

Based on National Curriculum of Pakistan 2022-23

Moel Textbook of
CHEMISTRY
Grade 9

National Curriculum Council
Ministry of Federal Education and Professional Training

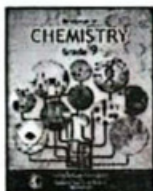


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**Model Textbook of Chemistry
for Grade 9**



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EDITION**

First Edition - First Impression: April 2024 | Pages: 258 | Quantity: 157000

Price: PKR 625/-

Code: STE-679, ISBN: 978-969-37-1588-0

Printer: Al-Fateh Publishers, Lahore.

Note: All the pictures, paintings and sketches used in this book are only
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PREFACE

In a historic footstep, the national curriculum of Pakistan 2022-2023 has introduced a new era for schooling in the country. This is the first-ever core curriculum in the 75-year history of Pakistan. It is in line with the protected right to school education by Article 25-A.

Chemistry might be a difficult subject for someone, but it holds significance for those who embrace a systematic approach to understanding its concepts.

This new Textbook has been developed as a model Textbook for Pakistan. The book consolidates critical thinking methodologies, guiding scientific reasoning, and thinking abilities. The book incorporates problem-solving strategies, which will guide students toward analytical thinking and skills. These skills would be invaluable for both academic as well as practical life.

The book also inspires concept assessment exercises in every unit, which have been designed to evaluate acquired knowledge and promote critical thinking and analyzing data..

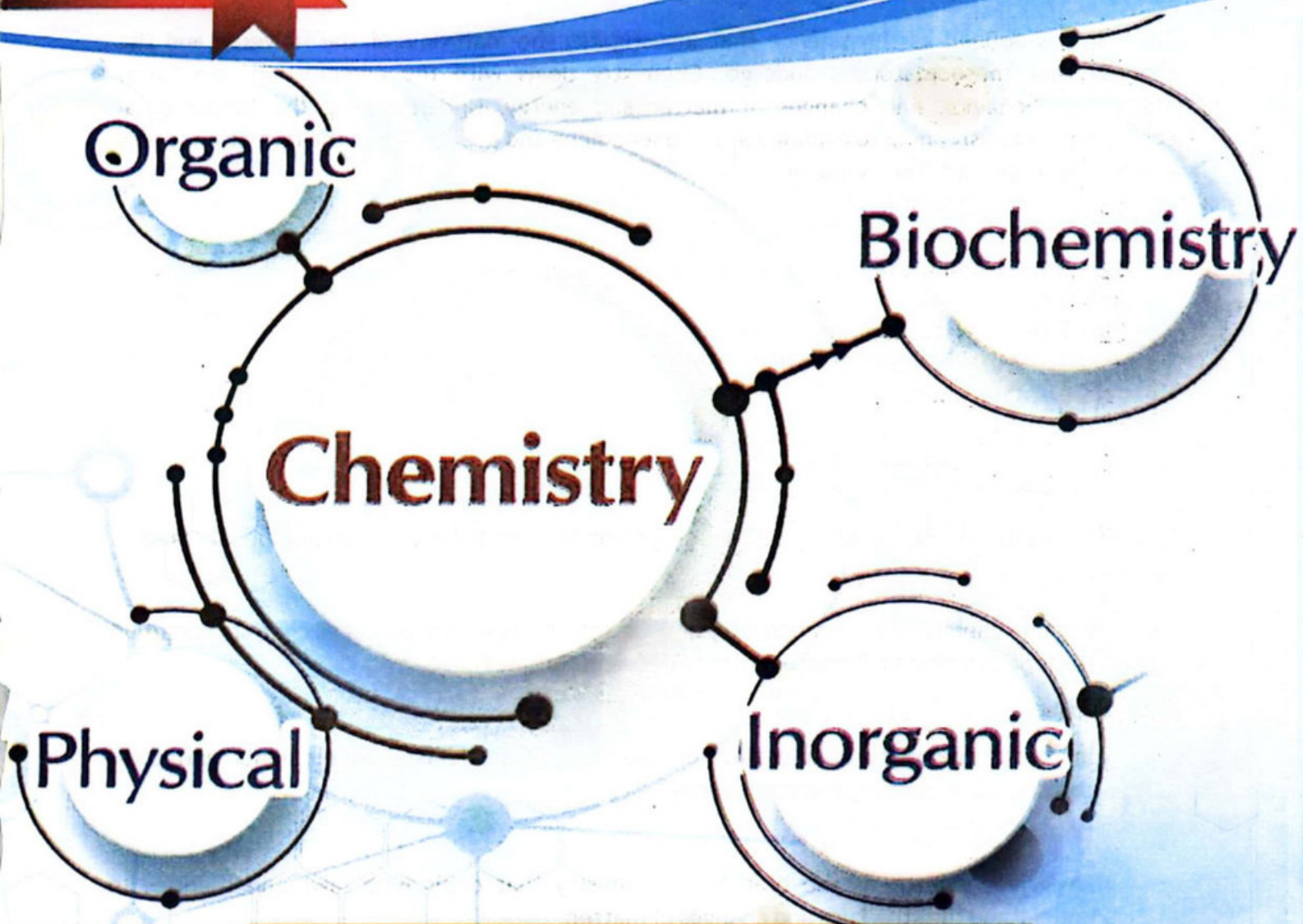
One of the book's distinctive features is the key points at the end of each unit, which serve as a quick reference to reinforce the salient features of each unit.

Dr. Raja Mazhar Hameed

Managing Director

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NATURE OF SCIENCE IN CHEMISTRY

Student Learning Outcomes (SLOs)

After completing this lesson, the student will be able to:

- Define chemistry as the study of matter, its properties, composition, and its interactions with other matter and energy.
- Explain with examples that chemistry has many sub-fields and interdisciplinary fields.
- Formulate examples of essential questions that are important for the branch of chemistry.
- Differentiate between 'science' 'technology' and 'engineering' by referring to examples from the physical sciences.

1.1 DEFINITION OF CHEMISTRY AND ITS INTERACTION WITH OTHER MATTER AND ENERGY:

Chemistry is defined as the science that investigates the materials of the universe and the changes that these materials undergo. Chemistry deals with the composition, structure, properties, behavior, and changes of matter and energy. Understanding the fundamental concepts of chemistry help to explain natural phenomena and apply them to the formation of new substances, drugs, and technologies.

DO YOU KNOW?

- How green chemistry is helpful in understanding and reducing pollution?
- Green chemistry is the model of chemical products and processes that reduce the use of hazardous substances.



1.2: BRANCHES OF CHEMISTRY

Chemistry is a diverse field of study, surrounding numerous sub-fields and interdisciplinary areas.

1. Organic Chemistry

Organic chemistry is a branch of chemistry that deals with substances containing carbon (except carbonates, bicarbonates, oxides, and carbides).

2. Inorganic Chemistry

Inorganic chemistry is a branch of chemistry that deals with elements and their compounds except organic compounds.

3. Physical Chemistry

Physical chemistry is the branch of chemistry that deals with laws and theories to understand the structure and changes of matter.

4. Analytical Chemistry

Analytical chemistry is a branch of chemistry that deals with the methods and instruments for determining the composition and properties of matter.

5. Biochemistry

The branch of chemistry that deals with physical and chemical changes that occur in living organisms is called biochemistry.

6. Environmental Chemistry

Environmental chemistry is the branch of chemistry that deals with the study of chemical and toxic substances that pollute the environment and their adverse effects on human beings.

7. Industrial Chemistry

Industrial chemistry is the branch of chemistry that deals with the large-scale production of chemical substances.

8. Medicinal Chemistry

The branch of chemistry that deals with the study of the interaction between drugs and biological targets, as well as the development of new medicinal agents.

9. Polymer Chemistry

The branch of chemistry that focuses on the study of polymers, their types, properties, uses, importance, and types of polymerizations is called polymer chemistry. Examples of synthetic polymers include nylon bearings, plastic bags, polyethylene cups, polyester, Teflon coated cook ware, and epoxy glue etc.

10. Geochemistry

Geochemistry is the branch of chemistry that deals with the study of chemical composition, distribution, and transformation of elements and compounds in the Earth's crust, such as rocks, minerals, soils, water, and the atmosphere.

11. Nuclear Chemistry

The branch of chemistry that deals with the changes that occur in atomic nuclei is called nuclear chemistry.

12. Astrochemistry

Astrochemistry is a branch of chemistry that deals with the study of chemical processes and reactions that occur in astronomical environments, such as stars, planets, comets, and interstellar space.

1.3 EXAMPLES OF ESSENTIAL QUESTIONS THAT ARE IMPORTANT FOR THE BRANCHES OF CHEMISTRY

Some essential questions for various branches of chemistry that can help enhance understanding are as follows:

Physical Chemistry

1. What is the structure of an atom, and how does it influence chemical behavior?
2. How do different types of chemical bonds (ionic, covalent, metallic) form and function?

Organic Chemistry

1. Why carbon is considered the backbone of organic compounds?
2. What are the major functional groups in organic molecules, and how do they affect chemical properties?

Inorganic Chemistry

1. What distinguishes inorganic compounds from organic compounds?
2. How does Periodic table helps to organise elements?

Analytical Chemistry

1. How are analytical methods used to identify and quantify chemical substances?

Biochemistry

1. How do biomolecules such as carbohydrates, proteins, nucleic acids, and lipids contribute to the structure and function of living organisms?

Environmental Chemistry

1. How do human activities contribute to air pollution, and what are the consequences for the environment?
2. What role do greenhouse gases play in climate change, and how can we mitigate their effects?

Medicinal Chemistry

1. How are drugs designed and developed for specific therapeutic purposes?

Polymer Chemistry

1. What are polymers, and how do their structures affect their properties?

Geochemistry

1. How do geological processes influence the distribution of elements in the Earth's crust?

Nuclear Chemistry

1. How do nuclear reactions differ from chemical reactions, and what are their applications?
2. What is the role of radioisotopes in medicine and industry?

Astronomy

1. What types of reactions occur in astronomical environments?

These questions can serve as a foundation for exploring the key concepts within each branch of chemistry.

1.4:DAILY LIFE APPLICATIONS OF CHEMISTRY

Organic Chemistry

To treat diseases, organic chemists synthesize new medicines that interact with specific targets like proteins or enzymes.





Inorganic Chemistry

Lithium-ion (Li-ion) batteries are used as rechargeable batteries for electronics, toys, wireless headphones, handheld power tools, small and large appliances, electrical storage devices, and electric vehicles.

Analytical Chemistry

Forensic chemistry is the application of analytical chemistry. It involves the examination of physical traces, such as body fluids, bones, fibers and drugs. It can be used to identify an unknown compound. For example drugs are often found in various colored powders and are analyzed to determine their content.



Physical Chemistry

Physical chemistry is a part of our everyday life. The batteries in our vehicles are built on the principle of electrochemistry.

Environmental Chemistry

Environmental chemistry is used to protect water that has been poisoned by soil, and dust by using different methods e.g., sedimentation, filtration, and disinfection.



1.5: 'SCIENCE' 'TECHNOLOGY' AND 'ENGINEERING'

Science

Science is the systematic process of constructing and organizing knowledge about the universe. Thus, science seeks to understand the natural world. For example, chemists seek to understand the behaviour and properties of materials, chemical reactions, and the fundamental principles that control the behaviour of matter.

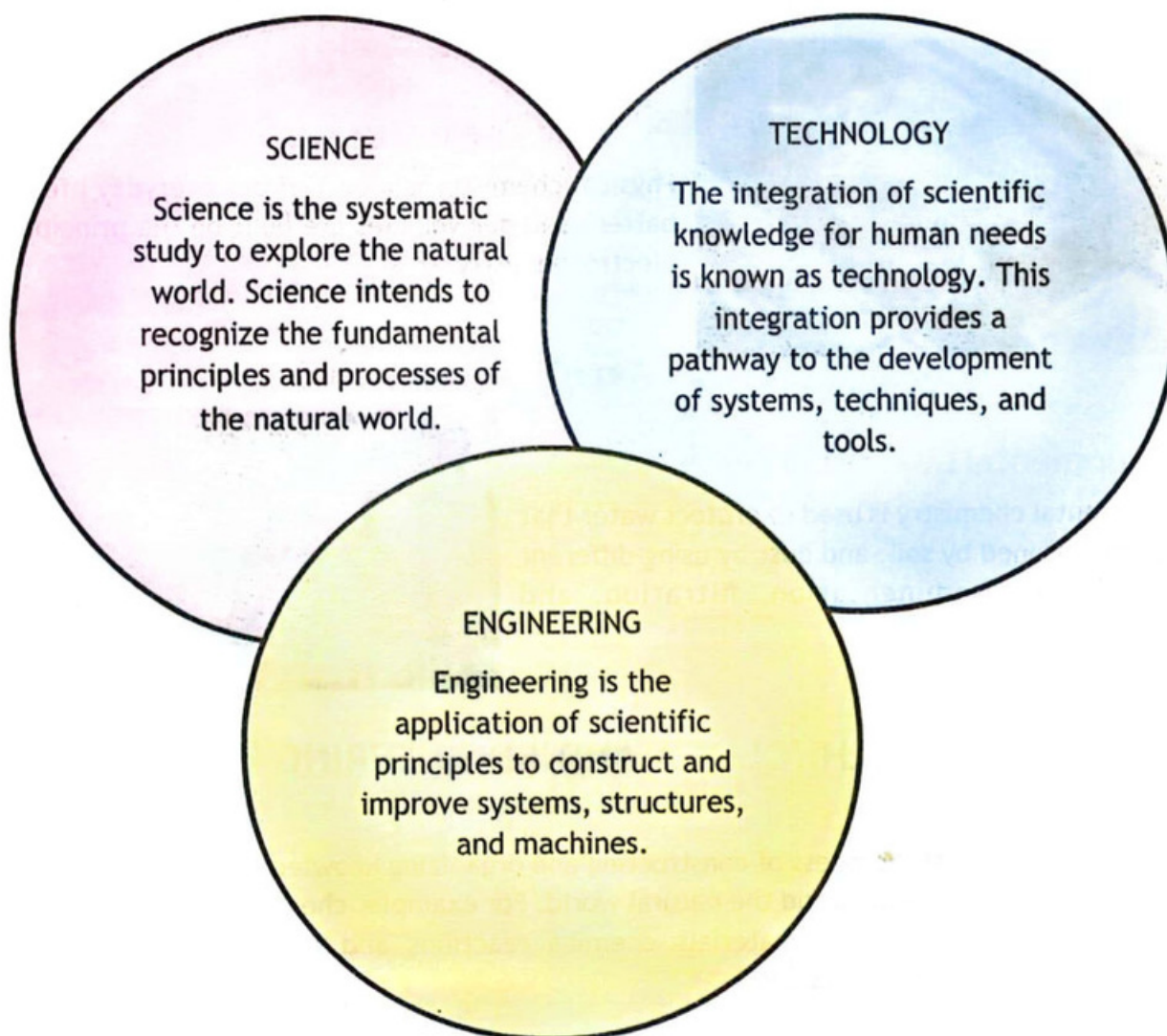
Technology

Technology is the process of applying scientific knowledge to practical applications, resulting in the creation of tools, machines, and systems that enhance our lives.

Science and technology play a major role in the field of chemistry by providing tools, machines, techniques and methods which can help in discovery and development of new materials. These also help in improving quality of products. Technology has revolutionized the field of chemistry, making research and applications more efficient. It has enabled chemists to more effectively analyze and identify substances. Their work is beneficial for chemists working in pharmaceutical and other chemical industries.

Engineering

Engineering is the use of science and mathematics to design and construct systems, structures, and tools for various processes. Chemical engineers develop and design manufacturing processes for the production of chemicals, fuels, food, medicines, polymers, detergents, paper etc. They often work to maximize productivity and product quality.



1.6: APPLICATIONS OF SCIENCE AND TECHNOLOGY AND ENGINEERING

Let's take a look at how science, technology and engineering work together to solve problems in real-world situations. For example:

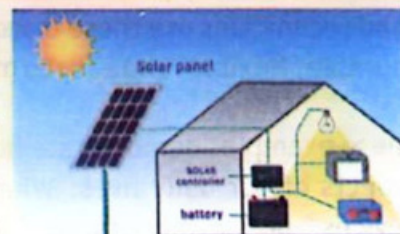
Example 1.1: Investigating rusting of iron.

Imagine trying to figure out why a bike or car will rust over time. Scientists could investigate the chemical reactions that occur between iron, water and oxygen that cause rust to form. Experiments could be conducted to understand the factors that influence this process and help develop strategies to prevent rust.



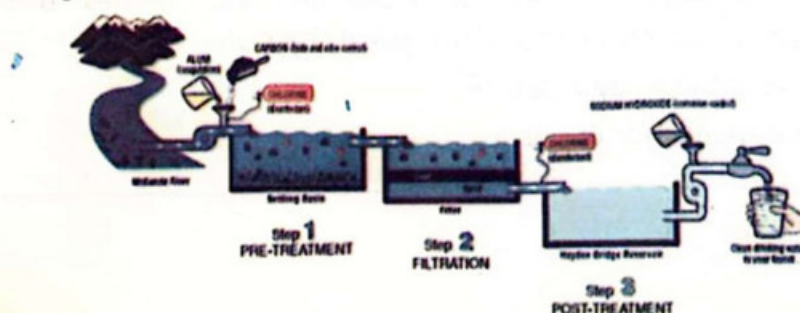
Example 1.2: Harnessing Solar Energy

Scientists may study the principles of photovoltaic cells to understand how sunlight can be converted into electricity. Technologists can develop solar panels based on the scientific principles discovered. Engineers play their role in designing and implementing large-scale renewable energy systems. For instance, an electrical engineer might design the wiring and connections of a solar power plant, a civil engineer could be involved in designing the infrastructure. In this example, science helps us understand the underlying principles of converting sunlight into electricity. Technology transforms this knowledge into practical applications, such as solar panels and energy storage systems. Engineering takes these technologies and implements them on a larger scale. Together, science, technology, and engineering contribute to the development and utilization of sustainable energy sources.



Example 1.3: Designing a Water Filtration System

Let's look at how engineers design water filtration systems. Chemical engineers can help develop processes to remove contaminants from water while mechanical engineers design physical components. Together, they create a solution to clean drinking water for a community. From understanding chemical reactions to using technological devices to solving practical problems through engineering.



Example 1.4: Organic Chemistry in Action

How do you make french fries. The oil used to fry potatoes contains carbohydrates, which are organic molecules. Scientists study carbohydrates to learn more about how they work, so food technologists extract oil from seeds. Chemical engineers design oil production equipment and processes so that oil is produced efficiently and safely for cooking.

**Example 1.5: Plastic Bags**

Think about the science behind plastic bags. Scientists study the small building blocks known as monomers. When monomers combine, they form long chains known as polymers. One of those long chains is polyethylene, which is one of the many polymers found in plastic bags! Engineers and technicians use these discoveries to create bags that are durable, flexible, and easy to make.



These examples demonstrate how science, technology, and engineering work together in various aspects of our daily lives. Whether it's understanding chemical reactions, using technological devices, or solving practical problems through engineering solutions, these concepts are interconnected and contribute to advancements that impact the world around us.

KEY POINTS

- Chemistry is the study of matter around us.
- The branch of chemistry deals with carbon compounds (except bicarbonates, carbonate oxides, and carbides).
- The branch of chemistry that deals with the elements and their compounds except organic compounds is called inorganic chemistry.
- Industrial chemistry is concerned with the large-scale production of chemical substances.
- The branch of chemistry that deals with the laws and theories to understand the structure and changes of matter is called physical chemistry.
- Science is defined as the study of nature.
- Technology is the application of science.

REVIEW QUESTIONS

1. Encircle the correct answer.

- (i) Which branch of chemistry is the study of elements and their compounds except for organic compounds?
- (a) Physical Chemistry (b) Organic Chemistry
(c) Inorganic Chemistry (d) Geochemistry Chemistry
- (ii) Which branch of chemistry helps to protect water that has been poisoned by soil?
- (a) Environmental Chemistry (b) Organic Chemistry
(c) Inorganic Chemistry (d) Geochemistry Chemistry
- (iii) Which area of Chemistry improves to gauge the behavior of pollutants and develop techniques for pollution control?
- (a) Analytical Chemistry (b) Organic Chemistry
(c) Environmental (d) Geochemistry
- (iv) The branch of chemistry that helps to synthesize new medicines.
- (a) Physical (b) Organic
(c) Inorganic (d) Environmental
- (v) The branch of science helps to understand chemical products and processes that reduce the use of hazardous substances:
- (a) Analytical Chemistry (b) Physical chemistry
(c) Green Chemistry (d) astrochemistry
- (vi) To identify the concentration of a particular solution through titration is and application of
- (a) Astrochemistry (b) Analytical Chemistry
(c) Geochemistry (d) Organic chemistry
- (vii) The batteries in our vehicles are built on the principle of electrochemistry. It is the application of:
- (a) Astrochemistry (b) Analytical Chemistry
(c) Organic chemistry (d) Physical chemistry
- (viii) The branch of chemistry that is concerned with the large-scale production of chemical substances is:
- (a) Industrial chemistry (b) Physical chemistry
(c) Inorganic chemistry (d) Environmental Chemistry
- (ix) The branch of chemistry that focuses on the study of polymers, their types, properties, uses is called:
- (a) Industrial Chemistry (b) Polymer chemistry
(c) Organic Chemistry (d) astrochemistry

- (x) The study of the interaction between drugs and biological targets, as well as the development of new medicinal agents.

- | | |
|-------------------------|-----------------------------|
| (a) Organic chemistry | (b) Medicinal chemistry |
| (c) Inorganic chemistry | (d) Environmental Chemistry |

2. Give short answer.

- (i) How does chemistry help a doctor to know about the chemical nature of medicine?
 - (ii) In what ways does technological innovation help to understand the development of new materials?
 - (iii) Differentiate between geochemistry and astrochemistry.
 - (iv) With the help of an example correlated the use of science, technology, and engineering.
 - (v) With the help of the Venn diagram compare and contrast organic and inorganic chemistry.
 - (vi) What are the uses of nuclear chemistry?
3. Define chemistry and its interactions with other matter and energy.
 4. Describe the applications of inorganic chemistry and its importance in our daily lives?
 5. With the help of few examples highlight the relation between science, technology and engineering.
 6. Evaluate the role of chemistry in environmental science.
 7. How does geochemistry help us to solve the problems such as pollution and climate change?
 8. How is organic chemistry applied in medicines, biochemistry and industrial science?

○ PROJECT ←

1. Draw figure of a tree showing different branches of chemistry.
2. Composting is a great way to recycle materials that might be thrown into landfill. It takes years to decompose them. Make an indoor composter and determine how readily different materials decompose.