EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

SCIENCE SKILLS
BASIC ATOMIC STRUCTURE AND THEORY

AN ACADEMIC SKILLS MANUAL
for
The Food Preparation Trades
This trade group includes the following trades:
Baker, Cook and
Retail Meat Cutter

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

SCIENCE SKILLS
BASIC ATOMIC STRUCTURE AND THEORY

An academic skill required for the study of the Food Preparation Trades

INTRODUCTION

Hey, did you hear about the two atoms that went to the movies? As they were coming out of the theatre, one of the atoms said to the other, "*I think I forgot an electron back at my seat*." The second atom said, "*Are you sure?"* The first atom answered*, "Yes, I'm positive."* If you didn't get the punch line, it should be obvious by the time you finish reading this skill manual about atoms.

Importance of Atomic Structure

Matter is made up of basic building blocks called atoms. Atoms are very small particles with a specific organization and design. Atoms bond together with other atoms to form all the materials found on earth, including the basic plant and animal foods, along with the mineral and chemical products used in the food preparation trades. Every different material or compound has a different type or configuration of atoms. The properties and behavior of everything you use at work depends on this basic atomic structure.

Atomic theory explains how different atoms join together to form all matter, including the products used in the food preparation trade. In your trade, you use many different kinds of materials while preparing different types of food products. Disinfectants and detergents must be used at the proper concentrations so that they effectively kill microorganisms but they don't harm the person using them. Knowing know how a compound reacts physically and chemically helps explain how to it safely.

Proper handling and cleaning is important in keeping food supplies safe. When some foods are left in the open, they begin to spoil. Meat left at room temperature can support the growth of harmful microorganisms. Steaming food depends on water changing state from a liquid to a vapour. Different foods are cooked to kill microorganisms that might be present, to make them more flavourful and to soften the texture of proteins found in meat.

All of these processes depend on chemical changes that occur because of the underlying molecular structure of food. Basic atomic theory provides the background needed to understand these changes. In this skills manual, we look at:

- Basic structure of an atom
- Elements
- Electrical charges
- Bonding between atoms
- Compounds and mixtures

BASIC STRUCTURE OF AN ATOM

Subatomic Particles

All matter is made of atoms. The atom is not actually a solid particle. It is made up of several different, smaller parts called *subatomic particles*. The main subatomic particles are the ***proton,*** the ***neutron*** and the ***electron***. Figure 1 shows the subatomic particles that form an atom and where they are located. Notice that there is a lot of empty space within an atom.

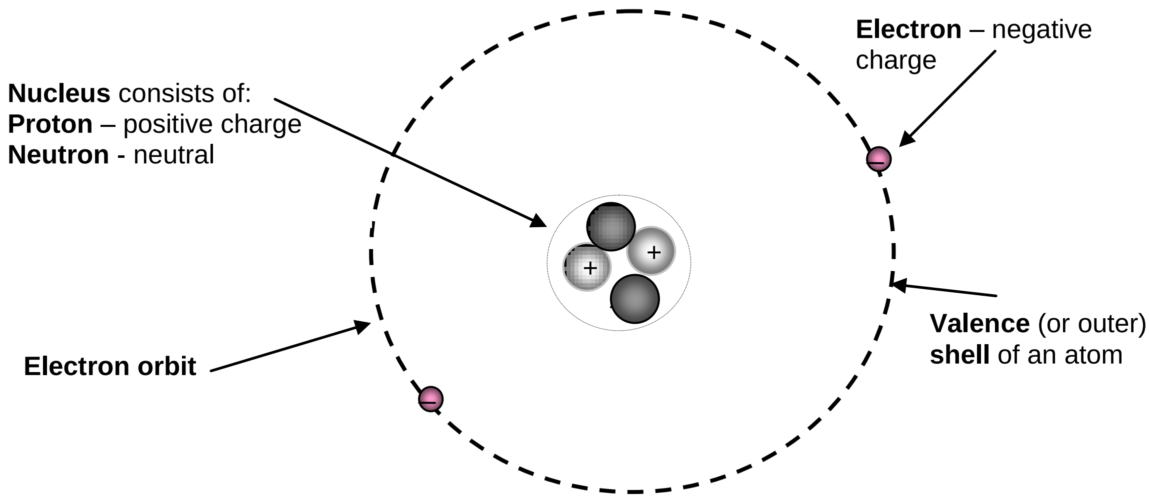

FIGURE 1: Basic Atomic Structure

Atoms are made of two main parts. The compact center of an atom is called the ***nucleus.*** Circling the nucleus are ***orbits*** or ***shells*** where the electrons are found**.** Both the nucleus and the shells contain smaller *sub-atomic particles.* The number and arrangement of these subatomic particles give each type of atom its distinctive qualities.

The nucleus, the small heavy centre of the atom, contains two main particles.

- ♦ ***Protons and neutrons*** are located in the nucleus.
  - The number of protons determines the kind of atom that is formed.

The ***orbits***, or shells surround the nucleus.

- ♦ Each shell contains one or more ***electrons***.
  - Electrons are very small particles that travel within a shell.
  - The outside shell, called the ***valence shell***, is the most active.

The ***number*** of protons and electrons in each atom determine its characteristics.

- ♦ There are usually has the same number of protons as there are electrons in an atom.
- ♦ However, an atom can gain or lose electrons in certain circumstances.

Charges on protons and electrons

- Protons and electrons have a very important property called ***charge***.
  - Protons and electrons have different types of charge.
    - Protons have ***positive*** charge.
    - Electrons have ***negative*** charge.
- The charges on electrons and protons are responsible for much of the underlying ***structure*** of matter.

The nucleus

The nucleus, or the centre of the atom, consists of two types of particles, the proton and the neutron. Strong nuclear forces hold them together, preventing the protons from leaving the nucleus.

- The number of protons in an atom is usually the same as the number of neutrons.
- Each proton has one positive charge.
- The neutron has no charge and is considered neutral.

Electron shells and electrons

One or more electron shells, or ***energy levels***, surround the nucleus of an atom. Electrons in these shells orbit the nucleus of the atom. The area occupied by the electron shells and their electrons ***forms the physical space an atom occupies*** and gives the atom its distinct, indivisible nature.

Each shell can hold only a certain, ***specific number of electrons before it is full***.

- There is a maximum number of electrons each shell can hold. There are:
  - ***Two*** in the first shell,
  - ***Eight*** in the second shell,
  - ***Eighteen*** in the third shell, etc.
- The outer shell of an atom is the most active. It is called the ***valence shell***.

The outer or valence shell of an atom is the most important in determining how an atom will interact with other atoms.

- A few atoms have filled outer shells (two, eight, eighteen electrons, etc) but most do not.
- An atom is ***more stable when its outermost shell is full***.
- To gain the stability of a full outer shell, an atom might give away or accept electrons, or share them. Thus, ***the number of electrons in an atom can vary***.
- This is important both for the way ***atoms bond together*** to form molecules and for the way ***electrical charges develop.***

Electrons are held in their orbit around the nucleus by the electrical attraction between electrons and protons that results from the fact that ***they have different charges.***

- The attraction between electrons and protons is weaker than the force that holds protons and neutrons together in the nucleus.
- The force that holds electrons close to the nucleus can be broken, allowing the electrons in the outer valence shells to be shared with or given to other atoms.

Different kinds of atoms
Each kind of atom has a specific number of subatomic particles. Thus, the number of protons, neutrons and electrons varies in each particular kind of atom.

- Look back at Figure 1. The atom shown here has two protons, two neutrons and (usually) two electrons. This is a helium atom.
- A carbon atom has six protons, six neutrons and six electrons.
- An oxygen atom has eight of each subatomic particle, while a silicon atom has fourteen.

The number of protons and electrons an atom has is very important.

- ♦ This number determines what kind of atom is formed and how it will behave.
- ♦ Under certain conditions, the number of electrons in an atom may vary.
- ♦ But, the number of protons in any specific type of atom remains constant.
- ♦ ***The number of protons determines what type of atom is formed.***
- ♦ Because the number of protons in an atom is so important, it is called the ***atomic number***.

There are many different types of atoms – more than a hundred that we know about. Some common types of atoms include hydrogen, oxygen, copper, silicon, nitrogen and aluminum atoms. Each type of atom has a specific, unchanging number of protons. Each type of atom forms a pure substance. These substances are called ***elements.***

ELEMENTS

Each specific type of atom forms a different ***element.*** An element cannot naturally be broken down into other, more simple substances. Each element is a ***pure substance*** made of only one type (of the more than one hundred possible types) of atom.

For example, iron and carbon *are* elements because they cannot be broken down further by physical or chemical means. On the other hand, steel *is not an element* because it can be broken down into separate particles of iron and carbon.

Each element looks and behaves differently from any other element. What makes this difference? The answer lies in the structure of each type of atom.

- ♦ Atoms of each different element have a specific *atomic number* based on the number of protons. This number differs in every element.

The atomic number and the number of electrons in any atom determine the following:

- ♦ The structure of the atom, including the number of electron shells.
- ♦ The way the atom interacts with other atoms.
- ♦ The way the atom reacts to changes in the environment.

Every different element is made up of a different, unique type of atom, so every element has different characteristics.

Periodic table

The elements are classified in a chart called the ***periodic table***. The periodic table lists the known elements in order according to the unique structure of the atoms which form each element. The table lists all the different elements in columns and rows. There is much information encoded in the arrangement of elements in the periodic table.

Elements are listed in order by their increasing atomic number in the periodic table.

Example: Hydrogen, the smallest element with one proton and one electron, is the first element listed in the periodic table.

Example: The next element on the table is helium, which has two protons and two electrons. A helium atom has a completely filled the first shell, which holds two electrons when full.

Example: The next element in the table, lithium, has three protons and three electrons.

- Its first shell is filled with two electrons, so its third electron is in the next, or second, shell.
- This second shell is full when it has eight electrons.
  - Since the lithium atom has only one electron in that shell, it tends to give away this lone electron so that it has a filled outer shell of two electrons.

Note: *When an element loses electrons to get a full outer shell, the number of shells it normally has will be reduced by one.*

Elements that have characteristics in common, such as similar metals or the inert gases, are associated in columns. There is an association between the number of electrons in the outer shell of an element and the column it appears in.

Example: Carbon and silicon are in the same column. Both are very common elements.

- Each has 4 electrons in their outer shells so they both react easily with other elements to form compounds.
- Carbon compounds form the basic materials of living organisms.
- Silicon joins with oxygen to form quartz, the most abundant mineral in surface rocks.

Metals

Elements like lithium that have only a few electrons in their outermost shell are called ***metals***. Many elements on the surface of the earth are metals. They include copper, aluminum and iron.

When only a few electrons fill the outermost shell of an atom, those electrons can easily be dislodged. When many atoms of the same metal join together, they arrange themselves as a closely-spaced, ordered crystal. The outer electrons from each atom are easily dislodged and they are shared by the whole crystal. It is these free-flowing, shared electrons that carry the electrical charge in metal conductors.

Non-metals
Non-metallic elements, like oxygen and chlorine, have almost full outer shells. They need only one or two electrons to completely fill their outer shell. *Atoms which need only a few electrons to fill an outer shell readily accept electrons from other atoms such as metals, which have nearly empty outer shells.*

Elements such as carbon and silicon, which have half full outer shells, readily give away, accept or share electrons to get full outer shells. This is one reason they react so readily with other elements.

- This tendency to share, give away or accept electrons enables atoms to bond with other atoms.
- These bonded atoms come together to create all the complex substances found on earth.

In brief:
- The atom consists of two parts:
  - an inner nucleus which contains protons and neutrons, and,
  - outer electron shells which contain the fast moving electrons that orbit the nucleus.
- The number of protons, called the atomic number, determines what element an atom forms.
- The number of protons is usually the same as the number of electrons.
- Forces holding neutrons and protons together in the nucleus are very strong; the forces holding electrons to the nucleus are much weaker.
- An atom is more stable when its outer electron shell is filled with the maximum number of electrons for that shell.
- Atoms can share, give away or accept electrons to obtain a filled outer shell.
- This exchange of electrons leads atoms to bond together.

Before looking at how bonds are formed, we will look at the properties of electrical charge.

ELECTRICAL CHARGE

Recall that a force is something that exerts a push or pull on an object. If the object is not held in place, it moves as a result of the applied force. Electrons and protons exert a force of ***attraction or repulsion*** on other electrons and protons. This force is called an ***electrical force or charge.***

- Similar particles, either two protons or two electrons, feel a force that pushes them apart.
- Dissimilar particles, a proton and an electron, feel a force that pulls them together.
- In other words, protons and electrons feel a force of attraction to each other. Electrons are repelled by other electrons. Protons are repelled by other protons.

An electrical force is similar to a magnetic force. The south and north poles of a magnet are attracted to each other and will be pulled together when they are brought near each other. Two magnetic south or north poles will push apart when they are near each other.

Charges on electrons and protons

Forces of attraction and repulsion exist between subatomic particles because protons and electrons have a different kind of charge.

- Protons have a ***positive charge;*** a positive charge is indicated by the symbol **+**.
- Electrons have a ***negative charge;*** a negative charge is indicated by the symbol −. These symbols are used in Figure 1.
- Neutrons have no charge.

In the atom, ***opposite charges attract*** each other:

- Protons, with their positive charge, are attracted to electrons, with their negative charge.
- Electrons, with their negative charge, are attracted to protons, with their positive charge.

In the atom, ***like charges repel, or push away***, each other:

- Protons repel other protons.
- Electrons repel other electrons.

This is summed up by the saying: ***opposite charges attract and like charges repel.***

The forces of attraction and repulsion keep all the subatomic particles in their places and give the atom its size, shape and special characteristics.

- Electrons are kept from flying out of their orbits by *their attraction to the protons* in the nucleus.
- At the same time, the *electrons repel each other*, which causes them to spread as far apart from each other as possible in their orbits around the outside of the atom.

Because protons are held tightly in the nucleus by atomic forces and are not free to move***, only the movement of electrons can give an atom a charge***.

- If an atom **gains** electrons, it has a **negative charge**.
- If it **loses** electrons, it has a **positive** charge.

So a negative charge comes from gaining extra electrons, while a positive charge comes from losing electrons.

Charges on a larger object

When a single atom gains extra electrons, it becomes negatively charged. In the same way, if an object such as a metal plate gains a large number of extra electrons, the whole object becomes negatively charged. On the other hand, if the atoms making up an object lose a large number of electrons, the object becomes positively charged.

If an atom has the ***same number*** of protons as electrons**,** the positive and negative charges balance each other, making the atom ***neutral*** (having no charge). An atom with the same number of electrons and protons is electrically neutral. In the same way, if the negative and positive charges on a large object are balanced, the object is neutral.

In Brief
The theory of charge:

- Each electron has one negative charge; each proton has one positive charge.
- Like charges repel; unlike charges attract.
- An extra electron transferred to an atom gives the atom a negative charge of −1.
- The loss of an electron gives an atom a positive charge of +1.
- An excess or deficiency of electrons determines the charge on a larger object.
  - ***More electrons*** than protons give a ***negative charge***.
  - ***Fewer electrons*** than protons give a ***positive charge.***

BONDING BETWEEN ATOMS

Atoms of different elements without filled outer shells can share, give away or accept electrons. When atoms exchange electrons, they become joined into more complex structures.

Atoms can bond with other atoms of the same element or, more usually, they join with atoms of different elements. When two or more atoms bond together, they form a ***molecule***. Molecules in turn combine to form all the different substances found on earth.

Different types of bonds
There are three main types of bonds:

- When atoms or molecules ***transfer*** electrons, the bonds formed are called ***ionic bonds***.
- When atoms or molecules ***share*** electrons, ***molecular*** or ***covalent bonds*** are formed.
- When metal atoms share electrons, ***metallic bonds*** are formed.

Substances on earth usually occur as molecules, not single atoms. This happens because one kind of atom will interact with another kind of atom so that both end up with a more stable, filled outer shell. These interactions result in molecules being formed. These molecules, in turn, often combine with other molecules to form new compounds.

All bonds are formed because of atomic interaction but the type of interaction varies in the three different kinds of bonds.

Remember, bonds are formed because:

- Atoms with filled outer shells are more stable.
- The outer shell of an atom might lose or gain electrons or share electrons so it can have a filled outer shell.

How Different Types Of Bonds Are Formed

Ionic bonds

An ionic bond is formed when an atom donates an electron to a different kind of atom so that both end up with stable, filled outer shells.

- Each of these atoms has now become charged. Because they are now charged particles, they are called ions.
- One atom or ion has more protons than electrons, giving it a positive charge.
- The other has one more electron than protons, giving it a negative charge.
- The negatively charged atom (which donated the electron) is attracted to the positively charged atom (which accepted the electron).
- This results in a molecule held together by an *ionic bond*.

Covalent bonds: A covalent bond is formed when atoms share electrons so that each ends up with a stable, filled outer shell.

- The shared electrons hold the atoms together in this more stable arrangement.
- This results in a molecule held together by a *covalent bond.*

Metallic bonds: A metallic bond is formed when atoms of solid metals pack closely together in a stable crystal formation. They release and share their loosely-held outer electrons so they each have filled outer shells.

- The free electrons are shared by all of the now stable atoms and move in a cloud around the outside.
- This results in molecules held together in a metallic bond.

When atoms join together in these different ways, we say they are *chemically bonded*.

Ions

If an atom or molecule loses electrons, it becomes positively charged. If an atom gains electrons, it becomes negatively charged. Atoms that gain a charge in this way are called ***ions***. Ions with opposite charge are attracted to each other.

Example: Salt is a compound made of ions. A sodium atom that loses an electron to an atom of chlorine, the sodium atom gains a positive charge of +1. It is now a positively charged sodium ion. The chlorine atom gains an electron and a negative charge of -1. It is now a negatively charged chlorine ion.

The oppositely charged ions are attracted to each other and form ionic bonds. When many such sodium and chlorine ions are joined by ionic bonds, the compound salt is formed. See Figure 2.

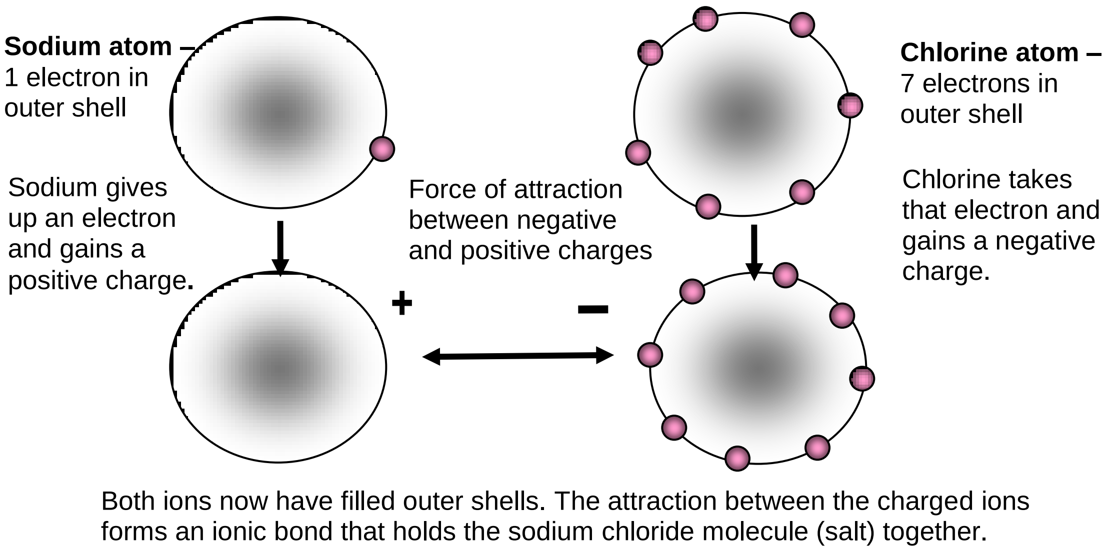

FIGURE 2: Ionic Bond Holding Sodium and Chlorine Atoms Together to Form Salt

Molecules

When atoms share electrons, they form a ***molecule***. A molecule is held together by a covalent bond. The molecule shares electrons with another atom in the area where the bond is. This area has more electrons than the rest of the molecule. Because of the extra electrons, this area becomes slightly negatively charged. The rest of the molecule has wider spaces between the electrons and now has a slight positive charge.

Although the molecule has areas where charge is unequally distributed, the molecule itself is not a charged particle because the total number of protons still equals the total number of electrons.

The unequal distribution of electrons in the molecule causes areas of greater negative and positive charge. The negative part of one molecule is attracted to the positive part of another, similar molecule. This attraction holds individual molecules together as larger substances.

Molecules can be formed by bonds between similar atoms, or more usually, by bonding between different types of atoms.

- Oxygen gas is formed from molecules made of only oxygen atoms. To form an oxygen molecule, two oxygen atoms each share two electrons so they both have eight in their outer shell. This gives them both a filled outermost shell.

- Most molecules are made of combinations of atoms from two or more different elements. For example, two hydrogen atoms and one oxygen atom combine to make a water molecule. The two hydrogen atoms and the one oxygen atom share their outer shell electrons so they each get a filled outer shell. This creates a molecular or covalent bond between the two different elements and a water molecule is formed. See Figure 3.

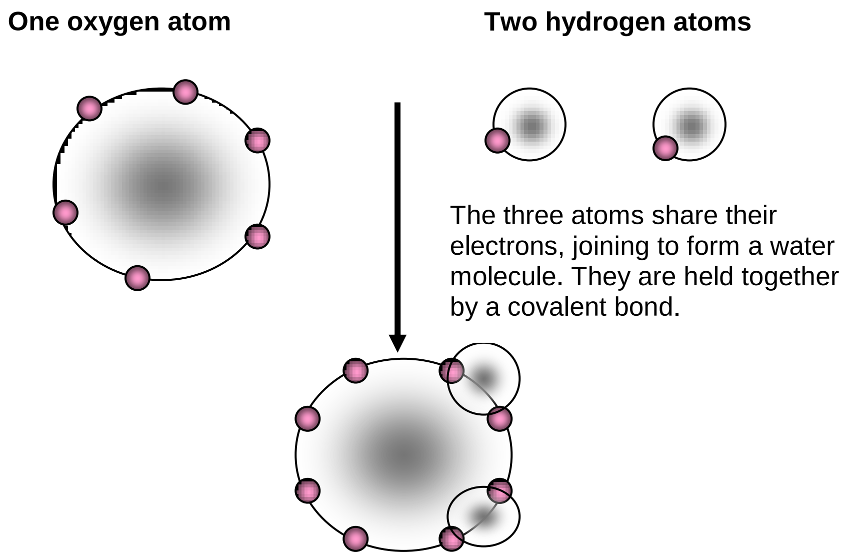

FIGURE 3: **Water Molecule**

Metals

Metal atoms are held together because each atom donates the loosely held electrons in their outer shell. They pack close together in a stable, regularly-arranged crystal. The donated electrons are shared by all the atoms in a free flowing cloud of electrons.

- When metal atoms share a large number of free electrons, there is a general attraction between all the protons and all the electrons.
  - This force of attraction holds metals together as strong solids.
- Electrons on the outside of thin wires of metal can move freely. This structure enables metals to be excellent conductors of electricity.
  - Because of this property, metal wire is used to send electrical currents long distances to where it is needed to do electrical work.

COMPOUNDS

When large numbers of similar molecules bond together, a ***compound*** is formed. We are aware of about ten million compounds so far, many of them man-made.

A compound is formed when numerous molecules of two or more elements ***chemically combine*** in a definite proportion. The ratio of one element to another in a compound is always the same for that compound.

Example: There is one atom of sodium for every atom of chlorine in a molecule of salt.

Example: Water is a common, naturally occurring compound. Each individual water molecule is made from two atoms of the element hydrogen (H) and one atom of the element oxygen (O). We write the name of the water molecule H_2O using the symbols that represent hydrogen (H) and oxygen (O). The $_2$ tells us there are two hydrogen atoms in each molecule of water.

A compound has different properties from the elements that form it.

Example: Water is made of hydrogen and oxygen but it has very different properties from the elements that make it up. Oxygen and hydrogen are both flammable gases at room temperature, while water is a liquid.

Note: *Water is an unusual substance for several reasons. It can be found in each of the three states, solid, liquid or gas, at temperatures that occur on earth. It is the most commonly found liquid and it often acts as a solvent, dissolving many other substances*.

Chemical changes

The chemical properties of a substance are determined by the types of atoms that make up the substance, and by the bonds that hold the atoms together. When the bonds holding a compound together are broken, the compound undergoes a chemical change. Its basic chemical structure is changed. A new substance different from the original substance is formed.

When a chemical change occurs, the process releases energy.

Example: Starch is a polysaccharide formed from molecules of sucrose which are bonded together. It used by plants as a way to store energy. When we eat starchy foods such as potatoes or wheat, our bodies use the digested starch as an energy source.

Chemical change can occur at different rates.

Example: When iron, a solid metal, is exposed to oxygen, the iron and oxygen slowly combine chemically. The resulting new substance, iron oxide, or rust, is a solid that is rusty red and much softer than iron.

Example: Oxygen gas combines slowly with iron but it can combine rapidly with other substances such as wood and gas in a rapid chemical process called combustion or burning. Burning gives off energy as heat and light. Heat from combustion is used in the food preparation trades for all the different ways that food is cooked.

Many chemical changes involve another substance called a ***catalyst or an enzyme***. Enzymes speed up the rate of a chemical reaction and help organize the molecules involved.

Example: Lactase is an enzyme necessary for the process in which milk sugar, called lactose, is broken down. Some people stop producing this enzyme when they get older and they can no longer digest milk products that contain lactose.

The ratio of one element to another in a compound is always the same for that compound. Water is a common, naturally occurring compound. Each individual water molecule is made from two atoms of hydrogen and one atom of oxygen. The short way of representing a water molecule is H_2O. The symbol H stands for hydrogen and the symbol O stands for oxygen. The $_2$ tells us there are two hydrogen atoms in each molecule of water.

Chemical Names of Compounds
You will be working with complex substances that have long names. For example, acetic acid, CH_2COOH, is a compound that gives vinegar its sour taste. It is used as an acidity regulator in food and as a condiment. Benzoates are used as preservatives in many foods such as meat products, drinks and cereals.

Sometimes the chemicals making up these compounds are written using a type of short hand. When talking about a water molecule, we noted that the symbol for hydrogen is H and the symbol for oxygen is O. All elements have a shorthand form represented by one or two letters. Some common elements and their symbols are:

- C for carbon
- H for hydrogen
- Cl for chlorine
- O for oxygen
- N for nitrogen
- K for potassium
- P for phosphorous

Every part of a compound's chemical name tells you something about its chemical composition. Information, such as the types and numbers of atoms which make up a molecule of a compound, is given by its chemical name.

Example: The chemical short form for carbon dioxide is CO_2.
- The name CO_2 tells you that the compound consists of carbon (C) and oxygen (O) atoms.
- The number $_2$ after the O tells us that there are two oxygen atoms in every molecule.
  - The prefix "di" in front of oxygen in the name carbon dioxide means two.
- Because there is not a subscript number written after the C, we assume there is one carbon atom.
- So every molecule of carbon dioxide consists of one atom of carbon and two atoms of oxygen.

Example: The chemical formula for acetic acid is CH_2COOH.
- There are a total of 7 atoms in one molecule of this substance: two carbon atoms, three hydrogen atoms and two oxygen atoms.
- The fact that two H's grouped with the first C and the other C is grouped with OOH provides additional information on the structure of the molecule.

MIXTURES

*A **mixture** is a combination of two or more substances that are combined physically but which retain their individual chemical properties.* Two or more substances can be mixed closely together without being chemically joined.

- In a mixture substances are held together by physical, not chemical, means.
  - A basin of detergent and water is a simple mixture. The detergent and the water are combined but they are not chemically joined.
- The elements in a mixture can sometimes be separated by physical means such as sieving or settling.
  - When herbs are soaked in a mixture to impart flavor, they can be removed later by pouring the mixture through a sieve.
- Although the substances that make up a mixture do not change chemically when mixed, a mixture can behave differently than its individual parts.
  - A mixture of ethylene glycol and water will freeze at a lower temperature than ordinary water. That is why it is used as antifreeze. However, the water and glycol still exist as separate entities and can be physically separated.

Kinds of mixtures
A mixture can have the same, uniform composition throughout, or its components can be randomly distributed.

- A non-uniform mixture is ***heterogeneous***.
  - If you sort out two baskets filled with beans and peas, you will find that there is a different number of beans and peas in each basket. *Heterogeneous mixtures* such as sugar and flour are called ***mechanical mixtures***.
- A uniform mixture is ***homogeneous***. The substances that make it up are evenly distributed.
  - When salt is mixed with water, the tiny particles of salt are evenly disbursed throughout. However, unlike compounds, the amounts of salt and water are not in the same proportions in every mixture of saltwater. Within limits, differing proportions of salt can be mixed with the same amount of water.

Solutions, solvents and solutes
Homogeneous mixtures are more commonly called solutions***.*** *A **solution** is a uniform mixture in which the substances that it is composed of are intermixed as atoms or molecules or ions*.

- One substance in a solution is called the dissolving agent or the ***solvent***.
- The other substance is the ***solute***.
  - There is usually a lot more solvent than solute in a solution.
- Many compounds that are liquid at room temperature, such as water and oil, are solvents.

Example: In a solution of sugar and water, molecules of water are evenly intermixed with molecules of sugar. Although the substances are evenly intermixed, they do not combine chemically with each other.

Solvents which react rapidly when exposed to air are called *volatile solvents.* We usually notice a strong odour as volatile solvents evaporate into the air.

Example: In a substance like vanilla extract, the solute is a volatile liquid. The smell of vanilla will fill the air when the lid of the bottle is left open. To preserve the flavor, the bottle should be kept tightly closed when it is not being used.

Concentration of solutions
The amount of the solute and the solvent in a solution can vary within certain limits.

- An unsaturated solution with a low amount of solute compared to the amount of solvent is ***dilute.***
- When more solute is added to a dilute solution, it will reach a point where no more solute can be dissolved in a solution. The solution is ***saturated***.

Acids and Bases
Some of the substances you handle on the job are classified as acids or bases.

- An acid, such as pure citric acid, can irritate your skin.
- A base such as tri-sodium phosphate, which is used as a cleaner, is caustic and can also irritate skin tissue.
- Pure water is considered neutral, that is, neither acidic nor basic.

CONCLUSION

The basic structure and organization of the atom is responsible for many of the characteristics of matter. Two facts about the atom are especially important in helping us understand why things act the way they do.

First is the fact that the number of protons and electrons in different types of atoms varies. The number of protons in an atom, called the atomic number, determines what element it forms.

The second is that electrons and protons have the property of being charged. An individual atom is neutral when it has the same number of positively charged protons and negatively charged electrons because their charges balance each other. But because an atom is more stable when its outer shell is full, it will gain, lose or share electrons in order to get a full outer shell. If an atom gains an extra electron, it has a charge of - 1. If an atom loses an electron, it has a charge of + 1.

Some elements donate or accept electrons to obtain filled outer shells, causing them to become charged. The charged particles are called ions. Ions will be attracted to other ions with the opposite charge, resulting in molecules held together by ionic bonds.

Other elements share electrons to fill their outer shells. The need to share electrons causes the atoms to bond together. These bonds are called covalent bonds.

Metals are solids that have only a few electrons in their outer shell. Metal atoms join together to form atomic crystals by sharing the easily dislodged, outer electrons. These shared electrons are free to flow along the surface of the metal. This is the reason metals are good conductors of electricity.

You can see the objects around you but you can't see their underlying atomic structure. In the same way, you see a cake's colour, shape and texture, but not the atoms and molecules that form the sugar, flour and butter used to make the cake.

Being familiar with basic atomic structure helps to explain why the different materials you use in the food preparation trades have unique qualities that make them useful for different applications.

And now you know why the atom coming out of the movie was *positive* about losing its electron.

Answer the following questions about the structure of the atom. The answers are on the next page.

1. How many different types of atoms is an element made up of? ____________

2. What two kinds of elements form the substance water? _____________, and ______________

3. The centre of an atom is called the _____________ .

4. The nucleus has two types of particles, the ______________ and the _______________ .

5. The tiny, fast-moving particles that orbit around the nucleus are called _________________.

6. The number of protons determines which _______________ an atom forms.

7. In the nucleus, the particles called ____________ have no charge and are electrically neutral.

8. Protons have a _______________ charge; electrons have a ______________ charge.

9. Like charges _____________ ; unlike charges ________________ .

10. It is either the absence of or an excess of ______________ which determines the charge on an atom.

11. If an atom had six protons and eight electrons, it would have a negative charge of________.

12. An atom with the same number of protons and electrons is electrically _________________.

13. An atom is more stable with a filled outer ________________ .

14. When an atom shares electrons, it forms a ___________________ bond.

15. The flow of _________________ occurs because electrons can move easily through conductors made of metals such as silver or copper.

Answer page

1. one
2. hydrogen, oxygen
3. nucleus
4. proton, neutron
5. electrons
6. element
7. neutrons
8. positive, negative
9. repel, attract
10. electrons
11. two
12. neutral
13. shell
14. molecular or covalent
15. electricity