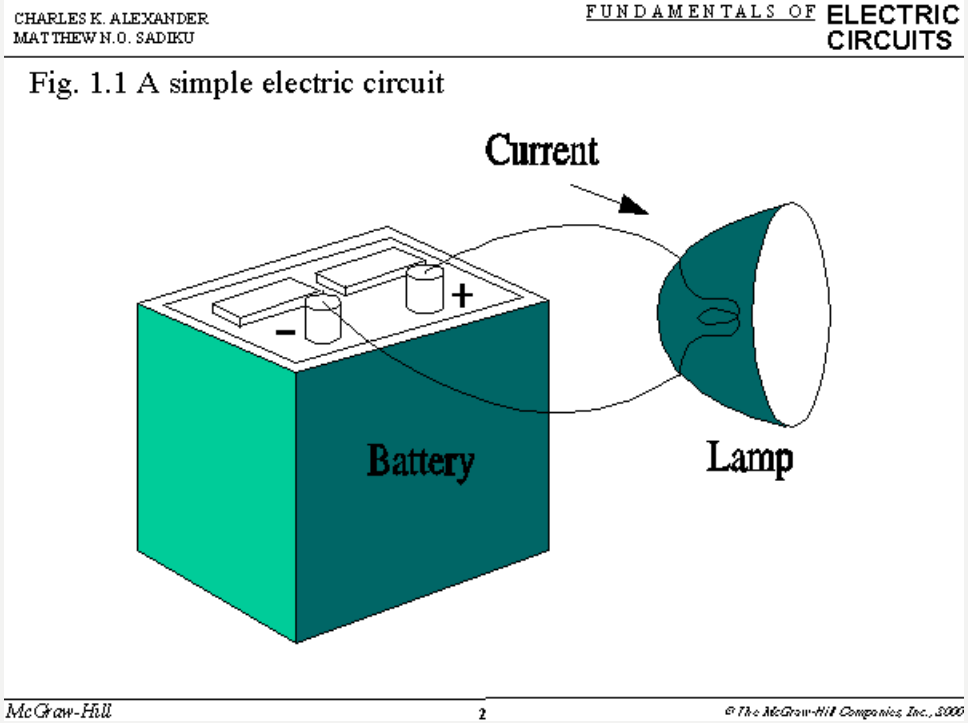
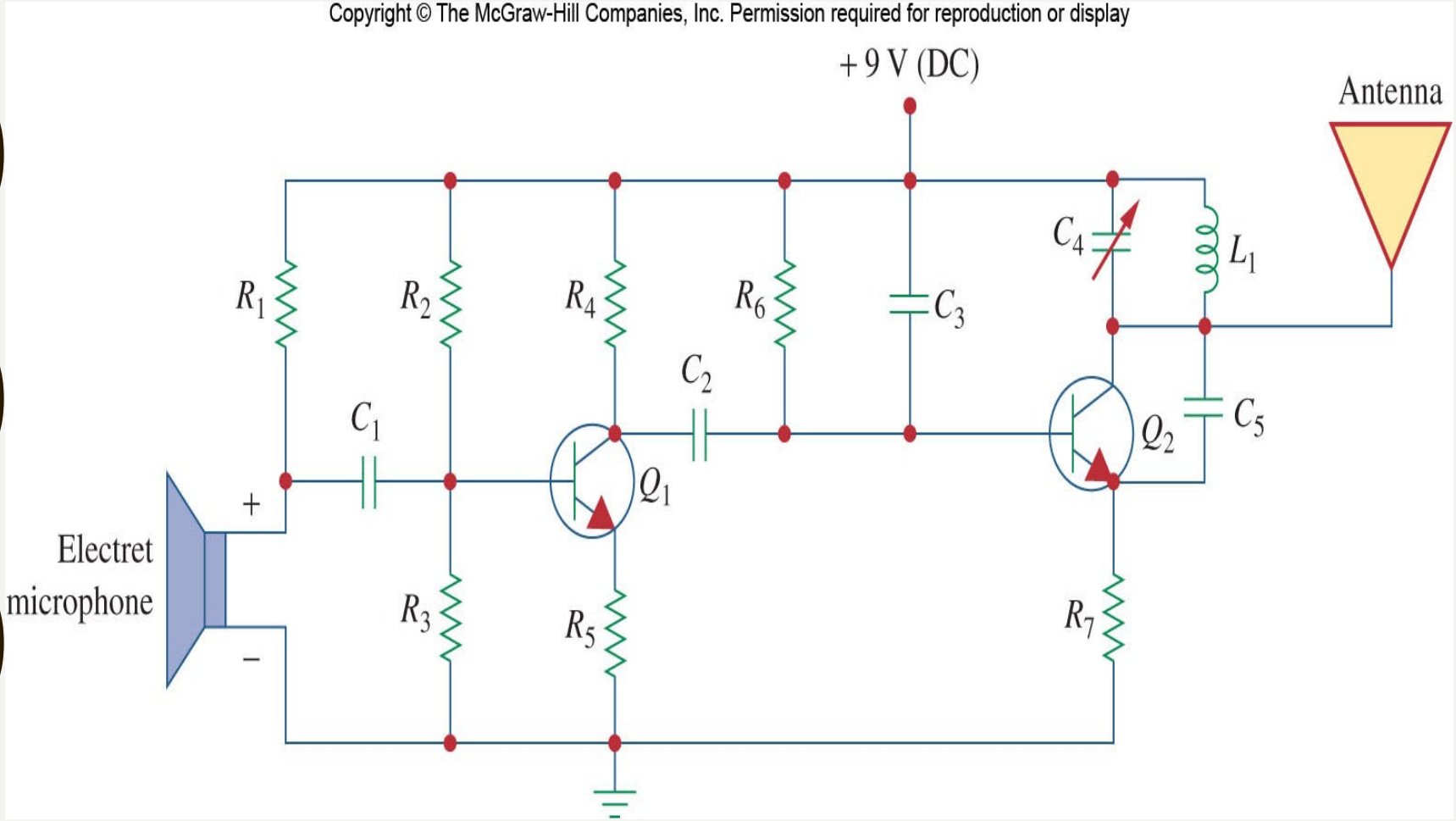
ELECTRIC CIRCUIT

- An electric circuit is an interconnection of electrical elements.



ELECTRIC CIRCUIT



SYSTEMS OF UNITS

- **When taking measurements, we must use units to quantify values**
- **We use the International Systems of Units (SI for short)**

BASIC SI UNITS

Quantity	Basic Unit	Symbol
Length	**meter**	**m**
Mass	**kilogram**	**kg**
Time	**second**	**s**
Electric current	**ampere**	**A**
Thermodynamic Temperature	**kelvin**	**K**
Luminous intensity	**candela**	**cd**

THE SI PREFI

- **Prefixes on SI units allow for easy relationships between large and small values**

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TABLE 1.2

The SI prefixes.

Multiplier	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

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10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

CHARGE

- **Charge** is a basic SI unit, measured in **Coulombs** (C)
- Charge of single electron is $1.602*10^{-19}$ C
- One Coulomb is quite large, $6.24*10^{18}$ electrons.

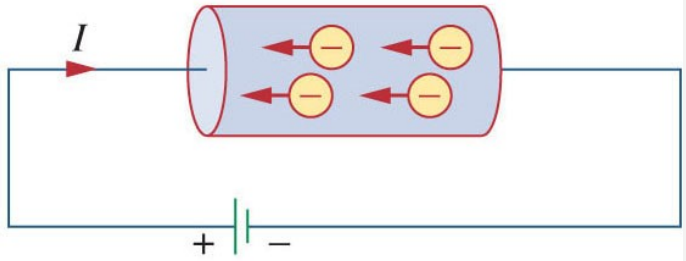
CHARGE

- In the lab, one typically sees (pC, nC, or μC)
- Charge is always multiple of electron charge
- Charge cannot be created or destroyed, only transferred.

ELECTRIC CURRENT

- The movement of charge is called a current
- Historically the moving charges were thought to be positive
- Thus we always note the direction of the equivalent positive charges, even if the moving charges are negative.

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Battery

ELECTRIC CURRENT

- Current, *i*, is measured as charge moved per unit time through an element. $$i \equiv \frac{dq}{dt}$$

- Unit is Ampere (A), is one Coulomb/second

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

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

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

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)



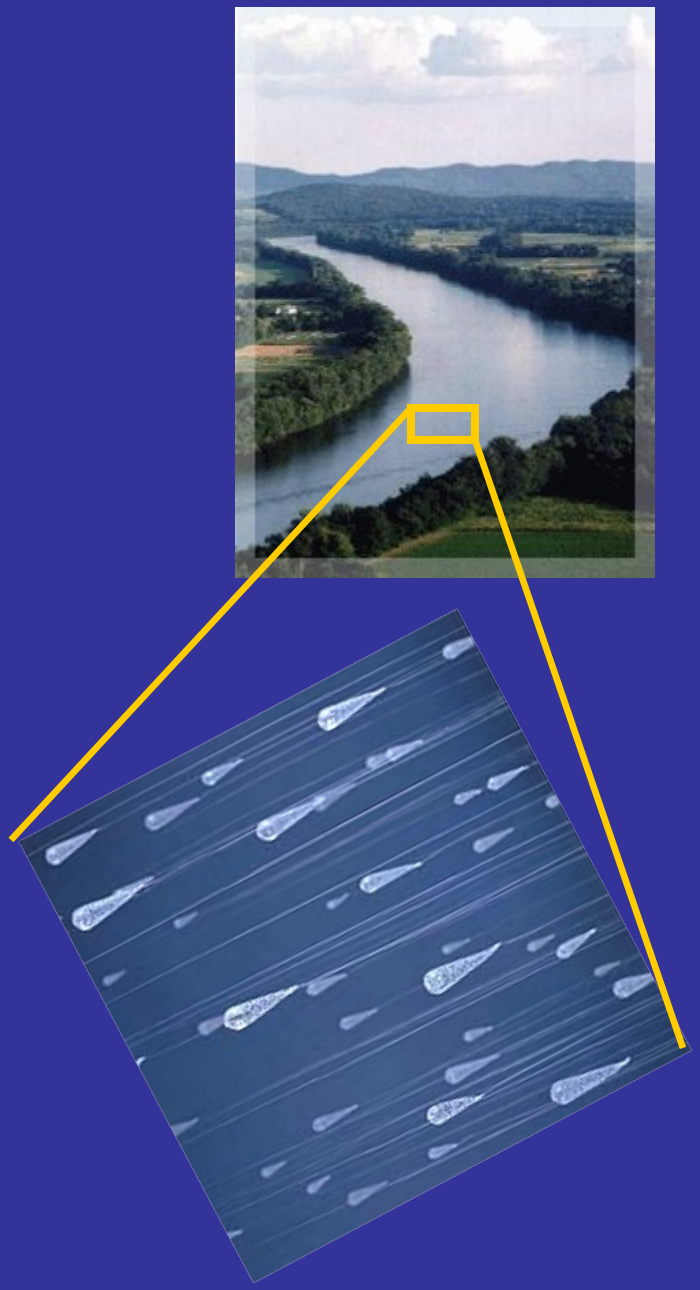
How you should be thinking about electric circuits:

<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!)



Example 1.1

If a current of 5 A flows for 2 minutes, find the quantity of electricity transferred.

Solution

Quantity of electricity $Q = It$ coulombs

$I = 5\,\text{A}$, $t = 2 \times 60 = 120\,\text{s}$

Hence, $Q = 5 \times 120 = 600\,\text{C}$

Force

The *unit of force* is the newton (N) where one newton is one kilogram meter per
second squared. The newton is defi ned as the force which, when applied to

Example 1.2

A mass of 5000 g is accelerated at 2 m/s^2 by a force. Determine the force needed.

Solution

Force = mass × acceleration

$$= 5\,\text{kg} \times 2\,\text{m/s}^2 = 10\,\frac{\text{kg m}}{\text{s}^2} = \mathbf{10\,N}$$

Example 1.3

Find the force acting vertically downwards on a mass of 200 g attached to a wire.

Solution

Mass = 200 g = 0.2 kg and acceleration due to gravity, g = 9.81 m/s^2

Force acting downwards = weight = mass × acceleration

$$= 0.2\,\text{kg} \times 9.81\,\text{m/s}^2$$

$$= \mathbf{1.962\,N}$$

Work

The *unit of work or energy* is the *joule* (J) where one joule is one Newton meter. The joule is defined as the work done or energy transferred when a force of one newton is exerted through a distance of one meter in the direction of the force. Thus,

work done on a body, in joules $W = Fs$

where F is the force in Newtons and s is the distance in meters moved by the body in the direction of the force. Energy is the capacity for doing work.

Example 1.4

A portable machine requires a force of 200 N to move it. How much work is done if the machine is moved 20 m and what average power is utilized if the movement takes 25 s?

Solution

Work done = force × distance

$$= 200\,\text{N} \times 20\,\text{m}$$

$$= 4000\,\text{Nm or } 4\,\text{kJ}$$

$$\text{Power} = \frac{\text{work done}}{\text{time taken}}$$

$$= \frac{4000\,\text{J}}{25\,\text{s}} = 160\,\text{J/s} = 160\,\text{W}$$

Power

The *unit of power* is the watt (W) where one watt is one joule per second. Power is defined as the rate of doing work or transferring energy. Thus,

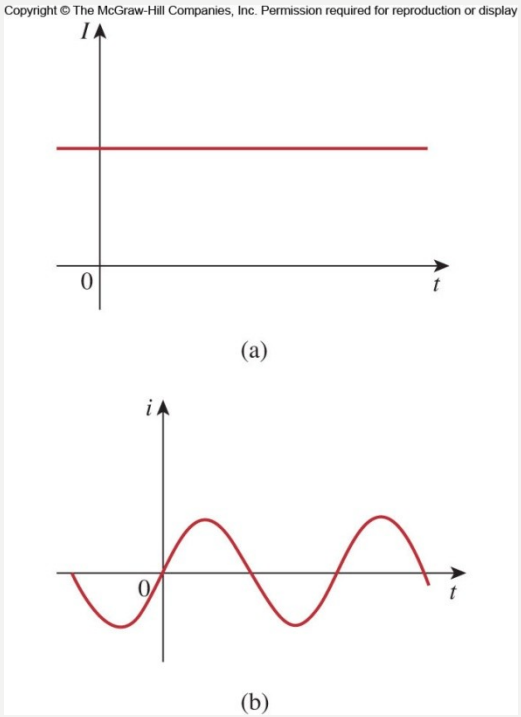
power in watts, $P = \frac{W}{t}$

where W is the work done or energy transferred in joules and t is the time in seconds. Thus,

energy, in joules, $W = Pt$

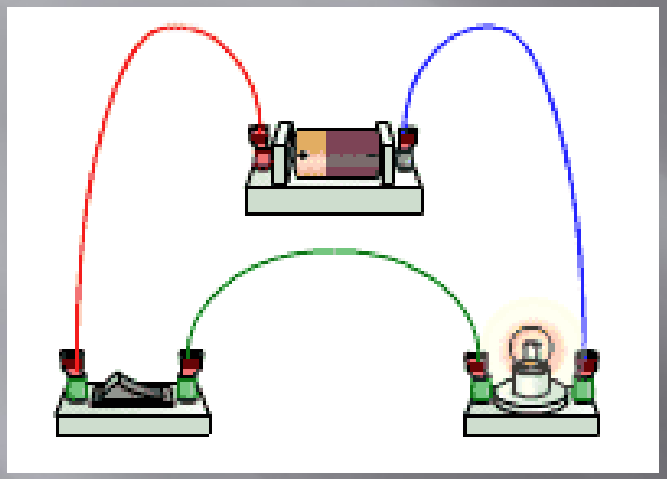
DC VS. AC

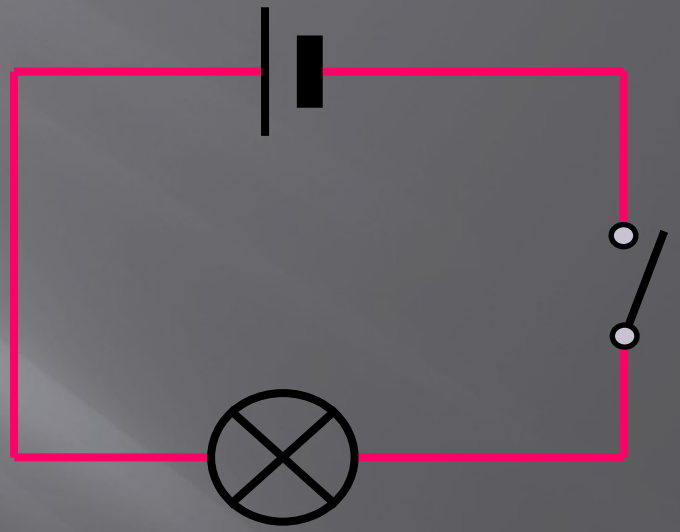
- A current that remains constant with time is called Direct Current (DC)
- Such current is represented by the capital *I*, time varying current uses the lowercase, *i*.
- A common source of DC is a battery.
- A current that varies sinusoidally with time is called Alternating Current (AC)
- Mains power is an example of AC

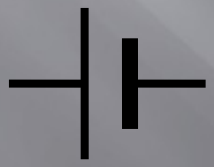


circuit diagram

Scientists usually draw electric circuits using symbols;







cell



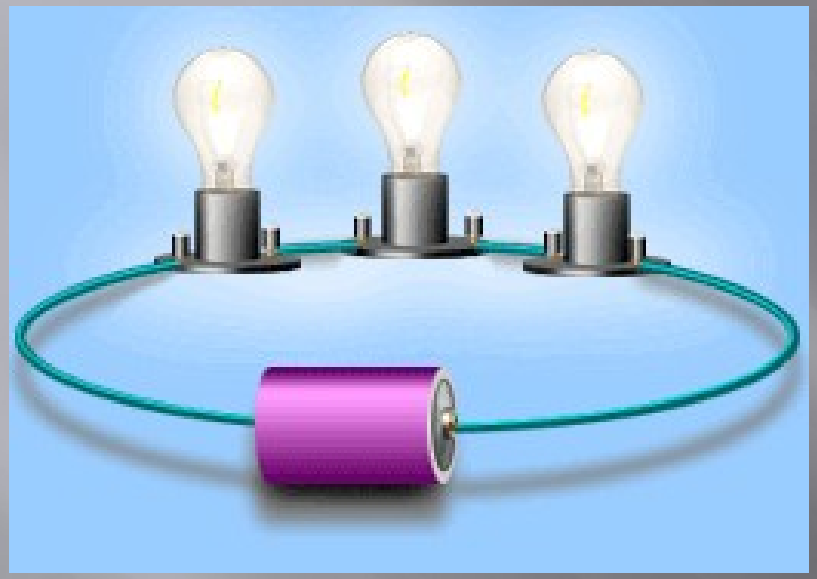
lamp



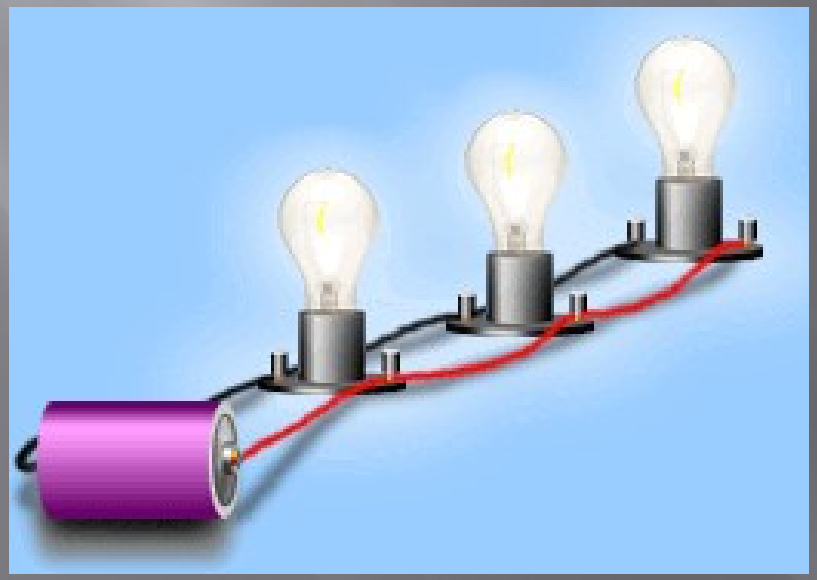
switch

wires

Simple Circuits



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

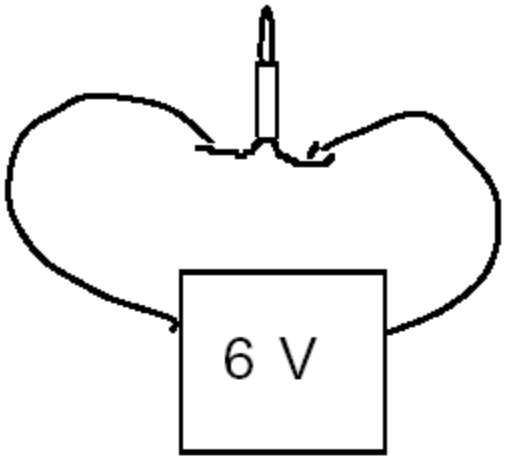


- Parallel circuit
  - Many paths for electricity
  - 1 light goes out and the others stay on

SERIES CIRCUITS



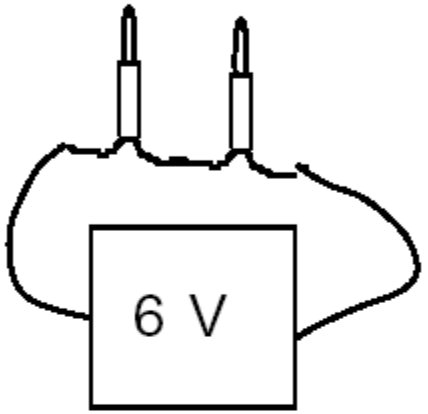
1



Connect one bulb to the battery.

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

2



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

3



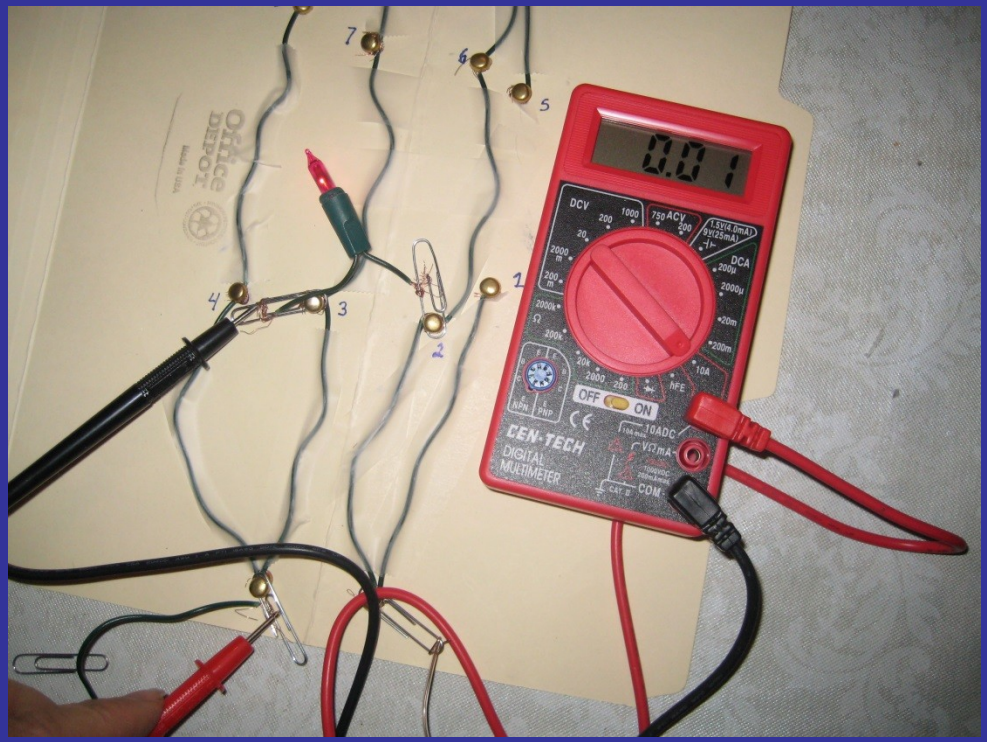
PARALLEL CIRCUIT

- 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)

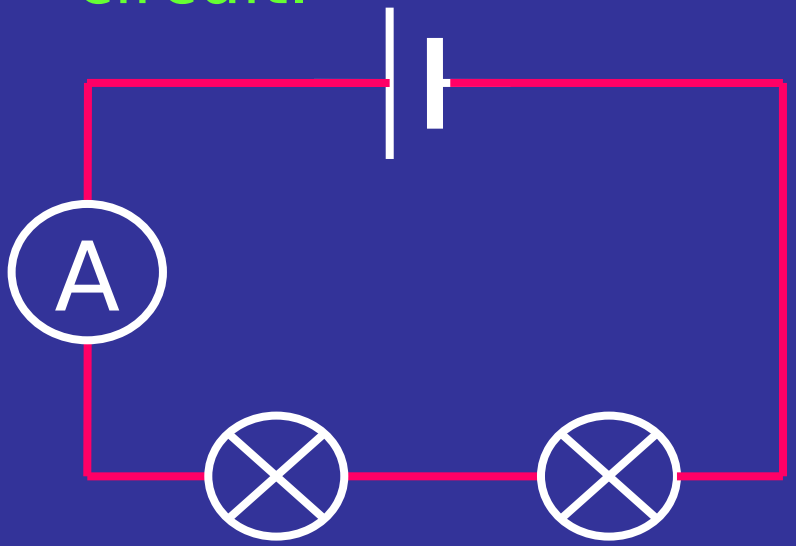
using an ammeter connected in series in



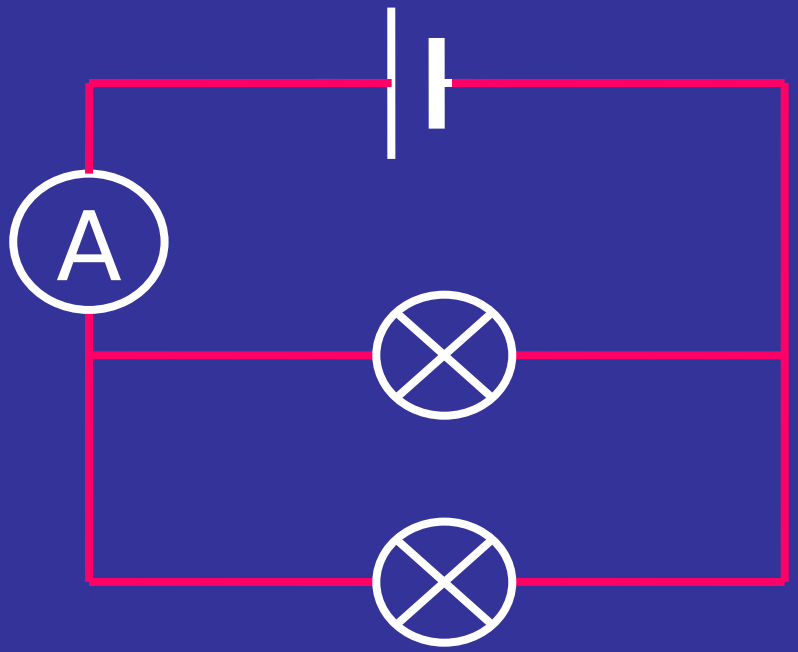


measuring current

This is how we draw an ammeter in a circuit.



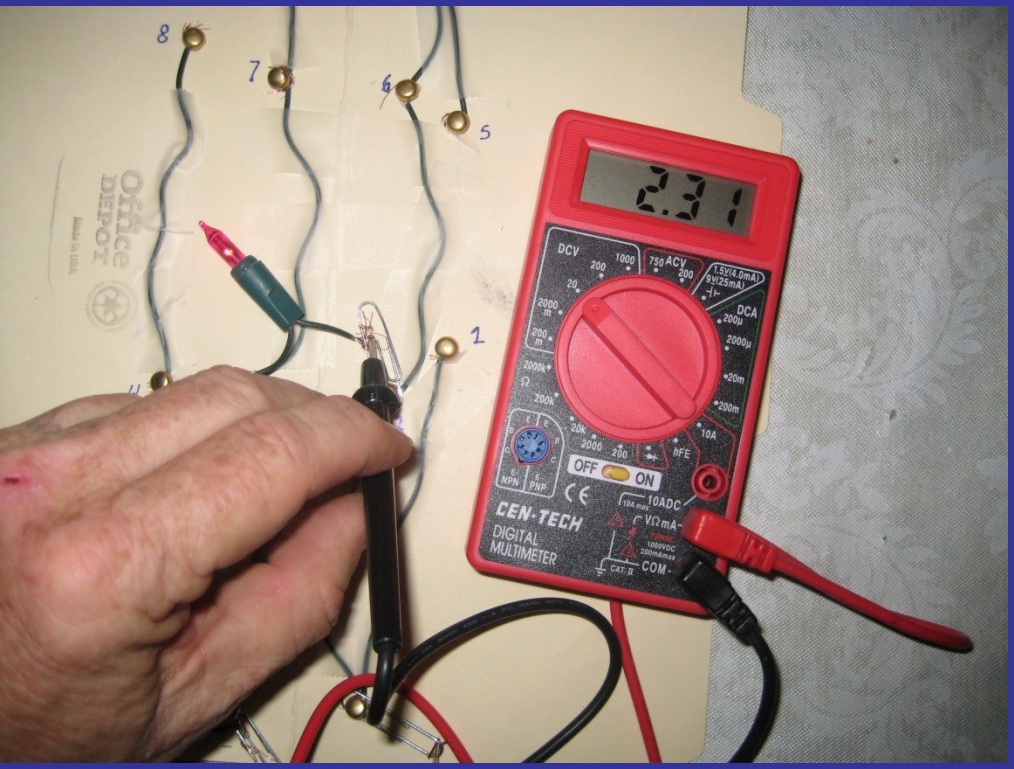
SERIES CIRCUIT



PARALLEL CIRCUIT

measuring voltage

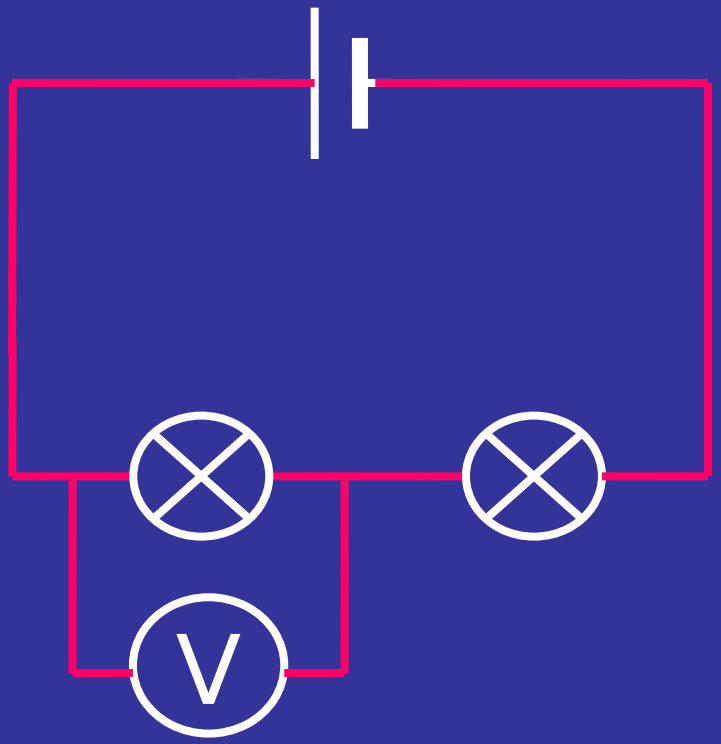
The ‘electrical push’ which the cell gives to the current is called the voltage. It is measured in **volts** (V) on a **voltmeter**



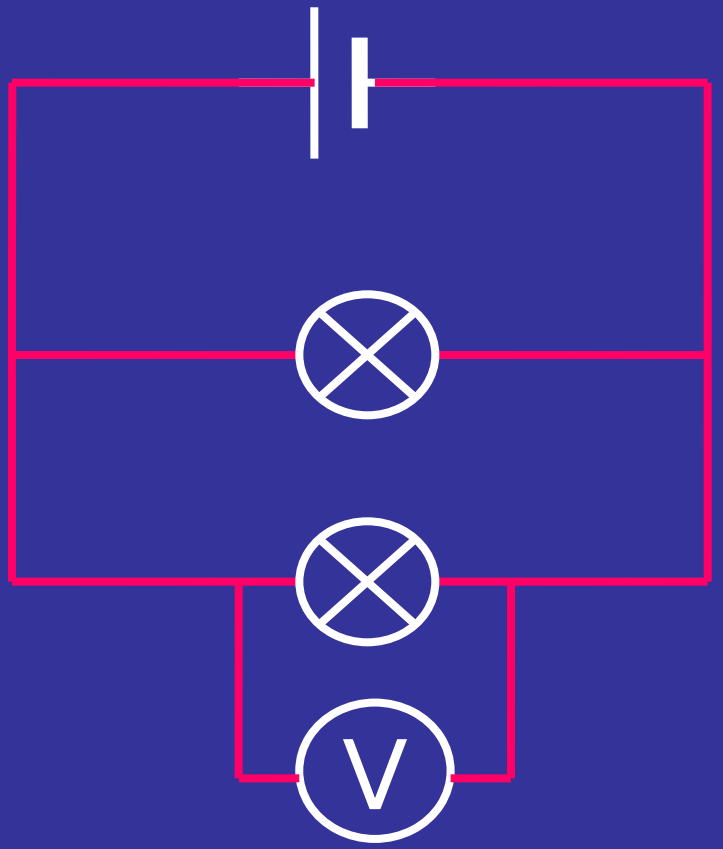


measuring voltage

This is how we draw a voltmeter in a circuit.



SERIES CIRCUIT



PARALLEL CIRCUIT