Introduction to Chemistry

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THEME

Chemistry finds applications in day- to-day life as well as in industries. Chemicals from simple to complex, are used in food, medicines, cosmetics, textile industry, agriculture, cleansing agents, etc. This theme will help children understand applications of Chemistry in their lives.

LEARNING OBJECTIVES

The children will be able to :

- discuss the importance of Chemistry in daily life and its role in different industries and life processes;
- list important applications of Chemistry in day to day life;
- list some industrial applications of Chemistry;
- discuss the bio-sketches of some great scientists and their works;
- appreciate the patience, perseverance, sacrifices and ethical conduct of scientists.

INTRODUCTION

All of us are familiar with the word 'Science'. But, what is science ? How has it been developed ? And why is it so important?

All these questions and many more such questions need to be answered to satisfy our curiosity and to enhance our knowledge.

Since ancient times, humans have always been curious to know about nature and the fascinating world around them. In this process of learning, human beings started observing natural phenomena carefully and came out with some conclusions. This effort further led to new ideas and concepts. These organised human discoveries were later on given the name **Science**.

This scientific knowledge gained importance and it was passed on from one generation to another, for the development of mankind. With the passage of time, this knowledge brought about vast changes in human behaviour and people started enjoying the 'miracles' of science.

In old days, probably a casually picked up branch of a tree or a stone became a tool for humans. With the help of such tools, early men could get their food easily and could protect themselves too. With time, these tools improved and tools made of metals came into existence.

Fig. 1.1 : Primitive human beings used stone tools

This fact can be further explained by the following examples :

While using stones as tools, an ancient man probably rubbed them together which made the stones so hot that a fire was produced. The fire gave them warmth and also kept the wild animals away from them. Accidently, a piece of meat fell into the fire. When that piece was taken out and eaten, it was tastier and easier to chew. Men now learnt to cook food and protect themselves from the cold weather and wild animals. They were also able to ignite fire with the help of wood.

Similarly, early man plucked a fruit from a tree, ate it and threw its seeds on the soil. After sometime, he saw that a plant had grown which further grew into a tree, bearing the same kind of fruits. This gave mankind an idea to grow plants and produce fruits.

Thus, slowly and gradually, the basic knowledge of science developed.

If today we know many advanced techniques of growing crops, it is only possible because of proper observations and efforts that early man had made and passed on to us.

Fig. 1.3 : A seed growing into a tree

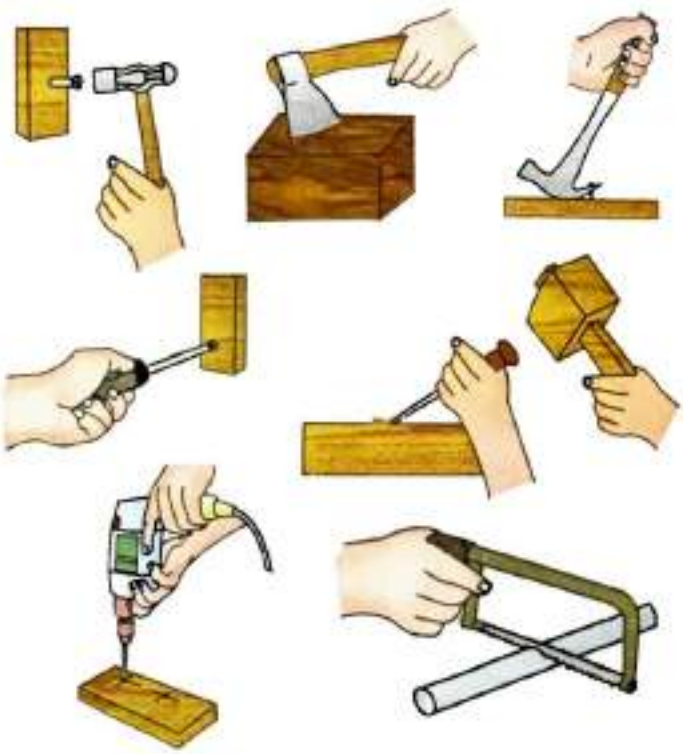

Fig. 1.2 : Uses of iron tools

Thus, we can now say that :

Science is the systematic, ongoing effort by human beings to study, understand and utilise nature for meaningful purposes. This understanding is slowly developed by careful observations and experiments.

CHEMISTRY — A BRANCH OF SCIENCE

Science is broadly classified into *three* main branches :

(i) Physics, (ii) Chemistry and

(iii) Biology.

Nature is a large reservoir of different kinds of substances. These substances need to be minutely studied in order to appreciate and understand :

- what are they made up of ?
- how are they made ?
- will they remain in the same form forever or will they change ?
- how can they become useful ?
- can they be prepared by man ?

Activity 1

Given below are 5 products that we use in our daily life. Write their uses.

Name	Use
1. Soap	.....
2. Toothpaste	.....
3. Shampoo	.....
4. Candle	.....
5. Pencil	.....

List 5 more such products and give their uses.

Note : All of these products are the gifts of Chemistry.

A detailed study of all these substances is done under *'Chemistry'*.

The branch of science that deals with the study of the composition and the physical and chemical properties of various forms of matter is called Chemistry.

Development of chemistry — A historical perspective.

ALCHEMY

The word **"Alchemy"** has its origin in a Greek word 'Khemeia' which means "art of transmuting metals". It was partly based on experimentations and partly on spiritual discipline. In India, it was mainly practised for medicines now known as Ayurvedic medicines.

Modern chemistry owes a great deal to 'alchemy', an ancient practice, which has played an important role in the development and growth of chemistry.

The people practising alchemy were considered to be early chemists and were known as 'Alchemists'. They used all general techniques of chemistry in healing humans. Their contribution proved valuable to the society and in the advancement of civilization.

The goal of alchemy was to find a mythical and magical substance called "philosopher's stone" (not an actual stone but wax, liquid or powder) with magical powers, which on heating with a base metal iron or copper would turn into **gold**, the purest form of matter which would bring wealth, health and immortality. However they could not succeed in finding this magical substance.

Alchemists were successful to some extent in developing processes to extract metals and make alloys. They were the first to isolate zinc and phosphorous. Alchemy has also contributed to an incredible number of future uses of chemicals, metals, ink, paints, cosmetics, medicines, porcelain, etc.

The iron pillar near Qutab Minar is notable for the rust resistant composition of metal used in its construction. It is 7 metres high. It is made up of iron mixed with high percentage of phosphorous.

Even though, alchemy was both a scientific and spiritual practice but alchemists never separated the two. It also lacked a common language for its concepts and processes and there was no standardized scientific practice.

By the 18th century, the field of 'chemistry' was completely separated from ancient traditional alchemy and was established as an important branch of science.

Some Great Chemists/Scientists and their contributions to Chemistry

Contributions of eminent scientists further helped in the development of Chemistry.

- **Robert William Boyle (1627-1691)** is known as the Father of Modern Chemistry. He was the first to perform experiments under controlled conditions. He played an important role in separating Chemistry from Alchemy.
- **Antoine Lavoisier (1743-1794)** brought a revolution in the development of Chemistry. He named the elements carbon, hydrogen and oxygen. He also discovered the role of oxygen in respiration and combustion. He established water as a compound.

- **John Dalton (1766-1844)** proved that matter consists of small particles called **atoms**. He proposed the atomic theory, which is popularly called as "Dalton's Atomic Theory".

- **Dmitri Mendeleev (1834-1907)** is best known for his "Periodic Law" and the formulation of "Periodic Table of elements".

- **Acharya P.C. Ray (1861-1944)**, an Indian scientist, was a pioneer in the field of medical industry in India. He was the founder of India's first "pharmaceutical company".

- **Alfred Nobel (1833-1896)** a Swedish chemist, who invented dynamite.

The "Nobel Prizes" are awarded for outstanding achievements in the fields of Physics, Chemistry, Medicine, Literature, Economics and Peace after his name every year on his death anniversary, *i.e.* 10th December.

- **Marie Curie (1867-1934)** discovered the radioactive metal radium. She won the "Nobel Prize" two times. She also developed a portable X-ray machine which saved many lives during World War I.

The names of some other noted scientists and their discoveries are given in the following table:

Name of Chemists/ Scientists	Discovery
• Joseph Priestly	Oxygen.
• Daniel Rutherford	Nitrogen.
• Sir Humphry Davy	Isolated potassium and sodium and devised a safety lamp.
• William Ramsay	Helium, Argon, Krypton and Xenon (inert gases).
• Henry Cavendish	Hydrogen and CO_2.

IMPORTANCE OF CHEMISTRY

Chemistry has played a vital role in the progress of mankind. Directly or indirectly, all human activities depend upon the knowledge of chemistry. Chemistry finds many applications in our daily life. It also plays an important role in industries. Everything from our food, cosmetics, medicines, fuels, soaps and detergents to the various industries, like textile, paper, etc. incorporates chemistry.

Thousands of useful substances are produced through chemical processes such as soap, detergents, toothpaste, shoe polish, clothes, dyes, plastics, paints, etc. They are all gifts of chemistry. They in turn help in improving our national economy.

APPLICATIONS OF CHEMISTRY

Let us now discuss the applications and uses of chemistry in some of the major fields.

1. **Food and agriculture** : Food supply to any society entirely depends on agriculture. Along with the quality of food, it is also important to increase its production with increasing population. This has been made possible by the development and application of advanced techniques and methods of agriculture.

Chemistry has helped farmers by providing them with agro-chemicals like fertilisers, pesticides, insecticides and fungicides. They are described below :

(i) **Fertilisers** : Fertilisers are the chemicals which provide essential nutrients to crops and increase their yield. The well-known fertilisers are urea, sodium nitrate, potash, ammonium phosphate, calcium nitrate, *etc.*

(ii) **Pesticides** : Pesticides are the chemicals used to kill pests which affect the yield of crops and fruits. *e.g.* Aldrin. Given below are some other types of pesticides :

(a) **Insecticides** : Insecticides are chemicals used to kill insects. Some commonly used insecticides are D.D.T., gammaxene (B.H.C.), etc.

(b) **Fungicides** : They protect crops from harmful fungi. Bordeaux mixture and sulphur act as ***fungicides***.

Fig. 1.4 : Agriculture

2. **Food processing and preservation :** Food processing is the transformation of raw food materials by physical or chemical means into marketable food products that can be easily prepared and served to the consumers, such as cheese, tinned vegetables, bread, jams, jelly, butter, snacks, soft drinks, etc.

Food preservatives : These are the chemicals added to a variety of foods to protect them from microorganisms and prevent their decomposition. Preservatives help check food wastage and allow food to be used for a longer period. Some common preservatives are sodium benzoate, ascorbic acid, sodium metabisulphite, citric acid, etc. Common salt acts as a preservative in pickles and sugar acts as a preservative in jams, jellies, etc.

Fig. 1.5 : Food preservation

3. **Clothings :** Chemistry is widely used in textile industry which manufactures clothing for us.

Cloth manufacturing begins with the knowledge of conversion of fibres into fabrics. Fibres can be natural or synthetic. Earlier only natural fibres (such as cotton, jute, silk, wool, etc.) were used to produce dress materials, sarees, bags, sweaters, shawls, etc. With more development,

Fig. 1.6 : Clothings

synthetic fibres were also made such as nylon, spandex, polyester, etc. These fibres are strong, wrinkle resistant and dry quickly. They are used to make towels, bed sheets, bags, curtains, carpets, blankets, dress materials, etc.

4. **Medicines :** Extensive research by chemists has led to the discovery and production of a large number of medicinal drugs. These medicines are the chemical substances which help to cure and prevent diseases.

They help in fighting diseases by killing their germs, and thus increase the life span of human beings.

Examples : Aspirin, paracetamol, antibiotics (like penicillin, tetracyclin), antiseptics, etc.

Fig. 1.7 : Medicines

5. **Minerals and Petroleum :** Knowledge gained through chemistry has helped us in developing methods for the extraction

of different metals from their ores and minerals. These metals are used to manufacture different kinds of machines and tools.

Petroleum products like petrol, diesel, kerosene, wax, paraffin, *etc.* are separated from crude oil with the help of chemical techniques.

Fig. 1.8 : Minerals and Petroleum

6. **Industry :** Chemistry has helped in the growth of different industries and in improving the efficiency of industrial processes. Industries are set up to produce a large number of consumer products like dyes, drugs, paints, plastics, synthetic fibres, petrochemicals, pharmaceuticals, steel, alloys, textiles, paper, pencil, glass, cleaning agents-soaps and detergents.

Preparation of common salt from sea water and sugar from canesugar juice is possible only through different physical and chemical processes.

Fig. 1.9 : Cosmetics

7. **Cosmetics :** Cosmetics are products used to cleanse, protect and change the appearance of external parts of human bodies. *Example :* talcum powder, skincare creams, lipsticks, eyes and facial make up, deodorants, lotions, perfumes, soaps, bathing oil, body butter, baby products, etc. This is possible only due to knowledge of chemistry.

Do You Know ?

Talcum powder is made up of a mineral called talc which contains elements like magnesium, silicon and oxygen.

8. **Building Materials :** Basic raw materials such as cement, mortar, steel, glass, paints, varnishes, *etc.* used for the construction of buildings, bridges, roads, *etc.*, are manufactured by chemical processes.

Fig. 1.10 : Building materials

9. **Transport :** Trains, buses, scooters, cars, aeroplanes and ships are common means of transport. They completely depend upon the **fuel** made available through the knowledge of chemistry.

Fuels are substances which on combustion produce a large amount of heat energy that can be used. *Example*: Cooking gas (LPG), petrol, diesel, *etc.* Compressed Natural Gas or CNG can be used in automobiles and also for cooking purposes.

10. **Communication devices** : Synthetic chemicals, metallic wires and plastics used in telephones, mobile phones, radios, transistors, tape recorders, *etc.* are all gifts of chemistry.
11. **National Defence** : Substances like gunpowder, T.N.T. (trinitrotoluene), phosgene, chemical weapons, laughing gas, *etc.* are all products of chemistry which contribute to the national defence.
12. **Recreation** : Chemistry plays a vital role in any mode of recreation. Sports goods are made from rubber, leather, plastics, metals and fibres. Substances for photographic films are the gifts of chemistry. The use of adhesives such as glue and tapes also incorporates chemistry.
13. **Chemistry and energy resources** : The energy resources of the world are mainly petroleum, coal, wood and nuclear fuels. To conserve the fast depleting reserves of coal and petroleum, attempts are being made by chemists to utilize alternative sources of energy. Solar energy, ocean energy and biogas, which are inexhaustible sources, are being studied under chemistry for future energy needs.

Thus, the progress of the human race is dependent on chemistry. It involves a lot of chemical research and its utility in industries. In other words, due to chemistry, the world economy has improved which, in turn, has raised the living standards of the people.

DARK SIDE OF CHEMISTRY

The knowledge of chemistry has given us many useful products which has made our day-to-day life very convenient, but it has also given rise to some life threatening substances, which when misused can cause very harmful effects on humans and society. Some of them are as follows :

1. **Chemical weapons** : The development of deadly explosives like TNT, RDX, atom bombs and hydrogen bombs can cause massive destruction. Although some explosives can potentially contribute to the national defence, their application must be avoided.
2. **Addictive drugs** : There are many harmful drugs like cocaine, brown sugar, heroin, angel dust, etc. which make the people, especially younger generation, addicted to them. When consumed frequently, they can even become fatal.
3. **Pollutants** : Many harmful substances called pollutants, like poisonous gases, smoke, waste products, etc. are produced due to various industrial processes. They cause pollution to air, water and soil resulting in a number of diseases in plants, animals and human beings.

Full form of

1. LPG — Liquified Petroleum Gas
2. DDT — Dichlorodiphenyl trichloro ethane.
3. BHC — Benzene hexachloride.
4. TNT — Trinitro-toluene.
5. RDX — Rapid detonating explosive

Do You Know ?

- Our body is a mobile chemical factory which uses food, water and oxygen as raw materials. These substances undergo a series of changes with the help of chemicals called **enzymes** that are secreted by our body.
- **Hormones** are another group of chemicals secreted in our body to control various activities.
- A strong acid called hydrochloric acid is produced in our stomach which helps in the digestion of food.
- There are more chemicals in the food we eat than we find elsewhere. Some of them are carbo-hydrates, proteins, vitamins, fats, minerals, *etc.* These are vital to life.

BENEFITS/GIFTS OF CHEMISTRY

CHEMISTRY

Textile Industry
- Development of synthetic fibres such as nylon, polyester, etc.
- Waterproof materials.
- Heat retaining clothing.
- Production of belts, shoes, bags, etc. from leather, plastics, rubber, etc.

Agricultural Industry
- Fertilizers.
- Pesticides.
- Insecticides.
- Fungicides.

Food Industry
- Food processing.
- Food preservation.
- Food colouring.
- Artifical food flavouring.
- Artificial sweeteners.
- Salt production and processing.

Soap Industry
- Bathing soaps, laundry detergents, floor cleaners, toilet cleaners, dish soaps, etc.
- e.g. Lizol, Harpic.

Pharmaceutical Industry
- Medicinal drugs like antibiotics, antiseptics, etc.
- Vaccines.
- Surgical materials.

Building Material Industry
- Manufacture of building materials like cement, mortar, paints, varnishes.
- Glass and glass products.

Cosmetic Industry
- Talcum powder.
- Skin care and baby care products.
- Creams and lotions.
- Deodorants and perfumes.
- Sunscreen.

Mineral and Petroleum Industry
- Extraction of metals from minerals.
- Construction of tools and machines from metals.
- Refinining of petroleum to produce petrol, diesel, LPG, CNG, kerosene, paraffin wax, etc.
- Production of gasoline, methanol, hydrogen fuel, etc.

RECAPITULATION

- Science is the sum of systematic efforts by human beings to control nature through experiments and observations for their own use.
- Development of science is an ongoing process.
- Chemistry is the branch of science which deals with the study of substances and the various changes that they undergo.
- Alchemy, an ancient practice has played an important role in the development and growth of Modern Chemistry.
- Contributions of chemistry in everyday life fulfill man's basic needs, such as food, health, clothes, cosmetics, etc.
- Chemistry helps in modifying natural materials into synthetic materials for the use of mankind.
- Chemistry plays an important role in improving our *national economy*.
- Contributions of eminent scientists like Boyle, Lavoisier, John Dalton, etc. are outstanding.

EXERCISE

A. OBJECTIVE TYPE QUESTIONS

1. Choose the correct answer from the multiple choices given below.

(i) Trinitrotoluene is used as :

(a) a preservative (b) a fertiliser
(c) a fuel (d) an explosive

(ii) Which one of the following is a pesticide?

(a) benzoic acid (b) aldrin
(c) sugar (d) gun powder

(iii) Mortar is used as :

(a) a plastic material
(b) a building material
(c) an insecticide
(d) a medicine

(iv) Urea is an important :

(a) fuel (b) preservative
(c) fertiliser (d) food item

(v) The chemicals prescribed by a doctor in treatment of infectious diseases are called :

(a) antigens (b) preservatives
(c) antibiotics (d) fertilisers

2. Fill in the blanks :

(a) ..... deals with the study of matter and the changes it undergoes.

(b) ..... help to increase the production of food.

(c) Food items like jams and pickles are protected by using ..... .

(d) L.P.G. is used for ..... .

(e) Inert gases were discovered by ..... .

3. Write "*True*" or "*False*" against the following statements and correct the false ones.

(a) Chemistry plays an important role in our national economy. .....

(b) Antibiotics are used as preservatives. .....

(c) D.D.T. is an important fertiliser. .....

(d) Gunpowder is an insecticide. .....

(e) Enzymes secreted by our body are chemicals.

4. Match the following words in column A with those in column B :

Column A	Column B
(a) Clothing	(i) toothpaste, cosmetics
(b) Green revolution	(ii) nylon, wool
(c) Building materials	(iii) agriculture
(d) Commodities of daily use	(iv) mortar, cement

5. Match the following scientists in column A with their discoveries or contributions in column B.

Column A	Column B
(a) Marie Curie	(i) Safety lamp
(b) John Dalton	(ii) Helium
(c) William Ramsey	(iii) Nobel Prize Winner (two times)
(d) Sir Humphry Davy	(iv) Atomic theory

B. SHORT ANSWER TYPE QUESTIONS

1. Name the scientists who discovered the following :
   (a) Atoms (b) Oxygen
   (c) Safety lamp (d) Elements
2. Give two examples for each of the following substances :
   (a) food preservatives (b) fuels
   (c) fungicides (d) medicines
   (e) building materials
   (f) chemical war weapons
3. Answer the following in one or two sentences.
   (a) What is science ?
   (b) What is chemistry ?
   (c) What is a fuel ?
   (d) What is 'Philosopher's stone' ?
4. Think and name six chemical products which you use daily.

C. LONG ANSWER TYPE QUESTIONS

1. Name the chemicals which help in increasing food production.
2. Who is known as the 'Father of Chemistry' ? Why ?
3. How is chemistry helpful in improving the health of human beings ?
4. (a) What is alchemy ?
   (b) What kind of experiments did Alchemists do ?
   (c) What is the main difference between alchemy and chemistry ?
5. What is the contribution of chemistry in the following fields ?
   (a) Industry (b) Clothing
   (c) Cosmetics (d) National Defence
   (e) Medicines

Project

1. Make a list of five products of daily use and their starting material.
2. Visit a nearby chemical industry and describe your experience in the class.