



Teacher's Guide SCIENCE



Mathayom **3**

Based on the Basic Education Curriculum B.E. 2551
(Revised Edition B.E. 2560)



Preface

The learning standards of science based on the Basic Education Curriculum B.E. 2551 (revised Edition B.E. 2560) are divided into four main strands. They are:

Strand 1: Biological Science

Strand 2: Physical Science

Strand 3: Earth and Space Science

Strand 4: Technology

All the elements in this course including the contents, the teaching and learning activities, and the measurement and evaluation of the learning outcomes are very important to be coherent in order to lay a good strong foundation in the students in every level from Grade 1 to Grade 12.

Students not only need to know and understand the basic knowledge of science, but also to apply it in their daily lives and hopefully when they further their studies in the disciplines of science. The contents of each strand are relevant and suitable for each level, neither too easy nor too difficult. There are also links between the knowledge, the learning process and learning activities that encourage students to develop thinking skills which include analytical, creative and critical thinking skills. Besides that, students are encouraged to develop science process skills and also the 21st century skills. These skills allow students to be lifelong learners and succeed in this information age. For example, by knowing how to carry out researches and construct their own knowledge with the use of inquiry strategies, students can solve their problems systematically. They can make great decisions based on the various kinds of information and empirical evidences gathered.

Goals

The new teaching and learning of science focuses on students themselves, allowing them to discover the knowledge mostly by themselves. With their fundamental knowledge and the results from their scientific investigations, students can construct their own principles, conceptual ideas and understandings systematically.

The teaching and learning of science has the following important goals:

1. To understand principles, theories and rules that are fundamental in science.
2. To understand the nature of science and the limitations of science.
3. To have important skills for study, research and technological development.
4. To realize the relationship between science, technology, humanity and the environment in which they affect and influence each other.
5. To apply knowledge and understanding in science and technology in order to benefit the society and life.
6. To develop the process of thinking and imagination, and the ability to manage and solve problems with excellent communication and decision-making skills.
7. To be a scientist who upholds values, moral and ethics issues when applying scientific knowledge and technology wisely.

General Learning Outcomes in Each Strand

This revised curriculum aims to provide the knowledge of science to students and focuses on the relation between the knowledge and the learning process. Students will develop important skills to carry out researches, construct the knowledge using the inquiry approach and solve a variety of problems. By having students participate in every stage of learning and doing various practical activities that

suit each level, they will acquire the following general learning outcomes in each strand:

❖ **Biological science**

Learning about life and living things, elements of living things, life processes, structures and functions of living things (how they live?), heredity, diversity of living things in the environment, the environment and the evolution of organisms.

❖ **Physical science**

Learning about the nature of substances, changes in substances, motion, energy and waves.

❖ **Earth Science and Space**

Learning about the components of the universe, interactions within the Solar System, space technology, Earth system, geological changes and the processes of changes of the climate and their effects on organisms and the environment.

❖ **Technology**

- Design and Technology

Learning about the technology for living in the fast-changing society. Using knowledge and skills in science and mathematics creatively to solve problems and improve our life by applying the engineering processes. Choosing an appropriate technology with consideration for the impact on life, society and the environment.

- Computer Science

Learning about computational thinking, analytical thinking, systematic problem solving and the application of computer science, information technology and communication to solve the real-life problems effectively.

Strands and Learning Standards

Strand 1: Biological Science

Standard 1.1: Understand the diversity of the ecosystem, the relationships between non-living things and living things, the relationships between organisms in the ecosystem, the energy transfer, the changes in the ecology, the meaning of population, the problems and impacts on the natural resources and environment, the guidelines for natural resource conservation and the environmental solutions including the applications of knowledge to benefit.

Standard 1.2: Understand the properties of organisms, the basic unit of life, the movement through cells, the relationships between structures and functions of different organ systems in animals and humans that work together, and the relationship between structures and functions of organ systems in plants that work together including the applications of knowledge to benefit.

Standard 1.3: Understand the processes and the importance of inheritance, the genetic materials, the genetic changes affecting organisms, biodiversity and the evolution of organisms including the applications of knowledge to benefit.

Strand 2: Physical Science

Standard 2.1: Understand the properties of matter, the component of matter, the relationships between the properties, structures and the energy bonds between particles, the principles and the nature of changes in the states of matter, the solution forming and the chemical reactions.

Standard 2.2: Understand the nature of forces in everyday life, the effects of forces on objects and the various kinds of movements of objects including the applications of the knowledge to benefit.

Standard 2.3: Understand the meaning of energy, the transition and transfer of energy, the interaction between matter and energy, energy in everyday life, the nature of waves, and the phenomena related to sound, light and electromagnetic waves including the applications of knowledge to benefit.

Strand 3: Earth and Space Science

Standard 3.1: Understand the components, the characteristics, the processes of forming and the evolution of the universe, the galaxy, the stars and the Solar System including the interactions within the objects in the Solar System that affects the organisms and the applications of knowledge to benefit.

Standard 3.2: Understand the components and relationships of the Earth's systems, the changes on the Earth's surface and inside the Earth, geohazards and the changes on the climate including the impacts on the organisms and environment.

Strand 4: Technology

Standard 4.1: Understand the key concepts of technology for living in a rapidly changing society, the applications of knowledge and skills in science and mathematics creatively to solve problems and improve our life with the engineering design processes and the selection of appropriate technology with consideration for the impact on life, society and the environment.

Standard 4.2: Understand and apply computational thinking in solving real-life problems systematically, and use information technology and communication to learn, work, and solve problems effectively, knowingly and ethically.

Learners' Quality for Grade 9 Students

- ❖ Understand the features and the main elements of cells of organisms, the relationships among the functions of the body systems in humans, plant's life, genetic transmission, the changes in genes or chromosomes and the examples of diseases caused by genetic changes, the benefits and impacts of Genetically Modified Organisms, biodiversity, the interactions between the components of the ecosystem, and the energy transfer in living organisms.
- ❖ Understand the components and properties of elements, solvents, pure substances and mixtures, the principles of separation, the changes in substances according to changes of states of matter, solution formation, the chemical reactions, physical properties of matter and the uses of polymers, ceramics and composites.
- ❖ Understand motion, resultant force and the effects of the resultant force acting on objects, the moment of a force, forces in daily life, field forces, the relationship of energy, kinetic energy, gravitational potential energy, the law of conservation of energy, energy transfer, heat balance, the relation of electrical quantities and home electrical circuits, electrical energy, and the fundamentals of electronic circuits.
- ❖ Understand the properties of waves and the characteristics of different waves, light, reflection and refraction of light and visual equipment.
- ❖ Understand the planets around the sun, seasons, the movement and appearance of the sun, lunar phases, the rise and fall of the moon, tides, the benefits of space technology and the development of the space exploration program.

- ❖ Understand the characteristics of the atmosphere, the components of weather and factors affecting the weather, the causes and effects of thunderstorms and tropical cyclones, weather forecast, the world climate changes, fossil fuel formation, the utilization renewable energy, the internal structure of the Earth, geological changes on the crust, soil layers, soil formation, surface water, groundwater, the causes and effects of natural disasters and geohazards.

- ❖ Understand the key concepts of technology such as technology system and technology change, the relationship between technology and science and mathematics, the analysis, comparison and decision making in selecting and using technologies with consideration for the impacts on life, society and environment. Apply knowledge, skills and resources to design and create solutions for everyday problems or career by using engineering design processes and choosing materials, equipment and tools properly, appropriately and safe, including being aware of the intellectual property rights.

- ❖ Take the primary data into the computer system, analyze, evaluate and present the data and information for the purpose to solve problems. Use computational thinking skills to solve real-life problems and write a simple program to help solve problems with the sense of social responsibility.

- ❖ Ask questions or identify problems associated with the evidences. Predict many answers and create a hypothesis that can lead to an investigation with controlled variables. Design and investigate using appropriate materials and tools. Use proper tools and information technology to collect both quantitative and qualitative data accurately and safely.

- ❖ Analyze and assess the correspondence of the collected data from evidence by using the knowledge and principles of science to interpret, conclude and communicate ideas and knowledge from various investigations or using information technology to facilitate the understanding of the information.
- ❖ Show interests, commitment, responsibility, prudence and honesty in the subject being studied. Be creative to study on your own interests by using the right and reliable tools and methods. Further study from various sources of knowledge, show your opinions, listen to other people's comments and accept the changes of knowledge discovered when there are more data and the new testimonies or another argument.
- ❖ Realize the values of science and technology knowledge used in daily life. Apply knowledge, technology and scientific processes in life. Praise and respect the rights of the inventors. Understand both positive and negative impacts of scientific development on the environment and other elements. Study more and conduct more projects or create pieces of work according to your own interests.
- ❖ Appreciate, concern, care and maintain the balance of ecosystems and biodiversity.

Yearly Teaching Plan

Science

Grade 9 (Mathayom 3)

8 chapters

120 hours

Learning areas	Time (hours)
1. Interdependence among Living Things and the Environment <ul style="list-style-type: none">• Interdependence among Organisms• Interactions between Organisms• Food Webs	13
2. Heredity <ul style="list-style-type: none">• Traits and Heredity Unit• Chromosomes• DNA and Genes• Inheritance of Traits• Cell Division• Genetic Disorders• Genetically Modified Organisms• Biodiversity• STEM Activity	22
3. Materials <ul style="list-style-type: none">• Polymers• Ceramics• Composite Materials• STEM Activity	10
4. Chemical Reactions <ul style="list-style-type: none">• Chemical Equations• Energy Changes in Chemical Reactions• Chemical Reactions in Daily Life• STEM Activity	13

<p>5. Electricity</p> <ul style="list-style-type: none"> • Electricity • Measuring Electricity • Current, Voltage and Resistance • Parallel and Series Circuits • Current, Voltage and Resistance in a Series Circuit • Current, Voltage and Resistance in a Parallel Circuit • Electronic Circuits • Cost of Electrical Energy • Importance of Safety Precautions in the Use of Electricity • STEM Activity 	26
<p>6. Waves</p> <ul style="list-style-type: none"> • What are Waves? • Electromagnetic Waves 	7
<p>7. Light</p> <ul style="list-style-type: none"> • Reflection of Light • Refraction of Light • Lenses and Light • Brightness of Light • STEM Activity 	15
<p>8. Sun-Earth-Moon System and Space Technology</p> <ul style="list-style-type: none"> • Gravitational Forces • Phenomena due to the Axial Tilt and Moon's Revolution • Space Technology and Space Exploration 	14

Note: The hours needed for each subtopic can be changed when necessary. The above allocated hours are just a suggestion. Total hours for this subject is as prescribed in the basic learning time structure, while the learners must attain the standard as prescribed in the learning standards and indicators.

Chapter 1 – Interdependence among Living Things and the Environment (13 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 1.1:</p> <p>1. Explain the interactions of the components of the ecosystem from the survey.</p>	<ul style="list-style-type: none"> ● Interdependence among Organisms
<p>2. Explain the patterns of relationships between organisms and different species organisms living in the same habitat from the survey.</p>	<ul style="list-style-type: none"> ● Interactions between Organisms
<p>3. Build a model to explain the energy transfer in a food web.</p> <p>4. Explain the relationship between producers, consumers and decomposers the ecosystem.</p> <p>5. Explain the accumulation of toxins in organisms in food chains.</p> <p>6. Be aware of the relationship of organisms and ecological environment without destroying the ecological balance.</p>	<ul style="list-style-type: none"> ● Food Webs

Learning Objectives

Students will be taught to:

1. Understand interdependence among living things.
2. Understand interactions between living organisms.
3. Understand food webs.
4. Understand bioaccumulation.

Learning Outcomes

Students will be able to:

1. Explain the terms – species, population, community, habitat and ecosystem.
2. Explain how interdependence of living organisms creates a balanced ecosystem.
3. Describe how living organisms interact and the types of interactions – prey-predator, symbiosis and competition.
4. Give examples of living things involved in those types of interactions.
5. Realize the importance of interactions between living organisms.
6. Explain how biological control is used to control pests and its advantages and disadvantages.
7. Describe the groups of organisms based on their roles in the ecosystem – producers, consumers and decomposers.
8. Explain the food chains and food webs.
9. Describe energy flow in food webs and pyramids of numbers.
10. Explain bioaccumulation and give examples of toxins.
11. Realize the effect of bioaccumulation.

Learning Areas

- Interdependence among living organisms
- Interactions between living organisms
- Food webs

Teaching and Learning Activities

1st – 3rd hours (Interdependence among Organisms)

1. Explain the terms– species, population, community, habitat and ecosystem.
2. Use the diagram on page 3 to explain the relation among those terms.
3. Explain the importance of interdependence among organisms. How does it help to balance our ecosystem? What happens when a population increases or decreases in number or when the climate changes?
4. Ask students to answer the questions of this subtopic on pages 2 and 3 of the workbook as their homework.
5. Have students try Test Yourself 1.1 and discuss the answers with them.

4th – 8th hours (Interactions between Organisms)

1. Explain why interactions between living things are important.
2. List the types of interactions between organisms – prey-predator, symbiosis and competition. Show the '[Competition, Predation and Symbiosis Chap 2 Science M3](#)' PowerPoint Presentation.
3. Explain how a prey and its predator interact. Give examples.
4. Explain the three types of symbiosis – commensalisms, mutualism and parasitism. What are the differences between each type? What are the organisms that interact that way? Which will be harmed and which is benefited?
5. Explain the factors that organisms compete with each other for and explain the two types of competition – intra-specific competition and inter-specific competition.
6. Ask students to answer Questions 1 and 2 of this subtopic on pages 3 to 5 of the workbook as their homework.
7. Carry out the activity on pages 8 and 9. Explain the importance of interactions between organisms.

8. Ask students what they should do if there are rats in their houses. Rear a cat? Explain biological control. What are the advantages and disadvantages of biological control?
9. Ask students to answer Question 3 of this subtopic on page 5 of the workbook as their homework.
10. Have students try Test Yourself 1.2 and discuss the answers with them.

9th – 12th hours (Food Webs)

1. Ask students what food chains are. Ask them to draw a food chain for the community in a paddy field. Ask them to identify the producers, primary consumers, secondary consumers and tertiary consumers.
2. Explain the producers, consumers and decomposers.
3. Remind them that as each species eats variety of food and has many predators, food chains are interlinked making a food web.
4. Explain a pyramid of numbers. Emphasize that the lowest level is always the producer, follow by the next level the primary consumer and secondary consumer in the next level and tertiary consumer in the upper level.
5. Explain the shape of the pyramid of numbers.
6. Using the diagram on page 14, explain how energy flows in a food web and the pyramid of numbers. Explain the reasons for the loss of energy when energy is transferred to the next level.
7. Explain how a disturbance in the number of a population in an ecosystem affects the balance the ecosystem.
8. Using the diagram on page 15, explain the bioaccumulation in a food chain, examples of toxins and the which organism in the food chain are affected the most.
9. Ask students to answer the questions of this subtopic on pages 6 and 7 of the workbook as their homework.
10. Have students try Test Yourself 1.3 and discuss the answers with them.

13th hour (Conclusion)

1. Use Conceptual Map on page 16 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 17.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Grouping and classifying
3. Communicating
4. Generating ideas
5. Predicting

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3



Learning Outcome Form

Name-Surname:

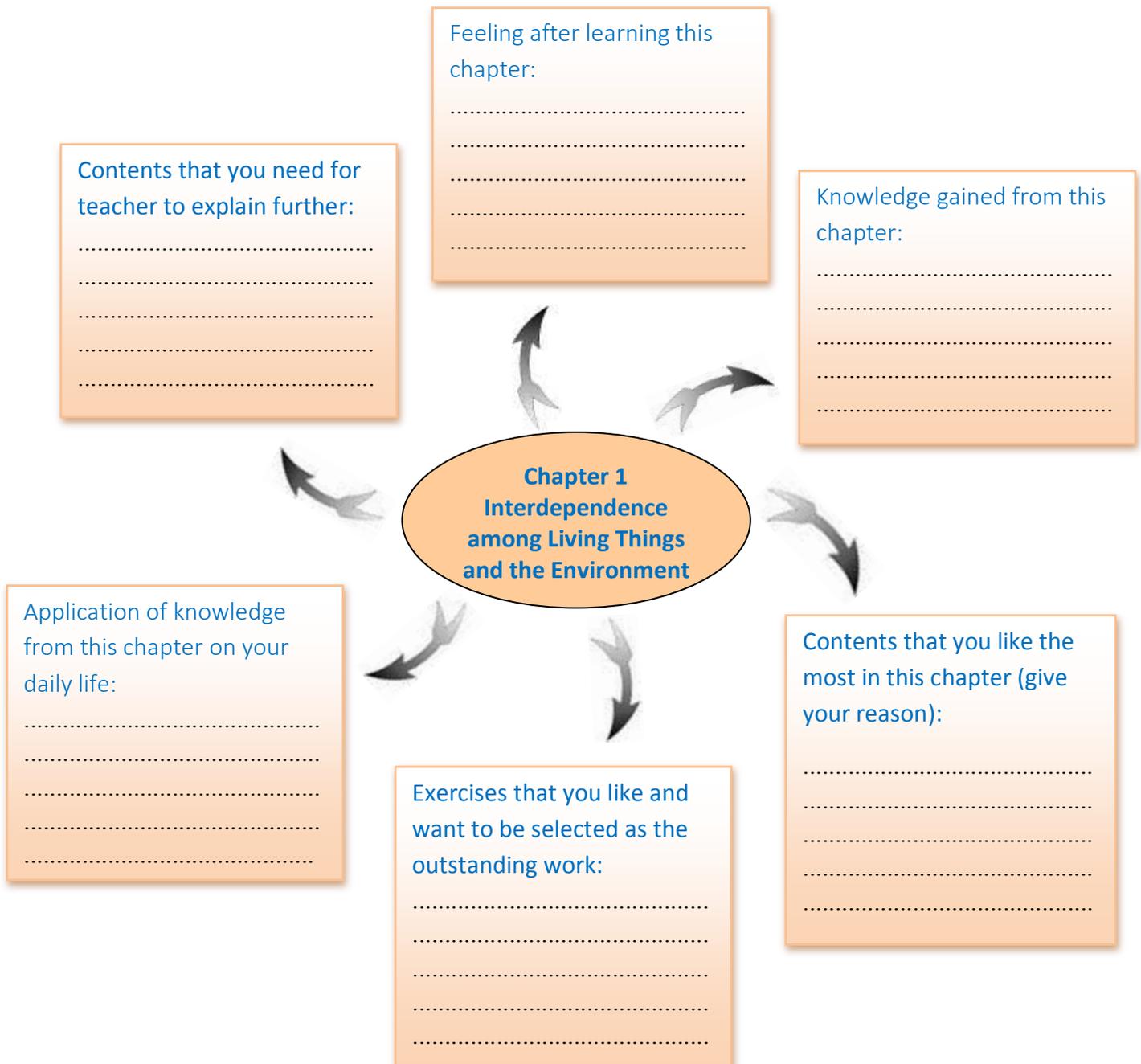
No.

Mathayom:

Date:

Chapter 1 Interdependence among Living Things and the Environment

Explanation: Summary of learning outcomes



Chapter 2 – Heredity (22 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 1.3:</p> <ol style="list-style-type: none">1. Explain the relationship between gene, DNA and chromosomes using a model.2. Explain genetic inheritance from the combinations by considering the only feature that the dominant allele completely dominates the recessive allele.3. Explain the genotype and phenotype of the offspring and calculate the ratio of genotype and the phenotype in the next generation.	<ul style="list-style-type: none">• Traits and Heredity Unit• Chromosomes• DNA and Genes• Inheritance of Traits
<ol style="list-style-type: none">4. Explain the differences in cell divisions between mitosis and meiosis.	<ul style="list-style-type: none">• Cell Division
<ol style="list-style-type: none">5. Tell about the changes in genes or chromosomes may cause genetic diseases and give examples of genetic diseases.6. Realize the benefits of the knowledge of genetic diseases. Know that before marriage should consult a doctor in order to check and diagnose the potential risk of genetic diseases that may occur in the baby.	<ul style="list-style-type: none">• Genetic Disorders

<p>7. Explain the use of Genetically Modified Organisms and its effects on humans and environment using the collected data.</p> <p>8. Realize the benefits and impacts of genetically modified organisms that may be harmful to humans and the environment by disseminating knowledge gained from scientific arguments with supporting information.</p>	<ul style="list-style-type: none"> • Genetically Modified Organisms
<p>9. Compare biodiversity and species diversity in different ecosystems.</p> <p>10. Explain the importance of biodiversity to a balance of ecosystems and human health.</p> <p>11. Show awareness of the value and importance of biodiversity by participating in the maintenance of biodiversity.</p>	<ul style="list-style-type: none"> • Biodiversity

Learning Objectives

Students will be taught to:

1. Understand traits, heredity and chromosomes.
2. Understand DNA and model of DNA.
3. Understand inheritance of traits and alleles.
4. Understand genotypes and phenotypes of a trait of an offspring.
5. Understand cell divisions.
6. Understand genetic disorders and premarital health screening.
7. Understand Genetically Modified Organisms (GMOs), its applications and people's concern.
8. Understand biodiversity.

Learning Outcomes

Students will be able to:

1. Explain what traits and heredity are.
2. Explain what chromosomes are.
3. Describe homologous chromosomes, diploid number and haploid number.
4. Describe DNA and the model of DNA.
5. Differentiate DNA and gene.
6. Explain what alleles are and how they determine traits in organisms and in their offspring.
7. Explain genotype and phenotype of a trait of the offspring of different parents.
8. Explain mitosis and meiosis.
9. Differentiate mitosis and meiosis.
10. Describe genetic disorders – color-blindness, hemophilia, sickle-cell disease, Down syndrome and Thalassemia.
11. Realize the use of premarital health screening.
12. Explain the use of Genetically Modified Organisms (GMOs) and the worries people have about GMOs.
13. Describe biodiversity.
14. Realize the importance of biodiversity and ways to maintain biodiversity.

Learning Areas

- Traits and heredity unit
- Chromosomes
- DNA and genes
- Inheritance of traits
- Cell division
- Genetic disorders

- Genetically modified organisms
- Biodiversity

Teaching and Learning Activities

1st – 2nd hours (Traits and Heredity Unit)

1. Ask students how they resemble their parents.
2. Explain heredity and genetics. Watch this animation by scanning the QR code below.



3. Briefly describe the work of Gregor Mendel.
4. Explain genes as units of inheritance.
5. Ask students to answer the questions of this subtopic on page 14 of the workbook as their homework.
6. Have students try Test Yourself 2.1 and discuss the answers with them.

3rd – 4th hours (Chromosomes)

1. Using the diagrams on page 22, guide students to understand chromatin and chromosomes. Watch this animation by scanning the QR code below.



2. Explain that every individual in a species has the same number of chromosomes. This number is an even number and it is known as diploid number.
3. Explain homologous chromosomes and haploid number.
4. Explain how babies have the same number of chromosomes as their parents.

5. Ask students to answer the questions of this subtopic on pages 15 and 16 of the workbook as their homework.
6. Have students try Test Yourself 2.2 and discuss the answers with them.

5th – 6th hours (DNA and genes)

1. Explain DNA to students.
2. Explain the Watson-Crick Model of DNA and also the importance of DNA. Watch this animation by scanning the QR code below.



3. Ask students to answer the questions of this subtopic on pages 16 and 17 of the workbook as their homework.
4. Have students try Test Yourself 2.3 and discuss the answers with them.

7th – 9th hours (Inheritance of Traits)

1. Explain what alleles are. The dominant allele will show its effect when it presents. The recessive allele will only show its effect with the absence of the dominant allele.
2. Explain that usually we use a capital letter to represent a dominant allele and a small letter to represent a recessive allele.
3. Using the diagram on page 27, explain how the alleles determine the trait in the offspring. If the offspring receives the same alleles for a particular trait, it is known as homozygote of that trait. If the offspring receives two different alleles for a particular trait, it is known as heterozygote of that trait.
4. Explain genotype and phenotype. Refer to page 28 for explanation.
5. Carry out the activity on pages 28 and 29.

6. Explain monohybrid crosses. Using the diagrams on pages 30 and 31, guide students to calculate the genotypic ratio and determine the phenotype of the offspring based on different parents.
7. Ask students to answer the questions of this subtopic on pages 17 to 19 of the workbook as their homework.
8. Have students try Test Yourself 2.4 and discuss the answers with them.

10th – 15th hours (Cell Division)

1. Explain cell division.
2. Explain mitosis. Using the diagrams on pages 32 and 33, guide student to understand each stage in mitosis.
3. Watch this animation by scanning the QR code below.



4. Ask students to answer Questions 1 to 4 of this subtopic on pages 19 to 21 of the workbook as their homework.
5. Explain meiosis. Using the diagrams on pages 33 to 35, guide students to understand each stage in meiosis.
6. Watch this animation by scanning the QR code below.



7. Ask students to answer Questions 5 and 6 of this subtopic on pages 21 to 23 of the workbook as their homework.
8. Explain the similarity and differences between mitosis and meiosis.

9. Ask students to answer Question 7 of this subtopic on pages 23 and 24 of the workbook as their homework.
10. Have students try Test Yourself 2.5 and discuss the answers with them.

16th – 17th hours (Genetic Disorders)

1. Explain that genetic disorder is a disease caused by a mutation or change in one's DNA. List the causes of mutation.
2. Explain two types of mutation – gene mutation and chromosome mutation.
3. Explain five types of genetic disorders – color-blindness, hemophilia, sickle-cell diseases, Down syndrome and Thalassemia.
4. Watch this animation by scanning the QR code below to know more about sickle-cell disease.



5. Explain how premarital health screening helps to prevent risk of transmitting the diseases to their children or spouse.
6. Explain how we can test for genetic disorders in fetus.
7. Ask students to answer the questions of this subtopic on page 24 of the workbook as their homework.
8. Have students try Test Yourself 2.6 and discuss the answers with them.

18th – 19th hours (Genetically Modified Organisms)

1. Explain to student what Genetically Modified Organisms (GMOs) is. Explain how GMO is used in food crops and medicines.
2. Explain the worries that people have about GMOs.

3. Watch this animation by scanning the QR code below to know more about GMOs.



4. Ask students to answer the questions of this subtopic on page 25 of the workbook as their homework.
5. Have students try Test Yourself 2.7 and discuss the answers with them.

20th – 21st hours (Biodiversity)

1. Explain biodiversity. Explain the three levels of biodiversity – genetic diversity, species diversity and ecological diversity.
2. Explain the importance of biodiversity.
3. Explain our duty and ways to care and maintain our biodiversity.
4. Ask students to answer the questions of this subtopic on pages 25 and 26 of the workbook as their homework.
5. Have students try Test Yourself 2.8 and discuss the answers with them.

22nd hour (Conclusion)

1. Use Conceptual Map on page 41 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 42.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Predicting
2. Comparing and contrasting
3. Classifying
4. Making inferences
5. Communicating

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3

STEM Activity: History of genetic research

Group size: 3 to 4 persons

Suggested time: 4-5 hours

Overview:

This activity will give a chance to students to prepare a timeline of events. It also allows students to realize that by using a timeline, they can understand the historical events easily.

Procedure:

1. Review their knowledge of heredity, and get students to answer these questions:
 - a. What is genetics?
 - b. Who was the first scientist who started the research on genetics? When?
 - c. Why do we take such a long time to study DNA that until now we have not fully understood it?
2. Let students read a situation on page 43 and identify the problem. Tell them to describe their mission and set their goal.
3. Ask students to do some research on the word '*history of genetic research*'. Then, encourage them to explore and integrate their knowledge of Science, Technology, Engineering and Mathematics by asking them these questions:
 - a. When did the study of genetics begin?
 - b. How are students going to apply that understanding in their project?
4. Brainstorm their possible solutions and draw their solution plans by labelling all materials needed. Let them explain how they work among their team members on:

- a. the materials they need
 - b. the reasons for using that materials
 - c. the steps to carry out their project
 - d. the reasons for each step they take
 - e. the assessment of their project
 - f. the achievement criteria
5. Allow students to do further research online about the similar project and let them tell the similarities and differences between their project and the project found on the internet to the class. Ask them whether they want to improve their plan or not. Is it necessary? Will it be better? Why? Guide them by asking these questions:
- a. Are they using digital presentation tools to show the timeline?
 - b. Will it be a text timeline, picture timeline or a 3D timeline? Why?
 - c. How can they make their timeline more interesting?
 - d. Will they incorporate pictures and sound effects?
- Then, let them choose the best one.
6. Ask students to draw a prototype in great details and build up their prototype following their plan.
7. When their project has finished, ask them to assess their work; what works and what does not work? How should they make it better?

Conclusion:

8. Get each group to present their projects using digital presentation tools and explain their process of creation.

- 9.** Encourage them to share their experiences by asking these questions:
- a.** Why did each group come up with the different solutions and designs?
 - b.** Which stage of the production process causes the project to have different outcomes?
 - c.** What are other factors that affect the outcomes?
 - d.** Can they control those factors?
 - e.** If their project is successful, will it be beneficial to humans and the environment in general?
 - f.** Is it possible to carry out in a large scale? How?
- 10.** For groups with their project that do not work well, encourage them to think the possible causes and ways to improve them, if they are given a chance to repeat the project.



Learning Outcome Form

Name-Surname:

No.

Mathayom:

Date:

Chapter 2 Heredity

Chapter 2 Heredity

Feeling after learning this chapter:
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.....
.....
.....

Contents that you need for teacher to explain further:
.....
.....
.....
.....

Knowledge gained from this chapter:
.....
.....
.....
.....

Application of knowledge from this chapter on your daily life:
.....
.....
.....
.....

Exercises that you like and want to be selected as the outstanding work:
.....
.....
.....
.....

Contents that you like the most in this chapter (give your reason):
.....
.....
.....
.....

Chapter 3 – Materials (10 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
Standard Sc 2.1: <ol style="list-style-type: none">1. Identify the physical properties and the uses of polymers, ceramics and composite materials using empirical evidence and information.2. Realize the values of using materials like polymers, ceramics and composite materials by providing the guidelines for using materials economically and cost effectively.	<ul style="list-style-type: none">• Polymers• Ceramics• Composite Materials

Learning Objectives

Students will be taught to:

1. Understand physical properties and uses of polymers, ceramics and composite materials
2. Understand the values of using polymers, ceramics and composite materials.

Learning Outcomes

Students will be able to:

1. Describe the properties of synthetic polymers.
2. Explain the uses of synthetic polymers.
3. Describe the properties of ceramics.
4. Explain the uses of ceramics.
5. Explain what composite material is and the properties of composite materials.

Learning Areas

- Polymers
- Ceramics
- Composite materials

Teaching and Learning Activities

1st – 3rd hours (Polymers)

1. Using the diagram on page 47, explain polymers to students.
2. Explain natural and synthetic polymers. Give examples of natural polymers and synthetic polymers.
3. Explain the properties of synthetic polymers.
4. Ask students to give examples of the use of synthetic polymers in their daily life. Using the table on pages 48 and 49, explain to students the properties and uses of different types of synthetic polymers.
5. Explain the disadvantages of using synthetic polymers. Explain the ways to use synthetic polymers in a wise manner. Watch this video by scanning the QR code below.



6. Ask students to answer the questions of this subtopic on pages 32 to 34 of the workbook as their homework.
7. Have students try Test Yourself 3.1 and discuss the answers with them.

4th – 6th hours (Ceramics)

1. Explain how ceramics are made. Watch this video by scanning the QR code on the next page to know more about the process of making ceramics.



2. Explain the properties of ceramics.
3. Ask students to give examples of the use of ceramics in their daily life.
Explain the properties and uses of different types of ceramics.
4. Ask students to answer the questions of this subtopic on pages 34 and 35 of the workbook as their homework.
5. Have students try Test Yourself 3.2 and discuss the answers with them.

7th – 9th hours (Composite Materials)

1. Explain what composite material is.
2. Explain the examples of composite materials and their properties.
3. Ask students to answer the questions of this subtopic on pages 35 and 36 of the workbook as their homework.
4. Have students try Test Yourself 3.3 and discuss the answers with them.

10th hour (Conclusion)

1. Use Conceptual Map on page 54 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 55.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Classifying
3. Generating ideas
4. Communicating

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3

STEM Activity: Making a future material

Group size: 3 to 4 persons

Suggested time: 4-5 hours

Overview:

This activity will allow students to think critically and creatively in order to make a composite material for building a sample house that can withstand a simulated earthquake. They can analyze how the composite materials that they have created has better properties than their original components.

Procedure:

1. Review their knowledge of composite materials and get students to answer these questions:
 - a. What is a composite material?
 - b. What are the properties of composite materials?

2. Let students read a situation on page 56 and identify the problem. Tell them to describe their mission and set their goal.

3. Ask students to do some research on the word '*composite material*'. Then, encourage them to explore and integrate their knowledge of Science, Technology, Engineering and Mathematics by asking them these questions:
 - a. What does *composite material* mean?
 - b. How are students going to apply that understanding in their project?
 - c. What are the suitable components of a composite material for building a sample house that can withstand earthquake?

4. Brainstorm their possible solutions and draw their solution plans by labelling all materials needed. Let them explain how they work among their team members on:
 - a. the materials they need
 - b. the reasons for using that materials
 - c. the steps to carry out their project
 - d. the reasons for each step they take
 - e. the assessment of their project
 - f. the achievement criteria

5. Allow students to do further research online about the similar project and let them tell the similarities and differences between their project and the project found on the internet to the class. Ask them whether they want to improve their plan or not. Is it necessary? Will it be better? Why? Guide them by asking these questions:
 - a. Does the composite material have better properties than the original components?
 - b. How do they use the composite material to build a sample house?
 - c. Can the sample house withstand the simulated earthquake?Then, let them choose the best one.

6. Ask students to draw a prototype in great details and build up their prototype following their plan.

7. When their project has finished, ask them to assess their work; what works and what does not work? How should they make it better?

Conclusion:

- 8.** Get each group to present their projects using digital presentation tools and explain their process of creation.

- 9.** Encourage them to share their experiences by asking these questions:
 - a.** Why did each group come up with the different solutions and designs?
 - b.** Which stage of the production process causes the project to have different outcomes?
 - c.** What are other factors that affect the outcomes?
 - d.** Can they control those factors?
 - e.** If their project is successful, will it be beneficial to humans and the environment in general?
 - f.** Is it possible to carry out in a large scale? How?

- 10.** For groups with their project that do not work well, encourage them to think the possible causes and ways to improve them, if they are given a chance to repeat the project.



Learning Outcome Form

Name-Surname:

No.

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Date:

Chapter 3 Materials

Chapter 3 Materials

Feeling after learning this chapter:
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Contents that you need for teacher to explain further:
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Knowledge gained from this chapter:
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Application of knowledge from this chapter on your daily life:
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Exercises that you like and want to be selected as the outstanding work:
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Contents that you like the most in this chapter (give your reason):
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Chapter 4 – Chemical Reactions (13 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 2.1:</p> <p>3. Explain the chemical reaction, including the rearrangement of atoms in a chemical reaction by using a model and chemical equations.</p> <p>4. Explain the law of conservation of mass using empirical evidence.</p>	<ul style="list-style-type: none">• Chemical Equations
<p>5. Analyze endothermic and exothermic reactions from a change in thermal energy during a chemical reaction.</p>	<ul style="list-style-type: none">• Energy Changes in Chemical Reactions
<p>6. Explain the reaction of rusting of steel, the reaction of acids with metals, the reaction of acids and bases and the reaction of bases with metals using empirical evidence. And explain the combustion reaction, the formation of acid rain, photosynthesis using the information including writing chemical equations represent chemical reactions as above.</p>	<ul style="list-style-type: none">• Chemical Reactions in Daily Life

7. Identify the advantages and disadvantages of chemical reactions affecting on the living creatures and the environment. Also, give examples of how to prevent and solve problems caused by the chemical reactions found in daily life from the information search.
8. Design solutions in everyday life using the knowledge of chemical reactions with the integration of science, mathematics, technology and engineering.

Learning Objectives

Students will be taught to:

1. Understand chemical reactions and chemical equations.
2. Understand Law of conservation of mass.
3. Understand energy changes in chemical reactions.
4. Understand chemical reactions in daily life.
5. Understand the advantages and disadvantages of chemical reactions and their effects on organisms and the environment.

Learning Outcomes

Students will be able to:

1. Explain a chemical reaction.
2. Give chemical formulas for compounds.
3. Write chemical equation.
4. Realize Law of Conservation of Mass.
5. Explain endothermic and exothermic reactions.

6. Explain the chemical reactions in daily life.
7. Realize the advantages and disadvantages of chemical reactions and their effects on organisms and the environment.

Learning Areas

- Chemical equations
- Energy changes in chemical reactions
- Chemical reactions in daily life

Teaching and Learning Activities

1st – 4th hours (Chemical Equations)

1. Explain a chemical change. Give some examples of chemical reactions that happen around us.
2. Explain a chemical equation.
3. Use the diagram on page 60 to explain the rearrangement of atoms in a chemical reaction.
4. Explain the chemical symbols of some elements.
5. Explain the chemical formulas of some compound.
6. Refer to page 61 to explain to students the steps to write a chemical equation.
7. Explain Law of Conservation of Mass.
8. Guide students to write chemical equations step by step. Use the examples on page 62.
9. Explain the common signs of a chemical reaction.
10. Ask students to answer the questions of this subtopic on pages 42 and 43 of the workbook as their homework.
11. Have students try Test Yourself 4.1 and discuss the answers with them.

5th – 8th hours (Energy Changes in Chemical Reactions)

1. Explain to students that all chemical reactions involve energy. Explain the Law of Conservation of Energy which states that energy cannot be created or destroyed in a system.
2. Explain that exothermic reactions are chemical reactions that release energy in the form of heat to the surroundings. This causes the surroundings to become hot.
3. Carry out the activity on pages 63 and 64 to study the heat change in an exothermic reaction.
4. Explain some examples of exothermic reactions.
5. Explain that endothermic reactions are chemical reactions that absorb energy in the form of heat from the surroundings. This causes the surroundings to become cold.
6. Carry out the activity on pages 65 to study the heat change in an endothermic reaction.
7. Explain some examples of endothermic reactions.
8. Ask students to answer the questions of this subtopic on pages 43 to 44 of the workbook as their homework.
9. Have students try Test Yourself 4.2 and discuss the answers with them.

9th – 12th hours (Chemical Reactions in Daily Life)

1. Using the examples on pages 66 to 68, explain the chemical reactions that take place around us every day. Explain the equations in each example.
2. Explain that some chemical reactions can bring harm with examples on page 68.
3. Ask students to answer the questions of this subtopic on pages 44 and 45 of the workbook as their homework.
4. Have students try Test Yourself 4.3 and discuss the answers with them.

13th hour (Conclusion)

1. Use Conceptual Map on page 69 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 70.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Classifying
3. Making inferences
4. Predicting
5. Communicating
6. Using and handling science apparatus correctly and safely
7. Handling specimen correctly and carefully

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3

STEM Activity: Keeping the eggs warm

Group size: 3 to 4 persons

Suggested time: 4-5 hours

Overview:

This activity will make students to realize the importance of incubation temperature for turtle eggs. This activity will allow them to think of the chemicals and the chemical reactions that can give out heat. This activity will also allow them to think of a suitable material to build a device to hold the egg and prevent heat lost. They can analyze how to place the chemicals in the device.

Procedure:

1. Review their knowledge of energy changes in chemical reactions and get students to answer these questions:
 - a. What are exothermic reactions and endothermic reactions?
 - b. What are the effects of exothermic reactions and endothermic reactions to the surrounding?
 - c. What are the examples of exothermic reactions and endothermic reactions?
2. Let students read a situation on page 71 and identify the problem. Tell them to describe their mission and set their goal.
3. Ask students to do some research on the word '*keep warm*'. Then, encourage them to explore and integrate their knowledge of Science, Technology, Engineering and Mathematics by asking them these questions:
 - a. What does 'keep warm' mean?
 - b. How are students going to apply that understanding in their project?
 - c. What is the suitable incubation temperature for turtle eggs?

- d. What are the examples of chemical reactions that give out heat and what are the chemicals involved?
 - e. What are the materials that can be used to make a portable device to hold the egg and prevent heat lost?
 - f. How do you place the chemicals in the device?
4. Brainstorm their possible solutions and draw their solution plans by labelling all materials needed. Let them explain how they work among their team members on:
 - a. the materials they need
 - b. the reasons for using that materials
 - c. the steps to carry out their project
 - d. the reasons for each step they take
 - e. the assessment of their project
 - f. the achievement criteria
5. Allow students to do further research online about the similar project and let them tell the similarities and differences between their project and the project found on the internet to the class. Ask them whether they want to improve their plan or not. Is it necessary? Will it be better? Why? Guide them by asking these questions:
 - a. Have they analyzed the chemical reactions that give out heat?
 - b. Which chemical reaction can give out the heat that suits the incubation temperature of turtle eggs?
 - c. Have they analyzed the materials for the portable device to hold the egg and prevent heat lost?
 - d. How do they place the chemicals in the portable device?Then, let them choose the best one.

6. Ask students to draw a prototype in great details and build up their prototype following their plan.
7. When their project has finished, ask them to assess their work; what works and what does not work? How should they make it better?

Conclusion:

8. Get each group to present their projects using digital presentation tools and explain their process of creation.
9. Encourage them to share their experiences by asking these questions:
 - a. Why did each group come up with the different solutions and designs?
 - b. Which stage of the production process causes the project to have different outcomes?
 - c. What are other factors that affect the outcomes?
 - d. Can they control those factors?
 - e. If their project is successful, will it be beneficial to humans and the environment in general?
 - f. Is it possible to carry out in a large scale? How?
10. For groups with their project that do not work well, encourage them to think the possible causes and ways to improve them, if they are given a chance to repeat the project.



Learning Outcome Form

Name-Surname:

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Chapter 4 Chemical Reactions

**Chapter 4
Chemical Reactions**

Feeling after learning this chapter:
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Contents that you need for teacher to explain further:
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Knowledge gained from this chapter:
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Application of knowledge from this chapter on your daily life:
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Exercises that you like and want to be selected as the outstanding work:
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Contents that you like the most in this chapter (give your reason):
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Chapter 5 – Electricity (26 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 2.3:</p> <ol style="list-style-type: none"> 1. Analyze the relationship between electric potential difference and resistance and calculate the relevant quantities using the equation $V = IR$ based on empirical evidence. 2. Draw a graph showing the relationship between electric current and electric potential difference. 3. Use a voltmeter and ammeter to measure electrical quantities. 	<ul style="list-style-type: none"> • Electricity • Measuring Electricity • Current, Voltage and Resistance
<ol style="list-style-type: none"> 4. Analyze of electric potential and electric current in the circuit when connecting multiple resistors in series and parallel circuits from empirical evidence. 5. Write a circuit diagram showing the connection of resistors in series and parallel circuits. 6. Describe the operation of simple electronic components in the circuit from the collected data. 	<ul style="list-style-type: none"> • Parallel and Series Circuits • Current, Voltage and Resistance in a Series Circuit • Current, Voltage and Resistance in a Parallel Circuit • Electronic Circuits

7. Draw a diagram and connect simple electronic components in the circuit.	
8. Describe and calculate the electrical energy using the equation $W = Pt$ and calculate the electric cost of household appliances.	<ul style="list-style-type: none"> • Cost of Electrical Energy
9. Realize the value of using electrical appliances by offering the guidelines how to use electrical appliances economically and safely.	<ul style="list-style-type: none"> • Importance of Safety Precautions in the Use of Electricity

Learning Objectives

Students will be taught to:

1. Understand electricity and the related terms.
2. Apply the understanding of measuring electricity.
3. Understand the relationship between current, voltage and resistance.
4. Understand parallel and series circuits.
5. Analyze current, voltage and resistance in series circuits.
6. Analyze current, voltage and resistance in parallel circuits.
7. Understand electronic circuit.
8. Analyze cost of electrical energy.
9. Realize the importance of safety precautions in the use of electricity.

Learning Outcomes

Students will be able to:

1. Investigate electricity using a Van de Graf generator.
2. State what current, voltage and resistance are.

3. State the directions of electron flow and current in an electric circuit.
4. Identify the instruments to measure current and voltage and their units.
5. Measure current and voltage in an electric circuit.
6. Design and carry out an experiment to study the relationship between current, voltage and resistance in an electric circuit.
7. Describe the relationship between current, voltage and resistance in an electric circuit.
8. State Ohm's law.
9. Identify the components and their symbols in an electric circuit.
10. Draw and built a series circuit and a parallel circuit.
11. Compare and contrast between a series circuit and a parallel circuit.
12. Describe the current, voltage and resistance in a series and a parallel circuit.
13. Explain the advantage and disadvantage of a series circuit and a parallel circuit.
14. Compare and contrast a series circuit and a parallel circuit in terms of current, voltage and resistance.
15. Explain the components in an electronic circuit – resistors, diodes, transistors and microchips.
16. Describe the relationship between electrical energy usage, power and time.
17. Calculate the amount of current flowing through an electrical appliance.
18. Solve problems by calculating the cost of electricity used.
19. Describe the possible causes of electrical accidents.
20. Describe the steps to be taken when electricity accidents occur.
21. State the safety features at home to prevent electrical accidents.
22. Justify the need to having safety precautions.

Learning Areas

- Electricity
- Measuring electricity
- Current, voltage and resistance
- Parallel and series circuits
- Current, voltage and resistance in a series circuit
- Current, voltage and resistance in a parallel circuit
- Electronic circuits
- Cost of electrical energy
- Importance of safety precautions in the use of electricity

Teaching and Learning Activities

1st – 3rd hours (Electricity)

1. List the sources of electrical energy.
2. Carry out the activity on pages 75 and 76 to show the flow of electric current using a Van de Graaff generator.
3. Explain current, voltage and resistance.
4. Explain the flow of electron and current in a circuit. They are always in the opposite directions of each other.
5. Ask students to answer the questions of this subtopic on page 52 of the workbook as their homework.
6. Have students try Test Yourself 5.1 and discuss the answers with them.

4th – 5th hours (Measuring Electricity)

1. List the units for current, voltage and resistance. Show them the instruments to measure current and voltage.

2. Carry out the activity on pages 79 to 81 to measure current and voltage. Emphasize that the ways to assemble ammeter and voltmeter to a circuit are different.
3. Ask students to answer the questions of this subtopic on page 53 of the workbook as their homework.
4. Have students try Test Yourself 5.2 and discuss the answers with them.

6th – 8th hours (Current, Voltage and Resistance)

1. State that current, voltage and resistance have a close relationship. In a circuit, if one of the three quantities is changed, the other two quantities will be affected.
2. Carry out the experiment on pages 82 to 84 to study how these three quantities are related.
3. Explain Ohm's Law and state the formula involving current, voltage and resistance.
4. Use Example 1 and 2 on page 85 to guide students to solve problems related to current, voltage and resistance.
5. Ask students to answer the questions of this subtopic on pages 54 and 55 of the workbook as their homework.
6. Have students try Test Yourself 5.3 and discuss the answers with them.

9th – 11th hours (Parallel and Series Circuits)

1. Guide students to understand the symbols used to represent different electrical components. We use these symbols when drawing a circuit diagram.
2. Ask students to answer Question 1 on page 55 of the workbook as their homework.
3. There are two types of circuits – series circuit and parallel circuit.
4. Carry out the activity on pages 88 to 90 to study these two circuits.

5. Then, guide them to compare and contrast both circuits. Refer to page 90.
6. Ask students to answer Question 2 on page 56 of the workbook as their homework.
7. Have students try Test Yourself 5.4 and discuss the answers with them.

12th – 14th hours (Current, Voltage and Resistance in a Series Circuit)

1. Carry out the activity on pages 91 to 93 to study the current, voltage and resistance in a series circuit.
2. Guide students to understand how the current, voltage and resistance of each component in a series circuit affect the current, voltage and resistance of the whole circuit.
3. Guide students to understand the advantages and disadvantages of a series circuit.
4. Ask students to answer the questions of this subtopic on pages 56 and 57 of the workbook as their homework.
5. Have students try Test Yourself 5.5 and discuss the answers with them.

15th – 17th hours (Current, Voltage and Resistance in a Parallel Circuit)

1. Carry out the activity on pages 94 and 95.
2. Guide students to understand how the current, voltage and resistance of each component in a parallel circuit affect the current, voltage and resistance of the whole circuit.
3. Guide students to understand the advantages and disadvantages of a parallel circuit.
4. Guide students to compare and contrast the similarities and differences between series circuits and parallel circuits.
5. Ask students to answer the questions of this subtopic on pages 58 and 59 of the workbook as their homework.
6. Have students try Test Yourself 5.6 and discuss the answers with them.

18th – 19th hours (Electronic Circuits)

1. Explain a few electronic circuits such as resistors, diodes, transistors and microchips.
2. Ask students to answer the questions of this subtopic on page 59 of the workbook as their homework.
3. Have students try Test Yourself 5.7 and discuss the answers with them.

20th – 22nd hours (Cost of Electrical Energy)

1. Show students the formula for power which is the rate at which an appliance uses energy.
2. Use Example 3 to guide students to solve problems involving power, voltage and current.
3. Power rating and voltage are marked on electrical appliances.
4. Explain the relationship between electrical energy usage, power and time. Use Examples 4 and 5 on page 101 for explanation.
5. The cost of electricity is based on the number of kilowatt-hours (kWh) used. Therefore, we can calculate the cost of energy used when we know the tariff rate.
6. Use Examples 6 and 7 on pages 102 and 103 for explanation.
7. Ask students to answer the questions of this subtopic on pages 59 and 60 of the workbook as their homework.
8. Have students try Test Yourself 5.8 and discuss the answers with them.

23rd – 25th hours (Importance of Safety Precautions in the Use of Electricity)

1. Explain the possible causes for electrical accidents.
2. Explain the steps to be taken when electrical accidents occur.
3. Explain some of the devices used to prevent electrical accidents.
4. Explain the safety precautions in using electricity.

5. Ask students to answer the questions of this subtopic on pages 61 and 62 of the workbook as their homework.
6. Have students try Test Yourself 5.9 and discuss the answers with them.

26th hour (Conclusion)

1. Use Conceptual Map on page 107 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 108.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Classifying
3. Predicting
4. Communicating
5. Analyzing
6. Solving problems

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3

STEM Activity: Burglar Alarm System

Group size: 3 to 4 persons

Suggested time: 4-5 hours

Overview:

This activity will give a chance to students to learn how to create a burglar alarm system. Then, they can use their creativity to devise multi-step alarm systems to protect their lockers, desks, pets or classroom door.

Procedure:

1. Review their knowledge of electric circuit, and get students to answer these questions:
 - a. What is complete circuit?
 - b. What does a complete circuit need?
2. Let students read a situation on page 110 and identify the problem. Tell them to describe their mission and set their goal.
3. Ask students to do some research on the word '*burglar alarm system*'. Then, encourage them to explore and integrate their knowledge of Science, Technology, Engineering and Mathematics by asking them these questions:
 - a. What does 'burglar alarm system' mean?
 - b. How many types of burglar alarm system are there?
 - c. How are the students going to apply that understanding in their project?
 - d. Is the circuit complete when the alarm goes off?
4. Brainstorm their possible solutions and draw their solution plans by labelling all materials needed. Let them explain how they work among their team members on:

- a. the materials they need
 - b. the reasons for using that materials
 - c. the steps to carry out their project
 - d. the reasons for each step they take
 - e. the assessment of their project
 - f. the achievement criteria
5. Allow students to do further research online about the similar project and let them tell the similarities and differences between their project and the project found on the internet to the class. Ask them whether they want to improve their plan or not. Is it necessary? Will it be better? Why? Guide them by asking these questions:
- a. What are the electrical components to make the system?
 - b. What do they need to make the alarm sound?
 - c. Is the circuit complete when the alarm goes off?
 - d. How will the alarm be triggered?
- Then, let them choose the best one.
6. Ask students to draw a prototype in great details and build up their prototype following their plan.
7. When their project has finished, ask them to assess their work; what works and what does not work? How should they make it better?

Conclusion:

8. Get each group to present their projects using digital presentation tools and explain their process of creation.

9. Encourage them to share their experiences by asking these questions:
 - a. Why did each group come up with the different solutions and designs?
 - b. Which stage of the production process causes the project to have different outcomes?
 - c. What are other factors that affect the outcomes?
 - d. Can they control those factors?
 - e. If their project is successful, will it be beneficial to humans and the environment in general?
 - f. Is it possible to carry out in a large scale? How?

10. For groups with their project that do not work well, encourage them to think the possible causes and ways to improve them, if they are given a chance to repeat the project.



Learning Outcome Form

Name-Surname:

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Date:

Chapter 5 Electricity

Explanation: Summary of learning outcomes

Feeling after learning this chapter:
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Contents that you need for teacher to explain further:
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Knowledge gained from this chapter:
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Chapter 5 Electricity

Contents that you like the most in this chapter (give your reason):
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Exercises that you like and want to be selected as the outstanding work:
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Application of knowledge from this chapter on your daily life:
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Chapter 6 – Waves (7 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
Standard Sc 2.3: 10. Create a model that explain the formation of wave and describe the wave components.	<ul style="list-style-type: none">• What are Waves?
11. Explain electromagnetic waves and electromagnetic spectrum from collected data. 12. Realise the benefits and harms of electromagnetic waves by offering various uses and dangers of electromagnetic waves in everyday life.	<ul style="list-style-type: none">• Electromagnetic Waves

Learning Objectives

Students will be taught to:

1. Understand the formation of waves.
2. Understand wave components.
3. Understand electromagnetic waves and electromagnetic spectrum.
4. Understand the uses and dangers of electromagnetic waves in everyday life.
5. Understand the benefits and harms of electromagnetic waves.

Learning Outcomes

Students will be able to:

1. Explain the formation of waves.

2. Explain the wave components.
3. Explain electromagnetic waves and electromagnetic spectrum.
4. Realize the benefits and harms of electromagnetic waves.
5. State the uses and dangers of electromagnetic waves in everyday life.

Learning Areas

- What are waves?
- Electromagnetic waves

Teaching and Learning Activities

1st – 3rd hours (What are Waves?)

1. Explain waves.
2. Carry out the activity on pages 114 and 115 to study on transverse and longitudinal waves.
3. Explain transverse waves and longitudinal waves.
4. Ask students to answer the Question 1 and 2 of this subtopic on page 68 of the workbook as their homework.
5. Explain how waves can also be produced by oscillations.
6. Explain wave components. Use examples on pages 117 and 118 to guide students to determine the wave components.
7. Ask students to answer the Question 3 to 9 of this subtopic on pages 69 to 71 of the workbook as their homework.
8. Have students try Test Yourself 6.1 and discuss the answers with them.

4th – 6th hours (Electromagnetic Waves)

1. Explain two types of waves – mechanical waves and electromagnetic waves. Give an example of a mechanical wave.
2. Explain electromagnetic waves. Use the diagrams on page 119 to explain electromagnetic waves and electromagnetic spectrum.

3. Use the table on pages 120 and 121 to explain each type of electromagnetic waves and their sources, characteristics and applications.
4. Explain the damaging effects of electromagnetic waves.
5. Explain what laser is and its uses.
6. Ask students to answer the questions of this subtopic on pages 71 and 72 of the workbook as their homework.
7. Have students try Test Yourself 6.2 and discuss the answers with them.

7th hour (Conclusion)

1. Use Conceptual Map on page 122 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 123.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Classifying
3. Generating ideas
4. Communicating

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3



Learning Outcome Form

Name-Surname:

No.

Mathayom:

Date:

Chapter 6 Waves

Explanation: Summary of learning outcomes

Feeling after learning this chapter:
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Contents that you need for teacher to explain further:
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Knowledge gained from this chapter:
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Chapter 6 Waves

Contents that you like the most in this chapter (give your reason):
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Exercises that you like and want to be selected as the outstanding work:
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Application of knowledge from this chapter on your daily life:
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Chapter 7 – Light (15 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 2.3:</p> <p>13. Design experiments and conduct experiments in an appropriate way to explain the law of reflection.</p> <p>14. Draw a diagram of the light movement showing the image formation from the mirror.</p>	<ul style="list-style-type: none">• Reflection of Light
<p>15. Explain the refraction of light through different transparent media and explain the dispersion of white light when it is passing through the prism from empirical evidence.</p>	<ul style="list-style-type: none">• Refraction of Light
<p>16. Draw a diagram of the light movement showing the image formation from thin lens.</p> <p>17. Explain the phenomena of light and how visual equipment works from the collected data.</p> <p>18. Write a diagram of the movement of light presenting visions from visual equipment and eye lens.</p>	<ul style="list-style-type: none">• Lenses and Light

19. Explain the effects of the brightness on the eyes from the information search.
20. Measure the brightness of the light using the light meter.
21. Realize the value of knowledge of the brightness of the light affecting on the eyes by analyzing the situation and suggesting the appropriate brightness for various activities.

- Brightness of Light

Learning Objectives

Students will be taught to:

1. Understand reflection of light.
2. Understand refraction of light.
3. Understand refraction of light in lenses.
4. Understand brightness of light.

Learning Outcomes

Students will be able to:

1. Describe reflection of light.
2. Realize the law of reflection.
3. Investigate the reflection of light.
4. List the characteristics of image on a plane mirror.
5. Draw a ray diagram of a person's view on an image of an object reflected by a mirror.
6. Describe the reflection of convex and concave mirrors.
7. Explain the characteristics of images formed by convex mirrors.
8. List the applications of reflection of light in daily life.
9. Describe refraction of light.

10. Investigate the refraction of light.
11. Describe convex lens and concave lens.
12. Draw ray diagram for a convex lens.
13. Explain the characteristics and positions of the image formed by convex lens and concave lens.
14. List the applications of lenses in daily life.
15. Describe brightness of light.
16. Investigate the relationship between the brightness of light and the distance from the light source.
17. Realize the appropriate brightness levels for various activities.
18. Realize the ways to care for our eyes.

Learning Areas

- Reflection of Light
- Refraction of Light
- Lenses and Light
- Brightness of Light

Teaching and Learning Activities

1st – 4th hours (Reflection of Light)

1. Explain how we see things.
2. Explain what reflection means. Use the diagram on the reflection on a plane mirror on page 126 to explain the rays and angles.
3. Explain the law of reflection. Use Example 1 on page 126 for explanation.
4. Carry out the activity on page 127.
5. Ask students to describe about their own image that they see in a mirror. Explain the characteristics of an image formed by a plane mirror.
6. Guide students on how to draw a ray diagram using the steps on page 128.

7. Ask students to work on Question 1 to 5 of this subtopic on pages 80 and 81 of the workbook as their homework.
8. Explain convex mirrors and concave mirrors.
9. Explain the terminologies related to curved mirrors.
10. Use Example 1 and Example 2 on page 130 to guide students to determine the characteristics of the images formed from a concave mirror and a convex mirror.
11. Refer to page 131 to explain the characteristics of the image formed by a convex mirror based on the distance of an object.
12. Refer to page 132 to explain the characteristics of the image formed by a convex mirror.
13. Discuss with students how reflection of light is applied in our daily life.
14. Ask students to work on Questions 6 to 8 of this subtopic on pages 81 and 82 of the workbook as their homework.
15. Have students try Test Yourself 7.1 and discuss the answers with them.

5th – 7th hours (Reflection of Light)

1. Explain what refraction is.
2. Carry out the activity on pages 133 and 134.
3. Explain how light refracts when passing through different media.
4. Describe some phenomena involving refraction.
5. Ask students to work on the questions of this subtopic on pages 82 and 83 of the workbook as their homework.
6. Have students try Test Yourself 7.2 and discuss the answers with them.

8th – 11th hours (Lenses and Light)

1. Explain what optical lenses are.
2. Use the diagram on page 136 to explain the two main types of lenses – convex lenses and concave lenses.

3. Explain the refraction of light rays when they pass through a convex lens and a concave lens.
4. Use the steps on pages 137 and 138 to guide students to draw a ray diagram for a convex lens.
5. Use the table on pages 138 and 139 to explain the characteristics and positions of the image formed by a concave lens.
6. Explain the characteristics and positions of the image formed by a concave lens.
7. Discuss with students how lenses are applied in daily life. Refer to page 139 to 141 for explanation.
8. Ask students to work on the questions of this subtopic on pages 84 and 85 of the workbook as their homework.
9. Have students try Test Yourself 7.3 and discuss the answers with them.

12th – 14th hours (Brightness of Light)

1. Explain what brightness is.
2. Carry out the experiment on pages 142 and 143.
3. Explain the brightness of light under certain conditions.
4. Explain the recommended brightness levels for some indoor areas. Ask student which brightness level is suitable for reading.
5. Explain how our eyes respond in dim and bright areas.
6. Explain the ways to care for our eyes.
7. Ask students to work on the questions of this subtopic on page 85 of the workbook as their homework.
8. Have students try Test Yourself 7.4 and discuss the answers with them.

15th hour (Conclusion)

1. Use Conceptual Map on page 144 to help students to understand the relationship of all the subtopics learnt in this chapter.

2. Revise the lesson using Basic Recall on page 145.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Predicting
2. Generating ideas
3. Observing
4. Classifying
5. Making inferences
6. Communicating
7. Using and handling science apparatus correctly and safely
8. Handling specimen correctly and carefully

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3

STEM Activity: New Model!

Group size: 3 to 4 persons

Suggested time: 4-5 hours

Overview:

This activity will allow students to explore the possibility of using lens to improve their periscope.

Procedure:

1. Review their knowledge of light, and get students to answer these questions:
 - a. How does light travel?
 - b. Can light be bent, diverged and converged?
2. Let students read a situation on page 146 and identify the problem. Tell them to describe their mission and set their goal.
3. Ask students to do some research on the word '*periscope*'. Then, encourage them to explore and integrate their knowledge of Science, Technology, Engineering and Mathematics by asking them these questions:
 - a. What does '*periscope*' mean?
 - b. How many types of periscope are there?
 - c. How are students going to apply that understanding in their project?
 - d. How do we improve the periscope?
4. Brainstorm their possible solutions and draw their solution plans by labelling all materials needed. Let them explain how they work among their team members on:
 - a. the materials they need
 - b. the reasons for using that materials

- c. the steps to carry out their project
 - d. the reasons for each step they take
 - e. the assessment of their project
 - f. the achievement criteria
5. Allow students to do further research online about the similar project and let them tell the similarities and differences between their project and the project found on the internet to the class. Ask them whether they want to improve their plan or not. Is it necessary? Will it be better? Why? Guide them by asking these questions:
- a. Can we use lenses or prisms to improve the periscope? How?
 - b. Does the shape of the periscope affect the outcomes?
- Then, let them choose the best one.
6. Ask students to draw a prototype in great details and build up their prototype following their plan.
7. When their project has finished, ask them to assess their work; what works and what does not work? How should they make it better?

Conclusion:

8. Get each group to present their projects using digital presentation tools and explain their process of creation.
9. Encourage them to share their experiences by asking these questions:
- a. Why did each group come up with the different solutions and designs?
 - b. Which stage of the production process causes the project to have different outcomes?
 - c. What are other factors that affect the outcomes?

- d. Can they control those factors?
 - e. If their project is successful, will it be beneficial to humans and the environment in general?
 - f. Is it possible to carry out in a large scale? How?
10. For groups with their project that do not work well, encourage them to think the possible causes and ways to improve them, if they are given a chance to repeat the project.



Learning Outcome Form

Name-Surname:

No.

Mathayom:

Date:

Chapter 7 Light

Explanation: Summary of learning outcomes

Chapter 7
Light

Feeling after learning this chapter:
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Contents that you need for teacher to explain further:
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Knowledge gained from this chapter:
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Application of knowledge from this chapter on your daily life:
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Exercises that you like and want to be selected as the outstanding work:
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Contents that you like the most in this chapter (give your reason):
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Chapter 8 – Sun-Earth-Moon System and Space Technology (14 hours)

Learning Standards and Learning Areas

Learning Standards	Learning Areas
<p>Standard Sc 3.1:</p> <p>1. Explain the orbits of planets around the sun with gravity from the equation $F = (Gm_1 m_2) / r^2.$</p>	<ul style="list-style-type: none"> • Gravitational Forces
<p>2. Create a model that explain the occurrence of seasons and the sun's motion.</p> <p>3. Create a model that explain the occurrence of Full Moon and Waning Moon (the phases of the moon), the time of Moon's rise and fall changes and tidal rise and fall.</p>	<ul style="list-style-type: none"> • Phenomena due to the Axial Tilt and Moon's Revolution
<p>4. Explain the use of space technology and give examples of the progress of the space exploration program based on collected data.</p>	<ul style="list-style-type: none"> • Space Technology and Space Exploration

Learning Objectives

Students will be taught to:

1. Understand the gravitational force between a planet and the Sun.
2. Understand the phenomena caused by the axial tilt and Moon's revolution.
3. Understand the developments in space technology and space exploration.

Learning Outcomes

Students will be able to:

1. Explain space objects orbit around the Sun with gravity.
2. Explain Newton's law of universal gravitation.
3. Explain the occurrence of seasons and different lengths of daytime and nighttime due to axial tilt.
4. Explain the occurrence of Moon phases, tides, different times of moonrise and moonset due to Moon's revolution.
5. Describe the space technology used in daily life.
6. Describe the developments in space exploration.
7. Justify the need to continue space exploration.

Learning Areas

- Gravitational Forces
- Phenomena due to the Axial Tilt and Moon's Revolution
- Space Technology and Space Exploration

Teaching and Learning Activities

1st – 2nd hours (Gravitational Forces)

1. Explain that there are many space objects that revolve around the Sun. Give examples of space objects. Explain that there is a ring of icy bodies called Kuiper belt.
2. Explain Newton's law of universal gravitation and state the formula.
3. Use Example 1 on page 150 to guide student to solve problems related to gravitational force.
4. Ask students to answer the questions of this subtopic on page 92 of the workbook as their homework.
5. Have students try Test Yourself 8.1 and discuss the answers with them.

3rd – 8th hours (Phenomena due to the Axial Tilt and Moon's Revolution)

1. Tell students that the Earth rotates on an imaginary axis which is tilted at an angle of $23\frac{1}{3}$ degrees. This axial tilt causes the occurrence of seasons and the different lengths of daytime and nighttime.
2. Ask students what are the countries that have four distinct seasons. Ask them why we do not experience seasons in Thailand. Scanning the QR code below to learn more about seasons.



3. Ask students to explain how day and night happen. They should be able to recall.
4. Explain to students that not every place on Earth has 12 hours of daytime and 12 hours of nighttime. The different lengths of daytime and nighttime is due to axial tilt.
5. Use the diagram on page 154 to explain the solstices and equinox.
6. Watch this video about Moon phases by scanning the QR code below.



7. Students should be able to explain how Moon phases occur.
8. Explain how tides occur. Watch this video by scanning the QR code below.



9. Explain different times of moonrise and moonset. Refer to diagram on pages 157 and 158.
10. Ask students to answer the questions of this subtopic on pages 92 to 95 of the workbook as their homework.

11. Have students try Test Yourself 8.2 and discuss the answers with them.

9th – 13th hours (Space Technology and Space Exploration)

1. Ask students to give examples of space technology used to get information from space and planets.
2. Explain Global Navigation Satellite System (GNSS), Earth-observation satellites (EOS), satellites for communications and International Space Station (ISS).
3. Discuss also the developments in space exploration.
4. Ask students to debate on the needs to continue space exploration.
5. Ask students to answer the questions of this subtopic on pages 95 and 96 of the workbook as their homework.
6. Have students try Test Yourself 8.3 and discuss the answers with them.

14th hour (Conclusion)

1. Use Conceptual Map on page 162 to help students to understand the relationship of all the subtopics learnt in this chapter.
2. Revise the lesson using Basic Recall on page 163.
3. Randomly select 5 objective questions in QR Quiz and 2 subjective questions from the Mastery Practice in the Textbook and have students solve them in the class. Have students work on the rest of the questions at home.
4. Ask students to do the Map It Out and the Enrichment Exercises in the workbook to test their understanding of this chapter as their homework.

Emphasized Skills:

1. Observing
2. Analyzing
3. Predicting
4. Communicating

5. Comparing and contrasting
6. Sequencing
7. Generating ideas
8. Making inferences

Learning Materials:

- Focus Smart Plus Textbook Science M3
- Focus Smart Plus Workbook Science M3



Learning Outcome Form

Name-Surname:

No.

Mathayom:

Date:

Chapter 8 Sun-Earth-Moon System and Space Technology

Explanation: Summary of learning outcomes

