

# NOTES ON ELECTRICITY

## What is Electricity?

What is Electricity?

<https://www.youtube.com/watch?v=ru032Mfsfig>

What is an amp?

<https://www.youtube.com/watch?v=xr68GxkiWFM>

What is voltage?

<https://www.youtube.com/watch?v=TBt-kxYfync>

Magnetism

[https://www.youtube.com/watch?v=d\\_aTC0iKO68](https://www.youtube.com/watch?v=d_aTC0iKO68)

Long but very good

<https://www.youtube.com/watch?v=VfXGWWyJPmQ>

## Voltage

<https://www.youtube.com/watch?v=TBt-kxYfync>

<https://www.youtube.com/watch?v=z8qfhFXjsrw>

## OHMS Law

<https://www.youtube.com/watch?v=CztiI0re5Eo>

Awesome

<https://www.youtube.com/watch?v=lf0IMDZVwTI>

## Resistance

<https://www.youtube.com/watch?v=NfcgA1axPLo>

## What is Voltage?

<https://www.youtube.com/watch?v=zYS9kdS56l8>

## **Series Circuit**

<https://www.youtube.com/watch?v=W1UH0jzWjtI>

**In a series and Parallel circuits, we can find answers to the following questions:**

- 1. What is the total voltage gain in the circuit?**
- 2. What is the equivalent resistance of the circuit?**
- 3. What is the total current through the circuit?**
- 4. What is the current through each resistor?**
- 5. What is the voltage drop across each resistor?**

<https://www.youtube.com/watch?v=XiHVe8U5PhU>

## Parallel Circuits Calculations

<https://www.youtube.com/watch?v=WT6wbh39MX4>

IN A MATERIAL THAT IS NOT MAGNETIZED,  
THE DOMAINS POINT IN **RANDOM**  
**DIRECTIONS.**

IN A MAGNETIZED MATERIAL ALL OF THE  
DOMAINS ARE ARRANGED IN THE SAME  
DIRECTION.

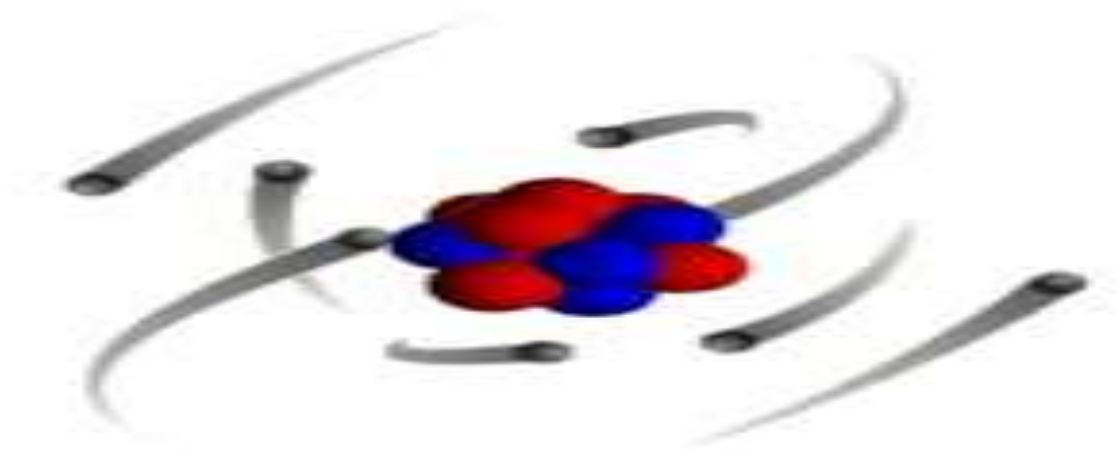
**HANS CHRISTIAN OERSTED** IN 1820  
DISCOVERED THAT MAGNETISM AND  
ELECTRICITY ARE RELATED.

AN ELECTRIC CURRENT FLOWING THROUGH  
A WIRE GIVES RISE TO A MAGNETIC FIELD

WHOSE DIRECTION DEPENDS UPON THE DIRECTION OF THE CURRENT.

THE RELATIONSHIP BETWEEN ELECTRICITY AND MAGNETISM IS CALLED **ELECTROMAGNETISM.**

MATTER CONTAINS PARTICLES CALLED **ELECTRONS AND PROTONS.**



Show this one

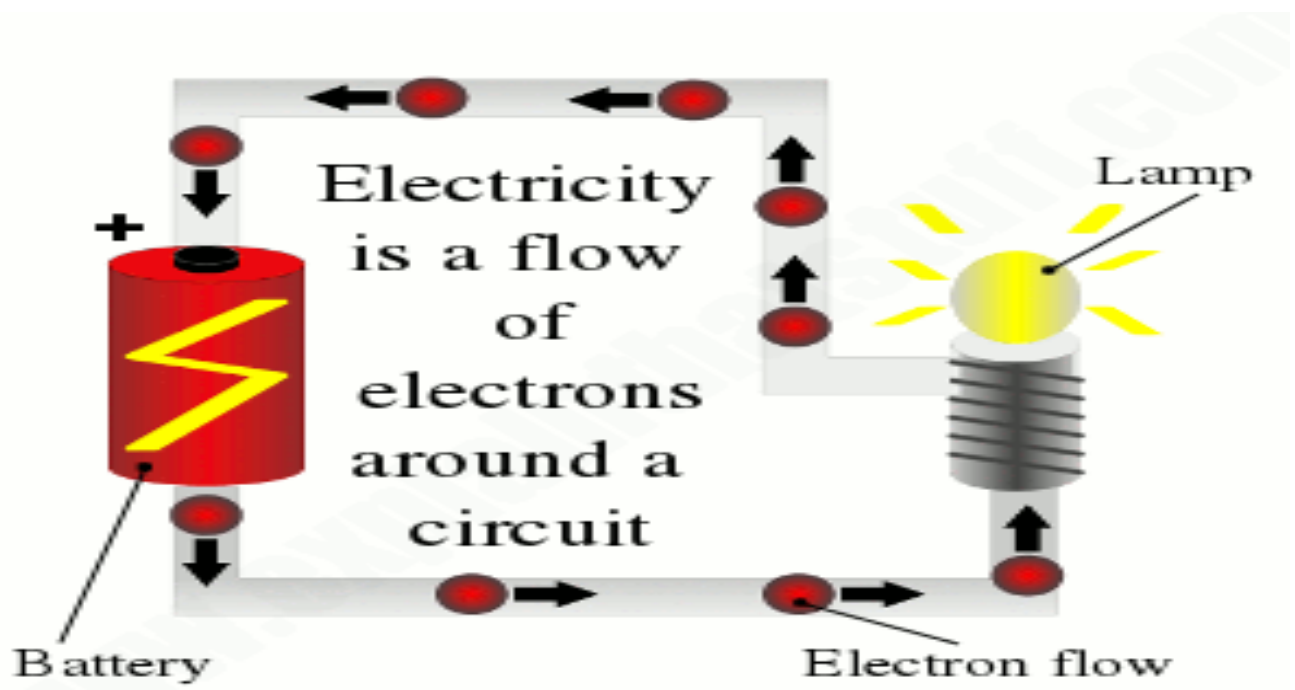
[https://www.youtube.com/watch?v=OGa\\_b26eK2c](https://www.youtube.com/watch?v=OGa_b26eK2c)

**ELECTRONS** AND **PROTONS** HAVE A  
PROPERTY CALLED **ELECTRIC CHARGE**.

ELECTRONS ARE **NEGATIVELY CHARGED**,  
AND PROTONS ARE **POSITIVELY CHARGED**.

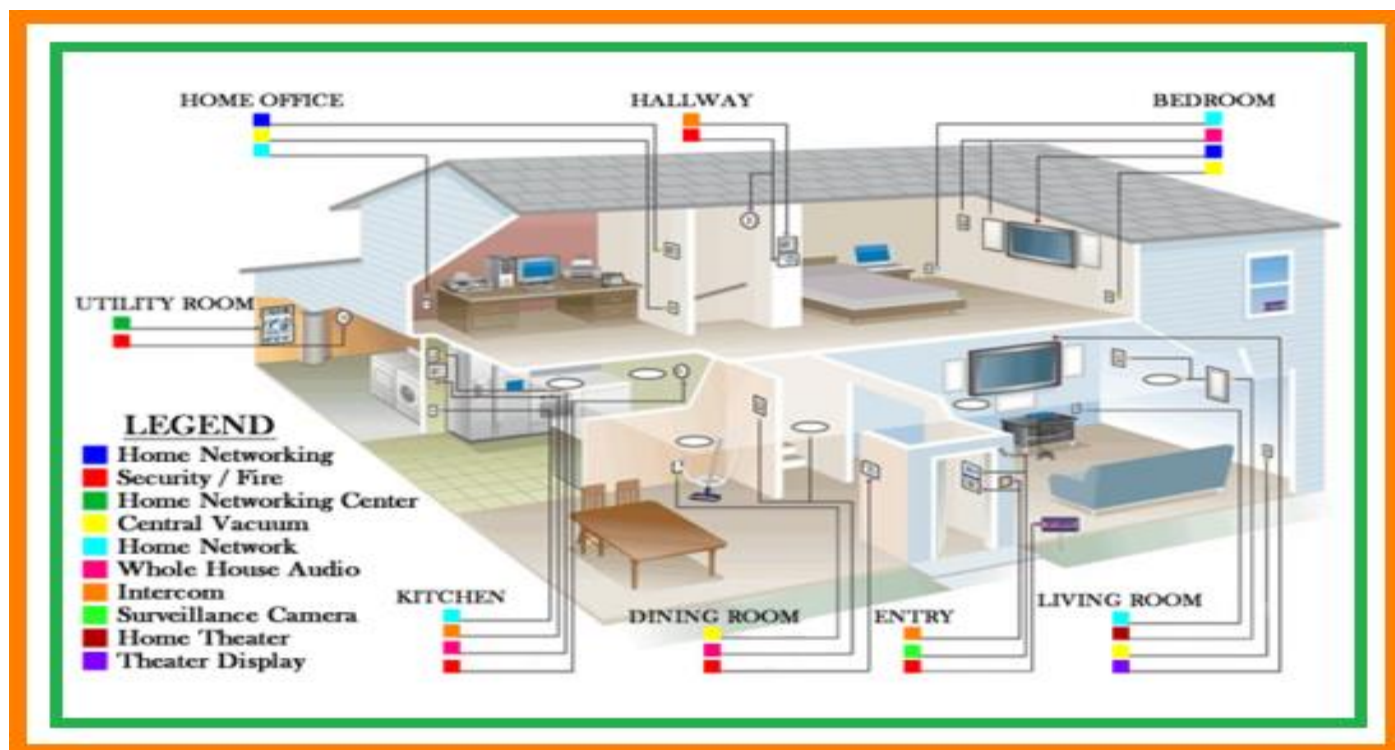
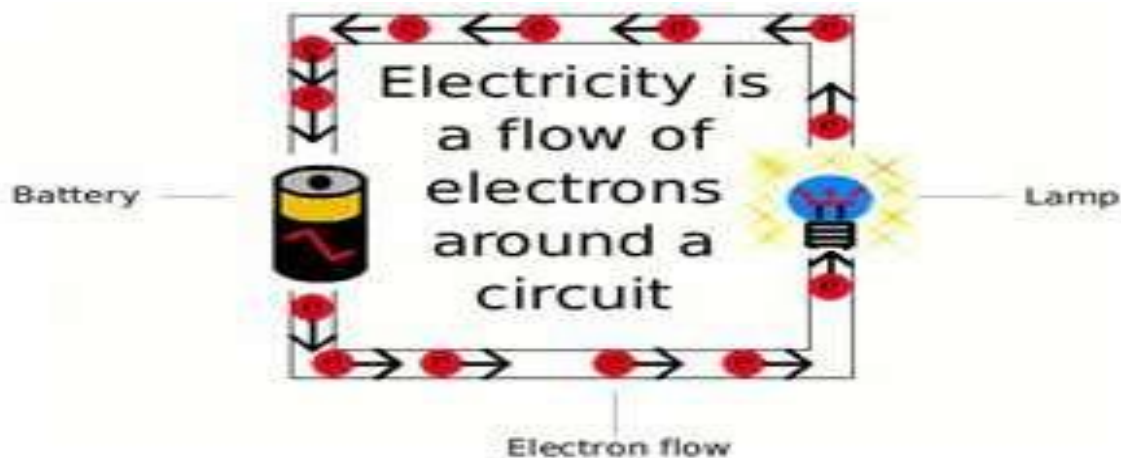
# NOTES ON ELECTRICITY

Electricity is the flow of electrons. It flows through wires called conductors.

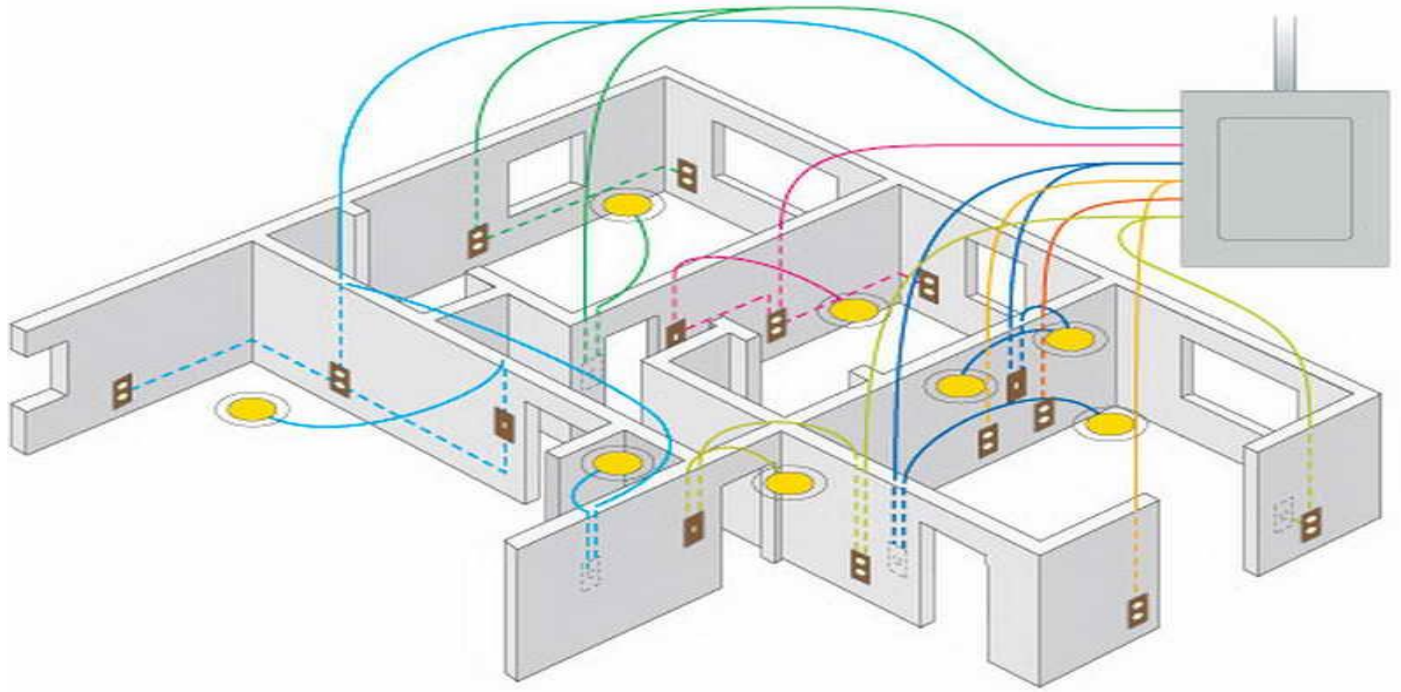


<https://www.youtube.com/watch?v=ru032Mfsfig>

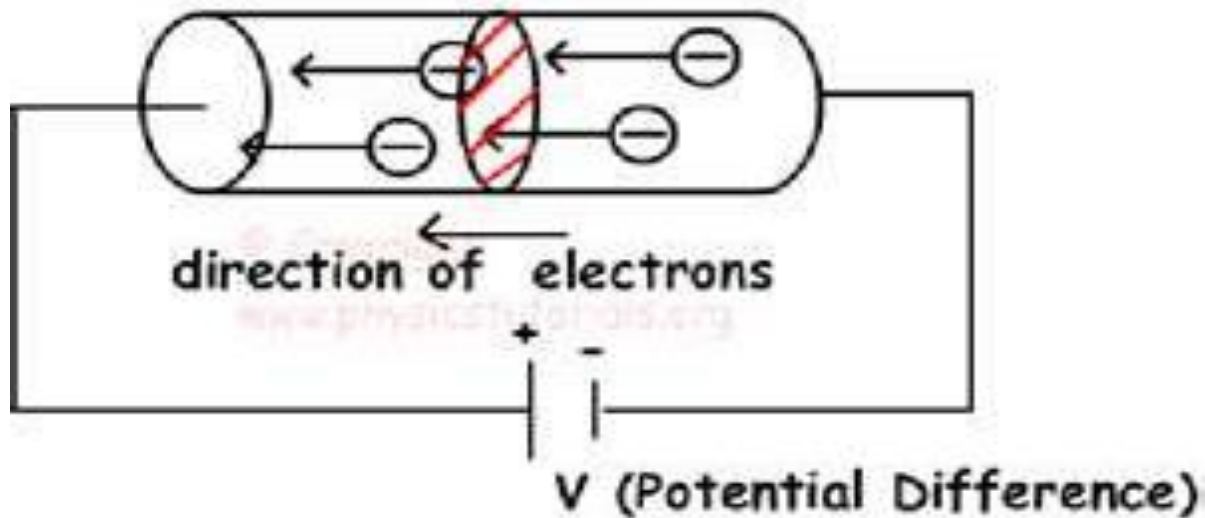
ONCE ELECTRONS ARE **PUSHED** INTO MOVING, THEY CAN BE MADE TO CONTINUE FLOWING, PROVIDING THEY HAVE A **PUSH AND A SOURCE**.











ELECTRONS FLOW FROM THE **NEGATIVE POLE** (anode) TO THE **POSITIVE POLE** (cathode) IN ORDER TO COMPLETE THE CIRCUIT.

# CIRCUITS

AN **ELECTRICAL CIRCUIT** IS A CONDUCTING PATH, EXTERNAL TO THE BATTERY, WHICH ALLOWS CHARGE TO FLOW FROM ONE TERMINAL TO THE OTHER.

<https://www.youtube.com/watch?v=RHpo4wKo8pQ>

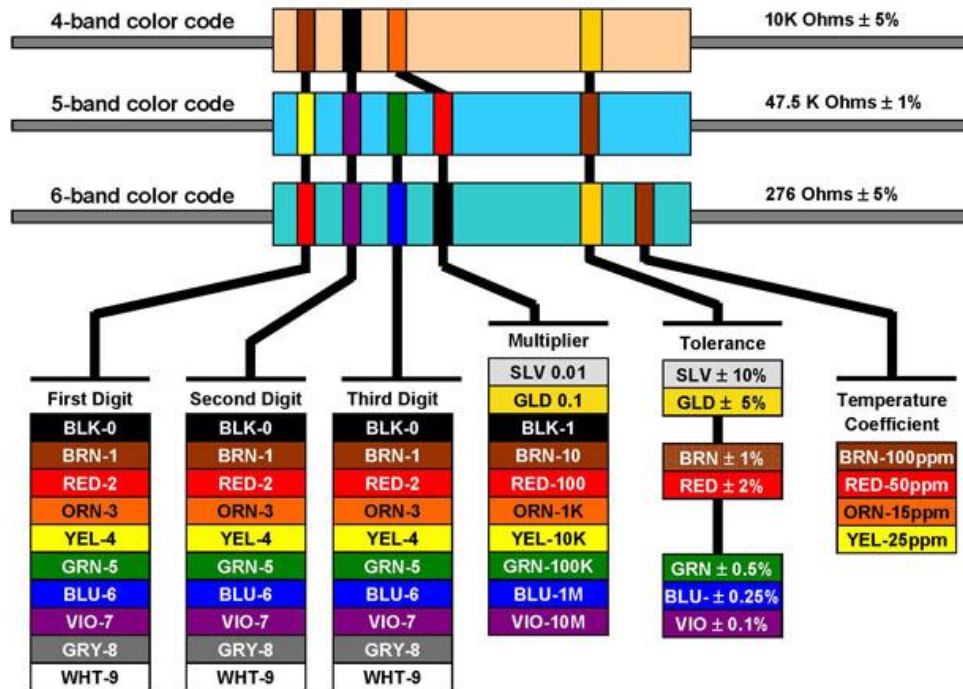
**AN ELECTRICAL CIRCUIT IS A CLOSED LOOP WITH THE FOLLOWING:**

- 1. A POWER SOURCE**
- 2. CONDUCTOR (wire)**
- 3. LOAD/RESISTOR**
- 4. CONTROL SWITCH**
- 5. GROUND**
- 6. FUSE (**PROTECTIVE DEVICE**)**

Show this one

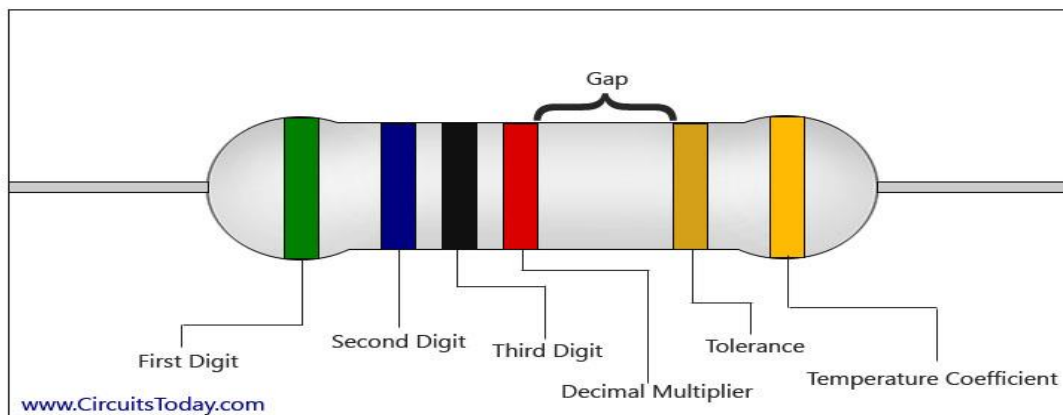
[https://www.youtube.com/watch?v=OGa\\_b26eK2c](https://www.youtube.com/watch?v=OGa_b26eK2c)

# Resistor Color Code



	Black	0
	Brown	1
	Red	2
	Orange	3
	Yellow	4
	Green	5
	Blue	6
	Violet	7
	Grey	8
	White	9

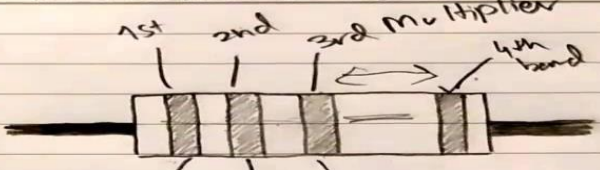
### Resistance Color Code



RookieElectronics.com

DATE 15 09 2012

1st 2nd 3rd Multiplier 4th band




2 7 1000

$27 \times 1000$

$27000 \Omega$

27K

Colour	Digit	Multiplier
Black	0	1
Brown	1	10
Red	2	100
orange	3	1K
yellow	4	10K
Green	5	100K
Blue	6	1M
violet	7	10M
Grey	8	
white	9	




**4 Band Resistors**

BAND 1	BAND 2	BAND 3 MULTIPLIER	BAND 4 TOLERANCE
0 BLACK	0 BLACK	BLACK × 1	NONE + or - 20%
1 BROWN	1 BROWN	BROWN × 10	SILVER + or - 10%
2 RED	2 RED	RED × 100	GOLD + or - 5%
3 ORANGE	3 ORANGE	ORANGE × 1,000	RED + or - 2%
4 YELLOW	4 YELLOW	YELLOW × 10,000	BROWN + or - 1%
5 GREEN	5 GREEN	GREEN × 100,000	
6 BLUE	6 BLUE	BLUE × 1,000,000	
7 VIOLET	7 VIOLET	SILVER × .01	
8 GRAY	8 GRAY	GOLD × .1	
9 WHITE	9 WHITE		

Example: Yellow - Violet - Brown - Gold


4 + 7 × 10 = 470 Ohms 5% Tolerance

### How to Read Resistor Color Codes

6-Band  = 274 Ω ± 2%, 250 ppm/K

Color	1st Digit	2nd Digit	3rd Digit	Multiplier	Tolerance	Temperature Coefficient
Black	0	0	0	1 Ω		250 ppm/K
Brown	1	1	1	10 Ω	± 1%	100 ppm/K
Red	2	2	2	100 Ω	± 2%	50 ppm/K
Orange	3	3	3	1k Ω		15 ppm/K
Yellow	4	4	4	10k Ω		25 ppm/K
Green	5	5	5	100k Ω	± 0.5%	20 ppm/K
Blue	6	6	6	1M Ω	± 0.25%	10 ppm/K
Violet	7	7	7		± 0.1%	5 ppm/K
Grey	8	8	8			1 ppm/K
White	9	9	9			
Gold				0.1 Ω	± 5%	
Silver				0.01 Ω	± 10%	

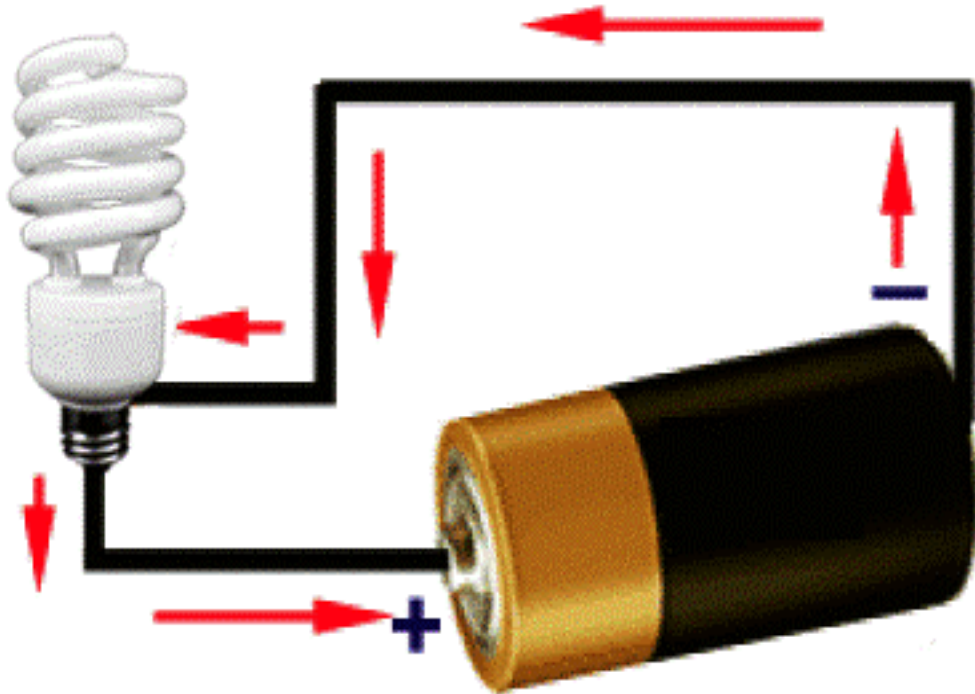
4-Band  = 1,200 kΩ ± 5%

5-Band  = 10,000 Ω ± 1%

THE SOURCE OF ELECTRIC ENERGY COMES FROM ELECTRIC CURRENT.

IN **SOLIDS**, THE FLOWING CHARGES ARE CALLED **ELECTRONS**. IN **LIQUIDS**, THE FLOWING CHARGES ARE **IONS** WHICH CAN BE POSITIVE OR NEGATIVE.

A WIRE MADE OF SUITABLE CONDUCTING MATERIAL FORMS THE **PATH**.



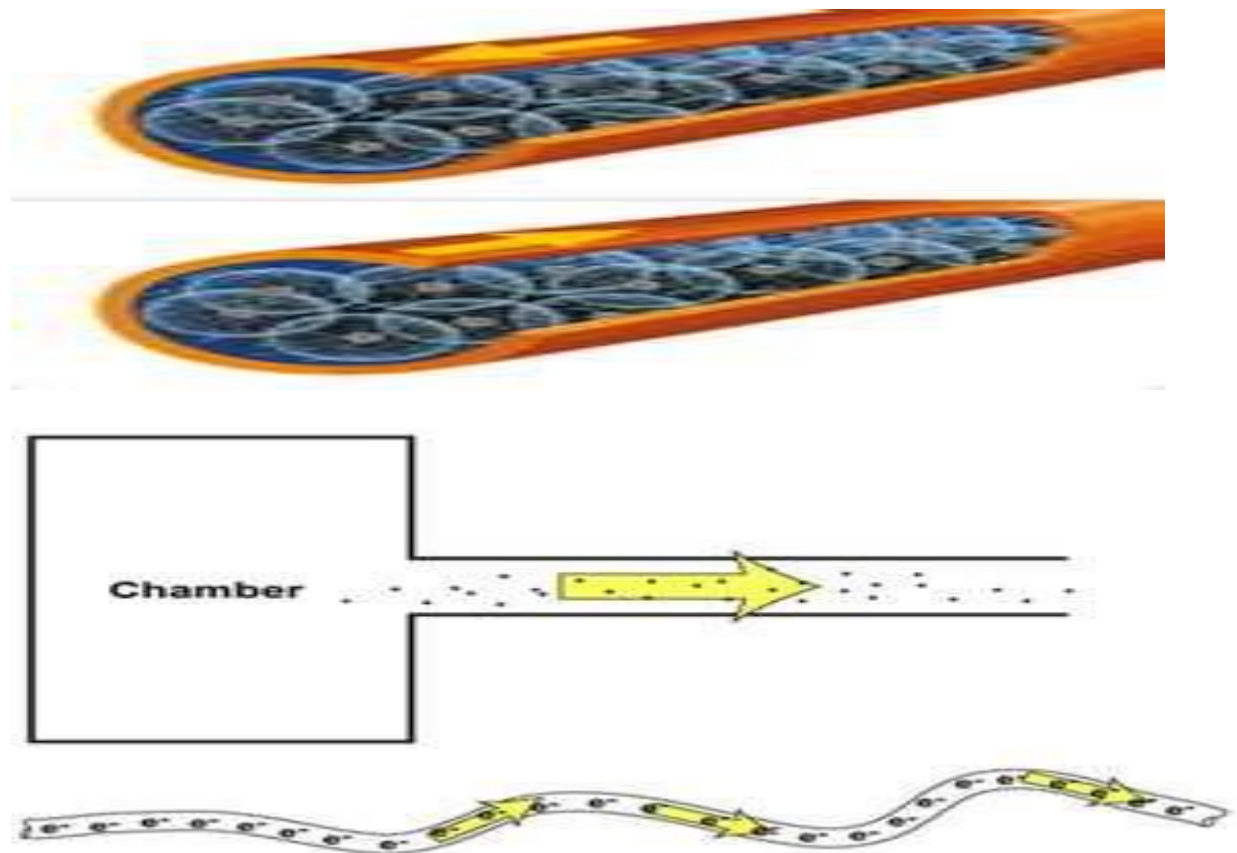
THE BEST CONDUCTING WIRE OF  
ELECTRICITY OF ALL THE METALS ARE  
**COPPER**, SILVER, ALUMINUM, GOLD, AND  
PLATINUM.

A DEVICE THAT PUMPS ELECTRONS FROM  
ONE OBJECT TO ANOTHER IS CALLED **THE**  
**SOURCE**.



## RESISTANCE OF ELECTRON FLOW

A **NARROW** WIRE HAS MORE RESISTANCE THAN A **WIDE** WIRE.



OPPOSITION TO THE FLOW OF ELECTRICITY IS **RESISTANCE**.

THE SYMBOL FOR RESISTANCE IS THE  
LETTER “**R**.” THE UNIT OF RESISTANCE IS  
THE ohm ( **$\Omega$** )

WIRES THAT MAKE GOOD CONDUCTORS,  
SUCH AS COPPER, HAVE A **LOW**  
**RESISTANCE**.

WIRES MADE OF POOR CONDUCTORS,  
SUCH AS IRON, HAVE A **HIGH RESISTANCE**.

THE RESISTANCE OF A WIRE DEPENDS  
UPON ITS **THICKNESS, LENGTH, AND**  
**TEMPERATURE**.

ELECTRONS MOVE MORE EASILY THROUGH  
A **THICK WIRE** THAN A THIN WIRE.

IN A THIN WIRE THERE IS LESS ROOM FOR  
THE ELECTRONS TO FLOW.

A THIN WIRE OFFERS MORE RESISTANCE TO  
AN ELECTRIC CURRENT THAN A THICK WIRE.

A **LONGER WIRE** OFFERS **MORE  
RESISTANCE** THAN A SHORT WIRE BECAUSE  
THE ELECTRONS HAVE A GREATER  
DISTANCE TO TRAVEL.

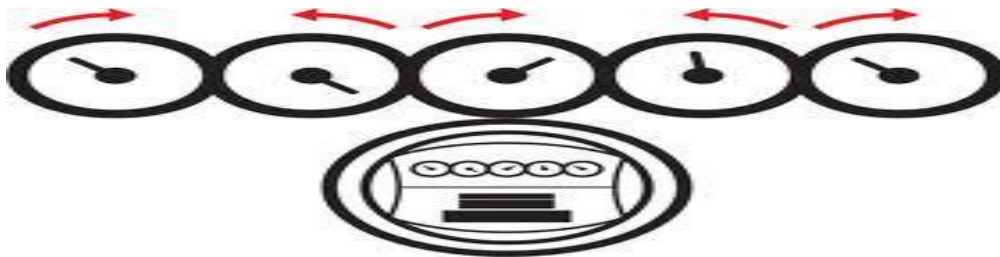
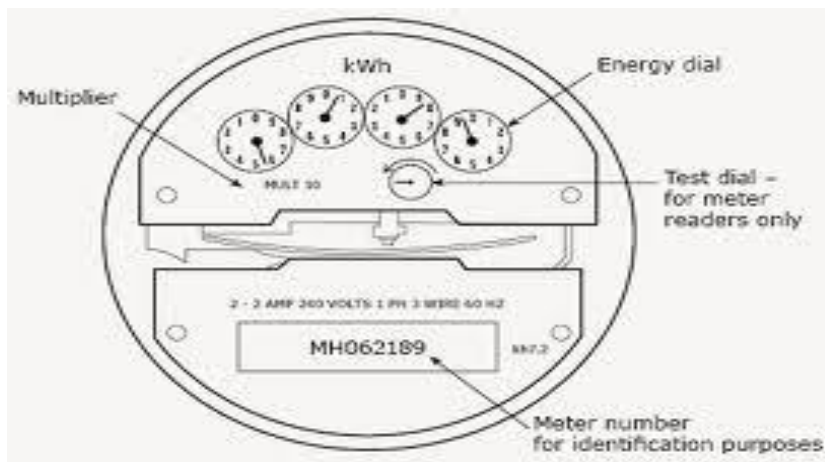
AS THE LENGTH OF THE WIRE INCREASE,  
THE RESISTANCE INCREASES.

**TEMPERATURE** AFFECTS THE RESISTANCE BECAUSE THE ABILITY OF A MATERIAL TO CONDUCT ELECTRICITY DEPENDS TO A CERTAIN EXTENT UPON TEMPERATURE.

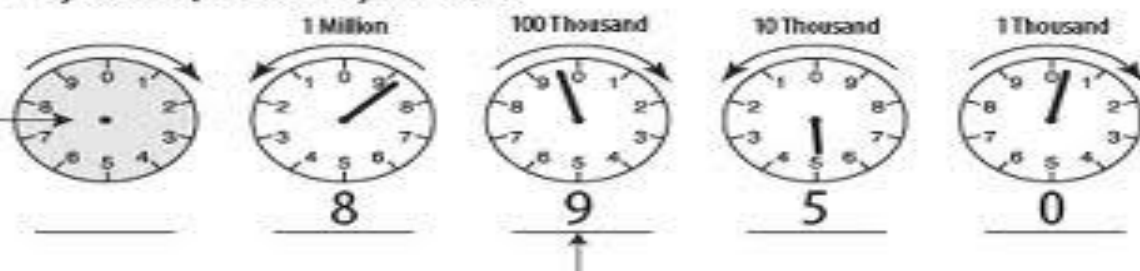
THE FLOW OF ELECTRONS THROUGH A WIRE IS CALLED **ELECTRIC CURRENT**.

**CURRENT** IS MEASURED ACCORDING TO HOW MANY **ELECTRONS** PASS A GIVEN POINT DURING EACH SECOND.

# ELECTRIC METER



May not be present on your meter



If the dial hand is between two numbers, please record the lower number.  
If the dial hand is between 9 and 0, then 9 is the lower number.



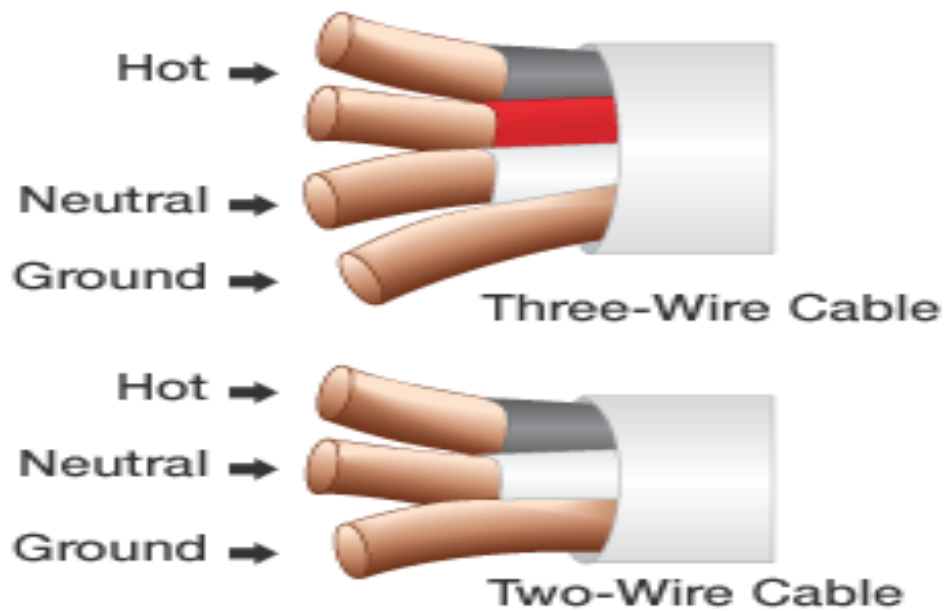
## ELECTRIC METER BASE



THE WHITE WIRE IS **NEUTRAL**.

THE **BLACK WIRE IS HOT** BECAUSE IT HAS TOO MUCH CURRENT FLOWING THROUGH IT.





THE HIGHER THE ELECTRIC CURRENT IN A WIRE THE MORE ELECTRONS ARE PASSING THROUGH.

THE SYMBOL FOR **CURRENT** IS THE LETTER  
“**I**” “I” **STANDS** FOR "INTENSITÉ DE  
COURANT" (FRENCH),

OR **CURRENT INTENSITY**. ANDRÉ-MARIE  
AMPERE, WHO DISCOVERED  
ELECTRICAL **CURRENT**, USED THIS  
SYMBOL.

WHY ELECTRIC **CURRENT** IS **DENOTED** BY  
“I” NOT C?

IT DENOTES THE '**INTENSITY**' OF THE  
FLOW OF ELECTRONS THROUGH A  
CLOSED PATH.

THE UNIT USED TO MEASURE CURRENT IS  
THE **AMPERE (A)** OR **AMP**.

THE 'I' SYMBOL WAS USED BY ANDRÉ-MARIE AMPÈRE THE UNIT OF ELECTRIC **CURRENT** IS NAMED.

**ONE AMPERE** IS DEFINED AS THE AMOUNT OF CURRENT THAT FLOWS PAST A GIVEN POINT PER SECOND.

## **OHMS LAW**

OHM'S LAW STATES THAT: "THE CURRENT IN A WIRE IS EQUAL TO THE VOLTAGE DIVIDED BY THE RESISTANCE."

<https://www.youtube.com/watch?v=If0lMDZVwTI>

CURRENT = **VOLTAGE / RESISTANCE**

OR

$$I = V/R$$

AMPERES = **VOLTS / OHMS**

**VOLTAGE IS THE MEASURE OF THE ENERGY  
AVAILABLE TO MOVE ELECTRONS.**

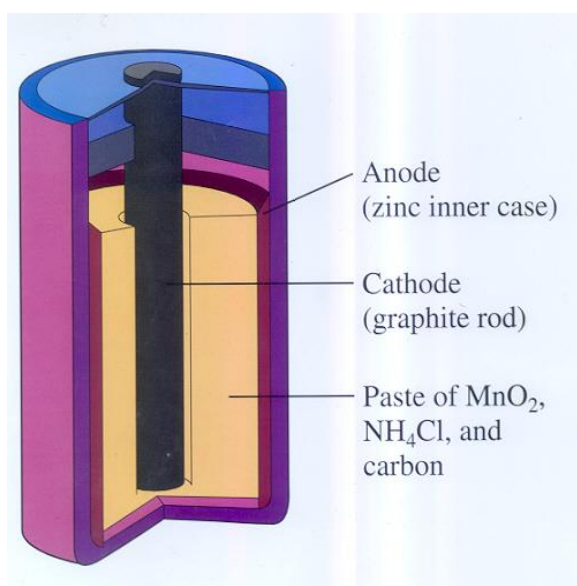
RESISTANCE IS THE OPPOSITION TO THE  
FLOW OF ELECTRICITY.

AMPERES IS THE UNIT USED TO MEASURE  
ELECTRIC CURRENT.

**OHMS** IS THE UNIT OF RESISTANCE.

IN ORDER TO PRODUCE ELECTRICITY THERE MUST BE A SOURCE OF ELECTRONS.

AN **ELECTRO-CHEMICAL CELL** PROVIDES A STEADY SUPPLY OF ELECTRIC CURRENT.



IN AN ELECTROCHEMICAL CELL, CHEMICAL ENERGY PRODUCED BY A CHEMICAL REACTION IS CHANGED INTO **ELECTRIC ENERGY**.



Show this one

<https://www.youtube.com/watch?v=UEPJXSXw7HA>

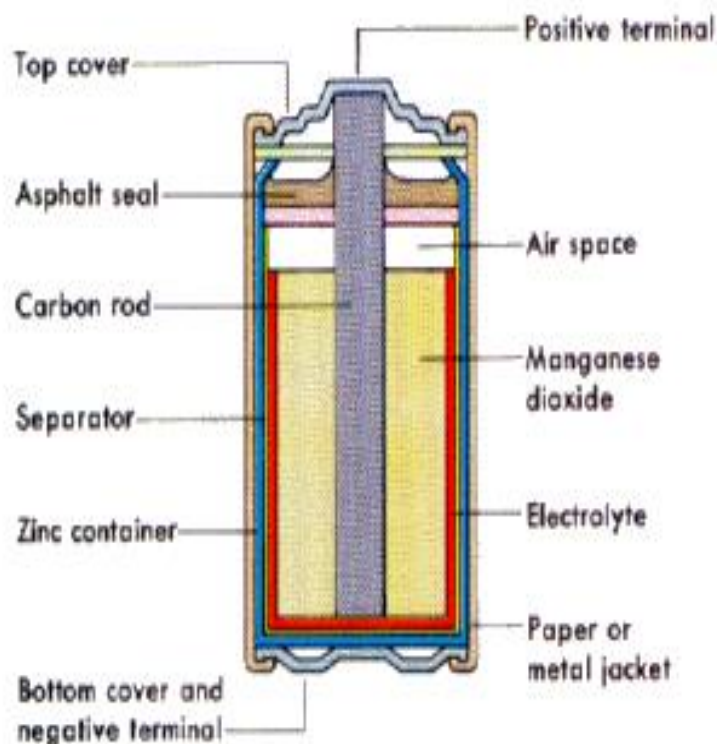
<https://www.youtube.com/watch?v=OLhbzcQkeHo>

<https://www.youtube.com/watch?v=9OVtk6G2TnQ>

## DRY CELL

IN A DRY CELL, THE REACTION THAT RELEASES ELECTRONS IS BETWEEN THE ELECTROLYTE PASTE AND THE ZINC.

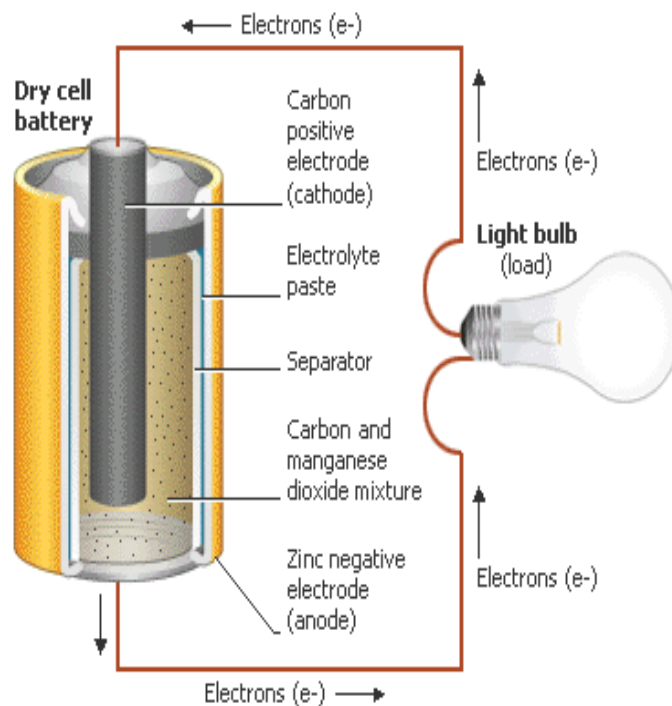




THE ELECTROLYTE PASTE IS THE CHEMICALS  
IN THE CELL THAT PRODUCES THE FREE  
ELECTRONS.







THE ELECTROLYTE PASTE IS MADE OF **ZINC CHLORIDE AND AMMONIUM CHLORIDE**.



ATTACHED TO THE ZINC IS THE NEGATIVE TERMINAL (**ANODE**) THAT PICKS UP THE ELECTRONS.

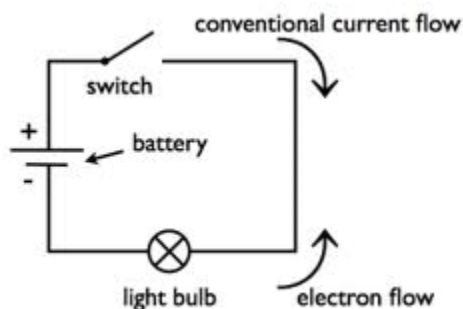
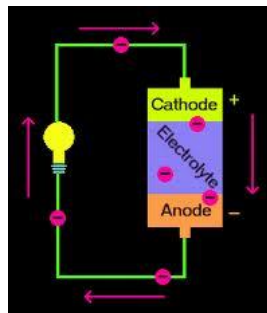
ATTACHED TO THE CARBON ROD IS A POSITIVE TERMINAL (**CATHODE**) THAT HAS A SHORTAGE OF ELECTRONS.

## HOW TO DEFINE ANODE AND CATHODE

### DEFINITION:

THE **ANODE (-)** OF A DEVICE IS THE TERMINAL WHERE CURRENT FLOWS **OUT**.

THE **CATHODE (+)** OF A DEVICE IS THE TERMINAL WHERE CURRENT FLOWS **IN** FROM THE OUTSIDE.



THE ELECTRODE TOWARDS WHICH ELECTRONS TRAVEL IS CALLED THE **CATHODE**, AND THE ELECTRODE FROM WHICH ELECTRONS TRAVEL IS CALLED THE **ANODE**.

ANODES AND CATHODES TOGETHER ARE CALLED **ELECTRODES**.

A DRY-CELL BATTERY IS ESSENTIALLY COMPRISED OF A METAL ELECTRODE OR GRAPHITE ROD (ELEMENTAL CARBON) SURROUNDED BY A **MOIST ELECTROLYTE** PASTE ENCLOSED IN A METAL CYLINDER.

IN THE MOST COMMON TYPE OF DRY CELL BATTERY, THE CATHODE IS COMPOSED OF

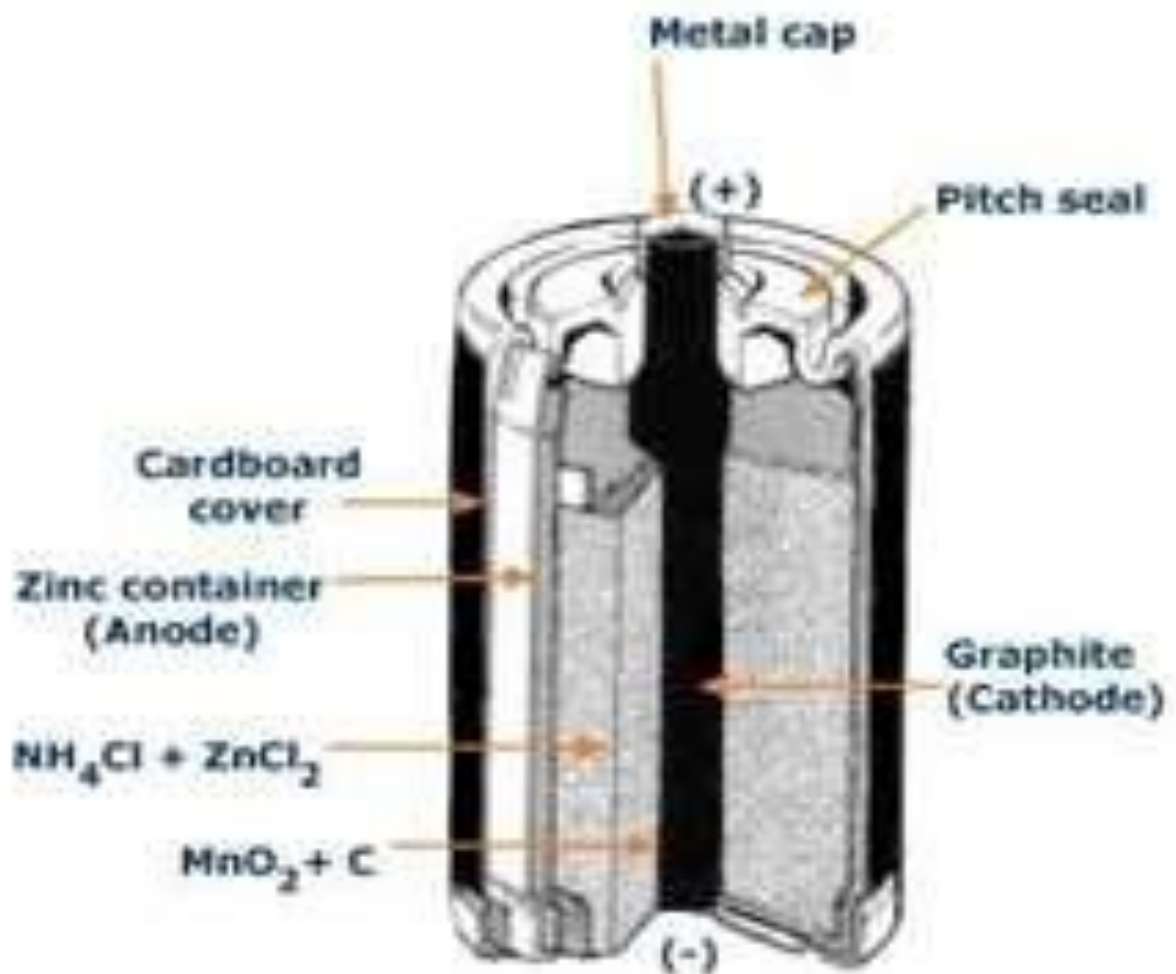
GRAPHITE AND THE ANODE IS COMPOSED OF ZINC.

IN AN ACIDIC DRY CELL, THE REDUCTION REACTION OCCURS WITHIN THE MOIST PASTE COMPRISED OF AMMONIUM CHLORIDE ( $\text{NH}_4 \text{Cl}$ ) AND MANGANESE DIOXIDE ( $\text{MnO}_2$ )

THIS DRY CELL PRODUCES ABOUT 1.5 VOLTS, THOUGH A HIGHER VOLTAGE CAN BE PRODUCED BY LINKING BATTERIES IN SERIES. IN THE ALKALINE BATTERY THE AMMONIUM CHLORIDE IS REPLACED BY KOH OR NaOH.

OTHER TYPES OF DRY CELL BATTERIES ARE THE SILVER BATTERY IN WHICH SILVER

METAL SERVES AS A CATHODE TO SUPPORT THE REDUCTION OF SILVER OXIDE ( $\text{Ag}_2\text{O}$ ) AND THE OXIDATION OF ZINC (ANODE) IN A BASIC MEDIUM. THE TYPE OF BATTERY COMMONLY USED FOR CALCULATORS IS THE MERCURY CELL. IN THIS TYPE OF BATTERY,  $\text{HgO}$  SERVES AS THE OXIDIZING AGENT (CATHODE) IN A BASIC MEDIUM, WHILE ZINC METAL SERVES AS THE ANODE. ANOTHER TYPE OF BATTERY IS THE NICKEL/CADMIUM BATTERY, IN WHICH CADMIUM METAL SERVES AS THE ANODE AND NICKEL OXIDE SERVES AS THE CATHODE IN AN ALKALINE MEDIUM. UNLIKE THE OTHER TYPES OF DRY CELLS DESCRIBED ABOVE, THE NICKEL/CADMIUM CELL CAN BE RECHARGED LIKE THE LEAD-ACID BATTERY.



THE DIFFERENCE IN NUMBER OF ELECTRONS BETWEEN THE TWO TERMINALS CAUSES AN ELECTRON PRESSURE THAT PUMPS THE ELECTRONS.

IF A WIRE IS CONNECTED TO EACH TERMINAL, THE ELECTRONS WILL FLOW

FROM THE **NEGATIVE TERMINAL** THROUGH  
THE WIRE TO THE **POSITIVE TERMINAL**.

A SERIES OF DRY CELL CONNECTED TO ONE  
ANOTHER IS CALLED A **BATTERY**.

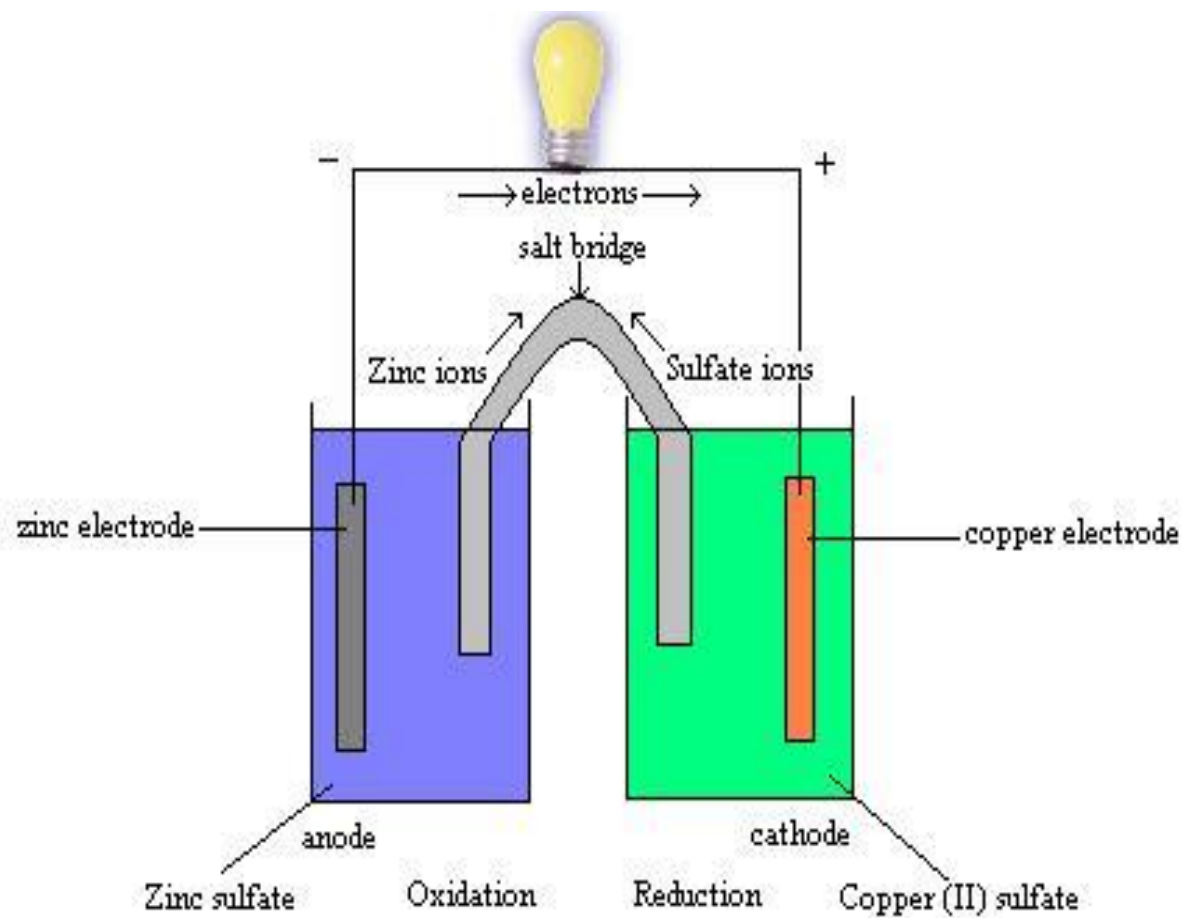
### **WET CELL**

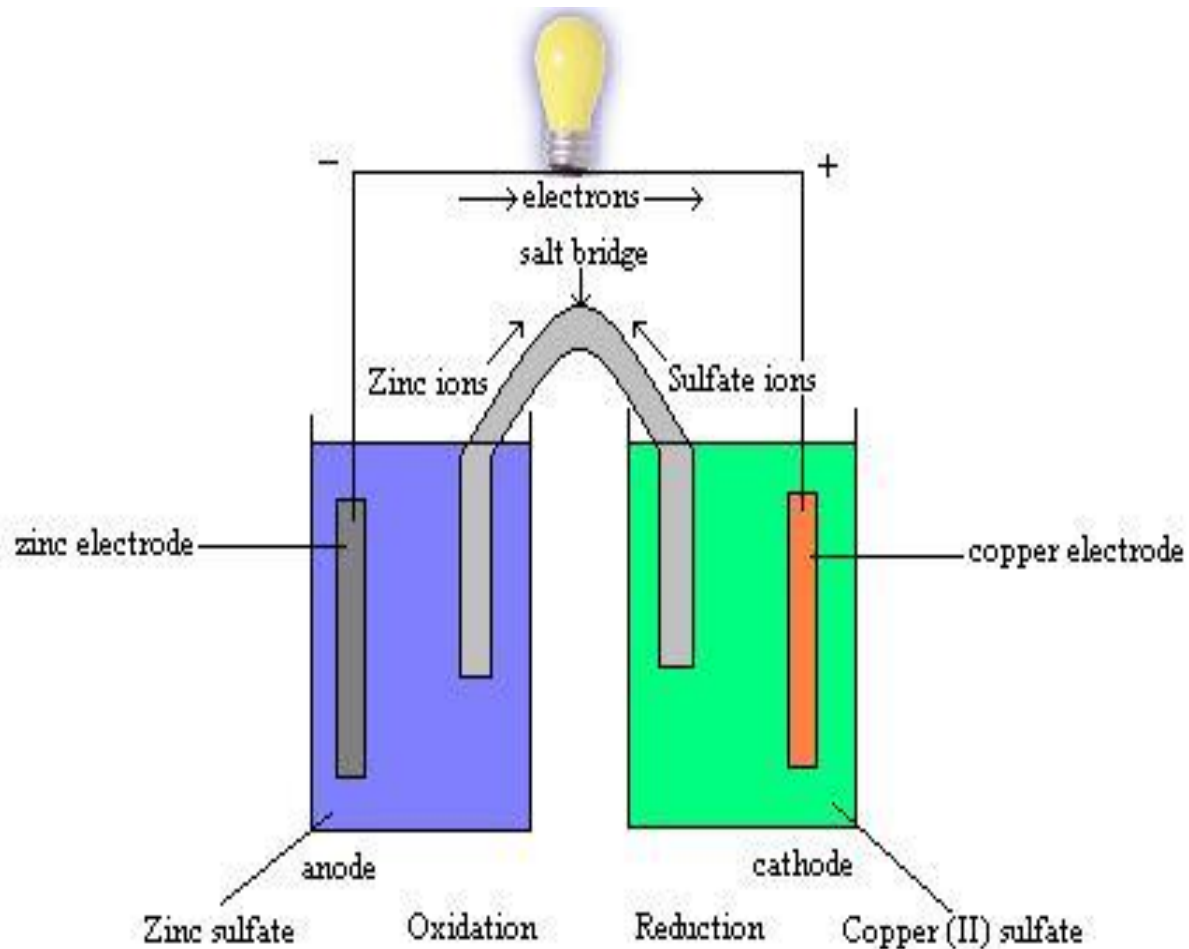
ANOTHER TYPE OF **ELECTRO-CHEMICAL**  
CELL IS A **WET CELL OR VOLTAIC CELL**.





IN A WET CELL TWO DIFFERENT METAL PLATES CALLED **ELECTRODES** ARE PLACED IN A CONDUCTING LIQUID CALLED AN **ELECTROLYTE**.

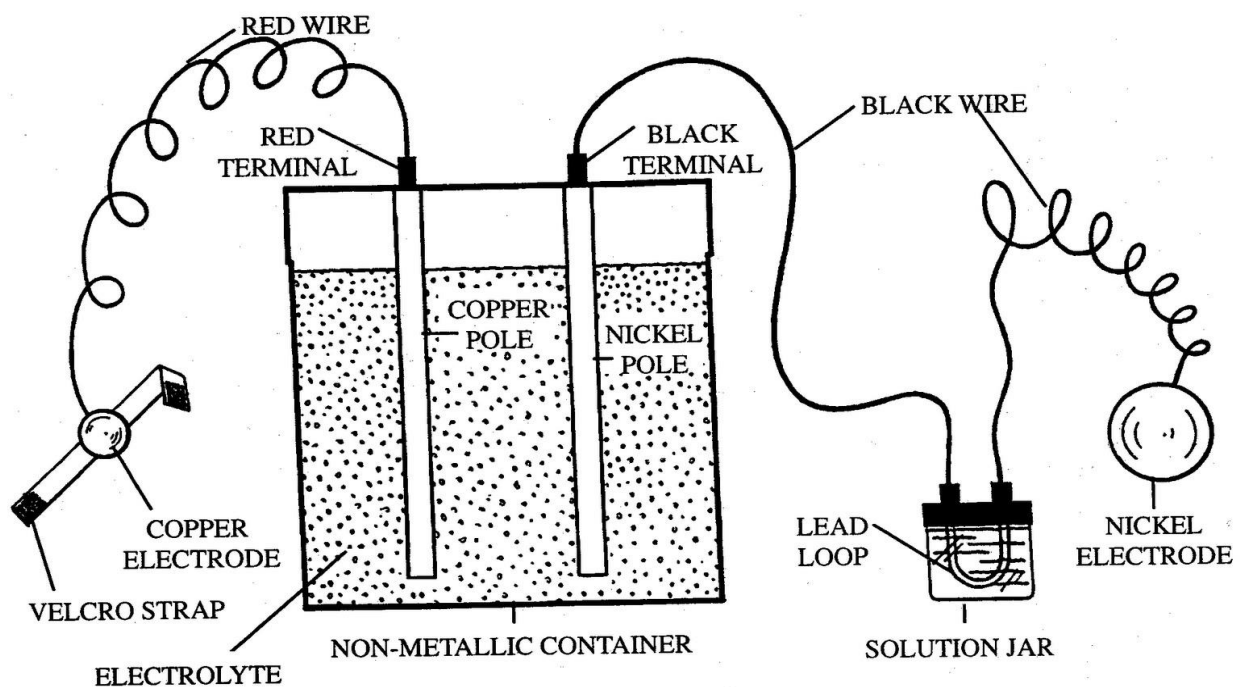




IN MANY WET CELLS THE ELECTRODES ARE MADE OF **ZINC** AND **COPPER**.

THE **ELECTROLYTE** IS HYDROCHLORIC ACID.  
(HCl)

AS THE ZINC REACTS WITH THE HYDROCHLORIC ACID, EACH ZINC ATOM RELEASES TWO ELECTRONS.



**FIGURE 1: WET CELL BATTERY (SHORT-POLE TYPE)**

AN EXCESS OF ELECTRONS BUILDS UP AT ZINC ELECTRODES. ONCE AGAIN ELECTRONS PRESSURE PUSHES THE ELECTRONS FROM THE NEGATIVE ZINC ELECTRODE TO THE POSITIVE COPPER ELECTRODE.

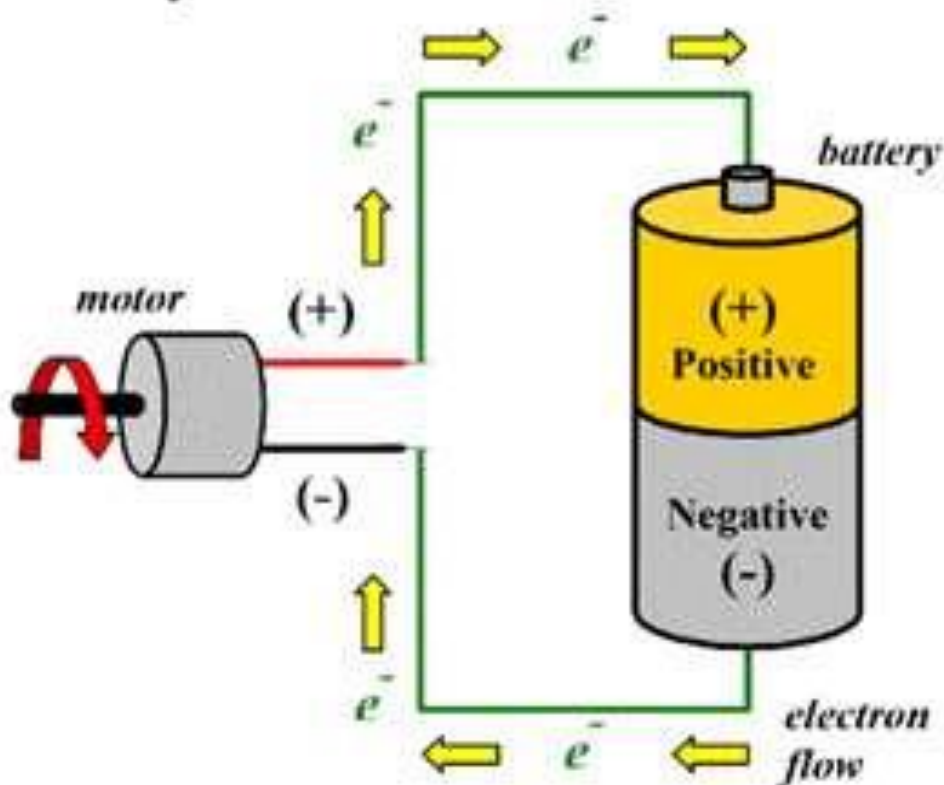
A WIRE CONNECTING THE TWO  
ELECTRODES PROVIDES A PATHWAY FOR A  
STEADY FLOW OF ELECTRIC CURRENT

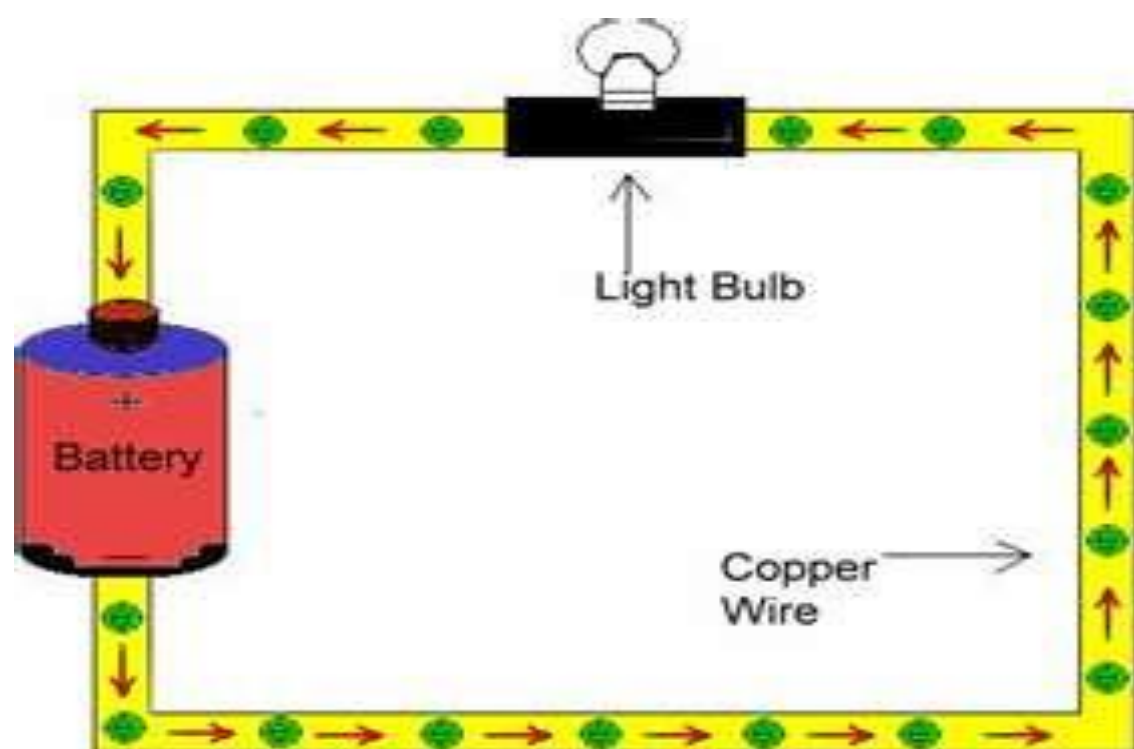


# DIRECTION CURRENT

WHEN ELECTRONS ALWAYS FLOW IN THE SAME DIRECTION, THE CURRENT IS CALLED **DIRECT CURRENT**, OR DC.

Battery Circuit





**THE CURRENT IS A DRY CELL, BATTERIES,  
AND THERMOCOUPLES**

**THE THERMOCOUPLES IS A DEVICE THAT  
CHANGES HEAT ENERGY INTO ELECTRIC  
ENERGY.**

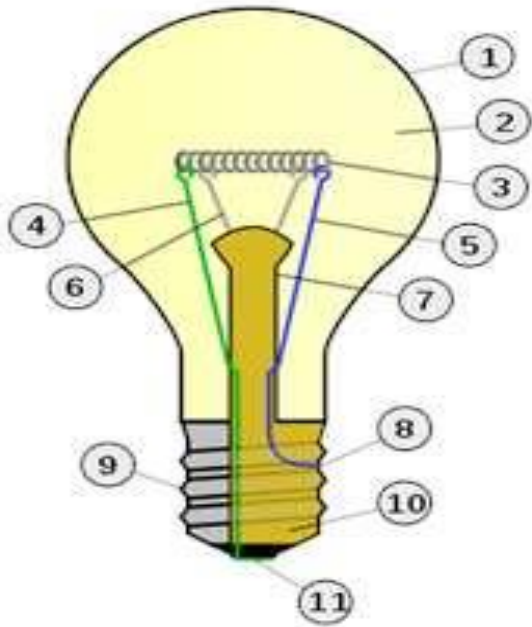
THERMOCOUPLES ARE USED AS  
THERMOMETERS IN CARS TO SHOW  
ENGINE TEMPERATURE.

WHEN ELECTRONS REVERSE THEIR  
DIRECTION REGULARLY ATR A RATE OF 60  
TIMES PER SECOND, THE CURRENT IS  
CALLED ALTERNATING CURRENT, OR AC.

BULBS

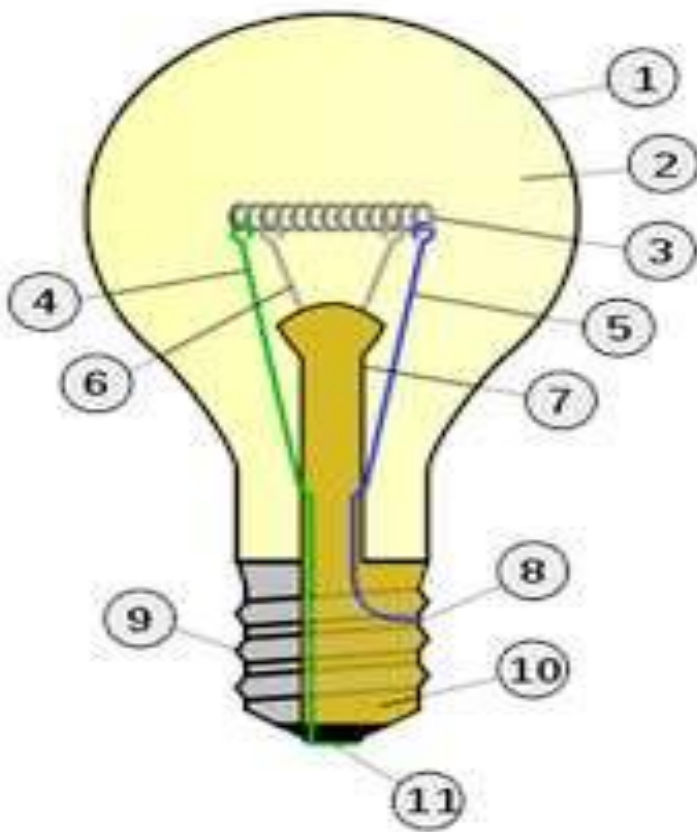


# WHAT IS A LIGHT BULB?



## PARTS OF A LIGHT BULB

1. Outline of Glass bulb
2. Low pressure inert gas (argon, nitrogen, krypton, xenon)
3. Tungsten filament
4. Contact wire (goes out of stem)
5. Contact wire (goes into stem)
6. Support wires (one end embedded in stem; conduct no current)
7. Stem (glass mount)
8. Contact wire (goes out of stem)
9. Cap (sleeve)
10. Insulation (vitrite)
11. Electrical contact



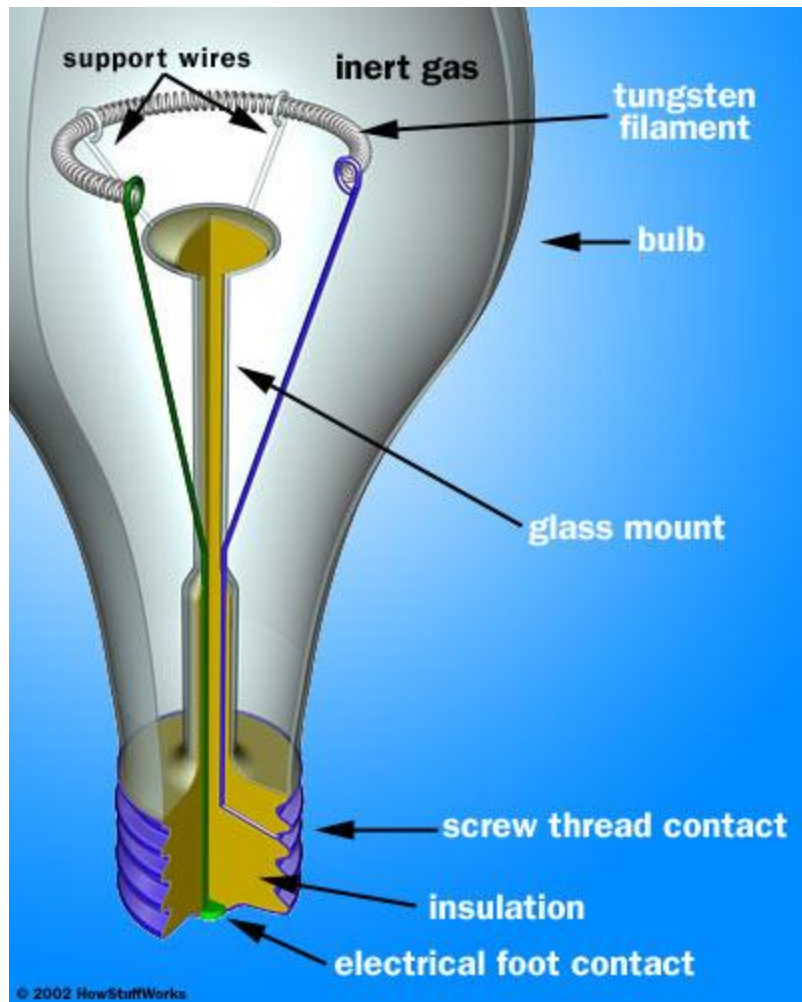
INCANDESCENT LIGHT BULBS CONSIST OF AN AIR-TIGHT GLASS ENCLOSURE (THE ENVELOPE, OR BULB) WITH A FILAMENT OF TUNGSTEN WIRE INSIDE THE BULB, THROUGH WHICH AN ELECTRIC CURRENT IS PASSED.

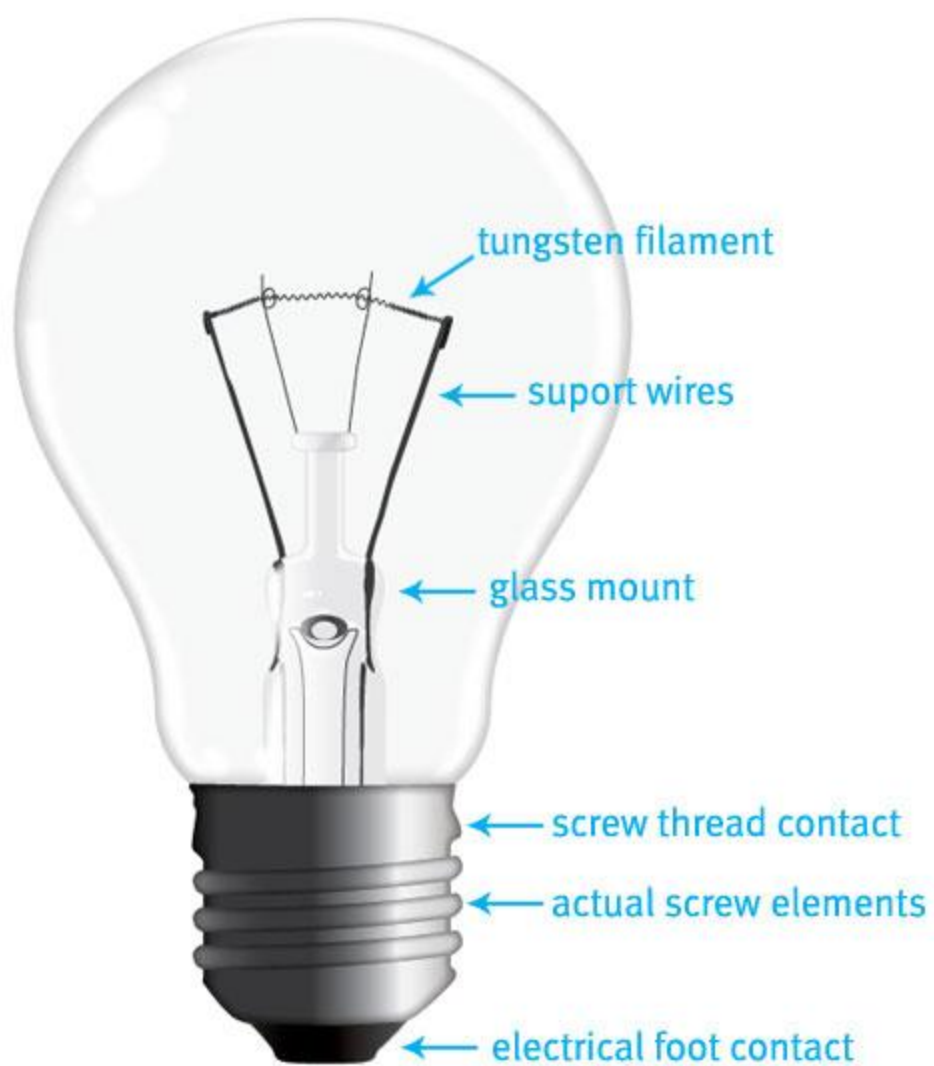
CONTACT WIRES AND A BASE WITH TWO (OR MORE) CONDUCTORS PROVIDE ELECTRICAL CONNECTIONS TO THE FILAMENT.

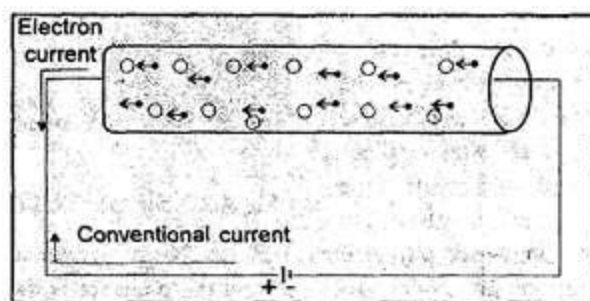
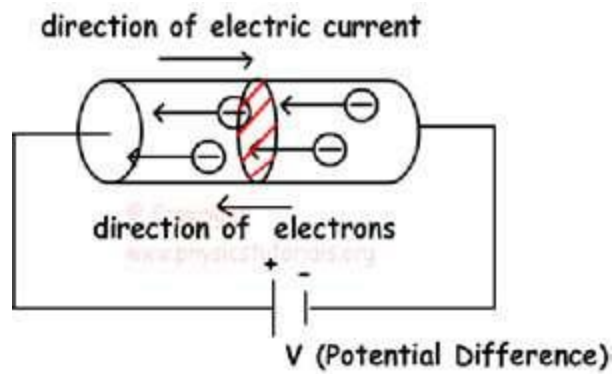
INCANDESCENT LIGHT BULBS USUALLY CONTAIN A STEM OR GLASS MOUNT ANCHORED TO THE BULB'S BASE THAT ALLOWS THE ELECTRICAL CONTACTS TO RUN THROUGH THE ENVELOPE WITHOUT AIR OR GAS LEAKS.

SMALL WIRES EMBEDDED IN THE STEM IN TURN SUPPORT THE FILAMENT AND ITS LEAD WIRES.

THE BULB IS FILLED WITH AN INERT GAS SUCH AS ARGON (93%) AND NITROGEN (7%) TO REDUCE EVAPORATION OF THE FILAMENT AND PREVENT ITS OXIDATION AT A PRESSURE OF ABOUT 70 KPA (0.7 ATM).[54] EARLY LAMPS, AND SOME SMALL MODERN LAMPS USED ONLY A VACUUM TO PROTECT THE FILAMENT FROM OXYGEN.







**Fig. 4.4: Motion of free electrons in one direction, when current is set up in the metal.**

