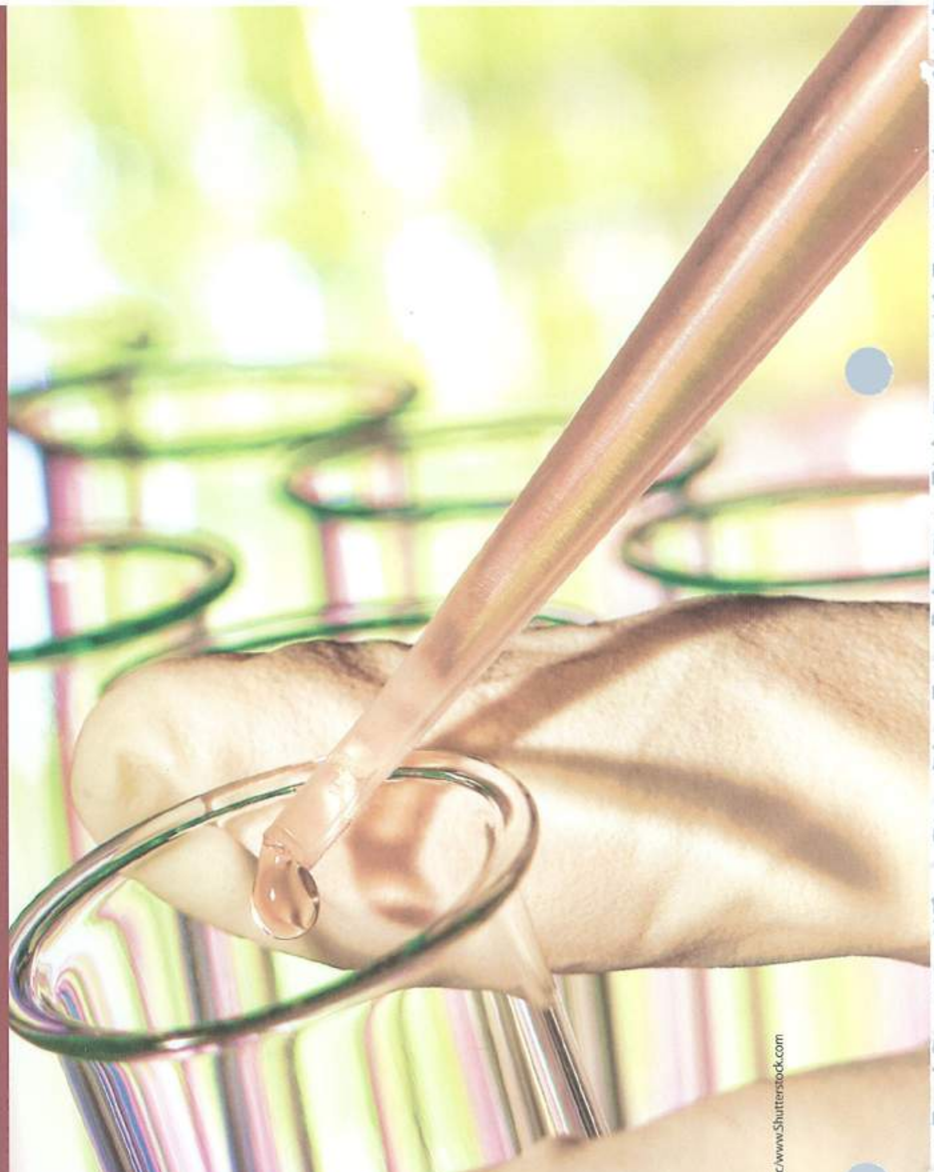
10 The Basics of Chemistry

Chapter Outline

- Why Study Chemistry?
- Chemistry
- Matter
- Potential Hydrogen (pH)



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Learning Objectives

After completing this chapter, you will be able to:

- ☑ **LO1** Explain the difference between organic and inorganic chemistry.
- ☑ **LO2** Discuss the different forms of matter: elements, compounds, and mixtures.
- ☑ **LO3** Explain the difference between solutions, suspensions, and emulsions.
- ☑ **LO4** Explain pH and the pH scale.

Key Terms

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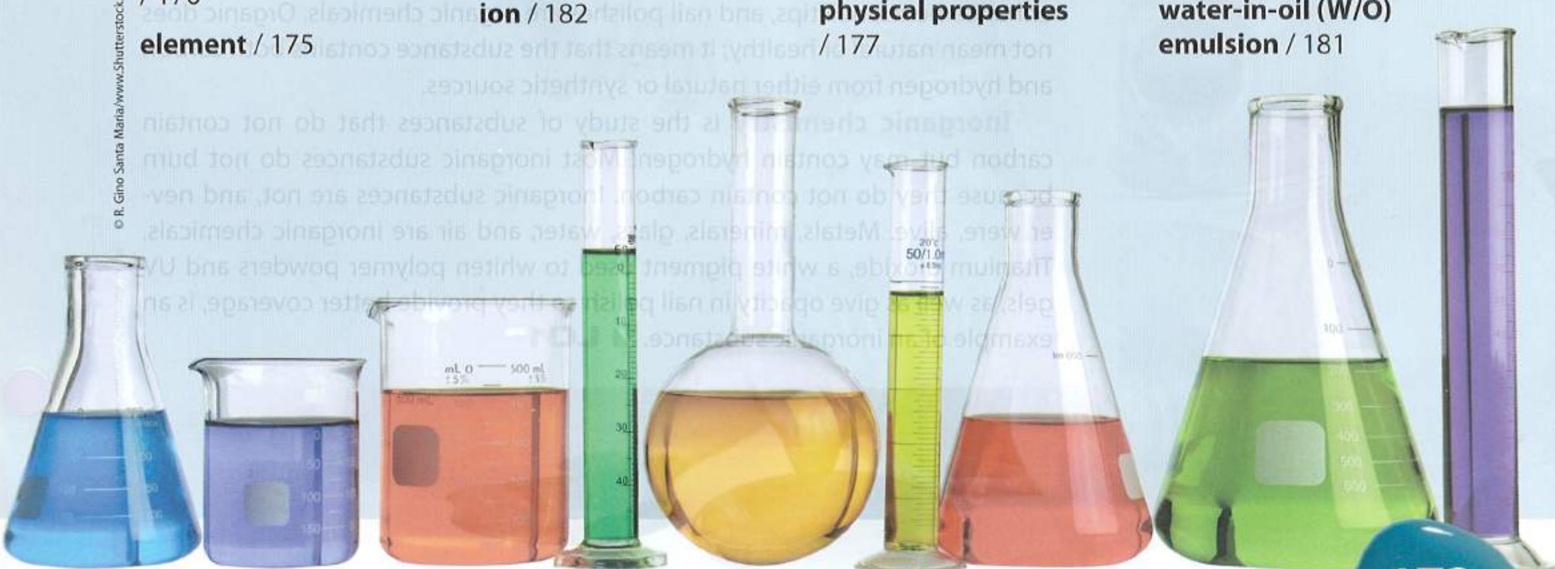


Nail services are not possible without the use of chemicals. Why? Because everything you can see or touch, except light and electricity, is a chemical. Our entire world, our bodies, and even the oxygen we breathe are made of chemicals. Of course this means that all cosmetics, including nail products, are entirely made up of chemicals. Therefore, it is very important to understand what chemicals are and how they are used in the salon. To use professional products effectively and safely, all nail professionals need to have a basic understanding of chemistry. With this knowledge, you can troubleshoot and solve the common problems you may encounter in nail services. This chapter provides you with an important overview of basic chemistry.

WHY STUDY CHEMISTRY?

Nail technicians should have a thorough understanding of chemistry because:

- Without an understanding of basic chemistry, you would not be able to use professional products effectively and safely.
- Every product used in the salon and in nail services contains some type of chemical.
- With an understanding of chemistry, you will be able to troubleshoot and solve common problems you may encounter in performing nail services.

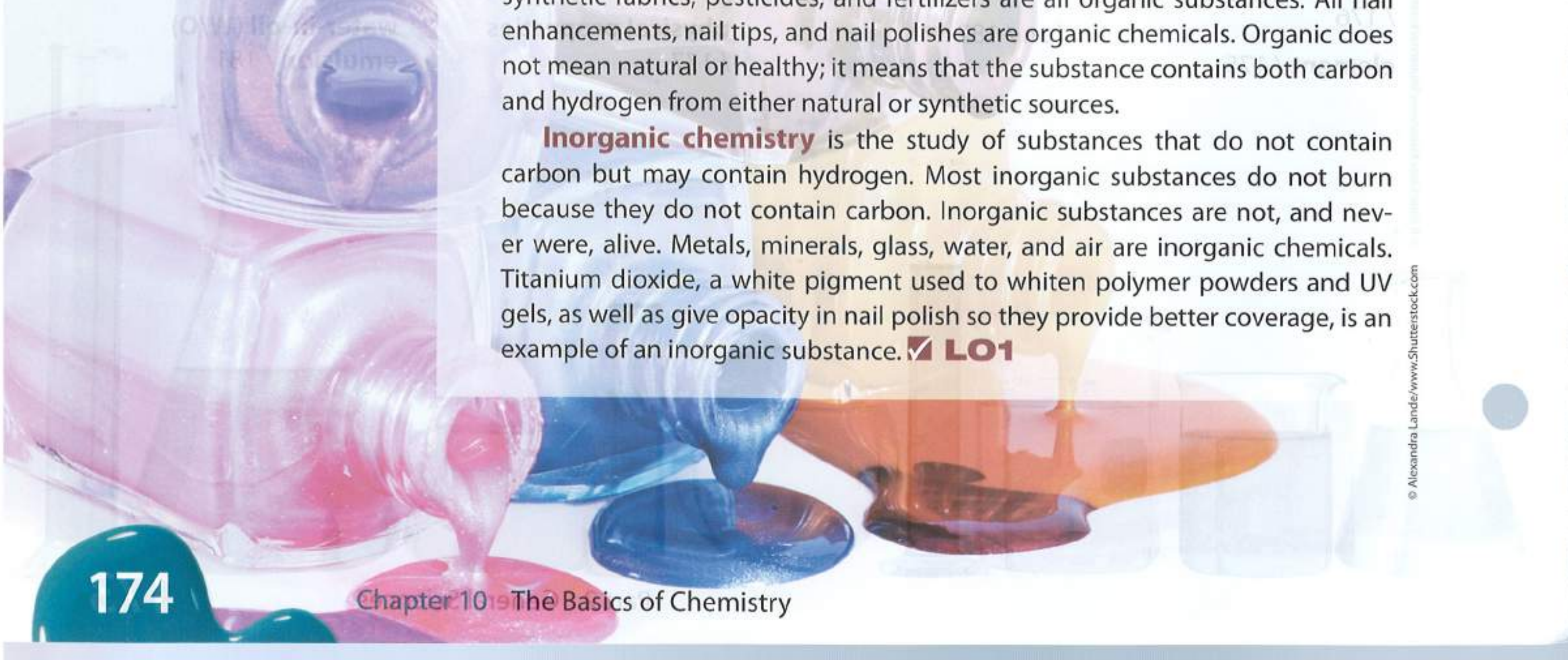
CHEMISTRY

Chemistry is the science that deals with the composition, structures, and properties of matter and how matter changes under different conditions.

Organic chemistry is the study of substances that contain the element carbon. All living things, or things that were once alive, whether they are plants or animals, contain carbon. Organic substances that contain both carbon and hydrogen may burn. Although the term "organic" is often used to mean safe or natural because of its association with living things, such as foods or food ingredients, not all organic substances are natural, healthy, or safe.

You may be surprised to learn that poison ivy, gasoline, motor oil, plastics, synthetic fabrics, pesticides, and fertilizers are all organic substances. All nail enhancements, nail tips, and nail polishes are organic chemicals. Organic does not mean natural or healthy; it means that the substance contains both carbon and hydrogen from either natural or synthetic sources.

Inorganic chemistry is the study of substances that do not contain carbon but may contain hydrogen. Most inorganic substances do not burn because they do not contain carbon. Inorganic substances are not, and never were, alive. Metals, minerals, glass, water, and air are inorganic chemicals. Titanium dioxide, a white pigment used to whiten polymer powders and UV gels, as well as give opacity in nail polish so they provide better coverage, is an example of an inorganic substance. ☑ LO1



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MATTER

Matter is any substance that occupies space and has mass (weight). All matter has physical and chemical properties and exists in the form of a solid, liquid, or gas. All matter is made from chemicals, so everything made out of matter is a chemical. Matter has physical properties that you can touch, taste, smell, or see. All matter is made up of chemicals. Visible light and electricity are the only examples of things you can see that are not made of matter, which explains why they are not considered to be chemicals. Light and electricity are forms of energy, and energy is not matter. Everything known to exist in the universe is either made of matter or energy; there are no exceptions to this rule.

Energy does not occupy space or have mass (weight). Energy is discussed in Chapter 12, "The Basics of Electricity." This chapter is dedicated to matter.

Elements

Elements are the building blocks of nature. An **element** is the simplest form of chemical matter and cannot be broken down into a simpler substance without a loss of identity. There are 90 naturally occurring elements, each with its own distinctive physical and chemical properties. All matter in the universe is made up of these 90 different chemical elements. Each element is identified by a letter symbol, such as O for oxygen, C for carbon, H for hydrogen, N for nitrogen, and S for sulfur.

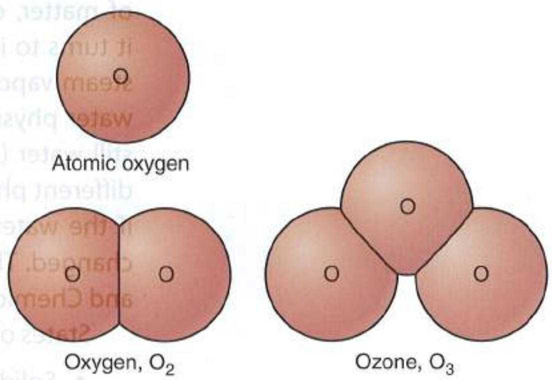
Atoms

Atoms are the chemical particles from which all matter is composed; therefore, all matter is made entirely of chemicals. Atoms are the structural units that make up the elements. Different elements are different from one another because the structure of their atoms is different. Each element is made from one type of atom, so differences between atoms are what make one element different from another. An atom is the smallest chemical particle of an element that retains the same properties of that element. Atoms cannot be divided into simpler substances by ordinary chemical means.

Molecules

Just as words are made by combining letters, molecules are made by combining atoms. A **molecule** is a chemical combination of two or more different types of atoms. For example, water is made from hydrogen and oxygen molecules. Carbon dioxide is made from carbon and oxygen.

Atmospheric oxygen makes up much of the air you breathe along with other chemical substances like nitrogen and helium. This type of oxygen is different from the element that is also called oxygen. The oxygen we breathe is a molecule that contains two atoms of the element oxygen that are chemically bonded together in fixed proportions. It is written as O_2. Ozone is a potentially harmful form of the element oxygen and a major component of smog: it contains three atoms of the element oxygen, and is written as O_3 **(Figure 10–1)**. Molecules made from combining the atoms of one type of element are called **elemental compounds** or **elemental molecules**.

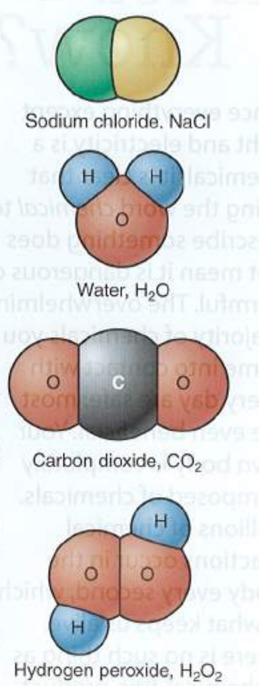


▲ **Figure 10–1** Elemental molecules contain atoms of the same element.

Did You Know?

Since everything except light and electricity is a chemical, it is clear that using the word *chemical* to describe something does not mean it is dangerous or harmful. The overwhelming majority of chemicals you come into contact with every day are safe; most are even beneficial. Your own body is completely composed of chemicals. Millions of chemical reactions occur in the body every second, which is what keeps us alive. There is no such thing as a chemical-free product, so do not be fooled by misleading marketing claims.

▼ **Figure 10–2** Compound molecules contain atoms of different sizes.



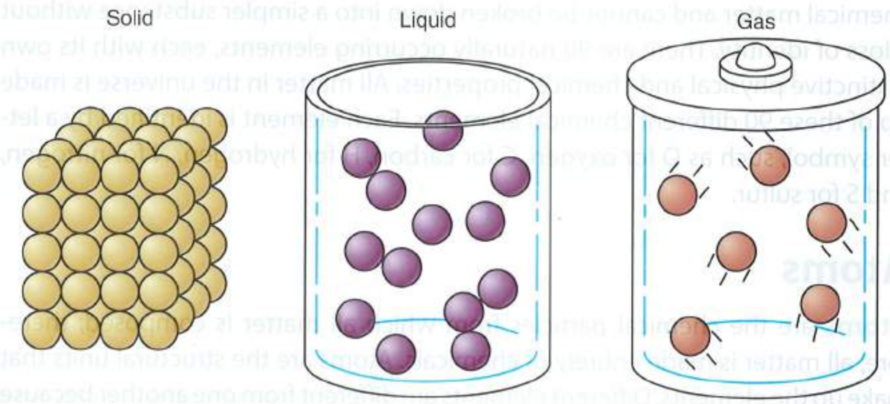
Compound molecules are made by combining two or more atoms of different elements **(Figure 10–2)**. Sodium chloride (NaCl), or common table salt, is a chemical compound that contains one atom of the element sodium (Na) and one atom of the element chlorine (Cl).

States of Matter

All matter exists in one of three different physical forms:

1. Solid
2. Liquid
3. Gas

These three forms are called the states of matter. Matter assumes one of these states, depending on its temperature **(Figure 10–3)**.



▲ **Figure 10–3** Solids, liquids, and gases.

Some substances, such as water (H_2O) can exist in three different states of matter, depending on its temperature. For instance, when water freezes, it turns to ice. When ice melts, it turns to water. When water boils, it turns to steam vapor. When the steam cools, it turns back into water. The form of the water physically changes according to changes in the temperature, but it is still water (H_2O). It does not become a different chemical—rather, it assumes different physical forms. Another example would be to dissolve sugar in water. If the water is evaporated, the sugar will be left behind but not chemically changed. These are examples of a physical change (see the section "Physical and Chemical Changes" in this chapter).

States of matter have the following distinct characteristics:

- Solids have a definite shape and volume. Ice is an example of a solid.
- Liquids have a definite volume, but not a definite shape. Water is an example of a liquid.
- Gases do not have a definite volume or shape and can never be liquid at normal temperatures and pressure. Propane is an example of a gas. It must be highly pressurized before it will turn into a liquid.

- Plasma is a special form of matter that behaves like a gas; however, unlike gases, plasmas conduct electricity. Plasmas are found in the Sun and other stars. On Earth, the most likely place you will find plasma is by observing lightning storms or by looking at a neon sign. When electricity is passed through the gases inside the types of tubes in a neon sign, a plasma is formed and visible light is emitted.

A **vapor** is a liquid that has evaporated into a "gas-like" state, but is not a gas. Vapors return to a liquid state when they cool down enough. Gases must be highly pressurized before they can become liquid, and when the pressure is lowered enough, the liquid becomes a gas once again. Steam is an example of a vapor. Vapors are not considered to be a unique state of matter but rather liquids that have undergone a physical change.

Physical and Chemical Properties

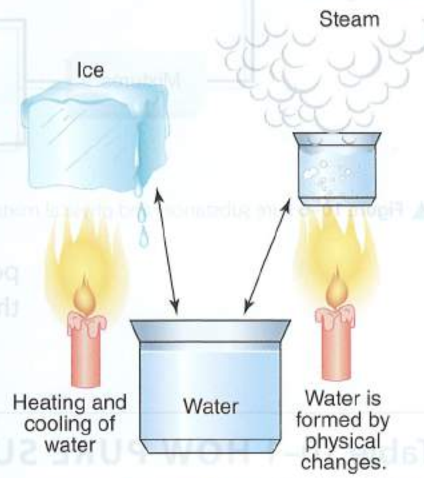
Every substance has unique properties that allow us to identify it. Two important types of properties are physical and chemical.

Physical properties are those characteristics that can be determined without a chemical reaction and do not involve a chemical change. Physical properties include color, size, weight, hardness, odor and gloss. **Chemical properties** are those characteristics that can only be determined by a chemical reaction and a chemical change in the substance. Chemical properties include the ability of iron to rust, wood to burn, or nail enhancements to polymerize or harden.

Physical and Chemical Changes

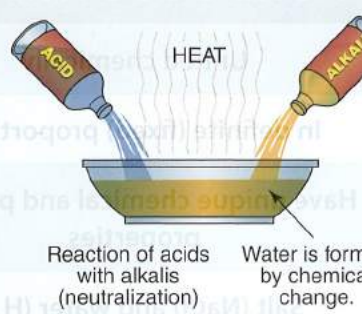
Matter can be changed in two different ways. Physical forces cause physical changes and chemical reactions cause chemical changes.

A **physical change** is a change in the form, or physical properties of a substance, without a chemical reaction or the creation of a new substance. No chemical reactions are involved in a physical change and no new chemicals are formed. Solid ice undergoes a physical change when it melts into liquid water and then converts into a vapor **(Figure 10–4)**. A physical change occurs when an abrasive file is used on the nail plate and both the nail plate and the file are changed, or when nail polish is dissolved and removed with a remover solvent. When nail polish dissolves in a solvent, it is not chemically changed. In fact, nail polish is made by dissolving certain solid ingredients into a blend of solvents, which then re-form into a solid film when the solvent evaporates away.



▲ **Figure 10–4** Physical changes.

A **chemical change** is an alteration in the chemical composition or makeup of a substance. These changes are the result of a chemical reaction that creates a new substance or substances, usually by combining or subtracting certain molecules. A chemical change results from chemical reactions that create new chemicals that are made from different molecules. These new chemical substances will have both different chemical and physical properties **(Figure 10–5)**. An example of a chemical change is the polymerization (hardening) of nail products to create artificial nail enhancements when exposed to UV energy. Under certain circumstances, chemical reactions can release a significant amount of heat. These types of chemical reactions are called **exothermic** (ek-soh-THUR-mik) **reactions**. An example of a nail product that undergoes exothermic reaction is a nail enhancement during polymerization. Exothermic reactions normally occur whenever nail enhancement products polymerize.



▲ **Figure 10–5** Chemical changes.

Did You Know?

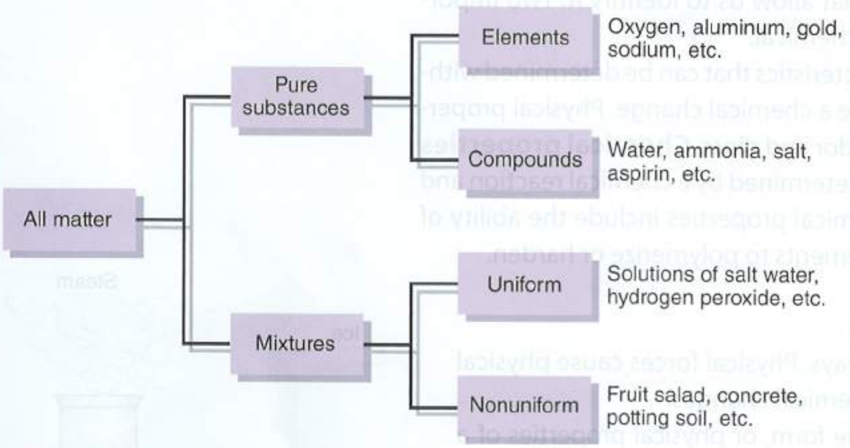
The sugar in grapes chemically converts into ethyl alcohol in wine when it is fermented. When food is digested, it is chemically changed. These are both examples of chemical reactions.

Normally, clients cannot feel the tiny amount of heat being released. When properly applied, high-quality nail enhancement products should not create excessive amounts of heat nor should they make the client uncomfortable.

Pure Substances and Physical Mixtures

All matter can be classified as either a pure substance or a physical mixture (blend).

A **pure substance** is a chemical combination of a single type of matter. Pure substances have unique properties that are specific to the substance. All atoms, elements, elemental molecules, and compound molecules are pure substances. Water is a pure chemical substance that results from the combination of two atoms of the element hydrogen and one atom of the element oxygen, in definite proportions. Liquid water has different properties than either hydrogen or oxygen gas. Even so, like many substances, water does not naturally exist in a pure state. Water may contain chlorine, dissolved minerals such as calcium or sodium, and considerable amounts of dissolved oxygen. Even pure air contains many substances, including nitrogen, helium, carbon dioxide gas, and water vapor.



▲ **Figure 10–6** Pure substances and physical mixtures.

A **physical mixture** is a physical combination of matter, in any proportions. The properties of a physical mixture are derived from combining the properties of each substance in the mixture. Saltwater is a physical mixture of salt and water, in any proportion that will dissolve the salt. The properties of saltwater are derived from the properties for both salt and water, for example, saltwater tastes salty. Most of the products nail technicians use to perform services are physical mixtures **(Figure 10–6)**. **Table 10–1** summarizes the differences between pure substances and physical mixtures. ✔ **LO2**

Table 10–1 HOW PURE SUBSTANCES AND PHYSICAL MIXTURES ARE UNITED

PURE SUBSTANCES	PHYSICAL MIXTURES
United chemically	United physically
In definite (fixed) proportions	In any proportions
Have unique chemical and physical properties	Have combined chemical and physical properties
Salt (NaCl) and water (H_2O)	Salt water is a physical mixture of salt (NaCl) and water (H_2O).

Solutions, Suspensions, and Emulsions

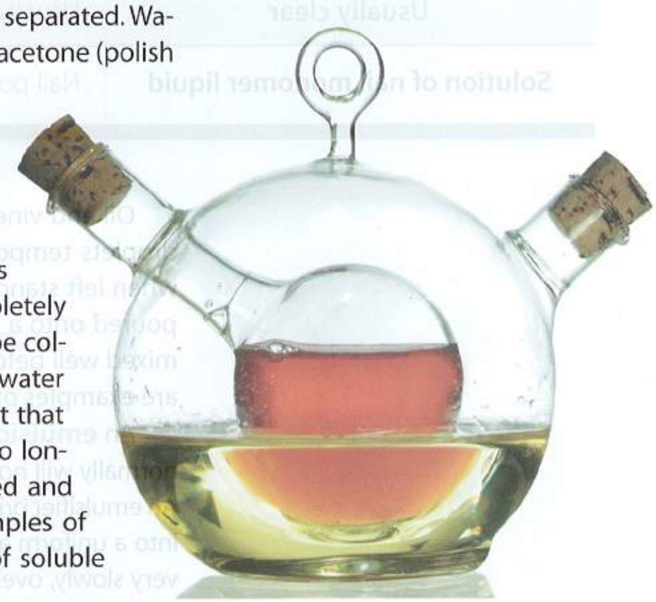
Solutions, suspensions, and emulsions are all examples of physical mixtures. The differences among them are determined by the size of the particles and the solubility of the substances.

A **solution** is a stable, uniform blend of two or more substances. The **solute** is the substance that is dissolved into solution. The **solvent** is the substance that dissolves the solute and makes the solution; it is the matrix that holds the solute. Water is an extremely powerful and useful solvent. Water is known as the "universal solvent" because it has the ability to dissolve more substances than any other known solvent. When two liquids are mixed, they are determined to be either miscible or immiscible.

Miscible (MIS-uh-bul) liquids are mutually soluble, meaning that they can be mixed together to form stable solutions that cannot be easily separated. Water and rubbing alcohol are examples of miscible liquids, as are acetone (polish remover) and water.

Immiscible liquids are not capable of being mixed into stable solutions. Water and oil are examples of immiscible liquids. No matter how well they are mixed, eventually these two liquids will separate.

Solutions are soluble mixtures created when all solid particles have completely dissolved and all liquid components are completely soluble. Solutions are usually transparent, although they may be colored. They do not separate when left to stand undisturbed. Saltwater is a solution of a solid dissolved in a liquid. Water is the solvent that dissolves the salt (solute) and holds it in solution. The salt is no longer a solid because its individual molecules are now separated and moving freely in the water. Artificial nail monomers are examples of solutions that can contain both dissolved solids and blends of soluble liquids.



Suspensions are unstable mixtures of undissolved particles floating in a liquid. Suspensions contain larger and less miscible particles than solutions. The particles are generally visible to the naked eye but not large enough to settle quickly to the bottom. Suspensions are not usually transparent and may be colored. Suspensions are unstable and separate over time, which is why lotions, creams, and the glitter in nail polish may separate in the bottle.

Activity

Put a tablespoon of sugar in a cup of hot water. Cover it loosely with a paper towel and set it aside for a week. What happens when the water evaporates? What are the crystals that form inside the cup made from? Taste them to see whether your conclusions are right. When sugar dissolves in water, is it a physical or chemical change? What if you heated the sugar on an open flame? Would this cause a chemical or physical change?

Table 10–2 SOLUTIONS, SUSPENSIONS, AND EMULSIONS

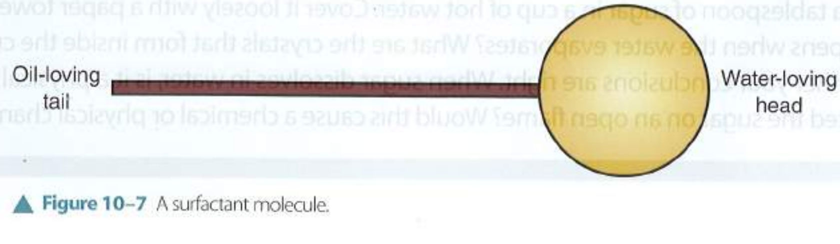
SOLUTIONS	SUSPENSIONS	EMULSIONS
Miscible	Slightly miscible	Immiscible
No surfactant	No surfactant	Surfactant
No particles	Small particles	Largest particles
Stable mixture	Unstable mixture	Limited stability
Usually clear	Usually cloudy	Usually a solid color
Solution of nail monomer liquid	Nail polish	Hand lotions

Oil and vinegar salad dressing is an example of a suspension, with tiny oil droplets temporarily suspended in the vinegar. The suspension will separate when left standing undisturbed; the dressing must be shaken well before it is poured onto a salad. Some lotions are suspensions and need to be shaken or mixed well before use. Calamine lotion, liquid mineral makeup, and nail polish are examples of suspensions.

An **emulsion** is an unstable physical mixture of two or more substances that normally will not stay blended without a special ingredient called an **emulsifier**. An emulsifier brings two normally incompatible materials together and binds them into a uniform and fairly stable blend. Eventually, emulsions separate, but usually very slowly, over time. A properly formulated emulsion, stored under ideal conditions can be stable for up to 3 years. Even so, it is best to use cosmetic products such as these within 1 year of purchase to ensure peak performance. Always refer to the product's instructions and cautions for specific details. **Table 10–2** offers a summary of the differences among solutions, suspensions, and emulsions.

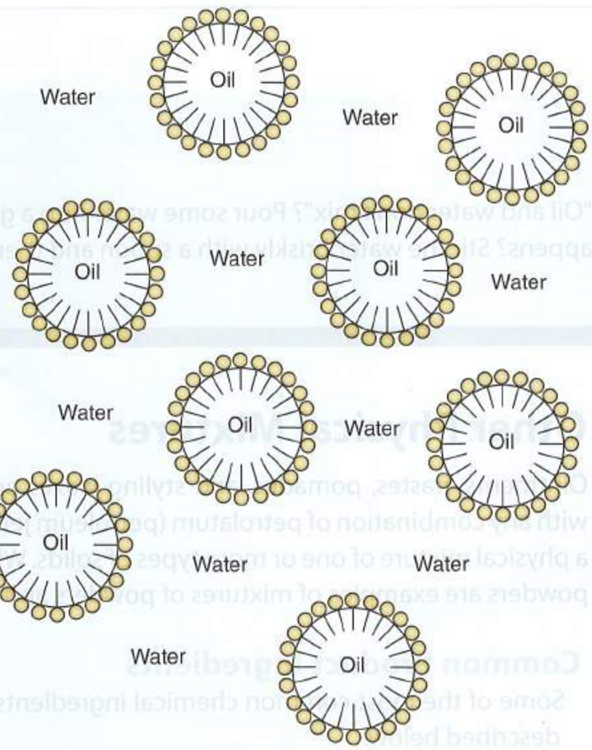
Surfactants (sur-FAK-tants) are substances that are often used as emulsifiers since they can act as a bridge to allow oils and water to mix, or emulsify and form emulsions. The term surfactant is a contraction for "surface active agent." A surfactant molecule has two distinct parts **(Figure 10–7)**.

The head of the surfactant molecule is **hydrophilic** (hy-drah-FIL-ik), meaning water loving; the tail is **lipophilic** (ly-puh-FIL-ik), meaning oil loving. As the old saying goes, "Like dissolves like": this is true for surfactants. The hydrophilic head dissolves in water and the lipophilic tail dissolves in oil. So a surfactant molecule mixes with and dissolves in both oil and water and temporarily links them together to form an emulsion.



▲ **Figure 10–7** A surfactant molecule.

▶ **Figure 10–8** Oil-in-water emulsions.



Did You Know?

Soaps were the first synthetic surfactants. Soaps were made about 4,500 years ago by boiling oil or animal fat with wood ashes. Modern soaps are made from animal fats or vegetable oils. Traditional bar soaps are highly alkaline and combine with the minerals in hard water to form an insoluble film that coats skin and can cause hands to feel dry, itchy, and irritated. They can also leave a film on the nail plate that could contribute to the lifting of the artificial nail enhancement. Modern synthetic surfactants have overcome these disadvantages and are superior to soaps; many are much milder on skin than soaps used in the past. Even so, they must also be completely removed from the nail plate before applying nail polish or artificial nail enhancements, or they may prevent proper adhesion to the nail plate.

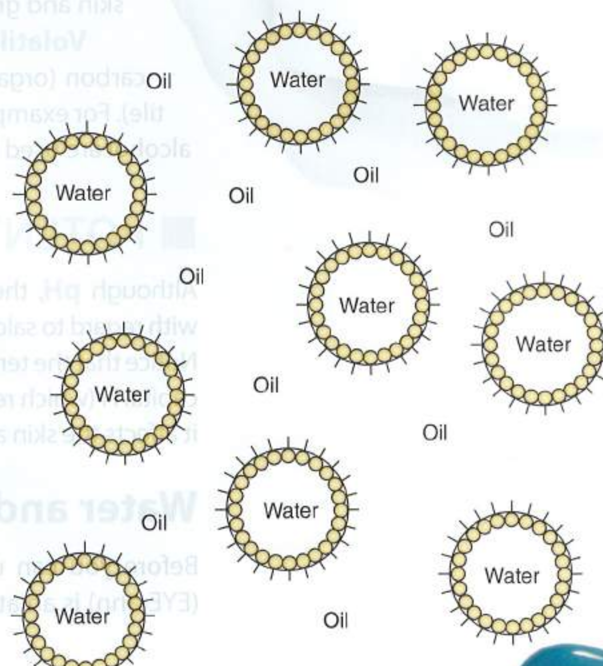
In an **oil-in-water (O/W) emulsion**, oil droplets are emulsified in water. The droplets of oil are surrounded by surfactants with their lipophilic tails pointing inward toward the center of the droplet. These tiny oil droplets form an O/W emulsion because the oil is completely surrounded by water **(Figure 10–8)**. An oil-in-water emulsion does not feel as greasy as a **water-in-oil (W/O) emulsion** because the oil is in a lower concentration than the water and is hidden by the surfactant molecules that completely surround it.

Mayonnaise is an example of an oil-in-water emulsion made of two normally immiscible liquids. Although oil and water are usually immiscible, the egg yolk behaves as the surfactant in mayonnaise that emulsifies the oil droplets in the water matrix. Without the egg yolk as an emulsifying agent, the oil and water would separate. Most of the emulsions used in a salon are oil-in-water. Lotions and creams are common examples.

In a water-in-oil emulsion, water droplets are emulsified in oil. The droplets of water are surrounded by surfactants with their hydrophilic heads pointing in **(Figure 10–9)**. Tiny droplets of water form the internal portion of a W/O emulsion because the water is completely surrounded by oil. W/O emulsions feel greasier than O/W emulsions because the water is hidden and oil forms the external portion of the emulsion. Foot balms are an example. Since W/O emulsions are so oily, they are not often used in nail salon products.

☑ **LO3**

▼ **Figure 10–9** Water-in-oil emulsions.



Activity

Have you ever heard the saying, "Oil and water don't mix"? Pour some water into a glass, and then add a little cooking oil (or other oil). What happens? Stir the water briskly with a spoon and then observe for a minute or two. What does the oil do?

Other Physical Mixtures

Ointments, pastes, pomades, and styling waxes are semisolid mixtures made with any combination of petrolatum (petroleum jelly), oil, and wax. Powders are a physical mixture of one or more types of solids. White and/or colored polymer powders are examples of mixtures of powders and pigments.

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Common Product Ingredients

Some of the most common chemical ingredients used in salon products are described below.

Most people are familiar with **volatile** (VAHL-uh-tul) alcohols: they evaporate easily. Examples include isopropyl alcohol (rubbing alcohol) and ethyl alcohol (alcoholic beverages). But there are many other types of alcohols, from free-flowing liquids to hard, waxy solids. Fatty alcohols, such as cetyl alcohol and cetearyl alcohol, are nonvolatile alcohol waxes that are used as skin conditioners.

Glycerin (GLIS-ur-in) is a sweet, colorless, oily substance. It is used as a solvent and as a moisturizer in skin and body creams.

Silicones are a special type of ingredient used in nail polish dryers and as skin protectants. Silicones form a "breathable" film that does not cause comedones (blackheads). Silicones also impart a silky smooth feel on the skin and great shine to hair.

Volatile organic compounds (VOCs) are compounds that contain carbon (organic) and evaporate very quickly (meaning that they are volatile). For example, volatile organic solvents such as ethyl acetate and isopropyl alcohol are used in nail polish, base and top coats, and polish removers.

POTENTIAL HYDROGEN (pH)

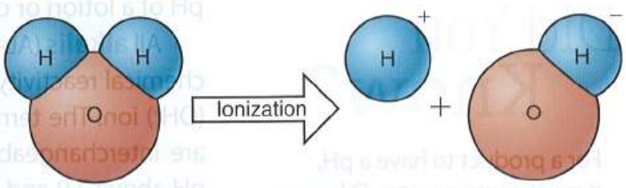
Although **pH**, the abbreviation used for potential hydrogen, is often discussed with regard to salon products, it is one of the least understood chemical properties. Notice that the term pH is written with a small p (which represents a quantity) and a capital H (which represents the hydrogen ion). Understanding what pH is and how it affects the skin and nails is essential to understanding all salon services.

Water and pH

Before you can understand pH, you need to first learn about ions. An **ion** (EYE-ahn) is an atom or molecule that carries an unbalanced electrical charge.

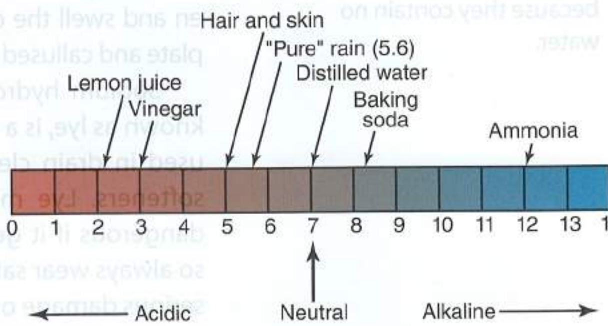
Ionization (eye-ahn-ih-ZAY-shun) causes an atom or molecule to split in two, creating a pair of ions with opposite electrical charges. An ion with a negative electrical charge is an **anion** (AN-eye-on). An ion with a positive electrical charge is a **cation** (KAT-eye-un).

In water, some of the water molecules (H_2O) naturally ionize into hydrogen ions and hydroxide ions. The pH scale measures these ions. The hydrogen ion (H^+) is **acidic**; the more hydrogen ions there are in a substance, the more acidic it will be. The hydroxide ion (OH^-) is alkaline; the more hydroxide ions the substance has, the more alkaline it will be. pH is only possible because of this ionization of water. Only products that contain water can have a pH.



▲ **Figure 10–10** The ionization of water.

In pure water, each water molecule that ionizes produces one hydrogen ion and one hydroxide ion **(Figure 10–10).** Pure water has a neutral pH because it contains the same number of hydrogen ions as hydroxide ions. It is an equal balance of 50 percent acid and 50 percent alkaline. The pH of any substance is always a balance of both acidity and alkalinity. As acidity increases, alkalinity decreases. The opposite is also true: as alkalinity increases, acidity decreases. Even the strongest acid also contains some alkalinity **(Figure 10–11).** Pure water is 50 percent acidic and 50 percent alkaline.



▲ **Figure 10–11** The pH scale.

The pH Scale

The **pH scale** measures the acidity and alkalinity of a substance. It has a range of 0 to 14. A pH of 7 indicates a neutral solution; a pH below 7 indicates an acidic solution; and a pH above 7 indicates an **alkaline** solution.

The term *logarithm* (LOG-ah-rhythm) means multiples of 10. Since the pH scale is a logarithmic scale, a change of one whole number represents a tenfold change in pH. That means that a pH of 8 is 10 times more alkaline than a pH of 7. A change of two whole numbers represents a change of 10 times 10, or a hundredfold change. That means that a pH of 9 is 100 times more alkaline than a pH of 7. A small change on the pH scale indicates a large change in the pH.

pH is always a balance of both acidity and alkalinity. Pure water has a pH of 7, which is an equal balance of acid and alkaline. Although a pH of 7 is neutral on the pH scale, it is not neutral compared to the hair and skin, which has an average pH of 5. Pure water, with a pH of 7, is 100 times more alkaline than a pH of 5. Pure water is 100 times more alkaline than your hair and skin. Pure water can cause the hair to swell as much as 20 percent and is drying to the skin.

Acids and Alkalis

All **acids** owe their chemical reactivity to the hydrogen ion (H^+). Acids have a pH below 7.0 and turn litmus paper from blue to red. Alpha hydroxy acids (AHA) are examples of acids found in salons. Citric acid is often used to help adjust the pH of a lotion or cream.

Did You Know?

For a product to have a pH, it must contain water. Oils, waxes, nail polish, and nail monomers have no pH because they contain no water.

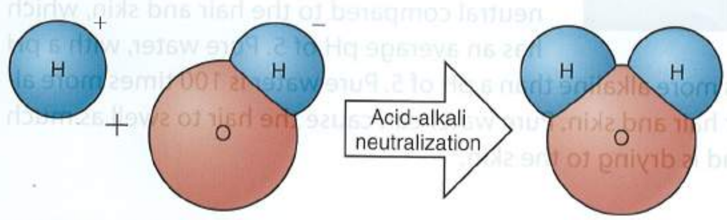
All **alkalis** (AL-kuh-lyz) owe their chemical reactivity to the hydroxide (OH^-) ion. The terms *alkali* and *base* are interchangeable. Alkalis have a pH above 7.0 and turn litmus paper from red to blue. They feel slippery and soapy on the skin. Alkalis soften and swell the cuticle on the nail plate and callused skin.

Sodium hydroxide, commonly known as lye, is a very strong alkali used in drain cleaners and callus softeners. Lye may be especially dangerous if it gets into the eyes, so always wear safety glasses to avoid eye contact. Eye exposure could result in serious damage or blindness. Products that contain lye must be used according to their manufacturer's instructions. Consult the product's SDS (formally called MSDS) for more specific information on safe use.

With regards to callus removers, avoid their use, since your license does not allow you to remove a callus. You may only smooth calluses with a gentle abrasive to make them more cosmetically attractive. High pH (12 to 13.5) callus softeners can be useful for softening the callus so that it can be smoothed more easily, but these products should be kept off living skin. Take special precautions while using a callus softener to avoid skin contact surround the callus. After just a few minutes of skin contact, some products can cause injury, so prevent contact and carefully rinse all traces from the hands or feet. Excessive exposure can result in the feet becoming red and irritated and a serious and painful skin burn that develops quickly. Residuals that are left on the client's skin can lead to severe irritation, so take the time to ensure proper removal.

Acid-Alkali Neutralization Reactions

The same reaction that naturally ionizes water (H_2O) into hydrogen (H^+) ions and hydroxide ions (OH^-) also runs in reverse. When acids (H^+) and alkalis (OH^-) are mixed together in equal proportions, they neutralize each other to form water (H_2O) **(Figure 10–12)**. Liquid soaps are usually slightly acidic and can help neutralize alkaline callus softener and remove any residues left on the skin after rinsing. **LO4**



▲ **Figure 10–12** Acid-alkali neutralization reaction.

Review Questions

1. What is chemistry?
2. Why is a basic understanding of chemistry important?
3. What is the difference between organic and inorganic chemistry?
4. What are atoms?
5. What are elements?
6. What are the physical and chemical properties of matter? Give examples.
7. What is the difference between a physical and chemical change? Give examples.
8. Describe the four states of matter.
9. Explain elemental molecules, compound molecules, pure substances, and physical mixtures.
10. What is the difference between solutions, suspensions, and emulsions? Give examples.
11. Define pH and the pH scale.