KEMENTERIAN
PENDIDIKAN
MALAYSIA

KURIKULUM STANDARD SEKOLAH MENENGAH

Sains Tambahan

Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 4 dan 5

(EDISI BAHASA INGGERIS)

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Bahagian Pembangunan Kurikulum
MEI 2019

Terbitan 2019

CONTENT

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 Subjects 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 Additional Science 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 Additional 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.
8. Choose a career in science, technology, engineering and mathematics (STEM).

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.

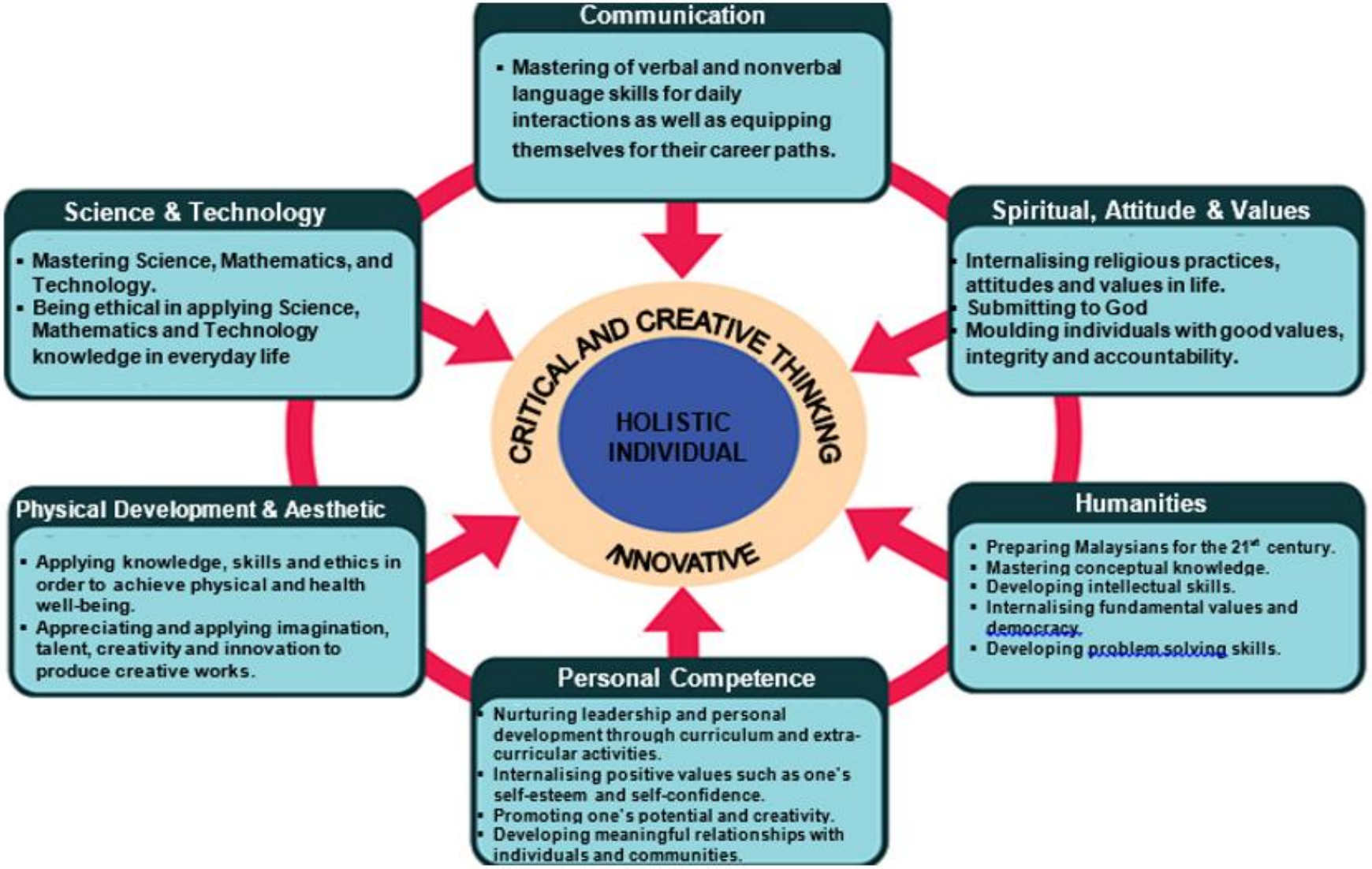

Figure 1: The Framework Of Secondary School Standard-Based Curriculum

FOCUS

The Additional Science subject for 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 like the 4.0 Industrial Revolution. 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.

The Content Standards of the Additional Science Curriculum Form 4 and 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 learners (Figure 2). The inquiry approach includes pupil-centred learning, constructivism, contextual learning, problem-based learning, mastery learning as well as related strategies and methods.

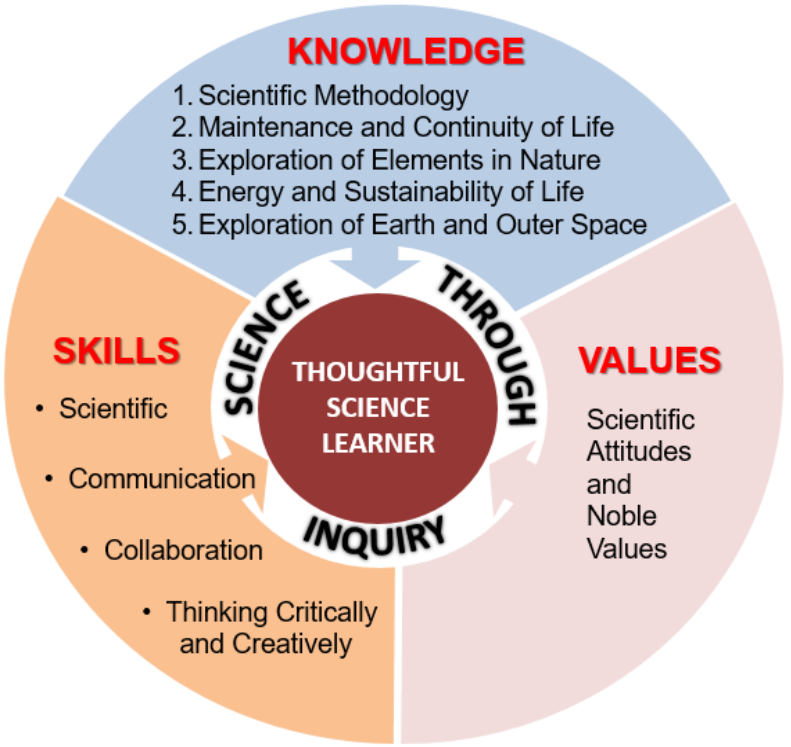

Figure 2: The Conceptual Framework for Science Curriculum

Thoughtful Science

According to 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 learner 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 creatively and critically, generate ideas and solving problem.

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.
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.
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)"*

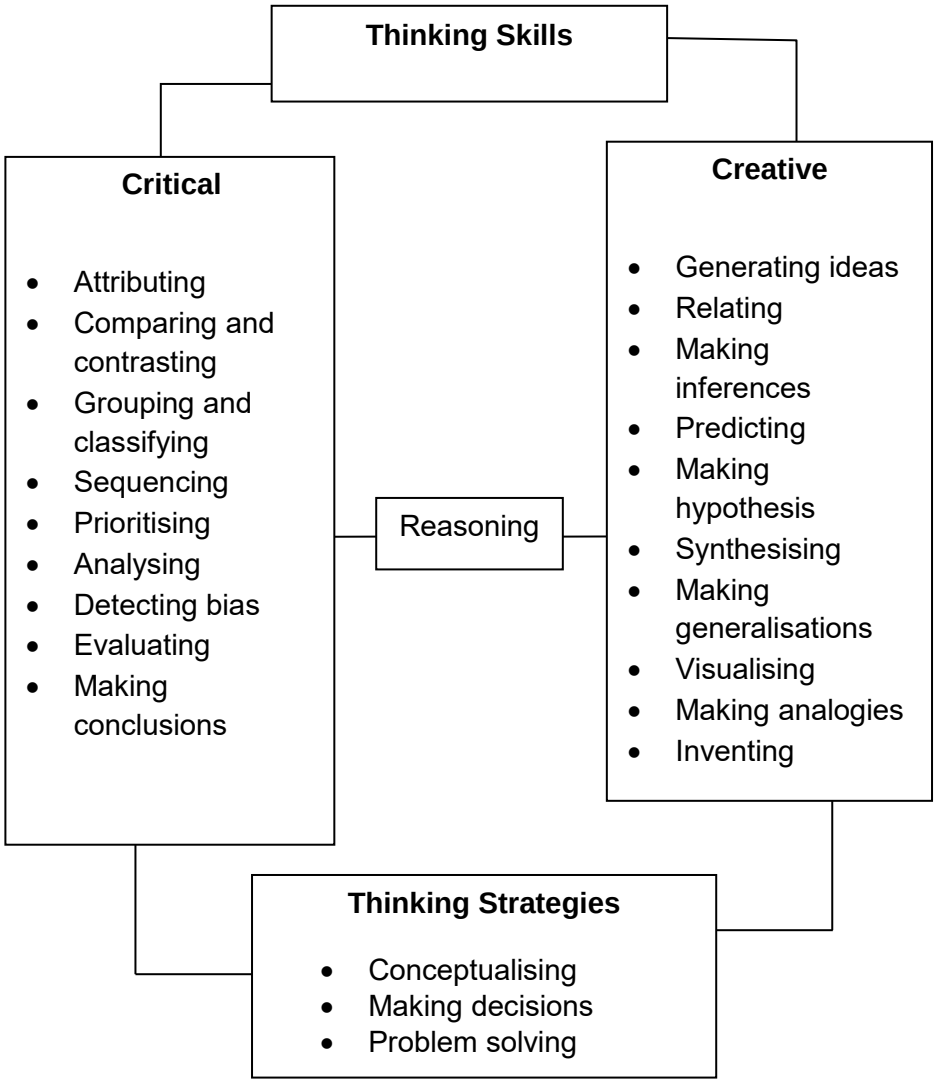

Figure 3: TSTS Model in Science

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.
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
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 futher findings based on observation of objects or phenomena analytically and specifically.
2	Classifying	• Collect/isolate evidens/data/objects/phenomena 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 anexperiment 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 hipotesis	(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

Experiences from learning science can foster positive attitudes 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
   - Collects 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 technologyresponsibly.

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 use 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 skills as well as life skills and inculcating noble values in their careers. 21st century skills aim to produce pupils who have the characteristics specified in the pupil profile as shown in Table 7 that enable them to compete globally. Acquiring the CS and LS in the Science curriculum contributes to the acquisition of 21st century skills among pupils.

Table 7: Pupils' Profile

PUPIL PROFILE	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, using a variety of media and technology.
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 perspective, 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 learning. Enjoy continuous life-long learning experiences.

PUPIL PROFILE	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 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) is explicitly stated in the curriculum to encourage teachers to incorporate them in teaching and learning, hence stimulating structured and focused thinking among pupils. Description of HOTS is focused on four levels 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 ideas, products or methods and innovatively.

HOTS are the ability to apply knowledge, skills and values for reasoning and reflecting in solving problems, making decisions, innovating and creating. HOTS includes critical thinking, creative thinking, reasoning and thinking strategy.

Critical thinking skill is the ability to evaluate an idea in a logical and rational manner to make a fair consideration by using reason and reliable evidence.

Creative thinking skill is the ability to produce or create something new and valuable by using genuine imaginative skill and unconventional thinking.

Reasoning skill is the ability of an individual to consider and evaluate logically and rationally.

Thinking strategy is a way of thinking that is structured and focused to solve problems.

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

TEACHING AND LEARNING STRATEGIES

Teaching and learning strategies in the Additional Science curriculum emphasise on thoughtful learning. Thoughtful learning is a process that helps pupils 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, science, technology and society, contextual learning and mastery learning. Learning activities should therefore be geared towards activating pupils' critical and creative thinking skills and not be confined to routine method. Pupils should be made aware of the thinking skills and thinking strategies that are being used in their learning.

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

Inquiry Approach

Inquiry-discovery approach emphasises learning through experiences. Inquiry generally means to find information, to question and to investigate a phenomenon. 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 conclusions 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 an ideology that suggests pupils learn by building their own understanding that is meaningful to them. The important attributes of constructivism are:

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

Contextual Learning

Contextual learning is an approach that associates learning with pupil's everyday life. This approach involves investigative learning as in the inquiry-discovery approach. In contextual learning, the relationship between knowledge taught and everyday life is explicitly demonstrated. In this context, pupils not only learn in theory but learn to appreciate the relevance of science in their lives.

Mastery Learning

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

Problem/Projects-Based Learning

Problem/project-based learning (PBL) is a pupils-centered pedagogy in which pupil 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 T&L 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 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, environmentand local as well as global community, as shown in Figure 4.

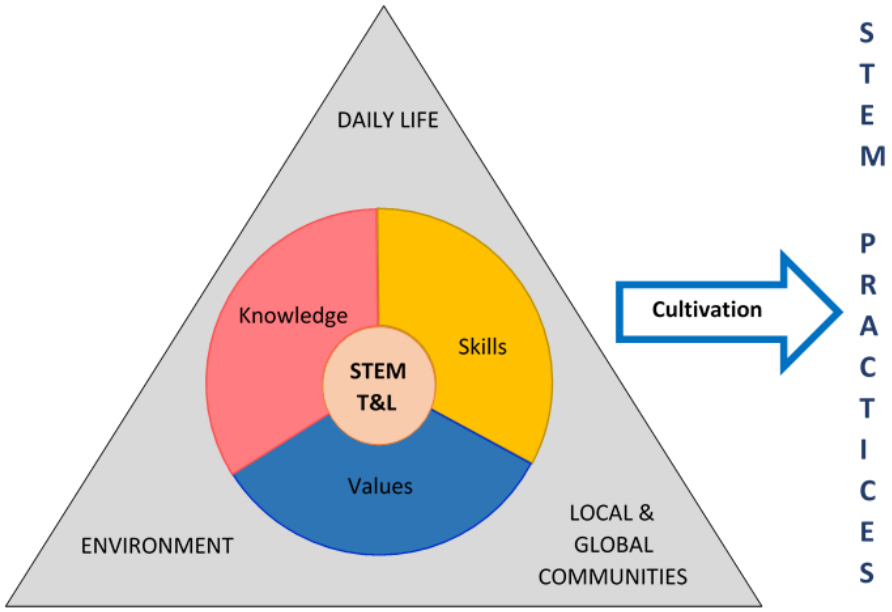

Figure 4: STEM Teaching and Learning Approach

STEM T&L which is contextual and authentic is able to encourage in depth learning amongst 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. Analyzing and interpreting data,
5. Using mathematical and computational thinking,
6. Developing explanation and designing solutions,
7. Engaging in argument and discussion based on evidence, and
8. Acquiring information, evaluating and communicating about the information.

Various T&L methods are able to elevate pupils' interest towards science. Less interesting science lessons will not motivate pupils to study which will affect the pupils' performance. The T&L methods should be based on the curriculum content, pupil's ability and multiple intelligences, as well as resources and facilities available.

Computational thinking is a cognitive process involved in formulating a problem and its solution can be represented in a form that can be effectively implemented by humans/or computers. Computational thinking helps pupils organise, analyse and present data or idea logically and systematically so that the complex problems can be easily solved.

The variety of teaching and learning activities will enhance pupils' interest in science. The less interesting science learning does not motivate pupils to learn and thus will influence pupils' achievement. The teaching and learning activities should be determined based on

the content of the curriculum, the ability of multi-intelligences of pupils as well as the resources and available infrastructure.

Some of the teaching and learning activities suggested are as follows:

Scientific Investigation/Carry Out Experiment

An experiment is a method commonly used in science lessons. Pupils test hypotheses through investigations to discover specific science concepts and principles scientifically. Scientific methods are used when conducting an experiment involving thinking skills, science process skills, and manipulative skills. In general, procedures to follow when conducting an experiment as in Figure 5:

In this standard curriculum, it is suggested that, besides guiding pupils to carry out experiments, pupils are given the opportunity to design experiments, which involves drafting their own experimental method, the data that can be measured, how to analyse data and how to present the results of their experiments.

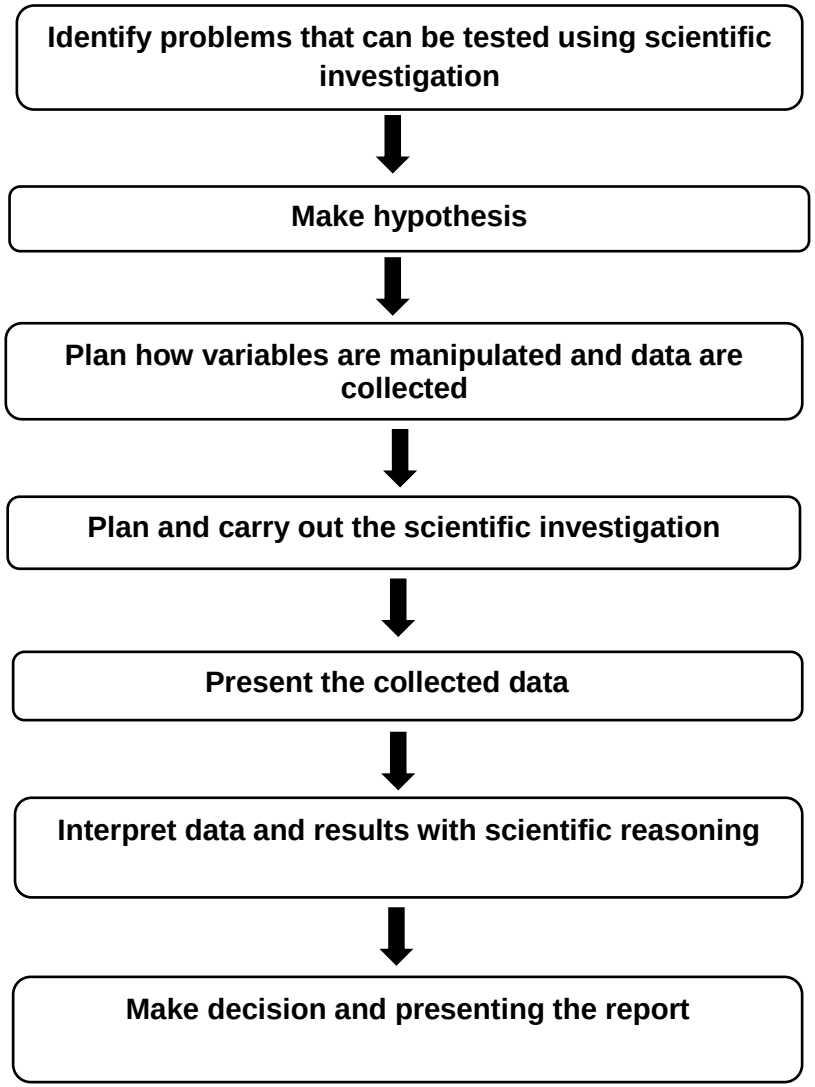

Figure 5: Steps to carry out an experiment

Simulation

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

Project (Collaborative Learning)

A project is an activity carried out individually or in groups to achieve a certain goal that takes a long time and exceeds formal teaching hours. Pupils are required to identify methods to solve the problem given and thus plan the entire project. The outcome of the project either in the form of a report, an artefact or in other forms needs to be presented. Projects encourage the development of problem solving skills, time management skills and self learning.

Visits and Use of External Resources

Learning science through visits to zoos, museums, science centres, research institutes, mangroves swamps and factories can make learning more effective, enjoyable and meaningful. Learning through visits can be optimised by careful planning whereby pupils have to carry out or perform tasks during the visit. Discussion after the visit should be held to conclude the activities carried out.

Application of Technology

Technology is an effective tool for enhancing the learning of science. Through the use of technology such as the television, radio, video, computer, internet, computer software, courseware and computer interfaces make the teaching and learning of science more interesting and effective. Animation and computer simulation is an effective tool for learning of difficult and abstract science concepts and can be presented in the form of courseware or website. Software applications such as word processors, graphic presentation software and electronic spreadsheets are valuable tools for the analysis and presentation of data.

The use of other technologies such as data loggers and computerized user interface in experiments and projects can assist effective in science teaching and learning.

ELEMENTS ACROSS THE CURRICULUM

Elements Across the Curriculum (EMK) is a value-added element applied in the teaching and learning process other than those specified in the standard content. The application of these elements is aimed at strengthening the human capital skills and competency as well as intended to prepare pupils for the challenges of the present and the future. The elements in the EMK are as follows:

1. **Language**
   - The accuracy of the language in instruction should be a priority in all subjects.
   - During the teaching and learning of each subject, emphasis is given on the aspects of pronunciation, sentence structure, grammar and the terminology of the language in order to assist pupils organise ideas as well as communicate effectively.

2. **Environmental Sustainability Awareness**
   - Developing awareness towards the love of the environment in the pupils' lives needs to be nurtured through the teaching and learning process in all subjects.
   - Knowledge and awareness on the importance of the environment would help to shape pupils' ethics in appreciating nature.

3. **Noble Values**
   - Noble values need to be emphasised in all subjects to ensure that pupils will be aware of the importance of these good principles and therefore will practise these elements in their lives.
   - Noble values encompass the aspects of spirituality, humanity and citizenship will be the centre core of the pupils' daily life.

4. **Science and Technology**
   - The increase of interest in the science and technology will help to improve scientific and technological literacy amongst 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 the use of technology in classrooms.

(iv) The use of technology in teaching and learning activities.

5. Patriotism

- Patriotism can be nurtured through all subjects, extra-curricular activities and community services
- Patriotism develops the spirit of love for the country as well as encourages the feelings of 'truly proud to be Malaysians' amongst pupils.

6. Creativity and Innovation

- Creativity is the ability to use imagination in gathering, extracting and generating ideas or creating new or original ideas or through combination of ideas.
- Innovation is the application of creativity through the modification 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 in the classroom.

7. Entrepreneurship

- The incorporation of entrepreneurship elements aims at developing specific attributes and entrepreneurial mind-set that will become a culture amongst pupils.
- Entrepreneurial attributes can be ingrained during lessons through fostering attitude such as diligence, honesty, trustworthiness and responsibility as well as developing creative and innovative mind-set to drive ideas into the market economy.

8. Information and Communication Technology Skills (ICT)

- Information and communication technology 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 content subject.

9. Global Sustainability

- The element of Global Sustainability aims to produce pupils with sustainable thinking, responsive towards the surrounding environment in daily life by applying knowledge, skills and values through sustainable **Consumption and Production** element, global citizenship and unity.
- The element of Global Sustainability is crucial in preparing pupils to face challenges and current issues at local, national and global level.
- This element is taught directly or indirectly in related subjects.

10. Financial Education

- Incorporation of Financial Education element aims to produce future generations capable of making wise financial decisions, practise ethical financial management and skills in managing financial affairs in a responsible manner.
- Financial Education element can be incorporated directly or indirectly into T&L. Direct incorporation of this element is through topics such as money with financial elements explicitely such as calculations of simple interest and compound interest. Indirect infusion of this element can be integrated through other topics across the curriculum. Exposure to financial management in real life is important to prepare pupils with knowledge, skills and values which can be applied effectively and meaningfully.

CLASSROOM ASSESSMENT

Classroom Assessment (CA) is a part of assessment approach which is a process that is planned, executed and reported by the teacher to gather information on pupils' development. This is an ongoing process implemented by the teacher formally and informally to determine pupils' performance level. School assessment should be executed holistically based on inclusive, authentic and localised principles. School Assessment provides valuable feedback to administrators, teachers, parents and pupils to plan further actions towards increasing the pupils' learning development.

CA can be executed by the teacher formatively and summatively. Formative assessment is carried out during teaching and learning process while summative assessment is carried out at the end of a lesson unit, term, semester or year. Teacher needs to plan, construct items, administer, check, record and report pupils' performance level of the subject 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 variety of assessment strategies that can be implemented by teachers and pupils.
- Taking into consideration the various levels of knowledge and skills learned.
- Allows pupils to show a wide range of learning ability.
- Assessing the level of mastery of pupils based on Learning Standards and Performance Standards.
- Take further action for remedial and enrichment.

Additional Science Performance Standards

Classroom Assessment for Additional Science is executed based on three main domains, which are **knowledge, skills and values.** Knowledge assessment in certain themes includes the integration of science process skills, aimed in determining the level of pupils' understanding in specific content standard holistically. Assessment of science process skills 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 basic knowledge and science skills.
2	**Understand** the science knowledge and skills as well as to explain their understanding.
3	**Apply** knowledge and skills to perform simple science tasks.
4	**Analysing** science knowledge and skills in the context of problem solving.
5	**Evaluating** the science knowledge and skills in the context of problem solving and making decision to perform a task.
6	**Create** by using science knowledge and 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 the notes **MUST** be carried out using the inquiry approach. List of scientific investigation/experiments is suggested in DSKP are shown in Table 10.

Table 10: List of Scientific Investigation/Experiments for KSSM Science Form 4

THEME	EXPERIMENTS	
MAINTENANCE AND CONTINUITY OF LIFE	2.1.4	Carry out an experiment to study the competition between plants.
	2.1.5	Carry out an experiment to study the effects of pH on the growth of seedlings.
EXPLORATION OF ELEMENTS IN NATURE	4.3.3	Carry out an experiment to obtain the chemical formula of compounds and the equation of reactions.
ENERGY AND SUSTAINABILITY OF LIFE	7.2.1	Carry out an experiment to formulate the equation F = ma.

THEME	EXPERIMENTS	
ENERGY AND SUSTAINABILITY OF LIFE	8.2.2	Carry out an experiment to determine the specific heat capacity of a solid and a liquid.
	8.3.2	Carry out an experiment to determine the specific latent heat of fusion of ice.
	8.3.3	Carry out an experiment to determine the specific latent heat of vapourisation of water.

Table 11: List of Scientific Investigation/Experiments for KSSM Science Form 5

THEME	EXPERIMENTS	
MAINTENANCE AND CONTINUITY OF LIFE	1.2.4	Carry out an experiment to test the strength of the bone.
	1.2.5	Carry out an experiment to test the relationship between the calsium composition and bone density.
EXPLORATION OF ELEMENTS IN NATURE	2.1.3	Carry out an experiment to compare the solubility of nitrate, sulphate, carbonate and chloride salts in water.
ENERGY AND SUSTAINABILITY OF LIFE	6.1.4	Carry out an experiment to determine the relationship between frequency and wavelength.
	7.2.1	Conduct an experiment to determine the relationship between current and potential difference of conductor..
	7.2.3	Conduct an experiment to determine the relationship between current and potential difference of conductor.

Evaluation report for scientific skills is conducted **twice a year** by referring to Table 12.

Table 12: Rubric for Scientific Investigation

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 explaination or the explaination 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.
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 dan make an accurate conclusion based on the aim of the scientific investigation. • Write a complete report on the scientific investigation.
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.

PERFORMANCE LEVEL	DESCRIPTOR
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 13.

Table 13: 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.
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 with reference to Table 14.

Table 14: Description of Overall Performance Level of Science

PERFORMANCE LEVEL	DESCRIPTORS
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.

CONTENT ORGANISATION

The content for the Science Curriculum Standard Form 1 to Form 5 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 Sustainabilty of Life and Exploration of Earth and Outer Space. However, in every learning year it need not consist of all five themes.

Each theme is divided into several learning areas as shown in Table 15.

Table 14: Description of Overall Performance Level of Science

FORM	THEME	LEARNING AREA	
4	Maintenance and Continuity of Life	1.0	Evolution and Taxonomy
		2.0	Dynamic Ecosystem
	Exploration of Elements in Nature	3.0	Modern Periodic Table of Elements
		4.0	Stoichiometry

FORM	THEME	LEARNING AREA	
	Exploration of Elements in Nature	5.0	Chemical Bonding
		6.0	Energy and Chemical Changes
	Energy and Sustainabilty of Life	7.0	Force and Motion
		8.0	Heat
5	Maintenance and Continuity of Life	1.0	Anatomy and Physiology
	Exploration of Elements in Nature	2.0	Salt
		3.0	Carbon Compounds in Daily Life
		4.0	Energy and Chemical Changes
		5.0	Material Chemistry
	Energy and Sustainabilty of Life	6.0	Waves
		7.0	Electric
	Exploration of Earth and Outer Space	8.0	Oceanography

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 learnng standard comprised of learning scope and scientifc 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 afective 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 afective 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 activites.

Teachers are encouraged to plan activites that will involve the active participation of pupils to generate thinking analitically, critically, innovatively and creatively besides using technology as a platform to achieve the content standard effectively. The implementation of teaching and learnng 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 14.

Table 14: Organisation of the DSKP

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

MAINTENANCE AND CONTINUITY OF LIFE

LEARNING AREA

1.0 EVOLUTION AND TAXONOMY

2.0 DYNAMIC ECOSYSTEM

Theme 1: **MAINTENANCE AND CONTINUITY OF LIFE**

This theme gives an understanding of the evolution process in terms of evidents observed by scientists that pioneered the Evolutionary Theory. The history of how classifying organisms and the importance of classification are emphasized to understand how organisms came to be in a particular ecosystem. The relationship between biotic and abiotic components in an ecosystem is also introduced. Students will carry out field study to understand the relationships in a dynamic ecosystem. Disturbances in ecosystems are also given attention so as to create awareness on the importance of managing development and ecosystem sustainanbly in order to create the balance in nature.

Learning Area:

1.0 Evolution and Taxonomy
- 1.1 Evidence of Evolutions
- 1.2 Evolutions Theory
- 1.3 Classification of Organism

2.0 Dynamic Ecosystem
- 2.1 Abiotic and biotic components in an ecosystem
- 2.2 Colonisation and succession process
- 2.3 Population Ecology
- 2.4 Issues in Ecosystem

1.0 EVOLUTION AND TAXONOMY

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.1 Evidence of Evolution	Pupil is able to: 1.1.1 Explain with examples the changes that occur in organisms based on time. 1.1.2 Explain the evolution process and its importance. 1.1.3 Examine examples of evidence that shows the process of evolution.	**Suggested Activity:** Gather the information from various sources to get the meaning of the evolution process. **Note:** Among the evidence in evolution process are: • Fossil record • The similarities in embrio stages • Homologue structure, vestige and analog
1.2 Evolution Theory	Pupil is able to: 1.2.1 Explain the Evolution Theory presented by Lamarck and Darwin.	**Note:** According to Evolutionary Theory by: • Jean-Baptiste Lamarck argues that evolution takes place based on inherited characteristics (inheritance of acquired characteristic)

CONTENT STANDARD	LEARNING STANDARD	NOTES
		• Charles Robert Darwin presented the Theory of Natural Selection stating that the most adaptable species to the environment will survive to continue life (*survival of the fittest*) **Reference:** Module 26 HEBAT Science (Biodiversity), discuss the Theory of Natural Selection for the adaptation of Darwin's beak bird at Galapagos, Chile.
	1.2.2 Determine the distribution of endemic animals or plants in habitats on the map of the world.	**Note:** The characteristics of organisms must be related to their habitat.
	1.2.3 Explain the diversity of organism which resulted from continental drift.	**Suggested Activity:** Gather information and carry out a presentation on how the animal in the same family are located at different continent. Examples: • African elephants and Asean elephants. • Polar bear and Sun bear

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.2.4 Explain the relationship between the mechanism of natural selection and the diversity of species.	**Suggested Activity:** Gather information and conduct multimedia presentation to explain the relationship between natural selection and diversity of species in nature.
	1.2.5 Do reasoning about the situations related to the process of evolution.	**Suggested Activity:** Discuss problems related to evolution such as: • If the fish evolved into amphibian, why does the fish still exist? • Do evolution still occur? • Do humans affect the evolutionary process? • How do evolution affect me in daily life?
1.3 Classification of Organism	Pupil is able to: 1.3.1 Describe the history and classification of Linneaus Binomial.	**Suggested Activity:** Gather information from the various sources to list 7 taxa in Linneaus classification. **Note:** Introduce the terms of kingdom, phylum, class, order, family, genus and species.

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td rowspan="3"></td><td></td><td>Examples:
<table><tr><th>Taxonomy</th><th>Animal</th><th>Plant</th></tr><tr><td>Kingdom</td><td>Animalia</td><td>Plantae</td></tr><tr><td>Phylum</td><td>Anelida</td><td>Angiospermaphyta</td></tr><tr><td>Class</td><td>Oligochitae</td><td>Dicotyledoneae</td></tr><tr><td>Order</td><td>Terricolae</td><td>Malvales</td></tr><tr><td>Family</td><td>Lumbricidae</td><td>Malvaceae</td></tr><tr><td>Genus</td><td>Lumbricus</td><td>Hibiscus</td></tr><tr><td>Species</td><td>terrestris</td><td>rosa-sinensis</td></tr><tr><td>Common Name</td><td>Earthworm</td><td>Hibiscus</td></tr></table>
Introduce the history of Linneaus Binomial and the method of writing Linneaus Binomial.</td></tr>
<tr><td>1.3.2 Justify the importance of taxonomy in science.</td><td>Suggested Activity:

Gather information and share the importance of taxonomy in the discipline of science.</td></tr>
<tr><td>1.3.3 Communicate about careers related to taxonomy.</td><td>Note:

Examples of taxonomy related career such as botanist, zoologist and taxonomist.</td></tr>
</table>

PERFORMANCE STANDARD

EVOLUTION AND TAXONOMY

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

2.0 DYNAMIC ECOSYSTEM

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.1 Abiotic and biotic components and interactions in an ecosystem	Pupil is able to: 2.1.1 Explain with examples the meaning of habitat, population, community, ecosystem and niche.	**Suggested Activity:** Gather information and conduct multimedia presentation on the common terminology used in ecosystem.
	2.1.2 Identify abiotic and biotic components in an ecosystem.	**Note:** Abiotic component in ecosystem such as: • Temperature • pH value • Light intensity • Humidity • Topography • Micro climate Biotic component in an ecosystem are producers, consumers and decomposer.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.1.3 Explain the interaction between biotic components in terms of nutrition.	**Suggested Activity:** Recall and do a multimedia presentation about the following interactions: • Symbiotic • Saprophytism • Prey and predator
	2.1.4 Carry out an experiment to study the competition between plants.	**Suggested Activity:** Study the intraspecific competition and interspecific competition in plants by using green bean seeds and red bean seeds.
	2.1.5 Carry out an experiment to study the effects of pH on the growth of seedlings.	**Suggested Activity:** Compare the growth of seedlings in two types of soil which have different pH values.
2.2 Colonisation and succession processes in plants	Pupil is able to: 2.2.1 Explain with examples the process of colonisation and succession. 2.2.2 Explain the characteristics of adaptation in pioneer and successor species.	**Suggested Activity:** Carry out a field study in an ecosystem to understand the following: • The terms of pioneer species, successor species, dominant species and climax community • The characteristics of adaptation of pioneer and successor species in a habitat during colonisation and succession process

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.2.3 Explain the changes of habitat in every stages caused by successor species until climax community.	**Suggested Activity:** Surf the internet to study the colonisation and succession processes.
2.3 Population Ecology	Pupil is able to: 2.3.1 Identify the suitable sampling technique to study the size of population of an organism. 2.3.2 Estimate the size of population of organism in a habitat.	**Suggested Activity:** Carry out field study to determine the distribution of organism by using quadrat sampling technique.
	2.3.3 Determine the distribution of organism based on density, frequency and percentage coverage of species.	**Suggested Activity:** Carry out an investigation to observe the relationship between organism population distribution with the changes of one of the abiotic factors.

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.4 Threats to Ecosystems	Pupil is able to: 2.4.1 Describe how human activities threatened the ecosystem. 2.4.2 Communicate about the steps to prevent and control pollution as well as the degradation of ecosystem's quality.	**Suggested Activity:** Carry out gallery walk activity for the issues below: • Global warming • Thinning of ozone layer • Water, air, thermal and sound pollution Refer to the Environmental Department website to get the information about the impact of pollution to ecosystems. STEM project Based-learning: Human activities such as deforestation, development of residential area, industries and transportation will disrupt the ecosystem and all living things on earth. Identify one issue that disrupts the ecosystem and suggest one solution to reduce the pollution and improve the ecosystem's quality. **Note:** Introduce the 16 noble values on environment. Refer to *"Panduan Guru Pendidikan Alam Sekitar Merentas Kurikulum KBSM, Pusat Perkembangan Kurikulum, 1998."*

PERFORMANCE STANDARD

DYNAMIC ECOSYSTEM

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

THEME

EXPLORATION OF ELEMENTS IN NATURE

LEARNING AREA

3.0 MODERN PERIODIC TABLE OF ELEMENTS

4.0 STOICHIOMETRY

5.0 CHEMICAL BOND

6.0 ENERGY AND CHEMICAL CHANGES

Theme 2: **EXPLORATION ELEMENTS IN NATURE**

This theme gives an understanding of the ' of development of the periodic table and how the elements are organized. The deep study of elements in terms of physical properties and chemical properties leads to the understanding of rules and laws that control the actions and behaviors of elements in nature. The uses of elements in the Periodic Table is also emphasized. Stoichiometriy are important to predict a chemical reaction. The skills of making prediction is a goal of studying science besides being able to explain a phenomena scientifically. The understanding of the bonds formed between the elements and the heat changes involved is very important in understanding the physical properties and chemical properties of a chemical substances. The skills of preparating solutions of various molarity are also emphasized in this theme.

Learning Area:

3.0 Periodic Table of Elements
- 3.1 History of Periodic Table
- 3.2 Group 1
- 3.3 Group 17
- 3.4 Group 18
- 3.5 Period 3
- 3.6 Transition Elements

4.0 Stoichiometry
- 4.1 Relative Atomic Mass, Relative Molecular Mass and Relative Formula Mass of Hydrocarbon.
- 4.2 Concept of Mole
- 4.3 Chemical Formula
- 4.4 Concept of Mole and Chemical Equation
- 4.5 Standard Solution

5.0 Chemical Bond
- 5.1 Stability of Elements
- 5.2 Ionic Bond

6.0 Energy and Chemical Changes
- 6.1 Production of Electrical Energy from Chemical Reaction
- 6.2 Redox Reactions

3.0 PERIODIC TABLE OF ELEMENTS

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.1 History of Periodic Table of Elements	Pupil is able to: 3.1.1 Describe the historical development of the Periodic Table of Elements.	**Suggested Activity:** Gather information of the following scientists on the development of the Periodic Table: • Jabir Ibnu Hayyan • Lavoisier • Newland (Octave Law) • Mendeleev (Blank spaces for unknown elements) • Moseley (Modern Periodic Table of Elements)
3.2 Group 1	Pupil is able to: 3.2.1 List the elements in Group 1. 3.2.2 Explain the physical properties and chemical properties of elements in group 1 that is lithium, sodium and potassium.	**Suggested activity:** Gather informations of physical properties for lithium, sodium and potassium based on: • Colour • Physical state • Melting point and boiling point • Hardness • Density • Electrical conductivity • Heat conductivity

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Conduct an investigation to study the chemical properties for reactions of lithium, sodium and potassium with: • Water • Oxygen
	3.2.3 Arrange in order the reactivity of lithium, sodium and potassium. 3.2.4 Predict the physical properties and chemical properties of other elements in Group 1. 3.2.5 Communicate about the uses of Group 1 elements in daily life.	**Suggested Activity:** Gather information and create multimedia presentation about elements in Group 1.
3.3 Group 17	Pupil is able to: 3.3.1 Identify the elements in Group 17. 3.3.2 Explain the physical properties and chemical properties of elements in Group 17 that is chlorine, bromine and iodine. 3.3.3 Arrange in order the reactivity of chlorine, bromine and iodine. 3.3.4 Predict the chemical properties and physical properties of other elements in Group 17. 3.3.5 Communicate about the uses of Group 17 elements in daily life.	**Suggested Learning:** Gather information about the physical properties for chlorine, bromine and iodine based on: • Colour • State of matter • Density • Electrical and heat conductivity Conduct investigation to study the chemical properties of reactions for chlorine, bromine and iodine with: • Water • Metal • Sodium hydroxide solution

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.4 Group 18	Pupil is able to: 3.4.1 Identify the elements of Group 18. 3.4.2 Explain the physical properties of elements in Group 18. 3.4.3 Explain the trends of physical properties of elements in Group 18. 3.4.4 Explain the inert chemical properties of elements in Group 18 and relate to their electrons arrangement. 3.4.5 Communicate the uses of Group 18 elements in daily life.	**Suggested activity:** Collect and intepret data to investigate the physical properties of helium, neon and argon based on: • Colour • State of matter • Density • Electrical conductivity • Heat conductivity
3.5 Period 3	Pupil is able to: 3.5.1 List elements of Period 3 that are metals, semi-metals and non-metals. 3.5.2 Explain the physical properties in Period 3 from sodium to argon. 3.5.3 Explain with examples base oxide, amphoteric oxide and acid oxide.	**Suggested activity:** Gather information of the Periodic Table to investigate the trends of Period 3 elements based on: • Atomic size • Number of protons • State of matter • Melting point • Boiling point

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.5.4 Communicate about the uses of semi-metals in daily life.	• Density Investigate the properties of oxides elements in Period 3 for magnesium, aluminium and sulphur. Differentiate between alkali and base.
3.6 Transition Elements	Pupil is able to: 3.6.1 Identify the transition elements in the Periodic Table. 3.6.2 Explain the special characteristics of transition elements besides its metallic characteristics. 3.6.3 Relate physical properties of transition elements with their uses in daily life.	**Note:** Transition elements need to introduce are: • Chromium • Copper • Cobalt • Iron • Nickel • Manganese
	3.6.4 Innovate existing devices by using transition elements.	**Suggested activity:** Research-based learning Transition elements are used widely and various ways in daily life such as electrical wires and stainless steel. Gather information and innovate devices by using transition elements so as to make the devices more efficient in terms of function and eco-friendliness.

PERFORMANCE STANDARD

PERIODIC TABLE OF ELEMENTS

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

4.0 STOICHIOMETRY

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.1 Relative Atomic Mass, Relative Molecular Mass and Relative Formula Mass.	Pupil is able to: 4.1.1 Describe relative atomic mass. 4.1.2 Calculate relative molecular mass and relative formula mass. 4.1.3 Solve numerical problem regarding relative molecular mass and relative formula mass.	**Note:** Gather information and share about: • Relative atomic mass • Relative molecular mass • Relative formula mass
4.2 Concept of Mole	Pupil is able to: 4.2.1 Explain concept of mole. 4.2.2 Relate the number of moles of atom with the mass of substance and the relative atomic mass/relative molecular mass. 4.2.3 Relate the number of moles of molecule with molecular mass and relative molecular mass. 4.2.4 Explain the meaning of Avogadro constant (N_A). 4.2.5 Relate Avogadro constant (N_A) with number of particles and number of moles. 4.2.6 Solve numerical problems that involve the number of moles.	**Suggested activity:** Browse the internet or youtube channel to understand the concept of mole and how to use in stoichiometry. **Note:** Introduce Avogadro constant (N_A) = 6.02×10^{23}

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.3 Chemical Formula	Pupil is able to: 4.3.1 Explain by drawing how the positive ion and negative ion are formed. 4.3.2 Write the chemical formula of compounds.	**Suggested activity:** Write the chemical formula through games.
	4.3.3 Carry out an experiment to obtain the chemical formula of compounds and the equation of reactions.	**Suggested activity:** Burn magnesium ribbons in oxygen to produce magnesium oxide compound.
4.4 Concept of Mole in Chemical Equations	Pupil is able to: 4.4.1 Write balanced chemical equations for chemical reactions. 4.4.2 Solve problems about the concept of mole based on the chemical equations for chemical reactions.	**Suggested activity:** Write simple balanced chemical equation and use the concept of mole to balance the chemical equations like: • Neutralisation between hydrochloric acid and sodium hydroxide • Formation of copper (II) sulphate through the reaction between copper (II) oxide with sulphuric acid • Reaction between sodium with water

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.5 Standard Solution	Pupil is able to: 4.5.1 Determine the concentration of solution using the number of moles concept. 4.5.2 Calculate the concentration of solution using the dilution method.	**Suggested activity:** • Preparation of solution with concentration of 0.1M, 0.5M and 1M from the solids. Examples of solid substances are copper (II) sulphate, sodium chloride • Preparation of solution with concentration of 0.1M and 0.5M from 1M solution **Note:** Introduce the unit for standard volume $\frac{\text{Mol}}{\text{dm}^3}$ = molar (M) Number of moles = $\frac{\text{Concentration x volume}}{1000}$ Introduce the formula; $m_1v_1 = m_2v_2$ m_1 = concentration volume 1 v_1 = volume of solution 1 m_2 = concentration of volume 2 v_2 = volume of solution 2

PERFORMANCE STANDARD

STOICHIOMETRY

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** knowledge and science skills of stoichiometry.
2	**Understand** stoichiometry and able to explain its understanding.
3	**Apply** knowledge of stoichiometry and able to carry out a simpel task.
4	**Analyse** knowledge of stoichiometry in context of problem solving about events or natural phenomena.
5	**Evaluate** knowledge of stoichiometry in context of **problem solving** and **decision making** to carry out a task.
6	**Create** by using knowledge and science skills of stoichiometry in context of **problem solving and decision making** or carry out a task in new situasion creatively and innovatively with regards to the social value/economy/culture of the community,

5.0 CHEMICAL BOND

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.1 Stability of Element	Pupil is able to: 5.1.1 Draw and explain the duplet and octet electron arrangements of noble gases. 5.1.2 Explain the properties of noble gases. 5.1.3 Relate the stability of noble gases with its electron arrangements.	**Suggested activity:** Draw duplet and octet electron arrangements for helium, neon and argon gases. **Note:** Properties of noble gas are stable and inert.
	5.1.4 Explain with examples how others elements achieve stable electron arrangements.	**Note:** The stability of atom can be achieved by: • Sharing electrons • Donating and receiving electrons
5.2 Ionic Bond	Pupil is able to: 5.2.1 Explain the formation of positive ion and negatif ion by drawing electron arrangements. 5.2.2 Describe the formation of ionic bonds in the ionic compounds.	**Note:** Draw the diagram of ionic compound for; • Sodium chloride • Magnesium oxide

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.2.3 Conclude the physical properties of ionic compounds. 5.2.4 Explain with examples ionic compounds in daily life.	**Suggested activity:** Conduct a scientific investigation to study the properties of ionic compounds based on: • Electrical conductivity • Melting point • Solubility in water
CONTENT STANDARD	**LEARNING STANDARD**	**NOTES**
5.3 Covalent Bond	Pupil is able to: 5.3.1 Explain the formation of single covalent bonds and double covalent bonds. 5.3.2 Draw the electron arrangements of covalent bonds.	**Suggested activity:** Discuss by drawing diagrams to show the formation of covalent compounds through sharing of electrons.
	5.3.3 Conclude the physical properties of covalent compounds. 5.3.4 Explain with examples covalent compounds in daily life.	**Suggested activities:** Study the properties of covalent compounds based on: • Electrical conductivity • Mellting point • Solubility in water

STANDARD PERFORMANCE

CHEMICAL BOND

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** knowledge and science skills about chemical bond.
2	**Understand** chemical bond and able to explain its understanding.
3	**Apply** knowledge of chemical bond and able to carry out a simple task.
4	**Analyse** knowledge of chemical bond in context of **problem solving** about events or natural phenomena.
5	**Evaluate** knowledge of chemical bond in context of **problem solving** and **decision making** to carry out a task.
6	**Create** by using knowledge and science skills of chemical bond in context of **problem solving and decision making** or carry out a task in new situasion creatively and innovatively with regards to the social value/economy/culture of the community.

6.0 ENERGY AND CHEMICAL CHANGES

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.1 Production of Electrical Energy from Chemical Reaction	Pupil is able to: 6.1.1 Describe the process of oxidation and reduction. 6.1.2 Build and describe the operation of simple voltaic cell. 6.1.3 Identify the reaction of oxidation and reduction at electrodes.	**Suggested activities:** Gather information to understand the terms of oxidation, reduction, oxidation agents and reducing agents.
6.2 Redox Reactions	Pupil is able to: 6.2.1 Explain the redox reactions in term of gaining and losing electrons. 6.2.2 Describe the uses of redox reaction in daily life.	**Suggested activity:** Surf the internet to understand about redox reaction and its uses in daily life.
	6.2.3 Create an energy source by using redox reaction to produce energy.	**Suggested activity:** Project-based learning: Redox reactions can produce electrical energy that is important in modern life. Design new sources of energy from different type of metals and an electrolyte.

PERFORMANCE STANDARD

ENERGY AND CHEMICAL CHANGES

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** knowledge and science skills of energy and chemical changes.
2	**Understand** energy and chemical changes and able to explain its understanding.
3	**Apply** knowledge of energy and chemical changes and able to carry out a simpel task.
4	**Analyse** knowledge of energy and chemical changes in context of problem solving about events or natural phenomena.
5	**Evaluate** knowledge of energy and chemical changes in context of **problem solving** and **decision making** to carry out a task.
6	**Create** by using knowledge and science skills of energy and chemical changes in context of **problem solving and decision making** or carry out a task in new situasion creatively and innovatively with regards to the social value/economy/culture of the community,

THEME

ENERGY AND SUSTAINABILITY OF LIFE

LEARNING AREA

7.0 FORCE AND MOTION

8.0 HEAT

Theme 3: **ENERGY AND SUSTAINABILITY OF LIFE**

This theme gives an understanding about the effect of foce that involves motion in daily life. Emphasis is given to rutine problem solving that involves scalar quantity and vector quantity. The relationship between force and motion is highlight to understand the concept of momentum and impulse. To comprehend about thermal equilibrium and specific heat capacity, these concepts are link to the phenomenon that is normal to the children. This theme encouraged mathematical thinking and creativity in solving related problems.

Learning Area:

7.0 Force and motion

- 7.1 Scalar and Vector Quantities
- 7.2 Force
- 7.3 Momentum
- 7.4 Impulse

8.0 Heat

- 8.1 Thermal Equilibrium
- 8.2 Specific Heat Capacity
- 8.3 Specific Latent Heat

7.0 FORCE AND MOTION

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.1 Scalar and Vector Quantities	Pupil is able to: 7.1.1 Explain with examples scalar and vector quantities. 7.1.2 Describe resultant vectors and resolving vectors.	**Suggested activity:** Carry out an activity to show physical quantities that have magnitude only and other physical quantities that have magnitude and direction. Carry out an activity to demonstrate force as a vector quantity using spring balances. Compile a list of scalar and vector quantities.
	7.1.3 Solve problems involving resultant vectors and resolving vectors.	**Suggested activity:** Draw scaled diagram of triangle of forces to determine the resultant vector. Use trigonometry to resolve a vector into two perpendicular vector components. **Note:** Resultant force problems are limited to two vectors where the vectors are: (i) Parallel vectors (ii) Opposite vectors (iii) Perpendicular vectors

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.2 Force	Pupil is able to: 7.2.1 Carry out an experiment to formulate the equation F = ma.	**Suggested activity:** Conduct an experiment to get a relationship between: • Acceleration and force when mass is constant • Acceleration and mass when force is constant
	7.2.2 Describe the equilibrium of forces.	**Suggested activity:** Discuss the equilibrium of forces on an object when it is • Stationary • Moving with constant velocity
	7.2.3 Solve problems involving resultant force in daily life.	**Suggested activity:** Use diagrams to determine the resultant force and acceleration of an object in situations such as: • In a lift • Hung on the pulley and • On an inclined plane

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.3 Momentum	Pupil is able to: 7.3.1 Explain momentum (p) as the product of mass (m) and velocity (v), p = mv.	**Suggested activity:** Carry out an activity to investigate how the mass and velocity of an object influence the effort to stop a moving object. Discuss the definition of momentum, its unit and momentum as a vector quantity. Discuss the applications of momentum in daily life.
	7.3.2 Communicate the Principle of Conservation of Momentum in one dimension for collisions and explosions.	**Suggested activity:** Investigate situations that involve the Principles of Conservation of Momentum in daily life. Use a Dynamic Cart Kit to investigate the Principle of Conservation of Momentum. Project-based learning: Launching a rocket uses the Principle of Conservation of Momentum in a form of explosion to push the rocket up. Gather information on the technology of rocket launching to design, innovate and build a water rocket.

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.4 Impulse	Pupil is able to: 7.4.1 Explain impulsive force and some example of situations involving impulsive force.	**Suggested activity:** Observe a computer simulation on collisions and explosions to generate ideas about impulsive force.
	7.4.2 Describe impulse as a change in momentum, that is: $Ft = mv - mu$. 7.4.3 Conclude that impulsive force is the rate of change of momentum in collisions or explosions occurring in a short time, that is: $F = \frac{mv - mu}{t}$	**Suggested activity:** Relate impulse with Newton's Second Law of Motion $F = ma$ $a = \frac{v - u}{t}$ $F = m\left(\frac{v-u}{t}\right)$ $Ft = mv - mu$
	7.4.4 Solve problems involving impulsive force.	**Suggested activity:** Solve numerical problems about situations where impulsive force needs to be reduced and suggest ways to reduce it. Gather information and discuss the use of waste materials to overcome the impact of impulse on fragile materials in the packaging service.

PERFORMANCE STANDARDS
FORCE AND MOTION

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** knowledge and science skills of force and motion.
2	**Understand** force and motion and able to explain its understanding.
3	**Apply** knowledge of force and motion and able to carry out a simpel task.
4	**Analyse** knowledge of force and motion changes in context of **problem solving** about events or natural phenomena.
5	**Evaluate** knowledge of force and motion in context of **problem solving** and **decision making** to carry out a task.
6	**Create** by using knowledge and science skills of force and motion in context of **problem solving and decision making** or carry out a task in new situasion creatively and innovatively with regards to the social value/economy/culture of the community,

8.0 HEAT

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.1 Thermal Equilibrium	Pupil is able to: 8.1.1 Explain with examples thermal equilibrium. 8.1.2 Explain the application of thermal equilibrium in daily life.	**Suggested activity:** Discuss the application of thermal equilibrium in devices that can fixed the temperature such as: • Oven • Refrigerator Discuss the working principle of a liquid-in-glass thermometer to determine the temperature of an object based on the principle of thermal equilibrium. **Note:** Thermal equilibrium is a condition when two objects of different temperatures in thermal contact, achieve the same temperature. The net heat flow between the two objects in thermal equilibrium is zero.

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.2 Specific Heat Capacity	Pupil is able to: 8.2.1 Describe specific heat capacity.	**Suggested activity**: Carry out an activity to compare the rise in temperature of different masses heated with the same quantity of heat. Relate the change of temperature with the specific heat capacity of the object. Gather information and prepare a table of specific heat capacity for different materials. Discuss insulators and conductors with respect to their specific heat capacities. **Note:** Specific heat capacity, c for an object, is the quantity of heat needed to raise the temperature a 1 kg of a material by 1^0C or 1 K. $c = \frac{Q}{m\theta}$ Where Q = quantity of heat needed m = the mass of material Θ = change of temperature

CONTENT STANDARD	LEARNING STANDARD	NOTES
	8.2.2 Carry out an experiment to determine the specific heat capacity of a solid and a liquid.	**Suggested activity:** Carry out an experiment to determine the specific heat capacity for water and aluminium.
	8.2.3 Communicate about the application of specific heat capacity in daily life and natural phenomena.	**Suggested activity:** Gather information or research and report on: • Natural phenomena such as land breeze and sea breeze • Application of specific heat capacity in daily life such as car radiator and cooking utensils Adaptation of green technology by using the concept of specific heat capacity to solve problems in the construction sector for example, the choosing of construction materials to build a smart building.

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.3 Specific Latent Heat	Pupil is able to: 8.3.1 Describe specific latent heat of fusion and specific heat latent heat of vapourisation.	**Suggested activity**: Investigate the change in temperature when ice is heated to steam. Sketch a graph of temperature against time and relate the shape of graph obtained with specific latent heat. Explain change of state using kinetic theory of matter.
	8.3.2 Carry out an experiment to determine the specific latent heat of fusion of ice. 8.3.3 Carry out an experiment to determine the specific latent heat of vapourisation of water.	**Suggested activity**: Carry out an experiment to determine the specific latent heat of • Fusion of ice • Vaporization of water Discuss the difference between specific latent heat of fusion of ice and specific latent heat of vapourisation of water in terms of molecular bonding.
	8.3.4 Compare the specific latent heat of fusion and specific latent heat of vapourisation for a material in terms of molecular bonding.	**Note:** Specific latent heat of fusion for a material is the heat needed to change 1 kg of a solid into a liquid at its melting point. Specific latent heat of vapourisation for a material is the heat needed to change 1 kg of a liquid into a vapour at its boiling point.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		$L = \frac{Q}{m}$ L = specific latent heat Q = quantity of heat needed m = mass of object
	8.3.5 Communicate the application of specific latent heat in daily life.	**Suggested activity:** Carry out an activity to show evaporation causes cooling. Research and report about the application of specific latent heat in daily life such as evaporation of sweat, cooling system in refrigerator, maintaining freshness of fish with ice and cooling down of body temperature with wet towels.

PERFORMANCE STANDARDS
HEAT

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** knowledge and science skills of heat.
2	**Understand** heat and able to explain its understanding.
3	**Apply** knowledge of heat and able to carry out a simpel task.
4	**Analyse** knowledge of heat changes in context of problem solving about events or natural phenomena.
5	**Evaluate** knowledge of heat in context of **problem solving** and **decision making** to carry out a task.
6	**Create** by using knowledge and science skills of heat in context of **problem solving and decision making** or carry out a task in new situasion creatively and innovatively with regards to the social value/economy/culture of the community,

Content Standard, Learning Standard and Performance Standard Form 5

THEME

MAINTENANCE AND CONTINUITY OF LIFE

LEARNING AREA

1.0 ANATOMY AND FISIOLOGY

Theme 1: **MAINTENANCE AND CONTINUITY OF LIFE**

This theme provides insights into the human anatomy of the nervous system, the musculoskeletal system, the circulatory system and the urinary system. The structure of the nervous system emphasizes the transmission of impulses through neurons and disruption to the nervous system in terms of its symptoms and causes. The musculoskeletal system examines the human skeletal, muscle, ligaments and tendons during the movement of the limbs, as well as examining the strength of the bones and diseases related to the musculoskeletal system. The circulatory system focuses on the mechanism of blood clotting and related diseases. The urinary system studies the structure, processes of urine production and related diseases which are on the rise in the society.

Learning area: **1.0 ANATOMY AND PHYSIOLOGY**

1.1 Transmission of impulse in the nervous system.

1.2 Skeletal muscle movement in the musculoskeletal system.

1.3 Blood clotting mechanism in the blood circulatory system.

1.4 Urine production in the urinary system.

1.0 ANATOMY AND PHYSIOLOGY

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.1 Trasmission of impulse in the nervous system	Pupil is able to: 1.1.1 Explain the types, structures and functions of the neurons.	**Suggested activity:** Recall the types, structures, functions of neurons and the transmission of impulse by using appropriate mind maps. **Note:** • Types of receptors and effectors • The role of neurons in transmission of impulse • Electrical (changes in membrane charges) and chemical (neurotransmitter) impulse transmission

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.1.2 Communicate about the transmission of impulse across neurons.	**Suggested activity:** Present the structure of synapse and transmission of impulse using multimedia. **Note:** • Introduction to neurotransmitters such as acetylcholine, and GABA (Gamma-aminobutyric acid) • The process of release and the role of neurotransmitters into synapses • Introduction to excitatory synapse and inhibitory synapse
	1.1.3 Describe the effects of pesticides and drugs on nerve function.	**Suggested activity:** Do active readings and design brochures on various effects of pesticides and drugs on transmission of impulse in synapses as follows: • Modify the synthesis of neurotransmitter's storage and release • Change of neurotransmitter interactions in synapses • Affecting the reabsorption and disintegration of neurotransmitters • Replacement of neurotransmitters

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.1.4 Communicate about neurological diseases.	**Suggested activity:** Project-based learning According to the Alzheimer's Disease Foundation Malaysia (2016), there are 50,000 Malaysians reported to have the disease. Normally this disease is not reported because it is thought to be common due to the old age factor. Carry out a study on Alzheimer's disease among Malaysians using the following methods: • Collecting information • Visit to the Neurology Unit of hospital • Visit to senior citizen care centre Make a multimedia presentation and Carry out a study session with students in school and local communities on Alzheimer's disease based on the following aspects: • Symptoms • Causes of illness • Methods of treatment and handling of patients • Preventive measures

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.2 Skeletal muscle movement in the musculoskeletal system	Pupil is able to: 1.2.1 Describe the need for movement and support in human 1.2.2 Identify the axial and appendicular skeletons in the human skeletal system	**Suggested Activity:** Use the skeleton model or the Human Anatomy Atlas freeware application to identify the structure of the human skeleton. **Note:** The axial skeleton consists of: • Skull • Vertebrae (cervical vertebrae, thoracic vertebrae, lumbar vertebrae, sacrum and coccyx) • Rib cage The appendicular skeleton consists of: • Pectoral arch that is the scapula, clavicle, humerus, ulna, radius, carpus, metacarpus • Pelvic arch that is the femur, tibia, fibula, tarsus, metatarsus and phalanges
	1.2.3 Design a model that describes the actions and functions of muscles, ligaments and tendons during the movement of human limbs.	**Suggested Activity:** Build a model to explain the position and function of the muscles, ligaments and tendons during movement in humans.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.2.4 Carry out an experiment to test the strength of the bone.	**Suggested Activity:** Carry out an experiment to compare the ability to support a weight between a solid glass and a hollow glass tube.
	1.2.5 Carry out an experiment to test the relationship between the calsium composition and bone density.	**Suggested Activity:** Study the relationship between calcium composition in bone and its strength by using chicken bones soaked in solution with different acidity.
	1.2.6 Communicate about diseases related to the musculoskeletal system.	**Suggested Activity:** Collect information and do a creative presentation about the diseases related to movement and support such as osteoporosis, muscular dystrophy and arthritis including: • Symptoms • Causes of illness • Treatment and handling of patients • Preventive measures

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.3 Blood clotting mechanism in the blood circulatory system	Pupil is able to: 1.3.1 Explain the mechanism of blood clotting.	**Suggested Activity:** Gather information on the sequences of blood clotting mechanism from various sources and develop a schematic diagram to show the mechanism of blood clotting. **Note:** Introduce the terms platelets, thrombokinase, fibrinogen, fibrin, prothrombin

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.3.2 Relate blood clotting to human health.	**Suggested Activity:** Prepare a multimedia presentation on diseases related to blood clotting such as haemophilia and thrombosis which comprises of: • Symptoms • Causes of illness • Treatment and handling of patients • Preventive measures
1.4 Urine production in the urinary system	Pupil is able to: 1.4.1 Explains the structure and function of the urinary system.	**Suggested Activity:** Use a model, charts/animation or the Human Anatomy Atlas freeware application to discuss the organs involved in the urinary system and its functions in the process of urine production. **Note:** Introduce nephron as a functional unit of the kidney.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	1.4.2 Communicate about urinary system related diseases.	**Suggested Activity:** Carry out an information sharing session with the Health Department officers or do active reading and design brochures about kidney failure and kidney stone formation in terms of: • Symptoms • Causes of illness • Treatment and handling of patients • Use of the haemodialysis machine • Preventive measures

PERFORMANCE STANDARD
ANATOMY AND PHYSIOLOGY

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** the knowledge and science skills on anatomy and physiology.
2	**Understand and explain** anatomy and physiology.
3	**Apply** knowledge about anatomy and physiology and able to carry out simple tasks.
4	**Analyse** knowledge about anatomy and physiology in context of problem solving on events or natural phenomena.
5	**Evaluate** knowledge about anatomy and physiology in context of problem solving and decision making to carry out a task.
6	**Design** a task using knowledge and science skills on anatomy and physiology 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

2.0 SALT

3.0 CARBON COMPOUNDS IN DAILY LIFE

4.0 ENERGY AND CHEMICAL CHANGE

5.0 MATERIAL CHEMISTRY

Theme 2: **EXPLORATION OF ELEMENTS IN NATURE**

This theme provides insight into the various processes that cause chemical changes of the material. The chemical processes studied are acid-base reactions, electrolysis, oxidation and recognition of ions. The topic of organic compound focuses on the chemical properties of palm oil and the best way in managing used cooking oil towards sustainable living. Study on chemical changes include light and thermochemistry. Material chemistry emphasises on different types of advanced materials and the impact of their usage on the quality of life.

Learning Area:

1.0 SALT

1.1 Salt

1.2 Qualitative analysis of salt

3.0 CARBON COMPOUNDS IN DAILY LIFE

3.1 Green Technology and Management of Used Palm Oil

4.0 ENERGY AND CHEMICAL CHANGE

4.1 Light energy in chemical change

4.2 Heat energy in chemical change

4.3 Electrical energy in chemical change

5.0 MATERIAL CHEMISTRY

5.1 Advanced material

2.0 SALT

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.1 Salt	A pupil is able to: 2.1.1 Explain by examples, the meaning of salt and its uses in daily life.	**Suggested activity:** Brainstorming on: • The meaning and examples of salt • Natural salt availability • Uses of salt in agriculture, medicine, preparation and preservation of food
	2.1.2 Describe the process of preparing soluble salts and insoluble salts. 2.1.3 Carry out an experiment to compare the solubility of nitrate, sulphate, carbonate and chloride salts in water.	**Note:** Chemical equation and ionic equation for the preparation of salts should be introduced.
	2.1.4 Explain the importance of purification process of soluble salt.	**Suggested activity:** Carry out activity to: • Purify soluble salt by recrystallization method. • Observe the physical properties of salt crystals. • Study the relationship between the size of crystals and the rate of cooling

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.1.5 Solve quantitative problems in stoichiometric reactions.	**Suggested activity:** Carry out problem solving exercises involving quantification of reactants and products in stoichiometric reactions.
2.2 Qualitative analysis of salt	A pupil is able to: 2.2.1 State the meaning of qualitative analysis. 2.2.2 Make inferences on salts based on colour and solubility in water	**Suggested activity:** Observe the colour and solubility in water for various salts and identify those salts.
	2.2.3 Determine tests to identify gases.	**Suggested activity:** Observe and carry out chemical tests to identify these gases i.e. oxygen, hydrogen, carbon dioxide, ammonia, chlorine, hydrogen chloride, sulfur dioxide.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	2.2.4 Describe the action of heat on salts.	**Suggested activity:** Carry out tests to study the action of heat on carbonate and nitrate salts. Observations are based on: • Changes in colour before, during and after heating • Gases released
	2.2.5 Identify chemical tests for anions and cations.	**Note:** Confirmatory test for: Cations: copper(II) ion (Cu^{2+}), magnesium ion (Mg^{2+}) aluminium ion (Al^{3+}), zinc ion (Zn^{2+}), iron(II) ion, (Fe^{2+}), iron(III) ion, (Fe^{3+}), plumbum(II) ion (Pb^{2+}) and ammonium ion, (NH_4^+) Anions: carbonate ion, (CO_3^{2-}), sulphate ion, (SO_4^{2-}), chloride ion, (Cl^-) and nitrate ion (NO_3^-).
	2.2.6 Plan qualitative analysis to identify salts.	**Suggested activity:** Test the presence of anions and cations in unknown salt solutions.

PERFORMANCE STANDARD

SALT

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** the knowledge and science skills on salt.
2	**Understand and explain** salt.
3	**Apply** knowledge about salt and able to carry out simple tasks.
4	**Analyse** knowledge about salt in context of problem solving on events or natural phenomena.
5	**Evaluate** knowledge about salt in context of problem solving and decision making to carry out a task.
6	**Design** a task using knowledge and science skills on salt 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 CARBON COMPOUNDS IN DAILY LIFE

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.1 Green technology and management of used palm oil.	A pupil is able to: 3.1.1 Compare and contrast the characteristics of palm oil and used palm oil. 3.1.2 Identify factors that cause the spoilage of palm oil. 3.1.3 Justify the needs to process used palm oil.	**Note:** Factors that cause the spoilage of palm oil are oxidation, hydrolysis and polymerisation. **Reference**: *Modul Teknologi Hijau KIMIA* CETREE, USM *Tajuk: Minyak masak terpakai ke arah kelestarian*
	3.1.4 Break down of used palm oil to produce biodiesel and glycerol. 3.1.5 Elaborate the uses of by-product that is glycerol.	**Note:** The used palm oil from industries that involved frying must go through absorption process to remove the odour by using charcoal powder. **Reference:** *Modul Teknologi Hijau KIMIA* CETREE, USM *Tajuk: Minyak masak terpakai ke arah kelestarian*

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.1.6 Justify the usage of green technology in managing used palm oil.	**Suggested activity:** Project based learning. Malaysians love for fried food is very high. If used palm oil is not properly managed, it will have a detrimental impact on the environment especially, aquatic life. Design the best management plan in reprocessing used palm oil to minimise the impact on the environment. **Reference:** *Modul Teknologi Hijau KIMIA* CETREE, USM Tajuk: *Minyak masak terpakai ke arah kelestarian*

PERFORMANCE STANDARD

CARBON COMPOUNDS IN DAILY LIFE

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** the knowledge and science skills on carbon compounds in daily life.
2	**Understand and explain** carbon compounds in daily life.
3	**Apply** knowledge about carbon compounds in daily life and able to carry out simple tasks.
4	**Analyse** knowledge about carbon compounds in daily life in context of problem solving on events or natural phenomena.
5	**Evaluate** knowledge about carbon compounds in daily life 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 daily life 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.

4.0 ENERGY AND CHEMICAL CHANGE

CONTENT STANDARD	LEARNING STANDARD	NOTES
4.1 Light energy in chemical reactions	A pupil is able to: 4.1.1 Explain with examples the chemical reactions that require light.	**Suggested activity:** Observe the environment to identify examples of fast and slow reactions due to the presence sunlight.
	4.1.2 Communicate about the effect of light to produce chemical reactions.	**Suggested activity:** Carry out a study of the effect of light on photochromic glass and its use in daily life. **Note:** Light decomposes argentum chloride on the photographic film causing the image to form.
4.2 Heat energy in chemical reactions	A pupil is able to: 4.2.1 Describe the heat changes in chemical reactions.	**Note:** Carry out quizzes to recall the meaning of endotermic reaction and exothermic reaction. Energy level diagrams in chemical reactions are introduced.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	4.2.2 Determine the heat of displacement in chemical reactions.	**Suggested activity:** Solve numerical problems to calculate heat changes in chemical reactions. **Note:** Numerical solutions involve the use of the following formula: $E = mc\,\Delta T$ $\Delta H = E / mol$ E = energy m = mass ΔT = temperature change The unit of heat change is kJ mol^{-1}
4.3 Electrical energy in chemical reactions	A pupil is able to: 4.3.1 Describe the energy changes in electrolytic cell and chemical cell.	**Suggested activity:** Carry out: electrolysis of salt solution and simple chemical cell. **Note:** Emphasis should be placed on energy change.

CONTENT STANDARD	LEARNING STANDARD		NOTES
	4.3.2	Explain with examples the half equation for reactions occurring in electrolytic cells and chemical cells.	**Suggested activity:** Write the half equations for the reactions in electrolytic cells and chemical cells.
	4.3.3	Communicate about the application of electrolytic cell in industry.	**Note:** Applications of electrolytic cell in industrie are: • Extraction of metals • Electroplating of metals • Purification of metals Emphasis is given to the efforts to reduce the impacts on the environment due to the application of electrolytic cells in industry. **Reference:** *Modul Teknologi Hijau KIMIA* CETREE, USM Tajuk: *Mewajarkan Teknologi Hijau Dalam Elektrokimia*

PERFORMANCE STANDARD

ENERGY AND CHEMICAL CHANGE

TAHAP PENGUASAAN	TAFSIRAN
1	**Recall** the knowledge and science skills on energy and chemical change.
2	**Understand and explain** energy and chemical change.
3	**Apply** knowledge about energy and chemical change and able to carry out simple tasks.
4	**Analyse** knowledge about energy and chemical change in context of problem solving on events or natural phenomena.
5	**Evaluate** knowledge about energy and chemical change in context of problem solving and decision making to carry out a task.
6	**Design** a task using knowledge and science skills on energy and chemical change 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 MATERIAL CHEMISTRY

CONTENT STANDARD	LEARNING STANDARD	NOTES
5.1 Advanced material	A pupil is able to : 5.1.1 Describe with examples of advanced material.	**Suggested activity:** Collect information on advanced materials such as fibre optic polymers, vulcanized rubber, composite materials and teflons.
	5.1.2 Communicate about polymer and copolymers.	**Suggested activity:** Classify examples given into polymers and copolymers. **Note:** • Natural polymers – polymer derived from animals and plants. • Synthethic polymers – artificial polymer. • Copolymers – polymers containing more than one type of monomer. **Reference:** *Modul Teknologi Hijau KIMIA*, CETREE USM. *Tajuk*: *Melestarikan Polimer Mesra Alam*. .

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.1.3 Justify the needs of composite material.	**Suggested activity:** Discuss the uses and advantages of using composite materials in daily life. **Note:** A composite material is a new material made from a mixture of two or more materials. Examples of composite materials are: • Fibre glass • Reinforced concrete • Photochromic glass • Fibre optic
	5.1.4 Explain with examples the uses of superCarry outors.	**Suggested activity:** Collect information and make multimedia presentations on the types and uses of superCarry outors. **Note:** Applications of superCarry outor are as follows: • Magnetic Levitation (Maglev) in transportation system • Magnetic Resonance Imaging (MRI) in image scanning

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.1.5 Describe the application of nanocarbon tubes.	**Suggested activity:** Collect information and make multimedia presentations on the application of nanocarbon tubes. **Note:** Applications of nanocarbon tubes are as follows: • Tissue engineering • Touch screen gadget • Bulletproof jacket • Solar panels • Water filter
	5.1.6 Justify the use of advanced materials in daily life.	**Suggested activity:** Find information on;line and discuss the advantages and disadvantages of using advanced materials in daily life. **Note:** Emphasis is placed advanced materilas that are biodegradable and non-biodegradable.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.1.7 Communicate about electronic waste.	**Suggested activity:** Project based learning. Electronic waste is a defective, outdated and obsolete electronic products. Due to rapid technology development, more electronic equipments become waste within a short period of time. This will have a detrimental impact on the environment. Carry out a school-wide study on electronic waste. Organise a campaign or sharing session in school to raise awareness of ways to reduce the impact on all living things.

PERFORMANCE STANDARD

MATERIAL CHEMISTRY

TAHAP PENGUASAAN	TAFSIRAN
1	**Recall** the knowledge and science skills on material chemistry.
2	**Understand and explain** material chemistry.
3	**Apply** knowledge about material chemistry and able to carry out simple tasks.
4	**Analyse** knowledge about material chemistry in context of problem solving on events or natural phenomena.
5	**Evaluate** knowledge about material chemistry in context of problem solving and decision making to carry out a task.
6	**Design** a task using knowledge and science skills on material chemistry 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

6.0 WAVE

7.0 ELECTRIC

Tema 3: **ENERGY AND SUSTAINABILITY OF LIFE**

This theme focuses on the nature and characteristics of the waves. In-depth knowledge of the properties of waves will give greater meaning to understanding the two main types of waves, namely sound waves and light waves. The application of the concept of waves in daily life is important to understanding the mechanics of the physical world. The topic of electricity explores the concept of electric current, potential difference and resistance using formulas in solving related problems. This will encourage mathematical thinking among students.

Learning Area:

6.0 WAVES

6.1 Production of waves

6.2 Tranverse and longitudinal waves

6.3 Properties of waves

6.4 Mechanical and electromagnetic waves

7.0 ELECTRIC

7.1 Electric current and potential difference

7.2 Electrical resistance

7.3 Electrical energy and power

6.0 WAVES

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.1 Production of waves	A pupil is able to: 6.1.1 Explain how waves are produced.	**Suggested activity:** Study the oscillation of a slinky/rope/tuning fork or water surface when a stone is dropped in water or view computer simulations to generate ideas of: • Waves produced by a vibrating system caused by an external force • Waves transfer energy without transferring matter
	6.1.2 Define and give examples of transverse and longitudinal waves.	**Suggested activity:** Carry out an inquiry based learning activities such as using a slinky to explain transverse and longitudinal waves in term of: • Definition of transverse and longitudinal waves • Examples of transverse and longitudinal waves

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.1.3 Communicate about characteristics of waves.	**Suggested activity:** Carry out activities using an oscillating system to define: • Amplitude *(A)* • Period *(T)* • Frequency *(f)* • Wavelength (λ) Determine λ from a displacement-distance graph and *f* from a displacement-time graph. Determine wave speed (v) using the formula v = f λ
	6.1.4 Conduct an experiment to determine the relationship between frequency and wavelength.	**Suggested activity:** Investigate the relationship between frequency and wavelength using ripple tank at a fixed depth. Determine wave speed (v) from the gradient of a λ againts 1/f graph. **Note:** Wave speed is constant when depth is a constant.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.1.5 Explain damping in an oscillating system.	**Suggested activity:** Explain the damping effect in an oscillating system such as a loaded spring/oscillating pendulum/ oscillating jigsaw blade using a displacement-time graph. **Note:** Amplitude decreases with time for an oscillating system that experiences damping but frequency remain the same. Factors that affect damping are air resistance (external damping) and friction between molecules in an oscillating system (internal damping).
	6.1.6 Communicate about examples of damping in oscillating systems in daily life.	**Note:** Example of damping in oscillating systems in daily life such as a swing in a playground and shock absorbers in vehicles.
6.2 Resonance	A pupil is able to: 6.2.1 Explain resonance in an oscillating system.	**Suggested activity:** Using a Barton's pendulum to investigate resonance. **Note:**. Resonance occurs when the driver frequency equals the system's natural frequency resulting in oscillations with a maximum amplitude.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.2.2 Communicate about the uses of resonance in daily life.	Suggested activity: Study and report about negative effects of resonance such as the collapse of Tacoma Narrows Bridge. Study and report about positive effects of resonance such as sound production from musical instruments and receiving radio signals.
6.3 Properties of waves	A pupil is able to: 6.3.1 Explain the properties of waves.	**Suggested activity:** Carry out activities using a ripple tank to observe the properties of wave phenomena: • Reflection • Refraction • Diffraction • Interference
	6.3.2 Communicate about the application of wave properties in daily life.	**Suggested activity:** Gather information related to application of properties of wave in daily life such as: • Determining depth of the sea by using sound wave reflection • Designing arrangement of seats in a cinema or an aeroplane using interference of sound waves

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Note: Sea depth, $d = \frac{vt}{2}$ v = velocity of sound in water (m/s) t = time (seconds)
6.4 Mechanical and electromagnetic waves	A pupil is able to: 6.4.1 Explain with examples mechanical and electromagnetic waves. 6.4.2 Differentiate mechanical and electromagnetic waves.	**Suggested activity:** Carry out active reading to discuss the differences between mechanical and electromagnetic waves.
	6.4.3 Determine the position of different types of signals in the spectrum of electromagnetic wave.	**Suggested activity:** Gather information to identify types of wave signals (such as bluetooth, LTE 4G, 3G, 2G, GPRS, GPS and WIFI) used in smart phone technologies and to determine their position in the electromagnetic spectrum.

PERFORMANCE STANDARD

WAVE

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** scientific knowledge and science skills on waves.
2	**Understand** and explain waves.
3	**Apply** knowledge about waves and able to carry out simple tasks.
4	**Analyse** knowledge on waves in the context of **problem solving** about the occurrence on events or natural phenomena of nature.
5	**Evaluate** knowledge on waves in the context of **problem solving and desicion making** to carry out a task
6	**Design** a task using knowledge and science skills on waves in a creative and innovative way in the context of **problem solving and decision making** or carry out a task in a new situation with regards to the social values/economy/culture of the community.

7.0 ELECTRIC

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.1 Electric current and potential difference	A pupil is able to: 7.1.1 Define electric current.	**Suggested activity:** Carry out activities using a Van de Graaff generator to observe the relationship between charge flow and current. Define electric current as the rate of electric charge flow in a conductor. $I = \frac{Q}{t}$ I = current Q = electric charge t = time
	7.1.2 Explain potential difference.	**Note:** Introduce the following formula: $V = \frac{E}{Q}$ V = potential difference E = electrical energy 1 V = 1 JC^{-1}

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.1.3 Solve numerical problems involving electric current and potential differences.	**Suggested activity:** Solve problems involving charge (Q), electric current (I), time (t), potential difference (V) and electrical energy (E), electron charge (e) and number of electrons (n) **Note:** The following formulae needs to be introduced: $Q = It$ $Q = ne$, hence $ne = It$ $e = 1.6 \times 10^{-19}$ C $E = VQ$
7.2 Electrical resistance	A pupil is able to: 7.2.1 Conduct an experiment to determine the relationship between current and potential difference of conductor. 7.2.2 Differentiate between characteristics of an ohmic conductor and a non-ohmic conductor.	**Suggested activity:** Study the relationship between current and potential difference and then draw a V againt I graph for an ohmic conductor (constantan wire) and a non-ohmic conductor (filament mentol)

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.2.3 Carry out an experiment to study factors that affect the resistance of a conductor.	**Note:** The following factors affect resistance: • length of a conductor • diameter of a conductor • types of conductor material • temperature of a conductor The s.w.g (*standard wire gauge) value* represents the diameter of a wire. The bigger the s.w.g. value, the smaller diameter of the wire.
	7.2.4 Justify choosing materials with high resistance as heating elements.	**Suggested activity:** Study and report about high resistance materials that are suitable to be used in heating elements.
7.3 Electrical energy and power.	A pupil is able to: 7.3.1 Relate electrical energy (E), potential difference (V), electrical current (I) and time (t).	**Note:** Derive the formula E= Vit from the following formulae: $Q = It$ $E = VQ$

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.3.2 Relate power (P), potential difference (V) and current (I).	**Suggested activity:** Derive the formula of P=VI from the formula E=VIt Hence, derive the formula • $P = \frac{V^2}{R}$ (to calculate resistance of electrical appliances from power rating) • $P = I^2R$ (to calculate power loss in an electrical wiring system)
	7.3.3 Determine the appropriate fuse value for electrical equipment in daily life.	**Suggested activity:** Carry out activities to determine a suitable fuse value for various electrical appliances at home using the following steps: • Identify and draw a table of power and potential difference of various electrical appliances. • Determine current value that flows in each appliance. • Determine appropriate fuse value.

PERFORMANCE STANDARD
ELECTRIC

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** the knowledge and science skills on electric.
2	**Understand and explain** electric.
3	**Apply** knowledge about electric and able to carry out simple tasks.
4	**Analyse** knowledge about electric in context of **problem solving** on events or natural phenomena.
5	**Evaluate** knowledge about electric in context of **problem solving and decision making** to carry out a task.
6	**Design** a task using knowledge and science skills on electric 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 EARTH AND OUTER SPACE

LEARNING AREA

8.0 OCEANOGRAPHY

Theme 4: **EXPLORATION OF EARTH AND OUTER SPACE**

This theme covers a variety of topics that include marine life and ecosystems, circulation of seawater, tectonic plates and geological features of the seabed, chemical and physical characteristics of the ocean. From the biological aspect, the relationship of distribution of aquatic life and their surroundings is studied. With regards to chemistry, focus is given to the composition of the seawater and how pollution affects aquatic life. From the physics perspective, emphasis is given to the movement of seawater and how differences in pressure and density affect aquatic life. With regards to geology, focus is given to the formation of mountains, trenches, and valleys as a result of the movement of tectonic plates that occurred millions of years ago. The sea as a source of life is given emphasis in addition to addressing other issues. Critical and creative thinking is encouraged in project-based learning to solve authentic life problems as well as hypothetical problems.

Learning Area

8.0 **OCEANOGRAPHY**

- 8.1 Ocean
- 8.2 Ocean floor mapping
- 8.3 Physical properties of seawater
- 8.4 Ocean biology
- 8.5 Seawater circulation
- 8.6 Ocean resources
- 8.7 Issues and challenges related to ocean

8.0 OCEANOGRAPHY

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
8.1 Ocean	A pupil is able to: 8.1.1 Explain the early history and reasons for ocean exploration.	**Suggested activity:** Discuss aims of ocean exploration from the aspects of economic, social and politics. Gather information about historical figures in ocean exploration such as Ibnu Battuta, Christopher Columbus and Vasco da Gamma.
	8.1.2 Identify major oceans on the world map.	**Suggested activity:** Gather information about : • Earth's major oceans • Southeast Asia seas
	8.1.3 Explain by a visual drawing the structure of sea floor.	**Suggested activity** Surf the web to gather information about sea floor structure. **Note:** The sea floor structures are mid-ocean ridges, seamounts, subdiction zones, abyssal plains and trenches. Introduce the Mariana Trench

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.1.4 Relate continental drift theory and tectonic plates to the evolution of the ocean floor.	**Suggested activity:** • Gather information and 3D presentations of continental drift theory and tectonic plates in ocean floor evolution • Relate continental drift theory and tectonic plates to ocean floor evolution **Note:** Introduce three types of tectonic plate boundaries: • Convergent Boundary - the formation of trenches in the ocean • Divergent boundary - the discovery of various minerals, sediments and organisms • Transform boundary - the creation of earthquakes

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
8.2 Sea floor mapping	A pupil is able to: 8.2.1 Explain how sea floor mapping is done using formula and sonar.	**Note:** Introduce tools used to map the ocean floor such as: • LIDAR (*Light detection and Ranging*) • Sonar • Satellite
	8.2.2 Communicate about the importance of ocean floor mapping.	**Suggested activity:** Gather information and prepare multimedia presentations on the importance and issues related to ocean floor mapping.
8.3 Physical properties of sea water	A pupil is able to: 8.3.1 Determine physical properties of seawater.	**Note:** Physical properties of seawater are: • Temperature • Salinity • Transparency • Density • Pressure

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.3.2 Describe the temperature profile of seawater.	**Suggested activity:** Gather online information to identify surface temperatures of some of the world's oceans and the temperature profile of seawater.
	8.3.3 Describe factors affecting the salinity of seawater.	**Note:** Natural factors that cause salinity to increase: • Ice formation • Evaporation Natural factors that cause salinity to decrease: • Ice melting • Rain/precipitation
	8.3.4 Relate the effect of transparency on seawater to distribution of aquatic organisms.	**Note:** The transparency of seawater is affected by : • Reef formation in tropical areas • Growth of sea algae

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.3.5 Explain the effect of different seawater pressures and densities on aquatic organisms.	**Suggested activity:** Carry out active reading of how aquatic organisms adapt to increasing depth and pressure in the ocean.
8.4 Ocean biology	Murid boleh: 8.4.1 Explain with examples how marine organisms are classified.	**Suggested activity:** Browse websites to gather information and create multimedia presentations to explain the distribution of marine life. Classify marine organisms according to size, mobility, location and life such as pleuston & neuston, plankton, necton and bentos. **Note:** Introduce seagrass
	8.4.2 Communicate about the dynamic interactions in the coral reef ecosystem.	**Suggested activity:** Conduct field studies on coral reefs or invite an oceanography expert for a sharing session that includes the following:

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
		• The diversity of organisms living in coral reefs • Conditions needed for coral growth such as light • Types and location of coral reefs in the world • Benefits of coral reefs in aquatic ecosystem • Issues related to coral reefs and ways to overcome them **Note:** Introduce scientific writing style to discuss:
8.5 Seawater circulation	A pupil is able to: 8.5.1 Communicate about the circulation of seawater.	**Suggested activity:** Carry out online research and create multimedia presentations to explain the circulation of seawater and the contributing factors for: • Direction of current and wave movement (influenced by depth) • Waves (caused by energy changes – Tsunami) • Tides (gravity of Earth, moon and Sun)

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.5.2 Justify how upwelling affects the distribution of marine life.	**Suggested activity:** Gather information to discuss the relationship between the percentage of dissolved oxygen in seawater and the distribution of marine life as in the Peruvian Seacoast.
8.6 Ocean resources	A pupil is able to: 8.6.1 Identify types of food obtained from a marine environment. 8.6.2 Identify factors that influence a country's dependence on the sea for food sources.	**Suggested activity:** Collect information and make multimedia presentations on: • Food sources from the sea. • Factors that determine how a country relies on the sea for food sources.
	8.6.3 Explain with examples the economic importance of marine products and related issues.	**Note:** The importance of marine products such as sea algae, plants and fish. Emphasis on over fishing and its impact on the global economy. Prohibition on the use of fishing trawlers.

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.6.4 Justify the role of aquaculture in meeting the demand for global seafood needs.	**Suggested activity:** STEM project based learning. It is expected that the human population will increase to 9.6 billion by 2050. As a result, food security will be a major issue. We need to produce more food with limited resources in agriculture. Plan a project on how pupils can solve the problem of inadequate marine resources with aquaculture. Share the findings via PAK 21. The elements of entrepreneurship can be applied.
8.7 Issues and challenges related to ocean	A pupil is able to : 8.7.1 Communicate about issues related to the marine ecosystem.	**Suggested activity:** Discuss the following issues: • The impact of natural disasters and pollution on the marine environment • Examples of endangered and nearly extinct species • Resolve issues related to the preservation and conservation of marine ecosystem

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
		Note: Examples of pollutants are oil, sewage waste, synthetic chemicals, heavy metals, solid materials, heat and radioactive waste. Give emphasis to natural disasters such as hurricanes, tsunamis, earthquakes, and man made disasters like oil spills, electric power generation and others. Introduce the following: • Carbon Sinks • Gazetted National Marine Park • Acts relating to the sea
	8.7.2 Design and create a product to solve problems/issues related to the ocean.	**Suggested activity:** STEM Project Based Learning Among issues related to the ocean are • Get drinking water from seawater/saltwater. • Oil spill cleanup • Ocean waste cleanup

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
		Select one of the above issues and using various disciplines of science, suggest a solution to the problem that have been identified. **Reference:** *Modul Teknologi Hijau Sains, CETREE USM.* *Tajuk: Tulenkah Aku*
	8.7.3 Describe careers in oceanology.	**Suggested activity**: Discuss job opportunities in: • Government and private agencies related to enforcement and environmental conservation (Fisheries Department, Marine Department, tourism company, marine parks, and so on). • Ecotourism related to the marine environment (Diving, beach recreation, marine recreation and others) • Fishing industries (Aquaculture, marine fishery and others)

STANDARD KANDUNGAN	STANDARD PEMBELAJARAN	CATATAN
	8.7.4 Reasoning and making analogies on a hypothetical situation when humans can live in the ocean.	**Suggested activity:** Problem based learning: Based on understanding of the physiology and basic needs of human life, predict changes and adaptations to enable humans to live in water. Discuss hypothetical questions such as: • Is it possible for humans to live in water someday? • What is the anatomical and physiological changes to enable humans to adapt to the environment in the ocean? • What are the pros and cons if humans can live in water?

PERFORMANCE STANDARD

OCEANOGRAPHY

PERFORMANCE LEVEL	DESCRIPTOR
1	**Recall** the knowledge and science skills on oceanography.
2	**Understand and explain** oceanography.
3	**Apply** knowledge about oceanography and able to carry out simple tasks.
4	**Analyse** knowledge about oceanography in context of **problem solving** on events or natural phenomena.
5	**Evaluate** knowledge about oceanography in context of **problem solving and decision making** to carry out a task.
6	**Design** a task using knowledge and science skills on oceanography 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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