



KEMENTERIAN
PENDIDIKAN
MALAYSIA

KURIKULUM STANDARD SEKOLAH MENENGAH

Sains

Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 4 dan 5

(EDISI BAHASA INGGERIS)



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Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 4 dan 5

(Edisi Bahasa Inggeris)

**Bahagian Pembangunan Kurikulum
MEI 2019**

Terbitan 2019

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RUKUN NEGARA

BAHAWASANYA Negara kita Malaysia mendukung cita-cita hendak:
Mencapai perpaduan yang lebih erat dalam kalangan seluruh masyarakatnya;
Memelihara satu cara hidup demokratik;
Mencipta satu masyarakat yang adil di mana kemakmuran negara
akan dapat dinikmati bersama secara adil dan saksama;
Menjamin satu cara yang liberal terhadap tradisi-tradisi
kebudayaannya yang kaya dan berbagai corak;
Membina satu masyarakat progresif yang akan menggunakan
sains dan teknologi moden;

MAKA KAMI, rakyat Malaysia, berikrar akan menumpukan seluruh tenaga dan usaha kami untuk mencapai cita-cita tersebut berdasarkan atas prinsip-prinsip yang berikut:

**KEPERCAYAAN KEPADA TUHAN
KESETIAAN KEPADA RAJA DAN NEGARA
KELUHURAN PERLEMBAGAAN
KEDAULATAN UNDANG-UNDANG
KESOPANAN DAN KESUSILAAN**

FALSAFAH PENDIDIKAN KEBANGSAAN

“Pendidikan di Malaysia adalah suatu usaha berterusan ke arah lebih memperkembangkan potensi individu secara menyeluruh dan bersepadu untuk melahirkan insan yang seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani, berdasarkan kepercayaan dan kepatuhan kepada Tuhan. Usaha ini adalah bertujuan untuk melahirkan warganegara Malaysia yang berilmu pengetahuan, berketerampilan, berakhlak mulia, bertanggungjawab dan berkeupayaan mencapai kesejahteraan diri serta memberikan sumbangan terhadap keharmonian dan kemakmuran keluarga, masyarakat dan negara”

Sumber: Akta Pendidikan 1996 (Akta 550)

DEFINISI KURIKULUM KEBANGSAAN

3. Kurikulum Kebangsaan

(1) Kurikulum Kebangsaan ialah suatu program pendidikan yang termasuk kurikulum dan kegiatan kokurikulum yang merangkumi semua pengetahuan, kemahiran, norma, nilai, unsur kebudayaan dan kepercayaan untuk membantu perkembangan seseorang murid dengan sepenuhnya dari segi jasmani, rohani, mental dan emosi serta untuk menanam dan mempertingkatkan nilai moral yang diingini dan untuk menyampaikan pengetahuan.

Sumber: Peraturan-Peraturan Pendidikan (Kurikulum Kebangsaan) 1997

[PU(A)531/97.]

FALSAFAH PENDIDIKAN SAINS KEBANGSAAN

Selaras dengan Falsafah Pendidikan Kebangsaan, pendidikan sains di Malaysia memupuk budaya Sains dan Teknologi dengan memberi tumpuan kepada perkembangan individu yang kompetitif, dinamik, tangkas dan berdaya tahan serta dapat menguasai ilmu sains dan keterampilan teknologi.

Sumber: Kementerian Sains, Teknologi dan Inovasi (MOSTI)

KATA PENGANTAR

Kurikulum Standard Sekolah Menengah (KSSM) yang dilaksanakan secara berperingkat mulai tahun 2017 akan menggantikan Kurikulum Bersepadu Sekolah Menengah (KBSM) yang mula dilaksanakan pada tahun 1989. KSSM digubal bagi memenuhi keperluan dasar baharu di bawah Pelan Pembangunan Pendidikan Malaysia (PPPM) 2013-2025 agar kualiti kurikulum yang dilaksanakan di sekolah menengah setanding dengan standard antarabangsa. Kurikulum berasaskan standard yang menjadi amalan antarabangsa telah dijelmakan dalam KSSM menerusi penggubalan Dokumen Standard Kurikulum dan Pentaksiran (DSKP) untuk semua mata pelajaran yang mengandungi Standard Kandungan, Standard Pembelajaran dan Standard Prestasi.

Usaha memasukkan standard pentaksiran di dalam dokumen kurikulum telah mengubah lanskap sejarah sejak Kurikulum Kebangsaan dilaksanakan di bawah Sistem Pendidikan Kebangsaan. Menerusinya murid dapat ditaksir secara berterusan untuk mengenal pasti tahap penguasaannya dalam sesuatu mata pelajaran, serta membolehkan guru membuat tindakan susulan bagi mempertingkatkan pencapaian murid.

DSKP yang dihasilkan juga telah menyepadukan enam tunjang Kerangka KSSM, mengintegrasikan pengetahuan, kemahiran dan nilai, serta memasukkan secara eksplisit Kemahiran Abad Ke-21 dan Kemahiran Berfikir Aras Tinggi (KBAT). Penyepaduan tersebut dilakukan untuk melahirkan insan seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani sebagaimana tuntutan Falsafah Pendidikan Kebangsaan.

Bagi menjayakan pelaksanaan KSSM, pengajaran dan pembelajaran guru perlu memberi penekanan kepada KBAT dengan memberi fokus kepada pendekatan Pembelajaran Berasaskan Inkuiri dan Pembelajaran Berasaskan Projek, supaya murid dapat menguasai kemahiran yang diperlukan dalam abad ke-21.

Kementerian Pendidikan Malaysia merakamkan setinggi-tinggi penghargaan dan ucapan terima kasih kepada semua pihak yang terlibat dalam penggubalan KSSM. Semoga pelaksanaan KSSM akan mencapai hasrat dan matlamat Sistem Pendidikan Kebangsaan.

Dr. MOHAMED BIN ABU BAKAR
Timbalan Pengarah
Bahagian Pembangunan Kurikulum
Kementerian Pendidikan Malaysia

INTRODUCTION

As articulated in the National Education Philosophy, education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner, to produce individuals who are intellectually, spiritually, emotionally and physically balanced. The primary and secondary school science curriculum standard is developed with the aim of producing such individuals.

Malaysia, moving towards becoming a developed nation, should foster a community that is scientific, progressive, inventive and visionary, while benefitting the development of latest technologies. This community must be able to contribute to the advancement of science and the sustainability of technological civilisation. To achieve this, we need to develop critical, creative, innovative and competent citizens who practice the culture of Science, Technology, Engineering and Mathematics (STEM).

The Malaysian science curriculum encompasses three core science subjects and four elective science subjects. The Core Science Subject are Primary School Science, Lower Secondary Science and Upper Secondary Science. The Elective Science subjects offered in upper secondary are Additional Science, Biology, Physics and Chemistry.

The core science subjects for secondary level is designed to develop pupils to be science literate, have high order thinking skills able to apply the scientific knowledge to make decision and solve problems in real life.

Meanwhile, the upper secondary elective science subjects will empower and strengthen their knowledge and skills in STEM towards preparing pupils for long-life learning. This group of pupils will hopefully embark on careers in science and technology which plays a role in national development.

AIMS

The KSSM Science for secondary schools aims is to strengthen the interest and develop creativity amongst pupil; through experience and investigation; so as to master knowledge in science, scientific skills, thinking skills and, scientific attitudes and values. The application of knowledge in science, scientific skills, thinking skills and, scientific attitudes and values enable them to solve problems and make decisions in daily life as well as preparing them to continue their studies in science and technology.

OBJECTIVES

The Science Standard Curriculum (KSSM) aim for pupils to:

1. use the inquiry approach to capitalise on their curiosity and interest in science.
2. strengthen their knowledge and understanding to explain phenomena scientifically.
3. communicate information relating to science and technology intelligently and effectively.
4. design and carry out scientific investigation, evaluate evidence and make conclusions.

5. apply scientific knowledge, procedural knowledge and epistemic knowledge in posing questions, interpreting data, problem solving and decision making in context of real life.
6. create awareness that discoveries through scientific research is a result of the ability of the human mind to understand natural phenomena towards a better life.
7. create awareness that development of science and technology has an implication on the mores, social, economic and environment issues in the local and global context.

FRAMEWORK OF THE STANDARD CURRICULUM FOR SECONDARY SCHOOL

Standard Curriculum for Secondary School (KSSM) is built based on six strands, which are Communication; Spiritual, Attitude and Value; Humanity; Personal Development; Physical Development and Aesthetic; and Science and Technology. The six strands are the main domain that support each other and are integrated with critical, creative and innovative thinking. This integration is aimed at developing human capital that appreciate noble values based on religion, being knowledgeable, competent, think creatively, critically and innovatively as illustrated in Figure 1.

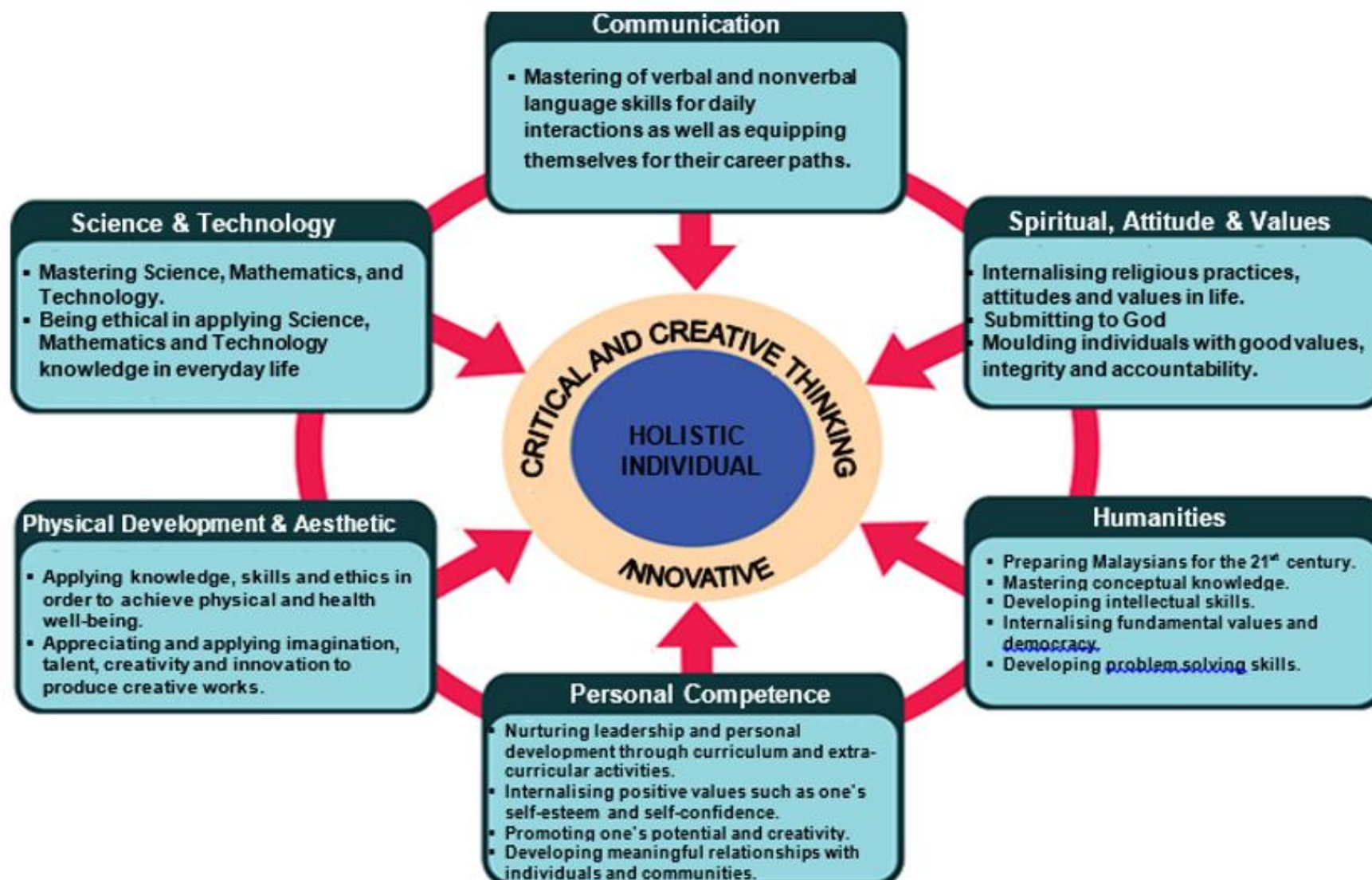


Figure 1: The Framework Of Secondary School Standard-Based Curriculum

FOCUS

The science subject for secondary schools focuses on thoughtful learning involving scientific and thinking skills for the acquisition of knowledge through inquiry as the main approach in science education. The science curriculum also aims to prepare pupils to face rapid technological development and various challenges of the 21st century. The group of pupils that have gone through this curriculum will become human resource in the field of science and technology, and will contribute towards national development.

Content Standards of the Science Curriculum from Year 1 to Form 5 are developed based on the three domains which are knowledge, skills and values. The development of these domains will be experienced by pupils through the inquiry method to becoming a thoughtful science learner (Figure 2). The inquiry approach includes pupil-centred learning, constructivism, contextual learning, problem-based learning, mastery learning as well as related strategies and methods.

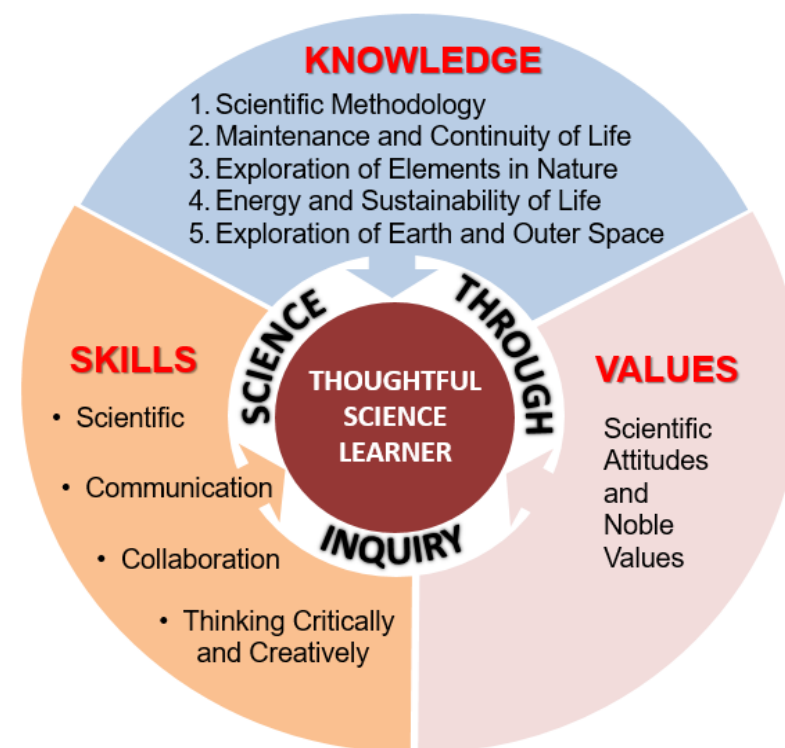


Figure 2: The Conceptual Framework for Science Curriculum

Thoughtful Science

According to the Fourth Edition (2005) of Kamus Dewan, thoughtful has the same meaning as the ability to think and reflect. In the context of science education, thoughtful science refers to the quality of pupils desired to be produced by the national science education system.

Thoughtful science learners are those who can understand scientific ideas and are able to communicate using scientific language; can evaluate as well as apply scientific knowledge and skills responsibly in daily life that involves science and technology, based on attitudes and values. Thoughtful science also intends to produce creative and critical individuals to fulfil the 21st century needs, in which the country's ability is highly dependent upon the ability of human capital that can think and generate ideas.

Thoughtful Learning

Thoughtful learning can be achieved if pupils are actively involved in the teaching and learning process. In this process, the teaching and learning activities are planned to encourage pupils to think so that they are able to conceptualize, solve problems and make decisions. Thus, thinking skills should be assimilated by pupils.

Thinking skills can be categorised as critical and creative thinking. A person who thinks critically always evaluates ideas systematically before accepting them. A person who thinks creatively is highly imaginative, generates original innovative ideas, and is also able to modify existing ideas and products.

Thinking strategy is a higher level of thinking process that involves several steps where each step involves a number of critical and creative thinking skills. Thinking strategy is the main function and final aim of the thinking process.

Critical Thinking Skills

Critical thinking skills are the ability to evaluate an idea logically and rationally to make a fair consideration by using reasons and reliable evidences. A brief description of each critical thinking skill is shown in Table 1.

Table 1: Critical Thinking Skills

CRITICAL THINKING SKILLS	DESCRIPTION
Attributing	Identifying criterias such as characteristics, features, qualities and elements of a concept or an object.
Comparing and Contrasting	Finding similarities and differences based on criteria such as characteristics, features, qualities and elements of an object or event.
Grouping and Classifying	Separating and grouping objects or phenomena into groups based on certain criteria such as characteristics, features. Grouping according to common characteristics or features.
Sequencing	Arranging objects and information in an orderly based on the quality or quantity of common characteristics or features such as size, time, shape or number.
Prioritising	Arranging objects or information in an orderly manner based on their importance or priority.

CRITICAL THINKING SKILLS	DESCRIPTION
Analysing	Processing information in detail by breaking it down into smaller parts to understand concepts or events as well as to find the implicit meanings.
Detecting Bias	Detecting views or opinions that have the tendency to support or oppose something.
Evaluating	Making considerations and decisions using knowledge, experiences, skills and values, and giving justifications.
Making Conclusions	Making a statement about the outcome of an investigation based on a hypothesis.

Creative Thinking Skills

Creative thinking skills are the ability to produce or create something new and valuable by using genuine imagination and unconventional thinking. A brief description of each creative thinking skill is as shown in Table 2.

Table 2: Creative Thinking Skills

CREATIVE THINKING SKILLS	DESCRIPTION
Generating Ideas	Giving ideas related to something.
Relating	Making connections in certain situations or events to find a structure or pattern of relationship.
Making Inferences	Making an initial conclusion and explaining an event using data collection and past experiences.
Predicting	Making forecast about events based on observations and previous experiences or collected data.
Making Generalisations	Making a general statement about certain matter from a group of observations on samples or some information from that group.
Visualising	Forming perception or making mental images about a particular idea, concept, situation or vision.
Synthesising	Combining separate elements to produce an overall picture in the form of writing, drawing or artifact.

CREATIVE THINKING SKILLS	DESCRIPTION
Making Hypotheses	Making a general statement about the relationship between the variables that is assumed to be true to explain an observation or event. The statement can be tested to determine its validity.
Making Analogies	Forming an understanding about a complex or abstract concept by relating it to simple or concrete concepts with similar characteristics.
Inventing	Producing something new or modifying something already in existence to overcome problems in a systematic manner.

Thinking Strategies

Thinking strategies are ways of thinking that are structured and focused to solve problems. Description of each thinking strategy is as shown in Table 3.

Table 3: Thinking Strategies

THINKING STRATEGIES	DESCRIPTION
Conceptualising	Making generalisations towards building of meaning, concept or model based on inter-related specific common characteristics.
Making Decisions	Selecting the best solution from several alternatives based on specific criteria to achieve the intended aims.
Problem Solving	Finding the right solutions in a systematic manner for situations that are uncertain or challenging or unanticipated difficulties.

Besides thinking skills and thinking strategies, another skill that is emphasised is reasoning. **Reasoning** is a skill used in making logical, rational, fair and just consideration. Mastery of critical and creative thinking skills and thinking strategies is made easier if an individual is able to provide reasoning in inductive and deductive manner. Figure 3 gives an overall picture of the thinking skills and thinking strategies. Mastery of TSTS through the teaching and learning of science can be developed through the following stages:

1. Introducing TSTS.
2. Practising TSTS with teacher's guidance.
3. Practising TSTS without teacher's guidance.
4. Applying TSTS in new situations and developed with teacher's guidance.
5. Applying TSTS together with other skills to accomplish thinking tasks.

Further information about the stages on the implementation of TSTS can be referred to the guidebook "*Buku Panduan Penerapan Kemahiran Berfikir dan Strategi Berfikir dalam Pengajaran dan Pembelajaran Sains (Curriculum Development Centre, 1999)*"

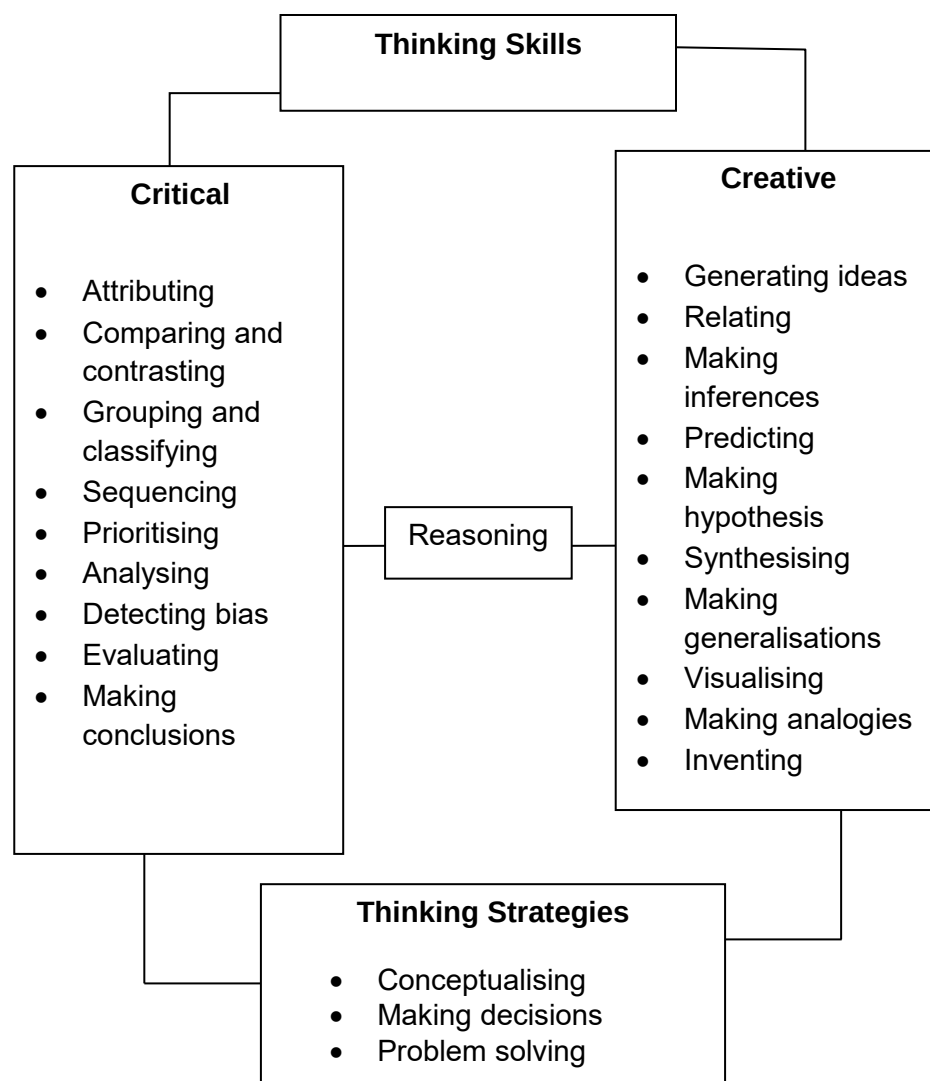


Figure 3: TSTS Model in Science

SCIENTIFIC SKILL

Science emphasizes inquiry and problem solving. In the process of inquiry and solving problem, scientific skills and thinking skills are used. Scientific skill is an important skill when carrying out activities by using scientific methods such as conducting experiments and projects.

Scientific skill consists of science process skills and manipulative skills.

Science Process Skills

Science Process Skills are skills that are required in the process of finding solutions to a problem or making decisions in a systematic manner. It is a mental process that promotes critical, creative, analytical and systematic thinking. Mastery of Science Process Skills together with knowledge and suitable attitudes ensure pupils to think effectively. Description of each science process skill is as in Table 4.

Table 4: Science Process Skills

SCIENCE PROCESS SKILLS	THINKING SKILLS
Observing	Using the sense of sight, hearing, touch, taste or smell to gather information about objects and phenomena.
Classifying	Using observations to group objects or phenomena according to similar characteristics.
Measuring and Using Numbers	Making quantitative observations using numbers or tools with standard units or tools standardised with reference units.
Making Inferences	Making initial conclusions that are reasonable, that may be true or false to explain events or observations.
Predicting	Making forecast about events based on observations and previous experiences or collected data.
Communicating	Accepting, choosing, arranging, and presenting information or ideas in the form of writing, verbal, tables, graphs, figures or models.
Using Space- Time Relationship	Describing changes in parameters such as location, direction, shape, size, volume, weight and mass with time.

SCIENCE PROCESS SKILLS	THINKING SKILLS
Interpreting Data	Giving rational explanations about an object, event or pattern derived from collected data.
Defining Operationally	Defining concepts by describing what must be done and what should be observed.
Controlling Variables	Identifying manipulated variables, responding variables and fixed variables. In an investigation, a variable is manipulated to observe its relationship with the responding variable. At the same time, the other variables are kept the same.
Making Hypothesis	Making a general statement about the relationship between the variables that is assumed to be true to explain an observation or event. The statement can be tested to determine its validity.
Experimenting	Planning and conducting an investigation to test a hypothesis, collecting and interpreting data until a conclusion can be obtained.

Manipulative Skills

In a scientific investigation, manipulative skills are psychomotor skills that enable pupils to:

- Use and handle science apparatus and substances correctly.
- Store science apparatus and substances correctly and safely.
- Clean science apparatus correctly
- Handle specimens correctly and carefully.
- Sketch specimens, apparatus and substances accurately

The Relationship between Science Process Skills and Thinking Skills

The mastery of Science Process Skills requires pupils to master the relevant thinking skills. The relevant thinking skills that are related to each science process skill are as in Table 5.

Table 5: Relationship between Science Process Skills and Thinking Skills

SCIENCE PROCESS SKILLS	THINKING SKILLS
Observing	Attributing Comparing and contrasting Relating

SCIENCE PROCESS SKILLS	THINKING SKILLS
Classifying	Attributing Comparing and contrasting Grouping and classifying
Measuring and Using Numbers	Relating Comparing and contrasting
Making Inferences	Relating Comparing and contrasting Analysing Making Inferences
Predicting	Relating Visualising
Using Space-Time Relationship	Sequencing Prioritising
Interpreting data	Comparing and contrasting Analysing Detecting bias Making conclusions Making Generalisations Evaluating
Defining operationally	Relating Making analogies Visualising Analysing

SCIENCE PROCESS SKILLS	THINKING SKILLS
Controlling variables	Attributing Comparing and contrasting Relating Analysing
Making hypothesis	Attributing Relating Comparing and contrasting Generating ideas Making hypothesis Predicting Synthesising
Experimenting	All thinking skills
Communication	All thinking skills

Teaching and Learning Based on Thinking Skills and Scientific Skills

This Science Curriculum Standard emphasises thoughtful learning based on thinking skills and scientific skills. In this curriculum, the intended learning standard is written by integrating acquisition of knowledge with mastery of thinking skills and scientific skills. Thus in teaching and learning, teachers need to integrate mastery of

skills together with acquisition of knowledge and the inculcation of scientific attitudes and noble values.

SPS implementation in Science exclusively encompass intended skills in the 21st century, indirectly encouraging and developing pupils' higher order thinking skills.

Science Process Skills Standard

Science process skills standards for each level of schooling are general suggestions that must be achieved by pupils. Each statement refers to the minimum standard that must be achieved according to their level of schooling and operational cognitive development. Science process skills at primary school level are stated explicitly as learning standards that should be mastered as a foundation before they further their studies at secondary level. Performance standards for science process skills in primary schools are elaborated to ease teachers to determine the development of the mastered skills. The suggested science process standards from primary to secondary schools are as shown in Table 6.

Table 6 : Science Process Skills

	SCIENCE PROCESS SKILLS	LEVEL 1 (YEAR 1-3)	LEVEL 2 (YEAR 4-6)	LEVEL 3 (FORM 1-3)	LEVEL 4 (FORM 4-5)
1	Observing	Use limbs and senses to make observations about the phenomena or changes that occur.	Use all the senses to make qualitative observations with the appropriate tools to explain phenomena or changes that occur.	- Make accurate and relevant qualitative and quantitative observations to identify patterns or sequences of objects or phenomena. - Use complex equipment suitable for making observations proficiently.	- Make qualitative and quantitative observations to make generalisations based on a pattern or sequence on an object or phenomenon. - Present further findings based on observation of objects or phenomena analytically and specifically.
2	Classifying	Collect/isolate evidens/data/objects/ph enomena based on the observed characteristics.	Compare/identify similarities and differences based on categories that are based on common characteristics.	Compare/identify similarities and differences to determine the selection criteria for category evidens/data/object /the phenomenon being studied.	Identify characteristics used to differentiate, collect, select and explain the object or phenomenon in greater detail.
3	Measuring and using numbers	Measure with the correct instrument in the correct standard unit.	Measure with the correct instrument in the correct standard unit and using the right technique.	- Measure with the correct instrument in the correct standard unit, using the right technique while recording in a complete and systematic way. - Change the base unit with the correct quantity - Use the correct units.	- Demonstrate how measurements are taken with the correct instrument in the correct standard unit, using the right technique; while recording in a systematic and complete way. - Using more complex derived units in the right manner.

	SCIENCE PROCESS SKILLS	LEVEL 1 (YEAR 1-3)	LEVEL 2 (YEAR 4-6)	LEVEL 3 (FORM 1-3)	LEVEL 4 (FORM 4-5)
4	Making inferences	Give a reasonable explanation for the observations.	Concluded the initial grounds for the observation using the information obtained	Create more than one initial conclusion that is reasonable for an event or observation using the information obtained.	- Generate a variety of possibilities to explain complex situations - Explain the relationship or pattern between variables observed with measurements made for an investigation.
5	Predicting	Describe a possible outcome for an event or data.	Make a reasonable assumption of an event based on observation, past experience or data.	Students can analyse trends/the flow/simple developments based on the data obtained to predict the future state of an object or phenomenon.	- Students can analyse trends/the flow/simple developments based on the data obtained to predict the future state of an object or phenomenon. - Forecasts made can also be tested.
6	Communicating	Record information or ideas in any form.	Record information or ideas in a suitable form and present the information or the ideas systematically.	Able to present the results of an experiment or data observed in various forms such as simple graphics, pictures or tables	Able to present the results of an experiment or data observed in various forms such as graphics, pictures or tables that are more complex to show how the patterns are related.

	SCIENCE PROCESS SKILLS	LEVEL 1 (YEAR 1-3)	LEVEL 2 (YEAR 4-6)	LEVEL 3 (FORM 1-3)	LEVEL 4 (FORM 4-5)
7	Use time-space relationships	(Not explicitly stated as Learning Standard)	Arrange occurrences of a phenomenon or event in chronological order.	- Arrange occurrences of a phenomenon or event in chronological order. - Interpret and explain the meaning of mathematical relationships.	Use, analyse and interpret numbers and numerical relationships efficiently while solving problems and conducting investigations.
8	Interpreting data	(Not explicitly stated as Learning Standard)	Select relevant ideas about objects, events or patterns on the data to make an explanation.	Give information rationally by making an intrapolation or an extrapolation of the data collected.	- Analyse data and suggest improvements. - Identify and explain the anomalies in the set of data obtained
9	Define operationally	(Not explicitly stated as Learning Standard)	Describe an interpretation of what is carried out and observed in a situation according to particular specifications.	Describe the most appropriate interpretation of a concept by stating what is carried out and observed for a situation.	Explain the interpretation made about the selection of instruments or methods on what is observed.
10	Controlling variables	(Not explicitly stated as Learning Standard)	Determine the responding and constant variable after the manipulated variable is determined in an investigation.	Determine all variables i.e. responding variable, manipulated variable and constant variable.	Change the constant variable to the manipulated variable and state the new responding variable.

	SCIENCE PROCESS SKILLS	LEVEL 1 (YEAR 1-3)	LEVEL 2 (YEAR 4-6)	LEVEL 3 (FORM 1-3)	LEVEL 4 (FORM 4-5)
11	Making a hypothesis	(Not explicitly stated as Learning Standard)	Make a general statement that can be tested, on the relationship between the variables in an investigation.	Form a relationship between the manipulated variable and responding variable, to form a hypothesis that can be tested.	Describe expected results of the scientific investigation designed.
12	Experimenting	(Not explicitly stated as Learning Standard)	Conduct an experiment, collect data, interpret the data and summarise to prove the hypothesis and make a report.	Make a hypothesis, select appropriate apparatus, design the method, conduct an experiment, collect data, carry out analysis on the data, make a conclusion and prepare a report.	Identify new problems and design an experiment to test the hypothesis of these problems.

Scientific Attitudes and Noble Values

Experience from learning science can foster positive attitude and positive values in pupils. Positive attitudes and values fostered are as the following:

1. Interest and curiosity towards the environment.

- Inquiring from teachers, friends and others.
- Self reading.
- Collect materials or specimens for research.
- Do their own research.

2. Honest and accurate in recording and validating data.

- Describe and record what have been observed.
- Data that recorded is not affected by emotion or imagination.
- Explain observations rationally.
- Make documentation of information resources used.

3. Flexible and open-minded.

- Accept others opinion.
- Manage to change one stand based on convinced proof.
- Not prejudice.

4. Diligent and persevere when carrying out a task.

- Do not give up.
- Ready to repeat the experiment.
- Determine during carry out a task.
- Ready to accept critics and challenges.
- Try to overcome problems and challenges.

5. Systematic, confident and ethic.

- Carry out activity in a systematic and orderly and abide to suitable time.
- Arrange apparatus and materials in order.
- Confident with the task given.
- Dare to try.
- Dare to defend what is being done.

6. Cooperative.

- Assist teachers and friends.
- Work together in carrying out activities and experiments.
- Selfless.
- Fair and just.

7. Being responsible about the safety of oneself, others and the environment.
 - Personal safety and partners.
 - Preserve and conserve the environment.
8. Virtuous.
 - Love all life.
 - Poise and respect.
9. Appreciating the contribution of science and technology.
 - Use science and technology invention with good manners.
 - Use public facilities invented through science and technology responsibly.
10. Appreciate God's gifts.
 - Content with what is given by god.
 - Use God's gifts wisely.
 - Thankful to God.
11. Appreciate and practise clean and healthy living.
 - Care for self hygiene and health.
 - Be sensitive to personal hygiene and environment.

12. Realising that science is a means to understand nature.

- Stating how science is used to solve problems.
- Stating the implications of using science to solve a problem or issue .
- Communicate through correct scientific language.

The assimilation of scientific attitudes and noble values generally take place according to the following stages:

- Realise and understand the important and need for scientific attitudes and noble values.
- Give attention to attitudes and noble values.
- Appreciate and practise the scientific attitudes and noble values.

Proper planning is required to optimise the assimilation of scientific attitudes and noble values during science teaching and learning. Teachers should examine all the learning outcomes in a field related learning including learning standards on the application of scientific attitudes and values before starting a lesson.

21st CENTURY SKILLS

One of the KSSM's intentions is to produce pupils who have 21st century skills, focusing on thinking and living skills as well as life skills and inculcating noble values in their careers. The 21st century skills aim to produce pupils who have the characteristics specified in the pupils' profile as shown in Table 7 that enable them to compete globally. The mastery of the Content Standard (CS) and Learning Standard (LS) in Science curriculum contributes to the acquisition of the 21st century skills among pupils.

Table 7: Pupils' Profile

PUPIL PROFIL	DESCRIPTION
Resilient	Able to face and overcome difficulties and challenges with wisdom, confidence, tolerance and empathy.
Communicator	Able to voice out and express their thoughts, ideas and information confidently and creatively in verbal and written form, using a variety of media and technology.

PUPIL PROFIL	DESCRIPTION
Thinker	Able to think critically, creatively and innovatively; solve complex problems and make ethical decisions. Think about learning and about being learners themselves. Generate questions and are receptive towards perspectives, values and individual traditions and society. Confident and creative in handling new learning areas.
Teamwork	Cooperate effectively and harmoniously with others. Share collective responsibility while respecting and appreciating the contributions of each member in the team. Acquire interpersonal skills through collaborative activities, which in turn mould them into better leaders and team members.
Curious	Develop natural curiosity to explore strategies and new ideas. Learn skills that are needed to carry out inquiry and research, as well as display independent traits in learning. Enjoy continuous life-long learning experiences.

PUPIL PROFIL	DESCRIPTION
Principled	Honest and have integrity, equality, fair and respect the dignity of individuals, group and community. Responsible for their actions, consequences and decisions.
Informative	Knowledgeable and form a wide understanding which is balanced across various disciplines. Explore knowledge on local and global issues effectively and efficiently. Understand ethical issues/ laws related to the information gained.
Caring/ Concern	Show empathy, compassion and respect towards needs and feelings of others. Committed to serve the society and ensure sustainability of nature.
Patriotic	Portray love, support and respect towards the country.

HIGHER ORDER THINKING SKILLS

Higher Order Thinking Skills (HOTS) are explicitly stated in the curriculum to enable teachers to incorporate in teaching and learning. These will stimulate structured and focused thinking among pupils. Description of HOTS focuses on four levels of thinking as shown in Table 8.

Table 8: Thinking levels in HOTS

THINKING LEVEL	DESCRIPTION
Applying	Using knowledge, skills and values to take actions in different situations.
Analysing	Breaking down information into smaller parts to enhance understanding and make relationship between the parts.
Evaluating	Using knowledge, experience, skills and values to consider, make decisions and give justifications.
Creating	Producing creative and innovative ideas, products or methods.

HOTS are the abilities to apply knowledge, skills and values in reasoning and reflecting to solve problems, make decisions and innovate and the abilities to create something. HOTS include critical thinking, creative thinking, reasoning and thinking strategy.

Critical thinking skills are the abilities to evaluate an idea logically and rationally to make a fair consideration using reasons and reliable evidences.

Creative thinking skills are the abilities to produce or create something new and valuable using genuine imagination and unconventional thinking.

Reasoning skills are the abilities of an individual to make consideration and evaluation and rationally.

Thinking strategies are ways of thinking that are structured and focused to solve problems.

HOTS can be applied in the classroom through activities such as reasoning, inquiry learning, problem solving and projects. Teachers and pupils need to use thinking tools such as thinking maps and mind maps as well as high level questioning to encourage pupils to think.

TEACHING AND LEARNING STRATEGIES

Teaching and learning strategies in the Science curriculum emphasise on thoughtful learning. Thoughtful learning is the process that helps pupil acquire knowledge and master skills that will help them develop their minds to the optimum level. Thoughtful learning can take place through various learning approaches such as inquiry, constructivism, contextual learning, mastery learning, problem/ project-based learning and STEM. Learning activities in thoughtful learning should be able to elicit critical and creative thinking among pupils and not be confined to routine. Pupils should be explicitly aware of the thinking skills and thinking strategies that are being used in their learning.

They should be challenged with higher order questions or problems and they are required to solve problems creatively and critically. Pupils are actively involved in teaching and learning which integrates the acquisition of knowledge, mastery of skills, inculcation of noble values and scientific attitudes.

The learning approaches that can be implemented by the teacher in the classroom are as follows:

Inquiry Approach

Inquiry approach emphasises on learning through experiences. Generally, inquiry means to find information, to question and to investigate a phenomenon around them. Discovery is the main characteristic of inquiry. Learning through discovery occurs when the main concepts and principles of Science are investigated and discovered by pupils themselves. Through activities such as experiments, pupils investigate a phenomenon and draw conclusion by themselves. Teachers then lead pupils to understand the science concepts through the results of the inquiry. Thinking skills and scientific skills are thus developed further during the inquiry process. However, the inquiry-discovery approach may not be suitable for all teaching and learning situations. Sometimes, it may be more appropriate for teachers to present concepts and principles directly or through guided inquiry-discovery to pupils.

Constructivism

Constructivism is a theory that suggests pupils learn by building their own understanding that is meaningful to them. The important attributes of constructivism are:

- Teachers consider pupils' prior knowledge;
- Learning is the result of pupils' own effort;
- Learning occurs when pupils restructure their existing ideas by relating new ideas to old ones; and
- Pupils have opportunities to cooperate, share ideas, experiences and reflect on their learning.

Contextual Learning

Contextual learning is an approach that associates learning with pupils' daily life. In this context, pupils do not only learn theoretically but learn to appreciate the relevance of science in their lives. This approach is used where pupils learn by investigating as in the inquiry-discovery approach.

Mastery learning

Mastery learning is an approach that ensures all pupils master the intended learning objectives. This approach is based on the principle that pupils are able to learn if opportunities are given. Pupils should be allowed to learn at their own pace, with the incorporation of remedial and enrichment activities as part of the teaching and learning process.

Problem/ Project-Based Learning

Problem/project-based learning (PBL) is a pupil-centred pedagogy in which pupils learn through experience in resolving issues/problems contained in the stimulus prepared by the teachers or projects given by the teachers. Teachers can prepare issues/problems or projects from a variety of sources such as newspapers, magazines, journals, books, textbooks, cartoons, videos, television, film and others with minor modification to fulfill the requirements of the teaching and learning process.

Real-world problems or relevant projects are used as a platform to encourage pupils to learn about concepts and principles aspired by teachers. PBL can encourage the development of critical thinking skills, problem solving abilities and communication skills.

PBL provides an opportunity for pupils to work in teams, collaborate to find and evaluate research materials, analyse data, justify and make decisions as well as foster traits of lifelong learners. To ensure the effectiveness of PBL, problems provided should;

- motivate pupils to understand concepts clearly and deeply.
- require pupils to make a decision that is reasonable and defend it.

- meet the content/learning standard to be achieved and relate it to the previous/ prior knowledge.
- have appropriate level of complexity to ensure that pupils are able to work together to resolve it.
- Be open-ended and interesting to motivate and enhance pupils' interest to solve them.

STEM (Science, Technology, Engineering and Mathematics) Approach

STEM approach is the teaching and learning method which applies integrated knowledge, skills and values of STEM through inquiry, problem solving or project in the context of daily life, environmental and local as well as global community, as shown in Figure 4.

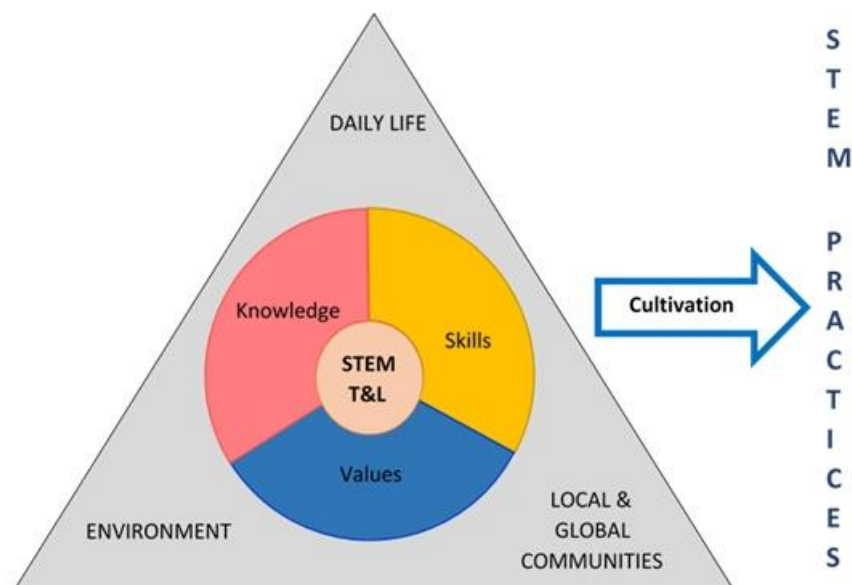


Figure 4: STEM Teaching and Learning Approach

STEM teaching and learning which is contextual and authentic is able to encourage in-depth learning among pupils. Pupils can work in groups or individually according to their ability to cultivate the STEM practices as follows:

1. Questioning and identifying problems.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analysing and interpreting data.

5. Using mathematical thinking and computational thinking.
6. Developing explanation and designing solutions.
7. Engaging in arguments and discussions based on evidences.
8. Acquiring information, evaluating and communicating about the information.

Computational thinking is the process of cognitive thinking involved in formulating the problem and the solution so that this solution can be represented in a form that can be implemented by human and/or computer effectively. Computational thinking helps pupils organise, analyse and present data or ideas logically and systematically so that complex problems can be resolved easily.

Various teaching and learning methods can increase pupils' interest in science. The less interesting lessons will not motivate pupils to learn, thus affecting their performance. The teaching and learning method should be based on the contents of the curriculum, pupils' abilities and multiple intelligences, availability of resources and infrastructure.

The following are brief descriptions of some teaching and learning methods:

Scientific Investigation/ Experiment

Scientific investigation/experiment is a method commonly used in science lessons. Pupils test hypotheses through investigations to discover specific science concepts and principles scientifically. They carry out scientific investigations/experiments using thinking skills, science process skills, and manipulative skills. Inquiry approach must be used while conducting scientific investigations/experiments. Figure 5 shows the steps in carrying out scientific investigations/ experiments.

In the implementation of Science curriculum, pupils should be given the opportunities to design their own scientific investigations/experiments besides being guided to carry them out. This involves drafting their own experimental method, identifying the data that can be measured, analysing data and presenting the results of their scientific investigations/experiments.

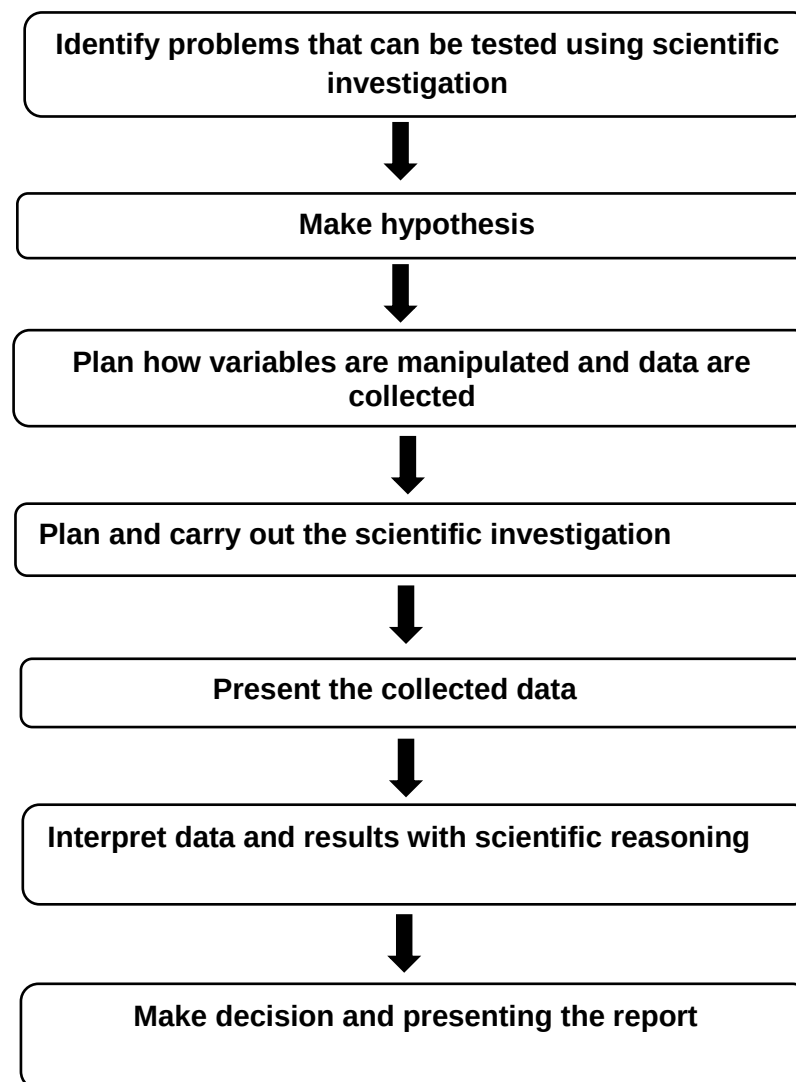


Figure 5: Steps in carrying out scientific investigations/ experiments

Simulation

Simulation is an activity that resembles the actual situation. Simulations can be carried out through role-play, games or use of models. In a role-play, pupils act out a particular role spontaneously based on a certain pre-determined conditions. When conducting games, pupils are required to follow certain procedures. Pupils play games in order to learn a particular principle or to understand the process of decision-making. Models are used to represent real objects or situations. Pupils will be able to visualise the real situation, thus understanding the concepts and principles learned.

Project

Project is an activity carried out by pupils to achieve a certain aim based on collaborative learning. A project takes a long time and exceeds formal learning hours to be completed. The outcome of the project such as reports, artefacts and scrapbooks needs to be presented. Project work encourages the development of communication skills, problem solving, time management and application of knowledge.

Visits and Use of External Resources

Learning science is not only restricted in school. Visits to zoos, museums, science centres, research institutes, mangrove swamps and factories can make learning more effective, enjoyable and meaningful. A well planned visit is required to optimise learning. Pupils have to carry out or perform tasks during the visit. Discussions after the visit should be held.

Application of Technology

Technology is one of the tools that has a high potential to enhance interest in learning science. The use of technology such as the television, radio, video, computer and internet makes the teaching and learning of science more interesting and effective. Technology eases teaching and learning of abstract or difficult science concepts. Application software such as word processors, graphic presentation software and electronic spreadsheets are suitable tools to analyse and present data. The use of other technologies such as data loggers and computerised interface in experiments and projects can assist teaching and learning science effectively.

CROSS-CURRICULAR ELEMENTS

Cross-Curricular Elements (CCE) is a value-added element applied in the teaching and learning process other than those specified in the content standard. These elements are applied to strengthen the skills and competency of the intended human capital, capable of dealing with the current and future challenges. The elements in the CCE are as follows:

1. Language

- The use of proper language of instruction should be emphasised in all subjects.
- During the teaching and learning of each subject, the pronunciation aspect, sentence structure, grammar and the terminology of the language need to be emphasised to assist pupils to organise ideas as well as communicate effectively.

2. Environmental Sustainability Awareness

- Awareness towards the love for the environment in the pupils' lives needs to be nurtured through the teaching and learning process in all subjects.
- Knowledge and awareness of the importance of the environment and global sustainability is important to shape pupils' ethics in appreciating nature.

3. Noble Values

- Noble values are emphasised in all subjects to ensure that pupils are aware of its importance and practise them.
- Noble values include the aspects of spirituality, humanity and citizenship which will be practiced in pupils' daily life.

4. Science and Technology

- The increase of interest in science and technology will help to improve scientific and technological literacy among pupils.
- The use of technology in teaching can help and contribute to efficient and effective learning.
- The integration of science and technology in the teaching and learning process covers four areas, namely:
 - i. The knowledge of science and technology (facts, principles, concepts related to science and technology);
 - ii. Scientific skills (process of thought and specific manipulative skills);
 - iii. Scientific attitudes (such as accuracy, honesty, security); and
 - iv. The use of technology in teaching and learning activities.

5. Patriotism

- Patriotism can be nurtured through all subjects, co-curricular activities and community services.
- Patriotism can produce pupils who have the spirit of patriotism and pride as Malaysians.

6. Creativity and Innovation

- Creativity is the ability to use imagination in gathering, extracting and generating ideas or creating something new or authentic using a combination of existing ideas.
- Innovation is the application of creativity through the modification, rectification and practice of ideas.
- Creativity and innovation are always inter-connected. Therefore, there is a need to ensure that human capital development is able to meet the challenges of the 21st century.
- Elements of creativity and innovation should be integrated in the teaching and learning.

7. Entrepreneurship

- The incorporation of entrepreneurship elements aims to develop attributes and entrepreneurial habits that will become a culture among the pupils.

- Entrepreneurial attributes can be ingrained in teaching and learning through activities that could foster attitudes such as diligence, honesty, trustworthiness and responsibility as well as developing creative minds and innovative ideas to spur the market.

8. Information and Communication Technology Skills

- Information and communication technology (ICT) elements are incorporated in the lessons to ensure pupils are able to apply and strengthen their basic knowledge and skills in ICT.
- The application of ICT in the lesson does not only motivate pupils to be creative but stimulates interesting and fun teaching and learning as well as improve the quality of learning.
- ICT should be integrated in the lessons based on appropriate topics to be taught to further enhance pupils' understanding of the subject content.
- One of the emphases in ICT is the computational thinking that can be applied in all subjects. Computational thinking is a skill that uses logical reasoning concept, algorithms, decomposition, pattern recognition, scaling and evaluation in computer-aided problem solving process.

9. Global Sustainability

- The Elements of Global Sustainability aims to develop pupils with sustainable thinking highly responsive attitude to the environment in their daily lives with the application of knowledge, skills, and values acquired through the elements of the Sustainable Consumption and Production, Global Citizenship and Solidarity.
- The element of Global Sustainability is important in preparing pupils to face challenges and current issues at the local, national and global levels.
- This element is taught directly and indirectly in related subjects.

10. Financial education

- Application of financial education elements aims at shaping the future generation that is capable of making right financial decisions, ethical practice and financial management skills to manage the financial affairs responsibly.
- The Elements of financial education can be applied in teaching and learning directly or indirectly. Direct application is done through the titles that contain explicit financial elements such as the calculation of simple interest and compound interest. Indirect application is integrated through other titles across the curriculum. Exposure to financial management in real life is important to provide pupils with the knowledge, skills and values that can be applied effectively and meaningfully.

CLASSROOM ASSESSMENT

Classroom assessment is a process of obtaining information about the progress of the pupils which is planned, carried out and reported by the teacher concerned. This process happens continuously to enable the teacher to determine pupils' performance level.

Classroom assessment can be executed by a teacher in formative and summative forms. Formative assessment is implemented in line with the teaching and learning process, while summative assessment is carried out at the end of a learning unit, term, semester or year. Teachers need to plan, construct items or assessment instruments, administer, check, record and report the performance level that is taught based on the Standard Curriculum and Assessment Document (DSKP).

In order to ensure that the assessment helps to improve the capability and mastery of the pupils, the teacher must perform the assessment that has the following features:

- Using a variety of assessment methods such as observation, oral and writing.
- Using a variety of assessment strategies that can be implemented by teachers and pupils.
- Taking into consideration the various levels of knowledge and skills learned.
- Allowing pupils to show a wide range of learning ability.
- Assessing the performance level of pupils based on Learning Standard and Performance Standard.
- Take further action for remedial and enrichment.

Science Performance Standards for Primary School

Classroom assessment for Science KSSR is executed based on three main domains which are knowledge, skills and values. Knowledge assessment of a certain theme includes the integration of science process skills, aimed to get information on the level of pupils' understanding in a specific content standard holistically. Assessment of SPS can be carried out throughout the year. Hence, it is important for teachers to use their professional judgement to determine pupils' performance level. Performance level of pupils is divided into six levels as shown in Table 9.

Table 9: Description of Performance Level of Knowledge and Skills

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and scientific skills.
2	Understand the knowledge and scientific skills as well as explain their understanding.
3	Apply the knowledge and scientific skills to perform tasks.
4	Analysing science knowledge and scientific skills in the context of problem solving .
5	Evaluate science knowledge and scientific skills in the context of problem solving and making decision to perform task.
6	Create by using science knowledge and scientific skills in the context of problem solving and making decision or in performing the tasks in a new situation creatively and innovatively.

All scientific investigation/experiments described in learning standard in DSKP **MUST** be carried out using the inquiry approach. List of scientific investigation/experiments are suggested for KSSM Science Form 4 and Form 5 are shown in Table 10a dan 10b.

Table 10a: List of Scientific Investigation/Experiment Science Form 4

THEME	EXPERIMENTS
SCIENTIFIC METHODOLOGY	3.2.2 Carry out experiment to determine human pulse rate
MAINTENANCE AND CONTINUITY OF LIFE	6.1.6 Carry out an experiment to differentiate the strength of compact bones with hollow bones.
	6.3.4 Carry out an experiment to determine a plant's growth pattern
EXPLORATION OF ELEMENTS IN NATURE	9.1.2 Carry out an experiment to compare alloys with its pure metals
ENERGY AND SUSTAINABILITY OF LIFE	11.3.1 Carry out an experiment to determine the acceleration of earth's gravity, g .
	11.3.3 Carry out an experiment to study free fall and non-free fall.
	11.4.3 Carry out an experiment to study the relationship between mass and inersia.

Table 10b: List of Scientific Investigation/Experiment Science Form 5

THEME	EXPERIMENTS
MAINTENANCE AND CONTINUITY OF LIFE	1.1.2 Carry out an experiment to show the presence of microorganisms.
	1.1.3 Carry out an experiment to investigate factors that affect the growth of microorganisms.
	1.3.3 Carry out an experiment to study the effect of antibiotic on bacterial growth.
	2.1.2 Carry out an experiment to estimate the energy value in food samples.
	2.2.2 Carry out an experiment to study the effect of macronutrients deficiency on plants.
EXPLORATION OF ELEMENTS IN NATURE	4.2.1 Carry out an experiment to study factors affecting rate of reaction.
	5.5.10 Carry out an experiment to produce soap through saponification process.

Evaluation report for Scientific Investigation/Experiment is conducted **twice a year** by referring to Table 11.

Table 11: Rubric for Scientific Investigation/Experiment

PERFORMANCE LEVEL	DESCRIPTOR
1	- Plan the strategy and procedure that is not accurate in the scientific investigation. - Use materials and apparatus that is not suitable in the scientific investigation. - No data collected and recorded. - No explanation or the explanation is not clear.
2	- Plan the correct strategy and procedure in the scientific investigation with guidance. - Use the suitable material and apparatus. - Collect and record incomplete data or not relevant. - Made interpretation and conclusion not based on the collected data.

PERFORMANCE LEVEL	DESCRIPTOR
3	- Plan and execute the correct strategy and procedure in the scientific investigation with guidance. - Use the correct material and apparatus. - Collect and record relevant data. - Organise data in numerical form or visual with some error. - Interpret data and make conclusion based on the collected data. - Write an incomplete scientific investigation report.
4	- Plan and execute the correct strategy and procedure in the scientific investigation. - Handle and use the correct material and apparatus to get an accurate result. - Collect relevant data and record in a suitable format. - Organise the data in the numerical form or visual with no error. - Interpret the data and make an accurate conclusion based on the aim of the scientific investigation. - Write a complete report on the scientific investigation.

PERFORMANCE LEVEL	DESCRIPTOR
5	- Carry out the scientific investigation and write a complete report. - Collect, organise and present the data in the form of numerical or visual accurately and done well. - Interpret the data and make conclusion accurately with scientific reasoning. - Identify the trend, pola and making connection with the data.
6	- Justify the outcome of the scientific investigation relating to theory, principle and law of science in the reporting. - Evaluate and suggest way to improve to the scientific investigation methods and further inquiry investigation if needed. - Discuss on the validity of the data and suggest way to improve the method of collecting data.

Scientific attitude and noble values are also assessed throughout the year by referring to Table 12.

Table 12: Rubric for Scientific Attitude and Noble Values

PERFORMANCE LEVEL	DESCRIPTOR
1	Pupil is not able to: - state how science is used to solve problems. - state the implication of using science to solve problem or certain issues. - use science language to communicate - document the source of information used.
2	Pupil is less able to: - state how science is used to solve problems. - state the implication of using science to solve problem or certain issues. - use science language to communicate - document the source of information used.

PERFORMANCE LEVEL	DESCRIPTOR
3	Pupil is able to: - state how science is used to solve problems. - state the implication of using science to solve problem or certain issues. - use limited science language to communicate - document a few sources of information used.
4	Pupil is able to: - determine how science is used to solve problems or certain issues. - determine the implication of using science to solve problem or certain issues. - always use sufficient science language to communicate. - document parts of the sources of information used.

PERFORMANCE LEVEL	DESCRIPTOR
5	Pupil is able to: • Conclude how science is used to solve problems or certain issues. • conclude the implication of using science to solve problem or certain issues. • always use good science language to communicate. • document most the sources of information used.
6	Pupil is able to: • Conclude how science is used to solve problems or certain issues. • discuss and analyse the implication of using science to solve problem or certain issues. • Always use the correct science language to communicate clearly and accurately. • document all the sources of information. • become a role model to other pupil.

OVERALL PERFORMANCE LEVEL

Overall performance level must be determined to give a value of performance level to pupil at the end of the school session. This overall performance level includes content, scientific skills, scientific value and noble value. Thus, teacher needs to evaluate pupil collectively and holistically through all aspect during learning process continuously by various method such as achievement in topical test, observation, exercise, presentation, response verbally from the pupil and group work. Teacher should use their professional consideration to evaluate overall performance level based on teacher experience with pupil, intelligence and discussing with other teacher.

Table 13: Description of Overall Performance Level of Science

PERFORMANCE LEVEL	DESCRIPTOR
1 (Know)	Pupils know the basics knowledge, skills or values can do basic skills in science.
2 (Know and understand)	Pupils show the understanding by explaining something they had learned in the various form of communication scientifically.
3 (Know, understand and do)	Pupils used knowledge to carry out certain skills in certain situation scientifically.
4 (Know, understand and do in a civilised manner)	Pupils use knowledge to carry out certain skills in a civilised manner according to procedure or analytically and systematically in science.
5 (Know, understand and do with commendable praise)	Pupils use knowledge and apply skills new situations by following procedures or systematically and consistently and being positive science.
6 (Know, understand and do in an exemplary manner)	Pupils are able to use prior knowledge and skills to new situation systematically, with positive attitude, creatively and innovatively in coming out of new ideas and that can be emulated scientifically.

Teachers can record student progress in teacher's record book, exercise books, notebooks, checklists, tables or other appropriate materials. Performance level will be recorded into the reporting templates provided after teaching and learning for each area, theme, skill or group of Content Standards and Learning Standards completed.

CONTENT ORGANISATION

The content for the Secondary Science Curriculum Standard is built based on the four discipline of science that is Biology, Chemistry, Physics and Earth Science. All four discipline are arranged into five themes that are Scientific Methodology, Maintenance and Continuity of Life, Exploration of Elements in Nature, Energy and Sustainability of Life and Exploration of Earth and Outer Space. However, each theme is divided into a few learning areas as shown in table 14.

Table 14: Theme and Learning Area Science Form 4 and 5

FORM	THEME	LEARNING AREA
4	Scientific Methodology	1.0 Safety Measures in Laboratory
		2.0 Emergency Help
		3.0 Techniques in Measuring The Parameters of Body Health
	Maintenance And Continuity Of Life	4.0 Green Technology for Environmental Sustainability
		5.0 Genetic
		6.0 Support, Movement and Growth
		7.0 Body Coordination
	Exploration Of Elements In Nature	8.0 Elements and Substances
		9.0 Chemical in Industries
		10.0 Chemical in Medicine and Health
	Energy And Sustainability Of Life	11.0 Force and Motion
		12.0 Nuclear Energy
5	Maintenance And Continuity Of Life Hidup	1.0 Microorganisms
		2.0 Nutrition and Food Technology
		3.0 Sustainability of The Environment

FORM	THEME	LEARNING AREA
5	Exploration Of Elements In Nature	4.0 Rate of Reaction
		5.0 Carbon Compounds
		6.0 Electrochemistry
	Energy And Sustainability Of Life	7.0 Cahaya dan Optik.
		8.0 Daya dan Tekanan.
	Exploration of Earth and Outer Space	9.0 Teknologi Angkasa Lepas.

Every theme is divided into a few learning areas. Learning area in every theme is detailed out in the Content Standard dan Learning Standard. The Content Standard may have one or more learning standards that had been conceptualized based on the learning area.

The learning standard is the learning objective written in the form of measurable behaviour. The learning standard comprised of learning scope and scientific skills as well as the thinking skills that demands the pupils' need to do science for them to acquire the intended scientific concept. Generally, the learning standard is arranged

accordingly through the hierarchy from simple to complex, however the sequence of the Learning Standard could be modified to cater to the need of learning. The Content Standard for the affective domain is normally written at the end of the cognitive domain of that particular Content Standard, however not all Content Standard cognitive domain will end with the affective domain.

The teaching and learning (t&l) should be planned holistically and integrated to enable a few learning standards be achieved depending on the suitability and needs of learning. Teachers should scrutinise all learning standards and performance standard in the content standard before planning the teaching and learning activities.

Teachers are encouraged to plan activities that will involve the active participation of pupils to generate thinking analytically, critically, innovatively and creatively besides using technology as a platform to achieve the content standard effectively. The implementation of teaching and learning that requires activities, investigations and experiments that can assist in achieving the learning standards should be carried out to strengthen the pupil's understanding.

The Science Curriculum Standard for Secondary Schools focuses on the achievement of knowledge, skills and values that correspond to the pupil's abilities based on Content Standards, Learning Standards and Performance Standards that are arranged in three columns as shown in Table 15.

Table 15: Interpretation of Content Standard, Learning Standard and Performance Standard

CONTENT STANDARD	LEARNING STANDARD	PERFORMANCE STANDARD
Specific statements about what pupils should know and can do during the schooling period encompassing the knowledge, skills and values.	A predetermined criteria or indicator of the quality in learning and achievement that can be measured for each content standard.	A set of general criteria which reflects the levels of pupils' achievement that they should display as a sign that certain topic has been mastered by pupils (indicator of success).

Content Standard,
Learning Standard
and Performance Standard
Form 4

THEME

SCIENTIFIC METHODOLOGY

LEARNING AREA

1.0 SAFETY MEASURES IN LABORATORY

2.0 EMERGENCY HELP

**3.0 TECHNIQUES IN MEASURING THE PARAMETERS OF
BODY HEALTH**

Theme 1: SCIENTIFIC METHODOLOGY

This theme focusses on introducing the pupils to the safety rules in laboratory, emergency help and techniques in measuring a number of body health parameters. Emphasis is also given to the skills of interpreting data and information. This knowledge is significant to increase the awareness of the pupils' in safety and health towards prosperity and continuity of life.

Learning area: 1.0 Safety Measures in laboratory

- 1.1 Self Protection Equipment
- 1.2 Disposable of Waste
- 1.3 Fire Extinguisher

2.0 Emergency Health

- 2.1 Cardiopulmonary resuscitation (CPR)
- 2.2 Heimlich Maneuver

3.0 Techniques in Measuring the Parameters Body Health

- 3.1 Body Temperature
- 3.2 Pulse rate
- 3.3 Blood Pressure
- 3.4 Body Mass Index (BMI)

1.0 SAFETY MEASURES IN LABORATORY

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.1 Self-protection equipment	Pupil is able to: 1.1.1 Explain with examples the self-protection equipments and their functions.	Note: Examples of self-protection equipments are gloves, clothes and lab shoes, eye wash, visor, hand wash, fume cupboard, laminar flow, biological safety cabinet, shower and others.
1.2 Disposable of wastes	Pupil is able to: 1.2.1 Explain with examples wastes that can be disposed into wash basins.	Note: Categories of substances that can be disposed into wash basin are: • Substances with pH value between 5 and 9 • Liquid or solution with low concentration and not hazardous
	1.2.2 Characterize substances that cannot be disposed into wash basins.	Note: Examples of substances that cannot be disposed into wash basins are like solid wastes, substances with pH value lower than 5 and more than 9, organic compound solvents, chemical substances (acids, grease, oil, oil paint, hydrogen peroxides), toxic substances, heavy metals, organic waste substances (microbes, carcasses), radioactive wastes, volatile substances and reactive substances.

CONTENT STANDARD	STANDARD LEARNING	NOTES
	1.2.3 Manage biological waste substances.	Suggested activity: Finding information on Standard Operational Procedures (SOP) and carry out multimedia presentation in order to generate new ideas on managing biological waste substances that the earth can no longer contained such as incinerator of the future.
	1.2.4 Communicate about steps to handle accidents in laboratory.	Suggested activity: Finding information on the role of Malaysian Association BioSafety and BioSecurity/National Institute for Occupational Safety and Health (NIOSH). Note: Emphasis is on the accidents which involve chemical substances spillage. Steps in managing the chemical substances are: (i) Report to the teacher/laboratory assistants (ii) Make the spillage area as a restricted area (iii) Stop the spillage from spreading by using sand (iv) Scoop the chemical spillage (v) Dispose safely

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Emphasis is given to the meaning of mercury poisoning, symptoms and steps to be taken when in contact with mercury. Steps in handling mercury spillage is as the following: (i) Report to the teacher/laboratory assistants (ii) Make the spillage area as a restricted area (iii) Sprinkle sulphur powder to cover the spillage (iv) Call the Fire Department
1.3 Fire Extinguisher	Pupil is able to: 1.3.1 Communicate about the types of fire extinguisher	Note: Introduce types of fire extinguishers: • Fire extinguisher type A, B, C and D (type ABC are for all types of fire except metals and non explosive gas) • The colour label and content of fire extinguisher • Usage of sand, water and fire blanket The fire blanket is made from two layers of glass fibres. The function of fire blanket is to put out small or moderate fire by wrapping the victim with it.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.3.2 Explain the method of using fire extinguisher.	Suggested activity: Demonstration and training on how to use fire extinguishers. Note: Things to be emphasized during the auditing are: • Expiry date • Types of fire extinguisher • Numbers of fire extinguisher location of fire extinguishers in the school emergency route plan
	1.3.3 Carry out an audit on the fire extinguishers at school.	
	1.3.4 Create a simple fire extinguisher.	Suggested activity: STEM Project Based Learning The kitchen has a variety of flammable substances such as flour, sugar, oil and so on. The existence of fuel can also be a source of fire at home Create a simple fire extinguisher that works by using materials available at home. Note: The application of entrepreneurial elements is encouraged.

2.0 EMERGENCY HELP

CONTENT STANDARD	STANDARD LEARNING	NOTES
2.1 Cardiopulmonary resuscitation (CPR)	Pupil is able to:	
	2.1.1 State the meaning of CPR and the situation that requires CPR.	Note: Before carrying out a CPR, security measures need to be taken into account. CPR is given when an individual does not respond toward stimulus, stop breathing, no heart beat or pulse. This situation may be due to heart attack, drowning, electrocution and lightning strike.
	2.1.2 Demonstrate CPR methods. 2.1.3 Explain the importance of CPR.	Suggested activity: Demonstration session by paramedics to show how to carry out a CPR. Note: Describe the science concepts and functions of every step in CPR.

CONTENT STANDARD	STANDARD LEARNING	NOTES
2.2 Heimlich Maneuver	Pupil is able to: 2.2.1 Explain Heimlich Maneuver and its importance.	Note: Heimlich Maneuver can be performed when an individual shows a sign of choking, unable to speak, coughing and breathing.
	2.2.2 Demonstrate Heimlich Maneuver.	Suggested activity: The science concept and function of every step in Heimlich Maneuver need to be explained. Carry out a demonstration by the paramedics to show the Heimlich Maneuver techniques.

3.0 TECHNIQUES OF MEASURING THE PARAMETERS OF BODY HEALTH

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.1 Body temperature	Pupil is able to: 3.1.1 Measure the body temperature with the correct technique. 3.1.2 Interpret body temperature.	Suggested Activity: Introduce the correct techniques to measure body temperature using: • Clinical thermometer • Laboratory thermometer • Rectal thermometer • Infrared thermometer Note: Normal human's body temperature is 36.9°C Factors that can cause body temperature to be above normal: • Infection • Exposure to extreme heat • Exercise Factors that can cause body temperature to be below normal is exposure to extremely low temperature.

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.2 Pulse rate	Pupil is able to: 3.2.1 Identify the pulse points on the body. 3.2.2 Carry out experiment to determine human's pulse rate.	Suggested activity: Investigate the pulse rate based on gender, age and physical activities. Note: - Babies and children have higher pulse rate compared to an adult - Individual with health problems has lower pulse rate compared to the healthy ones - Athletes have lower pulse rates because their cardiac muscles are stronger
3.3 Blood pressure	Pupil is able to: 3.3.1 Identify the meter for measuring blood pressure. 3.3.2 Measure and record blood pressure. 3.3.3 Interpret data from blood pressure readings.	Note: Introduce the digital Sphygmomanometer to measure blood pressure in millimetre mercury unit (mm Hg). - Normal blood pressure is 120/80 mm Hg - The reading of 120 mmHg shows blood pressure when the heart is contracting (systolic pressure) - The reading of 80 mmHg shows blood pressure when the heart is relaxing (diastolic pressure)

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.4 Body Mass Index (BMI)	Pupil is able to: 3.4.1 Calculate and determine Body Mass Index. 3.4.2 Interpret the Body Mass Index and make decision what to do next.	Note: BMI Formula = $\frac{\text{Body mass(kg)}}{\text{Height}^2 \text{ (m}^2\text{)}}$ Introduce the Body Mass Index chart. Emphasis is given to the fact that when the Body Mass Index is more than normal then the risk of getting high blood pressure and diabetes mellitus is higher.

PERFORMANCE STANDARD

SCIENTIFIC METHODOLOGY

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on safety measure in laboratory, emergency help, technique and procedure.
2	Understand the safety measure in laboratory, emergency help, technique and procedure and to explain their understanding.
3	Apply the knowledge on safety in laboratory , emergency help, technique and procedure to accomplish simple task.
4	Analyse the knowledge and science skills on safety measures in laboratory, emergency help, technique and procedure in the context of problem solving about event or natural phenomena.
5	Evaluate the knowledge on safety measure in laboratory, emergency help, technique and procedure in the context of problem solving and decision making to carry out a task .
6	Create by using the knowledge and science skills on safety measure in laboratory, emergency help, technique and procedure in the context of problem solving and decision making with regards to the social values/economy/culture of the community.

THEME

MAINTENANCE AND CONTINUITY OF LIFE

LEARNING AREA

4.0 GREEN TECHNOLOGY FOR ENVIRONMENTAL SUSTAINABILITY

5.0 GENETIC

6.0 SUPPORT, MOVEMENT AND GROWTH

7.0 BODY COORDINATION

Theme 2:

MAINTENANCE AND CONTINUITY OF LIFE

This theme is meant to provide understanding of the process that needs to be experienced by living organisms in order to continue survival. Focus is given to the advancement of science and technology in the fields of genetics, body coordination, support, movement and growth so that students are able to appreciate and look after their health. Emphasis is given to the green technology concept which is crucial for the survival of the present and the future life.

Learning Area:

4.0 Green Technology for Environmental Sustainability

- 4.1 Sustainable Environment
- 4.2 Energy Sector
- 4.3 Waste and Waste Water Management Sector
- 4.4 Agriculture and Forestry Sector
- 4.5 Transportation Sector
- 4.6 Green Technology and Life

5.0 Genetic

- 5.1 Cell Division
- 5.2 Inheritance
- 5.3 Mutation
- 5.4 Genetic Engineering Technology
- 5.5 Variation

6.0 Support, Movement and Growth

- 6.1 Support, Movement and Animal Growth
- 6.2 Movement and Human Growth
- 6.3 Support, Growth and Stability in Plants

7.0 Body Coordination

- 7.1 Human Endocrine System
- 7.2 Disturbances to the Body Coordination System
- 7.3 Healthy Minds

4.0 GREEN TECHNOLOGY FOR ENVIRONMENTAL SUSTAINABILITY

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.1 Environmental Sustainability	Pupil is able to: 4.1.1 Define and justify green technology in life. 4.1.2 Relate energy efficiency with green technology. 4.1.3 Identify sectors in green technology.	Note: Refer to Modul Teknologi Hijau Sains, <i>Centre for Education and Training in Renewable Energy, Energy Efficiency & Green Technology</i> (CETREE), USM. Introduce the three major areas of sustainability that is economy, social and environment. Sectors in Green Technology are energy, waste management and wastewater, agriculture and forestry, transportation, manufacturing industries and information and communications technology (ICT).
4.2 Energy Sector	Pupil is able to: 4.2.1 Describe socio-scientific issues. 4.2.2 Explain socio-scientific issues in the energy sector. 4.2.3 Justify the application of green technology to overcome socio-scientific issues in the energy sector.	Suggested activity: Conduct active reading and multimedia presentation on: • Socio-scientific issues in the energy sector • Contributing factors to socio-scientific issues in the energy sector • Application of green technology to overcome socio-scientific issues in the energy sector

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.3 Waste and Waste Water Management Sector	Pupil is able to: 4.3.1 Explain socio-scientific issues in the waste and waste water management. 4.3.2 Justify the application of green technology to overcome socio-scientific issues in the waste and waste water management.	Suggested activity: Gather information and conduct multimedia presentation on: - Socio-scientific issues in the waste and waste water management - Contributing factors to socio-scientific issues in the waste and waste water management - Application of green technology to overcome socio-scientific issues in the waste and waste water management Note: The waste and waste water management at garbage dump area using the following concepts: (i) Prevention and reduction - Prevention of food wastage and reduction in paper waste (ii) Separation and recycling - Waste separation and recycling (iii) Treatment and processing (biological process) - Conversion of waste into energy and fertilizer (iv) Reduction of waste, reuse, recycle (3R) - Minimization of waste

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.4. Agriculture and Forestry Sector	Pupil is able to: 4.4.1 Explain socio-scientific issues in the agriculture and forestry sector.	Suggested activity: Discuss and conduct multimedia presentation on: • Socio-scientific issues in the agriculture and forestry sector • Contributing factors to socio-scientific issues in the agriculture and forestry sector • Application of green technology to overcome socio-scientific issues in the agriculture and forestry sector
	4.4.2 Justify the application of green technology to overcome socio-scientific issues in the agriculture and forestry sector.	Note: The agriculture and forestry management sector is based on the following aspects: (i) Management of animal faeces • Bioenergy from agriculture waste (ii) Forestry • Reduce deforestation • Reforestation

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.5 Transportation Sector	Pupil is able to: 4.5.1 Explain socio-scientific issues in the transportation sector. 4.5.2 Justify the application of green technology to overcome socio-scientific issues in the transportation sector.	Suggested activity: Gather information and conduct multimedia presentation on: • Socio-scientific issues in the transportation sector • Contributing factors to socio-scientific issues in the transportation sector • Application of green technology to overcome socio-scientific issues in the transportation sector Note: Examples of the transportation sector management using alternative fuels such as: • Biofuel • Natural gas; Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG)

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.6 Green Technology and Life	Pupil is able to: 4.6.1 Justify the role of individuals in addressing the phenomena of global warming and climate change in reducing carbon footprint.	Suggested activity: STEM Project Based Learning The phenomena of global warming and climate change is plaguing our world now and needs to be given serious attention. The phenomena have resulted in many extreme effects on the earth. It is therefore important that we reduce this problem by applying knowledge about Green Technology to ensure the sustainability of nature for the future generations. Design an online awareness campaign to overcome global warming and climate change phenomena towards sustainable life on earth.

PERFORMANCE STANDARD
GREEN TECHNOLOGY IN SUSTAINABLE NATURE

PERFORMANCE LEVEL	DESCRIPTION
1	Recall knowledge and science skill on green technology in sustainable nature .
2	Understand green technology in sustainable nature and able to explain based on the understanding.
3	Applying the knowledge on green technology in sustainable nature and able to accomplish simple task.
4	Analyse knowledge on green technology in sustainable nature in context of problem solving on event or natural phenomena.
5	Evaluate knowledge on green technology in sustainable nature in context of problem solving and decision making to accomplish task.
6	Create using knowledge and science skills on green technology in sustainable nature in context of problem solving and decision making or accomplish a task in a new situation in a creative and innovative way with regards to social values/economy /community culture .

5.0 GENETIC

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.1 Cell Division	Pupil is able to: 5.1.1 Explain gene, deoxyribonucleic acid (DNA), and chromosomes in the nucleus.	Suggested activity: Use multimedia illustrations to show the structures of DNA, nucleotides and chromosomes. Build double helix structure of DNA. Note: Introduce karyotype (autosomes and sex chromosomes)
	5.1.2 Compare and contrast mitosis and meiosis.	Suggested activity: Conduct simulation or use animation to understand the cell division process. Emphasis in specific topics as the following: (i) Separation and movements of chromatid/chromosomes to the opposite poles (ii) Function of spindle fibers and centromeres (iii) Formation of new cells Note: Introduce the name of phases in mitosis and meiosis.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.1.3 Justify the importance of mitosis and meiosis.	Note: Gather information and conduct muliymedia presentation on the importance of: (i) Mitosis in growing process, repairing damaged cell and asexual reproduction (ii) Meiosis in gametes formation
5.2 Inheritance	Pupil is able to: 5.2.1 Explain inheritance in human.	Note: Use illustrations to introduce the terms of genes, dominant and recessive alleles, carrier and people with gene disorder diseases.
	5.2.2 Communicate about the inheritance mechanisms.	Suggested activity: Illustrate using schematic inheritance diagram of Mendel's Law to show gender determinations. Conduct activities to predict genotype and phenotype ratio for monohybrid cross. Note: Introduce the F1 and F2 generation.

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.3 Mutation	Pupil is able to: 5.3.1 Describe mutation definition and types of mutation.	Note: Explanation includes gene mutation and chromosomal mutation.
	5.3.2 Explain with examples the factors that cause gene mutation and chromosomal mutation.	Suggested activity: Gather information and conduct presentation on factors that cause gene and chromosomal mutation Example of gene mutations are colour blindness, sickle cell anaemia, thalassemia and haemophilia. Example of chromosomal mutation are Down syndrome, Turner syndrome and Klinefelter syndrome.
	5.3.3 Explain with example gene disorder diseases with its characteristics and the screening method of the disease.	Note: Example of screening method to detect gene disorder diseases are using the karyotypes and amniocentesis.
	5.3.4 Discuss genetic research application to increase living quality.	Suggested activity: Gather information and conduct presentation about genetic research such as: • Forensic science • Gene therapy • Genetic genealogy

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.3.5 Debate the effects of genetics research to human life.	Suggested activity: Evaluate the advantages and disadvantages of for example genetic screenings based on the following aspects: • Economy (insurance, job opportunities) • Harmonious living (family institution) • Etiquettes • Psychology • Social
5.4 Genetic Engineering Technology	Pupil is able to: 5.4.1 Justify genetic engineering technology.	Suggested activity: Collect information and make multimedia presentations on genetic engineering such as recombinant DNA (the use of plasmids), gene therapy and genetically modified organisms (GMOs). Note: Evaluate the advantages and disadvantages of genetic engineering in the field: • Medicine such as insulin and enzyme production • Agriculture such as tomatoes, soy bean and life stocks
	5.4.2 Debate the effects of genetic engineering technology in life.	
	5.4.3 Justify etiquette in genetic engineering technology.	Note: Evaluate the etiquette issue about cloning and <i>biohazard</i> .

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.5 Variation	Pupil is able to: 5.5.1 Communicate about continuous variation and discontinuous variation.	Suggested activity: Carry out activities to define by example and compare the variance of continuous variation and discontinuous variation such as: • Height • Body mass • Tongue rolling Draw a bar graph or histogram based on the activity being carried out. Collect information to identify factors that cause variation and discuss the importance of variation.

**PERFORMANCE STANDARD
GENETIC**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on genetic
2	Understand genetic and able to explain based on the understanding.
3	Apply knowledge on genetic and able to accomplish easy task.
4	Analyse knowledge on genetic in context of problem solving on events or natural phenomena.
5	Menilai knowledge of genetic in context of problem solving and decision making to accomplish a task.
6	Create using knowledge and science skills on genetic in context of problem solving and decision making or accomplish a task in a new situation in a creative and innovative way with regards to social values / economy / community culture

6.0 SUPPORT, MOVEMENT AND GROWTH

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.1 Support, Movement and Growth in animals	Pupil is able to: 6.1.1 Explain with examples the types of support in animals.	Suggested activity: Gather information and conduct a multimedia presentation on types of support in animals which are exoskeleton, endoskeleton and hydrostatic skeleton.
	6.1.2 Relate the size of exoskeleton with growth.	Suggested activity: Measure and record the morphometric data on an insect's shell. Plot the growth curve of insects and explain metamorphosis which involves the ecdysis
	6.1.3 Relate hydrostatic skeleton with movement.	Suggested activity: Conduct a multimedia presentation to explain hydrostatic skeleton. Conduct a discussion on how the fluid pressure in the lumen helps in animals' movement for example, earthworms and jellyfish.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.1.4 Elaborate the function of endoskeleton in animals.	Suggested activity: Gather information and create a multimedia presentation on the different functions of the endoskeleton for: • Aquatic vertebrates • Terrestrial vertebrates • Birds
	6.1.5 Dissect the human skeletal system.	Suggested activity: Label the diagram on human skeletal system. Examples: Cranium, vertebrates, ribcage, humerus, radius, ulna, pelvic, femur, tibia, fibula and patella
	6.1.6 Carry out an experiment to differentiate the strength of compact bones with hollow bones. 6.1.7 Relate support system with animal's stability.	Suggested activity: Carry out activities to make an analogy: • The strength of hollow bones in birds • The strength of compact bones in elephants Note: Factors that affect the animal's stability are the position of center of gravity and base area such as: • Giraffes spread their legs wide apart when drinking water to lower the center of gravity • Kangaroos support their body with their tail to widen the base area

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.2 Movement and Human Growth	Pupil is able to: 6.2.1 Explain the function of joints and muscles in movement.	Suggested activity: Use 3D animations to explain: • Position of joints and muscles and their functions • The involvement of antagonistic muscles movement in biceps and triceps Note: Introduce cartilage, tendon, ligament, synovial fluid and its functions.
	6.2.2 Generate ideas regarding problems with joints and muscles in daily life.	Suggested activity: Problem-based learning for solving • Injuries to the joints and muscles caused by physical activities • Knee pain in senior citizens Note: Gather information on related careers such as orthopaedic specialists, chiropractitioner and physiotherapist
	6.2.3 Explain the pattern of human growth.	Note: Human growth stages refer to infancy, childhood, adolescence, adulthood and old age.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.2.4 Compare and contrast the growth pattern between male and female.	Suggested activity: Draw the growth pattern for male and female.
6.3 Support, Growth and Stability in plants.	Pupil is able to :	
	6.3.1 Explain the support systems in terrestrial and aquatic plants.	Suggested activity: Conduct field work to study the support structures in plants like thorns, tendrils, supporting roots, prop roots, buttress roots and hollow stems.
	6.3.2 Determine the age of woody plants.	Study the age of woody plants based on the number of yearly rings.
	6.3.3 Relate the support system with stability in plants.	Study the support system of herbal, woody and aquatic plants.
	6.3.4 Carry out an experiment to determine a plant's growth pattern.	Suggested activity: Measure and record the length of green bean seedlings and interpret the graph.

PERFORMANCE STANDARD
SUPPORT, MOVEMENT AND GROWTH

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on support, movement and growth in human, animals and plants.
2	Understand support, movement and growth in human, animals and plants and able to explain based on the understanding.
3	Apply knowledge on support, movement and growth in human, animals and plants and able to accomplish simple task.
4	Analyse knowledge on support, movement and growth in human, animals and plants in context of problem solving on events or natural phenomena
5	Evaluate knowledge on support, movement and growth in human, animals and plants in context of problem solving and decision making to accomplish a task.
6	Create using knowledge and science skills on support, movement and growth in humans, animals and plants in context of problem solving and decision making or accomplish a task in a new situation in a creative and innovative way with regards to the social values / economy / community culture.

7.0 BODY COORDINATION

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.1 Human Endocrine System	Pupil is able to: 7.1.1 Explain endocrine system and its functions.	Suggested activity: Make multimedia presentations showing the main endocrine glands (pituitary glands, thyroid glands, adrenal glands, pancreas, ovaries and testis) and their functions. Note: Hormones that need to be explained are Anti-diuretic hormone (ADH), adrenaline, insulin, thyroxine, oestrogen and testosterone.
	7.1.2 Explain with examples the cause and effects of hormonal imbalance on health.	Suggested activity: Conduct a study on the cause and effects of the endocrine system malfunction such as: • Diabetes insipidus • Diabetes mellitus • Acromegaly • Low metabolism rate
7.2 Disturbances to body coordination	Pupil is able to: 7.2.1 Explain with examples the types of drugs.	Suggested activity: Listen to a talk from Agensi Antidadah Kebangsaan (AADK)/ Pharmacist and prepare a review to explain the examples and effects of taking drugs.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.2.2 do reasoning on the effects of drugs and alcohol abuse on body coordination and mental health.	Note: The effects of drugs and alcohol abuse on body coordination such as: • Hormonal imbalance • Slurring of speech • Slow reflex action • Loss in balance The effects of drugs and alcohol abuse on physical and mental health are: • Liver cirrhosis • Stomach ulcer • Violent behaviour • Hallucination • Insanity
7.3 Healthy mind	Pupil is able to: 7.3.1 Justify the need for a community who have healthy minds.	Suggested activity: Evaluate the importance of having a healthy mind towards family, workplace, community and country by conducting a campaign

PERFORMANCE STANDARD
BODY COORDINATION

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and scientific skills on body coordination
2	Understand the body coordination and able to explain based on the understanding
3	Apply the knowledge on body coordination and able to accomplish simple task
4	Analyse the knowledge on body coordination in context of problem solving on the occurrences or natural phenomena
5	Evaluate the knowledge on body coordination in context of problem solving and decision making to accomplish or accomplish a task
6	Create using knowledge and science skills on nutrition and food technology in context of problem solving and decision making or accomplish on a new situation in a creative and innovative way with regards to social values/economy/community culture

THEME

EXPLORATION ELEMENTS IN NATURE

LEARNING AREA

8.0 ELEMENTS AND SUBSTANCES

9.0 CHEMICAL IN INDUSTRIES

10.0 CHEMICAL IN MEDICINE AND HEALTH

Theme 3: EXPLORATION ELEMENTS IN NATURE

This theme aims to provide understanding of the variety materials that can be produced from the Earth's resources to make into various man-made materials using the modern technology. Exploration of radioactive materials lead to its applications in daily life. Focus is also given to the use of chemicals in medicine and food industry so as to create awareness that humans are responsible in managing nature wisely for the well-being of life.

Learning area:**8.0 Elements and Substances**

- 8.1 Matter
- 8.2 Modern Periodic Table of Elements
- 8.3 Isotope

9.0 Chemicals in Industry

- 9.1 Alloy
- 9.2 Glass and Ceramic
- 9.3 Polymer

10.0 Chemicals in Medicine and Health

- 10.1 Traditional and complementary medicine
- 10.2 Food supplements and health foods
- 10.3 Antioxidant
- 10.4 Health Products

8.0 ELEMENTS AND SUBSTANCES

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.1 Matter	Pupil is able to: 8.1.1 Explain with examples atoms, molecules and ions. 8.1.2 Explain the existence of elements in various form.	Suggested activity: Create a multimedia presentation about materials that are made of atoms, molecules and ions in daily life. Note: Example: Iron Hammer – material that is made up of iron atoms. Rust – material that is made up of iron ions. Example: Hydrogen Air – Hydrogen gas exists as molecules. Lime juice – Hydrogen exists as ions.
8.2 Modern Periodic Table of Elements	Pupil is able to: 8.2.1 Analyse the Modern Periodic Table of Elements. 8.2.2 Deduce the principle of arranging the elements in the Modern Periodic Table of Elements.	Suggested activity: Prepare a multimedia presentation to show the relationship between arrangement of elements and their proton number in the Modern Periodic Table of Elements.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	8.2.3 Draw and write the electron arrangement of elements in its group.	Note: Emphasis on the elements with atomic number 1 to 20
	8.2.4 Explain the formation of positive and negative ions.	Note: Examine the duplet and octet electron arrangement. The formation of positive ions are from atoms of metals and the negative ions from atoms of non-metals.
	8.2.5 Justify the loss and gain of electrons to achieve the stable electron arrangement.	Suggested activity: Problem based learning One of the main problems faced by vehicles and bridges are rusting. Therefore, maintenance of bridges and vehicles is a challenge to a country's economy. The surface of atomic material (e.g iron) must be kept in good condition. Discuss how maintenance work needs to be done to these bridges and vehicles.

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.3 Isotope	Pupil is able to: 8.3.1 Describe isotopes with examples.	Note: Isotopes for the same element have the same number of protons but different number of neutrons
	8.3.2 Determine the number of protons, number of neutrons and nucleon number of isotopes.	Suggested activity: Solve numerical problems regarding number of protons, neutrons and nucleon number of isotopes.
	8.3.3 Communicate about the use of isotopes in various fields.	Suggested activity: Carry out cooperative learning on the use of isotopes in various fields: • Agriculture (Phosphorus-32, Carbon-14) • Archaeology (Carbon-14) • Medicine (Iodine-131, gamma rays dari Cobalt-60) • Paper industry (Amerisium-241) • Food technology (Cobalt-60) • Geology (Carbon-14) • Generating electrical energy (Uranium-235)

**PERFORMANCE STANDARD
ELEMENTS AND SUBSTANCES**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on elements and substances.
2	Understands elements and substances and able to explain the understanding.
3	Apply knowledge of elements and substances and able to accomplish simple task.
4	Analyse knowledge of elements and substances in context of problem solving about events or natural phenomenon .
5	Evaluate knowledge of elements and substances in context problem solving and making decision to carry out a task
6	Create by using knowledge and science skills of elements and substances in context of problem solving and decision making or in carry out a task in new situation creatively and innovatively with regards to the social/ economy/ culture of the community

9.0 CHEMECAL IN INDUSTRY

CONTENT STANDARD	LEARNING STANDARD	NOTES
9.1 Alloy	Pupil is able to:	
	9.1.1 Define and give examples of alloys based on their composition of elements.	Suggested activity: Build model of particle arrangement in metals and alloys.
	9.1.2 Carry out an experiment to compare alloys with its pure metals.	Suggested activity: Study the features of pure metal and alloys such as hardness and resistance to corrosion. Besides the features mentioned above, discuss other characteristics of alloys.
	9.1.3 Justify the use of alloys in daily life.	Note: One of the uses of alloys should involve the description using alloys in the manufacturing of superconductors so as to improve the efficiency of electricity transmission.
9.2 Glass and Ceramics	Pupil is able to:	
	9.2.1 Describe the components of glass and ceramics.	Suggested activity: Provide reviews for sharing sessions about a visit to glass and ceramic manufacturing plants or watching videos.
	9.2.2 Explain with examples the application of glass and ceramics.	Entrepreneurial-based learning is encouraged in creating materials from glass and ceramics.
	9.2.3 Justify the suitability of using glass and ceramics in daily life.	

CONTENT STANDARD	LEARNING STANDARD	NOTES
9.3 Polymer	Pupil is able to:	
	9.3.1 Explain natural polymers and synthetic polymers.	Note: Introduce the following terms: • Monomer • Polymer • Polymerisation • Depolymerisation • Addition Polymerisation
	9.3.2 Explain the process of addition polymerisation.	
	9.3.3 Communicate about the characteristics and process of vulcanization of rubber.	Suggested activity: Study the characteristics of rubber based on: • Natural rubber properties • Action of acid on latex • Action of alkali on latex • Addition of sulphur on rubber Draw a molecular structure diagram to describe the properties of vulcanized rubber.
	9.3.4 Generating ideas about the latest technology based on rubber.	Suggested activity: Collect information and present the latest technology based on rubber.

**PERFORMANCE STANDARD
CHEMICALS IN INDUSTRY**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on chemical industry.
2	Understanding and can explain chemical industry.
3	Apply knowledge on industrial chemical and carry out simple tasks.
4	Analyse knowledge on industrial chemical in the context of problem solving about events or natural phenomena.
5	Evaluate knowledge of industrial chemical in the context of problem solving and decision making to carry out a task.
6	Create a task using science knowledge and skills on industrial chemical in the context of problem solving and decision making or in carrying out a task in a creative and innovative new situation by taking into account social/economic/cultural values of society.

10.0 CHEMICALS IN MEDICINE AND HEALTH

CONTENT STANDARD	LEARNING STANDARD	NOTES
10.1 Traditional Medicine, Modern Medicine and Complementary Medicine	Pupil is able to: 10.1.1 Explain the criteria of traditional medicine, modern medicine and complementary medicine.	Suggested activity: Gather information and create a multimedia presentation about traditional medicine that is practiced in Malaysia. Note: Refer to: <i>Dasar Perubatan Tradisional dan Komplementari Kebangsaan.</i> Penerbit: Bahagian Perubatan Tradisional dan Komplementari, Kementerian Kesihatan Malaysia. (2007)
	10.1.2 Explain the medicines used in traditional, modern and complementary medicine.	Note: Modern medicine is classified into three types: analgesics, antibiotics and psychotherapeutic.
	10.1.3 Justify the use of traditional, modern and complementary medicine.	Suggested activity: Discuss and make multimedia presentations about the efficacy of traditional, modern and complementary medicine.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	10.1.4 Do reasoning about the use of medicine from natural resources and man-made resources in treatments and healthcare.	Suggested activity: Discuss about: • The advantages and disadvantages of vitamin C found naturally in fruits compared to vitamin C in supplements • The side effects of taking medicine from natural and man-made resources
	10.1.5 Conclude the effect of misuse of medicine.	Suggested activity: The discussion should include the following: • Drug abuse • Too dependent on medicines • Consumption of medicines not according to the age specified • Consumption of medicines not according to the dosage perscribed like antibiotics, cough syrup and paracetamol

CONTENT STANDARD	LEARNING STANDARD	NOTES
10.2 Free radicals	Pupil is able to: 10.2.1 Define free radicals. 10.2.2 Do reasoning about the impact of free radicals on human health.	Suggested activity: Gather information from websites and write a report on: • The process of formation of free radical • How free radicals are found in the body • How free radicals act on body cells
10.3 Antioxidant	Pupil is able to: 10.3.1 Describe the antioxidant substances. 10.3.2 Explain the action of antioxidant substance on free radicals.	Suggested activity: Watch a video on how antioxidant acts against free radicals.
	10.3.3 Carry out an experiment to investigate the factors that affect the oxidation of food.	Suggested activity: Design and conduct an experiment on how to slow the process of oxidation of an apple using: • Salt • Sugar • Lemon juice/lime • Sodium bicarbonate

CONTENT STANDARD	LEARNING STANDARD	NOTES
10.4 Health Products	Pupil is able to: 10.4.1 Explain the meaning of active ingredients in health products. 10.4.2 Justify the use of health products available in the market.	Suggested activity: Research based learning There is an abundance of health products in local market nowadays. Pupils are encouraged to gather information for these health products. Refer to the official website of the Ministry of Health Malaysia, to identify the active ingredients found in the products and its effect on health. Make a multimedia presentation to be shared on the school's notice board. Note: Emphasis should be given to skills of analysing, evaluating and thinking creatively and critically.

PERFORMANCE STANDARD
CHEMICALS IN MEDICINE AND HEALTH

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall science knowledge and skills on chemistry in medicine and health
2	Understand and can explain the chemicals in medical and health.
3	Apply knowledge on chemistry in medicine and health and be able to carry out simple tasks.
4	Analyse knowledge on chemistry in medicine and health in the context of problem solving about event or natural phenomena
5	Evaluate knowledge of chemistry in medicine and health in the context of problem solving and making decision on a task.
6	Create a task using scientific knowledge and skills on chemistry in medicine and health in the context of problem solving and decision-making or in carrying out a task in a creative and innovative new situation taking into account the social / economic / cultural value of society.

THEME

ENERGY AND SUSTAINABILITY OF LIFE

LEARNING AREA

11.0 FORCE AND MOTION

12.0 NUCLEAR ENERGY

Theme 4:

ENERGY AND SUSTAINABILITY OF LIFE

This theme provides an introduction to the basic principles of force and motion, includes the applications of this science concepts in life. Mathematical thinking skills is emphasized in solving everyday life problems. Emphasis is also given to the production of nuclear energy to solve issue on energy and the importance of correct management of radioactive waste to prevent any catastrophe.

Learning area:

11.0 Force and Motion

- 11.1 Linear motion
- 11.2 Graph of Linear motion
- 11.3 Gravitational Acceleration and Free Fall
- 11.4 Mass and inertia

12.0 Nuclear Energy

- 12.1 The Use of Nuclear Energy
- 12.2 The Production of Nuclear Energy
- 12.3 Impact of Using Nuclear Energy
- 12.4 Nuclear Energy in Malaysia

11.0 FORCE AND MOTION

CONTENT STANDARD	LEARNING STANDARD	NOTES
11.1 Linear motion	Pupil is able to: 11.1.1 Explain the difference between distance and displacement and their units in daily life.	Suggested activity: Carry out an activity to show the difference between distance and displacement of two locations on a map. Note: Introduce measuring instruments like meter ruler, measuring tape, road meter and laser range meter.
	11.1.2 Explain with examples the meaning of speed, average speed, velocity and acceleration and their units in daily life.	Suggested activity: Discuss situations in daily life to understand the meaning of speed, average speed, velocity and acceleration. Discussions should also include motions with • Positive and negative value of velocity • Positive and negative value of acceleration Conduct activities to determine the speed, average speed, velocity and acceleration of an object using a ticker tape timer, photogate or any other suitable methods.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Note: Speed is defined as the rate of change of distance. S.I unit for speed is meter per second (ms^{-1}) $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ Average speed = $\frac{\text{Total distance}}{\text{Total time}}$ Velocity is defined as the rate of change of displacement. S.I unit for velocity is meter per second (ms^{-1}) $\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$ Acceleration is defined as the rate of change of velocity. S.I unit for acceleration is meter per second per second (ms^{-2}) $a = \frac{v - u}{t}$ where; a = acceleration v = final velocity u = initial velocity t = time

CONTENT STANDARD	LEARNING STANDARD	NOTES
	11.1.3 Solve problems that involve speed, average speed, velocity and acceleration in daily life.	Suggested activity: Solving numerical problems that involve speed, average speed, velocity and acceleration.
	11.1.4 Distinguish between the various types of linear motion.	Suggested activity: Carry out an activity to produce ticker tape charts of linear motion to study: • Uniform velocity • Uniform increasing velocity (uniform acceleration) • Uniform decreasing velocity (uniform deceleration) • Non-uniform velocity
11.2 Linear motion graphs	Pupil is able to: 11.2.1 Interpret the different types of motion from the linear motion graphs to determine distance, displacement, velocity, average velocity and acceleration.	Suggested activity: Draw and interpret the linear motion graph for: • Displacement-time • Velocity-time Solving numerical problems involving linear motion graphs Note: Emphasise the correct use of units.

CONTENT STANDARD	LEARNING STANDARD	NOTES
11.3 Gravitational acceleration and Free Fall	Pupil is able to: 11.3.1 Carry out an experiment to determine the acceleration of the earth's gravity, g .	Suggested activity: Determine the value of acceleration due to gravity, g , using a ticker timer or a free fall kit. Compare the value obtained with the actual value of g . Note: All objects on Earth experience the earth's gravitational force. Objects that fall due to the earth's gravitational force will experience an acceleration due to gravity, g .
	11.3.2 Interpret the motion graph for a free fall object.	Suggested activity: Sketch and describe the shape of motion graphs of an object experiencing free fall. Discussions should include two free fall conditions: • Object released from a certain height • Object thrown vertically upwards
	11.3.3 Carry out an experiment to study free fall and non-free fall.	Suggested activity: Discuss the motion of an object experiencing • Free fall • Non-free fall Discussions should include the experiment conducted by Galileo Galilei.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		STEM Project Based Learning In the event of a major flood, food and medical supplies sometimes need to be dropped from the air. Often these supplies will be damaged due to high velocity on impact upon reaching the surface of the earth. Parachutes are used to reduce the velocity Design and build a parachute to solve this problem. Among the features of the parachute that can be studied are: • Size of the canopy • Material of the canopy • Length of the strings • Number of strings Note: Free fall is the motion of a body due to gravity only. Non-free fall is the motion of a body due to gravity and other forces such as air friction.

CONTENT STANDARD	LEARNING STANDARD	NOTES
11.4 Mass and Inertia	Pupil is able to: 11.4.1 Explain mass. 11.4.2 Explain with examples the meaning of inertia.	Suggested activity: Discuss the meaning of inertia by studying situations that show the existence of inertia in daily life. Note: Introduce Newton's First Law of motion.
	11.4.3 Carry out an experiment to study the relationship between mass and inertia.	Suggested activity: Plan and conduct an experiment to study the relationship between mass and inertia using an inertial balance. Note: The inertial balance was created by NASA to determine the mass of an object in outer space.
	11.4.4 Communicate the effects of inertia in daily life.	Suggested activity: Discuss and share about situations that show benefits and damaging effects of inertia to humans.

PERFORMANCE STANDARD
FORCE AND MOTION

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall knowledge and science skills on force and motion.
2	Understand and able to explain force and motion for sustainability.
3	Apply the knowledge of force and motion and to be able to carry out simple related tasks.
4	Analyze the knowledge of force and motion in the context of problem solving in daily occurrences or natural phenomena.
5	Evaluate the knowledge of force and motion in the context of problem solving and decision making to carry out an assignment.
6	Creating using science knowledge and skills on force and motion in the context of problem solving and decision making or in carrying out an assignment in a creative and innovative new situation by taking into account the social / economic / cultural values of the society.

12.0 NUCLEAR ENERGY

CONTENT STANDARD	LEARNING STANDARD	CATATAN
12.1 Application of Nuclear Energy	Pupil is able to: 12.1.1 Justifies the use of nuclear energy for a country that has been identified.	Suggested activity: Use mind maps to show the benefits and adverse effects of nuclear power sources in comparison with other energy sources. Browse websites to gather information on countries using nuclear power in the world.
12.2 Production of Nuclear Energy	Pupil is able to: 12.2.1 Describe the production of nuclear energy by nuclear fission and nuclear fusion. 12.2.2 Describe the generation of electricity from nuclear energy. 12.2.3 Justify the use of nuclear energy in countries using it.	Suggested activity: Create a multimedia presentation to explain the generation of nuclear energy by: - nuclear fission. - Nuclear fusion. The explanation should include a nuclear reactor diagram. Gather information and do a sharing session about the use of nuclear energy in certain countries.

CONTENT STANDARD	LEARNING STANDARD	NOTES
12.3 Impact of using nuclear energy	Pupil is able to: 12.3.1 Tell a story about the impact of the usage of nuclear weapons on life and the environment. 12.3.2 Conclude the impact of nuclear tests on the environment.	Suggested activity: Browse the website and make a sharing session to get information about: - History of atomic bomb bombings in Hiroshima and Nagasaki - Nuclear tests
12.4 Nuclear Energy in Malaysia	Pupil is able to: 12.4.1 Justify the constructing of nuclear power plant in Malaysia.	Cadangan aktiviti Carry out a debate about the requirement of constructing a nuclear power plant in Malaysia. Nota: Nuclear power can be used as an alternative energy for the future.

**PERFORMANCE STANDARD
NUCLEAR ENERGY**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall knowledge and science skills on nuclear energy.
2	Understand and able to explain nuclear energy.
3	Apply the knowledge of nuclear energy and be able to carry out simple tasks.
4	Analyze the knowledge of nuclear energy in the context of problem solving in daily occurrences or natural phenomena.
5	Evaluate the knowledge of nuclear energy in the context of problem solving and decision making to carry out an assignment.
6	Creating using science knowledge and skills on nuclear energy in the context of problem solving and decision making or in carrying out an assignment in a creative and innovative new situation by taking into account the social / economic / cultural values of the society.

Content Standard,
Learning Standard
and Performance Standard
Form 5

THEME

MAINTENANCE AND CONTINUITY OF LIFE

LEARNING AREA

1.0 MICROORGANISMS

2.0 NUTRITION AND FOOD TECHNOLOGY

3.0 SUSTAINABILITY OF THE ENVIRONMENT

Theme 1:

MAINTENANCE AND CONTINUITY OF LIFE

This theme emphasizes the importance of ensuring the well-being of living things. The topic of microorganisms focuses on understanding the role of microorganisms in life. Emphasis is given to raise awareness about the importance of cleanliness when carrying out daily activities. The topic of nutrition focuses on the calorific requirement and nutrients for healthy growth. Food technology is introduced and issues related to the influx of health products into the market are also given attention so that pupils will become wise consumers especially when selecting products. The issue of pollution is highlighted in the sustainability of the environment allowing pupils to analyse the situations and make the right decisions to ensure that the ecosystem can function efficiently for the survival of living things.

Learning area:

1.0 MICROORGANISMS

- 1.1 World of microorganisms
- 1.2 Useful microorganisms
- 1.3 Prevention and treatment of diseases caused by harmful microorganisms

2.0 NUTRITION AND FOOD TECHNOLOGY

- 2.1 Balanced diet and calorific value
- 2.2 Nutrition requirements in plants
- 2.3 Nitrogen cycle
- 2.4 Food production technology
- 2.5 Food processing technology
- 2.6 Food and supplements

3.0 SUSTAINABILITY OF THE ENVIRONMENT

- 3.1 Product life cycle
- 3.2 Environmental pollution
- 3.3 Environmental preservation and conservation

1.0 MICROORGANISMS

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.1 World of microorganisms	Pupil is able to: 1.1.1 Communicate about microorganisms.	Suggested activity: Conduct quizzes to recall and classify microorganisms into bacteria, fungi, protozoa, viruses and algae based on size, shape, habitat, reproduction and nutrition. Note: Introduce the term 'normal flora'.
	1.1.2 Conduct an experiment to show the presence of microorganisms.	Suggested activity: Compare the growth of bacteria on nutrient agar for • Unwashed hands • Hands washed with water • Hands washed with water and soap Note: Awareness on hand hygiene should be emphasized in all daily activities, especially when handling food.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.1.3 Conduct an experiment to investigate factors that affect the growth of microorganisms.	Suggested activity: Study and discuss the effects of nutrient, moisture, light, temperature and pH values on the growth of microorganismss such as yeast or <i>Bacillus</i> sp.
1.2 Useful microorganisms	Pupil is able to: 1.2.1 Justify the application of useful microorganisms in life.	Suggested activity: Collect information and do multimedia presentation about the role of microorganisms in fields such as: • Medicine (antibiotics, vaccines) • Agriculture (animal digestion, nitrogen-fixing bacteria) • Industries (food, beverages, leather goods) Organize an industrial visit to understand the process of food production or other industrial products that uses microorganisms. Note: Elements of entrepreneurship can be inculcated and practice in this activity.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.2.2 Generate ideas on the potential use of microorganisms in biotechnology and sustainability of the environment.	Suggested activity: Carry out active readings to discuss the potential use of microorganisms as the following: • Production of enzymes from agricultural wastes • Treatment of sewage Reference: <i>Modul Teknologi Hijau Biologi, CETREE USM</i> <i>Tajuk: Memahami impak mikroorganisma ke atas sisa untuk kehidupan lestari</i>
1.3 Prevention and treatment of diseases caused by microorganisms	Pupil is able to: 1.3.1 Explain the concept of the statement 'prevention is better than cure' for diseases caused by microorganisms. 1.3.2 Explain the aseptic techniques to control the spreading of microorganisms.	Note: Examples of aseptic techniques are sterilization, boiling, use of disinfectant, antiseptics and radiation.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.3.3 Conduct an experiment to study the effect of antibiotic on bacterial growth.	Suggested activity: Study the effect of antibiotic concentrations (penicillin) on bacterial growth (<i>Bacillus</i> sp.). Note: Precautions should be adhered to when handling microorganisms.
	1.3.4 Communicate about methods of treatment of infectious diseases.	Suggested activity: Do a multimedia presentation to compare the differences between the usage of antibiotic, antifungal and antiviral to treat infectious diseases: • Usage of antibiotic to treat lung infections • Usage of antifungal to treat athlete's foot • Usage of antiviral to treat shingles Discuss the non-effectiveness of antibiotic when consumed: • At irregular times as prescribed • Non-prescription intake

PERFORMANCE STANDARD

MICROORGANISMS

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on microorganisms.
2	Understand and explain microorganisms.
3	Apply knowledge about microorganisms and able to carry out simple tasks.
4	Analyse knowledge about microorganisms in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about microorganisms in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on microorganisms in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

2.0 NUTRITION AND FOOD TECHNOLOGY

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.1 Balanced diet and calorific value	Pupil is able to: 2.1.1 Describe balanced diet.	Suggested activity: Carry out a Q and A session to recall balanced diet, factors that affect calorific requirements and the amount of energy needed by an individual. Reference: The campaign “ <i>Pinggan Sihat - Suku Suku Separuh</i> ” by the Ministry of Health Malaysia (MOH).
	2.1.2 Conduct an experiment to estimate the energy value in food samples.	Suggested activity: Determine the energy value in food samples (kJg^{-1}) using calorimeter bomb. Note: Energy Value = $\frac{4.2 \text{ Jg}^{-1} \text{ } ^\circ\text{C}^{-1} \times \text{water mass(g)} \times \text{water temperature(} ^\circ\text{C)}}{\text{mass of food sample(g)} \times 1000} \text{ kJg}^{-1}$ 1 ml water = 1g 1 kcal = 4.2 kJ/g

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.1.3 Justify the effects of consuming calories that do not meet individual requirements.	Suggested activity: Collect information about the effects of consuming insufficient or excessive calories. Relate the Malaysians' lifestyle to their eating habits and its effects on their health. Note: Discussions should include restaurants which operate 24 hours, fast food restaurants and junk food advertising.
2.2 Nutrient requirements in plants	Pupil is able to: 2.2.1 Explain with examples the functions of macronutrients and micronutrients to plants.	Suggested activity: Collect information and classify the elements required by plants based on their quantity and functions: • Macronutrients - Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur • Micronutrients - Boron, molybdenum, zinc, manganese, copper and iron

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.2.2 Conduct an experiment to study the effect of macronutrients deficiency on plants.	Suggested activity: Study the effect of macronutrientS deficiency to plant growth (nitrogen, phosphorus and potassium) Note: Proper pre-planning ahead of the experiment is required.
2.3 Nitrogen Cycle	Pupil is able to: 2.3.1 Communicate about the nitrogen cycle and its importance.	Suggested activity: Collect information and do a multimedia presentation on the processes and importance of nitrogen cycle.
2.4 Food Production Technology	Pupil is able to: 2.4.1 Communicate about how to improve resources, quality and quantity of food production.	Suggested activity: Gather information and discuss efforts to diversify food sources by various agencies to improve food quality and quantity of national food production such as: • Use quality breeds • Use modern technology • Education and guidance for farmers • Research and development • Optimal use of land and water areas • Efficient land management

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.4.2 Evaluate the use of pesticides and biological controls to increase the quality and quantity of food production.	Suggested activity: Discuss the effects as the following: • Side effects of insecticide use • Improper use of biological control
2.5 Food processing technology	Pupil is able to: 2.5.1 Communicate about food processing technology.	Suggested activity: Create a multimedia presentation on: a) The processing methods involved in producing several samples of food products: • Cooking • Fermentation • Dehydration/drying • Pasteurization • Canning • Freezing • Irradiation • Vacuum packaging

CONTENT STANDARD	LEARNING STANDARD	NOTES
		b) Chemicals used in food processing such as preservatives, food colouring, bleaches, flavours, stabilizers, sweeteners, antioxidants and emulsifiers with examples. c) The impact of using chemicals in food processing on human and pets' health that will increase the cost of treatment and subsistence.
2.6 Food and supplements	Pupil is able to: 2.6.1 Communicate about issues related to health foods and health supplements.	Suggested activity: Collect information and discuss about health food, health supplements and Halal Food status. Create a multimedia presentation on: • Food Act 1983 • Food Regulations 1985 • Malaysia's Halal Certification Procedure
	2.6.2 Communicate about issues related to Halal Food Status.	

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Note: Emphasis should be given to the following: • Food and beverage products are regulated by Food Safety and Quality Division, MoH • Health supplements and traditional drug preparations need to be registered with the Drug Control Authority, MOH before being marketed • Raising student awareness as consumers who can evaluate the influx of health products that may be harmful in the market

**PERFORMANCE STANDARD
NUTRITION AND FOOD TECHNOLOGY**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on nutrition and food technology.
2	Understand and explain nutrition and food technology.
3	Apply knowledge about nutrition and food technology and able to carry out simple tasks.
4	Analyse knowledge about nutrition and food technology in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about nutrition and food technology in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on nutrition and food technology in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

3.0 SUSTAINABILITY OF THE ENVIRONMENT

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.1 Product Life Cycle	Murid boleh: 3.1.1 Explain the meaning of carbon footprint. 3.1.2 Break down the product used by individual in a day.	Suggested activity: Create a table to observe how a product is used in one day from the early hours of the morning until bedtime which involves the use of electricity, water, transportation, food, waste and the release of greenhouse gases. The frequency of the product used should also be mentioned. Some of the questions to be answered: • Is the product environmentally friendly? • What are the negative impact in the process of manufacturing the product? • Is the product safe to be used? • How much waste is produced after the product is used? • What other product can be produced from the waste?

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.1.3 Justify the action that needs to be taken that is carbon handprint to reduce the emission of greenhouse gases in one day of one's life.	Note: Consumers need to evaluate the product to ensure that it does not negatively impact environmental sustainability. Reference: <i>Modul Teknologi Hijau BIOLOGI, CETREE USM</i> <i>Tajuk: Enzim Teknologi Hijau</i>
	3.1.4 Communicate about the life cycle of a product.	Suggested activity: Sketch the common life cycle of a product from source to disposal through recycling (cradle to cradle life cycle) or through decaying (cradle to grave life cycle). Note: Introduce the term upcycle.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.1.5 Generate ideas about efficient management of plastic waste towards environmental sustainability.	Suggested activity: STEM's project Based Learning Plastic pollution is the accumulation of plastic products in the environment that have adverse effects on wildlife, their habitats and humans. Furthermore, the chemical structure of most plastics allows them to withstand the natural decomposition process, resulting in plastics taking a longer time to decompose. Conduct a study on plastic pollution and collect data to organize a campaign on the impact of plastic use to raise awareness among school and local communities. Note: Introduce the issue of microplastic in the food chain. References: • Modul Teknologi Hijau KIMIA, CETREE USM. Tajuk: Melestarikan Polimer Mesra Alam • Modul Teknologi Hijau FIZIK, CETREE USM. Tajuk: Apungan Mesra Alam

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.2 Environmental Pollution	Pupil is able to: 3.2.1 Explain the types and sources of environmental pollution.	Suggested activity: Use a graphic organizer to show the types and sources of environmental pollution. Note: Pollution that need to be emphasized are: • Greenhouse effect and global warming • Acid rain • Soil pollution • Water pollution (including eutrophication) • Thermal pollution • Climate change
	3.2.2 Study the water pollution level from domestic waste.	Suggested activity: Measure the Biochemical Oxygen Demand, BOD as a water pollution parameter for different water samples. Note: The water pollution level is determined by the time taken for the methylene blue solution to decolourize. Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM.</i> <i>Tajuk: Justifikasi teknologi hijau dalam elektrokimia</i>

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.2.3 Create and design a purification method for contaminated water using green technology.	Suggested activity: Use effective microorganisms to treat contaminated water. Note: Introduce the term effective microorganisms. Reference: <i>Modul Teknologi Hijau SAINS, CETREE USM</i> <i>Tajuk: Sisa menjadi Wira Hijau</i>
3.3 Preservation and Conservation of the Environment	Pupil is able to: 3.3.1 Justify the role of individuals in managing natural resources to maintain the balance in the environment.	Suggested activity: Collect information on how to reduce carbon dioxide content in the atmosphere by using microalgae (negative emission technology). Discuss the use of Green Technology in the following sectors: • Hybrid cars • Solar technology • Biodiesel • Green buildings • Zero Carbon Emission Note: Introduce the term: Eco-currency.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		References: • Modul Teknologi Hijau BIOLOGI, CETREE USM Tajuk: Teknologi Penanaman Vertikal ke arah Pertanian Lestari • Modul Teknologi Hijau FIZIK, CETREE USM. Tajuk: Bangunan Mesra Hijau • Modul Teknologi Hijau FIZIK, CETREE USM Tajuk: Tenaga Solar dan Matahariku
	3.3.2 Debate on the role of United Nations in addressing environmental issues globally.	Suggested activity: Debate on the role of United Nations on the basis of several conventions that have been held like the Kyoto Protocol, the Rio Conference etcetera.

PERFORMANCE STANDARD
SUSTAINABILITY OF THE ENVIRONMENT

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on sustainability of the environment.
2	Understand and explain on sustainability of the environment.
3	Apply knowledge about on sustainability of the environment and able to carry out simple tasks.
4	Analyse knowledge about on sustainability of the environment in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about on sustainability of the environment in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on on sustainability of the environment in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

THEME

EXPLORATION OF ELEMENTS IN NATURE

LEARNING AREA

4.0 RATE OF REACTION

5.0 CARBON COMPOUNDS

6.0 ELECTROCHEMISTRY

Theme 2: EXPLORATION OF ELEMENTS IN NATURE

This theme aims to provide understanding about the rate of chemical reactions, carbon compounds and electrochemistry. Focus is given on the concept of the rate of chemical reactions, which is a fundamental requirement in the industrial field. The exploration of carbon compounds depends on their application in daily life. The field of electrochemistry also contributes to the industrial development in Malaysia. The understandings gained will create awareness that human are responsible for managing nature wisely for the well-being of life.

Learning Area: 4.0 RATE OF REACTION

- 4.1 Introduction to rate of reaction
- 4.2 Factors affecting the rate of reaction
- 4.3 Application of rate of reaction

5.0 CARBON COMPOUNDS

- 5.1 Introduction to carbon compounds
- 5.2 Hydrocarbons
- 5.3 Alcohol
- 5.4 Fats
- 5.5 Palm oil

6.0 ELECTROCHEMISTRY

- 6.1 Electrolytic cell
- 6.2 Chemical cell

4.0 RATE OF REACTION

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.1 Introduction to rate of reaction	A pupil is able to: 4.1.1 Explain with examples of fast reactions and slow reactions in daily life. 4.1.2 Define the rate of reaction. 4.1.3 Determine the rate of reaction.	Suggested activity: Carry out an activities to identify examples of fast and slow reactions and solve numerical problems involving data analysis.
4.2 Factors affecting rate of reaction	4.2.1 Carry out experiments to study factors affecting rate of reaction.	Suggested activity: Investigate the factors such as temperature, concentration, size of reactant and catalyst that affect the rate of reaction. Note: Other factor that affects the rate of reaction is pressure.
4.3 Aplication of rate of reaction	4.3.1 Communicate about the application of rate of reaction in daily life and industries.	Note: Haber Process and Contact Process need to be discussed.

**PERFORMANCE STANDARD
RATE OF REACTION**

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on rate of reaction.
2	Understand and explain rate of reaction.
3	Apply knowledge about rate of reaction and able to carry out simple tasks.
4	Analyse knowledge about rate of reaction in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about rate of reaction in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on rate of reaction in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

5.0 CARBON COMPOUNDS

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.1 Introduction to carbon compounds	A pupil is able to: 5.1.1 Identify carbon compounds in nature.	Note: Introduction to organic carbon compounds and inorganic carbon compounds.
	5.1.2 Explain the importance of Carbon Cycle.	Suggested activity: Illustrate a diagram of Carbon Cycle.
5.2 Hydrocarbons	A pupil is able to: 5.2.1 Describe hydrocarbon compounds and explain how carbon compounds are obtained from natural sources.	Suggested activity: Carry out fractional distillation for petroleum. Note: Saturated and unsaturated hydrocarbons should be introduced.
	5.2.2 Name members of the homologous group of alkanes and alkenes from carbon 1 to carbon 6.	Suggested activity: Build and name molecular model of alkanes and alkenes. Note: Only the first 6 straight-chain alkanes and alkenes are introduced.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.2.3 Communicate about alternative energy sources and renewable energy in daily life.	Suggested activity: STEM Project Based Learning Waste disposal sites release carbon dioxide and methane gas due to decomposition of organic waste. There are countries that use methane gas to generate electricity. Plan a project to produce methane gas from the food waste from the school canteen. Share the findings with the school community. Note: Precautions should be taken during the production of methane gas as it is flammable. Reference: <i>Modul Teknologi Hijau SAINS, CETREE USM.</i> <i>Title: Sisa Menjadi Wira Hijau.</i>

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.3 Alcohol	A pupil is able to: 5.3.1 Describe the preparation of alcohol.	Suggested activity: Carry out the fermentation process using various types of fruit or starchy food. Note: Purification methods through distillation process should be carried out.
	5.3.2 Identify the physical properties and chemical properties of alcohol.	Suggested activity: To study the physical properties of alcohol based on: • Colour • Smell • Physical properties at room temperature • Solubility in water • Volatility • Boiling point Carry out activities to study the chemical properties of alcohol through the process: • Combustion • Esterification

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.3.3 Communicate about the uses of alcohol in daily life.	Note: The uses of alcohol are as follows: • Fuel • Medicine • Cosmetics • Industry
	5.3.4 Communicate about the effects of excessive alcohol consumption.	Suggested activity: Create posters/ flyers/ scrapbooks on effects of excessive alcohol consumption on health
5.4 Fats	A pupil is able to: 5.4.1 State the content of fats and its sources. 5.4.2 Compare and contrast between saturated and unsaturated fats. 5.4.3 Explain with examples, the effects of eating food containing excess fat on health.	Suggested activity: Collect information and prepare multimedia presentation about: • Fat content from various sources • Saturated and unsaturated fats • The effect of excess fat intake on health

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.5 Palm oil	A pupil is able to	
	5.5.1 Describe the structure of palm oil fruit.	Suggested activity: Draw and label the cross section of the palm oil fruit.
	5.5.2 Identify the quantity of oil from pulp and kernel.	Suggested activity: Produce oil from palm oil fruits in the laboratory.
	5.5.3 Explain in order the process of palm oil extraction in industry.	Suggested activity: Organize a visit to the palm oil processing factory or to Malaysian Palm Oil Board, (MPOB).
	5.5.4 Describes components of palm oil.	Suggested activity: Search online and present the findings using a graphic organizer on the differences of composition in palm oil and other vegetable oils such as fatty acids and glycerol.
	5.5.5 Compare and contrast the composition of palm oil with other vegetable oils.	
	5.5.6 State the chemical properties of palm oil	Note: The chemical properties of palm oil are studied in the following aspects: • Oxidation • Hydrolysis • Esterification
	5.5.7 Explain the emulsification process of palm oil.	

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.5.8 List the nutritional content of palm oil.	Note: Examples of nutrients in palm oil such as fat, vitamins, antioxidants and others.
	5.5.9 Justify the use of palm oil in healthcare and food.	Suggested activity: Search online and discuss the use of palm oil products and its effects on health. Example of palm oil products: • Medicine • Plastic surgery • Cosmetic • Prostatic
	5.5.10 Carry out an experiment to produce soap through saponification process.	Note: Encourage the use of natural fragrance to produce fragrant soap. Elements of entrepreneurship can be applied and practiced in this activity. Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM.</i> <i>Tajuk: Minyak Masak Terpakai Ke Arah Kelestarian.</i>

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.5.11 Communicate about the cleansing action of soap.	Note: View video or simulation to discuss: • structure of soap molecule • cleansing action of soap Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM. Tajuk: Minyak Masak Terpakai Ke Arah Kelestarian.</i>
	5.5.12 Generate ideas on sustainable management and their importance in the palm oil industry.	Suggested activity: Conduct a debate/forum on the efficient management of the oil palm industry to counter the negative perception of western country on local palm oil. Note: The scope of the management discussed is: • Land use • Wastewater • Air quality • Palm oil waste

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Introduce the concept of zero waste in the palm oil industry. Reference: <i>Modul Teknologi Hijau BIOLOGI, CETREE USM.</i> <i>Tajuk: Memahami Impak Mikroorganisma Ke Atas Sisa Untuk Kehidupan Yang Lestari.</i>

PERFORMANCE STANDARD

CARBON COMPOUNDS

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on carbon compounds.
2	Understand and explain carbon compounds.
3	Apply knowledge about carbon compounds and able to carry out simple tasks.
4	Analyse knowledge about carbon compounds in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about carbon compounds in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on carbon compounds in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

7.0 ELECTROCHEMISTRY

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.1 Electrolytic Cell	A pupil is able to: 6.1.1 Understand electrolysis.	Suggested activity: Draw and label the electrolytic cell structure. Note: Introduce terms in electrolysis terms such as anode, cathode, anion, cation, electrolyte and non-electrolyte.
	6.1.2 Carry out an experiment to study electrolysis of ionic compounds in various conditions.	Suggested activity: Carry out electrolysis on ionic compounds in solid, molten and aqueous state. Note: Explain the movement of ions to electrodes in the electrolysis process. Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM.</i> <i>Tajuk: Mewajarkan Teknologi Hijau dalam Elektrokimia.</i>

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.1.3 Carry out an experiment to study the factors affecting the products in electrolysis.	Note: Factor affecting the products in electrolysis • Position of ions in the electrochemical series • Concentration of electrolyte • Types of electrode
	6.1.4 Communicate about application of electrolysis in the industries.	Note: Application of electrolysis in industries like: • Extraction of metal • Electroplating of metal • Purification of metal • Waste water treatment using electro-coagulation Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM. Tajuk: Mewajarkan Teknologi Hijau dalam Elektrokimia.</i>
6.2 Chemical cell	A pupil is able to: 6.2.1 Explain the energy change in a simple chemical cell.	Suggested activity: Construct a simple chemical cell Note: Indicates the process of converting chemical energy to electrical energy

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.2.2 Generate ideas on application of chemical cell concepts in generating electricity from a variety of sources.	Suggested activity: STEM Project Based Learning Generation of electrical energy can be obtained from a variety of sources. An example of simple chemical cell is a device that can convert chemical energy into electrical energy. Plan one activity to produce electrical energy from • Fruits or any parts of the plant • Sea water Reference: <i>Modul Teknologi Hijau KIMIA, CETREE USM. Tajuk: Mewajarkan Teknologi Hijau dalam Elektrokimia.</i>

PERFORMANCE STANDARD

ELECTROCHEMISTRY

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on electrochemistry.
2	Understand and explain electrochemistry.
3	Apply knowledge about electrochemistry and able to carry out simple tasks.
4	Analyse knowledge about electrochemistry in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about electrochemistry in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on electrochemistry in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

THEME

ENERGY AND SUSTAINABILITY OF LIFE

LEARNING AREA

7.0 LIGHT AND OPTICS

8.0 FORCE AND PRESSURE

Theme 3

ENERGY AND SUSTAINABILITY OF LIFE

This theme focuses on the application of physics concept in daily life. The topic of light and optics is an extension of the concept that has been introduced in the lower secondary level. The use of mathematical formulae allows the concept of light to be easier to understand. The use of lenses in optical tools are now expanded. Pupils use creativity and innovation to design or create a tool using the concept of transfer of pressure in fluids that facilitates and improves work efficiency.

Learning area:

7.0 LIGHT AND OPTICS

7.1 Formation of image by lenses

7.2 Optical instruments

8.0 FORCE AND PRESSURE

8.1 Pressure in fluids

7.0 LIGHT AND OPTICS

LEARNING STANDARD	CONTENT STANDARD	NOTES
7.1 Formation of image by lenses	Pupil is able to: 7.1.1 Describe convex lenses as a converging lenses and concave lenses as a diverging lenses.	Suggested activity: Use an optical ray kit to: • show a convex lenses as a converging lenses and a concave lenses as a diverging lenses • determine the focal point for convex and concave lenses
	7.1.2 Determine the focal length of a convex lens using a distant object.	Suggested activity: Carry out an activity to determine the focal length for a convex lens using a distant object.
	7.1.3 Determine the characteristics of images formed by convex and concave lenses using ray diagrams.	Suggested activity: Draw ray diagrams to determine the characteristics of images formed by convex and concave lenses for different object distances: • $u > 2f$ • $u = 2f$ • $f < u < 2f$ • $u = f$ • $u < f$

LEARNING STANDARD	CONTENT STANDARD	NOTES
		Note: Introduce the optical terms namely principal axis, lens axis, optical center (O), focal point (F), object distance (u), image distance (v) and focal length (f). A convex lens is used as a magnifying lens when $u < f$.
7.2 Optical instruments	Pupil is able to: 7.2.1 Describes the formation of the final image formed by telescopes and microscopes.	Suggested activity: Describes the formation of final image formed by a telescope and a microscope with the help of ray diagrams. Note: The magnifying power of a microscope is the product of the magnifying power of the object lens and the eyepiece, thus justifying the use of specific microscope lenses to study different microscopic objects.

LEARNING STANDARD	CONTENT STANDARD	NOTES
	7.2.2 Design and build a simple telescope.	Suggested activity: Build a simple telescope model. Note: At normal adjustment, the distance between the object lens and the eyepiece = $f_o + f_e$ f_o = focal length of the object lens f_e = focal length of the eyepiece
	7.2.3 Communicate about the application of lenses in optical instruments.	Suggested activity: Discuss the use of lenses in instruments such as cameras, smartphones, LCD projectors, spectacles, magnifying glass and CCTV. Further discussion on the limit of the thickness of a smartphone based on the focal length of the camera lens. Carry out a multimedia presentation on the contribution of science and technology in the creation of instruments that can overcome the limitations of human sight.

PERFORMANCE STANDARD

LIGHT AND OPTICS

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on light and optics.
2	Understand and explain light and optics.
3	Apply knowledge about light and optics and able to carry out simple tasks.
4	Analyse knowledge about light and optics in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about light and optics in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on light and optics in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

8.0 FORCE AND PRESSURE

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.1 Pressure in fluids	Pupil is able to: 8.1.1 Explain the concept of pressure in fluids in an enclosed system	Suggested activity: Carry out an activity to explain Pascal's principle using Pascal's piston. Note: Pascal's principle is described as pressure being uniformly transmitted in the fluid in an enclosed system. Explanation of the four fundamental principles of hydraulic systems should be emphasized: • Liquids have no shape. • Liquids are incompressible. • Transmit pressure in all directions • Able to perform heavy tasks.
	8.1.2 Communicate about the application of Pascal's principle in daily life.	Suggested activity: Gather information on the application of Pascal's principle in daily life such as: • Hydraulic jack system • Hydraulic brake system • Dental care chair

CONTENT STANDARD	LEARNING STANDARD	NOTES
	8.1.3 Explain the relationship between fluid velocity and pressure.	Suggested activity: Carry out an activity to describe Bernoulli's principle using a Venturi tube. Discuss natural phenomena such as the roof of a house being lifted during a storm and how to overcome the problem.
	8.1.4 Communicate about the application of Bernoulli's principle in daily life.	Suggested activity: Research and report on the application of Bernoulli's principle in daily life such as the aerofoil shaped wings of an airplane, helicopters, drones, bunsen burners, safety lines at the railway stations and in various sports. Note: The resulting lift on the wings of an airplane results from: • Aerofoil shape • Introduce the term angle of attack

CONTENT STANDARD	LEARNING STANDARD	NOTES
	8.1.5 Design a tool using the principle of pressure in fluids.	Suggested activity: STEM project-based learning Hydraulic systems work by transmitting pressure through fluids to move a piston. Machinery such as cranes, pumps, excavators and hydraulic jacks are used to lift or lower objects. Design a tool to simplify work using a hydraulic system. Reference: <i>Modul Teknologi Hijau ASAS KELESTARIAN, CETREE USM.</i> <i>Tajuk: Sistem Pengangkat Hijau.</i>

PERFORMANCE STANDARD
FORCE AND PRESSURE

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on force and pressure.
2	Understand and explain force and pressure.
3	Apply knowledge about force and pressure and able to carry out simple tasks.
4	Analyse knowledge about force and pressure in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about force and pressure in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on force and pressure in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

THEME

EARTH AND SPACE EXPLORATION

LEARNING AREA

9.0 SPACE TECHNOLOGY

Theme 4:

EARTH AND SPACE EXPLORATION

This theme focuses on space technology that is satellite which is widely used in today's communications systems. Emphasis is given on the type of orbits that determine the type of satellites to be placed in space. Satellite launch methods are introduced to understand how international space stations are located and how they function in the global community. Knowledge of the use of satellite applications in a Global Positioning System is also emphasized. Pupils also need to understand and make judgements from evidences in making decisions to address the impact of rapid development of space technology for the sake of well-being and survival.

Learning area:

9.0 SPACE TECHNOLOGY

9.1 Satellite

9.2 Global Positioning System (GPS)

CONTENT STANDARD	LEARNING STANDARD	NOTES
9.1 Satellite	Pupil is able to: 9.1.1 Explain the types of satellite orbits.	Suggested activity: Collecting information and describing the types of satellite orbits, that is Low Earth Orbit (LEO), Middle Earth Orbit (MEO), Geosynchronous Orbit (GSO), Geostationary Orbit (GEO) and High Earth Orbit (HEO).
	9.1.2 Explain with diagrams the apogee and perigee positions of a satellite in an elliptical orbit. 9.1.3 Relate the height of an orbit and the velocity of a satellite.	Suggested activity : Carry out activities to identify the relationship between the height of an orbit and the velocity of satellite by: • Identifying satellites and velocity of satellites at different orbital heights • Tabulate the information obtained • Conclude the relationship between the height of the orbit with the velocity of satellite. Note: Examples of URL that can be used: https://in-the-sky.org/satmap_worldmap.php

CONTENT STANDARD	LEARNING STANDARD	NOTES
	9.1.4 Explain how a satellite is launched and placed in orbit.	Suggested activity: Watch videos to explain how to place satellites in orbit directly or through Hohmann's transfer orbit. Find information and differentiate between single launch vehicles, expendable launch vehicles (ELV) and reusable launch vehicle (RLV).
	9.1.5 Explain the function of the space station.	Suggested activity: Gather information about space stations, such as the International Space Station (ISS) and watch videos to discuss the functions and lives of astronauts in the ISS. Note: Introduce microgravity.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	9.1.6 Communicate about the methods for tracking space stations.	Suggested activity: Gather information about the altitude of the orbit and velocity of the ISS and the radius of the Earth to calculate the frequency of ISS orbiting Earth in a day. Keep track of space station positions using smartphone apps and make observations when the space station as it passes through the observer's location.
	9.1.7 Elaborate the impact of rapid development in space technology.	Suggested activity: Gather information on the impact of the rapid development of space technology such as: • Increased waste in space (space junks) • Increased research and development activities
9.2 Global Positioning System (GPS)	Pupils is able to: 9.2.1 Explain Global Positioning Systems (GPS).	Suggested activity: Find information and explain: • Meaning of GPS • How GPS works • Uses of GPS

CONTENT STANDARD	LEARNING STANDARD	NOTES
	9.2.2 Apply GPS coordinate system for navigation purposes.	Suggested activity: Conduct a hiking activity from one location to another (with a minimum distance of 10 m) within the school area using GPS coordinates. Note: GPS coordinates for one location are written in the following two formats: • degrees, minutes and seconds (DMS) • decimal degree (DD) Example of GPS coordinates: National Planetarium DMS format coordinates: 3 ° 08 '22.04' 'N (Latitude) 101 ° 41'22.5 " E (Longitude) DD format coordinates: 3.139456, 101.689593 Rio de Janerio DMS format coordinates: 22 ° 58 '14.60' 'S (Latitude) 43 ° 10 '56.51' 'W (Longitude) DD format coordinates: -22.970722, -43.182365 Examples of navigation apps are like Google Maps and Waze.

PERFORMANCE STANDARD
SPACE TECHNOLOGY

PERFORMANCE LEVEL	DESCRIPTOR
1	Recall the knowledge and science skills on space technology.
2	Understand and explain space technology.
3	Apply knowledge about space technology and able to carry out simple tasks.
4	Analyse knowledge about space technology in context of problem solving on events or natural phenomena.
5	Evaluate knowledge about space technology in context of problem solving and decision making to carry out a task.
6	Design a task using knowledge and science skills on space technology in a creative and innovative ways to solve problems and making decision or carry out a task in a new situation taking into account the social/economic/cultural values of the community.

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