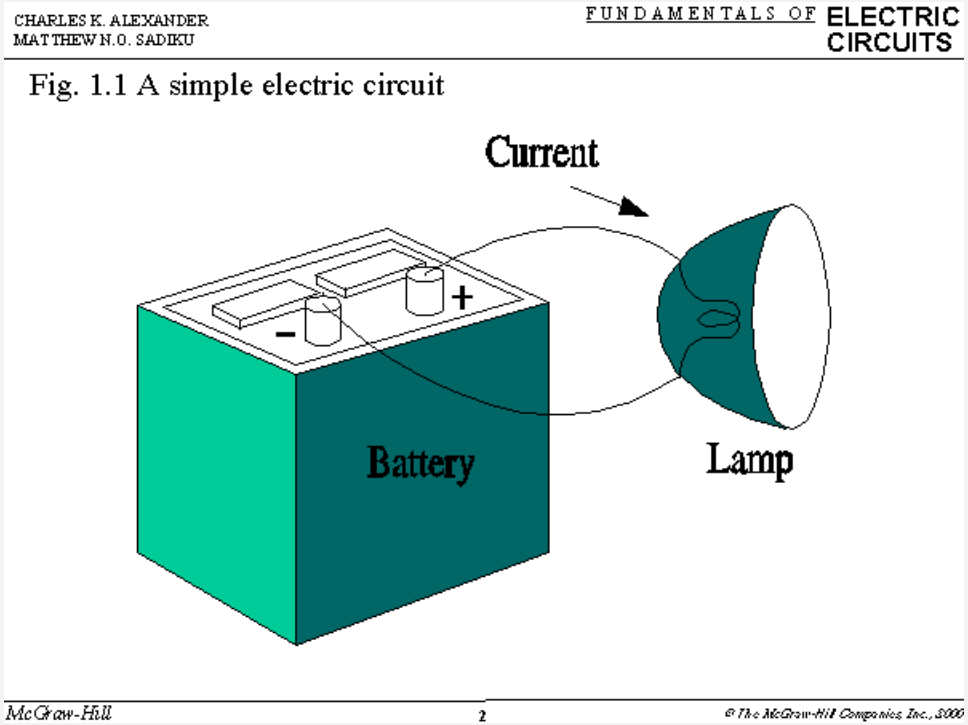
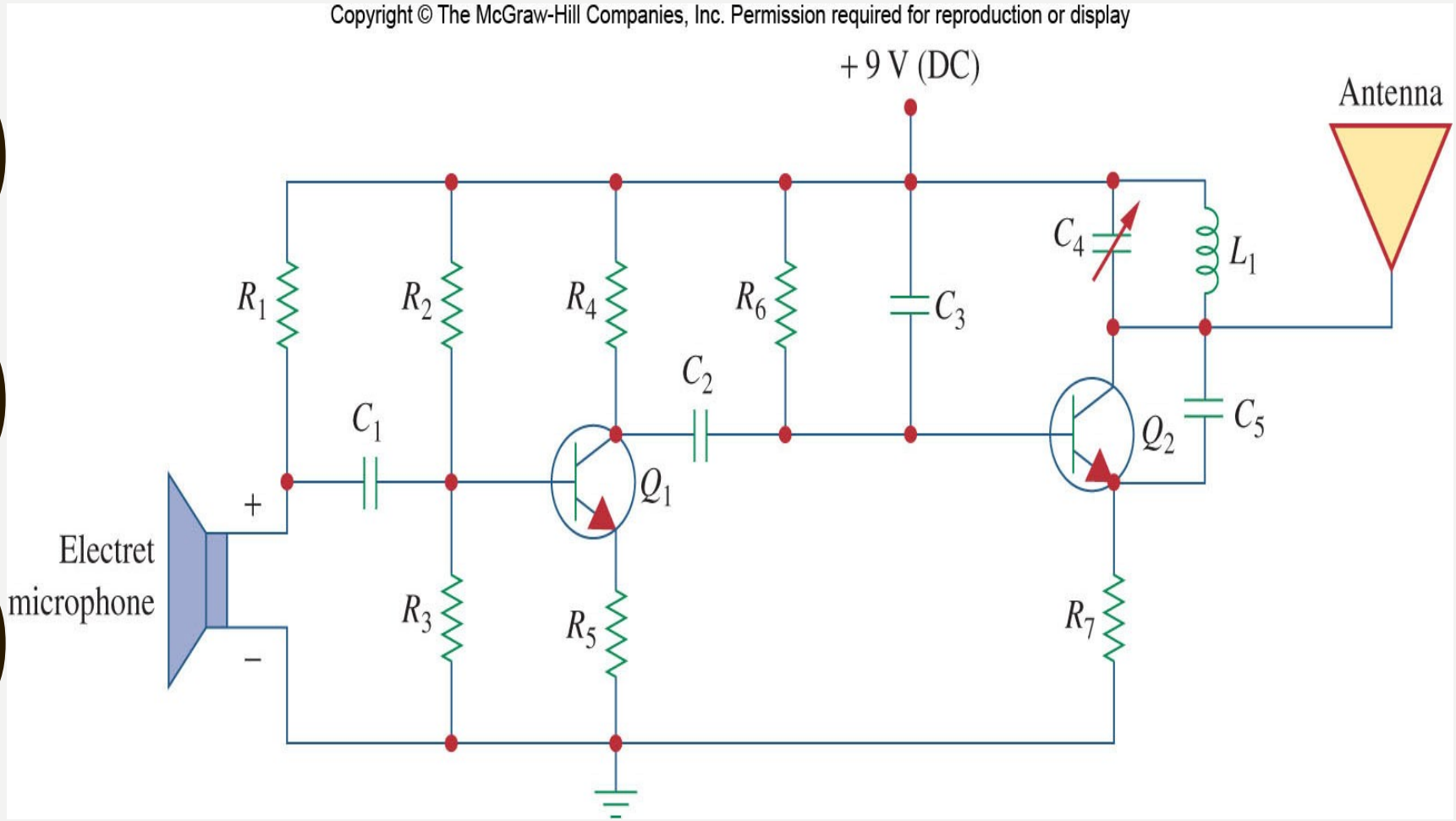
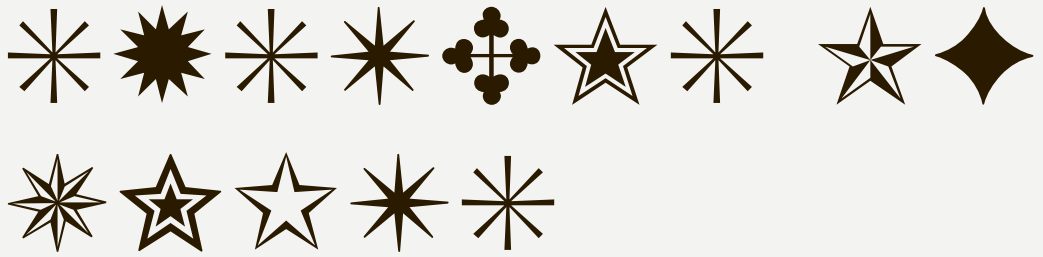
- An electric circuit is an interconnection of electrical elements.




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+ 9 V (DC)
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$R_3$
$R_5$
$R_7$



- **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** |

- **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 | $\mu$ |
| $10^{-9}$ | nano | n |
| $10^{-12}$ | pico | p |
| $10^{-15}$ | femto | f |
| $10^{-18}$ | atto | a |

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## TABLE 1.2

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| $10^{-12}$ | pico | p |
| $10^{-15}$ | femto | f |
| $10^{-18}$ | atto | a |

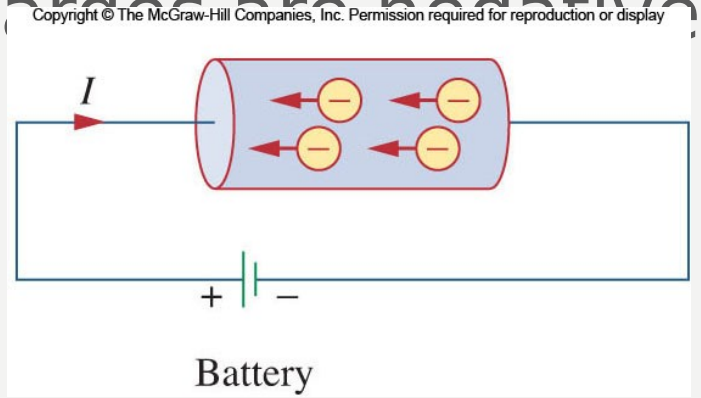
✣★✡✻✧✣

- **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.

✣★✡✻✧✣

- 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.

- 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.



- 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)**



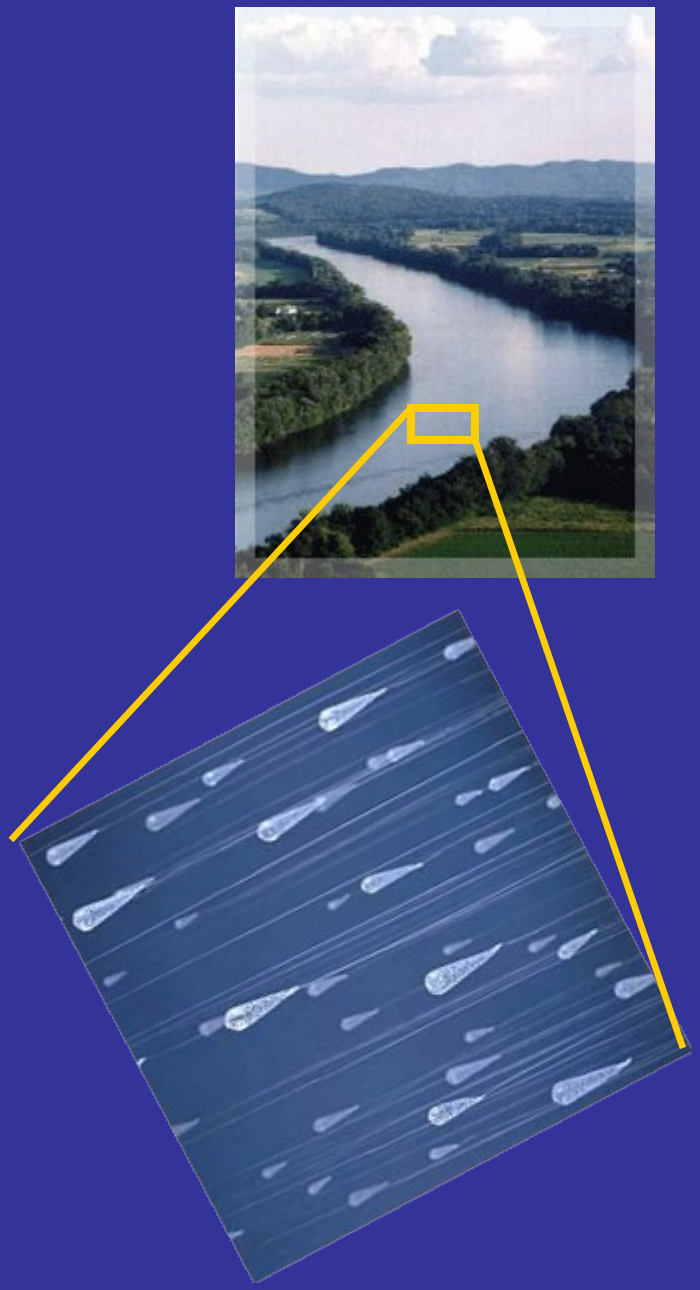
***How you should be thinking about electric circuits:***

**<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

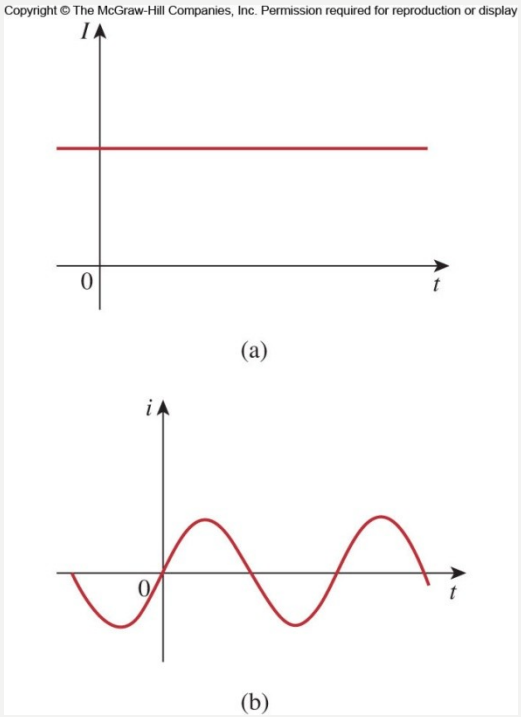
The *unit of power* is the watt (W) where one watt is one joule per second. Power is defined as the rate of doing work or transferring energy. Thus,

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,

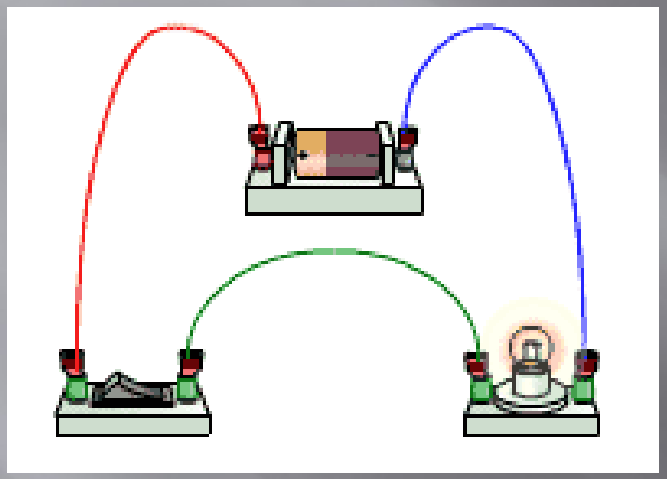
energy, in joules, $W = Pt$

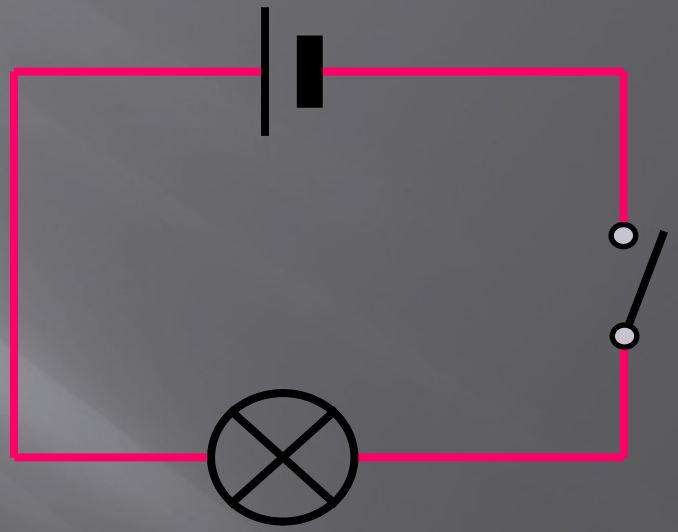
- A current that remains constant with time is called Direct Current (DC)
- Such current is represented by the capital *I*, time varying current uses the lowercase, *i*.
- A common source of DC is a battery.
- A current that varies sinusoidally with time  is called Alternating Current (AC)
- Mains power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

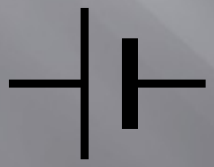


# circuit diagram

*Scientists usually draw electric circuits using symbols;*







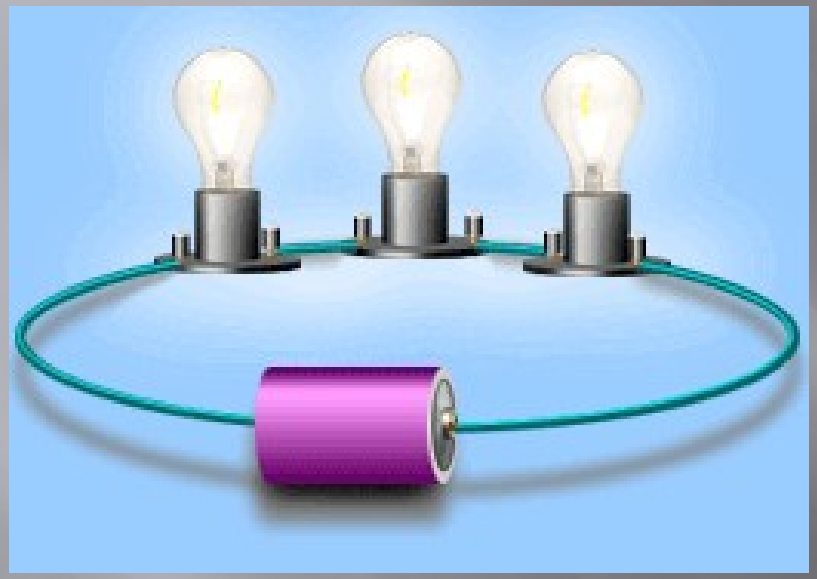




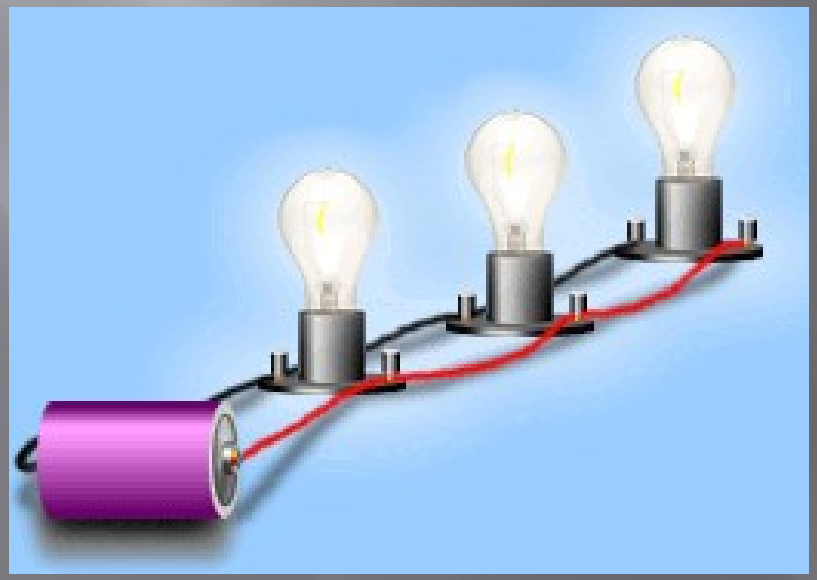


*cell* *lamp* *switch* *wires*

# Simple Circuits



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

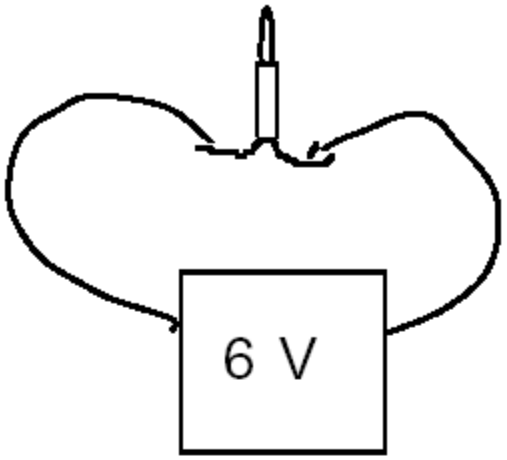


- Parallel circuit
  - Many paths for electricity
  - 1 light goes out and the others stay on

# SERIES CIRCUITS



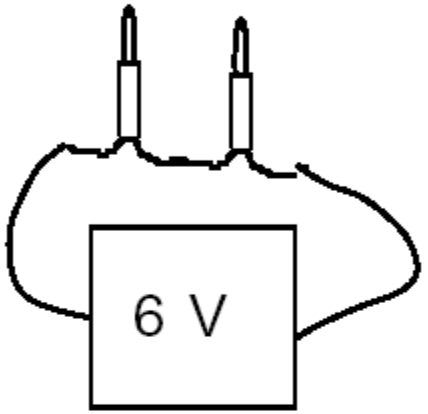
1




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.



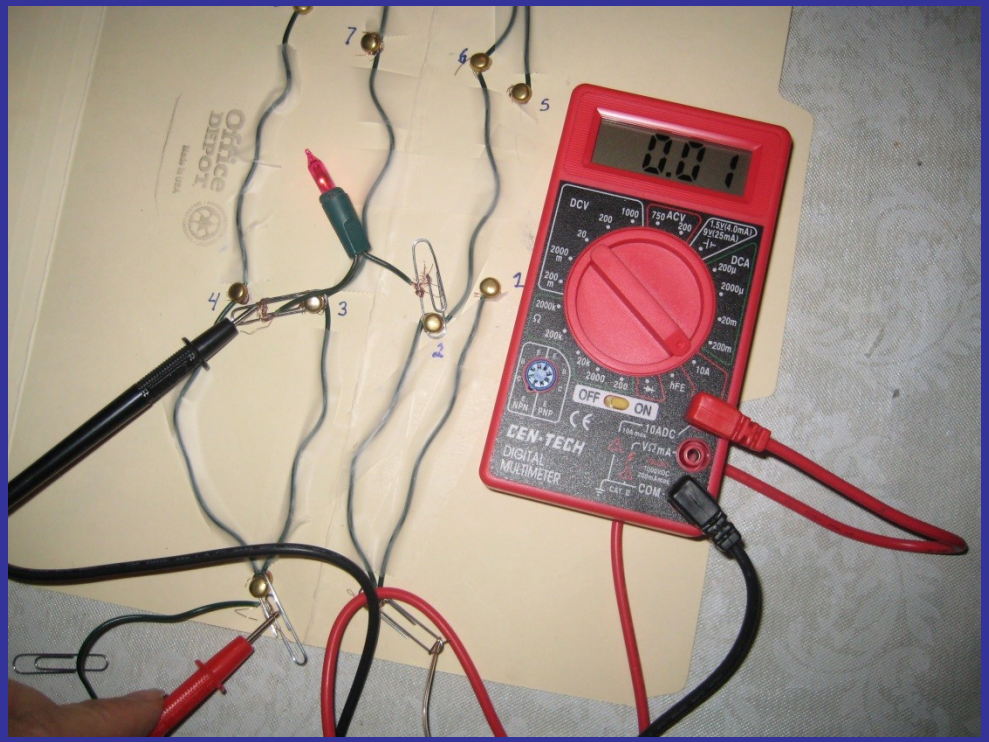
# PARALLEL CIRCUIT

- 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*

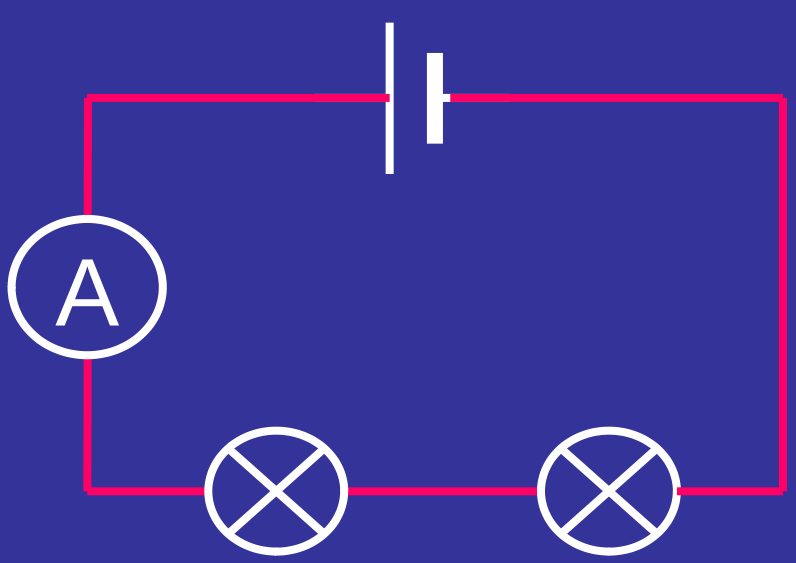
*connected in series in the circuit.*

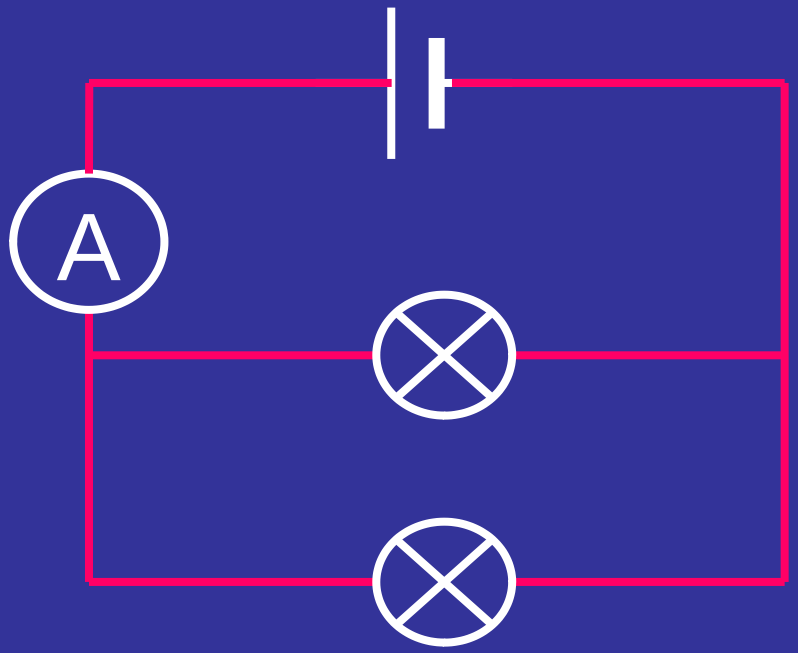





# measuring current

*This is how we draw an ammeter in a circuit.*



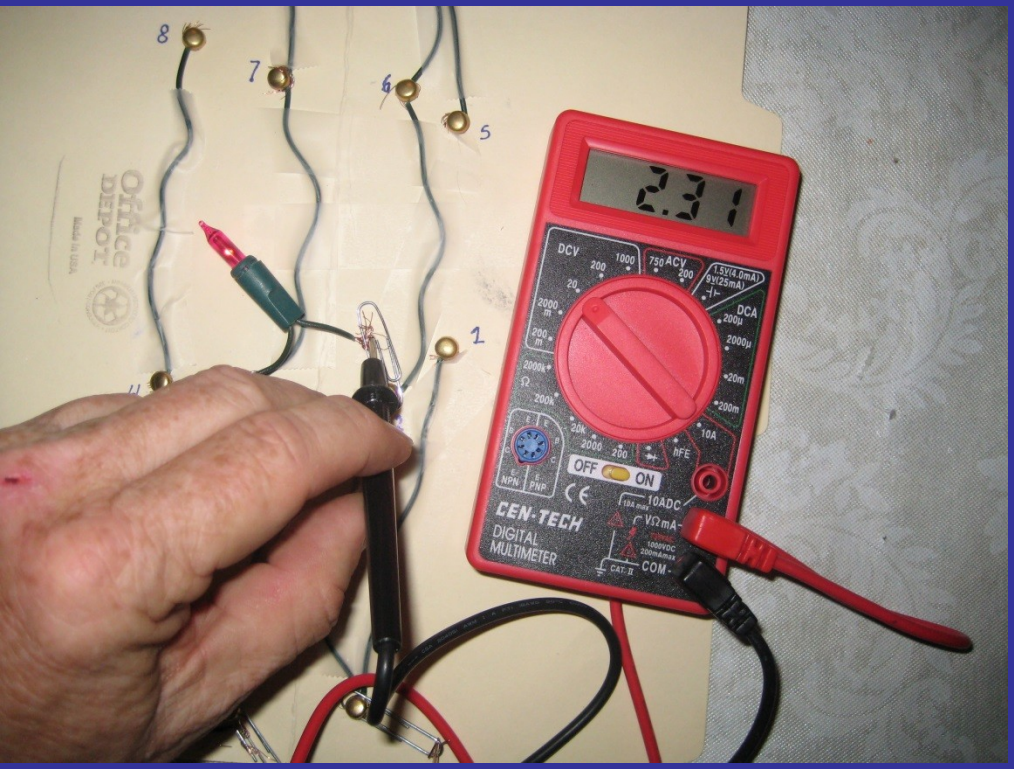




*SERIES CIRCUIT*

*PARALLEL CIRCUIT*

# *measuring voltage*

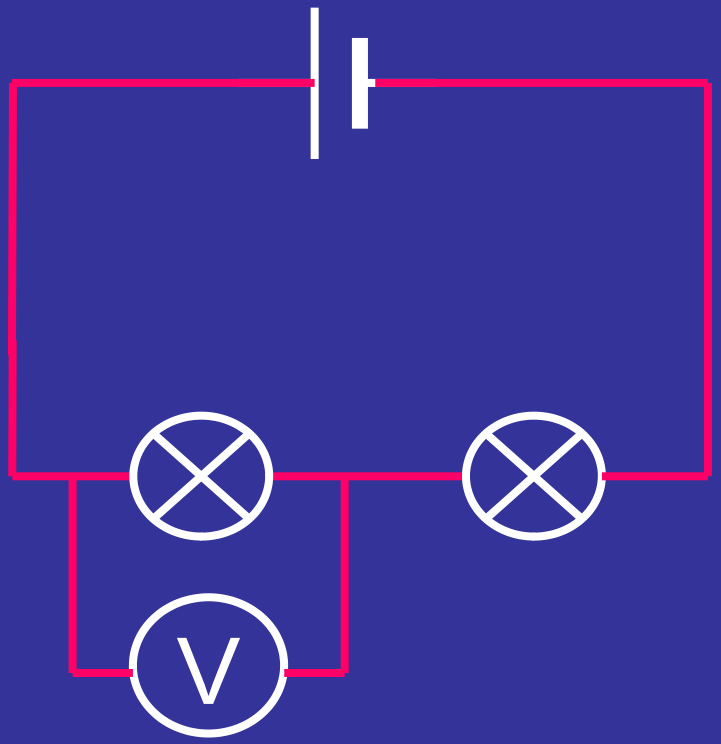
*The 'electrical push' which the cell gives to the current is called the voltage. It is measured in* ***volts*** *(V) on a* ***voltmeter***



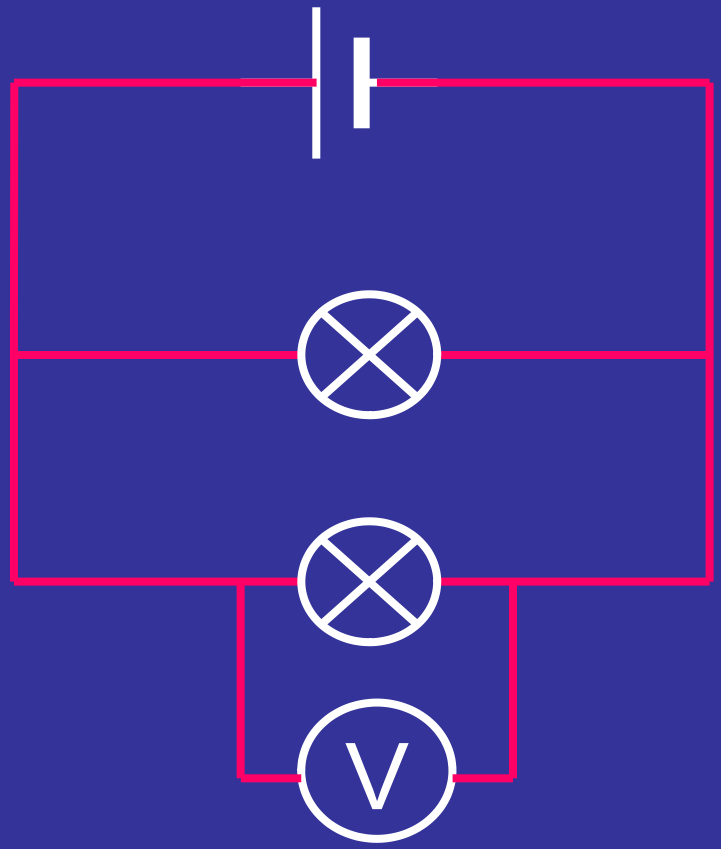



# measuring voltage

*This is how we draw a voltmeter in a circuit.*




SERIES CIRCUIT




PARALLEL CIRCUIT