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Science

Teacher's Guide
Unit 4

This book was collaboratively developed and reviewed by educators from public and private schools, colleges, and/or universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@deped.gov.ph.

We value your feedback and recommendations.

Department of Education
Republic of the Philippines

Science – Grade 10
Teacher's Guide
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Republic of the Philippines
Department of Education
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K to 12 Curriculum Guide

SCIENCE

(Grade 10)

December 2013

K to 12 BASIC EDUCATION CURRICULUM

CONCEPTUAL FRAMEWORK

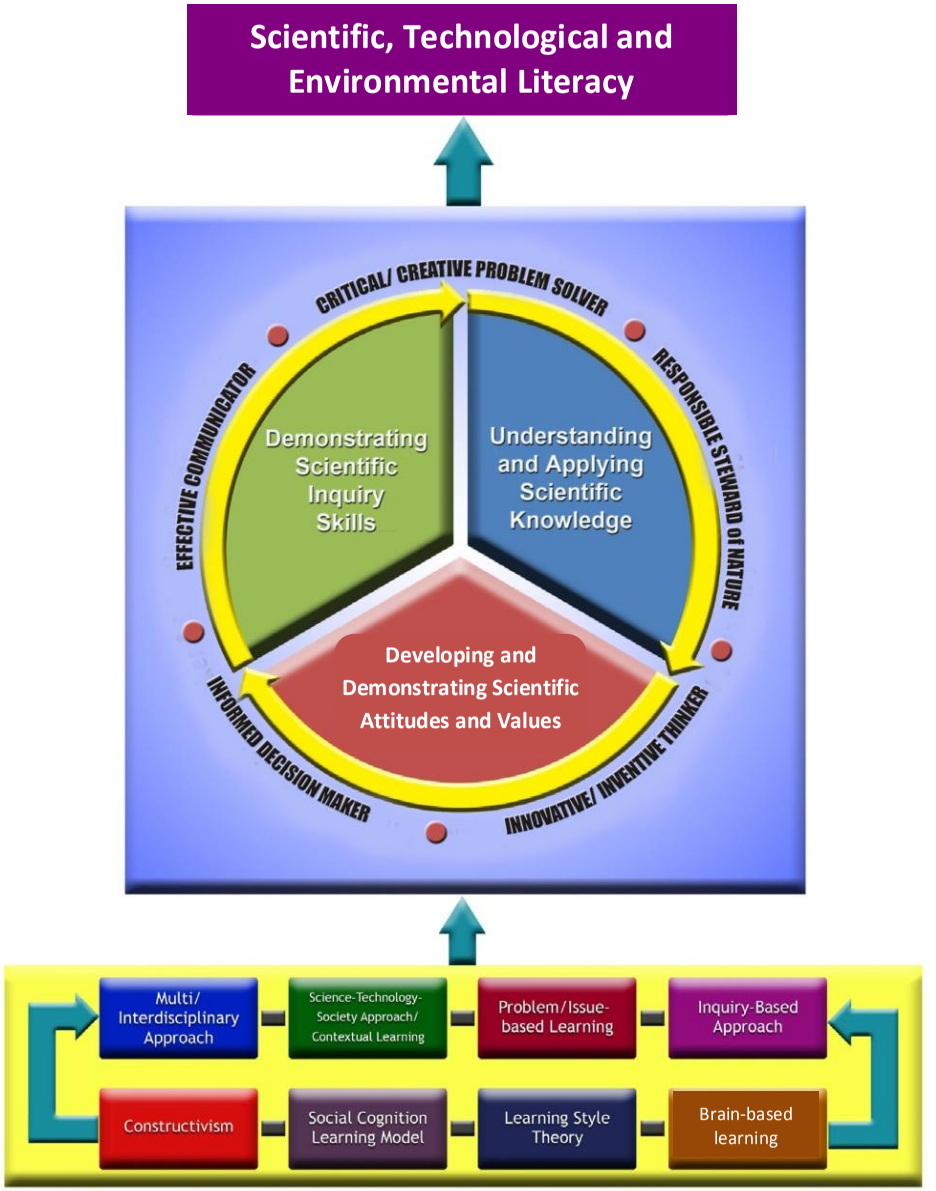
Science education aims to develop scientific literacy among learners that will prepare them to be informed and participative citizens who are able to make judgments and decisions regarding applications of scientific knowledge that may have social, health, or environmental impacts.

The science curriculum recognizes the place of science and technology in everyday human affairs. It integrates science and technology in the social, economic, personal and ethical aspects of life. The science curriculum promotes a strong link between science and technology, including indigenous technology, thus preserving our country's cultural heritage.

The K to 12 science curriculum will provide learners with a repertoire of competencies important in the world of work and in a knowledge-based society. It envisions the development of scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers, and effective communicators. This curriculum is designed around the three domains of learning science: understanding and applying scientific knowledge in local setting as well as global context whenever possible, performing scientific processes and skills, and developing and demonstrating scientific attitudes and values. The acquisition of these domains is facilitated using the following approaches: multi/interdisciplinary approach, science-technology-society approach, contextual learning, problem/issue-based learning, and inquiry-based approach. The approaches are based on sound educational pedagogy namely, constructivism, social cognition learning model, learning style theory, and brain-based learning.

Science content and science processes are intertwined in the K to 12 Curriculum. Without the content, learners will have difficulty utilizing science process skills since these processes are best learned in context. Organizing the curriculum around situations and problems that challenge and arouse learners' curiosity motivates them to learn and appreciate science as relevant and useful. Rather than relying solely on textbooks, varied hands-on, minds-on, and hearts-on activities will be used to develop learners' interest and let them become active learners.

As a whole, the K to 12 science curriculum is learner-centered and inquiry-based, emphasizing the use of evidence in constructing explanations. Concepts and skills in Life Sciences, Physics, Chemistry, and Earth Sciences are presented with increasing levels of complexity from one grade level to another in spiral progression, thus paving the way to a deeper understanding of core concepts. The integration across science topics and other disciplines will lead to a meaningful understanding of concepts and its application to real-life situations.



The Conceptual Framework of Science Education

K to 12 BASIC EDUCATION CURRICULUM

CORE LEARNING AREA STANDARD: (SCIENCE FOR THE ENTIRE K TO 12)

The learners demonstrate understanding of basic science concepts and application of science-inquiry skills. They exhibit scientific attitudes and values to solve problems critically, innovate beneficial products, protect the environment and conserve resources, enhance the integrity and wellness of people, make informed decisions, and engage in discussions of relevant issues that involve science, technology, and environment.

KEY STAGE STANDARDS: (STANDARDS FOR SCIENCE LEARNING AREAS FOR K-3, 4-6, 7-10 AND 11-2)

K–3	4–6	7–10	11-12
At the end of Grade 3, the learners should have acquired healthful habits and havedeveloped curiosity about self and their environment using basic process skills of observing, communicating, comparing, classifying, measuring, inferring and predicting. This curiosity will help learners value science as an important tool in helping them continue to explore their natural and physical environment. This should also include developing scientific knowledge or concepts.	At the end of Grade 6, the learners should have developed the essential skills of scientific inquiry – designing simple investigations, using appropriate procedure, materials and tools to gather evidence, observing patterns, determining relationships,drawing conclusions based on evidence, and communicating ideas in varied ways to make meaning of the observations and/or changes that occur in the environment. The content and skills learned will be applied to maintain good health, ensure the protection and improvement of the environment, and practice safety measures.	At the end of Grade 10, the learners should have developed scientific, technological, and environmental literacyand can make that would lead to rational choices on issues confronting them. Having been exposed to scientific investigations related to real life, they should recognize that the central feature of an investigation is that if one variable is changed (while controlling all others), the effect of the change on another variable can be measured. The context of the investigation can be problems at the local or national level to allow them to communicate with learners in other parts of the Philippines or even from other countries using appropriate technology. The learners should demonstrate an understanding of science concepts and apply science inquiry skills in addressingreal-world problems through scientific investigations.	At the end of Grade 12, the learners should have gained skills in obtaining scientific and technological information from varied sources about global issues that have impact on the country. They should have acquired scientific attitudes that will allow them to innovate and/or create products useful to the community or country. They should be able to process information to get relevant data for a problem at hand. In addition, learners should have made plans related to their interests and expertise, with consideration forthe needs of their community and the country — to pursue either employment, entrepreneurship, or higher education.

K to 12 BASIC EDUCATION CURRICULUM

GRADE/LEVEL	Grade-Level Standards
Kindergarten	The learners will demonstrate an emerging understanding of the parts of their body and their general functions; plants, animals and varied materials in their environment and their observable characteristics; general weather conditions and how these influence what they wear; and other things in their environment. Understanding of their bodies and what is around them is acquired through exploration, questioning, and careful observation as they infer patterns, similarities, and differences that will allow them to make sound conclusions.
Grade 1	At the end of Grade 1, learners will use their senses to locate and describe the external parts of their body; to identify, external parts of animals and plants; to tell the shape, color, texture, taste, and size of things around them; to describe similarities and differences given two objects; to differentiate sounds produced by animals, vehicles cars, and musical instruments; to illustrate how things move; to, describe the weather and what to do in different situations; to use appropriate terms or vocabulary to describe these features; to collect, sort, count, draw, take things apart, or make something out of the things; to practice healthy habits (e.g., washing hands properly, choosing nutritious food) and safety measures (e.g., helping to clean or pack away toys, asking questions and giving simple answers/ descriptions to probing questions).
Grade 2	At the end of Grade 2, learners will use their senses to explore and describe the functions of their senses, compare two or more objects and using two or more properties , sort things in different ways and give a reason for doing so, describe the kind of weather or certain events in the home or school and express how these are affecting them, do simple measurements of length, tell why some things around them are important , decide if what they do is safe or dangerous; give suggestions on how to prevent accidents at home, practice electricity, water, and paper conservation, help take care of pets or of plants , and tell short stories about what they do, what they have seen, or what they feel.
Grade 3	At the end of Grade 3, learners can describe the functions of the different parts of the body and things that make up their surroundings --- rocks and soil, plants and animals, the Sun, Moon and stars. They can also classify these things as solid, liquid or gas. They can describe how objects move and what makes them move. They can also identify sources and describe uses of light, heat, sound, and electricity. Learners can describe changes in the conditions of their surroundings. These would lead learners to become more curious about their surroundings, appreciate nature, and practice health and safety measures.
Grade 4	At the end of Grade 4, learners can investigate changes in some observable properties of materials when mixed with other materials or when force is applied on them. They can identify materials that do not decay and use this knowledge to help minimize waste at home, school, and in the community. Learners can describe the functions of the different internal parts of the body in order to practice ways to maintain good health. They can classify plants and animals according to where they live and observe interactions among living things and their environment. They can infer that plants and animals have traits that help them survive in their environment. Learners can investigate the effects of push or pull on the size, shape, and movement of an object. Learners can investigate which type of soil is best for certain plants and infer the importance of water in daily activities. They learned about what makes up weather and apply their knowledge of weather conditions in making decisions for the day. They can infer the importance of the Sun to life on Earth.

K to 12 BASIC EDUCATION CURRICULUM

GRADE/LEVEL	Grade-Level Standards
Grade 5	At the end of Grade 5, learners can decide whether materials are safe and useful by investigating about some of their properties. They can infer that new materials may form when there are changes in properties due to certain conditions. Learners have developed healthful and hygienic practices related to the reproductive system after describing changes that accompany puberty. They can compare different modes of reproduction among plant and animal groups and conduct an investigation on pollination. They have become aware of the importance of estuaries and intertidal zones and help in their preservation. Learners can describe the movement of objects in terms of distance and time travelled. Learners recognize that different materials react differently with heat, light, and sound. They can relate these abilities of materials to their specific uses. Learners can describe the changes that earth materials undergo. They can make emergency plans with their families in preparation for typhoons. They can observe patterns in the natural events by observing the appearance of the Moon.
Grade 6	At the end of Grade 6, learners recognize that when mixed together, materials may not form new ones thus these materials may be recovered using different separation techniques. They can prepare useful mixtures such as food, drinks and herbal medicines. Learners understand how the different organ systems of the human body work together. They can classify plants based on reproductive structures, and animals based on the presence or lack of backbone. They can design and conduct an investigation on plant propagation. They can describe larger ecosystems such as rainforests, coral reefs, and mangrove swamps. Learners can infer that friction and gravity affect how people and objects move. They have found out that heat, light, sound, electricity, and motion studied earlier are forms of energy and these undergo transformation. Learners can describe what happens during earthquakes and volcanic eruptions and demonstrate what to do when they occur. They can infer that the weather follows a pattern in the course of a year. They have learned about the solar system, with emphasis on the motions of the Earth as prerequisite to the study of seasons in another grade level.

K to 12 BASIC EDUCATION CURRICULUM

GRADE/LEVEL	Grade-Level Standards
Grade 7	At the end of Grade 7, learners can distinguish mixtures from substances through semi-guided investigations. They realize the importance of air testing when conducting investigations. After studying how organ systems work together in plants and animals in the lower grade levels, learners can use a microscope when observing very small organisms and structures. They recognize that living things are organized into different levels: Cells, tissues, organs, organ systems, and organisms. These organisms comprise populations and communities, which interact with non-living things in ecosystems. Learners can describe the motion of objects in terms of distance and speed, and represent this in tables, graphs, charts, and equations. They can describe how various forms of energy travel through different mediums. Learners describe what makes up the Philippines as a whole and the resources found in the archipelago. They can explain the occurrence of breezes, monsoons, and ITCZ, and how these weather systems affect people. They can explain why seasons change and demonstrate how eclipses occur.
Grade 8	At the end of Grade 8, learners can describe the factors that affect the motion of an object based on the Laws of Motion. They can differentiate the concept of work as used in science and in layman's language. They know the factors that affect the transfer of energy, such as temperature difference, and the type (solid, liquid, or gas) of the medium. Learners can explain how active faults generate earthquakes and how tropical cyclones originate from warm ocean waters. They recognize other members of the solar system. Learners can explain the behaviour of matter in terms of the particles it is made of. They recognize that ingredients in food and medical products are made up of these particles and are absorbed by the body in the form of ions. Learners recognize reproduction as a process of cell division resulting in growth of organisms. They have delved deeper into the process of digestion as studied in the lower grades, giving emphasis on proper nutrition for overall wellness. They can participate in activities that protect and conserve economically important species used for food.
Grade 9	At the end of Grade 9, learners have gained a a deeper understanding of the digestive, respiratory, and circulatory systems to promote overall health. They have become familiar with some technologies that introduce desired traits in economically important plants and animals. Learners can explain how new materials are formed when atoms are rearranged. They recognize that a wide variety of useful compounds may arise from such rearrangements. Learners can identify volcanoes and distinguish between active and inactive ones. They can explain how energy from volcanoes may be tapped for human use. They are familiar with climatic phenomena that occur on a global scale. They can explain why certain constellations can be seen only at certain times of the year. Learners can predict the outcomes of interactions among objects in real life applying the laws of conservation of energy and momentum.

K to 12 BASIC EDUCATION CURRICULUM

GRADE/LEVEL	Grade-Level Standards
Grade 10	At the end of Grade 10, learners realize that volcanoes and earthquakes occur in the same places in the world and that these are related to plate boundaries. They can demonstrate ways to ensure safety and reduce damage during earthquakes, tsunamis, and volcanic eruptions. Learners can explain the factors affecting the balance and stability of an object to help them practice appropriate positions and movements to achieve efficiency and safety such as in sports and dancing. They can analyze situations in which energy is harnessed for human use whereby heat is released, affecting the physical and biological components of the environment. Learners will have completed the study of the entire organism with their deeper study of the excretory and reproductive systems. They can explain in greater detail how genetic information is passed from parents to offspring, and how diversity of species increases the probability of adaptation and survival in changing environments. Learners can explain the importance of controlling the conditions under which a chemical reaction occurs. They recognize that cells and tissues of the human body are made up of water, a few kinds of ions, and biomolecules. These biomolecules may also be found in the food they eat.

SEQUENCE OF DOMAIN/STRANDS PER QUARTER

	G3	G4	G5	G6	G7	G8	G9	G10
1st Quarter	Matter	Matter	Matter	Matter	Matter	Force, Motion,& Energy	Living Things and Their Environment	Earth & Space
2nd Quarter	Living Things and Their Environment	Living Things and Their Environment	Living Things and Their Environment	Living Things and Their Environment	Living Things and Their Environment	Earth & Space	Matter	Force, Motion,& Energy
3rd Quarter	Force, Motion,& Energy	Force, Motion,& Energy	Force, Motion & Energy	Force, Motion,& Energy	Force, Motion,& Energy	Matter	Earth & Space	Living Things and Their Environment
4th Quarter	Earth & Space	Earth & Space	Earth & Space	Earth & Space	Earth & Space	Living Things and Their Environment	Force, Motion,& Energy	Matter

K to 12 BASIC EDUCATION CURRICULUM

SPIRALLING OF CONCEPTS GRADE 3 – GRADE 10

MATTER

Grade 3	Grade 4	Grade 5	Grade 6
PROPERTIES OF MATTER			
When learners observe different objects and materials, they become aware of their different characteristics such as shape, weight, definiteness of volume and ease of flow. Using characteristics, objects and materials can be grouped into solids, liquids or gases.	Aside from being grouped into solids, liquids, or gases, materials may also be grouped according to their ability to absorb water, ability to float or sink, and whether they decay or not	After learning how to read and interpret product labels, learners can critically decide whether these materials are harmful or not. They can also describe ways in which they can use their knowledge of solids and liquids in making useful materials and products.	In Grade 4, the learners have observed the changes when mixing a solid in a liquid or a liquid in another liquid. From these investigations, learners can now describe the appearance of mixtures as uniform or non-uniform and classify them as homogeneous or heterogeneous mixtures.
CHANGES THAT MATTER UNDERGO			
Using the characteristics observed among solids, liquids, and gases, learners investigate ways in which solid turns into liquid, solid into gas, liquid into gas, and liquid into solid, as affected by temperature.	Changes in some characteristics of solid materials can be observed when these are bent, hammered, pressed, and cut. After investigating the changes in some observable characteristics of materials due to temperature in Grade 3, learners can now inquire about changes observed when a solid is mixed with a liquid or when a liquid is mixed with another liquid. Learners learn that some changes in the characteristics of a product such as food or medicine may affect its quality. One way of finding out is by reading and interpreting product labels. This information helps them decide when these products become harmful.	In Grade 4, learners investigated changes in materials that take place at certain conditions, such as applying force, mixing materials, and changing the temperature. In Grade 5, they investigate changes that take place under the following conditions: presence or lack of oxygen (in air), and applying heat. They learn that some of these conditions can result in a new product. Knowing these conditions enable them to apply the "5R method" (recycling, reducing, reusing, recovering and repairing) at home and in school.	Based on the characteristics of the components of a heterogeneous mixture, learners investigate ways of separating these components from the mixture. They will infer that the characteristics of each of the components remain the same even when the component is part of the mixture.

Grade 7	Grade 8	Grade 9	Grade 10
PROPERTIES AND STRUCTURE OF MATTER			
In Grade 6, learners learned how to distinguish homogenous from heterogeneous mixtures. In Grade 7, learners investigate properties of solutions that are homogeneous mixtures. They learn how to express concentrations of solutions qualitatively and quantitatively. They distinguish mixtures from substances based on a set of properties. Learners begin to do guided and semi-guided investigations, making sure that the experiment they are conducting is a fair test.	Using models, learners learn that matter is made up of particles, the smallest of which is the atom. These particles are too small to be seen through a microscope. The properties of materials that they have observed in earlier grades can now be explained by the type of particles involved and the attraction between these particles.	Using their understanding of atomic structure learned in Grade 8, learners describe how atoms can form units called molecules. They also learn about ions. Further, they explain how atoms form bonds (ionic and covalent) with other atoms by the transfer or sharing of electrons. They also learn that the forces holding metals together are caused by the attraction between flowing electrons and the positively charged metal ions. Learners explain how covalent bonding in carbon forms a wide variety of carbon compounds. Recognizing that matter consists of an extremely large number of very small particles, counting these particles is not practical. So, learners are introduced to the unit—mole.	Learners investigate how gases behave in different conditions based on their knowledge of the motion of and distances between gas particles. Learners then confirm whether their explanations are consistent with the Kinetic Molecular Theory. They also learn the relationships between volume, temperature, and pressure using established gas laws. In Grade 9, learners learned that the bonding characteristics of carbon result in the formation of large variety of compounds. In Grade 10, they learn more about these compounds that include biomolecules such as carbohydrates, lipids, proteins, and nucleic acids. Further, they will recognize that the structure of these compounds comprises repeating units that are made up of a limited number of elements such as carbon, hydrogen, oxygen, and nitrogen.
CHANGES THAT MATTER UNDERGO			
Learners recognize that materials combine in various ways and through different processes, contributing to the wide variety of materials. Given this diversity, they recognize the importance of a classification system. They become familiar with elements and compounds, metals and non-metals, and acids and bases. Further, learners demonstrate that homogeneous mixtures can be separated using various techniques.	Learners learn that particles are always in motion. They can now explain that the changes from solid to liquid, solid to gas, liquid to solid, and liquid to gas, involve changes in the motion of and relative distances between the particles, as well as the attraction between them. They also recognize that the same particles are involved when these changes occur. In effect, no new substances are formed.	Learners explain how new compounds are formed in terms of the rearrangement of particles. They also recognize that a wide variety of useful compounds may arise from such rearrangements.	In Grade 9, learners described how particles rearrange to form new substances. In Grade 10, they learn that the rearrangement of particles happen when substances undergo chemical reaction. They further explain that when this rearrangement happens, the total number of atoms and total mass of newly formed substances remain the same. This is the Law of Conservation of Mass. Applying this law, learners learn to balance chemical equations and solve simple mole-mole, mole-mass, and mass-mass problems.

LIVING THINGS AND THEIR ENVIRONMENT

Grade 3	Grade 4	Grade 5	Grade 6
PARTS AND FUNCTION OF ANIMALS AND PLANTS			
In Grade 3, learners observe and describe the different parts of living things focusing on the sense organs of humans and the more familiar external parts of animals and plants. They also explore and describe characteristics of living things that distinguish them from non-living things.	In Grade 4, the learners are introduced to the major organs of the human body. They also learn about some parts that help plants and animals survive in places where they live.	After learning in Grade 4 how the major organs of the human body work together, the learners now focus on the organs of the reproductive systems of humans, animals, and plants.	In Grade 6, learners describe the interactions among parts of the major organs of the human body. They also learn how vertebrates and invertebrates differ and how non-flowering plants reproduce,
HEREDITY:INHERITANCE AND VARIATION			
Learners learn that living things reproduce and certain traits are passed on to their offspring/s.	Learners learn that humans, animals, and plants go through life cycles. Some inherited traits may be affected by the environment at certain stages in their life cycles.	Learners learn how flowering plants and some non-flowering plants reproduce. They are also introduced to the sexual and asexual modes of reproduction.	Learners learn how non-flowering plants (spore-bearing and cone-bearing plants, ferns, and mosses) reproduce.
BIODIVERSITY AND EVOLUTION			
Different kinds of living things are found in different places.	Learners investigate that animals and plants live in specific habitats.	Learners learn that reproductive structures serve as one of the bases for classifying living things.	They learn that plants and animals share common characteristics which serve as bases for their classification.
ECOSYSTEMS			
Learners learn that living things depend on their environment for food, air, and water to survive.	Learners learn that there are beneficial and harmful interactions that occur among living things and their environment as they obtain their basic needs.	Learners are introduced to the interactions among components of larger habitats such as estuaries and intertidal zones, as well as the conditions that enable certain organisms to live.	Learners are introduced to the interactions among components of habitats such as tropical rainforests, coral reefs, and mangrove swamps.

Grade 7	Grade 8	Grade 9	Grade 10
PARTS AND FUNCTION: ANIMAL AND PLANTS			
In Grade 7, learners are introduced to the levels of organization in the human body and other organisms. They learn that organisms consist of cells, most of which are grouped into organ systems that perform specialized functions.	In Grade 8, learners gain knowledge of how the body breaks down food into forms that can be absorbed through the digestive system and transported to cells. Learners learn that gases are exchanged through the respiratory system. This provides the oxygen needed by cells to release the energy stored in food. They also learn that dissolved wastes are removed through the urinary system while solid wastes are eliminated through the excretory system.	Learners study the coordinated functions of the digestive, respiratory, and circulatory systems. They also learn that nutrients enter the bloodstream and combine with oxygen taken in through the respiratory system. Together, they are transported to the cells where oxygen is used to release the stored energy.	Learners learn that organisms have feedback mechanisms that are coordinated by the nervous and endocrine systems. These mechanisms help the organisms maintain homeostasis to reproduce and survive.
HEREDITY:INHERITANCE AND VARIATION			
After learning how flowering and non flowering plants reproduce, Grade 7 learners are taught that asexual reproduction results in genetically identical offspring whereas sexual reproduction gives rise to variation.	Learners study the process of cell division by mitosis and meiosis. They understand that meiosis is an early step in sexual reproduction that leads to variation.	Learners study the structure of genes and chromosomes, and the functions they perform in the transmission of traits from parents to offspring.	Learners are introduced to the structure of the DNA molecule and its function. They also learn that changes that take place in sex cells are inherited while changes in body cells are not passed on.
BIODIVERSITY AND EVOLUTION			
Learners learn that the cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.	Learners learn that *species* refers to a group of organisms that can mate with one another to produce fertile offspring. They learn that biodiversity is the collective variety of species living in an ecosystem. This serves as an introduction to the topic on hierarchical taxonomic system.	Learners learn that most species that have once existed are now extinct. Species become extinct when they fail to adapt to changes in the environment.	Learners revisit the mechanisms involved in the inheritance of traits and the changes that result from these mechanisms. Learners explain how natural selection has produced a succession of diverse new species. Variation increases the chance of living things to survive in a changing environment.
ECOSYSTEMS			
Learners learn that interactions occur among the different levels of organization in ecosystems.	Learners learn how energy is transformed and how materials are cycled in ecosystems.	Learners learn how plants capture energy from the Sun and store energy in sugar molecules (photosynthesis). This	Learners investigate the impact of human activities and other organisms on ecosystems.

Grade 7	Grade 8	Grade 9	Grade 10
Organisms of the same kind interact with each other to form populations; populations interact with other populations to form communities.		stored energy is used by cells during cellular respiration. These two processes are related to each other.	They learn how biodiversity influences the stability of ecosystems.

FORCE, MOTION AND ENERGY

Grade 3	Grade 4	Grade 5	Grade 6
FORCE AND MOTION			
Learners observe and explore and investigate how things around them move and can be moved. They also identify things in their environment that can cause changes in the movement of objects.	Learners now learn that if force is applied on an object, its motion, size, or shape can be changed. They will further understand that these changes depend on the amount of force applied on it (qualitative). They also learn that magnets can exert force on some objects and may cause changes in their movements.	This time, learners begin to accurately measure the amount of change in the movement of an object in terms of its distance travelled and time of travel using appropriate tools.	Aside from the identified causes of motion in Grade 3, such as people, animals, wind, and water, learners also learn about gravity and friction as other causes or factors that affect the movement of objects.
ENERGY			
Learners observe and identify different sources of light, heat, sound, and electricity in their environment and their uses in everyday life.	Learners learn that light, heat, and sound travel from the source. They perform simple activities that demonstrate how they travel using various objects. *Note: Electricity is not included in Grade 4 because the concept of 'flow of charges' is difficult to understand at this grade level.*	This time, learners explore how different objects interact with light, heat, sound, and electricity (e.g., identifying poor and good conductors of electricity using simple circuits). They learn about the relationship between electricity and magnetism by constructing an electromagnet. They also learn about the effects of light, heat, sound, and electricity on people.	At this grade level, learners are introduced to the concept of energy. They learn that energy exists in different forms, such as light, heat, sound and electricity, and it can be transformed from one form to another. They demonstrate how energy is transferred using simple machines.

Grade 7	Grade 8	Grade 9	Grade 10
FORCE AND MOTION			
From a simple understanding of motion, learners study more scientific ways of describing (in terms of distance, speed, and acceleration) and representing (using motion diagrams, charts, and graphs) the motion of objects in one dimension.	This time, learners study the concept of force and its relationship to motion. They use Newton's Laws of Motion to explain why objects move (or do not move) the way they do (as described in Grade 7). They also realize that if force is applied on a body, work can be done and may cause a change in the energy of the body.	To deepen their understanding of motion, learners use the Law of Conservation of Momentum to further explain the motion of objects. From motion in one dimension in the previous grades, they learn at this level about motion in two dimensions using projectile motion as an example.	From learning the basics of forces in Grade 8, learners extend their understanding of forces by describing how balanced and unbalanced forces, either by solids or liquids, affect the movement, balance, and stability of objects.
ENERGY			
This time learners recognize that different forms of energy travel in different ways—light and sound travel through waves, heat travels through moving or vibrating particles, and electrical energy travels through moving charges. In Grade 5, they learned about the different modes of heat transfer. This time, they explain these modes in terms of the movement of particles.	Learners realize that transferred energy may cause changes in the properties of the object. They relate the observable changes in temperature, amount of current, and speed of sound to the changes in energy of the particles.	Learners explain how conservation of mechanical energy is applied in some structures, such as roller coasters, and in natural environments like waterfalls. They further describe the transformation of energy that takes place in hydroelectric power plants. Learners also learn about the relationship between heat and work, and apply this concept to explain how geothermal power plants operate. After they have learned how electricity is generated in power plants, learners further develop their understanding of transmission of electricity from power stations to homes.	Learners acquire more knowledge about the properties of light as applied in optical instruments. Learners also use the concept of moving charges and magnetic fields in explaining the principle behind generators and motors.

EARTH AND SPACE

Grade 3	Grade 4	Grade 5	Grade 6
GEOLOGY			
Learners will describe what makes up their environment, beginning with the landforms and bodies of water found in their community.	After familiarizing themselves with the general landscape, learners will investigate two components of the physical environment in more detail: soil and water. They will classify soils in their community using simple criteria. They will identify the different sources of water in their community. They will infer the importance of water in daily activities and describe ways of using water wisely.	In this grade level, learners will learn that our surroundings do not stay the same forever. For example, rocks undergo weathering and soil is carried away by erosion. Learners will infer that the surface of the Earth changes with the passage of time.	Learners will learn that aside from weathering and erosion, there are other processes that may alter the surface of the Earth: earthquakes and volcanic eruptions. Only the effects of earthquakes and volcanic eruptions are taken up in this grade level, not their causes (which will be tackled in Grades 8 and 9). Learners will also gather and report data on earthquakes and volcanic eruptions in their community or region.
METEOROLOGY			
Learners will describe the different types of local weather,	After making simple descriptions about the weather in the previous grade, learners will now measure the components of weather using simple instruments. They will also identify trends in a simple weather chart.	Learners will learn that the weather does not stay the same the whole year round. Weather disturbances such as typhoons may occur. Learners will describe the effects of typhoons on the community and the changes in the weather before, during, and after a typhoon.	After learning how to measure the different components of weather in Grades 4 and 5, learners will now collect weather data within the span of the school year. Learners will interpret the data and identify the weather patterns in their community.
ASTRONOMY			
Learners will describe the natural objects that they see in the sky.	After describing the natural objects that are seen in the sky, learners will now focus on the main source of heat and light on Earth: the Sun, its role in plant growth and development, and its effect on the activities of humans and other animals.	After learning about the Sun, learners will now familiarize themselves with the Moon and the stars. They will describe the changes in the appearance of the Moon and discover that the changes are cyclical, and that the cycle is related to the length of a month. Learners will identify star patterns that can be seen during certain times of the year.	In Grade 6, learners will turn their attention to Earth as another natural object in space (in addition to the Sun, Moon, and stars). Learners will learn about the motions of the Earth: rotation and revolution. Learners will also compare the different members that make up the Solar System and construct models to help them visualize their relative sizes and distances.

Grade 7	Grade 8	Grade 9	Grade 10
GEOLOGY			
Learners will explore and locate places using a coordinate system. They will discover that our country's location near the equator and along the Ring of Fire influences elements of up Philippine environment (e.g., natural resources and climate).	As a result of being located along the Ring of Fire, the Philippines is prone to earthquakes. Using models, learners will explain how quakes are generated by faults. They will try to identify faults in the community and differentiate active faults from inactive ones.	Being located along the Ring of Fire, the Philippines is home to many volcanoes. Using models, learners will explain what happens when volcanoes erupt. They will describe the different types of volcanoes and differentiate active volcanoes from inactive ones. They will also explain how energy from volcanoes may be tapped for human use.	Using maps, learners will discover that volcanoes, earthquake epicenters, and mountain ranges are not randomly scattered in different places but are located in the same areas. This will lead to an appreciation of plate tectonics—a theory that binds many geologic processes such as volcanism and earthquakes.
METEOROLOGY			
Learners will explain the occurrence of atmospheric phenomena (breezes, monsoons, and ITCZ) that are commonly experienced in the country as a result of the Philippines' location with respect to the equator, and surrounding bodies of water and landmasses.	Being located beside the Pacific Ocean, the Philippines is prone to typhoons. In Grade 5, the effects of typhoons were tackled. Here, learners will explain how typhoons develop, how typhoons are affected by landforms and bodies of water, and why typhoons follow certain paths as they move within the Philippine Area of Responsibility.	In this grade level, learners will distinguish between weather and climate. They will explain how different factors affect the climate of an area. They will also be introduced to climatic phenomena that occur over a wide area (e.g., El Niño and global warming).	**Note:** The theory of plate tectonics is the sole topic in Earth and Space in Grade 10. This is because the theory binds many of the topics in previous grade levels, and more time is needed to explore connections and deepen learners' understanding.
ASTRONOMY			
Learners will explain the occurrence of the seasons and eclipses as a result of the motions of the Earth and the Moon. Using models, learners will explain that because the Earth revolves around the Sun, the seasons change, and because the Moon revolves around the Earth, eclipses sometimes occur.	Learners will complete their survey of the Solar System by describing the characteristics of asteroids, comets, and other members of the Solar System.	Learners will now leave the Solar System and learn about the stars beyond. They will infer the characteristics of stars based on the characteristics of the Sun. Using models, learners will show that constellations move in the course of a night because of Earth's rotation, while different constellations are observed in the course of a year because of the Earth's revolution.	

K to 12 BASIC EDUCATION CURRICULUM

GRADE 10

CONTENT	CONTENT STANDARDS	PERFORMANCE STANDARDS	LEARNING COMPETENCY	CODE
Grade 10 – Earth and Space **FIRST QUARTER/FIRST GRADING PERIOD**				
1. Plate Tectonics 1.1 Distribution 1.1.1 volcanoes 1.1.2 earthquake epicenters 1.1.3 mountain ranges 1.2 Plate boundaries 1.3 Processes and landforms along plate boundaries 1.4 Internal structure of the Earth 1.5 Mechanism (possible causes of movement) 1.6 Evidence of plate movement	*The learners demonstrate an understanding of:* the relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges	*The learners shall be able to:* 1. demonstrate ways to ensure disaster preparedness during earthquakes, tsunamis, and volcanic eruptions 2. suggest ways by which he/she can contribute to government efforts in reducing damage due to earthquakes, tsunamis, and volcanic eruptions	*The learners should be able to…* 1. describe the distribution of active volcanoes, earthquake epicenters, and major mountain belts;	**S9ES –Ia-j-36.1**
			2. describe the different types of plate boundaries;	**S9ES –Ia-j-36.2**
			3. explain the different processes that occur along the plate boundaries;	**S9ES –Ia-j-36.3**
			4. describe the internal structure of the Earth;	**S9ES –Ia-j-36.4**
			5. describe the possible causes of plate movement; and	**S9ES –Ia-j-36.5**
			6. enumerate the lines of evidence that support plate movement	**S9ES –Ia-j-36.6**
Grade 10 – Force, Motion and, Energy **SECOND QUARTER/SECOND GRADING PERIOD**				
1. Electromagnetic Spectrum	*The learners demonstrate an understanding of:* the different regions of the electromagnetic spectrum	*The learners s hall be able to:*	*The learners should be able to…* 1. compare the relative wavelengths of different forms of electromagnetic waves;	**S10FE-IIa-b-47**

CONTENT	CONTENT STANDARDS	PERFORMANCE STANDARDS	LEARNING COMPETENCY	CODE
			2. cite examples of practical applications of the different regions of EM waves, such as the use of radio waves in telecommunications;	**S10FE-IIc-d-48**
			3. explain the effects of EM radiation on living things and the environment;	**S10FE-IIe-f-49**
2. Light **2.1 Reflection of Light in Mirrors** **2.2 Refraction of Light in Lenses**	the images formed by the different types of mirrors and lenses		4. predict the qualitative characteristics (orientation, type, and magnification) of images formed by plane and curved mirrors and lenses;	**S10FE-IIg-50**
			5. apply ray diagramming techniques in describing the characteristics and positions of images formed by lenses;	**S10FE-IIg-51**
			6. identify ways in which the properties of mirrors and lenses determine their use in optical instruments (e.g., cameras and binoculars);	**S10FE-IIh-52**
3. Electricity and Magnetism 3.1 Electromagnetic effects	the relationship between electricity and magnetism in electric motors and generators		7. demonstrate the generation of electricity by movement of a magnet through a coil; and	**S10FE-IIi-53**
			8. explain the operation of a simple electric motor and generator.	**S10FE-IIj-54**

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CONTENT	CONTENT STANDARDS	PERFORMANCE STANDARDS	LEARNING COMPETENCY	CODE
Grade 10 – Living Things and Their Environment **THIRD QUARTER/THIRD GRADING PERIOD**				
1. Coordinated Functions of the Reproductive, Endocrine, and Nervous Systems	*The learners demonstrate an understanding of:* 1. organisms as having feedback mechanisms, which are coordinated by the nervous and endocrine systems 2. how these feedback mechanisms help the organism maintain homeostasis to reproduce	*The learners should be able to:*	*The learners should be able to…* 1. describe the parts of the reproductive system and their functions;	**S10LT-IIIa-33**
			2. explain the role of hormones involved in the female and male reproductive systems;	**S10LT-IIIb-34**
			3. describe the feedback mechanisms involved in regulating processes in the female reproductive system (e.g., menstrual cycle);	**S10LT-IIIc-35**
			4. describe how the nervous system coordinates and regulates these feedback mechanisms to maintain homeostasis;	**S10LT-IIIc-36**
2. Heredity: Inheritance and Variation	1. the information stored in DNA as being used to make proteins 2. how changes in a DNA molecule may cause changes in its product 3. mutations that occur in sex cells as being heritable		5. explain how protein is made using information from DNA;	**S10LT-IIId-37**
			6. explain how mutations may cause changes in the structure and function of a protein;	**S10LT-IIIe-38**

CONTENT	CONTENT STANDARDS	PERFORMANCE STANDARDS	LEARNING COMPETENCY	CODE
3. Biodiversity and Evolution	how evolution through natural selection can result in biodiversity	write an essay on the importance of adaptation as a mechanism for the survival of a species	7. explain how fossil records, comparative anatomy, and genetic information provide evidence for evolution;	**S10LT-IIIf-39**
			8. explain the occurrence of evolution;	**S10LT-IIIg-40**
4. Ecosystems **4.1 Flow of Energy and Matter in Ecosystems** **4.2 Biodiversity and Stability** **4.3 Population Growth and Carrying Capacity**	1. the influence of biodiversity on the stability of ecosystems 2. an ecosystem as being capable of supporting a limited number of organisms		9. explain how species diversity increases the probability of adaptation and survival of organisms in changing environments;	**S10LT-IIIh-41**
			10. explain the relationship between population growth and carrying capacity; and	**S10LT-IIIi-42**
			11. suggest ways to minimize human impact on the environment.	**S10LT-IIIj-43**
Grade 10 – Matter **FOURTH QUARTER/FOURTH GRADING PERIOD**				
1. Gas Laws 1.1 Kinetic Molecular Theory 1.2 Volume, pressure, and temperature relationship 1.3 Ideal gas law	*The learners demonstrate an understanding of…* how gases behave based on the motion and relative distances between gas particles	*The learners shall be able to:*	*The learners should be able to…* 1. investigate the relationship between: 1.1 volume and pressure at constant temperature of a gas; 1.2 volume and temperature at constant pressure of a gas; 1.3 explains these relationships using the kinetic molecular theory;	**S10MT-IVa-b-21**

K to 12 BASIC EDUCATION CURRICULUM

CONTENT	CONTENT STANDARDS	PERFORMANCE STANDARDS	LEARNING COMPETENCY	CODE
2. Biomolecules 2.1 Elements present in biomolecules 2.2 Carbohydrates, lipids, proteins, and nucleic acids 2.2.1 Food Labels	the structure of biomolecules, which are made up mostly of a limited number of elements, such as carbon, hydrogen, oxygen, and nitrogen		2. recognize the major categories of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids;	**S10MT-IVc-d-22**
3. Chemical reactions	the chemical reactions associated with biological and industrial processes affecting life and the environment	using any form of media, present chemical reactions involved in biological and industrial processes affecting life and the environment	3. apply the principles of conservation of mass to chemical reactions; and	**S10MT-IVe-g-23**
			4. explain how the factors affecting rates of chemical reactions are applied in food preservation and materials production, control of fire, pollution, and corrosion.	**S10MT-IVh-j-24**

K to 12 BASIC EDUCATION CURRICULUM

CODE BOOK LEGEND

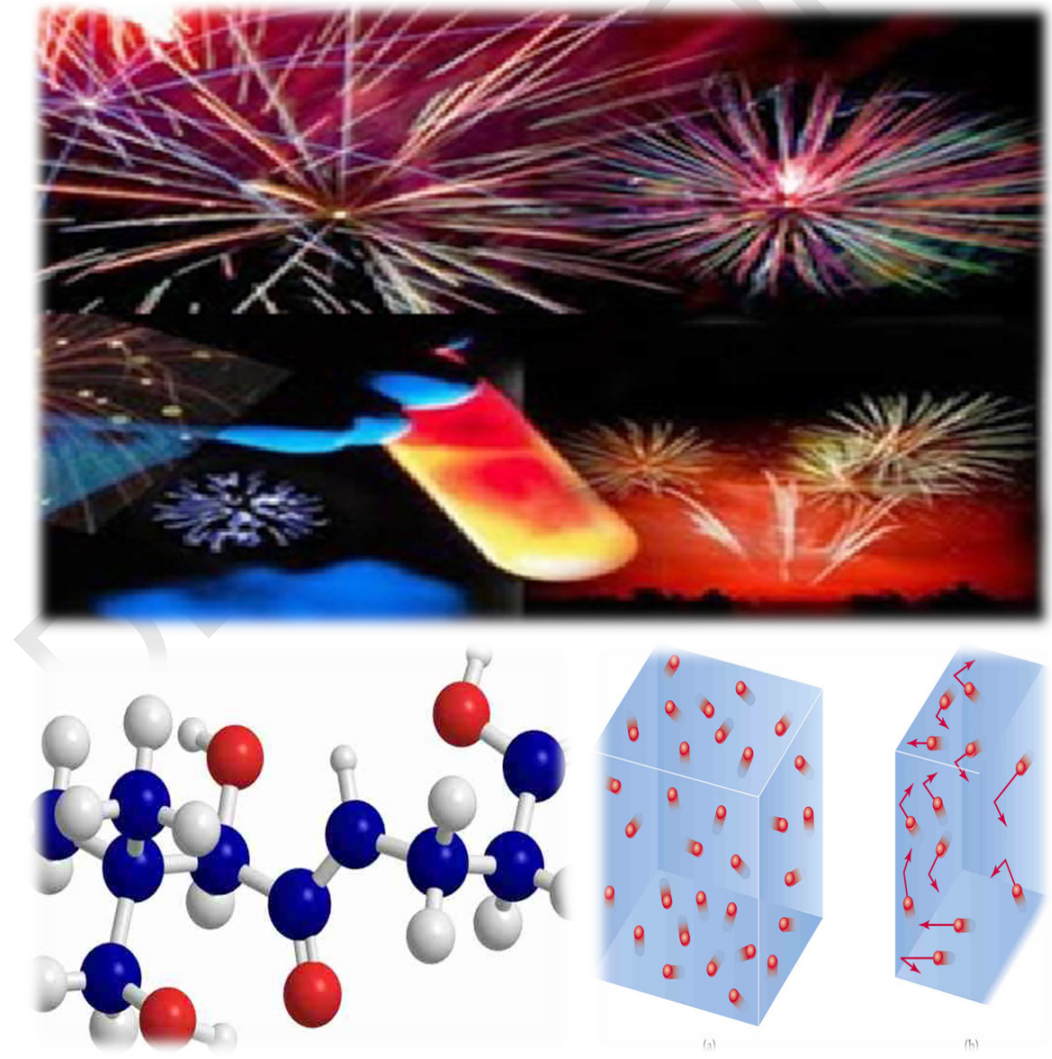
Sample: S8ES-IId-19

LEGEND		SAMPLE	
First Entry	Learning Area and Strand/ Subject or Specialization	Science	**S8**
	Grade Level	Grade 8	
Uppercase Letter/s	Domain/Content/ Component/ Topic	Earth and Space	**ES**
			-
Roman Numeral **Zero if no specific quarter*	Quarter	Second Quarter	**II**
Lowercase Letter/s **Put a hyphen (-) in between letters to indicate more than a specific week*	Week	Week four	**d**
			-
Arabic Number	Competency	Infer why the Philippines is prone to typhoons	**19**

DOMAIN/ COMPONENT	CODE
Living things and their Environment	LT
Force, Motion, and Energy	FE
Earth and Space	ES
Matter	MT

UNIT 4

Matter and Its Interactions



Unit 4: Matter and its Interactions

Introduction

In Grade 9 Science, the students have learned about chemical bonding and its various types. They have learned how chemical bonding occurs and how particles rearrange to form new substances. Basic mole concept was also introduced to them, relating mass and number of particles of substances. They were also able to analyze the bonding characteristics of carbon which results in the formation of large variety of compounds.

This Teacher's Guide for Grade 10 Science will help you teach them learn that the rearrangement of particles happen when substances undergo chemical reaction. The activities provided here will help you teach your students get to know how Law of Conservation of Mass applies to chemical reactions by analyzing masses and number of atoms of substances before and after a chemical reaction. Moving up from bonding characteristics of carbon, you will be guiding your students to study about biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.

Using the activities here, you will lead the students in investigating how gases behave in different conditions based on knowledge of the motion and distances between gas particles, which will enable them to explain behavior of gases using the assumptions in the Kinetic Molecular Theory as well as the relationships between volume, temperature, and pressure using established gas laws.

The modules included in this unit are as follows:

Module 1: Behavior of Gases

Module 2: Chemical Reactions

Module 3: Biomolecules

Unit 4
MODULE
1

Suggested time allotment: 14 hours

Behavior of Gases

Content Standards	Learning Competencies
The Learners demonstrate an understanding of… how gases behave based on the motion and relative distances between gas particles	• Investigate the relationship between: a. volume and pressure at constant temperature of a gas; and b. volume and temperature at constant pressure of a gas. • Explain the above mentioned relationships using the Kinetic Molecular Theory.

Overview

This *Teacher's Guide* on the use of the *Module on Gases* intends to equip the Grade 10 Teachers with the basic concepts about the properties and behavior of gases, and the laws that govern them. These laws can theoretically predict the values of the properties of gases once the conditions are changed. There are ideal and real gas laws. The real gas laws that are found in the module, as follows: Boyle's Law, Charles' Law, Gay-Lussac's Law and Avogadro's Law. Samples of gas law related problems are provided, discussed and analyzed in this module. Experimentally, the properties of gases can also be observed using the different laboratory apparatus. There are 7 experiments provided in the module which are all intended for the learners to have a feel of the properties of gases. This guide also explains the possible outcome of the experiments or activities that are provided in the *Module on Gases.* Moreover, it also looks into possible sources of error in each experiment or activity with the corresponding solutions or alternatives in cases that unexpected results occurred. The copies of the pre-assessment and summative assessment with answers can also be found at the last pages of this guide. The *pre-assessment* intends to measure the knowledge of the students on the topic before using the module, while the *summative assessment* intends to measure how much the students have learned after using the module.

For the Teachers

Teachers who intend or who are required to use the *Module on Gases* must consider the following points to remember:

1. The procedure of the experiment or activity should be discussed to the students. Before conducting the experiment, each step must be understood by them to get the best possible result and to avoid repetition of the experiment. Time is of the essence.
2. Precautions cited in the experiments or activities must be given emphasis to avoid any untoward incident. Prepare first aid kit that includes petroleum jelly, cotton and betadine.
3. As much as possible, do not leave the students while they are doing the experiment. Most of the students are very curious nowadays. We should always be on guard.
4. All the materials and/or chemicals must be readily available before conducting any activity or experiment to save time.
5. The values of the properties of gases can be varied. Hence, it is important that a student should learn to identify which values are for initial conditions and which are for the final conditions. There are cases that students get the wrong answers because of their inability to identify the given.
6. Students should have the mastery of the skills in the following:
   a. Determining the number of significant figure because the answers to gas law related problems must be based on these rules. These rules determine as to how many digits of the answers are certain or not.
   b. Determining the units used for measuring volume, pressure, temperature, and amount of a gas.
   c. Converting one unit to another
   d. Using scientific calculator when needed.
7. Require the students to answer the pre-assessment in the module. Have it checked using the answer key. Based on the test result, identify the topics that need to be given emphasis.

Let us start.

Gases have different properties. They have indefinite shape and size, and fit the shape and size of their containers. Gases also have mass, volume, temperature, and pressure. Volume is the amount of space occupied by the gases. Temperature is the measure of the coldness or hotness of the gas. Pressure is the force applied by the gas particles per unit area. For the students to have a feel of these properties, Activity 1 was designed for them.

Activity 1

Getting to Know Gases

A. Gases and Its Mass

All matter has mass including gases, to prove this, balloon is used in this experiment**.** The mass of the balloon will be measured before and after it is inflated. It is expected that the mass of the inflated balloon is heavier than the deflated one because of the introduction of gases inside the balloon.

Note: A digital balance with a 0.1precision must be used in this experiment since the mass of a gas is very light. This instrument can sense up to hundredths digit; others of the same kind are even more sensitive to a lighter mass. The expected result may not be achieved if another weighing scale, such as triple beam balance or platform balance is used as a substitute. The latter instruments are not as sensitive as the former.

During the weighing process, be sure that the area is free of air disturbances. Outside atmospheric forces may lead to false results.

Answers to questions

Q1. Is the mass of the deflated balloon different from the mass of the inflated balloon? *Yes*

Q2. Which is heavier, the inflated or the deflated balloon? *The inflated balloon is heavier than the deflated balloon*. Why? *The difference in the mass of the two balloons is due to the introduction of gas.*

Q3. What can you assume in this activity? *Gases like solids and liquids, also have mass*.

B. Gases and Its Volume

To prove that gases have volume, water covered with oil is used in this experiment. The air is then introduced in the water using a syringe. The oil will prevent the air from escaping. It is expected that the volume of the mixture will increase because gases in the air also have volume.

Note: If there is no increase in volume after introducing air, insert again the syringe until an increase in volume is already obvious.

Answers to questions

Q1. What happens to the volume reading of the water-oil mixture when an air is introduced to it? *The volume increases.*

Q2. What does it indicate? *Gas has volume.*

Table 6. Data on Volume-Pressure Relationship

Trial	Volume (L)	Pressure (atm)	VxP
1	2.0	10.00	20.
2	4.0	5.00	20.
3	8.0	2.50	20.
4	16.0	1.25	20.0

C. Gases and Its Temperature

To prove that gases have temperatures that can be changed, the temperatures of the air above the water level at different conditions are measured. The following conditions are considered; room temperature, low temperature and high temperature. The air above the water level at room temperature is set as the initial condition. Low temperature air is achieved by exposing the air to water full of ice. On the other hand, high temperature air is achieved by exposing the air to boiling water.

It is expected that the temperature of the air above the cold water level is the lowest while that of the air above the boiling water is the highest.

Note: The teacher must ensure that the students have the skill of using and reading the thermometer before doing this activity. Different thermometers have different increments.

Answers to questions

Q1. Is there a difference in the temperature of the air among the three set-ups? *Yes*

Q2. Explain the difference in temperature of the air.
Heat flows from the system to the surrounding or vice versa. If the water is cold, the surrounding air also gets cold. Conversely, if the water is hot, the surrounding air also gets hot.

D. Gases and Its Pressure

To prove that gases exert pressure, inflated and deflated balloons are used in this experiment. These balloons are inserted one at a time in an Erlenmeyer flask with hot water. It is expected that the inflated balloon will become bigger once it is placed on the mouth of the Erlenmeyer flask. The higher the temperature of the water, the bigger will be the balloon. Why?
Inside the sample balloons are *forces that are produced on the container walls by the rapid and continual bombardment of the huge number of vapor molecules. The average effect of these forces is known as the pressure exerted by the confined gas.*

Answers to questions

Q1. What happens to the inflated balloon?
The balloon becomes bigger.

Q2. What causes this phenomenon?
Heat flows. The heat of the water is transferred into the air above it, which then transfers the heat into the air inside the balloon. Once the air inside the balloon is heated, its molecules will become more excited causing an increase in their kinetic energy. The amount of kinetic energy that they possess becomes great enough that enable them to push the walls of the balloon. This phenomenon results to an increase in the spaces in between molecules of gases. Hence, the balloon becomes bigger.

Q3. What happens to the shape of the balloon?
The deflated balloon becomes inflated.

Q4. What causes the balloon to change its shape and size?
As the water is heated until it boils, water vapors are produced. These vapors are warm and warm air (including the vapor) moves upward just as cold air moves downward. Why? Warm air is less dense than cold air. The upwardly moving vapors enter the balloon and make it inflated, thereby changing its size and shape. The more vapors are produced; the bigger will be the balloon.

We have just learned from Activity 1, that gases have different properties namely; mass, volume, temperature, and pressure. It is a must that the learners should have the mastery of the units used in measuring these properties. They are as follows:

Volume units and their equivalents:

$1\ ml = 1cm^3$ $1\ L = 1dm^3$ $1m^3 = 1000\ L$

http://www.metric-conversions.org/volume/cubic-meters-to-liters.htm

Pressure units and their equivalents:

1atm = 760mmHg = 76cmHg = 760 torr = 101,325 Pa = 14.6956 psi

Temperature units and their equivalents:

0˚C = 273.15 K 0˚C = 32 ˚F

Gas properties such as volume, pressure, temperature, and amount of a gas can be varied. Hence, it is important that the learners can identify which values are for initial conditions and which ones are for final conditions. The variables for initial conditions are usually written with 1 as the subscript and the variables for final conditions are written with 2 as the subscript.

V_1 = initial volume
T_1 = initial temperature
P_1 = initial pressure
n_1 = initial amount of a gas in mole

V_2 = final volume
T_2 = final temperature
P_2 = final pressure
n_2 = final amount of a gas in mole

Theoretically, once these properties (volume, pressure, temperature, and amount of a gas) are varied, equations of the different gas laws can be used to predict or measure the effects of one variable to another. There are ideal and real gas laws, that are found in the module, as follows: Boyle's Law, Charles' Law, Gay-Lussac's Law and Avogadro's Law.

Boyle's law relate the volume of the gas with its pressure at constant temperature and amount of a gas. Activity 2 is designed for the learners to observe the effect of gas volume to pressure or vice versa.

Activity 2

Boyle's Law

To determine whether the volume of gas is affected by pressure or vice versa at constant temperature, the contained gas inside the syringe is used as the sample for this experiment. The initial volume of the gas the equal to the volume of the syringe once the plunger is pulled to its maximum capacity. In this experiment 25.0mL syringe is used.

It is expected that once a weight is added to the plunger, it will be pushed inside the syringe resulting to a decrease in the volume of the gas. The more weight is added, the greater will be the force and the pressure, and the lesser will be the volume of the gas.

The added mass will be converted first to force then to pressure using these equations:

F = ma where F = force; m = mass; a = acceleration due to gravity

P = F/a where P = pressure; F= force and A = area of the syringe

Sample computation: If the initial mass to be placed on the plunger is 500g and the value of acceleration to be used in this experiment is 9.8 m/s^2, how will you calculate the force, the area of the syringe and the pressure.

The solution should be

Step 1. The unit for force is *Newton* which is equivalent to $kg.m/s^2$. Convert the unit for mass from grams to kilograms. Since 1000 g = 1 kg, therefore 500.0 g = 0.5000 kg.

Step 2. Compute the amount of force. Substitute the values to this equation.

F = ma = 0.5000 kg (9.8 m/s^2) = **4.9 $kg.m/s^2$ or 4.9 N**

Step 3. Measure the diameter of the syringe and divide it by 2 to get the radius.

If the diameter of the syringe is 20.0 mm, then the radius is 20.0 mm/ 2 which is equal to 10.0 mm or 0.0100 m.

Step 4. Then, compute for the surface area of the syringe using this equation:

Surface Area of the syringe = πr^2 = 3.14 (0.0100m) ^{2} = **3.14 x 1^{-4} m^2**

Step 5. Finally, compute the amount of pressure**.** Substitute the values to this equation.

P = F/A = 4.9 N/ 3.14 x1^{-4} m^2 = **16000 N/m^2**

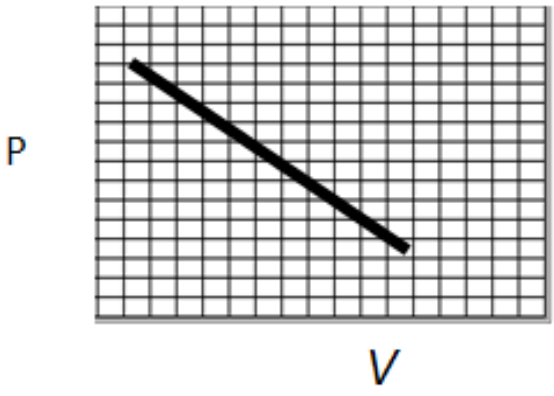
Note: Syringes of bigger sizes are better because the bigger the syringe, the smaller is the pressure required to push the plunger. On the contrary, the smaller the syringe, the greater is the pressure required to push the plunger.

Answers to questions

Q1. What happens to the volume of the syringe as the set of weights is added on top of it? *The volume of the gas inside the syringe decreases.*

Q2. What happens to the pressure on the syringe when the set of weights is added?
The pressure increases.

Q3. Describe the graph. *The recorded volume must be decreasing while the recorded pressure must be increasing. Therefore when a line graph of gas' volume vs. its pressure is plotted, with the pressure on the y axis and the volume on the x axis, it should look like this*



Q4. What is the relationship between volume and pressure of gases at constant temperature? *inversely proportional*

The graph shows that the relationship between volume and pressure of gases at constant temperature is inversely proportional. This is known as the Boyle's Law. He explained that as the pressure increases, it forces the gas particles to move closer to each other. This causes a decrease in the spaces in between and among them resulting to a decrease in the total volume of the gas. Conversely, when the pressure is decreased, lesser force controls the movements of the gas particles. This phenomenon can make them move as far as possible from one another because they have very weak intermolecular force of attraction. This will lead to an increase in the total volume of the gas.

Using this Boyle's Law equation, $\mathbf{V_1P_1 = V_2P_2}$, the answers to the following problems were provided.

1. *Oxygen gas inside a 1.5L-gas tank has a pressure of 0.95 atm. Provided that the temperature remains constant, how much pressure is needed to reduce its volume by ½?*
   Answer: $P_2 = V_1P_1 / V_2$
   $= (1.5L)(0.95\ atm) / (0.75L)$
   $=$ **1.9 atm**
   (the volume is reduced so the pressure is increase)

2. *A scuba diver needs a diving tank in order to provide breathing gas while he is underwater. How much pressure is needed for 6.00 liters of gas at 1.01 atmospheric pressure to be compressed in a 3.00 liter cylinder ?*
   Answer: $P_2 = V_1P_1 / V_2$
   $= (6.00L)(1.01\ atm) / (3.00L)$
   $= 2.02$ **atm**
   (the volume is reduced so the pressure must increased)

3. *A sample of fluorine gas occupies a volume of 600 mL at 760 torr. Given that the temperature remains the same, calculate the pressure required to reduce its volume by 1/3.*

   Answer: $P_2 = V_1P_1 / V_2$
   $= (600\ mL)(760\ torr) / (200\ mL)$
   $= 2280$ **torr**
   (the volume is reduced so the pressure must increased)

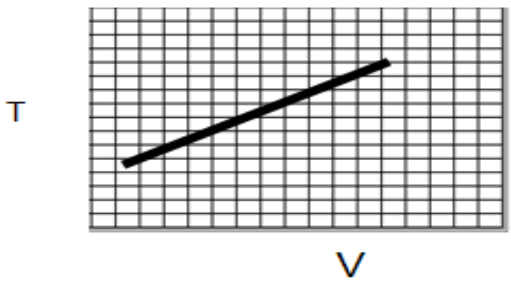
Activity 3

Charle's Law

To determine whether the volume of gas is affected by temperature or vice versa at constant pressure, three balloons are submerged water at different temperatures. The circumferences of the balloons are measured before and after they are subjected to different temperatures.

Hot water has higher temperature than tap water and cold water. Hence, it is expected that the balloon soaked in hot water will be the biggest and the one soaked in cold water will be the smallest. Charles' Law states that volume and temperature are directly related. Which means that, both temperature and volume increase at the same time. Likewise, they decrease at the same as long as the pressure and the amount of gas are held constant.

Therefore when a line graph of gas' volume vs. its temperature is plotted, with the temperature on the y axis and the volume on the x axis, it should look like this



The graph shows that the relationship between volume and temperature of gases at constant pressure is directly proportional. This is known as the Charles' Law. He explained that as the temperature increases, the volume also increases. As we have emphasized in Activity 1, once the air inside the balloon is heated, its molecules will become more excited, which can cause an increase in their kinetic energy. The amount of kinetic energy that they possess becomes great enough to enable them to push the walls of the balloon. This phenomenon results to an increase in the spaces in between molecules of gases. Hence, the balloon becomes bigger.

Answers to questions

Q1. What happens to the size of the balloon as the temperature decreases?
The balloon becomes smaller.

Q2. How does the change in the temperature relate to the volume of gas in the balloon?
directly proportional

Table 8. Data on Volume-Temperature Relationship

Trial	Volume Reading (mL)	Temperature (°C)	Temperature (K)	V/T
1	25	2	275.15	0.091
2	30.	57	330.15	0.091
3	35	102	375.15	0.091
4	40.	152	425.15	0.091

Using the Charles' Law equation, $\mathbf{V_1T_2 = V_2T_1}$, the answers to the following problems are provided. It is important to note that the scale of the temperature must be converted to Kelvin before solving any gas-law related problem.

1. A cylinder with a movable piston contains 250 cm^3 air at 10°C. If the pressure is kept constant, at what temperature would you expect the volume to be 150cm^3?

Answer: $\mathbf{T_2 = V_2T_1 / V_1}$
$= (150\ cm^3)\ (10°C + 273.15) / 250\ cm^3$
$\mathbf{= 170\ K}$
The volume decreases, so the temperature is also decreased.

2. A tank (not rigid) contains 2.3L of helium gas at 25°C. What will be the volume of the tank after heating it and its content to 40°C temperature at constant pressure?

Answer: $\mathbf{V_2 = V_1T_2 / T_1}$
$= (2.3L)\ (40°C + 273.15) / (25°C + 273.15)$
$\mathbf{= 2.4\ L}$
The temperature is increased, so the volume is also increased .

3. At 20°C, the volume of chlorine gas is 15dm^3. Compute the resulting volume if the temperature is adjusted to 318K provided that the pressure remains the same.

Answer: $\mathbf{V_2 = V_1T_2 / T_1}$
$= (15dm^3)\ (318K) / (20°C + 273.15)$
$\mathbf{= 2.4\ L}$
The volume decreases, so the temperature is decreased.

Activity 4

Gay-Lussac's Law

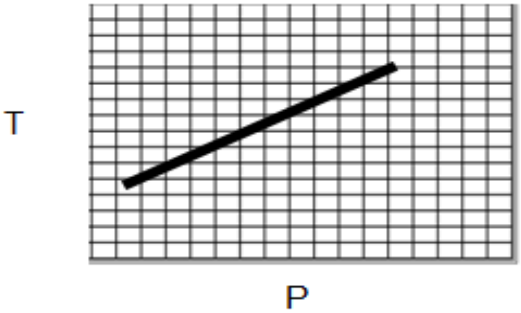
To determine whether the pressure of gas is affected by temperature at constant volume or vice versa, a few drops of denatured alcohol is placed in an Erlenmeyer Flask. It was allowed to evaporate for 2 minutes, so that there will be a vapor sample inside the flask. The temperature of the vapor was taken before and after shaking the flask.

It is expected that the pressure of the shaken vapor is higher than that of the unshaken one. Why? Once a flask is shaken, *forces are produced on the container walls by the rapid and continuous flow of the huge number of vapor molecules. The average effect of these forces is known as the pressure exerted by the contained gas.* There is also pressure inside the unshaken vapor but the shaken one has greater pressure because aside from the natural tendency of the gases to bombard one another, their flow is intensified by the applied force of the experimenter as he/she is shaking the flask.

It is also expected that the temperature of the shaken flask is higher than the unshaken one. Once a flask is shaken, the average kinetic energy of the gas molecules also increases. Since the kinetic energy of the molecules is proportional to their temperature, the higher the kinetic energy is, the higher the temperature is. Another contributory factor is that the heat of the hands of the experimenter can also be transferred or added to the heat of the molecules of the gas inside the flask, thereby increasing its temperature.

Note: If there is no visible change in temperature, try to increase the time of shaking.

Therefore when a line graph of gas' pressure vs. its temperature is plotted, with the temperature on the y axis and the pressure on the x axis, it should look like this



The graph shows that the relationship between pressure and temperature of gases at constant volume is directly proportional. This is known as the Gay-Lussac's Law. He explained that as the temperature increases, the pressure also increases. Both of them also decrease at the same.

Answers to questions

Q1. What happens to the drops of denatured alcohol after 2 minutes? after another 2 minutes ? T*hose were converted into vapor.*

Q2. Compare the pressure exerted by the denatured alcohol molecules before and after shaking? *The pressure of the shaken vapor is higher than that of the unshaken one.*

Q3. How is the temperature of gas molecules affected by pressure or vice versa? *The relationship between pressure and temperature of gases at constant volume is directly proportional. As the temperature increases, the pressure also increases. Both of them also decreases at the same.*

Table 10. Data on Temperature-Pressure Relationship of Gases

Trial	Pressure (atm)	Temperature (K)	P/T
1	1.0	100	0.1
2	2.0	200	0.1
3	3.0	300	0.1
4	4.0	400	0.1

Using this Gay-Lussac's Law equation, $\mathbf{P_1T_2 = P_2T_1}$, the answers to the following problems were provided.

1. A certain light bulb-containing argon has a pressure of 1.20atm at 18°C. If it will be heated to 85°C at constant volume, what will be the resulting pressure? Is it enough to cause sudden breakage of the bulb?

Answer: $P_2 = P_1T_2 / T_1$
$= (1.20 \text{ atm}) (85\mathbf{°C + 273.15)} / (18°C + 273.15)$
$= \mathbf{1.48 \text{ atm}}$

The temperature is increased, so the pressure also increases.

2. At 20°C a confined ammonia gas has a pressure of 2.50 atm. At what temperature would its pressure be equal to 760. mmHg?

Answer: $T_2 = P_2T_1 / P_1$
$= (760.\ mmHg)(20°C + 273.15) / (2.50\ atm.)$
$(760\ mmHg / 1\ atm.)$
$=$ **117 K**

The pressure is decreased, so the temperature also decreases.

3. The helium tank has a pressure of 650 torr at 25°C.What will be the pressure if the temperature is tripled?

Answer: $P_2 = P_1T_2 / T_1$
$= (650\ torr)\ (75°C + 273.15) / (25°C + 273.15)$
$=$ **760 torr**

The temperature is increased, so the pressure also increases.

Activity 5

Combined Gas Laws

To prove that pressure, volume and temperature can affect one another, keeping the amount of a gas constant, a cylindrical container is used in this experiment. The small hole is placed near the end of the container to have an opening where a source of heat can be initiated. A few drops of denatured alcohol are dropped into the container. It is also shaken to convert the sample liquid into vapor.

It is assumed that once a source of heat is initiated into the small hole, the cover of the cylinder will automatically pull out of the container because of the increase in pressure and volume caused by increase in temperature. It is important to note that t*he pressure and volume of a gas are inversely proportional to each other, but are both directly proportional to the temperature of that gas.*

Answers to questions

Q1. What happens to the cylindrical container when a source of heat is placed near the hole? *The cover automatically pulls out.*

Q2. Why do you need to shake the container after putting 5 drops of denatured alcohol? *To convert the drops into vapor.*

Q3. How is the volume of a gas related to its temperature and pressure? *directly proportional*

Using this equation of combined gas laws, $\mathbf{V_1P_1T_2 = V_2P_2T_1}$ the answers are provided in the following problems:

1. *Helium gas has a volume of 250 mL at 0°C at 1.0atm. What will be the final pressure if the volume is reduced to 100. mL at 45°C?*

   Answer:

   $P_2 = V_1P_1T_2 / V_2T_1$

   = (250mL) (1.0atm.)(45°C + 273.15) / (100. mL) (0°C + 273.15)

   = **2.9 atm.**

2. *The volume of a gas at 27°C and 700. mmHg is 600. mL. What is the volume of the gas at -20.0°C and 500. mmHg?*

   Answer:

   $V_2 = V_1P_1T_2 / P_2T_1$

   = (600. mL)(700. mmHg)(-20.0°C) / (500. mmHg) (27°C + 273.15)

   = **708 mL**

3. *A 2.5L of nitrogen gas exerts a pressure of 760 mmHg at 473K. What temperature is needed to reduce the volume to 1.75L at 1140torr?*

   Answer:

   $T_2 = V_2P_2T_1 / V_1P_1$

   = (*1.75L*) (*1140torr*)(*473K*) / (*2.5L*) (*760 mmHg*)

   Since 1 mmHg = 1 torr, then

   T_2 = (*1.75L*) (*1140torr*)(*473K*) / (*2.5L*) (*760 torr*)

   = 496.65 ≈ **5.0×10^2 K**

Avogadro's Hypothesis and this equation, $\mathbf{V_1n_2 = V_2n_1}$, is used to provide answers to the following questions:

1. Suppose we have 24.4 L pure sample containing 1.0 mole of oxygen gas at a pressure of 0.50 atm and temperature of 10ºC. If all of the oxygen gas were converted into ozone gas, what will be the volume of the ozone produced, considering that the temperature and pressure remain the same.

Answer:

Step 1. Use your knowledge in chemical reaction to balance this equation:

$3O_2 \longrightarrow 2O_3$

Step 2. According to Avogadro, the whole number ratio in the balanced equation is proportional to the volume of the gases. Therefore, O_2 and O_3 have 3:2 volume ratio. For instance, 3 L of O_2 will produce 2 L of O_3 based on the given chemical reaction. To determine the volume of O_3 produced if 24.4 L of O_2 is completely used up; simply multiply the given with the proportionality constant.

24.4 L O_2 x 2 L O_3 / 3 L O_2 = **16.3 L O_3**

2. A 7.25 L sample of nitrogen gas (N_2) is identified to contain 0.75 mole of nitrogen. How many moles of nitrogen gas would there be in a 20.0 L sample provided the temperature and pressure remains the same?

Answer: $n_2 = V_2n_1 / V_1$

= (20.0 L)(0.75 mole) / 7.25 L

= 2.1 mole N_2

The volume is increased, so the number of moles also increases.

3. Consider this chemical equation: 2 NO_2 (g) → N_2O_4 (g)

If 50.0 mL of NO_2 gas is completely converted to N_2O_4 gas, under the same conditions, what volume will the N_2O_4 occupy?

Answer: According to Avogadro, the whole number ratio in the balance equation is proportional to the volume of the gases. Therefore, NO_2 and N_2O_4 have 2:1 volume ratio. For instance, 2 mL of NO_2 (g) will produce 1 mL of N_2O_4 (g) based on the given chemical reaction. To determine the volume of N_2O_4 (g) produced if 50.0 mol of NO_2 (g) is completely used up; simply multiply the given with the proportionality constant.

50.0 mL of NO_2 *x* 1 mL of N_2O_4 / 2 mL NO_2 = 25.0 mL N_2O_4

Table 12. Data on Avogadro's Law

Volume (L)	No. of Moles (mol)	V/n
2.50	0.50	5.0
5.00	1.0	5.0
7.50	1.5	5.0
10.00	2.0	5.0
12.50	2.5	5.0

Activity 6

Squashing the Bottle

Activities here are designed to show the relationship among volume, temperature, pressure and number of moles.

Activity A. This activity is designed to determine the effect of higher temperature on pressure and /or volume of a gas. Hot water is placed into the plastic bottle (not rigid) of soft drinks. The hot water is then thrown and the bottle is immediately covered.

Answers to questions

Q1. What happened when you cover the bottle? *The bottle will immediately shrink.*

Q2. What caused it to happen? *The hot water leaves hot gases inside the bottle. Once it is closed, the hot gases are trapped. At constant amount of a gas,hot gases have high temperature and high kinetic energy that cause high pressure. Since the pressure is inversely to the volume of a gas, the volume is suddenly reduced.*

Activity B. This activity is designed to determine the effect of lower temperature to pressure and /or volume of a gas. Ice is placed inside the bottle until the bottle is thoroughly chilled.

Answers to questions

Q4. What happened to the bottle? *The bottle also shrinks but only slightly.*

Q5. Explain the phenomenon. *The ice absorbs the heat from the gases inside the bottle causing these gases to have lower temperature, lower kinetic energy, and lower pressure. Since the volume of a gas is directly proportional to its temperature at constant amount of gas, the volume also decreases.*

Ideal Gas Law

The gas law that interrelates volume, temperature, pressure and number of moles of a gas is the Ideal Gas Law. Ideal gas law equation is used in providing the answers to these problems:

1. *Calculate the pressure exerted by a 0.25 mole sulfur hexafluoride in a steel vessel having a capacity of 1,250 mL at 70.0°C.*

   Answer:

   In solving Ideal Gas Law related problem, it is important that the given unit for volume is in liter to cancel the units of the constant (R). If not, it must be converted. Since 1L = 1000 mL, therefore, 1250 mL = 1.25 L

   Then substitute the values to this equation:
   P = nRT / V
   = (0.25 mole) (0.0821 L.atm./mole.K)(70.0 + 273.15 K) / 1.25L
   = 0.56 atm

2. *Fermentation of glucose produce gas in the form of carbon dioxide. How many moles of carbon dioxide is produced if 0.78L of carbon dioxide at 20.1°C and 1.00 atm was collected during the process?*

   Answer:

   n = PV /RT
   n = (1.00 atm) (0.78 L) / (0.0821 L.atm./mole.K)(20.1 + 273.15K)
   = 0.032 mole CO_2

3. *A sample of liquid acetone is placed in a 25.0 mL flask and vaporized by the heating to 75°C at 1.02 atm. The vapor weighs 5.87 g. Calculate the number of moles of the acetone.*

   Answer:

   n = PV /RT
   n = (1.02 atm) (0.0250 L) / (0.0821 L.atm./mole.K)(75 + 273.15K)
   = 8.92×10^{-4} mole of acetone

Activity 7

A Gaseous Outlook

Activities here are designed for the learners to have a feel of the concepts included in the Kinetic Molecular Theory.

A. Jet-Propelled Balloon. In this activity the compressed gases inside the balloon is suddenly released. It is expected that the balloon will suddenly shoot up. The higher the compression, the higher is the amount of kinetic energy, the faster is the speed of the balloon.

Answers to questions

Q1. Using the concept of the gas laws, explain why the balloon shoots along the thread at a certain speed.*The compressed gases have high kinetic energy that allows the balloon to move. There are molecules of gases that push the walls of the balloon and there are gases that push the air near the opening of the balloon. The balloon moves toward the direction of the gases with the greater force.*

Q2. What does this prove regarding the compressibility of gases? *The lower the compression, the higher is the amount of kinetic energy, the faster is the speed*.

B. The Rising Water. In this activity, the glass will be carefully placed upside down inside the bowl with water. It is expected that the water level outside the glass will increase. Why? *There are gases inside the glass that have volume that adds to the volume of the water, hence the level of the water increases***.**

Answers to questions

Q1. What happened to the level of the water inside the glass? *The water did not enter the glass.*

Q2. What caused this to happen? *The spaces between the water molecules at the bottom of the basin are not enough to accommodate the molecules of gases inside the glass.*

Q3. If the rim of the glass was raised above the surface of the water what might have happened? *If the glass is raised without leaving the water, or if the glass is totally removed from the water, the volume of the gas is also reduced causing a decrease in the level of the water.*

Kinetic Molecular Theory

Answers to questions: True or False

1. A gas consists of a collection of small particles moving in straight line motion and following Newton's Laws. False

2. The molecules in a gas do not occupy a volume (that is, they are points). False

3. Collisions between molecules are perfectly elastic (that is, no energy is gained nor lost during the collision). True

4. There are negligible attractive or repulsive forces between molecules of gases. True

5. The average kinetic energy of a molecule is constant. True

(Lifted from "Applied Academics for Excellence" (APEX)

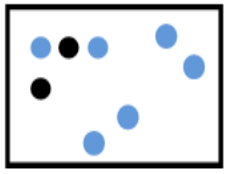
Key to Corrections:

Pre-Assessment Key

1. c. air inside the syringe
2. a. burning fuels
3. d. the pressure of the gas inside the tire is increased
4. a. put a balloon in a digital balance before and after you fill it with air
5. a

6. d

7. c. carbon dioxide
8. b. Increases
9. a. Boyle's Law
10. c. Combined Gas Law
11. d. Ideal Gas
12. a



13. d. combination of a, b and c
14. b. the pressure will decrease
15. c. the gas pressure increases

Summative Assessment Key

1. d. air molecules can be compressed
2. c. the can will eventually explode
3. d.

4. b. expansion of the balloon as it is being submerged in hot water
5. d. I, II, III, & IV
6. a. oxygen gas
7. b. high temperature during summer season causes the air inside the tire to expand
8. d. both the temperature and pressure inside the vessel increase
9. b. the gas temperature decreases
10. b. 2.5 atm
11. b. II & IV
12. a. the volume of the balloon will become higher than 200mL
13. a. 0.32atm
    b. the gaseous form of dry ice exerts lower pressure due to the bigger volume that results to lesser collisions of the gas particles.
14. d. its volume is decreased
15. d. its volume is decreased

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Unit 4
MODULE

2

Suggested time allotment: 12 hours

Chemical Reactions

Content Standard	Performance Standard
• Understand the chemical reactions associated with biological and industrial processes affecting life and the environment.	• Using any form of media, present chemical reactions involved in biological and industrial processes affecting life and the environment.

Overview:

During their Grade 9 Chemistry, students learned about chemical bonding, and that chemical bonds that hold atoms together in compounds. Chemical bonds may be ionic, covalent or metallic. They also learned that forming chemical bonds between atoms leads to a formation of new substances, which have new sets of physical and chemical properties from the combining elements.

This module will help them further understand that breaking and forming new bonds are involved in chemical reactions. They will be able to identify indicators / evidences of chemical reactions and describe how these reactions occur. They will also be able to classify the chemical reactions by analyzing their chemical equations and identifying the factors affecting reaction rate. This module also aims to give the students a clearer perspective on why reactions occur at different rates and what is the significance of controlling their rates in the industry as well as in the environment.

Learning Competencies:

The learner should be able to:

- Write chemical equations of chemical reactions.
- Apply the principle of conservation of mass to chemical reactions.
- Identify the factors that affect reaction rates and explain them according to collision theory.
- Explain how the factors affecting rates of chemical reactions are applied in food preservation and materials production, fire control, pollution, and corrosion.

Key questions:

How do chemical reactions take place?
How are the factors affecting rates of chemical reactions applied in different chemical awareness?

Pre-Assessment Answer:

1. B
2. C
3. D
4. C
5. C
6. True
7. True
8. True
9. False (lower activation energy)
10. False (activation energy)

	Chemical Equation
11.	$CaCO_3 + 2\,HCl \text{ ------> } CaCl_2 + H_2CO_3$
12.	$2AgNO_3 + Zn \text{ -----> } Zn(NO_3)_2 + 2Ag$

13. MnO_2 (Manganese dioxide acts as a catalyst, it hastens the decomposition of hydrogen peroxide)

14. Iron filings rust faster because of its bigger surface area; the bigger the surface area the faster the reaction rate.

15. Enzymes are biological catalysts. Enzymes in molds and bacteria cause food to spoil faster. Putting food inside the refrigerator slows down spoilage due to lower temperature. The higher the temperature the higher the reaction rate. The lower the temperature the slower the reaction rate.

Activity 1

"Everything has Changed"

Various changes are happening all around us. We can expect students to easily point out numerous common changes they encounter in their daily lives. Some of these changes only involve a change in state. In boiling water, liquid water changes to steam (gas); this is involved in the process of producing distilled water that we drink, as well as in the water cycle.

While they may point out some examples of chemical changes, they may not be able to recognize other changes which are categorized as chemical. Obtaining oxygen and hydrogen gas from water involves chemical reaction. Students may not be too familiar with this reaction, as well as with other changes most especially when there is no color change. Some chemical changes are not easy to observe, not if one doesn't know what evidences/ indicators he is looking for.

This activity will be the students' guide in determining whether a chemical reaction has occurred. The evidences of chemical reactions will be identified by the students in this activity.

Teaching Tips:

- For preliminaries, it would be of help if previous knowledge on chemical bonding is revisited through discussion; how atoms combine to form compound/s; how the new compound/s have new set of physical and chemical properties.
- Prepare the materials beforehand.
- Do the preparations of solutions needed if aqueous solutions are not available (eg. Aqueous copper sulfate and Aqueous sodium hydroxide)
- Note: aqueous solution means solution with water as the solvent)
- Give a clear description of the task, explain the procedure.
- Post on the board some safety and precautionary measures and discuss.
    - Wear goggles
    - Be careful with the use of matches.
    - Observe caution in lighting alcohol burner.
    - Remove combustible materials near open flame.
    - Do not touch chemicals with bare hands, it may cause skin irritation.
- After the activity is completed, process the results, let the students identify the evidence/s in each part (A- E);
- Give examples of changes (preferably using pictures) and let them identify the evidence/s that distinguish them as chemical change. (ex. Rotting of fruits- color change, evolution of gas; manufacture of soap through the process known as saponification- formation of precipitate, etc.).
- Relate reaction with oxygen as one of significant examples of chemical reactions. (found in Learner's Module).

Observation:

Note**:** Use new nail in the first set-up.

Table 1. Iron Nail-Copper Sulfate Reaction

Materials	Color Before Mixing	Color After mixing
Copper sulfate solution	Blue	Colorless
Nail	Grayish	Reddish brown

Answers to Questions:

Q1. The copper sulfate solution turned colorless.

Q2. The color turned reddish brown.

Q3. It produced a brilliant white light.

Q4. Oxygen from the air reacted with magnesium.

Q5. The product formed was a white ash.

Table 2. Magnesium Ribbon Reaction

Materials	Before Burning		During Burning	
	Color	Appearance	Color	Appearance
Magnesium	Grayish	Metallic solid	White	White ash

Q6. It produced bubbles (bubbles are indication of evolution of gas).

Q7. The flame grew brighter (indicates that the gas evolved is O_2).

Table 3. Agua Oxigenada Reaction

Materials	Before Reaction	With addition of MnO_2
Agua oxigenada	Colorless	Colorless liquid with black powder

Note: The manganese dioxide did not chemically combine with agua oxigenada, that's why it is still distinguishable. (It acted as a catalyst. It only hastened the reaction)

Q8. The mixture produced bubbles.

Q9. The gas extinguished the flame. (indicates that the gas is carbon dioxide CO_2)

Table 4. Vinegar and Baking Soda Reaction

	OBSERVATION	
Materials	Before Reaction	During Reaction
Vinegar	Colorless	Cloudy With bubbles
Baking soda	White powder	

Q10. A blue solid was produced.

Table 5. Copper Sulfate-Sodium Hydroxide Reaction

	APPEARANCE	
Materials	**Before Reaction**	**After Reaction** (Copper sulfate + sodium hydroxide)
Copper sulfate solution	Light blue solution	Colorless liquid with blue solid
Hydroxide solution	Colorless solution	

- Relate lesson learned in Grade 9 Chemistry that substances undergo chemical bonding so that atoms can become stable. Chemical bonding results to breaking of old bonds and forming of new bonds, thus producing new substances. Formation of new substances means chemical reaction is taking place

KEY CONCEPT TO EMPHASIZE:

When a physical change occurs, there is no breaking and forming of bonds. There are certain things that will help us identify if a chemical reaction has taken place. The following are evidences that chemical reactions took place:

1. Production of light
2. Evolution of gas
3. Temperature change
4. Change in intrinsic change in color and taste)
5. Formation of precipitate

Activity 2

"What's in a Reaction"

In this activity, students will distinguish reactants from products. They will be able to trace how a chemical reaction takes place, and how reactants are converted into products. Once they have identified the reactants and products, they will sum up a chemical reaction in a chemical equation using symbols of elements and formulas.

Teaching Tips:

- The formulas of the compounds were given since they have not yet taken up formula writing.
- The symbols of elements used as reactants were not given to allow them to recall lesson on symbol of elements which they have learned from previous grade levels.
- Formulas of common compounds (water and carbon dioxide) were also not given to check students' basic knowledge.

- Note that not all elements are written as diatomic. Familiarize them with some diatomic elements (Cl_2, H_2 , O_2 , N_2, Br_2 , I_2 ,F_2)
- Correct possible misconception of students, such as identifying MnO_2 as a reactant; Emphasize this is a catalyst.

Answers to Table 6:

Table 6. Reactants and Products

Reaction	Reactants	Products
1	Iron, Copper sulfate	Iron (II) sulfate, Copper.
	Fe, $CuSO_4$	$FeSO_4$, Cu
2	Magnesium, Oxygen	Magnesium oxide
	Mg, O_2	MgO
3	Hydrogen peroxide	Water, Oxygen
	H_2O_2	H_2O, O_2
4	Acetic acid, Sodium bicarbonate	Sodium acetate, Carbon dioxide, Water
	$HC_2H_3O_2$, $NaHCO_3$	$NaC_2H_3O_2$, CO_2, H_2O
5	Copper sulfate, Sodium hydroxide	Copper (II) hydroxide, Sodium sulfate
	$CuSO_4$, NaOH	$Cu(OH)_2$, Na_2SO_4

Answer to Table 8:

Table 8. Chemical Equation

Note: Leave the equations unbalanced. It will be balanced after activity on Law of Conservation of Mass.

Reaction	Chemical Equation
1	$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$
2	$Mg + O_2 \longrightarrow MgO$
3	$H_2O_2 \xrightarrow{MnO_2} H_2O + O_2$
4	$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa$
5	$CUSO_4 + NaOH \longrightarrow Cu(OH)_2 + Na_2SO4$

- A chemical equation represents the way in which a reaction rearranges the atoms in reactants.
- To write an equation, you must know the:
  - reactants and products
  - atomic symbols and formulas of the reactants and products
  - direction of the reaction.

- An arrow is used to separate the reactants and products, and to show the direction of change. The reactants are written on the left of the arrow while the products on the right. A double arrow (⇄) is sometimes used, this indicates a reversible reaction. This means that as the they are produced, products are also converted back to reactants.

KEY CONCEPT TO EMPHASIZE:

A **chemical equation** is a chemist's shorthand for a chemical reaction. The equation diffentiates between the **reactants**, which are the starting materials and the **products** which are the resulting substance/s. It shows the symbols or formulas of the reactants and products, the phases (solid, liquid, gas) of these substances, and the ratio of the substances as they react.

Activity 3

"We simply click together"

After the students have learned how to translate chemical reactions into chemical equations, it will now be their task to classify reactions into various types. Here, they will be using their previous tabulated data on Activity 2 "What's in a Reaction" ? From the analysis of their answers, reactions will be classified based on how the atoms grouped or regrouped in their conversion from reactants to products.

Teaching Tips:

- See to it that the students individually have the answered copy of Table 8: Chemical Reaction for their reference.
- Recheck if they have the correct data in Table 8
- Transfer data on Table 9: Types of Chemical Reaction
- Using the Guide Card, let them classify the reactions.
- Verify answers after.
- The teacher can use a diagram representation of ¨The Types of Chemical Reactions" as a supplementary material to the Guide Card
- (examples below). These may first be analyzed before they proceed to the activity proper. (The teacher can make their own similar diagram).

Figure 1. Combination Reaction

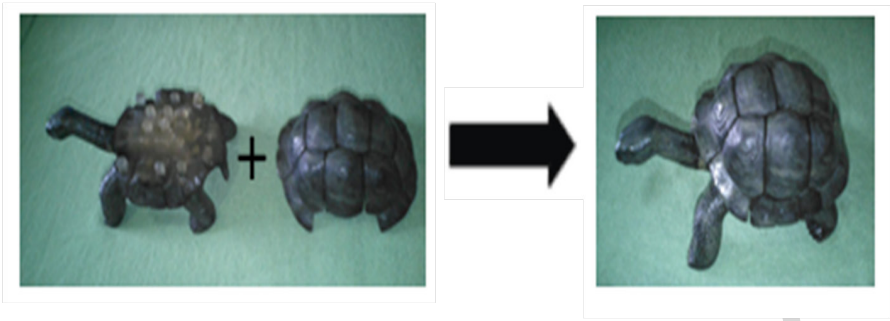


Figure 2. Decomposition Reaction

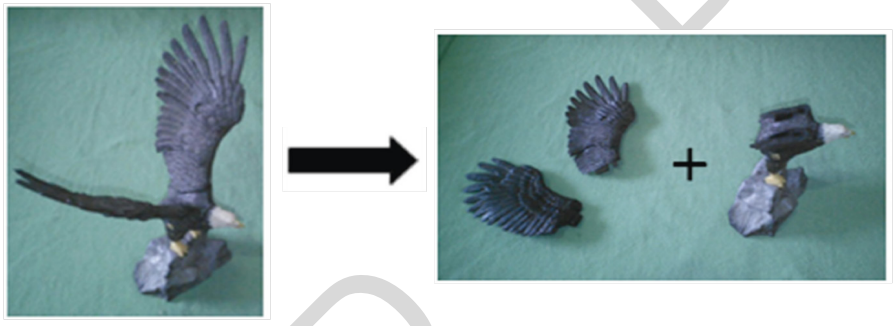
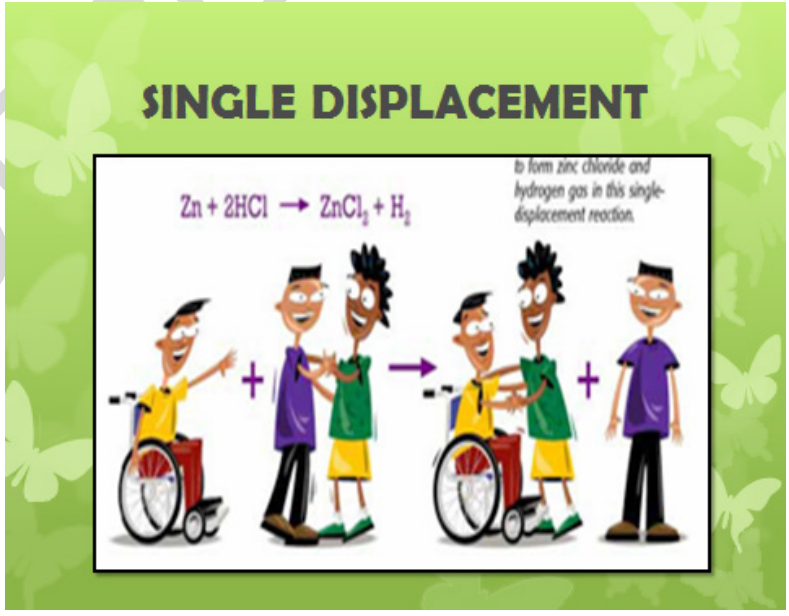
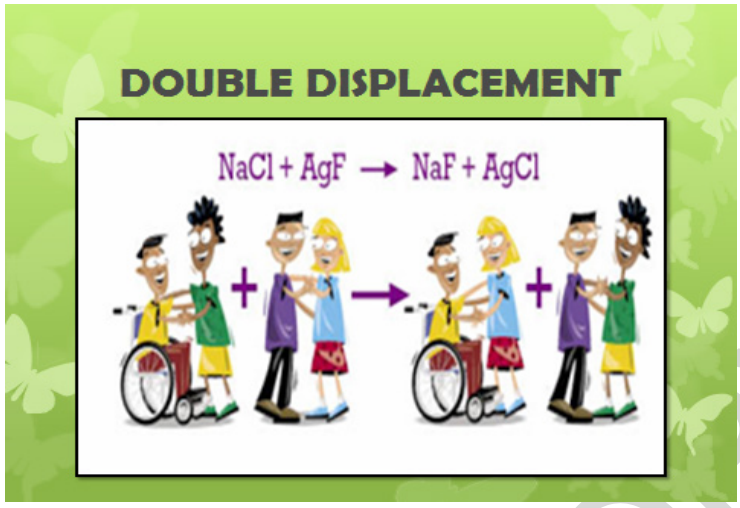


Figure 3. Single Displacement Reaction



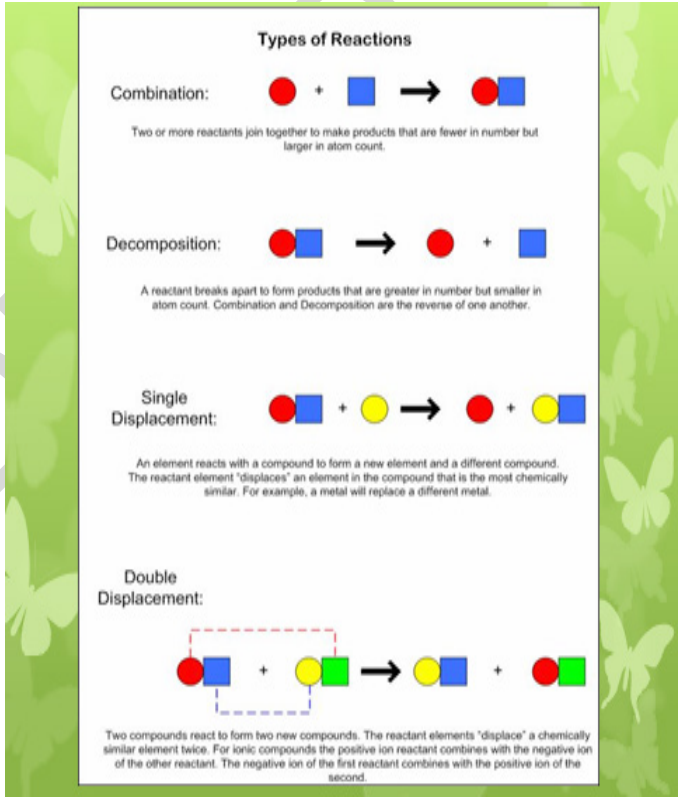
http://1.bp.blogspot.com/_c9z5BMBX-Jo/S7EH6a2E0dI/AAAAAAAAAEw/_Wiq1otyc8E/s1600/sd+reaction.png(accessed: July16, 2014)

Figure 4. Double Decompisition



http://mrsdallas.weebly.com/uploads/1/0/6/3/10631343/1674835_orig.png
(accessed: July16, 2014)

Figure 5. Types of Chemical Reactions



http://media-cache-ec0.pinimg.com/236x/5b/32/68/5b3268b3b19840bf75f91196bea29124.jpg

Answers to Questions:

Q12. Two reactants were used , one product was formed in the second chemical reaction.

Q13. One reactant was used, two products were formed in the third chemical reaction

Q14. Copper was replaced by iron.

Q15. 2 reactants and 2 products were involved, they were compounds.

Q16. The reactants exchanged positive and negative ions on the product side.

Table 9. Types of Chemical Reactions

Rxn	Chemical Equation	Types of Chemical Reaction
1	$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$	Single Displacement
2	$Mg + O_2 \rightarrow MgO$	Combination
3	$H_2O_2 \xrightarrow[MnO2]{} H_2O + O_2$	Decomposition
4	$HC_2H_3O_2 + NaHCO_3 \rightarrow NaC_2H_3O_2 + CO_2 + H_2O$	Double Displacement
5	$CuSO_4 + NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$	Double Displacement

- From their data, four types of reactions are used: combination, decomposition, single displacement and double displacement. Relate that these are the basic types of reaction. The last two are special types which involve specifically acids and bases (Acid-Base Reaction), and oxygen and hydrocarbons (Combustion Reaction).

KEY CONCEPT TO EMPHASIZE:

Chemical reactions can be classified according to the following types:

A. **COMBINATION REACTION**: Reactants combine to form a single product.

The general formula for this reaction is: A + B ------→ AB

B. **DECOMPOSITION REACTION:** In this reaction, a single reactant breaks down into 2 or more products. This is the reverse of combination reaction. The general formula for this reaction is: AB ------→ A + B

C. **SINGLE DISPLACEMENT** (Replacement) **REACTION**: This is when one element replaces another element from a compound. The more active element takes the place of the less active element in a compound. The general formula for this reaction is: A + BC ------→ AC + B

D. **DOUBLE DISPLACEMENT REACTION** (Metathesis): This is when the positive ions (cations) and negative ions (anions) of different compounds switch places, forming two entirely different compounds. The general formula for this reaction is: AB + CD → AD + CB

E . **COMBUSTION** (Burning) **REACTION**: This when oxygen combines with a hydrocarbon to form water and carbon dioxide.

F. **ACID-BASE REACTION**: This is a special kind of double displacement that takes place when an acid and base react with each other.

Answers To Enrichment:

1. Double Displacement
2. Combustion
3. Single Displacement
4. Double Displacement
5. Acid- Base / Double Displacement
6. Combination

7. Decomposition
8. Combustion
9. Acid- Base
10. Double Displacement

Activity 4

"How much can you take?"

The Law of Conservation of Mass states that mass is conserved in a chemical reaction. It means that the total mass of reactants is equal to the total mass of the products.

The laboratory activity will give the students a feel of how Antoine Lavoisier discovered that law. A follow up activity, "Paper Clip Reaction Model" will help the students apply this law to chemical equations.

Teaching Tips:

- Prepare the materials before the start of activity.
- Post on the board some safety and precautionary measures and discuss each of them.
  - Wear googles.
  - Be careful with the use of matches.
  - Observe caution in lighting the alcohol burner.
  - Remove combustible materials near the open flame.
  - Do not touch chemicals with bare hands, it may cause skin irritation.
- See to it that the students are measuring the mass correctly.
- Ask students to write their observed data in a manila paper (both the table for the laboratory activity and the Paper Clip Reaction Model).
- They can use scotch tape in attaching the paper clips in cartolina.
- If there are not enough white, red and green paper clips, they may use other colors, as long as they write a legend for their element color representation.
- The Paper Clip Reaction Model is preferably done individually, this will help students clearly visualize what a balanced equation is. From the model, the concept of coefficient will be clearly understood by the students.
- Post on the board the students output for easy discussion of their results.
- After activity, discuss how Antoine Lavoisier discovered the Law of Conservation of Mass.

Answers to Questions:

Q19. The grayish color of the steel wool changed to brown color.

Q20. Evidence of chemicl change was the change in color of steel wool and the $CuSO_4$ solution. From blue, $CUuSO_4$ solution turned yellowish-green.

Q21. So that no other substance can be added or removed in the process of chemical reaction between the reactants, that may result to competing side reactions.

Q22. The total mass is the same, before and after the reaction.

Q23. 2 sets of H_2

Q24. 1 set O_2

Q25. 2 sets of H_2O

Q26. **2** H_2 + O_2 → **2** H_2O

Q27. 1 set of N_2

Q28. 3 sets of H_2

Q29. 2 sets of NH_3

Q30. N_2 + **3** H_2 → **2** NH_3

Q31.

N_2 + 3 H_2	→ **2** NH_3
2 x 14 g	3 (2 x 1 g)	2 [14g + (3 x 1 g)]
18 g	6 g	2 (17 g)
34 g		**34 g**

Q32. The total mass of reactants is equal to the total mass of the products.

- Antoine Lavoisier did an experiment where he heated a metal mercury in air. He observed that a reddish orange product was formed which has a heavier mass than the original metal. He repeated the experiment, only the next time, he placed the mercury in a jar, sealed and recorded the total mass of the set up. After the mercury was heated in the jar, the total mass of the jar and its contents did not change.

  Lavoisier showed that the air in the jar would no longer support burning- a candle flame was snuffed out by this air. He concluded that a gas in the air, which he called oxygen, had combined with the mercury to form the new product.

  Lavoisier conducted many experiments of this type and found in all cases that the mass of the reactants is equal to the mass of the products.

KEY CONCEPT TO EMPHASIZE:

Law of Conservation of Mass states that mass is conserved in a chemical reaction. The total mass of the reactants is equal to the total mass of the products. No new atoms are created or destroyed, there was only grouping or regrouping (rearrangement) of atoms.

Activity 5

"Balancing Act"

From Activity 4, the students have learned that chemical reactions follow the Law of Conservation of Mass, which states that mass is conserved in a chemical reaction. Chemical equations should reflect this conservation in terms of atoms. The same number of atoms of each element must appear on both sides of a chemical equation. However, simply writing down the chemical formulas of reactants and products does not always result in equal number of atoms. There is a need to balance equation to make the number of atoms equal on each side.

As a follow up to Activity 4, Activity 5 reinforces the concepts on balancing equation. This time, no paper clips will be used as guide. They will only be using the unbalanced chemical equations they have developed in the previous activity and a set of guidelines (steps) in balancing equation.

Teaching Tips:

- Start out by checking the students' understanding of the difference between subscript and coefficient using data from their previous activities.

$$N_2 + \mathbf{3}\, H_2 \rightarrow \mathbf{2}\, NH_3$$

For the product $\mathbf{2}\, NH_3$:

1. What number represents the coefficient? 2
2. What number represents the subscript? 3
3. What element is represented by the letter "H" ? Hydrogen
4. How many atoms of H do you have? 6

- After analysis of the sample equation $\mathbf{2}\, H_2 + O_2 \rightarrow \mathbf{2}\, H_2O$, try another equation before proceeding to the balancing of data in Table 9. Use this equation:

$$\mathbf{Al + CuCl_2 \rightarrow AlCl_3 + Cu}$$

- Discuss step by step on how balancing of equation is done.

Steps in Balancing Equations:

<table>
<tr><td>1. Write the unbalanced chemical equation, make sure you have followed correctly the rules in writing formulas of compounds.</td><td colspan="2">Al + $CuCl_2$ → $AlCl_3$ + Cu</td></tr>
<tr><td>2. Take note of the elements present in the reactant and product side.</td><td>Reactants
Al
Cu
Cl</td><td>Products
Al
Cu
Cl</td></tr>
<tr><td>3. Count the number of atom/s of each element present in the reactant and product side.</td><td>Reactants
Al = 1 atom
Cu = 1 atom
Cl = 2 atoms</td><td>Products
Al = 1 atom
Cu = 1 atom
Cl = 3 atoms</td></tr>
<tr><td>4. Apply the Law of Conservation of Mass to get the same number of atoms of every element on each side of the equation.

Balance chemical equations by placing the appropriate coefficients before the symbol or formula.

Do not change the subscripts of the formula in an attempt to balance the equation as it will change the identity of the components.</td><td colspan="2">Al and Cu appear to be balanced already, so proceed to balancing Cl

Cl to be balanced, we should consider finding their LCM (least common multiple)
the LCM of 2 and 3 is 6
3 x 2 Cl atoms (LCM 6) 2 x 3 Cl atoms

Supply the numbers 2 and 3 as coefficients in the equation
Al + $3CuCl_2$ → $2AlCl_3$ + Cu
Check the number of atoms again
Reactants Products
Al = 1 Al = 2
Cu = 3 Cu = 1
Cl = 6 Cl = 6
Note that after balancing Cl, Al and Cu were no longer balanced
Proceed to balancing Al and Cu using the same step.
For Al : 1 and 2, LCM is 2
2 x 1 Al atoms (LCM 2) 1 x 2 Al atoms

For Cu: 3 and 1 LCM is 3
1 x 3 Cu atoms (LCM 3) 3 x 1 Cu atoms
Supply the coefficients now to the equation, coefficient 1 is no longer written
$2Al + 3CuCl_2$ → $2AlCl_3$ + 3Cu
Final accounting of number of atoms:
Reactants Products
Al = 2 Al = 2
Cu = 3 Cu = 3
Cl = 6 Cl = 6
The chemical equation is now balanced, therefore it now conforms to the Law of Conservation of Mass.</td></tr>
</table>

- The students may then be ready to answer the activity. Some students especially the slow learner group may need additional equation for board practice, so prepare extra for them.
- Encourage them to be patient, if they cannot easily balance some equations,
- Relate that this may need trial and error.

Table with balanced equations.

Rxn	Chemical Equation
1	$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
2	$2\ Mg + O_2 \rightarrow 2\ MgO$
3	$2\ H_2O_2 \xrightarrow[MnO_2]{} 2\ H_2O + O_2$
4	$HC_2H_3O_2 + NaHCO_3 \rightarrow NaC_2H_3O_2 + CO_2 + H_2O$
5	$CuSO_4 + 2\ NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

KEY CONCEPT TO EMPHASIZE:
For a chemical equation to conform to the Law of Conservation of Mass, it has to be balanced.
Chemical equations are balanced by placing the appropriate coefficients before the symbols or formulas of reactants and products. Certain steps are observed in balancing reactions.

Answers To Enrichment:

1. $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$
2. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
3. $Fe + 3\ NaBr \rightarrow FeBr_3 + 3\ Na$
4. $SiCl_4 + 2\ H_2O \rightarrow SiO_2 + 4\ HCl$
5. $2\ N_2 + 5\ O_2 + 2\ H_2O \rightarrow 4\ HNO_3$
6. $P_4 + 5\ O_2 \rightarrow 2\ P_2O_5$
7. $2\ NaNO_3 \rightarrow 2\ NaNO_2 + O_2$
8. $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
9. $3\ Fe + 4\ H_2O \rightarrow 4\ H_2 + Fe_3O_4$
10. $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$

Activity 6

"Race to the Finish Line"

From the seemingly ordinary task that people do like putting leftover foods inside the refrigerator and cutting meat and vegetables in smaller pieces to a more technologically advanced method of using a catalytic converter in automobiles and electroplating metals, people are controlling rates of chemical reactions to maximize its benefits.

This activity will help the students understand about the different factors affecting reaction rate.

Teaching Tips:

- For motivation, provide pictures of a burning vehicle and a puppy. Write the following statements below the pictures. A burning vehicle and a puppy are undergoing the same kind of chemical reaction. What reaction could this be?

  After posting the question, proceed to providing a picture/ diagram of digestion process.

  Explanation:
  Both the vehicle and the puppy are experiencing combustion reactions. Burning and digestion are both combustion reaction.
  The rates of reactions though are different. Gasoline reacts rapidly with oxygen to produce extreme amounts of heat. Glucose in the puppy's cells reacts slowly with oxygen from the blood to produce small amounts of heat.

- The teacher can also demonstrate collision theory.
  - (Sufficient energy) Try hitting a ball with another ball using one finger only,then using her/his hand.
  - (Correct orientation) Have pieces of a toy puzzle and try to form the puzzle in the wrong orientation of the pieces, then in the right one.

- Verify students' understanding of fruitful or effective collisions.

- Discuss with class the energy diagram, activated complex, and activation energy.

- In Table 10 The Effect of Particle Size or Surface Area on Reaction Rate, time may vary due to different size of cups used by different groups, but they will have the same qualitative observation. However a, slower rate of reaction will be observed in the whole Alka-seltzer, a faster rate in powderized.

Answers to Questions:

Part 1: Collision Theory

Q33. Rearrangement/ regrouping of atoms causes chemical reaction.

Q34. For a chemical reaction to take place, there must be effective collision of atoms/molecules.

Q35. There must be sufficient energy and molecules should be properly oriented when they collide.

Q36. A catalyst lowers the activation energy. (decreases the minimum energy required)

KEY CONCEPT TO EMPHASIZE:

COLLISION THEORY: Reactions can only happen when the reactant particles collide, but most collisions are NOT successful in forming product molecules despite the high rate of collisions.
Reactants should have sufficient energy, and their molecules should be in proper orientation for a successful collision to happen.

The minimum energy required for a reaction to happen is known as the **activation energy.**

Part 2: Factors Affecting Reaction Rates

A. Effect of Particle size or Surface Area on Reaction Rate

Q37. a. The whole tablet fizzed for a longer time.
b. The powderized one has bigger surface area than the whole tablet.

Q38. a. The bigger the surface area, the faster the rate of reaction.

B. Effect of Temperature on Reaction Rate

Q39. Yes, reaction occurred at different rates for cold and hot water.

Q40. The higher the temperature, the higher the rate of reaction.

C. Effect of a Catalyst on Reaction Rate

Q41. Bubbles were produced at faster rate in the test tube with manganese dioxide.

Q42. MnO_2 is written below the arrow.

Q43. No, the MnO_2 did not react with H_2O_2.

Q44. A catalyst speeds up/hastens the chemical reaction.

D. Effect of Concentration on Reaction Rate

Q45. No, the different solutions discolored the papers at different rates.

Q46. The higher the concentration, the faster the rate of reaction.

Q47. The factors affecting reaction rate can be explained using the following way:

a) Particle size or Surface Area

Smaller particles size have bigger surface area. Bigger surface area means bigger exposed portions of a solid which are available points of contact between reactants.

(Breaking a large piece of a substance into smaller parts increases the surface area. All the inner materials have no surface when it is inside the large piece. Each time a large piece is broken however, more surface is exposed. The amount of the material does not change but breaking it into smaller parts increases its surface area.)

b) Temperature

The higher the temperature, the higher the rate of reaction. At higher temperature, atoms have higher kinetic energy, making the particles move faster and therefore increases the chance for the particles to come in contact with each other.

c) Catalyst

The presence of catalyst speeds up the rate of reaction. A catalyst provides an energy pathway needed to start a reaction, therefore increasing the reaction rate.

d) Concentration

The higher the concentration, the faster the rate of reaction. Concentration is a measure of the number of particles in a given volume. A higher concentration means greater number of possible effective collisions among molecules resulting to faster rate of reaction.

KEY CONCEPT TO EMPHASIZE:

The rate of chemical reaction is affected by the following factors:

a. temperature
b. surface area of reactants
c. presence of catalyst
d. concentration of reactants

Answer to Enrichment:

1. True
2. Heat, light or change in odor can indicate a chemical change.
3. Low temperature slows down reaction rates.
4. True

Activity 7

"Making Connections"

In Activity 6, students were able to identify the different factors affecting reaction rate. This time in Activity 7, these factors will be discussed in detail, in terms of the significance of controlling the rates of some chemical reactions. Life and industry depends on chemical reactions. Industry uses chemical reactions to make useful products. Some chemical reactions enhance quality of life. However, other chemical reactions bring harm to life and degradation of the quality of our ecosystem.

As the title suggests "Making Connections," this activity will connect and integrate important principles about chemical reactions around us. This aims to teach students how to make relevant observations and researches on chemical reactions.

Teaching Tips:

- Convey to the students this activity ahead of time, to provide them ample time to secure resources/researches, and to plan for their presentation
- Explain fully the product that they are tasked to deliver.
- Assign a particular topic from the selection to each group, to avoid repetition of topic.
- Clarify the standards and criteria that they have to meet, which are the bases of the evaluation of their product.
- Discuss the GRASP Task Design; it will serve as their guidelines in the preparation and presentation of their work.
- Relate their use of the Critical Thinking Rubric. Stress that they will prepare this individually.

Answers To Questions:

Q48. gas emissions by vehicles

Q49. Acid rain is produced by the reaction of water vapor with gas emissions from vehicles, thermal power plants, and coal mining industries. Rain contaminated with these gases results to acid rain.

Q50. Corrosion of metals (such as bronze) and the deterioration of paint and stone (such as marble and limestone). These effects significantly reduce the societal value of building, bridges, cultural objects (such as statues, monuments and tombstones), and cars.

Acid rain also have adverse effects on living organisms. Fish and shellfish cannot tolerate acidities below pH 4.8.

It reduces plant's ability to produce oxygen. It also destroys vegetation, as well as aquatic life.

Q51. Everybody should be responsible, since we are all affected by the ill effects of pollution to our environment. Our health and even our supply of food are affected by its ill effects.

Q52. Switch to low sulfur fuels (alternative energy sources), scrubbing of stack of gases before they are released to the environment.

Related Readings:

Photochemical smog is a type of air pollution that happens when primary pollutants such as nitrogen oxides and volatile organic compounds react with oxygen gas and ozone under the influence of sunlight. An important role in the air pollution chemistry, especially in the formation of ozone is played by nitrogen oxides, NO_x which stands for a group of compounds such as nitric oxide (NO), dinitrogen trioxide, (N_2O_3),and nitrogen dioxide (NO_2). These compounds, along with other hazardous gases, are emitted when coal is burned in power plants and industrial boilers for the generation of power, and from automobiles. Most of the NO_x emitted from combustion is nitric oxide, formed according to the following reaction.

$$N_2 + O_2 \rightarrow 2NO$$

The high temperatures (600°C to 1000°C) which are maintained in combustion favor the formation of NO. However, the following reactions can also take place in the furnace, in the stack, or later, in the atmosphere:

$$2NO + O_2 \rightarrow 2NO_2$$
$$NO_2 + NO \rightarrow N_2O_3$$
$$2NO_2 \rightarrow N_2O_4$$
$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

Nitrogen dioxide (NO_2) reacts with hydrocarbons which are present in the atmosphere to form aldehydes and ketones through photochemical reactions. It also can react with oxygen in the presence of sunlight to give nitric oxide and ozone: $NO_2 + O_2 \rightarrow NO + O_3$

Major Chemical Pollutants in Photochemical Smog: Sources and Environmental Effects

Toxic Chemical	Sources	Environmental Effects	Additional Notes
Nitrogen Oxides (NO and NO_2)	-combustion of oil, coal, gas in both automobiles and industry - bacterial action in soil - forest fires - volcanic action - lightning	- decreased visibility due to yellowish color of NO_2 - NO_2 contributes to heart and lung problems - NO_2 can suppress plant growth - decreased resistance to infection - may cause the spread of cancer	- all combustion processes account for only 5% of NO_2 in the atmosphere, most is formed from reactions involving NO -concentrations are likely to rise in the future
Volatile Organic Compounds (VOCs)	- evaporation of solvents - evaporation of fuels - incomplete combustion of fossil fuels - naturally occurring compounds like terpenes from trees	- eye irritation - respiratory irritation - some are carcinogenic - decreased visibility due to blue-brown haze	- the effects of VOCs are dependent on the type of chemical - samples show over 600 different VOCs in the atmosphere - concentrations are likely to continue to rise in future
Ozone (O_3)	- formed from photolysis of NO_2 - sometimes results from stratospheric ozone intrusions	- bronchial constriction - coughing, wheezing - respiratory irritation - eye irritation - decreased crop yields - retards plant growth - damages plastics - breaks down rubber - harsh odor	- concentrations of 0.1 parts per million can reduce photosynthesis by 50% - people with asthma and respiratory problems are influenced the most - can only be formed during daylight hours

Car Airbag

The development of airbags began with the idea for a system that can restrain automobile drivers and passengers in an accident, whether or not they are wearing their seat belts.

http://www.rmsautodiagnostics.com/wp-content/uploads/airbag.jpg (accessed July 17,2014)

Figure 6. Car Airbag

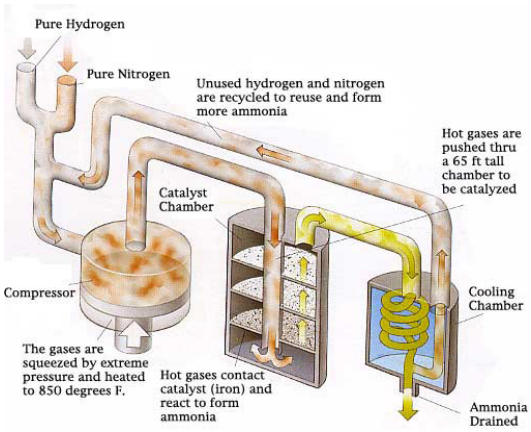
Chemical Reactions Used to Generate the Gas in Car Airbags

Inside the airbag is a gas generator containing a mixture of NaN_3, KNO_3, and SiO_2. When the car undergoes a head-on collision, a series of three chemical reactions inside the gas generator produce gas (N_2) to fill the airbag and convert NaN3, which is highly toxic (the maximum concentration of NaN3 allowed in the workplace is 0.2 mg/m_3), to harmless gas as shown in the following table. Sodium azide (NaN_3) can decompose at 300°C to produce sodium metal (Na) and nitrogen gas (N_2). The signal from the deceleration sensor ignites the gas-generator mixture by an electrical impulse, creating the high-temperature condition necessary for NaN_3 to decompose. The nitrogen gas that is generated then fills the airbag.

This table summarizes the species involved in the chemical reactions in the gas generator of an airbag.

Gas-Generator Reaction	Reactants	Products
Initial Reaction Triggered by Sensor.	NaN_3	Na N_2 (g)
Second Reaction	Na KNO_3	K_20 Na_2O N_2(g)
Final Reaction	K_2O Na_2O SiO_2.	alkaline silicate (glass)

http://sun.menloschool.org/~dspence/arda/chem_project/web_kwan/fertilizer2.htm (accessed: Aug.4, 2014)



The Haber Process

The raw materials for this process are hydrogen and nitrogen. Hydrogen is obtained by reacting natural gas - methane - with steam, or through the cracking of oil. Nitrogen is obtained by burning hydrogen in air. Air is 80 percent nitrogen; nearly the rest is oxygen. When hydrogen is burned in air, oxygen combines with hydrogen, leaving nitrogen behind.

Nitrogen and hydrogen will react together under these conditions:

- a high temperature - about 450ºC
- a high pressure - about 200 atmospheres (200 times normal pressure)
- an iron catalyst

The reaction is reversible.

nitrogen + hydrogen ⇌ ammonia

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The (g) indicates that the substance is a gas.

The chart shows the main stages in the Haber process. The reaction is reversible, and some nitrogen and hydrogen remain mixed with the ammonia. The reaction mixture is cooled so that the ammonia liquefies and can be removed. The remaining nitrogen and hydrogen are recycled.

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/chemreac/energychangesrev3.shtml (accessed: July 14, 2014)

The Effect Of The Haber Process On Fertilizers

As world population kept on increasing, so did the use of fertilizers. Using fertilizer with a high nitrogen content provided good crop yield, but caused some scientists in the 1890's to begin to worry about the depletion of the sources of nitrogen for chemical fertilizer. Since plants could not directly convert atmospheric nitrogen to soluble nitrogen compounds, mankind had to search for a solution.

The early 20th century produced three methods to "fix" nitrogen, that is, convert it from an inactive gas in the air to nitrogen compounds that would be further reacted to produce fertilizers or used directly. Two methods, the electric arc process and the cyanamid process never proved important in making fertilizer in the United States though they were of some importance through the first part of this century. The third process, the Haber Process, has made a lasting impression on chemical technology and fertilizers.

The full name for the process is the Haber-Bosch Process. Fritz Haber and Karl Bosch of Germany developed the process in the early years of this century, before World War I. The effort was a joint one between German industry and the German university. While the reaction between nitrogen gas and hydrogen gas to produce ammonia gas had been known for many years, the yields were very small and the reaction was very slow. Haber and Bosch and their coworkers determined the conditions necessary (high temperatures and very high pressures) and the catalysts necessary (a variety was found, the cheapest and most effective being oxides of iron with traces of oxides of other common elements). German industry also developed the high pressure equipment necessary to run the process. By 1913, a chemical plant was operating in Germany, producing ammonia by means of the Haber-Bosch process.

The use of ammonia in fertilizers has made it the second most important chemical in the United States. It is the most important source of nitrogen in fertilizers today. The use of fertilizers today is over 400% greater than it was in 1940. Because of increased demand and iincreasing population, the demand for nitrogen based fertilizers will remain high. The fertilizer industry is considered a mature industry but a growing and changing one. Current research is directed more toward improving techniques and methods of production and in lowering costs rather than toward the discovery of a new and different way of producing fertilizers.

Fire Control

Various materials act as fuel to sustain fire, so different fire prevention and control measures are recommended.

How To Prevent Fires

Class A — Ordinary combustibles

Keep storage and working areas free of trash. Place oily rags in covered containers.

Class B — Flammable liquids or gases

Don't refuel gasoline-powered equipment in a confined space, especially in the presence of an open flame such as a furnace or water heater.

Don't refuel gasoline-powered equipment while it is hot.

Keep flammable liquids stored in tightly closed, self-closing, spill-proof containers.

Pour from storage drums only what you will need.

Store flammable liquids away from spark-producing sources.

Use flammable liquids only in well-ventilated areas.

Class C — Electrical equipment

Look for old wiring, worn insulation and broken electrical fittings. Immediately report any hazardous condition.

Prevent motors from overheating by keeping them clean and in good working order. A spark from a rough-running motor can ignite the oil and dust in it.

Utility lights should always have some type of wire guard over them. Heat from an uncovered light bulb can easily ignite ordinary combustibles.

Don't misuse fuses. Never install a fuse rated higher than specified for the circuit.

Check any appliance or electrical equipment that smells strange. Unusual odors can be the first sign of fire.

Don't overload wall outlets. Two outlets should have no more than two plugs.

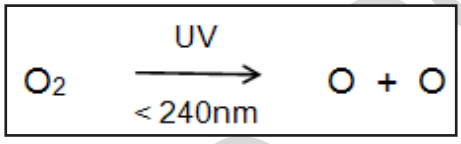
Class D — Flammable metals

Flammable metals such as magnesium and titanium generally require a very hot heat source to ignite. However, once ignited they are difficult to extinguish as the burning reaction produces sufficient oxygen to support combustion, even under water.
Source: http://www.ulm.edu/police/fire-extinguishers (accessed: June30, 2014)

Ozone Layer

In the stratosphere , ozone acts as our protective shield against UV radiation, which can induce skin cancer, cause genetic mutations, and destroy crops and other forms of vegetation.

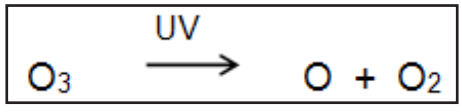
The formation of ozone in the stratosphere begins with the photodissociation of oxygen molecules by solar radiation at wavelength below 240 nm:



The highly reactive O atoms combine with oxygen molecules to form ozone as follows:

$$O + O_2 + M \rightarrow O_3 + M$$

Where M is some inert substance such as N_2. The role of M in this exothermic reaction is to absorb some of the excess energy released and prevent the spontaneous decomposition of the O_3 molecule. The energy that is absorbed by M is given off as heat.



The process continues when O and O_2 recombine to form O_3, further warming the stratosphere.

CFCs (chlorofluorocarbons) and nitrogen oxides cause destruction of the ozone layer. Because of their relative inertness, the CFCs slowly diffuse unchanged up to the stratosphere, where UV radiation of wavelengths between 175 nm and 220 nm causes them to decompose:

$$CFCl_3 \rightarrow CFCl_2 + Cl$$
$$CF_2Cl_2 \rightarrow CF_2Cl + Cl$$

The reactive chlorine atoms then undergo the following reactions:

$$Cl + O_3 \rightarrow ClO + O_2$$
$$ClO + O \rightarrow Cl + O_2$$

The overall result is the net removal of an O_3 molecule from the stratosphere:

$$O_3 + O \rightarrow 2O_2$$

Catalytic Converters

At high temperatures inside a running car's engine, nitrogen and oxygen gases react to form nitric oxide:

$$N_2(g) + O_2(g) \rightarrow {}_2NO(g)$$

Incomplete combustion of the fuel in the car engine produces carbon monoxide. When released into the atmosphere, NO rapidly combines with O_2 to form NO_2. Nitrogen dioxide and other gases emitted by a car, such as carbon monoxide (CO) and various unburned hydrocarbons, make car exhaust a major source of air pollution.

Most cars are equipped with catalytic converters. An efficient catalytic converter serves two purposes: It oxidizes CO and unburned hydrocarbons to CO_2 and H_2O and it reduces NO and NO_2 to N_2 and O_2. Hot exhaust gases into which air has been injected are passed through the first chamber of one converter to accelerate the complete burning of hydrocarbons and to decrease CO emission. However, since high temperatures increase NO production, a second chamber containing a different catalyst and operating at a lower temperature are required to dissociate NO into N_2 and O_2 before the exhaust is discharged through the tailpipe.

Answer to Summative Assessment:

1. A
2. B
3. B
4. A
5. D
6. B
7. C
8. C
9. B
10. A

11 – 12. There is a danger of explosion in coal mines where there are large quantities of powdered combustible materials because powdered combustible materials have very large surface area, increasing the number of collisions between particles, resulting to rapid chemical reaction (explosion).

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DepEd Project EASE Module 17 Lesson 1

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http://chemistry.mtu.edu/~pcharles/SCIHISTORY/PhlogistonTheory.html

How to prevent fire http://www.ulm.edu/police/fire-extinguishers

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/chemreac/

energychangesrev3.shtml

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http://sun.menloschool.org/~dspence/arda/chem_project/web_kwan/fertilizer2.htm

Unit 4
MODULE

3

Suggested time allotment: 12 hours

Biomolecules

Content Standards:
• The Learners demonstrate an understanding of the structure of biomolecules which are made up mostly of a limited number of elements such as Carbon, Hydrogen, Oxygen and Nitrogen.

Overview:

In grade 9, the students have learned why carbon is so unique that it can form bonds with hydrogen or oxygen and form long chains of compounds compared to other elements. In this module, the students will understand the structure of biomolecules which are made up mainly of carbon, hydrogen and oxygen as well as proteins and nucleic acids and some derivatives of carbohydrates and lipids which also contain nitrogen. They will also learn why these biomolecules are important to all living things and what differentiates them from each other.Though this topic is complex; it is the role of the teacher to make the learning process interesting and challenging. This module contains two activities that will enhance understanding about the major groups of biomolecules.

Students will be able to:

- Identify the major categories of biomolecules such as carbohydrates, lipids, proteins and nucleic acids.
- Differentiate the biomolecules from each other in terms of their structure and function.

At the end of Module 3, you will be able to answer the following key question.

Pre-assessment Answer:

1. D	6. A
2. C	7. B
3. C	8. C
4. B	9. D
5. C	10. C

Suggestions for the motivation:

1. Show pictures of different foods or it is better if actual sample of foods should be brought in class. Ask the students which of the foods are classified as carbohydrates? Why do you think they are classified as carbohydrates?

2. The teacher can also use the pre-assessment questions #1 and #2 as a springboard in the discussion of the lesson.

(After giving the motivation, apply the jigsaw strategy)

- To ensure maximum participation among the students, the teacher may use Jigsaw as his/her strategy in teaching the topic. However, there should be an **advanced preparation** for the students and the teacher. Assigned topic should be given ahead of time at least one week before the actual teaching giving ample time for the students to research on their assigned topic. This could be used as the strategy for teaching the different biomolecules- carbohydrates, lipids, proteins and nucleic acids.

Suggested Procedure for the Jigsaw strategy

Carbohydrate Jigsaw- I need an Expert!

Objectives:

- Determine the elements present in the molecules.
- Identify the general formula of the group.
- Describe the classification of carbohydrates in terms of
  A. number of units (monomer)
  B. structure
  C. function

Materials Needed:

- Handout: Carbohydrates (prepared by the teacher)
- Laptop per learning station
- Internet access
- Multimedia presentation

Note: The laptop and internet access can be used by schools which have these kinds of instructional materials.

Procedure:

1. The class will be divided into 4 learning stations. These are called the “home Groups.” Each home group will have “expert groups”to discuss the assigned topics on carbohydrates. Once that the “expert groups” gain a very good understanding of their assigned topics, they will meet back with their “home group” and teach the assigned topics on carbohydrates.

2. After the “expert groups” meet their “home group,” they can exchange with the other learning stations until all the groups are done with the discussions.

Resources on Carbohydrates

Carbohydrate	Suggested Links
Classification	http://www.rawfoodexplained.com/carbohydrates/classifications-of-carbohydrates.html
Sources	http://www.rawfoodexplained.com/carbohydrates/sources-of-carbohydrates.html
Composition& Structure	http://www.austincc.edu/biocr/1406/lec/carbs/index.html
Functions	http://www.rawfoodexplained.com/carbohydrates/the-role-of-carbohydrates-in-the-body.html

- **Suggested academic sources**:
  Biochemistry 3rd Edition (2004) by Donald Voet
  Judith Voet
  Principles of Biochemistry 1st edition (1995) by Geoffrey Zubay, William Parson and Dennis Vance
  Biochemistry: An Introduction (1999) by Trudy Mckee and James Mckee

NOTE: The teacher should allot one day for each topic. Additional information about the topic will be provided by the teacher. The students can also go over the readings in the learner's module to help them understand the assigned topics.

Lipids Jigsaw- I need an Expert!

Objectives:

- Determine the elements present in the molecules.
- Identify the general formula of the group.
- Describe the classification of lipids in terms of
  a. number of units (monomer)
  b. structure
  c. function

Materials Needed:

Handout: Lipids (prepared by the teacher)

- Laptop per learning station
- Internet access

Note: The laptop and internet acces can be used by schools which have these kinds of instructional materials.

Procedure:

1. The class will be divided into 4 learning stations. These are called the “home groups.” Each home group will have “expert groups “to discuss the assigned topics on Lipids. Once that the “expert groups” gain a very good understanding of their assigned topics, they will meet back with their “home group” and teach the assigned topics on Lipids.

2. After the “expert groups” meet their “home group,” they can exchange with theother learning stations until all the groups are done with the discussions.

Resources on Lipids

Carbohydrate	Suggested Links
Classification	http://www.laney.edu/wp/cheli-fossum/files/2012/01/Classification-of-Lipids.pdf
Sources	http://www.ehow.com/about_5412277_sources-lipids.html http://www.livestrong.com/article/238909-food-sources-of-fats-lipids/
Composition& Structure	http://wps.aw.com/bc_goodenough_boh_4/177/45509/11650458.cw/index.html
Functions	http://healthyeating.sfgate.com/lipids-used-body-8282.html http://www.biology.lifeeasy.org/1877/what-are-the-major-functions-of-lipids-in-living-organisms

- Suggested Academic Sources:

  Biochemistry 3rd edition (2004) by Donald Voet
  Judith Voet

  Principles of Biochemistry 1st Edition (1995) by Geoffrey Zubay,
  William Parson and Dennis Vance

  Biochemistry: An Introduction (1999) by Trudy Mckee and James Mckee

Note:

1. Assign two/three students (depending on the class size) as “experts” in each topic so that at the end of this module, students will be able to submit multimedia presentation/ created their blog about their assigned topics.

2. The same strategy will be used or followed in discussing proteins and nucleic acids.

Answers to Developmental Questions in the learner's material:

Q1. What is the name of the disaccharide found in cheese and other milk product?

- The name of the disaccharide found in cheese and other milk product is lactose.

Q2. Why do you think marathon runners eat a meal rich in carbohydrates the day before a race?

- Marathon runners eat a meal rich in carbohydrates (the strategy is called carbo-loading) the day before a race to store as much glucose as possible in their muscle cells to sustain them during their prolonged activity.

Q3. Carbohydrates and lipids are composed of the same chemical elements, but in different proportions. Both are used as energy sources for cell metabolism. Which type of molecule has the higher calorie content per gram. Explain the reasons for your answers.

- Both carbohydrates and lipids serve as sources of energy but these compounds contain different capacities for energy storage. Each gram of carbohydrates stores four (4) calories of energy, whereas each gram of lipid stores nine (9) calories. As a result, lipids serve as a more compact way to store energy since it contains more energy per gram than carbohydrates.

❖ To enhance the understanding of the students on the two major groups of biomolecules- carbohydrates and lipids, let them perform Activity 1

Activity1

Test for Carbohydrates and Lipids

In this activity, the students will perform chemical tests for carbohydrates and lipids.

❖ Group the students into six or ten groups (depending on the class size).

❖ Remind students of the precautionary measures when handling glassware and chemicals. Also, they must observe carefully the color change of the indicator to accurately identify the biomolecules present in the food samples.

I. Results of Carbohydrate Test

Food Sample	Test for simple sugars/ Benedict's Test	Iodine Test
Cooked pasta		✓
Cracker		✓
Cooked rice		✓
Table sugar		
Pineapple		

II. Results of the Ethanol Emulsion Test for Lipids

Food Sample	Colorless	Layer of Cloudy White Suspension
Oil		✓
Peanut butter		✓
Egg		✓
Fried chicken		✓
Butter		✓
Milk		✓
Burger		✓
Mashed potato	✓	

Q1. Which foods tested will the body use for a quick burst of energy? Which could be used for energy when no carbohydrates are available?

- For a quick burst of energy, you need simple sugars (e.g. sucrose, honey). When no carbohydrates are available, egg, peanut butter, fried chicken, oil, etc can be used.

Q2. Why it is that Benedict's test gives a negative (-) result with sucrose or table sugar?

- Sucrose is a non-reducing sugar because of the way the bonds are attached to the two monosaccharides making up sucrose. It will therefore give a negative result with Benedict's test.

Q3. What kind of foods rih in fats should be taken in moderation? Why?

- Foods that are rich in saturated fats and transfats should be taken in moderation because they are considered to be bad fats. Saturated fats raise total blood cholesterol as well as LDL (low density lipoprotein) cholesterol (bad cholesterol). Saturated fats are found in fatty beef, pork poultry with skin, beef fat, lard and cream, butter, cheese and other dairy products made from whole or reduced-fat milk. A diet should emphasize vegetables, fruits, whole grains low-fat dairy products, lean meat and poultry without skin, fish, and nuts. On the other hand transfats are found in many commercially packaged foods, commercially fried foods

such as French fries from some fast food chains. Also, avoid too much sugar in the diet because it is converted to fats.

- ❖ The result of the activity reinforces the knowledge of the students on carbohydrates and lipids. They know what food they will include in their diet that will keep them going and those that they must be taken in moderation to maintain a healthy lifestyle.

- ❖ The teacher may also include caloric content lab activity to explain the percent composition of biomolecules in food labels content. Procedure can be adapted from the following sources:www.soinc.org/sites/default/files/…/PSV-10-COMP-energy of food.pdf
  www.chymist.com/energy%20of%20a%20peanut.pdf

- ❖ The students still need to explore another activity to enhance their knowledge and skills on the identification of protein present in foods.

Activity 2

A. Test for Proteins

IV. Data/Results:

Food Samples	Biuret Test
	Depends on the food samples
	brought by students

Q4. Describe what you observed in each test tube. Answer will vary depending on food samples.

Q5. Which foods may be used for building body parts?

- Those foods rich in proteins like beans.

- ❖ Part B of the activity will help the students identify agents for the denaturation of proteins; relate the denaturation of proteins to home or ordinary activities; and explain what happens to proteins on denaturation.

B. The Denaturation of Proteins

Adapted from: Sourcebook on Practical Work for Teacher Trainers, High School Chemistry volume 2, UP-NISMED

- In this activity, the students will find out the different agents which can denature proteins. They will investigate the effect of heat, electrolyte (e.g. copper sulfate), mineral acid (e.g. HCl), and organic solvent (e.g. ethanol) on the proteins in egg white. Egg white is more than 90% water and the rest are proteins (principally albumin).

  Take Note: Preparation of egg white sample:

  Mix together one portion of egg white with five portion of water in a small beaker. Add a very small amount of sodium chloride.

Teaching Tips:

Adapted from: Sourcebook on Practical Work for Teacher Trainers, High School Chemistry volume 2, UP-NISMED

- Cite some familiar examples of denaturation your students encounter at home without mentioning the term denaturation, e.g. pickling, salting, use of germicides and fungicides. Oil extraction from coconut gata, use of egg white as antidote for lead poisoning, etc. Make them guess what is common to all of these home practices. Withhold the right answer or do not confirm their answers yet. Tell them that they will find out the answer when they perform the activity.
- Make them perform the activity.
- When conducting the post lab, make them define denaturation based on their observations. Go back to the different examples of denaturation you cited in the prelab discussion and confirm the correct answer given by the students.
- You can bring in to your discussion the different levels of protein structures and how these relate to their functions. Then you may proceed to discuss which level of structure is affected by denaturation.

Answers to Guide Questions:

Q6. Answer will vary.

Q7. Copper sulfate is used as a fungicide in the garden. Explain the relation of this application to what you just observed.

- The copper ion is the part of copper sulfate that has toxic implications for the fungi. The copper ion causes protein denaturing which leads to cell damage.

Q8. A 70% solution of ethanol in water is used as a disinfectant. Explain the basis for this application.

- A 70% alcohol solution is used as a disinfectant on the skin. This concentration of alcohol is able to penetrate the bacterial cell wall and denatures the proteins and enzymes inside the cell. Alcohol denatures proteins by disrupting the side chains intramolecular hydrogen bonding.

2. Get test tube D and apply heat. Observe any change.

Q9. Describe what happens.

- The reason why proteins of egg white dissolve in water giving a transparent appearance is because these proteins are hydrophilic (water-loving). However, when heat is applied, the protein molecules are denatured and unfolded exposing hydrophobic amino acids that aggragate so that they become insoluble in water.

Q10. Give other examples of ordinary activities at home that involves the denaturation of proteins.

- Preservation of foods by pickling and salting involve denaturation of proteins. Vinegar and salts are agents for denaturation. Decay microorganisms are killed when their cell proteins are denatured.

Note:

❖ The same strategy (jigsaw) will be used or followed in discussing proteins and nucleic acids.

Answers to the Summative Test

1. B
2. C
3. D
4. A
5. D
6. B
7. C
8. B
9. C
10. C
11. A
12. A
13. C
14. D
15. B

Summary: (LeMay Jr., 2000)

Carboydrates

- They are molecules made from aldehydes and ketones containing numerous hydroxyl groups.
- Monosaccharides are composed of a single units of carbohydrates.
- Disaccharides consist of two monosaccharides that are chemically combined.
- Polysaccharides are polymers containing numerous monosaccharide monomers.

Lipids

- They are water insoluble molecules that are composed of carbon, hydrogen and oxygen.
- Fats and oils are triglycerides that come from the combinations of glycerol and three fatty acids.
- Waxes are lipids that come from the combinations of a long-chain alcohol and a fatty acid.

Proteins

- Proteins are polymers of amino acids.They have many functions in the body. One of which are found as structural materials in hair, nails and connective tissues.
- Enzymes are proteins that act as biological catalysts**.**

Nucleic Acids

- Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA) are nucleic acids.Both DNA and RNA are polymers that are made up of nucleotides.
- Nucleotides are molecules that are composed of three parts: a five carbon sugar, a nitrogen-containing base, and a phosphate group.

❖ Both proteins and nucleic acids contain nitrogen in addition to carbon, hydrogen and oxygen in their structures.

Glossary of Terms

- Biomolecule is any large molecule that is produced by a living organism, including large macromolecules such as proteins, polysaccharides, lipids and nucleic acids.

- Dehydration synthesis/condensation is a process by which two molecules are joined by removing a molecule of water.

- Hydrolysis is a reaction in which water is added to a reactant, breaking the reactant into two product molecules.

- Monomer is a small molecule that combines with other similar molecules to make a polymer; repeating units of a polymer

- Polymer is a large organic molecule consisting of small repeating units called monomers

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