Physics Form 4 Syllabus - September 2010 onwards

The new Physics SEC syllabus 2012 applies.

The new Physics SEC syllabus aims to develop students' understanding of Physics around them and how it affects their daily lives. It aims to develop students' questioning, analytical and problem solving approach to scientific problems and issues. It intends to develop students' practical skills in Physics and an understanding of how Physics works through an investigative approach. It aspires to connect the applications of Physics to technology and environmental issues and to develop students' understanding through a historical context within which scientific ideas are developed. It also intends to encourage a positive attitude towards science in general and the environment, and to create enthusiasm about Physics leading to further studies in the area.

The key features of the new syllabus are:

- Focus on a context-oriented approach.
- Focus on the needs of the students.
- Links with science, society and technology.
- Links with ICT.
- Reference to historical context.
- Encourages teaching through practical learning activities.

Topics to be covered in **Form 4**

Theme	***Reference nos***
Theme 1: On the Move	1.1 - 1.14
Theme 3: The Nature of Waves	All
Theme 5: Electricity in the Home	5.1 - 5.21

Theme 1: On the Move (1.1 - 1.14)

Learning programme

- Measuring motion and changes in (velocity, acceleration)
- Equations of Linear Motion
- Motion in situations of zero resultant force (Newton's first Law)
- Motion under the effect of a resultant force (Newton's second Law)
- Effects of forces in pairs (Newton's third Law)
- Momentum as a property of a moving object
- Principle of conservation of momentum applied to colliding objects.

Learning Outcomes

Learners will:

- Calculate the average speed of a moving object using the formula:

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}.$$

- Sketch and interpret a distance-time graph for a moving object and calculate its speed from the graph.
- Calculate the acceleration of a moving object using the formula:

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{change in time}}.$$

- Sketch and interpret a velocity-time graph of an object in motion and calculate (i) its acceleration, and (ii) the distance covered, using the graph.
- Investigate the motion of a body, using the air track or data loggers or any other suitable apparatus.
- Use the equations of motion to calculate the value of one missing variable in problems related to motion. $v = u + at$; $v^2 = u^2 + 2as$; $s = (u + v)t/2$; $s = ut + ½ at^2$.
- Name at least three factors which affect the thinking distance and the braking distance of a car which is brought to a stop.
- Investigate and observe that objects of different mass and size accelerate equally

when falling freely to the ground provided there is no opposing force.

- Apply Newton's 1st Law of Motion, which states that there is no change in motion (at rest or uniform motion) when there is no resultant force acting on a body, to practical situations.
- Apply Newton's 2nd Law of Motion, which states that the resultant (unbalanced) force leads to a change in motion (acceleration) in the direction of the force, to practical situations.
- Use the calculation, $F = ma$, in problems related to motion.
- Using the air track, data loggers or any other suitable apparatus, investigate the relationship between the resultant force and the acceleration of a body in motion, keeping the mass of the body constant.
- Using the air track, data loggers or any other suitable apparatus, investigate the relationship between the mass and the acceleration of a body in motion, keeping the resultant force constant.
- Apply Newton's 3rd Law of Motion, which states that forces occur in pairs, to practical situations.
- Calculate the momentum of a moving object using the formula, $p = mv$.
- Apply the Principle of Conservation of Momentum to situations where two objects in the same line of direction collide with each other and to situations where two objects move away from each other after explosion.
- Using the air track, data loggers or any other suitable apparatus, set-up the apparatus to investigate the conservation of momentum for different types of collisions, including explosions.
- Calculate the impact force during collision as the rate of change of momentum, using the formula: $F = \frac{mv - mu}{t}$.
- Interpret the value of the rate of change of momentum in practical situations.

Theme 3: The Nature of Waves

Learning Programme

- Meaning of wave motion and how waves transfer energy from one place to another without transfer of the medium.
- Distinguish between transverse and longitudinal waves using examples.
- Meaning of terms: frequency, wavelength, wave velocity; amplitude; periodic time; oscillation and wavefront.
- Wave equation: $v = f \lambda$
- Relationship between frequency of wave source and the wavelength.
- Sound production from a vibrating source.
- Speeds of light and sound compared.
- Approximate range of audible frequencies.
- Ultrasound and its use to scan body organs without undesirable effects.
- Relationship between pitch and frequency and also between loudness and amplitude.
- Reflection of water waves in a ripple tank compared to reflection of light in a plane mirror, and compared to reflection of sound waves in echoes.
- Characteristics of image formed in a plane mirror.
- Refraction of water waves in a ripple tank compared to refraction of light in a glass block.
- Total internal reflection and its use in optic fibres.
- Dispersion of white light by a prism.
- Electromagnetic spectrum: its properties and uses.
- Action of a converging lens and a diverging lens on a beam of light falling on it: focus and focal length.
- Formation of real and virtual images by a converging lens using ray diagrams; describing properties of images produced and calculating of lens magnification.
- Uses of lenses in simple cameras, projectors, magnifying glass and to correct eyesight (no detailed explanations expected).
- Diffraction of water waves in a ripple tank, using a single gap only.

Learning Outcomes

Learners will:

- Use ropes, springs, tuning forks and water waves to observe and describe waves.
- Identify the wavelength, amplitude, frequency, speed, periodic time and wavefront of a wave.
- Associate pitch with frequency and loudness with amplitude.
- Know that waves carry energy from one location to another, as demonstrated by water waves in a ripple tank and in a slinky spring.
- Know that mechanical waves require a medium to travel.
- Distinguish between transverse and longitudinal waves, giving examples of both.
- Define and apply these terms to a wave model: displacement, amplitude, periodic time, compression, rarefaction, crest and trough.
- Recall that the frequency of the waves, in Hertz is defined as the number of waves per second that are produced by the source or that pass through any particular point.
- Use the equation: $T = {}^{1}\!/_{f}$ to solve simple wave problems.
- Know that the wavelength of a wave is the distance between the same point on two adjacent disturbances.
- Present and analyse information related to waves from a displacement-time graph representing a transverse wave.
- Know that the speed of sound and the speed of light have different values.
- Know that ultrasound consists of high frequency longitudinal waves which have a frequency greater than 20 kHz.
- Use the equation $v = f\,\lambda$ in simple problems concerning waves.
- Use the ripple tank to show the reflection of water waves.
- Draw and interpret wave diagrams to represent the reflection of water waves in water and of sound waves hitting an object. Draw and interpret wave diagrams to show the reflection of light from a plane mirror.

- Select apparatus and set-up an experiment to investigate the reflection of light from a plane mirror.
- Identify the incident ray and the reflected ray, the angle of incidence and angle of reflection for reflection of light. Use the law: angle of incidence = angle of reflection.
- Use a plane mirror to show the formation and characteristics of the image produced.
- Associate refraction with a change in wave speed.
- Use the ripple tank to demonstrate refraction of water waves.
- Know that a ray of light is refracted when it travels between media of different densities.
- Investigate and draw a ray diagram for the refraction of light in water when an object is viewed from vertically above.
- Calculate the refractive index of water using the equation:

$$\eta = \frac{\text{Real depth}}{\text{Apparent depth}}$$

- Investigate and draw a ray diagram to show how a parallel sided transparent block can be used to demonstrate refraction of light waves.
- Identify the incident ray and the refracted ray, the angle of incidence and angle of refraction for the refraction of light.
- Calculate the refractive index of a medium using the equation:

$$\eta = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

- Use a semicircular glass block to investigate that the direction of the emergent ray depends upon the angle of incidence of the ray in the glass block.
- Identify the critical angle and total internal reflection.
- Select apparatus and set-up an experiment to investigate the formation of images for various object positions for a converging lens.
- Draw ray diagrams to illustrate the formation of real and virtual images produced by a converging lens.

- Calculate the magnification of a lens as the ratio of the image and object height and / or distances from the lens.
- Know that when a ray of white light passes through a glass prism, it is dispersed into different colours.
- Know that light is part of the electromagnetic spectrum of radiations which travel at the same velocity.
- Identify the component radiations making up the electromagnetic spectrum in order of increasing wavelength (decreasing frequency).
- Recall some of the properties and uses of the above types of radiations.
- Use the ripple tank to show diffraction of water waves as they spread out at a narrow gap.

Theme 5: Electricity in the Home (5.1 - 5.21)

Learning programme

- ➢ Measuring charge.
- ➢ There are forces acting between charged objects.
- ➢ Difference between conductors and insulators.
- ➢ Measuring and describing current and potential difference.
- ➢ Ways of producing electricity.
- ➢ The resistance of materials depends on particular factors.
- ➢ The change of resistance of electrical devices is used in a variety of applications.
- ➢ The potential difference, current and resistance in a circuit are related.
- ➢ The behaviour of potential difference, current and resistance differs through different circuits.

Learning Outcomes

Learners will:

- Investigate and describe how positive and negative charges are produced using materials such as cloth, polythene and Perspex.
- Know that like charges repel and unlike charges attract.
- Distinguish between electrical conductors, insulators and semi-conductors in terms of conductors contain loosely bound electrons while insulators contain bound electrons, and in terms of their electrical conductivity.
- Give examples of conductors, insulators and semiconductors.
- Know that an electric current (measured in amperes) is the rate of flow of charge (measured in coulombs), given as $I = {}^{Q}\!/_{t}$.
- Measure current flowing in a circuit using an ammeter.
- Measure the potential difference across an electrical component using a voltmeter.
- Know that a cell connected to a closed circuit uses up its chemical energy to push charge through the circuit. This chemical energy is converted into other forms of energy in the circuit.
- Use the equations $E = Q\,V$ and $E = I\,V\,t$
- Select apparatus and set-up a circuit to investigate the relationship between the current flowing through a resistor in a circuit and its potential difference, provided that the temperature of the resistor is kept constant.
- Plot a graph of the values of the potential difference (y-axis) and current (x-axis) through an electrical component in a circuit. Calculate a value for the resistance of the electrical component by calculating the gradient of the graph.
- Know and apply Ohm's Law, $V = I\,R$ to problems involving electrical components in circuits.
- Set-up a number of circuits to investigate the factors affecting the resistance in a wire: the length, diameter, type of material and temperature of the wire.
- Draw circuits using standard symbols shown in Table of Symbols (Appendix 1) of

SEC syllabus 2012.

- Know the position where the ammeter and voltmeter is connected in a circuit.
- Investigate how the resistance of an LDR changes with light level.
- Investigate how the resistance of a thermistor changes with temperature.
- Select apparatus and set-up circuits to determine the V-I graphs for an ohmic metal conductor kept at constant temperature and a filament lamp.
- Interpret the V-I graphs for an ohmic metal conductor kept at constant temperature, a filament lamp and a thermistor.
- Know that the value of the current at every point in a series circuit is the same.
- Know that the sum of the potential difference across each electrical component in series in a circuit is equal to the potential difference of the supply.
- Calculate the combined resistance of two or more resistors in series.
- Know that the current from the source is the sum of the current in the separate branches of a parallel circuit.
- Know that the potential difference across electrical components connected in parallel is the same.
- Calculate the combined resistance of two resistors in parallel using the equation:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Use of ICT as a tool for teaching and learning

The use of ICT in the classroom and beyond is an integral part of the teaching and learning of Physics. Each theme in the new Physics SEC syllabus 2012 is preceded by a number of web-links related to the theme. It is hoped that these links will be further developed by SEC over the years. Web simulations, PowerPoint presentations, web video clips, participation in online science projects and other innovate technology is an integral part of the pedagogy in the classroom and beyond.

Language of Communication

The English language should be the principal language of communication during the Physics lessons. This may be supplemented with the Maltese language in those instances where the teacher feels it is appropriate. Communicate in the English language helps the students to grasp the key phrases, understand better the HW assignments and tests and communicate better both verbally and in writing. One must remember that all science resources, in books and in digital format are in the English language.

Assessment

Assessment for Learning should be an integral part of each and every lesson. Each question asked during the lesson is an opportunity for further learning. Every feedback and comment shared between the teacher and the students is an opportunity to assess, encourage and elaborate about the students' learning process.

Students will be assessed by means of a school-based examination for their Half Yearly Examination. Even this examination is an opportunity for formative assessment when the teacher uses the answers provided by the students to identify needs and encourage further learning. The end-of-year summative assessment will be in the form of an Annual Examination which will consist of a national examination paper set by the Curriculum Management and eLearning Department. This examination will have a total of 85 marks. The remaining 15 marks will be assigned to the practical work done by students and reported in their Lab Book. Teachers are highly encouraged to use an inquiry based approach to practical work with the students as part of their practical work portfolio.

Experiments & Investigations

This new 2012 Physics SEC syllabus stipulates that at the end of the three year Physics course, students should present for SEC moderation:

Either 15 experiments

Or 13 experiments and a longer investigation which will be equivalent to the work done to perform two experiments.

It is also recommended that students present at least two experiments from each of the themes 1 - 6. The investigation may be chosen from any area of the syllabus. Simple experiments using data loggers are recommended.

Report Writing

Each school should develop a policy of gradual introduction of laboratory work report writing, starting from Form 3 onwards. Students need to be slowly integrated into the norms of report writing of practical work or investigations. The skill of report writing needs to be learned. An added bonus for the students is when they know beforehand the detailed criteria of how the teacher will assess the experimental report.

Gaetano Bugeja (EO Physics)
June 2010