# 13

# BASICS OF ELECTRICITY

## OUTLINE



# LEARNING OBJECTIVES

After completing this chapter, you will be able to:

**LO1**
Identify the nature of electricity and the two types of electric current.

**LO2**
List electrical measurements.

**LO3**
Understand the principles of electrical equipment safety.

**LO4**
Examine the main electric modalities used in cosmetology.

**LO5**
Outline other types of electrical equipment that cosmetologists use and describe how to use them.

**LO6**
Explain the electromagnetic spectrum, visible spectrum of light, and invisible light.

**LO7**
Compare the types of light therapy and their benefits.

You decided to enter this field because you love cosmetology and all of the services it offers to clients: hairstyling, haircoloring, perms, facials, mani-pedis. How many of these services could you offer without using electricity? As you study this chapter, you will learn how important it is for cosmetology professionals to have a basic working knowledge of electricity.

## why study BASICS OF ELECTRICITY?

**Cosmetologists should study and have a thorough understanding of the basics of electricity because:**

- Cosmetologists use and rely upon a variety of electrical appliances. Knowing what electricity is and how it works will allow you to use it wisely and safely.
- A basic understanding of electricity will enable you to properly use and care for your equipment and tools.
- Electricity and its use impact other aspects of the salon environment, such as lighting and the temperature of styling irons. Therefore, it impacts the services you offer your clients.

*After reading the next few sections, you will be able to:*

LO 1 **Identify the nature of electricity and the two types of electric current.**

**DID YOU KNOW?**
Lightning bolts travel through the air at speeds of up to 60,000 miles per hour.

# Understand Electricity

If you look at lightning on a stormy night, what you will see are the effects of electricity. If you plug a poorly wired appliance into a socket and sparks fly out of the socket, you will also see the effects of electricity. You are not really seeing electricity, however; instead, you are seeing its *visual* effects on the surrounding air. Electricity does not occupy space or have mass (weight), so it is not matter. If it is not matter, then what is it? **Electricity** (ee-lek-TRIS-ih-tee) is the movement of electrons from one atom to another along a conductor. Electricity is a form of energy that, when in motion, exhibits magnetic, chemical, or thermal effects.

An **electric current** (ee-LEK-trik KUR-unt) is the flow of electricity along a conductor. All materials can be classified as conductors or nonconductors (insulators) depending on the ease with which an electric current can be transmitted through them.

A **conductor** (kahn-DUK-tur) is any material that conducts electricity. Most metals are good conductors. This means that electricity will pass through the material easily. Copper is a particularly good conductor and is used in electric wiring and electric motors. Pure (distilled) water is a poor conductor, but the ions usually found in ordinary water, such as tap water

**DID YOU KNOW?**
When you touch something and get a static shock, it is a form of electricity.

or a river or a lake, make it a good conductor. This explains why you should not swim in a lake during an electrical storm.

A **nonconductor**, (nahn-kun-DUK-tur), also known as *insulator* (IN-suh-layt-ur), is a material that does not transmit electricity. Rubber, silk, wood, glass, and cement are good insulators. Electric wires are composed of twisted metal threads (the conductor) covered with a rubber or plastic coating (the nonconductor or insulator). A **complete electric circuit** (kahm-PLEET ee-LEK-trik SUR-kit) is the path of negative and positive electric currents moving from the generating source through the conductors and back to the generating source.

## Types of Electric Current

There are two types of electric current:

- **Direct current** (dy-REKT KUR-unt), abbreviated DC, is a constant, even-flowing current that travels in one direction only and is produced by chemical means. Flashlights, mobile telephones, and cordless hairstyling tools use the direct current produced by batteries. The battery in your car stores electric energy. Without it, your car would not start. An **inverter** (in-VUR-tur) is an apparatus that changes direct current to alternating current. Inverters usually have a plug and a cord. They allow you to use appliances outside of the salon or your home that normally would have to be plugged into an electric wall outlet. The mobile phone charger in a car is an example of an inverter (figure 13-1).
- **Alternating current** (AWL-tur-nayt-ing KUR-rent), abbreviated AC, is a rapid and interrupted current, flowing first in one direction and then in the opposite direction; it is produced by mechanical means and changes directions 60 times per second. Corded hair dryers, curling irons, electric files, and table lamps that plug into a wall outlet use alternating current. A **rectifier** (REK-ti-fy-ur) is an apparatus that changes alternating current (AC) to direct current (DC). Cordless electric clippers and mobile phone chargers use a rectifier to change the AC from an electric wall outlet to the DC needed to recharge their batteries.

Table 13-1 outlines the differences between direct current and alternating current.

**DID YOU KNOW?**

Electricity travels very fast: 186,000 miles per second. If you were to travel that fast, you could go around the world eight times in the few seconds that it takes you to turn on a light switch.

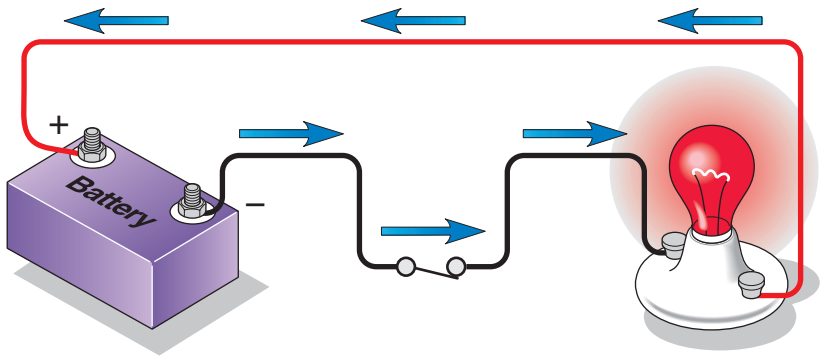



figure 13-1
A complete direct current (DC) electric circuit

table 13-1

DIRECT CURRENT (DC) AND ALTERNATING CURRENT (AC)

| Direct Current | Alternating Current |
|---|---|
| Constant, even flow | Rapid and interrupted flow |
| Travels in one direction | Travels in two directions |
| Produced by chemical means | Produced by mechanical means |

*After reading the next few sections, you will be able to:*

LO2 List electrical measurements.

## Electrical Measurements

The flow of an electric current can be compared to water flowing through a hose on a shampoo sink in the salon. Without pressure, neither water nor electricity would flow.

- A **volt** (VOLT), abbreviated V and also known as *voltage* (VOL-tij), is the unit that measures the pressure or force that pushes electric current forward through a conductor (figure 13-2). Car batteries are 12 volts. Normal electric wall sockets that power your hair dryer and curling iron are 120 volts. Most air conditioners and clothes dryers run on 240 volts. A higher voltage indicates more power. Nominal system voltage is 240, minimum service voltage requirement is 220.
- An **ampere** (AM-peer), abbreviated A and also known as *amp* (AMP), is the unit that measures the strength of an electric current. Just as the sink hose must be large enough to carry the amount of water flowing through it, a wire also must be large enough to carry the amount of electricity (amps) flowing through it. A hair dryer rated at 12 amps must have a cord that is twice as thick as one rated at 6 amps; otherwise, the cord might overheat and start a fire. A higher amp rating indicates a greater number of electrons and a stronger current (figure 13-3).

**DID YOU KNOW?**

One kilowatt-hour will power a television for three hours, run a 100-watt bulb for 12 hours, and keep an electric clock ticking for three months.

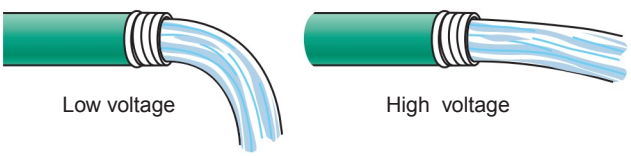



figure 13-2
Volts measure the pressure or force that pushes the electric current forward through a conductor.

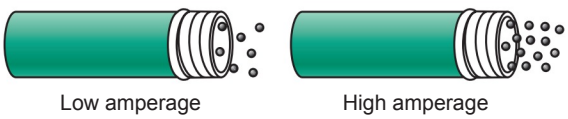



figure 13-3
Amps measure the strength of the electric current.

**CAUTION**

Underwriters Laboratories (UL) certifies the safety of electrical appliances. Curling irons, hair dryers, electric clippers, UV lamps, pedicure chairs, heating mitts, and electric files should be UL approved. This certifies that they are safe when used according to the manufacturer's directions. Always look for the UL symbol on electric appliances and take the time to read and follow the manufacturer's directions.

- A **milliampere** (mil-ee-AM-peer), abbreviated mA, is ⅟₁,₀₀₀ of an ampere. The current used for facial and scalp treatments is measured in milliamperes; an ampere current would be much too strong. If used for facials and scalp treatments, an ampere current would damage the skin or body.
- An **ohm** (OHM), abbreviated O, is a unit that measures the resistance of an electric current. Current will not flow through a conductor unless the force (volts) is stronger than the resistance (ohms).
- A **watt** (WAHT), abbreviated W, is a unit that measures how much electric energy is being used in one second. A 40-watt light bulb uses 40 watts of energy per second.
- A **kilowatt** (KIL-uh-waht), abbreviated kw, is 1,000 watts. The electricity in your house is measured in kilowatts per hour (kwh). A 1,000-watt (1-kilowatt) hair dryer uses 1,000 watts of energy per second.

*After reading the next few sections, you will be able to:*

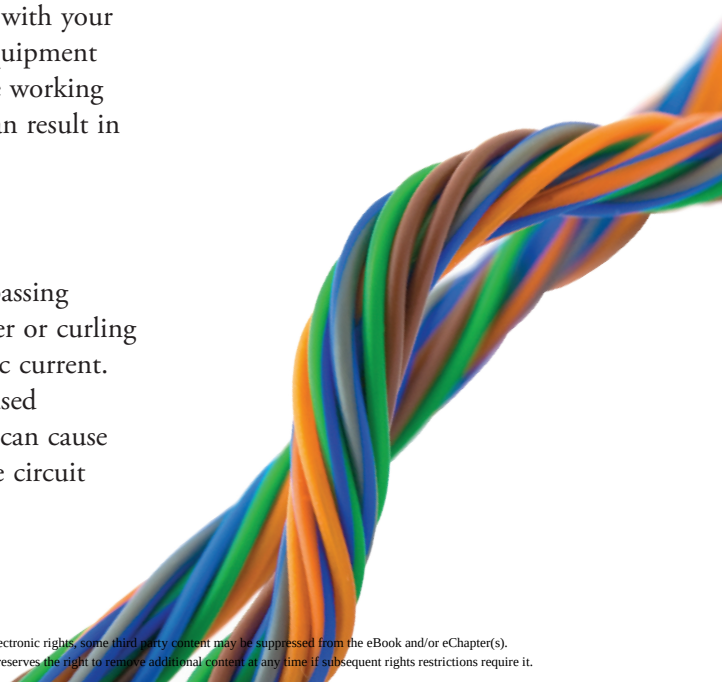
LO3 Understand the principles of electrical equipment safety.

# Practice Electrical Equipment Safety

When working with electricity, you must always be concerned with your own safety, as well as the safety of your clients. All electrical equipment should be inspected regularly to determine whether it is in safe working order. Careless electrical connections and overloaded circuits can result in an electrical shock, a burn, or even a serious fire.

## Safety Devices

A wire that is not large enough to carry the electrical current passing through it will overheat. The heating element in your hair dryer or curling iron heats up because it is not large enough to carry the electric current. Heating elements are designed to overheat and are safe when used properly, but when the electrical wires in a wall overheat, they can cause a fire. If excessive current passes through a circuit or a fuse, the circuit breaker turns off the circuit to prevent overheating.



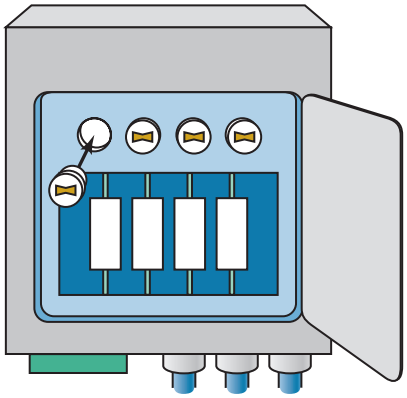


figure 13-4
Fuse box

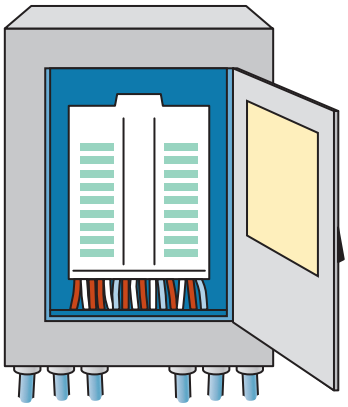


figure 13-5
Circuit breakers

These are the electrical safety devices that you may encounter when working in a salon:

- A **fuse** (FYOOZ) prevents excessive current from passing through a circuit. It is designed to blow out or melt when the wire becomes too hot from overloading the circuit with too much current, such as when too many appliances or faulty equipment is connected to an electric source. To re-establish the circuit, disconnect the appliance, check all connections and insulation, insert a new fuse, then reconnect the appliance. Fuses are often found in older buildings that have not been renovated or modernized (figure 13-4).
- A **circuit breaker** (SUR-kit BRAYK-ar) is a switch that automatically interrupts or shuts off an electric circuit at the first indication of an overload. Circuit breakers have replaced fuses in modern electric circuits. They have all the safety features of fuses but do not require replacement and can simply be reset by switching the circuit breaker back on. Your hair dryer has a circuit breaker located in the electric plug that is designed to protect you and your client in case of an overload or short circuit. When a circuit breaker shuts off, you should disconnect the appliance and check all connections and insulation before resetting it (figure 13-5).

### *Grounding*

**Grounding** (GROWND-ing) completes an electric circuit and carries the current safely away. It is another important way to promote electrical safety. All electrical appliances must have at least two rectangular electrical connections, or prongs, on the plug. This is called a two-prong plug. The two prongs supply electric current to the circuit. If you look closely at the two prongs, you will see that one is slightly larger than the other. This guarantees that the plug can be inserted into an outlet only one way and protects you and your client from an electric shock in the event of a short circuit.

For added protection, some appliances (especially the ones with metal casing) have a third circular electric connection that is a grounding pin. This is called a three-prong plug. The grounding pin is designed to guarantee a safe path of electricity and protect the user from electrical shock even if a wire comes loose. Appliances with a third circular grounding pin offer the most protection for you and your clients (figure 13-6).

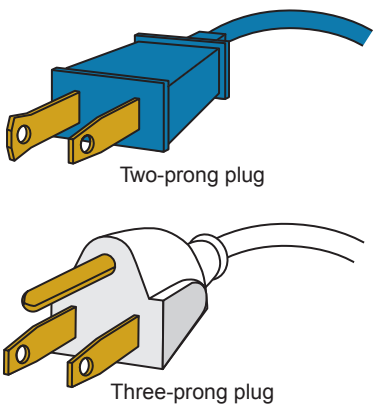



figure 13-6
Two-prong and three-prong plugs

### *Ground Fault Interrupter (GFI)*

**Ground fault interrupters** are designed to protect from electrical shock by interrupting a household circuit when there is a leak in the circuit. GFI's are required by the electrical code for receptacles in bathrooms, kitchens, and some outside receptacles. GFI is designed to detect currents of few milliamperes and trip a breaker at the receptacle or at the breaker panel to remove shock hazard. When it is working properly it has a green light and when it trips the light turns red. Once the appliance is removed from the socket it can be reset with a "reset" button on the panel (figure 13-7).

figure 13-7
GFI outlet

## Guidelines for Safe Use of Electrical Equipment

Salon fires are often caused by electrical problems such as shorts in the wiring of the building or improper use of items such as appliances, extension cords, and plugs. Careful attention to electrical safety involves following recommended UL guidelines, manufacturer's directions, and the safety instructions and policies of your salon. The guidelines below will help you use electricity and electrical equipment safely.

- All the electrical appliances you use should be UL certified (figure 13-8).
- Read all instructions carefully before using any piece of electrical equipment.
- Disconnect all appliances when not in use; pull on the plug, not the cord, to disconnect.
- Inspect all electrical equipment regularly.
- Keep all wires, plugs, and electrical equipment in good repair.
- Use only one plug in each outlet; overloading may cause the circuit breaker to pop. If more than one plug is needed in an area, use a power strip with a surge protector (figure 13-9).
- Avoid contact, for both you and your client, with water and metal surfaces when using electricity and do not handle electrical equipment with wet hands.
- Keep electrical cords off the floor and away from everyone's feet; getting tangled in a cord could cause you or your client to trip.
- Do not leave your client unattended while the client is connected to an electrical device.
- Do not attempt to clean around electric outlets while equipment is plugged in.
- Do not touch two metal objects at the same time if either is connected to an electric current.
- Do not step on or place objects on electrical cords.
- Do not allow electrical cords to become twisted; this can cause a short circuit.
- Do not attempt to repair electrical appliances. If you have a problem with electric wiring or an electrical device or appliance, tell your supervisor immediately, take the device to a repair store, or call a certified electrician or repair representative to resolve the issue.


figure 13-8
UL symbol, as it appears on electrical devices

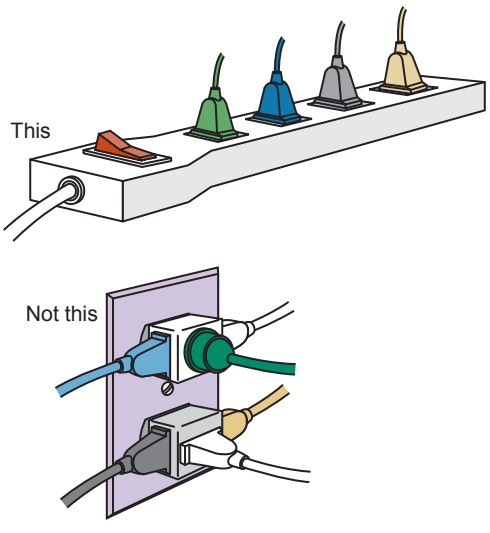



figure 13-9
Use only one plug per outlet on a power strip or on the wall.

*After reading the next few sections, you will be able to:*

LO4 Examine the main electric modalities used in cosmetology.

**CAUTION**

Older buildings and homes may have two-prong wall outlets. Some equipment and tools have three-prong plugs. Never tamper with the wiring of the building or home, the wall outlets, or the plugs to make them fit your equipment and tools. Adapters are available, if it is appropriate for you to use one. Consult the manufacturer and your local hardware store about whether you can use an adapter and, if so, what type of an adapter is recommended.

# Understand Electrotherapy

The use of electrical currents to treat the skin is commonly referred to as electrotherapy (ee-lek-troh-thair-uh-pee). Currents used in electrical facial and scalp treatments are called **modalities** (MOH-dal-ih-tees). Each modality produces a different effect on the skin.

An **electrode** (ee-LEK-trohd), also known as *probe*, is an applicator for directing electric current from an electrotherapy device to the client's skin. It is usually made of carbon, glass, or metal. Each modality requires two electrodes—one negative and one positive—to conduct the flow of electricity through the body. The only exception to this rule is the Tesla high-frequency current, which is covered in more depth later in this chapter.

## Polarity

**Polarity** (poh-LAYR-ut-tee) is the negative or positive pole of an electric current. The electrodes on many electrotherapy devices have one negatively charged pole and one positively charged pole. The positive electrode is called an **anode** (AN-ohd); the anode is usually red and is marked with a *P* or a plus (+) sign. The negative electrode is called a **cathode** (KATH-ohd); it is usually black and is marked with an *N* or a minus (–) sign (figure 13-10). The negatively charged electrons from cathode flows to positively charged anode. If the electrodes are not marked, ask your instructor, salon manager, or supervisor to help you determine the positive and negative poles.

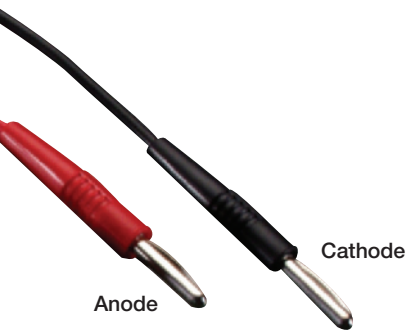



figure 13-10
Anode and cathode

## Modalities

The main modalities used in cosmetology are galvanic current, microcurrent, and Tesla high-frequency current.

### *Galvanic Current*

**Galvanic current** (gal-VAN-ik KUR-unt) is a constant and direct current, having a positive and negative pole, that produces chemical changes when it passes through the tissues and fluids of the body.

Two different chemical reactions are possible with galvanic current, depending on the polarity (positive or negative) that is used (table 13-2). The **active electrode** (AK-tiv ee-LEK-trohd) is the electrode used on the area to be treated. The **inactive electrode** (in-AK-tiv ee-LEK-trohd) is the opposite pole from the active electrode. The effects produced by the positive pole are the exact opposite of those produced by the negative pole. Galvanic current is used to infuse water soluble products into unbroken skin and the scientific term for that process is called phoresis.

**Iontophoresis** (eye-ahn-toh-foh-REE-sus) is the process of infusing water-soluble products into the skin with the use of electric current, such as the use of the positive and negative poles of a galvanic machine.

**DID YOU KNOW?**

Galvanic current is named after a doctor named Luigi Galvani who was born in Italy and lived there until his death in 1798. His studies about electric charges and how they affected the muscles of animals helped others to develop the galvanic current machines that are used in salons today.

table 13-2

## EFFECTS OF GALVANIC CURRENT

| Positive Pole (Anode) Cataphoresis | Negative Pole (Cathode) Anaphoresis |
|---|---|
| Produces acidic reactions | Produces alkaline reactions |
| Closes the pores | Opens the pores |
| Soothes nerves | Stimulates and irritates the nerves |
| Decreases blood supply | Increases blood supply |
| Contracts blood vessels | Expands blood vessels |
| Hardens and firms tissues | Softens tissues |

**Cataphoresis** (kat-uh-foh-REE-sus) infuses an acidic (positive) product into deeper tissues using galvanic current from the positive pole toward the negative pole.

**Anaphoresis** (an-uh-foh-REE-sus) infuses an alkaline (negative) product into the tissues from the negative pole toward the positive pole. **Desincrustation** (des-inkrus-TAY-shun) is a form of anaphoresis and is a process used to soften and emulsify grease deposits (oil) and blackheads in the hair follicles. Desincrustation is frequently used to treat acne, milia (small, white cyst-like pimples), and comedones (blackheads and whiteheads).

### *Microcurrent*

**Microcurrent** (MY-kroh-kur-unt) is an extremely low level of electricity that mirrors the body's natural electrical impulses. Microcurrent can be used for iontophoresis, firming, toning, and soothing skin. It also can help heal inflamed tissue such as acne.

Newer microcurrent devices have negative and positive polarity in one probe, not two probes. This allows the client to relax rather than to have to hold on to one of the probes during the service or treatment (figure 13-11).

Microcurrent does not travel throughout the entire body; it serves only the specific area being treated.

Microcurrent can be effective in the following ways:

- Improves blood and lymph circulation
- Produces acidic and alkaline reactions
- Opens and closes hair follicles and pores
- Increases muscle tone
- Restores elasticity
- Reduces redness and inflammation
- Minimizes healing time for acne lesions
- Improves the natural protective barrier of the skin
- Increases metabolism

When microcurrent is used during aging-skin treatments, it may give your client's skin a softer, firmer, more hydrated appearance.

**CAUTION**

Do not use negative galvanic current on skin with broken capillaries or pustular acne conditions or on clients with high blood pressure or metal implants.

**CAUTION**

As with all electric current devices, microcurrent should not be used on clients with pacemakers, epilepsy, cancer, pregnancy, phlebitis, or thrombosis. It also should not be used on anyone under a physician's care for a condition that may exclude them from using certain ingredients or products or from having treatments. If you are unsure about whether it is appropriate to treat clients, ask them to obtain physician consent for the service.

**DID YOU KNOW?**

The Tesla high-frequency current is named after an electrical engineer named Nikola Tesla who was born in 1856 in Croatia. He moved to the United States in 1884, where he did the majority of the work on alternating current. Tesla died in New York City in 1943.

figure 13-11
A microcurrent treatment

figure 13-12
Applying Tesla high-frequency current with a facial electrode

### *Tesla High-Frequency Current*

The **Tesla high-frequency current** (TES-luh HY-FREE-kwen-see KUR-ent), also known as *violet ray*, is a thermal or heat-producing current with a high rate of oscillation or vibration that is commonly used for scalp and facial treatments. Tesla current does not produce muscle contractions, and the effects can be either stimulating or soothing, depending on the method of application. The electrodes are made from either glass or metal and only one electrode is used to perform a service (figure 13-12).

The benefits of the Tesla high-frequency current are:

- Stimulates blood circulation
- Increases elimination and absorption
- Increases skin metabolism
- Improves germicidal action
- Relieves skin congestion

As you learn more about facials and treatments, you will become familiar with the term *contraindication*, a condition that requires avoiding certain treatments, procedures, or products to prevent undesirable side effects.

*After reading the next few sections, you will be able to:*

LO5 Outline other types of electrical equipment that cosmetologists use and describe how to use them.

**CAUTION**

Tesla high-frequency current should not be used on clients who are pregnant or who have epilepsy (seizures), asthma, high blood pressure, a sinus blockage, a pacemaker, or metal implants. The client also should avoid contact with metal, such as chair arms, jewelry, and metal bobby pins during the treatment. A burn may occur if contact is made.

# Identify Other Electrical Equipment

As a cosmetologist, you will be using many types of electrical equipment and tools. Here are a few of the most common electrical tools you may encounter, along with some information regarding their use:

- Conventional hood hair dryers or heat lamps are sources of dry heat that can be used to shorten chemical processing time. Since dry heat causes evaporation, the hair must be covered with a plastic cap to avoid drying the hair during a chemical process.
- Ionic hair dryers with the crystalline mineral tourmaline and styling irons are effective at combating static electricity and flyaway hair. When tourmaline is heated, it produces positive and negative ions that cancel the electric charges in the hair that cause static electricity. Claims that ionic dryers dry hair faster or condition hair have not been proven.
- Electric curling and flat irons are available in many types and sizes. They have built-in heating elements and plug directly into a wall outlet. Thermal styling tools now have the capacity to get extremely hot (up to 410 degrees Fahrenheit, or higher, on some styling tools). This extreme heat causes the water within the hair to boil and can severely damage hair.
- Heating caps provide a uniform source of heat and can be used with hair and scalp conditioning treatments.

**STATE REGULATORY ALERT!**

Always be certain that you are in compliance with your state's regulations for licensing and use of electric current devices.

- Haircolor processing machines, or accelerating machines, shorten the time it takes to process chemical hair services. These processors usually look similar to a hood dryer and dispense a hot water vapor inside the hood. A haircolor service processed with a machine at 90 degrees Fahrenheit (32 degrees Celsius) will process twice as fast as it would at a normal room temperature of 72 degrees Fahrenheit (22 degrees Celsius).
- A steamer or vaporizer produces moist, uniform heat that can be applied to the head or face. Steamers warm and cleanse the skin by increasing the flow of both oil and sweat. Some steamers also may be used for hair and scalp conditioning treatments. Estheticians often add essential oils to a facial steamer as part of a skin therapy and to enhance a client's general well-being.
- Light therapy equipment includes lasers, light-emitting diode (LED), and intense pulse light. These types of equipment are medical devices and should be used only by licensed professionals. Light therapy is described in the next section.

**ACTIVITY**

Research the Web for local and state procedures for licensing electrical, light, and laser therapy devices. Also look at the labels, precautions, and warning labels on various styling tools in your class and home. Discuss your observations in class.

**DID YOU KNOW?**

People used to believe light traveled in straight rays, but we now know that it oscillates in wave formations, called wavelengths. The word *ray* still remains, as UV rays, UVA and UVB rays, or light rays, but it represents the term *radiation*.

*After reading the next few sections, you will be able to:*

LO6 **Explain the electromagnetic spectrum, visible spectrum of light, and invisible light.**

# Explain Light Energy and Light Therapy

The **electromagnetic spectrum** (ee-lek-troh-MAG-ne-tik SPEK-trum), also known as *electromagnetic spectrum of radiation*, is the name given to all of the forms of energy (or radiation) that exist. The forms of energy in the electromagnetic spectrum are radio waves (used by radios and televisions), microwaves (used in microwave ovens), light waves (infrared light, visible light, and ultraviolet light used for light therapy services), X-rays (used by physicians and dentists), and gamma rays (used for nuclear power plants) (figure 13-13).

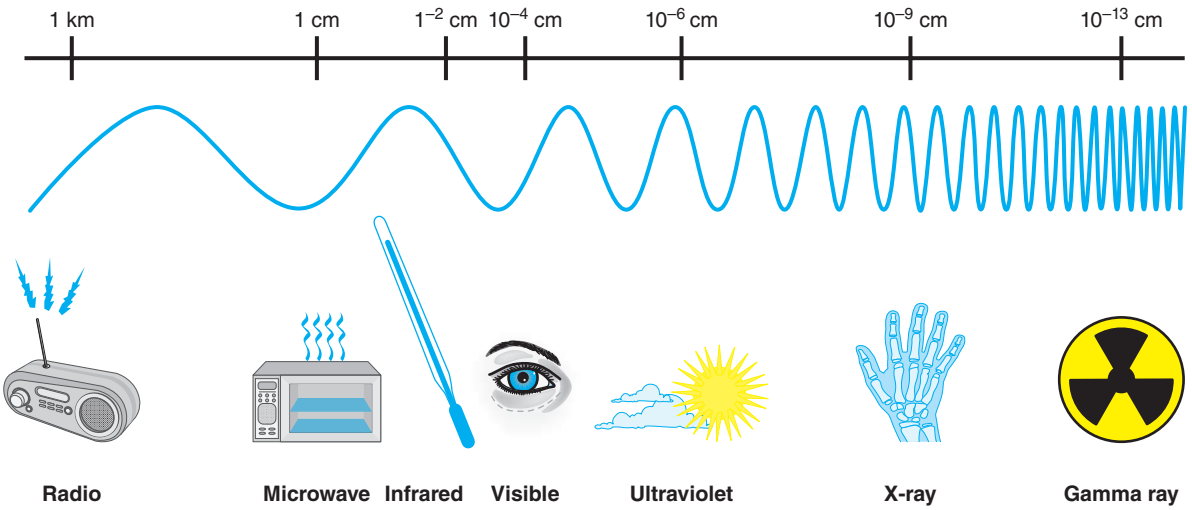



figure 13-13
The electromagnetic spectrum

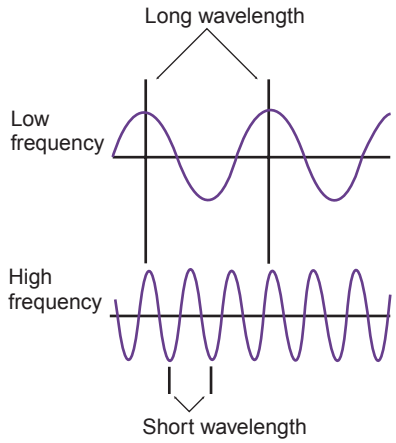



figure 13-14
Waveform patterns of long and short wavelengths

**DID YOU KNOW?**

Although the electric lighting in the salon is not a form of light therapy, the quality of this light can have an effect on your work and on your client's satisfaction. Fluorescent light is produced by fluorescent lamps and may be cooler (green-blue) than natural sunlight. Incandescent light is produced by standard (tungsten) light bulbs and is warmer (yellow-gold) than either natural sunlight or fluorescent light. Your client's hair and skin will appear more green-blue when viewed with fluorescent lighting and more golden when viewed with incandescent lighting.

Be careful when handling fluorescent light bulbs; they contain dangerous substances, including mercury. Avoid breaking fluorescent bulbs and dispose of used bulbs properly.

Energy moves through space on waves. These waves are similar to the waves caused when a stone is dropped on the surface of water. Each type of energy has its own **wavelength**, the distance between successive peaks of electromagnetic waves. A **waveform** is the measurement of the distance between two wavelengths. Some wavelengths are long and some are short (table 13-3). Long wavelengths have low frequency, meaning that the number of waves is less frequent (fewer waves) within a waveform pattern. Short wavelengths have higher frequency because the number of waves is more frequent (more waves) within a waveform pattern (figure 13-14).

## Visible Spectrum of Light

The **visible spectrum of light** is the part of the electromagnetic spectrum that can be seen. Visible light makes up only 35 percent of natural sunlight. Within the visible spectrum of light, violet has the shortest wavelength and red has the longest. The wavelength of infrared light is just below that of red light and the wavelength of ultraviolet light is just above that of violet light.

Although they are referred to as *light*, infrared light and ultraviolet light are not really light. Ultraviolet light and infrared light, which are covered in more depth later in this chapter, are also forms of electromagnetic energy but they are invisible because their wavelengths are beyond the visible spectrum of light. Invisible light makes up 65 percent of natural sunlight (figure 13-15).

**DID YOU KNOW?**

Natural sunlight is made up of three types of light:

Visible light = 35 percent
Invisible infrared light = 60 percent
Invisible ultraviolet light = 5 percent

table 13-3

LONG WAVELENGTHS COMPARED WITH SHORT WAVELENGTHS

| Long Wavelengths | Short Wavelengths |
|---|---|
| Low frequency | High frequency |
| Deeper penetration | Less penetration |
| Less energy | More energy |

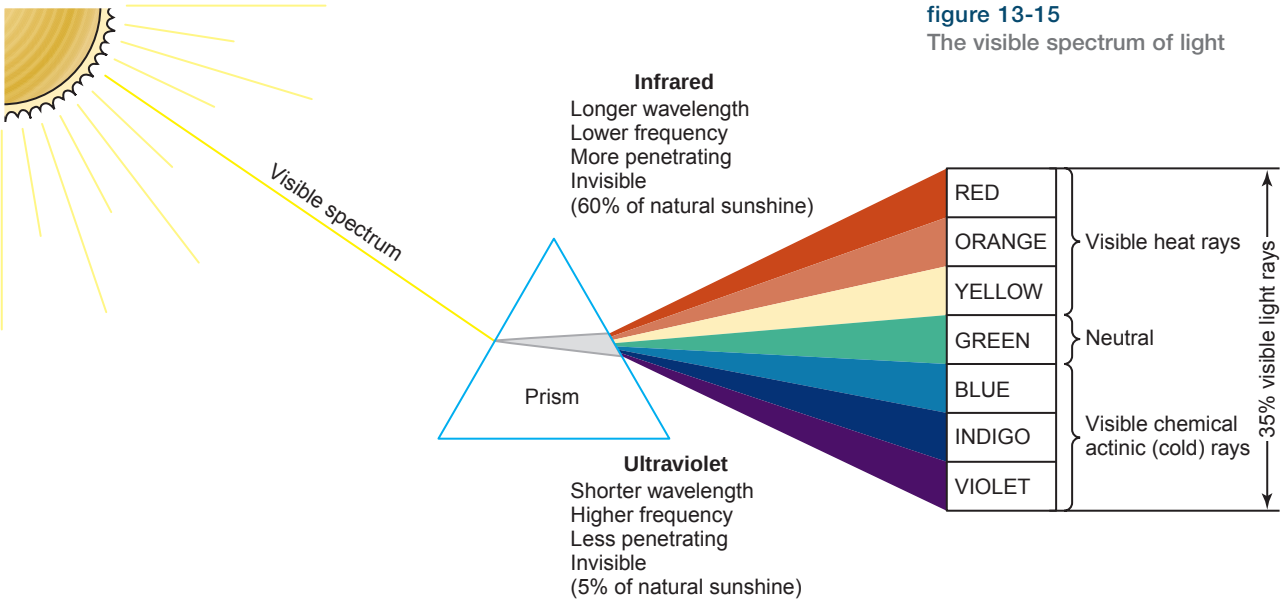



figure 13-15
The visible spectrum of light

## Invisible Light

**Invisible light** is the light at either end of the visible spectrum of light that is invisible to the naked eye. Before the visible violet light of the spectrum is ultraviolet light; it is the shortest and least-penetrating light of the spectrum. Beyond the visible red light of the spectrum is infrared light, which produces heat.

**Ultraviolet light** (ul-truh-VY-uh-let LYT), abbreviated UV light and also known as *cold light* or *actinic light* (ak-TIN-ik LYT), is invisible light that has a short wavelength (giving it higher energy), is less penetrating than visible light, causes chemical reactions to happen more quickly than visible light, produces less heat than visible light, and kills some germs.

UV light prompts the skin to produce vitamin D, a fat-soluble vitamin that is good for bone growth and health. We need sunlight to survive on the planet but overexposure to UV light can cause premature aging of the skin and skin cancer. Incidence of skin cancer has reached a near-epidemic level, with over one million new cases being diagnosed each year. It is estimated that one in five Americans will develop skin cancer and that 90 percent of those cancers will be the result of exposure to UV radiation from natural sunlight, sun lamps, and tanning beds.

There are three types of UV light:

- **Ultraviolet A (UVA).** Ultraviolet A light has the longest wavelength of the UV light spectrum and penetrates directly into the dermis of the skin, damaging the collagen and elastin. UVA light is the light that is often used in tanning beds.
- **Ultraviolet B (UVB).** Ultraviolet B light is often called the burning light because it is most associated with sunburns. Excessive use of both UVA and UVB light can cause skin cancers.
- **Ultraviolet C (UVC).** Ultraviolet C light is blocked by the ozone layer. If the Earth loses the protective layer of the ozone, life will no longer exist as we know it. We do not want to deplete the ozone layer because it protects us from UVC radiation.

**DID YOU KNOW?**

If light from the sun is passed through a glass prism (usually a glass or plastic prism resembles a pyramid shape after it is cut), it will appear in seven different colors, known as the rainbow, displayed in the following manner: violet (the shortest wavelength), indigo, blue, green, yellow, orange, and red (the longest wavelength). These colors, which are visible to the eye, constitute visible light.

**DID YOU KNOW?**

Some animals can see parts of the visible spectrum that humans cannot. For example, many insects can see ultraviolet light.

**CAUTION**

Although the application of UV light can be beneficial, it must be done with the utmost care in a proper manner by a qualified professional because overexposure can lead to skin damage and skin cancer. It has been used to kill bacteria on the skin and to help the body produce vitamin D. Dermatologists use UV therapy in addition to drugs for the treatment of psoriasis.

**DID YOU KNOW?**

We need to strike a delicate balance with sunlight exposure. Keep in mind that tanned skin is damaged skin. Tanning will eventually cause photoaging (premature aging due to sun exposure) and irreversibly damage the skin's collagen-building properties

**Infrared light** (in-fruh-RED LYT) has longer wavelengths, penetrates more deeply, has less energy, and produces more heat than visible light. Infrared light makes up 60 percent of natural sunlight.

Infrared lamps are used mainly during hair conditioning treatments and to process haircolor. They are also used in spas and saunas for relaxation and for warming up muscles. Infrared light has been used to diminish signs of aging such as wrinkles, to heal wounds, and to increase circulation.

## Light Versus Heat and Energy

**Catalysts** are substances that speed up chemical reactions. Some catalysts use heat as an energy source while others use light. Whatever the energy source, catalysts absorb energy like a battery. At the appropriate time, they pass this energy to the initiator and the reaction begins. Like other chemicals, a catalyst will not get consumed in a chemical reaction.

*After reading the next few sections, you will be able to:*

LO 7 Compare the types of light therapy and their benefits.

**DID YOU KNOW?**

The wavelength of infrared light is too long to be visible to the human eye.

## Light Therapy

**Light therapy**, also known as *phototherapy*, is the application of light rays to the skin for the treatment of wrinkles, capillaries, pigmentation, or hair removal. Lasers and light therapy devices have been used for decades, but some of the original techniques are still valid today. Lasers are designed to focus all of the light power to a specific depth and in one direction within the skin, using the same color of light. In contrast, other light therapies have multiple depths, colors, and wavelengths and the light may be scattered. The most important point to remember about light therapy is that the equipment you use is selected based on the skin type and condition you are treating.

figure 13-16
Removing facial hair with laser

## Lasers

**Laser** is an acronym for *light amplification stimulation emission of radiation*; it is a medical device that uses electromagnetic radiation for hair removal and skin treatments. There are many types of lasers used to treat a variety of skin conditions. All lasers work by selective **photothermolysis** (FOTO-ther-moll-ih-sis), a process that turns the light from the laser device into heat. Depending on the intended use and type, lasers can remove blood vessels, disable hair follicles, remove tattoos, or eliminate some wrinkles without destroying surrounding tissue. Lasers have been used for decades in a variety of surgical procedures. In laser hair removal the light is converted to heat as it passes through the skin. The heat is absorbed by melanin in the follicles and the follicles are damaged, inhibiting hair growth. Figure 13-16 shows removing facial hair with a laser.

Lasers work by means of a medium (solid, liquid or gas, or semiconductor) that emits light when stimulated by a power source. The medium is placed in a specifically designed chamber with mirrors located inside both ends. That chamber is stimulated by an energy source, such as electric current, which, in turn, stimulates the particles. The mirrors create light that becomes trapped and goes back and forth through the medium, gaining energy with each pass. The medium determines the wavelength of the laser and its use.

Most lasers are classified as a Level II medical device or above, which means that estheticians must be working under the supervision of a qualified physician to operate the laser.

**STATE REGULATORY ALERT!**

Always be certain that you are in compliance with your state's regulations for the licensing and use of laser and light therapy devices.

## Light-Emitting Diode (LED)

A **light-emitting diode**, abbreviated LED, is a medical device used to reduce acne, increase blood circulation, and improve the collagen content in the skin. The LED works by releasing light onto the skin to stimulate specific responses at precise depths of the skin tissue. Each color of light corresponds to a different depth—measured in one billionths of a meter, which are called nanometers—in the tissue. The LED light color seeks a color in the skin tissue known as a **chromophore**, a color component within the skin such as blood or melanin. The term chromophore is derived from the Greek term *chroma,* meaning color. When the colored light reaches a specific depth in the tissue, it triggers a reaction, such as stimulating circulation or reducing bacteria. Depending on the type of equipment used, the LED can be blue, red, yellow, or green. Blue light LED reduces acne. Red light increases circulation and improves the collagen and elastin production in the skin. Yellow light reduces swelling and inflammation and green light reduces hyperpigmentation (table 13-4). Blue light LED also can be used in medical procedures performed by physicians for precancerous lesions (figure 13-17).

Courtesy of Revitalight

figure 13-17
LED treatment reduces redness and improves the collagen content in the skin.

table 13-4
BENEFICIAL EFFECTS OF LED THERAPY

| Color nm (nanometers) | Beneficial Effects |
|---|---|
| Blue light 570 nm | Reduces acne and reduces bacteria |
| Red light 640 nm | Increases circulation<br>Improves collagen and elastin production<br>Stimulates wound healing |
| Yellow light 590 nm | Reduces swelling and inflammation<br>Improves lymphatic flow<br>Detoxifies and increases circulation |
| Green light 525 nm | Reduces hyperpigmentation<br>Reduces redness<br>Calms and soothes |

figure 13-18
Acne before and after treatment

© iStock.com/jtyler

**DID YOU KNOW?**

During space studies about 40 years ago, the National Aeronautics and Space Administration (NASA) found that LED improved the healing and growth of human tissue. These original studies have laid the foundation for light energy and LED use in skin rejuvenation.

Figure 13-18 shows the result from before and after treatment with Blue light LED therapy in reducing acne. A remarkable decrease in wrinkle reduction is illustrated in (figure 13-19) with LED red light.

As with all light therapies, it is important to be certain that you have viewed the client consultation form for any contraindications. Light therapy should not be performed on anyone who has light sensitivities (photosensitivities), phototoxic reactions, is taking antibiotics, has cancer or epilepsy, is pregnant, or is under a physician's care. If you are not sure whether you should treat certain clients, refer them to their physicians.

## Intense Pulse Light

**Intense pulse light** is a medical device that uses multiple colors and wavelengths (broad spectrum) of focused light to treat spider veins, hyperpigmentation, rosacea and redness, wrinkles, enlarged hair follicles and pores, and excessive hair. As with most devices, multiple treatments are required. These treatments are provided only under the supervision of a qualified physician.

From dermatologists using UV therapy for treating psoriasis to estheticians using blue light therapy for acne to surgeons using lasers for advanced surgical procedures, the power of light therapy is here to stay.

**WEB RESOURCES**

For more information on electricity and energy, visit the U.S. Energy Information Administration's website at eia.doe.gov or the Library of Congress' website at loc.gov and enter the search words *electricity* or *energy*.

© ollyy/Shutterstock.com

figure 13-19
Before and after anti-wrinkle treatment

## REVIEW QUESTIONS

1. Define electric current.
2. Explain the difference between a conductor and a nonconductor (insulator).
3. Describe the two types of electric current and give examples of each.
4. Explain the difference between a volt and an amp.
5. Define ohm.
6. Define watt and kilowatt.
7. Explain the function of a fuse.
8. What is the purpose of a circuit breaker?
9. What is the purpose of grounding?
10. List at least five steps to take for electrical safety.
11. List and describe the two main electric modalities (currents) used in cosmetology.
12. What are electromagnetic radiation, visible light, and invisible light?
13. List and describe the two main types of light therapy.
14. What are the benefits of LED therapies?
15. Identify the colors of LED lights and their wavelengths (nm)?
16. Name two important precautions to observe when using light therapy.

## STUDY TOOLS

- **Reinforce what you just learned:** Complete the activities and exercises in your Theory or Practical Workbook, or your Study Guide.
- **Expand your knowledge:** Search for websites about the topics in this chapter and make a list of additional resources.
- **Study and prepare for your quiz:** Take the chapter test in your Exam Review or your Milady U: Online Licensing Prep.
- **Re-Test your knowledge:** Take the Chapter 12 *Quizzes*!
- **Learn even more:** Look up in a dictionary or search the internet for the definitions of any additional terms you want to learn about.

## CHAPTER GLOSSARY

| | | |
|---|---|---|
| **active electrode**<br>AK-tiv ee-LEK-trohd | p. 280 | Electrode of an electrotherapy device that is used on the area to be treated. |
| **alternating current**<br>AWL-tur-nayt-ing KUR-rent | p. 275 | Abbreviated AC; rapid and interrupted current, flowing first in one direction and then in the opposite direction; produced by mechanical means and changes directions 60 times per second. |
| **ampere**<br>AM-peer | p. 276 | Abbreviated A and also known as *amp* (AMP); unit that measures the strength of an electric current. |
| **anaphoresis**<br>an-uh-foh-REE-sus | p. 281 | Process of infusing an alkaline (negative) product into the tissues from the negative pole toward the positive pole. |
| **anode**<br>AN-ohd | p. 280 | Positive electrode of an electrotherapy device; the anode is usually red and is marked with a *P* or a plus (+) sign. |

| | | |
|---|---|---|
| **catalysts** | p. 286 | Substances that speed up chemical reactions. |
| **cataphoresis**<br>kat-uh-foh-REE-sus | p. 281 | Process of fusing an acidic (positive) product into deeper tissues using galvanic current from the positive pole toward the negative pole. |
| **cathode**<br>KATH-ohd | p. 280 | Negative electrode of an electrotherapy device; the cathode is usually black and is marked with an *N* or a minus (–) sign. |
| **chromophore** | p. 287 | A color component within the skin such as blood or melanin. |
| **circuit breaker**<br>SUR-kit BRAYK-ar | p. 278 | Switch that automatically interrupts or shuts off an electric circuit at the first indication of overload. |
| **complete electric circuit**<br>kahm-PLEET ee-LEK-trik SUR-kit | p. 275 | The path of negative and positive electric currents moving from the generating source through the conductors and back to the generating source. |
| **conductor**<br>kahn-DUK-tur | p. 274 | Any material that conducts electricity. |
| **desincrustation**<br>des-inkrus-TAY-shun | p. 281 | A form of anaphoresis; process used to soften and emulsify grease deposits (oil) and blackheads in the hair follicles. |
| **direct current**<br>dy-REKT KUR-unt | p. 275 | Abbreviated DC; constant, even-flowing current that travels in one direction only and is produced by chemical means. |
| **electric current**<br>ee-LEK-trik KUR-unt | p. 274 | Flow of electricity along a conductor. |
| **electricity**<br>ee-lek-TRIS-ih-tee | p. 274 | The movement of electrons from one atom to another along a conductor. |
| **electrode**<br>ee-LEK-trohd | p. 280 | Also known as *probe*; applicator for directing electric current from an electrotherapy device to the client's skin. |
| **electromagnetic spectrum**<br>ee-lek-troh-MAG-ne-tik SPEK-trum | p. 283 | Also known as *electromagnetic spectrum of radiation*; name given to all of the forms of energy (or radiation) that exist. |
| **fuse**<br>FYOOZ | p. 278 | Prevents excessive current from passing through a circuit. |
| **galvanic current**<br>gal-VAN-ik KUR-unt | p. 280 | Constant and direct current, having a positive and negative pole, that produces chemical changes when it passes through the tissues and fluids of the body. |
| **grounding**<br>GROWND-ing | p. 278 | Completes an electric circuit and carries the current safely away. |
| **inactive electrode**<br>in-AK-tiv ee-LEK-trohd | p. 280 | Opposite pole from the active electrode. |
| **infrared light**<br>in-fruh-RED LYT | p. 286 | Infrared light has longer wavelengths, penetrates more deeply, has less energy, and produces more heat than visible light; it makes up 60 percent of natural sunlight. |
| **intense pulse light** | p. 288 | A medical device that uses multiple colors and wavelengths (broad spectrum) of focused light to treat spider veins, hyperpigmentation, rosacea and redness, wrinkles, enlarged hair follicles and pores, and excessive hair. |
| **inverter**<br>in-VUR-tur | p. 275 | Apparatus that changes direct current to alternating current. |
| **invisible light** | p. 285 | Light at either end of the visible spectrum of light that is invisible to the naked eye. |

| | | |
|---|---|---|
| **iontophoresis**<br>eye-ahn-toh-foh-REE-sus | p. 280 | Process of infusing water-soluble products into the skin with the use of electric current, such as the use of the positive and negative poles of a galvanic machine. |
| **kilowatt**<br>KIL-uh-waht | p. 277 | Abbreviated kw; 1,000 watts. |
| **laser** | p. 286 | Acronym for light amplification stimulation emission of radiation; a medical device that uses electromagnetic radiation for hair removal and skin treatments. |
| **light-emitting diode** | p. 287 | Abbreviated LED; a medical device used to reduce acne, increase blood circulation, and improve the collagen content in the skin. |
| **light therapy** | p. 286 | Also known as *phototherapy*; the application of light rays to the skin for the treatment of wrinkles, capillaries, pigmentation, or hair removal. |
| **microcurrent**<br>MY-kroh-kur-unt | p. 281 | An extremely low level of electricity that mirrors the body's natural electrical impulses. |
| **milliampere**<br>mil-ee-AM-peer | p. 277 | Abbreviated mA; $\frac{1}{1,000}$ of an ampere. |
| **modalities**<br>MOH-dal-ih-tees | p. 280 | Currents used in electrical facial and scalp treatments. |
| **nonconductor**<br>nahn-kun-DUK-tur | p. 275 | Also known as *insulator* (IN-suh-layt-ur); a material that does not transmit electricity. |
| **ohm**<br>OHM | p. 277 | Abbreviated O; unit that measures the resistance of an electric current. |
| **photothermolysis**<br>FOTO-ther-moll-ih-sis | p. 286 | Process that turns the light from a laser device into heat. |
| **polarity**<br>poh-LAYR-ut-tee | p. 280 | Negative pole or positive pole of an electric current. |
| **rectifier**<br>REK-ti-fy-ur | p. 275 | Apparatus that changes alternating current (AC) to direct current (DC). |
| **Tesla high-frequency current**<br>TES-luh HY-FREE-kwen-see KUR-ent | p. 282 | Also known as *violet ray*; thermal or heat-producing current with a high rate of oscillation or vibration that is commonly used for scalp and facial treatments. |
| **ultraviolet light**<br>ul-truh-VY-uh-let LYT | p. 285 | Abbreviated UV light and also known as *cold* light or *actinic* light (ak-TIN-ik LYT); invisible light that has a short wavelength (giving it higher energy), is less penetrating than visible light, causes chemical reactions to happen more quickly than visible light, produces less heat than visible light, and kills germs. |
| **visible spectrum of light** | p. 284 | The part of the electromagnetic spectrum that can be seen. Visible light makes up only 35 percent of natural sunlight. |
| **volt**<br>(VOLT) | p. 276 | Abbreviated V and also known as *voltage*; unit that measures the pressure or force that pushes electric current forward through a conductor. |
| **watt**<br>(WAHT) | p. 277 | Abbreviated W; unit that measures how much electric energy is being used in one second. |
| **waveform** | p. 284 | Measurement of the distance between two wavelengths. |
| **wavelength** | p. 284 | Distance between successive peaks of electromagnetic waves. |