Electrotherapy lecture 2

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In this lecture:

1. *Define electricity, potential difference, ampere, &watt, resistance, and Ohm's law.*
2. *Show types of waveforms & pulse characteristics.*
3. *Discriminate between series and parallel circuit.*
4. *Establish the various treatment parameters that must be considered with electrical stimulation.*
5. *The differences between alternating direct and pulsatile currents, and between alternating direct and pulsatile currents.*
6. *Categorize the types of electrodes, their configurations and how used with electrical stimulation application.*

- **The electric current** is the flow of electrons from higher to the lower concentration.
- **Cathode (-):** The electrode connected to the negative terminal of battery, point of high e-concentration
- **Anode (+):** The electrode connected to the positive terminal of battery, Point of low e-concentration.
- **Intensity of Current** : the rate of an (e-)flow through a conductor from cathode (-) to anode (+), per second. Usually measured in Ampere or (mA= 1/1,000 ampere) or (μA; 1/1,000,000 ampere) 1 amp = 6.25 x 1018 e- / sec
- **Electrical Power:** It is the rate of work that produces in unit of time. The unit to measure the power is watt. • Watt = Volts x Amperes (VI) • 1 Watt = 1 amp of current flowing with a force of 1 V.
- **Voltage (electrical potential difference):** A difference of potential exists between similar bodies charged with different quantities of electricity. The force that produces this motion is called EMF. The force resulting from an accumulation of e- at one point in an electrical circuit. • Higher voltages result in deeper penetration.

Resistance: is a quantitative degree of opposition to the flow of electron. It depends on;

1. Type of the material
2. Length
3. Cross-sectional area
4. Temperature

Resistance is directly proportional to length and inversely proportional to cross section area of a conductor.

Ohm`s Law:

The relation between current and voltage, the current is directly proportion to voltage and inversely proportional to resistance,

$$I = V/R$$

Where: I=current flow, V=Potential differences, R=Resistance •

Ohm: (Ω) unit to measure resistance to current flow; • 1 ohm = the amount of resistance needed to develop 0.24 calories of heat when 1 A of current is applied for 1 second

Clinical applications to overcome skin resistance:

- Decrease distance between electrodes (length)
- Increase the size of electrodes (cross section area)
- Minimize air-electrode interface
- Use electrodes jelly or moisten the electrodes
- Pre-warming the skin by moisten heat (i.e. hot packs)

Preheating the treatment area may increase the comfort of the patient but also increases resistance and need for higher output intensities

Conductor:

means the elements whose atoms have few e- in their outer orbit, and facilitate passage of an electrical current.

Higher conductance materials:

free flow of e^-_s

- Silver, Copper,
- Electrolyte solutions
- Blood cell: highest ionic & H_20
- Inner layer of the skin
- Nerves
- Muscle fibers
- Cell membranes

Low conductance materials:

few free e-s

- Air, Wood, Glass, Rubber
- Bone
- Cartilage
- Tendons
- Ligaments
- Outer layer of Skin has keratinized epithelium (little H_20) acts as insulator

In human body: The greater is the percentage of H_2O in the tissues, the better is the conductance of electricity.

H.W.:

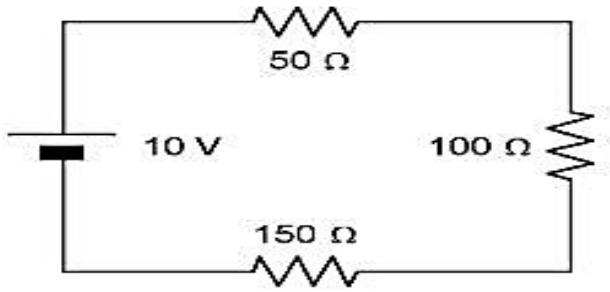
1. *Is the human body conductor or insulator.*
2. *If it is conductor, why doesn't electricity pass through when we touch the terminals?*

Electric Circuits:

Types of Electric Circuits

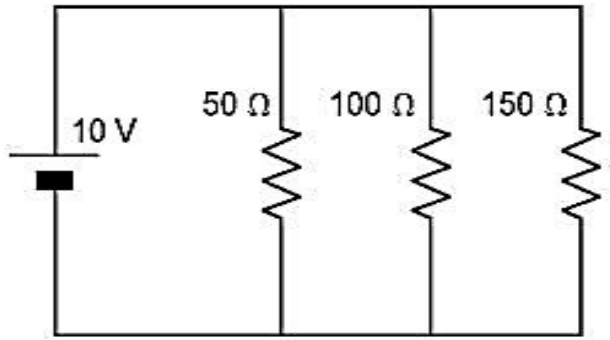
Series Circuit

- Only one pathway for current flow
- $R_{total} = R_1 + R_2 + R_3$
- Voltage will decrease at each resistance component
- Higher resistance and lower current flow

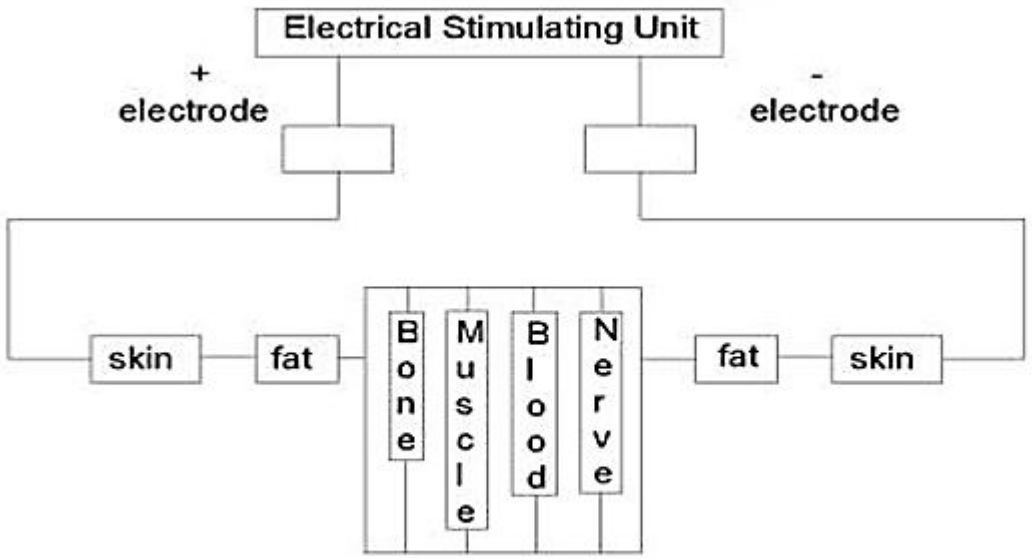


Parallel Circuit

- More than one pathway for flow of electrons
- $1/R_{total} = 1/R1 + 1/R2 + 1/R3$
- Voltage will not decrease at each resistance component
- Lower resistance and higher current flow



In human body, Current enters the body through a SERIES circuit (skin &fat). Once the current enters the tissues, it takes many different PARALLEL paths

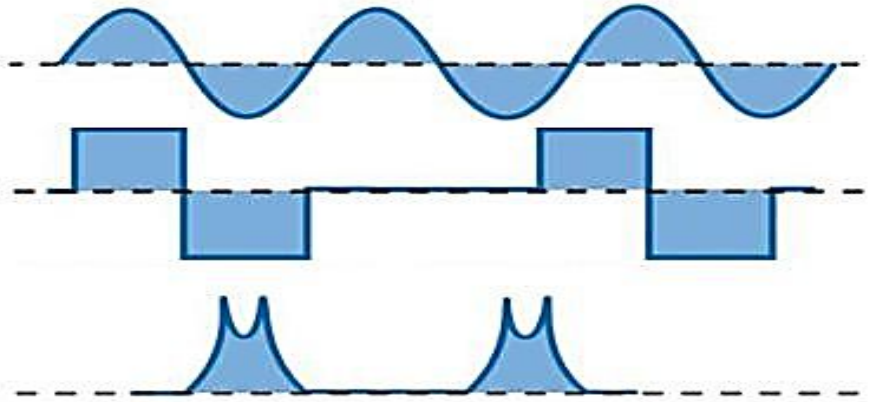


Waveforms

Waveform is a graphic representation of shape, direction, amplitude, duration and frequency of the electrical current.

1-Waveforms Shape:

- Sine wave
- Rectangular wave
- Square wave
- Triangular wave
- Saw tooth wave
- Trapezoid wave



All types of current may take on any of the waveform

Waveforms

. Symmetrical waveforms

Each phase

Equal in amplitude,

Equal in shape & size

Net charge is zero

Asymmetrical waveforms :

Each phase

Not equal in amplitude,

Not equal in shape &size

Net charge > than zero.