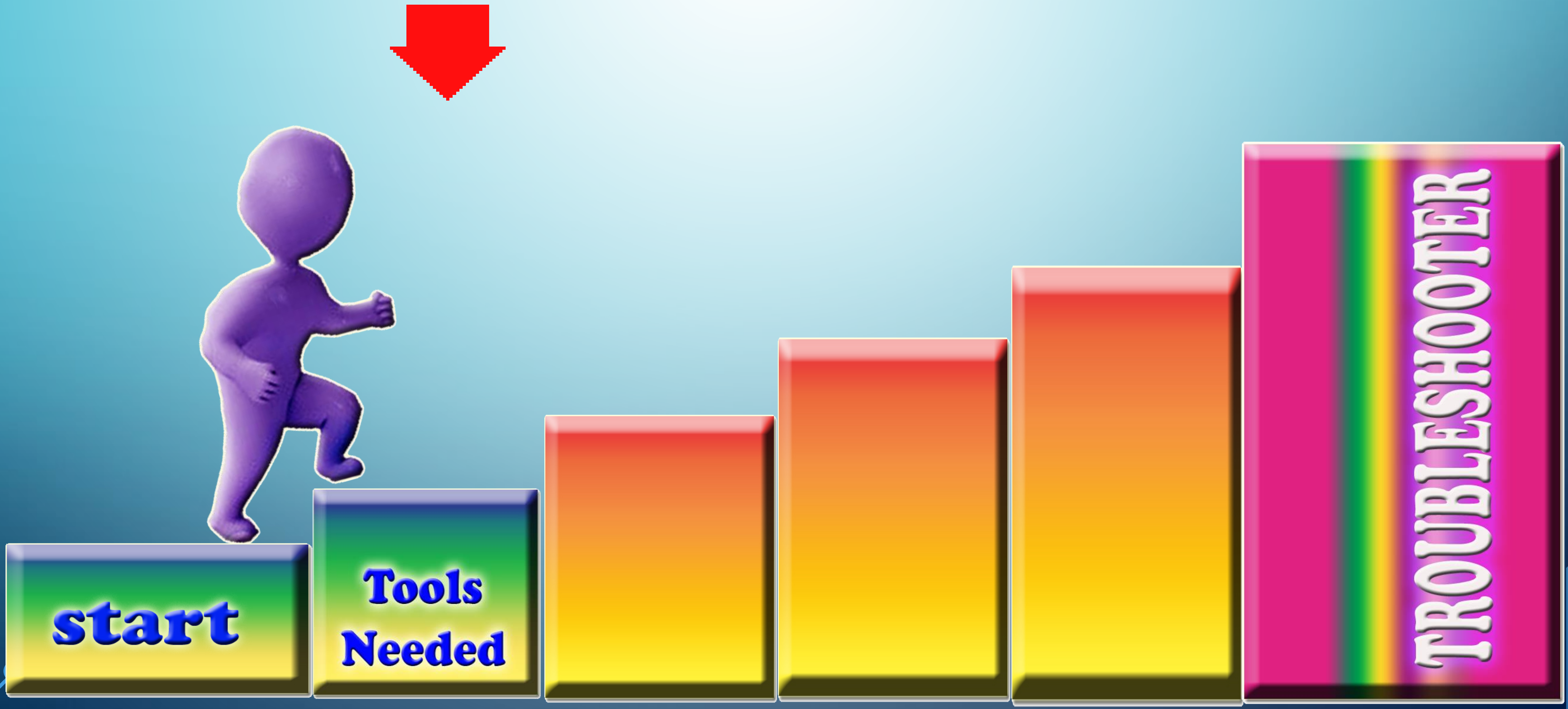
EQUIPMENT MAINTENANCE AND REPAIR IN LABORATORY SETTING

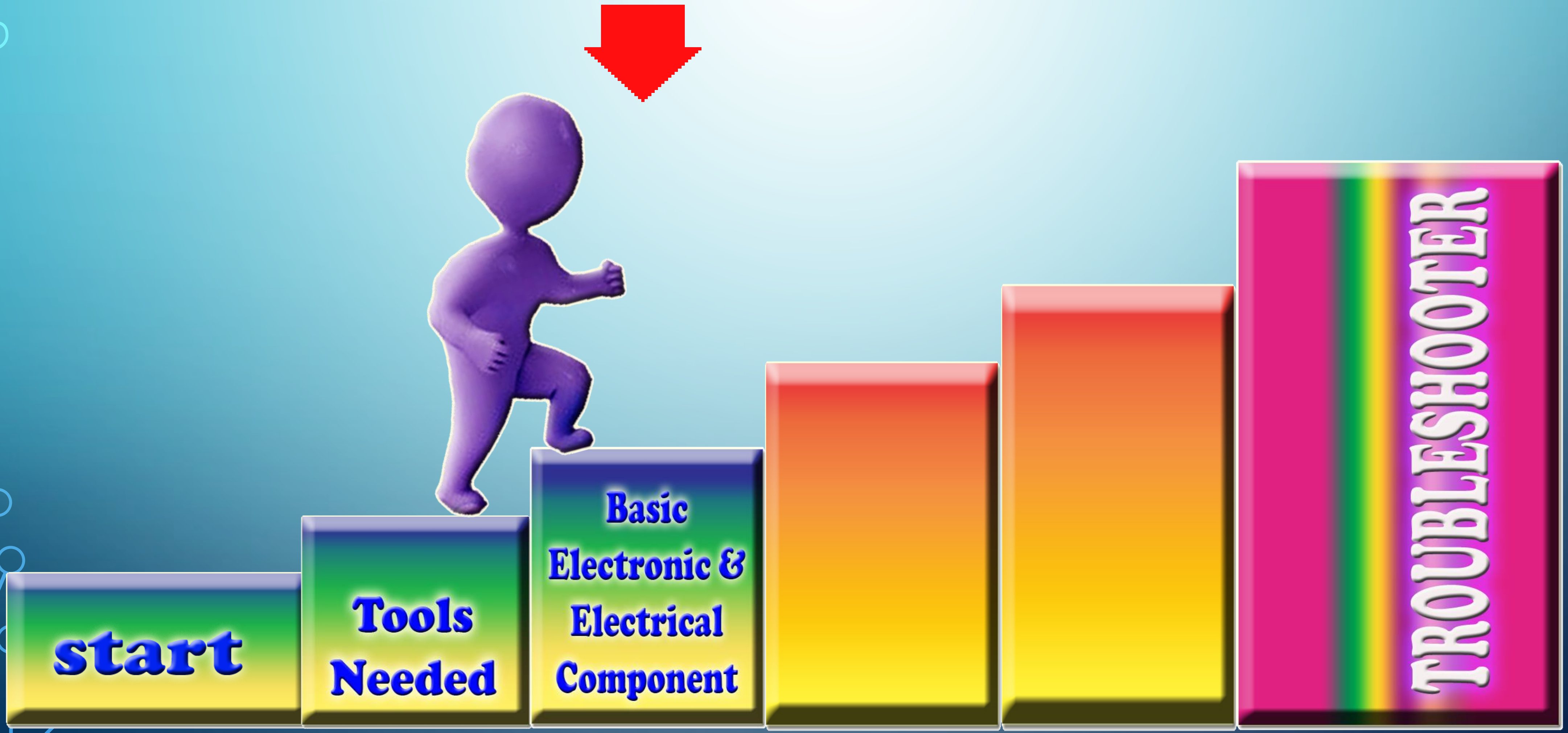
JIMMY C. SANTOS

- TO BE A “TROUBLESHOOTER” ONE MUST HAVE :
  - **KNOWLEDGE ON**
    - TOOLS NEEDED
    - BASIC ELECTRICAL AND ELECTRONIC COMPONENTS
    - CIRCUIT ANALYSIS
    - REPAIR AND MAINTENANCE PROCEDURES

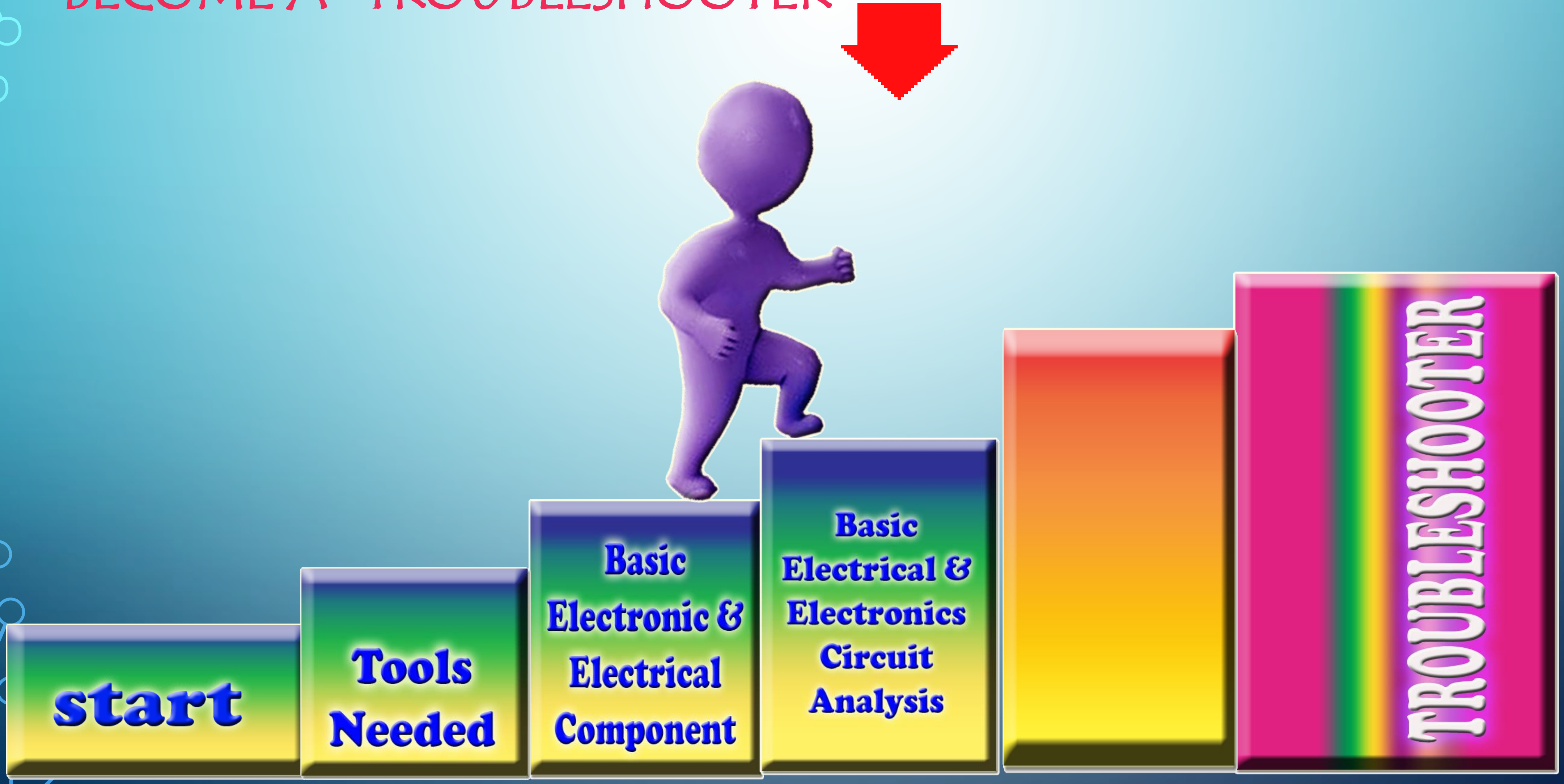
CLIMBING THE LADDER TO BECOME A "TROUBLESHOOTER"



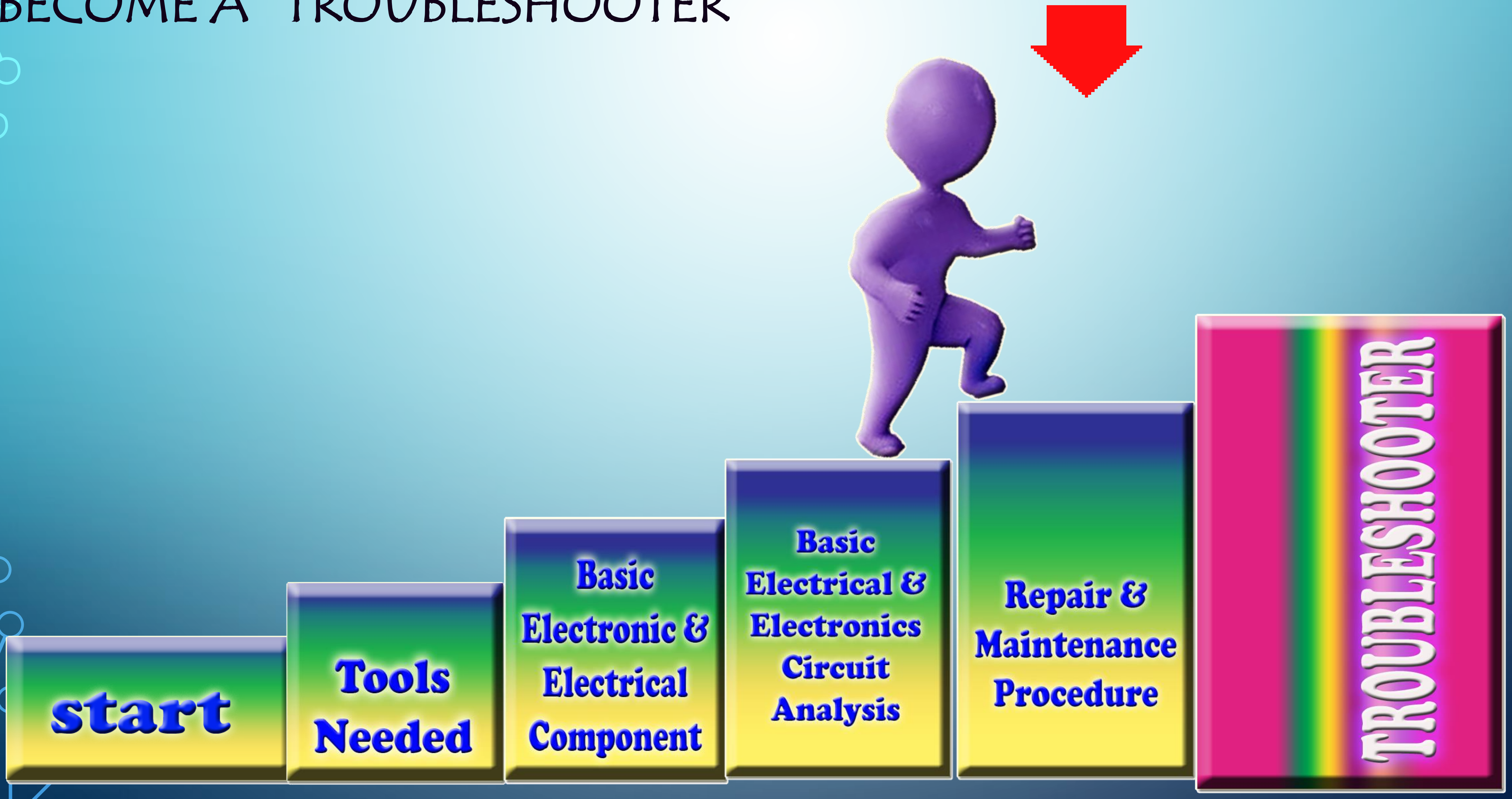
CLIMBING THE LADDER TO BECOME A "TROUBLESHOOTER"



CLIMBING THE LADDER TO BECOME A "TROUBLESHOOTER"



CLIMBING THE LADDER TO BECOME A "TROUBLESHOOTER"



CLIMBING THE LADDER TO BECOME A "TROUBLESHOOTER"


APPLAUSE


Thank you

TOOLS NEEDED

TOOLS NEEDED

- MULTIMETERS
- WIRING TOOLS
- SCREWDRIVERS
- MISCELLANEOUS TOOLS
- DO-IT-YOURSELF TOOLS

MULTIMETERS

- REQUIRED FEATURES (minimum)
  - Can measure up to 50 VDC
  - Can measure up to 250 VAC
  - Measures Resistance or Continuity
- DESIRABLE FEATURES
  - Can measure entry level current to approximately 250 milli-ampere
  - Can measure DC and AC current up to 10 Amperes

TYPES OF MULTIMETER

1. ANALOG MULTIMETER

Advantage:

Low Cost

Disadvantages:

Difficult to read measured value.

Need to start at **highest range** and work way down to suitable range.

2. DIGITAL MULTIMETER

Advantages:

Easy to read measured value

More accurate readings

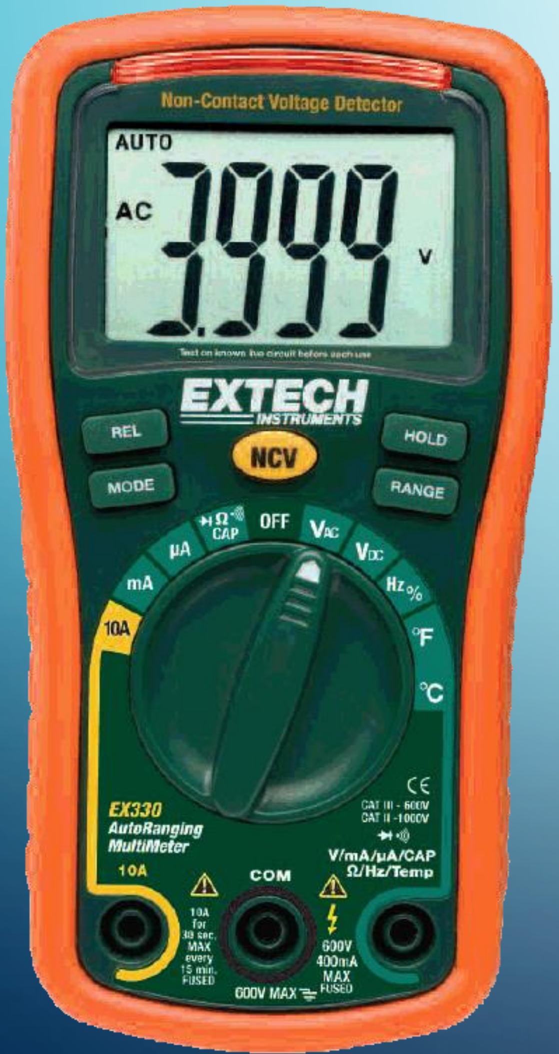
Disadvantages:

High Cost

Need to start at **highest range** and work way down to suitable range

TYPES OF MULTIMETER

3. AUTO-RANGING MULTIMETER



Advantage:

Need only to select the function.

Disadvantage:

High cost

WIRING TOOLS

WIRE CUTTER – Diagonal/Side Cutter

- 5 or 6 inches overall size
- Plastic or Rubber cushion grip

WIRE STRIPPER AND CUTTER

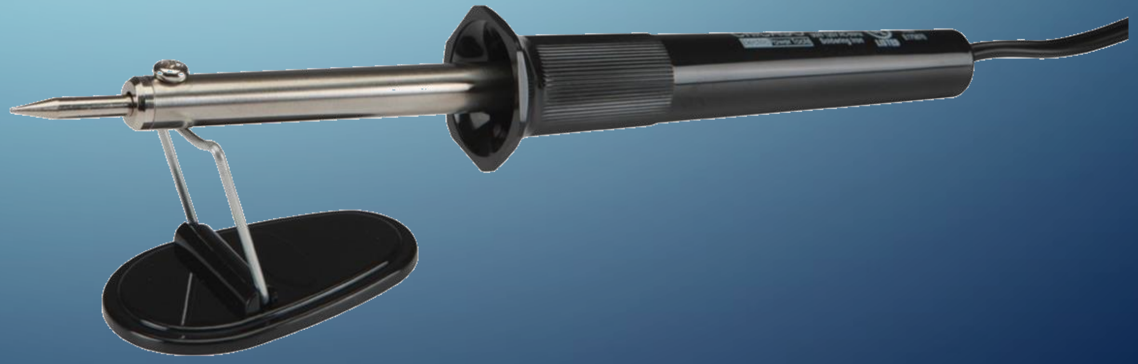
USE TO STRIP-OFF OR REMOVE INSULATION OF WIRES

ELECTRICAL MASTER SET

WIRING TOOLS

Soldering Iron or Soldering Gun

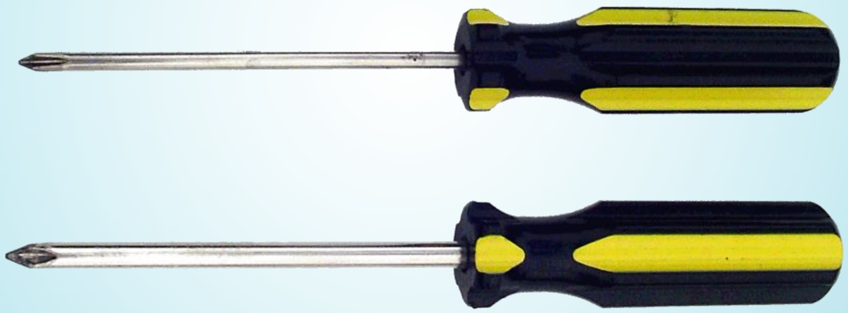
- 30-40 Watts: used in fixing electronic components in circuit boards and splicing wires with small diameters.
- 60-100 Watts: used in fixing large components such as heat sink and transformers in circuit boards, and on for bigger diameter wire splicing.



SCREWDRIVERS

1. Blade/Flat – ¼” to $^{3}/_{8}$ " and must have at least 4” shaft, with plastic or rubber grip.

2. Star/Phillips – must have at least 4” shaft, with plastic or rubber grip.



3. Precision Screwdrivers – use for smaller screw drives.

4. SET OF INSULATED SCREW DRIVERS

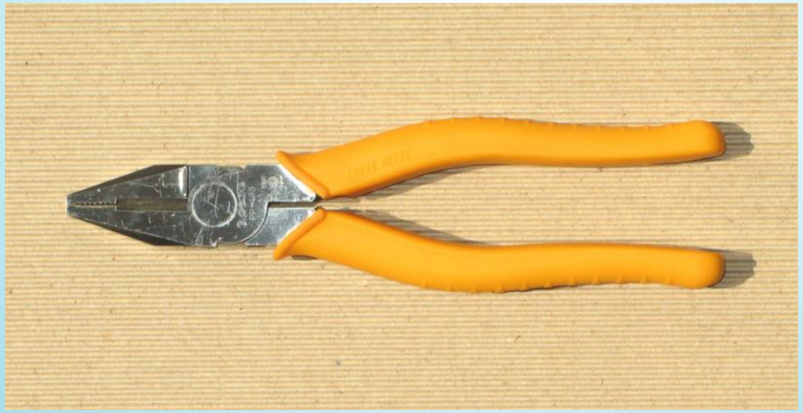
MISCELLANEOUS TOOLS

1. **PLIERS** - use to hold objects such as wires and electronic/electrical components

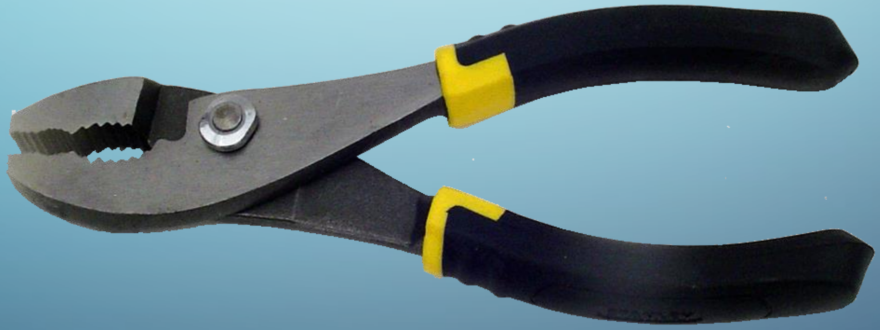
TYPES

- Long/Needle Nose

- Side Cutting Pliers



- Slip-Joint Pliers



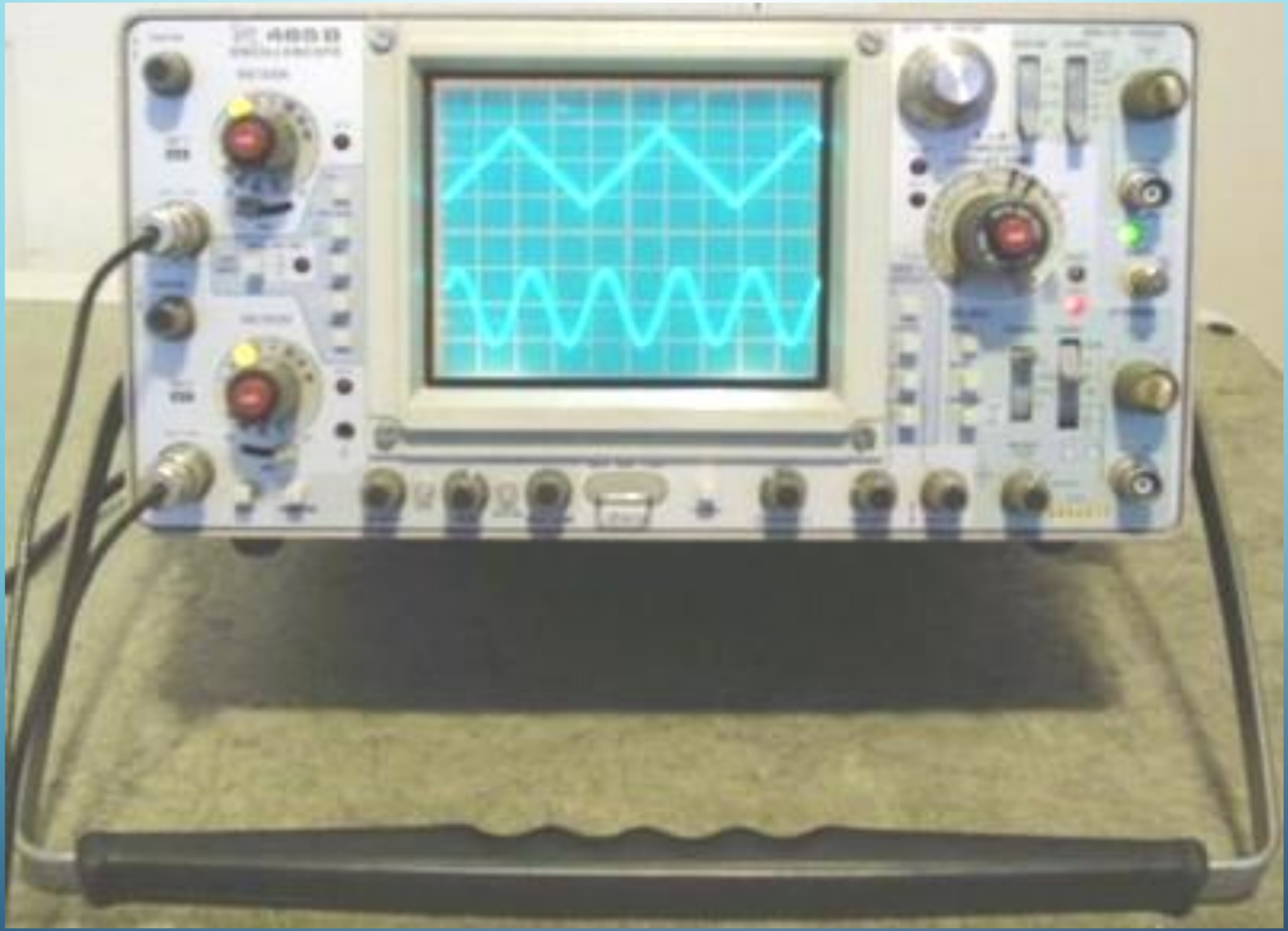
2. WRENCH – for electrical and mechanical works

- Open Wrench

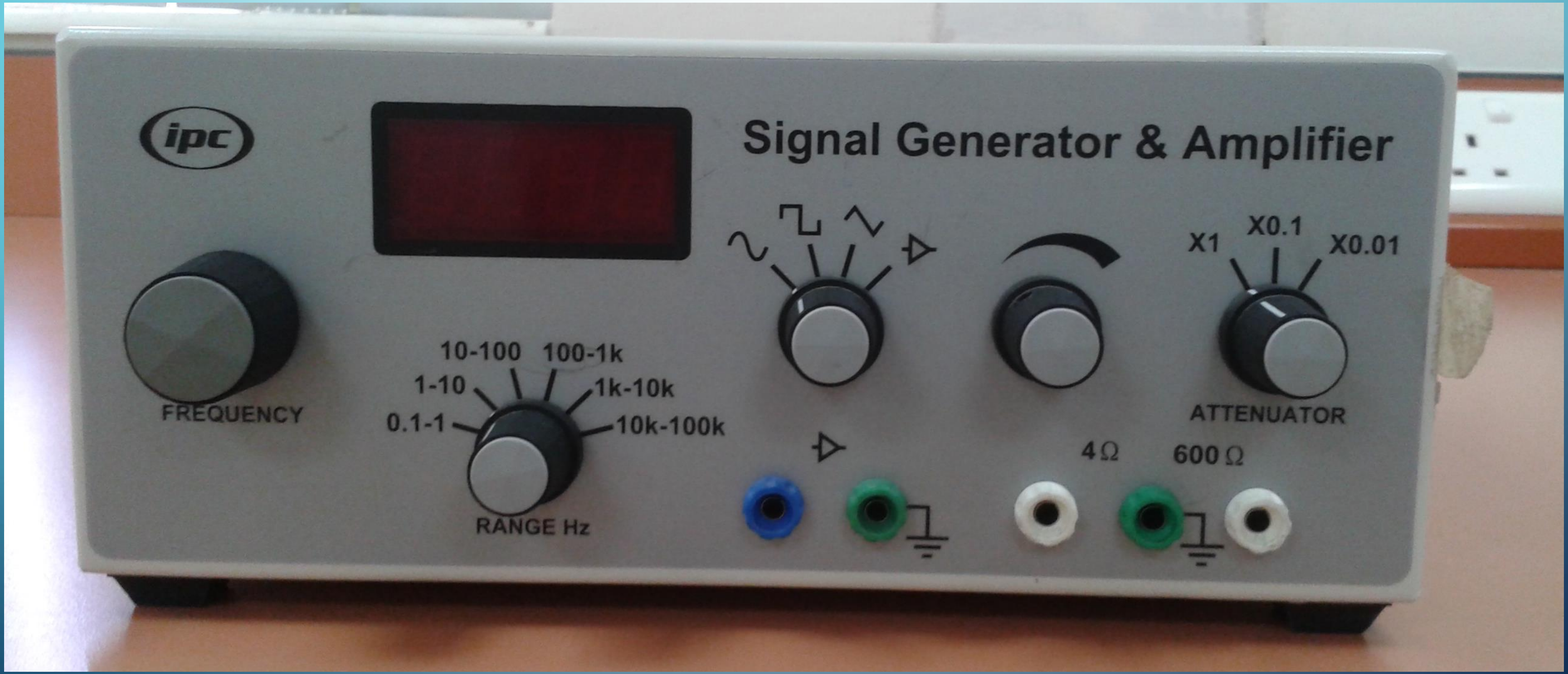
- Close Wrench

- Adjustable Wrench

CATHODE RAY OCILLOSCOPE



SIGNAL GENERATOR



BACK TO TOP

BASIC COMPONENTS

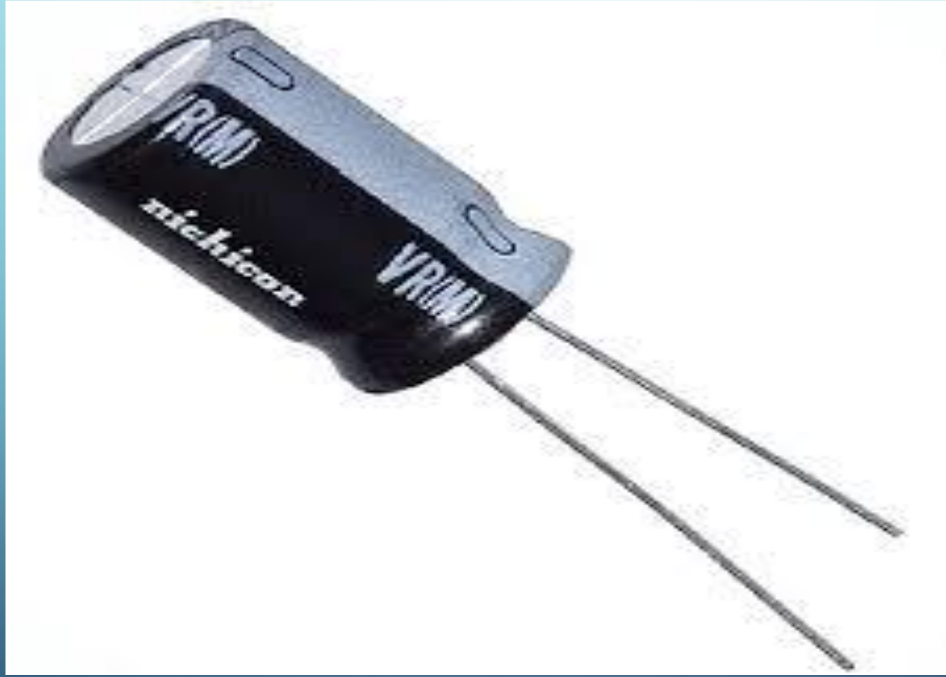
BASIC ELECTRICAL AND ELECTRONIC COMPONENTS

- **PASSIVE DEVICES** – devices or components which do not require external source to their operation.

1. **Resistors** – a two-terminal passive component that opposes the flow of current (reduces the electric current) and at the same time lowers the voltage levels in a circuit.

BASIC ELECTRICAL AND ELECTRONIC COMPONENTS

2. **Capacitors** – a two-terminal passive component that is used to store energy. It can be used in a circuit as smoothing, coupling and bypass component.



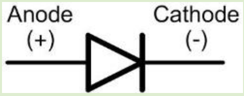
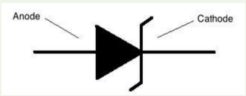
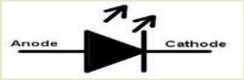
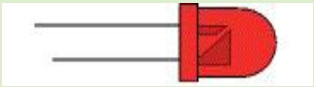
BASIC ELECTRICAL AND ELECTRONIC COMPONENTS

3. **Inductors** – a two-terminal passive component that store energy in the form of magnetic field. It is used in circuit as “choke” and “reactor” in RF receiver and transmitter circuits.

BASIC ELECTRICAL AND ELECTRONIC COMPONENTS

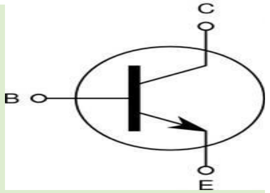
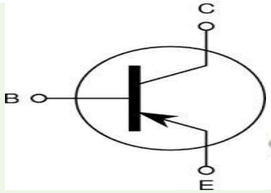
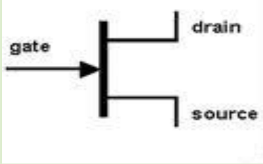
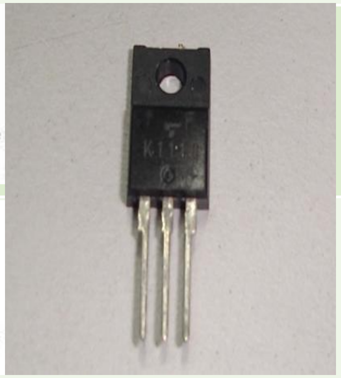
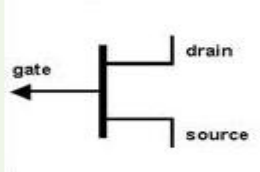
- **ACTIVE DEVICES** – devices or components which requires external source to their operation.

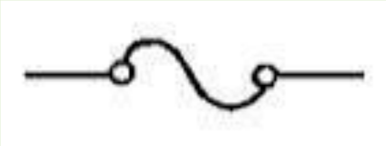
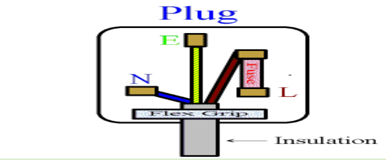
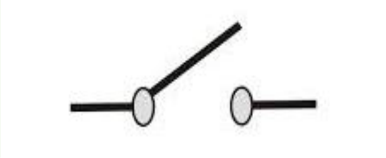
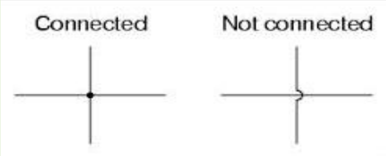
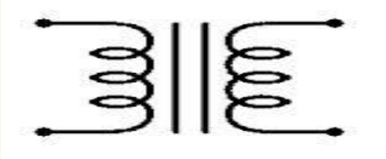
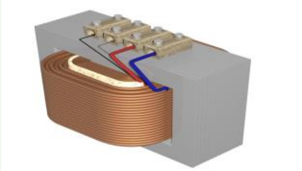
1. **Diodes** – a two terminal PN junction device that allows the flow of current only in one direction.

TYPE (BASIC)	SYMBOL/PICTURE	FUNCTION
RECTIFIER DIODES	 	Rectifier Circuits of Power Supply Units
ZENER DIODES	 	Voltage Regulator in Power Supply Units
LED – Light Emitting Diode	 	Calculator Displays, TV, Mobile Phone Displays

BASIC ELECTRICAL AND ELECTRONIC COMPONENTS

2. Transistor – a three terminal active component that is used mainly in boosting or amplifying electrical signals; both AF and RF ranges. Other applications of transistor includes

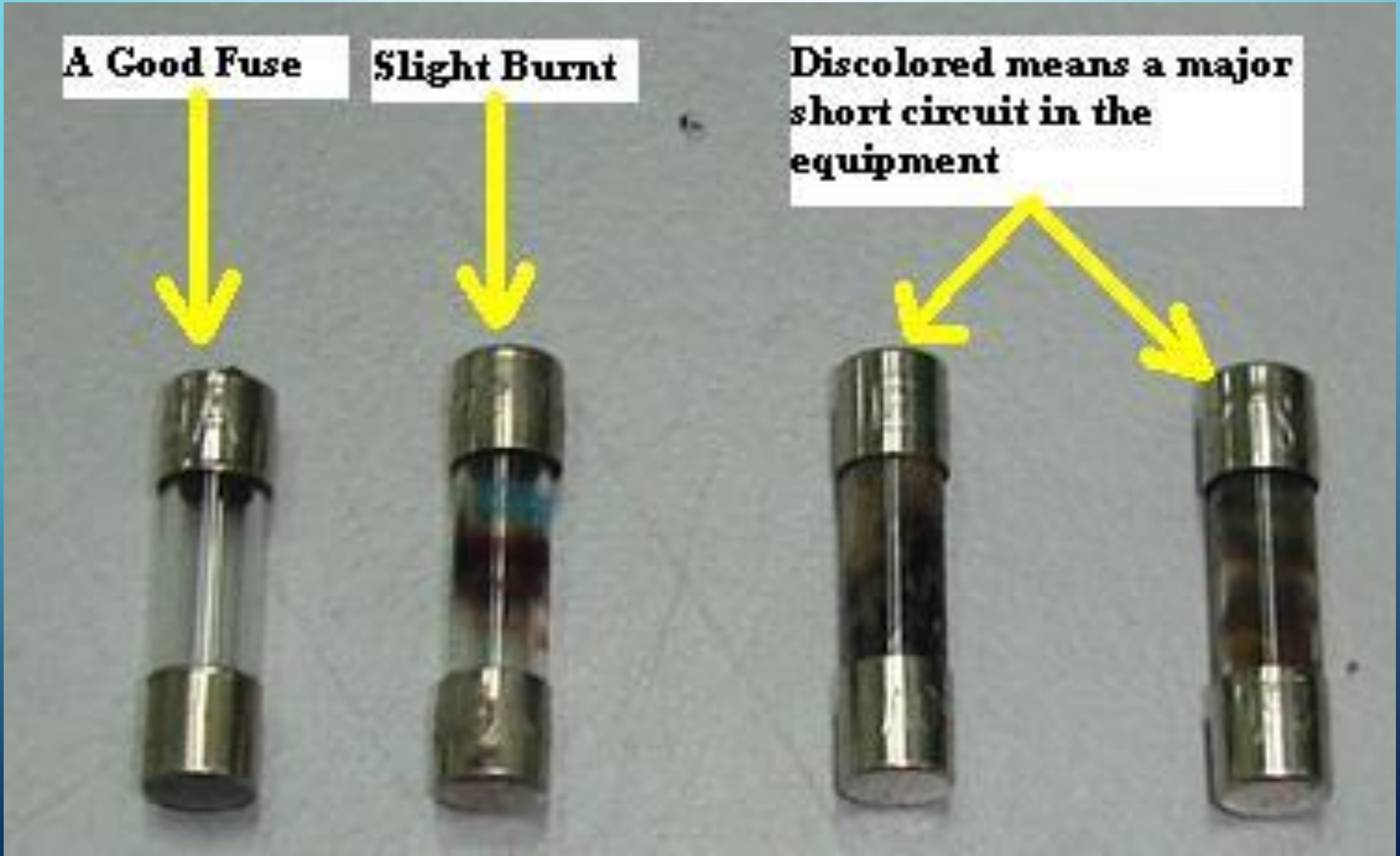
TYPE (BASIC)		SYMBOL/PICTURE	FUNCTION
BIPOLAR JUNCTION TRANSISTORS (BJT) – current controlled device	NPN	 	Voltage Regulation Audio Frequency Amplification,
	PNP		
FIELD EFFECT TRANSISTORS (FET) – voltage controlled device	N-channel	 	Audio and Radio Frequency Amplification,
	P-Channel		

COMPONENTS	SYMBOL/PICTURE	FUNCTION
FUSE	 	Limit the amount of current that can be drawn by an electric circuit by opening (blowing or melting) when the current exceeds a preset limit.
BULB	 	Serve as the Load. It turns the electrical energy into light.
POWER CORD/PLUG		Temporarily connects an appliance or an equipment to the mains electricity supply via wall socket or an extension cord
SWITCHES	 	Necessary to turn the electrical circuit "on" or "off"
CONNECTING WIRES	 	To create a complete circuit path through which current flow from the source going to the circuit load.
TRANSFORMER	 	Protection of appliance and equipment connected to AC power supplies. It can change the electrical voltage or current from one level to another

BASIC COMPONENTS TESTING

FUSE

- PHYSICAL APPEARANCE OF GOOD AND BLOWN FUSE

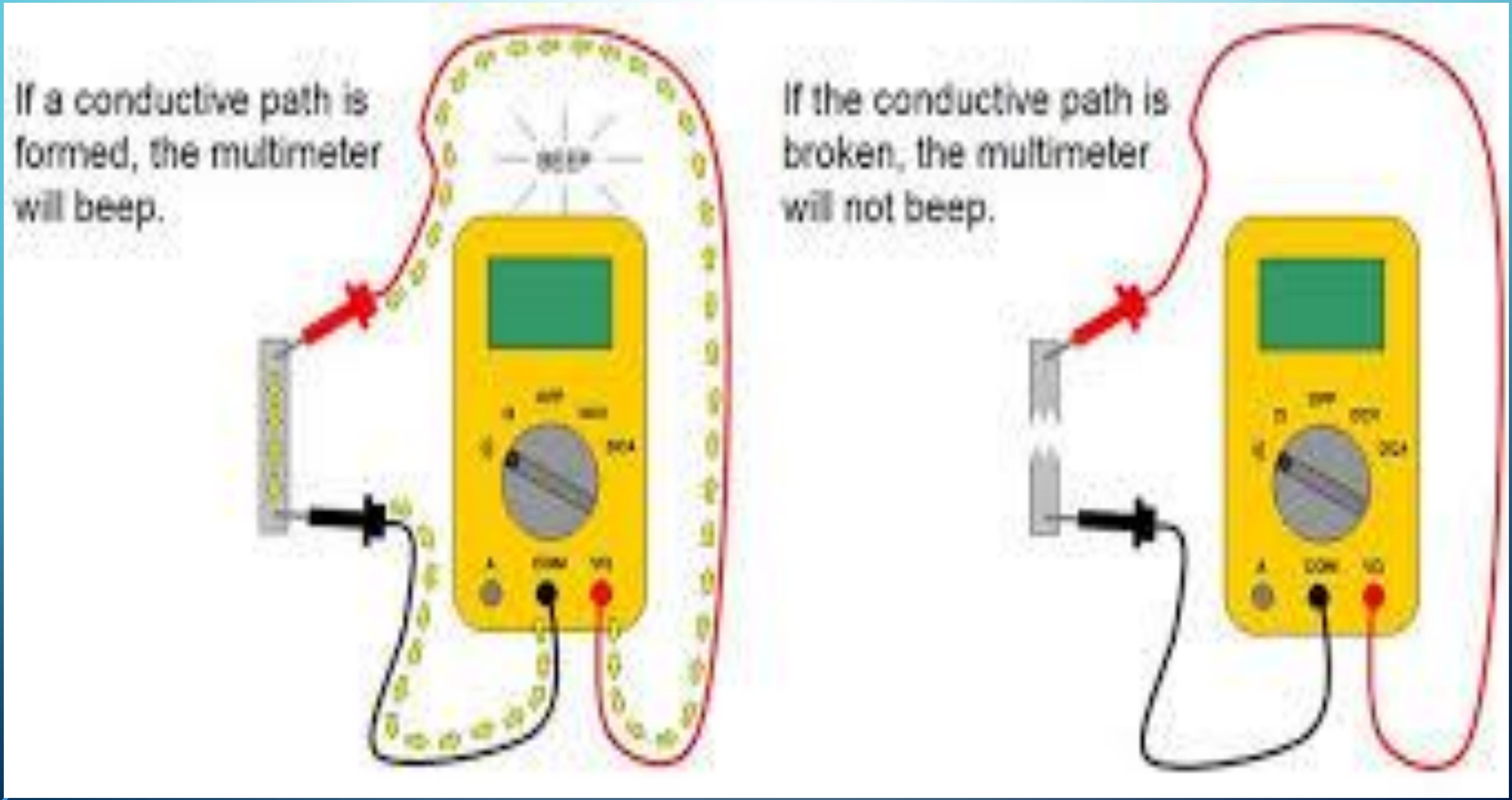


MULTIMETER INDICATION FOR GOOD AND BLOWN FUSE

GOOD

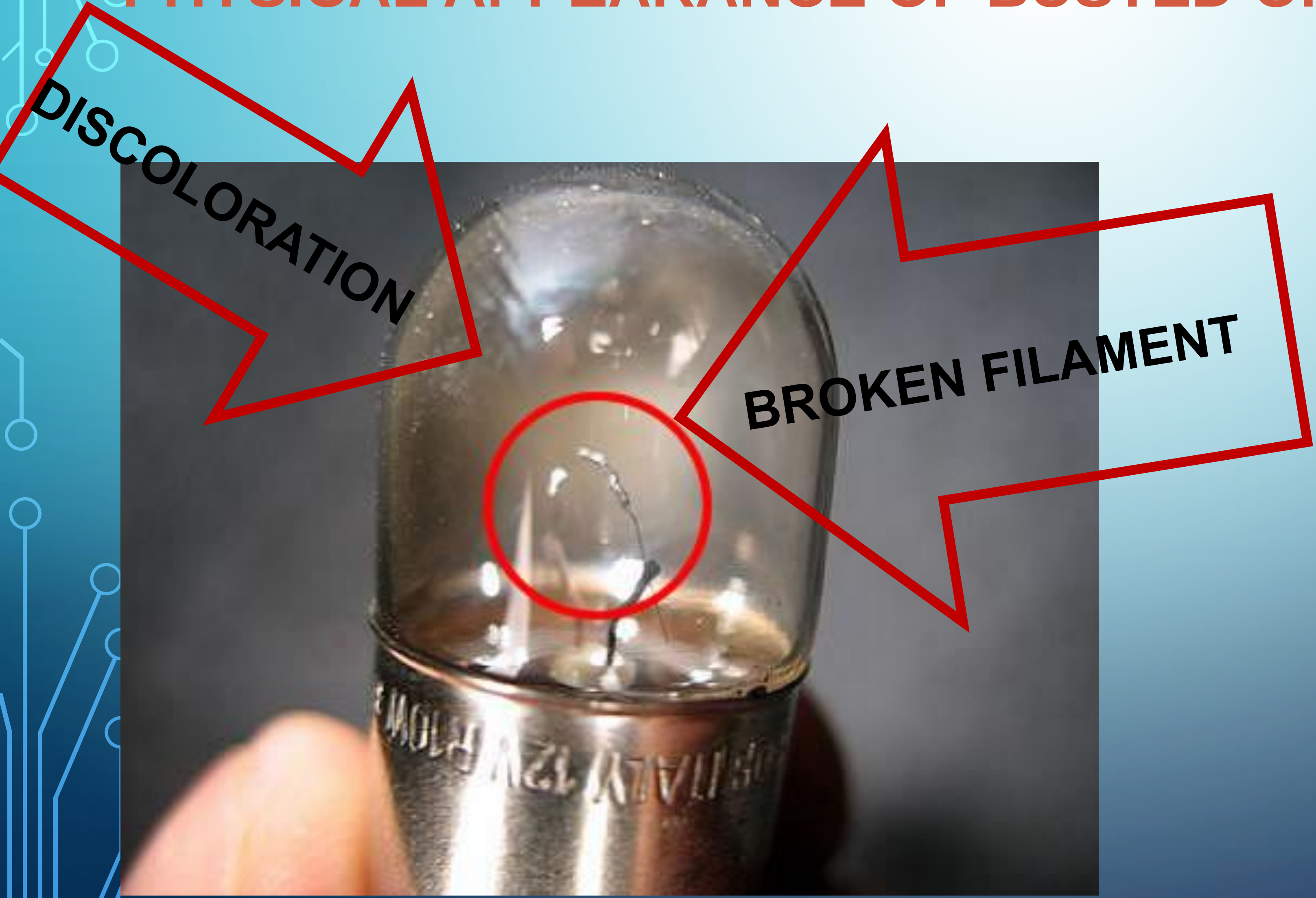
BLOWN

Using the continuity test function of the multimeter



BULB/LAMP

- PHYSICAL APPEARANCE OF BUSTED OR BURNT OUT BULB



Busted Bulb – Infinite Resistance (OPEN), no continuity.

Good Bulb – Low Resistance but not zero.

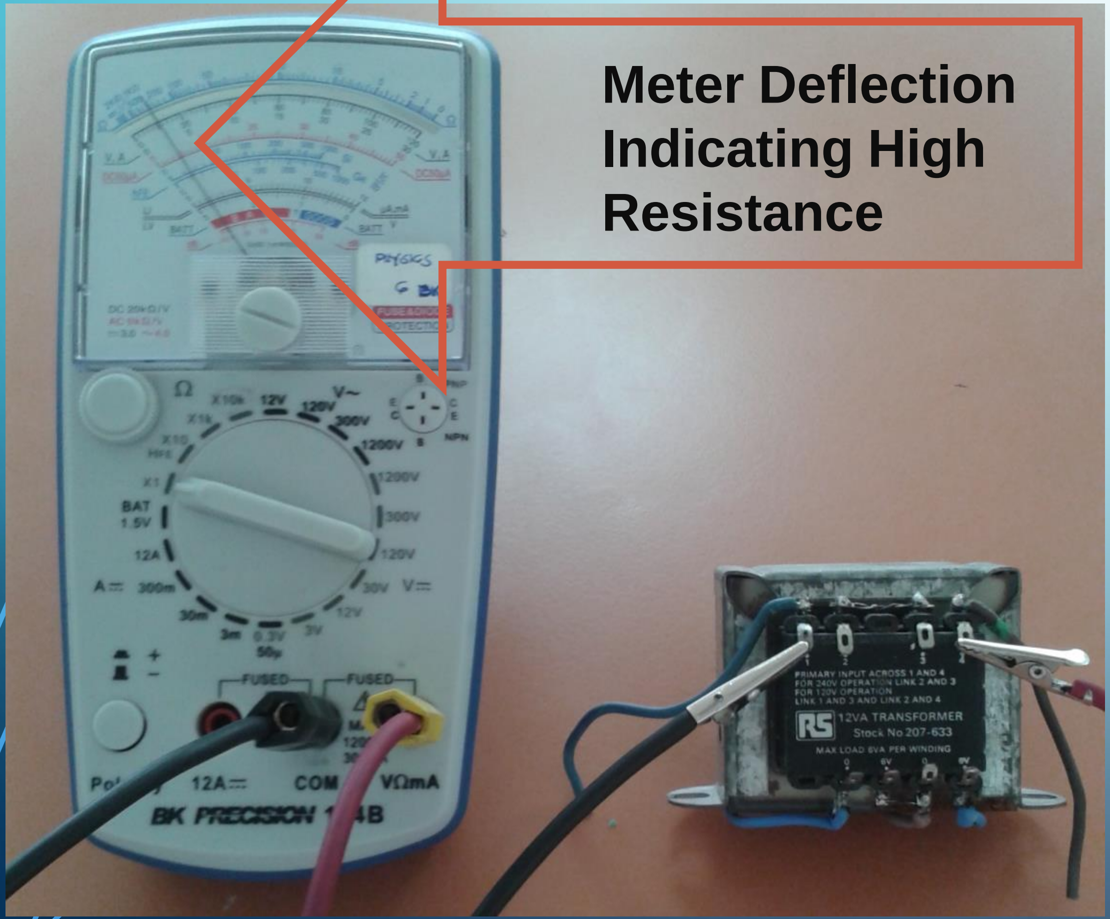
SWITCH

- "ON" – multimeter reading must indicate **continuity.**
- "OFF" – multimeter reading must indicate **no continuity.**

TRANSFORMER

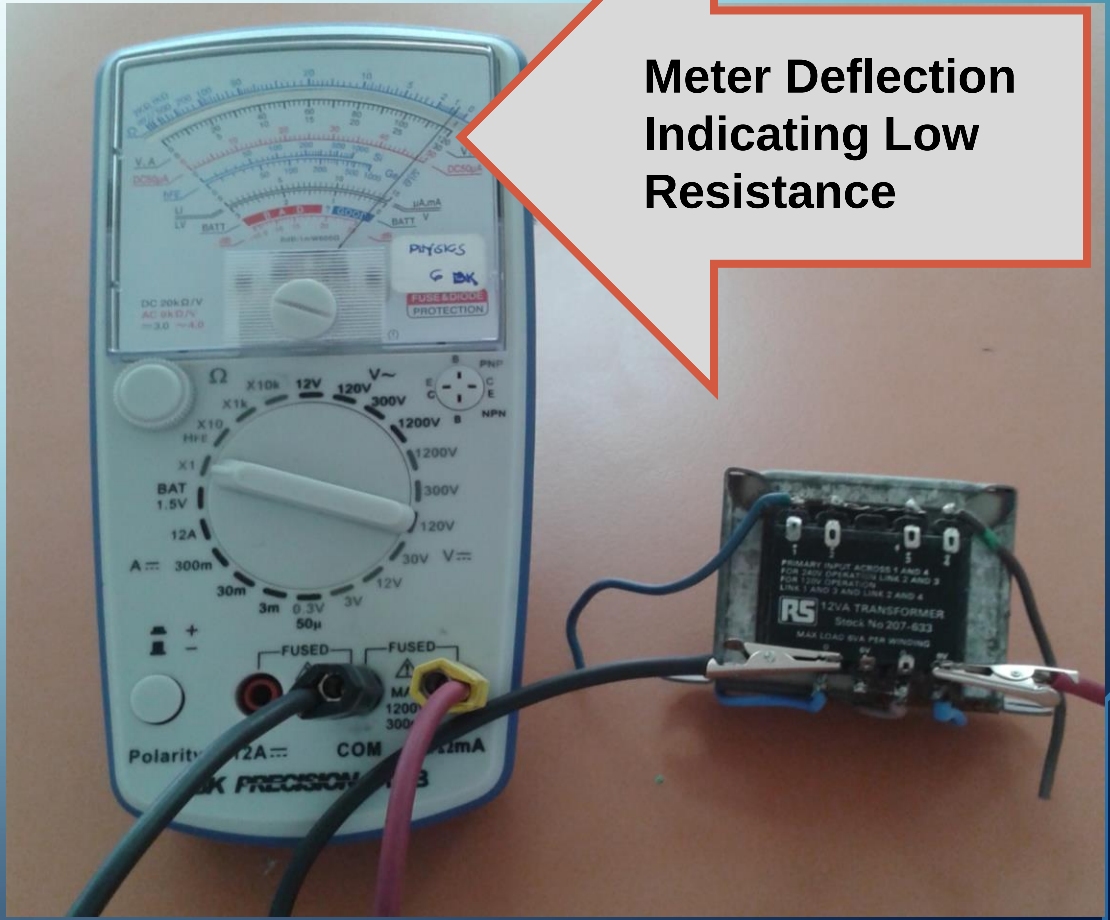
METER INDICATION FOR TESTING A GOOD TRANSFORMER

PRIMARY WINDING



Meter Deflection Indicating High Resistance

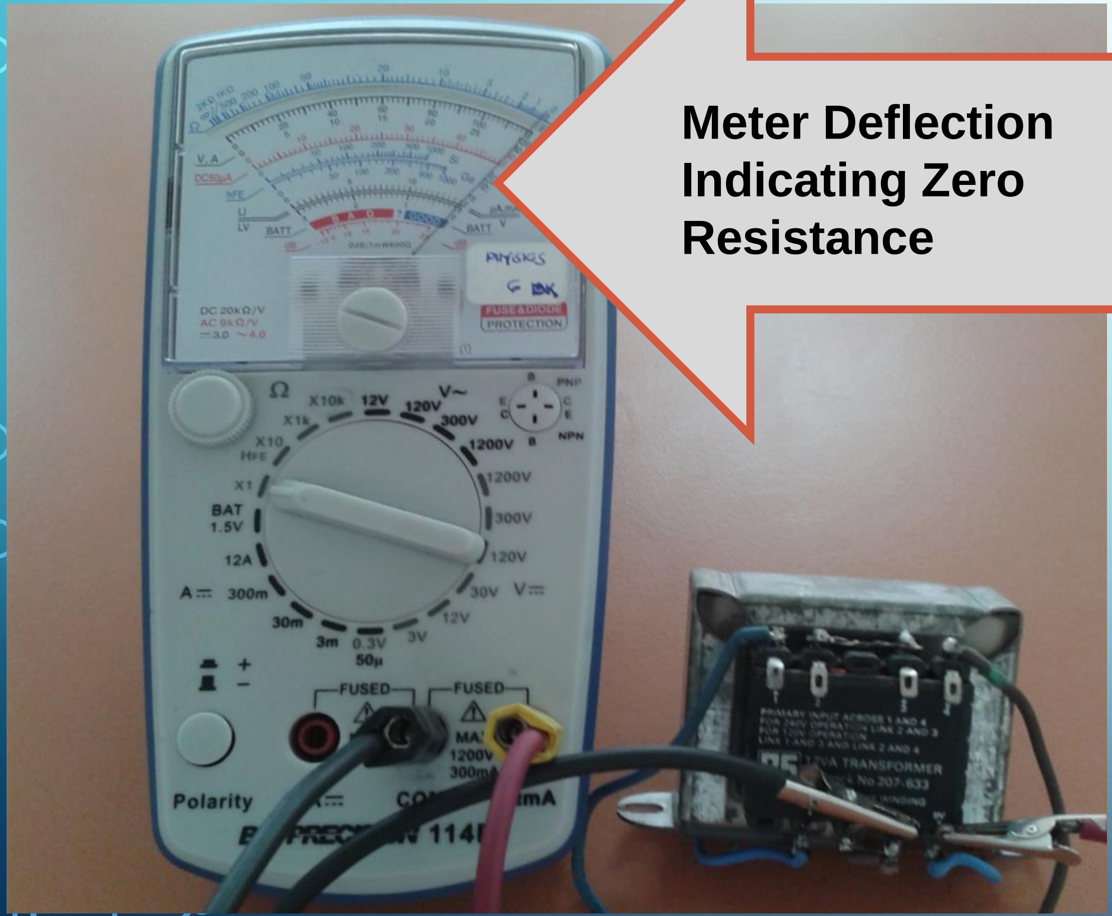
SECONDARY WINDING



Meter Deflection Indicating Low Resistance

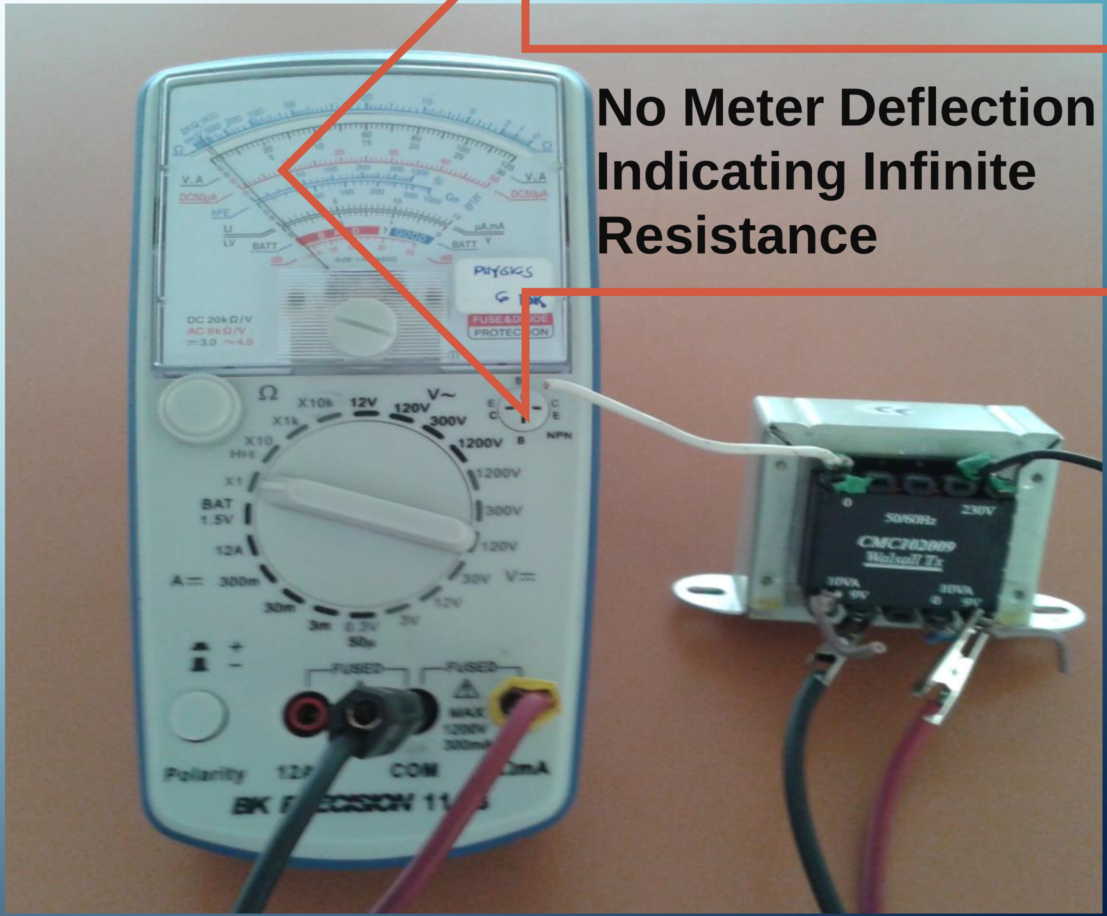
METER INDICATION FOR TESTING A BAD/DEFECTIVE TRANSFORMER

Shorted



Meter Deflection Indicating Zero Resistance

Open

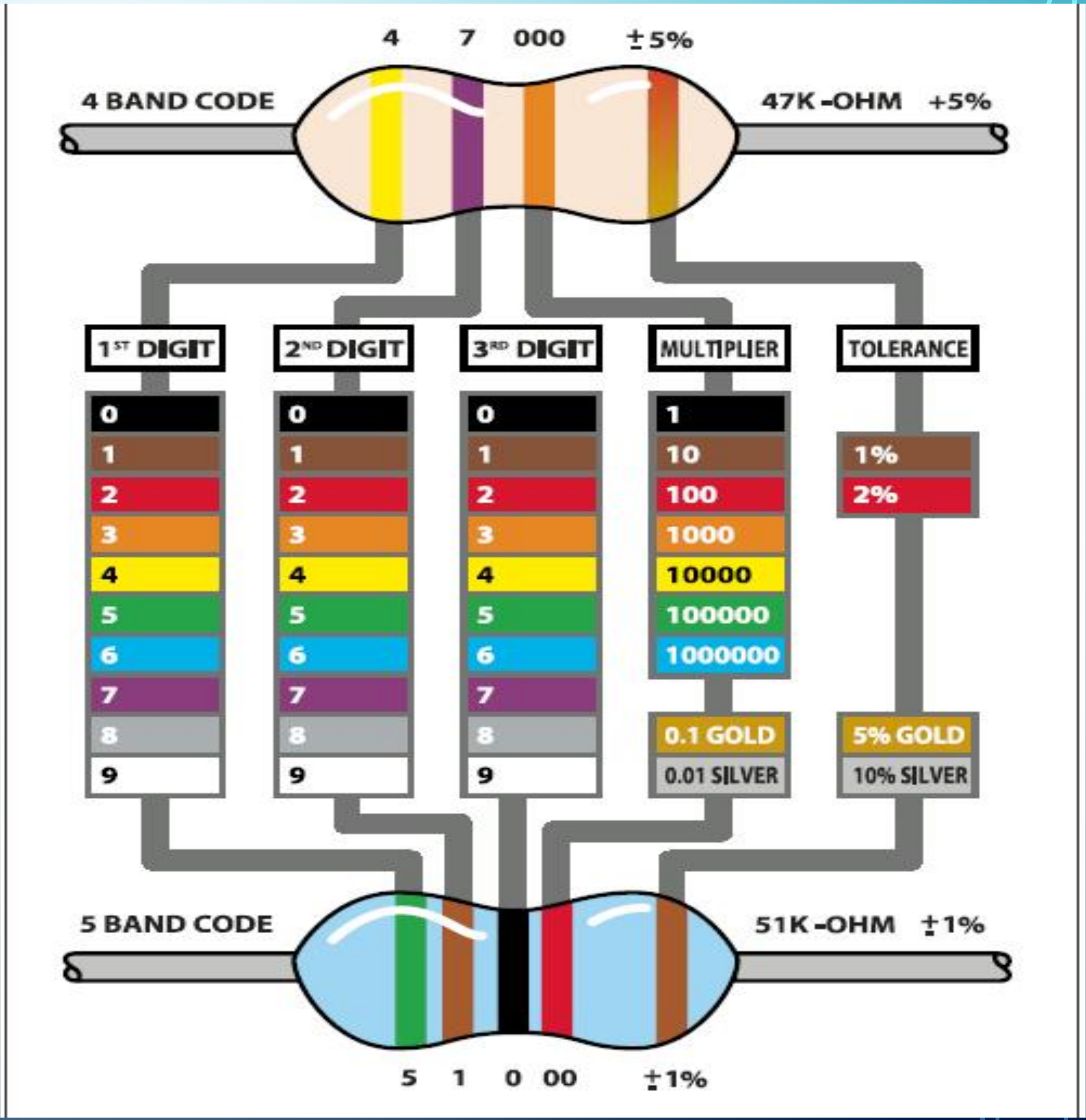


No Meter Deflection Indicating Infinite Resistance

RESISTOR

Good Resistor

- **Measured Value** is within the range of the ***Rated Value.***
- ***Measured Value*** *– using an* ***Ohmmeter or a Multimeter***
- ***Rated Value*** *– determining the Resistance of the Resistor thru* ***RESISTOR COLOR CODING***

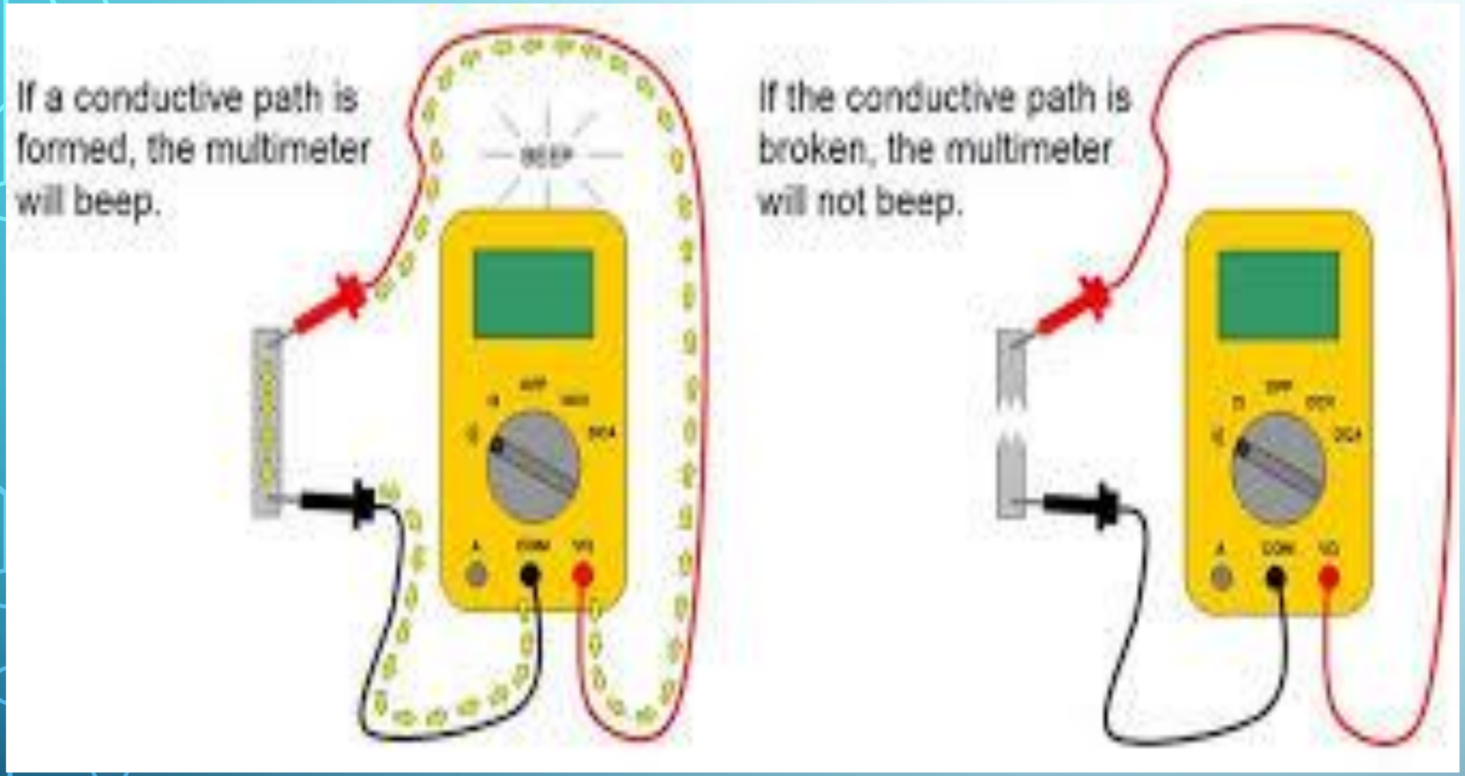


Bad/Defecive Resistor

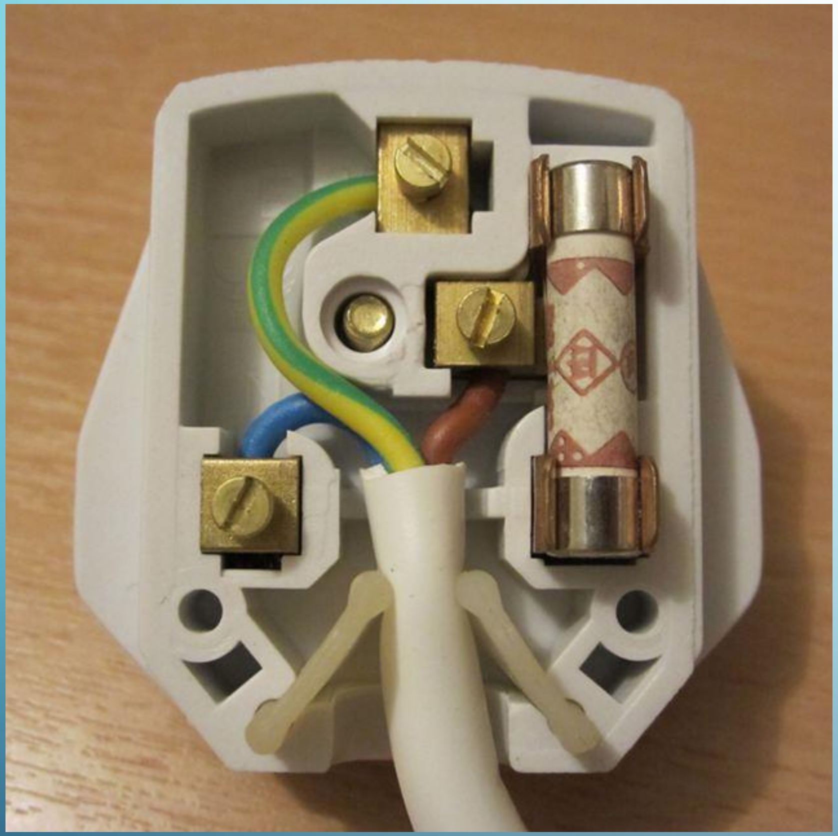
- **Open – meter deflection indicates INFINITE resistance reading.**
- **Shorted – meter deflection indicates ZERO resistance reading.**
- **Change Value – rare defect of resistor; measured value is not within the range of the rated value.**

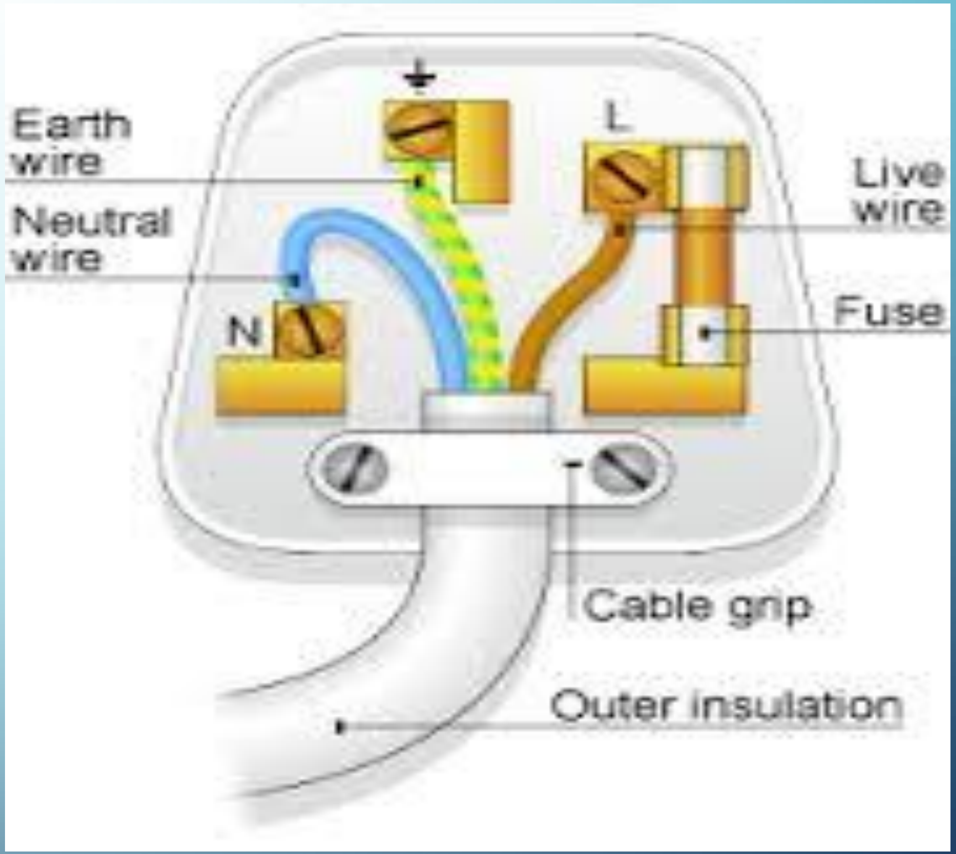
Physical appearance of bad/defective resistor

ACTIVITY 1.1:
FUSE, BULB AND SWITCH TESTING

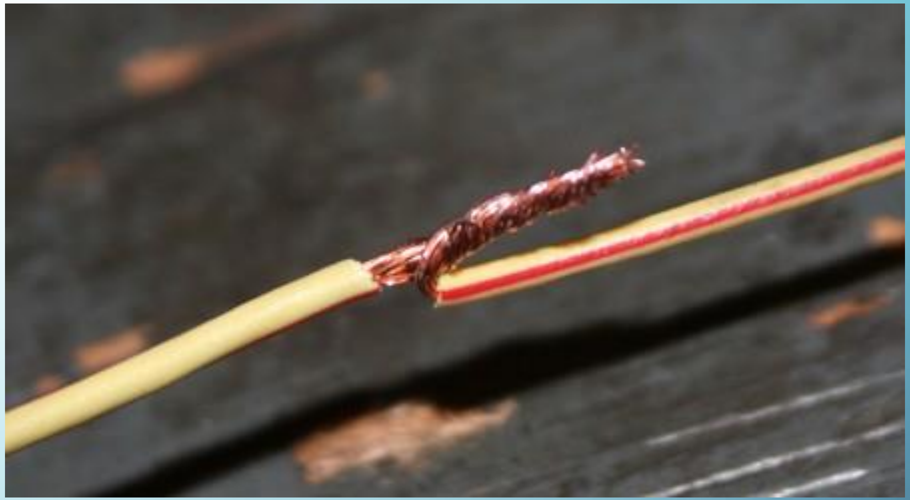


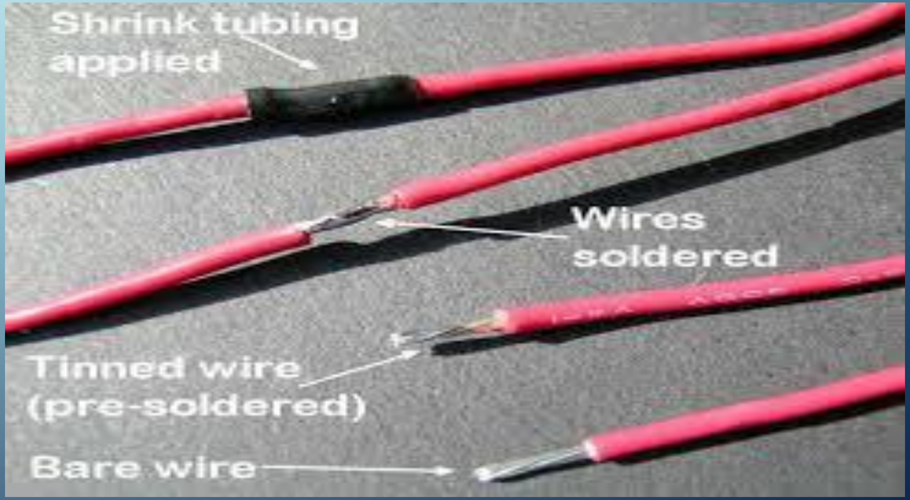
ACTIVITY 1.2
POWER CORD/PLUG PROPER WIRING





ACTIVITY 1.3
PROPER JOINING or SPLICING



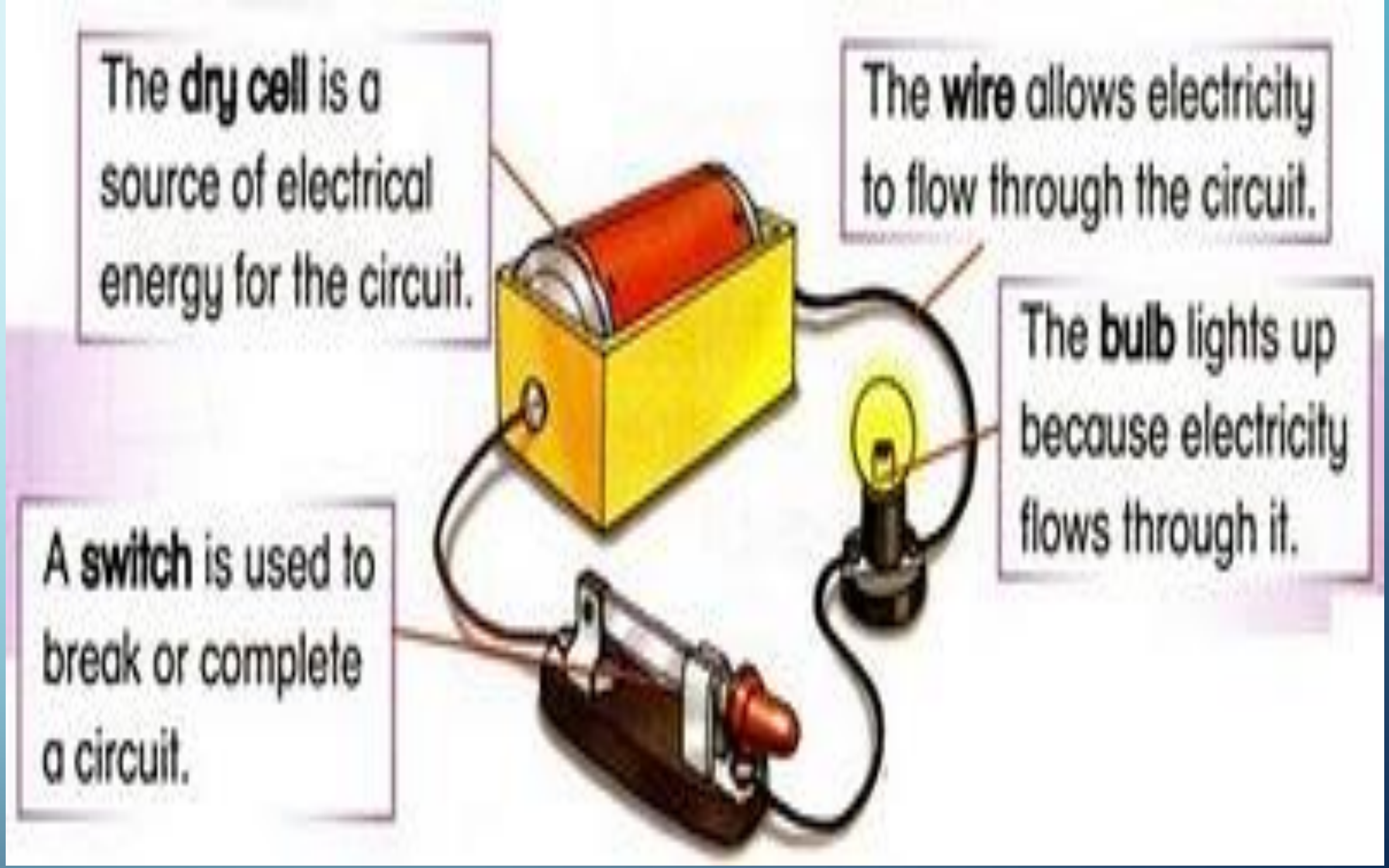


BACK TO TOP

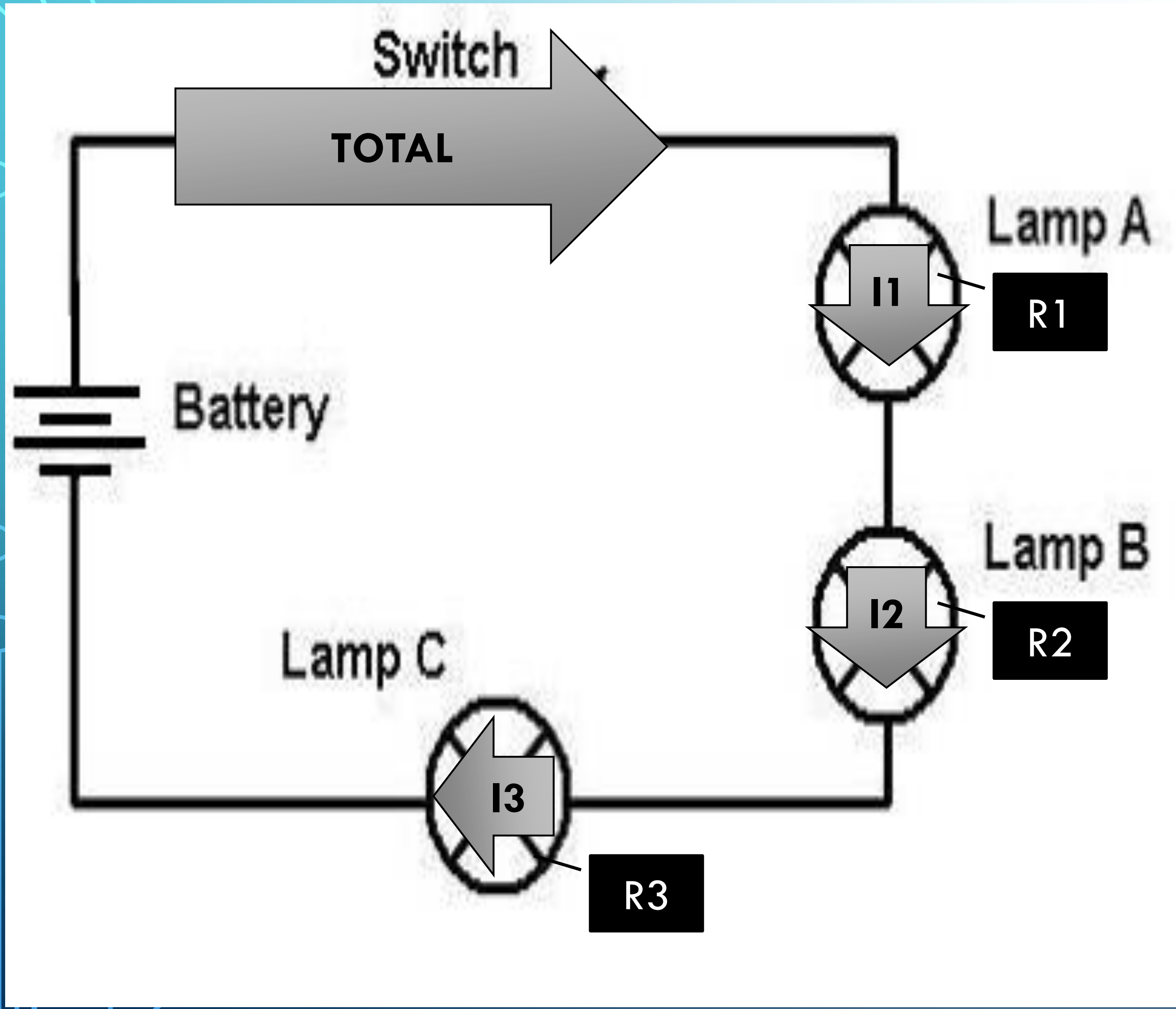
BASIC CIRCUITS

CIRCUIT COMPONENTS

1. Source
2. Switch
3. Connecting Wires
4. Load

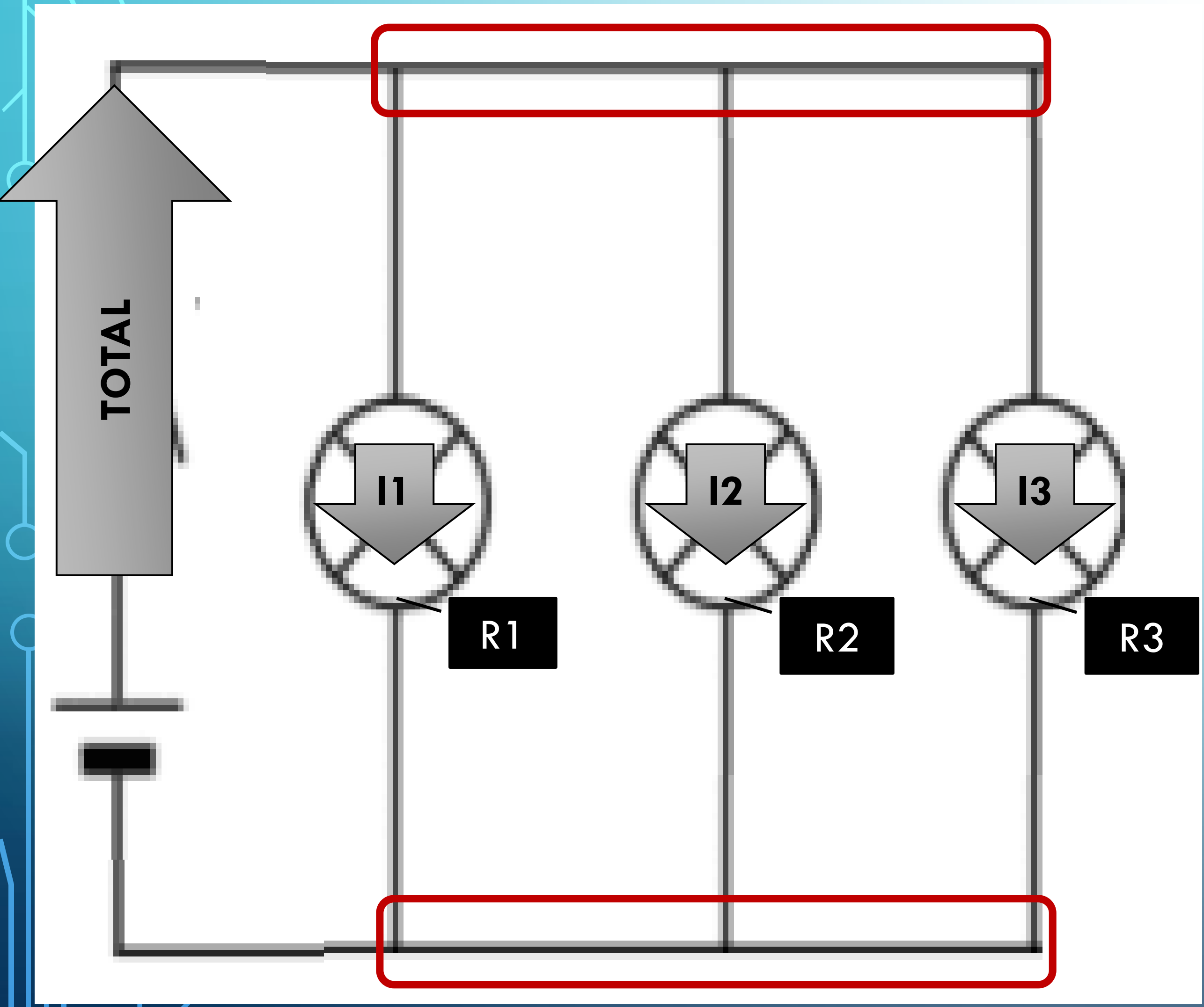


1. SERIES CONNECTION



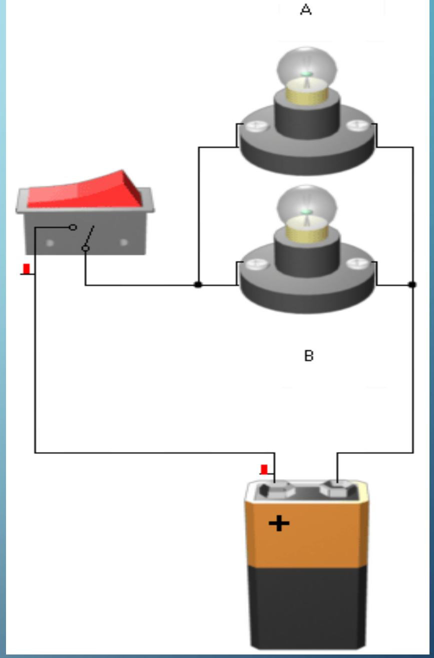
- BULB OR LAMPS (KNOWN AS THE LOAD) ARE ARRANGED IN CHAIN.
- CIRCUIT CURRENT HAS ONLY ONE PATH TO TAKE. CURRENT FLOWING THROUGH EACH RESISTOR IS THE SAME.
- TOTAL CIRCUIT RESISTANCE IS FOUND BY SIMPLY ADDING UP THE RESISTANCE VALUES OF THE INDIVIDUAL LOADS.
- TOTAL VOLTAGE AND POWER IS DIVIDED ACCORDINGLY THROGH THE LOADS.

2. PARALLEL CONNECTION



- LOADS ARE ARRANGED SUCH THAT TWO ELECTRICALLY COMMON ENDPOINTS ARE CREATED.
- TOTAL CIRCUIT CURRENT IS DIVIDED ACCORDINGLY THROUGH EACH PARALLEL BRANCH.
- TOTAL RESISTANCE IS FOUND BY ADDING UP THE RECIPROCALS OF THE RESISTANCE VALUES, AND THEN TAKING THE RECIPROCAL OF THE TOTAL.
- VOLTAGE IN EACH PARALLEL BRANCH IS THE SAME AS THE SOURCE VOLTAGE.

SERIES CIRCUIT	Electrical Parameter	PARALLEL CIRCUIT
R1 + R2 + R3 >R's	Total Resistance (R_T)	$\frac{1}{\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}}$ <Smallest Resistance
Constant	Total Current (I_T)	Sum of the currents in each branch
Sum of all Voltage Drop	Total Voltage (V_T)	Constant
$V_T I_T$	Total Power (P_T)	$V_T I_T$



SERIES CONNECTION

WHAT WILL HAPPEN IF ONE BULB BURNS OUT???

WHAT WILL HAPPEN IF ONE BULB BURNS OUT?

NONE OF THE BULBS WOULD LIGHT UP…

PARALLEL CONNECTION

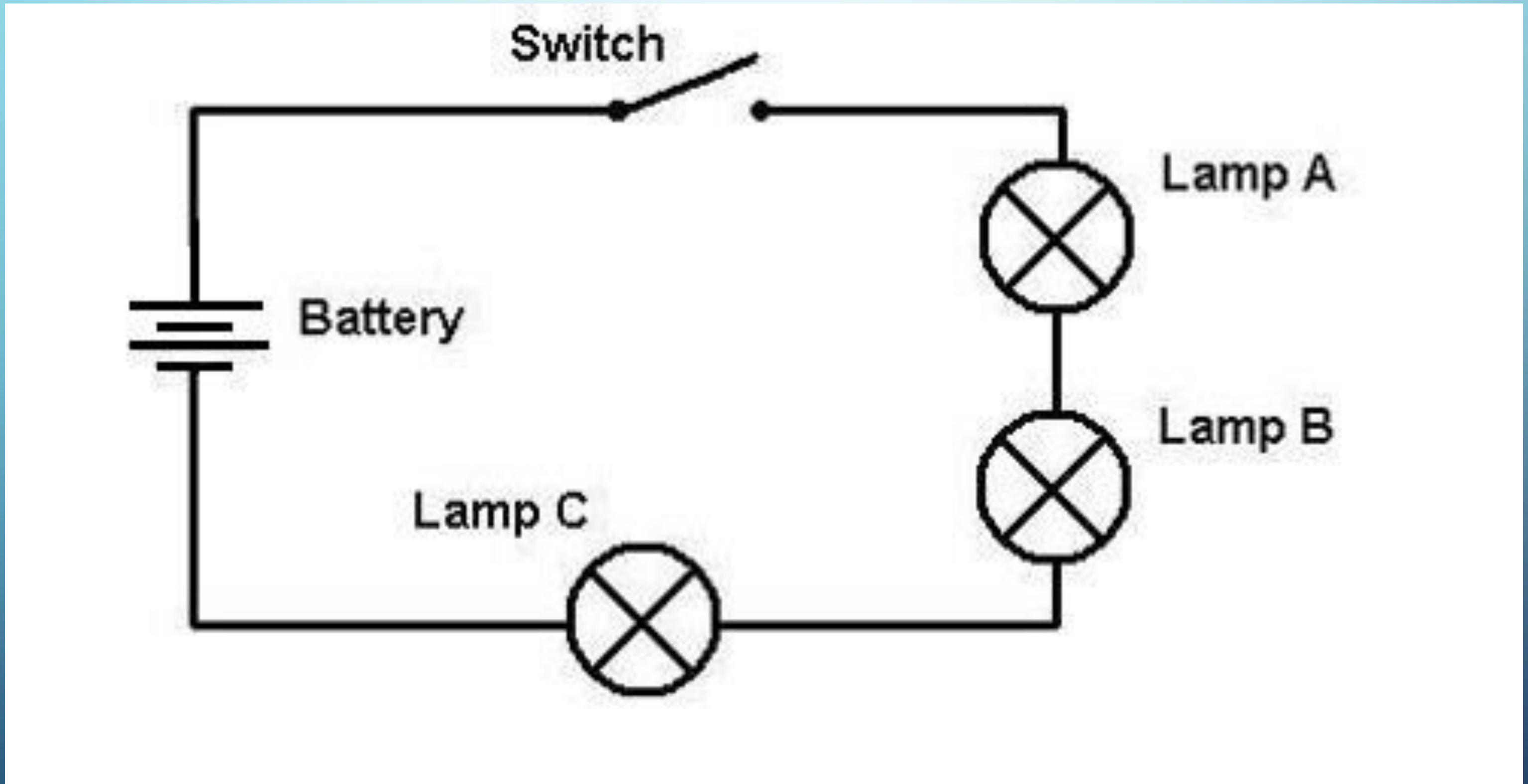
WHAT WILL HAPPEN IF ONE BULB BURNS OUT???

WHAT WILL HAPPEN IF ONE BULB BURNS OUT?

REMAINING BULBS WOULD LIGHT UP…

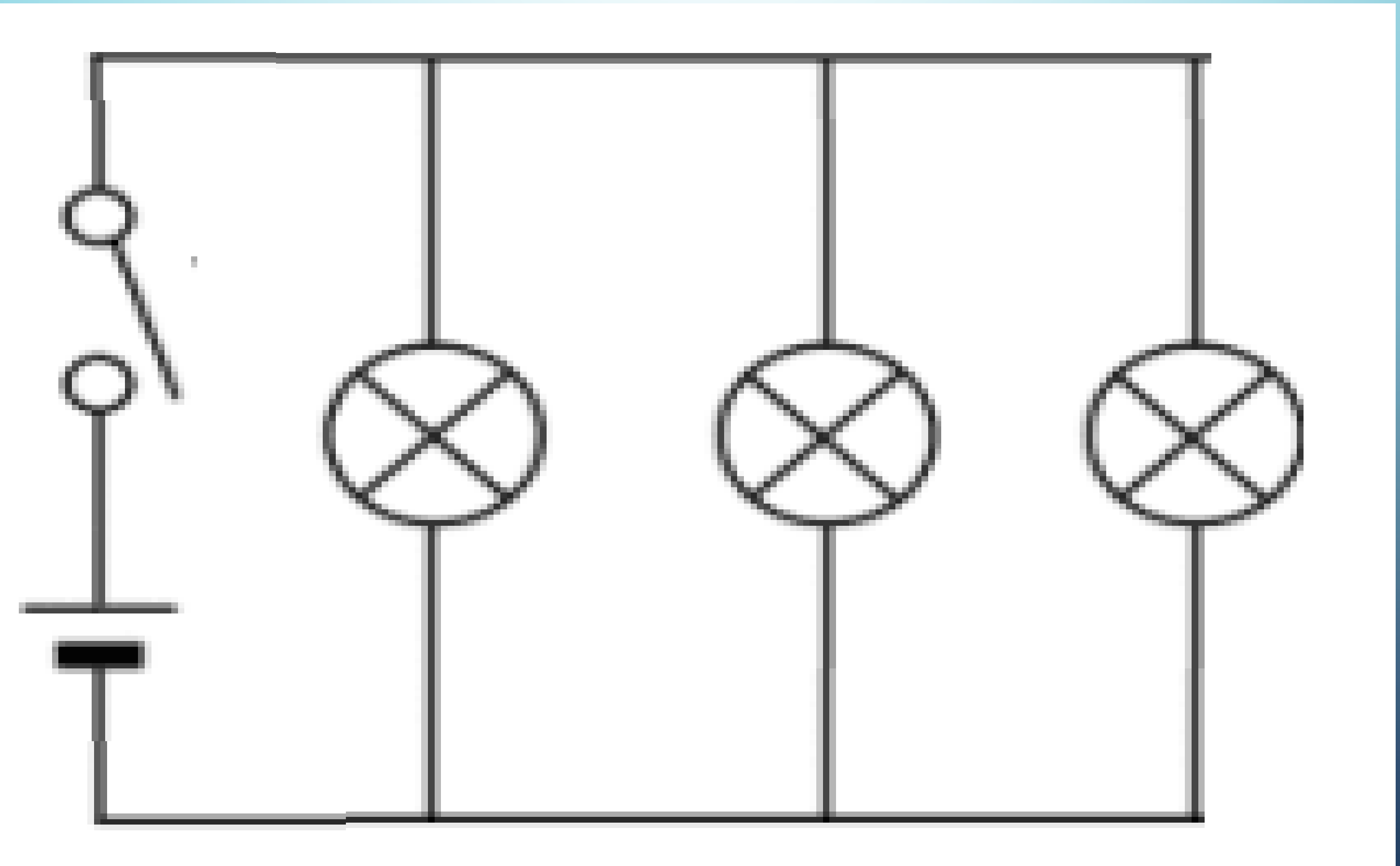
ACTIVITY 2
CIRCUIT CONNECTION

1. **SERIES CONNECTION**



ACTIVITY 2
CIRCUIT CONNECTION

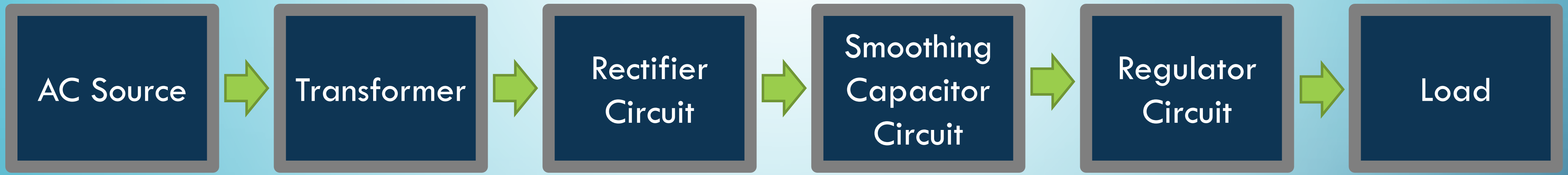
2. PARALLEL CONNECTION



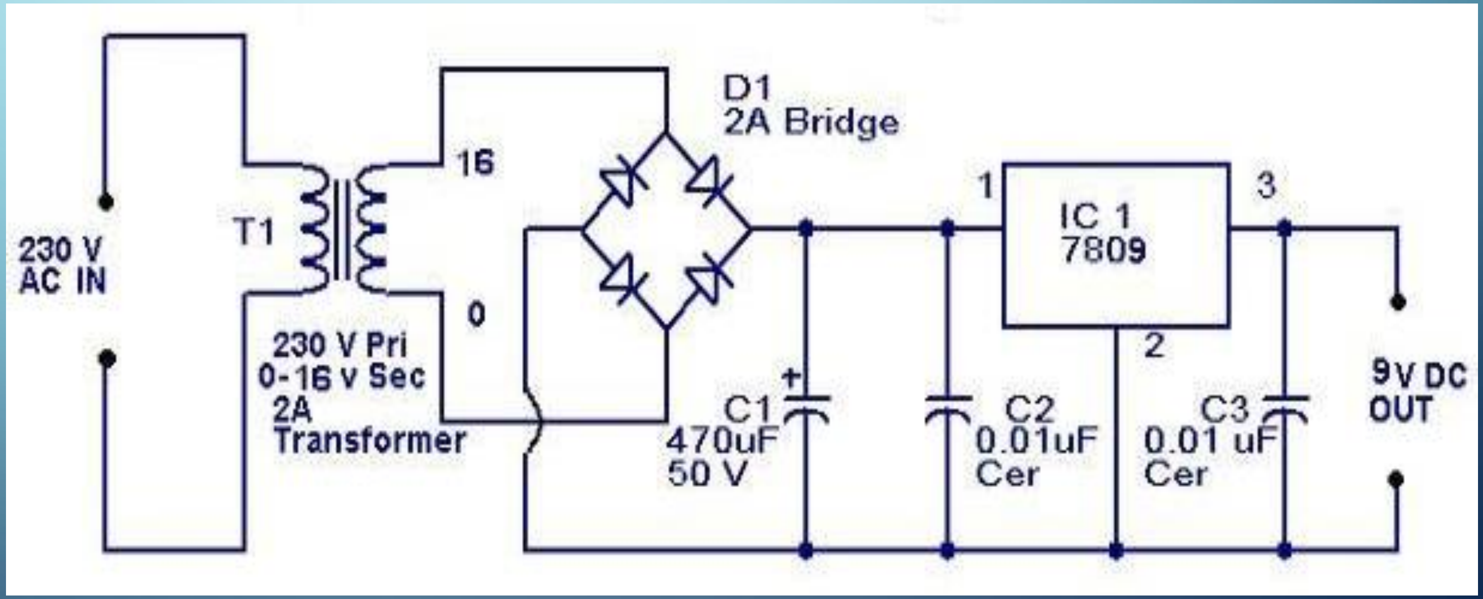
BACK TO TOP

POWER SUPPLY UNIT

- **Block Diagram**



- **Circuit Diagram**



BACK TO TOP

TROUBLESHOOTING & REPAIR PROCEDURES

SAFETY CONCERNS:

- Contact professionals and qualified servicemen for equipment that poses risk.
- Proper tools are a must.
- Instruments must be well-maintained and correctly calibrated.
- Most low-voltage electrocutions are the result of the failure to lock out, disconnect or isolate power.
- Use insulated gloves and tools.
- Use GFCIs. (Ground Fault Circuit Interrupter)

MAIN CONCERN

The effective & efficient working condition of a certain laboratory equipment depends on the following four features:

- Maintenance
- Servicing
- Troubleshooting
- Repair

MAINTENANCE

- Maintenance is a continuous process.
- Must include both the Hardware and the Software.
  - Hardware:
    - Cleaning/Dusting
    - Maintaining prescribe levels of parameters such as electrical, environmental, and others.
  - Software:
    - Reinstallation/Uninstallation
    - Upgrade

SERVICING

- Mainly associated with the hardware parts of the equipment.
- It Includes:
  - Check-ups,
  - Repairs, and
  - Updating of all physical components

SERVICING

- **STEPS:**

1. Uninstall all physical components starting from power connections.
2. Clean dust from the components.
3. Perform a visual check or electronic check as required.
4. Reinstall all components carefully and properly.

SERVICING (cont.)

5. Check for loose wiring or crack cables.
6. Check if any jumper is missing, if required replace it with a new one.
7. Check for physical damages of peripherals and replace them if needed.
8. Tighten all internal and external connections.
9. Switch on the power supply and observe.

TROUBLESHOOTING

- Detection and rectification of faults in the equipment.

REPAIRING

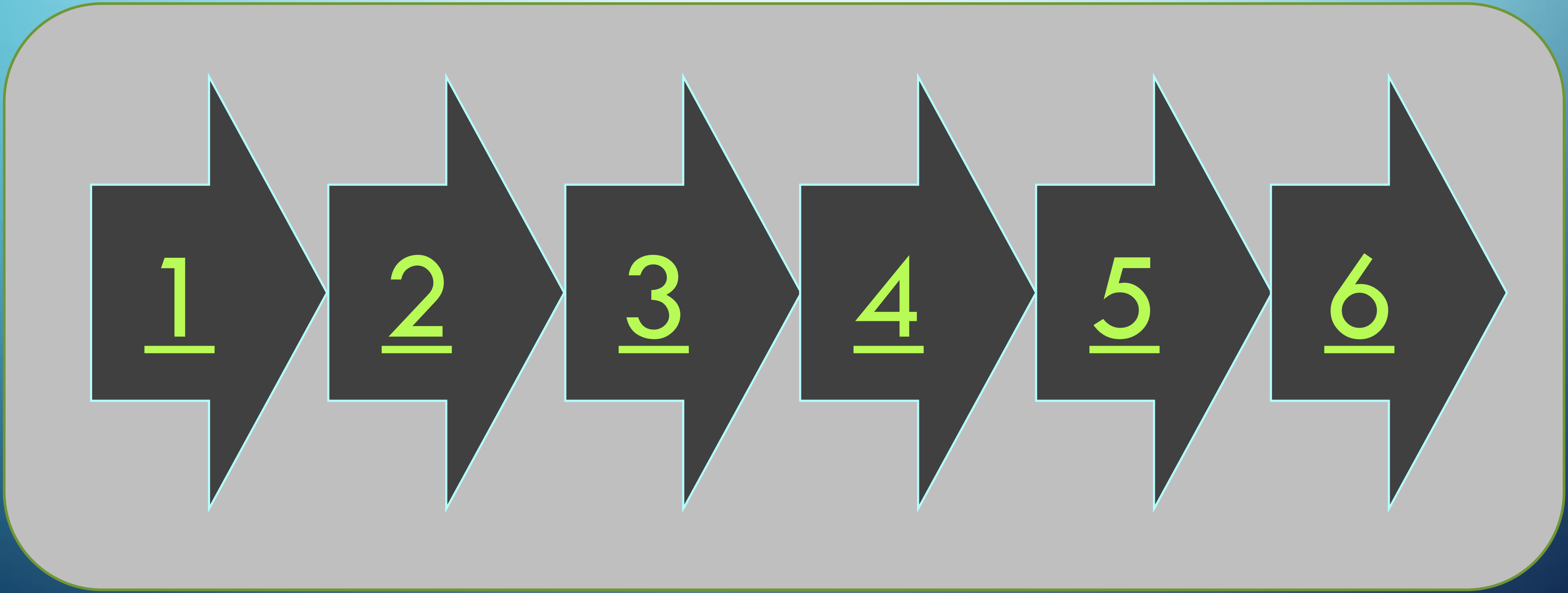
Repairing means to rectify the problem in the hardware or software.

It is an essential part of troubleshooting.

Repairing may also include replacement of a component.

SIX-STEP PROCEDURE

- A standardized approach toward electronic troubleshooting and maintenance:



SYMPTOM RECOGNITION

- Determine if the equipment is functioning as design.
- A trouble symptom is an indicator of malfunction.
- Use your senses of **SIGHT** and **HEARING**.

BACK

SYMPTOM ELABORATION

- What fault is probably causing the specific symptoms?
- Symptom elaboration requires an evaluation of all observed displays.
- Indications must be evaluated in relation to each other as well as the overall operation.
- Record information observed! For example: How did each control affect an associated meter or other indicator?
- “Think” about the information before jumping to a conclusion

BACK

LISTING PROBABLE FAULTY FUNCTIONS

- Dividing the equipment into functional areas can save numerous trouble shooting steps.

- Use **FUNCTIONAL BLOCK DIAGRAM (FBD)**

FBD shows the functional areas of an equipment, as well the detailed functions, levels of input and output parameters (voltage and current).

BACK

LOCALIZING THE FAULTY FUNCTION

<u>* Isolating the functional area</u> that has an indication of ***<u>malfunction</u>***. :

* **<u>Knowledge, skill, and proper test equipment</u>** should now be used to isolate the faulty functional area.

BACK

LOCALIZING THE TROUBLE TO THE CIRCUIT

- Isolating the circuits within the faulty unit.
- More extensive troubleshooting is now required within the identified faulty unit.
- Look for improper voltages, improper waveforms, obvious component overheating.
- Isolate the defective circuit group.

BACK

FAILURE ANALYSIS

- Steps 1 and 2 were used to ***recognize, verify, and obtain descriptive information***
- Step 3 allowed you to ***make a logical selection*** of the logical faulty unit
- Step 4 provided for simple input-output ***tests and localized the faulty functions***
- Step 5 ***localized the fault to the circuit*** within the faulty unit
- Step 6 will involve the ***actual replacement or repair of faulty circuit components***

BACK TO TOP