



MINISTRY OF EDUCATION MALAYSIA

## **Integrated Curriculum for Secondary Schools**

**Curriculum Specifications**

**PHYSICS**  
**Form 4**



Curriculum Development Centre  
Ministry of Education Malaysia  
2005



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## TABLE OF CONTENTS

|                                       | <i>Page</i> |
|---------------------------------------|-------------|
| The National Philosophy               | v           |
| The National Philosophy of Education  | vii         |
| National Science Education Philosophy | ix          |
| Preface                               | xi          |
| <br>                                  |             |
| Introduction                          | 1           |
| Aims and Objectives                   | 2           |
| Scientific Skills                     | 3           |
| Thinking Skills                       | 4           |
| Scientific Attitudes and Noble Values | 9           |
| Teaching and Learning Strategies      | 11          |
| Content Organisation                  | 14          |
| Introduction to Physics               | 15          |
| Forces and Motion                     | 18          |
| Forces and Pressure                   | 27          |
| Heat                                  | 32          |
| Light                                 | 36          |
| Acknowledgements                      | 41          |
| Panel of Writers                      | 42          |



## **THE NATIONAL PHILOSOPHY**

OUR NATION, MALAYSIA, being dedicated

to achieving a greater unity of all her people;

to maintaining a democratic way of life;

to creating a just society in which the wealth of the nation shall be equitably shared;

to ensuring a liberal approach to her rich and diverse cultural traditions;

to building a progressive society which shall be oriented toward modern science and technology;

We, her people, pledge our united efforts to attain these ends guided by these principles:

BELIEF IN GOD

LOYALTY TO KING AND COUNTRY

UPHOLDING THE CONSTITUTION

RULE OF LAW

GOOD BEHAVIOUR AND MORALITY



## **NATIONAL PHILOSOPHY OF EDUCATION**

Education in Malaysia is an on-going effort towards further 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 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 Physics 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 Physics 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.

(MAHZAN BIN BAKAR SMP, AMP)  
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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 physics curriculum for secondary school are to provide students with the knowledge and skills in science 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 physics curriculum will have a foundation in physics to enable them to pursue formal and informal further education in science 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 physics curriculum for secondary school enables students to:

1. Acquire knowledge in physics and technology in the context of natural phenomena and everyday life experiences.
2. Understand developments in the field of physics 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. Appreciate the contributions of science and technology towards national development and the well-being of mankind.
9. 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.
10. Be aware of 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 explain 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 variables, 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 |

**Hypothesising** fixed variables are kept constant. 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.

**Experimenting** 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**

---

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 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 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.                                     |

## Detecting Bias

Identifying views or opinions that have the tendency to support or oppose something in an unfair or misleading way.

## Evaluating

Making judgements on the quality or value of something based on valid reasons or evidence.

## Making Conclusions

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 situation to determine a structure or pattern of relationship.                       |
| <b>Making Inferences</b> | Using past experiences or previously collected data to draw conclusions and explain 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 on, or 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 statements about the relationship between manipulated variables and responding variables to explain an observation or event. The statements can be tested to determine validity. |
| <b>Making Analogies</b>       | Understanding abstract or a complex concepts by relating them to a simpler or concrete concepts with similar characteristics.                                                                     |
| <b>Inventing</b>              | 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:

|                         |                                                                                                                           |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>Conceptualising</b>  | Making generalisations based on inter-related and common characteristics in order to construct meaning, concept or model. |
| <b>Making Decisions</b> | Selecting the best solution from various alternatives based on specific criteria to achieve a specific aim.               |
| <b>Problem Solving</b>  | Finding solutions to challenging or unfamiliar situations or unanticipated difficulties in a systematic manner.           |

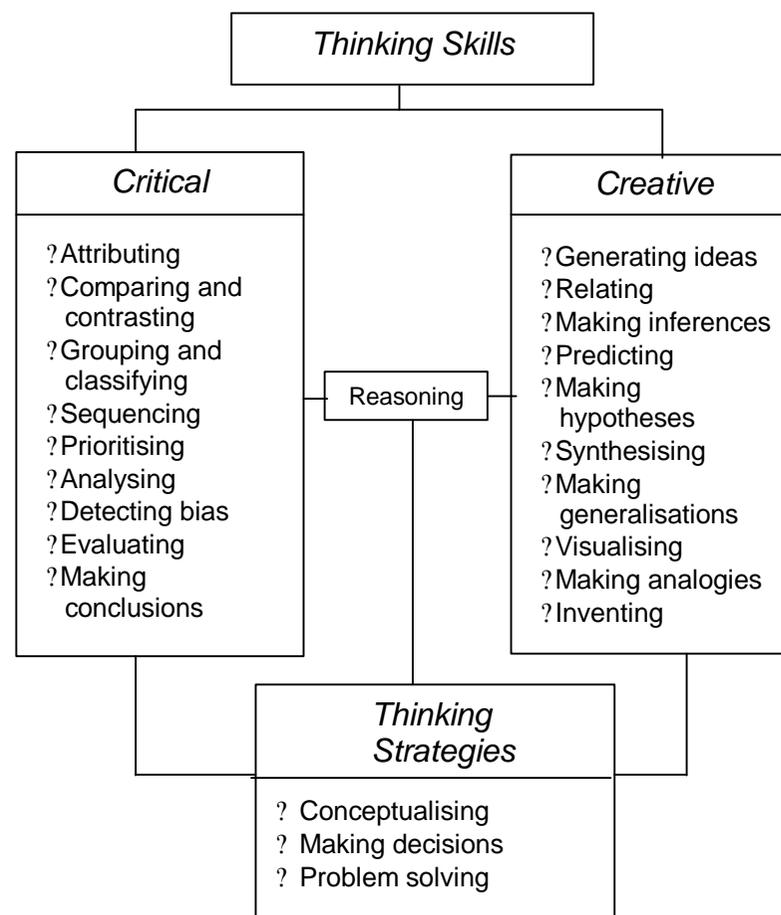
Besides the above thinking skills and thinking strategies, another skill emphasised is reasoning. Reasoning is a skill used in making logical, just and rational judgements. Mastering of critical and creative thinking skills and thinking strategies is made simpler if an individual is able to reason in 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<br>Comparing and contrasting<br>Relating                    |
| Classifying                 | Attributing<br>Comparing and contrasting<br>Grouping and classifying    |
| Measuring and Using Numbers | Relating<br>Comparing and contrasting                                   |
| Making Inferences           | Relating<br>Comparing and contrasting<br>Analysing<br>Making inferences |

| Science Process Skills        | Thinking Skills                                                                                                             |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Predicting                    | Relating<br>Visualising                                                                                                     |
| Using Space-Time Relationship | Sequencing<br>Prioritising                                                                                                  |
| Interpreting data             | Comparing and contrasting<br>Analysing<br>Detecting bias<br>Making conclusions<br>Generalising<br>Evaluating                |
| Defining operationally        | Relating<br>Making analogy<br>Visualising<br>Analysing                                                                      |
| Controlling variables         | Attributing<br>Comparing and contrasting<br>Relating<br>Analysing                                                           |
| Making hypotheses             | Attributing<br>Relating<br>Comparing and contrasting<br>Generating ideas<br>Making hypotheses<br>Predicting<br>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: Deduce from the shape of a velocity-time graph when a body is:

- i. at rest
- ii. moving with uniform velocity
- iii. moving with uniform acceleration.

Thinking Skills: analysing, relating

### Explanation:

To achieve the above learning outcome, students must first analyse graphs to relate the shape of the graph to the motion of an object.

## 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.
- ? dare 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 Four                                                                                                                                                                            |
| Learning Area:                        | 2. Forces and Motion                                                                                                                                                                 |
| Learning Objective:                   | 2.7 Being aware of the need for safety features in vehicles                                                                                                                          |
| Learning Outcome:                     | describe the importance of safety features in vehicles.                                                                                                                              |
| Suggested Learning Activities         | Research and report on the physics of vehicle collisions and safety features in vehicles in terms of physics concepts.<br><br>Discuss the importance of safety features in vehicles. |
| Scientific attitudes and noble values | Appreciating the contribution of science and technology.<br><br>Having critical and analytical thinking.                                                                             |

**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.

## LEARNING AREA: 1. INTRODUCTION TO PHYSICS

| Learning Objective                                                  | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                    | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Notes                                                                                                                                                                                                                                                                                          | Vocabulary                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1.1<br/>Understanding Physics</p>                                | <p>Observe everyday objects such as a table, a pencil, a mirror etc and discuss how they are related to physics concepts.</p> <p>View a video on natural phenomena and discuss how they are related to physics concepts.</p> <p>Discuss fields of study in physics such as forces, motion, heat, light etc.</p>                                                                                  | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? explain what physics is.</li> <li>? recognize the physics in everyday objects and natural phenomena.</li> </ul>                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                      |
| <p>1.2<br/>Understanding base quantities and derived quantities</p> | <p>Discuss base quantities and derived quantities.</p> <p>From a text passage, identify physical quantities then classify them into base quantities and derived quantities.</p> <p>List the value of prefixes and their abbreviations from nano to giga, e.g. nano (<math>10^{-9}</math>), nm (nanometer).</p> <p>Discuss the use of scientific notation to express large and small numbers.</p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? explain what base quantities and derived quantities are.</li> <li>? list base quantities and their units.</li> <li>? list some derived quantities and their units.</li> <li>? express quantities using prefixes.</li> <li>? express quantities using scientific notation.</li> <li>? express derived quantities as well as their units in terms of base quantities and base units.</li> </ul> | <p>Base quantities are: length (<math>l</math>), mass (<math>m</math>), time (<math>t</math>), temperature (<math>T</math>) and current (<math>I</math>).</p> <p>Suggested derived quantities: force (<math>F</math>), density (?), volume (<math>V</math>) and velocity (<math>v</math>).</p> | <p>base quantities – <i>kuantiti asas</i></p> <p>derived quantities – <i>kuantiti terbitan</i></p> <p>length – <i>panjang</i></p> <p>mass – <i>jisim</i></p> <p>time – <i>masa</i></p> <p>temperature – <i>suhu</i></p> <p>current – <i>arus</i></p> |

| Learning Objective                                | Suggested Learning Activities                                                                                                                                                                                                   | Learning Outcomes                                                                                                                                                         | Notes                                                                                                                  | Vocabulary                                                                                                                                                                                                    |
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|                                                   | <p>Determine the base quantities (and units) in a given derived quantity (and unit) from the related formula.</p> <p>Solve problems that involve the conversion of units.</p>                                                   | ? solve problems involving conversion of units.                                                                                                                           | More complex derived quantities may be discussed when these quantities are introduced in their related learning areas. | <p>force – <i>daya</i></p> <p>density – <i>ketumpatan</i></p> <p>volume – <i>isipadu</i></p> <p>velocity – <i>halaju</i></p> <p>scientific notation – <i>bentuk piawai</i></p> <p>prefix - <i>imbuhan</i></p> |
| 1.3<br>Understanding scalar and vector quantities | <p>Carry out activities to show that some quantities can be defined by magnitude only whereas other quantities need to be defined by magnitude as well as direction.</p> <p>Compile a list of scalar and vector quantities.</p> | <p>A student is able to:</p> <p>? define scalar and vector quantities.</p> <p>? give examples of scalar and vector quantities.</p>                                        |                                                                                                                        |                                                                                                                                                                                                               |
| 1.4<br>Understanding measurements                 | <p>Choose the appropriate instrument for a given measurement.</p> <p>Discuss consistency and accuracy using the distribution of gunshots on a target as an example.</p> <p>Discuss the sensitivity of various instruments.</p>  | <p>A student is able to:</p> <p>? measure physical quantities using appropriate instruments.</p> <p>? explain accuracy and consistency.</p> <p>? explain sensitivity.</p> |                                                                                                                        | <p>accuracy – <i>kejituan</i></p> <p>consistency – <i>kepersisan</i></p> <p>sensitivity – <i>kepekaan</i></p> <p>error – <i>ralat</i></p> <p>random - <i>rawak</i></p>                                        |

| Learning Objective                                 | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Notes                                            | Vocabulary |
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|                                                    | <p>Demonstrate through examples systematic errors and random errors. Discuss what systematic and random errors are.</p> <p>Use appropriate techniques to reduce error in measurements such as repeating measurements to find the average and compensating for zero error.</p>                                                                                                                                                                                                                                                                                                                                              | <p>? explain types of experimental error.</p> <p>? use appropriate techniques to reduce errors.</p>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |            |
| <p>1.5<br/>Analysing scientific investigations</p> | <p>Observe a situation and suggest questions suitable for a scientific investigation. Discuss to:</p> <ol style="list-style-type: none"> <li>identify a question suitable for scientific investigation</li> <li>identify all the variables</li> <li>form a hypothesis</li> <li>plan the method of investigation including selection of apparatus and work procedures</li> </ol> <p>Carry out an experiment and:</p> <ol style="list-style-type: none"> <li>collect and tabulate data</li> <li>present data in a suitable form</li> <li>interpret the data and draw conclusions</li> <li>write a complete report</li> </ol> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? identify variables in a given situation.</li> <li>? identify a question suitable for scientific investigation.</li> <li>? form a hypothesis.</li> <li>? design and carry out a simple experiment to test the hypothesis.</li> </ul><br><ul style="list-style-type: none"> <li>? record and present data in a suitable form.</li> <li>? interpret data to draw a conclusion.</li> <li>? write a report of the investigation.</li> </ul> | <p>Scientific skills are applied throughout.</p> |            |

## LEARNING AREA: 2. FORCES AND MOTION

| Learning Objective                     | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Notes                                                                               | Vocabulary                                                                                                                                                                                    |
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| <p>2.1<br/>Analysing linear motion</p> | <p>Carry out activities to gain an idea of:</p> <p>a) distance and displacement.<br/>b) speed and velocity<br/>c) acceleration and deceleration</p> <p>Carry out activities using a data logger/graphing calculator/ ticker timer to:</p> <p>a) identify when a body is at rest, moving with uniform velocity or non-uniform velocity<br/>b) determine displacement, velocity and acceleration.</p> <p>Solve problems using the following equations of motion:</p> <p>a) <math>v = u + at</math><br/>b) <math>s = ut + \frac{1}{2} at^2</math><br/>c) <math>v^2 = u^2 + 2as</math></p> | <p>A student is able to:</p> <p>? define distance and displacement<br/>? define speed and velocity and state that average velocity, <math>v = \frac{s}{t}</math>.</p> <p>? define acceleration and deceleration and state that <math>a = \frac{v - u}{t}</math>.</p> <p>? calculate speed and velocity.<br/>? calculate acceleration/ deceleration.</p> <p>? solve problems on linear motion with uniform acceleration using</p> <p>i. <math>v = u + at</math>.<br/>ii. <math>s = ut + \frac{1}{2} at^2</math>.<br/>iii. <math>v^2 = u^2 + 2as</math>.</p> | <p>average speed = <math>\frac{\text{total distance}}{\text{time taken}}</math></p> | <p>distance – <i>jarak</i><br/>displacement – <i>sesaran</i><br/>speed – <i>laju</i><br/>velocity – <i>halaju</i><br/>acceleration – <i>pecutan</i><br/>deceleration – <i>nyahpecutan</i></p> |

| Learning Objective                     | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                       | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Notes                                                                                                                                                                                                                                          | Vocabulary |
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| <p>2.2<br/>Analysing motion graphs</p> | <p>Carry out activities using a data logger/graphing calculator/ticker timer to plot<br/>a) displacement-time graphs<br/>b) velocity-time graphs</p> <p>Describe and interpret:<br/>a) displacement-time and<br/>b) velocity-time graphs</p> <p>Determine distance, displacement, velocity and acceleration from displacement-time and velocity-time graphs.</p> <p>Solve problems on linear motion with uniform acceleration involving graphs.</p> | <p>A student is able to:</p> <p>? plot and interpret displacement-time and velocity-time graphs.</p> <p>? deduce from the shape of a displacement-time graph when a body is:<br/>i. at rest.<br/>ii. moving with uniform velocity.<br/>iii. moving with non-uniform velocity.</p> <p>? determine distance, displacement and velocity from a displacement-time graph.</p> <p>? deduce from the shape of a velocity-time graph when a body is:<br/>i. at rest.<br/>ii. moving with uniform velocity.<br/>iii. moving with uniform acceleration.</p> <p>? determine distance, displacement, velocity and acceleration from a velocity-time graph.</p> <p>? solve problems on linear motion with uniform acceleration.</p> | <p>Reminder:<br/>Velocity is determined from the gradient of displacement-time graph.</p> <p>Acceleration is determined from the gradient of velocity-time graph.</p> <p>Distance is determined from the area under a velocity-time graph.</p> |            |

| Learning Objective                   | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                                                           | Notes                                                              | Vocabulary                                                                                                                                                                          |
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| <p>2.3<br/>Understanding inertia</p> | <p>Carry out activities/view computer simulations /situations to gain an idea on inertia.</p> <p>Carry out activities to find out the relationship between inertia and mass.</p> <p>Research and report on<br/>a) the positive effects of inertia<br/>b) ways to reduce the negative effects of inertia</p>                                                                                                            | <p>A student is able to:</p> <p>? explain what inertia is.</p> <p>? relate mass to inertia.</p> <p>? give examples of situations involving inertia.</p> <p>? suggest ways to reduce the negative effects of inertia.</p>                                                    | <p><i>Newton's First Law of Motion may be introduced here.</i></p> | <p>inertia - <i>inersia</i></p>                                                                                                                                                     |
| <p>2.4<br/>Analysing momentum</p>    | <p>Carry out activities/view computer simulations to gain an idea of momentum by comparing the effect of stopping two objects:<br/>a) of the same mass moving at different speeds<br/>b) of different masses moving at the same speed.</p> <p>Discuss momentum as the product of mass and velocity.</p> <p>View computer simulations on collisions and explosions to gain an idea on the conservation of momentum.</p> | <p>A student is able to:</p> <p>? define the momentum of an object.</p> <p>? define momentum (<math>p</math>) as the product of mass (<math>m</math>) and velocity (<math>v</math>) i.e. <math>p = mv</math>.</p> <p>? state the principle of conservation of momentum.</p> |                                                                    | <p>momentum – <i>momentum</i></p> <p>collision – <i>pelanggaran</i></p> <p>explosion – <i>letupan</i></p> <p>conservation of linear momentum – <i>keabadian momentum linear</i></p> |

| Learning Objective                                  | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                  | Vocabulary                                                                                                                                               |
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|                                                     | <p>Conduct an experiment to show that the total momentum of a closed system is a constant.</p> <p>Carry out activities that demonstrate the conservation of momentum e.g. water rockets.</p> <p>Research and report on the applications of conservation of momentum such as in rockets or jet engines.</p> <p>Solve problems involving linear momentum.</p>                            | <p>? describe applications of conservation of momentum.</p> <p>? solve problems involving momentum.</p>                                                                                                                                                                                                                          | <p>Reminder: Momentum as a vector quantity needs to be emphasised in problem solving.</p>                                                                                                                                              |                                                                                                                                                          |
| <p>2.5<br/>Understanding the effects of a force</p> | <p>With the aid of diagrams, describe the forces acting on an object:</p> <p>a) at rest<br/>b) moving at constant velocity<br/>c) accelerating.</p> <p>Conduct experiments to find the relationship between:</p> <p>a) acceleration and mass of an object under constant force<br/>b) acceleration and force for a constant mass.</p> <p>Solve problems using <math>F = ma</math>.</p> | <p>A student is able to:</p> <p>? describe the effects of balanced forces acting on an object.</p> <p>? describe the effects of unbalanced forces acting on an object.</p> <p>? determine the relationship between force, mass and acceleration i.e. <math>F = ma</math>.</p> <p>? solve problems using <math>F = ma</math>.</p> | <p>When the forces acting on an object are balanced they cancel each other out (nett force = 0). The object then behaves as if there is no force acting on it.</p> <p><i>Newton's Second Law of Motion may be introduced here.</i></p> | <p>balanced – <i>seimbang</i></p> <p>unbalanced – <i>tidak seimbang</i></p> <p>nett force – <i>daya bersih</i></p> <p>resultant – <i>daya paduan</i></p> |

| Learning Objective                                   | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Notes | Vocabulary                                                                  |
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| <p>2.6<br/>Analysing impulse and impulsive force</p> | <p>View computer simulations of collisions and explosions to gain an idea on impulsive forces.</p> <p>Discuss</p> <p>a) impulse as change in momentum</p> <p>b) an impulsive force as the rate of change of momentum in a collision or explosion,</p> <p>c) how increasing or decreasing time of impact affects the magnitude of the impulsive force.</p> <p>Research and report situations where:</p> <p>a) an impulsive force needs to be reduced and how it can be done</p> <p>b) an impulsive force is beneficial</p> <p>Solve problems involving impulsive forces.</p> | <p>A student is able to:</p> <p>? explain what an impulsive force is.</p> <p>? give examples of situations involving impulsive forces.</p> <p>? define impulse as a change in momentum, i.e.<br/><math>Ft = mv - mu</math>.</p> <p>? define impulsive force as the rate of change of momentum in a collision or explosion, i.e.<br/><math>F ? \frac{mv - mu}{t}</math>.</p> <p>? explain the effect of increasing or decreasing time of impact on the magnitude of the impulsive force.</p> <p>? describe situations where an impulsive force needs to be reduced and suggest ways to reduce it.</p> <p>? describe situations where an impulsive force is beneficial.</p> <p>? solve problems involving impulsive forces.</p> |       | <p>impulse – <i>impuls</i></p> <p>impulsive forces – <i>daya impuls</i></p> |

| Learning Objective                                                     | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                                                                                                                                                                                                                                                                                                          | Vocabulary                                                                     |
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| <p>2.7<br/>Being aware of the need for safety features in vehicles</p> | <p>Research and report on the physics of vehicle collisions and safety features in vehicles in terms of physics concepts.</p> <p>Discuss the importance of safety features in vehicles.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? describe the importance of safety features in vehicles.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                |                                                                                |
| <p>2.8<br/>Understanding gravity</p>                                   | <p>Carry out an activity or view computer simulations to gain an idea of acceleration due to gravity. Discuss</p> <ul style="list-style-type: none"> <li>a) acceleration due to gravity.</li> <li>b) a gravitational field as a region in which an object experiences a force due to gravitational attraction</li> <li>c) gravitational field strength (<math>g</math>) as gravitational force per unit mass.</li> </ul> <p>Carry out an activity to determine the value of acceleration due to gravity.</p> <p>Discuss weight as the Earth's gravitational force on an object.</p> <p>Solve problems involving acceleration due to gravity.</p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? explain acceleration due to gravity.</li> <li>? state what a gravitational field is.</li> <li>? define gravitational field strength.</li> <li>? determine the value of acceleration due to gravity.</li> <li>? define weight (<math>W</math>) as the product of mass (<math>m</math>) and acceleration due to gravity (<math>g</math>) i.e. <math>W = mg</math>.</li> <li>? solve problems involving acceleration due to gravity.</li> </ul> | <p>When considering a body falling freely, <math>g</math> (<math>= 9.8 \text{ m s}^{-2}</math>) is its acceleration but when it is at rest, <math>g</math> (<math>= 9.8 \text{ N kg}^{-1}</math>) is the Earth's gravitational field strength acting on it.</p> <p>The weight of an object of fixed mass is dependent on the <math>g</math> exerted on it.</p> | <p>gravitational field – <i>medan graviti</i></p> <p>weight - <i>berat</i></p> |

| Learning Objective                                       | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                 | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                          | Notes                                                      | Vocabulary                                                                                                                                                                                                      |
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| 2.9<br>Analysing forces in equilibrium                   | <p>With the aid of diagrams, describe situations where forces are in equilibrium, e.g. a book at rest on a table, an object at rest on an inclined plane.</p> <p>With the aid of diagrams, discuss the resolution and addition of forces to determine the resultant force.</p> <p>Solve problems involving forces in equilibrium (limited to 3 forces).</p>                                   | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? describe situations where forces are in equilibrium.</li> <li>? state what a resultant force is.</li> <li>? add two forces to determine the resultant force.</li> <li>? resolve a force into the effective component forces.</li> <li>? solve problems involving forces in equilibrium.</li> </ul>   |                                                            | <p>resultant force – <i>daya paduan</i></p> <p>resolve - <i>lerai</i></p>                                                                                                                                       |
| 2.10<br>Understanding work, energy, power and efficiency | <p>Observe and discuss situations where work is done. Discuss that no work is done when:</p> <ol style="list-style-type: none"> <li>a) a force is applied but no displacement occurs</li> <li>b) an object undergoes a displacement with no applied force acting on it.</li> </ol> <p>Give examples to illustrate how energy is transferred from one object to another when work is done.</p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? define work (<math>W</math>) as the product of an applied force (<math>F</math>) and displacement (<math>s</math>) of an object in the direction of the applied force i.e. <math>W = Fs</math>.</li> <li>? state that when work is done energy is transferred from one object to another.</li> </ul> | <p>Have students recall the different forms of energy.</p> | <p>work – <i>kerja</i></p> <p><b>kinetic energy – <i>tenaga kinetik</i></b></p> <p>gravitational potential energy – <i>tenaga keupayaan graviti</i></p> <p>conservation of energy – <i>keabadian tenaga</i></p> |

| Learning Objective | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                              | Notes | Vocabulary |
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|                    | <p>Discuss the relationship between work done to accelerate a body and the change in kinetic energy.</p> <p>Discuss the relationship between work done against gravity and gravitational potential energy.</p> <p>Carry out an activity to show the principle of conservation of energy.</p> <p>State that power is the rate at which work is done, <math>P = W/t</math>.</p> <p>Carry out activities to measure power.</p> <p>Discuss efficiency as:<br/> <math display="block">\frac{\text{useful energy output}}{\text{energy input}} \times 100\%</math></p> <p>Evaluate and report the efficiencies of various devices such as a diesel engine, a petrol engine and an electric engine.</p> <p>Solve problems involving work, energy, power and efficiency.</p> | <p>? define kinetic energy and state that <math>E_k = \frac{1}{2}mv^2</math></p> <p>? define gravitational potential energy and state that <math>E_p = mgh</math>.</p> <p>? state the principle of conservation of energy.</p> <p>? define power and state that <math>P = W/t</math>.</p> <p>? explain what efficiency of a device is.</p> <p>solve problems involving work, energy, power and efficiency.</p> |       |            |

| Learning Objective                                                          | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                           | Learning Outcomes                                                                                                                                                                                                                                                                                                    | Notes | Vocabulary                                                                                                                                                                                     |
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| 2.11<br>Appreciating the importance of maximising the efficiency of devices | Discuss that when an energy transformation takes place, not all of the energy is used to do useful work. Some is converted into heat or other types of energy. Maximising efficiency during energy transformations makes the best use of the available energy. This helps to conserve resources.                                                                                                                                                                        | A student is able to:<br><br>? recognise the importance of maximising efficiency of devices in conserving resources.                                                                                                                                                                                                 |       |                                                                                                                                                                                                |
| 2.12<br>Understanding elasticity                                            | Carry out activities to gain an idea on elasticity.<br><br>Plan and conduct an experiment to find the relationship between force and extension of a spring.<br><br>Relate work done to elastic potential energy to obtain $E_p = \frac{1}{2} kx^2$ .<br><br>Describe and interpret force-extension graphs.<br><br>Investigate the factors that affect elasticity.<br><br>Research and report on applications of elasticity.<br><br>Solve problems involving elasticity. | A student is able to:<br><br>? define elasticity.<br><br>? define Hooke's law.<br><br>? define elastic potential energy and state that $E_p = \frac{1}{2} kx^2$ .<br><br>? determine the factors that affect elasticity.<br><br>? describe applications of elasticity.<br><br>? solve problems involving elasticity. |       | elasticity – <i>kekenyalan</i><br><br>intra-molecular force – <i>daya antara molekul</i><br><br>extension – <i>pemanjangan</i><br><br>elastic potential energy- <i>tenaga keupayaan kenyal</i> |

### LEARNING AREA: 3. FORCES AND PRESSURE

| Learning Objective                       | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                 | Learning Outcomes                                                                                                                                                                                                                                          | Notes                                                                          | Vocabulary                                                                                       |
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| 3.1<br>Understanding pressure            | <p>Observe and describe the effect of a force acting over a large area compared to a small area, e.g. school shoes versus high heeled shoes.</p> <p>Discuss pressure as force per unit area.</p> <p>Research and report on applications of pressure.</p> <p>Solve problems involving pressure.</p>                                                                                                                                            | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? define pressure and state that <math>P = \frac{F}{A}</math>.</li> <li>? describe applications of pressure.</li> <li>? solve problems involving pressure.</li> </ul>                  | <p>Introduce the unit of pressure pascal (Pa).<br/>(Pa = N m<sup>-2</sup>)</p> | <p>pressure - <i>tekanan</i></p>                                                                 |
| 3.2<br>Understanding pressure in liquids | <p>Observe situations to form ideas that pressure in liquids:</p> <ul style="list-style-type: none"> <li>a) acts in all directions</li> <li>b) increases with depth</li> </ul> <p>Observe situations to form the idea that pressure in liquids increases with density.</p> <p>Relate depth (<i>h</i>), density (<math>\rho</math>) and gravitational field strength (<i>g</i>) to pressure in liquids to obtain <math>P = h\rho g</math>.</p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? relate depth to pressure in a liquid.</li> <li>? relate density to pressure in a liquid.</li> <li>? explain pressure in a liquid and state that <math>P = h\rho g</math>.</li> </ul> |                                                                                | <p>depth – <i>kedalaman</i></p> <p>density – <i>ketumpatan</i></p> <p>liquid - <i>cecair</i></p> |

| Learning Objective                                                    | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                   | Notes                                                                                                                                                                                                                                                                                                                                                              | Vocabulary |
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|                                                                       | <p>Research and report on</p> <p>a) the applications of pressure in liquids</p> <p>b) ways to reduce the negative effects of pressure in liquids.</p> <p>Solve problems involving pressure in liquids.</p>                                                                                                                                                                                                                                                                                                                                                             | <p>? describe applications of pressure in liquids.</p> <p>? solve problems involving pressure in liquids.</p>                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                    |            |
| <p>3.3</p> <p>Understanding gas pressure and atmospheric pressure</p> | <p>Carry out activities to gain an idea of gas pressure and atmospheric pressure.</p> <p>Discuss gas pressure in terms of the behaviour of gas molecules based on the kinetic theory.</p> <p>Discuss atmospheric pressure in terms of the weight of the atmosphere acting on the Earth's surface.</p> <p>Discuss the effect of altitude on the magnitude of atmospheric pressure.</p> <p>Research and report on the applications of atmospheric pressure.</p> <p>Solve problems involving atmospheric and gas pressure including barometer and manometer readings.</p> | <p>A student is able to:</p> <p>? explain gas pressure.</p> <p>? explain atmospheric pressure.</p> <p>? describe applications of atmospheric pressure.</p> <p>? solve problems involving atmospheric pressure and gas pressure.</p> | <p>Students need to be introduced to instruments used to measure gas pressure (Bourdon Gauge) and atmospheric pressure (Fortin barometer, aneroid barometer). Working principle of the instrument is not required.</p> <p>Introduce other units of atmospheric pressure:</p> <p>1 atmosphere = 760 mm Hg = 10.3 m water = 101 300 Pa</p> <p>1 milibar = 100 Pa</p> |            |

| Learning Objective                    | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Learning Outcomes                                                                                                                                                                                                                                                | Notes                                                                                                | Vocabulary                                                                                                                                                                                  |
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| 3.4<br>Applying Pascal's principle    | <p>Observe situations to form the idea that pressure exerted on an enclosed liquid is transmitted equally to every part of the liquid.</p> <p>Discuss hydraulic systems as a force multiplier to obtain:<br/> <math display="block">\frac{\text{output force}}{\text{input force}} = \frac{\text{output piston area}}{\text{input piston area}}</math></p> <p>Research and report on the applications of Pascal's principle (hydraulic systems).<br/> <b>Solve problems involving Pascal's principle.</b></p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? state Pascal's principle.</li> <li>? explain hydraulic systems.</li> <li>? describe applications of Pascal's principle.</li> <li>? solve problems involving Pascal's principle.</li> </ul> |                                                                                                      | <p>enclosed – <i>tertutup</i></p> <p>force multiplier – <i>pembesar daya</i></p> <p>hydraulic systems – <i>sistem hidraulik</i></p> <p>transmitted - <i>tersebar</i></p>                    |
| 3.5<br>Applying Archimedes' principle | <p>Carry out an activity to measure the weight of an object in air and the weight of the same object in water to gain an idea on buoyant force.</p> <p><b>Conduct an experiment to investigate the relationship between the weight of water displaced and the buoyant force.</b></p>                                                                                                                                                                                                                          | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? explain buoyant force.</li> <li>? relate buoyant force to the weight of the liquid displaced.</li> <li>? state Archimedes' principle.</li> <li>?</li> </ul>                                | <p>Recall density and buoyancy.</p> <p>Apparent weight equals actual weight minus buoyant force.</p> | <p>buoyancy – <i>keapungan</i></p> <p>buoyant force – <i>daya apung</i></p> <p>submerged – <i>tenggelam</i></p> <p>fluid – <i>bendalir</i></p> <p>apparent weight – <i>berat ketara</i></p> |

| Learning Objective                                 | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Learning Outcomes                                                                                                                                        | Notes | Vocabulary                                                               |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------|
|                                                    | <p>Discuss buoyancy in terms of:</p> <p>a) an object that is totally or partially submerged in a fluid experiences a buoyant force equal to the weight of fluid displaced</p> <p>b) the weight of a freely floating object being equal to the weight of fluid displaced</p> <p>c) a floating object has a density less than or equal to the density of the fluid in which it is floating.</p> <p>Research and report on the applications of Archimedes' principle, e.g. submarines, hydrometers, hot-air balloons. Solve problems involving Archimedes' principle.</p> <p>Build a cartesian diver. Discuss why the diver can be made to move up and down.</p> | <p>? describe applications of Archimedes principle.</p> <p>? solve problem involving Archimedes' principle.</p>                                          |       |                                                                          |
| <p>3.6<br/>Understanding Bernoulli's principle</p> | <p>Carry out activities to gain the idea that when the speed of a flowing fluid increases its pressure decreases. e.g. blowing above a strip of paper, blowing through straw between two ping-pong balls suspended on strings.</p>                                                                                                                                                                                                                                                                                                                                                                                                                            | <p>A student is able to:</p> <p>? state Bernoulli's principle.</p> <p>? explain that a resultant force exists due to a difference in fluid pressure.</p> |       | <p>fluid – <i>bendalir</i></p> <p>lifting force – <i>daya angkat</i></p> |

| Learning Objective | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                               | Learning Outcomes                                                                                                      | Notes | Vocabulary |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------|------------|
|                    | <p>Discuss Bernoulli's principle.</p> <p><b>Carry out activities to show that a resultant force exists due to a difference in fluid pressure.</b></p> <p>View a computer simulation to observe air flow over an aerofoil to gain an idea on lifting force.</p> <p>Research and report on the applications of Bernoulli's principle.<br/>Solve problems involving Bernoulli's principle.</p> | <p>? describe applications of Bernoulli's principle.</p> <p>? solve problem involving Bernoulli's principle.<br/>?</p> |       |            |

## LEARNING AREA: 4. HEAT

| Learning Objective                          | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                            | Learning Outcomes                                                                                                                                                                                                                                                                                                         | Notes                                                                                                                                                                                                                                                                    | Vocabulary                                        |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 4.1<br>Understanding thermal equilibrium    | <p>Carry out activities to show that thermal equilibrium is a condition in which there is no nett heat flow between two objects in thermal contact.</p> <p>Use the liquid-in-glass thermometer to explain how the volume of a fixed mass of liquid may be used to define a temperature scale.</p>                                                                                                                                                                        | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? explain thermal equilibrium.</li> <li>? explain how a liquid-in-glass thermometer works.</li> </ul>                                                                                                                                                 |                                                                                                                                                                                                                                                                          | thermal equilibrium – <i>keseimbangan terma</i>   |
| 4.2<br>Understanding specific heat capacity | <p>Observe the change in temperature when:</p> <ol style="list-style-type: none"> <li>a) the same amount of heat is used to heat different masses of water.</li> <li>b) the same amount of heat is used to heat the same mass of different liquids.</li> </ol> <p>Discuss specific heat capacity.</p> <p>Plan and carry out an activity to determine the specific heat capacity of</p> <ol style="list-style-type: none"> <li>a) a liquid</li> <li>b) a solid</li> </ol> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? define specific heat capacity (<math>c</math>).</li> <li>? state that <math>c = \frac{Q}{m\Delta\theta}</math>.</li> <li>? determine the specific heat capacity of a liquid.</li> <li>? determine the specific heat capacity of a solid.</li> </ul> | <p>Heat capacity only relates to a particular object whereas specific heat capacity relates to a material.</p> <p>Guide students to analyse the unit of <math>c</math> as <math>\text{J kg}^{-1} \text{K}^{-1}</math> or <math>\text{J kg}^{-1} \text{C}^{-1}</math></p> | specific heat capacity – <i>muatan haba tentu</i> |

| Learning Objective                        | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                      | Notes                                                                                        | Vocabulary                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                           | <p>Research and report on applications of specific heat capacity.</p> <p>Solve problems involving specific heat capacity.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>? describe applications of specific heat capacity.</p> <p>? solve problems involving specific heat capacity.</p>                                                                                                                                                                                                                                                                                                    |                                                                                              |                                                                                                                                                                                                                                                                                                                                        |
| 4.3<br>Understanding specific latent heat | <p>Carry out an activity to show that there is no change in temperature when heat is supplied to:</p> <p>a) a liquid at its boiling point.<br/>b) a solid at its melting point.</p> <p>With the aid of a cooling and heating curve, discuss melting, solidification, boiling and condensation as processes involving energy transfer without a change in temperature.</p> <p>Discuss</p> <p>a) latent heat in terms of molecular behaviour.<br/>b) specific latent heat.</p> <p>Plan and carry out an activity to determine the specific latent heat of:</p> <p>c) fusion<br/>d) vaporisation</p> <p>Solve problems involving specific latent heat.</p> | <p>A student is able to:</p> <p>? state that transfer of heat during a change of phase does not cause a change in temperature.</p> <p>? define specific latent heat (<math>l</math>)</p> <p>? state that <math>l = \frac{Q}{m}</math>.</p> <p>? determine the specific latent heat of fusion.</p> <p>? determine the specific latent heat of vaporisation.</p> <p>? solve problems involving specific latent heat.</p> | <p>Guide students to analyse the unit of <math>l</math> as <math>\text{J kg}^{-1}</math></p> | <p>melting – <i>peleburan</i></p> <p>solidification – <i>pemejalan</i></p> <p>condensation – <i>kondensasi</i></p> <p>specific latent heat – <i>haba pendam tentu</i></p> <p>specific latent heat of fusion – <i>haba pendam tentu pelakuran</i></p> <p>specific latent heat of vaporisation - <i>haba pendam tentu pengewapan</i></p> |

| Learning Objective                        | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Notes | Vocabulary                                                                           |
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| <p>4.4<br/>Understanding the gas laws</p> | <p>Use a model or view computer simulations on the behaviour of molecules of a fixed mass of gas to gain an idea about gas pressure, temperature and volume.</p> <p>Discuss gas pressure, volume and temperature in terms of the behaviour of molecules based on the kinetic theory.</p> <p>Plan and carry out an experiment on a fixed mass of gas to determine the relationship between:</p> <p>a) pressure and volume at constant temperature<br/> b) volume and temperature at constant pressure<br/> c) pressure and temperature at constant volume</p> <p>Extrapolate P-T and V-T graphs or view computer simulations to show that when pressure and volume are zero the temperature on a P-T and V-T graph is <math>-273^{\circ}\text{C}</math>. Discuss absolute zero and the Kelvin scale of temperature.</p> | <p>A student is able to:</p> <p>? explain gas pressure, temperature and volume in terms of the behaviour of gas molecules.</p> <p>? determine the relationship between pressure and volume at constant temperature for a fixed mass of gas i.e. <math>pV = \text{constant}</math>.</p> <p>? determine the relationship between volume and temperature at constant pressure for a fixed mass of gas i.e. <math>\frac{V}{T} = \text{constant}</math>.</p> <p>? determine the relationship between pressure and temperature at constant volume for a fixed mass of gas i.e. <math>\frac{p}{T} = \text{constant}</math>.</p> <p>? explain absolute zero.</p> |       | <p>Kelvin scale – <i>skala Kelvin</i></p> <p>absolute zero – <i>sifar mutlak</i></p> |

| Learning Objective | Suggested Learning Activities                                                                | Learning Outcomes                                                                                                                                     | Notes | Vocabulary |
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|                    | <p>Solve problems involving the pressure, temperature and volume of a fixed mass of gas.</p> | <p>? explain the absolute/Kelvin scale of temperature.</p> <p>? solve problems involving pressure, temperature and volume of a fixed mass of gas.</p> |       |            |

## LEARNING AREA: 5. LIGHT

| Learning Objective                               | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes | Vocabulary                                                                                                                                                                                                                                                                              |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>5.1<br/>Understanding reflection of light</p> | <p>Observe the image formed in a plane mirror. Discuss that the image is:</p> <ul style="list-style-type: none"> <li>a) as far behind the mirror as the object is in front and the line joining the object and image is perpendicular to the mirror,</li> <li>b) the same size as the object,</li> <li>c) virtual,</li> <li>d) laterally inverted.</li> </ul> <p>Discuss the laws of reflection.</p> <p>Draw ray diagrams to determine the position and characteristics of the image formed by a</p> <ul style="list-style-type: none"> <li>a) plane mirror,</li> <li>b) convex mirror,</li> <li>c) concave mirror.</li> </ul> <p>Research and report on applications of reflection of light.</p> <p>Solve problems involving reflection of light.</p> | <p>A student is able to:</p> <ul style="list-style-type: none"> <li>? describe the characteristics of the image formed by reflection of light.</li> <li>? state the laws of reflection of light.</li> <li>? draw ray diagrams to show the position and characteristics of the image formed by a               <ul style="list-style-type: none"> <li>i. plane mirror,</li> <li>ii. convex mirror,</li> <li>iii. concave mirror.</li> </ul> </li> <li>?</li> </ul> |       | <p>plane mirror – <i>cermin satah</i></p> <p>reflection – <i>pantulan</i></p> <p>image – <i>imej</i></p> <p>virtual – <i>maya</i></p> <p>laterally inverted – <i>songsang sisi</i></p> <p><b>convex mirror – <i>cermin cembung</i></b></p> <p>concave mirror – <i>cermin cekung</i></p> |

| Learning Objective                       | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                     | Notes | Vocabulary                                                                                                                                                                |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          | Construct a device based on the application of reflection of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ? describe applications of reflection of light.<br>? solve problems involving reflection of light.<br>? construct a device based on the application of reflection of light.                                                                                                                                                                                           |       |                                                                                                                                                                           |
| 5.2<br>Understanding refraction of light | <p>Observe situations to gain an idea on refraction.</p> <p>Conduct an experiment to find the relationship between the angle of incidence and angle of refraction to obtain Snell's law.</p> <p>Carry out an activity to determine the refractive index of a glass or perspex block.</p> <p>Discuss the refractive index, <math>n</math>, as <math>\frac{\text{speed of light in a vacuum}}{\text{speed of light in a medium}}</math>.</p> <p>Research and report on phenomena due to refraction, e.g. apparent depth, the twinkling of stars.</p> | <p>A student is able to:</p> <p>? explain refraction of light.</p> <p>? define refractive index as <math>n = \frac{\sin i}{\sin r}</math>.</p> <p>? Determine the refractive index of a glass or perspex block.</p> <p>? state the refractive index, <math>n</math>, as <math>\frac{\text{speed of light in a vacuum}}{\text{speed of light in a medium}}</math>.</p> |       | <p>refraction – <i>pembiasan</i></p> <p>refractive index – <i>indeks pembiasan</i></p> <p>real depth – <i>dalam nyata</i></p> <p>apparent depth – <i>dalam ketara</i></p> |

| Learning Objective                                              | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                            | Learning Outcomes                                                                                                                                                                                                                              | Notes | Vocabulary                                                                                                  |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------|
|                                                                 | <p>Carry out activities to gain an idea of apparent depth. With the aid of diagrams, discuss real depth and apparent depth.</p> <p>Solve problems involving the refraction of light.</p>                                                                                                                                                                                                                                                 | <p>? describe phenomena due to refraction.</p> <p>? solve problems involving the refraction of light.</p>                                                                                                                                      |       |                                                                                                             |
| <p>5.3<br/>Understanding total internal reflection of light</p> | <p>Carry out activities to show the effect of increasing the angle of incidence on the angle of refraction when light travels from a denser medium to a less dense medium to gain an idea about total internal reflection and to obtain the critical angle.</p> <p>Discuss with the aid of diagrams:</p> <p>a) total internal reflection and critical angle.</p> <p>b) the relationship between critical angle and refractive index.</p> | <p>A student is able to:</p> <p>? explain total internal reflection of light.</p> <p>? define critical angle (<math>c</math>).</p> <p>? relate the critical angle to the refractive index i.e. <math>n = \frac{1}{\sin c}</math>.</p> <p>?</p> |       | <p>total internal reflection – <i>pantulan dalam penuh</i></p> <p>critical angle – <i>sudut genting</i></p> |

| Learning Objective                  | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                            | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes | Vocabulary                                                                                                                                                                                                                                                             |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | <p>Research and report on</p> <p>a) natural phenomenon involving total internal reflection</p> <p>c) the applications of total internal reflection, e.g. in telecommunication using fibre optics.</p> <p>Solve problems involving total internal reflection.</p>                                                                                                                                                                                         | <p>? describe natural phenomenon involving total internal reflection.</p> <p>? describe applications of total internal reflection.</p> <p>? solve problems involving total internal reflection.</p>                                                                                                                                                                                                                                               |       |                                                                                                                                                                                                                                                                        |
| <p>5.4<br/>Understanding lenses</p> | <p>Use an optical kit to observe and measure light rays traveling through convex and concave lenses to gain an idea of focal point and focal length. Determine the focal point and focal length of convex and concave lenses.</p> <p>With the help of ray diagrams, discuss focal point and focal length.</p> <p>Draw ray diagrams to show the positions and characteristics of the images formed by a</p> <p>a) convex lens</p> <p>b) concave lens.</p> | <p>A student is able to:</p> <p>? explain focal point and focal length.</p> <p>? determine the focal point and focal length of a convex lens.</p> <p>? determine the focal point and focal length of a concave lens.</p> <p>? draw ray diagrams to show the positions and characteristics of the images formed by a convex lens.</p> <p>? draw ray diagrams to show the positions and characteristics of the images formed by a concave lens.</p> |       | <p><b>light rays</b> – <i>sinar cahaya</i></p> <p>convex lens – <i>kanta cembung</i></p> <p>concave lens – <i>kanta cekung</i></p> <p>focal point - <i>titik fokus</i></p> <p>focal length – <i>panjang fokus</i></p> <p>ray diagrams – <i>gambar rajah sinar.</i></p> |

| Learning Objective | Suggested Learning Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                | Notes | Vocabulary                                                                                                                     |
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|                    | <p>Carry out activities to gain an idea of magnification.</p> <p>With the help of ray diagrams, discuss magnification.</p> <p>Carry out an activity to find the relationship between <math>u</math>, <math>v</math> and <math>f</math>.</p> <p>Carry out activities to gain an idea on the use of lenses in optical devices.</p> <p>With the help of ray diagrams discuss the use of lenses in optical devices such as a telescope and a microscope.</p> <p>Construct an optical device that uses lenses.</p> <p>Solve problems involving lenses.</p> | <p>? define magnification as<br/> <math display="block">m = \frac{v}{u}</math></p> <p>? relate focal length (<math>f</math>) to the object distance (<math>u</math>) and image distance (<math>v</math>), i.e. <math>\frac{1}{f} = \frac{1}{u} + \frac{1}{v}</math>.</p> <p>? describe, with the aid of ray diagrams, the use of lenses in optical devices.</p> <p>? construct an optical device that uses lenses.</p> <p>? solve problems involving lenses.</p> |       | <p>magnification - <i>pembesaran</i></p> <p>object distance – <i>jarak objek</i></p> <p>image distance – <i>jarak imej</i></p> |

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