ELECTRICAL CIRCUITS

All you need to be an inventor is a good imagination and a pile of junk.

-Thomas Edison

Ohm's Law

$$I = V / R$$

Georg Simon Ohm (1787-1854)

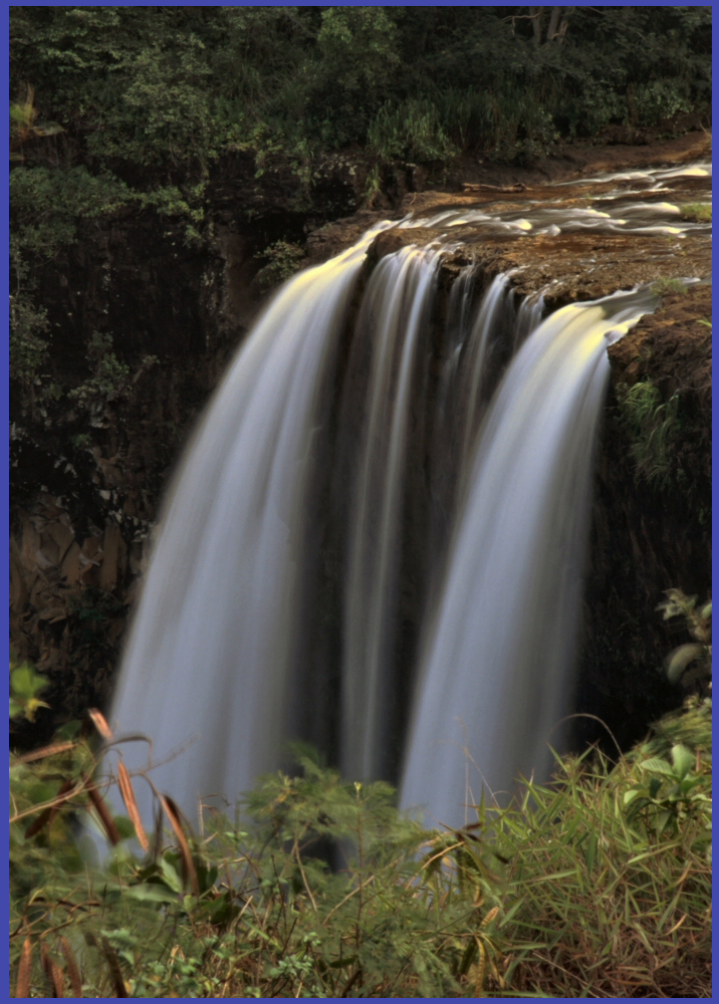
I = Current (Amperes) (amps)

V = Voltage (Volts)

R = Resistance (ohms)

How you should be thinking about electric circuits:

<u>Voltage</u>: a force that pushes the current through the circuit (in this picture it would be equivalent to gravity)

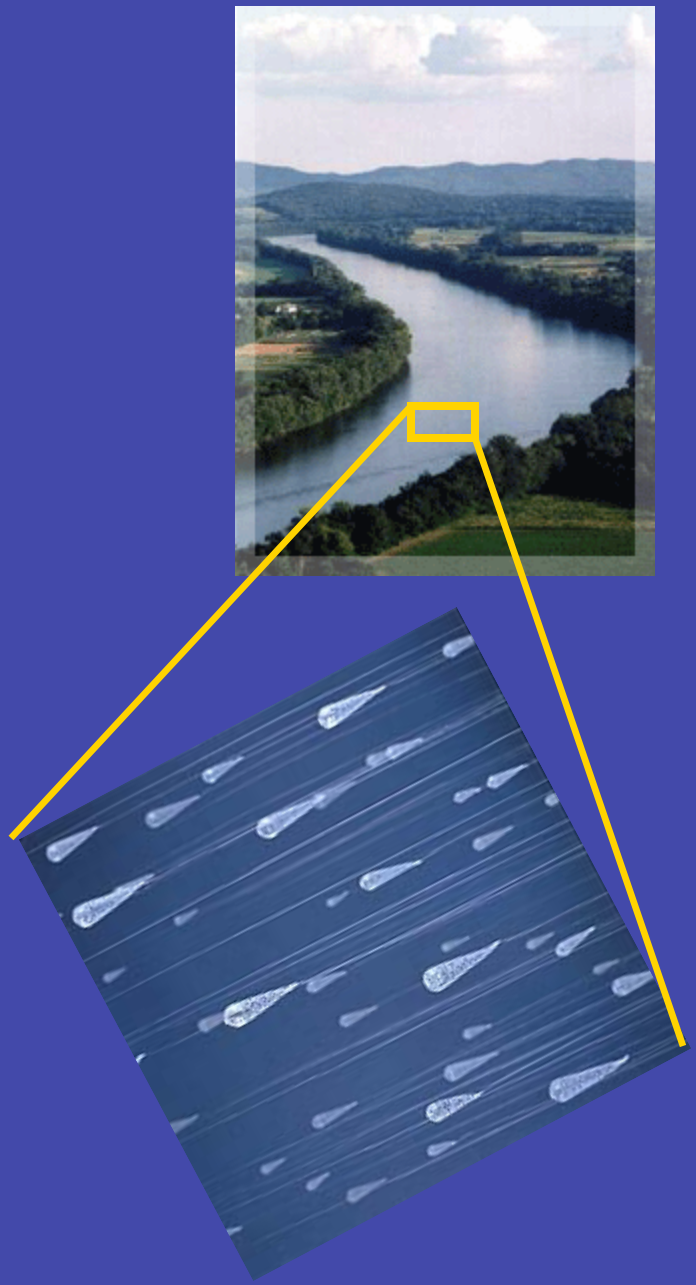


How you should be thinking about electric circuits:

<u>Resistance</u>: friction that impedes flow of current through the circuit (rocks in the river)

How you should be thinking about electric circuits:

Current: the actual "substance" that is flowing through the wires of the circuit (electrons!)



Would This Work?

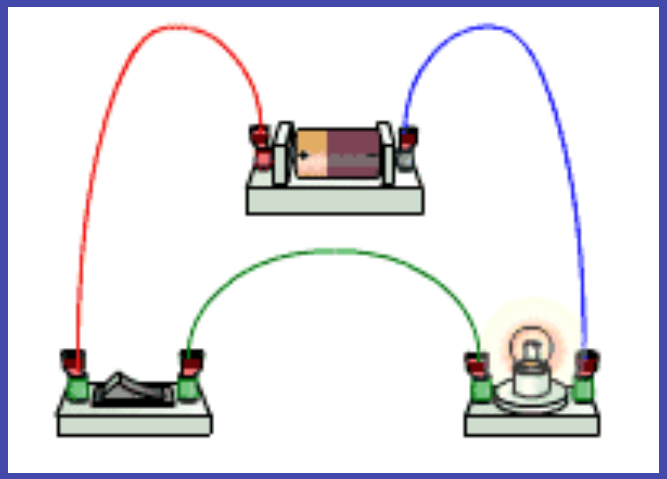
Would This Work?

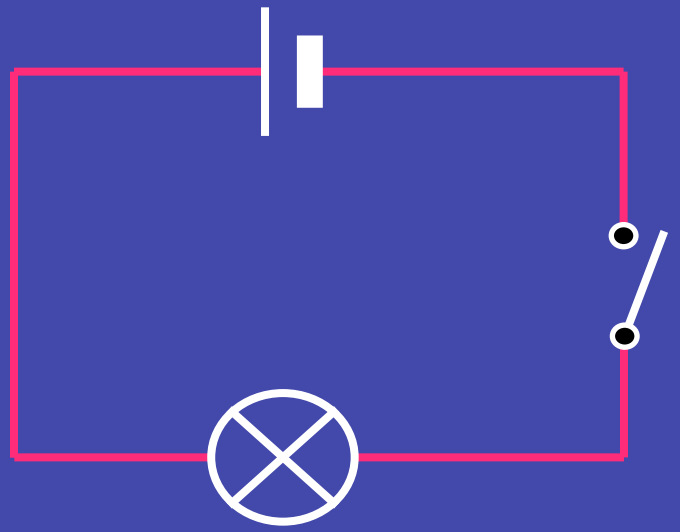
Would This Work?

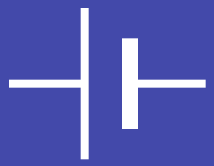
The Central Concept: Closed Circuit

circuit diagram

Scientists usually draw electric circuits using symbols;

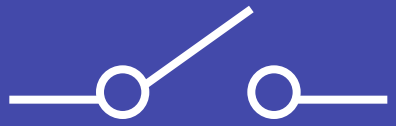






cell

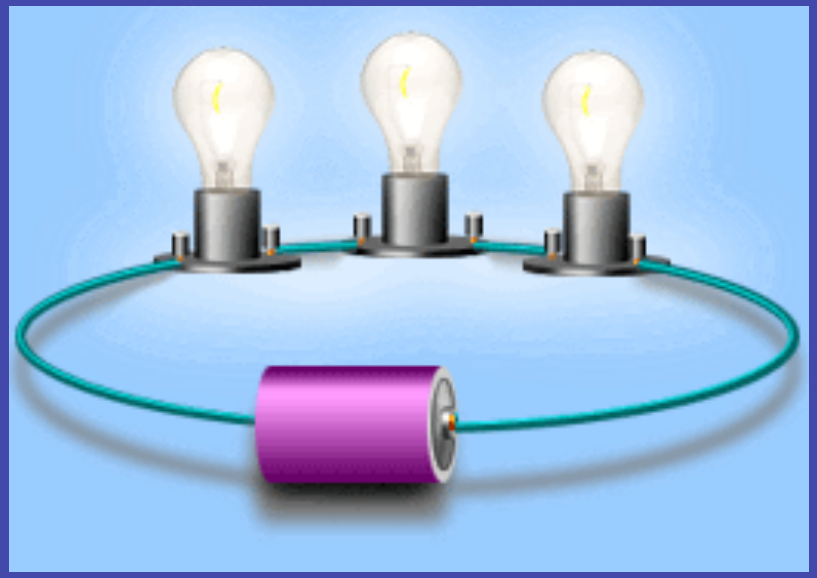
lamp



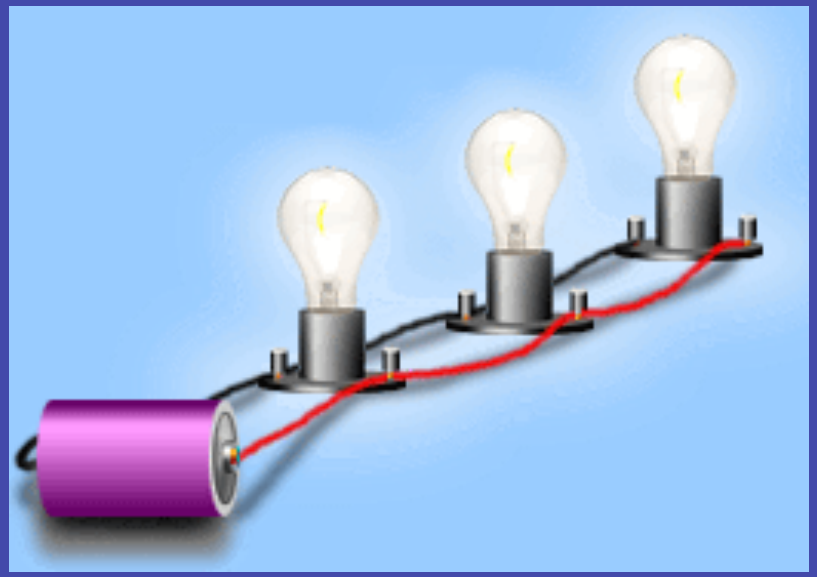
switch

wires

Simple Circuits



- Series circuit
  - All in a row
  - 1 path for electricity
  - 1 light goes out and the circuit is broken

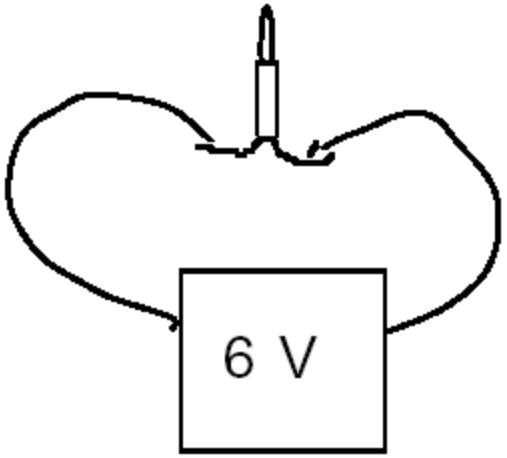


- Parallel circuit
  - Many paths for electricity
  - 1 light goes out and the others stay on

SERIES CIRCUITS

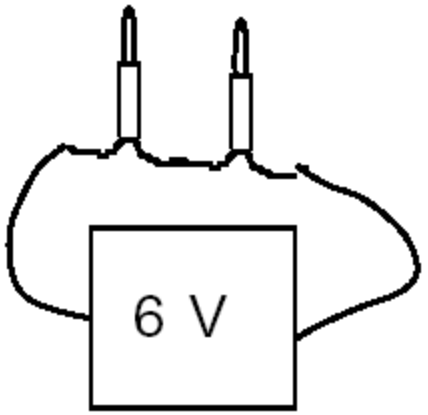
Connect one bulb to the battery.

1



Connect 2 bulbs and the battery to form a series circuit.

2



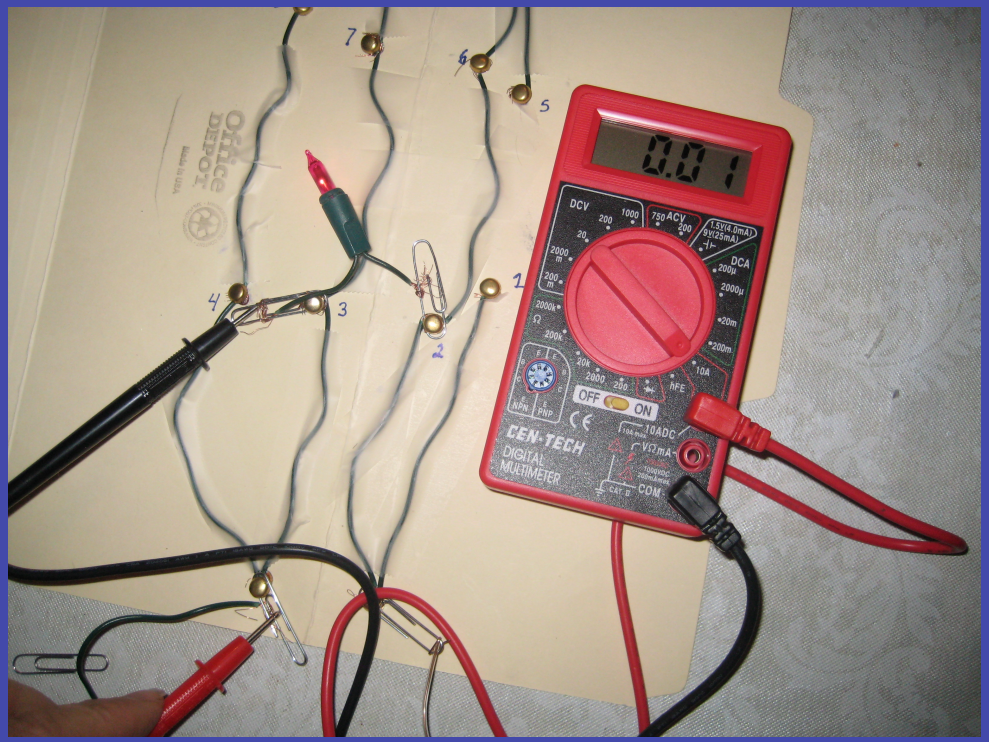
Connect 3 bulbs and the battery to form a series circuit.

PARALLEL CIRCUIT

- Place two bulbs in parallel. What do you notice about the brightness of the bulbs?
- Add a third light bulb in the circuit. What do you notice about the brightness of the bulbs?
- Remove the middle bulb from the circuit. What happened?

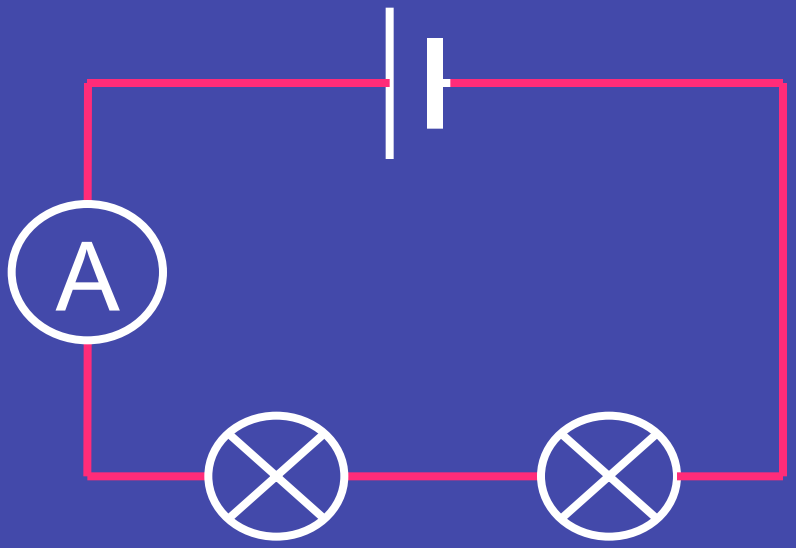
measuring current

Electric current is measured in **amps** (*A*) using an ammeter connected in series in the circuit.

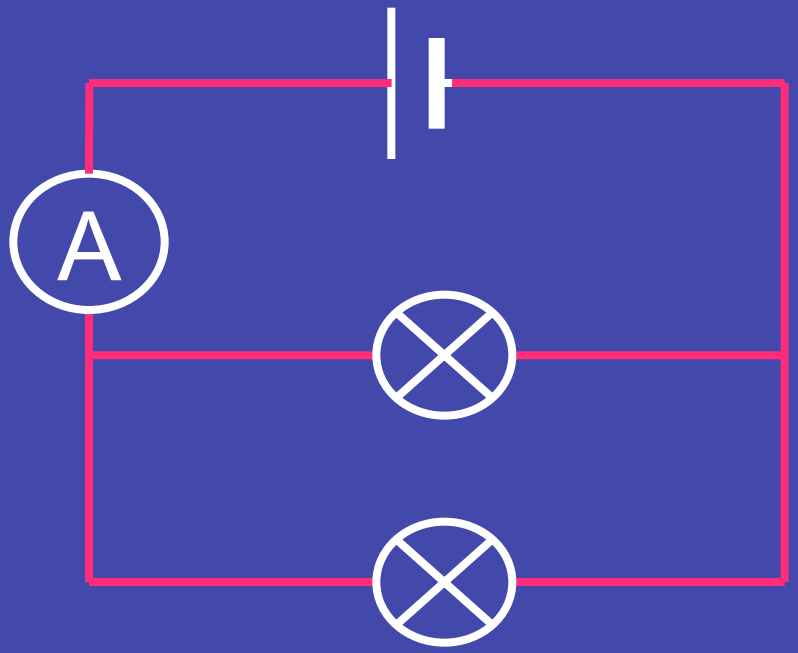


measuring current

This is how we draw an ammeter in a circuit.



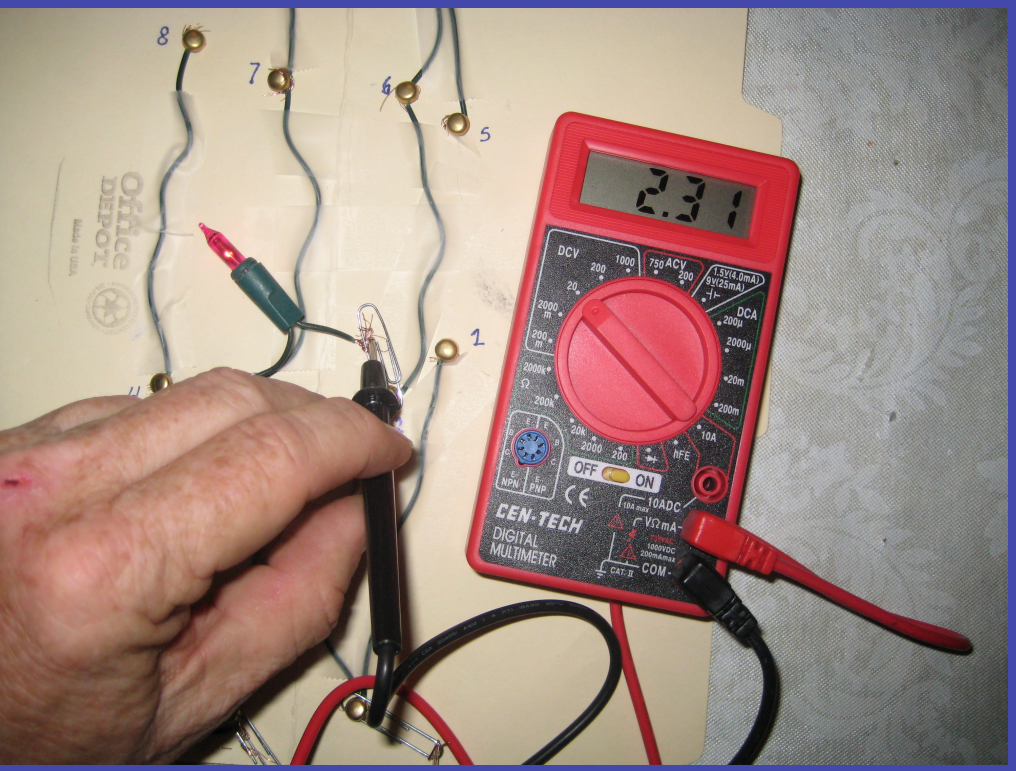
SERIES CIRCUIT



PARALLEL CIRCUIT

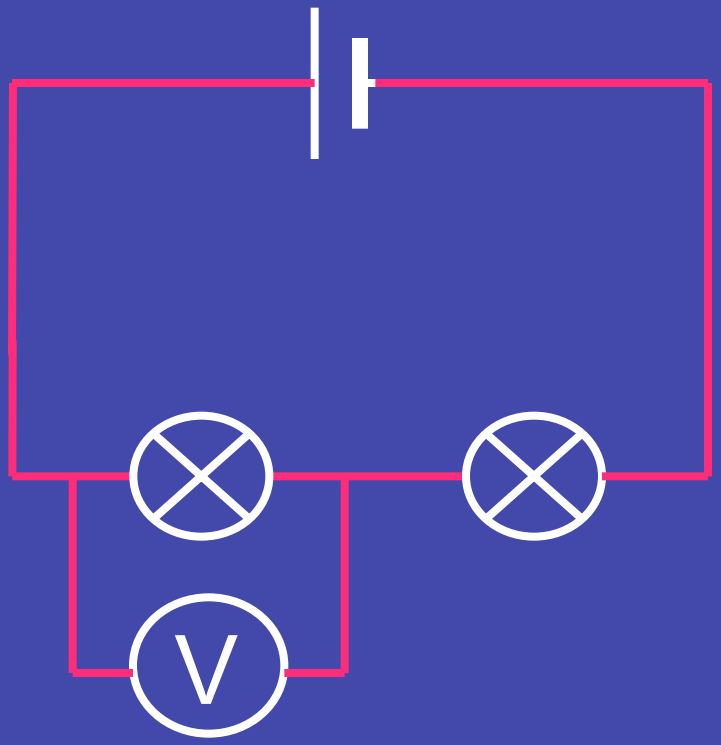
measuring voltage

The 'electrical push' which the cell gives to the current is called the voltage. It is measured in **volts** (V) on a **voltmeter**

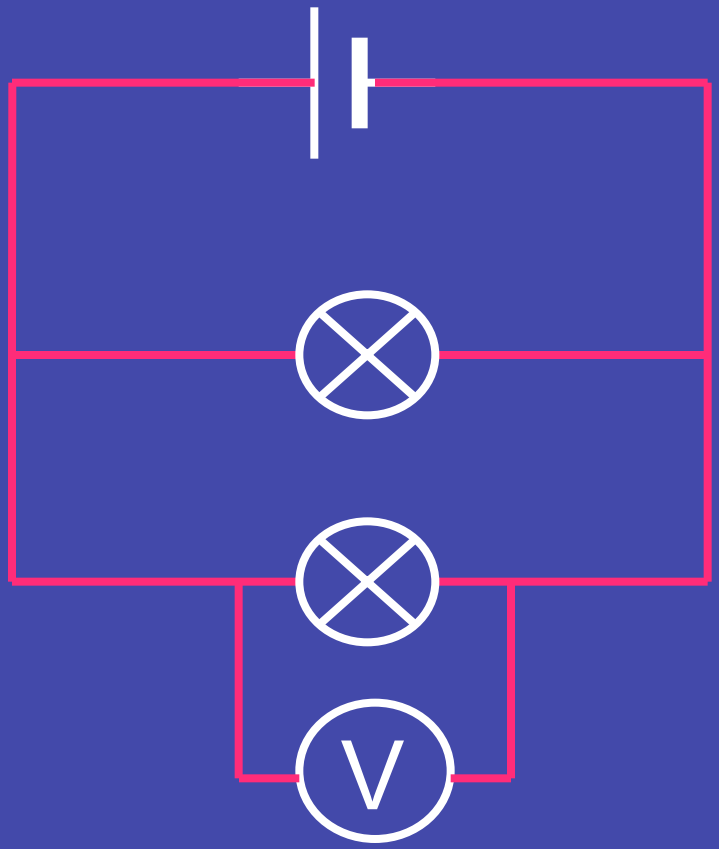


measuring voltage

This is how we draw a voltmeter in a circuit.



SERIES CIRCUIT



PARALLEL CIRCUIT

OHM's LAW

- Measure the current and voltage across each circuit.
- Use Ohm's Law to compute resistance

Series Circuit

Voltage	Current	Resistance

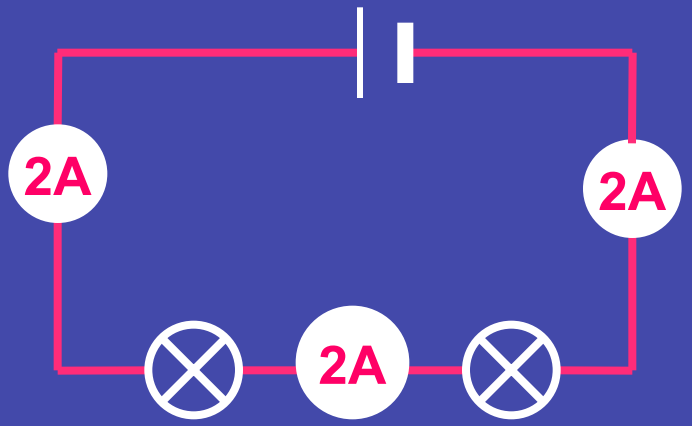
Parallel Circuit

Voltage	Current	Resistance

measuring current

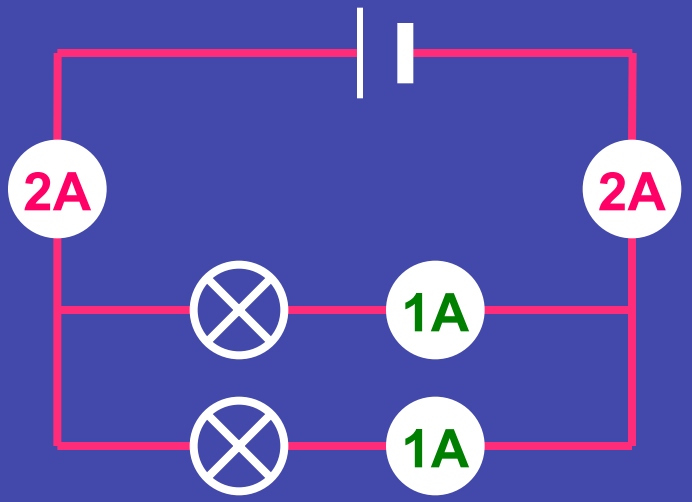
SERIES CIRCUIT

- current is the **same** at all points in the circuit.

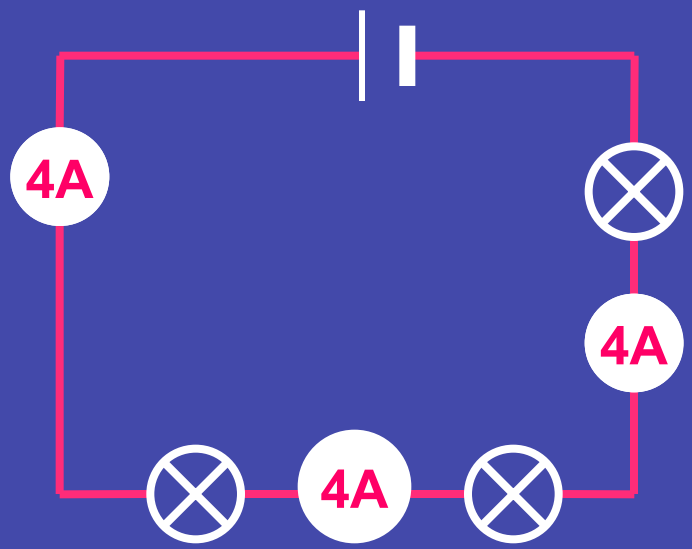


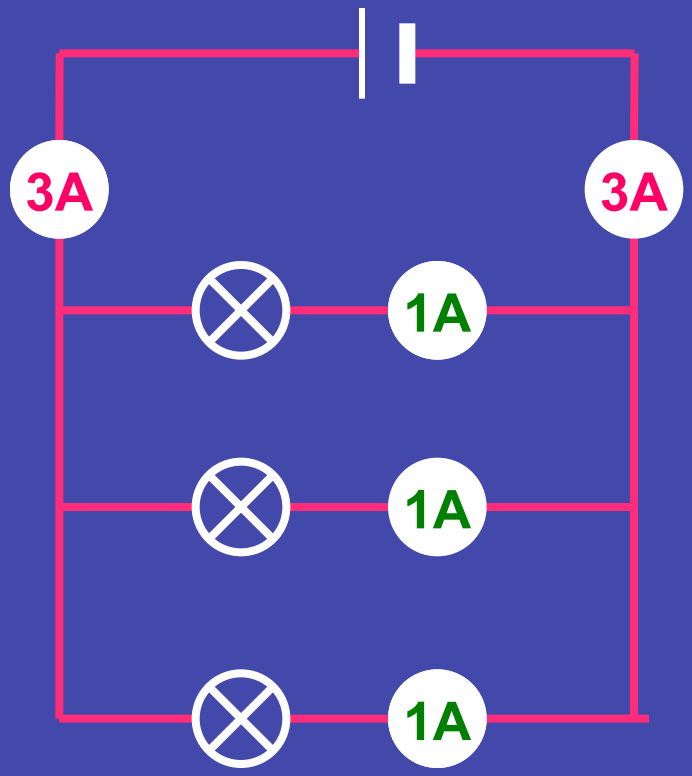
PARALLEL CIRCUIT

- current is **shared** between the components



fill in the missing ammeter readings.





SERIES CIRCUITS

Explain what happens to the current in a series circuit when there is a break in the circuit.

The circuit is no longer complete, therefore current can not flow

Explain what happens to the voltage across each bulb as more bulbs are added to the circuit.

The voltage decreases because the current is decreased and the resistance increases.

PARALLEL CIRCUITS

Explain what happens to the current in each bulb as more bulbs are added to the circuit.

The current remains the same. The total resistance drops in a parallel circuit as more bulbs are added

Explain what happens to the total current provided by the battery as more bulbs are added to the circuit.

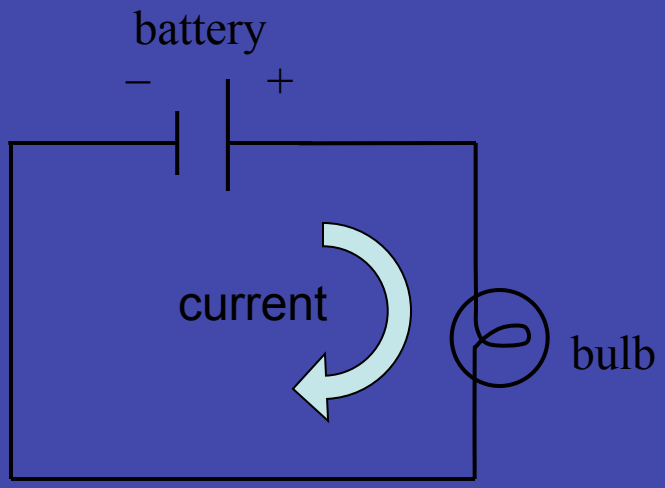
The current increases.

Series and Parallel Circuits

- Series Circuits
  - only one end of each component is connected
  - e.g. Christmas tree lights

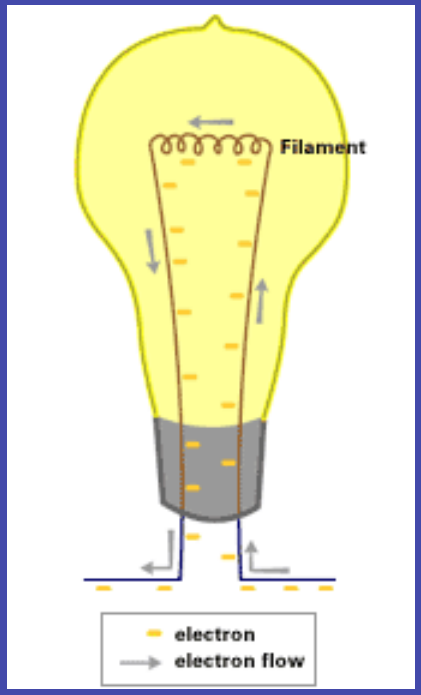
- Parallel Circuits
  - both ends of a component are connected
  - e.g. household lighting

Circuit in Diagram Form



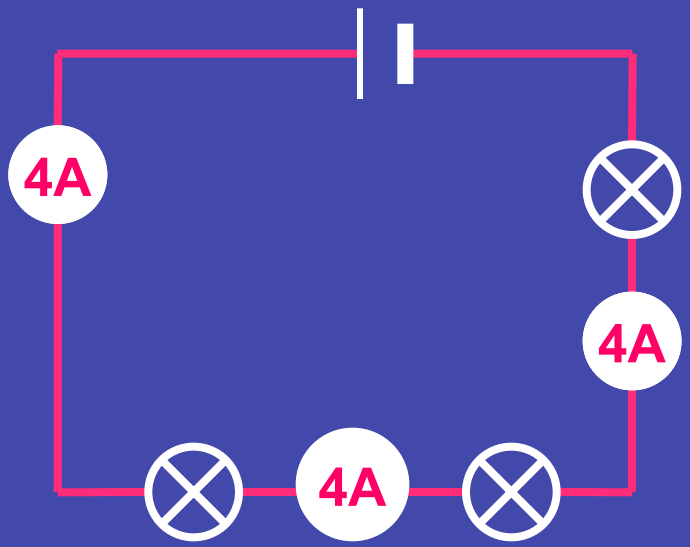
In a closed circuit, current flows *around* the loop

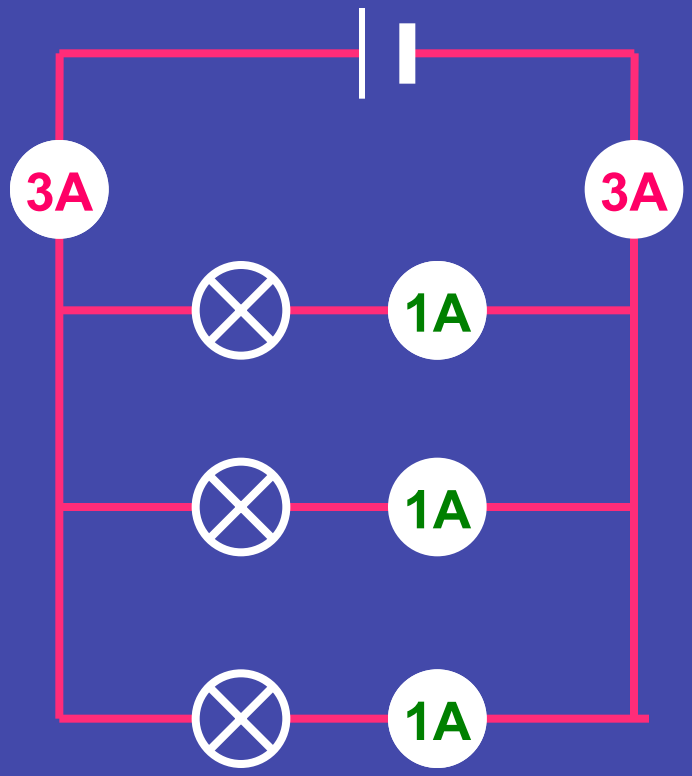
electrons flow *opposite* the indicated current direction! (repelled by negative terminal)



Current flowing through the filament makes it glow.
No Loop → No Current → No Light

copy the following circuits and fill in the missing ammeter readings.





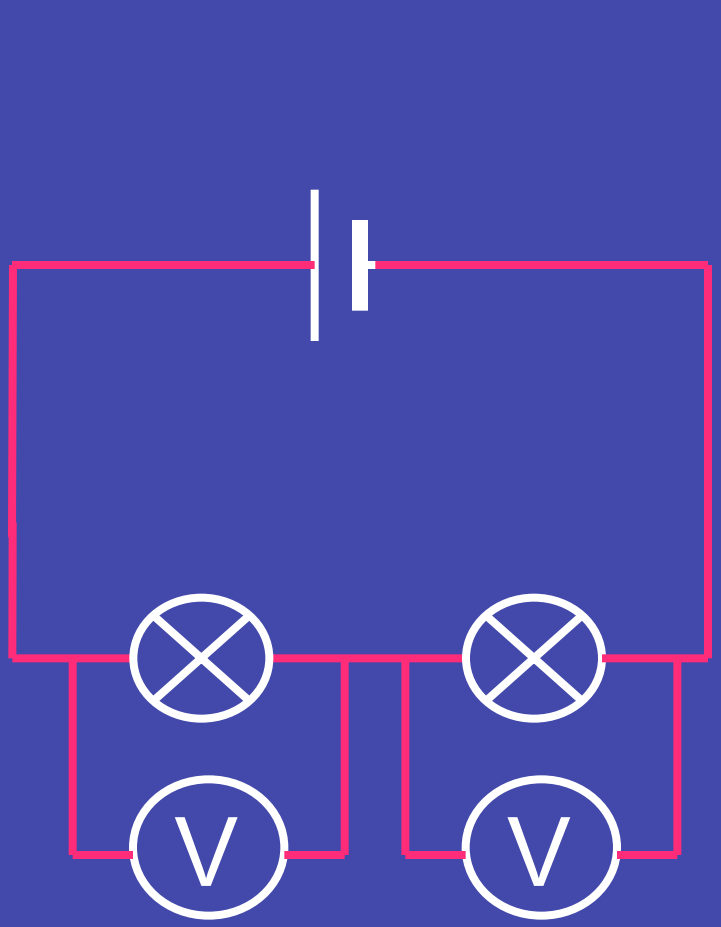
measuring voltage

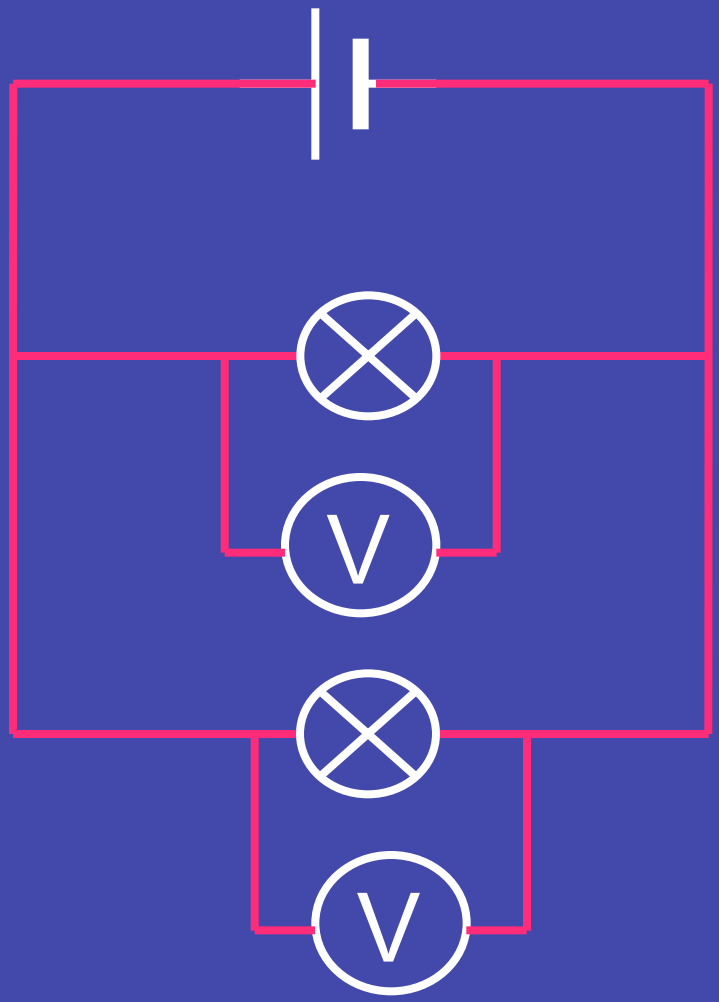
Different cells produce different voltages. The bigger the voltage supplied by the cell, the bigger the current.

Unlike an ammeter, a voltmeter is connected across the components

Scientist usually use the term **Potential Difference** (pd) when they talk about voltage.

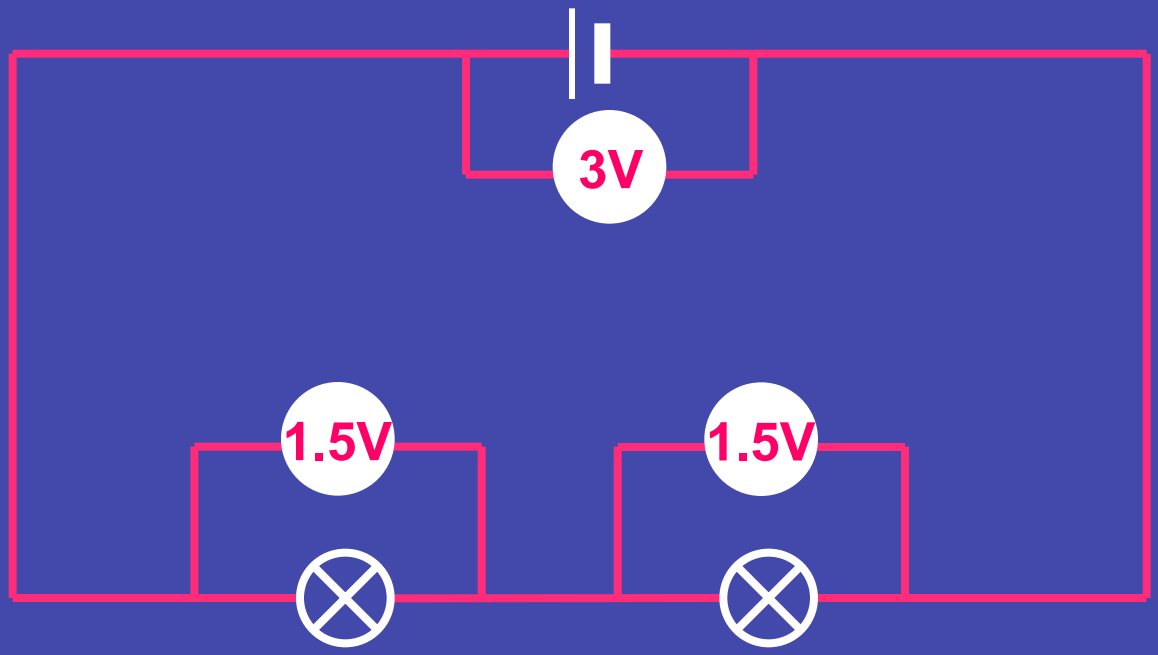
measuring voltage





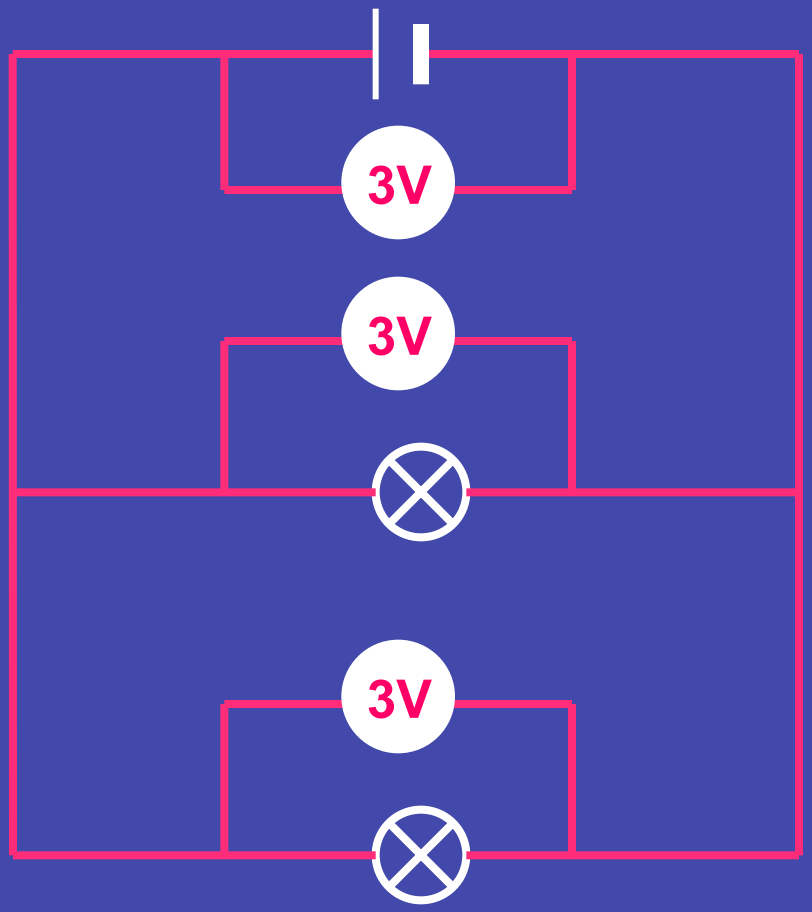
series circuit

- voltage is **shared** between the components



parallel circuit

- voltage is the **same** in all parts of the circuit.



measuring current & voltage

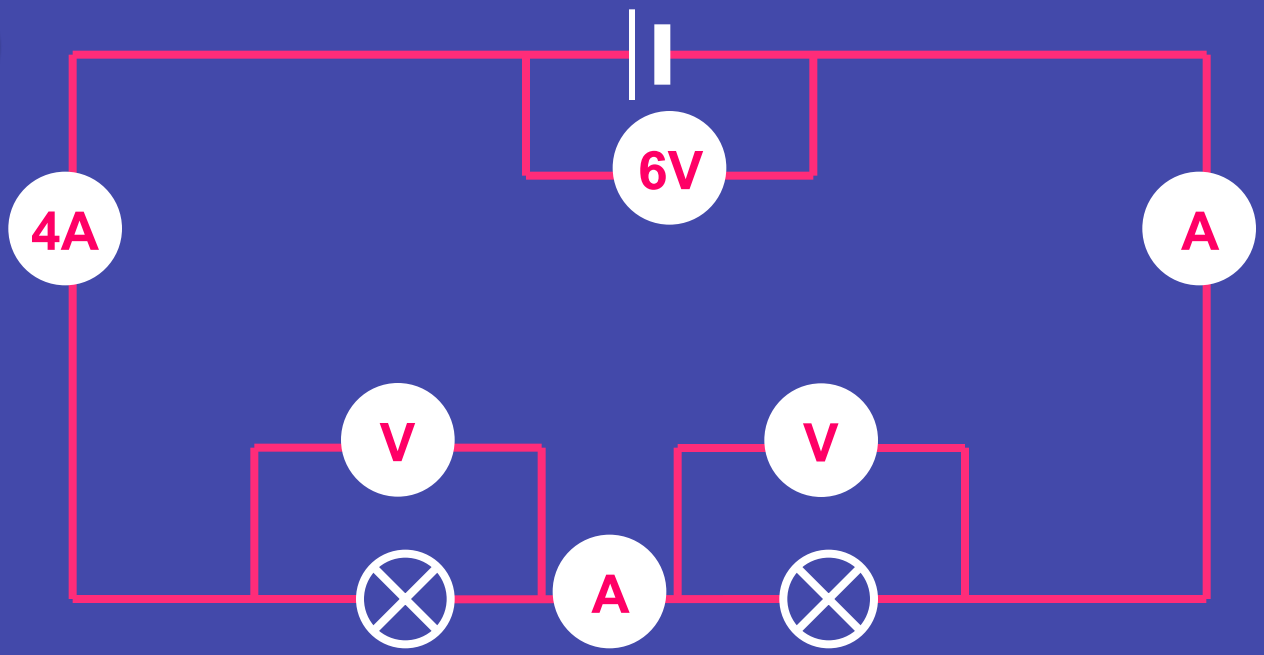
copy the following circuits on the next two slides.

complete the missing current and voltage readings.

remember the rules for current and voltage in series and parallel circuits.

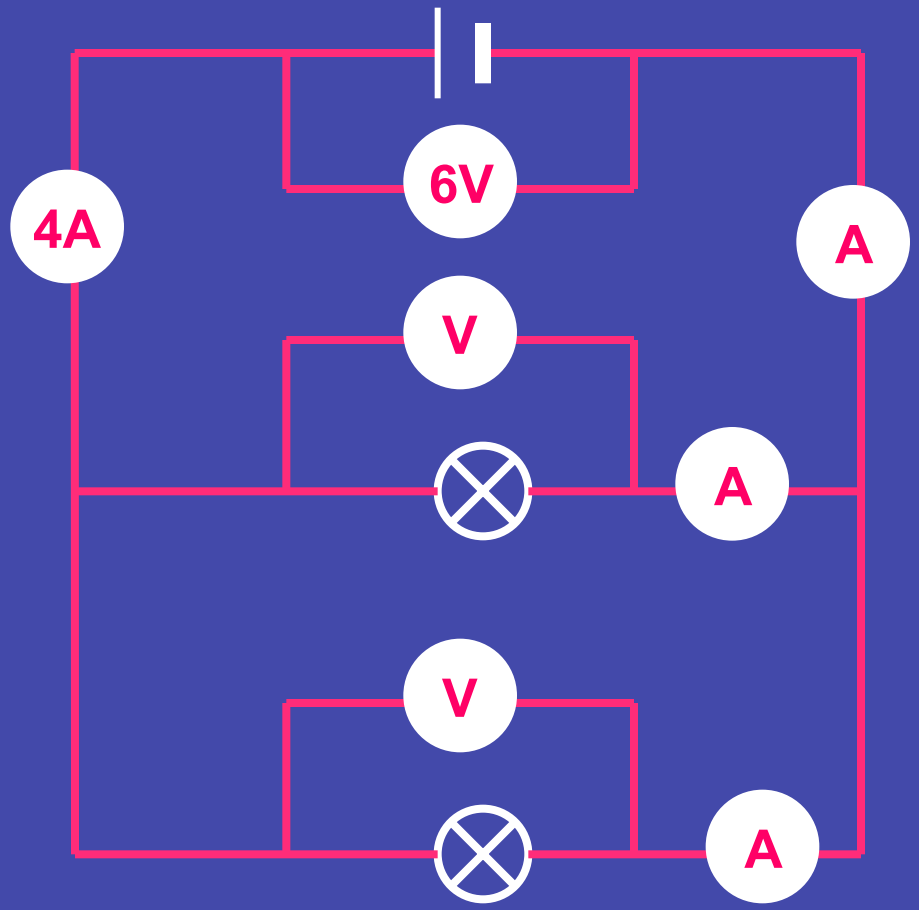
measuring current & voltage

a)



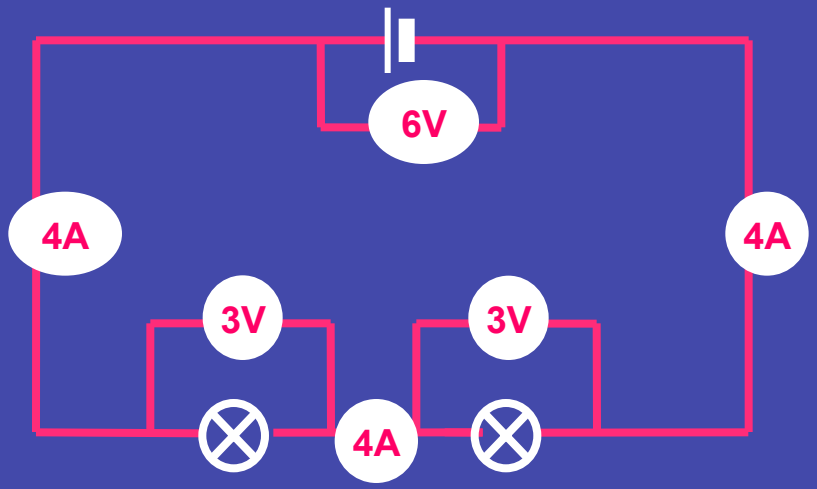
measuring current & voltage

b)

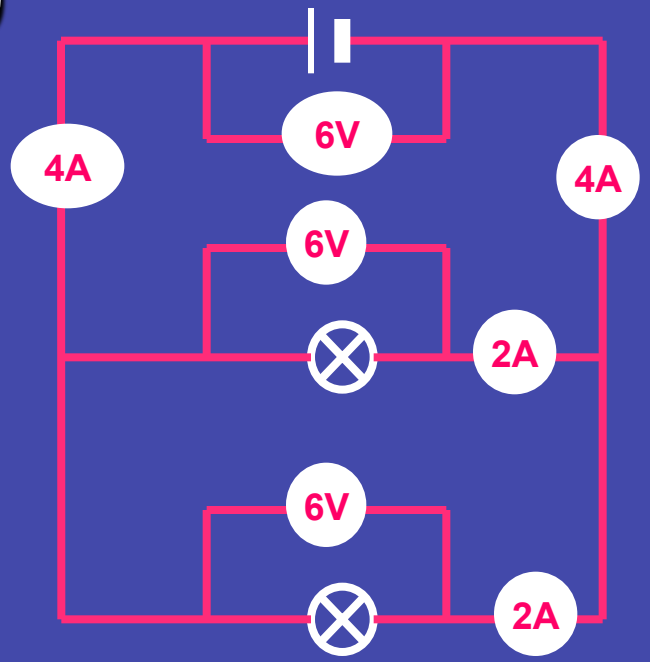


answers

a)



b)



Voltage, Current, and Power

- One Volt is a Joule per Coulomb (J/C)
- One Amp of current is one Coulomb per second (6.24 x10^18 electrons/second).
- If I have one volt (J/C) and one amp (C/s), then multiplying gives Joules per second (J/s)
  - this is power: J/s = Watts
- So the formula for electrical power is just:

  $P = VI$: power = voltage × current

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