KEMENTERIAN PENDIDIKAN MALAYSIA

KURIKULUM STANDARD SEKOLAH MENENGAH

Sains

Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 3

(EDISI BAHASA INGGERIS)

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Tingkatan 3

(Edisi Bahasa Inggeris)

Bahagian Pembangunan Kurikulum

APRIL 2017

Terbitan 2017

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 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 kurikulum 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 (SK), Standard Pembelajaran (SP) dan Standard Prestasi (SPi).

Usaha memasukkan standard pentaksiran dalam dokumen kurikulum telah mengubah landskap sejarah sejak Kurikulum Kebangsaan dilaksanakan di bawah Sistem Pendidikan Kebangsaan. Menerusinya murid dapat ditaksir secara berterusan untuk mengenalpasti 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. SARIAH BINTI ABD. JALIL
Pengarah
Bahagian Pembangunan Kurikulum

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 using 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 Biology, Physics, Chemistry and Additional Science.

The core science subjects for lower secondary is designed to equip pupils with science knowledge and STEM skills to be science literate and able to do science in upper secondary. Higher order thinking skill will also be developed so that the pupils will be able to apply the scientific knowledge to make decision and solve problems in real life creatively and innovatively.

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

AIMS

The science curriculum for secondary schools aims is to cultivate 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; enabling them to solve problems and make decisions in daily life.

OBJECTIVES

The Science Standard Curriculum (KSSM) aim for pupils to achieve the following objectives to:

1. Use the inquiry approach to fulfil their curiosity and their interest in science;
2. Acquire knowledge and understanding to explain phenomena scientifically;
3. Communicate information relating to science and technology intelligently and effectively;
4. Design and carry out scientific investigation, evaluate evidence and make conclusions;
5. Apply scientific knowledge, procedural knowledge and epistemic knowledge in posing questions, interpreting data, problem solving and decision making in context of real life;
6. Create awareness that discoveries through scientific research is a result of the ability of the human mind to understand natural phenomena towards a better life;
7. Create awareness that development of science and technology has an implication on the mores, social, economic and environment issues in the local and global context.

FRAMEWORK OF THE STANDARD CURRICULUM FOR SECONDARY SCHOOL

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

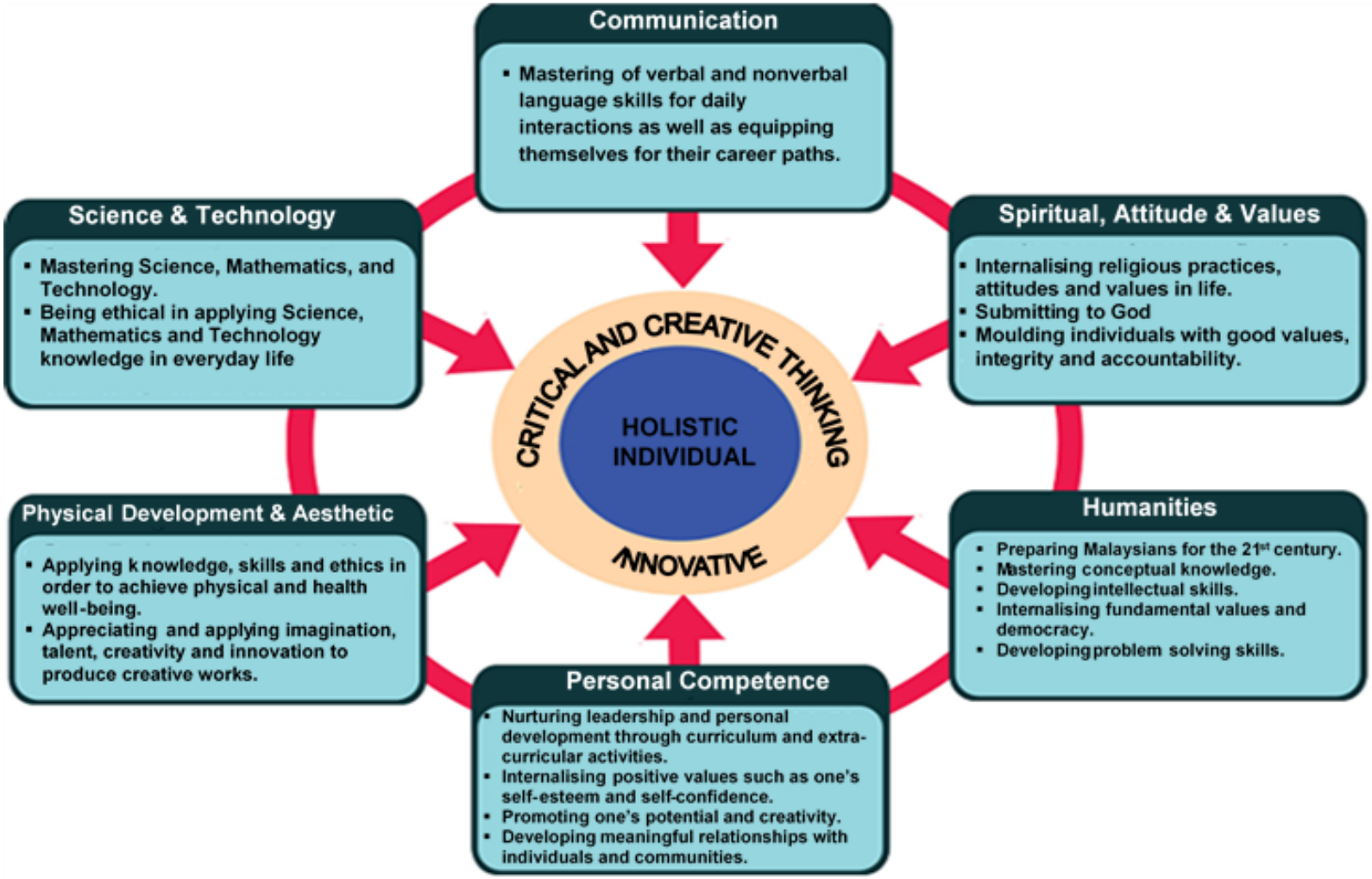


Figure 1: The Framework of Secondary School Standard-Based Curriculum

FOCUS

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

Content Standards of the Science Curriculum from Year 1 to Form 5 are developed based on the three domains which are knowledge, skills and values. The development of these domains will be experienced by pupils through the inquiry method to becoming 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.

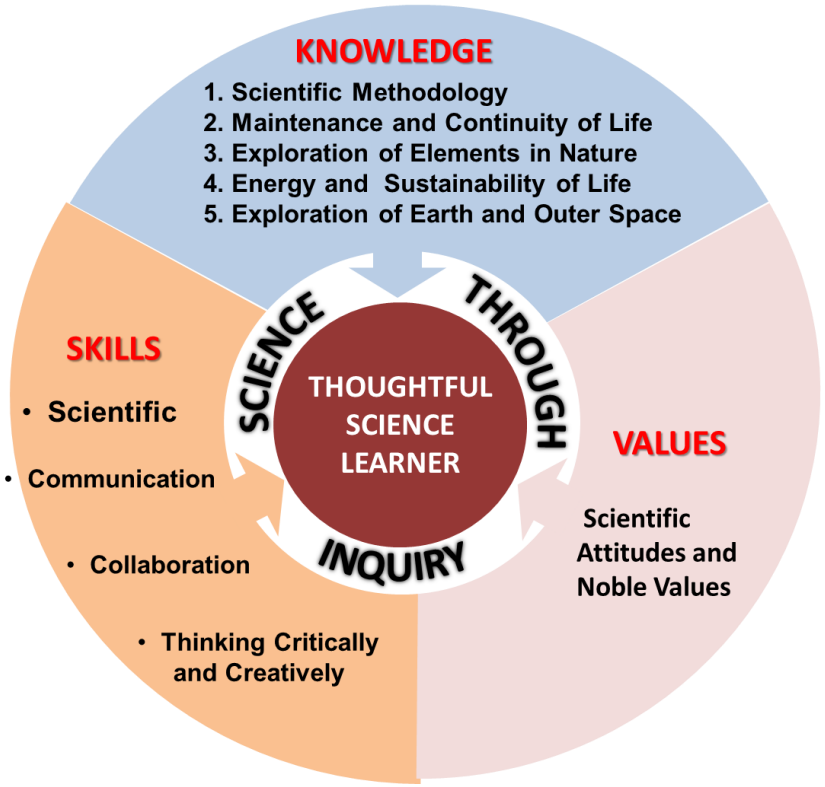


Figure 2: The Conceptual Framework for Science Curriculum

Thoughtful Science

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

Thoughtful Learning

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

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

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

Critical Thinking Skills

A brief description of each critical thinking skill is as in Table 1:

Table 1: Critical Thinking Skills

CRITICAL THINKING SKILLS	DESCRIPTION
Attributing	Identifying 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 objects or events.
Grouping and Classifying	Separating and grouping objects or phenomena into groups based on certain criteria such as common characteristics or features.
Sequencing	Arranging objects and information in order based on the quality or quantity of common characteristics or features such as size, time, shape or number.
Prioritising	Arranging objects or information in order based on their importance or urgency.
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 on the good and bad qualities of something based on valid evidences or propositions.
Making Conclusions	Making a statement about the outcome of an investigation based on a hypothesis or strengthening something based on an investigation.

Creative Thinking Skills

A brief description of each creative thinking skill is as in Table 2.

Table 2: Creative Thinking Skills

CREATIVE THINKING SKILLS	DESCRIPTION
Generating Ideas	Producing 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 artefact.
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 Strategy

Description of each thinking strategy is as in Table 3.

Table 3: Thinking Strategy

THINKING STRATEGY	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)"*

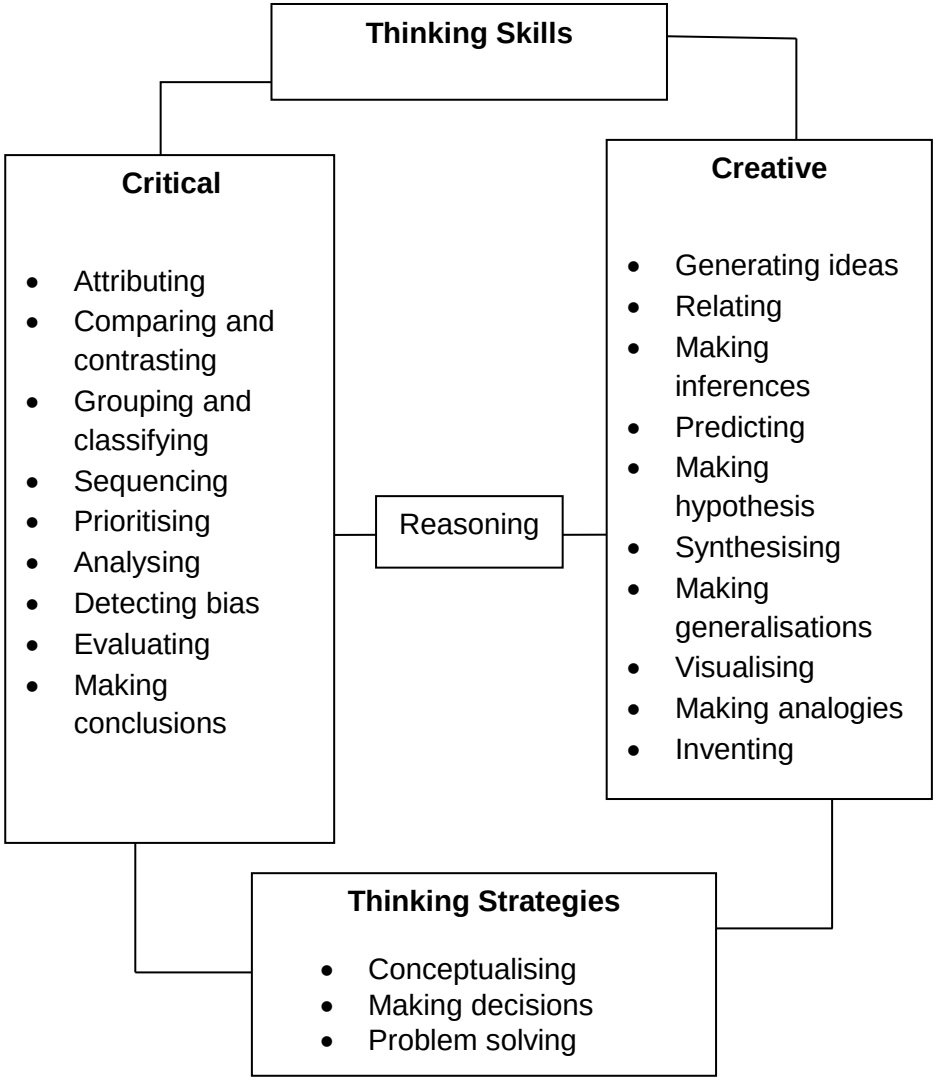


Figure 3: TSTS Model in Science

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 attitude and appropriate knowledge to guarantee the ability of pupils to think effectively.

Description of each science process skill is as in Table 4.

Table 4: Science Process Skills

SCIENCE PROCESS SKILLS	DESCRIPTION
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 similarities and differences.
Measuring and Using Numbers	Making quantitative observations using numbers and tools with standard units will ensure an accurate measurement.
Making Inferences	Using collected data or past experiences to draw conclusions and make explanations of events.
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.

SCIENCE PROCESS SKILLS	DESCRIPTIONS
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

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: Science Process Skills and Thinking Skills

SCIENCE PROCESS SKILLS	DESCRIPTION
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
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

The guide of the development of science process skills from primary school to secondary school are as shown in Table 6.

Table 6: Science Process Skills

	SCIENCE PROCESS SKILLS	LEVEL 1 YEAR (1 - 3)	LEVEL 2 YEAR (4 - 6)	LEVEL 3 FORM (1 - 3)	LEVEL 4 FORM (4 - 5)
1	Observing	• Use limbs and senses to make observations about the phenomena or changes that occur.	• Use all the senses to make qualitative observations with the appropriate tools to explain phenomena or changes that occur.	• Make accurate and relevant qualitative and quantitative observations to identify patterns or sequences of objects or phenomena. • Use complex equipment suitable for making observations proficiently.	• Make qualitative and quantitative observations to make generalisations based on a pattern or sequence on an object or phenomenon. • Present further findings based on observation of objects or phenomena analytically and specifically.
2	Classifying	• Collect / isolate evidens / data / objects / 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		• 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		• 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		• 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		• 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		• 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		• 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.

PUPIL PROFILE	DESCRIPTION
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.
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.

PUPIL PROFILE	DESCRIPTION
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 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.

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.

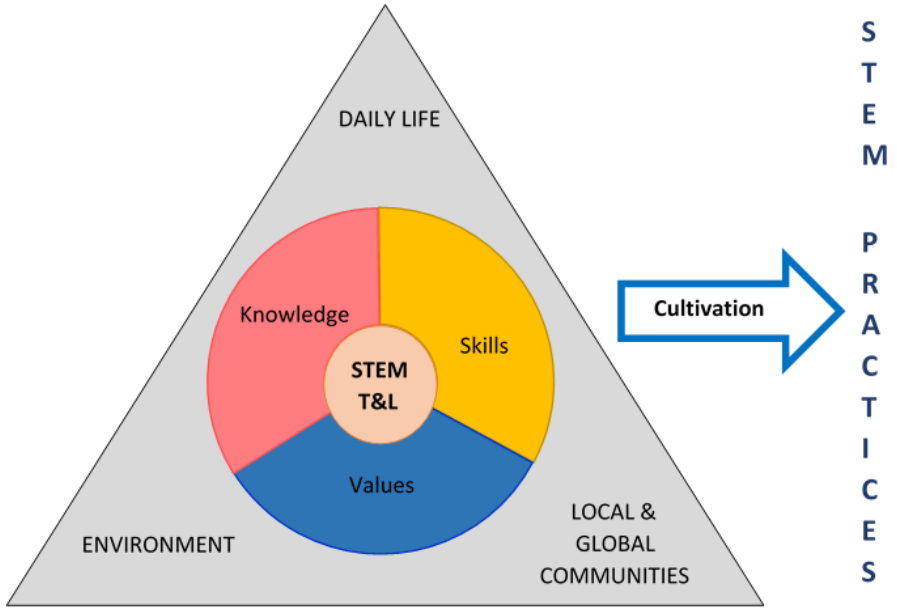


Figure 4: STEM Teaching and Learning Approach

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.

Explanation of the T&L methods in science is as follows:

Scientific Investigation/Experiment

An experiment is a method commonly used in science lessons. Pupils test hypotheses through investigations to discover specific science concepts and principles. 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:

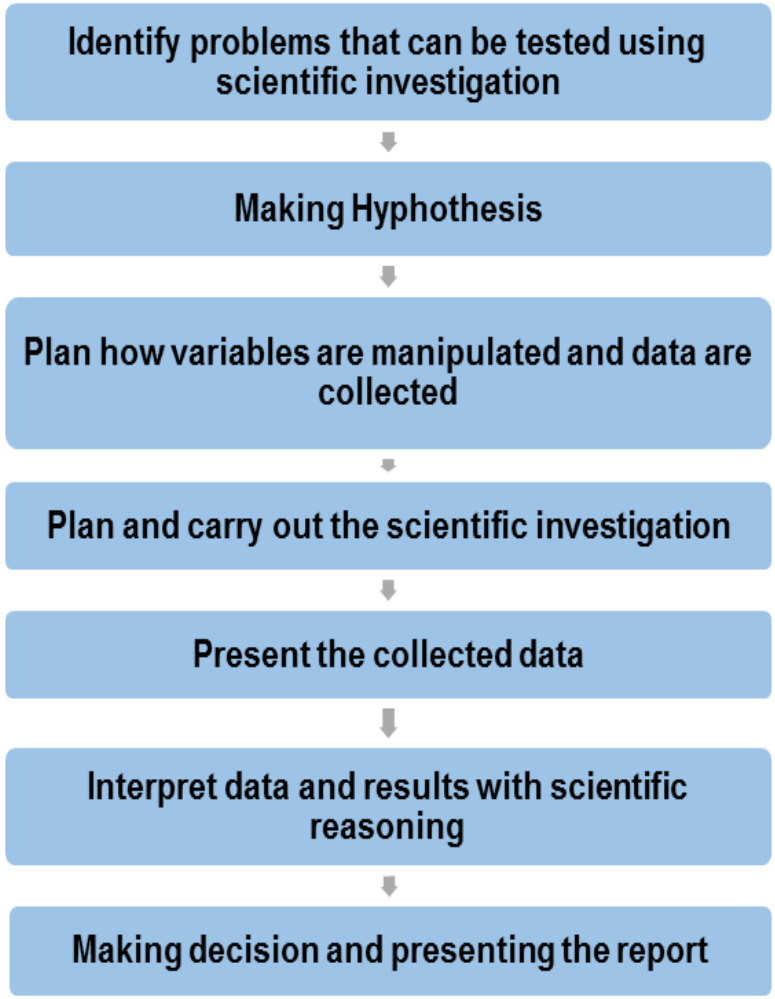


Figure 5: Steps to carry out an experiment

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.

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.

The Use 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 are explained below:

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.

SCHOOL ASSESSMENT

School Assessment 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.

School assessment 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).

The main purpose of formative assessment is to monitor the pupil's learning. Therefore, it is important for teachers to design a valid, reliable and authentic assessment instruments. Information gathered through formative assessment should assist teachers to determine pupil's strengths and weaknesses in achieving the content standard for a subject and not to compare the achievement of one pupil to another. It should assist teachers in adapting teaching and learning based on the needs of their pupils.

A comprehensive assessment should be well planned and carried out continuously as part of the activities in classrooms. Teachers' effort in implementing a holistic assessment assists to improve pupils' weaknesses, forming a conducive and balanced learning ecosystem.

Summative assessment is to evaluate pupils' learning based on several content standards of a subject in a period of time.

In order to ensure the assessment could assist pupils to increase their potentials and performances, teachers should use assessment strategies that have these following characteristics:

- various forms
- fair to all pupils
- consider various cognitive levels
- enable pupils to exhibit a variety of learning abilities
- consider the knowledge and skills learnt by pupils and assess the level of their understanding.

Assessment of Content Standards for each cluster is carried out using the Performance Standard as the teacher's reference to determine pupils' achievement in mastering a particular Content Standard. Performance Standards are hierarchically arranged from Level 1 to Level 6 representing the lowest to the highest standards of achievement. Pupils' achievement must be recorded in the assessment form.

Science Performance Standards for Secondary School

Science assessments in schools rely 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. (Refer Table 10)

All experiments/ scientific investigation described in the notes **MUST** be carried out using the inquiry approach. List of experiments/scientific investigation for each theme are shown in Table 9. However the assessment of scientific skills and values and practices will be assessed only **twice a year** for any theme referring to Table 11.

Scientific attitude and moral value can be assessed any suitable time in whole year referring to Table 12

Learning based project focus on development of product to solve real life problem. Pupils are encourage to do learning at least twice a year.

Table 9: List of experiments/ scientific investigation

THEME	EXPERIMENTS	
MAINTENANCE AND CONTINUITY OF LIFE	1.3.3	Carry out experiments to study responses in plants towards various stimuli.
	2.1.2	Carry out experiments to investigate the differences in the content of gases in inhaled and exhaled air.
	2.3.2	Carry out an experiment to show the effects of smoking on the lungs.
	3.2.3	Carry out experiments to study factors that affect pulse rate.
	3.4.2	Carry out experiments to investigate the factors affecting the rate of transpiration.
EXPLORATION OF ELEMENTS IN NATURE	5.1.3	Carry out an experiment to compare and contrast endothermic and exothermic reactions.
ENERGY AND SUSTAINABILITY OF LIFE	6.2.1	Carry out an experiment to build a step-up and a step-down transformer.

The General Statement to Interpret the Achievement of Knowledge Level for Science Subject is shown in Table 10.

Table 10: Rubric for Knowledge

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	**Inventing** 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

The General Statement to interpret the achivement for Scientific Investigation for Science Subject is shown in Table 11.

Table 11: 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.
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.

The General Statement for Scientific Investigation for Scientific Attitude and Noble Values is shown in Table 12.

Table 12: Rubric for Scientific Attitude and Noble Values

PERFORMANCE LEVEL	DESCRIPTOR
1	Pupil is **notable** 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.
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 can make professional consideration to evaluate overall performance level based on teacher experience with pupil, intelligence and discussing with other teacher.

ORGANISATION OF SCIENCE CURRICULUM STANDARD

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.

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 Content Standard is written according to the hierachy in the cognitive and afectivedomains. The Content Standard statement is the general statement consisting of elements of knowledge, scientific skills, thinking skills, scientific attitude and noble value in line with the intended learning standard.

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 hierachyfrom simple to complex, however the sequence of the Learning Standardcould 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, howevernot all Content Standard cognitive domain will end with the afective domain.

The pupil's development is prescribed with one or more qualifier using a word or a phrase that signify a standard in the form of learning outcome. 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.

The content standard for the afective domain is indirectly integrated when the content standard for the cognitive domain is being carried out. Activities can be varied to achieve one content standard to fulfil the need of learning to suit the pupils's capability and style of learning.

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 13.

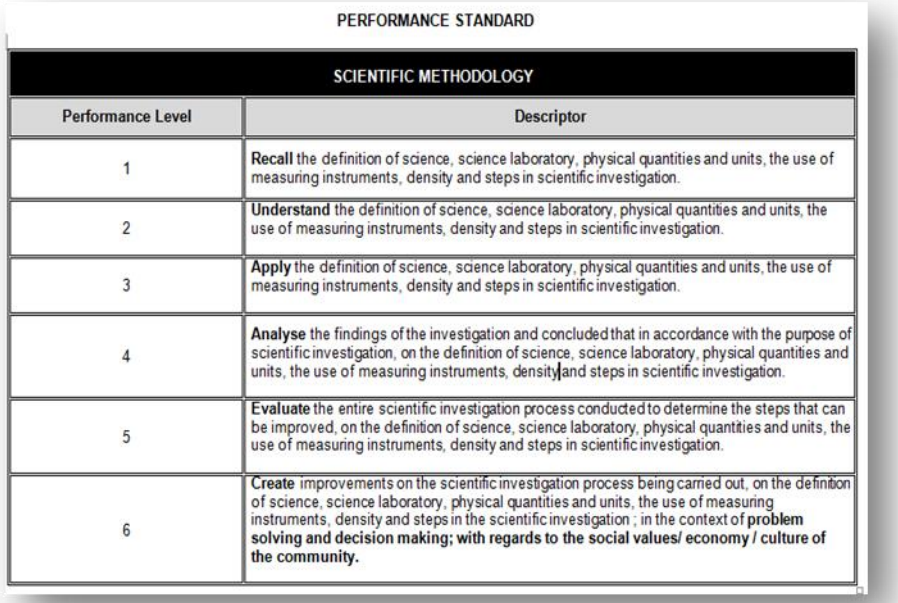
Table 13: Organisation of the DSKP

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).

Figure 6 represents the performance standard placed at the end of every theme in the DSKP.

There is also a Notes column that details out among others:

- the limitation and the scope for the content standard and learning standard,
- suggested teaching and learning activities.



PERFORMANCE STANDARD

SCIENTIFIC METHODOLOGY	
Performance Level	Descriptor
1	**Recall** the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in scientific investigation.
2	**Understand** the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in scientific investigation.
3	**Apply** the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in scientific investigation.
4	**Analyse** the findings of the investigation and concluded that in accordance with the purpose of scientific investigation, on the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in scientific investigation.
5	**Evaluate** the entire scientific investigation process conducted to determine the steps that can be improved, on the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in scientific investigation.
6	**Create** improvements on the scientific investigation process being carried out, on the definition of science, science laboratory, physical quantities and units, the use of measuring instruments, density and steps in the scientific investigation ; in the context of **problem solving and decision making; with regards to the social values/ economy / culture of the community.**

Figure 6: Performance Standard for Scientific Methodology

In preparing the right and relevant activities and the learning environment to suit the pupils' abilities and interest, teachers need to use their creativity and profesional judgement.

The list of suggested activities is not compulsory and teachers are encouraged to use variety of sources like books and internet in preparing the teaching and learning activities to fulfil the pupils abilities and interest.

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

This theme aims to provide an understanding of life processes which all living things undergo. Among the life processes emphasised are the aspects of stimulation and response, respiration and transportation that are important for the survival of human beings and other living things. Focus is also given on the importance of maintaining the health of organs or parts involved in the systems.

Learning area:

1.0 Stimuli and Responses

- 1.1 Human nervous system
- 1.2 Stimuli and responses in human
- 1.3 Stimuli and responses in plants
- 1.4 Importance of responses towards stimuli in other animals

2.0 Respiration

- 2.1 Human respiratory system
- 2.2 Movement and exchange of gases in human body
- 2.3 Health of human respiratory system
- 2.4 Adaptation in respiratory system
- 2.5 Gaseous exchange in plants

3.0 Transportation

- 3.1 Transport system in organisms
- 3.2 Blood circulatory system
- 3.3 Human blood
- 3.4 Transport system in plants
- 3.5 Blood circulatory system and transport system

1.0 STIMULI AND RESPONSES

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.1 Human nervous system	A pupil is able to:	
	1.1.1 Describe the structures and functions of human nervous system through drawings.	**Note:** Human nervous sytem consists of the brain, spinal cord and peripheral nerves.
	1.1.2 Make a sequence to show the pathway of impulses in voluntary and involuntary actions.	**Suggested activity:** Make a creative presentation on: ● Parts involved in the movement of impulses from the affector to the effector. ● The pathways of impulses in voluntary and involuntary actions. Carry out activites to determine the importance of both voluntary and involuntary actions such as: ● Measuring the speed of response in catching a falling ruler (voluntary action), ● Detecting the changes in the pupil towards light intensity (involuntary action).
	1.1.3 Justify the importance of human nervous system in life.	

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.2 Stimuli and responses in human	1.2.1 Draw the structures of sensory organs and explain their functions and sensitivities towards stimuli.	**Suggested activity:** Make a creative presentation on the structure and functions of each part of the eye, ear, nose, skin and tongue. Carry out activites to show the sensitivity of sensory organs (tongue and skin) towards stimuli related to the number of receptors. **Note:** Introduce the functions of: • Photoreceptors (rods and cones). • Taste buds (different taste areas on the tongue including umami). • Olfactory receptor cells.
	1.2.2 Explain the mechanism of hearing and sight through drawings.	**Suggested activity:** Discuss and explain using a model : • Hearing mechanism. • Sight mechanism.
	1.2.3 Relate the human sensory organs to the sensitivity towards various combination of stimuli.	**Suggested activity:** Carry out activities to show the sensitivity of sensory organs towards stimuli which relate to the number of receptors.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Investigate the sensitivity of sensory organs in the combination of: ● Sense of taste and sense of smell. ● Sense of touch and sense of sight. ● Sense of hearing and sense of sight. ● Sense of hearing and balancing.
	1.2.4 Explain through examples how the limitation of senses, defect in sensory organs and aging affect human hearing and sight.	**Suggested activity:** Make a multimedia presentation on: ● Optical illusion and blind spot. ● Various types of audio visual defects such as short-sightedness, long-sightedness, astigmatism and hearing defects. ● Correcting audio visual defects using convex lens, concave lens and hearing aids. ● Examples and effects of unhealthy lifestyle or high risk careers that affect the sensitivity of sensory organs. ● Being thankful for the Gift of senses and the importance of practicing safety and healthcare of the sensory organs.
	1.2.5 Justify how innovations and technologies can improve the ability to sense in sensory organs	

CONTENT STANDARD	LEARNING STANDARD	NOTES
1.3 The stimuli and responses in plants.	1.3.1 Describe the parts of a plant that are sensitive towards stimuli.	**Note:** Responses in plants include phototropism, geotropism, hydrotropism, thigmotropism and nastic movement in the following aspects: ● Stimuli detected by plants. ● Parts of a plant that respond towards stimuli. ● Directions of responses towards stimuli (positive or negative).
	1.3.2 Justify how responses in plants ensure their sustainability and survival.	**Note:** Relate plants response towards stimuli to get the best conditions for growth. How the plants response need to be stated.
	1.3.3 Carry out experiments to study responses in plants towards various stimuli.	**Suggested activity**: Carry out investigation through experiments on responses in plants towards light, water, gravity and touch. Solve problems on responses in plants in different situations such as in the ISS (International Space Station).

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td rowspan="2">1.4 Importance of responses to stimuli in animals</td><td>1.4.1 Explain with examples the types of sight and hearing in animals.</td><td>Suggested activity:

Make a multimedia presentation on:

● Stereoscopic and monoscopic vision in animals,
● Stereophonic hearing and different frequencies for different animals.</td></tr>
<tr><td>1.4.2 Communicate how sensory organs ensure the survival of animals on Earth.</td><td>Suggested activity:

Discuss responses in animals such as:

<table>
<tr><th>Responses</th><th>Example</th></tr>
<tr><td>Whiskers</td><td>Hysterix africaeaustralis</td></tr>
<tr><td>Electric field</td><td>Gymnarchus niloticus</td></tr>
<tr><td>Pheromone</td><td>Melolontha melolontha</td></tr>
<tr><td>Jacobson's organ</td><td>Vipera berus</td></tr>
<tr><td>More than a pair of eyes</td><td>Lyssomanes viridis</td></tr>
<tr><td>Body sensor</td><td>Valanga nigricornis</td></tr>
<tr><td>Lateral line</td><td>Scomber australasicus</td></tr>
</table>

Scientific names of the animals are only for teacher’s reference.</td></tr>
</table>

PERFORMANCE STANDARD

STIMULI AND RESPONSES

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

2.0 RESPIRATION

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.1 Respiratory system	A pupil is able to:	
	2.1.1 Draw and label the internal structures of the human respiratory system and describe the breathing mechanism.	**Suggested activity:** Make a multimedia presentation to explain the structure in the human respiratory system. Make a model or simulation to discuss the actions of the diaphragm, intercostal muscles, movement of the rib cage, changes in the volume and air pressure in the thoracic cavity during inhalation and exhalation.
	2.1.2 Carry out experiments to investigate the differences in the content of gases in inhaled and exhaled air.	**Note:** Compare the results of the experiments to the percentage of oxygen and carbon dioxide in inhaled and exhaled air theoretically.

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.2 Movement and exchange of gases in the human body	2.2.1 Describe the movement and exchange of oxygen and carbon dioxide in the human body.	**Suggested activity:** Make a creative presentation to show the: • Exchange of oxygen and carbon dioxide due to the difference in concentration in the alveolus and blood capillary. • Diffusion of oxygen from the alveolus into the blood capillary. • Formation of an unstable compound, that is, oxyhaemoglobin. • Release of oxygen into the body cells. • Oxidation of food during cellular respiration to release energy. • Diffusion of carbon dioxide from the cell into the blood capillary then into the alveolus.
	2.2.2 Justify the importance of adaptation of the alveolar structure to increase efficiency of gaseous exchange in the human body.	**Note:** Factors that affect the efficiency of the alveolus to maximise the gaseous exchange are thickness, moisture, surface area and network of capillaries.

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.3 Health of human respiratory system	2.3.1 Communicate about substances that are harmful to the respiratory system as well as diseases and their symptoms.	**Suggested activity:** Gather information, analyse and make a multimedia presentation based on data from the Malaysia Health Ministry or other countries on respiratory diseases such as: • Emphysema • Lung cancer • Bronchitis • Asthma **Note:** Examples of substances that are harmful to the respiratory system are tar, sulphur dioxide, carbon monoxide, nitrogen dioxide, pollen grains, haze and dust.
	2.3.2 Carry out an experiment to show the effects of smoking on the lungs.	**Note:** Realise that smoking affects the health of the smoker and others who do not smoke. Introduce the term passive smoker.

CONTENT STANDARD	LEARNING STANDARD	NOTES
2.4 Adaptation in respiratory system	2.4.1 Justify how the respiratory system adapts in different situations.	**Suggested activity:** Do a creative presentation to explain how other organisms carry out respiration • Moist skin • Gills • Trachea Carry out an active reading activity on the adaptation and the ability of the respiratory system in the following context: • Different altitudes (at the bottom of the sea and mountainous regions) • Sports activities and lifestyle (athlete and swimmer) • Diseases (anaemia and sickle cell patient) **Note:** Realise that exercise and the choice of healthy lifestyle are important to the respiratory system.
2.5 Gaseous exchange in plants	2.5.1 Explain the mechanism of gaseous exchange in plants.	**Suggested activity:** Soak a leaf in boiling water to observe the gas released from its surface.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Observe the structure of a stoma under a microscope and make a multimedia presentation to show: • A stomatal pore is controlled by two guard cells • During the day, water enters the guard cells by osmosis, causing them to become turgid and open the stomatal pore. • Diffusion of carbon dioxide takes place in the stoma due to the difference in concentration. • During the night, water is lost from the guard cells through osmosis causing the stomatal pore to close. **Note:** Osmosis needs to be introduced to explain how it affects the stomatal pore.
	2.5.2 Communicate to justify the importance of an unpolluted environment for the growth and survival of plants	**Suggested activity:** Make a multimedia presentation on the effects of pollution on plants and preventive steps to be taken in local or global context.

PERFORMANCE STANDARD

RESPIRATION

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

3.0 TRANSPORTATION

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td rowspan="4">3.1 Transport system in organisms</td><td colspan="2">A pupil is able to:</td></tr>
<tr><td>3.1.1 Describe the function of transport systems in complex and simple organisms.</td><td rowspan="3">Suggested activity:

Gather and share information on:

● The need for a transport system in organisms

● The function of a transport system in organisms

● The importance of a functional transport system in organisms and its impact if the system does not function properly.

Note:

A simple organism does not have any specific transport system. Substances such as oxygen and nutrients from the environment enter the cell via diffusion through the cell membrane. Excretory products are eliminated from cells via the same method.</td></tr>
<tr><td>3.1.2 Compare and contrast the functions of transport systems in complex and simple organisms.</td></tr>
<tr><td>3.1.3 Justify the importance of the function of transport system in organisms.</td></tr>
</table>

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.2 Blood circulatory system	3.2.1 Generalise the meaning of blood circulatory system in animals.	**Suggested activity:** Carry out an active reading activity to compare and contrast the blood circulatory system in vertebrates such as, mammals, reptiles, amphibians, birds and fishes. **Note:** The blood circulatory system is a tubular system comprising of a pump and valves to ensure the flow of blood in one direction.
	3.2.2 Communicate to explain the structure and functions of a heart and blood vessels in human blood circulatory system.	**Suggested activity:** Make a multimedia presentation based on research of real animal hearts to explain its structure and functions. Focus on the heart's structures which enable it to carry out its function. Draw cross sections of an artery, vein and blood capillary to differentiate the structures and functions. **Note:** Introduce pulmonary and systemic circulatory systems. Religious sensitivities have to be taken into account when obtaining the real animal heart.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.2.3 Carry out experiments to study factors that affect pulse rate.	**Suggested activity:** Carry out vigorous activities to relate the increase in pulse rate to the rate of oxygen uptake and release of carbon dioxide. Measure and take blood pressure readings (systolic and diastolic readings) and discuss the *lub dub* sound produced during heartbeat. Study the effect of physical activities on pulse rate and discuss other factors that influence pulse rate such as: ● Gender ● Age ● Body health
	3.2.4 Justify the importance of maintaining a heathy heart.	**Suggested activity:** Attention should be given to heart health due to the significance of its functions in one's wellness. Carry out project-based learning using STEM approaches to plan an awareness campaign to enhance knowledge and understanding about heart health.

CONTENT STANDARD	LEARNING STANDARD	NOTES
3.3 Human blood	3.3.1 Separate the components and constituents of human blood.	**Suggested activity:** Separate the component of blood using centrifugal separation. Carry out an active reading activity on the constituents transported in blood, that is, nutrients, gases, enzymes, hormones and waste products.
	3.3.2 Identify blood groups and the effects of receiving incompatible blood groups.	**Suggested activity:** Collect data on blood groups from each student and discuss: ● Compatibility of blood donors and recipients in aspects of antigen types and antibodies for blood groups A, B, AB and O. ● Effects of incompatible blood types such as blood coagulation.
	3.3.3 Communicate about the importance of blood donation in context of daily life.	**Suggested activity:** Blood is needed everyday in saving lives. Blood is required for surgery and blood transfusion for accident victims as well as treating diseases like leukemia, thalassaemia and haemophilia. Carry out project-based learning using STEM approaches to plan and organize activities to solve the following issues:

CONTENT STANDARD	LEARNING STANDARD	NOTES
		• Importance of blood donation. • Criteria to be a blood donor • Issues related to blood donation. • Methods of handling and storing donated blood. Please refer to frequently asked questions posed in the National Blood Bank website/www/pdn.gov.my for further insight on this discussion.
3.4 Transport system in plants	3.4.1 Describe transpiration in plants	**Suggested activity:** Observe video to understand transpiration in plants. **Note:** Introduce guttation in plants.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	3.4.2 Carry out experiments to investigate the factors affecting the rate of transpiration.	**Notes:** Factors affecting the rate of transpiration are: ● Light intensity ● Air humidity ● Temperature ● Wind Being thankful to the uniqueness of the transport system for continuity of life.
	3.4.3 Differentiate between the structure and functions of components in a vascular bundle of a plant.	**Suggested activity:** Investigate water pathway in the cross section of a stem using dye or browse the internet to locate the position and structure of the xylem and phloem in a vascular bundle. Based on the understanding of transport system in plants, discuss examples of hypothetical situations in the absence of xylem or phloem.
3.5 Blood circulatory system and transport system in plants	3.5.1 Compare blood circulatory system in animals with transport sytem in plants.	**Note:** Being thankful for the uniqueness of the circulatory system to the continuity of life.

PERFORMANCE STANDARD

TRANSPORTATION

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

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

This theme aims to introduce the various minerals found in the Earth's crust. The reactivity series of metals is constructed with the purpose of understanding the process of extraction of metal from its ores. Mining issues are also highlighted to increase awareness on the importance of managing the environment sustainably. The knowledge of energy in chemical changes gives an understanding on the application of exothermic and endothermic processes in the production of goods in daily life.

Learning standard:

4.0 Reactivity of metals

- 4.1 Variety of minerals.
- 4.2 Reactivity series of metals.
- 4.3 Extraction of metals from its ores.

5.0 Thermochemistry

- 5.1 Endothermic and exothermic reactions.

4.0 REACTIVITY OF METALS

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td rowspan="3">4.1 Variiety of minerals</td><td colspan="2">A pupil is able to:</td></tr>
<tr><td>4.1.1 Explain with examples minerals that are found in the Earth’s crust.</td><td>Note:

Minerals in Earth’s crust consist of:

• Elements such as gold and silver.

• Compounds such as bauxite, haematite, galena and cassiterite.</td></tr>
<tr><td>4.1.2 Identify elements found in natural compounds.</td><td>Suggested activity:

Carry out activities to show that natural compounds are formed from the combination of several elements.

Introduce the common and scientific names for a compound. Example:

<table>
<tr><th>Common name</th><th>Scientific name</th><th>Elements</th></tr>
<tr><td>Bauxite (aluminium ore)</td><td>Aluminium Oxide</td><td>Aluminium and Oxygen</td></tr>
<tr><td>Galena (plumbum ore)</td><td>Plumbum(II) Sulphide</td><td>Lead and Sulphur</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td></td><td>4.1.3 Explain with examples the characteristics of natural minerals and its uses in daily life.</td><td>Suggested activity:

Gather information on natural minerals and its uses.
Examples:
<table><tr><th>Natural minerals</th><th>Chemical / physical characteristic</th><th>Uses</th></tr><tr><td>Calcium oxide</td><td>Basic</td><td>Neutralise acidic soil</td></tr><tr><td>Silicon dioxide</td><td>High melting point</td><td>Make glass</td></tr></table></td></tr>
<tr><td rowspan="2">4.2 Reactivity series of metals</td><td>4.2.1 Construct a reactivity series of metals based on its reactivity with oxygen and write the word equation for the reactions.</td><td>Suggested activity:

Study the reaction of heating metals such as magnesium, aluminium, zinc, ferrum and lead, with oxygen.

Arrange metals into a reactivity series based on their reactions.</td></tr>
<tr><td>4.2.2 Determine the position of carbon and hydrogen in the reactivity series of metals.</td><td>Suggested activity:

Demonstration by teacher:
• Determine the position of carbon in the reactivity series by heating ferrum(II) oxide with carbon (Example – Thermite reaction).</td></tr>
</table>

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Pupils carry out these metal heating activities: • Zinc oxide with carbon. • Aluminium oxide with carbon. **Note:** The position of hydrogen in the reactivity series of metals is determined by interpretation of data.
4.3 Extraction of metals from its ore.	4.3.1 Communicate about the extraction of metals from its ore by illustrations.	**Suggested activity:** Make a multimedia presentation on how metals extraction is done based on process below: • Extraction of Iron. • Extraction of tin in Malaysia.
	4.3.2 Generate ideas on how to solve problems from unplanned mining activities to life on Earth.	**Suggested activities:** Debate on mining issues in Malaysia and its impact on the environment. Make a poster presentation or gallery walk on how efforts are made to conserve mining areas towards sustainable development.

PERFORMANCE STANDARD

REACTIVITY OF METALS

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

5.0 THERMOCHEMISTRY

<table>
<tr><th>CONTENT STANDARD</th><th>LEARNING STANDARD</th><th>NOTES</th></tr>
<tr><td rowspan="4">5.1 Endothermic and exothermic reactions</td><td colspan="2">A pupil is able to:</td></tr>
<tr><td>5.1.1 Define endothermic and exothermic reactions.</td><td rowspan="3">Suggested activity:
Carry out an investigation to verify similarities and differences in endothermic and exothermic reactions with respect to:
• Changes in thermometer reading.
• Changes in heat.
Relate these changes with the concept of thermal equilibrium.
Note:
Examples of chemical changes that involve heat are the burning of paper, photosynthesis, bomb explosion, cake baking, and respiration.</td></tr>
<tr><td>5.1.2 Relate heat absorbed or released in a chemical reaction to endothermic and exothermic reactions.</td></tr>
<tr><td>5.1.3 Carry out an experiment to compare and contrast endothermic and exothermic reactions.</td></tr>
</table>

CONTENT STANDARD	LEARNING STANDARD	NOTES
	5.1.4 Explain with examples exothermic and endothermic reactions.	**Suggested activity:** Carry out project based learning to determine the best parameter or variables for: • Producing materials to relieve muscle cramp • Producing emergency lamps during power failure • Building a container which maintains high temperature or low temperature. Refer to Modul 7 HEBAT Sains (Heat)
	5.1.5 Design materials using the concept of exothermic and endothermic processes to solve problems in life.	

PERFORMANCE STANDARD

TERMOCHEMISTRY

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

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

This theme gives an understanding on sources of energy and how electricity is generated and distributed. Awareness of the importance of saving electricity through green technology is introduced. Scientific and computational thinking skills are encouraged in the learning areas of energy and power. Radioactivity is introduced in the form of a daily life application in an effort to improve the well-being of life.

Learning Area:

6.0 Electricity and magnetism

- 6.1 Generation of electricity
- 6.2 Transformer
- 6.3 Transmission and distribution of electricity
- 6.4 Calculating the cost of electricity consumption

7.0 Energy and Power

- 7.1 Work, Energy and Power
- 7.2 Potential energy and kinetic energy
- 7.3 Principle of Conservation of Energy

8.0 Radioactivity

- 8.1 The discovery of radioactivity
- 8.2 Atom and nucleus
- 8.3 Ionising and non-ionising radiation
- 8.4 Usage of radioactive radiation

6.0 ELECTRICITY AND MAGNETISM

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.1 Generation of electricity	A pupil is able to:	
	6.1.1 Describe energy sources in terms of renewable energy and non-renewable energy.	**Note:** Examples of renewable energy sources are hydropower, waves, solar, tides, winds, biomass, and geothermal. Examples of non-renewable energy sources are nuclear energy, coal, natural gas and diesel. Refer to Module 19 HEBAT Sains (Earth Resources).
	6.1.2 Explain with examples the process of generating electricity from various sources of energy.	**Suggested activity:** Build a simple generator that can light up LEDs, using magnets and coils of wire. It should be stressed that current is induced only when the magnetic field is cut. Carry out a group discussion on how electricity is generated in power stations using various sources of energy.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.1.3 Differentiate between direct current and alternating current.	**Suggested activity:** Use a cathode ray oscilloscope to show the difference in the shape of the graph, direction of the current and voltage change for direct current (d.c.) and alternating current (a.c.). **Note:** Most generators generate a.c. while solar cells and batteries produce d.c.
	6.1.4 Solve problems related to electricity supply in life. .	**Suggested activity:** Make a model or innovation to solve problems involving the generation of electricity in rural areas, using turbines and generators, without affecting the environment. Refer to Module 22 HEBAT Sains (Energy).
6.2 Transformer	6.2.1 Carry out an experiment to build a step-up and a step-down transformer.	**Suggested activity:** Make a creative presentation about transformers: ● Describe that transformers only work with alternating current. ● Build a simple transformer using a laminated iron core. ● Control variables such as the ratio of the number of secondary coils to the number of primary coils in building step-up and step-down transformers.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.2.2 Communicate about transformers and the use of transformers in electrical home appliances.	**Suggested activity:** Make a multimedia presentation about the use of transformers in home appliances. **Note:** Introduce the formula: $\frac{N_p}{N_s} = \frac{V_p}{V_s}$ N_p - Number of turns of primary coil. N_s - Number of turns of secondary coil. V_p - Input voltage of primary coil. V_s - Output voltage of secondary coil.
	6.2.3 Solve numerical problems using formula involving transformers.	

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.3 Transmision and distribution of electricity	6.3.1 Explain the function of components in the transmission and distribution of electricity by drawing.	**Suggested activity:** Arrange in order the components in the transmission and distribution of electricity such as power stations, step-up transformer stations, National Grid Network, step-down transformer stations, distribution sub-stations, switches, main intake sub-stations. Discuss the issues and impact of National Grid Network pylons near residential area.
	6.3.2 Explain with examples electricity supply and wiring systems in homes.	**Suggested activity:** Discuss single phase and 3-phase wiring systems in homes. **Note:** Components of home wiring system include a fuse box, circuit breaker, main switch, live wire, neutral wire, earth wire, electrical meter and the usage of international color codes in wiring. Introduce 2 pin and 3 pin plugs and its suitability of use in different countries.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.3.3 Distinguish between safety components in a home electrical wiring system.	**Suggested activity:** Carry out an activity to identify the functions, types and rating of fuses, and to determine the suitable value of fuse to be used. Make a group discussion to identify: • Function of earth wire. • Function of the Miniature Circuit Breaker(MCB), and Earth Leakage Circuit Breaker(ELCB). • Lightning conductor. • Switch.
	6.3.4 Communicate about safety in transmission and distribution of electricity and the use of electrical appliances.	**Suggested activity:** Make brochures or posters for the following: • Cause of electrical short circuit. • Cause of electrical accidents. • Safety measures when using electricity. • Steps to take when electrical shock occurs.

CONTENT STANDARD	LEARNING STANDARD	NOTES
6.4 Calculate the cost of electricity consumption	6.4.1 Define energy efficiency.	**Note:** Introduce the role of the Energy Commision in the labelling of electrical equipments using Energy Efficiency Rating and Labelling.
	6.4.2 List examples of technology that applies the concept of energy efficiency.	
	6.4.3 Determine the amount of electricity used in electrical appliances.	**Suggested activity**: • List down the power and voltage values of electrical appliances at home. • Calculate the current used by each electrical appliances. **Note:** Introduce formula: Power (W) = Electrical energy used (J) / Time (s) Power (W) = Voltage (V) x Electric current (A)
	6.4.4 Relate electrical energy consumption, power and time by calculating the cost of electrical energy used by electrical appliances.	**Note:** Introduce the formula: Energy Consumption (kWh) = Power (kW) x Time(h)
	6.4.5 Conduct a home energy audit of electrical appliances used as a measure to save electricity usage at home.	**Suggested activity:** Interpret data on electricity use with reference to the electricity bill collected within a specified period of time. Make conclusions about usage patterns observed and suggest saving measures that need to be taken.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	6.4.6 Communicate about ways of saving electrical energy usage at home.	**Suggested activity:** Make a multimedia presentation on the concept of green building in a local or global context. Malaysia is aiming to reduce carbon footprint by reducing carbon dioxide emissions by 45% by 2030. *Extracted from Sun Daily 21 April 2016* Design or innovate a model of a green building that applies the concept of energy conservation, through project base learning, using STEM approach. Emphasis is given to: • Energy efficiency. • Power sales • Appliances with Energy Efficiency Rating and Labelling

PERFORMANCE STANDARD

ELECTRICITY AND MAGNETISM

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

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.1 Work, Energy and Power	A pupil is able to:	
	7.1.1 Define work and solve problems related to energy in the context of daily life.	**Suggested activity:** Conduct activities and solve numerical problems to calculate work done for: ● An object moving horizontally. ● An object moving vertically (against gravitational force). Discuss the relationship between total work done and energy used. **Note:** Work is defined as the product of force and displacement in the direction of the force. Energy is the ability to do work. Work = Force x Displacement (W=Fs) S.I. unit for work is Joule. When a force of 1 Newton is applied to move an object over a displacement of 1 meter in the direction of the force, 1 J of energy is used. (1 Nm = 1 J)

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.1.2 Relate power with work and solve problems in the context of daily life. .	**Suggested activity:** Conduct activities and solve numerical problems to calculate power when: ● An object is moving horizontally. ● An object is moving vertically. using a spring balance and stopwatch. **Note:** Power is defined as the rate of doing work. Power = Work/ Time. S.I. unit for power is Watt. When 1 Joule of work is done in 1 second, power of 1 Watt is used. (1 J/s = 1 W)

CONTENT STANDARD	LEARNING STANDARD	NOTES
7.2 Potential Energy and Kinetic Energy	7.2.1 Explain with examples gravitational potential energy and solve problems in the context of daily life.	**Suggested Activity:** Conduct activity to solve numerical problems related to potential energy. **Note:** Gravitational potential energy is work done to lift an object to a height, *h*, from the Earth's surface. Gravitational potential energy =*mgh* Note: Weight (W) = mass(m) x gravitational acceleration(*g*). *g* is approximately 10 m/s^2 or 10 N/kg
	7.2.2 Calculate elastic potential energy in the context of daily life.	**Suggested activity:** Discuss that elastic potential energy is the energy stored in a compressed or stretched spring. Relate elastic potential energy, E_p as work done, W to compress or stretch a spring over a displacement, x from the position of equilibrium.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Note: Elastic potential energy, $E_p = ½ Fx$ Force to extend a spring increases uniformly from zero with the extention of the spring. Therefore, to calculate work done in stretching a spring, we use average value of force, that is: Average force = $(0 + F)/2 = ½ F$
	7.2.3 Explain with examples kinetic energy in the context of daily life.	**Suggested activity:** Discuss that kinetic energy is the energy possessed by a moving object. **Note:** Kinetic energy, $E_k = ½ mv^2$
7.3 Principle of Conservation of Energy	7.3.1 Explain with examples The Principle of Conservation of Energy.	**Suggested activity:** Conduct an activity to demonstrate The Principle of Conservation of Energy, by observing an oscillating system such as a simple pendulum and loaded spring.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	7.3.2 Solve qualitative and quantitative problems involving the transformation of kinetic energy and potential energy in a closed system.	**Suggested activity:** Discuss daily situations involving the conversion of energy such as the motion of a swing, the falling of an object from a certain height, the movement of the roller-coaster and toys with springs like toy cars and pistols. Solve quantitative problems using the following equations: **Note:** $mgh = ½ mv^2$ $½ Fx = mgh$ $½ Fx = ½ mv^2$

PERFORMANCE STANDARD

TERMOCHEMISTRY

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

8.0 RADIOACTIVITY

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.1 History of the discovery of radioactivity	A pupil is able to:	
	8.1.1 Describe the history of the discovery of radioactivity.	**Note:** Introduce the following physicists: • Wilhelm Roentgen. • Henri Becquerel. • Marie and Pierre Curie.
	8.1.2 Explain with examples radioactive materials, radioactivity and the concept of half-life.	**Suggested activity:** Make a cloud chamber to study the tracks produced by radioactive substances. **Note:** Radioactivity is the spontaneous decomposition of an unstable nucleus by emitting radioactive radiations. Examples of radioactive materials are: Carbon-14 (C-14), Radon-222 (Rn-222), Thorium-232 (Th-232), Uranium-235 (U-235) Introduce unit of radioactivity such as Becquerel (Bq) and Curie (Ci).

CONTENT STANDARD	LEARNING STANDARD	NOTES
8.2 Atom and nucleus	8.2.1 Draw an atomic structure in a stable state.	**Note:** According to Dalton's Atomic Theory, atoms are the smallest particles in matter. However, the development of science has succeeded in finding particles that are even smaller than protons and neutrons. Emphasis is given to the understanding that an atom is neutral because the number of protons and electrons are the same.
	8.2.2 Explain the formation of positive ions and negative ions.	
8.3 Ionising radiation and Non- ionising radiation	8.3.1 Describe ionising radiation and non-ionising radiation.	**Suggested activity:** Research and report on ionising radiation such as alpha, beta, gamma and X-rays. **Note:** The difference between the three rays in terms of particle size, charge, ionising power, penetrating power, deflection by magnetic field and electric field.
	8.3.2 Differentiate the three types of ionising radiation in radioactive decay.	
	8.3.3 Explain with examples sources of ionising radiation in the environment, natural resources and man-made sources	**Suggested activity:** Carry out an activity to detect natural background radiation in soils, rocks and plants using a background radiation survey meter. **Note:** • Natural sources of ionising radiation are cosmic rays and background radiation

CONTENT STANDARD	LEARNING STANDARD	NOTES
		• Man-made sources of ionising radiation are nuclear accidents, nuclear tests, and the production of radioisotopes for various uses. • The unit of dose rate measurement for background radiation is microSievert/hour (μSv / h). 1 Sv is equal to 1 Joule of radioactive energy absorbed by 1 kilogram of living tissue. • Dose rate less than 0.2 μSv / h is considered a safe level of background radiation.
	8.3.4 Discuss ways to manage the risks from exposure to natural and man made ionising radiation.	**Suggested activity**: Interprete health-related data on the level of ionising radiation absorbed by the human body. Determine the action to be taken if it exceeds the safety level, especially for individuals working in the aviation sector or industries related to radioisotope processing and production.
8.4 The use of radioactive radiation	8.4.1 Communicate about the use of radioactive radiation for wellbeing.	**Suggested activity:** Conduct a gallery walk on the use of radioactive radiation in the areas of agriculture, defense, medicine, archeology or geochronology, industrial and food preservation.

CONTENT STANDARD	LEARNING STANDARD	NOTES
	8.4.2. Justify the importance of proper handling of radioactive substances and radioactive waste.	**Note:** Safety measures in the handling of radioactive substances and radioactive waste. To be in awe of the Almighty for creating radioactive particles that have many uses to sustain life. .

PERFORMANCE STANDARD

RADIOACTIVITY

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

Theme 4: **EARTH AND SPACE EXPLORATION**

This theme gives an understanding on the effects of Sun's activities towards the weather in outer space which also directly affect the life on the Earth. This theme also explores technological development in outer space exploration and astronomy.

Learning area:

9.0 Space Weather

- 9.1 The Sun's activities that affect the Earth
- 9.2 Space weather

10.0 Space Exploration

- 10.1 Development in astronomy
- 10.2 Development of technology and its application in space exploration

9.0 SPACE WEATHER

CONTENT STANDARD	LEARNING STANDARD	NOTES
9.1 The Sun's activities that affect the Earth	A pupil is able to:	
	9.1.1 Explain the structure of the Sun and phenomena that occur on the Sun's surface by drawing.	**Suggested activity:** Gather and share information on the Sun's structure consisting of core, convection zone, radiation zone, photosphere, chromosphere and corona. **Notes:** Examples of phenomena that occur on the surface of the Sun are granules, prominence, solar flares, solar cycle, sunspots, coronal mass ejections and solar wind.
	9.1.2 Justify the importance of the Earth's magnetosphere.	**Suggested activity:** Gather and share information about the magnetosphere in terms of definition, formation, shape and its importance. Brainstorming on the condition of Earth without the magnetosphere.

CONTENT STANDARD	LEARNING STANDARD	NOTES
9.2 Space Weather	9.2.1 Communicate about space weather and its effects on Earth.	**Suggested activity:** Gather and share information on space weather in terms of its definition and effects on the Earth such as the formation of aurora, disturbances of telecommunication, navigation system and power lines. Interpreting space weather data by relating the number of sunspots (solar cycle) with the increase of coronal mass ejections and solar wind. **Note:** An aurora is formed when cosmic rays collide with gas atoms and molecules in the Earth's atmosphere.

PERFORMANCE STANDARD

SPACE WEATHER

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

10.0 SPACE EXPLORATION

CONTENT STANDARD	LEARNING STANDARD	NOTES
10.1 Development in astronomy	A pupil is able to:	
	10.1.1 Explain the historical development of the Solar System model by drawing.	**Suggested activitiy:** Carry out an active reading activity to know the development of model built by: ● Ptolemy ● Copernicus ● Kepler Realizing that knowledge gained by scientific research is a product of human effort to obtain rational explanations about natural phenomena based on the ability to think out of the box.
10.2 Development of technology and its application in space exploration	10.2.1 Communicate about the importance of the development of technology and its application in space exploration.	**Suggested activity:** Carry out an active reading activity or make a multimedia presentation on: The history of space exploration. Construction of rockets, satellites and space probes. Remote sensing technology used in agriculture, geology, disaster management, defence and etc.

CONTENT STANDARD	LEARNING STANDARD	NOTES
		Note: Explain the role of the Malaysian Remote Sensing Agency (MRSA) in various fields.
	10.2.2 Justify the need to continue space exploration.	**Suggested activity:** Debate on issues of space exploration in the local and global context.

PERFORMANCE STANDARD

SPACE EXPLORATION

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

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