Electrical Fundamentals

Electrical Fundamentals

- Demonstrates a working knowledge of the purpose, principles of operation and applications of electrical concepts.

Electrical Fundamentals

- Defines the purpose, fundamentals and principles of electricity

Electrical Fundamentals

- Electricity is a form of energy.
- Electricity cannot be seen, heard, touched or smelled.
- Electricity cannot be weighed or measured in the conventional way.
- We can, however, measure its actions, and we can see, hear, touch many of its effects.

Electrical Fundamentals

- When scientists first tried to describe electricity, they compared with a more familiar substance-water.
- Scientists noticed many similarities between how water and electricity behaved.
- Words to decribe the movement of water (flow and current) were to describe electricity

Electrical Fundamentals

- Electricity behaves like water in the following way:
- Electricity contains Potential energy-
- The energy of flowing electricity can drive electrical equipment in much the same way that the energy of flowing water can drive the blades on a turbine or waterwheel

Electrical Fundamentals

- Electricity always seeks to equalize its level:
- Electricity always flows from areas of high electric potential to areas of low electrical potential. Just as water will flow until all of it is at the same level, electricity will flow until the potential is equal in all parts of the circuit.

Electrical Fundamentals

- Electricity is lazy:

  -- like water, electricity will seek the path of least resistance.

Electrical Fundamentals

- Electron Theory:
- Electron theory helps to explain electricity, the basic building block for matter. All matter is made up of molecules or atoms joined together.

Electrical Fundamentals

- What we know about electricity comes from theories that help us to understand its behaviour without being able to see it

Electrical Fundamentals

- Matter
- Matter is the general name given to everything in the universe.
- Matter is anything that has mass and occupies space.
- The only place where matter does not exist is in a total vacuum.

Electrical Fundamentals

- Matter is made up of over 100 individual components or chemical building blocks called *elements*
- Matter can exist in any of the three states:

  Solid, Liquid or Gas
- Water for example, can exist in the form of ice, as a liquid, or as a gas in the form of steam.

Electrical Fundamentals

- An element is matter that cannot be reduced to anything simpler by chemical means.
- Some are familiar elements such as oxygen, gold and copper.
- An element is a substance is a substance that cannot be chemically divided into a simpler substance.

Electrical Fundamentals

- If an element is reduced in size, the smallest remaining part that can still be identified as that particular element is called an ***atom.***

Electrical Fundamentals

- The atom:
- An atom is the smallest unit of sll elements. The dense center of each atom is called the nucleus.
- The nucleus contains protons and neutrons. (protons have a positive charge (indicated in diagrams by a “+” symbol and the neutrons are electrically neutral, have no charge)

Electrical Fundamentals

- The atom
- In orbits surrounding the nucleus are the electrons are the electrons. (electrons have a negative charge, indicated in diagrams by a “-“ symbol.
- An atom is like a tiny solar system.

Electrical Fundamentals

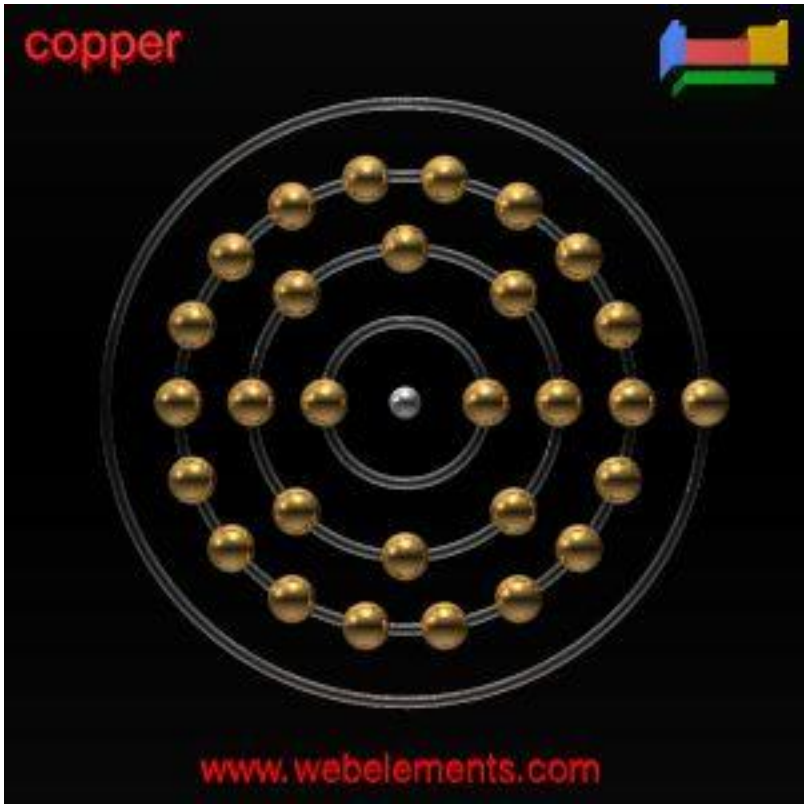
- The number of negative charged electrons is balanced with the same number of positive charged protons, an atom has a neutral charge (no charge).
- This is referred to as a balanced atom.

Electrical Fundamentals

- Atomic structure examples:
- Hydrogen has the simpelest atom with one proton in the nucleus and one electron rotating around. Go to> www.webelemenst.com
- Copper is more complex with 29 electrons in four different rings in rotating around a nucleus that has 29 protons and neutrons. Other elements have different atomic structures.

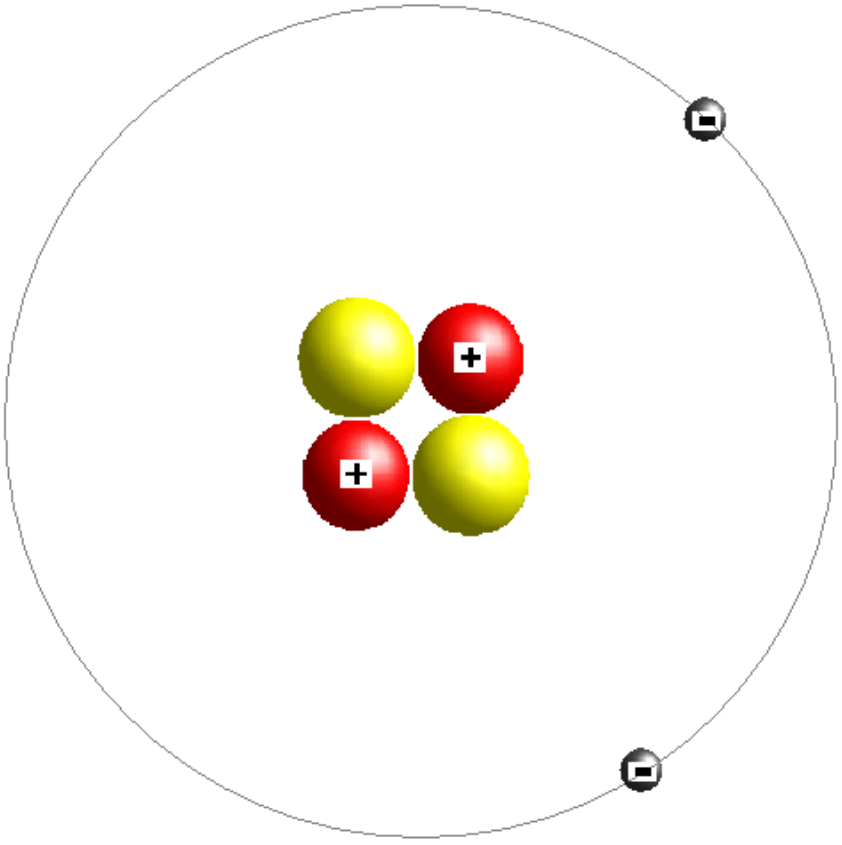
Electrical Fundamentals

- The 29 electrons in copper are in four separate orbits (shells) around the nucleus.
- The first three orbits do not concern us.



Electrical Fundamentals

- Valence electrons include the electrons in the outermost shell of an atom.
- This is often called the valence shell.



Helium atom

Electrical Fundamentals

- With a little push, we will be able to the electron out of its orbit.
- The fewer the electrons in the valence orbit (shell), the easier they move or travel between atoms.
- These electrons are referred to as being ***“free.”***

Electrical Fundamentals

- An atom that has a negative or positive charge as a result of losing or gaining one or more electrons is referred to as an ion.
- By pushing a series of electrons along a conductor/ wire from one atom to the next, we have a simple definition : moving electrons.
- The more electrons that move, the more electricity.

Electrical Fundamentals

- A good conductor has 3 or less electrons in its valence.
- The movement of drifting electrons is called the current.
- The amount of current flow depends on the number of electrons moving.

Electrical Fundamentals

- A good insulator has 5 to 8 electrons in its valence ring.
- These electrons are tightly held together and are referred to as bound electrons because drifting electrons having trouble moving them.

Electrical Fundamentals

- Insulators are materials such as rubber, glass and certain plastics.
- Insulators are used in electric systems to ensure the electron flow stays within the conductor and is directed to the proper place within the system.

Electrical Fundamentals

- Materials with 4 electrons in their valence shell are neither good conductors nor good insulators.
- These materials are known as semi-conductors (e.g. carbon).
- Semi-conductors are used in solid state components such as diodes and transistors.

Electrical Fundamentals

- **Electron flow:**
- If free electrons are left to drift without direction, it is called *random drift of electrons*, and will not produce current flow.
- Current is produced from a directed, concentrated flow of electrons from one point to another.

Electrical Fundamentals

- To achieve this condition, we must positively charge one end of the conductor and negatively charge the other.

Electrical Fundamentals

- Current flow theories:
- Conventional theory- used for automotive systems, say current flows from (+) to (-) … excess electrons flow from an area of high potential to one of low potential.
- Electron theory- commonly used in electronics, says current from (-) to (+) …. Excess electrons cause an area of negative potential and flow towards an area of lacking electrons.

Electrical Fundamentals

- **Volt**
- Voltage is electrical pressure, a potential force or difference in electrical charge between two points.
- Voltage can push electrical current through a wire, but not through its insulation

Electrical Fundamentals

- Voltage is measured in ***volts.*** One volt can push a certain amount of current, two volts twice as much and so on.
- A voltmeter measures the difference in electrical pressure between two points.
- A voltmeter is used in parallel.

Electrical Fundamentals

Electrical Fundamentals

Voltage	**Basic unit**	Units for small small amount		Units for large small amount	
Symbol	V	uV	mV	kV	MV
Pronounced as	Volt	Micro-volt	Milli-volt	Kilo-volt	Mega-volt
Multiplier	1	0.000001	0.001	1,000	1,000,000

Electrical Fundamentals

- **Current:**
- Current is electrical flow moving through a conductor
- Current flows in a wire pushed by voltage.
- Current is measured in *amperes*, or *amps*.
- An ammeter measures current flow in amps
- It is inserted into the path of current flow, or in series, in a circuit.

Electrical Fundamentals

Electrical Fundamentals

Voltage	**Basic unit**	Units for small amount		Units for large amount	
Symbol	A	uA	mA	kA	MA
Pronounced as	Ampere (amp)	Micro-ampere	Milli-ampere	Kilo-ampere	Mega-ampere
Multiplier	1	0.000001	0.001	1,000	1,000,000

Electrical Fundamentals

- **Resistance:**
- Resistance opposes current flow. It is like electrical “friction”. The resistance slows the flow of the current.
- Every electrical component or circuit has resistance….This resistance changes electrical energy into another form of energy-heat, light and motion.

Electrical Fundamentals

- The **ohm:**
- **Resistance** is measured in ***ohms***.
- An ohmmeter can measure the resistance of a device in ohms when ***no*** current is flowing.

Electrical Fundamentals

Resistance	**Basic unit**	Units for large small amount		Units for large amount	
Symbol	A	uA	mA	kA	MA
Pronounced as	Ohm	Micro-ohm	Milli-ohm	Kilo-ohm	Mega-ohm
Multiplier	1	0.000001	0.001	1,000	1,000,000

Electrical Fundamentals

- **Factors affecting resistance:**
- Five factors determine the resistance of conductors
- These factors are length of the conductor, diameter, temperature, physical condition and conductor material.

Electrical Fundamentals

- **Length:**
- If two wires are the same material and diameter, the longer wire will have more resistance than the shorter wire.
- Wire resistance is often listed in ohms per foot (e.g. spark plug cables at 5 ohms per foot).Length must be considered when replacing wires.

Electrical Fundamentals

- **Diameter:**
- Large conductors allow more current flow with less voltage.
- Temperature:
- In most conductors, resistance increases as the wire temperature increases.

Electrical Fundamentals

- **Physical condition:**
- Partially cut or nicked wire will act like a smaller wire high resistance in the damaged area. A kink in the wire, poor splices, and loose or loose or corroded connections also increase resistance.

Electrical Fundamentals

- Material:
- Materials with many free electrons are good conductors with low resistance to current flow.
- Materials with many bound to electrons are poor conductors, (insulators) with high resistance to current flow.

Electrical Fundamentals

- **Voltage, Current and Resistance in Circuits:**
- A simple relationship exits between voltage, current and resistance in electrical circuits.
- Understanding this relationship is important for fast, accurate electrical problem diagnosis and repair.

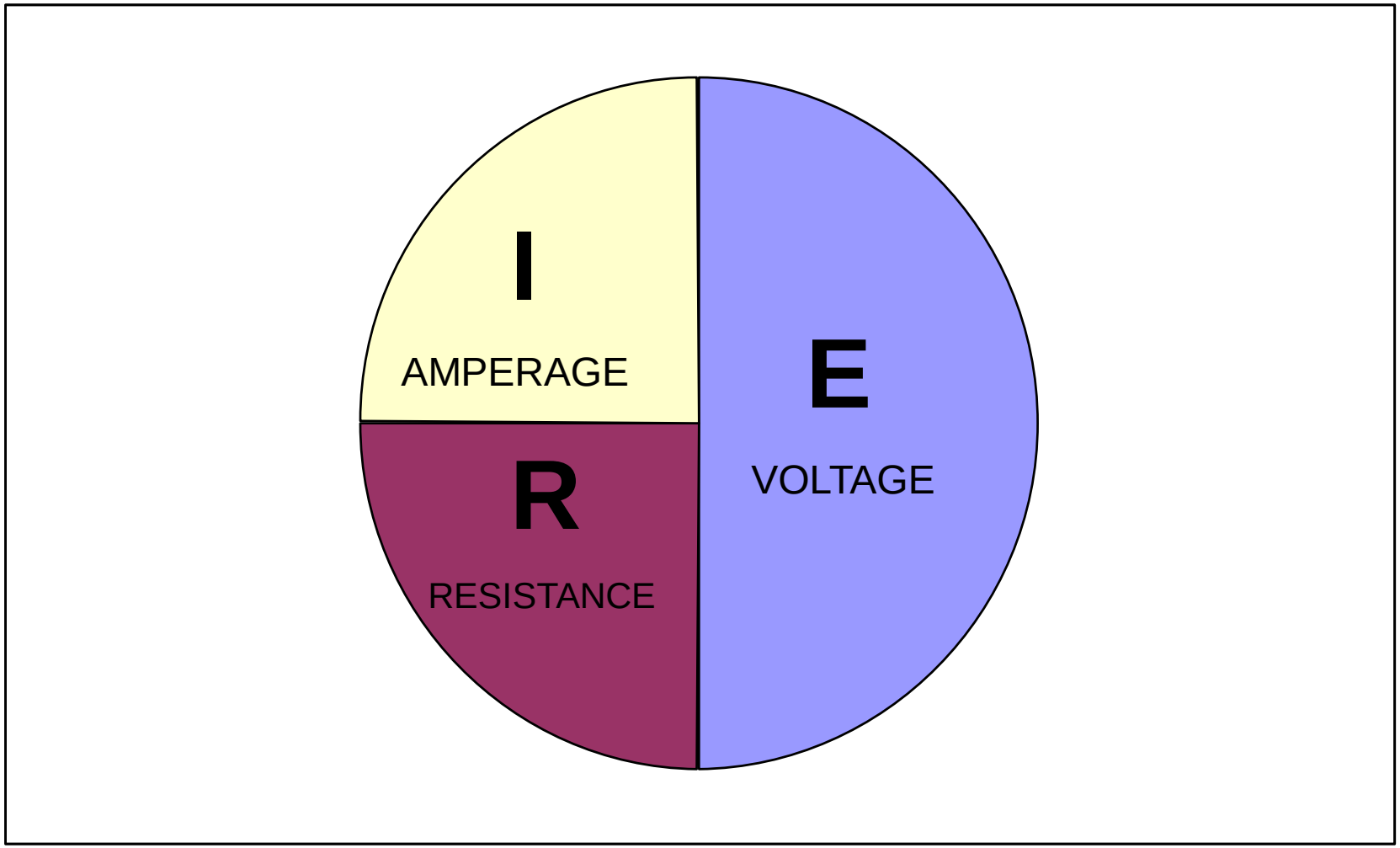
Electrical Fundamentals

- **Ohm's Law**
- When a force of one volt pushes one ampere of current through a circuit, the resistance present is one ohm.
- $E=I \times R$
- $I=E/R$
- $R=E/I$

Electrical Fundamentals

- **Ohms' Law**
- The current in a circuit is directly proportional to the applied voltage and inversely proportional to the amount of resistance.
- This means that if the voltage goes up, the current flow will go up, and vice-versa. Also as the resistance goes up, the current goes down and vice-versa.

This diagram will help you remember the ohm's law formula. Cover the unknown value and multiply or divide the other two.



Electric Power and Work

- Voltage and current are not measurements of power and work. Power, in watts, is a measure of electrical energy.
- Power (P) equals current in amps times voltage (E).
- $P=I \times E$

Electric Power and Work

- Work in watt-hours, is a measure of the energy used in a period of time.
- Work equals power in watts (W) times time in seconds or hours. W=P x time.
- Electrical energy performs work when it is changed into thermal (heat), radiant (light), audio (sound), mechanical (motive) and chemical energy.