Republic of Iraq
Ministry of Education
General Directorate
of Curricula

CHEMISTRY

1

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PREFACE

Chemistry is an interesting and fundamental branch of science because it gives us the chance to explain the secrets of nature.

What is water? What do we use in our cars as fuel? What is aspirin? What are perfumes made of? These kinds of questions and their answers are all part of the world of chemistry. Chemists work everyday to produce new compounds to make our lives easier with the help of this basic knowledge. All industries depend upon chemical substances, including the petroleum, pharmaceuticals, garment, aircraft, steel, and electronics industries, etc.

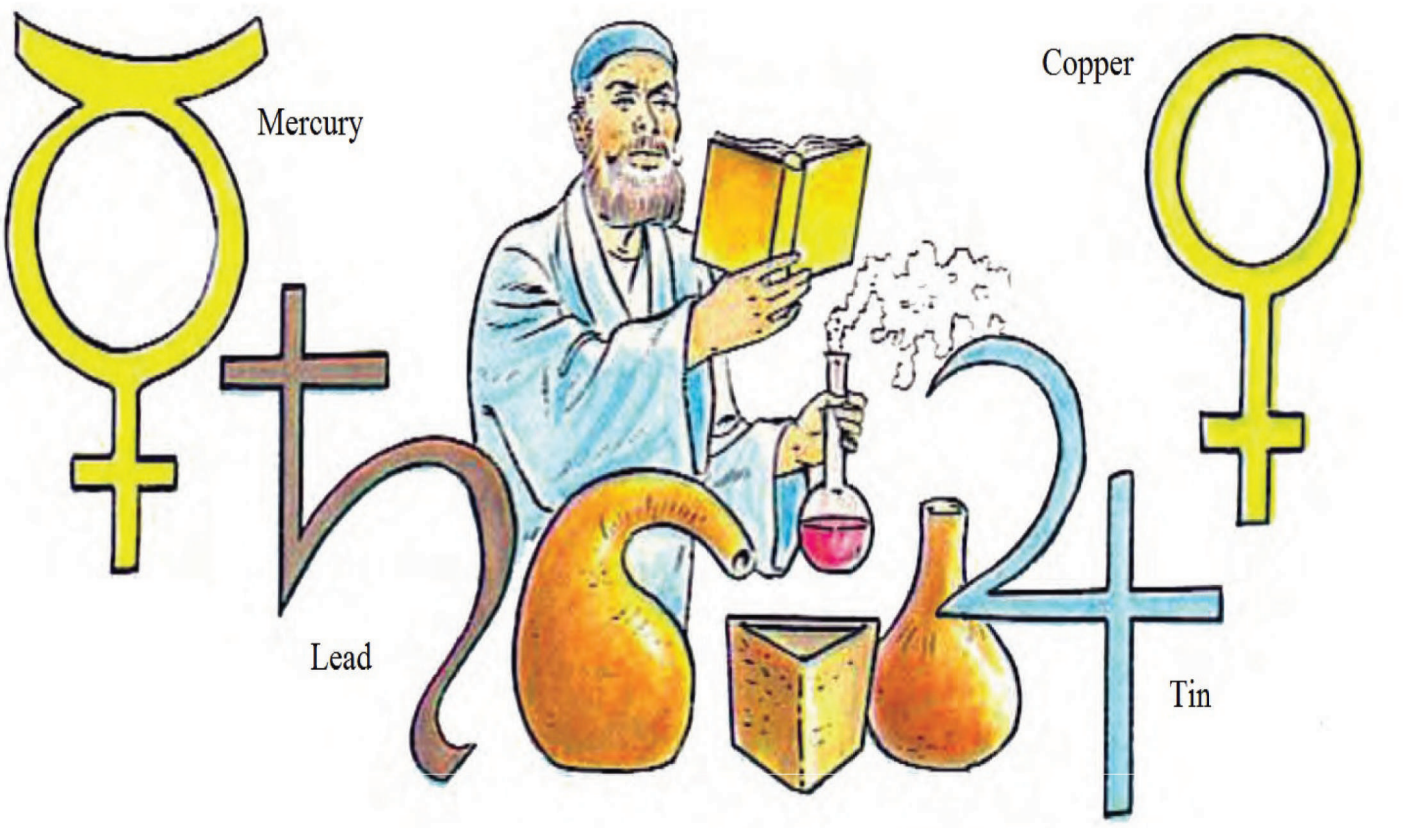
This book helps everyone to understand nature. However, one does not need to be a chemist or scientist to understand the simplicity within the complexity around us. The aim was to write a modern, up-to-date book where students and teachers can get concise information about chemical reactions and inorganic compounds. Sometimes reactions are given in detailed form, but, in general, excessive detail has been omitted. Throughout the book, different figures, colourful tables, important reactions are used to help explain ideas.

We hope that after studying this book, you will find chemistry in every part of your life.

The Author

CHAPTER 01

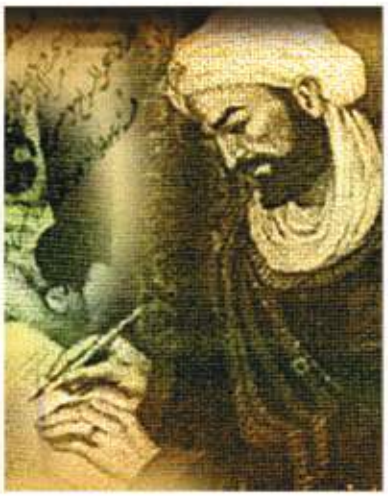
The Role of Arab and Muslim Scientists in Development of Chemistry



ACHIEVEMENTS

After studying this chapter, the student will be able to:

- give a definition of chemistry.
- know the role of Arab and Muslim scientist in the development of science.
- identifies the relationship of chemistry to other sciences.
- develop skills to deal with the chemicals and tools for the purpose of testing a simple process in the laboratory.
- know how to study chemistry.
- give some examples of branches of chemistry.



One of Arab scientis when writing his results

1-1 HISTORY OF CHEMISTRY

The word **chemistry** officially comes from the old French **alkemia**, but has an even older root stemming from the Arabic origin of **al-kimia**, which means the art of transformation.

We can trace the beginning of chemistry to ancient times. The first chemists were mainly concerned with pottery, metallurgy, dyes, and food. We can retrace the earliest chemical principle to 3500 B.C. in Egypt and Mesopotamia.

Chemistry's beginning, or alchemy, as it was then known, was equal to performing magic or having superpowers. Alchemy was the practice of combining elements of chemistry, physics, religion, mysticism, astrology, art, signs, metallurgy, and medicine.

The most famous interests of alchemists were the transmutation of metals to gold, and the search for **Abu hayat**, or the elixir of life to produce immortality.

In the Middle Ages, Muslim scientists **Jabir ibn Hayyan** - the first to use lab equipment - was known as Geber, or the **Father of Chemistry** in Europe; and Abu Bakr-Al-Razi (865-925); both greatly contributed in chemistry's early beginnings.

Latin translations of these two Muslim scientists' discoveries helped build the fundamentals of chemistry. Six centuries later, European scientists **Robert Boyle** and **Antoine Lavoisier** - regarded as the **Fathers of Modern Chemistry** - built the basis for what we know today as modern chemistry.

In the 21st century, chemistry has become the largest collection of knowledge (science) because of its many sub - branches. Today, the world's largest and most current database that contains information regarding chemical substances, CAS, has more than 29 million chemical substances. Everyday, 4000 new substances are added to this database.

CAS = Chemical Abstracts Service

Jabir Ibn Hayyan (721 - 815) AD
He is known as the Father of Chemistry.

1-2 ARAB PIONEERS OF CHEMISTRY

Chemistry was ranked high for Arab scientists, which has been known for some in this science, and has authored books on this science, including:

1-2-1 Jabir Ibn Hayyan (721 - 815 AD)

Jabir Ibn Hayyan is the founder of the science of chemistry and regarded as father of chemistry, chemistry reached the highest scientific and applied by applying the following:

1. Taking the scientific method when dealing with chemicals and chemical compounds.

2. Taking the principle of the experiment and observation.

3. Establish procedures and conclusions for those who work in the laboratory.

4. Interest and adoption experience results.
5. Not jump into conclusion and sayings Geber "All that theory of probability ratification and disbelief ignore them is not valid only with proof". Jabir was patient and persistent and reticent and silent chemist has been named in his day workmanship Jabber.
The most important of his books:
1. Al-Rahma
2. Al- Mawazin
3. Al- Malagm
4. Al- Samum
5. Al- Sir Al- maknon
6. Al- eilm Al- ilahi
Jabir Ibn Hayyan wrote a lot of chemical opinions in his writing.


Development of Science by Muslim Scientists.

1-2-2 El Macriti (950 - 1007 AD)

El macriti is Abu al-Qasim Muslima bin Ahmed known El Macriti. He was born in Cordoba in Andalusia in 950 and died in Andalusia in 1007 AD. He was popular at mathematics and astronomy has some books in chemistry and was the first who proved the conservation of mass law in chemical reactions. Note that when heating 1/4 pound (old measurement) of mercury element in a closed glass container like the egg and the presence of air (oxygen) turns mercury into fine red powder today called as mercury(II) oxide (pilgrimage) without a change in the mass of reacting substances.
The most important of his books:
1. Rutbat Al - hakim is one of the most important sources relied upon in the history of chemistry in Andalusia.
2. Ghayt Al-hakim

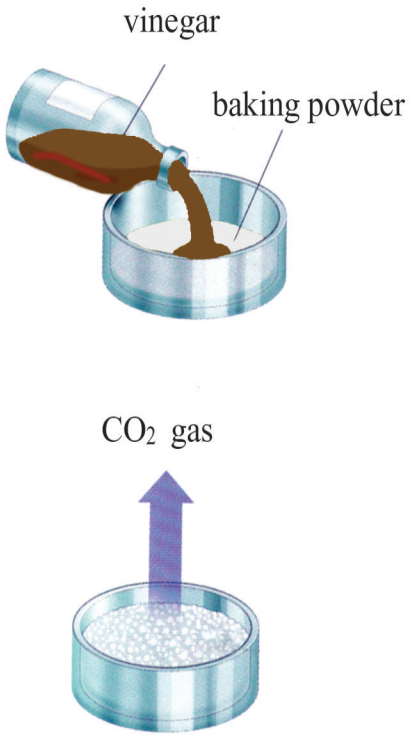
Do you know that:
The last 200 years have heralded a multitude of scientific equipment and millions of chemical compounds which were all discovered through synthesis.

1-2-3 Abu Bakr Al Razi (865-925 AD)

Al Razi was a Wiseman , an alchemist and a philosopher. In medicine, his contribution was so significant that it can only be compared to that of Ibn Sina. Some of his works in medicine e.g. Kitab al- Mansoori, Al-Hawi, Kitab al-Mulooki and Kitab al- Judari waal- Hasabah earned everlasting fame.
Al-Razi was the first in Islam to write a book based on home medical (remedial) advisor entitled Man la Yahduruhu Teb for the general public. In his book Mnafi' al-Aghthiyyah, al-Razi followed a pattern that had been introduced earlier by Galen but in it, al-Razi attempted to correct several errors made by Galen himself. The development of professional pharmacy, as a separate entity from medicine, started in Islam under the patronage of the early' Abbasiyyah caliphs in Baghdad. This first clear-cut separation of the two professions, and the recognition of the independent, academically oriented status of professional pharmacy materialized in the Abbasiyyah capital (Baghdad) and Al Razi was one of the few pharmacists who added

Al-Razi
(865-925AD)

very valuable contributions to medicine and pharmacy while most of Europe was still living in the dark ages.



vinegar reaction with baking powder

1-3 CHEMISTRY

Natural sciences have been divided in the past into two parts:

1. Biological Sciences.

2. Physical Sciences.

Since the living and non-living have a chemical structure, chemistry was considered the basis of all sciences. To deduce the importance of chemistry in our lives let's apply the following activity:

Practical activity (simple reaction) Materials and tools:

1. Few dilute acetic acid (vinegar can be used in the home)
2. A small amount of sodium bicarbonate (can use bread yeast powder)
3. Bottle
4. Tea spoon
5. Balloon

Procedure:

1. Take into spoon a bit of (baking powder) in a glass vase.
2. Gradually add a small amount of diluted vinegar in the pot, as in what you observe.

* What do we call this phenomenon?
* What is the science that studies this phenomenon?

An understanding of living organisms, including the human being have reached us through chemistry, the science dealing with materials, their composition, and the changes, which they undergo. Chemistry and chemical changes help us understand the human body. Chemistry fits into our lives. It offers new chemical frontiers and tells us what benefits may flow from them. Chemistry contributes to our existence, our culture, and our quality of life. Chemistry is concerned with the changes we see around us, like the rusting of iron, growing of grass, burning of wood and many more. Without these changes or chemical reactions our Planet Earth would be lifeless. A plant takes carbon dioxide from the air and water from the soil to produce carbohydrates through a wondrous series of chemical reactions called photosynthesis. All living processes are chemical reactions. Everything we use, wear, live in, ride in, and play with is produced through controlled chemical reactions. Chemists design reactions that will convert chemical substances we find around us into chemical substances that serve our needs.

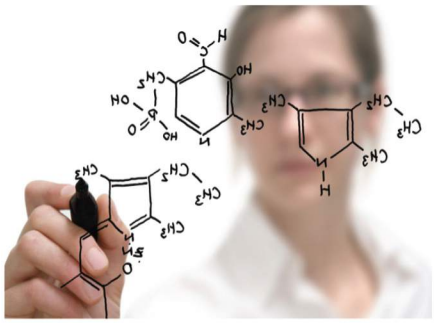
Chemistry answers the needs of our society through a deep understanding of the factors that govern and furnish control of chemical reactions. It plays a critical role in man's attempt to feed the world population, to tap new sources of energy, to clothe and house hu-

mankind, to provide renewable substitutes for dwindling or scarce materials, to improve health and conquer disease, and to monitor and protect our environment. Because of this responsiveness to human needs, chemistry has become a crucial factor in the nation's economic well-being. Aside from that, our culture believes that learning about our place in the universe is not enough reason for encouraging scientific inquiry. Nothing concerns humans more than questions about the nature of life and how to preserve it. Since all life processes are brought about by chemical changes, understanding chemical reactivity is a vital foundation for our ultimate understanding of life. Thus chemistry, along with biology, contributes to human knowledge in areas of universal philosophical significance.

1-4 BRANCHES OF CHEMISTRY

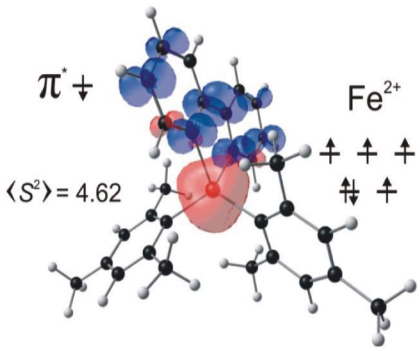
Chemistry includes several branches of study, research and following seven major branches linked to each other and interact with each other:

1-4-1 Organic Chemistry



The chemistry of compounds containing carbon (originally defined as the chemistry of substances produced by living organisms but now extended to substances synthesized artificially). The development and expansion of this section has provided us a lot of material that have uses in our daily lives, such as petroleum derivatives such as (oil) and fuels, dyes, pharmaceuticals, explosives and pesticides. In industry used as resins, gums, plastics and others.

1-4-2 Inorganic chemistry

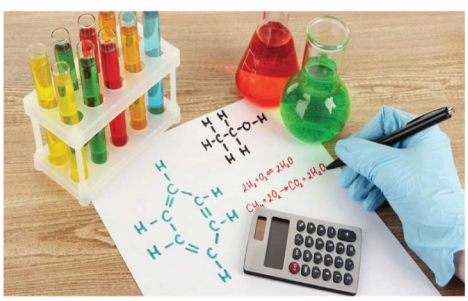


Deals with the synthesis and behavior of inorganic materials which include metals and organometallic compounds and increases the use of metallic compounds in the production of cosmetics and perfumes, paints, medicines and plating anything with a valuable metal to give brilliant appearance to the material.

1-4-3 Analytical Chemistry

Specializes in studying the type and quantity of elements and compounds found in the sample to be analyzed with the help of gravimetric or volumetric methods, spectral, electrical or other methods.

1-4-4 Physical Chemistry



If you like math, complex calculations, and a little bit of physics, then this is the chemistry for you! It's really not all bad. Don't let the math keep you away. Physical chemistry is the newest field of chemistry. Since physical chemistry uses both chemistry and physics, it is the study of both matter and energy. It studies the details of atoms and elements. Those studies could not be done 200 years ago, because we didn't have the technology. Physical chemists study the thermodynamics of reactions and then do the complex calculations

to figure out the amounts energy involved. These folks also look deep into the structure of compounds and their atoms. It's truly amazing.

1-4-5 Biochemistry

It is one of the crossover fields of chemistry. Biochemists have to understand both the living world and the chemical world to be the best at their jobs. Even if you didn't want to become a biochemist, you'll still have to know the details of how atoms move if you wanted to be a biologist. The key thing to remember is that biochemistry is the chemistry of the living world. Plants, animals, single-celled organisms... They all use the same basic chemical compounds to live their lives. Biochemistry is not about the cells or the organisms. It's about the smallest parts of those organisms, the molecules. Today, the findings of biochemistry are used in many areas, from genetics to molecular biology and from agriculture to medicine. The first application of biochemistry was probably the making of bread using yeast, about 5000 years ago.

1-4-6 Industrial Chemistry

It focuses on studying applied aspects of the different branches of chemistry and other sciences in which they are designing plants to produce various chemical substances and chemical compounds with less cost and more quantity and the best quality. The benefits of industrial chemistry are very wide including paper industry, cement, sugar, oils, mining methods, punching metal, forming medicines and aromatics and other industrial applications of chemistry in everyday life.

1-4-7 Theoretical Chemistry (Computational Chemistry)

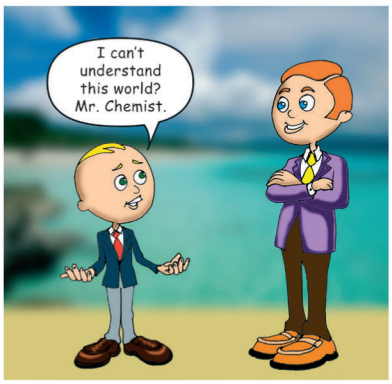
It deals with the studying of principles that underlie the chemical behavior of compounds and predict new compounds and study their properties. And also put modern theories that fit with the theoretical assumptions developed by chemists.

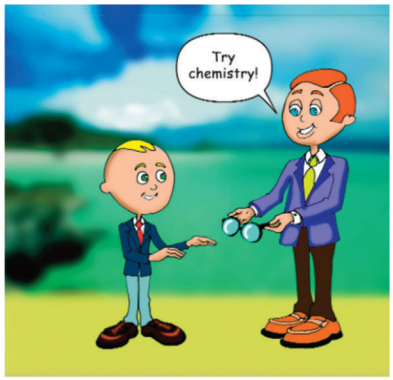
1-5 EXPERIMENTAL WORLD OF CHEMISTRY

As you remember, chemistry is a branch of science. To understand this better, let's first see what science is. People observe their surroundings, other creatures and themselves to discover their nature and to find out their relationship among themselves. When they come face-to-face with problems, they use systematic methods to overcome them. From ancient times until today, acquired knowledge has been collected on a regular basis. This accumulated knowledge is known simply as science. Throughout the world's history, humankind's knowledge has been continuously transmitted to newer generations. People shared this knowledge by writing, speaking and searching for the relations between the cause and effect of facts. As

a result, we were able to reach conclusions. All of these activities, hypothesized carefully and tested systematically, are called scientific studies. Individuals who conduct scientific studies are called scientists.

Today's generation is grateful for past and present scientific studies since their welfare has been enhanced. Chemistry, as we've seen, is an important branch of science. It's certainly true that chemists who study the changes that occur in the structure of substances have a great contribution in the development of science and technology. The applications of scientific principles in the service of mankind is called technology. Although developments in industry and technology enhance the welfare of human beings, there are negative sides of scientific developments. Some gases cause air pollution, poisonous chemical wastes and their by-products cause cancer; all weapons and atomic bombs threaten the balance of mankind. At first glance, the branches of scientific studies seem to be boring due to groups of formulas, theories and definitions. But, actually, science reflects the attractive sides of the universe and informs us what is happening in our surroundings.





1-6 CHEMISTRY IS AN EXPERIMENTAL SCIENCE

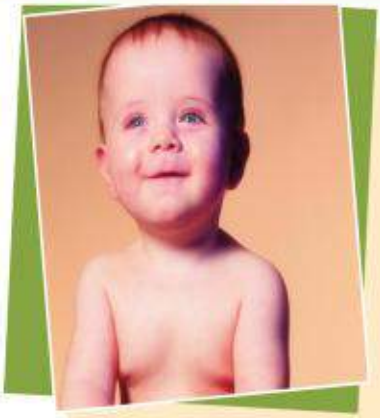
The word **experiment** comes from Latin experiri or experimentum, which means **attempt**. In the scientific method, experiments are the processes from which all empirical knowledge is born. In chemistry, chemists always need experiments to research cause/effect relationships between phenomena.

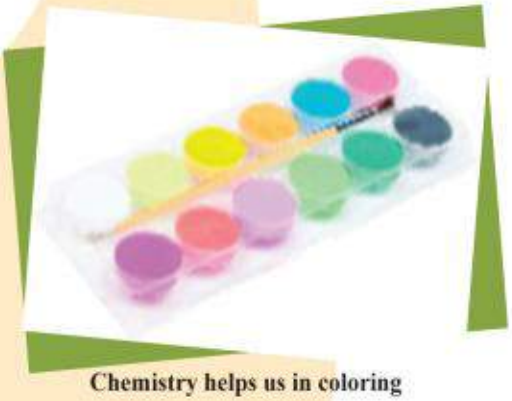
Like other scientists, such as physicists, biologists, and many others, chemists must follow four systematic steps while experimenting:

1. Setting up the experimental equipment and procedures
2. Conducting the experiment
3. Recording data
4. Analyzing results, reaching a conclusion and sharing results

Through the use of experiments, chemists understand the properties and changes which occur in matter and the various reactions between different substances.

READING





Chemistry helps us in coloring our world.

for example without chemicals, our body, and our nervous system couldn't function.

CHEMISTRY IS LIFE

Doctors may guess the disfunction (illness) you are suffering from. In other words, the apparent chemical change that occurred in your organs (in the tissues or cells). If a doctor diagnoses your illness, he will probably advice some medicine (products of chemicals) or different remedies (all contain different compounds or chemicals).

You cannot escape from the scope of chemistry because we are living in a material world, or chemical world. Have you ever thought that we need chemicals everyday in every second to live?

In fact, the air we breathe contains N_2, O_2, . . . all are chemicals. The water we drink many times a day is also a chemical. Salt, pepper, sugar, ice-cream, all fruits and all vegetables (all foods) are all composed of chemicals!

No chemistry! No transportation!

All the drugs are produced from chemicals.

Paper and pencils are all produced with chemical materials.

All patients need the products of chemistry in diagnoses or treatments.

READING

CHEMISTRY IS LIFE

All toys, including dolls and models, can be produced with the knowledge of chemistry.

We can decorate, paint, protect and clean our houses thanks to chemistry.

CHEMISTRY

This reading simply explains the importance of chemistry in our lives. You can see chemistry in every part of our life. For example, while preparing this textbook we used pencils, pens and papers. To type it, computers were used and printers to print its pages with different inks (paints); paper and printing machines were also utilized. All materials and machines used in the printing of this book are also the products of chemicals. In other words, they are produced with the help of different elements or/and compounds. All these are the subjects of chemistry. Yet another example, what if you were to become ill, how would your ailment be diagnozed?

New polymers are making our life easier.

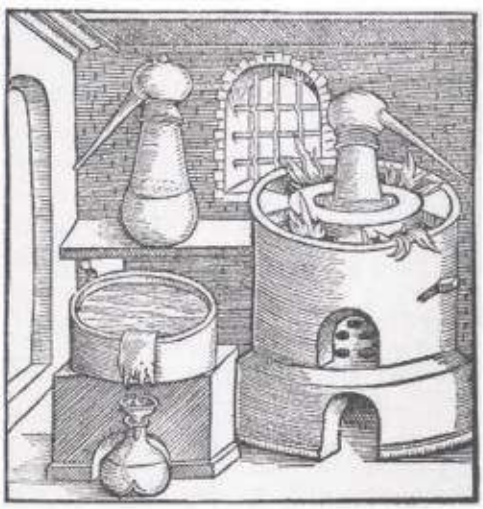
Chemistry even helps us with our clothing and footwear.

Computer technology only thrives with the help of chemistry.

READING

FATHER OF CHEMISTRY

JABIR IBN HAYYAN (721 - 815 AD)



Jabir Ibn Hayyan, the chemist of the Middle Ages, is generally known as the father of chemistry. Abu Musa Jabir Ibn Hayyan, sometimes called al-Harrani and al-Sufi, was the son of the druggist (Attar). The precise date of his birth is the subject of some discussion, but it is established that he practiced medicine and chemistry in Kufa around 776. In his early days, he practiced medicine and was under the patronage of the Barmaki Vizir during the Abbassid Caliphate of Haroon al-Rashid. He shared some of the effects of the downfall of the Barmakis and was placed under house arrest in Kufa, where he died in 815.

Jabir's major contribution was in the field of chemistry. He introduced experimental investigation into chemistry, which rapidly changed its character into modern chemistry. On the ruins of his well-known laboratory remained after centuries, but his fame rests on over 100 monumental treatises, of which 22 relate to chemistry. His contribution of fundamental importance to chemistry includes perfection of scientific techniques such as crystallization, distillation, calcinations, sublimation, evaporation and development of several instruments for the same. The fact of early development of chemistry as a distinct branch of science by the Arabs, instead of the earlier vague ideas, is well-established and the very name chemistry is derived from the Arabic word al-Kimya, which was studied and developed extensively by the Muslim scientists.

Perhaps Jabir's major practical achievement was the discovery of mineral and others acids, which he prepared for the first time in his alembic (Anbique). Apart from several contributions of basic nature to chemistry, involving largely the preparation of new compounds and development of chemical methods, he also developed a number of applied chemical processes, thus becoming a pioneer in the field of applied science. His achievements in this field include preparation of various metals, development of steel, dyeing of cloth and tanning of leather, varnishing of water-proof cloth, use of manganese dioxide in glass-making, prevention of rusting, lettering in gold, identification of paints, greases, etc. During the course of these practical endeavors, he also developed aqua regia to dissolve gold. The alembic is his great invention, which made easy and systematic the process

READING

of distillation. Jabir laid great stress on experimentation and accuracy in his work. Based on their properties, he has described three distinct types of substances. First, spirits i.e. those which vaporize on heating, like camphor, arsenic and ammonium chloride; secondly, metals, for example, gold, silver, lead, copper, iron, and thirdly, the category of compounds which can be converted into powders. He thus paved the way for such later classification as metals, non-metals and volatile substances. Although known as a chemist, he did not seem to have seriously pursued the preparation of noble metals as a chemist; instead he devoted his effort to the development of basic chemical methods and study of mechanisms of chemical reactions in themselves and thus helped evolve chemistry as a science from the legends of chemistry. He emphasized that, in chemical reactions, definite quantities of various substances are involved and thus can be said to have paved the way for the law of constant proportions.

A large number of books are included in his corpus. Apart from chemistry, he also contributed to other sciences such as medicine and astronomy. His books on chemistry, including his Kitab-al-Kimya, and Kitab al-Sab'een were translated into Latin and various European languages. These translations were popular in Europe for several centuries and have influenced the evolution of modern chemistry. Several technical terms devised by Jabir, such as alkali, are today found in various European languages and have become part of scientific vocabulary. Only a few of his books have been edited and published, while several others preserved in Arabic have yet to be annotated and published.

Doubts have been expressed as to whether all the voluminous work included in the corpus is his own contribution or it contains later commentaries/additions by his followers. According to Sarton, the true worth of his work would only be known when all his books have been edited and published.

His various breakthroughs e.g., preparation of acids for the first time, notably nitric, hydrochloric, citric and tartaric acids, and emphasis on systematic experimentation are outstanding and it is on the basis of such work that he can justly be regarded as the father of modern chemistry. The development of chemistry in Europe can be traced directly to Jabir Ibn Hayyan.

CHAPTER QUESTIONS 01

1- Which one of the following is not a Branch of Chemistry ?

A) Organic Chemistry
B) Biochemistry
C) Autochemistry
D) Physical Chemistry

2- Which one of the following is not an Arab Pioneer of Chemistry?

A) Jabir Ibn Hayyan B)Mimar sinan
C) El macriti D)Abu bakr al razi

3- ……used lab equipments at first?

A) Robert Boyle
B) Antonie Lavoisier
C) Jabir Ibn Hayyan
D) Abu Bakr Al Razi

4- Which one of the following scientist is known as father of chemistry?

A) Jabir Ibn Hayyan
B) El -Macriti
C) Thomas Edison
D) Omar Bin Hayyam

5- Which of the following is not a step in a scientific study?

A) Observation B) Hypothesis
C) Experiment D) Reading

6- Give the right order for the steps in an experiment.

I. Recording data
II. Conducting experiment
III. Setting up experimental equipment
IV. Analyzing results

A) II, I, III, IV B) I, II, III, IV
C) III, II, I , IV D) II, IV, III, I

7- What were chemists once named?

A) Old chemists B) All chemists
C) Alchemists D) Only chemists

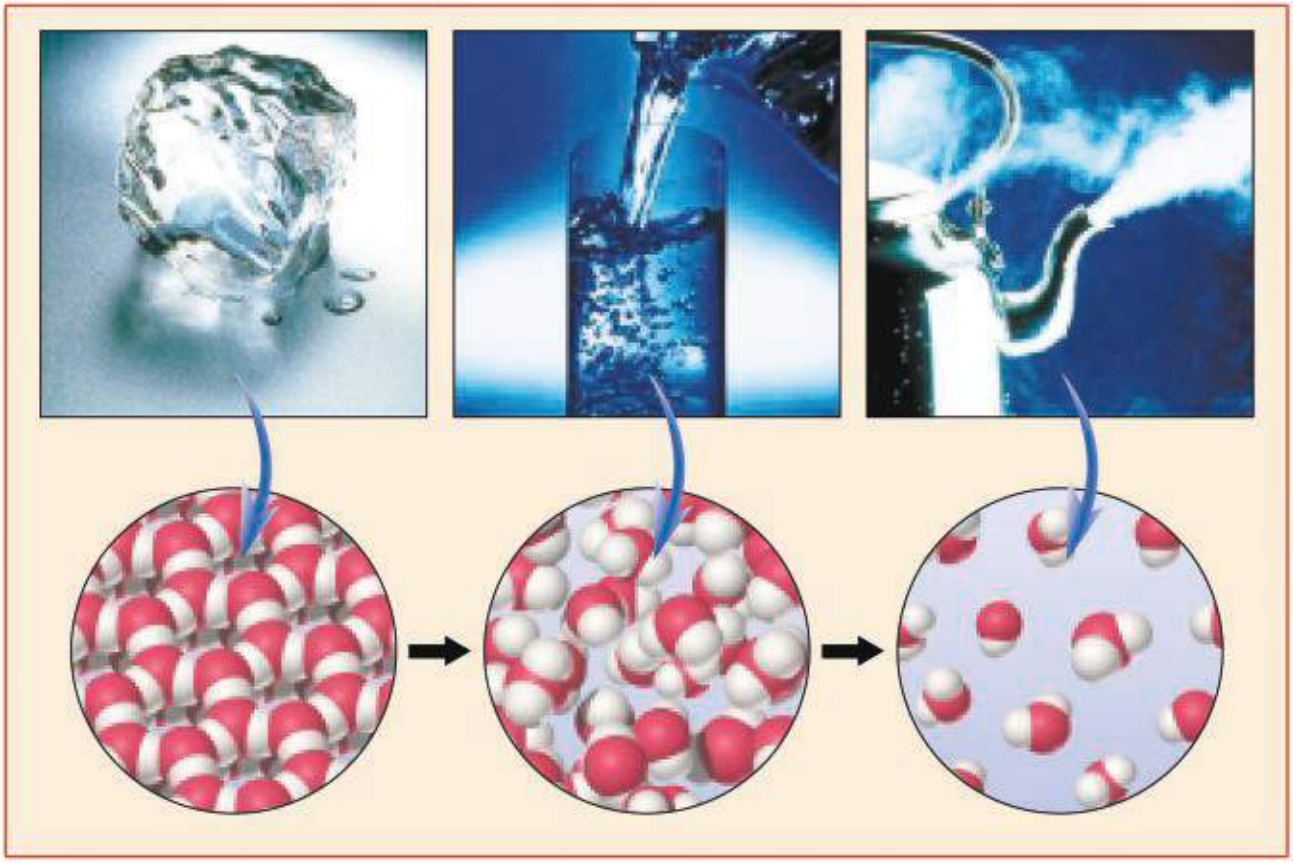
8- Write five “branches of chemistry”.

9- Write “The Name of Arab Pioneers” in chemistry.

10- Why is the chemistry so important? Explain.

CHAPTER 02

MATTER



ACHIEVEMENTS

After studying this chapter, the student will be able to:

- recognize matter and its properties.
- know the three states of matter.
- understand structure of the atom and its components.
- have understanding about the periodic table.
- describe the types of matter as elements, compounds and mixtures.

Figure 2-1
In the physical world, everything can be accepted as matter

2-1 MATTER

In chemistry, matter is simply everything; every physical body or substance. Matter is anything that has mass and takes up space.
If you remember, we defined chemistry as the study of matter and its changes in the previous chapter.
Look at the picture given below, the mountains, rocks, trees, and lakes are all composed of thousands of substances.

In this chapter we will study the states of matter, its classification and properties. In addition to these, we will see how different substances can be separated.

2-2 STATES OF MATTER

Matter can be found in different states, or phases, in the universe. The most common states are: solid, liquid and gaseous (Figure 2-2). Plasma is often called the fourth state of matter.

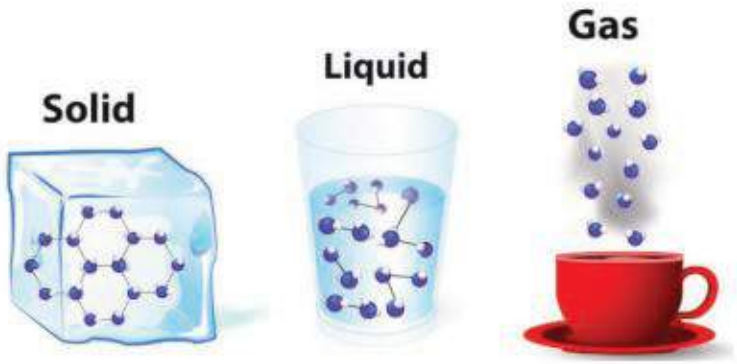
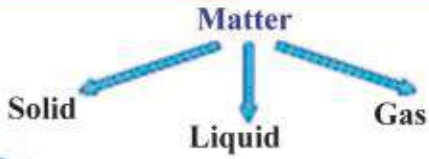


Figure 2-2 States of Matter



2-2-1 Solid State

Solid substances have a definite volume and shape. The particles (atoms or molecules) in solids are very close to each other - there is a minute amount of space between atoms or molecules. Solids can be picked up and carried around without a special container.

Various solids have different shapes.

2-2-2 Liquid State

Liquids have definite volume, but no definite shape. Liquids can flow, be poured, and take the shape of their container. The particles in liquids are more loosely contained than those of solids. Hence, that's how liquids can flow.

Different liquids

2-2-3 Gaseous State

Gases have no definite volume and no definite shape. A gas takes the shape and fills the volume of any container in which it is placed. Gas particles are apart from each other so they can move freely. Gases will spread out if they are not in a container. Most gases are colorless, and, therefore, cannot be seen.

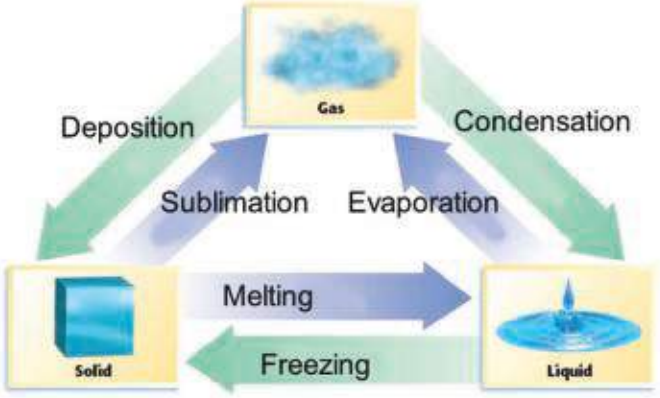
Gaseous (adjective)
Gas (noun)

We all live in a gaseous world.

Although many gases are colorless, some of them are tinted. For example, nitrogen dioxide (NO_2) has a reddish - brown color and is an extremely toxic gas.

2-3 PHASE CHANGE OF MATTER

A phase change is a transition of matter from one state to another. Phase changes occur regularly in nature and can be conducted by people. These changes are given below.

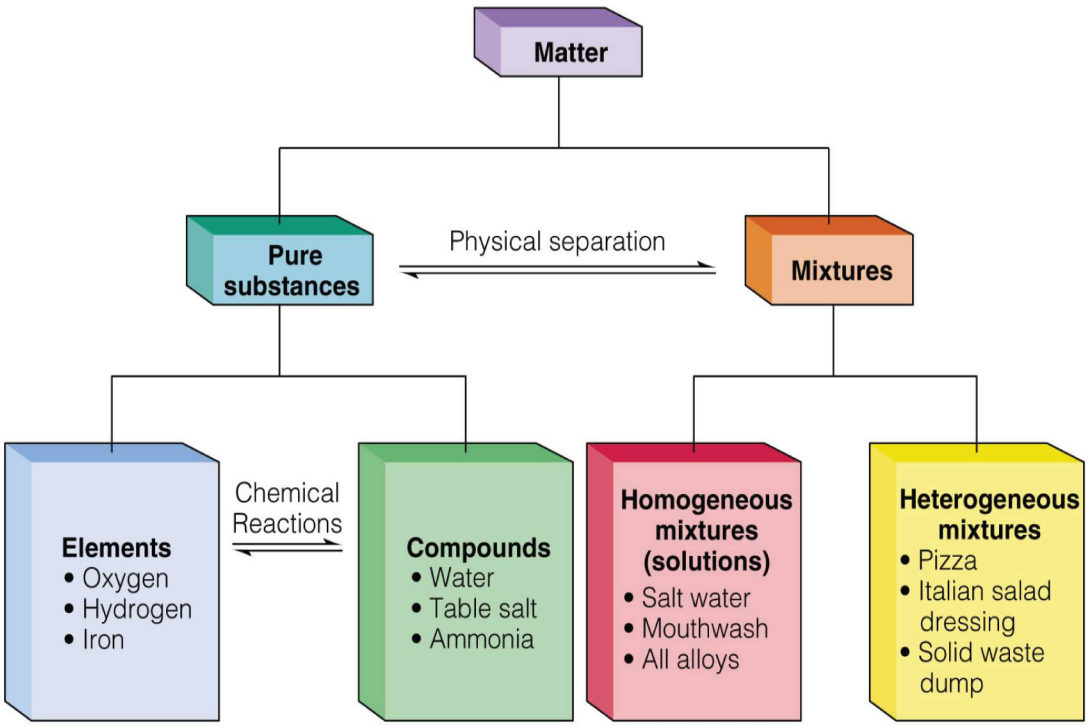


Liquids take the shape of their containers.

There are six phase changes that can occur as follows.
Freezing occurs when a liquid changes to a solid.
Melting occurs when a solid changes to a liquid.
Sublimation occurs when a solid changes directly to a gas.
Deposition occurs when a gas changes directly to a solid.
Condensation occurs when a gas changes to a liquid.
Evaporation happens when a liquid changes to a gas.

2-4 CLASSIFICATION OF MATTER

Matter exists in millions of different forms in the world. Water is matter just like gold. Matter can be easily classified according to its purity, as follows:



Do you know that:
Tap water (city water) is not a pure substance because it not only contains water molecules, but also particles. Tap water contains other ions, such as calcium, which causes hardness of water.

2-4-1 Pure Substance

Pure substances are elements and compounds. They have only one type of particle in their structure. For example, pure water only contains water molecules, and gold solely gold atoms. Particles in elements and compounds cannot be seen with the naked eye.

2-5 ELEMENTS

Elements contain only one type of particle (the atom). All elements are shown by the use of symbols; gold (Au), oxygen (O) and calcium (Ca) are some examples of elements. Today, 118 elements are known; 92 of which are called natural elements. All symbols for elements are placed on a special table called the periodic table shown in Table 2-1.

Table 2-1 The Periodic Table of Elements is the most popular table in chemistry.

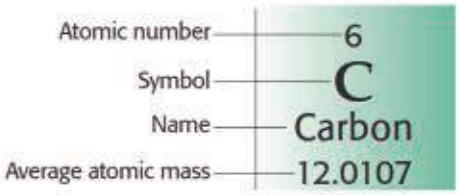
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Aluminum is an element.

NaCl is a compound.

The symbols for elements can have up to two letters in Latin. The first letter is always capitalized and the second must be lower - cased. For example, H : Hydrogen and Al : Aluminum (If element is unnamed then three letters such as Uub, Uuq etc. temporarily are used in symbols).



2-5-1 Properties of Elements

1. An element cannot be broken down into another substance.
2. The basic building blocks of elements are atoms.
3. When elements react with each other, they produce compounds.

2-6 TYPES OF ELEMENTS

2-6-1 Metals

Some of the properties of metals may be familiar to you. For example, you can recognize metals by their shininess, or metallic luster.

Properties of Metals:

1. They are good conductors of electricity.
2. They are solid at room conditions. except mercury which remain liquid
3. They have a metallic, shiny color.
4. They can be hammered into sheets.
5. They can be drawn into wires.

He, Ne, Ar, Kr, Xe, and **Rn** are named Noble gases. These are unreactive and very stable elements.

Copper

Lead

Gold

2-6-2 Nonmetals

Many nonmetals are gases at room temperature such as nitrogen, oxygen and chlorine. One nonmetal, bromine, is a liquid.
The solid nonmetals include carbon, sulfur, etc.

Properties of Nonmetals:

1. They do not conduct electricity, except for carbon (graphite).
2. They can be solid, liquid or gaseous at room conditions.
3. They have a dull color. or colourless
4. Some are brittle (cannot be hammered).
5. They cannot be drawn into wires.

Sulfur

Bromine

Chlorine

2-6-3 Metalloids

As you look from left to right on the periodic table, you can see that the blue stair-step line between the metals and the nonmetals. A metalloid is an element that has some characteristics of metals and some characteristics of nonmetals. All metalloids are solids at room temperature. They tend to be less malleable than metals but not as brittle as nonmetals.

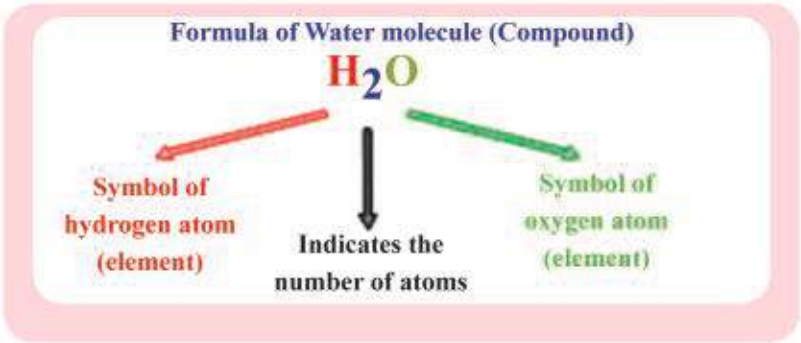
Silicon

Arsenic

Figure 2-3
Metalloids

2-7 COMPOUNDS

Salts, acids, bases, and oxides are all different classes of compounds. Unlike the elements that only amount to 118, there are millions of compounds in the world. All compounds are shown by formulas. For example, H_2O for pure water and CO_2 for carbon dioxide. All compounds contain at least two types of particles (atoms).



Properties of Compounds:

1. A compound can be decomposed into components through chemical methods.
2. Elements combine in definite proportions by mass to form compounds.
3. The chemical properties of compounds are different from those of elements found in that compound.

Compounds must be kept in closed containers.

Copper (II) chloride
(Green / Blue)

Cobalt (II) chloride
(Red / Pink)

Ammonium dichromate
(Orange)

2-8 MIXTURES

Mixtures are material made up of two or more different substances which are mixed but not combind chemically. In mixtures, the chemical properties of the starting substances do not change. Mixtures can be homogeneous or heterogeneous. In a homogeneous mixture, the composition of its parts is equal. But in heterogeneous mixtures, the composition of its parts is different.

homogeneous = same type

heterogeneous = different type

Properties of Mixtures

1. Components of a mixture have their respective chemical properties.
2. Mixtures may be composed of different elements and compounds.
3. There is no fixed ratio among the components.
4. Components can be easily separated

2-8-1 Homogeneous Mixtures

A mixture composition and properties throughout.
For example, air is a homogeneous mixture of gases. A teaspoonful of table salt stirred into a glass of water also makes a homogeneous mixture.

copper (II) sulfate + water is a homogeneous mixture.

2-8-2 Heterogeneous Mixtures

A mixture which is not uniform throughout but consists of parts or phases that differ in properties. A mixture of sunflower seed oil and water is an example in which the sunflower seed oil floats on the water as a separate layer.

A heterogeneous mixture
(sand + water + sulfur)

EXTRA

Types of mixtures according to physical states

Homogeneous Mixtures (Solutions)		*Heterogeneous Mixtures*	
State	*Examples*	*State*	*Examples*
Solid	*Coins, dental fillings*	*Solid*	*Mineral ores*
Liquid	*Fizzy drinks*	*Liquid*	*Milk*
Gas	*Air*	*Gas*	*Aerosols*

Differences between the compound and the mixture.

Compounds	Mixtures
1- Definite composition – you cannot vary the amount of each element in a compound.	1- Variable composition – you can vary the amount of each substance in a mixture.
2- The different elements are chemically joined together.	2- The different substances are not chemically joined together.
3- The compound has properties different from the elements it contains.	3- Each substance in the mixture keeps its own properties
4- It can only be separated into its elements using chemical reactions.	4- Each substance is easily separated from the mixture.
5- They are show by formulas	5- They are not shown by specific symbols or formulas.

Unlike compounds, mixtures can be separated into their parts (components) by using physical methods.

2-9 SEPARATION OF MIXTURES

As we previously learned, mixtures are not pure substances. In order to obtain one of the components in a mixture, we need to separate them. The separation of mixtures can only be possible when we use the physical properties of substances.
For different types of mixtures, different methods are needed. Now let's see some of these methods used to separate mixtures.

2-9-1 By means of the Use of Electricity

Some mixtures can easily be separated if one component in the mixture is attracted by an electrified object. For example, when an electrified ebony rod comes into contact with a pepper (isot) - salt

mixture, the rod attracts small pepper particles, which then become separated from the table salt (Figure 2-4).

Figure 2-4
Separation of pepper (isot) and salt mixture by using an electrified ebony rod.

2-9-2 By means of the Use a Magnet

Some substances can be separated from a mixture through the use of a magnet. Since iron, nickel and cobalt are attracted by magnets, they can be separated from other substances. As an example, an iron - sulfur mixture can be separated by using the magnetic property of iron (Figure 2-5).

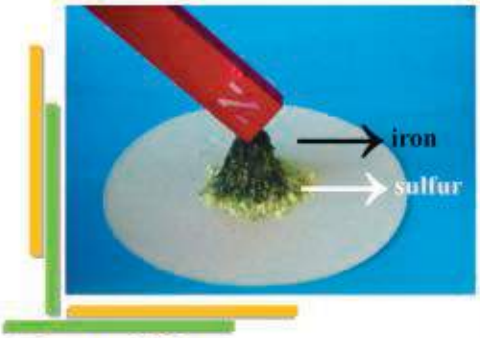


Figure 2-5
Separation of an iron from sulfur in a mixture by using a magnet.

2-9-3 By means of Density Differences

If immiscible liquids, which have different densities, are mixed in a container, the denser liquid settles at the bottom and the lighter one at the top. This type of mixture can be separated by using a separatory funnel as shown in Figure 2-6.

Figure 2-6
Separation of an olive oil-water mixture

*Liquids which do not mix with each other are called **immiscible** liquids, such as olive oil and water. Liquids which mix with each other in any ratio are called **miscible** liquids such as water and ethyl alcohol.*

Do you know that:
A substance that is insoluble in water may be soluble in another liquid.

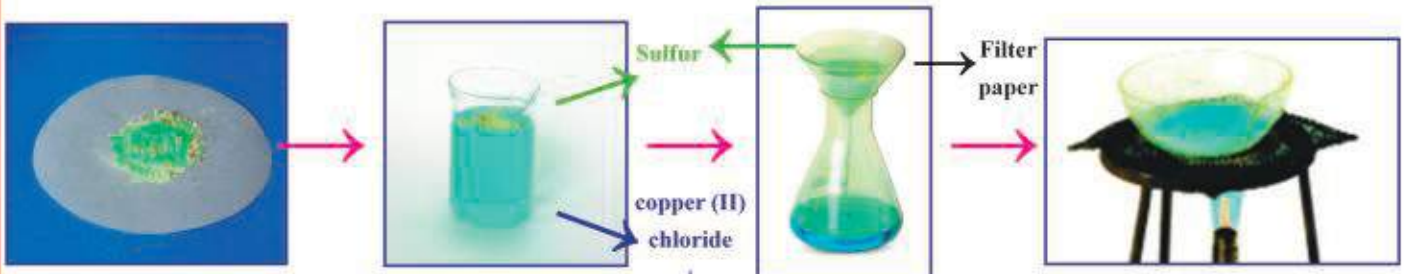
2-9-4 By means of Solubility

The solubilities of pure substances are generally different in a solvent. For example, some substances are soluble in water, and others are not. It can be said that the solubility of a substance in water is characteristic under given conditions.

The separation of a copper (II) chloride-sulfur mixture (shown Figure 2-7) can be achieved by using the solubility differences of the components in water. When this mixture (a) is placed in water, copper (II) chloride will dissolve.

Whereas, the sulfur will not (b). If this mixture is filtered, the sulfur particles will be obtain through a filter paper (c). The copper (II) chloride solution will then be heated to evaporate the water to obtain copper (II) chloride (d).

Figure 2-7
Separation of a copper (II) chloride - sulfur mixture.



a. Copper(II) chloride-sulfur mixture
b. Copper (II) chloride mixture dissolved in water
c. Filtration of mixture
d. Evaporation of the water in the copper (II) chloride solution

Filtration is a method to separate two or more substances. In filtration, a filter paper is placed in a funnel.

2-9-5 By means of the Process of Distillation

As we previously stated, the melting and boiling points of substances vary. Using these variations, it's possible to separate liquids having different boiling points in a mixture. Distillation is a process to separate mixtures by their different boiling points. Now, let's see two types of distillation:

1. Simple distillation is the separation of a liquid from a solution, such as water from sea water (Figure 2-8).
2. Fractional distillation is a method used to separate a mixture of miscible (mix with each other) liquids (Figure 2-9). For example, gasoline from petroleum.

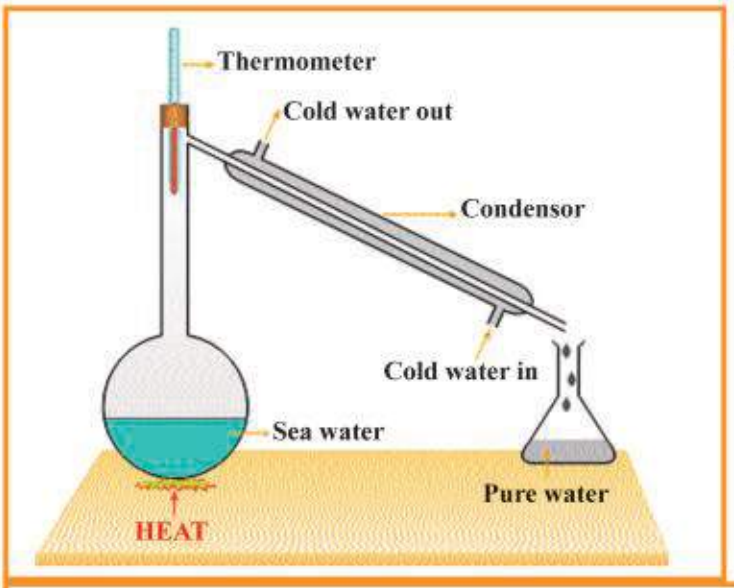


Figure 2-8
Simple distillation

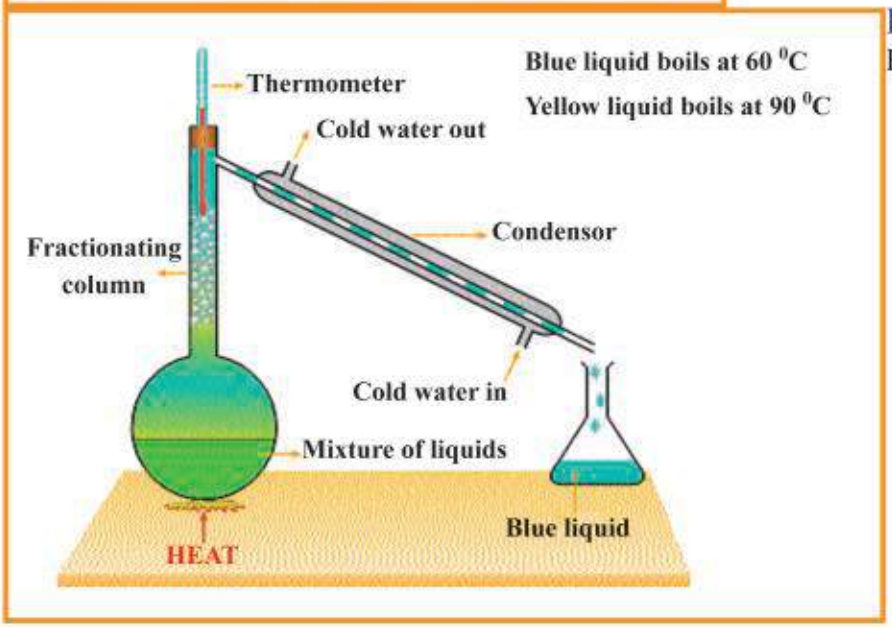


Figure 2-9
Fractional distillation

It's possible to separate a mixture of liquids that have different boiling points.

2-10 PROPERTIES OF MATTER

Matter has certain properties. Some of them, such as mass and volume, are common for all substances. Other properties like boiling point, density, solubility, etc... are characteristics to each type of substance. Now, let's see how we can classify them:

Every substance has two kinds of properties.

1. Chemical Properties
2. Physical Properties

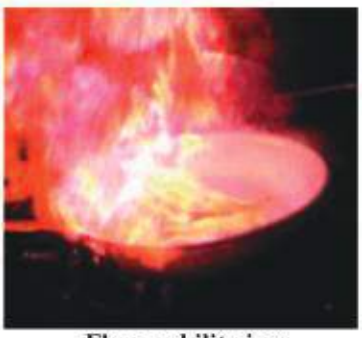
2-10-1 Chemical Properties

Chemical properties are properties that change the nature of matter.

Flammability, aciditiy, basicity, and reactivity with water are some examples of chemical properties. When the chemical properties of a substance are altered, it means a chemical change (new substance formed) occurred.

The rusting of iron is a chemical change.

Fireworks are comprised of tiny metals.



Flammability is a chemical property.

2-10-2 Physical Properties

Physical properties are the properties of a substance that can be observed and measured without altering the substance. Physical properties can be organized as intensive and extensive.

Mass is an extensive property.

Extensive Properties

Extensive properties of matter depend on the amount of matter involved. Extensive properties are also called common properties, such as mass, weight, volume, length, and charge.

Intensive Properties

Intensive properties of matter do not depend on the amount of matter given. Intensive properties are sometimes called distinctive, or characteristic, properties. Color, odor, solubility, hardness, heat/electrical conductivity, melting/freezing point, boiling point, density, luster, ductility, malleability, etc. are all intensive properties.

Luster : Shiny
Ductility : Ability to be bent
Malleability : Ability to be hammered

Mercury :
Liquid at room temperature
Melts at –37.9 °C
Boils at 357 °C
Silvery shiny color
Odorless
Good electrical conductor
Has a density 13.6 g/cm^3 at 20 °C

Figure 2-10
Mercury and some of its intensive properties
Mercury is a very toxic (poisonous) substance!

2-10-3 Some Important Physical Properties

a. Density

Density is the relation between the mass of a substance and its volume. It is denoted by d or r (rho). If a unit of mass is expressed in g and the unit of volume in cm^3(mL), then the unit of density becomes g/cm^3.

The density of a substance is given at constant temperature because its density changes when its volume is altered by a change in temperature. Elements and compounds have characteristic densities at definite conditions (Table 2-2).

When a substance's physical properties change, it goes through a physical change.

Solid		Liquid		Gas	
Name	Density (g/cm^3)	Name	Density (g/cm^3)	Name	Density (g/cm^3)
Gold	19.3	Water (at 4°C)	1.00	Ammonia	$7.70.10^{-4}$
Aluminum	2.70	Olive oil	0.91	Nitrogen	$1.25.10^{-3}$
Copper	8.92	Gasoline	0.88	Air	$1.29.10^{-3}$
Iron	7.86	Mercury	13.6	Hydrogen	$8.40.10^{-5}$
Silver	10.5	Ethyl alcohol	0.78	Carbon dioxide	$1.86.10^{-3}$

Table 2-2
Densities of some substances at 25 °C and 1 atmospheric pressure

b. Melting Point (m.p.) and Freezing Point (f.p.)

Melting point is the temperature at which a solid starts to transform into a liquid.

Freezing point is the temperature of the reverse change (liquid to solid). In other words, the melting point and freezing point of a pure substance occur at the same temperature. For instance, ice (freezes) at 0 °C and under 1 atm air pressure.

Ice is frozen water.

Element	Melting Point(°C)
Hydrogen	–259
Oxygen	–218
Aluminum	660
Helium	–272
Gold	1063
Iron	1535
Platinum	1769

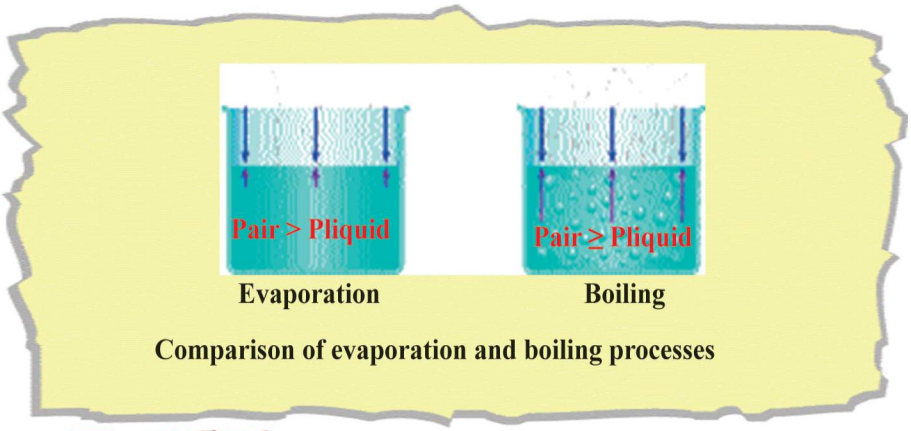
Melting points of some elements

Compound	Boiling Point(°C)
Water	100
Naphthalene	217
Ethyl alcohol	78
Butane	1

Boiling points of some substances under 1 atm pressure.

c. Boiling Point (b.p.)

A boiling point is a temperature at which the vapor pressure of the liquid equals the pressure surrounding the liquid and the liquid changes to vapor. Actually, a liquid may change to its gaseous state below its boiling point. This process is called evaporation, and it only happens on the liquid's surface. In the boiling process, all molecules in a liquid may be ready to alter to their gaseous state.

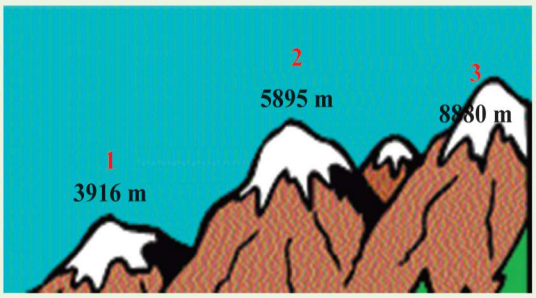


Comparison of evaporation and boiling processes

Evaporation may occur at every temperature, but boiling only occurs at the boiling point.

EXTRA

Boiling point of water at different altitudes*



Peak I. Mt. Erciyes (Turkey) : Bp of water ~90 °C
Peak II. Mt. Kilimanjaro (Tanzania) : Bp of water ~80 °C
Peak III. Mt. Everest (China and Nepal) : Bp of water ~70 °C
**Atmospheric pressure decreases when we go up in the atmosphere.*

Boiling points depend on pressure. For example, water boils at 100 °C at sea level.

Example 2-1

What are the physical states of X,Y and Z at room temperature (25 °C) ?

	m.p.(°C)	b.p. (°C)
X :	10	56
Y :	–250	–59
Z :	350	1506

Answer:

Substances are liquids at temperatures between their melting and boiling points. Hence, at room temperature X is a liquid, Y is a gas, and Z is a solid.

d. Solubility

Solubility is the amount of substance (solute) dissolved in a given solvent at a given temperature. Dissolving, or dissolution, means the disappearance of a solute in a given solvent. After the dissolving process, solutions are produced.

Many chemical compounds can be dissolved in water. Table 2-3 shows the solubilities of different substances in 100 g of water at 20 °C.

Solute is a substance that is present in lesser amount than the solvent in a solution.
Solvent is a substance that is present in the greatest amount in a solution.
Solution is a homogeneous mixture of solute and solvent.
Dissolution is simply the mixing of a solute in a solvent.

Table 2-3
Solubilities of some substances in 100 grams of water at 20°C under 1 atm pressure.

Substance	Solubility ($g/100g H_2O$)
Table salt	36
Sugar	190
Sodium nitrate	88
Lead (II) nitrate	52
Potassium dichromate	11
Baking soda	10

For example, 11 g of potassium dichromate can only be dissolved in 100 g of water, as shown in Figure 2-11.

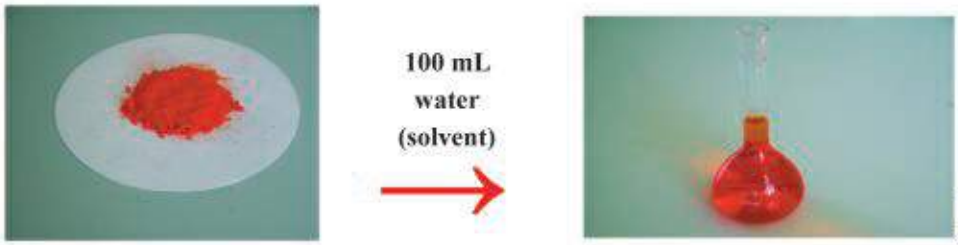


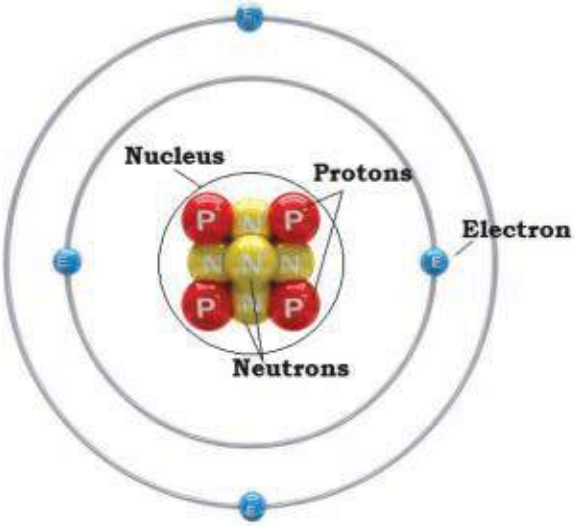
Figure 2-11
Solubility of potassium dichromate is 11g/100g water

Even tough many substances dissolve in water, some substances like sulfur cannot dissolve in water (Figure 2-12).

Figure 2-12
Sulfur is not water-soluble.

2-11 THE STRUCTURE OF ATOM

Atoms are the basic units of matter and the defining structure of elements. Atoms are made up of three particles: protons, neutrons and electrons. Protons and neutrons are heavier than electrons and reside in the center of the atom, which is called the nucleus.



2-11-1 Nucleus

Nucleus is the central part of an atom. It is composed of protons and neutrons. It contains most of an atom's mass.

a. Proton p^+

Proton is positively charged particle. It is found within an atomic nucleus.

b. Neutron n^0

Neutron is uncharged particle. It is found within an atomic nucleus.

2-11-2 Electron e^-

Electron is negatively charged particle. It is located in shells that surround an atom's nucleus.

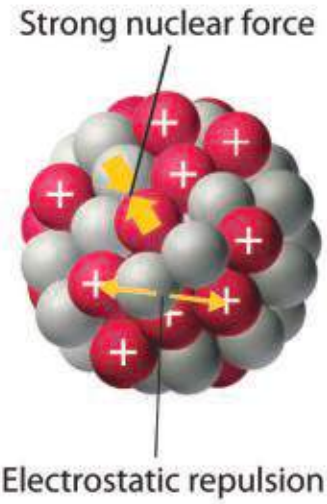


Figure 2-13
Nucleus

CHAPTER QUESTIONS 02

1- What is the most common type of matter we use in daily life? Discuss in the classroom.

2- Can you cite an example of non - matter?

3- How many states of matter exist? What are the differences between them?

4- Where can we see solid, gaseous and liquid states in the human body?

5- What is the name of the table that shows all elements? Why is it useful?

6- Classify the various homogeneous mixtures according to their physical states and give examples for each.

7- Why do we need to know the melting and the freezing points of substances?

8- What are the methods used in your kitchen by your mother and methods used in a chemistry laboratory to separate mixtures? Compare these methods.

9- What is sieving? Where is it used in daily life? (Research)

10- If oxygen gas is not soluble in water, what would happen to seawater? (Research)

11- How would you measure the real volume of sugar found in a cup (200 mL)? (Research) Discuss the results with your friends.

12- Why are some elements (gold and platinum) more expensive than others (aluminum and iron)? (Research)

13- Why is (pure) water not suitable for drinking? (Research)

14- Explain the reasons why the labels "Drink cool" or "Store in a cold place" appear on cans/bottles of fizzy drinks? (Research)

15- What are the components of the following mixtures? (Research)

a. Sea water
b. Cough syrup
c. 18K Gold
d. Air

16- Look at the periodic table and find the name of the following elements.

a. He
b. U
c. Ag
d. N

17- Classify the following as pure substance or mixture.

a. Bread
b. Jam
c. Ice (water)
d. Soap
e. Orange juice
f. Snowflake
g. Milk
h. Sea water
i. Air
j. Oxygen
k. Exhaust gas
l. Carbon dioxide

18- Separate the following mixtures by using separation methods, and indicate the minimum amount of steps necessary for separation.

a. Chalk dust + table salt
b. Iron powder + water + wood
c. Alcohol + water + pepper

19- Which of the following is not matter?

A) Chalk B) Milk
C) Snow D) Light E) Wood

20- Which element below is found in its liquid state at room conditions?

A) Mercury B) Aluminum C) Gold
D) Oxygen E) Copper

21- Which one(s) of the following statements is/are correct?

I. Gases have definite shapes.
II. All liquids flow at the same speed.
III. Petroleum (raw oil) is a mixture.

A) I only B) II only
C) III only D) I and II E) II and III

22- Which of the following is not a compound?

A) Table salt B) Sugar
C) Water D) Ammonia E) Bread

23- What is hard water?

A) Solid water B) Difficult water
C) Water with some ions D) A type of music
E) Pure water

24- Which of the following is not a physical property?

A) Flammability B) Boiling Point
C) Density D) Solubility
E) Conductivity

25- Which of the following is an intensive property?

A) Mass B) Volume
C) Weight D) Solidity
E) Length

26- Which one(s) of the following mixture(s) could be separated by fractional distillation?

I. Salt from salty water
II. Sugar from a sand - sugar mixture
III. Gasoline from petroleum

A) I only B) II only
C) III only D) I and II E) II and III

27- Sugar dissolves in water, whereas naphthalene does not. In order to separate a sugar - naphthalene mixture to obtain pure sugar, which of the following processes, and, in which sequence, must be followed?

I. Evaporation
II. Dissolution in water
III. Filtration

A) III, II, I B) II, III, I
C) I, III, II D) III, I, II
E) II, I, III

28- ..... are the neutral subatomic particles and located in the nucleus.

A) Electrons B) Atoms
C) Neutrons D) Protons

29- The nucleus of many atoms are made up of .....

A) protons B) neutrons
C) protons and neutrons D) electrons

30- ..... are the negatively charged subatomic particles and located around the nucleus.

A) Electrons B) Atoms
C) Neutrons D) Protons

CHAPTER 03

WATER AND ATMOSPHERE

ACHIEVEMENTS

After studying this chapter, the student will be able to:

- recognize that what substances present in air.
- know the air pressure .
- have understanding about oceans.
- know how clouds, rains and storms form.
- describe layers of atmosphere.
- study water pollution.

3-1 WATER

3-1-1 Occurrence of Water in Nature

Water (chemical formula: H_2O) is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of organisms. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms.
Water can exist in three physical states on Earth.

1- Liquid state such as lakes, oceans.
2- Solid state such as snow, ice.
3- Gaseous state such as steam (water vapor).

It also exists as snow, fog, dew and cloud.
Water is of major importance to all living things; in some organisms, up to 90% of their body weight comes from water. Up to 60% of the human adult body and up to 50 % of some tissues of plants are water. It can be found in the composition of many minerals and rocks and in 87% of the milk as well.

3-1-2 Properties of Water

The most important properties of water are as follows:
1- Pure water is transparent liquid, colorless, tasteless, and odorless.
2- Pure water boils at 100 ˚C and Freezes at 0 ˚C under 1 atmosphere pressure.
3- Density of water is 1 cm^3/g. The solid form of most substances is denser than the liquid phase; thus, a block of most solids will sink in the liquid. However, a block of ice floats in liquid water because ice is less dense. Therefore many creatures can live under the surface of the frozen lake and sea.
4- Pure water is poor conductor of electricity.
5- Water is a universal solvent. It is able to dissolve a large number of different substances such as table salt (NaCl), sugar ($C_{12}H_{22}O_{11}$), oxygen (O_2), carbon dioxide (CO_2), and nitrogen (N_2) etc.

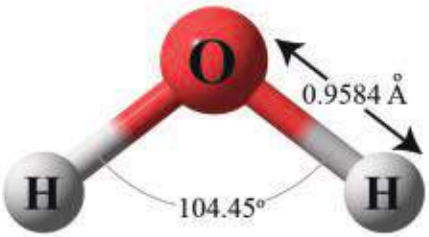


Figure 3-1
Water Molecule

3-1-3 The Importance of Water for Our Bodies

Water makes up more than two thirds of human body weight, and without water, we would die in a few days. The human brain is made up of 95% water, blood is 82% and lungs 90%. A mere 2% drop in our body's water supply can trigger signs of dehydration: fuzzy short-term memory, trouble with basic math, and difficulty focusing on smaller print, such as a computer screen. Mild dehydration is also one of the most common causes of daytime fatigue.
Water is important to the mechanics of the human body. The body cannot work without it, just as a car cannot run without gas and oil.

Dehydration is a condition that results when the body loses more water than it takes in.

In fact, all the cell and organ functions that make up our entire anatomy and physiology depend on water for their functioning.

3-1-4 The Structure of Water

Pure water is poor conductor of electricity but when salt or sulfuric acid is added, it becomes good conductor of electricity. As seen in the figure 3-2, water can be separated by using electricity and electrolysis machine.

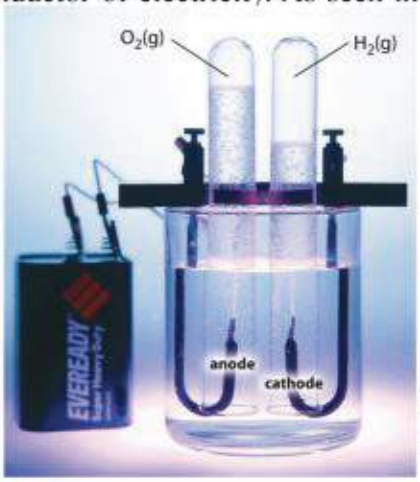


Figure 3-2
Electrolysis cell

Electrolysis machine is filled with acidic water after that electric current is passed through the solution. Water can be separated by this process into hydrogen and oxygen gases. As seen in the figure, oxygen gas (O_2) is collected at the anode and hydrogen gas (H_2) is collected at the cathode. The volume of hydrogen gas is twice the volume of oxygen gas because water molecule (H_2O) contains two hydrogen atoms and one oxygen atom.(Figure 3-3)

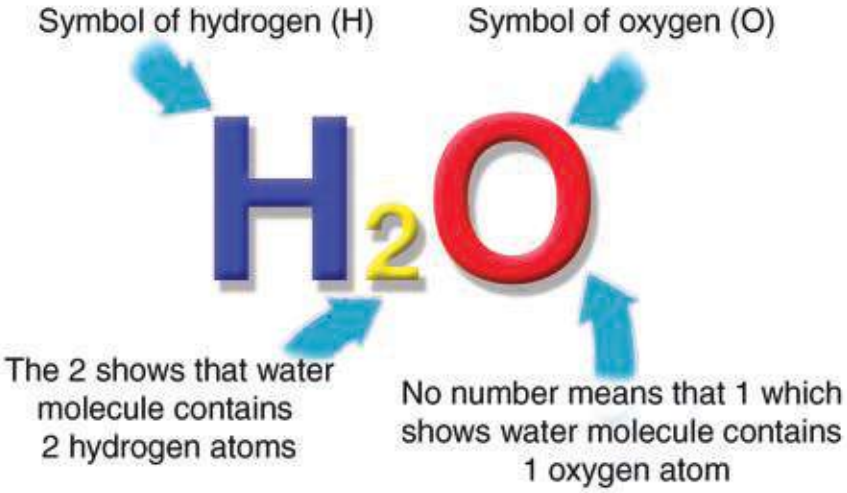


Figure 3-3
Structure of Water Molecule

3-1-5 Water Cycle

In the water cycle water evaporates from oceans, lakes and rivers and later falls as rain, snow, hail, dew and frost. Weather forecasters talk about relative **humidity.** This is a measure of the amount of

1 Which holds more vapour?

You will need: 2 beakers, 3 test tubes, crushed ice, warm water, teaspoon, salt

1 Take a test tube and check that it is perfectly dry. If it isn't, get a dry one.

2 Carefully add about 5 cm of ice to the tube, without wetting the outside of the tube.

3 Observe the outside of the tube for a few minutes.

- Write an inference to explain your observation. What is the name of the process that has occurred here?

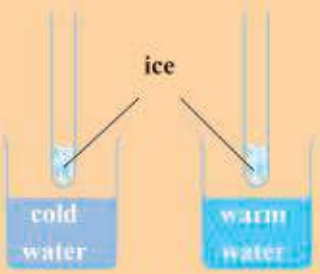
4 Take two beakers. Half-fill one with cold water and the other with warm water.

- Make a prediction about which air you expect to contain most water vapour—that over the warm water or that over the cold water. Explain your prediction.

5 Take two more dry test tubes. Put ice in each, as before.

6 Hold one tube above the water in each beaker, without touching the water. Carefully observe the outside of the tubes.

- Was your prediction correct?
- Which was most humid—the air over the warm water or the air over the cold water?



2 Which heats up more?

INVESTIGATION

Predict which will heat up more quickly—sand or water. Which will cool down more quickly? Why? Now design an experiment to test your prediction. You will need to work out what equipment you will need and the details of your method. You could also compare sand and soil or sand of different colours.

Write your report

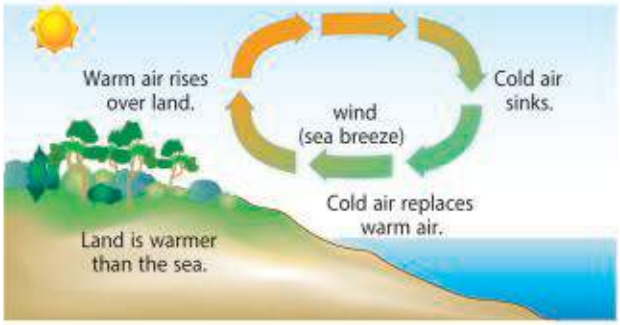
You will need to write your own aim, apparatus, method, and results. In your conclusion try to explain how uneven heating of the Earth could cause winds. Use your test results and the information on the next page.

water vapour in the air compared with the maximum amount possible. If the humidity is 100% the air is saturated (which means it cannot hold any more water) and it is raining or foggy. People feel most comfortable when the humidity is about 50%.

3-1-6 How winds form?

The weather is caused by the sun warming the Earth and its atmosphere. Not all parts of the Earth heat up and cool down at the same time or to the same temperature. You can investigate this for yourself in Practical 2.

Along the coast, on most afternoons, a sea breeze blows from the sea towards the land. This is because in the morning the land heats up faster than the sea, as you probably found in Investigation 2. The warm land heats the air just above it and this causes the air particles to move apart. This in turn makes the air less dense, and it begins to rise. Cool air from the sea then comes in to take the place of the rising air, forming a circular current as shown. This is a sea breeze.



Most winds are more complex than a sea breeze, but they are all caused by the uneven heating of the Earth's surface.

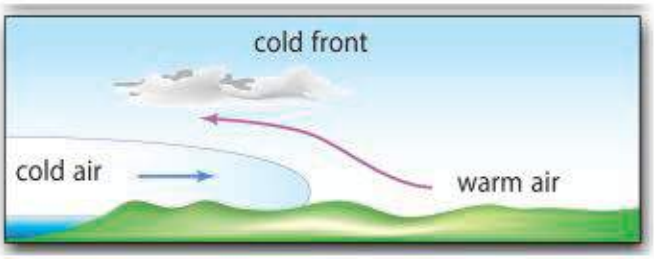
3-1-7 Clouds, rain and storms

There are three ways in which clouds can form.

1- Imagine a mass of warm air drifting over the ocean towards a range of mountains. As the air passes over the ocean it absorbs a lot of water vapour, and its relative humidity becomes very high. As the air reaches the mountains it is forced to rise. As it rises it cools, and can no longer hold so much water vapour. So some of the water vapour turns to liquid water, or condenses. If there are particles of dust in the atmosphere (and there usually are), the liquid water forms tiny droplets around the dust particles. These droplets float in the atmosphere, and we see them as clouds.

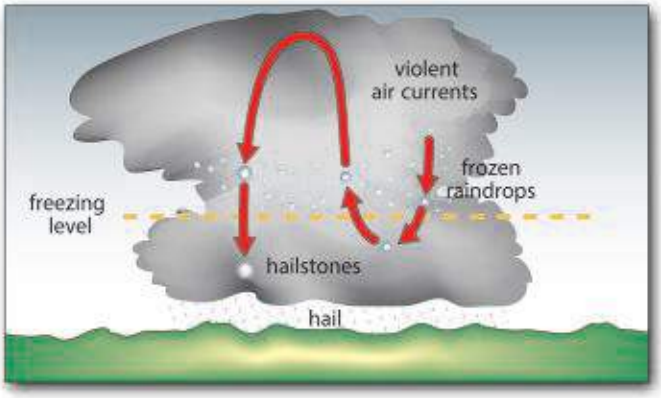
2- Clouds can also form when one area of the Earth heats up more than the areas around it. When this happens a patch of warmer air, called a thermal, is produced. As this thermal rises it cools, and water droplets condense from it, forming clouds.

3- Clouds sometimes form when a large mass of cold air moves under a large mass of warm moist air, pushing it up to where it is cooler. This is called a cold front. These are common in southern Australia.



As long as the water droplets in a cloud remain small they will not fall to Earth, because the air holds them up. If the air warms up again the liquid water turns back to water vapour, and the cloud disappears. However if the water droplets join together to make larger drops, they fall as rain.

Hailstones are frozen raindrops. They are usually formed when the raindrops are tossed up and down in a thunderstorm cloud by violent air currents. This makes them melt and freeze over and over again. The hailstones become larger as more water freezes around them. Eventually they become heavy enough to fall to the ground, where they can do extensive damage to houses, cars and crops. Tornadoes are funnel-shaped clouds that sometimes form under severe thunderstorms.



How hail is formed.

The river in our village flows into the sea, and the water in the sea evaporates and forms clouds. The water then becomes rain and comes back to us as river and ground water.

3 Making rain

You will need: Bunsen burner equipment, large beaker, watch glass, ice

1 Boil some water in the beaker.

2 Fill the watch glass with ice and put it on top of the beaker.

- Observe carefully what happens inside the beaker.
- Explain why this happens.

3-2 WATER POLLUTION

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings.

Many human activities produce pollution that can harm the oceans, lakes and streams. Some of this pollution comes from a specific source. Pollution that can be traced to one source is called point-source pollution. However, some pollution comes from many sources. Pollution that cannot be traced to a single source is called non-point-source pollution.

3-2-1 Trash Dumping

People dump trash in many places, including the oceans, lakes and streams. In the 1980s, scientists became alarmed by the kinds of trash that were washing up on beaches.

Bandages, vials of blood, and other medical wastes were found among the trash. The Environmental Protection Agency (EPA) found that hospitals in the United States were dumping medical wastes into the oceans. Much of this waste is now buried in sanitary landfills. However, other kinds of trash are still dumped into water.

3-2-2 Effects of Trash Dumping

Trash thrown into the water can affect the organisms that live there. It also affects the organisms, such as people, that depend on oceans, lakes and streams for food. For example, most plastic material that is thrown into the water does not break down for thousands of years. Animals can mistake plastic material for food and choke on it.

Marine animals, such as this bird, can choke on plastic trash that is thrown into the oceans.

3-2-3 Sludge Dumping

Raw sewage is all of the liquid and solid wastes that are flushed down toilets and poured down drains. In most places, raw sewage is collected and sent to a treatment plant. The treatment removes solid waste and cleans the raw sewage. The solid waste that remains is called sludge.

In many places, people dump sludge into the oceans, lakes and streams. Currents can stir up the sludge and move it closer to shore. The sludge can pollute beaches and kill ocean life. Many countries have banned sludge dumping. However, it still happens in many parts of the world.

3-2-4 Oil Spills

Most of the world uses oil as an energy source. However, oil is only found in certain places around the world. Therefore, large tankers must transport billions of barrels of oil across the oceans and seas. Sometimes, the tankers break open and the oil spills out of them. Oil spills can cause many problems for the environment. Oil is poisonous to plants and animals. It is also very hard to clean up oil spills, so their effects can last for a long time.

3-2-5 Nonpint-Source Pollution

Nonpoint-source pollution is pollution that comes from many sources instead of a single place. Most water pollution is nonpoint-source pollution. Things that people do on land can pollute rivers. The rivers can carry the pollution into oceans, seas and lakes . Nonpoint-source pollution is hard to control because it enters the water in many different ways. However, there are things that people can do to help reduce nonpoint-source pollution. For example, we can throw away chemicals, such as used motor oil, properly instead of pouring them into sewers.

3-2-6 How Can We Protect Our Water Resources?

People have begun to take steps to save and protect our water resources. From international treaties to volunteer cleanups, efforts to conserve and protect water resources are making a difference around the world.

3-2-7 Nations Take Notice

In the 1970s and 1980s, water pollution was very bad. Many countries realized that they would need to work together to reduce water pollution. In 1989, 64 countries signed a treaty that bans the dumping of many harmful materials into the ocean. Many other treaties and laws have also been passed to help protect the oceans and seas. For example, Congress passed the Clean Water Act in 1972. This law gave the Environmental Protection Agency more control over the trash that is dumped into the water. Another law, the U.S. Marine Protection, Research, and Sanctuaries Act, was also passed in 1972. This law forbids people from dumping harmful materials into oceans, seas and lakes. These laws have helped to reduce the pollution entering the water. However, waste dumping and oil spills still happen.

3-2-8 Citizens Take Charge

Citizens of many different countries have demanded that their governments do more to prevent water pollution. They have also begun to take the matter into their own hands.

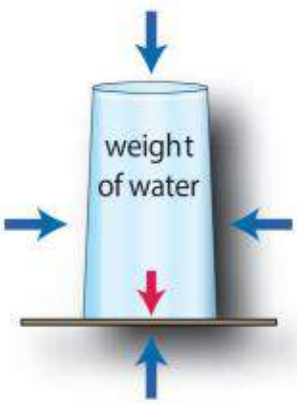
For example, people began to organize beach cleanups. Millions of tons of trash have been gathered from beaches. Also, people are helping to spread the word about the problems with dumping wastes into the waters.

3-3 AIR PRESSURE

The invisible air around us can exert a **pressure**. This is the force per square metre exerted by the air on a surface. This air pressure is due to tiny, fast-moving, invisible particles of air that continually bombard any surface open to the air.

Air exerts pressure *in all directions*. In Activity 4 the air exerted a pressure *downwards* on the newspaper. This held the newspaper in place with enough force to enable you to snap the ruler. With the upside down glass of water, the air exerted a pressure upwards on the cardboard.

The *upwards* force due to this air pressure is greater than the downwards weight of the water, so the cardboard did not fall off.



force due to air pressure

ACTIVITY 4

Air exerts pressure

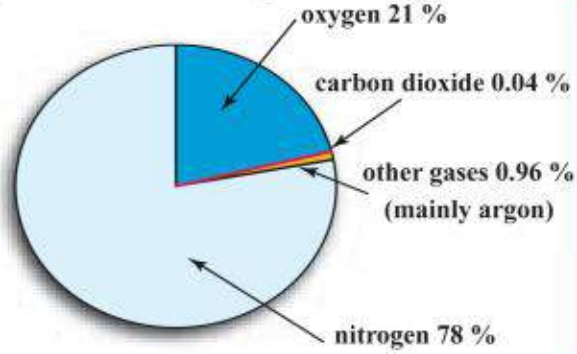
You will need: large sheet of newspaper, thin wooden ruler, glass or jar, piece of cardboard Place a thin wooden ruler on a table with one end as far as possible over the edge and the other covered by a single large sheet of newspaper, as shown. Smooth the newspaper so that there is as little air as possible under it.

If you now hit the end of the ruler sharply it should snap.

- Try to explain what happened.

3-4 OUR AIR

The Earth is surrounded by a layer of air called the atmosphere. Air is a mixture of gases as shown in the pie chart below.



About four-fifths of the air is nitrogen (N_2). The other one-fifth is oxygen (O_2), which we need to live. Argon is an unreactive gas used to fill light bulbs; and carbon dioxide (CO_2) is used by plants in photosynthesis. Air contains varying amounts of water vapour (H_2O), and this affects the weather.

3-4-1 Some Common Gases

In Practical 5 you will make two different gases— hydrogen, oxygen and carbon dioxide. Surprisingly there is very little hydrogen (H_2) in our atmosphere, even though it makes up about 90% of the total universe. Hydrogen is a colourless gas that is at least 15 times lighter than any other substance. In the presence of a flame, hydrogen reacts so rapidly with the oxygen in the air that it explodes.

We cannot live without oxygen—our bodies need a constant supply of it. Oxygen is needed to get energy from food in the process of respiration. We use about 20 liters every hour. Oxygen is used to help people breathe in difficult situations such as after car accidents and in hospitals during operations. It is also used in places where there is not enough oxygen to breathe normally. For example, divers, jet plane pilots, mountain climbers and fire fighters carry a supply of oxygen.

Oxygen is a colourless gas that has no smell. It is very reactive, meaning it combines chemically with many substances. For example, burning (or combustion) is the process in which oxygen combines rapidly with other substances producing light and heat.

Carbon dioxide is another invisible gas. It is more dense than air and things will not burn in it. It is put into soft drinks to make them fizzy. It is produced by our body in respiration. It is also produced during fermentation and the holes in bread are caused by bubbles of CO_2 produced by yeast.

INVESTIGATION 5

Hydrogen gas

Aim

To make and test the properties of hydrogen and oxygen gases.

Risk assessment and planning

You must be well organized for this investigation, so study the Method (including the diagram) for each part before you start.

1) Why is it essential that you wear safety glasses when doing this investigation?

2) What special precautions are necessary with hydrochloric acid?

PART A: Hydrogen

Apparatus

- test tube rack and 3 test tubes
- piece of magnesium ribbon (about 2 cm)
- taper and matches
- dilute hydrochloric acid (1M)

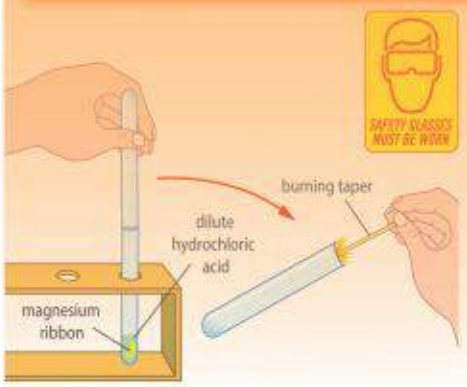
Method

1) Put a test tube in the test tube rack and one-third fill it with dilute hydrochloric acid.

2) Pick up another test tube. Put the magnesium ribbon into the acid. Then hold the empty test tube upside down over the mouth of the first test tube, as shown below.

3) Carefully remove the top test tube. Tilt it so that the mouth is just turned upwards, and immediately put a burning taper near its mouth. A 'pop' or 'squeak' indicates that the gas in the tube is hydrogen. You may want to repeat this with another tube of hydrogen.

☺ What do you observe on the inside of the test tube? How can you explain this?

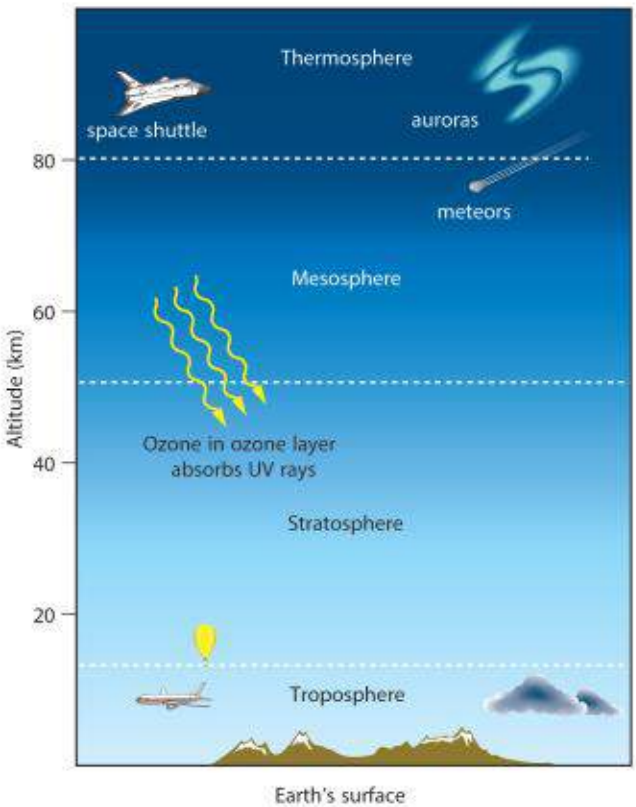


3-5 OUR ATMOSPHERE

3-5-1 Layers of the atmosphere

The atmosphere is like a blanket of air around the Earth. It is held there by the force of gravity which pulls the molecules of air towards the Earth. Without gravity the atmosphere would float off into space.

Scientists describe the atmosphere as consisting of four main layers. Each layer fades into the next, so that it is difficult to say where one layer ends and the next begins.



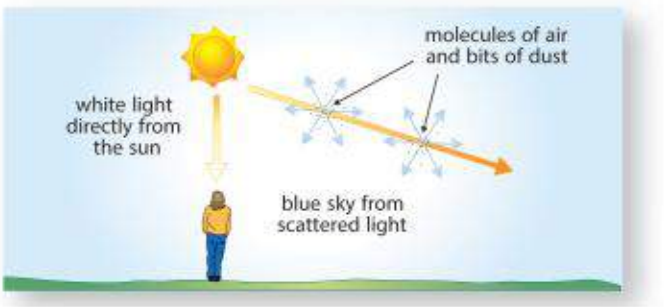
The layer closest to the Earth is called the **troposphere** (TROP-os-fear). It is about 16 km thick and contains about 75% of the air in the atmosphere. It also contains most of the water vapour, dust and clouds, and is where our weather occurs.

The **stratosphere** begins at a height of about 16 km above the Earth and supersonic aircraft can fly in its lower levels. An example is the Concorde. As you move upwards through the stratosphere the temperature increases, due to the absorption of ultraviolet radiation by molecules of ozone gas. This is the **ozone layer**.

In the **mesosphere** the temperature decreases again to about –90°C. Meteors burn up in its upper zone. The **thermosphere** is the layer furthest from the Earth, and it gets very hot.

Why is the sky blue?

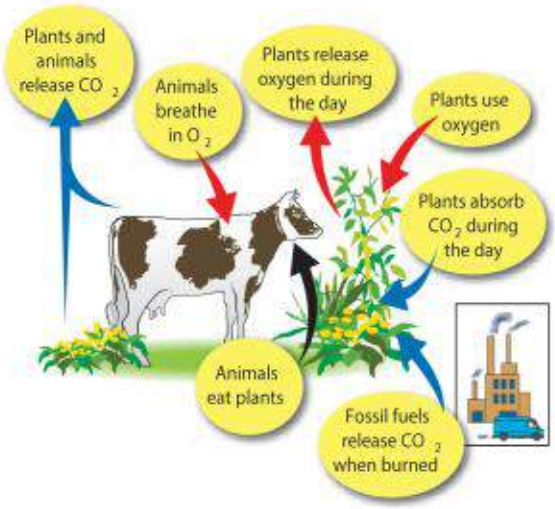
Sunlight is really a mixture of the different colours you can see in a rainbow. As sunlight goes through the atmosphere it bumps into molecules of air and tiny bits of dust. Some colours, like red and orange, pass straight through, but most of the blue light gets scattered all around the sky. This is why the sky looks blue. As the Sun rises or sets its light has to travel further through the atmosphere to get to you.



Because the blue light has been scattered you see only the orange and the red.

3-5-2 Keeping the Atmosphere in Balance

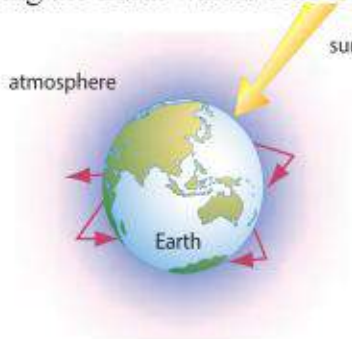
In the troposphere the most important gases are oxygen and carbon dioxide. Plants use carbon dioxide for photosynthesis. In the process they produce oxygen. Both plants and animals use oxygen in respiration and release carbon dioxide. Together, plants and animals keep the amounts of carbon dioxide and oxygen in the atmosphere in balance, as shown. However human activities are upsetting this balance. Every year in the burning of fossil



fuels releases about 70 million tonnes of carbon dioxide into the atmosphere. Trees absorb this carbon dioxide and produce oxygen, but in two thirds of the forests that existed 200 years ago have been cleared! The trend is towards more carbon dioxide and less oxygen, and it is becoming more and more difficult to keep the balance.

3-5-3 The greenhouse effect

During the day sunlight warms up the Earth's surface. At night much of the heat escapes but the gases in the atmosphere trap some of it, thus keeping the Earth warm. This is called the greenhouse effect because it is like what happens in a greenhouse.



INVESTIGATION 6 — A model greenhouse

Design a controlled experiment to show how the Earth's atmosphere acts like the glass roof of a greenhouse, trapping heat from the Sun.
Work out what equipment you will need to make a model greenhouse and how you are going to collect temperature data. You could use a small juice box with a window in it and cover it with a piece of glass or plastic. You will also need a control for comparison—a second setup without glass. If possible graph your results. Write a full report of your experiment using the headings Aim, Risk assessment, Apparatus, Method, Results, Conclusion and Discussion.

Carbon dioxide traps more heat than most other gases in the atmosphere. This is why people are concerned about the increasing levels of carbon dioxide in the atmosphere. It is causing global warming and may cause changes to the climate and rising sea levels.

3-5-4 Hole in the ozone layer

Small amounts of the gas ozone are present in the stratosphere, but in the late 1970s it was discovered that the amount of ozone was decreasing over Antarctica. This thinning of the ozone layer is referred to as the hole in the ozone layer.
Ozone is essential for life on Earth because it blocks out more than 95% of the Sun's ultraviolet rays. These UV rays cause sunburn and skin cancer. Many of the chemicals we were using were drifting up into the stratosphere and causing chemical reactions that destroyed ozone. The main problems were CFCs (chlorofluorocarbons) used in spray cans and older air conditioners and refrigerators.
The use of these ozone-destroying chemicals has now been drastically reduced, but the hole is still there and it will be many years before it repairs itself. Meanwhile increased exposure to UV rays will result in many more cases of skin cancer. UV radiation can damage our immune system. It can also lead to eye problems such as cataracts, where the lens of the eye becomes clouded. So hats, sunscreen and sunglasses are essential.

CHAPTER QUESTIONS 03

1- Which one of the following is not correct for oxygen?

A) We cannot live without oxygen.
B) We use it to get energy from food.
C) Oxygen is colorless gas.
D) Oxygen has bad smell.

2- Which one of the below is not correct for carbon dioxide (CO_2)?

A) It is invisible gas.
B) It is more dense than air.
C) We need it for respiration.
D) It is put into soft drinks to make them fizzy.

3- Carbon dioxide traps more heat than most other gases in the atmosphere.
End of the this process what happens ?
A) Greenhouse Effect
B) Global Warming
C) Damage of the Ozone
D) Tornadoes

4- Write the physical states of water that exists on Earth and give example for each state.

5- What are the properties of water?

6- How can water be separated into its elements

7- What is the formula of water?

8- Can pure water conduct electricity?

9- Explain the greenhouse effect.

10- What is the function of ozone layer?

11- How can trash harm the organisms that live in the oceans?

12- Write your own definition for nonpoint-source pollution.

13- How is point-source pollution different from nonpoint-source pollution?

CHAPTER 04

ENERGY AND FUEL TYPES

ACHIEVEMENTS

After studying this chapter, the student will be able to:

- Know the Energy Resorceses
- Give some examples of Fossil Fuels
- Study the principles of Nuclear energy
- Understand the Alternative Sources of energy
- Study the Solar energy

As You Read

What You' ll learn

- Explain what renewable, nonrenewable, and alter native resources are.
- Describe the advantages and disadvantages of using various energy sources.

Vocabulary

nonrenewable resource
alternative resource
renewable resource
inexhaustible resource
photovoltaic

Why It's Important

Energy is vital for survival and making life comfortable. Developing new energy sources will improve modern standards of living.

4-1 USING ENERGY

Press a button on the remote control and your favorite program appears on television. Open your refrigerator and pull out something cold to drink. Ride to the mall in a car. For any of these things to occur, a transfer of energy must take place. Radiant energy is transferred to your television, electrical energy is transferred to your refrigerator, and the chemical energy in gasoline is transferred to the engine of the car.

Every day energy is used to provide light and to heat and cool homes, schools, and workplaces. Energy is used to run cars, buses, trucks, trains, and airplanes that transport people and materials from one place to another. Energy also is used to make clothing and other materials and to cook food.

According to the law of conservation of energy, energy can't be created or destroyed. Energy only can change form. If a car or refrigerator can't create the energy they use, then where does this energy come from?

4-2 ENERGY RESOURCES

Energy cannot be made, but must come from the natural world. As you can see in **Figure 4-1**, the surface of Earth receives energy from two sources—the Sun and radioactive atoms in Earth's interior. Of these two energy sources, the energy from the Sun has much more impact on your life. Nearly all the energy you used today can be traced to the Sun, even the gasoline used to power the car or school bus you came to school in.

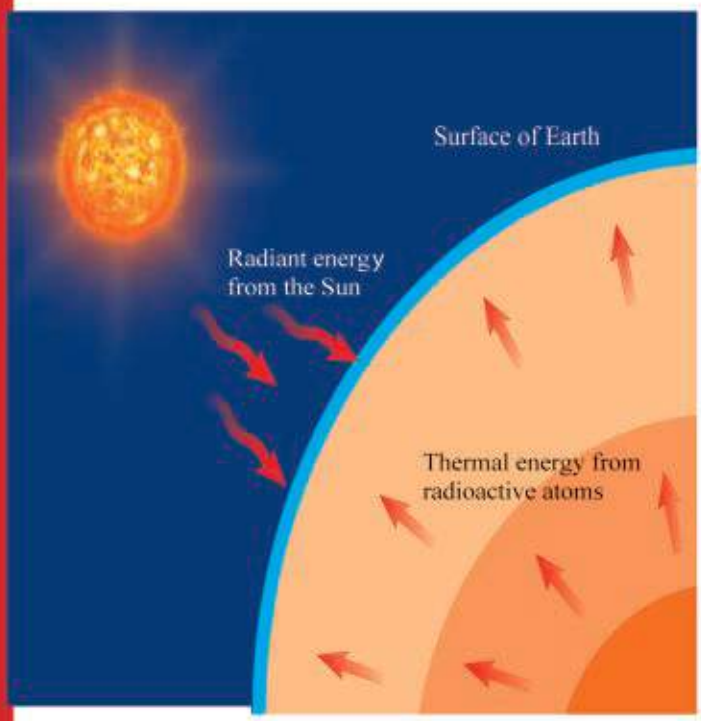


Figure 4-1
All the energy you use can be traced to one of two sources—the Sun or radioactive atoms in Earth's interior.

4-2-1 Fossil Fuels

Fossil fuels are coal, oil, and natural gas. Oil and natural gas were made from the remains of microscopic organisms that lived in Earth's oceans millions of years ago. Heat and pressure gradually turned these ancient organisms into oil and natural gas. Coal was formed by a similar process from the remains of ancient plants that once lived on land, as shown in Figure (4.2).

Through the process of photosynthesis, ancient plants converted the radiant energy in sunlight to chemical energy stored in various types of molecules. Heat and pressure changed these molecules into other types

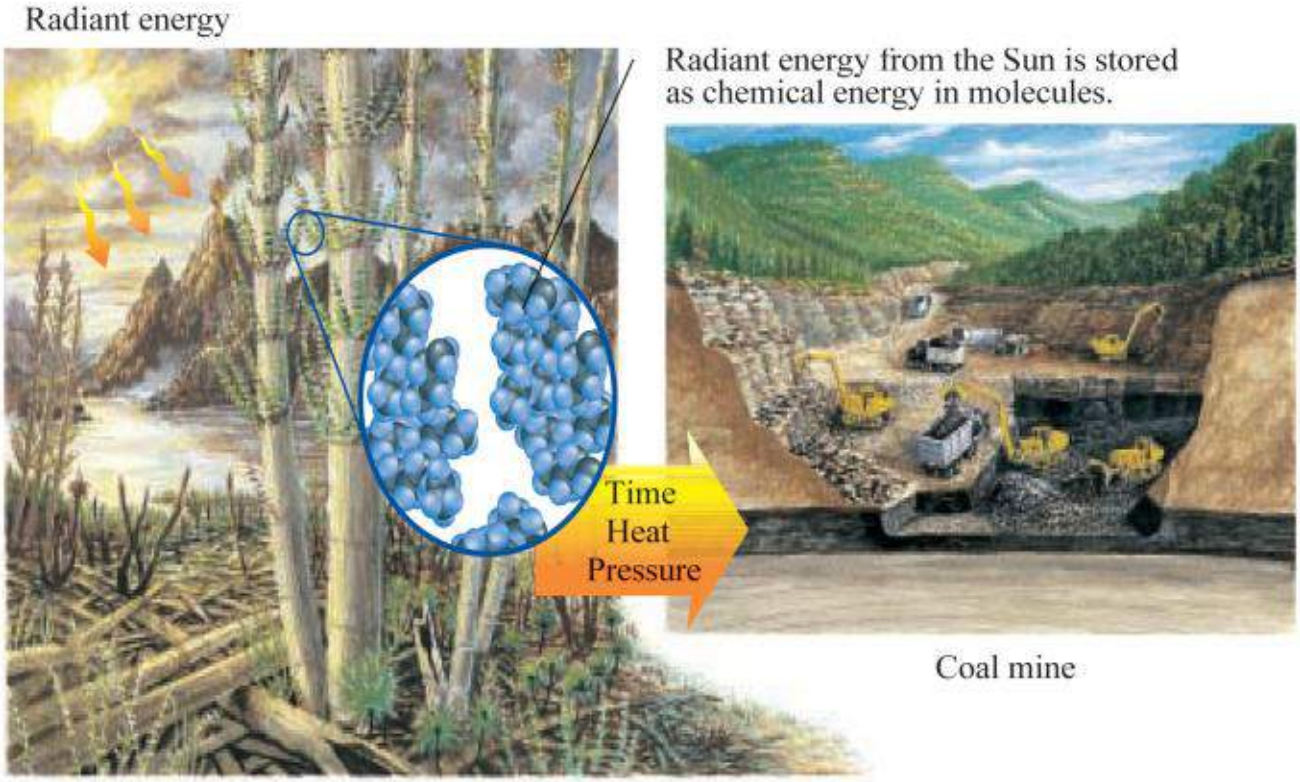


Figure 4-2
Coal is formed after the molecules in ancient plants are heated under pressure for millions of years. The energy stored by the molecules in coal originally came from the Sun.

of molecules as fossil fuels formed.
Chemical energy stored in these molecules is released when fossil fuels are burned.

1- Using Fossil Fuels:

The energy used when you ride in a car, turn on a light, or use an electric appliance usually comes from burning fossil fuels. However, it takes millions of years to replace each drop of gasoline and each lump of coal that is burned. At the rate oil is being used, Earth might run out of oil before the end of this century. An energy source that is used up much faster than it can be replaced is a nonrenewable resource. Fossil fuels are nonrenewable resources. Burning fossil fuels to produce energy also generates chemical compounds that cause pollution. Each year billions of kilograms of air pollutants are produced by burning fossil fuels. These pollutants can cause respiratory illnesses and acid rain. Also, the carbon dioxide gas formed when fossil fuels are burned might cause Earth's climate to warm.

4-2-2 Nuclear Energy

Can you imagine running an automobile on 1 kg of fuel that releases almost 3 million times more energy than 1 L of gas? What could supply so much energy from so little mass? The answer is the nuclei of

Environmental Science
INTEGRATION

Fossil fuels occur only in certain places around the world and must be transported to where they are used. For example, pipelines and supertankers are used to transport oil over long distances. Research the effects on the environment of obtaining and transporting fossil fuels.

uranium atoms. Some of these nuclei are unstable and break apart, releasing enormous amounts of energy in the process. This energy can be used to generate electricity by heating water to produce steam that spins an electric generator, as shown in Figure(4-3). Because no fossil fuels are burned, generating electricity using nuclear energy helps make the supply of fossil fuels last longer. Also, unlike fossil fuel power plants, nuclear power plants produce almost no air pollution. In one year, a typical nuclear power plant generates enough energy to supply 600,000 homes with power and produces only 1 m^3 of waste.

Nuclear Wastes Like all energy sources, nuclear energy has its advantages and disadvantages. One disadvantage is the amount of nonrenewable uranium in Earth's crust. Another is that the waste produced by nuclear power plants is radioactive and can be dangerous to living things. Some of the materials in the nuclear waste will remain radioactive for many thousands of years. As a result the waste must be stored so no radioactivity is released into the environment for a long time. One method is to seal the waste in a ceramic material, place the ceramic in protective containers, and then bury the containers far underground. However, the burial site would have to be chosen carefully so underground water supplies aren't contaminated. Also, the site would have to be safe from earthquakes and other natural disasters that might cause radioactive material to be released.

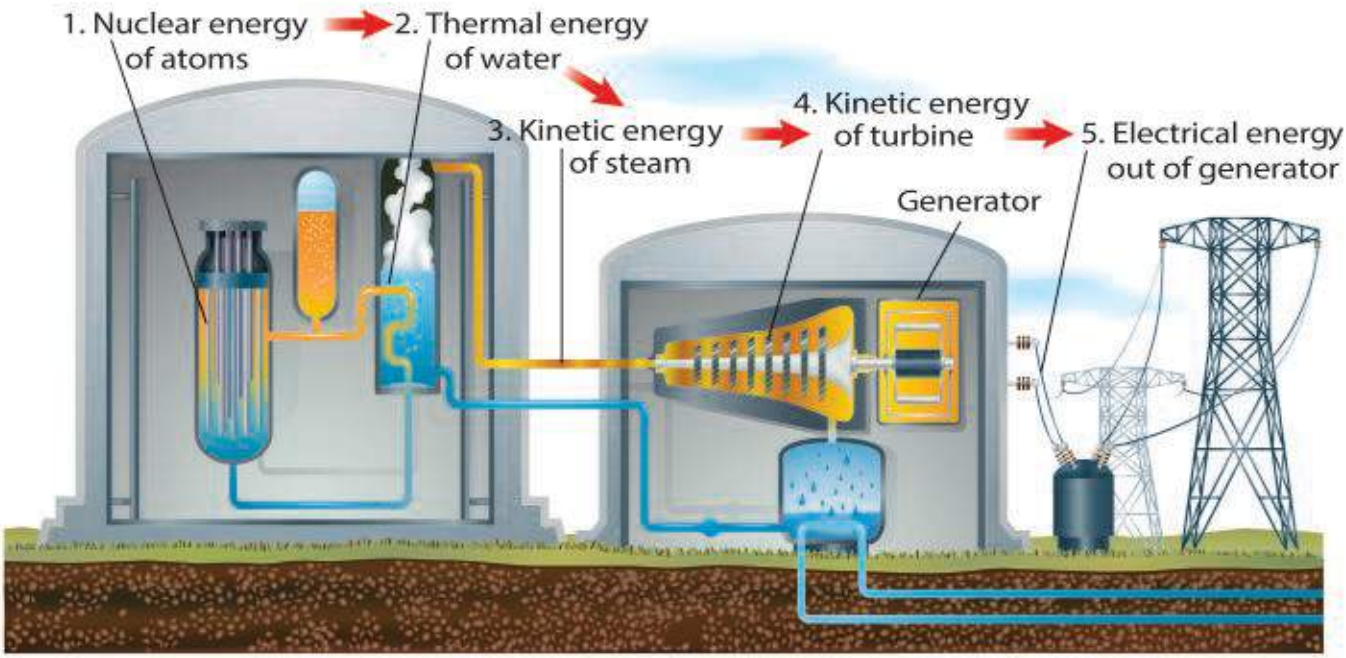


Figure 4-3
To obtain electrical energy from nuclear energy, a series of energy transformations must occur.

4-2-3 Hydroelectricity

Currently, transforming the potential energy of water that is trapped behind dams supplies the world with almost 20 percent of its electrical energy. Hydroelectricity is the largest renewable source of energy. A renewable resource is an energy source that is replenished continually. As long as enough rain and snow falls to keep rivers flowing, hydroelectric power plants can generate electrical energy, as shown in Figure 4-4.

Although production of hydroelectricity is largely pollution free, it has one major problem. It disrupts the life cycle of aquatic animals, especially fish. This is particularly true in the Northwest where salmon spawn and run. Because salmon return to the spot where they were hatched to lay their eggs, the development of dams has hindered a large fraction of salmon from reproducing. This has greatly reduced the salmon population. Efforts to correct the problem have resulted in plans to remove a number of dams. In an attempt to help fish bypass some dams, fish ladders are being installed. Like most energy sources, hydroelectricity has advantages and disadvantages.

Problem Solving Activity

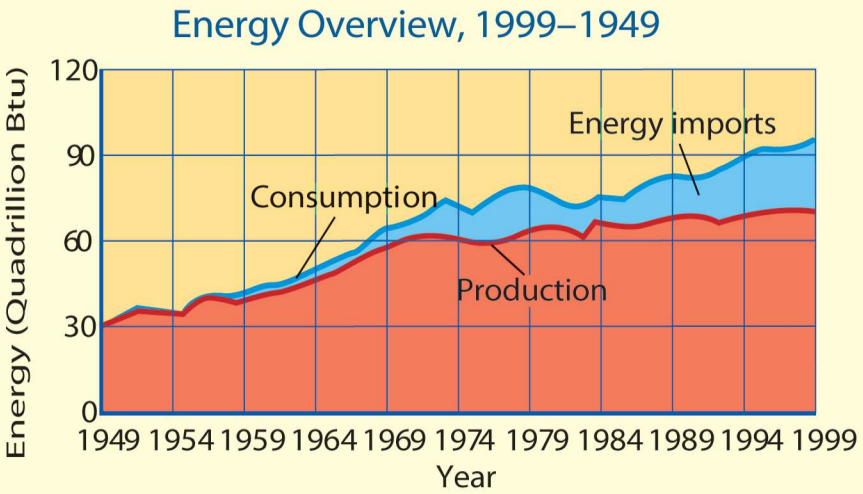
MATH TEKS 6.10 ,6.5 D

Is energy consumption outpacing production?

You use energy every day—to get to school, to watch TV, and to heat or cool your home. The amount of energy consumed by an average person has increased over the last 50 years. Consequently, more energy must be produced.

Identifying the Problem

The following graph shows the energy produced and consumed in the United States from 1949 to 1999. How does energy that is consumed by Americans compare with energy that is produced in the United States?



Solving the problem

1. Determine the approximate amount of energy produced in 1949 and in 1999 and how much it has increased in 50 years. Has it doubled or tripled?
2. Do the same for consumption. Has it doubled or tripled?
3. Using your answers for steps 1 and 2, and the graph, where does the additional energy that is needed come from? Give some examples.

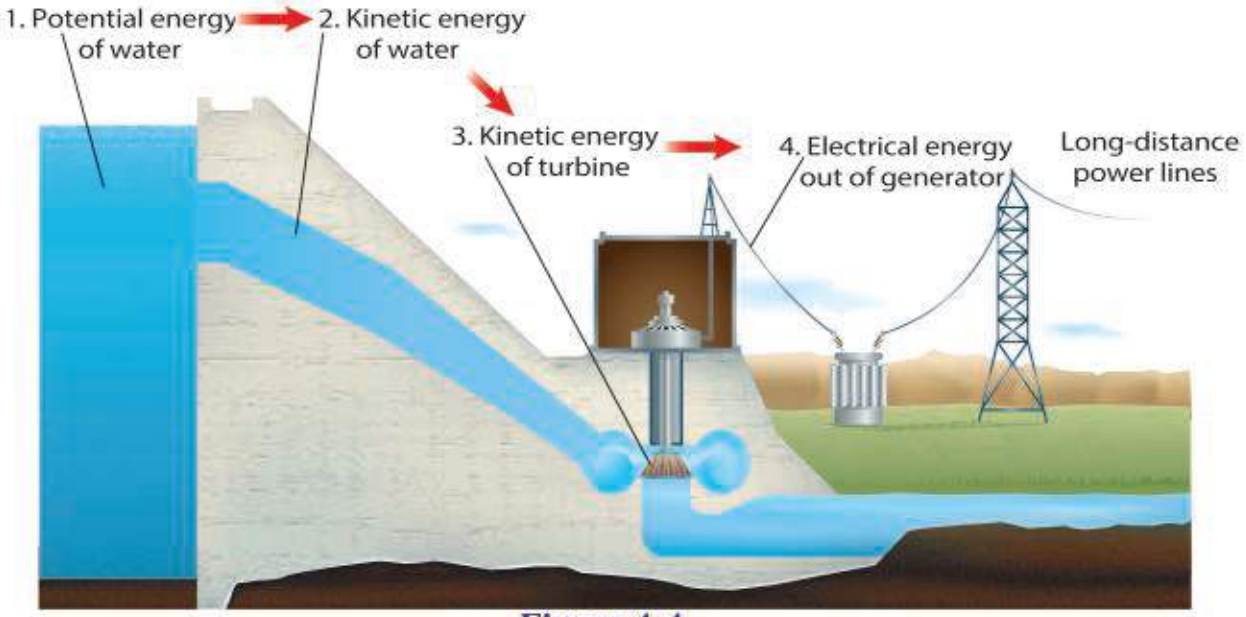


Figure 4-4
The potential energy of water behind a dam supplies the energy to turn the turbine. Why is hydropower a renewable energy source?

Mini LAB

Building a Solar Collector

Procedure

1. Line a large pot with black plastic and fill with water.
2. Stretch clear-plastic wrap over the pot and tape it taut.
3. Make a slit in the top and slide a thermometer or a computer probe into the water.
4. Place your solar collector in direct sunlight and monitor the temperature change every 3 min for 15 min.
5. Repeat your experiment without using any black plastic.

Analysis

1. Graph the temperature changes in both setups.
2. Explain how your solar collector works.

4-3 ALTERNATIVE SOURCES OF ENERGY

Electrical energy can be generated in several ways. However, each has disadvantages that can affect the environment and the quality of life for humans. Research is being done to develop new sources of energy that are safer and cause less harm to the environment. These sources often are called **alternative resources.** These alternative resources include solar energy, geothermal energy, and wind .

4-3-1 Solar Energy

The Sun is the origin of almost all the energy that is used on Earth. Because the Sun will go on producing an enormous amount of energy for billions of years, the Sun is an inexhaustible source of energy. An **inexhaustible resource** is an energy source that can't be used up by humans.

Each day, on average, the amount of solar energy that strikes the Iraq is more than the total amount of energy used by the entire country in a year. However, less than 0.1 percent of the energy used in the Iraq comes directly from the Sun. One reason is that solar energy is more expensive to use than fossil fuels. However, as the supply of fossil fuels decreases, the cost of finding, mining, and refining these fuels will increase. Then, it may be cheaper to use solar energy to generate electricity and heat buildings than to use fossil fuels.

1- Collecting the Sun's Energy

Two types of collectors capture the Sun's rays. If you look around your neighborhood, you might see large, rectangular panels attached to the roofs of buildings or houses. If, as in Figure, pipes come out of the panel, it is a thermal collector. Using a black surface, a thermal collector heats water by directly absorbing the Sun's radiant energy. Water circulating in this system can be heated to about 70°C. If the panel has no pipes, it is a photovoltaic (foh toh vol TAY ihk) collector, like the one pictured in **figure (4-5)** . A photovoltaic is a device that transforms radiant energy directly into electrical energy. Photovoltaics are used to power calculators and satellites, including the **International** Space Station.

Figure 4-5
Solar energy can be collected and utilized by individuals using thermal collectors or photovoltaic collectors. as in pictures A,B

4-3-2 Geothermal Energy

Imagine taking a journey to the center of Earth— down to about 6,400 km below the surface. As you went deeper and deeper, you would find the temperature increasing. At a depth of only 100 km, the temperature would be over 900°C. Because Earth's interior is hotter than its surface, heat flows from inside Earth. This heat is called geothermal energy.

In some places cracks in Earth's crust enable molten rock to rise close to the surface. This molten rock can heat underground water. Geothermal power plants change this hot water to steam that spins a turbine and generates electricity. Geothermal energy is an inexhaustible energy source. California currently generates about 5 percent of its electricity using this energy source.

1- Heat pumps

Geothermal energy enables heat pumps to heat and cool buildings. At a depth of several meters, geothermal energy helps keep the temperature of the ground nearly constant at about 10°C to 20°C. A heat pump contains a water-filled loop of pipe that is buried to a depth where the temperature is constant. In summer the air is warmer than this underground temperature. Warm water from the building is pumped through the pipe down into the ground, where the water is cooled. The water cools and then is pumped back to the building where it absorbs more heat, and the cycle is repeated. In the winter time, the air is cooler than the ground below. Then cool water absorbs heat from the ground and releases it into the building.

Figure 4-6
Windmills work on the same basic principles as a power plant. Instead of steam turning a turbine, wind turns the rotors. What are some of the advantages and disadvantages of using windmills?

4-3-3 Winds

Wind is another inexhaustible supply of energy. Modern windmills, like the ones in **figure (4-6)** , convert the kinetic energy of the wind to electrical energy. These windmills can stand as high as 80 m above the ground and have rotors, or propellers, that are 80 m across. The propeller is connected to a generator so that electrical energy is generated when wind spins the propeller.

4-4 CONSERVING ENERGY

As fossil fuels are used up and become more expensive and harder to find, energy shortages may occur. One way to help prevent energy shortages is to make the supply of fossil fuels last longer by using less energy. Reducing the use of energy is called conserving energy.

You can avoid wasting electricity and conserve energy by turning off lights and appliances such as televisions when you are not using them. Also keep doors and windows closed tightly when it's cold or hot to keep heat from leaking out of or into your house. Energy could also be conserved if buildings are properly insulated, especially around windows. The use of oil could be reduced if cars were used less and made more efficient, so they went farther on a L of gas. Recycling materials such as aluminum cans and glass also helps conserve energy.

1. What is the ultimate source of most of the energy stored on Earth?
2. What is a renewable resource? Give an example of a renewable and non-renewable resource and explain the difference.
3. Which of the energy sources in this section do not produce waste products when they are used during electricity production?
4. What are the disadvantages of using hydroelectricity and solar energy?

5. Think Critically Explain whether or not the following satement is true: All energy on Earth can be traced back to the Sun.

Skill Builder Activities

6. Using an Electronic Spreadsheet Use a spreadsheet to compare the effects on the environment of using fossil fuels,nuclear energy, and dams to produce electricity. Include in your spreadsheet the environmental effects of obtaining, transforming, and distributing the energy.

7. Using Proportions As you go deeper into Earth, it becomes hotter. Using the information from this section, calculate the temperature at the center of Earth if its radius is 6,370 km.

Activity Use the Internet

Energy to Power Your Life

Over the past 100 years, the amount of energy used in the planet has greatly increased. Today, a number of energy sources are available, such as coal, oil, natural gas, nuclear energy, hydroelectric power, wind, and solar energy. Some of these energy sources are being used up and are nonrenewable, but others are replaced as fast as they are used and, therefore, are renewable. Some energy sources are so vast that human usage has almost no effect on the amount available. These energy sources are inexhaustible.

Think about the types of energy you use at home and school every day. In this activity, you will investigate how and where energy is produced, and how it gets to you. You will also investigate alternative ways energy can be produced, and whether these sources are renewable, nonrenewable, or inexhaustible.

Recognize the Problem

What are the sources of the energy you use every day?

Form a Hypothesis

When you wake up in the morning and turn on a light, you use electrical energy. When you ride to school in a car or bus, its engine consumes chemical energy. What other types of energy do you use? Where is that energy produced? Which energy sources are nonrenewable, which are renewable.

Goals

- Identify how energy you use is produced and delivered.
- Investigate alternative sources for the energy you use.
- Outline a plan for how these alternative sources of energy could be used.

Local Energy Information	
Energy Type	
Where is that energy produced?	
How is that energy produced?	
How is that energy delivered to you?	
Is the energy source renewable, nonrenewable, or inexhaustible?	
What type of alternative energy source could you use instead?	

Using Scientific Methods

Test Your Hypothesis

Plan

1. Think about the activities you do every day and the things you use. When you watch television, listen to the radio, ride in a car, use a hair drier, or turn on the air conditioning, you use energy. Select one activity or appliance that uses energy.

2. **Identify** the type of energy that is used.

3. **Investigate** how that energy is produced and delivered to you.

4. **Determine** if the energy source is renewable, nonrenewable, or inexhaustible.

5. If your energy source is nonrenewable, describe how the energy you use could be produced by renewable sources.

Do

1. Make sure your teacher approves your plan before you start.

2. Organize your findings in a data table, similar to the one that is shown.

Analyze Your Data

1. **Describe** the process for producing and delivering the energy source you researched. How is it created, and how does it get to you?

2. How much of the energy you use every day comes from the energy source you investigated?

3. Is the energy source you researched renewable, nonrenewable, or inexhaustible? Why?

4. What other renewable or inexhaustible energy sources are used, or could be used, to generate electricity in your area?

Draw Conclusions

1. If the energy source you investigated is nonrenewable, describe how you could reduce your use of this energy source.

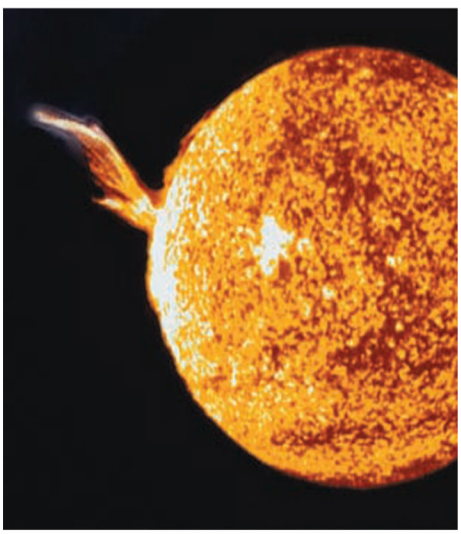
2. What alternative sources of energy could you use for everyday energy needs? On the computer, create a plan for using renewable or inexhaustible sources.

Energy To Burn

Did you know...

...Garbage—paper, vegetation, animal waste, and more—could be a huge source of energy. Garbage converted to fuel can be used for heating, cooking, transportation, and electricity production.

...Energy experts estimate that the Iraq could obtain all of the energy it needs from the Sun. This energy from the Sun could be captured if solar energy collectors were placed on one percent of the country's land area.



...The energy Earth gets each half hour from the Sun is enough to meet the world's demands for a year. Renewable and inexhaustible resources, including the Sun, account for only 18 percent of the energy that is used worldwide.

CHAPTER QUESTIONS 04

1- Which one below is not a fossil fuels?
A) Nuclear Energy B) Oil
C) Natural Gas C) Coal

2- Which one of the following is not nonrenewable resource?
A) Nuclear Energy B) Natural Gas
C) Solar Energy D) Coal

3- I. Fossil fuels produce energy.
II. Fossil fuels don't cause air pollution.
III. It takes millions of years to be formed fossil fuels.
IV. Nuclear factory produce almost air pollution.
Which information above is correct?

A) Only II B) I and II
C) I and III D) II, III and IV

4- Which one of the following is not disadventages of the nuclear energy?

A) The amount of nonrenewable uranium.
B) Nuclear power plants is radioactive.
C) They cause air pollution.
D) They can be dangerous for living things.

5- Which one below is not alternative sources?

A) Wind
B) Solar Energy
C) Hydroelectricity
D) Geothermal Energy

6- Which one of the following is inexhaustible resource?

A) Solar Energy
B) Natural Gas
C) Nuclear Energy
D) Wind Energy

7- What are the disadvantages of fossil fuels?

8- Write the disadvantages and advantages of nuclear energy.

9- What is the meaning of inexhaustible energy?

CHAPTER 05

SOME CHEMICAL INDUSTRIES IN IRAQ

ACHIEVEMENTS

After studying this chapter, the student will be able to:

- recognize the kinds of industries.
- list the types of cement and materials involved in the manufacture and explain the stages of production.
- explain the glass industry manually and things to be taken into account when forming the glass and stained glass components known each according to its color.
- know bacteria or vinegar and its importance in the industry.
- explain the use of reeds and papyrus plant in the paper industry shows the importance of all industry developments.
- know as crude oil and how its formation and extraction and lists methods for drilling oil wells producing.
- know the refining process and how to get the various petroleum products.
- study the sugar Industry.

Chapter - 5

5.1 INTRODUCTION

Chemistry has an important and vital role in our lives, as it provides much of what we need in our daily life such as food storage bags, kitchenware, textiles, medical and agricultural materials. Shortly, it is impossible to take apart chemicals from our daily life.

Industry to the nation is extremely important. Without industries, countries will not make progress. It is on the record that only those nations are on top who are also on top in the industrialization. There are several reasons for progress of industry as follows:

1. The importance of industry is what it provides for the people or companies engaged in a particular kind of commercial enterprise. Industry provides goods to consumers. The consumer gleans the benefit of the goods which enhances their existence by augmenting or provisioning food, clothing, or shelter and even entertainment.

2. The industrial manufacturer provides employment.
3. Industry consumes raw materials which are sold by others and bought by the industrial complex as an activity of daily business.
4. Industry results in employment for ancillary support services (hospitals, fire departments, state and local governments via taxation, infrastructure, and other businesses benefit by having goods and services for the people within the industrial complex who have wages providing them with money to spend on those goods and services.
5. Industry provides recycling opportunities either directly via their own mechanisms (like a hydroelectric plant with a dam resulting in a lake for boating and swimming or by providing a means (the cash) for people to pursue their own recycling interests in the form of vacations and leave policies in addition to the wages they pay.
6. The most significant importance of industry is the advances in science and engineering provided by the work of industry providing the means for more development of the economic cycle industry stimulates.

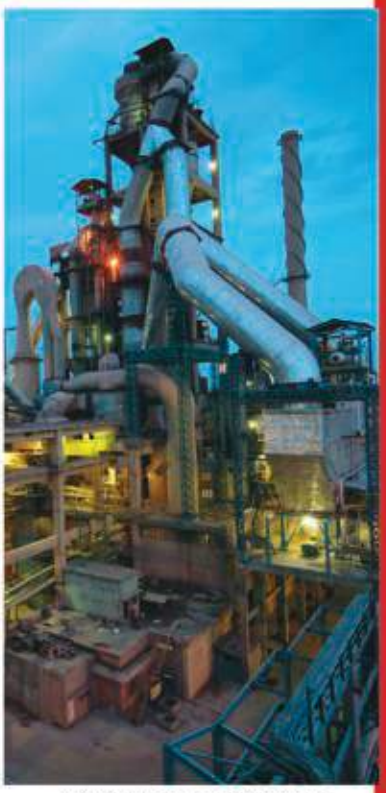
The chemical industry comprises the companies that produce industrial chemicals. Central to the modern world economy, it converts raw materials (oil, natural gas, air, water, metals, and minerals) into more than 70,000 different products. In this chapter, we will study some chemical industries located in Iraq.

5-2 CEMENT INDUSTRY

The dictionary meaning of 'cement' is 'to join'. Cement may be defined as adhesive substances capable of uniting fragments or masses of solid matter to a compact whole. Constructions are the backbone of civilization and development of society. From the time immemorial, constructions have

evolved around some type of building blocks, joined together with some binder. Mud blocks, pieces of stone cut and dressed to size, or bricks are examples of 'building blocks', which are joined with, may be mud mortar (specially in climates with little or no rain), lime or cement mortar, or even bitumen, and laid one over the other to erect the structure. Seen in this perspective, cement is the essential binder of the present day constructions, and concrete, again made with cement, is the leading building material the world over. The use of cementing materials is very old. The ancient Egyptians used calcined impure gypsum. The Greeks and Romans used calcined limestone and later learned to make lime mortar by adding other substances like sand, crushed stone or brick, and broken tiles, to lime and water. From the chemistry viewpoint, present-day cements bear similarity with lime, which was known as the classical building material for many centuries.
The cement used in our country Iraq is called as Portland cement.
Normal Portland cement is defined as a synthetic mixture of calcium silicates formed from a molten matrix from a suitably proportioned and homogeneously prepared mixture of calcareous and argillaceous components. Accordingly, Portland cement is made primarily from a calcareous material, such as limestone or chalk, and from alumina and silica found as clay or shale. The manufacturing process involves the following principal stages;

- Mining of raw materials, size reduction and grinding,
- Mixing them intimately in the desired proportions,
- Burning in a large rotary kiln at a temperature up to about 1450°C, when the materials sinter and partially fuse to form balls, known as 'clinkers'.
- Cooling of the clinker and storage,
- Grinding of the clinker along with gypsum to a fine powdery form. This is 'cement'.Cement is stored in suitable containers like 50 kg bags, one ton 'jumbo' bags, or tankers, for dispatch by road, rail or sea route to the point of use. The above description is rather simplistic, and in actual practice, considerable innovations take place. Take for example the raw materials. Clay may not be separately added and SiO_2 obtained from the coal ash and what is contained in limestone may be sufficient. Alumina and iron oxides are needed to act as flux in the clinker formation process, and additives like Bauxite and/or iron ore may have to be separately incorporated in the raw mix. Finish grinding of clinker may not be with only mineral gypsum but other forms of calcium sulphate may be used. Supplementary cementitious materials like fly ash, burnt clay or granulated blast furnace slag can be added at the stage of cement grinding to produce 'blended' or 'composite' cements. Depending upon the raw materials being mixed and fed to the kiln in dry form or as slurry with water, different 'processes' of cement manufacture are adopted. Finally, considerable engineering judgment and input of material science in all stages of various unit operations are required to optimize the energy requirement, meet demands of environmental restrictions and quality of the final product.



A typical cement factory

5-2-1 Types of Cement

The most important types of cement are given below:

Core-formed Phenician glass bottle (400s BC)

Glass factory in Anbar

1. Portland cement (normal): used in construction work in general. There are different varieties of this type, such as white cement and oil-well cement used in the lining of the oil wells.

2. Quick set cement: This is different kind of cement for ordinary cement in several respects. Characterized a greater degree of smoothness of ordinary cement, which leads to rapid solidification and generate heat rapidly. And this type is used in road construction.

3. Low temperature cement: has a low of calcium sulfate that lead to decrease in the degree of heat generated from the production of this type of cement.

4. Salts resistant cement: is characterized by its ability to resist high salt because of its components, and is used in concrete construction are vulnerable to the effects of salts (especially sulfates) is used in sewage and laboratories and factories dealing with chemicals.

5-3 GLASS INDUSTRY

People make glass by melting a particular kind of sand in a fire. This is sand that has a lot of silica in it. People have been using naturally occurring glass since the Stone Age, when they wanted an especially sharp edge on a tool or an arrowhead. Obsidian is a natural glass which forms when sand shoots out of a volcano during an eruption and is heated by the hot gases until it melts into glass. You find it in the Aegean islands between Greece and Turkey, where there are a lot of volcanoes. Even in the Stone Age, people used to sail there specially to get the obsidian. It wasn't until around 2500 BC that people began to make glass for themselves. The first glass was little glass beads, which people used for necklaces. Later they learned to make strings of glass, which you could wrap around a clay pot to decorate it. All through Iraq Mesopotamia and ancient Egypt, people used this kind of glass.

By about 1700 BC the Phoenicians (who were very good at glass working) could make core-formed glass perfume bottles. You made a solid bottle-shaped core out of clay, and then you wrapped lots of these glass strings around it, until it was all covered in them (kind of like a rubber-band ball). Then you let it cool and scraped out the clay to make a glass bottle. But this way of making glass bottles took a long time, and so glass was only used for jewelry and fancy bottles for a long time.

By 300 BC, traders had brought some of these early glass beads as far away as China.

Anbar is the largest province in Iraq and encompasses much of the Western territory. The province is rich in minerals and raw material which are suitable for the production of glass.Glass factory in Anbar resumed production after
10 years in 2012.

5-3-1 Glass Manufacturing

The main manufactured glass today is composed of essentially sodium and calcium silicates. The glass is manufactured from the fundamental

substances; those are pure sand (silica) and limestone (most of which calcium carbonate). Also there are additive substances such as broken glass; sodium sulfate or carbonate; or aluminum oxide and other substances are added according to the desired glass and its production condition:
The glass paste is prepared by mixing the fundamental substances with the additives in a definite ratios as the desired glass requires. The mixture places in a furnace coated internally by firestone and heated to a temperature ranges between 1300-1450 °C; the mixture fuses and forms a glassy paste that easy to be reformed.


A typical glass manufacturing

5-3-2 The Glass-Manufacturing In Iraq

The idea of glass manufacturing came to existence in Iraq after the great need to cover the markets demand to glass devices for the house's needs. The support to build up this factory where the occurrence of the rough substances and their cheapness; occurrence of experienced workers and existence of other factories those are of great needs to glass wares so the glass factory was built in Anbar province. More attentions were given to this work, which reflects the good quantity of its production.

5-3-3 Kinds of the Glass

Many kinds of glass were manufactured for different purposes the most important are:
a. Soda lime glass: is a kind of glass which is easy reformable. Bottles, glass containers of different volume and shape and glass plates for windows are made from this kind of glass.
b. Lead Glass: From this kind of glass, the valuable glass devices are manufactured such as lenses, prisms, chandeliers and the high cost vessels called crystals.
c. Pyrex Glass: This kind of glass is unaffected by instantly rising the temperature hence the most laboratory glass equipment's are made from this kind of glass:
d. The Glass Fibbers: Made from specials kind of glass paste, pressed through fine holes and pulled in form of thin fibbers which may be spindle and weaved in form of excellent woven characterized by softness of the stuff and used in production of fire proofed clothes stuff. These glass fibbers used as thermo isolators and in transmission of telephonic conversation and television programs.


Pyrex glasses can withstand high temperature.

5-4 VINEGAR INDUSTRY

Our country, Iraq is one of the countries that grow the kinds of dates, as the numbers of palm trees are over 30 million. Therefore, there is a factory in An Numaniyah city to produce annually 6,5 million liters of palm vinegar using 2000 tons of dates. Vinegar made from dates is a traditional product of Iraq. Vinegar is a liquid consisting mainly of acetic acid (CH_3COOH) and water. Vinegar is now mainly used as a cooking ingredient, but historically, as the most easily available mild acid, it had a great variety of industrial, medical, and domestic uses, some of which (such as a general household cleanser) are still promoted today.

5-4-1 Vinegar Manufacturing

Commercial vinegar is produced either by fast or slow fermentation processes. In general, slow methods are used with traditional vinegars, and fermentation proceeds slowly over the course of weeks or months. The longer fermentation period allows for the accumulation of a nontoxic slime composed of acetic acid bacteria. Fast methods add mother of vinegar (i.e., bacterial culture) to the source liquid before adding air using a venturi pump system or a turbine to promote oxygenation to obtain the fastest fermentation. In fast production processes, vinegar may be produced in a period ranging from 20 hours to three days.

a. Slow Method:

The atmospheric air contains numerous types of bacteria, from which "vinegar mother " when placed in sweet fruit's juice, such as grapes or apples or dates; they grow forming a floating layer on the juice surface. Since the exchange of the carbohydrates in the fruit's juice to vinegar takes place by attachment with this bacteria and the attachment of bacteria with the juice, by this method is too slow because it is limited by that area of the part that exposed to the air, hence the operation will be very slow and percentage of the obtained solution reaches 4-5% through extent of 40-60 days. For this reason we try with the rapid method.

b. Rapid Method:

The porous tool such as pieces of wood is placed in a special reservoir, and then covered by a layer of bacterial. The vinegar mother, then a solution of 12-15% alcohol, enriched with necessary food for the bacteria growth, is allowed to flow through the wood pieces; at the same time a stream of warmed air pulled up through the same medium in order a rapid oxidation of alcohol takes place, hence the attachment of the bacteria, that covers a wide area of the porous wood pieces, with the airis too great. In an interval of many hours, a solution formed that contains 8-10% acetic acid which diluted with water to about 4-5% concentration and used as vinegar.

5-5 SUGAR INDUSTRY

Sugar is a chemical substance with a structural formula of $C_{12}H_{22}O_{11}$. The sugarcanes which grow in Mosul and Sulaimanyah provinces are considered as the basic sources for the sugar industry in our country, it is manufactured by following steps:

sugarcanes

1. The starting materials (sugar cane) are taken from the farms, transported to the fabrics, where washed with a strong water stream to isolate dust, then cut into small pieces mechanically and mixed with enough water to extract the sugar from them as more as possible, then pressed to isolate remain sugar in these pieces.

2. The extracted sugar solution, which is named as sugar-drink, is heated with excess calcium oxide to isolate the excess undesired substances. The excess calcium oxide reacts with water to form calcium hydroxide which is isolated by passing a stream of carbon dioxide in the sugar solution to react with calcium hydroxide and changing the later to undissolved calcium carbonate. The sugar solution (the sugar drink) is then purified from impurities

by filtration to obtain a clear colored solution.

3. The sugar solution (the sugar drink) is then bleached by mixing with animal charcoal (that coal is prepared from animal bones), and then filtered to obtain clear and colorless solution.

4. The obtained sugar solution is then heated under reduced pressure at the temperature-range 60-65 °C, hence the majority of solution's water is vaporized and concentration of the sugar is increased in the solution till a thick solution (syrup) is obtained. Sugar easily decomposes under the influence of high temperature, hence it's heating with boiled water leads to its decomposition and the obtained sugar solution is evaporated under reduced pressure to avoid its decomposition.

5. The condensed sugar solution is placed in centrifugal tubes to separate the crude sugar crystal out of the solution. The crude sugar is the normal one with yellow color since it contains undesired impurities.

6. The crude sugar undergoes some operations to extract and isolate it from the impurities. Finally the condensed sugar solution is placed in centrifuges again and heated by hot air to separate the pure, dry sugar crystals. Then transported to stores where as packed in sacks and sold in the demanded form.

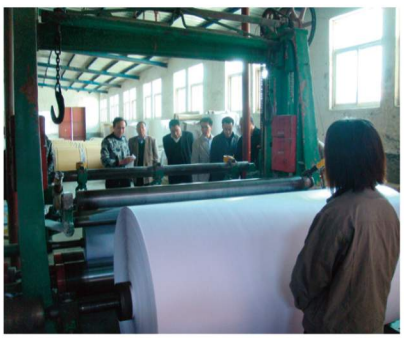
sugarcanes

5-6 PAPER INDUSTRY

As it is known, the paper industry depends on cellulose fibbers that are present in plants. Cellulose is a chemical substance whose chemical formula is $(C_6H_{10}O_5)_n$. In Iraq, the paper industry depends on essentially Egyptian reed, which grows naturally in the marshlands.

The cellulose fibbers in the plant are connected together by gummy substances called "Lignin". In paper industry this substance is dissolved by treatment with chemical reagents in different methods.

The paper industry from cellulose fibbers passes through different stages, of which: Crude cellulose fiber cutting into small pieces ranges between (1.5-2.5) cm length nearly to simplify saturate with chemicals and paper paste is formed. After cutting operation, the reed (or the Egyptian reed) pieces are passed through special machines to clean them from dusts and impurities that suspended with land. Then cooked with sodium hydroxide and sodium sulfide in a big, rotated, pot which is called "the digester" and the cooking achieves under relatively high temperature & pressure; a gray-black colored paste and black colored concentrated liquid are obtained. Then paste is separated from liquid and washing with hot water obtained gray paste which is bleached with chlorine gas first, then with bleaching powder to complete the bleach operation. Then pulled by special machines and changed to paper plates. In this stage, certain substances are added that increase the weight and the quality, then dried, ironed and cut as demands.



Paper manufacturing

5-7 CRUDE PETROLEUM

5-7-1 Existence:

Crude petroleum exists in different parts of the world in different qualities and structures. Some of them exist near the earth surface, which is bad quality since it has lost majority of the desired volatile substance occur in

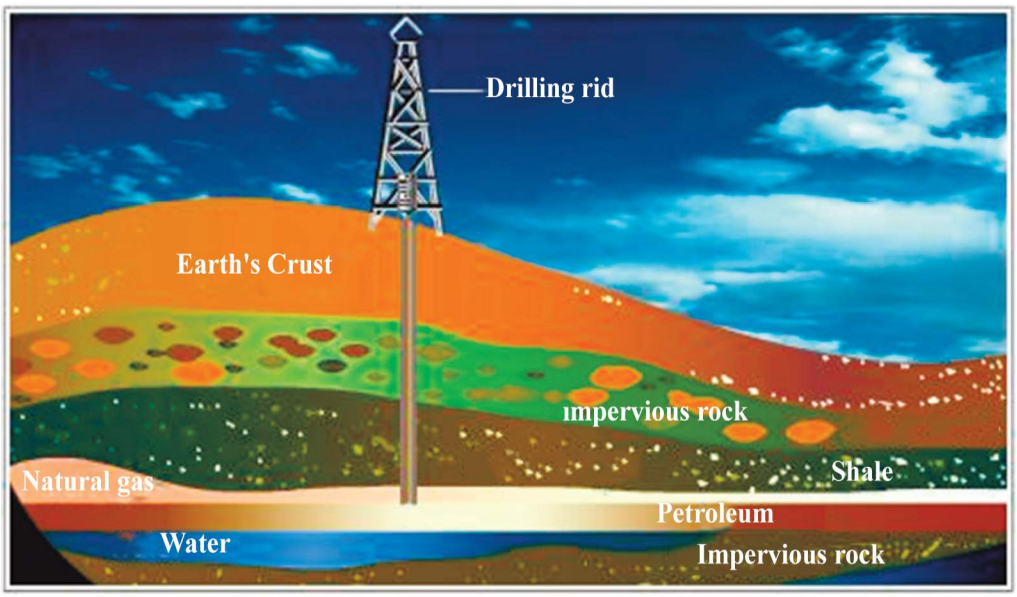
crude oil, while those far from the earth surface are good quality.

5-7-2 Formation:

The crude petroleum is viscose, condensed black greenish color oil having undesirable odor. It consists of a complex mixture of organic compounds of carbon and hydrogen elements (hydro carbonic compounds) as essential parts of compounds and it also contains sulfur to which undesirable odor belongs. The ratio of constituents of the petroleum differs according to the origin existence.

The theories that explains its formation are different, but the more accepted one is organic source theory, which returns the origin of its formation; precipitation of micro-organisms of animals and plants lived then died at the bottom of the sea at million years ago, where water was covering great area of the earth, then sediment under the influence of very high heat and pressure in the interior of the earth, changed to the petroleum droplets and moved through the porous rocks till it had reached a nonporous layer or water layer then accumulated and remained floating over. Above the petroleum layer there is a gas cup as indicated in the following figure 5-1.

Figure 5-1



The reality of the organic theory is confirmed by the discovery of tracks of some putrefied microorganisms near the petroleum-layers. It is important to know that the Iraqi crude petroleum undergoes this theory.

5-7-3 Derivation (extraction):

The good qualified crude petroleum is derived from wells of more than many thousand meters deep and this requires special method to dig, which is called "porous rock diggings" method. The digging instrument is carried and fixed by the dig tower as illustrated in figure 5-2.

Figure 5-2
Contribution of crude oil to the national economy is incredibly huge.

Meanwhile of the digging operation, a metallic pipe is alighted till it reaches to bottom of the petroleum well then translates the crude oil up and derived petroleum is generally mixed with quantities of natural gas, water, and sand; for this reason it must be extracted from the impurities by specified devices, then stored in great containers in order to separate its constituents.

5-7-4 Refining:

The separation of the essential parts of the crude petroleum is called refining. This operation applied by translation of the petroleum (after its extraction from the impurities) to the refining tower, which is composed of a high tower containing. Many plates each of which composed of a number of small plates and tubes to separate the petroleum's constituents as in the figure 5-3. Before entering the refining tower, the crude petroleum is heated in absence of the air at temperature range about 400 °C, hence vaporized gases ascend through the tower, then the vapor is condensed and separated to its essential parts that we obtain from this tower. The important parts are:

1. Refinery gas: is a mixture of many gases among them: propane and butane gases which are separated from the refinery gas then compressed together in special kinds of containers, sold under the name "liquefied gas" such as that used in our country.

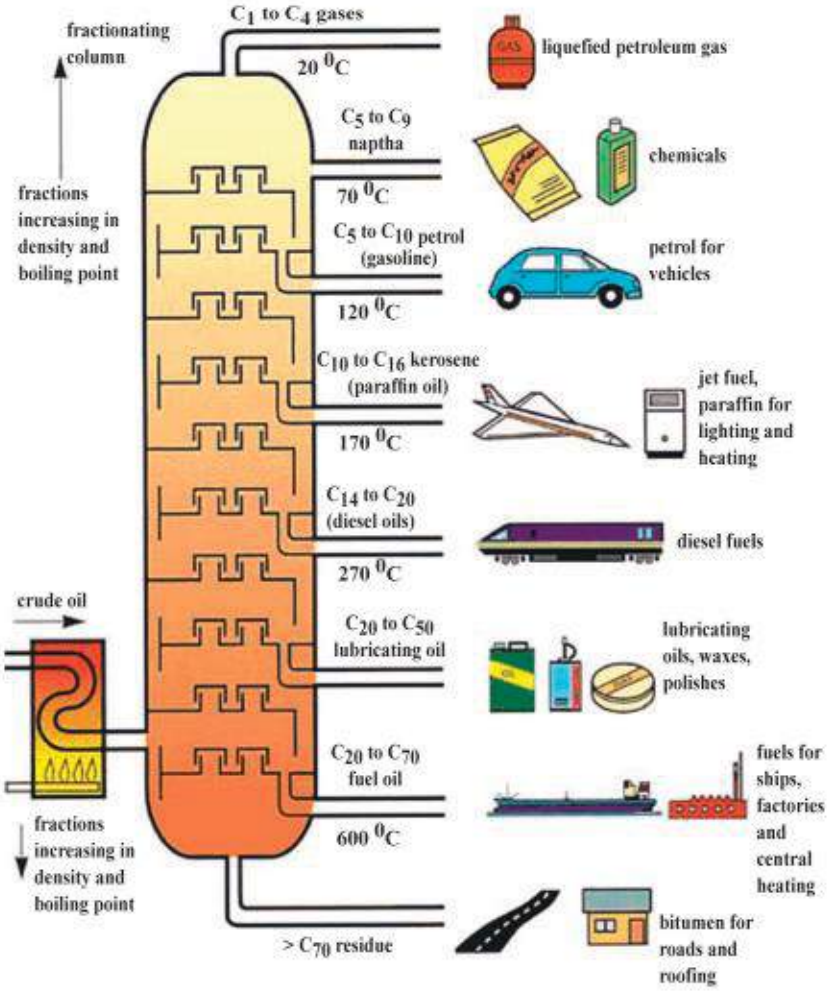


Figure 5-3
Refining of crude petroleum

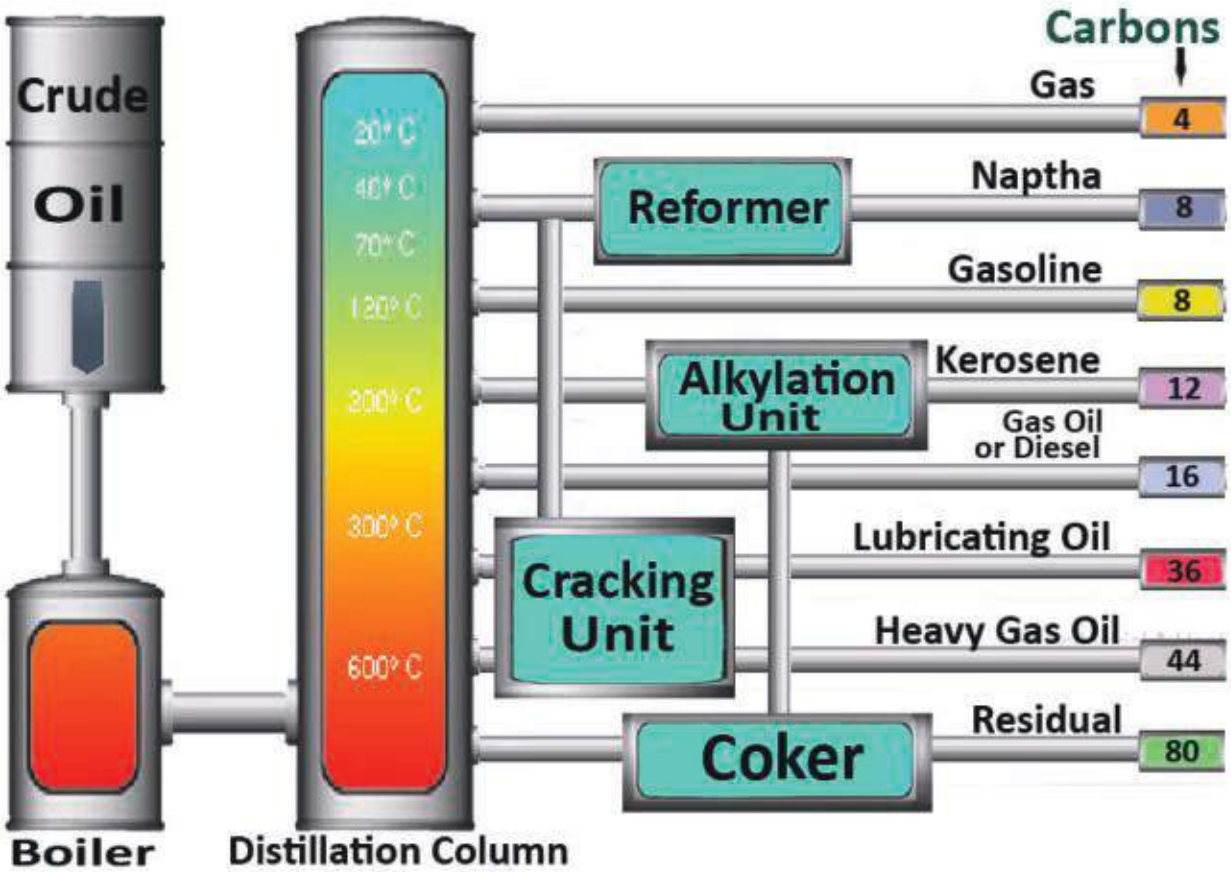
2. The gasoline (benzene): is used as light fuel in high compression motors of the automobiles.

3. The kerosene (white oil): is used in heating and lighting purposes and in airplane fuels.

4. The gas oil: is used as heavy engine's fuel for the of high compression motors of diesel motors and for producing other substance.

5-7-5 Importance of the petroleum industry:

Petroleum is an essential source for many starting materials used in different new industries, in addition to its used as a basic fraction of fuels. Many chemical compounds were manufactured that enters to different branches of our life such as different types of plastics and rubbers, dyes, synthetic fibbers & textiles, and more of the medical drugs and insecticides.



READING PART

PETROLEUM

Petroleum, along with oil and coal, is classified as a fossil fuel. Fossil fuels are formed when sea plants and animals die, and the remains become buried under several thousand feet of silt, sand or mud. Fossil fuels take millions of years to form and therefore petroleum is also considered to be a non-renewable energy source.

Petroleum is formed by hydrocarbons (a hydrocarbon is a compound made up of carbon and hydrogen) with the addition of certain other substances, primarily sulfur. Petroleum in its natural form when first collected is usually named crude oil, and can be clear, green or black and may be either thin like gasoline or thick like tar.
There are several major oil producing regions around the globe. The Kuwait and Saudi Arabia's crude oil fields are the largest, although Middle East oil from other countries in the region such as Iran and Iraq also make up a significant part of world production figures.

Originally the primary use of petroleum was as a lighting fuel, once it had been distilled and turned into kerosene. When Edison opened the world's first electricity generating plant in 1882 the demand for kerosene began to drop. However, by this time Henry Ford had shown the world that the automobile would be the best form of transport for decades to come, and gasoline began to be a product in high demand.

World War I was the real catalyst for petroleum production, with more petroleum being produced throughout the war than had ever been produced previously. In modern times petroleum is viewed as a valuable commodity, traded around the world in the same way as gold and diamonds.

Most people tend to believe that petroleum is mostly used to power internal combustion engines in the form of gasoline or petrol. Although our automobiles and other forms of transport do consume the highest quantity of petroleum it is used for a vast array of applications.

In its thickest form, the almost black petroleum is named bitumen, this is used for paving road, forming the blacktop, it is also an excellent water repellent and is used in roofing.

Petroleum is also a major part of the chemical makeup of many plastics and synthetics. Possibly the most startling usage of petroleum for many people is its appearance in foodstuffs such as beer and in medications such as aspirin.

The world has a limited supply of petroleum, and current estimations tell us that within the next few decades mankind will have completely depleted this valuable natural resource. Although measures have been taken to ensure that there are cheap, renewable fuel options in place for the eventuality it is still obvious that mankind faces a serious problem when petroleum supplies finally run out.

CHAPTER QUESTIONS 05

1- Explain the following.

1) Types of glass
2) Types of cement
3) Cement manufacturing steps
4) Crude oil formation steps

2- How can a glass in a different color be obtained?

3- Why are limestone and sodium sulphate or chloride added to the glass paste?

4- Why does crude oil smell bad?

5- How does the quality of crude oil change?

6- When is chlorine gas used in paper manufacturing?

7- Why low temperature and unbalanced pressure are used in sugar manufacturing?

8- Why is carbon dioxide, CO_2 gas used in sugar manufacturing?

9- What should be the percentage of acetic acid in vinegar?

10- What are raw material used in sugar manufacturing?

11- What is the chemical formula of sugar?

12- At what temperature are the raw materials of cement burnt in oven?

13- What was the reason to build glass factory in Anbar province?

14- What is used in heat isolation and telephone transmission lines?

15- Define Portland cement.

16- How do you prove that crude oil is derived from animal fossils in Iraq?

17- Explain refining of crude oil and petroleum products obtained after refinery.

18- Where and how is crude petroleum found in nature?

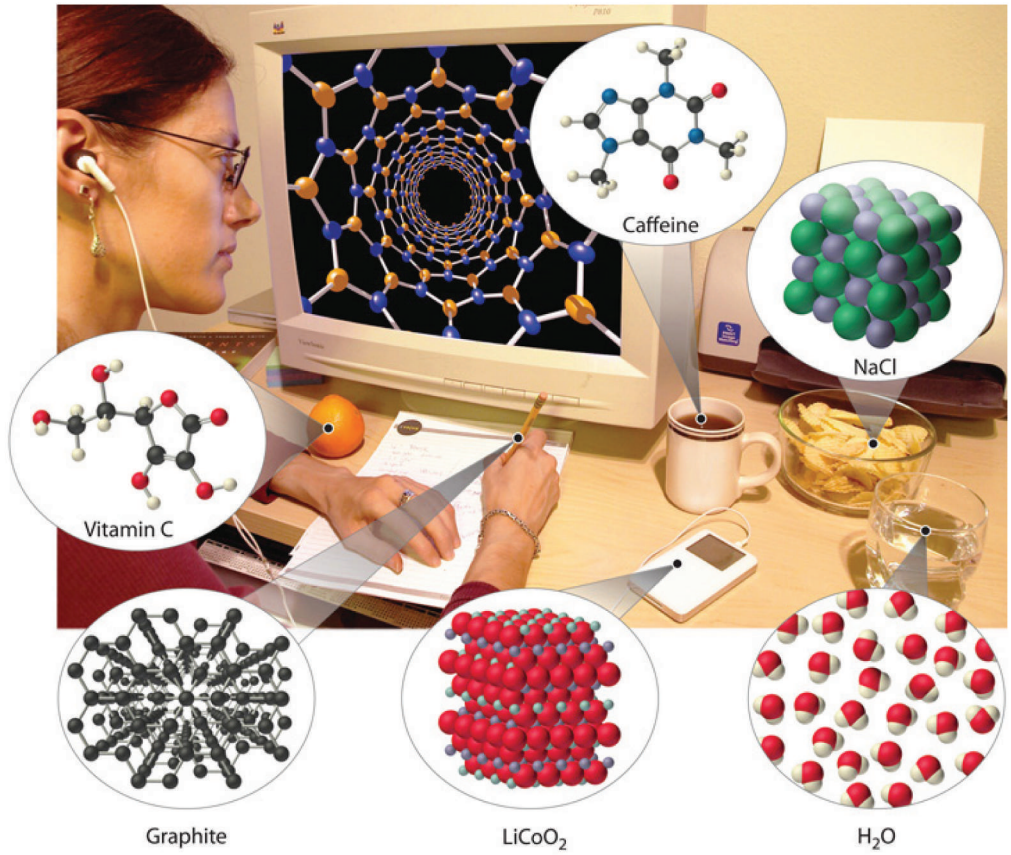
19- Explain everything about Pyrex glasses.

20- What are the importances of crude petroleum for countries?

21- What is the importance of industry for countries?

CHAPTER 06

CHEMISTRY IN EVERYDAY LIFE



ACHIEVEMENTS

After studying this chapter, the student will be able to:

- recognize the bacteria-free environment.
- enumerate certain types of ink.
- show how to get rid of types of stains.
- classify types of leather used.
- demonstrate how tanning leather.
- show the importance of milk and dairy products.

6-1 CHEMICALS IN DAILY LIFE

Toothpaste is an example of chemical substance that can be found in our daily life. What are chemical substances? Can you live without chemical substance? Find the answer right away! In this topic, we will learn about chemical substances that can be found or usually used in our daily life. Generally, chemical substances are classified into two types, chemical substance in food and non food materials. In this session, we just discuss about chemical substance in non food materials.

6-2 CHEMICAL SUBSTANCES

6-2-1 What are chemical substances?

Do you still remember what is chemistry? Chemistry is a science which studies matter and its changes. Based on this concept, we might conclude that those matter consist of all chemical substances, include elements, compounds, and mixtures. Some common examples of chemical substances in daily life are water, salt, sugar, and vinegar. But in daily life, the concept of chemical substances are related to artificial chemicals (synthetic).

6-2-2 Classification of Chemical Substances

Based on its origin, chemical substances can be classified as natural and artificial chemicals.

a. Natural Chemicals

Natural chemicals come from natural resources such as kerosene, coal, plant, animal, sea, and air. Gasoline, kerosene, and diesel fuel are natural chemicals that come from petroleum. Some examples of chemical substances that come from plants are sugar which made of sugar cane and caffeine which made of coffee, whereas table salt made of seawater. The air can also produce some chemicals that are in the form of gas, such as nitrogen, oxygen, and noble gas like argon and neon.

b. Artificial Chemicals (Synthetic)

Artificial chemicals are made of many kinds of chemical substances. The making of artificial chemicals in small scale is usually carried out in the laboratory, whereas for large scale is usually carried out in industry. Some examples of artificial chemicals are sodium hydroxide, acetic acid (vinegar), nitric acid, sulphuric acid, and ammonia.

6-2-3 Chemical Properties

Chemical substances has many properties, such as flammable, explosive, corrosive (able to erode or damage other substances), and toxic. Some examples of flammable chemicals are gasoline and alcohol, whereas some examples of explosive chemicals are liquid propane gas and the mixtures of hydrogen and air. For corrosive chemicals, the examples are sulphuric acid and nitric acid, whereas the examples of toxic chemicals are chlorine gas and mercury. Be careful when using chemicals! Careless use of chemical substances can be dangerous. It' s very important to study chemical properties and how to use them. So, you can safely use chemical

substances. We have to be very careful in dealing with toxic chemicals. The level of toxic in chemical substances are various. The toxic can be absorbed through the skin and respiration, or unintentionally swollen by mouth. Toxic chemicals not only caused direct bad effects, but also gave long term bad effects.

6-2-4 Information about Chemical Substances

How can we know about the properties and the way to use a chemical substance? Chemical substance which has dangerous properties, usually is labeled specially. Information on the label warns the user to be careful when use it. Some examples of warnings and suggestions in the label of a product:

No:	Warning	Suggestions
1	Watch out, flammable product!	Keep away from fire or hot materials.
2	Watch out, easy to explode!	Do not expose to heat and keep away from fire.
3	Watch out, corrosive material!	Avoid direct contact. If contact with skin or clothes occurs, wash with plenty of clean water.
4	Watch out, toxic substance!	Do not eat!

Keep out of reach of children! Also frequently can be found at the product package which potent to be dangerous, for example at mosquito repellent or floor cleaner. Try to observe, what kind of warning stated in the product that you usually use?

Beside warning label, in the package or container of a chemical or product usually listed information about direction and dosage. This means to hinder failure by the user so it can reduce accident risk.

Another information which is usually found in the label of a product is the composition or ingredients. The list of ingredients are very important for all consumers. By using such information, consumers will be able to differentiate one product from another, so that they can choose the right product for themselves. By reading the composition list on the label of a product, consumers can also find out about the quality of such product.

6-2-5 Packages of Chemical Substances

The package or container of a product must be correspond to the properties of the chemical substance and its safety. That' s why we are able to identify the properties of a chemical substance from its container or package. Here are some chemical properties that can be identified from their containers

To evaluate your understanding, please answer the questions below:

1. Write down any information that you get from the label of a product!

2. What are the advantages that can you get if you understand the warnings and suggestions which mentioned in such label?

3. What will happen if you don' t follow the warnings in the label of a product?

or packages: The form and the safety of substances. Solid and safe substances are usually packed in the containers or packages made of paper, whereas liquid substances are usually placed in the bottles or cans. The resistance of substances to the effects of air and direct sun's heat; the substances which have this property are placed in light proof cans or bottles. The resistance of substances to evaporate; substances which are easy to evaporate usually placed in the bottles with narrow mouth and dense cap.

6-3 CHEMICAL SUBSTANCES AND THEIR USAGES

There are many benefits that can we get from chemical substances. Chemical substances make our life easier and develop our quality of life. Now, we are going to learn about some chemical substances in our daily life.

6-3-1 Cleaner Products

Examples of cleaner products that are usually used in many houses are soaps, detergents, toothpaste, and shampoos. What are soaps, detergents, toothpaste, and shampoos?

a. Soap

Soap is a basic salt that is made of many fatty acids. Recently, soaps are made using modern processes. We can make soap by reacting sodium hydroxide base or potassium hydroxide with a fatty acid, either animal fat or plant fat. The process of making soap is called saponification. Soap does not only consist of sodium hydroxide or potassium hydroxide, but also other substances such as dyes and fragrances. That's why we often find soaps in many beautiful colors and with fruit and flower fragrances. Beside that, some soap also contain cream, vitamins, and moisturizer.

b. Detergent

Detergents are cleaner that contain an active substance called surfactantor surface active material. Surfactants are able to reduce the tension of water surface so that it can be mixed with oil or fat. That' s why we use to soak the dirty clothes with detergent because it can wash many kind of dirt, either in solid or liquid form.

Other major substances in detergent are as follows:
The filler (sodium sulfate) that can be used to increase or enlarge detergent' s volume. The supporting material such as sodium hydroxide and phosphate compound. These materials can be used to increase the cleaning power of detergent. Additional material for example CMC (carboxy methyl cellulose) that can be used as anti-redeposition which means to maintain the cleanliness of clothes. Fragrance (perfume) that makes the clothes not only clean but also fragrant after being washed by detergent. Enzyme is usually added to modern detergents. It functions to increase the cleaning power of detergent. It also can break some biological stains

such as sweat, blood, and egg stains.

How does detergent work?

Detergent can be dissolved in water because they contain some materials that correspond to water (hydrofil). Detergents also contain some materials that do not match with water (hydrofob). If hydrofil and hydrofob work together, they will be able to wash away dirts. The molecule tip of hydrofob or stick to the molecule of the oily dirts. At the same time, the part of hydrofil which surrounds the particle of oily dirts form a ball structure that is called misel. The dirt molecules which have been surrounded still waft about the water and since they have been blocked, they can not stick to the cloth fiber. If we wash the clothes with clean water, the dirt molecules will disappear and the clothes will be clean again.

c. Shampoo

The detergent content in a shampoo is able to decrease the tension of water surface, with the intention that it can move throughout the hair. Besides that, the detergent in shampoo can break the fat so that we can easily wash our hair. There are many other materials that you can find in a shampoo. Those materials are written down in the label of the shampoo.

Some examples of them are fruit extracts, vitamins, eggs, honey, herbs, calamondins, and celeries. Try to find other materials that are usually added in shampoo! Shampoo break and draw out all stains, dirts, dandruffs, salts, and oil from hair. These can not be done by water only.

d. Toothpaste

Toothpaste is used to clean out tooth from the remains of food that are still there and plague (tartar). It is made of refined calcium carbonate which are mixed with glycerin. Other materials added to toothpaste are sweetener, dye, breath refresher, also germ and microbe resistor. Toothpaste also contain an active substance called sodium fluoride which is able to strengthen tooth enamel, restrain the formation of tartar, and guard against cavity.

6-3-2 Whitener

Whitener is materials that used to make things whiter. Whitener commonly used by humans are whitener for clothes, skin, and tooth. There are two types of clothes whitener, solid and liquid whitener. The active substance of a whitener is chlorine, which are classified as sodium hypochlorite (in liquid form) and calcium hypochlorite (in solid form). Clothes whitener is only recommended for white clothes to make it more sparkle. The usage of whitener for colored clothes will fade its color.

Over usage of whitener also will damage clothes because of active ingredient (chlorine) can damage clothes fiber. Clothes which are made of polyester will become yellowish if we soak them into whitener. In the container of a whitener, we always find a warning which tell us not to

mix whitener with soap or detergent. We can not do that because if we mix them, they will produce a toxic gas which is called chlorine gas, Cl2. It will be very dangerous for us if we inhale that toxic gas continuously or in large amount.

Beside clothes whitener, we are also familiar with tooth and skin whitener. One of used in tooth whiteners are hydrogen peroxide (H_2O_2) and carbamide peroxide. 10% of hydrogen peroxide is the same as 2% peroxide. The chemical substance that are usually found in skin whiteners are hydroquinone, kojic acid, and azelaic acid. Those three substances obstruct the formation of melanine skin pigment.

6-3-3 Fragrance

Fragrance is an aromatic chemical compound that has certain odor. Aromatic chemical compound usually volatile, so it can be smelled by our nose. That is why fragrance always kept in bottle with narrow neck. Fragrance can be made of synthetic or natural substances. Most of natural fragrance derived from some parts of plants such as flower, fruits, root, bark, or wood. For example, the geraniol from roses, jasmone from jasmines, citrus from oranges, and sassafras oil from sassafras woods. Those ingredient is taken by extraction or steam distillation.

Synthetic fragrance is made by mixing chemical substance with esterification reaction. Esterification is a chemical reaction between alcohol and carboxylic acid that produce ester compound with pleasant odor. Ester compound usually has similar odor with some flowers and fruits. For example, methyl butyric which has fresh apple characteristic odor and amyl acetic which has banana odor. Nowadays, synthetic fragrance is preferred because it is easier to be made and more economical.

6-3-4 Insecticide

Active ingredients of an insect repellents in houses are permethrin and tetramethrin. Those are synthetic chemicals which work by attacking nervous system of insect. Permethrin is known to have low toxicity to mammals and is poorly absorb by skin. The others active ingredient of insect repellent are transflutrin, DEET (N, N-dietil-mtoluamide), and icaridin. Transflutrin is an insect repellent which is usually used in indoor environment. DEET is an active ingredient of insect repellent which is intended to be applied to skin. Icaridin also known as picaridin is active ingredient an insect repellent which is almost colorless and odorless. It is effective to kill some insects.

Many insecticides are not only made of synthetic active materials, but also natural materials such as:

a. Pyrethrin is derived from chrysant flower (Chrysanthemum cinerariaefolium).

b. p-menthane -3,8-diol or also called PMD is derived from Eucalyptus citriodora leaf oil is an active ingredient which give menthol odor and cool effect.

c. Nepetalactone is isolated from catnip plant (Nepeta cataria) which is effective to kill cockroach and mosquito.

d. Citronellal oil is derived from lemon grass plant.

Some examples of active ingredient of insecticide being used in agriculture are as follow:
a. Organochloride compound such as DDT, chlordane, aldrin, and lindane.
b. Organophosphor compound such as acephate, chloetoxyfos, dichlorof os, and fenamifos.
c. Carbamate compound such as aldicarb and carbofuran.
d. Phyretoid compound such as permethrin.
e. Neonicotinoid compound such as acetamipid and clotianidin.

There are also natural active ingredient of insecticide being used in agriculture which are derived from plants, such as:
1. Caffeine is derived from tea and coffee plant.
2. Rotenone is derived from climbing leguminous plant, derris.
3. Nicotine is derived from tobacco plant.
4. Tetranottriterpenoid is derived from neem plant (Azadirachta indica).

6-3-5 Paint

Paints are thick colored solution which can be used for coloring the surface of an object. Based on their usages, we already know many types of paint such as wall paint, wood paint, car paint, iron paint, and special paint for painting. Based on its solvent, paints are classified into water paint and oil paint. Water paint or water color is also known as acrylic paint. Paints are made of many kinds of chemical substance. Commonly, paints are made of three components, i.e. dyes, binding substance, and solvent. Other than those three main substances, additive substances are usually added to paints. Additive substances have certain functions, such as fungicide as anti fungus, dryer substance as the dryer of paints, coagulant substance to make the paint thicker, fragrance, and other substances that can protect paints from raindrops, sunlight, and water changes.

6-3-6 Fertilizer

Just like humans and animals, plants also need food for their growth and enlargement. Plants get its food from soil, that' s why the fertility of the soil is very important for the growth of the plants. Fertilizers contain such substances that needed by plants. We add some fertilizers if the substances in the soil are not sufficient for the plants. Based on its origin, fertilizers are classified into natural and artificial fertilizer. Some examples of natural fertilizers are compost and manure. Artificial fertilizers are chemically made in factories and an example of them is urea-based fertilizer. There are three components which are needed for the growth of plants, i.e. nitrogen (N), phosphorus (P), and sodium (Na). Some types of fertilizers which are useful for plants such as nitrogen fertilizer, phosphorus fertilizer, and sodium fertilizer.

CHAPTER QUESTIONS 06

1- Explain the following terms;

1) disinfectant
2) antiseptic
3) insecticide
4) synthetic

2- How does detergent work? Explain.

3- What is the benefit of killing of microscopic organism.

4- Give example about types of fertilizer.

5- Why is your hair shining after bathing?

6- How many chemical substance are there? Explain briefly?

7- What is the importance of chemical substance?

8- What is the advantages and disadvantages of chemical fertilizer?

9- Which of the following chemicals is artificial?

A) Kerosene B) Hydrogen
C) Nitric acid D) Water

10- Which of the following chemicals is corrosive?

A) Propane gas B) Oxygen gas
C) Hydrochloric acid D) Ester

11- Which of the following chemicals is toxic?

A) Sodium hydroxide B) Chlorine gas
C) Acetic acid D) Oxygen gas

12- Which of the following expressions is not true for soap?

A) Soap is made of many fatty acids.
B) Soap consists of sodium hydroxide, dyes and fragrances.
C)Some soap contain cream, vitamins, and moisturizer.
D) Soap does not contain fatty acids.

Common Laboratory Apparatus and Equipment

Learning Objectives

- Laboratory
- Common laboratory apparatus and equipment
- Recording of an experiment
- Safety rules in chemistry laboratory

Chemistry is the branch of science which deals with the properties and reactions of substances. It helps us to understand the basic principles that govern the interaction of different substances.

Thirst for Knowledge

A person who studies chemistry is called a chemist.

Chemistry involves a lot of experimentation. An **experiment** can be defined as a test carried out under controlled conditions to demonstrate a known truth, examine the validity of a hypothesis or determine the efficacy of something previously untried.

LABORATORY

Have you seen a laboratory in your school? It is a place where experiments are carried out and analyses are performed to reach a conclusion.

Most laboratories are well-organized and clean places that have provisions to control conditions such as temperature, pressure, humidity, etc. A good chemistry laboratory is fully-equipped with the basic measuring and analytical laboratory apparatus that allow a good study of all the branches of chemistry.

Chemistry laboratory

A chemistry laboratory should be equipped with the following facilities:

1. **Working table:** It is a place where a chemist works. It should consist of gas taps, sink, reagent shelf, waste paper basket, a side shelf for keeping glassware apparatus, a fume closet and a gas cylinder.
2. **Reagent shelf:** All the reagents and chemicals should be kept in a reagent shelf with proper labels.
3. **Exhaust fans:** A laboratory should have exhaust fans on top of the walls with a vent to expel poisonous gases and fumes.

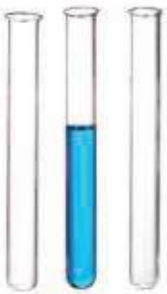
4. **Balance room:** There should be a balance room with a number of balances for weighing chemicals. It should be free of dust and smoke for accurate measurements.

COMMON LABORATORY APPARATUS AND EQUIPMENT

Apparatus is a group of materials or devices required to carry out experiments. They are used to measure, observe and compare things with greater accuracy. Common laboratory apparatus and equipments are described below.

Test Tube

It is a cylindrical glass tube whose one end is open while the other closed end is curved outwards. There are different types of test tubes made of different types of glasses. Test tubes are available in different sizes. Test tubes are used for heating and boiling small quantities of chemicals.



Test tubes

Thirst for Knowledge

Test tubes that are made from expansion-resistant glasses such as pyrex can be placed directly over a Bunsen burner's flame. They are also called hard glass tubes or boiling test tubes.

Test tube stand or rack

Test Tube Stand or Rack

A test tube stand or rack is made up of steel, plastic or wood. It is used to keep test tubes. It has bars and holes to keep the test tubes in inverted or upright position respectively.

Test Tube Holder

It is a metallic rod with plastic or wooden handle at one end and a clamp at the other end. It is used to hold a test tube either while heating a substance or when strong chemicals like acids or alkalis are poured into another apparatus.

Test tube holder

Beaker

Beaker

It is an open glass container, cylindrical in shape, with a flat bottom and a lip for pouring. Beakers are available in a wide range of sizes and are made of different types of glasses. There are beakers with and without graduations. Beakers are used for stirring, mixing and heating solutions.

Round-bottom Flask

It is a glass container with spherical bottom and a narrow cylindrical neck. It is generally used for heating solutions. The round bottom of the flask allows uniform heating and/or boiling of solutions. Round-bottom flasks are available in many sizes.

Round-bottom flask

Flat-bottom flask

Flat-bottom Flask

It is a flask which is similar to round-bottom flask but has a flat bottom that allows it to stand on a levelled surface. It is used for storing and mixing liquid chemicals. It is not used for heating purposes.

Conical Flask

A conical flask is also known as Erlenmeyer flask. It has a flat bottom, conical body and a cylindrical neck. It has markings on its outer surface to indicate the approximate volume of contents. It is often used to heat solutions and for titration experiments.

Conical flask

Glass tubing/ tube

Glass Tubing/Tube

It is a hollow piece of glass and is open at both the ends. It can be bent by heating to red hot over a non-luminous Bunsen flame, to transfer gases from one vessel to another.

Glass Rod

It is also known as stirring rod. It is a solid glass tube. It is used to stir solutions in flasks and beakers.

Glass rod

Funnel

Funnel

A funnel has a conical-shaped mouth and a long tapering neck. It is used to pour liquids or channel fine grained substances into containers with a small mouth. It is available in various sizes and is usually made of glass or plastic.

China Dish

It is also called an evaporating dish. It is made of porcelain. It is used to evaporate liquids by heating.

China dish

Pipette

Pipette

It is a long narrow tube with a nozzle at one end and a bulb in the middle. Nowadays, pipette with a rubber vacuum bulb is also available. A pipette is used to transfer a measured volume of liquid.

Note: You should never pipette any chemical using your mouth.

Burette

It is a long cylindrical graduated tube with stopcock near its bottom end. It is used for measuring and dispensing known amounts of liquids and is widely used in titration experiments.

Burette

Measuring cylinder

Measuring Cylinder

It is also called graduated cylinder. It is a cylindrical graduated glass or plastic vessel with a flat bottom and lip for pouring. A measuring cylinder is used to measure a fixed volume of liquid.

Iron Stand

It has a long iron rod fixed on a flat base. Clamps can be attached on the iron rod. It is used for holding apparatus such as round-bottom flasks or test tubes in a specific position.

Iron stand

Tripod stand

Tripod Stand

It has three legs and a triangular base in the middle. It is made of iron. A tripod stand is used for supporting apparatus while heating.

Asbestos Wire Gauze

It is an iron wire mesh with thin asbestos in the middle. It is placed over the tripod stand to provide a stage for a glass apparatus while heating. It helps in even distribution of heat from the burner to the glass apparatus.

Asbestos wire gauze

Pestle and mortar

Pestle and Mortar

A pestle is a heavy baseball bat-shaped stick whose end is used for pounding and grinding. A mortar is a bowl in which the substance to be grind, crush or mix is kept. Pestle and mortar are made of porcelain, stoneware, marble and wood. They are used to crush, grind and mix solid substances.

Spirit Lamp

It is a device used for heating purposes. It burns alcohol or other liquid fuel. It has three parts—tank, neck and cap. The fuel is filled in the tank. A cotton wick that is immersed in the fuel passes through the neck. The cotton wick soaks up the fuel and burns when lighted. The flame of the spirit lamp is extinguished by carefully covering it with the cap (cover).

Spirit lamp

Note: A spirit lamp should never be extinguished by blowing air from the mouth.

Bunsen burner

Bunsen Burner

These days spirit lamps are replaced by another heating device called Bunsen burner. It consists of a mixing tube in which gas and air are mixed. The gas comes from the nozzle and air comes from the air holes. When ignited, it burns with a blue flame on top of the burner. The flame can be adjusted by opening or closing the adjustable air holes.

Spatula

It is like a spoon. It is used to take small quantities of solid chemicals.

Spatula

Dropper

Dropper

It is a long tube made up of glass or plastic with a vacuum bulb at one end. A dropper is used for drawing a liquid and releasing a very small quantity of it at a time.

Watch Glass

It is a circular, slightly concave piece of glass. It is used to evaporate a liquid, to hold solids while being weighed or as a cover for a beaker.

Watch glass

Analytical Balance

Analytical balance

It is also called a balance scale or a laboratory balance. It consists of a horizontal metallic beam with a support and a pointer at its centre. The beam can move freely about the support. From the ends of the beam, two identical pans are suspended such that they are equidistant from the centre of the beam. This entire arrangement is kept inside a transparent enclosure with doors. This is done so that dust does not collect and any air current in the room does not affect the balance's operation. An analytical balance is used to measure mass to a very high degree of precision and accuracy.

Reagent Bottle

It is a container used to hold liquid chemicals. It is usually made up of glass and has a lid which should be replaced immediately after withdrawing chemical from the bottle.

Reagent bottle

Gas jar

Gas Jar

It is a glass container with a broad base and broad opening. It is used for collecting gas during experiments.

Besides these equipment, there are others like test tube brush, beehive shelf, cork borer, etc. that are used in a chemistry laboratory.

Test tube brush

Beehive shelf

Cork borer

RECORDING AN EXPERIMENT

There is a systematic way of recording an experiment. The experiment is recorded in the notebook in the following manner:

1. Experiment number
2. Aim of the experiment
3. Apparatus or material required
4. Procedure
5. Observation
6. Conclusion or result
7. Precautions

Take a Break!

1. _____ and _____ are used to crush, grind and mix solid substances.
2. A flat-bottom flask is used for heating liquids. (True/False)
3. _____ is used for collecting gas during experiments.
4. A (spatula/dropper) is used to take small quantities of solid chemicals.
5. A glass rod is also known as _____ tube.

SAFETY RULES IN CHEMISTRY LABORATORY

We know that the study of chemistry involves a lot of experimentation. But it is very important to conduct each experiment safely. A few safety signs and symbols which you can see in a chemistry laboratory are shown in Figure.

Safety signs and symbols

Given below is a list of safety rules which should be followed in a chemistry laboratory:

- Before entering the laboratory, wear an apron. Do not wear loose clothes, sandals or contact lens. Tie long hair back and wear safety glasses.
- Carefully follow all the written and verbal instructions.
- Never work alone in the laboratory. Always work under adult supervision.
- Do not touch any equipment, any unknown chemical or any material until instructed. Do not taste or smell any chemical unless specially instructed to do so.
- Arrange the apparatus to be used in the experiment before beginning the experiment.
- Do not eat or drink in the laboratory. Do not use laboratory glassware for eating or drinking purposes.
- Always work in a well-ventilated area and switch-on the exhaust fans.
- While working with volatile substances or poisonous vapours, work in fume hood. Always remember to keep your head out of the fume hood.
- Ask your instructor before disposing of any chemical. Do not throw solid waste in the sink.
- Do not haphazardly mix chemicals. Chemicals should be handled carefully.
- Handle all glassware carefully to avoid breakage.
- Keep your hands away from your body while working with chemicals.
- While heating, make sure that your hair, clothing and hands are at a safe distance from the flame at all the times.
- Check the labels on chemical bottles before using them.
- Wash your hands properly with soap and water after completing experiments.

- Keep your work area clean and tidy. After completing the experiment, do not leave anything on your working table.
- In case of any accidents or injuries, immediately report to your instructor and lab assistants.

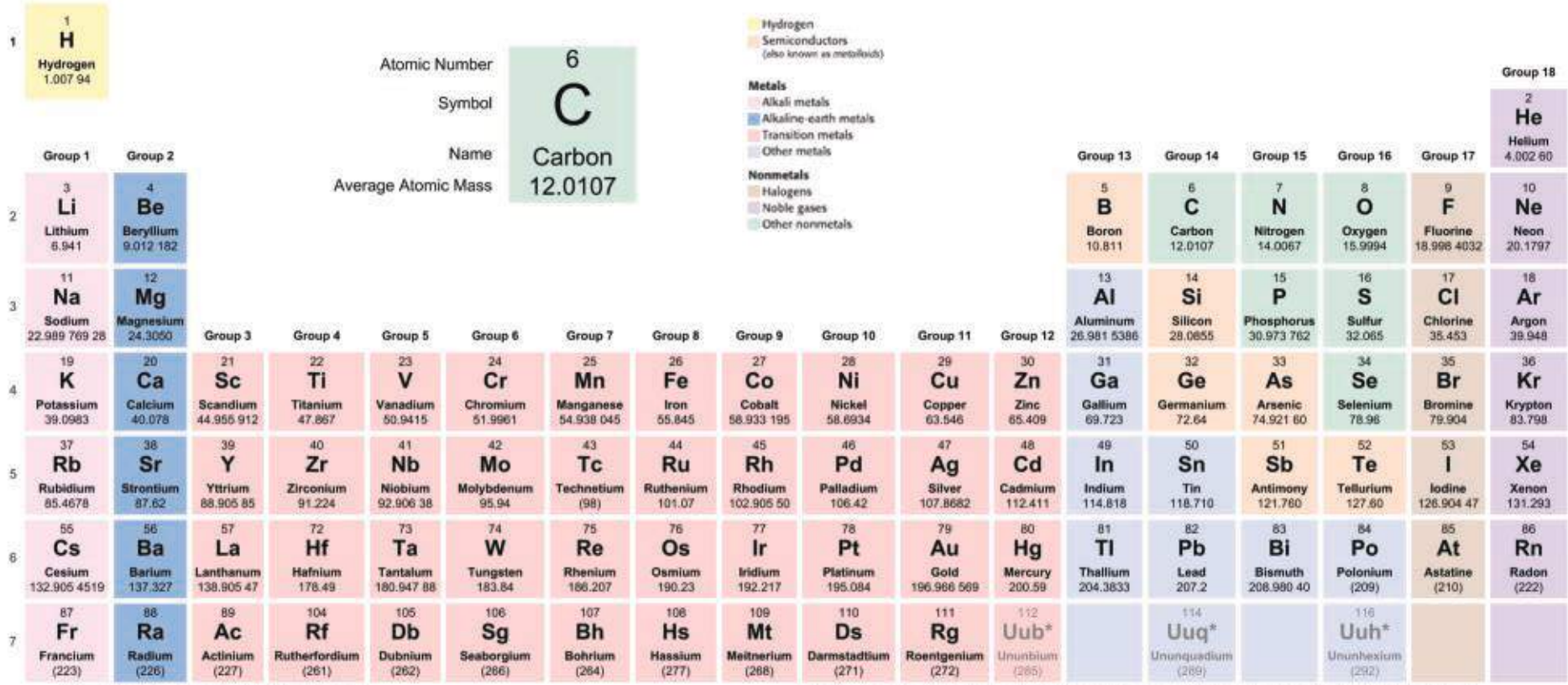
VOCABULARY

- **Chemistry:** The branch of science which deals with the properties and reactions of substances
- **Experiment:** A test carried out under controlled conditions to demonstrate a known truth, examine the validity of a hypothesis or determine the efficacy of something previously untried
- **Laboratory:** A place where experiments are carried out and analyses are performed to reach a conclusion
- **Apparatus:** A group of materials or devices required to carry out experiments

SUMMARY

- Chemistry helps to understand the basic principles that govern the interaction of different substances.
- Chemistry involves a lot of experimentation.
- A good chemistry laboratory is fully-equipped with basic measuring and analytical laboratory apparatus that allow a good study of all the branches of chemistry.
- A chemistry laboratory should be equipped with working table, reagent shelf, exhaust fans and balance room.
- Common laboratory apparatus and equipments are test tube, test tube stand, test tube holder, beaker, round-bottom flask, flat-bottom flask, conical flask, glass tubing, glass rod, funnel, china dish, pipette, burette, measuring cylinder, iron stand, tripod stand, asbestos wire gauze, pestle and mortar, spirit lamp, Bunsen burner, spatula, dropper, watch glass, analytical balance, reagent bottle, test tube brush, beehive shelves, cork borer, gas jar, etc.
- It is very important to conduct each experiment safely. While in the laboratory, one must follow all safety rules.

Periodic Table of the Elements



- The systematic names and symbols for elements greater than 111 will be used until the approval of trivial names by the IUPAC.

The discoveries of elements with atomic numbers 112, 114, and 116 have been reported but not fully confirmed.

The atomic masses listed in this table reflect the precision of current measurements. (Each value listed in parentheses is the mass number of that radioactive element's most stable or most common isotope.)

NOTES