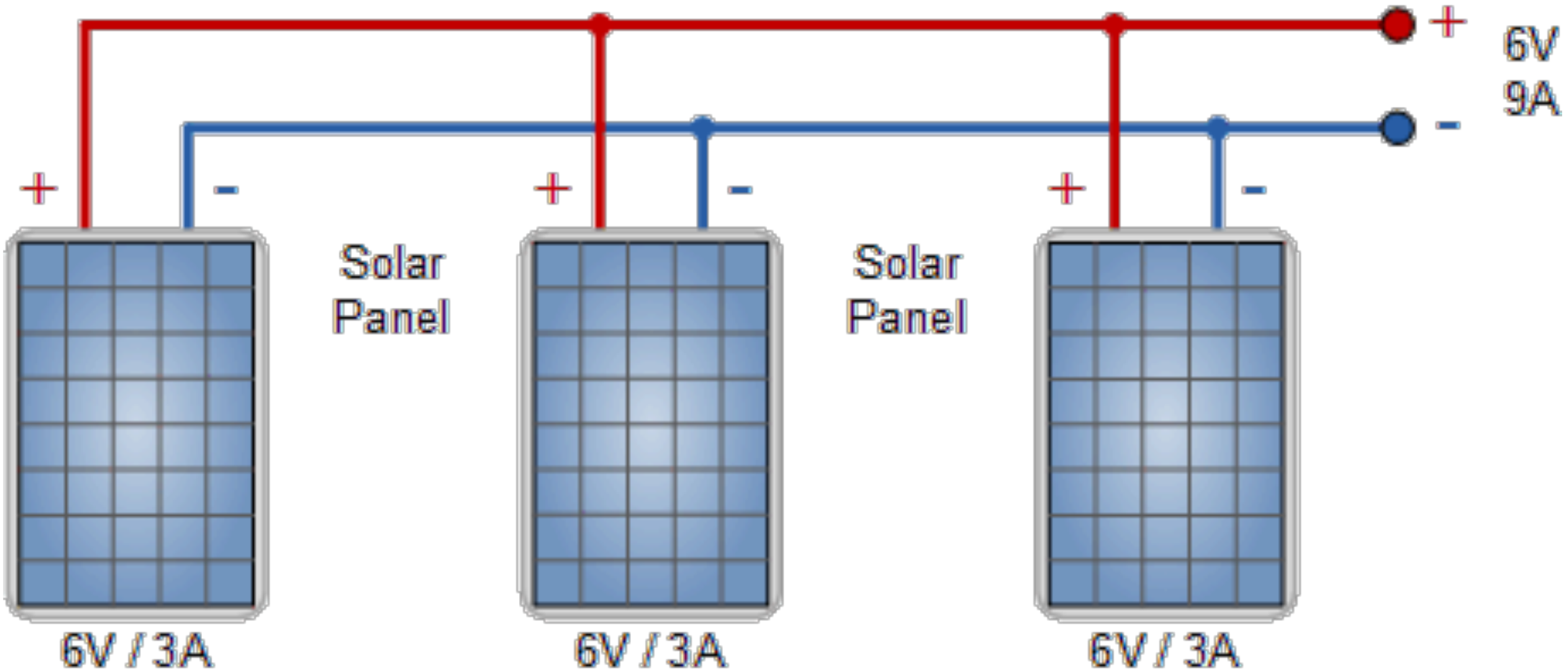
Figure 2-3

PV MODULES IN *PARALLEL*

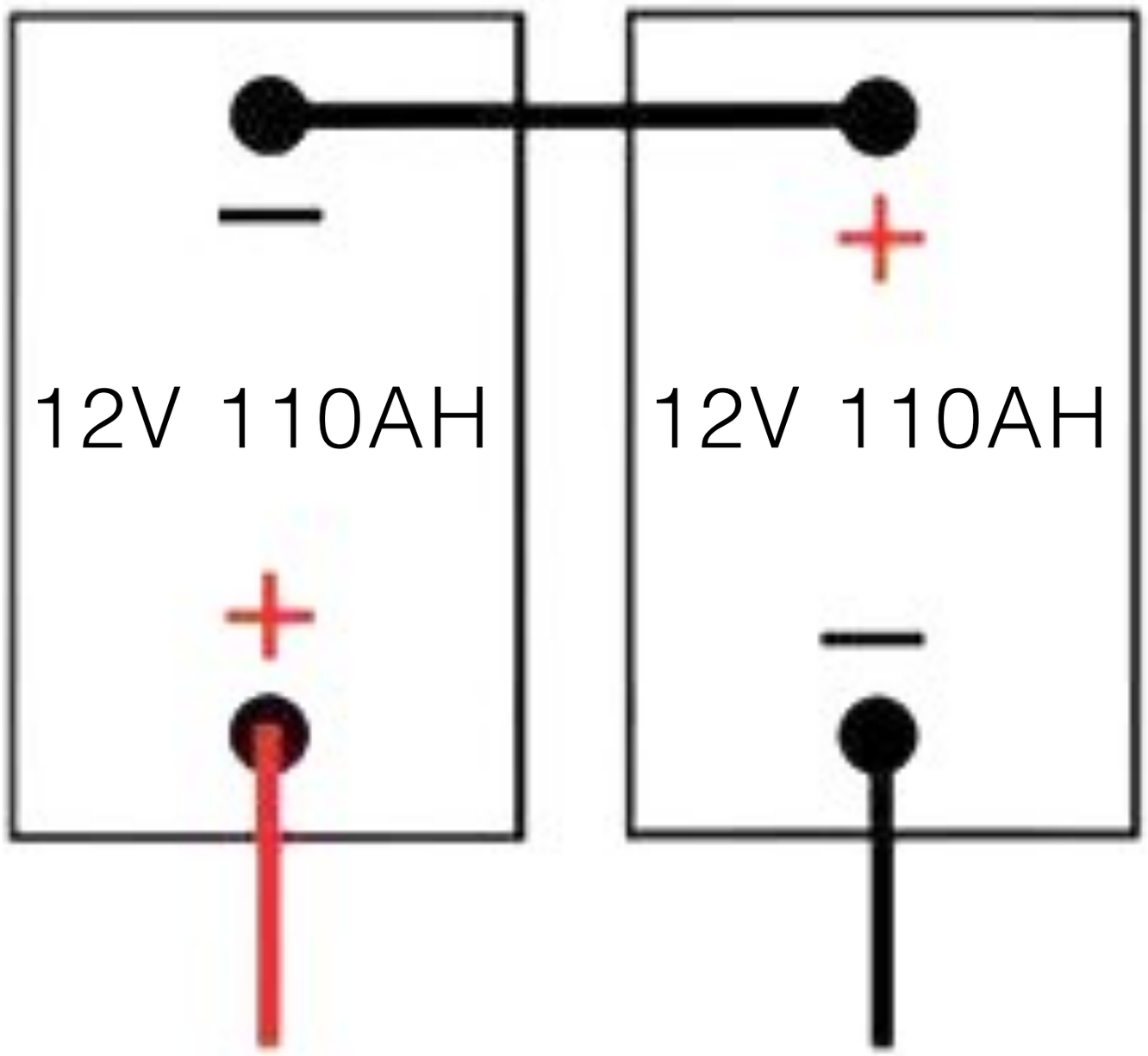
Wiring in Series



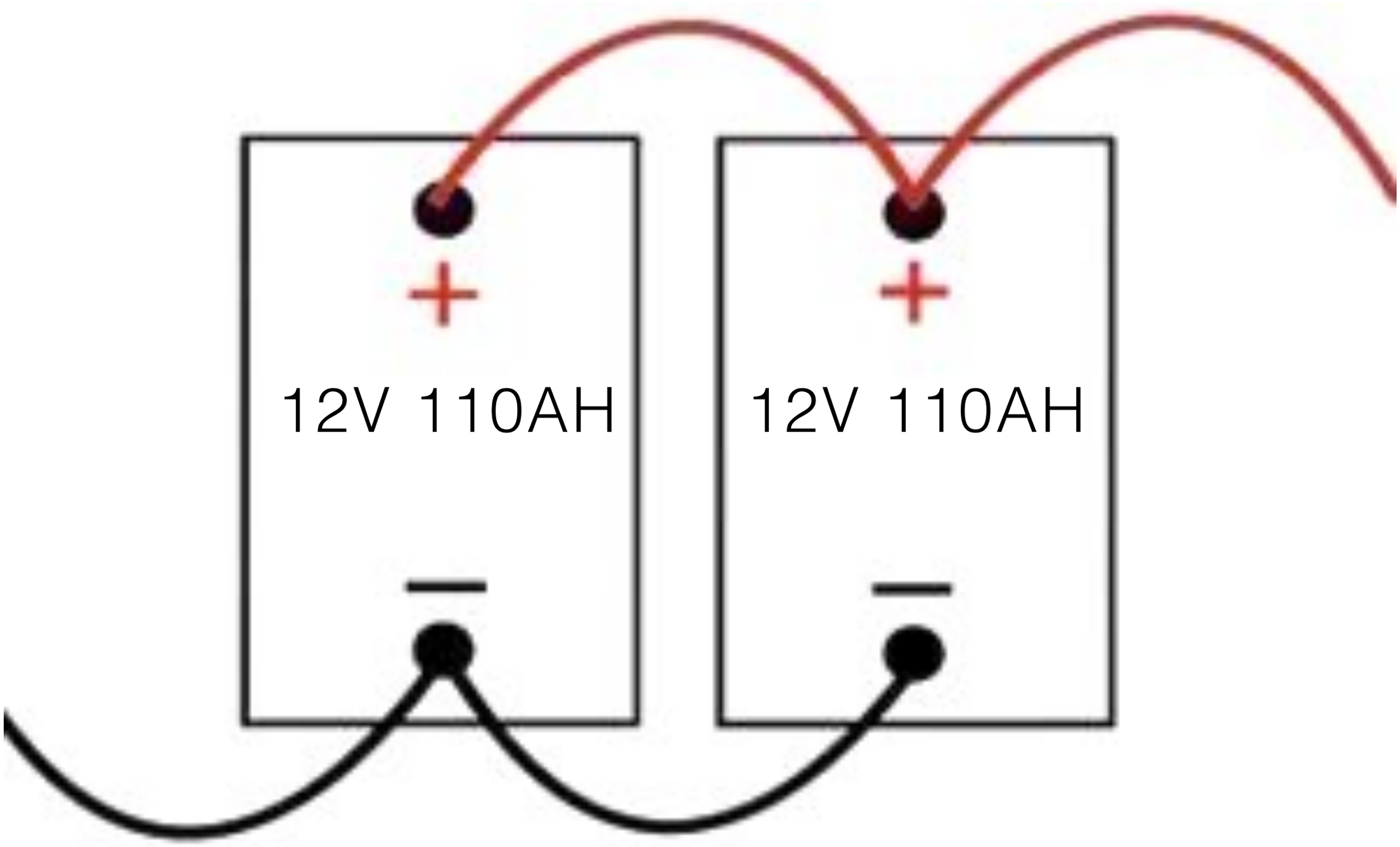
Wiring in Parallel



Batteries in Series

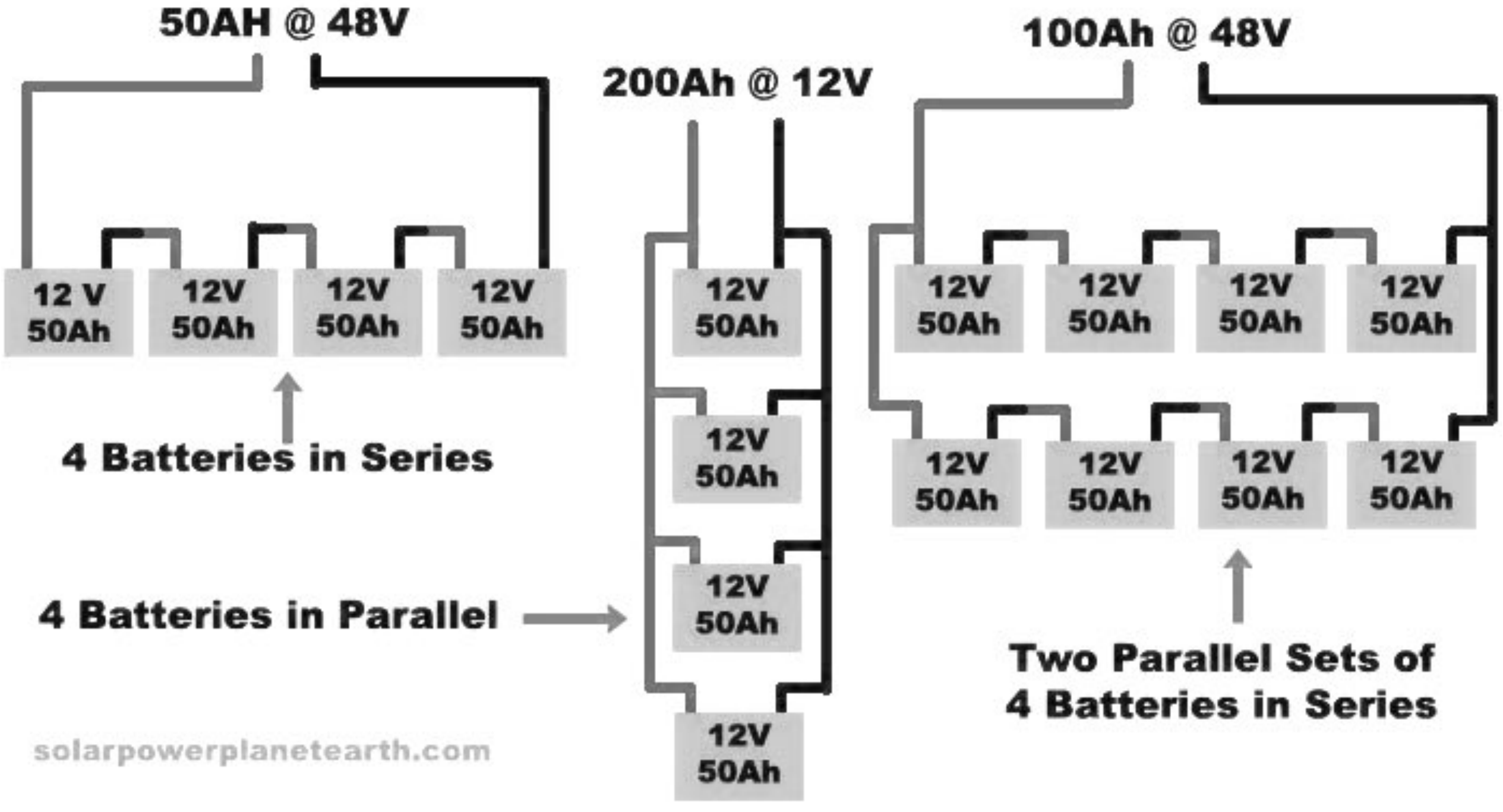


Batteries in Parallel

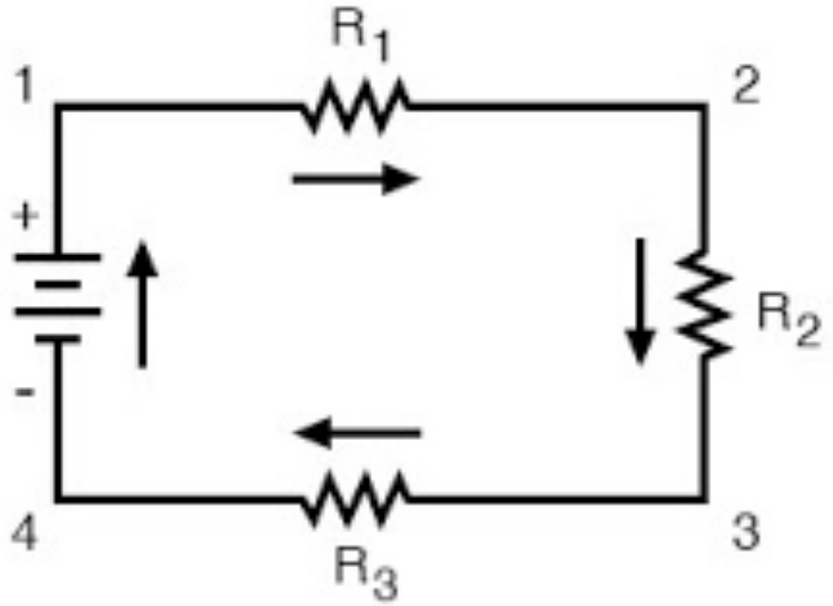


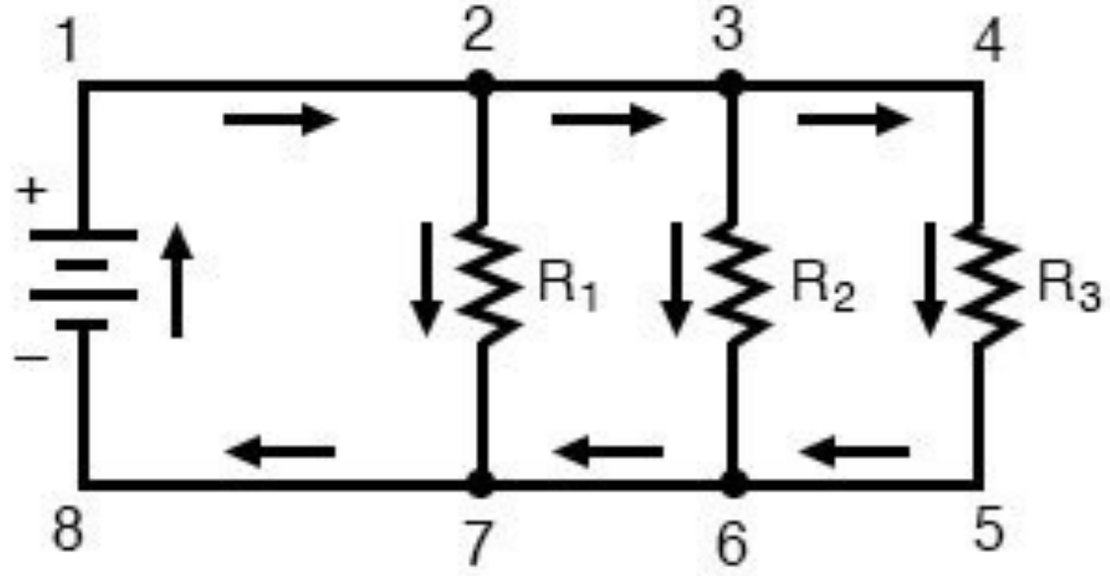
12V 220AH

Batteries every which way



Circuits in Series and Parallel





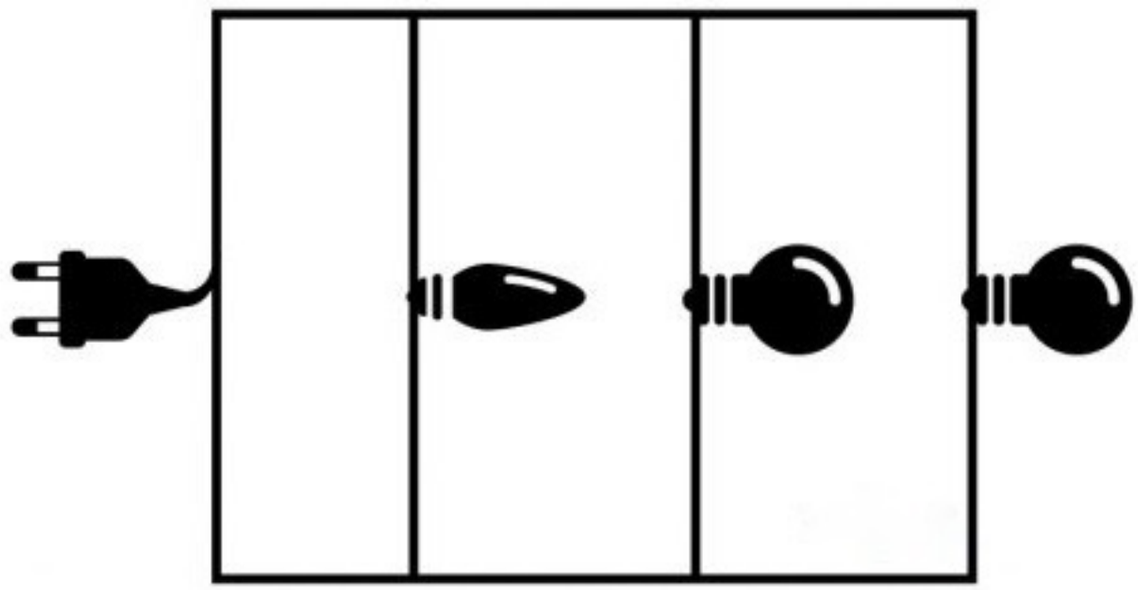
Series

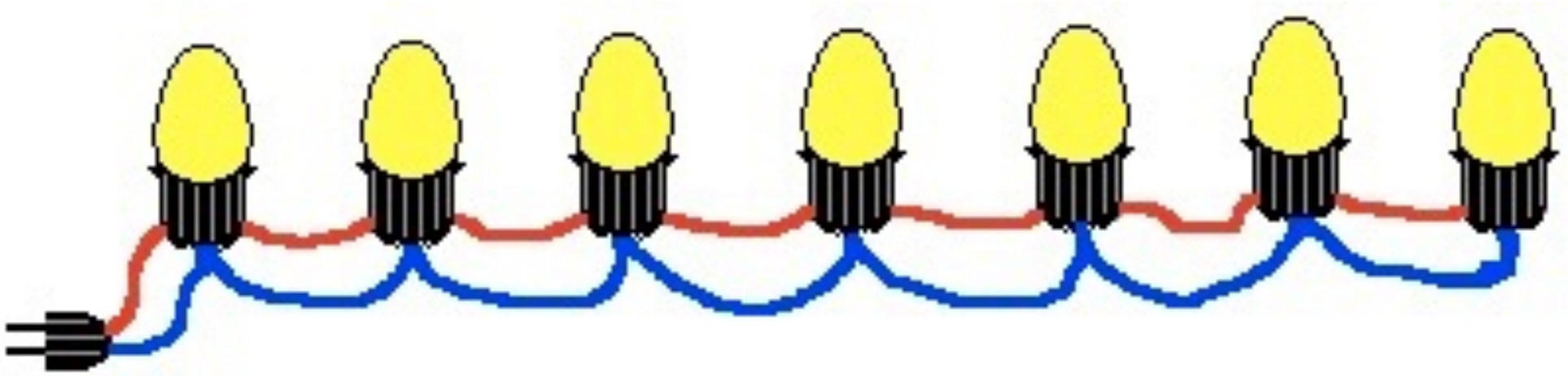
Current/Amps is the same in all components

Parallel

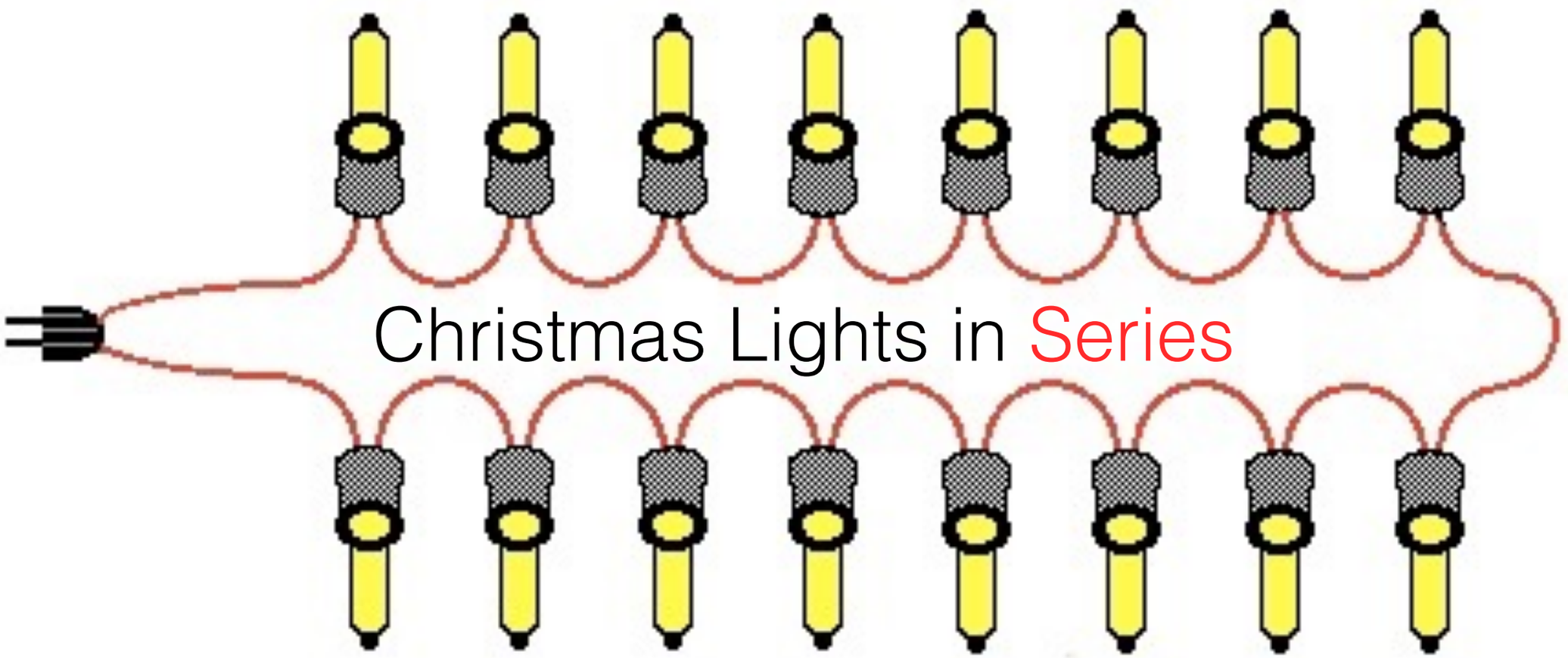
Voltage is the same across all branches

Christmas Lights in Series and Parallel





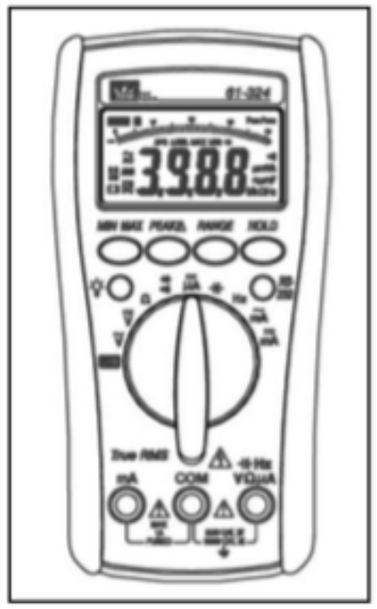
Christmas Lights in Parallel



Christmas Lights in Series

In series if one light goes out they all go out

Measuring Electricity with a multimeter



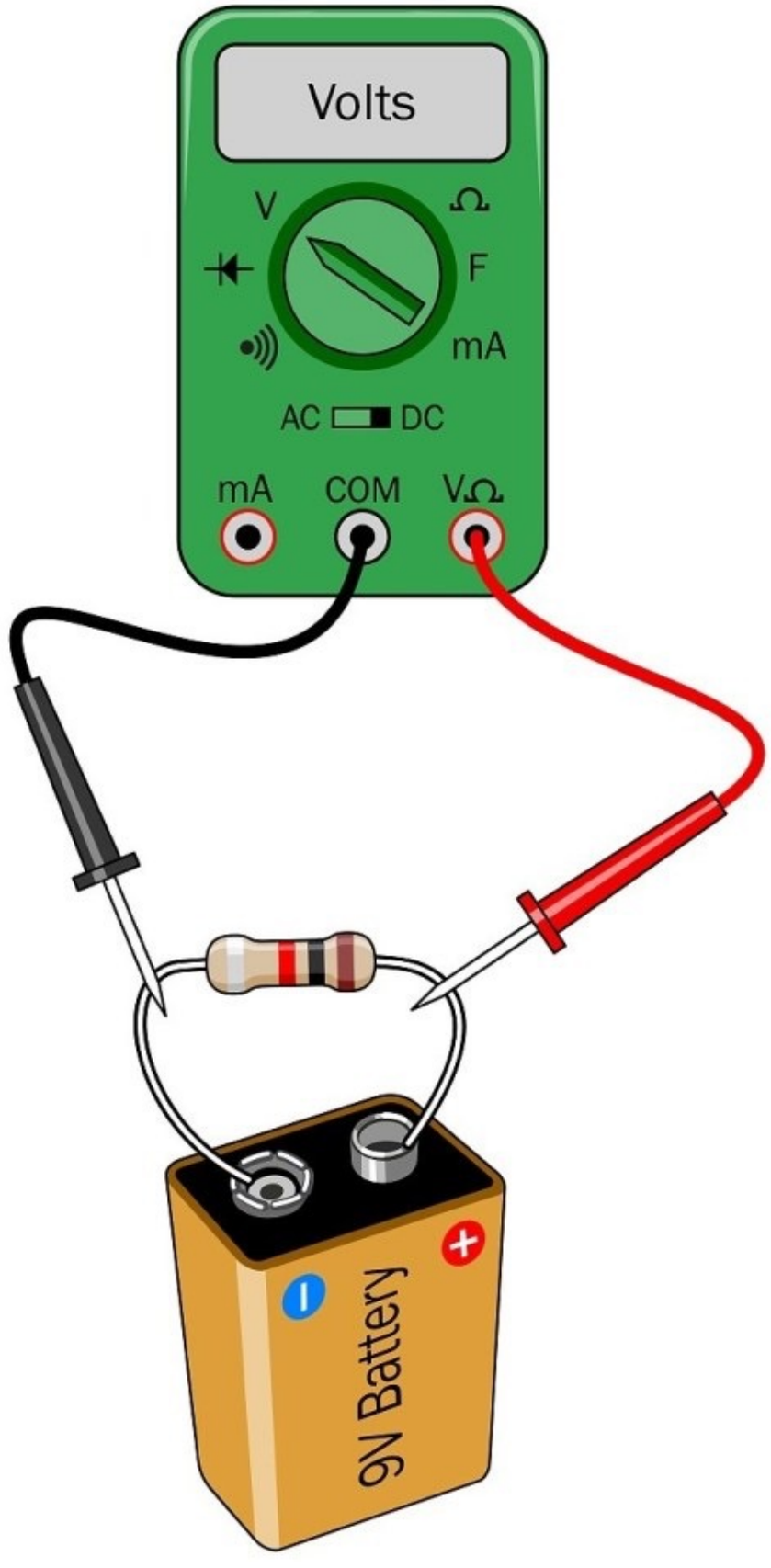
Volts

Amps

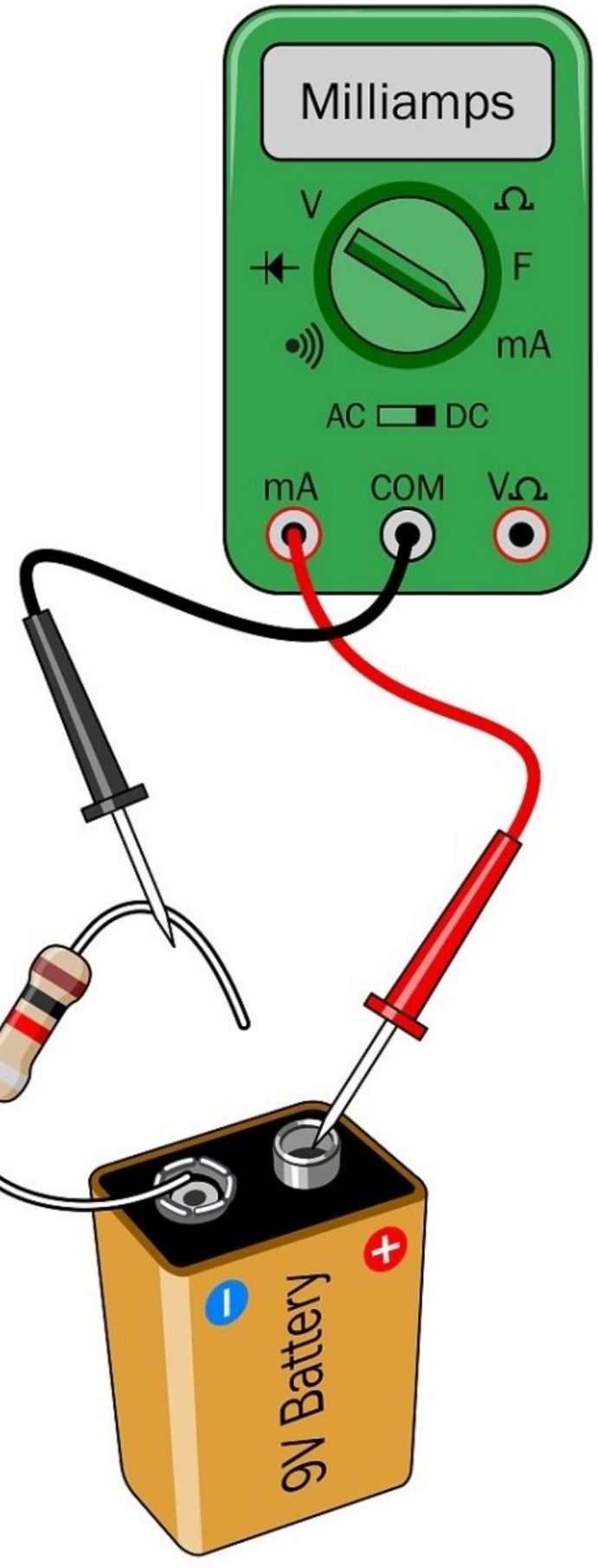
Ohms

and you are going to get one

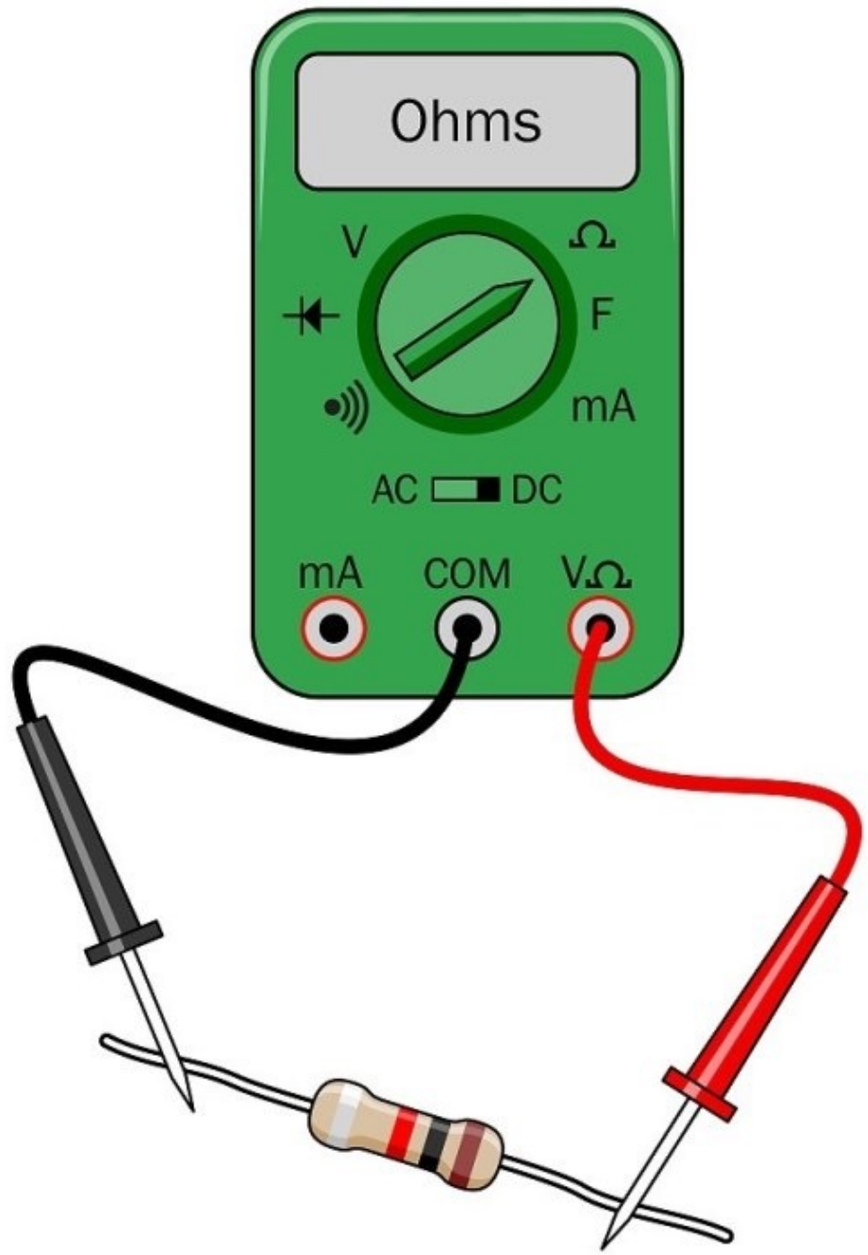
Voltage measurements are made with the test leads connected in Parallel



Current measurements are made with the test leads connected in Series



To measure
Ohms /Resistance
measure across
the Load



Homework

Questions can be asked during conference call.

1.
You have two 6 volt batteries and you want 12 volts.
Do you wire the two 6 volt batteries in series or in parallel?

2.
You have two 12 volt, 110 amp hour batteries and you want to double your amps.
Do you wire the batteries in series or parallel?

3.
You have two 12 volt solar panels and you want to double your amps.
Do you wire your panels in series or parallel?

4.
How many 12 volt solar panels in series do you need to get 24 volts?

5.
How many 6 volt batteries in series do you need to get 48 volts?

6.
How many amps do you get from four 12 volt, 6 amp panels wired in series?

7.
How many amps do you get from six 12 volt,
6 amp solar panels wired in parallel?

8.
How many volts do you get from six 12 volt
6 amp solar panels wired in parallel?

9.
How do you wire up four 12 volt batteries to get 24 volts?

10.
How do you wire up four 12 volt, 6 amp solar panels
to get 12 amps and 24 volts?

11.
How do you wire up four 12 volt 110 amp hour batteries
to get 220 amp hours?

12.
If you wire two pairs of 12 volt batteries in parallel
and then wire the pairs in series how many volts will you have?