



NATE (Core)

Instructor
Technical Service Trainer

Monday, July 20, 2026



DISCLAIMER

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This training seminar is dedicated to Bill “The Professor” Doster for the many years he devoted to passing his knowledge to the HVAC industry and beyond.

Bill “The Professor” Doster
January 3, 1943 – May 23, 2026



SERVICE TECH APP

Carrier Service Technician

- Carrier Google Play



- Carrier App Store



Bryant® Service Technician

- Bryant Google Play



- Bryant App Store



RC Mobile Technician

- RC Google Play



- RC App Store



CAFFEINE & COILS PODCAST



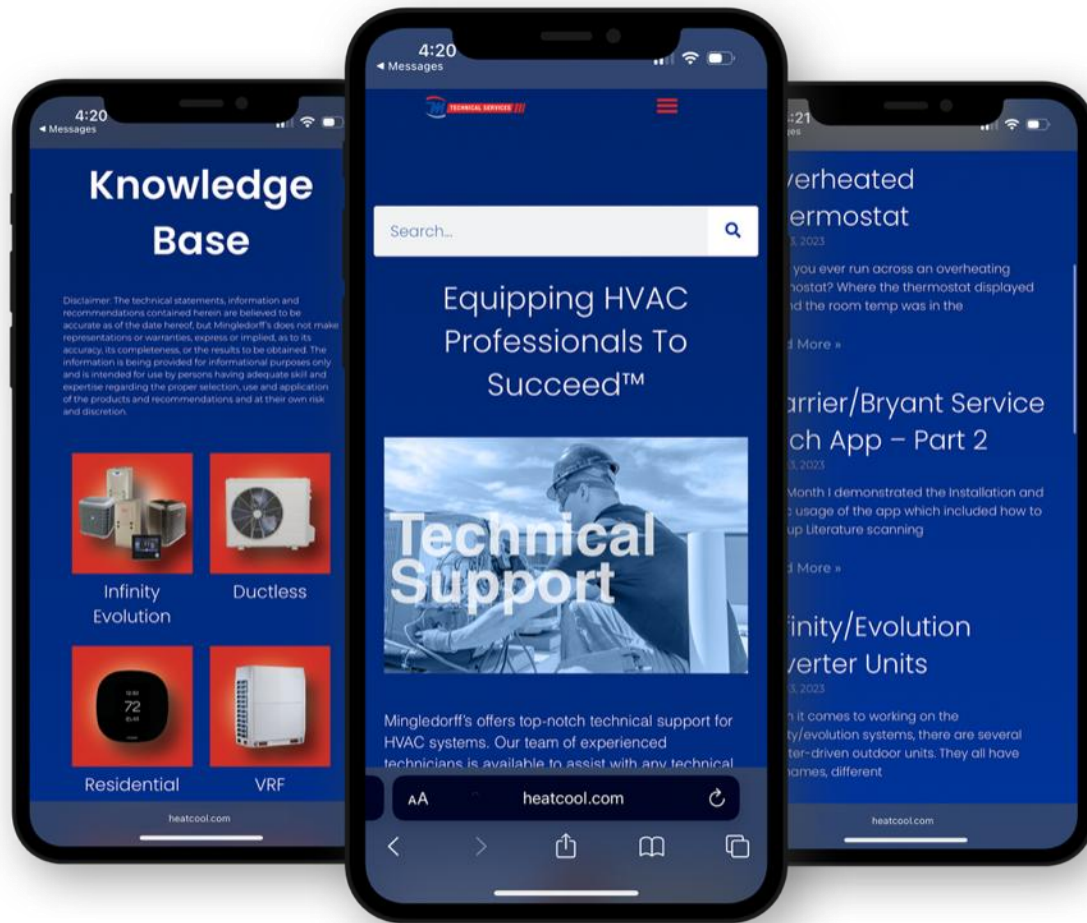
- Mingledorff's new podcast featuring Jenny Brown and Deanna Lassiter
- This podcast is your go-to source for valuable insights, expert interviews, and cutting-edge industry trends.



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An improved digital experience for those in the field



HEATCOOL.COM



INTRODUCING MINGLEDORFF'S NEWEST TECHNICAL AND WARRANTY RESOURCE! EVERYTHING TECHNICAL AND WARRANTY RELATED UNDER A SIMPLE URL – HEATCOOL.COM.

- **TECHNICAL SUPPORT**
 - Product Knowledgebase
 - Access to Factory Manuals
 - Technical Services Contacts
- **WARRANTY SUPPORT**
 - Helpful Links & Resources
 - Online Warranty Tips
 - Warranty Experts Contacts
- **TECH TIPS – MONTHLY NEWS ARTICLES**
- **TRAINING CALENDAR AND ONLINE LEARNING**
- **MANAGED BY TECHS FOR TECHS**



TECH TIPS AND TRAINING INFORMATION



Ecobee Setup

Ecobee thermostats provide multi-speed fan control to work with 2/4-pipe fan coil units with/without pipe sensors (24V systems only) and multi-speed PTAC units. These settings are accessed through the "I'm a Pro" setup flow. Many of the same first-run configuration steps apply as described in the "I'm a homeowner" section, however this section will callout and describe the key screens and settings.

First step is to determine the correct configuration for the application the ecobee is going to be controlling.



Servicing Carrier VRF Part 2

As service and installation technicians we need to be able to figure out problems or ensure a system is running as it should. Are VRF systems serviced like a residential split system? The simple answer is no. VRF contains many more moving parts and electronics depending on what you're looking at.

Last month we covered how to get the software and your service computer hooked to a system. If you need a refresher or missed that portion you can find it here: [\(PLEASE INSERT LINK TO ARTICLE HERE\)](#). When first opening STT (Service Technical Tool) it can be a little confusing how to get started and figure out what exactly you're looking at or looking for. Today we will be exploring this software.

Monthly **REAL** “how too technical tips.”
Upcoming Training Seminars & link to registration of those seminars.
Consistent & accurate technical information.
View articles that have been archived.
If you are not receiving the newsletter, contact Erin at: Erin.Turner@mingleodrffs.com

Spring Service Update

MingleDorff's Spring Service Update class focuses on the latest techniques and best practices for maintaining HVAC systems during the spring season. The class covers a range of topics related to seasonal system checks, preventative maintenance, and troubleshooting common issues that arise.

- Earn 4 FAD distributor hours, 4 NATE hours and 4 State CEU's
- Topics to be covered:
 - ACU Refrigerant
 - IntelliSense
 - Replacement VFD Update
 - SystemVu
 - Quality Update

REGISTER NOW

or click to register

*Vacuum pump clinic available

Location	Date / Time
MingleDorff's - Atlanta 1402 Technia Dr. Atlanta, GA 30318	3/9/ 8am-12pm
MingleDorff's - Newnan 20 Enterprise Ct. Newnan, GA 30285	3/11/ 5pm-9pm
MingleDorff's - Norcross 6675 Jones Mill Ct Peachtree Corners, GA 30092	3/12/ 5pm-9pm
MEC - Braselton 5455 Dutton Ct Braselton, GA 30017	3/13/ 10am-2pm
MingleDorff's - Forest Park 2138 Kennedy Rd, Suite D Forest Park, GA 30097	3/13/ 5pm-9pm
LOCA - Live Oak Room 2718 Jamming Creek Road Lawrenceville, GA 30045	3/14/ 5pm-9pm
MingleDorff's - Marietta 6665-D Trail Ct. Marietta, GA 30063	3/18/ 5pm-9pm
VFW - Conyers 1422 VFW Drive SW Conyers, GA 30012	3/19/ 5pm-9pm
Gwinnett Tech - Banquet Hall Rm 1309 1100 Sugarloaf Parkway Lawrenceville, GA 30043	3/20/ 5pm-9pm
Comfort Inn - Blue Ridge 63 Blue Ridge Overlook Blue Ridge, GA 30513	3/20/ 5pm-9pm
GNTO - Building H, Room 101 1 Maurice Outberson Dr. SW Rome, GA 30161	3/25/ 5pm-9pm
MingleDorff's - Lithia Springs 302 Thornton Rd Suite 106 Lithia Springs, GA 30122	3/26/ 5pm-9pm
Athens Technical College Building T Rm 108 605 1st St. Athens, GA 30601	3/28/ 5pm-9pm

Upcoming Training Information

EPA 608 Online

Become EPA 608 certified online with our EPA 608 Review & Test sessions via Zoom!

- Each technician must have a computer with a camera and the exam will be recorded
- Only one student per computer is allowed
- The technician must be in view of the camera at all times during the exam
- Due to online proctoring regulations, space is extremely limited. When you register, you will receive instructions on how to get to the study guide and practice test.

Register Now



OBSERVE ALL SAFETY MEASURES



- Remove Jewelry Before Servicing



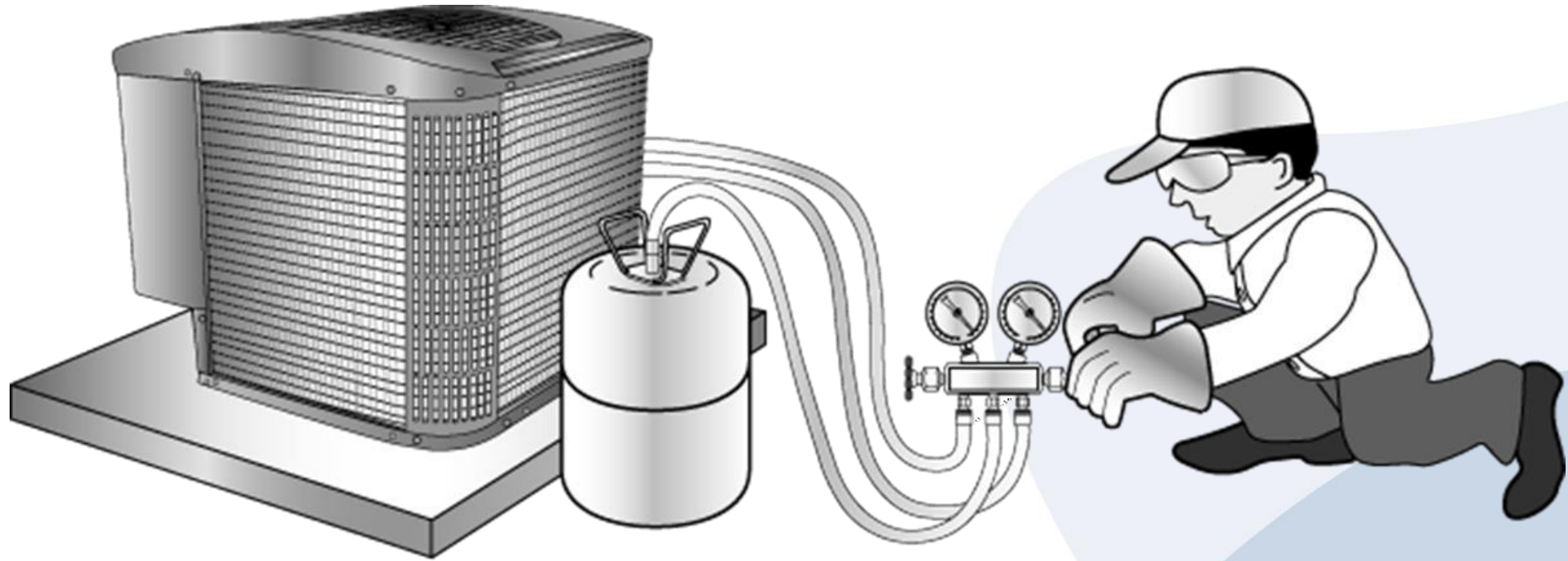
Lock out/tag out equipment disconnect switch



Gas pipe leak testing



SAFETY REVIEW



Use Safety Equipment

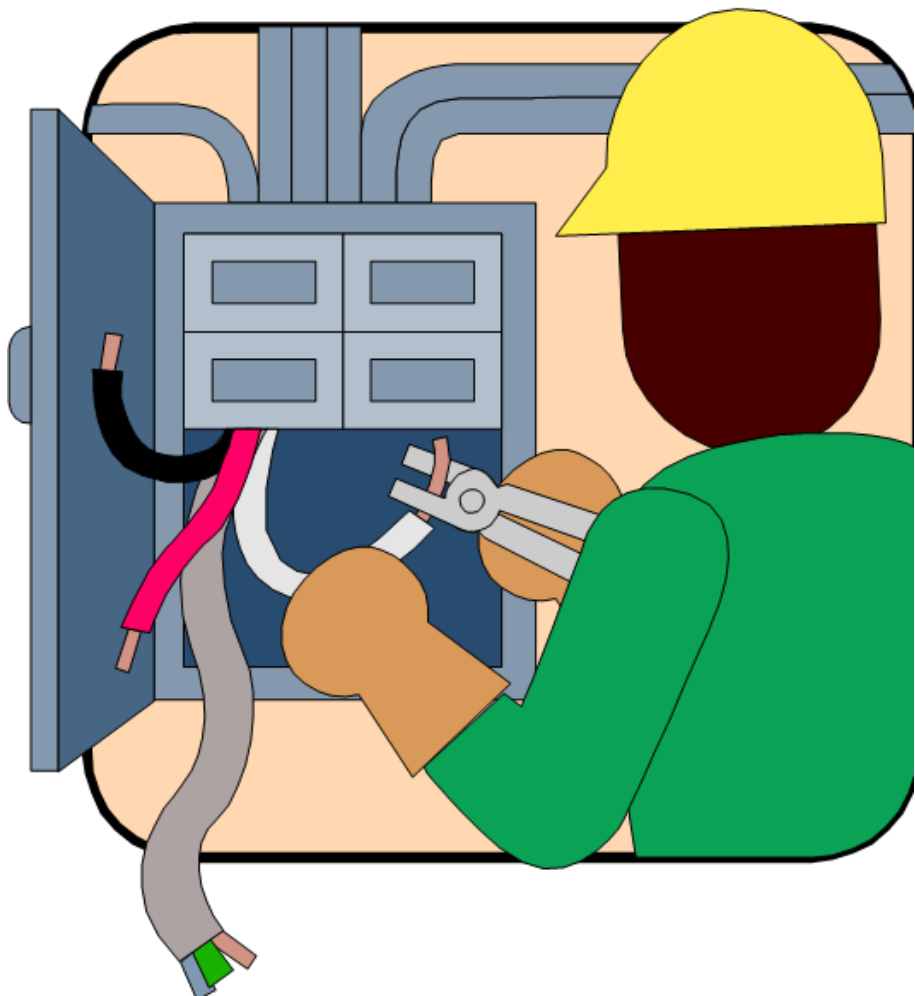


SAFETY REVIEW



Lift and Move Correctly

- High voltage is always dangerous.
- Even 40 volts can be lethal if skin is wet or damaged.



- Do not wear rings or jewelry when working on electrical circuits.
- Never use screwdrivers or other conductive tools in an electrical panel when the power is on.



GENERAL SAFETY

- *Use two hands to grasp the ladder*
- *Observe the type of roof material you may walk on. Slate roofs are extremely slippery at all times*
- **Observe safety rating on each ladder**
- **Extend ladder past roof line (36 in.)**
- **Never stand on top of A-frame ladder**
- *Seat belts should be worn at all times*
- *Never use oxygen to pressurize a system to check for leaks in a refrigeration system*
- *Never start a hermetic compressor while in a vacuum*



EPA REGULATIONS

Federal regulation requires anyone servicing, repairing or disposing of any equipment containing a controlled refrigerant to have in his/her possession a card certifying that he/she has obtained the proper level of certification for the work he/she is performing.

THIS MEANS YOU CANNOT WORK UNDER ANOTHER PERSON'S CERTIFICATION.



EPA Regulations

EPA regulations require that hoses be equipped with low-loss fittings.

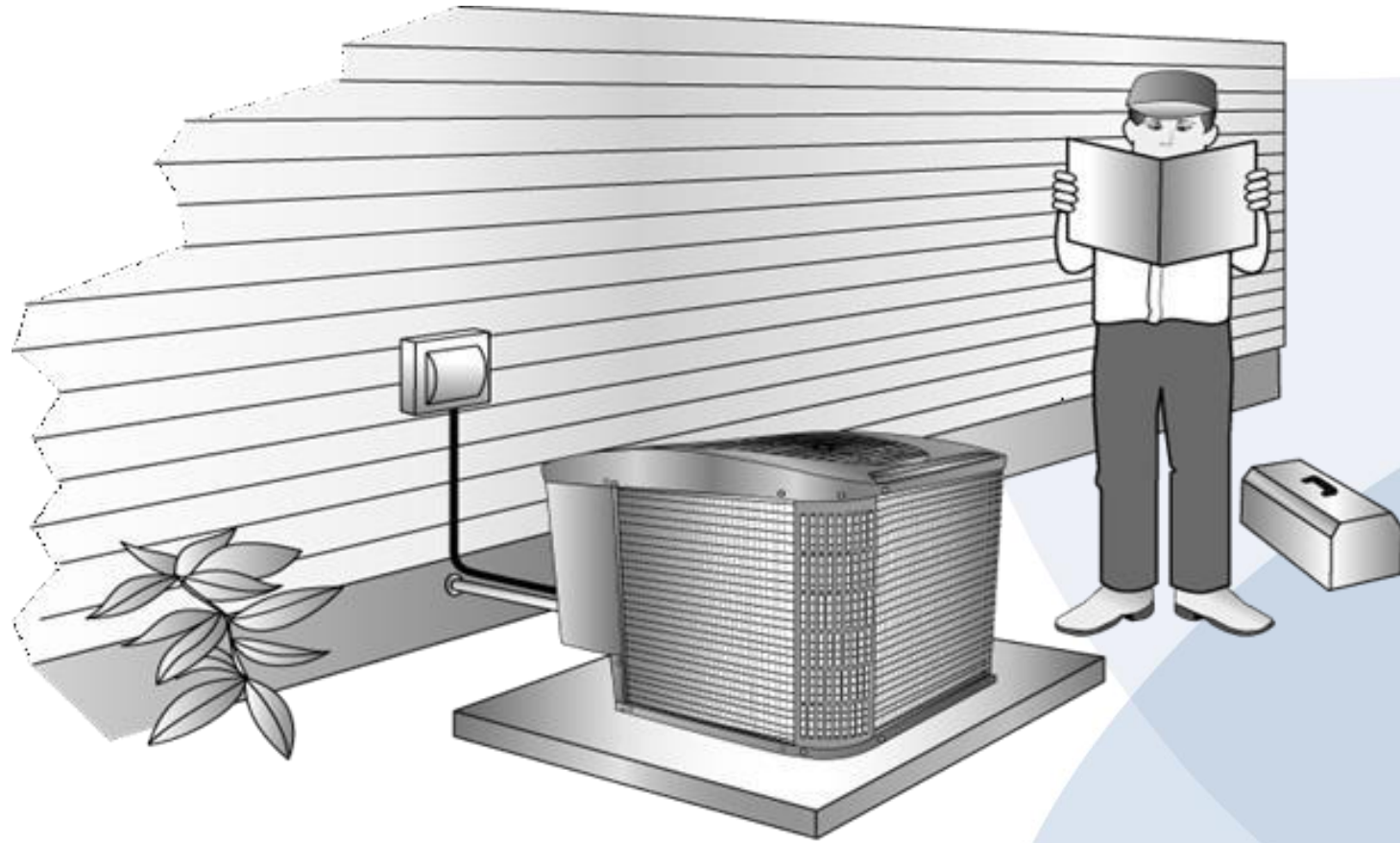




EPA REGULATIONS

- Require a red color marking on all process tubes and other pipes through which a flammable refrigerant passes and at the service connection.
- The color marking must extend one inch in both directions from service locations.

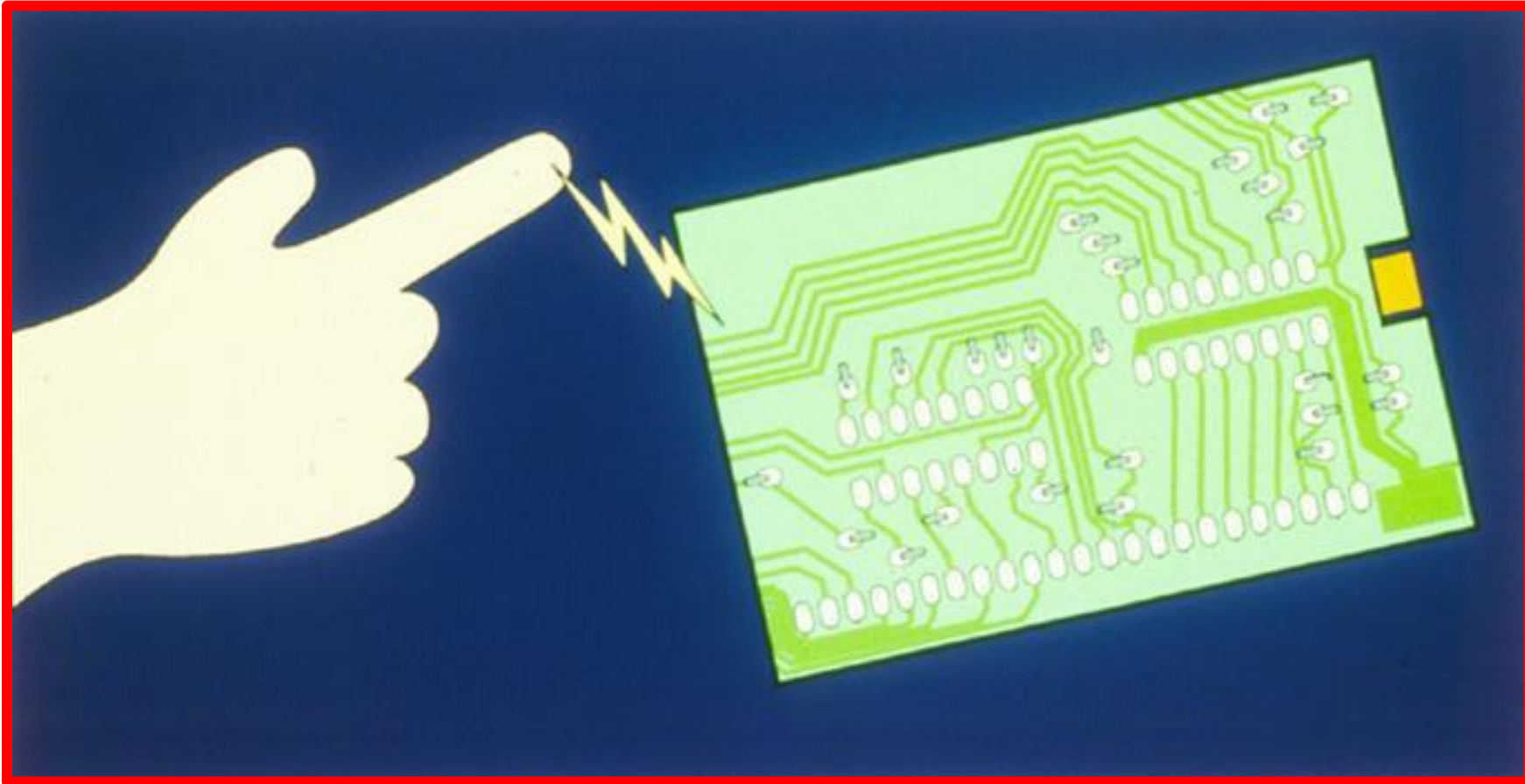
Wingledorff's FOLLOW SERVICE, INSTALLATION AND START-UP INSTRUCTIONS





STATIC ELECTRICITY

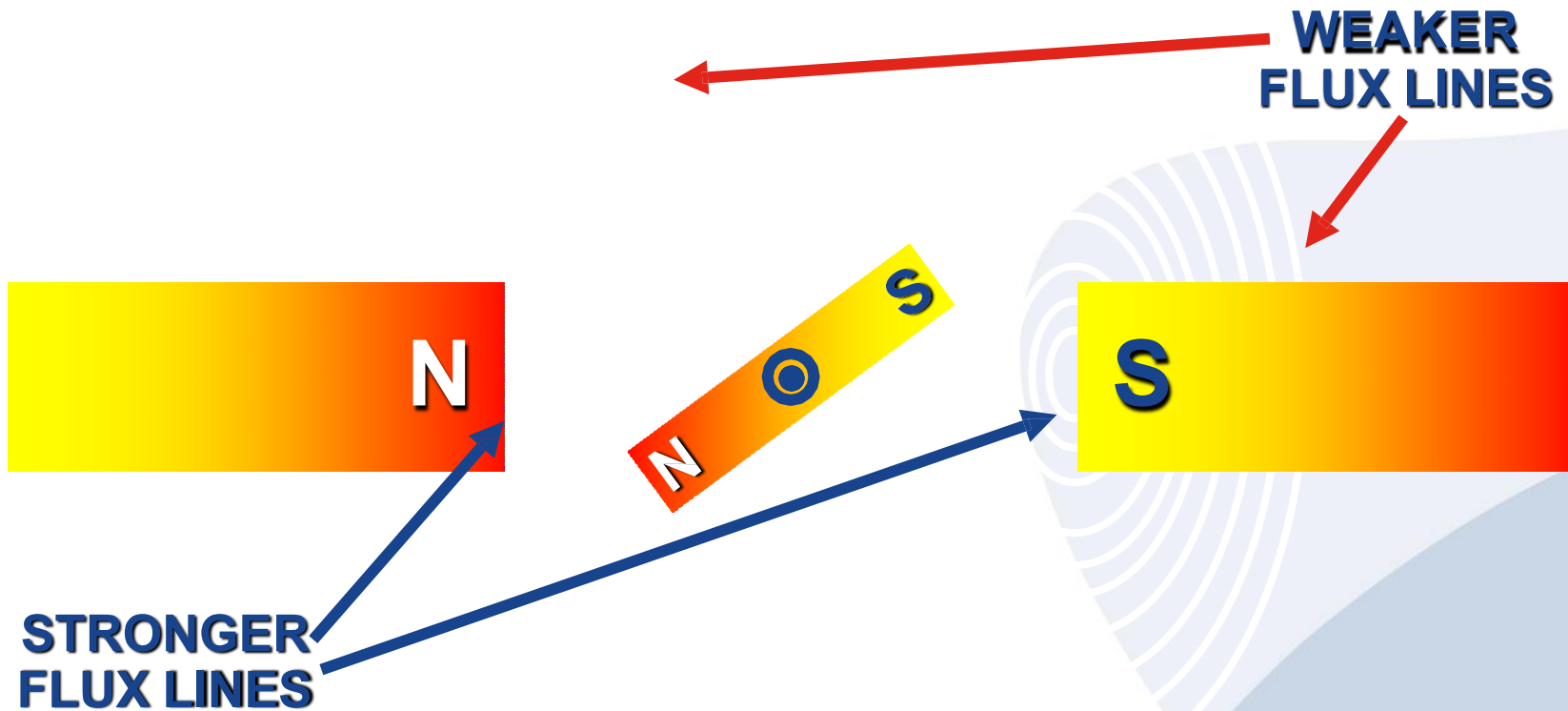
IS ELECTRICITY
AT REST



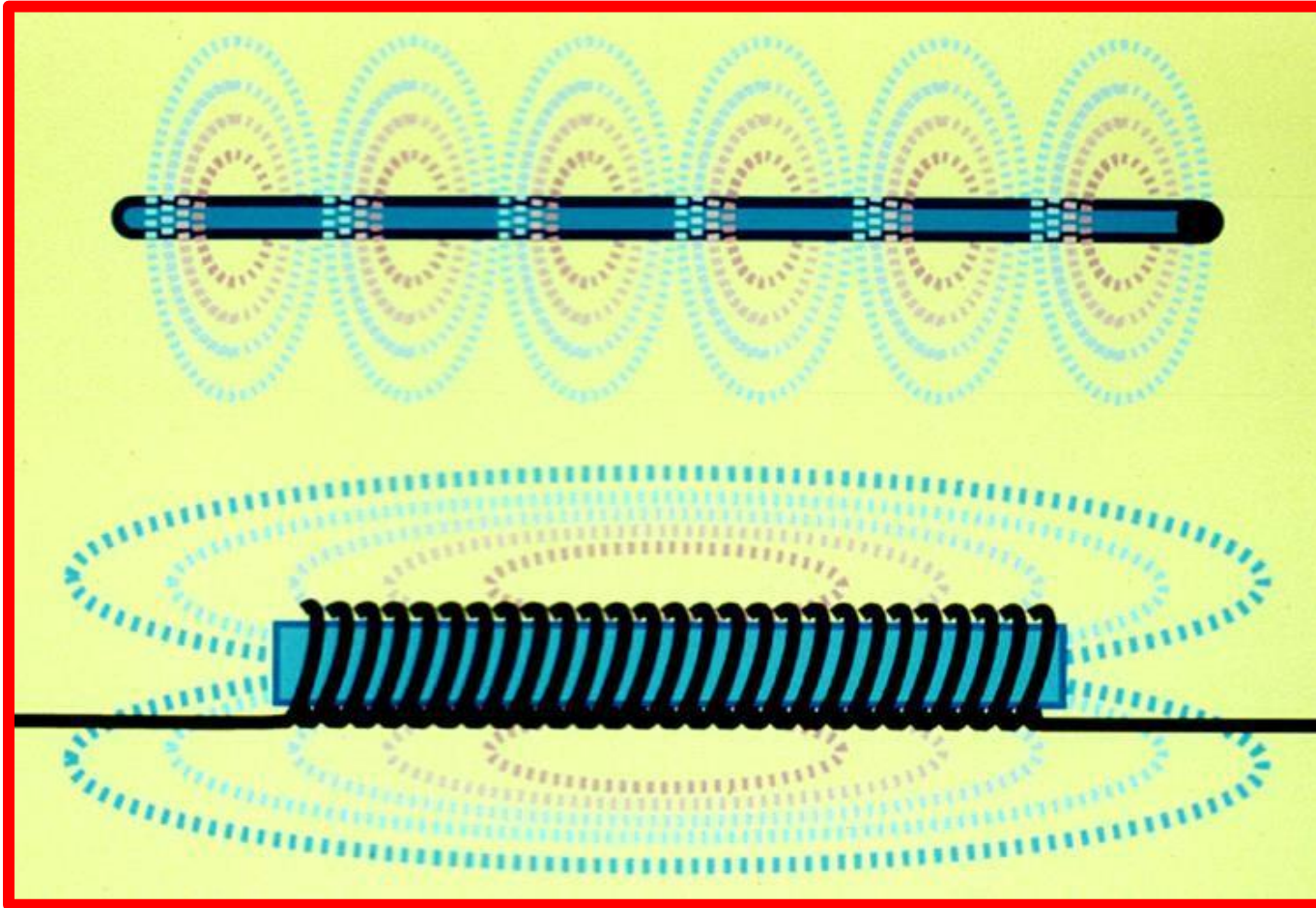
**CARE MUST BE TAKEN WHEN TOUCHING CIRCUIT
BOARDS TO PREVENT STATIC DISCHARGE**



FLUX LINES



**FLUX LINES ARE MAGNETIC LINES OF FORCE THAT
ARE STRONGER NEAR THE MAGNETIC POLE**



Magnetism is also produced by electricity. An electric current flowing through a wire produces a magnetic field around a wire.



CURRENT REFERS TO THE FLOW OF ELECTRONS

**THROUGH A
CONDUCTOR**



CURRENT ELECTRICITY



DC or Direct Current flows from negative to positive.
AC or Alternating Current flows both directions.

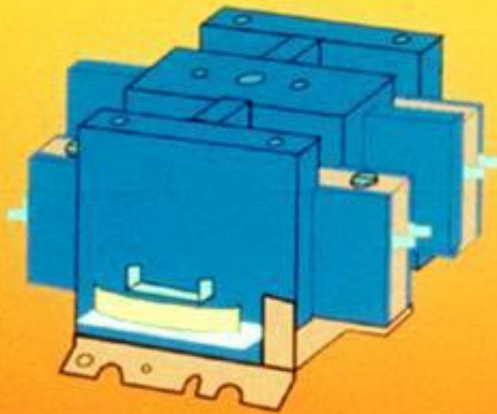
EMF

**THE POTENTIAL DIFFERENCE CREATES A FORCE
CALLED “ELECTROMOTIVE FORCE”**

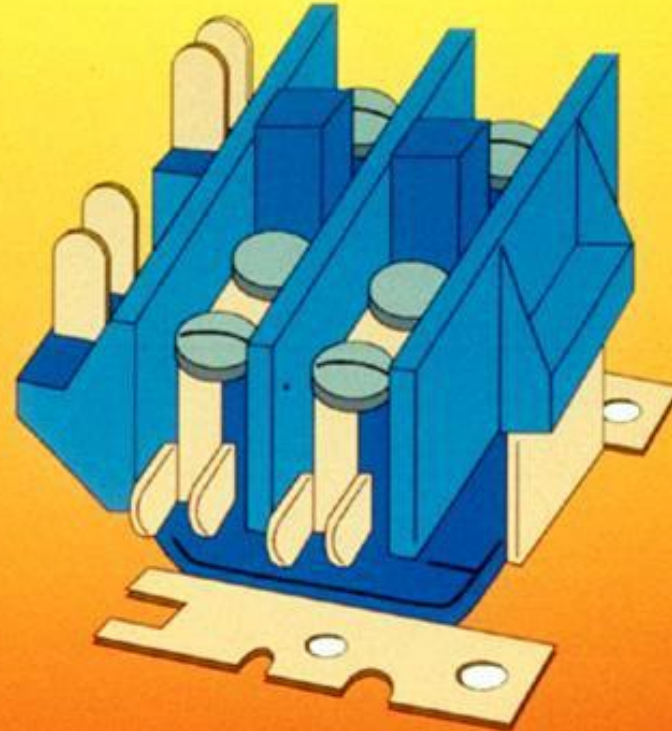
Element	Measurement Symbol		Unit
Current		I	Amperes (A)
Resistance		R	Ohms (Ω)
Voltage		E	Volts (V)

CONTACTS AND RELAYS

Corroded, pitted, or dirty contacts can cause a voltage reading while the contacts are closed



Relay



Contactor

**Electric pressure
that causes
electrons to flow**

The amount of
pressure required to
force one ampere
through a resistance
of one ohm

**The unit of
measurement for
current flow**



MAXIMUM VOLTAGE & CURRENT IMBALANCE

Maximum Acceptable Deviation for a 120 Volt Circuit = $\pm 10\%$

Maximum Voltage Imbalance in a 3-Phase Circuit is 2%

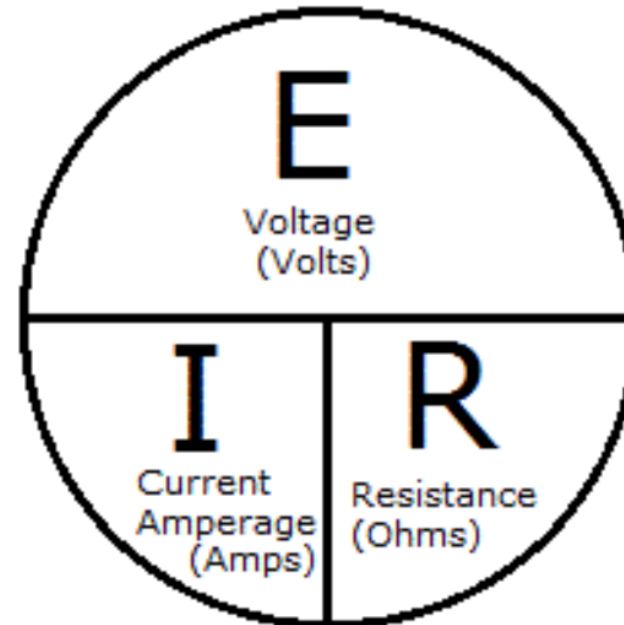
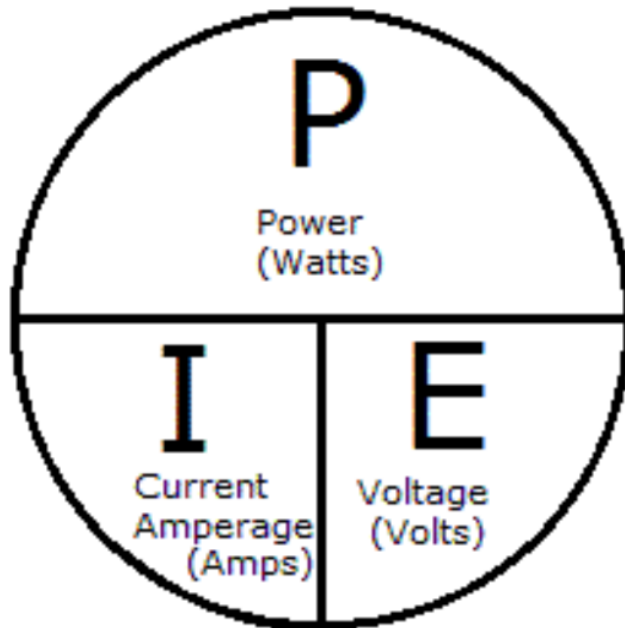
$$\% \text{ Voltage Imbalance} = \frac{100 \times \text{Max. Deviation from Average Voltage}}{\text{Average Voltage}}$$

Maximum Current Imbalance in a 3-Phase Circuit is 10%

$$\% \text{ Current Imbalance} = \frac{100 \times \text{Max. Deviation from Average Current}}{\text{Average Current}}$$

The unit of measurement for resistance

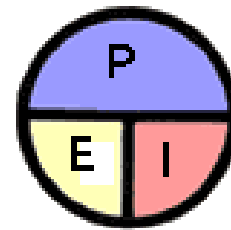
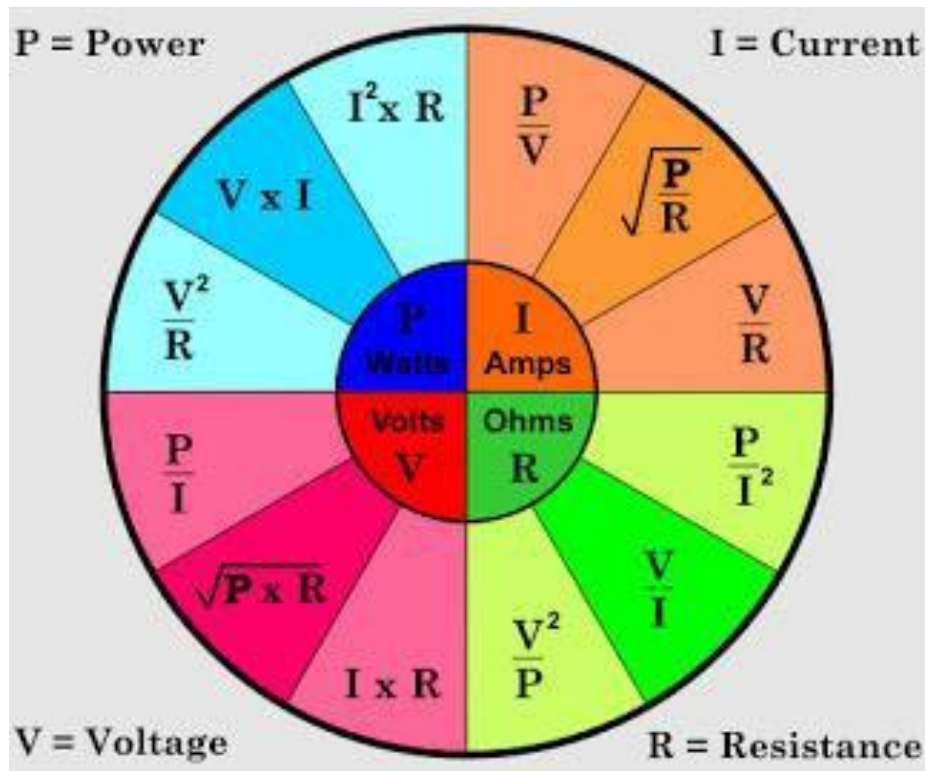
Ohms Law



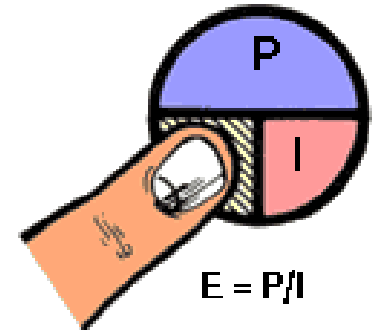
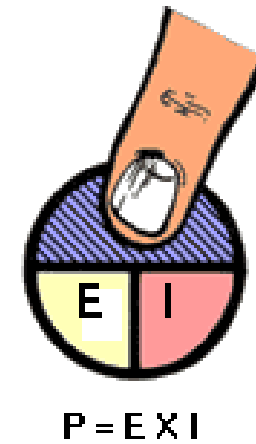
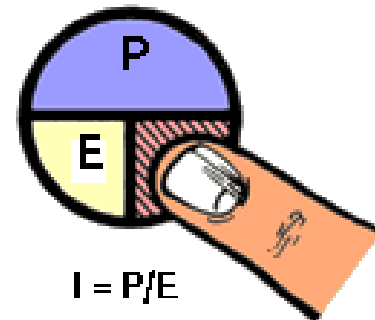
$P = 240$ Watts
 $I = 2$ Amps
 $E = 120$ Volts
 $R = 60$ Ohms

() Means
Measured in!

OHMS-POWER WHEEL



P= POWER - WATTS
E= VOLTAGE, POTENTIAL, EMF -VOLTS
I= CURRENT - AMPS





APPLYING OHMS LAW

The percentage of voltage increase equals the percentage of amperage decrease



FORMUAL FOR POWER

Voltage (volts) x Current (amps) = Power (watts)



WATT TO BTU CONVERSION

1 WATT = 3.414 BTU/HR



TON OF AIR CONDITIONING

1 Ton = 12,000 Btu/H



HORSEPOWER

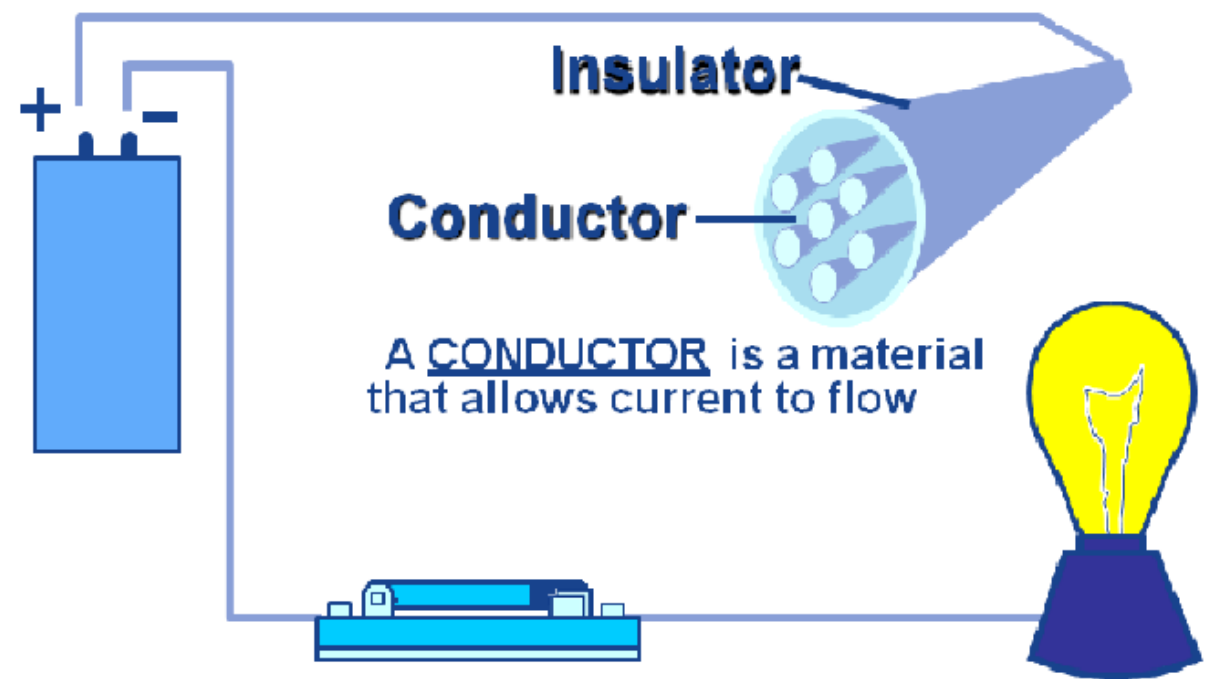
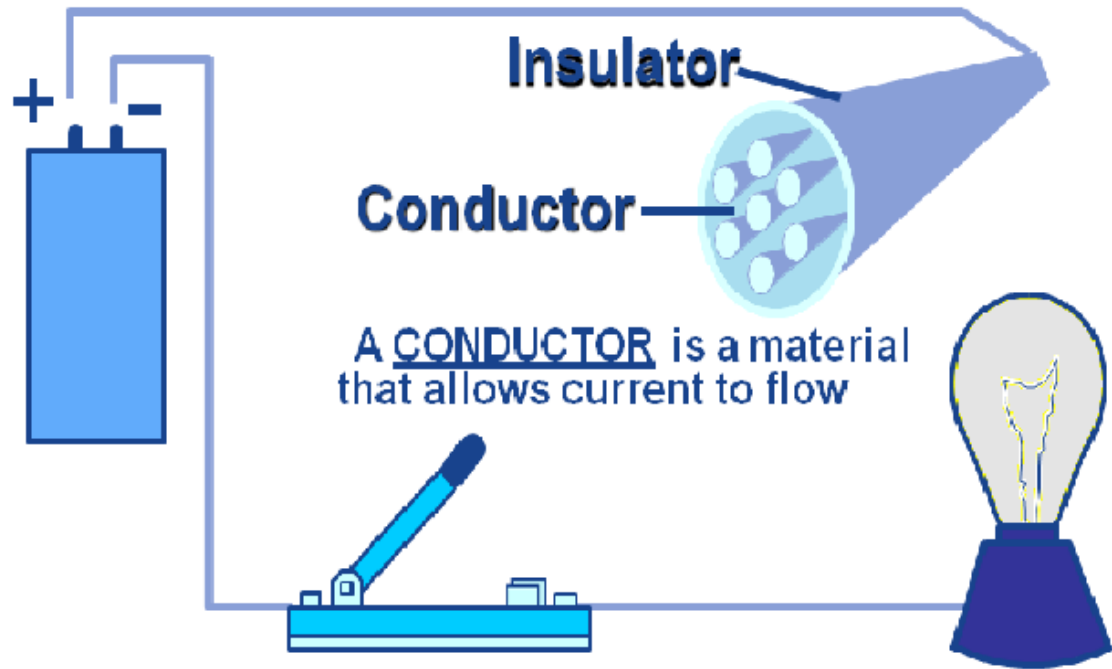
746 watts = 1 HP



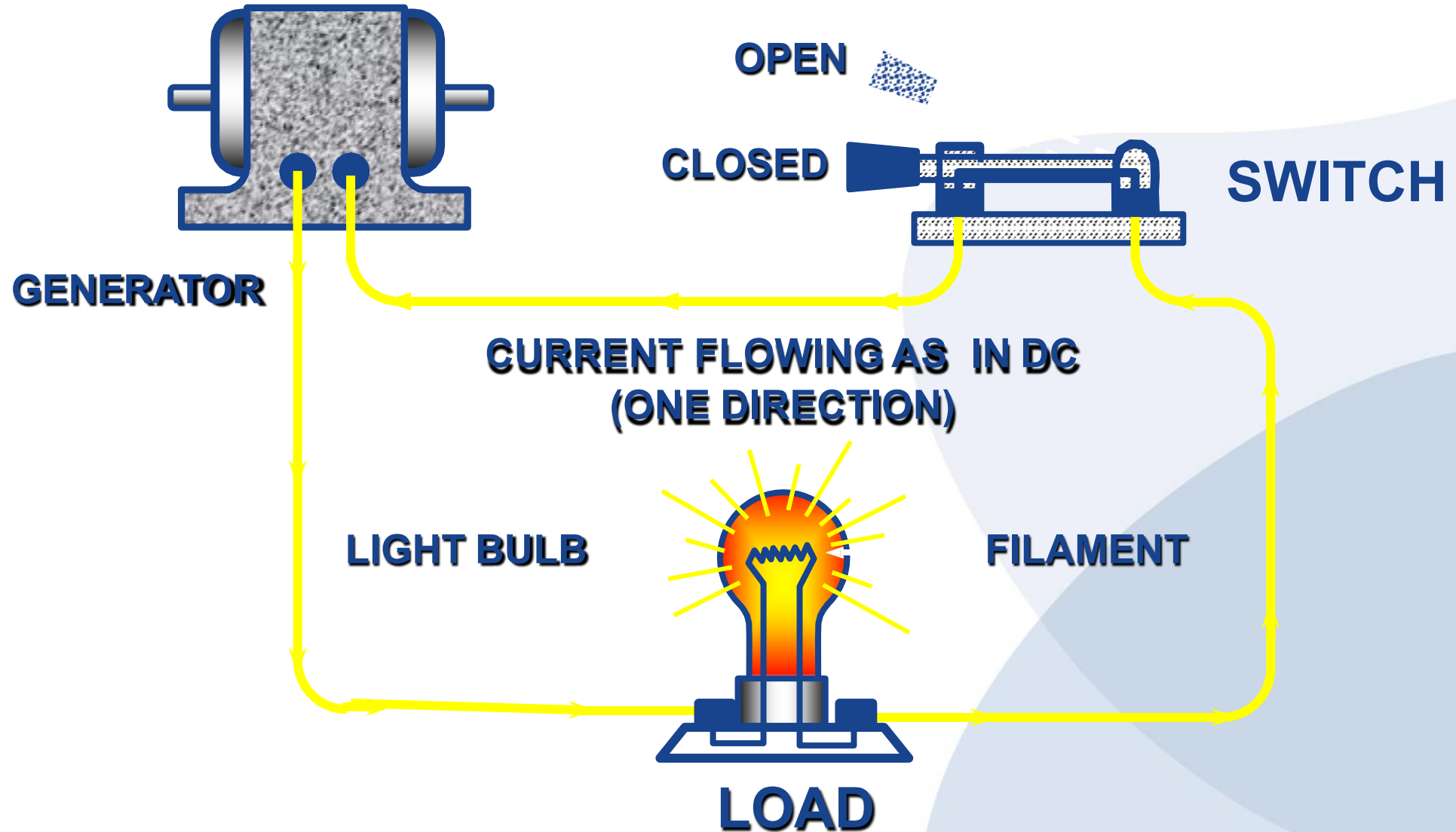
HORSEPOWER

1 HP = 550 Ft/lbs. per second

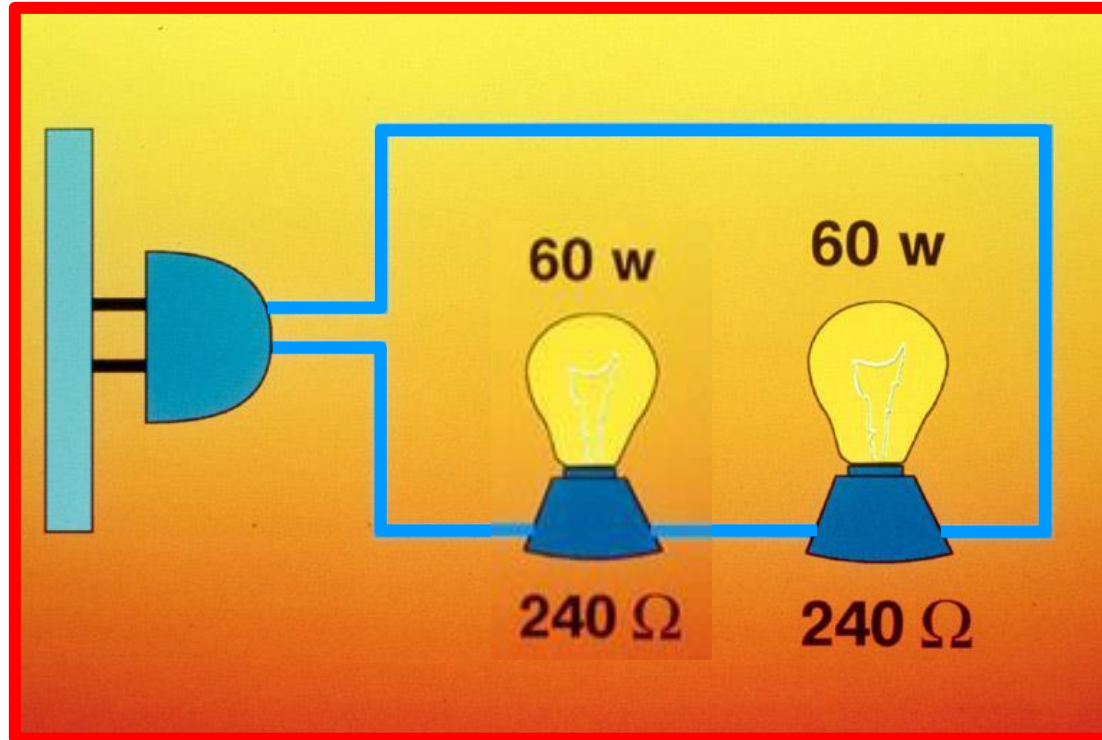
INSULATOR & CONDUCTOR



SWITCH & LOAD



SERIES CIRCUIT



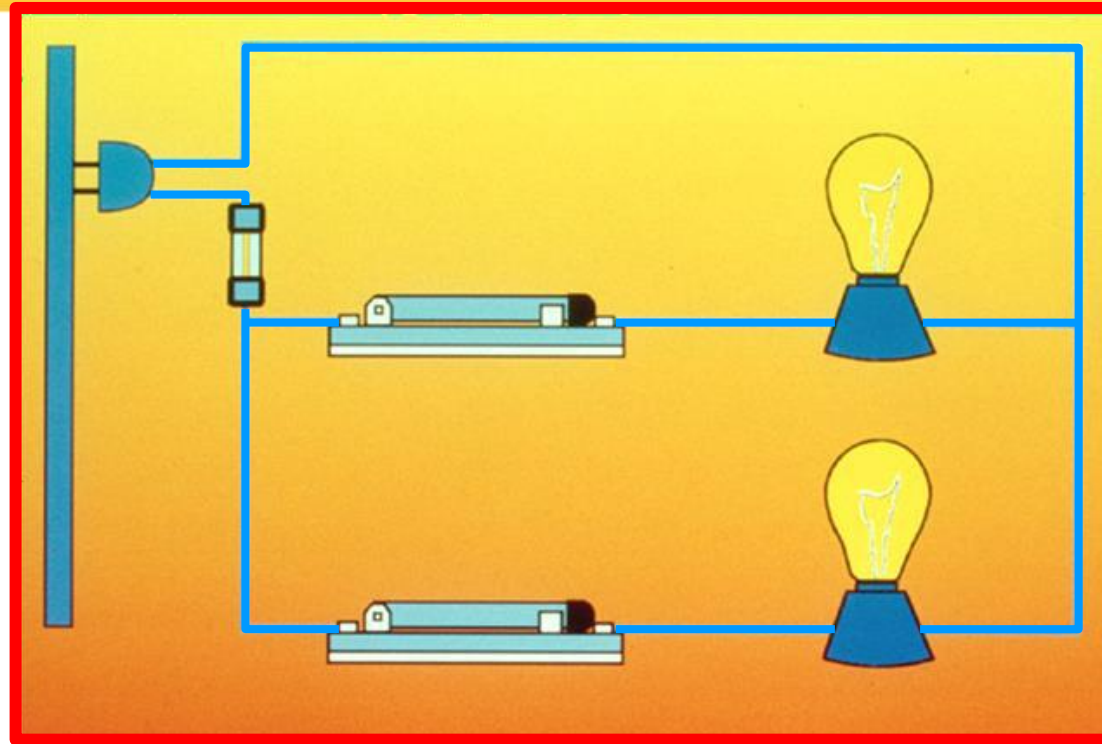
**THE LOADS ARE CONNECTED
IN SERIES ON THE SAME CIRCUIT
TO THE VOLTAGE SOURCE**



SERIES CIRCUIT

- Each load added to a series circuit reduces the amount of current flowing in the circuit, and therefore, reduces the amount of work performed by the circuit. Each additional load has reduced current available.
- When one component in a series circuit fails, the entire circuit fails. While this characteristic may not be helpful in a lighting circuit, it is important for control and protective circuits.

PARALLEL CIRCUIT



**EACH OF THE LOADS
IS CONNECTED DIRECTLY
TO THE VOLTAGE SOURCE**

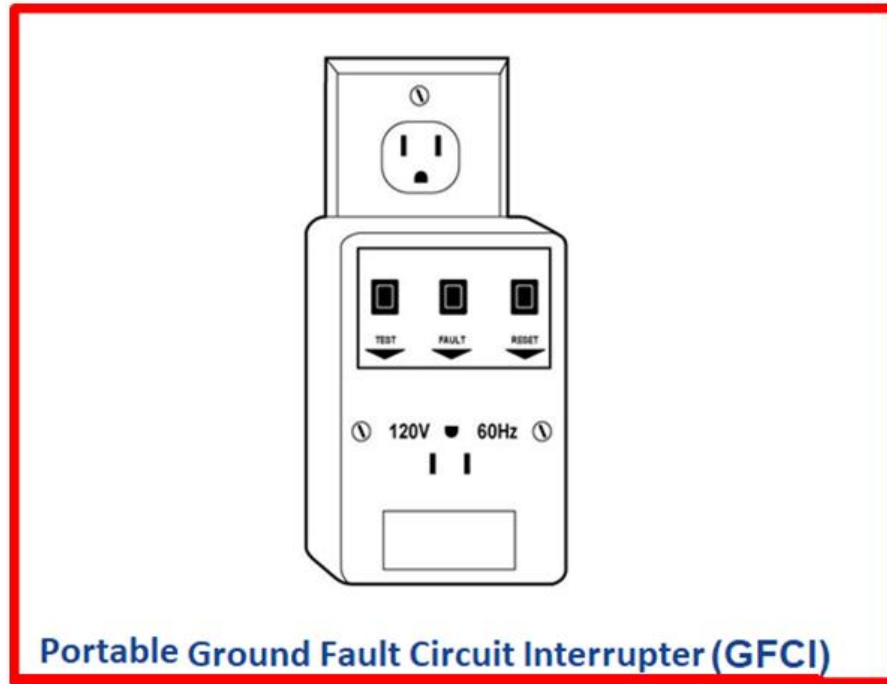


PARALLEL CIRCUIT

- **Unlike the series circuit, we can continue to add loads without reducing the effectiveness of the existing loads, though limited by the rating of the fuse and current carrying capacity of the conductors. Adding loads to a parallel circuit increases current unlike a series circuit which would reduce the current with added load.**
- **When one component in a parallel circuit fails, the others continue to operate. Loads are wired in parallel with each other while control and protective devices are wired in series with the loads.**



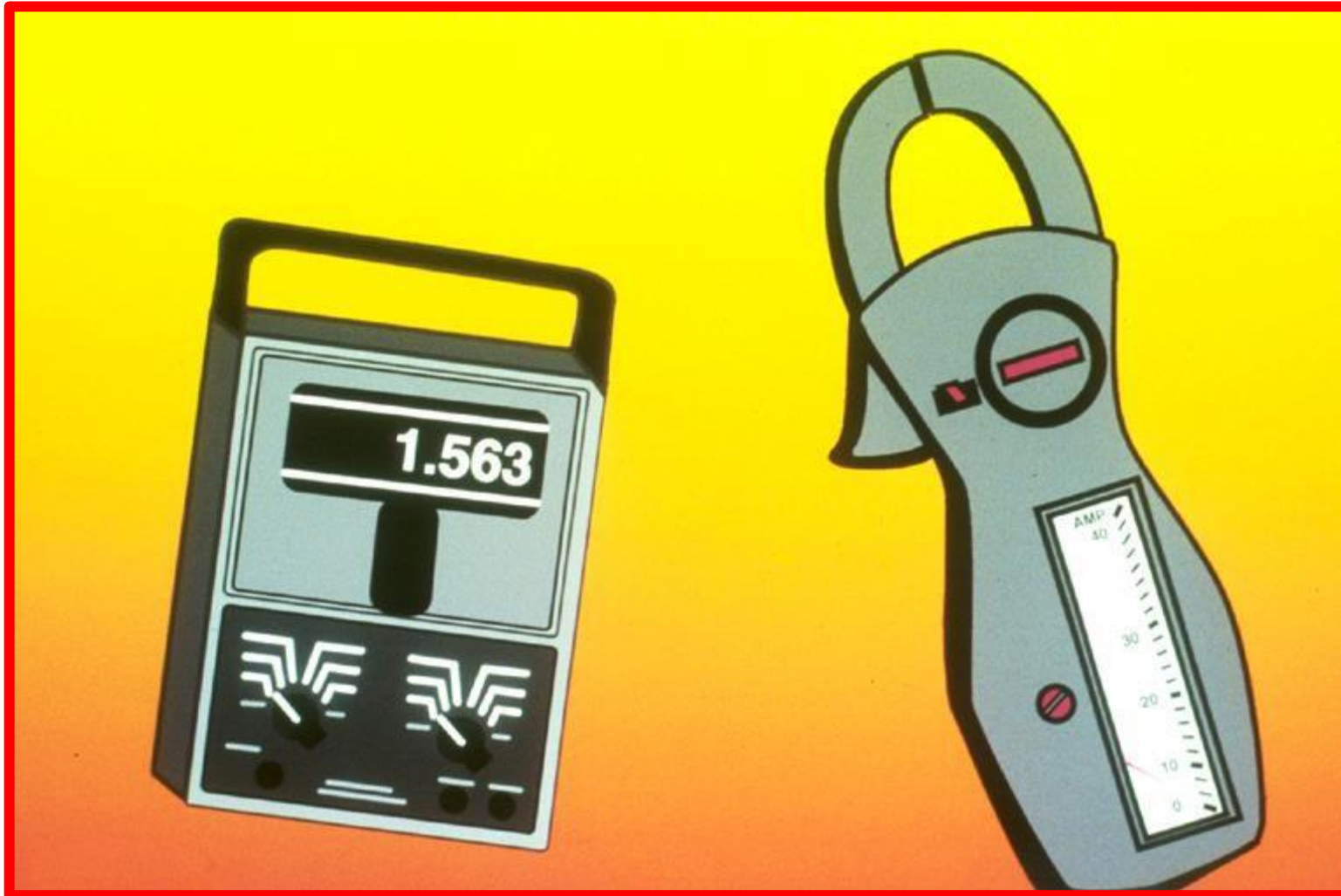
GROUND FAULT INTERRUPTER (GFI)



Portable Ground Fault Circuit Interrupter (GFCI)

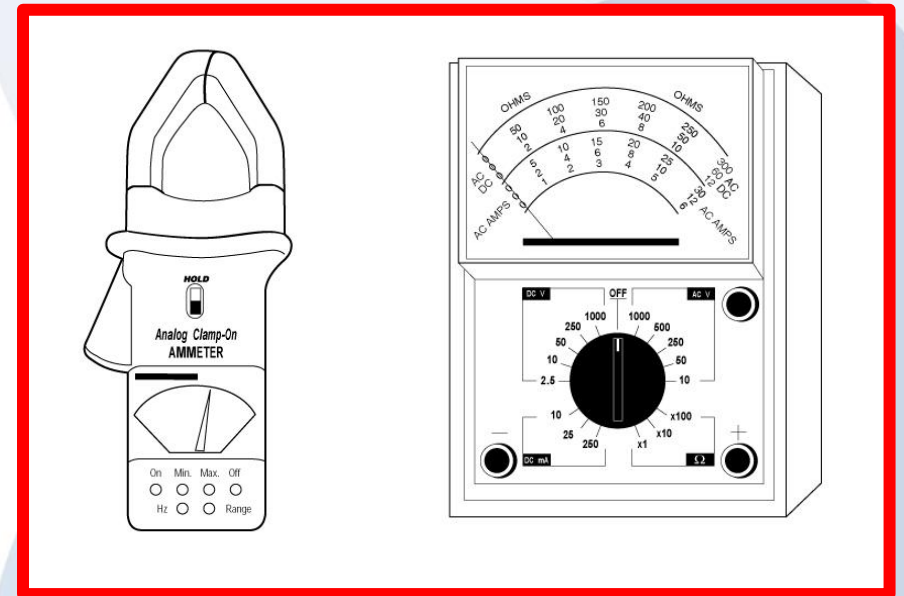
An over current device that detects minute leaks of current and quickly de-energizes the circuit. It is used to protect against electrical shock from defective appliances and extension cords.

AMMETER, VOLTMETER, AND OHMMETER

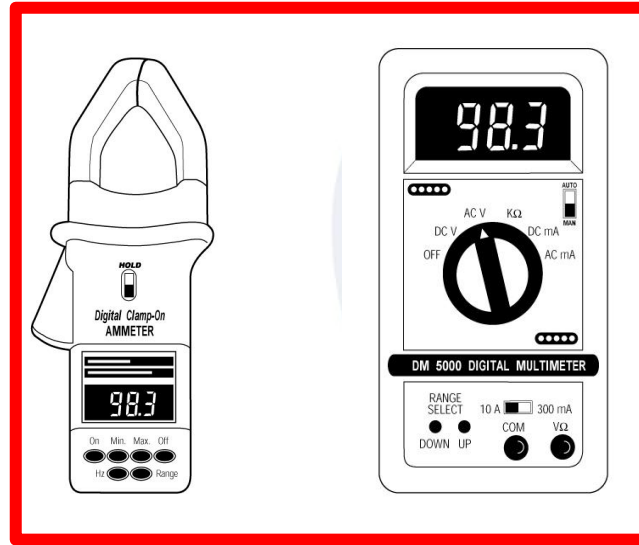




- **Accuracy**
 - Needle should be at mid-scale to upper third
- **Calibrate meter periodically to ensure accuracy**
- **Protection**
 - Start on a high scale and work down

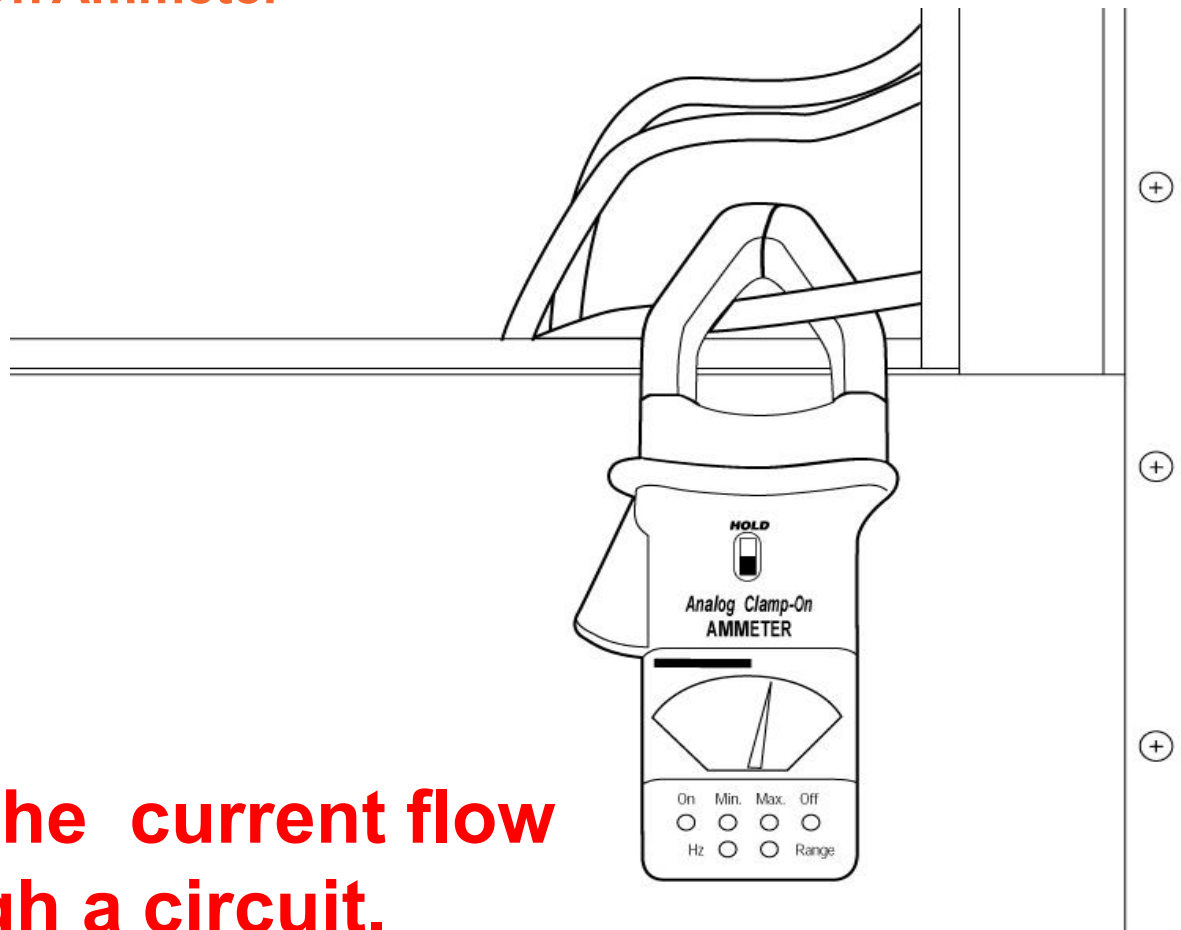


Offer several advantages:



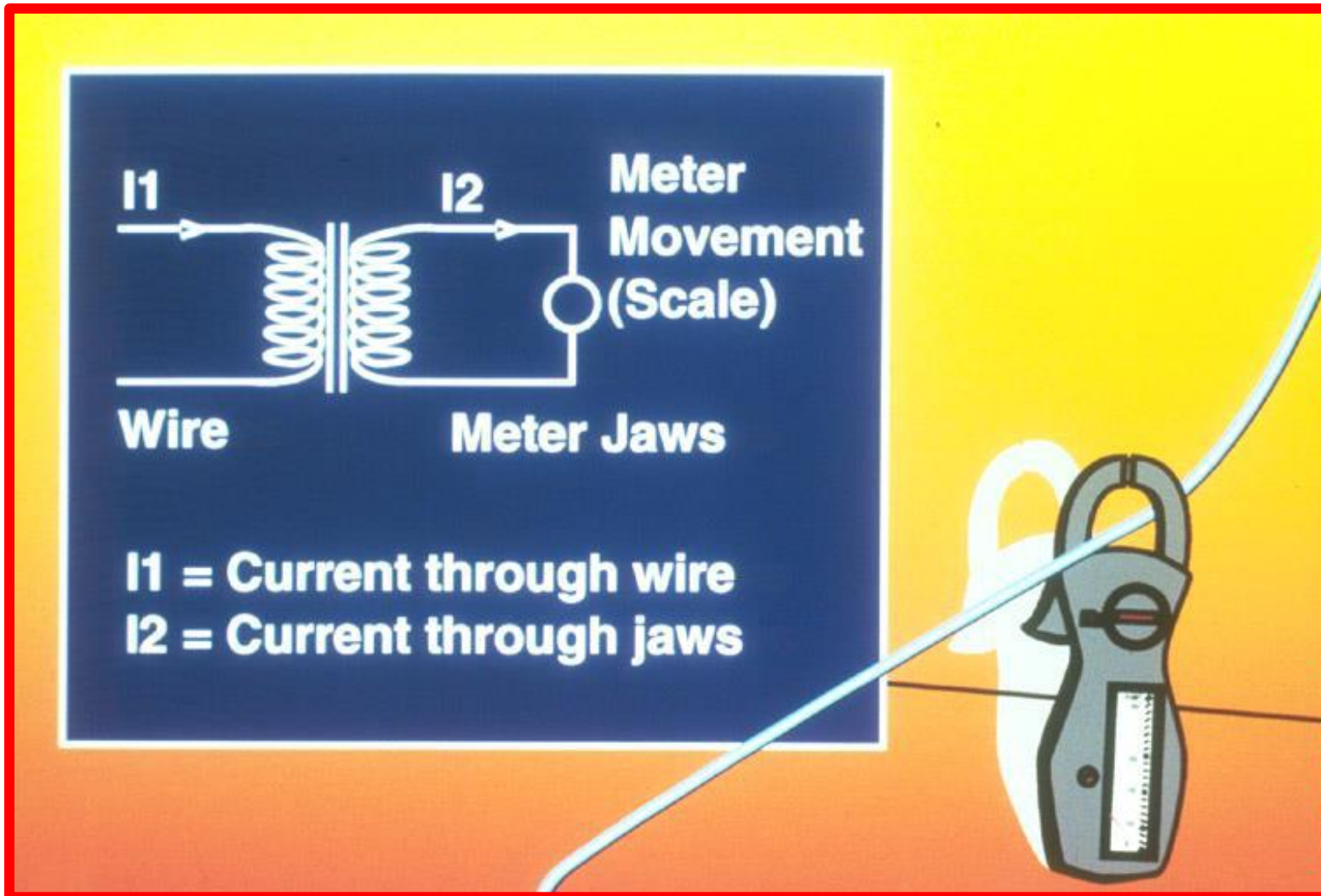
- **Direct Reading**
 - No need to interpret a scale
- **Read accurately to three decimal places**
- **No Moving parts**
 - Less likely to fail or lose calibration

Analog Clamp-On Ammeter



Measures the current flow through a circuit.

HOW TO USE AN AMMETER



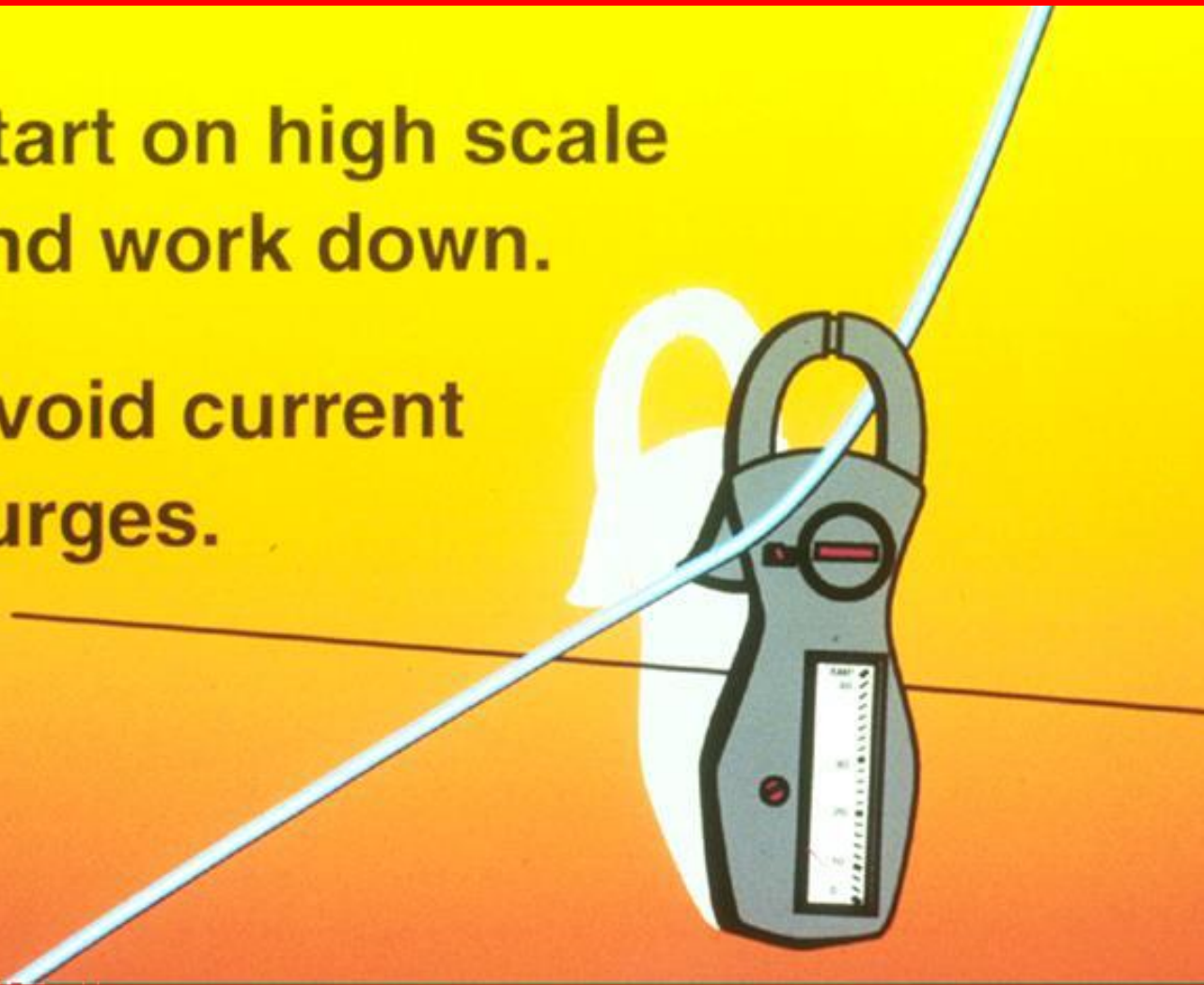
HOW TO USE AN AMMETER

Keep jaws clean
and properly aligned.



HOW TO USE AN AMMETER

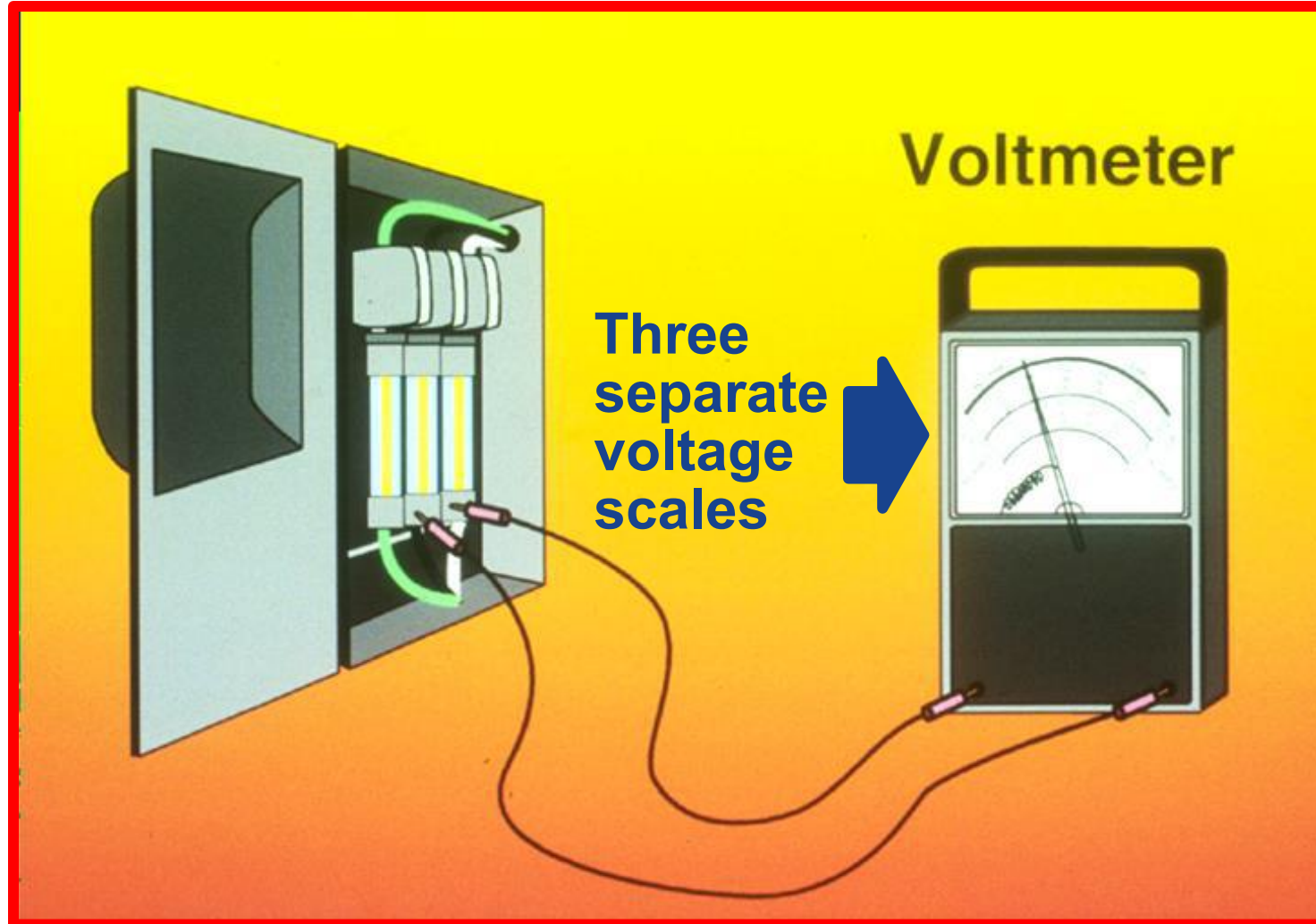
- Start on high scale and work down.
- Avoid current surges.



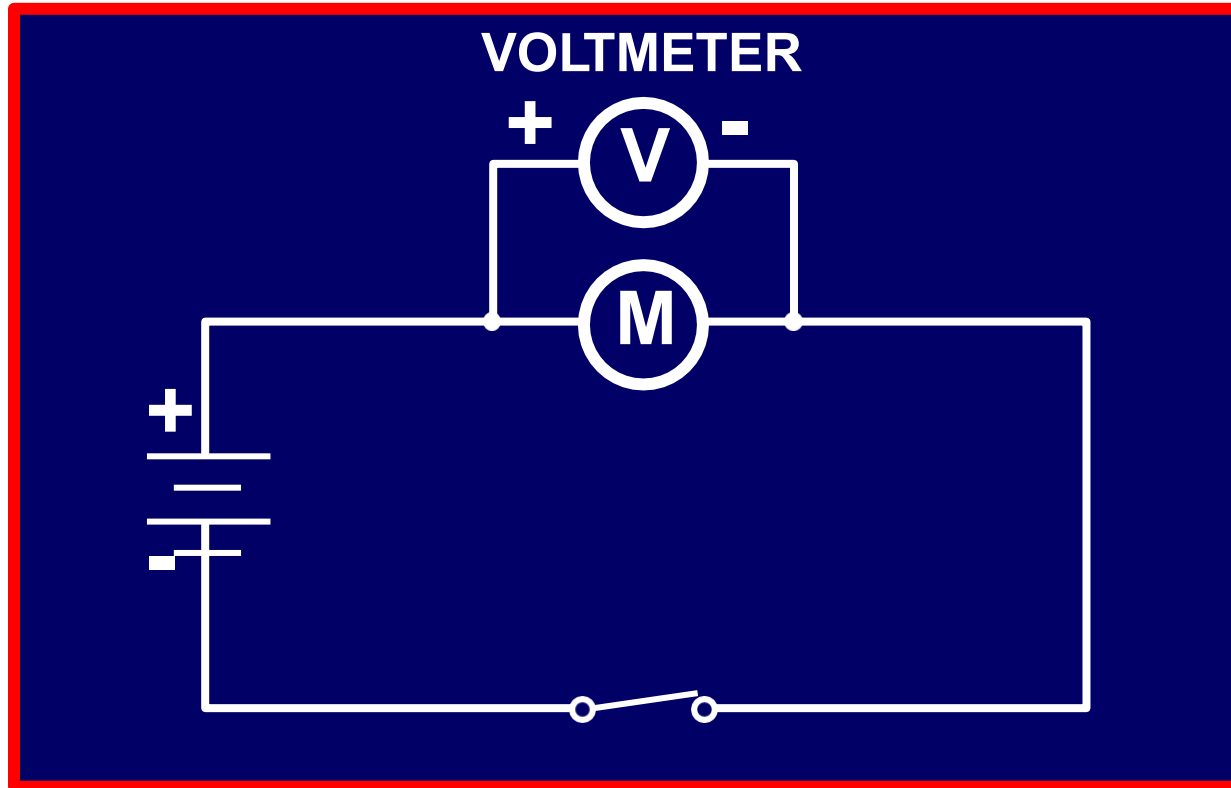
HOW TO USE AN AMMETER



NEVER CLAMP THE JAWS AROUND TWO DIFFERENT WIRE(PHASES) AT THE SAME TIME.



HOW TO USE A VOLTMETER

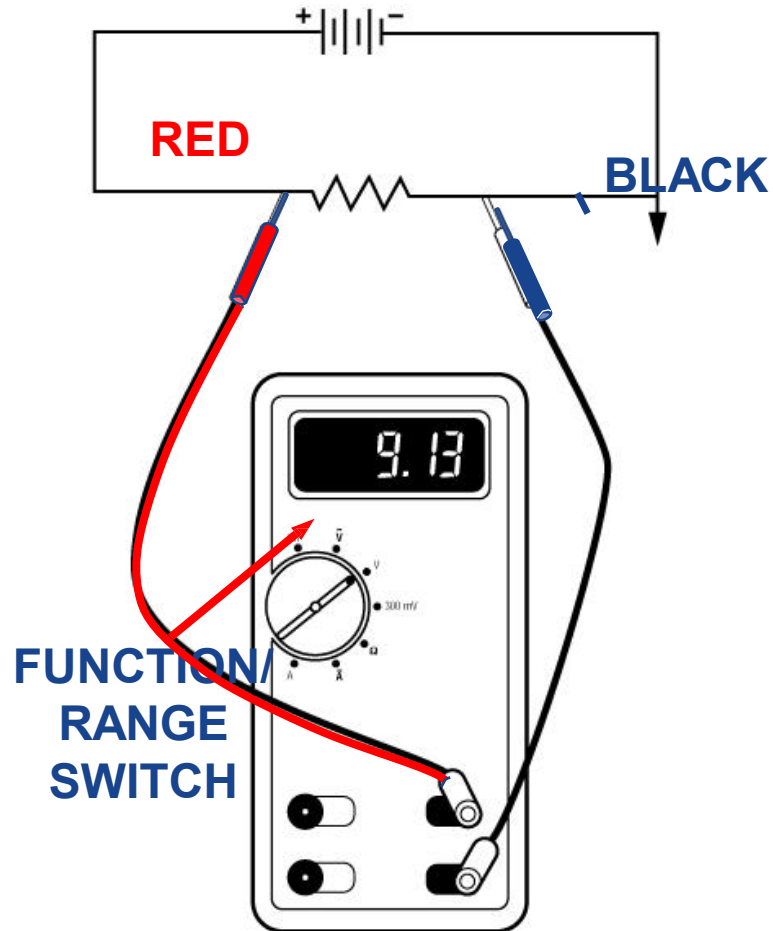


The voltmeter must be connected across - that is, in parallel with - the circuit or device being tested.

BE CAUTIOUS MEASURING VOLTAGE ON MOTORS!

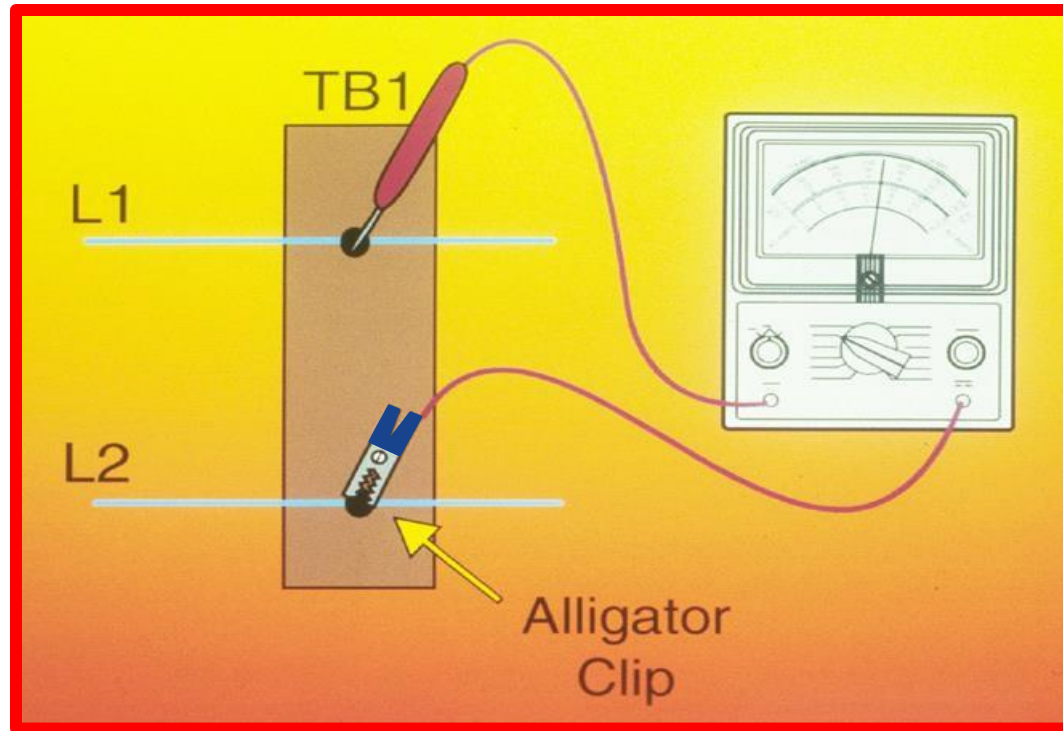


HOW TO USE A VOLTMETER



The voltmeter must be connected in parallel with the circuit or device being tested. When checking contacts with a circuit energized you should have your meter set for volts.

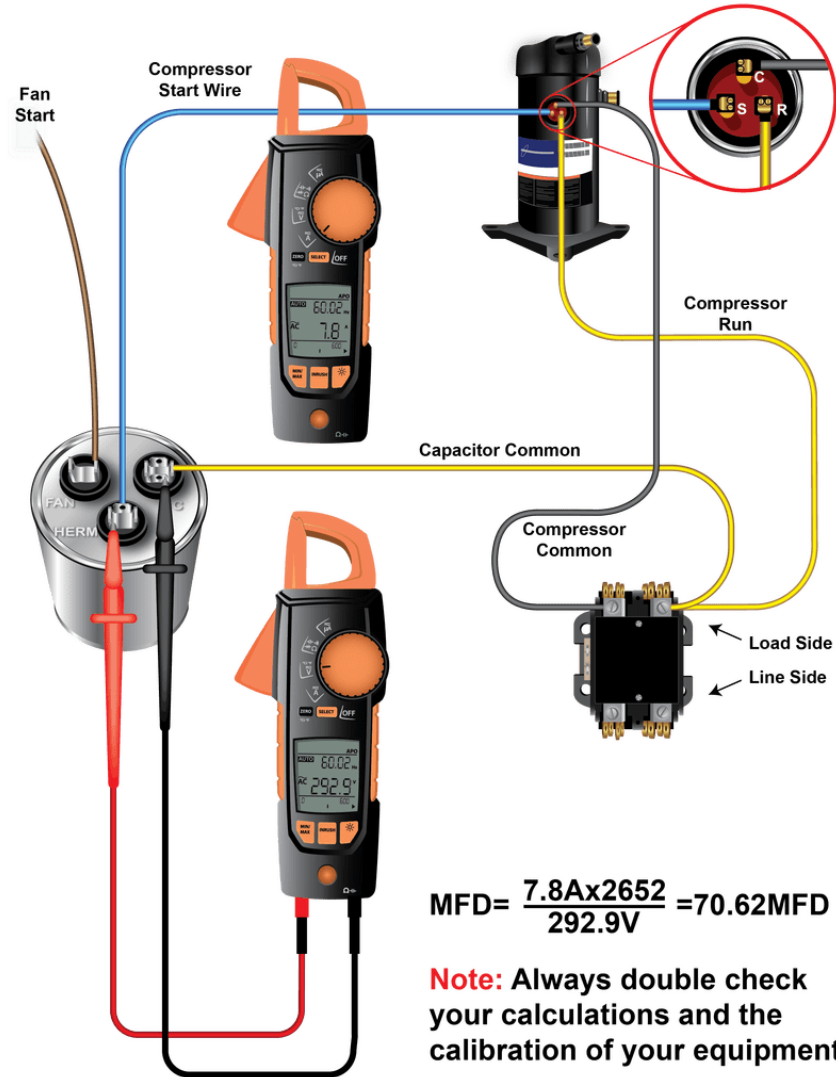
HOW TO USE A VOLTMETER



SAFETY HINT - Use an insulated alligator clip to attach one probe to a test point, then touch the other probe to the other test point. This is much safer because you have only one hand in the unit at a time.

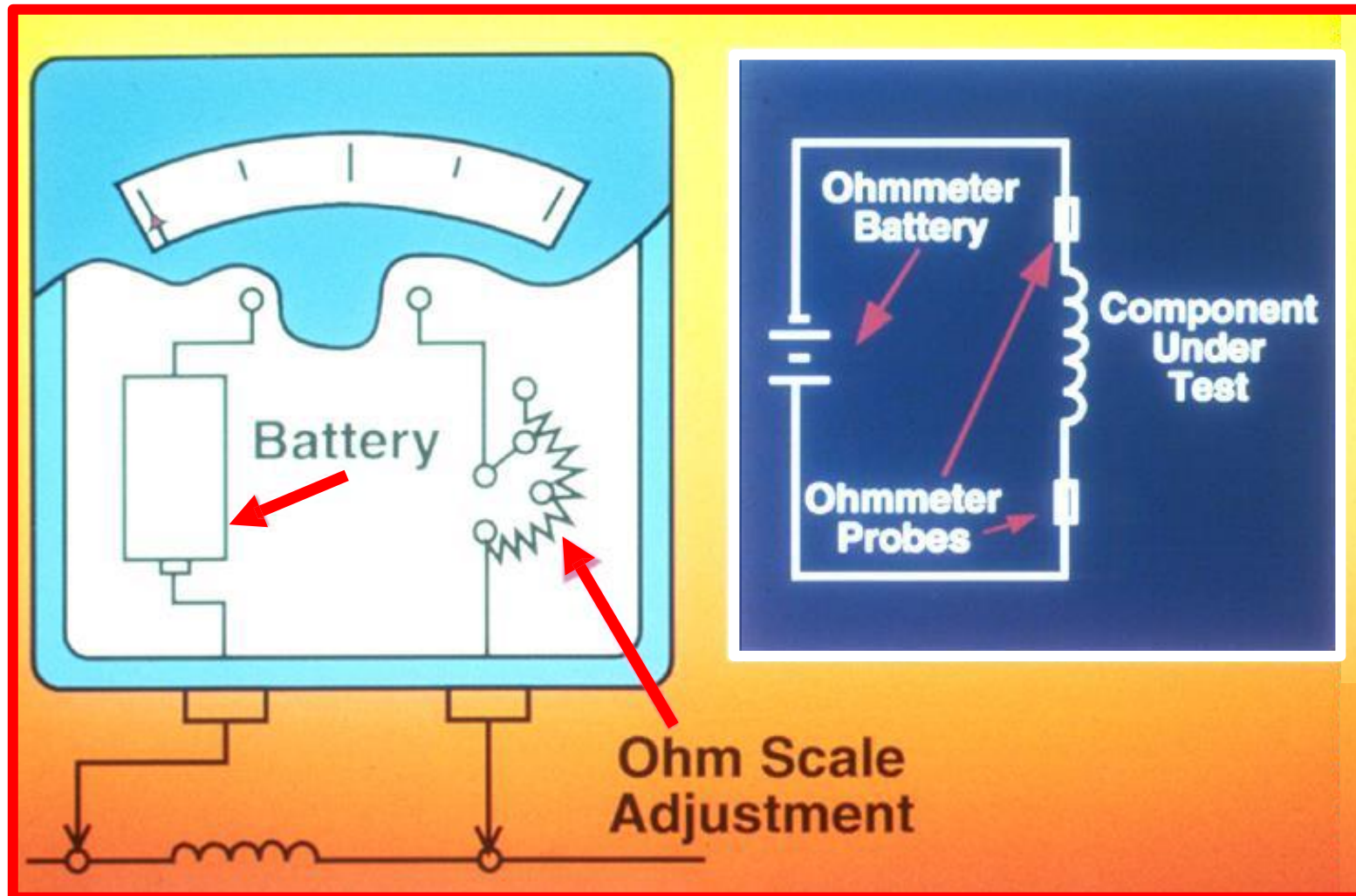


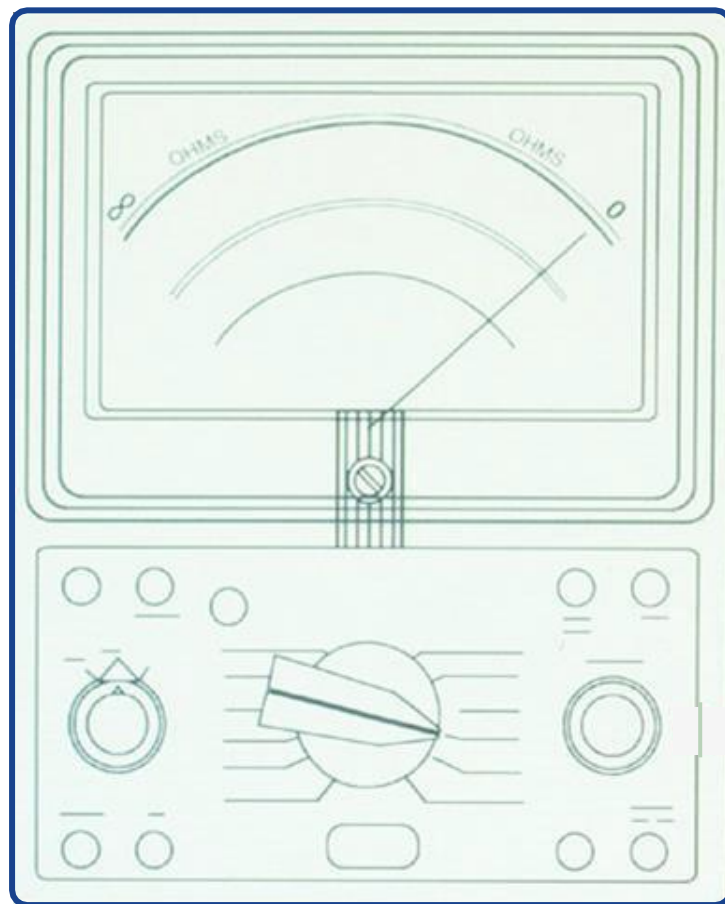
CHECKING A CAPACITOR LIVE



$$\text{MFD} = \frac{7.8 \times 2652}{292.9} = 70.62 \text{ MFD}$$

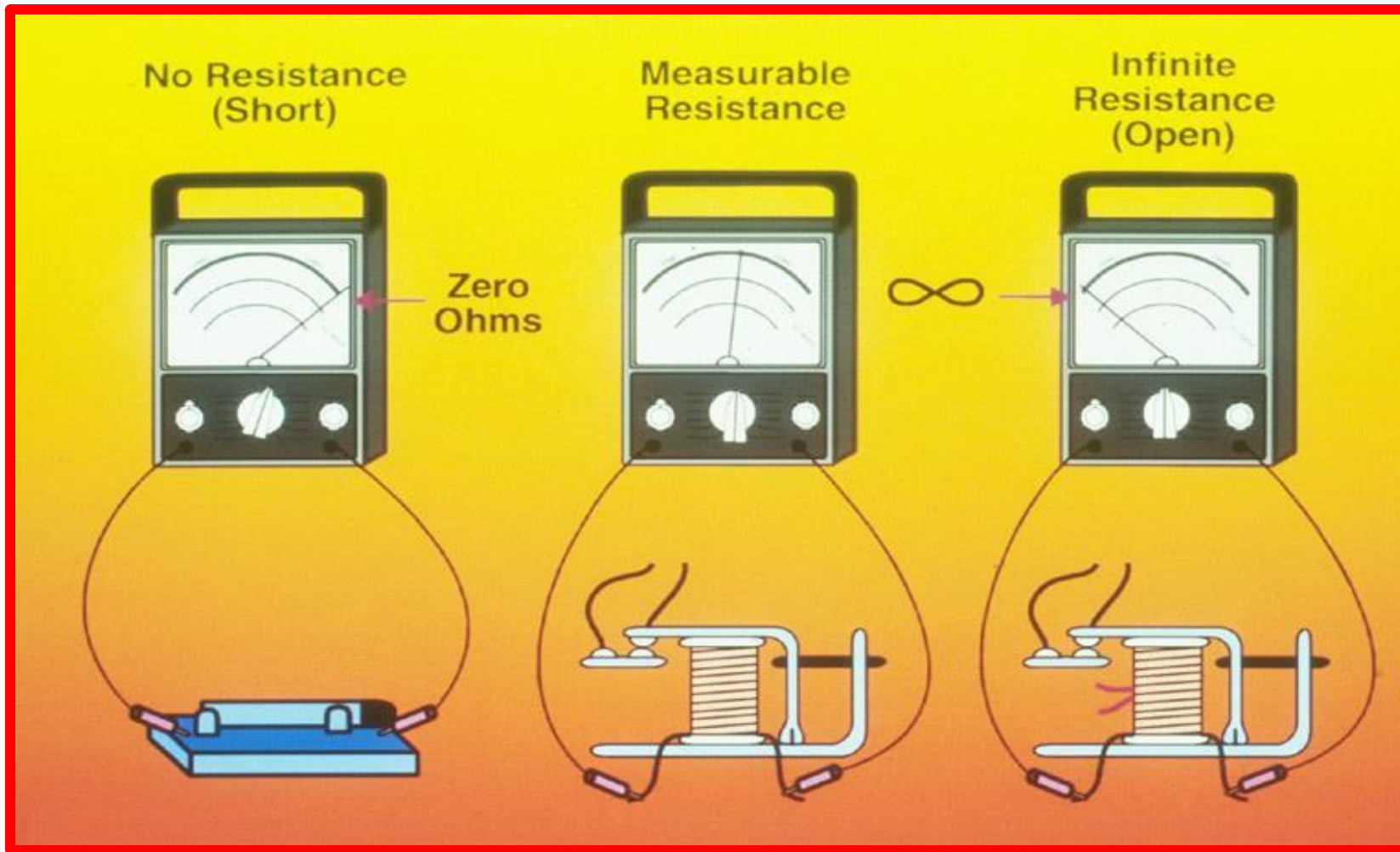
Note: Always double check your calculations and the calibration of your equipment.





- **Turn Off System Power**
- **Discharge Capacitors**

HOW TO USE AN OHMMETER

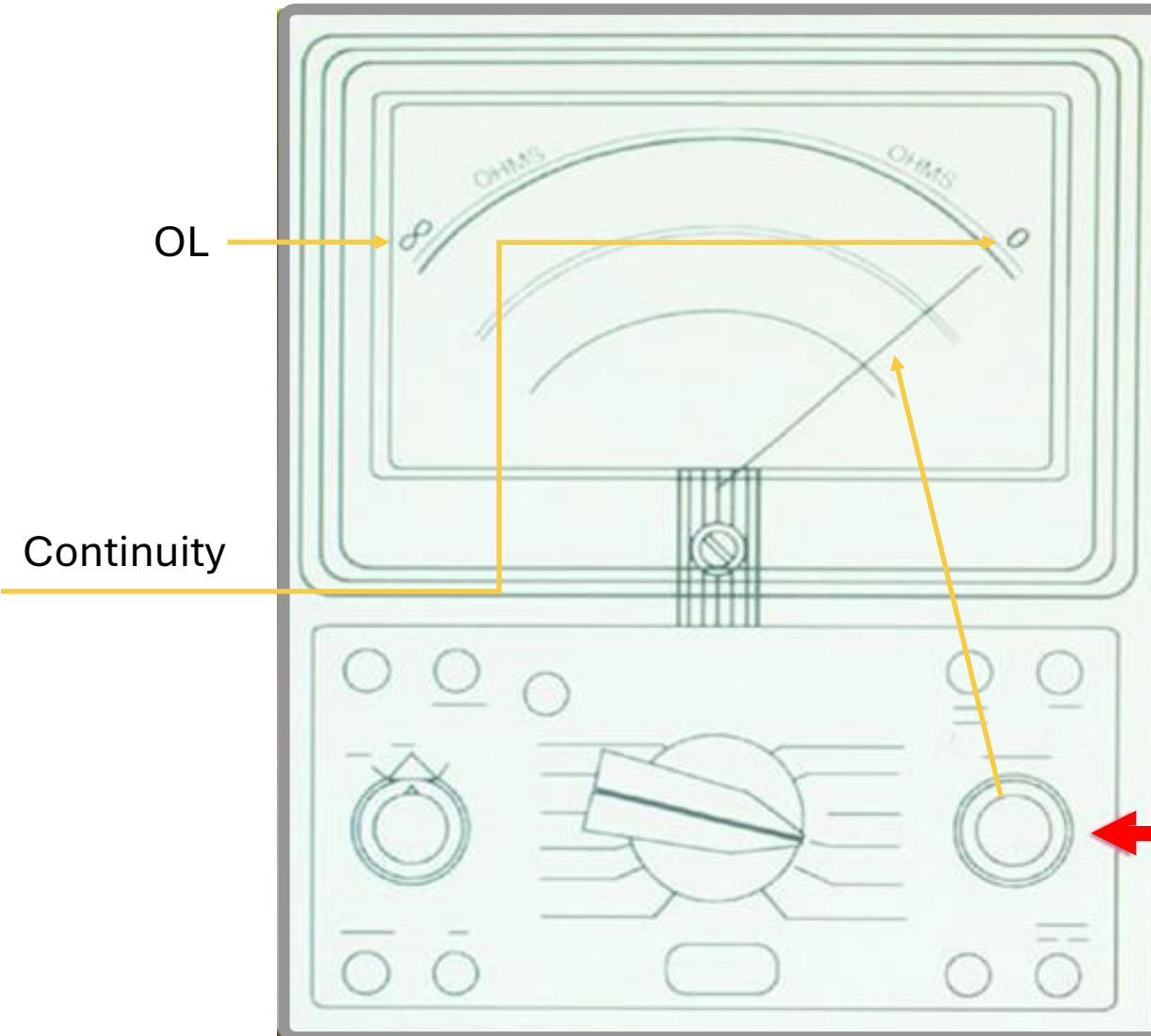


CONTINUITY TESTING

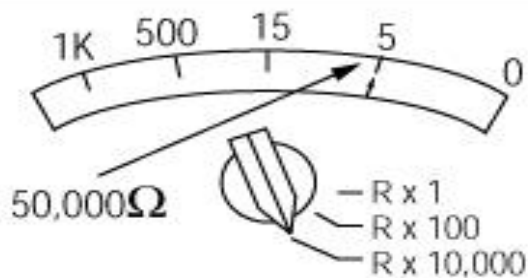
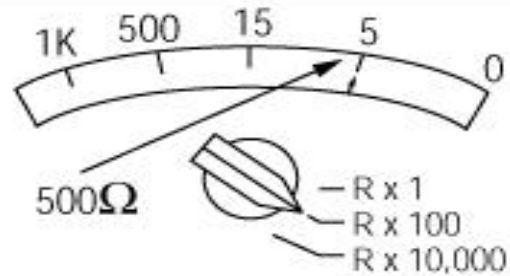
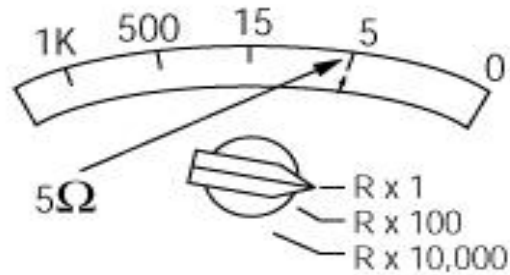
HOW TO USE AN OHMMETER

- Replace batteries periodically
- Before using, check by touching probes together
- If meter does not read zero, use zero adjustment knob to reset
- Zero meter whenever resistance range is changed

Zero Ohm Adjustment



HOW TO USE AN OHMMETER



- Common meter has three separate scales
- Use center knob to select scale
- Always select a range that places reading at, or slightly above the middle of the scale
- When in doubt, start with the highest range and work downward

HOW TO USE AN OHMMETER



***NEVER USE AN OHMMETER ON A SOLID STATE
ELECTRONIC DEVICE UNLESS SPECIFIED!***

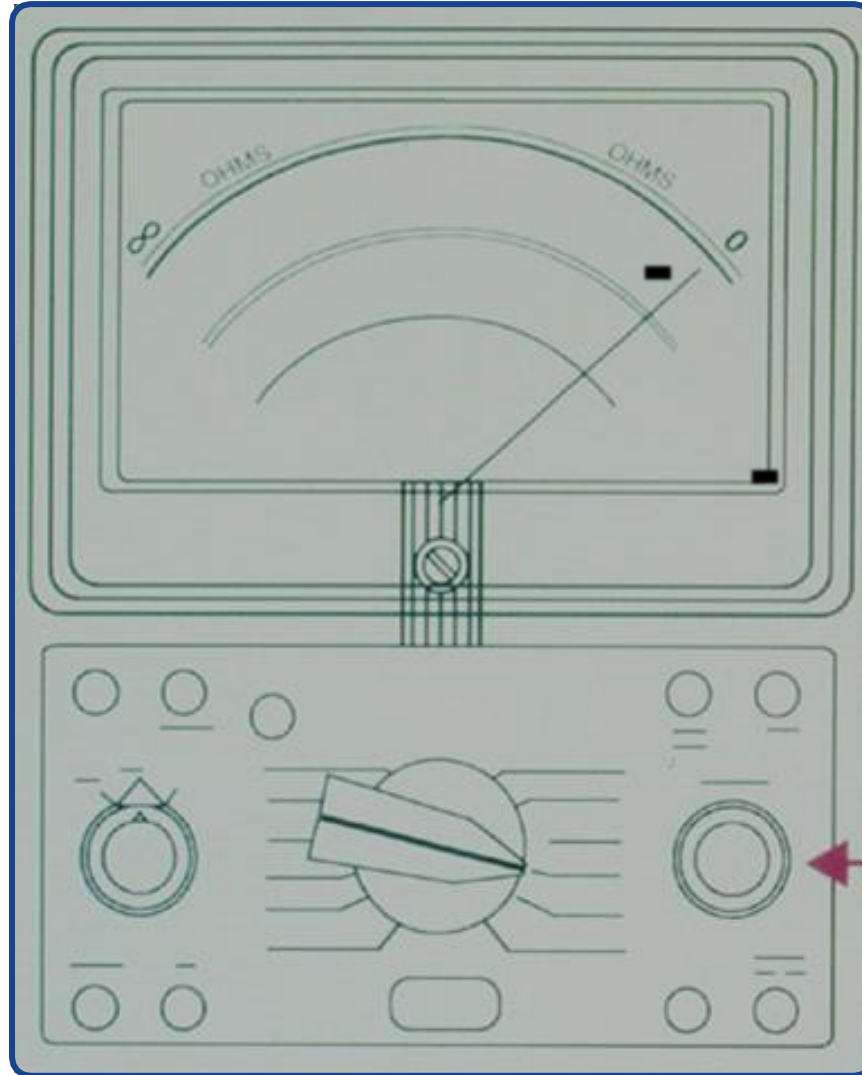


HOW TO USE AN OHMMETER

R x 1

R x 100

R x 10,000

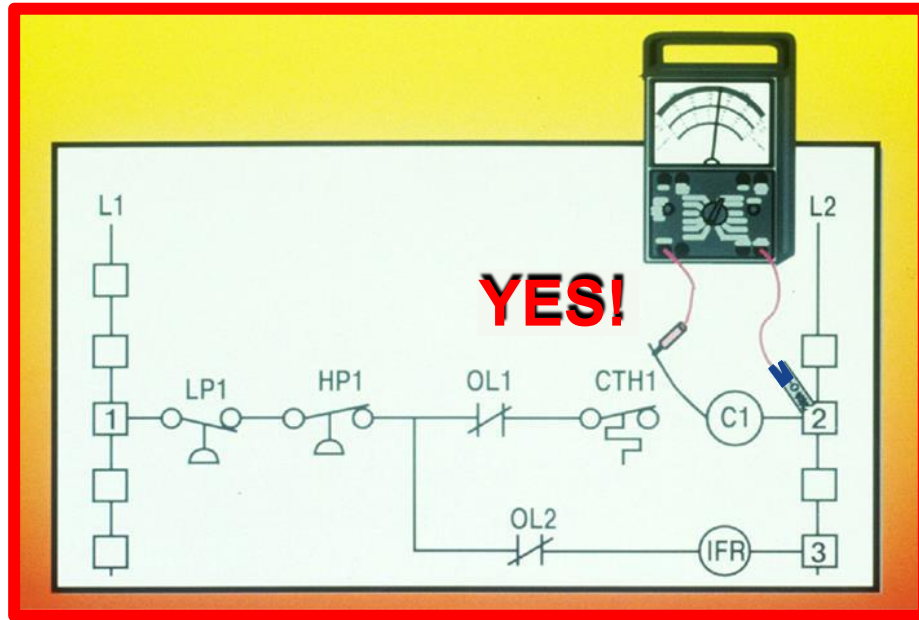
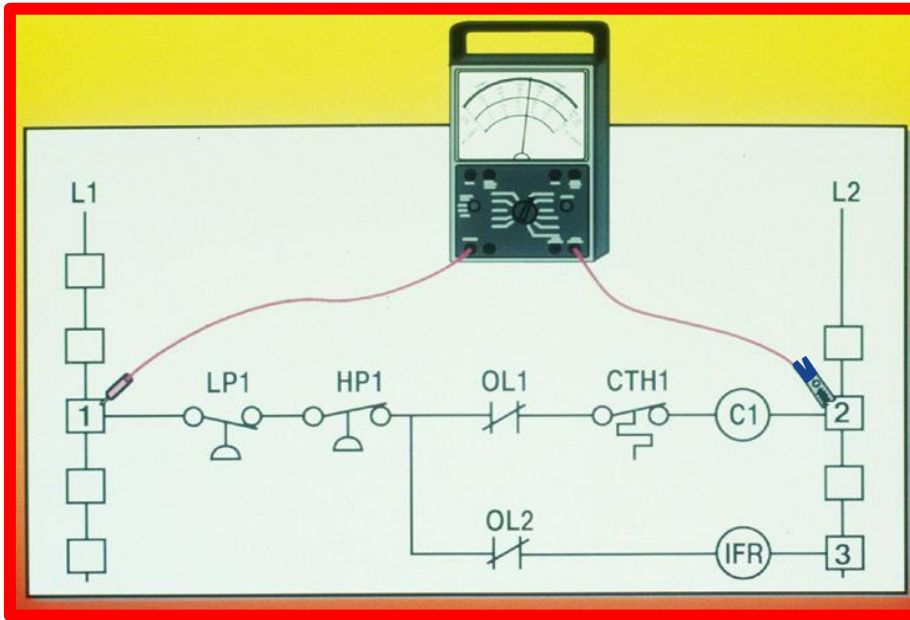


0 - 200 Ohms

200 - 20,000 Ohms

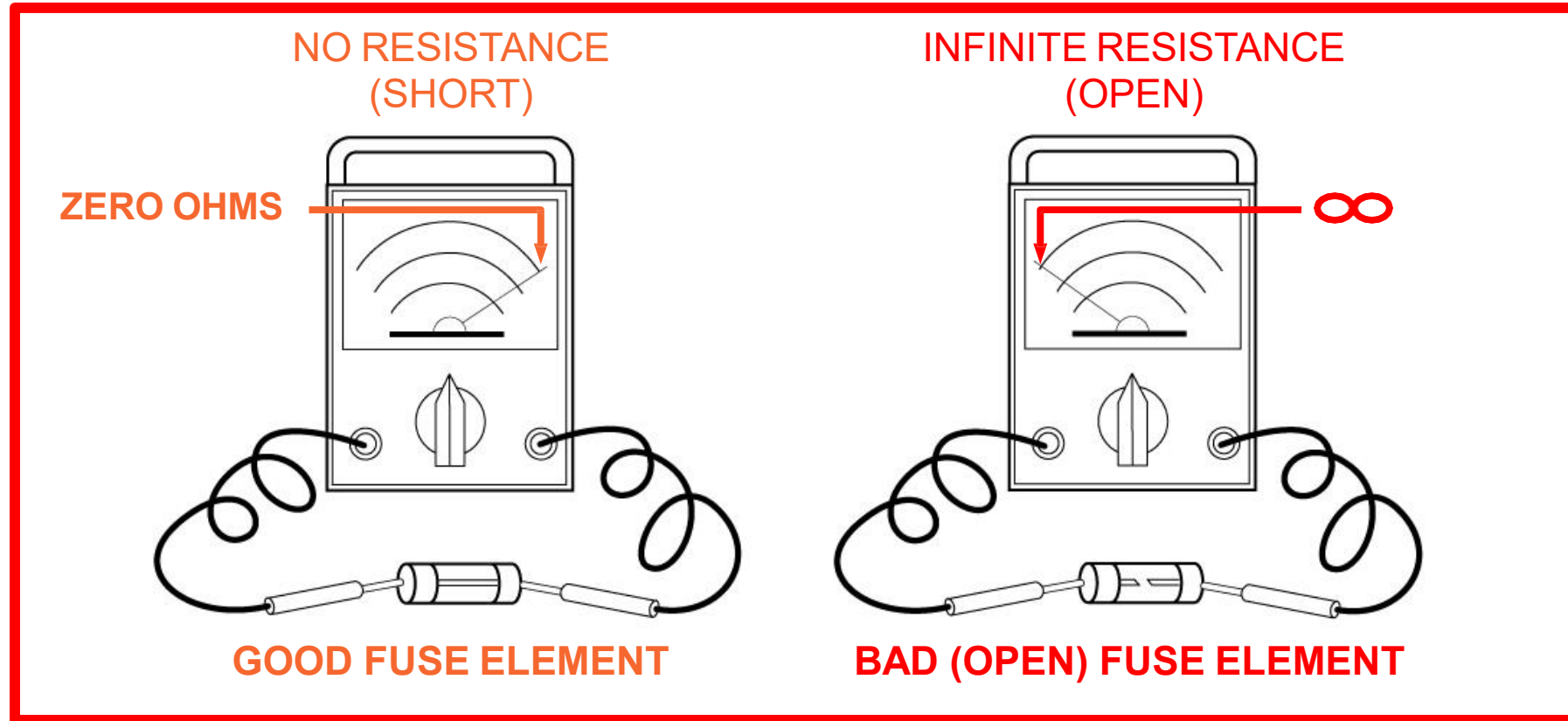
20,000 Ohms and up

ISOLATING A COMPONENT



DISCONNECT ONE SIDE OF THE COMPONENT BEING TESTED TO ELIMINATE THE POSSIBILITY OF READING THE RESISTANCE OF THE PARALLEL CIRCUIT.

HOW TO USE A MULTIMETER



Analog Meter Used to Measure Continuity

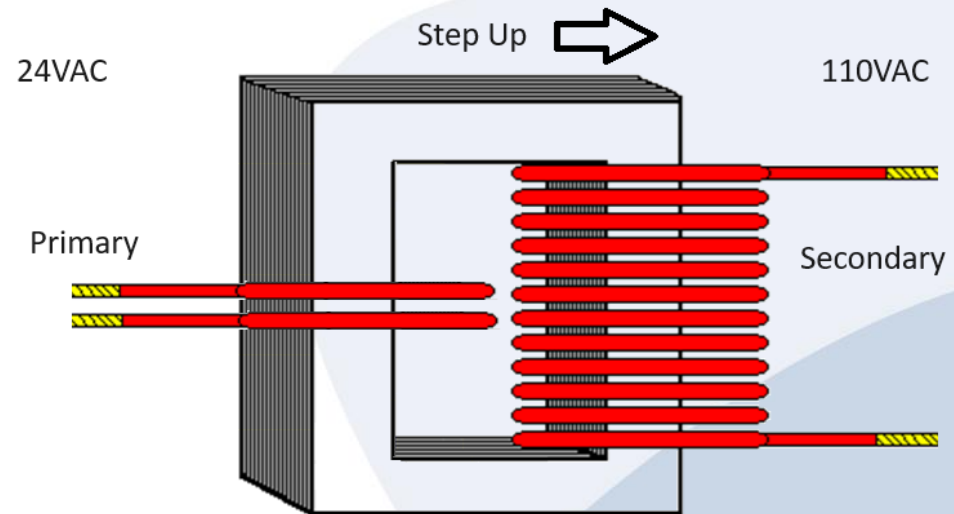
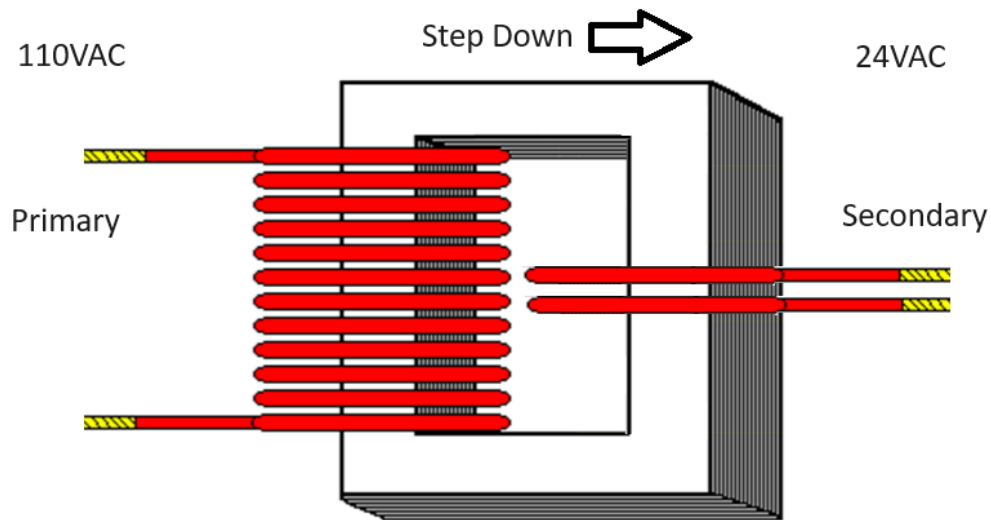


KEY POINTS ABOUT ELECTRICAL METERS

METER	MEASURE	UNIT STATUS	NOTES
Ammeter	Measures current flow (amps) through an electrical load	Always used with the unit ON and loads operating	Clamp-on type is most common
Voltmeter	Determines voltage available to an electrical circuit	Used with unit ON	
Ohmmeter	Determines continuity or resistance of an electrical circuit	NEVER used with system power on	
Multimeter	Combines functions of all three types	Depends on meter used	Many can only read direct current in the milliamp range and inaccurate or intermittent readings can occur near high-voltage sparks

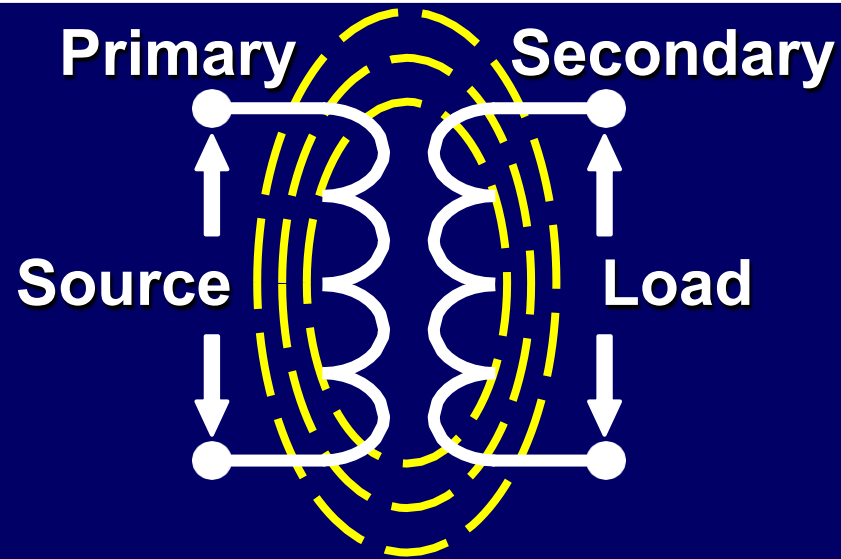
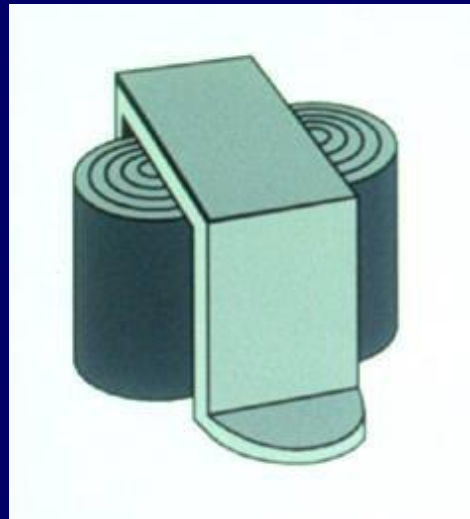
TRANSFORMERS

Transformers have two windings, a **primary** (incoming voltage), and a **secondary** (outgoing voltage).



Voltage at the secondary (step-up or step-down) is determined by the number of coils in the secondary versus the number of coils in the primary. Single phase transformers are rated by VA (volts x amps) at the secondary.

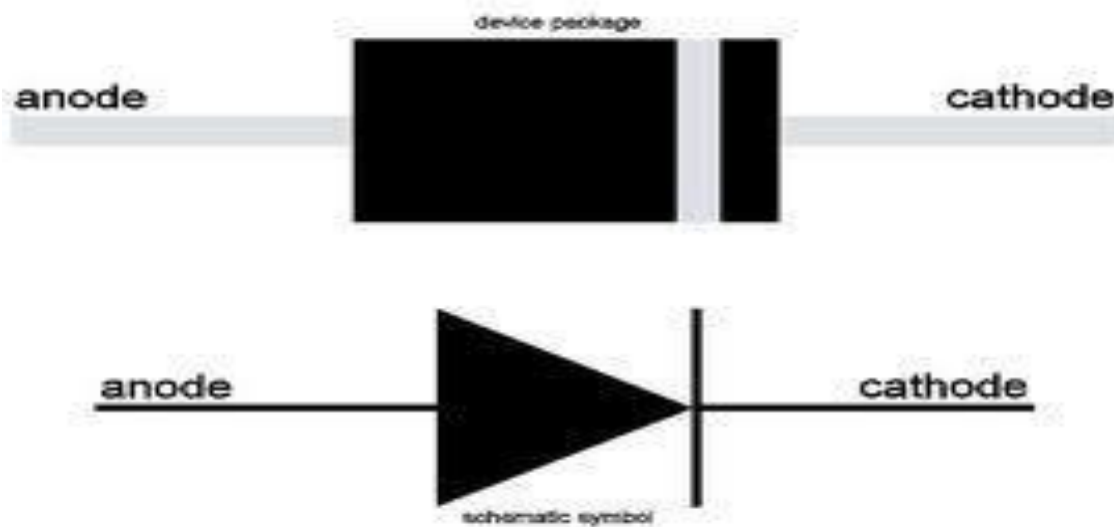
TRANSFORMER RATIO



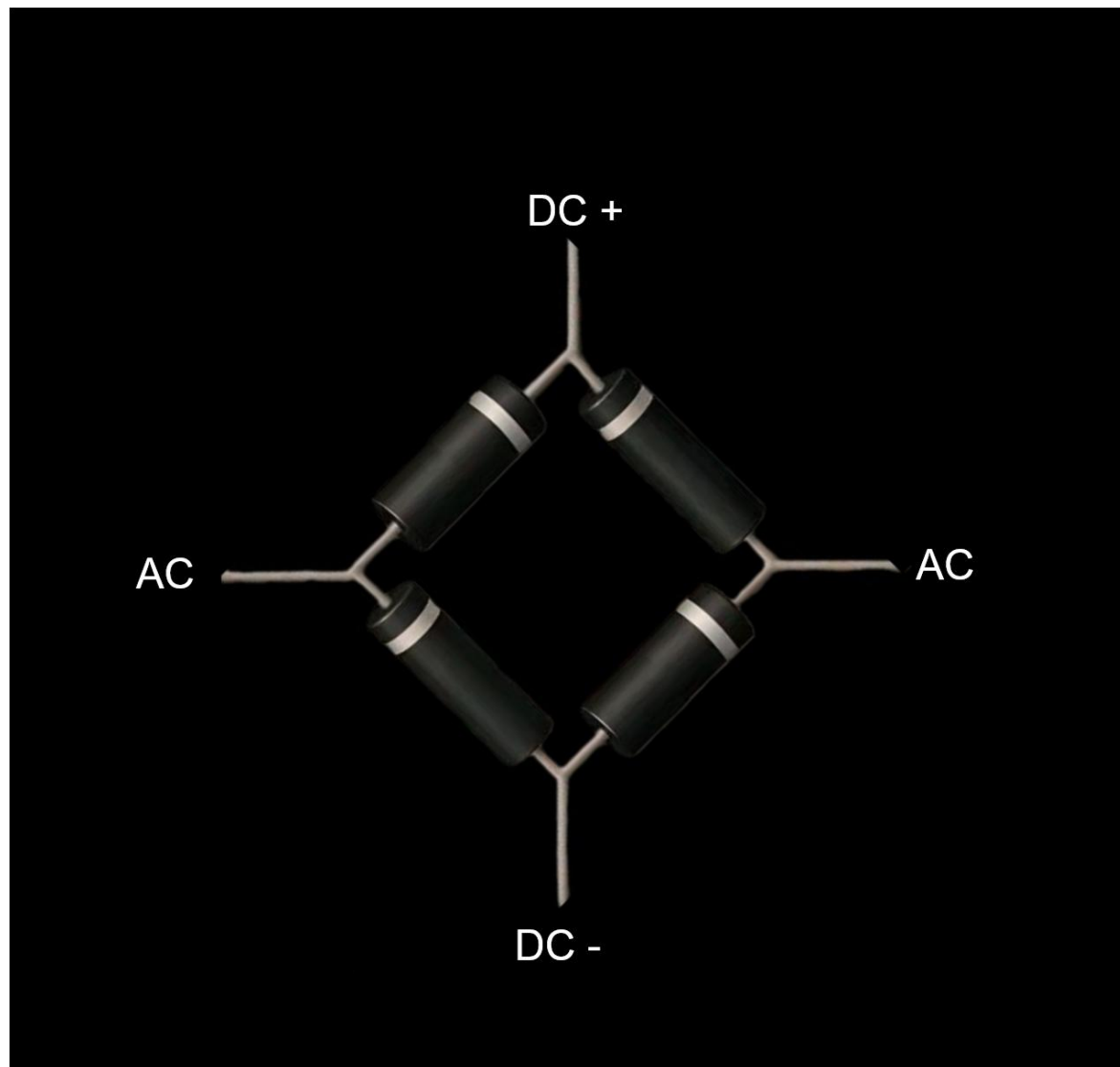
A TRANSFORMER IS USED TO RAISE OR LOWER VOLTAGE LEVELS AND USUALLY CONSISTS OF TWO OR MORE COILS OF WIRE WOUND AROUND A COMMON MAGNETIC SOURCE. THE PRIMARY SIDE OF THE TRANSFORMER CAN ALSO BE CALLED THE INPUT SIDE OF THE TRANSFORMER.

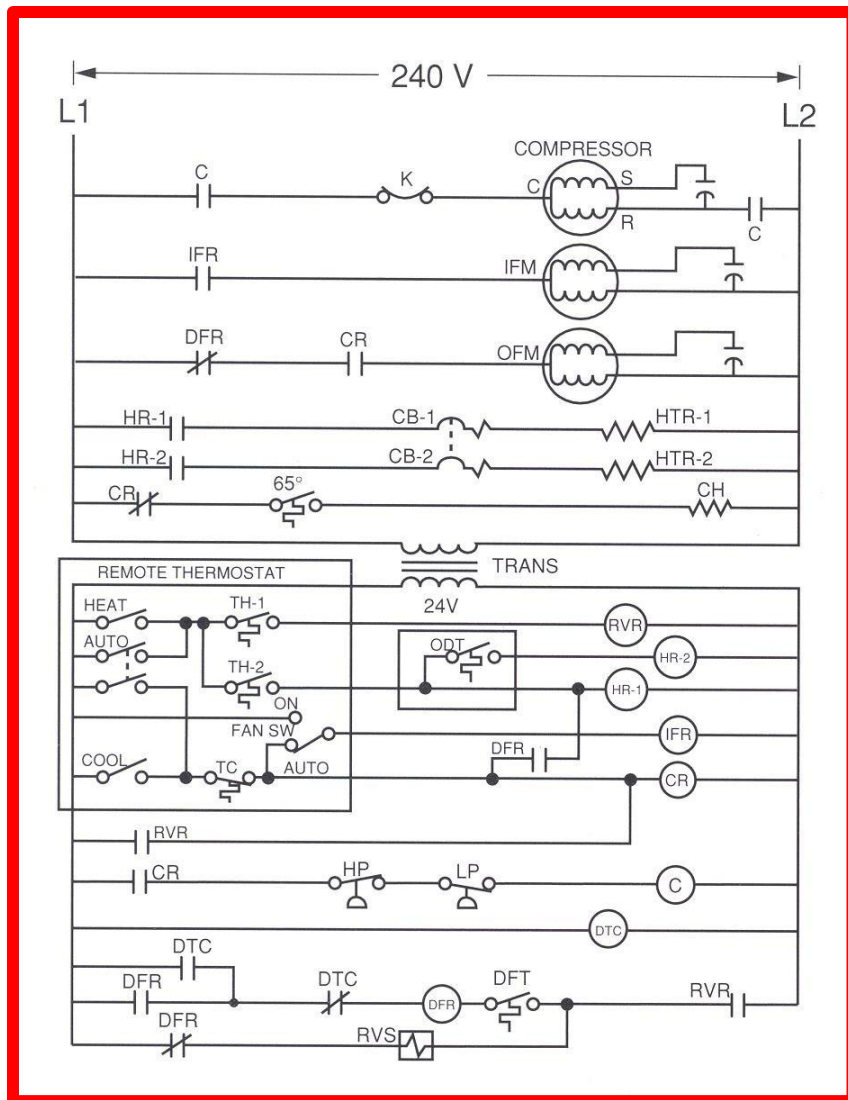
The feedback potentiometer (internal, driven potentiometer) signals the drive potentiometer (externally set, drive potentiometer) that a damper motor has reached its designated position or rotation.

A diode is a semiconductor device that permits current flow in only one direction in an electrical circuit.



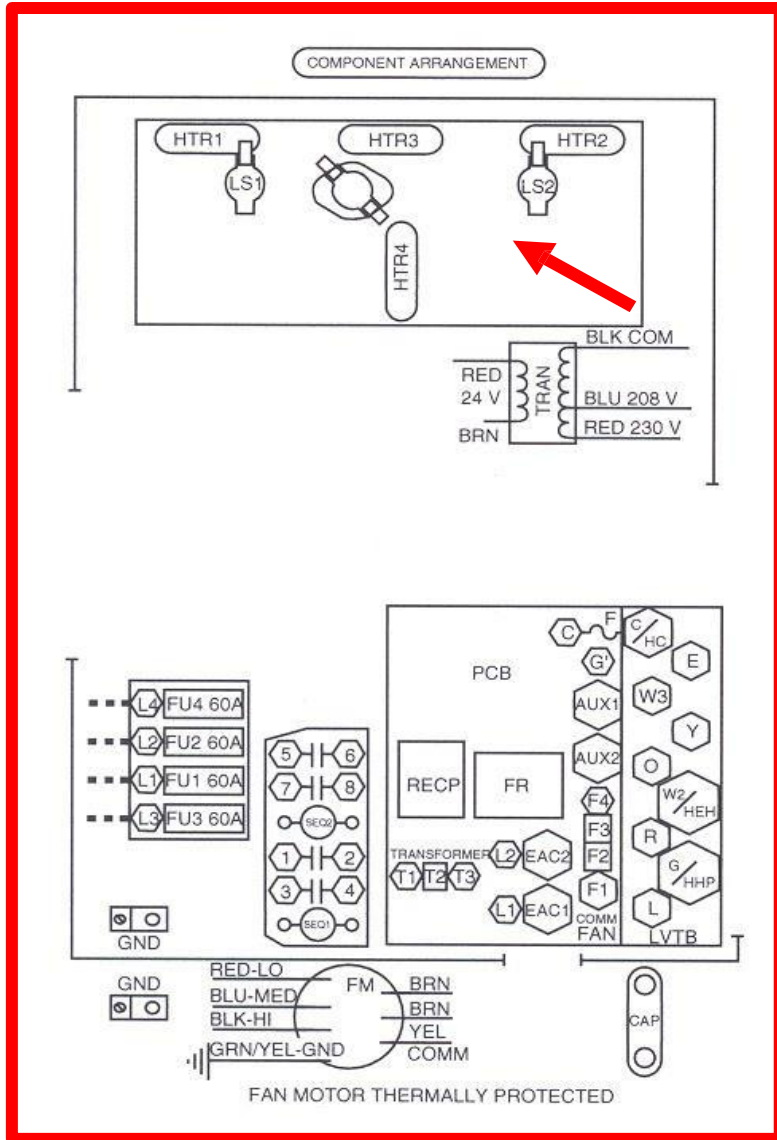
BRIDGE RECTIFIER CONVERTS AC TO DC





Ladder Diagram

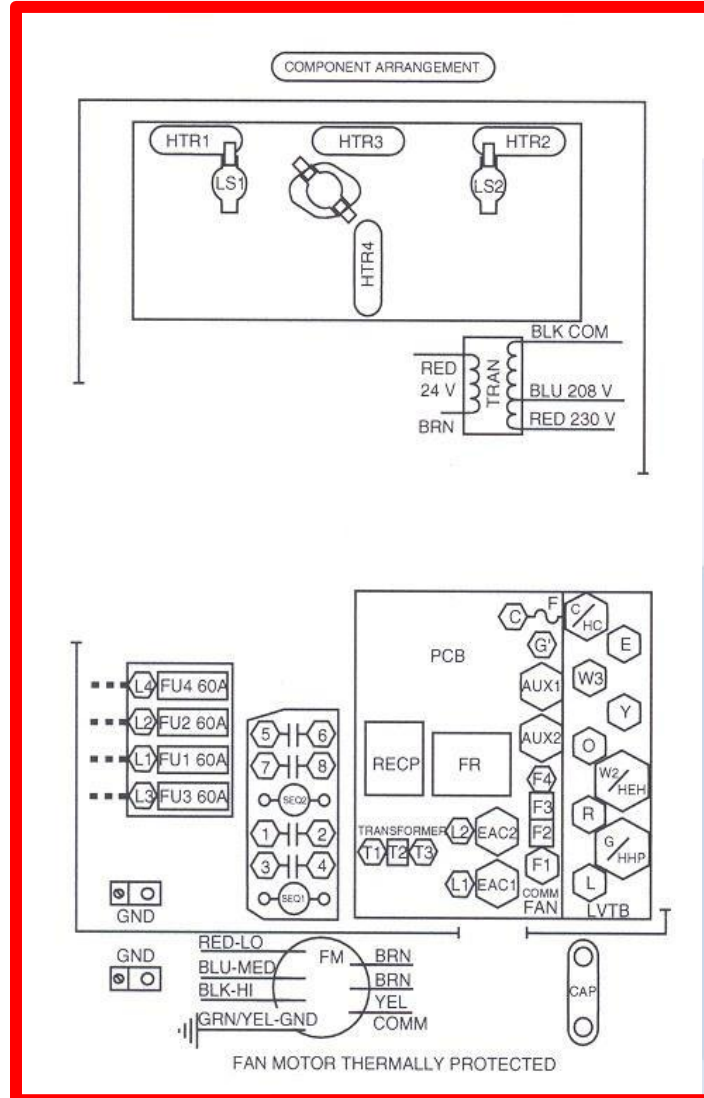
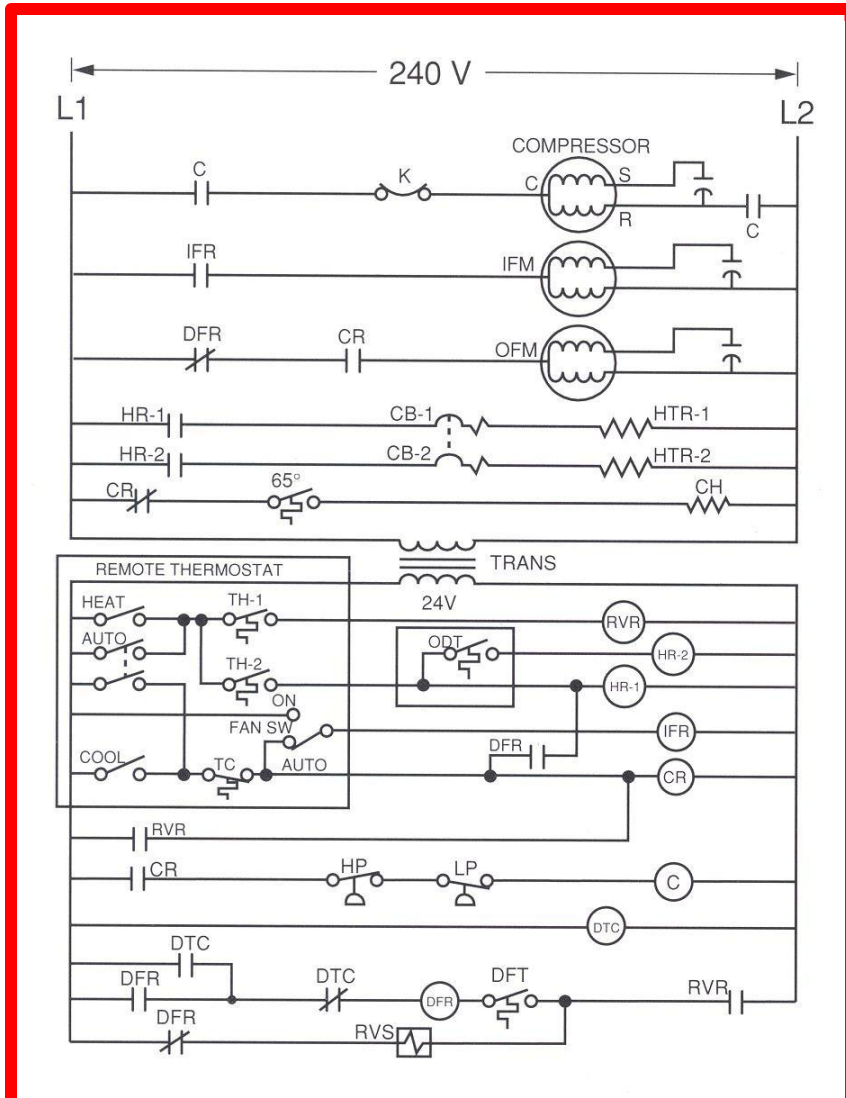
A simplified schematic in which each load line is shown as a separate circuit and is useful for troubleshooting electrical issues. Field wiring for 120/240 volt wiring is typically shown as broken heavy lines.

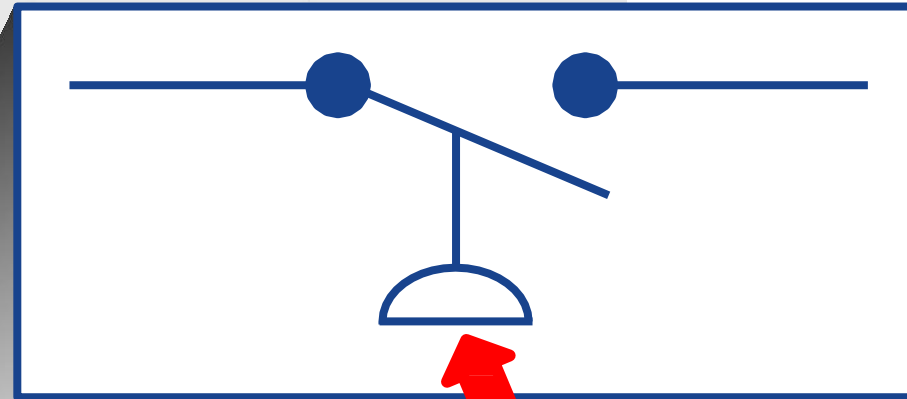
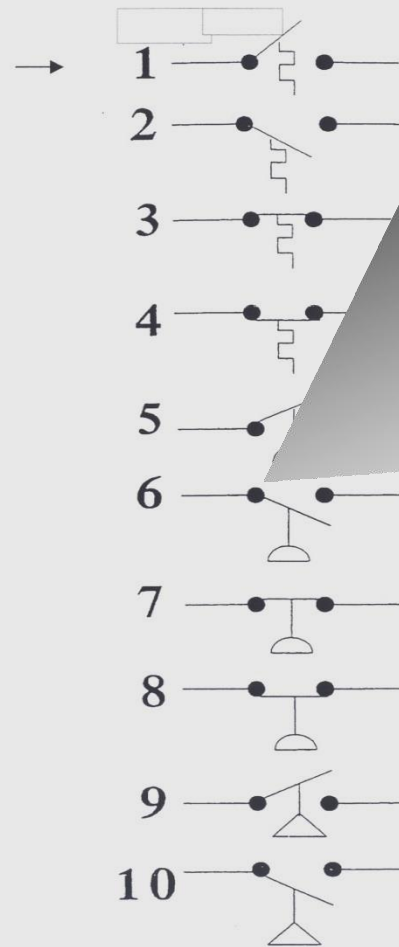


***Pictorial or
Component
Arrangement
Diagram***

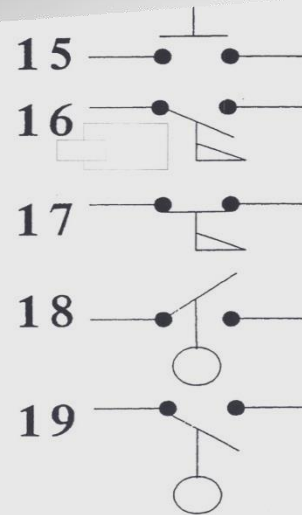
***Shows where
electrical
components are
physically located
in the unit.***

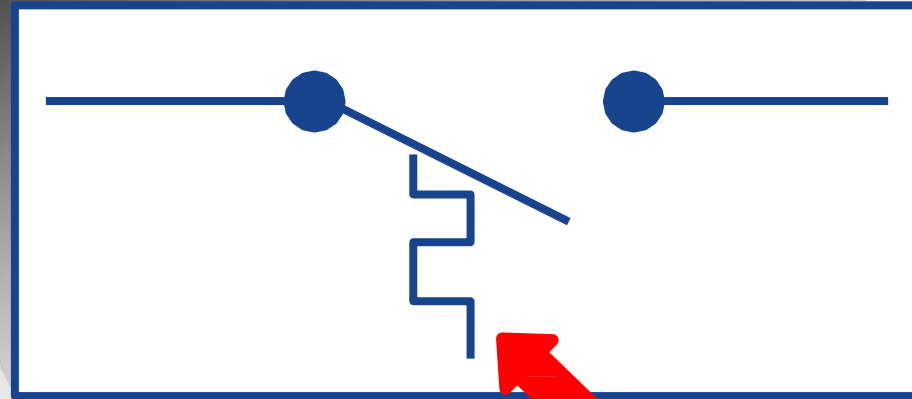
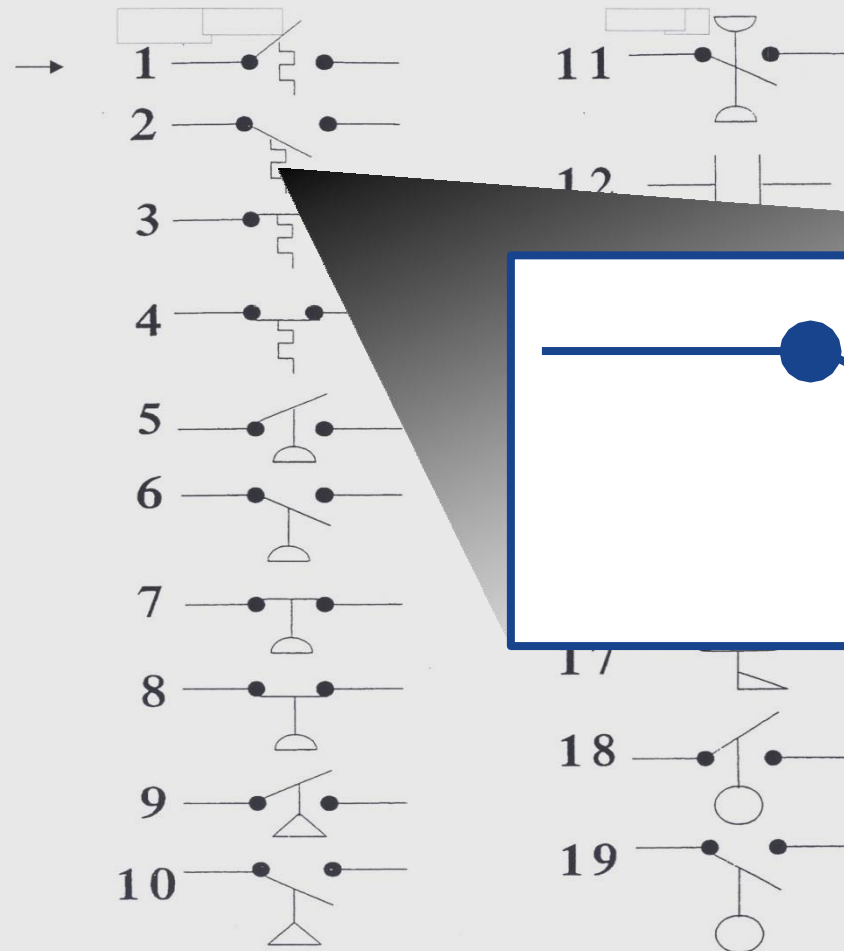
BOTH TOGETHER



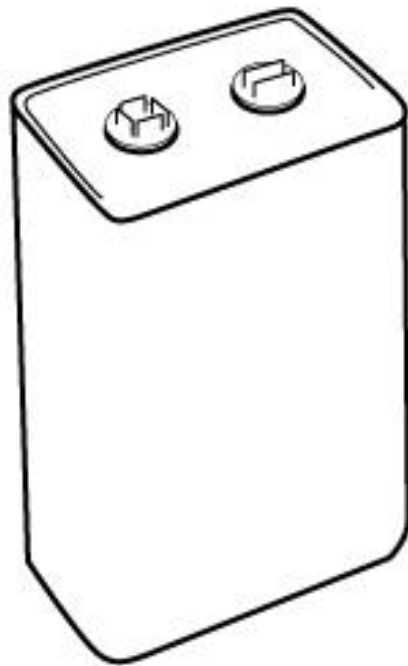


**THIS DESIGNATES A
PRESSURE SYMBOL**



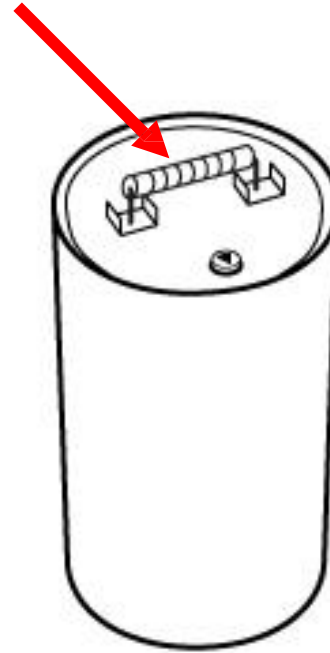


**THIS DESIGNATES A
TEMPERATURE SYMBOL**



RUN CAPACITOR

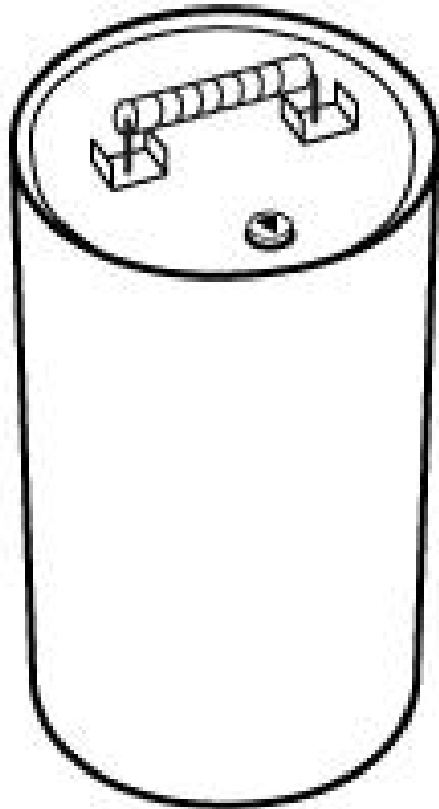
BLEEDER RESISTOR



START CAPACITOR

ALWAYS REPLACE CAPACITORS WITH SAME SIZE AND VOLTAGE

START CAPACITOR



A start capacitor is used on a capacitor start motor to provide a high starting torque and is switched out of the circuit by the start relay as soon as the motor is running.



REPLACEMENT CAPACITORS

IN REGARD TO REPLACEMENT CAPACITORS:

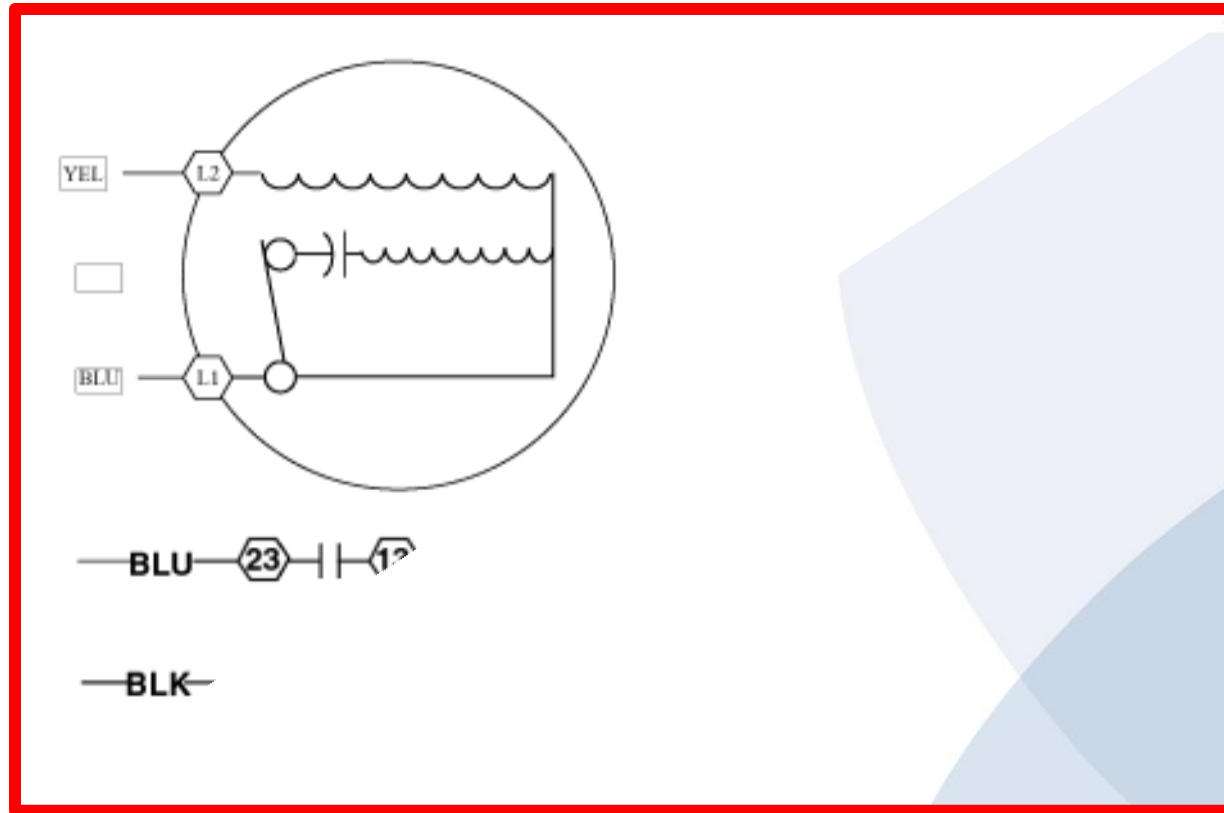
Always try to use an exact replacement capacitor in respect to voltage and capacitance. Any changes or deviations from the original must be marked inside the unit, for the next technician to be aware of any changes.

1. The voltage rating on the replacement capacitor must be equal to or greater than the voltage rating on the original capacitor.
2. The start capacitor capacitance must be equal to or no more than plus+ 20% of the original capacitance.
3. The run capacitor capacitance must be within $\pm 10\%$.

* If the start capacitor is undersized, the motor may not start. If the start capacitor is oversized, the high current may burn out the motor.

CAPACITOR START INDUCTION RELAY MOTOR

**C
S
I
R**



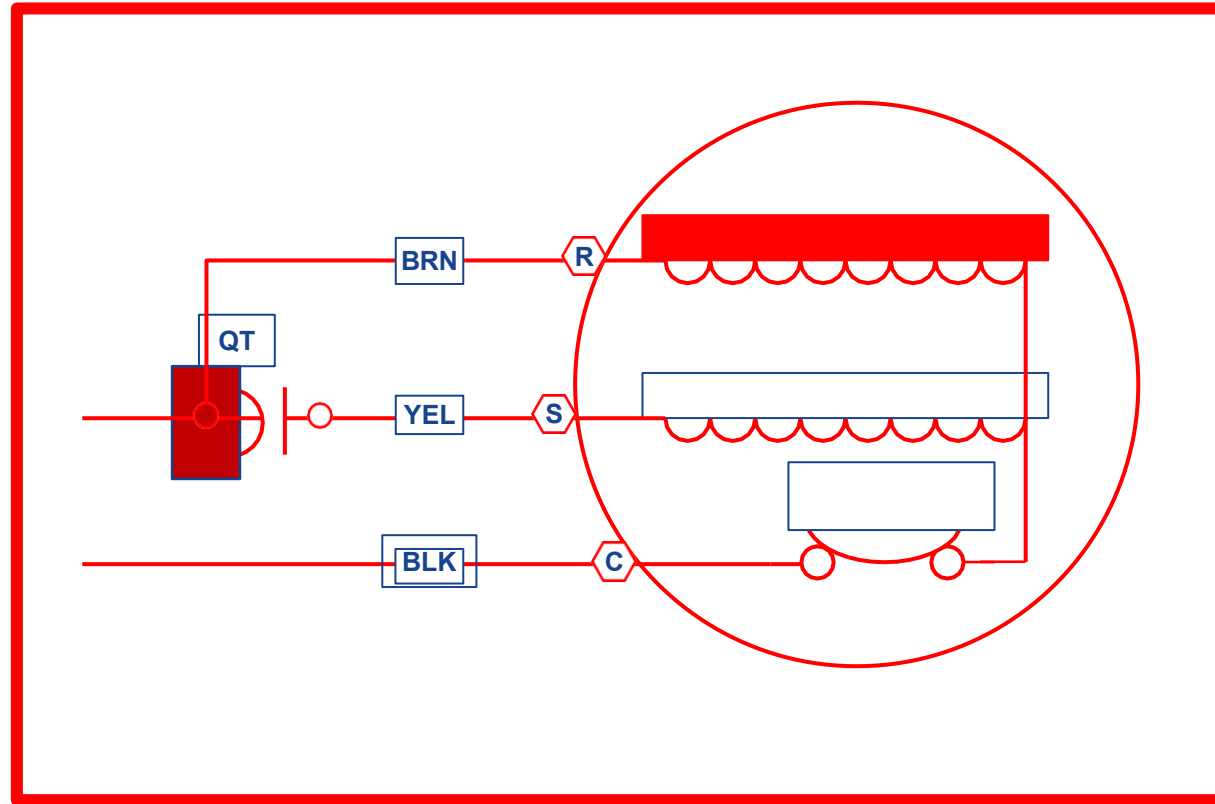
**USES A START CAPACITOR AND SWITCHING DEVICE
HIGH STARTING TORQUE - LOW RUNNING EFFICIENCY**

**USES RUN CAPACITOR, START CAPACITOR & START RELAY
HIGH TORQUE – EXCELLENT RUNNING EFFICIENCY**



PERMANENT SPLIT CAPACITOR

P
S
C



USES A RUN CAPACITOR

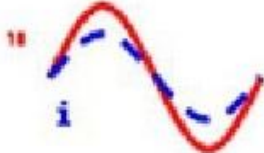
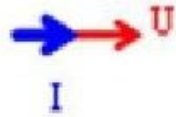
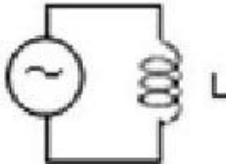
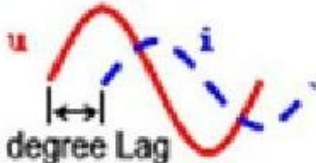
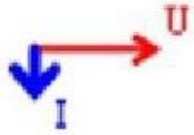
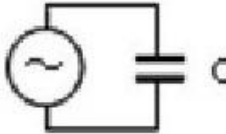
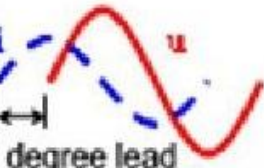
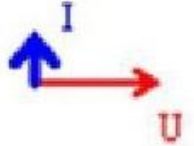
MODERATE STARTING TORQUE – EXCELLENT RUNNING EFFICIENCY



STARTING TORQUE

- **CAPACITOR START INDUCTION RELAY MOTOR (CSIR)** has a start capacitor only which increases its starting torque but does not increase its running efficiency.
- **CAPACITOR START - RUN MOTOR (CSR)** has both a start capacitor and a run capacitor, giving it high torque and excellent running efficiency.
- **PERMANENT SPLIT CAPACITOR MOTOR (PSC)** has a run capacitor only which increases its running efficiency and has a lower starting torque than a CSIR motor.

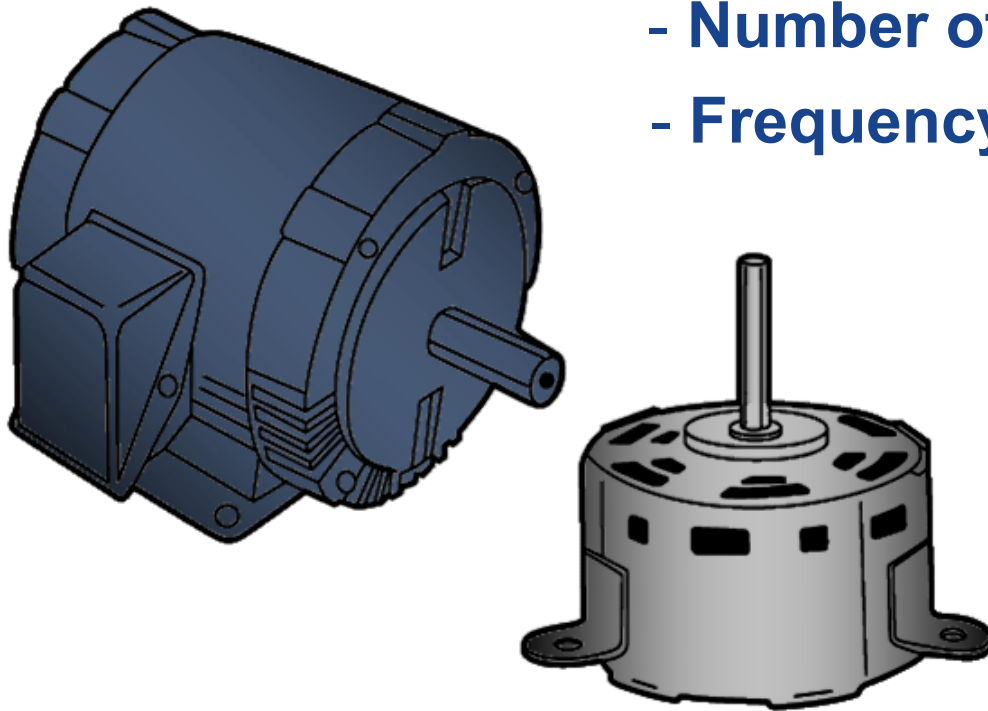
Capacitor current for rms

Load Type	Circuit	Voltage/Current Waveform	Vector Diagram
Resistance			
Inductance			
Capacitance			

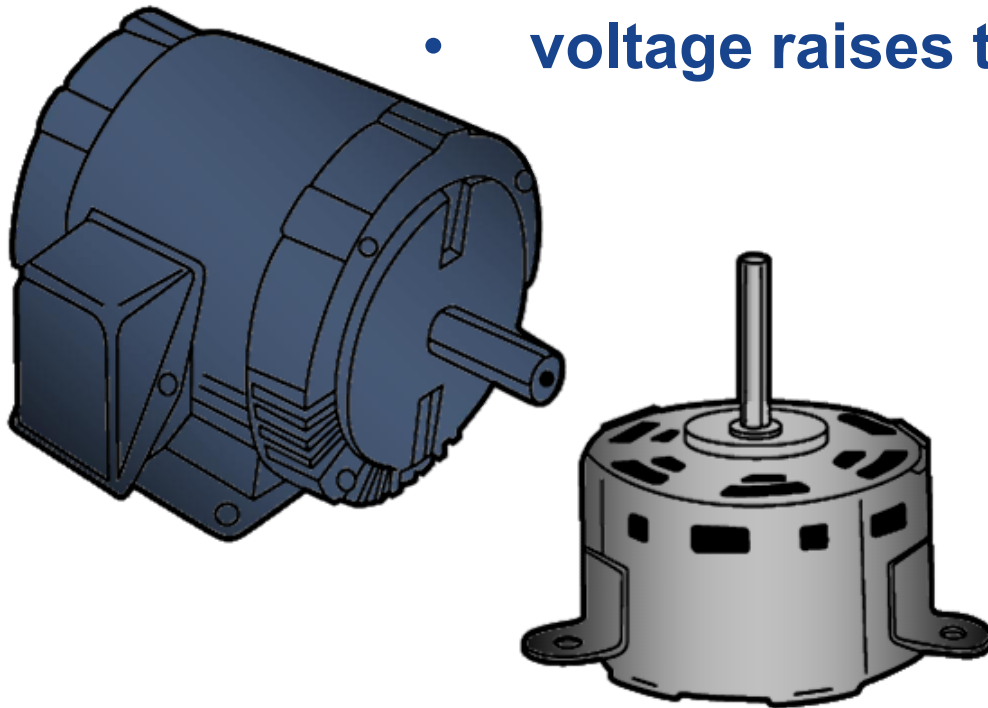
If a capacitor is connected in series for power factor correction, does the rms current increase due to the decrease in total impedance?
Yes and so does the voltage across the load!

MOTOR SPEED IS DETERMINED BY:

- Number of Stator Poles
- Frequency of Applied Voltage

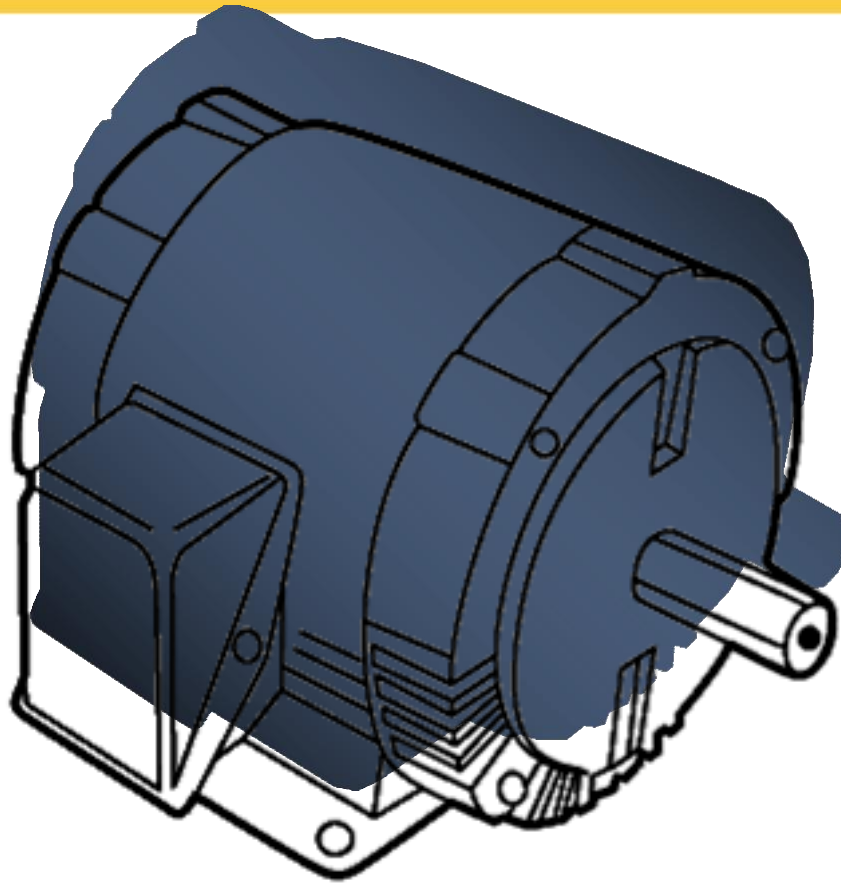


- Increasing the number of stator poles
- lowers the motor speed (RPM).
- Increasing the frequency of the applied
- voltage raises the motor's speed.

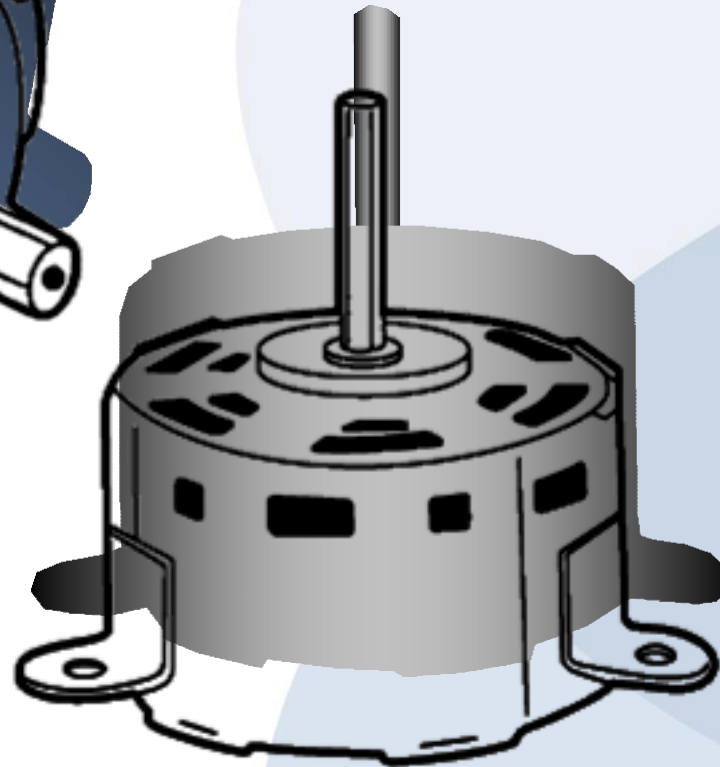




COUNTER EMF



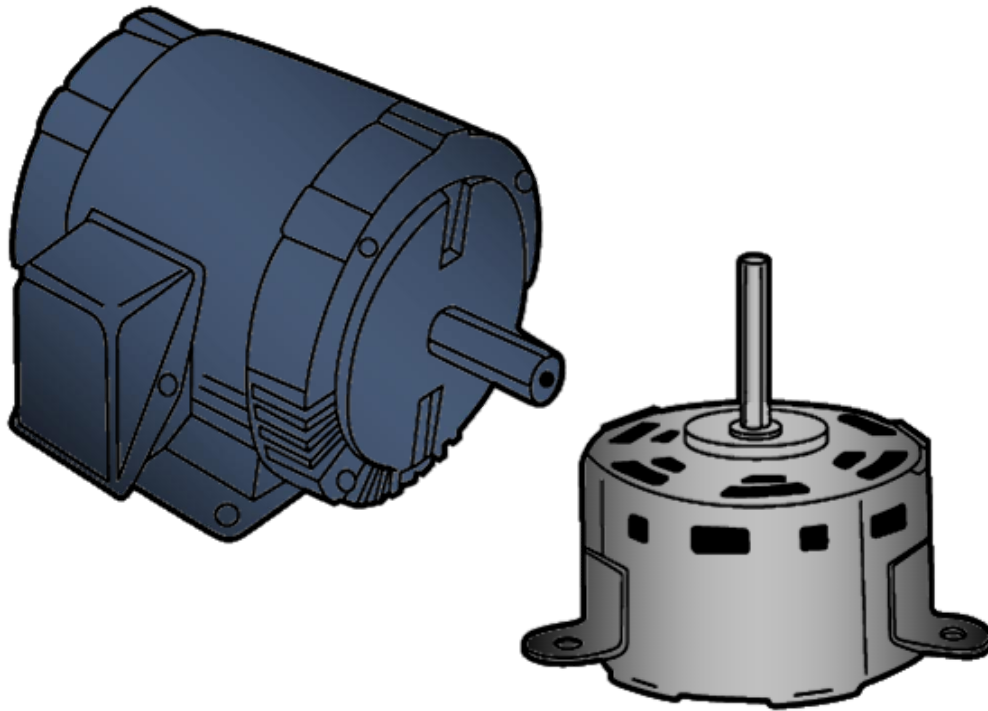
**Also Called
Back EMF**



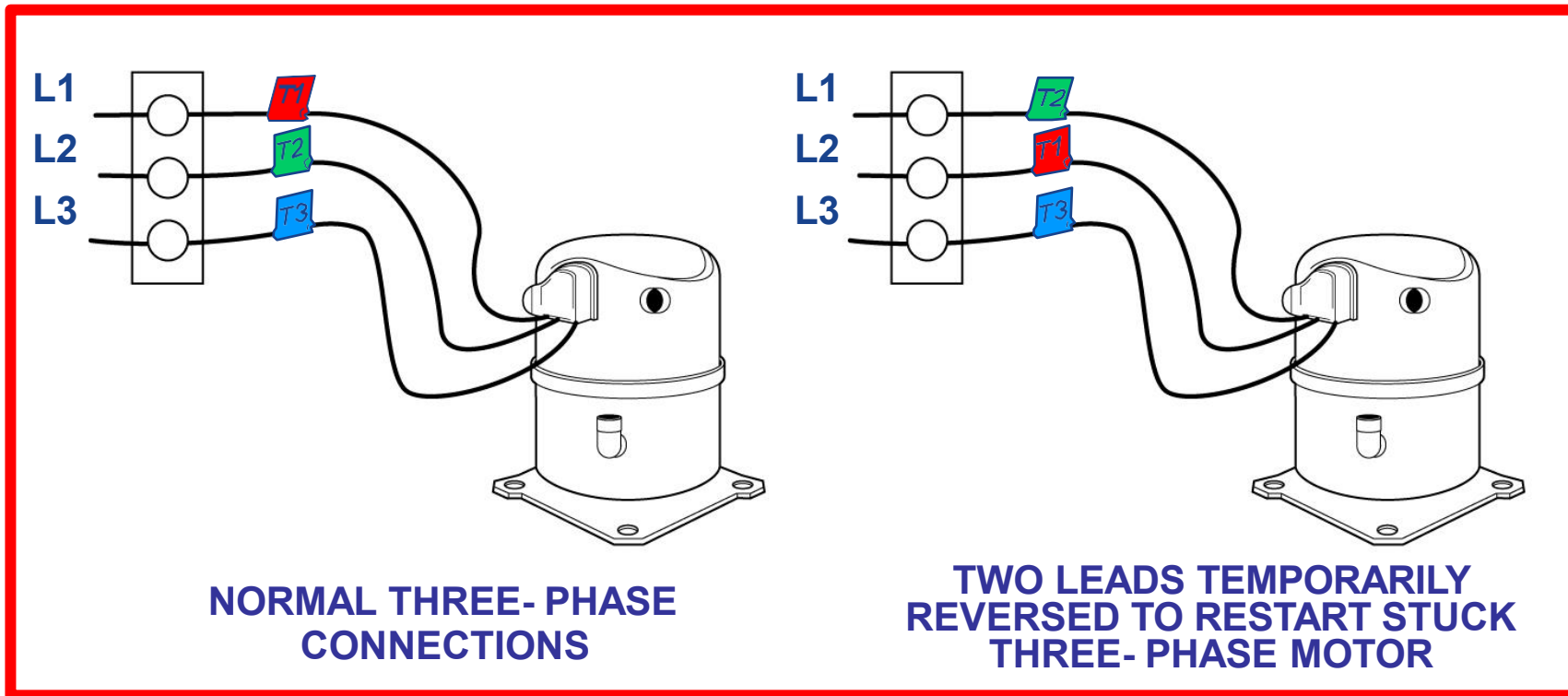


MOTOR INFORMATION

Typically, 5 horsepower belt driven motors are 240/460-volt three phase motors.



REVERSING A THREE-PHASE MOTOR

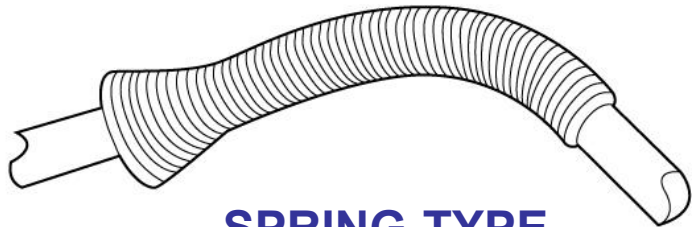


RESTARTING A “STUCK” THREE-PHASE MOTOR

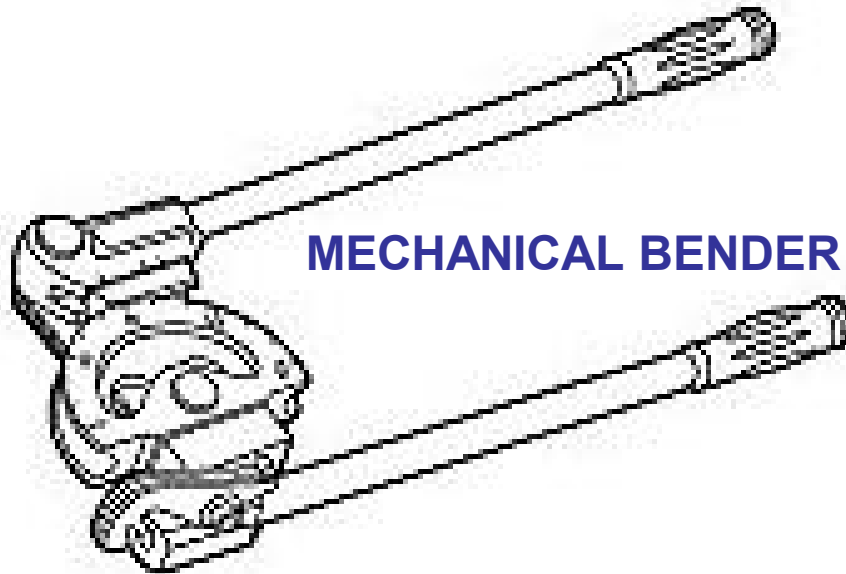
- Current flows in one direction
- Produced by dry cell batteries or dc generators.
- Mostly used on control circuits



COPPER TUBING



**SPRING-TYPE
BENDER**



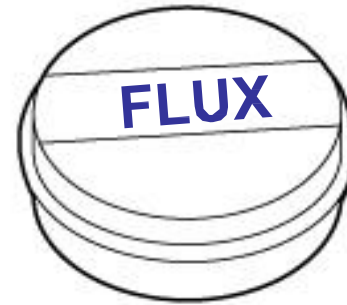
MECHANICAL BENDER

***SPRING-TYPE OR MECHANICAL
BENDERS ARE USED TO BEND SOFT
COPPER TUBING TO PREVENT
KINKING OR FLATTENING***

**BRAZING
RODS**

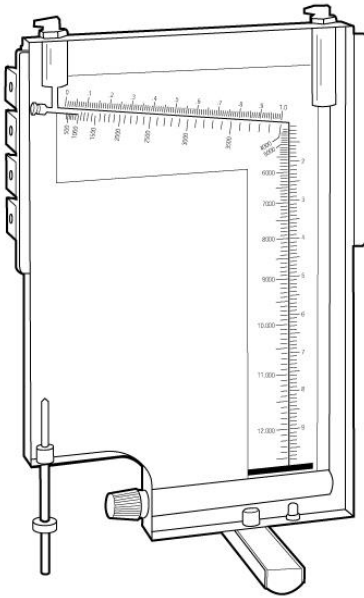


FLUX



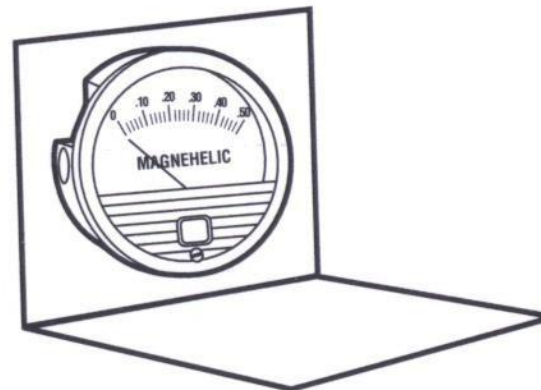
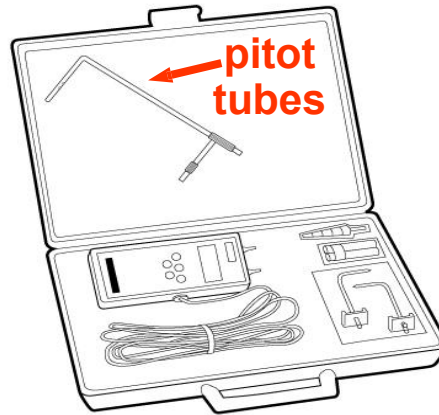
- SILVER SOLDER ALLOYS
 - are used to join the same or dissimilar metals (copper to copper, copper to steel, or copper to brass)
- FLUX
 - is a chemical substance that dissolves and removes oxides from surfaces,
 - prevents re-oxidation during heating and helps melted alloy flow into joints of the cleaned metal to be joined
- Oxy-acetylene torch set
 - has an advantage other torch sets due to the fact it will generate higher flame temperatures.

Manometers are used to measure velocity, static and gas pressures. Static can be measured by the difference between supply and return.



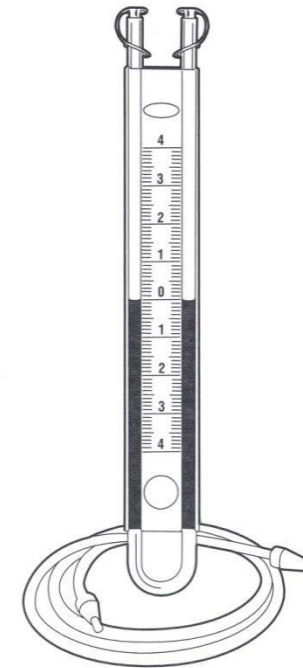
**Inclined-Vertical Manometer
(Air Velocity Meter)**

Electronic Manometers



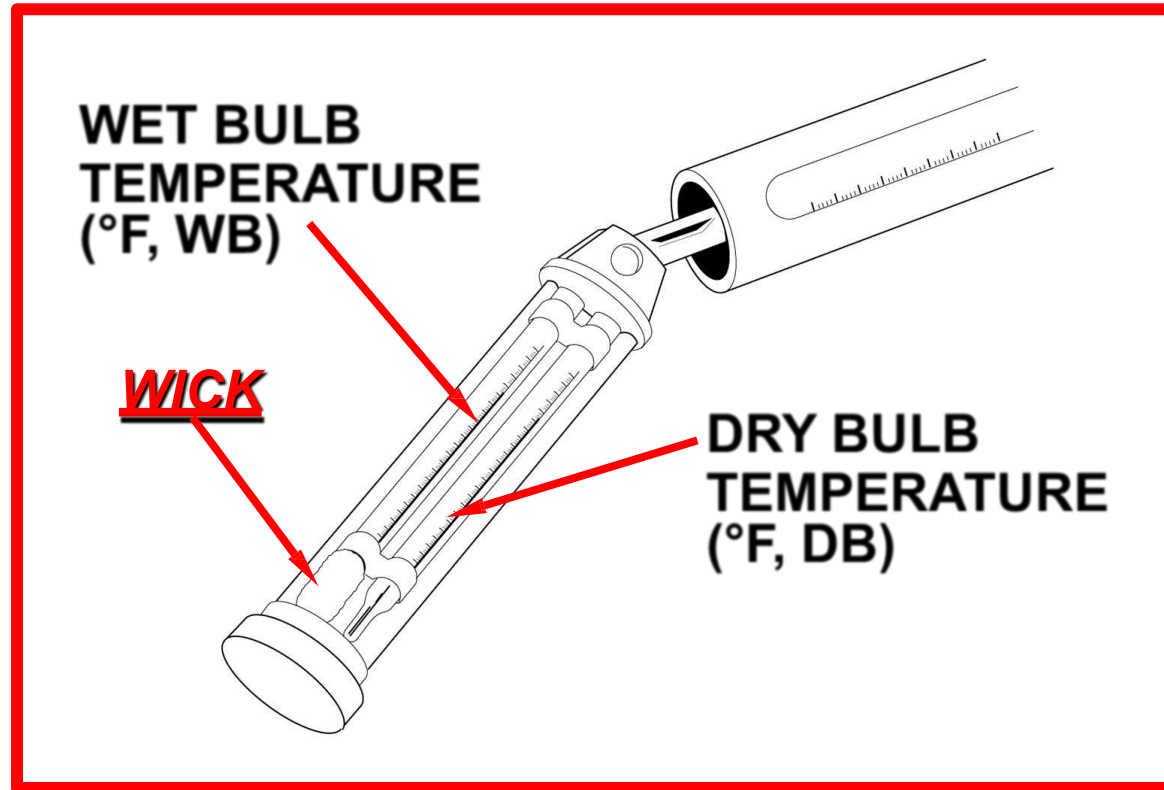
**Magnehelic™ Pressure/Air
Velocity Gauge**

U-Tube Manometer





SLING PSYCHROMETER



A device with wet and dry bulb thermometers that is whirled rapidly in the air to measure sensible wet, dry bulb temperatures, and relative humidity. Liquid filled thermometers are often used for accurate readings.



HUMAN COMFORT

- **Dry bulb readings are used most often when customers describe their level of comfort**
- **Location of the equipment should be considered to prevent noise or vibration coming from the equipment.**
- **The damper for a bypass humidifier must be open during the winter months.**
- **Humidifiers are installed to increase the relative humidity in the home and to increase the customers comfort level.**



CALCULATING CFM

If the equipment is a sensible heat source, you can use the following formula!

Temperature Rise Method



CALCULATING CFM

Volts X Amps = Watts (Power)

1 Watt = **3.414** BTU'S

The SQRT of 3 is **1.73**

Constant 1.08

(1.08 = $0.24 \times 0.075 \times 60$) FYI Not on TEST (Specific heat of air is 0.24, Specific density of air is 0.075 and 60 is number of minutes. 1.08 is not truly a constant but we use it below 2000')

Delta T is the Temperature Difference Between Supply and Return

Gas Heat

$$\text{CFM} = \frac{\text{Heating Capacity}}{1.08 \times \text{Delta T}}$$

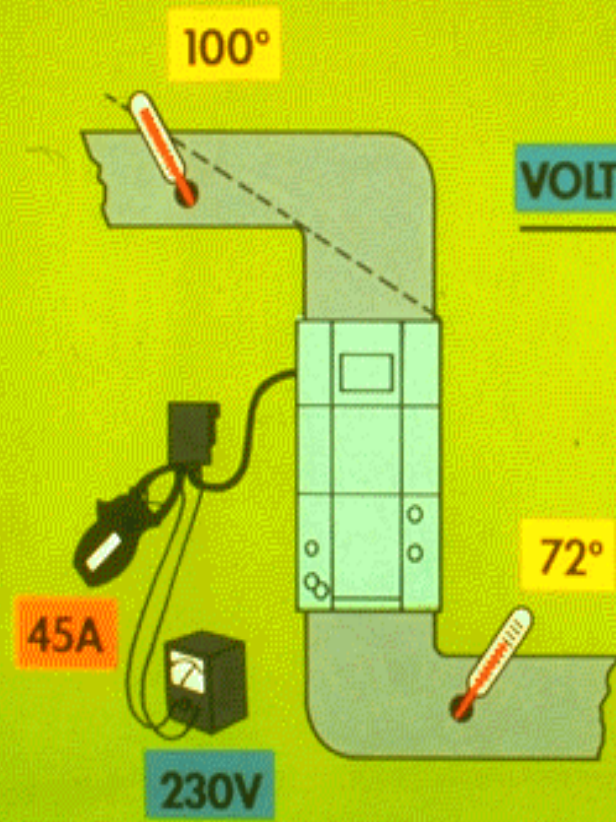
Single Phase Electric Heat

$$\text{CFM} = \frac{\text{Volts X Amps X } \mathbf{3.414}}{1.08 \times \text{Delta T}}$$

Three Phase Electric Heat

$$\text{CFM} = \frac{\text{Volts X Amps X } \mathbf{3.414} \times \mathbf{1.73}}{1.08 \times \text{Delta T}}$$

CFM =



100°

72°

45A

230V

$$\frac{\text{VOLTS} \times \text{AMPS} \times 3.414 \text{ BTU/WATT}}{1.08 \times \text{TEMP. DIFF.}} =$$

$$\frac{230 \times 45 \times 3.414}{1.08 \times 28} =$$

1170 C.F.M.

COMBUSTION (BURNING) IS THE RAPID OXIDATION OF FUEL-GAS ACCOMPANIED BY THE PRODUCTION OF HEAT, OR LIGHT AND HEAT.
THE PROCESS OF BURNING IS A CHEMICAL PROCESS



THERE ARE THREE THINGS NEEDED FOR COMBUSTION

1.FUEL

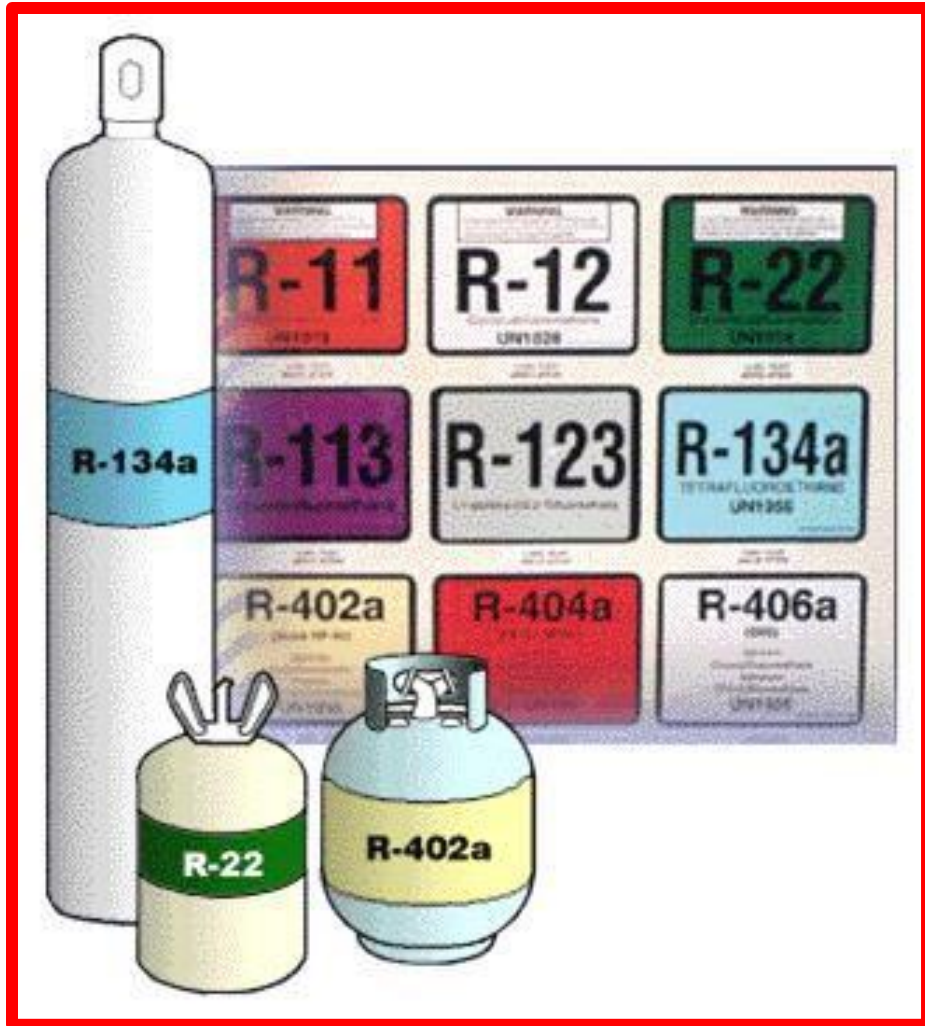
2.OXYGEN

3.IGNITION





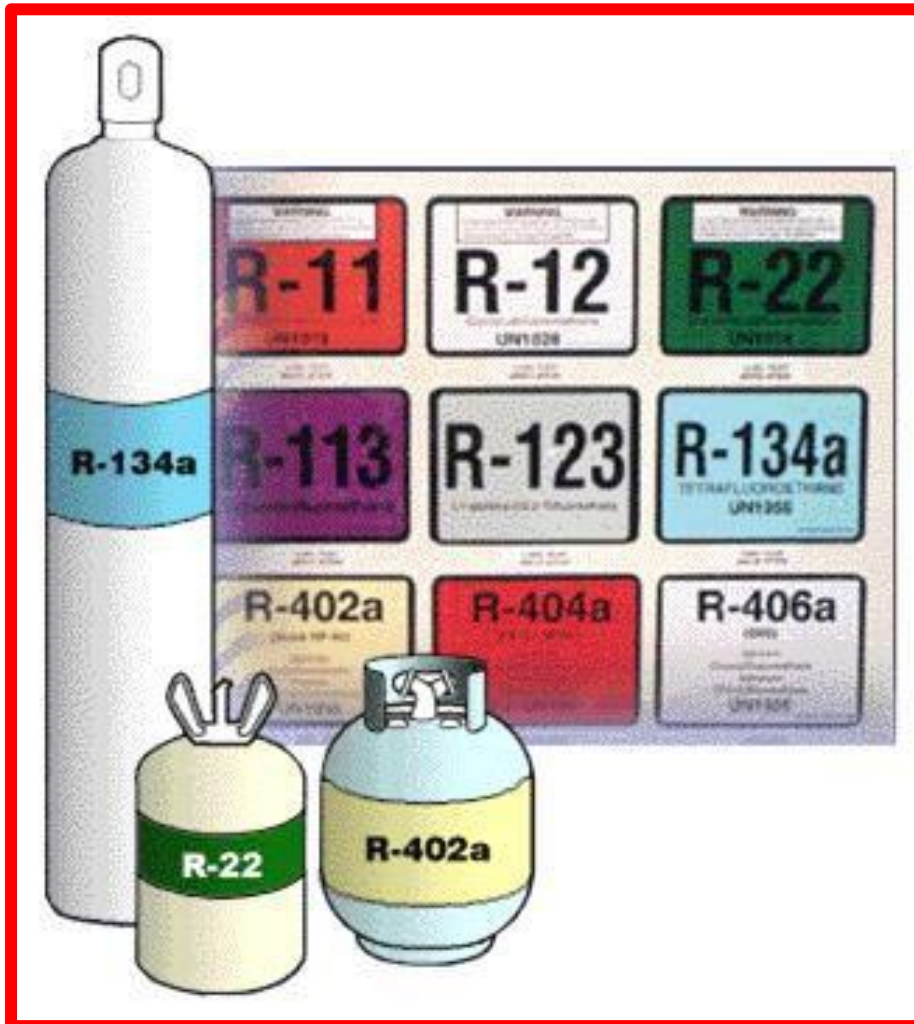
Flamable Gas is No. 2
 Flamable Liquid is No. 3
 Non-Flamable Gas 2 has bottle



***THE SHIPMENT OF
REFRIGERANTS IS GOVERNED
BY THE DEPARTMENT OF
TRANSPORTATION
ALL REFRIGERANTS SHOULD
BE SHIPPED IN THE UPRIGHT
POSITION***



REFRIGERANT MAXIMUM STORAGE



**TEMPERATURE
FOR R-22 AND
R-410A IS
125°F**



REFRIGERANTS



Min-Max Safety Disc Relief Pressures

525 to 800 PSIG For R410A

Versus

341 to 520 PSIG For R-22



PRESSURE/TEMPERATURE CHARTS

TEMP	R-22	R-410A	TEMP	R-22	R-410A	TEMP	R-22	R-410A	TEMP	R-22	R-410A
-40	0.5	11.6	10	32.8	62.3	60	101.6	169.6	110	226.3	365
-39	0.9	12.2	11	33.7	63.8	61	103.5	172.6	111	229.5	370
-38	1.3	12.9	12	34.7	65.4	62	105.4	175.5	112	232.7	375.1
-37	1.7	13.5	13	35.7	66.9	63	107.3	178.5	113	236	380.2
-36	2.2	14.2	14	36.7	68.5	64	109.2	181.6	114	239.3	385.4
-35	2.6	14.9	15	37.7	70	65	111.2	184.3	115	242.7	390.7
-34	3	15.6	16	38.7	71.7	66	113.2	187.7	116	246	396
-33	3.5	16.3	17	39.8	73.3	67	115.2	190.9	117	249.4	401.3
-32	3.9	17	18	40.8	75	68	117.2	194.1	118	252.9	406.7
-31	4.4	17.8	19	41.9	76.6	69	119.3	197.3	119	256.3	412.2
-30	4.9	18.5	20	43	78.3	70	121.4	200.6	120	259.8	417.7
-29	5.4	19.3	21	44.1	80.1	71	123.5	203.9	121	263.4	423.2
-28	5.8	20.1	22	45.3	81.8	72	125.6	207.2	122	266.9	428.8
-27	6.4	20.9	23	46.4	83.6	73	127.8	210.6	123	270.5	434.5
-26	6.9	21.7	24	47.6	85.4	74	130	214.4	124	274.2	440.2
-25	7.4	22.5	25	48.7	87.3	75	132.2	217.4	125	277.9	445.9
-24	7.9	23.4	26	49.9	89.1	76	134.4	220.9	126	281.6	451.8
-23	8.5	24.2	27	51.1	91	77	136.7	224.4	127	285.3	457.6
-22	9	25.1	28	52.4	92.9	78	138.9	228	128	289.1	463.5
-21	9.6	26	29	53.6	94.9	79	141.3	231.6	129	292.9	469.5
-20	10.1	26.9	30	54.9	96.8	80	143.6	235.3	130	296.7	475.6
-19	10.7	27.8	31	56.2	98.8	81	145.9	239	131	300.6	481.6
-18	11.3	28.7	32	57.5	100.8	82	148.3	242.7	132	304.5	487.8
-17	11.9	29.7	33	58.8	102.9	83	150.7	246.5	133	308.5	494
-16	12.5	30.7	34	60.1	105	84	153.2	250.3	134	312.5	500.2
-15	13.2	31.7	35	61.5	107.1	85	155.6	254.1	135	316.5	506.5
-14	13.8	32.7	36	62.8	109.2	86	158.1	258	136	320.6	512.9
-13	14.4	33.7	37	64.2	111.4	87	160.6	262	137	324.6	519.3
-12	15.1	34.7	38	65.6	113.6	88	163.2	266	138	328.8	525.8
-11	15.8	35.8	39	67	115.8	89	165.8	270	139	333	532.4
-10	16.5	36.8	40	68.5	118	90	168.4	274.1	140	337.2	539
-9	17.2	37.9	41	69.9	120.3	91	171	278.2	141	341.4	545.6
-8	17.9	39	42	71.4	122.6	92	173.6	282.3	142	345.7	552.3
-7	18.6	40.2	43	72.9	125	93	176.3	286.5	143	350	559.1
-6	19.3	41.3	44	74.5	127.3	94	179	290.8	144	354.4	565.9
-5	20	42.5	45	76	129.7	95	181.7	295.1	145	358.8	572.8
-4	20.8	43.7	46	77.6	132.2	96	184.5	299.4	146	363.2	579.8
-3	21.6	44.9	47	79.1	134.6	97	187.3	303.8	147	367.7	586.8
-2	22.4	46.1	48	80.7	137.1	98	190.1	308.2	148	372.2	593.8
-1	23.1	47.3	49	82.4	139.6	99	193	312.7	149	376.8	601
0	23.9	48.7	50	84	142.2	100	195.9	317.2	150	381.4	608.1

RTD (Resistive Temperature Device)

An RTD (Resistive Temperature Device) is made of metal such as Platinum (PT) or Nickle (Ni).

As temperature increases the resistance measured in ohms increases; this response is called PTC (Positive Temperature Coefficient). A Thermistor is typically made of ceramic or polymer material.

- *Software needed to operate*
- Becoming more and more prevalent in the industry
- Are you computer literate?



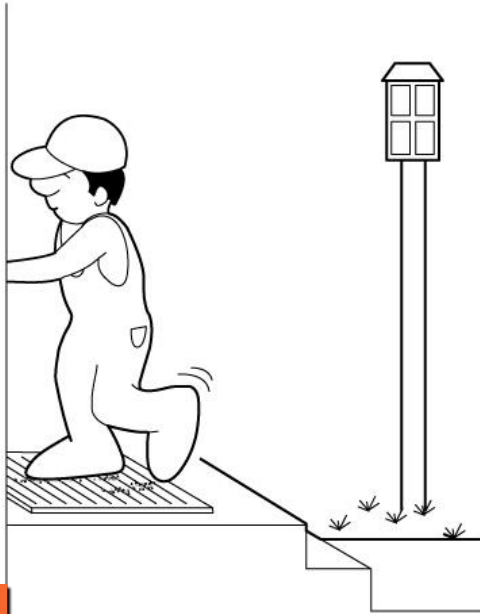
APPEARANCES COUNT



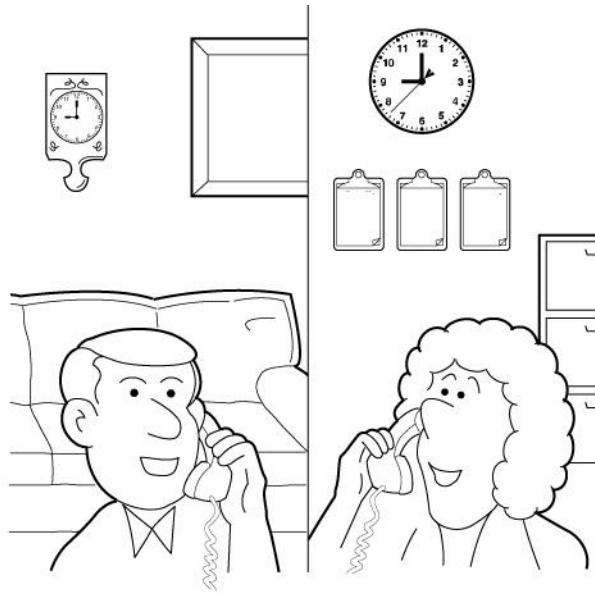
- **Look Alert and Rested**
- **Practice Good Personal Hygiene**
- **Wear Neat, Clean Uniform and Shoes**
- **Promptly Show the Proper ID**
- **Smile, Be Confident and Polite**



CUSTOMER RESPECT

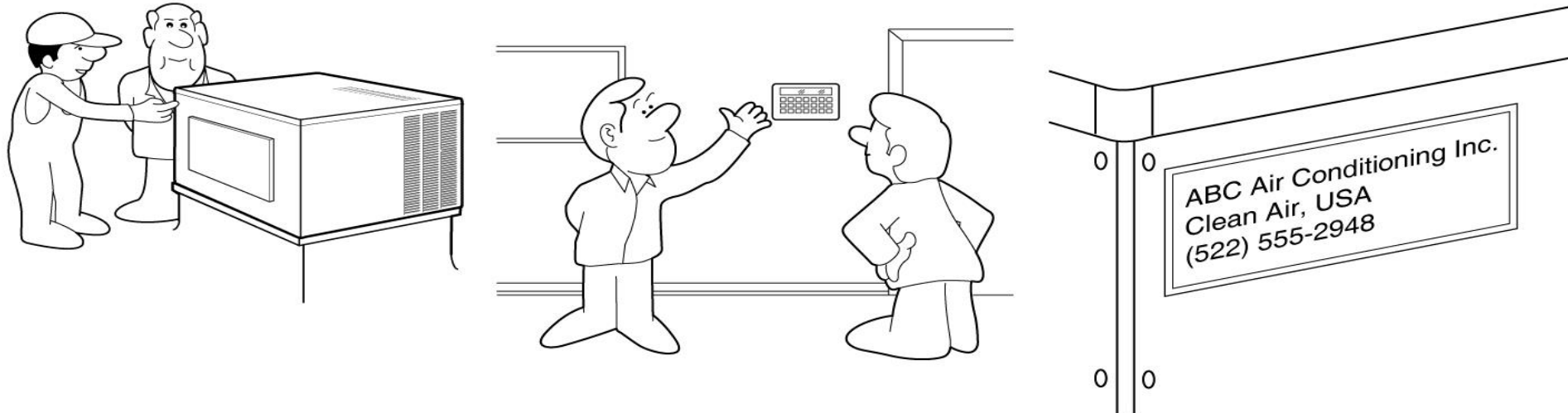


- **No Smoking**
- **Protect the Work Area**
- **Carry Rags and Clean Up**
- **Use Drop Cloths to Protect Floors**
- **Keep From Tracking In Dirt**
- **Leave the Home in Original Condition**



- **Be On Time**
- **Arrive Prepared and Informed**
- **Bring a Full Set of Tools, Neatly Packed**
- **Do the Installation Promptly**
- **Avoid General Social Conversation**

WHAT TO SAY AND DO



- **Give a Good Overview / Leave Literature**
- **Explain How Things Work At The Convenience Of The Customer**
- **Explain the Need for Regular Maintenance**
- **Suggest Home Maintenance Hints**
- **LEAVE A BUSINESS CARD AND STICKER**
- **Call to Follow-Up a Few Days Later**



JOB SITE INFORMATION SHEET

AIR CONDITIONING JOBSITE INFORMATION SHEET	
REMEMBER:	1. Circle Metering device used. 2. Circle Yes or No at drier locations. 3. Circle Service Ports used. 4. Sat. Temp. is pressure converted to Temp.
Low PSIG High PSIG	Formula For Super Heat Formula For Sub Cooling
Indoor Coil Indoor Temp. Leaving Indoor Temp. Entering	Outdoor Coil Outside Temp. *SEE NOTE
Liquid Line Vapor Line	Hot Gas Line Compressor
1. Liquid Line Size: 2. Liquid Line Length Vertical/Horizontal: 3. Vapor Line Size: 4. Vapor Line Length Vertical/Horizontal: 5. Vertical Separation Below/Above: 6. Air Handler CFM:	Location of coils from outdoor to indoor. (in below/out above) (in above/out below) or both are on the same level.

Questions/Discussions



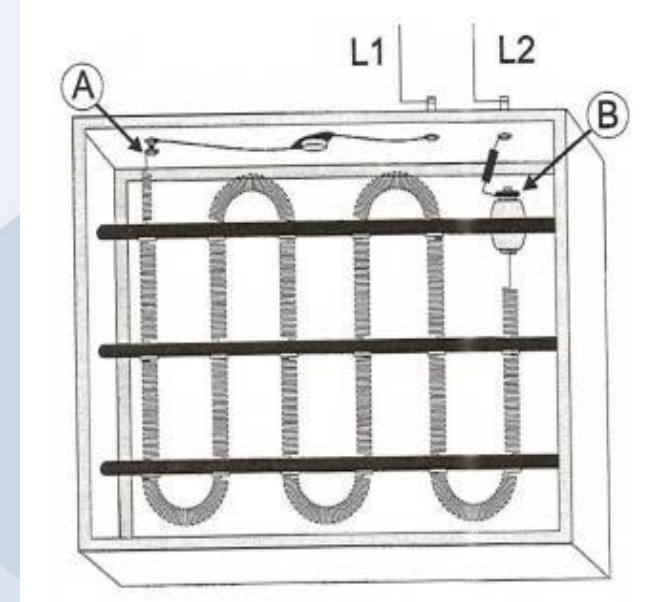
THINGS TO CONSIDER

Core “Things To Consider”



THINGS TO CONSIDER

- The temperature most often used by customers when discussing human comfort is: **A dry bulb reading.**
- How much heat is created by one watt: **3.41 BTU**
- The type of heat that must be added to or removed from a substance to cause a change physical state is: **Latent Heat**
- LP gas pressure should be between **10 and 11 in. W.C.**
- Air that is mixed with fuel before ignition is: **Primary Air**
- You are troubleshooting an electric furnace and find 242 volts measured across the heating element at points “A” and “B”, and you subsequently measure no amperage when checking with an ammeter around the wire connected to L1. The problem with this system is? **The element is open**





THINGS TO CONSIDER

Most safety controls are wired in: **Series with the load**

What state is the refrigerant in as it enters the condenser: **A hot, high-pressure vapor**

The color code for a drum of R-22 is: **Light Green**

The color code for a drum of R-410a is: **Rose**

There are two refrigerant drums, Drum A and Drum B. Both drums contain virgin R-410a and there are no condensibles in them. Both are sitting in the same ambient temperature. Drum A is filled to a level of 10 percent and Drum B is filled to its maximum level of 80 percent. Which drum will have the higher pressure?

Both drums have equal pressure.

The law of electric charges states that: **Opposite charges attract & like charges repel**



THINGS TO CONSIDER

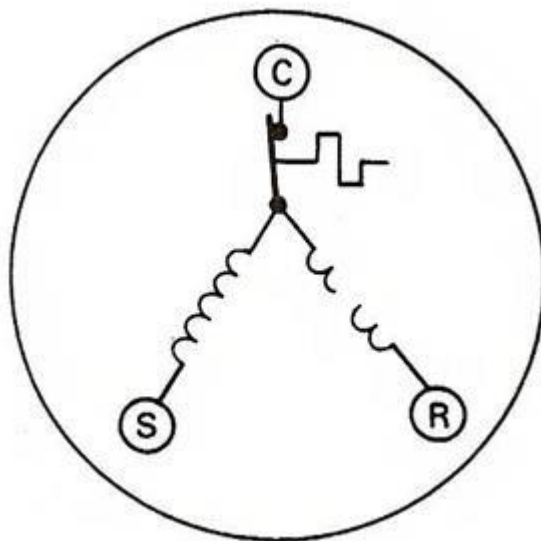
Electromotive Force is a term related to: **Volts**

Current flow is related to the term: **Amps**

The phrase cycles per second relates to: **Hertz**

In a PSC motor, the run capacitor is: **Wired in series with the start winding**

The condition of this compressor would be described as: **Open**





THINGS TO CONSIDER

Which of the following could be responsible for the suction pressure in a comfort cooling refrigeration system being lower than normal? **A restriction in a filter-drier**

Which combination is necessary to accomplish the combustion process? **Air, Fuel and Ignition**

Carbon monoxide is identified by the symbol: **CO**

A heat pump isn't providing sufficient heat on a cold day. You should: **Survey the overall installation to make sure there is proper air flow through the duct system.**

At 32°F, 1 lb. of ice can be changed to 1 lb. of water by adding _____ Btu. **144 BTU**

Heat transferred by radiation travels through space without heating the space. **True**



THINGS TO CONSIDER

Approximately _____volts is required for creating a spark on a spark ignition system: **15,000vac**

RTD which measure temperature have a positive temperature coefficient: **True**

Which one of the following in the refrigeration cycle changes the refrigerant from low pressure gas to high pressure gas: **Compressor**

_____is a combination of both sensible heat and latent heat: **Enthalpy**

Heat transfer that takes place in liquids and gases in which of the following: **Convection**

The heat energy change that is associated with a change in the phase (state) is: **Latent Heat**

Modern high-efficiency burners use combustion blowers: **True**



THINGS TO CONSIDER

A ceiling which slopes upward from the walls to the center of the room is referred to as a: **Cathedral Ceiling**

When measuring external static pressure, the high port of the pressure gauge should be placed in the duct system to sense: **Supply air pressure**

When the external static pressure rises, the delivered air volume will: **Decrease**

To extinguish an electrical fire a fire extinguisher must have a class rating: **Class C**

The frame of an electric motor is grounded to. **Maintain the frame at zero potential**

When working with chemical solvents the technician should review: **MSDS or SDS**

Refrigerant vapors in high concentrations should not be inhaled since they: **May cause heart irregularities or unconsciousness**

The input side of a step-down transformer is also properly called the: **Primary side**



THINGS TO CONSIDER

Combustion is what type of process? **Chemical**

What's the accurate formula for Ohm's law? **$R = E \div I$**

The temperature most often used by customers when discussing human comfort is: **A dry bulb reading**

The unit of electrical pressure is the: **Volt**

Each leg of line voltage only is typically represented by the: **Two lines on the side of a ladder diagram**

Humidifiers are used with heating systems to raise: **Relative humidity and increase customer comfort**

Care should be taken before sawing basement walls that are part of the original construction of a home because these walls are typically: **Load Bearing**



THINGS TO CONSIDER

Construction fall protection is required whenever: **Working over a minimum of 4 feet**

Sheathing is used over roof beams or rafters as a: **Base for the roofing**

A tap is a tool specifically made to: Thread a hole in metal

The temperature at which water vapor condenses is called: **Dew Point**

A sling psychrometer can measure wet bulb and dry bulb temperature.

These measurements are then used to compute: **Relative humidity**

Because they are very accurate, liquid filled thermometers are often used in: **Sling psychrometers**

The following is an example of a wet bulb thermometer: **A conventional thermometer with a moistened cloth wick covering its sensor**



THINGS TO CONSIDER

As a general rule, a continuity check using an ohmmeter shows continuity by reading: **At zero or a specific resistance**

Combustion is what type of process: **Chemical**

How is a voltmeter connected for taking voltage readings: **By connecting the voltmeter in parallel with the voltage to be measured**

A digital electric multimeter marked for "auto ranging" will automatically set itself for: **Reading type and range of values for all volts, amps and ohms**

What method of heat transfer does not require fluid or solids: **Radiation**

A pier and beam is a type of residential flooring over what section of the residence: **Crawl space**

3.41 BTU of heat is created by: **1 Watt**

Power is measured in: **Watts**



THINGS TO CONSIDER

The primary purpose for bringing outdoor air into a residential air distribution system is to: **Provide fresh air to a conditioned space**

What is the proper care for hand tools: **Clean and wipe them regularly**

What unit is sound level measured in: **Decibels**

A conventional thermometer with a moistened cloth wick covering its' sensor:
Wet bulb thermometer

The primary purpose for bringing outdoor air into a residential air distribution system is to: **Provide fresh air to a conditioned space**

One who is free from fraud or deception, credible, and is marked with integrity:
An honest person

According to health and safety regulations, when climbing up or down a ladder the worker must always do what: **Face the ladder**



THINGS TO CONSIDER

In a DC circuit Current flows only in one direction: **True**

In the following paragraph taken from a technician's note, "the relay appeared to be overheated. Replacing it should fix the problem:

The service tech is stating his opinion

A coil of wire moving through a magnetic field will generate what: **Current**

Any pressure exerted by a liquid or gas on a surface is typically measured as a reading relative to: **Atmospheric pressure**

Field wired 120 and 240V wiring is typically shown on a wiring diagram as:

Solid heavy lines

Which particular right triangle has two equal sides: **45 Degree**

Customers often volunteer to advise a service technician on what they believe is the problem with a unit that is not operating properly:

The tech should consider the customer's opinion to see if they have merit





THINGS TO CONSIDER

The phrase “Educate me and I will buy from you” means: **If the customer learns more about how you can fill their needs, they are more likely to buy your products**

Hacksaws should never be used to cut copper tubing because:

Chips can remain inside the tubing

According to Ohms Law, when the voltage to an electric heating element is increased by 10% the current through the element: **Increases by 10%**

A continuity check using an ohmmeter shows continuity by:

Reading zero or specific resistance

A capacitor in an AC circuit is often used to:

Increase starting torque in some motors

What is an acceptable practice when selecting a screwdriver:

Use a screwdriver for the specific screw type and fastening method for which it is designed



THINGS TO CONSIDER

Radiation is a method of heat transfer that does NOT require what:

Fluids or Solids

Latent heat is the heat added or removed when a substance:

Changes its physical state

The following conditions exist: *24V transformer with a 5:1 turns ratio: Primary voltage is 120V, in the event of a 4% primary voltage drop, what will be the secondary voltage?
(4% of 120vac is 4.8 4% of (24vac = 0.96))

The heat that causes a thermometer reading to change is called: **Sensible heat.**

Which component pumps refrigerant through the system and raises the vapor temperature: **Compressor**

What is the primary function performed by a thermal expansion valve

It maintains the correct superheat in the suction vapor leaving the evaporator



THINGS TO CONSIDER

Capillary tubing should only be cut to length using a:

Triangular or knife edge file

When making a flare the height of the tubing above the flare block is critical because the flare with too much starting height will: **Not fit into the flare nut**



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THE END

Questions/Discussions