



MINISTRY OF EDUCATION MALAYSIA

## **Integrated Curriculum for Secondary Schools**

**Curriculum Specifications**

### **CHEMISTRY Form 5**



Curriculum Development Centre  
Ministry of Education Malaysia  
2006

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## **THE NATIONAL PHILOSOPHY**

Our nation, Malaysia, is dedicated to achieving a greater unity of all her people; maintaining a democratic way of life; creating a just society in which the wealth of the nation shall be equitably shared; ensuring a liberal approach to her rich and diverse cultural traditions; building a progressive society which shall be oriented towards modern science and technology.

We, the people of Malaysia, pledge our united efforts to attain these ends guided by the following principles:

BELIEF IN GOD

LOYALTY TO KING AND COUNTRY

SUPREMACY OF THE CONSTITUTION

RULE OF LAW

GOOD BEHAVIOUR AND MORALITY

## **NATIONAL PHILOSOPHY OF EDUCATION**

Education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards and who are responsible and capable of achieving a high level of personal well being as well as being able to contribute to the harmony and betterment of the family, society and the nation at large.

## **NATIONAL SCIENCE EDUCATION PHILOSOPHY**

In consonance with the National Education Philosophy, science education in Malaysia nurtures a Science and Technology Culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency.

## PREFACE

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The aspiration of the nation to become an industrialised society depends on science and technology. It is envisaged that success in providing quality science education to Malaysians from an early age will serve to spearhead the nation into becoming a knowledge society and a competitive player in the global arena. Towards this end, the Malaysian education system is giving greater emphasis to science and mathematics education.

The Chemistry curriculum has been designed not only to provide opportunities for students to acquire science knowledge and skills, develop thinking skills and thinking strategies, and to apply this knowledge and skills in everyday life, but also to inculcate in them noble values and the spirit of patriotism. It is hoped that the educational process en route to achieving these aims would produce well-balanced citizens capable of contributing to the harmony and prosperity of the nation and its people.

The Chemistry curriculum aims at producing active learners. To this end, students are given ample opportunities to engage in scientific investigations through hands-on activities and experimentations. The inquiry approach, incorporating thinking skills, thinking strategies and thoughtful learning, should be emphasised throughout the teaching-learning process. The content and contexts suggested are chosen based on their relevance and appeal to students so that their interest in the subject is enhanced.

In a recent development, the Government has made a decision to introduce English as the medium of instruction in the teaching and learning of science and mathematics. This measure will enable students to keep abreast of developments in science and technology in contemporary society by enhancing their capability and know-how to tap the diverse sources of information on science written in the English language. At the same time, this move would also provide opportunities for students to use the English language and hence, increase their proficiency in the language. Thus, in implementing the science curriculum, attention is given to developing students' ability to use English for study and communication, especially in the early years of learning.

The development of this curriculum and the preparation of the corresponding Curriculum Specifications have been the work of many individuals over a period of time. To all those who have contributed in one way or another to this effort, may I, on behalf of the Ministry of Education, express my sincere gratitude and thanks for the time and labour expended.

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# INTRODUCTION

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As articulated in the National Education Policy, 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 and harmonious. The primary and secondary school science curriculum is developed with the aim of producing such individuals.

As a nation that is progressing towards a developed nation status, Malaysia needs to create a society that is scientifically oriented, progressive, knowledgeable, having a high capacity for change, forward-looking, innovative and a contributor to scientific and technological developments in the future. In line with this, there is a need to produce citizens who are creative, critical, inquisitive, open-minded and competent in science and technology.

The Malaysian science curriculum comprises three core science subjects and four elective science subjects. The core subjects are Science at primary school level, Science at lower secondary level and Science at upper secondary level. Elective science subjects are offered at the upper secondary level and consist of Biology, Chemistry, Physics, and Additional Science.

The core science subjects for the primary and lower secondary levels are designed to provide students with basic science knowledge, prepare students to be literate in science, and enable students to continue their science education at the upper secondary level. Core Science at the upper secondary level is designed to produce students who are literate in science, innovative, and able to apply scientific knowledge in decision-making and problem solving in everyday life.

The elective science subjects prepare students who are more scientifically inclined to pursue the study of science at post-secondary level. This group of students would take up careers in the field of science and technology and play a leading role in this field for national development.

For every science subject, the curriculum for the year is articulated in two documents: the syllabus and the curriculum specifications. The syllabus presents the aims, objectives and the outline of the curriculum content for a period of 2 years for elective science subjects and 5 years for core science subjects. The curriculum specifications provide the details of the curriculum which includes the aims and objectives of the curriculum, brief descriptions on thinking skills and thinking strategies, scientific skills, scientific attitudes and noble values, teaching and learning strategies, and curriculum content. The curriculum content provides the learning objectives, suggested learning activities, the intended learning outcomes, and vocabulary.

## AIMS

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The aims of the chemistry curriculum for secondary school are to provide students with the knowledge and skills in chemistry and technology and enable them to solve problems and make decisions in everyday life based on scientific attitudes and noble values.

Students who have followed the secondary science curriculum will have the foundation in science to enable them to pursue formal and informal further education in chemistry and technology.

The curriculum also aims to develop a concerned, dynamic and progressive society with a science and technology culture that values nature and works towards the preservation and conservation of the environment.

## OBJECTIVES

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The chemistry curriculum for secondary school enables students to:

1. Acquire knowledge in science and technology in the context of natural phenomena and everyday life experiences.
2. Understand developments in the field of science and technology.
3. Acquire scientific and thinking skills.
4. Apply knowledge and skills in a creative and critical manner for problem solving and decision-making.

5. Face challenges in the scientific and technological world and be willing to contribute towards the development of science and technology.
6. Evaluate science- and technology-related information wisely and effectively.
7. Practise and internalise scientific attitudes and good moral values.
8. Realise the importance of inter-dependence among living things and the management of nature for survival of mankind.
9. Appreciate the contributions of science and technology towards national development and the well-being of mankind.
10. Realise that scientific discoveries are the result of human endeavour to the best of his or her intellectual and mental capabilities to understand natural phenomena for the betterment of mankind.
11. Create awareness on the need to love and care for the environment and play an active role in its preservation and conservation.

## SCIENTIFIC SKILLS

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Science emphasises inquiry and problem solving. In inquiry and problem solving processes, scientific and thinking skills are utilised. Scientific skills are important in any scientific investigation such as conducting experiments and carrying out projects.

Scientific skills encompass science process skills and manipulative skills.

### Science Process Skills

Science process skills enable students to formulate their questions and find out the answers systematically.

Descriptions of the science process skills are as follows:

<b>Observing</b>	Using the sense of hearing, touch, smell, taste and sight to collect information about an object or a phenomenon.
<b>Classifying</b>	Using observations to group objects or events according to similarities or differences.
<b>Measuring and Using Numbers</b>	Making quantitative observations using numbers and tools with standardised units. Measuring makes observation more accurate.
<b>Inferring</b>	Using past experiences or previously collected data to draw conclusions and make explanations of events.

<b>Predicting</b>	Stating the outcome of a future event based on prior knowledge gained through experiences or collected data.
<b>Communicating</b>	Using words or graphic symbols such as tables, graphs, figures or models to describe an action, object or event.
<b>Using Space-Time Relationship</b>	Describing changes in parameter with time. Examples of parameters are location, direction, shape, size, volume, weight and mass.
<b>Interpreting Data</b>	Giving rational explanations about an object, event or pattern derived from collected data.
<b>Defining Operationally</b>	Defining concepts by describing what must be done and what should be observed.
<b>Controlling Variables</b>	Identifying the fixed variable, manipulated variable, and responding variable in an investigation. The manipulated variable is changed to observe its relationship with the responding variable. At the same time, the fixed variable is kept constant.
<b>Hypothesising</b>	Making a general statement about the relationship between a manipulated variable and a responding variable in order to explain an event or observation. This statement can be tested to determine its validity.
<b>Experimenting</b>	Planning and conducting activities to test a certain hypothesis. These activities include collecting, analysing and interpreting data and making conclusions.

## Manipulative Skills

Manipulative skills in scientific investigation are psychomotor skills that enable students to:

- ? use and handle science apparatus and laboratory substances correctly.
- ? handle specimens correctly and carefully.
- ? draw specimens, apparatus and laboratory substances accurately.
- ? clean science apparatus correctly, and
- ? store science apparatus and laboratory substances correctly and safely.

## THINKING SKILLS

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Thinking is a mental process that requires an individual to integrate knowledge, skills and attitude in an effort to understand the environment.

One of the objectives of the national education system is to enhance the thinking ability of students. This objective can be achieved through a curriculum that emphasises thoughtful learning. Teaching and learning that emphasises thinking skills is a foundation for thoughtful learning.

Thoughtful learning is achieved if students are actively involved in the teaching and learning process. Activities should be organised to provide opportunities for students to apply thinking skills in conceptualisation, problem solving and decision-making.

Thinking skills can be categorised into critical thinking skills and creative thinking skills. A person who thinks critically always

evaluates an idea in a systematic manner before accepting it. A person who thinks creatively has a high level of imagination, is able to generate original and innovative ideas, and modify ideas and products.

Thinking strategies are higher order thinking processes that involve various steps. Each step involves various critical and creative thinking skills. The ability to formulate thinking strategies is the ultimate aim of introducing thinking activities in the teaching and learning process.

## Critical Thinking Skills

A brief description of each critical thinking skill is as follows:

<b>Attributing</b>	Identifying criteria such as characteristics, features, qualities and elements of a concept or an object.
<b>Comparing and Contrasting</b>	Finding similarities and differences based on criteria such as characteristics, features, qualities and elements of a concept or event.
<b>Grouping and Classifying</b>	Separating and grouping objects or phenomena into categories based on certain criteria such as common characteristics or features.
<b>Sequencing</b>	Arranging objects and information in order based on the quality or quantity of common characteristics or features such as size, time, shape or number.

<b>Prioritising</b>	Arranging objects and information in order based on their importance or priority.
<b>Analysing</b>	Examining information in detail by breaking it down into smaller parts to find implicit meaning and relationships.
<b>Detecting Bias</b>	Identifying views or opinions that have the tendency to support or oppose something in an unfair or misleading way.
<b>Evaluating</b>	Making judgements on the quality or value of something based on valid reasons or evidence.
<b>Making Conclusions</b>	Making a statement about the outcome of an investigation that is based on a hypothesis.

### **Creative Thinking Skills**

A brief description of each creative thinking skill is as follows:

<b>Generating Ideas</b>	Producing or giving ideas in a discussion.
<b>Relating</b>	Making connections in a certain situation to determine a structure or pattern of relationship.
<b>Making Inferences</b>	Using past experiences or previously collected data to draw conclusions and make explanations of events.
<b>Predicting</b>	Stating the outcome of a future event based on prior knowledge gained through experiences or collected data.

<b>Making Generalisations</b>	Making a general conclusion about a group based on observations made on, or some information from, samples of the group.
<b>Visualising</b>	Recalling or forming mental images about a particular idea, concept, situation or vision.
<b>Synthesising</b>	Combining separate elements or parts to form a general picture in various forms such as writing, drawing or artefact.
<b>Making Hypotheses</b>	Making a general statement on the relationship between manipulated variables and responding variables in order to explain a certain thing or happening. This statement is thought to be true and can be tested to determine its validity.

**Making Analogies** Understanding a certain abstract or complex concept by relating it to a simpler or concrete concept with similar characteristics.

**Inventing** Producing something new or adapting something already in existence to overcome problems in a systematic manner.

## Thinking Strategy

Description of each thinking strategy is as follows:

**Conceptualising** Making generalisations based on inter-related and common characteristics in order to construct meaning, concept or model.

**Making Decisions** Selecting the best solution from various alternatives based on specific criteria to achieve a specific aim.

**Problem Solving** Finding solutions to challenging or unfamiliar situations or unanticipated difficulties in a systematic manner.

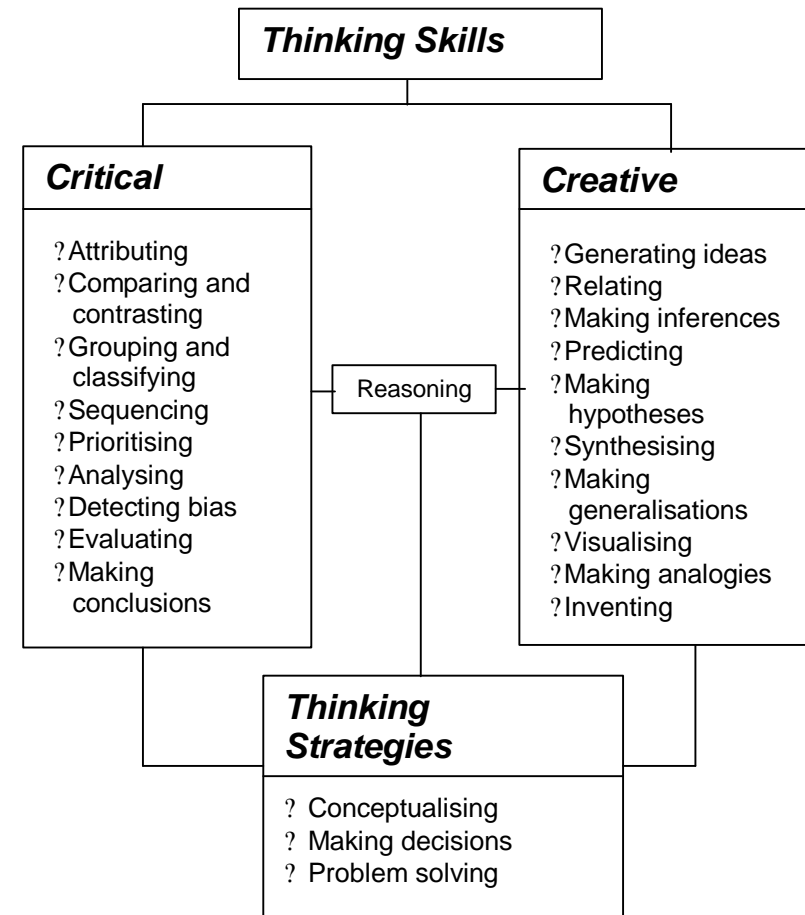
Besides the above thinking skills and thinking strategies, another skill emphasised is reasoning. Reasoning is a skill used in making logical, just and rational judgements. Mastering of critical and creative thinking skills and thinking strategies is made simpler if an individual is able to reason in an inductive and deductive manner. Figure 1 gives a general picture of thinking skills and thinking strategies.

Mastering of thinking skills and thinking strategies (TSTS) through the teaching and learning of science can be developed through the following phases:

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

Further information about phases of implementing TSTS can be found in the guidebook *"Buku Panduan Penerapan Kemahiran Berfikir dan Strategi Berfikir dalam Pengajaran dan Pembelajaran Sains"* (Curriculum Development Centre, 1999).

Figure 1 : TSTS Model in Science



## Relationship between Thinking Skills and 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. Mastering of science process skills and the possession of suitable attitudes and knowledge enable students to think effectively.

The mastering of science process skills involves the mastering of the relevant thinking skills. The thinking skills that are related to a particular science process skill are as follows:

Science Process Skills	Thinking Skills
Observing	Attributing Comparing and contrasting Relating
Classifying	Attributing Comparing and contrasting Grouping and classifying
Measuring and Using Numbers	Relating Comparing and contrasting
Making Inferences	Relating Comparing and contrasting Analysing Making inferences

Science Process Skills	Thinking Skills
Predicting	Relating Visualising
Using Space-Time Relationship	Sequencing Prioritising
Interpreting data	Comparing and contrasting Analysing Detecting bias Making conclusions Generalising Evaluating
Defining operationally	Relating Making analogy 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
Communicating	All thinking skills

## Teaching and Learning based on Thinking Skills and Scientific Skills

This science curriculum emphasises thoughtful learning based on thinking skills and scientific skills. Mastery of thinking skills and scientific skills are integrated with the acquisition of knowledge in the intended learning outcomes. Thus, in teaching and learning, teachers need to emphasise the mastery of skills together with the acquisition of knowledge and the inculcation of noble values and scientific attitudes.

The following is an example and explanation of a learning outcome based on thinking skills and scientific skills.

### Example:

Learning Outcome: Compare and contrast metallic elements and non-metallic elements.

Thinking Skills: Comparing and contrasting

### Explanation:

To achieve the above learning outcome, knowledge of the characteristics and uses of metals and non-metals in everyday life are learned through comparing and contrasting. The mastery of the skill of comparing and contrasting is as important as the knowledge about the elements of metal and the elements of non-metal.

## SCIENTIFIC ATTITUDES AND NOBLE VALUES

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Science learning experiences can be used as a means to inculcate scientific attitudes and noble values in students. These attitudes and values encompass the following:

- ? Having an interest and curiosity towards the environment.
- ? Being honest and accurate in recording and validating data.
- ? Being diligent and persevering.
- ? Being responsible about the safety of oneself, others, and the environment.
- ? Realising that science is a means to understand nature.
- ? Appreciating and practising clean and healthy living.
- ? Appreciating the balance of nature.
- ? Being respectful and well-mannered.
- ? Appreciating the contribution of science and technology.
- ? Being thankful to God.
- ? Having critical and analytical thinking.
- ? Being flexible and open-minded.
- ? Being kind-hearted and caring.
- ? Being objective.
- ? Being systematic.
- ? Being cooperative.
- ? Being fair and just.
- ? Daring to try.
- ? Thinking rationally.
- ? Being confident and independent.

The inculcation of scientific attitudes and noble values generally occurs through the following stages:

- ? Being aware of the importance and the need for scientific attitudes and noble values.

- ? Giving emphasis to these attitudes and values.
- ? Practising and internalising these scientific attitudes and noble values.

When planning teaching and learning activities, teachers need to give due consideration to the above stages to ensure the continuous and effective inculcation of scientific attitudes and values. For example, during science practical work, the teacher should remind pupils and ensure that they carry out experiments in a careful, cooperative and honest manner.

Proper planning is required for effective inculcation of scientific attitudes and noble values during science lessons. Before the first lesson related to a learning objective, teachers should examine all related learning outcomes and suggested teaching-learning activities that provide opportunities for the inculcation of scientific attitudes and noble values.

The following is an example of a learning outcome pertaining to the inculcation of scientific attitudes and values.

Example:

Year:	Form 5
Learning Area:	1. Rate of Reaction
Learning Objective:	1.4 Practising scientific knowledge to enhance quality of life
Learning Outcome:	A student is able to apply knowledge on factors affecting the rate of reaction in everyday activities, and adopt problem solving approaches and make rational decisions based on research.

**Suggested Learning Activities**

Carry out some daily activities related to factors affecting the rate of reaction.

Collect and interpret data on scientists' contribution in enhancing the quality of life.

Carry out problem solving activities involving rate of reaction in the field of science and technology through experiment and research.

**Scientific attitudes and noble values**

Appreciating the contribution of science and technology.

Being thankful to God.

Having critical and analytical thinking.

Being honest and accurate in recording and validating data

**Inculcating Patriotism**

The science curriculum provides an opportunity for the development and strengthening of patriotism among students. For example, in learning about the earth's resources, the richness and variety of living things and the development of science and technology in the country, students will appreciate the diversity of natural and human resources of the country and deepen their love for the country.

## TEACHING AND LEARNING STRATEGIES

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Teaching and learning strategies in the science curriculum emphasise thoughtful learning. Thoughtful learning is a process that helps students acquire knowledge and master skills that will help them develop their minds to the optimum level. Thoughtful learning can occur through various learning approaches such as inquiry, constructivism, contextual learning, and mastery learning. Learning activities should therefore be geared towards activating students' critical and creative thinking skills and not be confined to routine or rote learning. Students should be made aware of the thinking skills and thinking strategies that they use in their learning. They should be challenged with higher order questions and problems and be required to solve problems utilising their creativity and critical thinking. The teaching and learning process should enable students to acquire knowledge, master skills and develop scientific attitudes and noble values in an integrated manner.

### Teaching and Learning Approaches in Science

#### *Inquiry-Discovery*

Inquiry-discovery emphasises learning through experiences. Inquiry generally means to find information, to question and to investigate a phenomenon that occurs in the environment. Discovery is the main characteristic of inquiry. Learning through discovery occurs when the main concepts and principles of science are investigated and discovered by students themselves. Through activities such as experiments, students investigate a phenomenon and draw conclusions by themselves. Teachers then lead students 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 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 to students.

#### *Constructivism*

Constructivism suggests that students learn about something when they construct their own understanding. The important attributes of constructivism are as follows:

- ✍ Taking into account students' prior knowledge.
- ✍ Learning occurring as a result of students' own effort.
- ✍ Learning occurring when students restructure their existing ideas by relating new ideas to old ones.
- ✍ Providing opportunities to cooperate, sharing ideas and experiences, and reflecting on their learning.

#### *Science, Technology and Society*

Meaningful learning occurs if students can relate their learning with their daily experiences. Meaningful learning occurs in learning approaches such as contextual learning and Science, Technology and Society (STS).

Learning themes and learning objectives that carry elements of STS are incorporated into the curriculum. STS approach suggests that science learning takes place through investigation and discussion based on science and technology issues in society. In the STS approach, knowledge in science and technology is to be learned with the application of the principles of science and technology and their impact on society.

#### *Contextual Learning*

Contextual learning is an approach that associates learning with daily experiences of students. In this way, students are able to appreciate the relevance of science learning to their lives. In

contextual learning, students learn through investigations as in the inquiry-discovery approach.

### ***Mastery Learning***

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

### **Teaching and Learning Methods**

Teaching and learning approaches can be implemented through various methods such as experiments, discussions, simulations, projects, and visits. In this curriculum, the teaching-learning methods suggested are stated under the column “Suggested Learning Activities.” However, teachers can modify the suggested activities when the need arises.

The use of a variety of teaching and learning methods can enhance students’ interest in science. Science lessons that are not interesting will not motivate students to learn and subsequently will affect their performance. The choice of teaching methods should be based on the curriculum content, students’ abilities, students’ repertoire of intelligences, and the availability of resources and infrastructure. Besides playing the role of knowledge presenters and experts, teachers need to act as facilitators in the process of teaching and learning. Teachers need to be aware of the multiple intelligences that exist among students. Different teaching and learning activities should be planned to cater for students with different learning styles and intelligences.

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

### ***Experiment***

An experiment is a method commonly used in science lessons. In experiments, students test hypotheses through investigations to discover specific science concepts and principles. Conducting an experiment involves thinking skills, scientific skills, and manipulative skills.

Usually, an experiment involves the following steps:

- ✍ Identifying a problem.
- ✍ Making a hypothesis.
- ✍ Planning the experiment
  - controlling variables.
  - determining the equipment and materials needed.
  - determining the procedure of the experiment and the method of data collection and analysis.
- ✍ Conducting the experiment.
- ✍ Collecting data.
- ✍ Analysing data.
- ✍ Interpreting data.
- ✍ Making conclusions.
- ✍ Writing a report.

In the implementation of this curriculum, besides guiding students to do an experiment, where appropriate, teachers should provide students with the opportunities to design their own experiments. This involves students drawing up plans as to how to conduct experiments, how to measure and analyse data, and how to present the outcomes of their experiment.

### ***Discussion***

A discussion is an activity in which students exchange questions and opinions based on valid reasons. Discussions can be conducted before, during or after an activity. Teachers should play the role of a facilitator and lead a discussion by asking questions that stimulate thinking and getting students to express themselves.

### ***Simulation***

In simulation, an activity that resembles the actual situation is carried out. Examples of simulation are role-play, games and the use of models. In role-play, students play out a particular role based on certain pre-determined conditions. Games require procedures that need to be followed. Students play games in order to learn a particular principle or to understand the process of decision-making. Models are used to represent objects or actual situations so that students can visualise the said objects or situations and thus understand the concepts and principles to be learned.

### ***Project***

A project is a learning activity that is generally undertaken by an individual or a group of students to achieve a certain learning objective. A project generally requires several lessons to complete. The outcome of the project either in the form of a report, an artefact or in other forms needs to be presented to the teacher and other students. Project work promotes the development of problem-solving skills, time management skills, and independent learning.

### ***Visits and Use of External Resources***

The learning of science is not limited to activities carried out in the school compound. Learning of science can be enhanced through the use of external resources such as zoos, museums, science centres, research institutes, mangrove swamps, and factories. Visits to these places make the learning of science more interesting, meaningful and effective. To optimise learning opportunities, visits need to be carefully planned. Students may be involved in the planning process and specific educational tasks should be assigned during the visit. No educational visit is complete without a post-visit discussion.

### ***Use of Technology***

Technology is a powerful tool that has great potential in enhancing the learning of science. Through the use of technology such as television, radio, video, computer, and Internet, the teaching and learning of science can be made more interesting and effective.

Computer simulation and animation are effective tools for the teaching and learning of abstract or difficult science concepts.

Computer simulation and animation can be presented through courseware or Web page. Application tools such, as word processors, graphic presentation software and electronic spreadsheets are valuable tools for the analysis and presentation of data.

The use of other tools such as data loggers and computer interfacing in experiments and projects also enhance the effectiveness of teaching and learning of science.

## CONTENT ORGANISATION

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The science curriculum is organised around themes. Each theme consists of various learning areas, each of which consists of a number of learning objectives. A learning objective has one or more learning outcomes.

Learning outcomes are written based on the hierarchy of the cognitive and affective domains. Levels in the cognitive domain are: knowledge, understanding, application, analysis, synthesis and evaluation. Levels in the affective domain are: to be aware of, to be in awe, to be appreciative, to be thankful, to love, to practise, and to internalise. Where possible, learning outcomes relating to the affective domain are explicitly stated. The inculcation of scientific attitudes and noble values should be integrated into every learning activity. This ensures a more spontaneous and natural inculcation of attitudes and values. Learning areas in the psychomotor domain are implicit in the learning activities.

Learning outcomes are written in the form of measurable behavioural terms. In general, the learning outcomes for a particular learning objective are organised in order of complexity. However, in the process of teaching and learning, learning activities should be planned in a holistic and integrated manner that enables the achievement of multiple learning outcomes according to needs and context. Teachers should avoid employing a teaching strategy that tries to achieve each learning outcome separately according to the order stated in the curriculum specifications.

The Suggested Learning Activities provide information on the scope and dimension of learning outcomes. The learning activities stated under the column Suggested Learning Activities are given with the intention of providing some guidance as to how learning outcomes can be achieved. A suggested activity may cover one or more learning outcomes. At the same time, more than one activity may be suggested for a particular learning outcome. Teachers may modify the suggested activity to suit the ability and style of learning of their students. Teachers are encouraged to design other innovative and effective learning activities to enhance the learning of science.

**THEME : INTERACTION BETWEEN CHEMICALS**

**LEARNING AREA : 1. RATE OF REACTION**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>1.1 Analysing rate of reaction</p>	<p>Discuss: (a) the meaning of rate of reaction, (b) some examples of fast reactions, (c) some examples of slow reactions.</p> <p>Discuss to identify observable changes to reactants or products and its method of measurement in order to determine the rate of reaction.</p> <p>Carry out an activity involving a reaction between zinc and acid, and plot a graph to determine average rate of reaction and the rate of reaction at any given time.</p> <p>Carry out problem solving activities involving rates of reaction.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>? state what rate of reaction is,</li> <li>? identify observable changes to reactants or products for determining rate of reaction,</li> <li>? determine average rate of reaction,</li> <li>? determine the rate of reaction at any given time from a graph,</li> <li>? solve numerical problems involving average rate of reaction,</li> <li>? solve numerical problems involving rate of reaction at any given time.</li> </ul>	<p>The rate of reaction at any given time is also known as instantaneous rate of reaction.</p>	<p>reactant – <i>bahan tindak balas</i></p> <p>product- <i>hasil tindak balas</i></p> <p>rate of reaction – <i>kadar tindak balas</i></p> <p>observable change – <i>perubahan yang dapat diperhatikan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.2 Synthesising factors affecting the rate of reaction	<p>Discuss possible factors affecting the rate of reaction.</p> <p>Design and carry out activities to investigate factors affecting the rate of reaction, i.e. size of reactant, concentration, temperature and catalyst.</p> <p>Some suggested reactions:            (a) a reaction between calcium carbonate, <math>\text{CaCO}_3</math>, and hydrochloric acid, <math>\text{HCl}</math>,            (b) a reaction between sodium thiosulphate, <math>\text{Na}_2\text{S}_2\text{O}_3</math>, and sulphuric acid, <math>\text{H}_2\text{SO}_4</math>,            (c) decomposition of hydrogen peroxide, <math>\text{H}_2\text{O}_2</math>, in the presence of a catalyst.</p> <p>View computer simulations to investigate how the movement and collision of particles in a reaction are affected by temperature, size of reactant, pressure, concentration and catalyst.</p> <p>Collect and interpret data to explain factors affecting the rate of reaction in</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>design experiments to investigate factors affecting the rate of reaction,</li> <li>give examples of reactions that are affected by size of reactant, concentration, temperature and catalyst,</li> <li>explain how each factor affects the rate of reaction,</li> <li>describe how factors affecting the rate of reaction are applied in daily life and in industrial processes,</li> </ul>	<p>Using examples discuss the meaning and characteristics of catalyst.</p> <p>Size of reactants is related to the total surface area.</p>	<p>catalyst – <i>mangkin</i></p> <p>decomposition-<i>penguraian</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>the following:</p> <p>(a) combustion of charcoal,            (b) storing food in a refrigerator,            (c) cooking food in a pressure cooker,            (d) industrial production of ammonia, sulphuric acid and nitric acid.</p> <p>Solve problems involving rate of reaction.</p>	<ul style="list-style-type: none"> <li>• solve problems involving factors affecting rate of reaction.</li> </ul>		
1.3 Synthesising ideas on collision theory	<p>Carry out simulations on:</p> <p>(a) movement and collision of particles in chemical reactions,            (b) movement and collision of particles in reaction affected by temperature, size of reactant, pressure, concentration and catalyst.</p> <p>Collect, interpret data and discuss the following:</p> <p>(a) collision,            (b) effective collision,            (c) activation energy,            (d) collision frequency,            (e) effective collision frequency,            (f) energy profile diagram.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• relate reaction with energy produced by movement and effective collision of particles,</li> <li>• describe activation energy,</li> <li>• sketch and describe energy profile diagram,</li> <li>• relate the frequency of effective collisions with the rate of reaction,</li> </ul>		<p>effective collision – <i>perlanggaran berkesan</i></p> <p>activation energy- <b>tenaga pengaktifan</b></p> <p>frequency- <i>frekuensi / kekerapan</i></p> <p>energy profile diagram- <i>rajah profil tenaga</i></p>

**LEARNING AREA : 1. RATE OF REACTION**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss to conceptualise collision theory.</p>	<ul style="list-style-type: none"> <li>• relate the frequency of effective collisions with factors influencing the rate of reaction,</li> <li>• describe how a certain factor affects the collision of particles in a reaction.</li> </ul>		
<p>1.4 Practising scientific knowledge to enhance quality of life</p>	<p>Carry out some daily activities related to factors affecting the rate of reaction.</p> <p>Collect and interpret data on scientists' contribution in enhancing the quality of life.</p> <p>Carry out problem solving activities involving rate of reaction in the field of science and technology through experiment and research.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• apply knowledge on factors affecting the rate of reaction in everyday activities,</li> <li>• adopt problem solving approaches and make rational decisions based on research.</li> </ul>		

**THEME : INTERACTION BETWEEN CHEMICALS**

**LEARNING AREA : 2. CARBON COMPOUNDS**

**Chemistry - Form 5**

<b>Learning Objectives</b>	<b>Suggested Learning Activities</b>	<b>Learning Outcomes</b>	<b>Notes</b>	<b>Vocabulary</b>
2.1 Understanding carbon compounds	<p>Collect and interpret data on:</p> <ul style="list-style-type: none"><li>(a) the meaning of carbon compound,</li><li>(b) the meaning of organic compound with respect to its sources, content and combustion products,</li><li>(c) the meaning of hydrocarbon, inclusive of saturated and unsaturated hydrocarbons,</li><li>(d) sources of hydrocarbon,</li><li>(e) examples of organic and inorganic compounds.</li></ul> <p>Carry out an activity to identify the products of the combustion of organic compounds, i.e. carbon dioxide and water.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"><li>• state what carbon compound is,</li><li>• state that carbon compounds can be classified into two groups, i.e. organic and inorganic,</li><li>• state what organic compound is,</li><li>• gives examples of organic and inorganic carbon compounds,</li><li>• state what a hydrocarbon is,</li><li>• list the sources of hydrocarbon,</li><li>• identify the combustion products of organic carbon compounds.</li></ul>	<p>The term 'organic' should not be limited to carbon compounds derived from living organisms.</p>	<p>saturated – <i>tepu</i></p> <p>unsaturated – <i>tak tepu</i></p> <p>combustion - <i>pembakaran</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.2 Analysing alkanes	<p>Collect and interpret data on: (a) the meaning of alkane, (b) the meaning of structural formula,</p> <p>Carry out an activity to construct molecular models and draw structural formulae of the first ten straight-chain alkanes.</p> <p>Construct a table showing names, molecular formulae, structural formulae and physical properties of the first ten straight-chain alkanes.</p> <p>Collect and interpret data on: (a) physical properties of alkanes, i.e. melting and boiling points, density, physical state at room temperature, solubility in water and electrical conductivity, (b) chemical properties of alkanes, i.e. combustion, substitution reactions with halogen.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what alkane is,</li> <li>• state what structural formula is,</li> <li>• deduce the molecular formulae of the first ten alkanes,</li> <li>• draw the structural formulae for the first ten straight-chain alkanes,</li> <li>• deduce the general formula of alkanes,</li> <li>• name the first ten alkanes,</li> <li>• relate changes in physical properties with increase in the number of carbon atoms in alkane molecules,</li> <li>• explain the effect of the increase in number of carbon atoms in alkane molecules on the molecules boiling points,</li> </ul>	<p>Methane may be used as examples for combustion and substitution reactions.</p>	<p>straight-chain alkane – <i>alkana rantai lurus</i></p> <p>substitution - <i>penukargantian</i></p>

**LEARNING AREA : 2. CARBON COMPOUNDS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss:</p> <p>(a) the relationship between changes in physical properties with increase in the number of carbon atoms in alkane molecules,</p> <p>(b) the effect on boiling points of alkanes due to increase in the number of carbon atoms in alkane molecules,</p> <p>(c) the complete and incomplete combustion of alkanes,</p> <p>(d) the substitution reactions of alkanes.</p> <p>Write chemical equations for combustion and substitution reactions of methane.</p> <p>Discuss that decomposition of organic matter produces methane and how this may cause fire in land fills and peat swamps.</p>	<ul style="list-style-type: none"> <li>• describe complete and incomplete combustion of alkanes,</li> <li>• describe the substitution reaction of alkanes,</li> <li>• write chemical equations for combustion and substitution reactions of methane.</li> <li>• describe how methane affects everyday life.</li> </ul>		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.3 Analysing alkenes	<p>Collect and interpret data on the meaning of alkene,</p> <p>Carry out an activity to construct molecular models and draw structural formulae of the first nine straight-chain alkenes with one double bond.</p> <p>Construct a table showing names, molecular formulae, structural formulae and physical properties of the first nine straight-chain alkenes.</p> <p>Collect and interpret data on:</p> <p>(a) physical properties of alkenes, i.e. melting and boiling points, density, physical state at room temperature, solubility in water and electrical conductivity,</p> <p>(b) chemical properties of alkenes, i.e. combustion, addition reaction and polymerisation.</p> <p>Discuss:</p> <p>(a) the relationship between changes of physical properties with increase in the number of carbon atoms in alkene molecules,</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what alkene is,</li> <li>• deduce the molecular formulae of the first nine alkenes,</li> <li>• deduce the general formula of alkenes,</li> <li>• name the first nine alkenes,</li> <li>• draw the structural formulae for the first nine straight-chain alkenes,</li> <li>• relate changes in physical properties with increase in the number of carbon atoms in alkene molecules,</li> <li>• explain the effects on boiling points of alkenes due to increase in the number of carbon atoms in alkene molecules,</li> <li>• describe chemical properties of alkenes,</li> </ul>	<p>Restrict to the first three members of alkene.</p>	<p>addition – <i>penambahan</i></p> <p>sootiness – <i>kejelagaan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>(b) how the increase in the number of carbon atoms in alkenes, affect their boiling points,</p> <p>(c) the combustion of alkenes,</p> <p>(d) the addition reaction of alkenes,</p> <p>(e) the polymerisation of alkenes.</p> <p>Write chemical equations for combustion, addition and polymerisation reactions of alkenes.</p> <p>Investigate addition reactions of alkenes through computer simulation.</p> <p>Carry out activities to compare properties of alkanes and alkenes having the same number of carbon atoms such as hexane, C<sub>6</sub>H<sub>14</sub>, and hexene, C<sub>6</sub>H<sub>12</sub>, with respect to:</p> <p>(a) sootiness of flame,</p> <p>(b) reactions with bromine, Br<sub>2</sub>,</p> <p>(c) reaction with acidified potassium manganate(VII), KMnO<sub>4</sub>.</p> <p>Compare qualitatively the sootiness of flame during combustion of an alkane with the corresponding alkene.</p>	<ul style="list-style-type: none"> <li>• compare and contrast alkanes with alkenes.</li> <li>• relate the reactivities of alkanes and alkenes to their chemical bonds.</li> </ul>	<p>Hexene or cyclohexene can be used.</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss to generalise the characteristics of homologous series in terms of having the same general formula, can be made by similar methods, steady changes in physical properties, and similar chemical properties.</p>	<ul style="list-style-type: none"> <li>• generalise the characteristics of homologous series based on alkanes and alkenes.</li> </ul>		
<p>2.4 Synthesising ideas on isomerism</p>	<p>Construct all possible models and draw structural formulae for a particular alkane and alkene.</p> <p>Construct a table showing names and formulae of alkyl groups.</p> <p>Discuss isomerism.</p> <p>Discuss the existence of isomers.</p> <p>Draw structural formulae of alkane and alkene isomers and name them.</p> <p>Examine isomerism through models or computer simulations.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• construct various structural formulae of a particular alkane and alkene,</li> <li>• explain what isomerism is,</li> <li>• use IUPAC nomenclature to name isomers.</li> </ul>	<p>(a) Examples of isomers should not include cyclic carbon compounds.</p> <p>(b) Examples of alkanes and alkenes should not exceed five carbon atoms.</p>	<p>IUPAC nomenclature- <i>sistem penamaan IUPAC</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.5 Analysing alcohols	<p>Carry out an activity to derive the general formula of alcohols and identify the functional group.</p> <p>Construct a table of names and molecular formulae for the first four alcohols.</p> <p>Carry out an activity to draw various possible structural formulae of the first four alcohols and name them.</p> <p>Collect and interpret data on the industrial production of ethanol,</p> <p>Carry out an activity on the preparation of ethanol in the laboratory through fermentation and distillation.</p> <p>Collect and interpret data on the physical properties of ethanol (C<sub>2</sub>H<sub>5</sub>OH), i.e. colour, odour, boiling point, physical state at room temperature, volatility and solubility,</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state the general formula of alcohols,</li> <li>• identify the functional group of alcohols,</li> <li>• list the names and the molecular formulae of the first four alcohols,</li> <li>? draw structural formulae for isomers of propanol (C<sub>3</sub>H<sub>7</sub>OH) and butanol (C<sub>4</sub>H<sub>9</sub>OH),</li> <li>? name isomers of propanol and butanol using IUPAC nomenclature,</li> <li>• describe the industrial production of ethanol,</li> <li>• describe the preparation of ethanol in the laboratory,</li> <li>• state the physical properties of ethanol,</li> </ul>		<p>functional group- <i>kumpulan berfungsi</i></p> <p>odour – <i>bau</i></p> <p>fermentation- <i>penapaian</i></p> <p>distillation – <i>penyulingan</i></p> <p>volatility – <i>kemeruapan</i></p> <p>dehydration- <i>pendehidratatan</i></p>

**LEARNING AREA : 2. CARBON COMPOUNDS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out activities to investigate the chemical properties of ethanol in terms of:</p> <p>(a) combustion, (b) oxidation, (c) dehydration.</p> <p>Write chemical equations for the above reactions involving ethanol, propanol and butanol.</p> <p>Carry out an activity to predict the chemical properties for other members of alcohols.</p> <p>Collect and interpret data on:</p> <p>(a) uses of alcohols in everyday life, (b) effects of alcohol misuse and abuse.</p>	<ul style="list-style-type: none"> <li>• describe the chemical properties of ethanol,</li> <li>• predict the chemical properties of other members of alcohols,</li> <li>• explain with examples the uses of alcohols in everyday life,</li> <li>• explain the effects of the misuse and abuse of alcohols.</li> </ul>		
2.6 Analysing carboxylic acids	<p>Carry out an activity to derive the general formula of carboxylic acids and identify the functional group.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state the general formula of carboxylic acids,</li> <li>• identify the functional group of carboxylic acids,</li> </ul>		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Construct a table with names and molecular formulae of the first four members of carboxylic acid, and draw their structural formulae</p> <p>Collect and interpret data on the preparation of ethanoic acid (<math>\text{CH}_3\text{COOH}</math>) in the laboratory,</p> <p>Collect and interpret data on the physical properties of ethanoic acid, i.e. colour, odour, boiling point, physical state at room temperature and solubility in water,</p> <p>Carry out activities to investigate the chemical properties of ethanoic acid through its reactions with:</p> <p>(a) base,            (b) metallic carbonate,            (c) metal,            (d) alcohol.</p>	<ul style="list-style-type: none"> <li>• list the names and molecular formulae of the first four members of carboxylic acid,</li> <li>? draw structural formulae of the first four members of carboxylic acid and name them using the IUPAC nomenclature,</li> <li>• describe the preparation of ethanoic acid in the laboratory,</li> <li>• state the physical properties of carboxylic acids,</li> <li>• state the chemical reactions of ethanoic acid with other chemicals,</li> </ul>		

**LEARNING AREA : 2. CARBON COMPOUNDS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out an activity to write chemical equations for the above reactions involving propanoic acid (<math>C_2H_5COOH</math>) and butanoic acid (<math>C_3H_7COOH</math>).</p> <p>Carry out an activity to predict the chemical properties of other members of carboxylic acids.</p> <p>Collect and interpret data on the uses of carboxylic acids in everyday life.</p>	<ul style="list-style-type: none"> <li>• predict the chemical properties for other members of carboxylic acid,</li> <li>• explain with examples the uses of carboxylic acids in everyday life.</li> </ul>		
<p>2.7 Analysing esters</p>	<p>Carry out an activity to derive the general formula of esters and identify the functional group.</p> <p>Construct a table of molecular formulae and names of esters.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>? state the general formula of esters,</li> <li>• identify the functional group of esters,</li> <li>• list the names and molecular formulae of simple esters,</li> <li>? draw structural formulae of simple esters and name them using the IUPAC nomenclature,</li> </ul>	<p>The separation process is not needed in the preparation of ethyl ethanoate.</p> <p>Esterification involves molecules requiring catalyst, whereas neutralisation involves ions to form water.</p>	

**LEARNING AREA : 2. CARBON COMPOUNDS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out an activity to prepare ethyl ethanoate (<math>\text{CH}_3\text{COOC}_2\text{H}_5</math>) in the laboratory.</p> <p>Carry out an activity to investigate the physical properties of ethyl ethanoate, i.e. the odour and solubility.</p> <p>Discuss to predict the esters produced from the esterification between various carboxylic acids and alcohols.</p> <p>Write equations for esterification reactions.</p> <p>Collect and interpret data on: (a) natural sources of ester, (b) uses of ester in everyday life.</p> <p>Carry out a project to extract esters from plants.</p>	<ul style="list-style-type: none"> <li>• describe the preparation of ester in the laboratory,</li> <li>• state the physical properties of ethyl ethanoate,</li> <li>• predict the ester produced from the esterification reaction,</li> <li>• write equations for the esterification reactions,</li> <li>• state the natural sources of ester,</li> <li>• state the uses of ester in everyday life.</li> </ul>	<p>Limit discussion to esterification reactions between the first four members of alcohols and the first four members of carboxylic acids.</p>	<p>esterification – <i>pengesteran</i></p> <p>extraction - <i>pengekstrakan</i></p>
<p>2.8 Evaluating fats</p>	<p>Collect and interpret data on: (a) what oils and fats are, (b) why our body needs oils and fats, (c) sources and the uses of oils and fats, (d) the difference between oils and fats at room temperature in terms of physical state,</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what oils are,</li> <li>• state what fats are,</li> <li>• state the importance of oils and fats for body processes,</li> </ul>	<p>Suggested fatty acids:</p> <p>Palmitic acid, <math>\text{CH}_3(\text{CH}_2)_{14}\text{COOH}</math></p> <p>Stearic acid, <math>\text{CH}_3(\text{CH}_2)_{16}\text{COOH}</math></p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>(e) structural formulae for fat molecules of certain fatty acids.</p> <p>Collect and interpret data on:</p> <p>(a) what saturated and unsaturated fats are,</p> <p>(b) sources and compositions of saturated and unsaturated fats,</p> <p>(c) the differences between saturated and unsaturated fats,</p> <p>(d) the need to convert unsaturated to saturated fats,</p> <p>(j) effects of fats on health.</p>	<ul style="list-style-type: none"> <li>• state the sources of oils and fats,</li> <li>• list the uses of oils and fats,</li> <li>• state the differences between oils and fats,</li> <li>? identify structural formulae for fat molecules of certain fatty acids,</li> <li>• state what saturated fats are,</li> <li>• state what unsaturated fats are,</li> <li>• compare and contrast between saturated and unsaturated fats,</li> <li>• describe the process of changing unsaturated fats to saturated fats,</li> <li>• describe the effects of eating food high in fats on health,</li> </ul>	<p>Linoleic acid,  <math>\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CH}\text{CH}_2\text{CH}(\text{CH}_2)_7-\text{COOH}</math></p> <p>Oleic acid,  <math>\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}</math></p> <p>Students are not required to know how to draw the structural formulae of fat molecules.</p> <p>Margarine can also be produced by the mechanical squeezing method.</p>	

**LEARNING AREA : 2. CARBON COMPOUNDS**

**Chemistry - Form 5**

<b>Learning Objectives</b>	<b>Suggested Learning Activities</b>	<b>Learning Outcomes</b>	<b>Notes</b>	<b>Vocabulary</b>
	<p>Discuss the production of margarine by hydrogenation,</p> <p>Visit a palm oil factory, margarine manufacturing plant or palm oil research institute.</p> <p>Discuss:                      (a) the advantages of palm oil as compared to other vegetable oils,                      (b) research on oil palm in Malaysia,                      (c) the importance of palm oil industry to the development of the country.</p>	<ul style="list-style-type: none"> <li>• describe the industrial extraction of palm oil,</li>   <li>• justify the use of palm oil in food production.</li> </ul>		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.9 Analysing natural rubber	<p>Collect and interpret data on:</p> <p>(a) natural polymer i.e. natural rubber, starch and protein, and their respective monomers,</p> <p>(b) properties of natural rubber in terms of elasticity, oxidation and the effects of heat and solvents.</p> <p>(c) uses of natural rubber,</p> <p>(d) structural formula of natural rubber.</p> <p>Carry out an activity to investigate the coagulation of latex and methods to prevent coagulation.</p> <p>Carry out activities to produce latex products such as gloves and balloons.</p> <p>Carry out an activity to produce vulcanised rubber.</p> <p>Investigate the process of rubber vulcanisation using computer simulation.</p> <p>Discuss:</p> <p>(a) how the presence of sulphur atoms in vulcanised rubber changes the properties of vulcanised rubber.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• list examples of natural polymers and their monomers,</li> <li>• draw the structural formula of natural rubber,</li> <li>• state the properties of natural rubber,</li> <li>• state the uses of natural rubber,</li> <li>• describe the coagulation process of latex,</li> <li>• describe the method used to prevent latex from coagulating,</li> <li>• describe the vulcanisation of rubber,</li> <li>• describe how the presence of sulphur atoms changes the properties of vulcanised rubber,</li> </ul>	<p>Students need only to draw a simple (molecular) structure formula of isopropane.</p> <p>Unvulcanised rubber is also known as non-vulcanised rubber</p>	<p>elasticity- <i>kekenyalan</i></p> <p>vulcanised - <i>tervulkan</i></p> <p>coagulation- <i>penggumpalan</i></p>

**LEARNING AREA : 2. CARBON COMPOUNDS**

**Chemistry - Form 5**

<b>Learning Objectives</b>	<b>Suggested Learning Activities</b>	<b>Learning Outcomes</b>	<b>Notes</b>	<b>Vocabulary</b>
	<p>(b) research on natural rubber in Malaysia.</p> <p>Carry out an activity to compare the elasticity of vulcanised and unvulcanised natural rubber.</p> <p>Visit a rubber plantation, a latex processing factory, a rubber product manufacturing plant or a rubber research institute.</p>	<ul style="list-style-type: none"> <li>compare and contrast the properties of vulcanised and unvulcanised natural rubber.</li> </ul>		

**LEARNING AREA : 2. CARBON COMPOUNDS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
2.10 Creating awareness of order in homologous series	Construct a table naming each member of the homologous series according to the increasing number of carbon atoms.  Discuss the order in the physical and chemical properties of compounds in homologous series.	A student is able to: <ul style="list-style-type: none"> <li>? describe the systematic approach in naming members of homologous series,</li> <li>• describe the order in the physical and chemical properties of compounds in homologous series.</li> </ul>		
2. 11 Expressing gratefulness for the variety of organic materials in nature	Collect and interpret data on the existence of a variety of organic materials in consumer products.  Attend activities (talks, forum, exhibition) related to good nutrition for health.  Conduct a forum related to the contribution of palm oil and natural rubber industries with the country's economy.	A student is able to: <ul style="list-style-type: none"> <li>• describe the existence of various organic materials and their uses in everyday life,</li> <li>? practise good nutrition for health,</li> <li>• relate the contribution of palm oil and natural rubber to the economic development of the country.</li> </ul>		gratefulness - <i>kesyukuran</i>

**THEME : INTERACTIONS BETWEEN CHEMICALS**

**LEARNING AREA : 3. OXIDATION AND REDUCTION**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>3.1 Analysing redox reactions</p>	<p>Collect and interpret data on oxidation, reduction, redox reaction, oxidising agent and reducing agent based on: (a) loss or gain of oxygen, (b) loss or gain of hydrogen, (c) transfer of electron, (d) change in oxidation number.</p> <p>Calculate the oxidation number of an element in a compound.</p> <p>Carry out an activity to identify the oxidation number of an element in a compound and name the compound using the IUPAC nomenclature.</p> <p>Carry out an activity to identify oxidation and reduction processes in chemical equations: (a) using oxidation number, (b) in terms of electron transfer.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what oxidation is,</li> <li>• state what reduction is,</li> <li>• explain what redox reaction is,</li> <li>• state what oxidising agent is,</li> <li>• state what reducing agent is,</li> <li>• calculate the oxidation number of an element in a compound,</li> <li>• relate the oxidation number of an element to the name of its compound using the IUPAC nomenclature,</li> <li>• explain with examples oxidation and reduction processes in terms of the change in oxidation number,</li> <li>• explain with examples oxidation and reduction processes in terms of electron transfer,</li> </ul>	<p>Redox reactions must be clarified through half-equation and ionic equation.</p> <p>Half-equation is also known as half-reaction.</p> <p>Oxidation number is also known as oxidation state.</p>	<p>oxidising agent- <i>agen pengoksidaan</i></p> <p>reducing agent- <i>agen penurunan</i></p> <p>oxidation state- <i>keadaan pengoksidaan</i></p> <p>metal displacement- <i>penyesaran logam</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Carry out activities to investigate oxidation and reduction in the following reactions:</p> <p>(a) combustion of metal in oxygen or chlorine,</p> <p>(b) heating of metallic oxide with carbon,</p> <p>(c) change of <math>\text{Fe}^{2+}</math> ions to <math>\text{Fe}^{3+}</math> ions and <math>\text{Fe}^{3+}</math> ions to <math>\text{Fe}^{2+}</math> ions,</p> <p>(d) displacement of metal from its salt solution,</p> <p>(e) displacement of halogen from its halide solution,</p> <p>(f) transfer of electrons at a distance (a variety of solutions to be used).</p> <p>Carry out an activity to write oxidation and reduction half-equations and ionic equations for the above reactions.</p>	<ul style="list-style-type: none"> <li>explain with examples oxidising and reducing agents in redox reactions,</li> <li>write oxidation and reduction half-equations and ionic equations.</li> </ul>	<p>Use 1,1,1-trichloroethane, <math>\text{CH}_3\text{CCl}_3</math>, as a solvent to replace tetrachloromethane <math>\text{CCl}_4</math>, in confirming halogen displaced</p>	

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.2 Analysing rusting as a redox reaction	<p>Collect and interpret data on:</p> <p>(a) conditions for the rusting of iron,            (b) the meaning of corrosion of metal,            (c) the process of rusting in terms of oxidation and reduction.</p> <p>Discuss the redox reactions in corrosion of metals including rusting.</p> <p>Discuss on the use of other metals to control rusting.</p> <p>Carry out an activity to investigate the effect on iron nails when it is in contact with other metals.</p> <p>Collect and interpret data on methods to control metal corrosion using a more electropositive metal or a less electropositive metal.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state the conditions for the rusting of iron,</li> <li>• state what corrosion of metal is,</li> <li>• describe the process of rusting in terms of oxidation and reduction,</li> <li>• generate ideas on the use of other metals to control rusting,</li> <li>• explain with examples on the use of a more electropositive metal to control metal corrosion,</li> <li>• explain with examples on the use of a less electropositive metal to control metal corrosion.</li> </ul>		<p>corrosion – <i>kakisan</i></p> <p>rusting – <i>pengaratan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.3 Understanding the reactivity series of metals and its application	<p>Carry out an activity to investigate the reactivity of some metals with oxygen.</p> <p>Arrange metals in terms of their reactivity with oxygen.</p> <p>Carry out activity to determine the position of carbon and hydrogen in the reactivity series of metals.</p> <p>Discuss to predict the position of other metals in the reactivity series.</p> <p>Collect and interpret data on the extraction of iron and tin.</p> <p>Visit metal extraction factories or view a video on the extraction of metals.</p> <p>Discuss the use of the reactivity series of metals to predict possible reactions involving metals.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>compare the differences in the vigour of the reactions of some metals with oxygen,</li> <li>deduce the reactivity series of metals,</li> <li>determine the position of carbon and hydrogen in the reactivity series of metals,</li> <li>state what the reactivity series of metals are,</li> <li>describe the extraction of iron and tin from their ores,</li> <li>explain the use of carbon as the main reducing agent in metal extraction,</li> <li>use the reactivity series of metals to predict possible reactions involving metals.</li> </ul>		<p>reactivity series – <i>siri kereaktifan</i></p> <p>vigour – <i>kecergasan</i></p> <p>extraction – <i>pengekstrakan</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.4 Analysing redox reactions in electrolytic and chemical cells	<p>Carry out an activity to investigate oxidation and reduction reactions in electrolytic and chemical cells.</p> <p>Using computer simulation, study and discuss redox reactions in various types of cells.</p> <p>Discuss the differences between electrolytic and chemical cells in terms of:</p> <p>(a) basic structure, energy conversion and the transfer of electrons at the electrodes,</p> <p>(b) oxidation and reduction processes.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• explain with examples the oxidation and reduction reactions at the electrodes of various chemical cells,</li> <li>• explain with examples the oxidation and reduction reactions at the electrodes of various electrolytic cells,</li> <li>• state the differences between electrolytic and chemical cells in terms of basic structure, energy conversion and the transfer of electrons at the electrodes,</li> <li>• compare and contrast electrolytic and chemical cells with reference to the oxidation and reduction processes.</li> </ul>		<p>electrolytic cell – <i>sel elektrolisis</i></p> <p>chemical cell – <i>sel kimia</i></p> <p>energy conversion – <i>pertukaran tenaga</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
3.5 Appreciating the ability of elements to change their oxidation numbers	<p>Discuss the applications of the change of oxidation number in substances in the following processes:</p> <p>(a) extracting metal from its ore,            (b) corrosion of metal,            (c) preventing corrosion of metal,            (d) generation of electricity by cell,            (e) recycling of metals.</p> <p>Collect and interpret data on:</p> <p>(a) the existence of various types of ores in our country,            (b) methods of preventing corrosion of metal,            (c) varieties of chemical cells,            (d) recycling of metals.</p> <p>Discuss:</p> <p>(a) the contribution of metal extraction industry to the economy of our country,            (b) the potential of new chemical cells to be developed as an alternative source of renewable energy.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• describe the various applications of the change of oxidation number in substances,</li> <li>• describe the existence of various types of ores in our country,</li> <li>• describe efforts to prevent corrosion of metals,</li> <li>• describe the contribution of metal extraction industry to the economy of our country,</li> <li>• appreciate chemical cell as a source of renewable energy.</li> </ul>	<p>Look into cells/ technologies such as:</p> <ul style="list-style-type: none"> <li>? rechargeable,</li> <li>? alkaline,</li> <li>? lithium,</li> <li>? photo/solar.</li> </ul>	

**THEME : INTERACTION BETWEEN CHEMICALS**

**LEARNING AREA : 4. THERMOCHEMISTRY**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
4.1 Evaluating energy changes in chemical reactions	<p>Discuss the meaning of exothermic and endothermic reactions.</p> <p>Carry out activities to study exothermic and endothermic reactions in the:</p> <p>(a) reaction between sodium hydrogen carbonate, <math>\text{NaHCO}_3</math>, and an acid,</p> <p>(b) reaction between sodium hydroxide, <math>\text{NaOH}</math>, and hydrochloric acid, <math>\text{HCl}</math>,</p> <p>(c) dissolving of sodium hydroxide in water,</p> <p>(d) dissolving of ammonium salts, such as ammonium chloride, <math>\text{NH}_4\text{Cl}</math>, ammonium nitrate, <math>\text{NH}_4\text{NO}_3</math>, and ammonium sulphate, <math>(\text{NH}_4)_2\text{SO}_4</math>, in water.</p> <p>Carry out an activity to construct energy level diagrams for exothermic and endothermic reactions.</p> <p>Discuss to interpret an energy level diagram.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"><li>? state what exothermic reaction is,</li><li>? state what endothermic reaction is,</li><li>? identify exothermic reactions,</li><li>? identify endothermic reactions,</li><li>? give examples of exothermic reactions,</li><li>? give examples of endothermic reactions,</li><li>? construct energy level diagrams for exothermic reactions,</li><li>? construct energy level diagrams for endothermic reactions,</li><li>? interpret energy level diagram,</li></ul>		

**LEARNING AREA : 4. THERMOCHEMISTRY**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	<p>Discuss the release or the absorption of energy during formation and breaking of bonds using simulation, computer animation, games or other methods.</p> <p>Show and discuss the application of exothermic and endothermic reactions, such as in cold or hot packs.</p>	<p>? interrelate energy change with formation and breaking of bonds,</p> <p>? describe the application of knowledge of exothermic and endothermic reactions in everyday life.</p>		
<p>4.2 Understanding heat of precipitation</p>	<p>Discuss the meaning of heat of reaction for the following types of reactions: (a) precipitation, (b) displacement, (c) neutralisation, (d) combustion.</p> <p>Carry out an activity to determine the heat of precipitation for a reaction and construct its energy level diagram.</p> <p>Carry out an activity to solve numerical problems related to heat of precipitation using information based on thermochemical equations.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what heat of reaction is,</li> <li>• state what heat of precipitation is,</li> <li>• determine the heat of precipitation for a reaction,</li> <li>• construct an energy level diagram for a precipitation reaction,</li> <li>• solve numerical problems related to heat of precipitation.</li> </ul>	<p>Unit for energy is joule (J).</p> <p>Calculations should be based on the assumption that there is no heat loss to the surrounding.</p>	<p>precipitation – <i>pemendakan</i></p> <p>displacement – <i>pernyesaran</i></p> <p>neutralisation – <i>peneutralan</i></p> <p>thermochemical equations – <i>persamaan termokimia</i></p> <p>specific heat capacity – <i>muatan haba tentu</i></p>

**LEARNING AREA : 4. THERMOCHEMISTRY**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>4.3 Understanding heat of displacement</p>	<p>Discuss the meaning of heat of displacement.</p> <p>Carry out an activity to determine the heat of displacement for a reaction and construct the energy level diagram.</p> <p>Calculate heat of displacement using information based on thermochemical equations.</p> <p>Carry out an activity to solve numerical problems related to heat of displacement using information based on thermochemical equations.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what heat of displacement is,</li> <li>• determine heat of displacement,</li> <li>• construct the energy level diagram for a displacement reaction,</li> <li>• solve numerical problems related to heat of displacement.</li> </ul>		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
4.4 Understanding heat of neutralisation	<p>Discuss the meaning of heat of neutralisation.</p> <p>Carry out activities to determine the heat of neutralisation, and construct energy level diagrams, for the following types of reactions between:</p> <p>(a) strong acid and strong alkali,            (b) weak acid and strong alkali,            (c) strong acid and weak alkali,            (d) weak acid and weak alkali.</p> <p>Discuss the difference between the heat of neutralisation for a strong acid and/or strong alkali with heat of neutralisation for a reaction involving a weak acid and a weak alkali.</p> <p>Carry out an activity to solve numerical problems related to heat of neutralisation using information based on thermochemical equations.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what heat of neutralisation is,</li> <li>• determine the heat of neutralisation,</li> <li>• construct energy level diagrams for various types of neutralisation reactions,</li> <li>• compare the heat of neutralisation for the reaction between a strong acid and a strong alkali with the heat of neutralisation for a reaction between a weak acid and/or a weak alkali,</li> <li>• explain the difference of the heat of neutralisation for a strong acid and a strong alkali with the heat of neutralisation for a reaction involving a weak acid and/or a weak alkali,</li> <li>• solve numerical problems related to heat of neutralisation.</li> </ul>		

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
4.5 Understanding heat of combustion	<p>Discuss the meaning of heat of combustion.</p> <p>Carry out activities to determine heat of combustion of various alcohols.</p> <p>Discuss:</p> <p>(a) the difference between heat of combustion of various alcohols,            (b) the difference between fuel values of various fuels,            (c) the selection of suitable fuel for specific purposes.</p> <p>Carry out an activity to solve numerical problems related to heat of combustion using information based on thermochemical equations.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what heat of combustion is,</li> <li>• determine heat of combustion for a reaction,</li> <li>• construct an energy level diagram for a combustion reaction,</li> <li>• compare the heat of combustion of various alcohols,</li> <li>• state what fuel value is,</li> <li>• describe the difference between heats of combustion of various alcohols,</li> <li>• describe the applications of fuel value,</li> <li>• compare and contrast fuel values for various fuels,</li> <li>• solve numerical problems related to heat of combustion.</li> </ul>	<p>Fuel value is also known as heat value. The unit used is kJ.</p>	<p>fuel value –  <i>nilai haba bahan api</i></p>

**LEARNING AREA : 4. THERMOCHEMISTRY**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>4.6 Appreciating the existence of various energy sources</p>	<p>Carry out group work where each group:</p> <ul style="list-style-type: none"> <li>(a) brainstorm and identify the various energy sources,</li> <li>(b) choose an energy source,</li> <li>(c) identify technology used to harness this energy,</li> <li>(d) discuss the pros and cons in using this energy source.</li> </ul> <p>Discuss the use of various energy sources and its effect on humans and the environment.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>? describe a variety of energy sources,</li> <li>? identify various technology used to harness energy,</li> </ul> <ul style="list-style-type: none"> <li>• justify the use of a particular energy source.</li> </ul>		<p>harnessing energy sources – <i>penyadapan sumber tenaga</i></p> <p>environmental pollution – <i>pencemaran alam</i></p>

**THEME : PRODUCTION AND MANAGEMENT OF MANUFACTURED CHEMICALS**

**LEARNING AREA : 5. CHEMICALS FOR CONSUMERS**

**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
<p>5.1 Analysing soap and detergent</p>	<p>Collect and interpret data on: (a) the history of soap manufacturing, (b) what soap and detergent are, (c) the additives in detergent such as biological enzymes and whitening agents, (d) the preparation of detergent.</p> <p>Carry out an activity to prepare soap using the saponification process.</p> <p>Investigate the cleansing action of soap and detergent using simulation and computer animation.</p> <p>Discuss: (a) the cleansing action of soap and detergent, (b) the differences in the effectiveness of the cleansing action of soap and detergent.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• state what soap is,</li> <li>• state what detergent is,</li> <li>• describe soap preparation process,</li> <li>• describe detergent preparation process,</li> </ul> <p>? describe the cleansing action of soap,</p> <p>? describe the cleansing action of detergent,</p> <ul style="list-style-type: none"> <li>• compare and contrast the effectiveness of the cleansing action of soap and detergent,</li> <li>• identify the additives in detergent and their respective functions.</li> </ul>	<p>The use of banned substances such as alkyl benzene sulphonate to illustrate detergent preparation should be avoided.</p>	<p>additive – <i>bahan tambahan</i></p> <p>biological enzyme – <i>enzim biologi</i></p> <p>detergent – <i>detergen</i></p> <p>saponification - <i>saponifikasi</i></p>

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	Conduct a competition or carry out a project related to: (a) the manufacturing of soap, (b) the preparation of detergent for multiple purposes such as shampoo and dish cleaner.			
5.2 Evaluating the use of food additives	Collect and interpret data on the various types of food additives in the market.  Collect and interpret data on the types of chemicals used in food additives and their functions as: (a) preservatives and antioxidants, e.g. sodium nitrite, sodium benzoate, ascorbic acid, (b) flavouring agents, e.g. monosodium glutamate (MSG), aspartame, (c) stabilizers and thickening agents, e.g. gelatine, acacia gum, (d) dyes, e.g. azo compound, triphenyl compound.  Carry out a project to collect and observe the labels on food packs and identify the additives used.	A student is able to: <ul style="list-style-type: none"> <li>• state the types of food additives and their examples,</li> <li>• state the functions of each type of food additive,</li> </ul>		preservative – <i>pengawet</i>  antioxidant – <i>pengantioksidasi/ antipeongsida</i>  flavouring – <i>agen perisa</i>  stabiliser – <i>pengstabil</i>  thickener agent – <i>agen pemekat</i>

**LEARNING AREA : 5. CHEMICALS FOR CONSUMERS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
	Discuss: (a) the rationale for the use of food additives, (b) the effect of food additives on health and the environment, (b) life without food additives.	<ul style="list-style-type: none"> <li>• justify the use of food additives,</li> <li>• describe the effects of food additives on health and the environment.</li> </ul>		
5.3 Understanding medicine	Collect and interpret data on various types and functions of medicine, i.e: (a) traditional medicines derived from plants and animals, (b) analgesics such as aspirin, paracetamol and codeine, (c) antibiotics such as penicillin and streptomycin, (d) psychotherapeutic medicine such as stimulant, antidepressant and antipsychotic.  Collect and interpret data on: (a) the side effects of modern and traditional medicines, (b) the correct usage of modern and traditional medicines.	A student is able to:  <ul style="list-style-type: none"> <li>• state examples of traditional medicine, their sources and uses,</li> <li>• state the types of modern medicine and their examples,</li> <li>• state the functions of each type of modern medicine,</li> <li>• describe the possible side effects of using modern and traditional medicine,</li> <li>• describe the correct usage of modern and traditional medicines.</li> </ul>	Any natural or artificially made chemical which is used as a medicine is called drug.  Teacher should also discuss relevant drugs such as Viagra, ecstasy pills and the like.	

**LEARNING AREA : 5. CHEMICALS FOR CONSUMERS**
**Chemistry - Form 5**

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
5.4 Appreciating the existence of chemicals	<p>Collect and interpret data on:</p> <p>(a) discovery of chemicals that can improve the quality of life, such as antibiotic and detergent,</p> <p>(b) side effects of chemicals on life and the environment,</p> <p>(c) describe common traits among scientists in carrying out research, such as patience, meticulousness and perseverance.</p> <p>Carry out an activity to discuss and predict how life would be without chemicals.</p> <p>Discuss and practise proper management of chemicals towards better life, hygiene and health.</p>	<p>A student is able to:</p> <ul style="list-style-type: none"> <li>• describe that the discovery of chemicals improves quality of life,</li> <li>• state the side effects of chemicals on humans and the environment,</li> <li>? describe common traits among scientists in carrying out research,</li> <li>• describe life without chemicals,</li> <li>• state appreciation and support for proper management of chemicals.</li> </ul>		

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