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الإطار المنهجي لمادة الفيزياء

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Physics Syllabus

Grades 11-12 –Bilingual Program

2023-2024

Contents

Introduction

Science plays a major role in the evolution of knowledge. It empowers us to use creative and independent approaches to problem solving. It arouses our natural curiosity and enables us to meet diverse and ever-expanding challenges. It enhances our ability to inquire, seek answers, research and interpret data. These skills lead to the construction of theories and laws that help us to explain natural phenomena and exercise control over our environment. Science is, thus, an integral component of a balanced education.

This syllabus focuses on the content essential for preparing students to be engaged and productive citizens. A good foundation in the sciences will help citizens to respond to the challenges of a rapidly changing world using the scientific approach. It addresses, in addition to a specific knowledge base, the development of related skills and attitudes. Critical thinking, enquiry and reasoning are emphasized to ensure that students develop the ability to work creatively, think analytically and solve problems. The syllabus also ensures that students become aware of their moral, social, and ethical responsibilities, as well as the benefits intrinsic to the practical application of scientific knowledge to careers in the scientific field. Teaching these standards requires teaching methods that are varied and experiential. Effective lessons will concert and incorporate with practical work and the science standards, the place of information and communications technology in the science standards, teaching about science, technology and society, the mathematical requirements of the science standards.

The overall aims of science standards are that students should:

1. develop and sustain an interest in science and its applications.
2. have a sound and systematic knowledge of important scientific facts, concepts, and principles, and possess the skills needed to apply these in new and changing situations in a range of personal, domestic, industrial and environmental contexts.
3. recognize the importance of the application of scientific knowledge in the modern world and be aware of the moral, ethical, social, and environmental implications.
4. develop relevant attitudes, such as a concern for accuracy and precision, objectivity, integrity, enquiry, initiative, and inventiveness.
5. develop an understanding of the scientific skills essential for both further study and everyday life.
6. plan, design and perform experiments to test theories and hypotheses.
7. be proficient in the use of a range of scientific methods and techniques and in handling apparatus.
8. develop the ability to work independently and collaboratively with others when necessary.
9. integrate Information and Communication Technology (ICT) tools and skills.

Important Skills:

- **Scientific enquiry skills:** Scientific enquiry, which ensures the development of scientific skills, intellectual and practical, should be integrated in the learning of the scientific content across all the science branches. Scientific enquiry skills include the following:

1. carry out the practical experiments to develop the practical skills which will be mentioned in detail below.
2. find secondary information sources such as the resources available in the public libraries and on the Internet and use this after validation and making sure of the suitability of the subject.
3. apply scientific knowledge and procedures to the situations of real life.
4. recognize the importance of cooperative teamwork, put work plans, distribute responsibilities, and regulate and sets specific targets for work.

- **Know how scientists are working:**

1. realize that with science we can bring great benefits to humanity also if it is abused can cause serious damage to the environment.
2. know how scientists are carrying out their work, such as environmental monitoring and control of industrial processes.
3. know how scientists publish and present their ideas and results in order to encourage debate and development.
4. know that science could lead to the emergence of ethical considerations and discuss them.
5. know that there are many questions and considerations that cannot be answered by science.
6. trace the historical development of some key scientific models and know what contributions scientists presented in this development.

- **Processing and delivery of information**

1. present qualitative and quantitative data using a variety of methods, such as descriptive texts, graphics, images, tables, and maps with the use of technology methods and computer when it is appropriate, then analyse and explain these data to extract conclusions from them.
2. use mathematical relationships routinely to calculate the quantities.
3. do calculations based on data taken from the graphs and distinguish between dependent and independent variables.
4. handle data and write reports about the results.
5. use symbolic equations to represent chemical reactions and simple physical relationships.
6. use the appropriate methods to deliver scientific information.

- **ICT application:**

This syllabus provides students with a wide range of opportunities to use ICT in their study of science in order to play a full part in modern society, students need to be confident and effective users of ICT. Opportunities for ICT include:

1. gathering reliable information from electronic resources.
2. using spreadsheets and other software to process data.
3. using animations and simulations to visualize scientific ideas.
4. using software to present ideas and information on paper and on screen.
5. using distance learning programs and platforms.

Skills and abilities to be assessed:

The skills students are expected to develop on completion of this syllabus, have been grouped under three main headings:

1. knowledge and understanding.
2. application of knowledge and understanding, analysis and evaluation of information.
3. scientific enquiry skills and procedures.

1. Knowledge and understanding

Assessment Objectives	Skills: The ability to
Knowledge	● identify, remember and grasp the meaning of basic facts, concepts and principles.
Understanding	● select appropriate ideas, match, compare and cite examples of facts, concepts and principles in familiar situations; ● explain familiar phenomena in terms of theories, models, laws and principles.

Questions testing these skills will often begin with one of the following words: define, state, describe, explain.

2. Application of knowledge and understanding, analysis and evaluation of information

Assessment Objectives	Skills: The ability to
Application	● use facts, concepts, principles, and procedures in unfamiliar situations. ● transform data accurately and appropriately ● use common characteristics as a basis for classification ● use information to identify patterns, report trends and draw inferences. ● use formulae accurately
Analysis and Interpretation	● identify and recognize the component parts of a whole and interpret the relationships between those parts. ● identify causal factors and show how they interact with each other. ● infer, predict, and draw conclusions. ● make necessary and accurate calculations and recognize the limitations and assumptions of data. ● present reasoned explanations for phenomena, patterns, and relationships
Synthesis	● combine component parts to form a new meaningful whole. ● make predictions and solve problems. ● locate, select, organize, and present information from a variety of sources.
Evaluation	● make reasoned judgments and recommendations based on the value of ideas and information and their implications.

Questions testing these skills will often begin with one of the following words: predict, suggest, calculate or determine.

3. Scientific enquiry skills and investigations.

Assessment Objectives	Skills: The ability to
Planning and designing a practical procedure	● identify problems, make predictions, and design a practical procedure to answer a question, solve a problem or test a hypothesis. ● select and use suitable apparatus for carrying out experiments accurately and safely. ● consider possible sources of errors and danger in the design of an experiment. ● evaluating experimental procedures and identifying weaknesses and develop realistic strategies for improvement ● work in a way that is committed to ethical and moral standards such as honesty and authenticity of his results and writing of the used references.
Control	● use experimental controls where appropriate. ● appreciate that, unless certain variables are controlled, experimental results may not be valid ● recognize the need to choose appropriate sample sizes, and study control groups where necessary.
Risk assessment	● identify possible hazards in practical situations, the risks associated with these hazards, and methods of minimizing the risks.
Manipulation and measurement	● follow a detailed set or sequence of instructions. ● make measurements with due regard for precision and accuracy. ● use apparatus and measuring instruments.
Observation, recording and reporting	● select observations relevant to the particular activity. ● make accurate observations and minimise experimental errors ● record observations, measurements, methods, and techniques with due regard for precision, accuracy and units. ● record and report unexpected results. ● select and use appropriate models of recording data or observations, for example, tables and diagrams. ● organize and present information, ideas, descriptions and arguments clearly and logically in a complete report, using spelling, punctuation, grammar and scientific terminology with an acceptable degree of accuracy.

Assessment Objectives	Skills: The ability to
Analyzing and interpreting data	● appreciate when it is appropriate to calculate a mean, calculate a mean from a set of at least three results and recognize when it is appropriate to ignore anomalous results in calculating a mean. ● recognize patterns in data, form hypotheses and deduce relationships. ● use and interpret tabular and graphical representations of data. ● evaluate data, considering its repeatability, reproducibility and validity in presenting and justifying conclusions.
Making conclusions	● draw conclusions that are consistent with the evidence obtained and support them with scientific explanations
Drawing	● draw the best-fit lines for the graphs representing data that varies continuously. ● use fix scales for each of the x and y axes. ● label the axes including the measurements and units. ● draw precise diagrams e.g. (electric circuits, ray diagrams for the mirrors and lenses).

الإطار المنهجي لمادة الفيزياء للصفين الحادي عشر والثاني عشر

Grades 11-12 Physics Syllabus

Grades 11-12 Syllabus

Physics is a science that is concerned with systems, laws, models, principles, and theories that explain the physical behavior of our world and the universe. Physics is an enquiry-based discipline involving practical and investigational skills as well as knowledge and is regarded as a fundamental scientific discipline since all advances in technology can be traced either directly or indirectly to the physical laws and theories. This syllabus emphasizes on the application of scientific concepts and principles. Such an approach is adopted in order to develop those long-term transferable skills of ethical conduct, teamwork, problem solving, critical thinking, innovation and communication. The syllabus will assist students to develop positive values and attitudes towards the physical components of the environment and will also provide a sound foundation for those who wish to pursue further studies in science.

Aims: Physics syllabus enables students to:

1. develop their knowledge and understanding of physics.
2. develop and apply their knowledge and understanding of the scientific process.
3. develop their understanding of the relationships between hypotheses, evidence, theories, and explanations.
4. develop and apply their observational, practical, modeling, enquiry and problem-solving skills, and their understanding in laboratory, field, and other learning environments.
5. develop their skills in reporting and presenting information clearly and logically in different formats.
6. develop their skills in communication, mathematics, and the use of technology in scientific contexts.
7. appreciate the contributions of some of the outstanding regional and international scientists to the development of Physics.
8. develop the ability to evaluate information critically, identify patterns, cause and effect, stability, and change, and evaluate ideas.

How to this syllabus?

This syllabus is arranged according to the following manner:

- **Outcomes:**

Indicate the scope of the content, including practical work, which will be examined as well. However, practical work should not necessarily be limited to these objectives.

The numbering key: [Unit – Topic –Learning outcome]

e.g. **Unit 2**. (2. Kinematics); **Topic 1** (2.1 motion in one dimension); and **a) is the first learning outcome** (a) Recall distance, displacement, speed and velocity.

1. For the topics refer to the textbooks that are recommended by MOE in the approved books list which are:
   - Cambridge International AS and A Level Physics, Third Edition, Mike Crundell and Geoff Goodwin, Hodder Education, 2020. (for grades 11&12)
   - Cambridge International AS and A Level Complete Physics, Third Edition, Jim Breithaupt, Hossam Attya, Camille Pervenche and Jaykishan Sharma, Oxford University Press, 2020

2. For the practical works and activities refer to:
   - Practical lab manual for Grade 11 Physics, Hajir Al Balushi, Ministry of Education, 2023.

- **Practical experiments and activities:**

Show some examples of active learning activities and do not represent full -scale activities that can be done. It is recommended that all of the suggested laboratory-related activities, such as conducting experiments must be done. Other activities like making field trips and viewing audio-visual materials, can be done also. Take into account the sufficient time to carry out the practical experiments determined in this syllabus and explained in detail in the student textbook and in the practical resources and train students in practical skills related to them. The teachers should get benefit from the student textbooks, teacher's resources, practical workbooks, and the interactive digital resources, that are recommended by MOE in the approved books list. The teachers should include the practical lessons in the semester plan.

- Resources for teachers to upgrade their knowledge and skills

The main resources for the teachers are the textbooks. These resources are:

1. Cambridge International AS & A Level Physics, Practical Skills Workbook, Third Edition, David Styles, Catherine Jones, Hodder Education, 2020.
2. Cambridge International AS & A Level Physics Practical Workbook, Third Edition, Graham Jones, Steve Field, Chris Hewlett, David Styles, Cambridge University Press, 2020.

Note that teachers must have both textbooks and should rely on both of them to cover the outcomes.

Furthermore, teachers can make use of other publications that serves this syllabus greatly and can be found in Cambridge Assessment International Education website:
https://www.cambridgeinternational.org/programmes-and-qualifications/cambridge-international-as-and-a-level-physics-9702/published-resources/

Some other resources are listed at the last of this syllabus can provide support for teachers for this syllabus. The range of resources covers a large area of this syllabus so it is well worth exploring these sites before the course starts to discover relevant resources that can be used or recommended to students when appropriate.

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual**)**	**No. of lessons**
Semester 1			
1. Physical quantities and units			
1.1 Errors and Uncertainties	a) Distinguish between random and systematic errors. b) Understand what is meant by uncertainty, accuracy, and precision. c) Express the uncertainty in a measurement as an absolute or percentage uncertainty, and translate between these forms. d) Determine uncertainty when addition, subtraction, multiplication, and division combine data.		**4**
1.2 scalars and vectors	a) Understand the difference between scalar and vector quantities and give examples of scalar and vector quantities included in the syllabus. b) Determine mathematically the resultant of two vectors in the case of: i. Coplanar vectors (same and opposite directions). ii. Perpendicular vectors (Pythagoras theorem). iii. Two vectors with an angle θ (this outcome requires dividing oblique vector(s) into x and y components).		**3**
2. Kinematics			
2.1 motion in one dimension	a) Recall distance, displacement, speed, and velocity. b) Define and understand acceleration. c) Represent graphically the displacement-time graph and velocity-time graph for an object moving at constant acceleration. d) Determine the displacement using area under a velocity-time graph. e) Determine velocity from the gradient of the displacement-time graph.	**Experiment 1** **Experiment 2**	**12**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
	f) Determine the acceleration using the gradient of the velocity-time graph. g) Derive and use the equations of uniformly accelerated rectilinear motion (UARM). h) Relate the motion of a freely falling body to motion with constant acceleration. i) Solve problems using equations of uniformly accelerated rectilinear motion including free falling bodies. j) Describe an experiment to determine the acceleration of free fall using a falling body.		
2.2 motion in two dimensions	a) Describe and explain motion due to a uniform acceleration in two perpendicular dimensions (projectile motion). b) Solve problems to determine the maximum height, the range, and the time of flight for projectile motion.		**5**
3. Dynamics			
3.1 Newton's laws of Motion	a) Understand that mass is the property of a body that resists change in motion and give applications (Newton's first law of motion). b) Recall the relationship $F = ma$ and solve problems using it, appreciating that acceleration and resultant force are always in the same direction. c) Solve problems of balanced and unbalanced forces and appreciate that for balanced forces the resultant $F=0$ and $a=0$ d) recall and apply Newton's third law of motion.	**Experiment 3**	**7**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work (**from MOE lab manual**)**	**No. of lessons**
Semester 1			
3.2 applications on Newton's second law	a) Describe and use the concept of weight as the effect of a gravitational field on a mass and recall that the weight of a body is equal to the product of its mass and the acceleration of free fall. b) Describe qualitatively the non-uniform motion of bodies falling with air resistance (e.g. parachutes). c) Understand that objects moving against a resistive force may reach a terminal (constant) velocity. d) Describe and use the concept of normal force as the contact force, which acts at right angle on the surface. e) Describe the tension, the friction, and the drag forces (no treatment of the coefficients of friction and viscosity is required, and a simple model of drag force increasing as speed increases is sufficient). f) Draw and analyze the force diagram for a body moving on a horizontal surface and solve related problems. (Consider the air resistance and the friction force) g) Draw and analyze the force diagram for a body moving on an inclined plane and solve related problems. (Consider frictionless and frictional surfaces) h) Analyze and solve problems in acceleration and apparent weight for an elevator in different situations.		**10**
3.3 Linear momentum and its conservation	a) Define and use linear momentum as the product of mass and velocity. b) State the principle of conservation of momentum. c) Apply the principle of conservation of momentum to solve simple problems, including elastic and inelastic interactions between bodies in both one and two dimensions (knowledge of the concept of coefficient of restitution is not required).	**Experiment 4**	**7**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
	d) Recognize that, for a perfectly elastic collision, the relative speed of approach is equal to the relative speed of separation. e) Understand that, while momentum of a system is always conserved in interactions between bodies, some change in kinetic energy may take place. f) Derive the relationship between the force and rate of change of momentum.		
4. Force, density, and pressure			
4.1 moment of a force and torque	a) Understand that the weight of an object may be taken as acting at a single point known as its center of gravity. b) State and apply the principle of moments. c) Understand that a couple is a pair of forces that tends to produce rotation only. d) State and use the principle of moment to find an unknown force (the pivot is in different points). e) Define and apply the torque of a couple. f) Understand that, when there is no resultant force and no resultant torque, a system is in equilibrium.		**6**
4.2 Density and Pressure	a) Define density and use the equation $\rho = m/V$. b) Define and pressure and use the equation $p = F/A$. c) Derive, from the definitions of pressure and density, the equation of hydrostatic pressure $\Delta p = \rho g \Delta h$. d) Use the equation $\Delta p = \rho g \Delta h$. e) Understand that the upthrust acting on an object in a fluid is due to a difference in hydrostatic pressure.		**6**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
	f) Calculate the upthrust acting on an object in a fluid using the equation $F = \rho g V$ (archimede's principle).		
5. Work, energy, and power			
5.1 Work	a) Understand and use the concept of work. b) Recall and use: $work\ done = force \times displacement\ in\ the\ direction\ of\ force$		**1**
5.2 Energy	a) Derive and use the formula for the kinetic energy: $Change\ in\ kinetic\ energy = work\ done$ b) Derive and use the formula for the potential energy c) State the principle of conservation of energy. d) Give examples of conservation of energy between different forms. *decrease in g.p.e=gain in k.e* e) Apply the principle of conservation of energy to solve problems involving energy in different forms. f) Understand and use the concept of efficiency of a system	**Experiment 5**	**7**
5.3 Power	a) Define power as work done per unit time. b) Use the formula $P=W/t$ to solve problems. c) Derive power as the product of force and velocity. d) Use the formula $P=Fv$ to solve problems.		**2**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
1. Motion in a circle			
1.1 uniform circular motion and centripetal force	a) Define the radian and express angular displacement in radians. b) Convert the values of angles from degrees to radians, and vice versa. c) Understand and use the concept of angular velocity to solve problems. $\omega = \Delta\theta/\Delta t$ d) Recall and use $v = r\omega$ to solve problems. e) Describe qualitatively motion in a curved path due to a perpendicular force, and understand the centripetal acceleration in the case of uniform motion in a circle. f) Recall and use centripetal acceleration equations $a = v\omega$ and $a = \frac{v^2}{r} = r\omega^2$ g) Recall and use centripetal force equations $F = mr\omega^2 = m\frac{v^2}{r}$	**Experiment 1**	**6**
2. Gravitational field			
2.1 Gravitational force between point masses	a) Use Newton's law of gravitation in the form $F = G\frac{m_1 m_2}{r^2}$ b) Understand that, for a point outside a uniform sphere, the mass of the sphere may be considered to be a point mass at its center. c) Analyze circular orbits in inverse square law fields, including geostationary orbits, by relating the gravitational force to the centripetal acceleration it causes. d) Derive and use speed of a satellite orbiting the Earth $v = \sqrt{G\frac{M}{r}}$		**4**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
2.2 Gravitational field of a point mass	a) Understand the concept of a gravitational field as an example of a field of force and define gravitational field strength as force per unit mass $g = \frac{F}{m}$ b) Derive, from Newton's law of gravitation and the definition of gravitational field strength, the equation $g = G\frac{M}{r^2}$ for the gravitational field strength of a point mass (M is the mass of the Earth). c) Solve problems using the equation $g = G\frac{M}{r^2}$ d) Show an appreciation that on the surface of the Earth g is approximately constant.		**5**
2.3 Gravitational potential	a) Define potential at a point as the work done per unit mass in bringing a small test mass from infinity to the point. b) Solve problems using the equation $\phi = -\frac{GM}{r}$ for the potential in the field of a point mass. c) describe how the concept of gravitational potential leads to the gravitational potential energy of two point masses and use $E_P = -GMm / r$.		**4**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
3. Oscillations			
3.1 Simple harmonic oscillations	a) Describe simple examples of free oscillations. b) Understand and use the terms amplitude, period, frequency, angular frequency and phase difference and express the period in terms of both frequency and angular frequency. c) Investigate simple harmonic motion using graphs. d) Recognize and use the equation $a = -\omega^2 x$ as the defining equation of simple harmonic motion. e) Describe, using the following equations with graphical illustrations, the changes in displacement, velocity and acceleration during simple harmonic motion: i. $x = x_\circ \sin(\omega t)$ ii. $v = v_\circ \cos(\omega t) = \omega x_\circ \cos(\omega t)$ iii. $a = -a_\circ \sin(\omega t) = -\omega^2 x_\circ \sin(\omega t)$ (these equations represent S.H.M when the oscillation starts from the equilibrium position). f) Recognize and use the equation $v = \pm\omega\sqrt{x_\circ^2 - x^2}$	**Experiment 2** **&** **Experiment 3**	**11**
3.2 Energy in simple harmonic motion	a) Solve problems related to the: i. kinetic energy using $E_k = \frac{1}{2} m\omega^2 (x_\circ^2 - x^2)$ ii. potential energy using $E_p = \frac{1}{2} m\omega^2 x^2$ iii. total energy $E_{tot} = \frac{1}{2} m\omega^2 x_\circ^{\,2}$		**4**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
	b) Describe graphically the interchange between kinetic, potential and total energy during simple harmonic motion. c) Apply the conservation of energy in S.H.M $(E_p + E_k = E_{tot})$		
3.3 Damped and forced oscillations, resonance	a) Define damped oscillations and describe practical examples. b) Define and describe practical examples of resonance. c) Describe graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system. d) Appreciate that there are some circumstances in which resonance is useful and other circumstances in which resonance should be avoided.		**2**
4. Electric fields			
4.1 Coulomb's law	a) Understand that, for any point outside a spherical conductor, the charge on the sphere may be considered to act as a point charge at its center. b) Recall and use Coulomb's law $F = Q1\ Q2\ /(4\pi\varepsilon_0 r^2)$ for the force between two-point charges in free space.		**4**
4.2 Concept of an electric field and field strength	a) Understand the concept of an electric field. b) Represent an electric field by means of field lines. c) Define electric field strength as force per unit positive charge acting on a stationary point charge ($E = \frac{F}{Q}$)	**Experiment 4**	**4**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
	Semester 2		
	d) Calculate the electric field strength due to a point charge (radial field) using the formula $(E = \frac{Q}{4\pi\varepsilon_{\circ} r^2})$ e) Use the equation $E = Q/(4\pi\varepsilon_0 r^2)$ for the electric field strength due to a point charge in free space. f) Solve problems to determine the point at which the net electric field strength exerted by two charges placed in a straight line is equal to zero.		
4.3 Electric potential of a point charge	a) Define electric potential at a point as the work done per unit positive charge in bringing a small test charge from infinity to the point. b) Calculate the electric potential due to a point charge (radial field) $(V = \frac{Q}{4\pi\varepsilon_{\circ} r})$ c) State that the field strength of the electric field at a point is equal to the negative of potential gradient at that point. d) Define potential difference between two points (P.d) as the work done per unit positive charge. $P.d = V = \frac{W}{Q} = \frac{\Delta PE}{Q}$ e) Describe electric potential energy and the changes of electrostatic potential energy in a uniform field. f) Compare and contrast electric and gravitational field.		**10**
4.4 Uniform electric fields	a) Calculate the field strength of the uniform field between charged parallel plates in terms of potential difference and separation $E = \frac{V}{d}$.		**6**

Grade 11 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual**)**	**No. of lessons**
Semester 2			
	b) Calculate the forces on charges in a uniform electric field $F = QE = Q\frac{V}{d}$ c) Describe the effect of a uniform electric field on the motion of charged particles.		

Yearly plan for physics grade 11

	Grade 11– semester one		**Grade 11– semester two**
1	Physical Quantities and units	5	Motion in a circle
2	Kinematics	6	Gravitational field
3	Dynamics	7	Oscillations
4	Force, work, energy and power	8	Electric fields

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
1. Electricity			
1.1 Electric current	a) Define electric current as the flow of charge carriers. b) Solve problems using $Q = It$. (Where Q=Ne, N is the number of electrons) c) Define the coulomb as the charge flow in one second when the current is one amphere. d) Derive and use, for a current-carrying conductor, the expression $I = Anve$, where n is the number of charge carriers per unit volume (number density). e) Solve problems involving the average drift speed (drift velocity) of charge carriers.		**2**
1.2 Potential difference, e.m.f, resistance and electric power	a) Define potential difference and the volt. b) Recall and use $V = \frac{W}{Q}$ c) Define electromotive force (e.m.f). d) Use energy consideration to distinguish between (P.d) and (e.m.f). e) Define resistance and the ohm. f) State Ohm's law. g) Solve problems using $V = IR$ h) Sketch and discuss the I–V characteristics of a metallic conductor at constant temperature (Ohmic conductor), a filament lamp, a semiconductor diode. i) Distinguish between forward bias and reverse bias in the diode. j) Distinguish between the effect of temperature on the resistance in metals and semiconductors. k) Recall the factors that effect on the resistance for a metal in the shape of a wire.	**Experiment 1** **Experiment 2**	**10**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
	l) solve problems involving the resistivity of a material $(R = \frac{\rho L}{A})$ m) recall and use $P = VI$, $P = I^2R$, $P=W/t$ and $P=V^2/R$		
1.3 Kirchhoff's laws	a) Recall Kirchhoff's first law and appreciate the link to conservation of charge. b) Recall Kirchhoff's second law and appreciate the link to conservation of energy. c) Derive, using Kirchhoff's laws, the formulae for the combined resistance of two or more resistors in series. d) Solve problems using the formula for the combined resistance of two or more resistors in series. e) Derive, using Kirchhoff's laws, the formulae for the combined resistance of two or more resistors in parallel. f) Solve problems using the formula for the combined resistance of two or more resistors in parallel. g) Solve problems using the formula for the combined resistance of two or more resistors in series and parallel. h) Apply Kirchhoff's laws to solve circuit problems (with maximum two simultaneous equations).	**Experiment 3**	**8**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
1.4 Practical circuits	a) Understand the effects of the internal resistance of a source of e.m.f. on the terminal potential difference. b) use the equation $(emf = IR + Ir)$ c) Understand the principle of a potential divider circuit as a source of variable p.d. d) Recall and solve problems using the principle of the potentiometer as a means of comparing potential differences.	**Experiment 4**	**4**
2. Capacitance			
2.1 Capacitors and Capacitance	a) Define capacitance and the farad, as applied to paralleled plate capacitors. b) Show the function of a capacitor in simple circuits. c) Recall and use $C = \frac{Q}{V}$. d) derive and use formulae for combined capacitance for capacitors in series and in parallel e) Distinguish between capacitors connected in series and in parallel and solve problems. f) deduce, from the area under a potential-charge graph, the equation $W = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$ g) Explain discharging capacitors in terms of charge and show graphs of variations of potential difference, charge and current for a capacitor during discharging) h) Use the time constant formula: $\tau = RC$.	**Experiment 5**	**5**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
	i) Use equations of the form $x = x_0 e^{-(t/\tau)}$ where x could represent current, charge or potential difference for a capacitor discharging through a resistor j) Use the natural logarithmic function of the exponential decay function $\ln x = \ln x_0 - t/\tau$ k) Analyse the straight-line graph of the equation $\ln x = \ln x_0 - t/\tau$ l) State some uses of capacitors in electric circuits.		
3. Magnetic fields and electromagnetism			
3.1 Concept of magnetic field	a) Understand that a magnetic field is an example of a field of force produced either by current-carrying conductors or by permanent magnets. b) Sketch magnetic field patterns due to permanent magnets, long straight wires, flat circular coils, and long solenoids. c) Use the right-hand rule to determine the direction of magnetic field or current in a long straight wire, a flat circular coil, and a long solenoid.		**2**
3.2 Force on a current carrying conductor	a) Appreciate that a force might act on a current-carrying conductor placed in a magnetic field. b) Solve problems using the equation $F = BIL\sin\theta$ with directions as interpreted by Fleming's left-hand rule. c) Define magnetic flux density and the tesla using the equation $F = BIL\sin\theta$. d) Explain the force between two parallel current-carrying conductors and predict the direction of the force.		**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
3.3 Force on a moving charge	a) Predict the direction of the force on a positive and a negative charge moving in a magnetic field using Fleming's left-hand rule. b) Derive and use the equation of the force exerted on a charge moving in a magnetic field. $F = QvB\sin\theta$ 、 c) Understand the origin of hall effect and the use of a hall probe to measure magnetic flux density. d) Derive and use the expression $V_H = BI/(ntq)$ e) Recall that the charge moves in a circular path when the velocity is perpendicular with the magnetic field. f) Derive the radius of the circular path of a charge moving in a magnetic field and use the formula $r = \frac{mv}{Be}$ g) Recall the construction of an electron beam tube. h) Use the specific charge of the electron $\frac{e}{m_e} = \frac{2V}{B^2r^2}$ i) Describe and analyze the deflection of beams of charged particles by uniform electric and uniform magnetic fields. (velocity selection) j) Determine the magnitude and the direction of the electric force exerted on an electron beam moving in an electron beam tube. k) Derive the velocity of the path of the charge particles when no deflection $v = \frac{E}{B}$	**Experiment 6**	**7**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
4. Electromagnetic induction			
4.1 Electromagnetic induction	a) Define magnetic flux and the weber. b) Recall and use: ● $\emptyset = BAcos\theta$ (where θ is the angle between B and the normal to A) OR ● $\emptyset = BAsin\theta$ (where θ is the angle between B and A) c) Define magnetic flux linkage $N\emptyset = BAN$. d) State Faraday's law of electromagnetic induction. e) Apply Fleming's right-hand rule to determine the direction of the induced current f) Solve problems using Faraday's law of electromagnetic induction to find the magnitude of the induced e.m.f $E = \frac{-\Delta(N\emptyset)}{\Delta t}$ g) Infer from appropriate experiments on electromagnetic induction: • that a changing magnetic flux can induce an e.m.f. in a circuit. • the cases when e.m.f is not induced. • that the direction of the induced e.m.f. opposes the change producing it (Lenz's law). • the factors affecting the magnitude of the induced e.m.f.	**Experiment 7**	**8**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
5. Alternating currents			
5.1 characteristics of alternating currents	a) Define and use use the terms period, frequency and peak value as applied to an alternating current or voltage. b) Use equations of the form $x = x_0 \sin \omega t$ representing a sinusoidally alternating current or voltage. c) Use the fact that the mean power in a resistive load is half the maximum power for a sinusoidal alternating current. d) Distinguish between root-mean-square (r.m.s.) and peak values and recall and use $I_{r.m.s.} = I_0 / \sqrt{2}$ and $V_{r.m.s.} = V_0 / \sqrt{2}$ for a sinusoidal alternating current.		**3**
5.2 The transformers	a) Understand the principle of operation of a simple laminated iron-cored transformer and state the types of transformers. b) Solve problems using $\frac{N_s}{N_P} = \frac{V_s}{V_P} = \frac{I_P}{I_s}$ for an ideal transformer.		**2**
5.3 Transmission of electrical energy	a) Appreciate the practical and economic advantages of alternating current and of high voltages for the transmission of electrical energy. b) Solve problems using $P=IV=I^2R$ for power loss.		**1**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 1			
5.4 Rectification and smoothing	a) Understand the characteristic of an alternating current or voltage. b) Understand the meaning of rectification. c) Distinguish graphically between half-wave and full-wave rectification. d) Explain the use of a single diode for the half-wave rectification of an alternating current. e) Explain the use of four diodes (bridge rectifier) for the full-wave rectification of an alternating current. f) Define smoothing by capacitors. g) Analyze the effect of a single capacitor in smoothing, including the effect of the value of capacitance in relation to the load resistance.		**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
1. Waves			
1.1 Progressive waves	a) Describe what is meant by wave motion as illustrated by vibration in ropes, springs, and ripple tanks. b) Compare transverse and longitudinal waves. c) Analyse and interpret graphical representations of transverse and longitudinal waves. d) Understand and use the terms displacement, amplitude, phase difference, period, frequency, wavelength, and speed. e) deduce, from the definitions of speed, frequency and wavelength, the wave equation $v = f\lambda$ f) Recall and use the equation $v = f\lambda$ g) Understand that energy is transferred by a progressive wave. h) recall and use intensity= power/area and is proportional to (amplitude)^2 for a progressive wave.		**4**
1.2 Doppler effect	a) Define Doppler effect of as the frequency change due to the relative motion between a source of sound or light and an observer. b) Understand that whenever there is a relative motion between the source of wave and the observer there is a change in the observed frequency. c) Use the expression $f_{\circ} = \frac{f_s v}{(v \mp v_s)}$ for the observed frequency when a source of sound waves moves relative to a stationary observer. d) Appreciate that Doppler effect is observed with all waves, including sound and light. (Applications of Doppler effect need not to be discussed in light).		**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
2. Superposition of waves			
2.1 Interference, two-source interference	a) State the principle of superposition of waves. b) Understand the terms interference, fringes, crest, trough, and coherence. c) Explain the constructive and destructive interferences. d) Discuss the conditions of constructive and destructive interference quantitatively. e) Show an understanding of experiments that demonstrate two source interference using water ripples. f) Show an understanding of two sources interference in sound waves and light. g) Understand the conditions required if two-source interference fringes are to be observed. h) Use Young's double-slit experiment to calculate the wavelength of light. i) Solve problems using the equation $\lambda = \frac{ax}{D}$	**Experiment 1**	**6**
2.2 Diffraction	a) Explain the meaning of the term diffraction. b) Show an understanding of experiments that demonstrate diffraction with both a wide gap and a narrow gap using a ripple tank. (You can use video or simulation to change both width gap and wavelength.		**2**
2.3 Diffraction grating	a) Define the diffraction grating. b) Solve problems using the formula $d \sin\theta = n\lambda$ c) Explain the production of the spectrum of white light with a diffraction grating.	**Experiment 2**	**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
2.4 Electromagnetic waves and Polarization	a) state that all electromagnetic waves are transverse waves that travel with the same speed c in free space b) recall the order of ranges of wavelengths in free space of the principal regions (radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma rays) of the electromagnetic spectrum c) Understand that polarisation is a phenomenon associated with transverse waves d) Use Malus's law ($I = I_0 \cos^2\theta$) to calculate the intensity of a plane polarised electromagnetic wave after transmission through a polarising filter or a series of polarising filters.		**4**
2.5 Stationary waves in stretched strings	a) Explain the formation of the stationary waves using the principle of superposition. b) Explain the terms node and antinode. c) Explain the formation of a stationary wave using a graphical method. d) Derive and use the general expression for the frequency of the *n*th mode $f_n = \frac{nv}{2L}$ e) Calculate the speed of stationary waves in a stretched string.	**Experiment 3**	**4**
2.6 Stationary waves in closed columns	a) Understand the formation of standing waves in air using closed tubes (resonance) and name the different modes of vibrations. b) Derive and use the general expression for the frequency of the *n*th mode of vibration of the air in the closed tubes $f_n = \frac{(2n-1)v}{4L}$ c) Calculate the speed of sound in air using stationary waves	**Experiment 4**	**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
3. Quantum physics			
3.1 Energy of a photon	a) Appreciate the particulate nature of electromagnetic radiation. b) Define the term photon. c) Recall and use $E = hf$. (both in Joule and eV)		**1**
3.2 Photoelectric emission of electrons	a) Define photoelectric effect, threshold frequency and work function. b) Understand that the photoelectric effect provides evidence for a particulate nature of electromagnetic radiation while phenomena such as interference and diffraction provide evidence for a wave nature. c) Recall the significance of threshold frequency and use $(\phi = hf_\circ)$. d) Explain photoelectric phenomena in terms of photon energy and work function energy. e) Explain why the maximum kinetic energy of the photoelectrons is independent of intensity, whereas the photoelectric current is proportional to intensity. f) Recall, use and explain the significance of $hf = \phi + \frac{1}{2}mv_{max}^2$ g) Describe an experiment to measure the maximum kinetic energy of photoelectrons. h) Define the stopping potential and use the concept of the *loss of kinetic energy = the gain of electrical potential energy* equation $(\frac{1}{2}mv_{max}^2 = eV_\circ)$. i) Study the graph of the maximum kinetic energy of photoelectrons against frequency or wavelength. j) Study the graph of the stopping voltage against frequency or wavelength.		**6**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
3.3 Wave-particle duality	a) Describe and interpret qualitatively the evidence provided by electron diffraction for the wave nature of particles. b) Solve problems using the relation for the de Broglie wavelength $\lambda = \frac{h}{mv}$		**1**
3.4 Energy levels in atoms and line spectra	a) Show an understanding of the existence of discrete electron energy levels in isolated atoms (e.g. atomic hydrogen) and deduce how this leads to spectral lines. b) Distinguish between emission and absorption line spectra c) Recall and solve problems using the relation $\Delta E = hf = E_f - E_i = \frac{hc}{\lambda}$		**3**
4. Particle and nuclear physics			
4.1 Atoms, nuclei and radiation	a) Infer from the results of the α-particle scattering experiment the existence and small size of the nucleus. b) Describe a simple model for the nuclear atom to include protons, neutrons, and orbital electrons. c) Distinguish between nucleon number and proton number. d) Understand that an element can exist in various isotopic forms, each with a different number of neutrons. e) Use the usual notation for the representation of nuclides. f) Appreciate that nucleon number, proton number, and mass- energy are all conserved in nuclear processes.		**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
	Semester 2		
	g) Compare the nature, mass, charge, ionizing and penetration power of α-, β- and γ-radiations (both β– and β+ are included). h) State that antineutrinos and neutrinos are produced during β– and β+ decay. i) Explain the changes occurs in a nuclide during a nuclear emission.		
4.2 Mass defect and nuclear binding energy	a) Show an appreciation of the association between energy and mass as represented by $E = mc^2$ and recall and use this relationship. b) Understand the significance of the terms mass defect and mass excess in nuclear reactions. c) Represent simple nuclear reactions by nuclear equations of the form $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$ d) Define and calculate mass defect, binding energy and binding energy per nucleon. e) Analyse the graph of the variation of binding energy per nucleon with nucleon number. f) Explain what is meant by nuclear fusion and nuclear fission with giving examples. g) Explain the relevance of binding energy per nucleon to nuclear fusion and to nuclear fission.		**4**
4.3 Radioactive decay	a) Infer the random nature of radioactive decay from the fluctuations in count rate. b) Show an appreciation of the spontaneous and random nature of nuclear decay. c) Define the terms activity and decay constant and and solve problems using $A = \frac{\Delta N}{\Delta t} = -N\lambda$		**4**

Grade 12 (Bilingual) Physics - Learning outcomes			
Subtopics	**Learning Outcomes**	**Practical work** (from MOE lab manual)	**No. of lessons**
Semester 2			
	d) Infer and sketch the exponential nature of radioactive decay and solve problems using the relationship $x = x_o e^{-\lambda t}$, where *x* could represent activity *A*, number of undecayed nuclei *N* or received count rate *R*. e) Define half-life. f) Solve problems using the relation $\lambda = \frac{0.693}{t_{1/2}}$		

Yearly plan for physics grade 12

	Grade 12– semester one		Grade 12– semester two
1	Electricity	6	Waves
2	Capacitance	7	Superposition
3	Magnetic fields and electromagnetism	8	Quantum physics
4	electromagnetic induction	9	Particle and nuclear physics
5	Alternating currents		

Resources for teachers to upgrade their knowledge and skills

Teacher support	http://www.cie.org.uk/teaching-and-learning/
Past paper resource	https://papers.xtremepape.rs/CAIE/AS%20and%20A%20Level/Physics%20(9702)/ https://www.savemyexams.co.uk/
Teaching strategies	http://www.teachthought.com/pedagogy/instructional-strategies/50-teaching-strategies-to-jumpstart-your-teacher-brain/
Interactive simulations	https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

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