Physics

Introduction

1. Physics is one of the elective subjects in the Key Learning Area (KLA) of Science Education[1]. The Physics Curriculum serves as a continuation of the Science (S1-3) Curriculum and builds on the strength of the current Physics Curricula. It will provide a range of balanced learning experiences through which students can develop the necessary scientific knowledge and understanding, skills and processes, and values and attitudes embedded in the strand "Energy and Change" of science education and in other related strands for personal development, and for contributing towards a scientific and technological world. The curriculum will prepare students for entering tertiary courses, vocation-related courses or the workforce in various fields of physical science.

Rationale

2. The emergence of a highly competitive and integrated economy, rapid scientific and technological innovations, and a growing knowledge base will continue to have a profound impact on our lives. In order to meet the challenges posed by these changes, Physics, like other science electives, will provide a platform for developing scientific literacy and for building up essential scientific knowledge and skills for life-long learning in science and technology.

3. Physics is one of the most fundamental natural sciences. It involves the study of universal laws, and the behaviours and relationships among a wide range of physical phenomena. Through the learning of physics, students will acquire conceptual and procedural knowledge relevant to their daily life. In addition to the relevance and intrinsic beauty of physics, a study of physics also helps students to develop an understanding of the practical applications of physics to a wide variety of other fields. With a solid foundation in physics, students should be able to appreciate the intrinsic beauty and quantitative nature of physical phenomena, and the role of physics in many important developments in engineering, medicine, economics and other scientific and technological fields. Furthermore, learning about the contributions, issues and problems related to innovations in physics will help students to develop a holistic view of the relation of science, technology and society.

[1] Please refer to the appendix on p.225 for the overall curriculum framework of science education and the proposed elective subjects in the Key Learning Area of Science Education.

4. The curriculum attempts to make the study of physics exciting and relevant. It is suggested to introduce the learning of physics in real life contexts. The adoption of diverse learning contexts, learning and teaching strategies, and assessment practices is intended to appeal to students of all abilities and aspirations, and to stimulate interest and motivation for learning among them. Together with other learning experiences, students are expected to be able to apply the knowledge of physics they gain, to appreciate the relationship between physics and other disciplines, to be aware of the science-technology-society (STS) connections of contemporary issues, and to become responsible citizens.

Curriculum Aims

5. The overarching aim of the Physics Curriculum is to provide physics-related learning experiences for students to develop scientific literacy, so that they can participate actively in our rapidly changing knowledge-based society, prepare for further studies or careers in fields related to physics, and become life-long learners in science and technology.

The broad aims of the curriculum are to enable students to:

- ✧ develop interest and maintain a sense of wonder and curiosity about the physical world;
- ✧ construct and apply knowledge of physics, and appreciate the relationship between physical science and other disciplines;
- ✧ appreciate and understand the nature of science in physics-related contexts;
- ✧ develop skills for making scientific inquiries;
- ✧ develop the ability to think scientifically, critically and creatively, and to solve problems individually or collaboratively in physics-related contexts;
- ✧ understand the language of science and communicate ideas and views on physics-related issues;
- ✧ make informed decisions and judgments on physics-related issues; and
- ✧ be aware of the social, ethical, economic, environmental and technological implications of physics, and develop an attitude of responsible citizenship.

Curriculum Framework

(This part should be read in conjunction with the section "Curriculum Framework" of the Main Document. It should be noted that the curriculum framework suggested below is for initial consultation only. Feedback from the public will be taken into account and further details will be provided in the next stage of consultation.)

6. The learning targets of this curriculum are categorised into three domains: knowledge and understanding, skills and processes, and values and attitudes. Through the learning embodied in the Physics Curriculum, students will acquire the relevant learning targets in various physics-related contexts.

Knowledge and Understanding

Students are expected to:

- ✧ understand phenomena, facts and patterns, principles, concepts, laws, theories and models in physics;
- ✧ learn vocabulary, terminology and conventions in physics;
- ✧ acquire knowledge of techniques and skills specific to the study of physics;
- ✧ group and organise physical knowledge and understanding, and apply them to familiar and unfamiliar situations; and
- ✧ develop an understanding of technological applications of physics and of their social implications.

Skills and Processes

Students are expected to:

- ✧ develop scientific thinking and problem-solving skills;
- ✧ acquire an analytical mind to critically evaluate physics-related issues;
- ✧ communicate scientific ideas and values in meaningful and creative ways with appropriate use of diagrams, symbols, formulae, equations and conventions, as well as verbal means;
- ✧ acquire practical skills such as how to manipulate apparatus and equipment, carry out given procedures, analyse and present data, draw conclusions and evaluate experimental procedures;
- ✧ make careful observations, ask relevant questions, identify problems and formulate hypotheses for investigation;

- ✧ plan and conduct scientific investigations individually or collaboratively with appropriate instruments and methods, collect quantitative and qualitative data with accuracy, analyse and present data, draw conclusions, and evaluate evidence and procedures; and
- ✧ develop study skills to improve the effectiveness and efficiency of learning; and develop abilities and habits that are essential to life-long learning.

Values and Attitudes

Students are expected to:

- ✧ develop positive values and attitudes such as curiosity, honesty, respect for evidence, perseverance and tolerance of uncertainty through the study of physics;
- ✧ develop a habit of self-reflection and the ability to think critically;
- ✧ be willing to communicate and comment on issues related to physics, and demonstrate an open-mindedness towards the views of others;
- ✧ be aware of the importance of safety for themselves and others, and be committed to safe practices in their daily life;
- ✧ appreciate the achievements made in physics and recognise their limitations;
- ✧ be aware of the social, economic, environmental and technological implications of achievements in physics; and
- ✧ recognise the importance of life-long learning in our rapidly changing knowledge-based society.

7. The curriculum will consist of compulsory and elective parts. The compulsory part will cover a range of content that enables students to develop understanding of fundamental principles and concepts in physics, and the scientific process skills. It is suggested to include topics such as “Heat Transfer and Gases”, “Force and Motion”, “Wave Motion”, “Electricity and Magnetism” and “Atomic Physics”.

8. To cater for the diverse interests, abilities and needs of students, an elective part will be included in the curriculum. The elective part aims to provide an in-depth treatment of some of the topics in the compulsory part, an extension of certain areas of study, or a synthesis of knowledge, understanding and skills in a particular context. Some possible topics in the elective part are: “Advances in Physics”, “Astronomy and Space Science”, “Energy Efficiency”, “Medical Physics”, and “Modelling”.

9. To facilitate the integration of knowledge and skills acquired, students are required to conduct an investigative study relevant to the curriculum. A proportion of total lesson time will be allocated for this study.

10. The suggested content and time allocation for the compulsory and elective parts are listed in the following tables.

I. Compulsory part (Total 205 hours) Some possible topics are suggested as follows:		Suggested lesson time (hrs)
1. Heat Transfer and Gases	• Temperature, heat and internal energy • Transfer process • Change of state • Gases • Kinetic theory of gases	25
2. Force and Motion	• Position and movement • Force and motion • Static equilibrium • Work, energy and power • Momentum • Projectile motion • Circular motion	50
3. Wave Motion	• Nature and properties of waves • Light • Optical instruments • Sound	40
4. Electricity and Magnetism	• Electrostatics • Current electricity • Capacitors • Electromagnetism • Alternating current	50
5. Atomic Physics	• Radiation and radioactivity • Extra-nuclear structure of an atom • Nuclear energy	25
6. Investigative Study	• Students should conduct an investigation with a view to solving an authentic problem	15
	Subtotal:	205

II. Elective part (Total 50 hours, any 2) Some possible topics are suggested as follows (no. of topics listed in the elective part are to be determined after consultation):		Suggested lesson time (hrs)
1. Advances in Physics	• Modern developments in physics • Applications of physics in society	25
2. Astronomy and Space Science	• Developments in astronomy • The mechanical universe • Stars and the universe	25
3. Energy Efficiency	• Energy generation, transmission and consumption in society • Alternative energy sources	25
4. Medical Physics	• Physics of our senses • Physics principles in medicine	25
5. Modelling	• Mathematical models in physics • Application of computational algorithms	25
	Subtotal:	50
	Total lesson time:	**255**

Learning and Teaching

11. The curriculum has an in-built flexibility to cater for the interests, abilities and needs of students. This flexibility also provides a means to bring about a balance between the quality and quantity of learning. Teachers should provide ample opportunities for students to engage in a variety of learning experiences, such as investigations, discussions, demonstrations, practical work, field studies, model-making, case-studies, questioning, oral reports, assignments, debates, information search and role-play. Teachers should give consideration to the range of experiences that would be most appropriate to their students. The context for learning should be made relevant to daily life, so that students will experience physics as interesting and important to them.

12. Practical work and investigations are essential components of the curriculum. They enable students to gain personal experience of science through hands-on activities, and to develop the skills and thinking processes associated with the practice of science. Participation in these activities encourages students to bring scientific thinking to the

processes of problem-solving, decision-making and evaluation of evidence. Engaging in scientific investigation enables students to gain an understanding of the nature of science and the limitations of scientific inquiry.

Assessment

(This part should be read in conjunction with the section "Assessment" of the Main Document.)

Aims of assessment

13. Assessment is an integral part of the learning and teaching cycle. Assessment is the practice of collecting evidence of student learning. Its aims are to improve learning and teaching and to recognise the achievement of students. Therefore, assessment design should be aligned with the learning targets, the curriculum design and the learning progression.

Internal Assessment

14. Internal assessment refers to the assessment practices that schools will employ as part of the learning and teaching strategies during the three years of study in physics. These practices should be aligned with curriculum planning, teaching progression, student abilities and the local school contexts. Internal assessment includes both formative and summative assessment practices. The information collected will help to motivate and promote student learning. The information will also help teachers to find ways of promoting more effective learning and teaching. A range of assessment practices, such as written tests, oral questioning, observation, project work, practical work and assignments, should be used to promote the attainment of various learning outcomes.

Public Assessment

15. Public assessment of the Physics subject leads to a qualification in the subject to be offered by the Hong Kong Examinations and Assessment Authority. Public assessment of the Physics subject will comprise two components: Written Examination and School-based Assessment (SBA). The written examination will consist of various types of item to assess students' performance in a broad range of skills and abilities. Students will be assessed continuously through the SBA component. This will comprise a variety of assessment modes, such as practical work, investigations, assignments and oral reports.

16. In the public assessment, a standards-referenced approach will be adopted for grading and reporting student performance. The purpose of this approach is to recognise the learning outcomes that the students have attained in the subject at the end of the 3-year senior secondary education. Each student's performance will be matched against a set of performance standards, rather than compared to the performance of other students. Standards-referenced Assessment (SRA) makes the implicit standards explicit by providing specific indication of individual student performance. Descriptors will be provided for the set of standards at a later stage.

17. The proposed weighting of the SBA component will be 20-25% of the total weighting of the public assessment of the Physics subject. The merits of adopting SBA are as follows:

(i) SBA provides a more valid assessment than an external examination on its own, since it can cover a more extensive range of learning outcomes, through flexibly employing a wider range of assessment practices that are not all possible in written examinations.

(ii) SBA enables the sustained work of students to be assessed. It provides a more comprehensive picture of student performance throughout the period of study rather than their performance in a one-off examination alone.

18. It should be noted that SBA is not an "add-on" element in the curriculum. Assessing student performance through practices such as class discussion and class observation is a normal in-class and out-of-class activity. The modes of SBA selected in the Physics subject will be appropriate to the learning objectives and processes to be assessed. The design and implementation of SBA should make reference to the nature of the subject and avoid unduly increasing the workload of both teachers and students.

Supporting Measures

19. A subject curriculum and assessment guide will be published to support learning and teaching. The Guide will provide stakeholders with information on the rationale, curriculum aims, curriculum framework, learning and teaching strategies and assessment. In addition, it is anticipated that quality textbooks and related learning and teaching materials, aligned with the rationale and the recommendations of the curriculum, will be available on the market.

20. Resource materials that facilitate learning will be developed by the Education and Manpower Bureau (EMB) to support the implementation of this curriculum. Tertiary institutions and professional organisations will be invited to contribute to the development of resource materials. Existing resource materials, such as "Physics World", "Contextual Physics", "Contextual Physics in Ocean Park", "Using Datalogger in the Teaching of

Physics" and "Enhancing Science Learning through Electronic Library", published by the EMB and various working partners will be updated to meet with the latest curriculum development. Furthermore, schools are encouraged to develop their own learning and teaching materials to meet the needs of their students, as necessary. Schools are also advised to adopt a wide variety of suitable learning resources, such as school-based curriculum projects, useful information from the Internet, the media, relevant learning packages and educational software packages. Last but not the least, experiences from various collaborative research and development projects, such as "Informed Decisions in Science Education", "Assessment for Learning in Science", "Infusing Process and Thinking Skills into Science lessons" and "Collaborative Development of Assessment Tasks and Assessment Criteria to Enhance Learning and Teaching in Science Curricula" are good sources of information for teachers.

21. To facilitate the implementation of the curriculum, professional development programmes will be organised for physics teachers. Listed below are the major domains of the professional development programmes to be provided.

- ✧ Understanding the rationale and the implementation of the Physics Curriculum;
- ✧ Sharing of learning and teaching strategies and good practices;
- ✧ Latest development in the field of physics (science update programmes);
- ✧ Curriculum management and leadership (curriculum leadership courses); and
- ✧ Internal assessment, School-based Assessment and Standards-referenced Assessment.

22. Besides, teacher networks and learning communities will be formed to facilitate reflection and discussion on various aspects related to the curriculum. Detailed information on support materials can be obtained from the CDI homepage (http://www.emb.gov.hk/cd) or the webpage for physics teachers (http://www.hk-phy.org).

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