CAISL
Carlucci American International School of Lisbon

GRADE 11 ADVANCED PHYSICS LEVEL 1 - IB PHYSICS Y1

Contents

THEMES AND CONTENT

- Measurements and Uncertainties – measurements in Physics; errors and uncertainties; vectors and scalars.
- Mechanics – motion; forces; work, energy and power; momentum and impulse.
- Thermal Physics – thermal concepts; gases and kinetic theory.
- Waves – Oscillations and SHM; travelling waves; waves characteristics and behavior (polarization, reflection, refraction, diffraction, interference); standing waves.
- Electricity and Magnetism – Electric fields, forces and potentials; electric current and electric resistance; electric cells and electric circuits; electric power; potential dividers; magnetic fields and forces.
- Circular motion and gravitation – Uniform circular motion; centripetal forces and centripetal acceleration; Newton's law of gravitation; gravitational fields; orbital motion.

OTHER SKILLS AND EXPECTATIONS

MATH SKILLS

- Perform the basic arithmetic functions: addition, subtraction, multiplication and division.
- Carry out calculations involving means, decimals, fractions, percentages, ratios, approximations and reciprocals.
- Carry out manipulations with trigonometric functions.
- Use standard scientific notation.
- Use direct and inverse proportion.
- Solve simple algebraic equations and linear simultaneous equations.
- Plot graphs (with suitable scales and axes) including two variables that show linear and non-linear relationships.

- Interpret graphs, including the significance of gradients, changes in gradients, intercepts and areas.
- Draw lines (either curves or linear) of best fit on a scatter plot graph.
- On a best-fit linear graph, construct linear lines of maximum and minimum gradients with relative accuracy (by eye), taking into account all uncertainty bars.
- Interpret data presented in various forms (for example, bar charts, histograms and pie charts).
- Express uncertainties to one or two significant figures, with justification.

SCIENCE NOTEBOOK

- Science notebooks are an independent responsibility of the student.
- Students are expected to keep an organized notebook with notes from class, work done at home and data collected during labs.

SCIENTIFIC WRITING

- Students are expected to write an exploration section to every practical investigation done. This exploration must include:
    - Research question.
    - Scientific background information.
    - Detailed methodology for data collection and data processing.
    - Ethical, environment and safety considerations.
- Students are expected to present raw and processed data using an Excel spreadsheet.
    - Processed data includes, but is not limited to: converting units, performing calculations, doing averages, rounding, plotting data, adding trendlines, interpreting data from graphs and trendlines, and discussing quality of data and results.
- Students are expected to write an evaluation section for the investigations done. The evaluations must include:
    - The answer to the research question.
    - Comparison to the relevant accepted scientific context.
    - Strengths and weaknesses of the investigation emphasizing any methodological issues.
    - Realistic improvements and extensions.
- Students are expected to always quote their sources in all written assignments submitted.

USE OF A CALCULATOR

- Students are expected to use a graphic calculator both in class and during assessments (while there is no specific model which is not allowed at this level, there are calculators which are recommended and the list can be made available to students upon request).

INFORMATION TECHNOLOGY

- Students will be provided with a school computer containing all the required software, including but not limited to Excel, LoggerPro, Wolfram, etc. Students are expected to use them in the practical investigations done.
- Students are expected to appropriately select and quote online resources used.

SCIENCE LABORATORY SAFETY EXPECTATIONS

Students will be expected to learn and to follow the expectations for safe and appropriate practices during laboratory activity, as shown on the “Science Laboratory Safety” document.

ASSESSMENT

For students to receive a credit in science towards their High School Diploma, they must demonstrate proficiency on:

- In-class unit tests
- Laboratory Report
- Interdisciplinary Science Project
- Final Exam

Students who are pursuing the IB Diploma in addition to the High School Diploma must complete both years of the program. While there are no internal assessments sent to the IB nor external exams set by the IB during the 1st year of the program, much of the work done will be revised or adapted early in Year 2 to be evaluated by the IB.

In year 1 students pursuing the IB Diploma will complete the IB Group 4 Project.

PERFORMANCE INDICATORS

MEASUREMENT AND UNCERTAINTIES

Use SI units in the correct format for all required measurements, final answers to calculations and presentation of raw and processed data.
Use scientific notation and metric multipliers.
Quote and compare ratios, values and approximations to the nearest order of magnitude.
Estimate quantities to an appropriate number of significant figures.
Explain how random and systematic errors can be identified and reduced.
Collect data that include absolute and/or fractional uncertainties and state these as an uncertainty range (expressed as: best estimate ± uncertainty range).
Propagate uncertainties through calculations involving addition, subtraction, multiplication, division and raising to a power.
Plot graphs (with suitable scales and axes) including two variables that show linear and non-linear relationships.
Interpret graphs, including the significance of gradients, changes in gradients, intercepts and areas.
Draw lines (either curves or linear) of best fit on a scatter plot graph.
In a best-fit linear graph, construct linear lines of maximum and minimum gradients with relative accuracy (by eye) taking into account all uncertainty bars.
Determine the uncertainty in gradients and intercepts.
Express uncertainties to one or two significant figures, with justification.
Solve vector problems graphically and algebraically.

MECHANICS

Determine instantaneous and average values for velocity, speed and acceleration.
Solve problems using equations of motion for uniform acceleration.
Sketch and interpret motion graphs.
Determine the acceleration of free-fall experimentally.

Analyze projectile motion, including the resolution of vertical and horizontal components of acceleration, velocity and displacement, carrying out manipulations with trigonometric functions.
Qualitatively describe the effect of fluid resistance on falling objects or projectiles, including reaching terminal speed.
Represent forces as vectors.
Sketch and interpret free-body diagrams.
Describe the consequences of Newton's first law for translational equilibrium.
Use Newton's second law quantitatively and qualitatively.
Identify force pairs in the context of Newton's third law.
Solve problems involving forces and determine resultant force.
Describe solid friction (static and dynamic) by coefficients of friction.
Discuss the conservation of total energy within energy transformations.
Sketch and interpret force–distance graphs.
Determine work done including cases where a resistive force acts.
Solve problems involving power.
Quantitatively describe efficiency in energy transfers.
Apply conservation of momentum in simple isolated systems including (but not limited to) collisions, explosions, or water jets.
Use Newton's second law quantitatively and qualitatively in cases where mass is not constant
Sketch and interpret force–time graphs.
Determine impulse in various contexts including (but not limited to) car safety and sports.
Qualitatively and quantitatively compare situations involving elastic collisions, inelastic collisions and explosions.

THERMAL PHYSICS

Describe temperature change in terms of internal energy.
Use Kelvin and Celsius temperature scales and convert between them.
Apply the calorimetric techniques of specific heat capacity or specific latent heat experimentally.
Describe phase change in terms of molecular behavior.
Sketch and interpret phase change graphs.
Calculate energy changes involving specific heat capacity and specific latent heat of fusion and vaporization.
Solve problems using the equation of state for an ideal gas and gas laws.
Sketch and interpret changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams.
Investigate at least one gas law experimentally.

WAVES

Qualitatively describe the energy changes taking place during one cycle of an oscillation.
Sketch and interpret graphs of simple harmonic motion examples.
Explain the motion of particles of a medium when a wave passes through it for both transverse and longitudinal cases.
Sketch and interpret displacement–distance graphs and displacement–time graphs for transverse and longitudinal waves.
Solve problems involving wave speed, frequency and wavelength.
Investigate the speed of sound experimentally.
Sketch and interpret diagrams involving wave fronts and rays.
Solve problems involving amplitude, intensity and the inverse square law.

Sketch and interpret the superposition of pulses and waves.
Describe methods of polarization.
Sketch and interpret diagrams illustrating polarized, reflected and transmitted beams.
Solve problems involving Malus' law.
Sketch and interpret incident, reflected and transmitted waves at boundaries between media.
Solve problems involving reflection at a plane interface.
Solve problems involving Snell's law, critical angle and total internal reflection.
Determine refractive index experimentally.
Qualitatively describe the diffraction pattern formed when plane waves are incident normally on a single slit.
Quantitatively describe double-slit interference intensity patterns.
Describe the nature and formation of standing waves in terms of superposition.
Distinguish between standing and travelling waves.
Observe, sketch and interpret standing wave patterns in strings and pipes.
Solve problems involving the frequency of a harmonic, length of the standing wave and the speed of the wave.

ELECTRICITY AND MAGNETISM

Identify two forms of charge and the direction of the forces between them.
Solve problems involving electric fields and Coulomb's law.
Calculate work done in an electric field in both joules and electron volts.
Identify sign and nature of charge carriers in a metal.
Identify drift speed of charge carriers.
Solve problems using the drift speed equation.
Solve problems involving current, potential difference and charge.
Draw and interpret circuit diagrams.
Identify ohmic and non-ohmic conductors through a consideration of the V/I characteristic graph.
Solve problems involving potential difference, current, charge, Kirchhoff's circuit laws (solving linear simultaneous equations), power, resistance and resistivity.
Investigate combinations of resistors in parallel and series circuits.
Describe ideal and non-ideal ammeters and voltmeters.
Describe practical uses of potential divider circuits, including the advantages of a potential divider over a series resistor in controlling a simple circuit.
Investigate one or more of the factors that affect resistance experimentally.
Investigate practical electric cells (both primary and secondary).
Describe the discharge characteristic of a simple cell (variation of terminal potential difference with time).
Identify the direction of current flow required to recharge a cell.
Determine internal resistance experimentally.
Solve problems involving emf, internal resistance and other electrical quantities.
Determine the direction of force on a charge moving in a magnetic field.
Determine the direction of force on a current-carrying conductor in a magnetic field.
Sketch and interpret magnetic field patterns.
Determine the direction of the magnetic field based on current direction.
Solve problems involving magnetic forces, fields, current and charges.

CIRCULAR MOTION AND GRAVITATION

Identify the forces providing the centripetal forces such as tension, friction, gravitational, electrical, or magnetic.

Solve problems involving centripetal force, centripetal acceleration, period, frequency, angular displacement, linear speed and angular velocity.
Qualitatively and quantitatively describe examples of circular motion including cases of vertical and horizontal circular motion.
Describe the relationship between gravitational force and centripetal force.
Apply Newton's law of gravitation to the motion of an object in circular orbit around a point mass.
Solve problems involving gravitational force, gravitational field strength, orbital speed and orbital period.
Determine the resultant gravitational field strength due to two bodies.