**Curriculum**

**IB Physics Y1**

**Course Overview**

The Physics course explores the workings of the world through a detailed study of energy and forces. Laboratory work on a weekly basis forms an integral part of the course, and there is an emphasis on the use of mathematics for problem-solving.

**Department Standards**

**STANDARD 1: THE NATURE OF SCIENCE**

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**STANDARD 3: THE PHYSICAL SETTING**

**STANDARD 4: THE LIVING ENVIRONMENT**

**STANDARD 5: SCIENCE AND SOCIETY**

**Benchmarks**:

[IB Benchmarks](http://acidale.on-rev.com/dante/Science/IBPhysicsGuide.pdf)

**Performance Indicators**

**IB Year 1 Physics**

**Performance Indicators**

**First Quarter**

The Realm of Physics:

Students should be able to:

State and compare quantities to the nearest order of magnitude

State the ranges of magnitude of distances, masses and times that occur in the universe, from smallest to greatest.

State ratios of quantities as differences of orders of magnitude

Estimate approximate values of everyday quantities to one or two significant figures and/or to the nearest order of magnitude.

Discuss what scientific standards are and why they are used.

Discuss SI units for physical quantities in particular those for length, mass, time, temperature, current and amount.

Discuss that the fundamental SI units can be combined to derive all other units such as those used for quantities such as density, area and volume

Know the appropriate units for the physical quantities and the prefixes commonly used including use of scientific notation

Convert between different units of quantities

Distinguish between accuracy and precision

Describe and give examples of random and systematic errors

Explain how the effects of random errors may be reduced

Calculate quantities and results of calculations to the appropriate number of significant digits.

Read measurements with the correct degree of precision for the instrument given

State uncertainties as absolute, fractional and percentage uncertainties

State uncertainties in results

Identify uncertainties as error bars in graphs

State random uncertainty as an uncertainty range (+/-) and represent it graphically as an “error bar”

Determine the uncertainties in the gradient and intercepts of a linear graph

Draw a graph from relevant data, making sure it has a title, is properly labelled with appropriate scales and has a line of best fit.

Understand the mathematical significance of determining the gradient and area of a graph.

Distinguish between vector and scalar quantities, and give examples of each.

Determine the sum or difference of two vectors by a graphical method.

Resolve vectors into perpendicular components along chosen axes (x and y).

Determine the resultant or the equilibrant vector of two or more vectors using the component method of vector addition.

MECHANICS

Kinematics:

Students should be able to:

Define the concepts of distance, position, displacement, speed, velocity and acceleration for the motion of objects.

Explain the difference between instantaneous and average values of speed, velocity and acceleration.

Outline the conditions under which the equations for uniformly accelerated motion may be applied and can use the equations to solve problems involving one-dimensional motion.

Draw and analyse graphs of each of the kinematics quantities (distance, displacement, velocity and acceleration) as a function of time

Derive each of the other graphs from the appropriate slope and area relationships.

Recognize that acceleration of a body in a vacuum near the Earth’s surface is the acceleration of free fall (g).

State the independence of the vertical and horizontal components of velocity for a projectile in a uniform field

Describe and sketch the path of a projectile in the absence of resistance

Describe qualitatively the effect of air resistance on the trajectory of a projectile

Solve problems on horizontal projectile motion

Determine Relative Velocity in one and in two dimensions.

Dynamics:

Students should be able to:

State the First Law and analyze situations in which the conditions apply.

Identify the forces acting on an object and draw free body diagrams representing the forces acting.

Determine the resultant force in different situations.

Describe the effects of air resistance on falling objects.

State the condition for translational equilibrium and solve problems.

Describe the relationship between the force that acts on a body and the resulting change in the body’s acceleration (F = ma)

Calculate for a body the velocity change that results when a constant force F acts over a specified time interval.

Calculate the weight (force of gravity) of a body using the expression W = m g

Identify forces such as gravity, the pull of strings (tension) or contact forces in order to draw free body diagrams, showing all real forces acting on the body.

Analyze situations in which a body moves with a specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or one of the forces that produce the net force. This may include motion up or down with constant acceleration in an elevator, two or more bodies attached by string, bodies on an inclined plane

Understand the significance of the coefficient of friction and be able to:

Identify the factors affecting friction

Apply the relationship between the normal force and the frictional force on a surface.

Analyze situations in which a body slides down a rough inclined plane or is pulled or pushed across a rough surface.

Analyze static situations involving friction to determine under what circumstances a body will start to slip, or to calculate the magnitude of force of static friction.

**Second Quarter**

MECHANICS (cont'd)

Impulse & Linear Momentum:

Students should be able to;

Relate mass, velocity and linear momentum for a moving body and can calculate the total momentum of a system of objects.

Relate impulse to the change in momentum and the average force acting on the body.

Analyze force-time graphs and momentum-time graphs

Explain the conservation of linear momentum

Analyze situations in which linear momentum or a component of the linear momentum vector is conserved in collisions and explosions.

Derive Newton’s Second Law from Conservation of Momentum.

State and apply Newton’s Third Law Identify the body on which the reaction force acts and state the magnitude and direction of the force.

Analyze the force of contact between two bodies that accelerate together along a horizontal surface.

Derive Newton’s Third Law from Conservation of Momentum

Uniform Circular Motion:

Students should be able to

Relate the radius of the circle and the speed or rate of revolution of the body to the magnitude of the centripetal acceleration.

Describe the direction of the body’s velocity and acceleration at any instant during the motion.

Identify the forces that produce circular motion in various situations.

Apply the expression for centripetal acceleration and solve problems involving:

a) Motion in a horizontal circle (ex. Mass on a rotating merry-go-round, car rounding a bend, mass on the end of a string)

b) Motion in a vertical circle (ex. Mass swinging on the end of a string, cart on a curved track, rider on a Ferris wheel)

Gravitation:

Students should be able to;

State Newton’s Law of Universal Gravitation

Determine the force that one body exerts on another.

Relate it to the circular motion of a satellite in order to recognize that the motion does not depend on the body’s mass.

Describe qualitatively how the velocity, period of revolution and centripetal acceleration depend upon the radius orbit.

Develop a formula to determine the relationship between radius and period of satellites around a central body (Kepler’s Third Law).

Work, Energy and Power:

Students should be able to;

Describe what work is.

Calculate the work done by a constant force on a body that undergoes a specified displacement. F(d) (cos θ)

Determine the work done by a non-constant force by interpreting a graph showing force as a function of displacement.

Outline what is meant by kinetic energy.

Calculate the change in kinetic energy or speed that results from performing a specified amount of work on a body.

Calculate the work performed by the net force, or by each of the forces that make up the net force, on a body that undergoes a specific change in speed or kinetic energy.

Determine the change in a body’s kinetic energy or speed that results from the application of a specified force.

Outline what is meant by a change in gravitational potential energy.

Calculate the gravitational potential energy of a single body in a uniform gravitational field.

Calculate the force required to return an elastic body to its original position and determine the elastic potential energy stored in a deformed elastic body.

State the principle of Conservation of Energy. Identify situations in which mechanical energy is and is not conserved.

Apply conservation of energy in analyzing the motion of bodies that are moving in a gravitational field Apply conservation of energy in analyzing the motion of bodies that move under the influence of a spring. List different forms of energy and describe examples of the transformation of energy from one form to another.

Define power.

Define and apply the concept of efficiency.

Calculate both the work performed by a force that supplies constant power and the power required to perform work during a given time interval.

Waves

Students should be able to:

Describe a wave pulse and a continuous progressive (travelling) wave.

State that pulses and waves transfer energy

Describe and give examples of transverse and longitudinal waves.

Describe waves in two dimensions, including the concepts of wave fronts and of rays.

Define the terms crest, trough, compression and rarefaction.

Draw and explain both displacement-time and displacement-position graphs that represent travelling waves.

Describe waves in two dimensions and determine the amplitude, wavelength and frequency of a wave from a graph.

Define the terms displacement, amplitude, frequency, period, wavelength, wave speed (velocity) and intensity.

Derive and apply the relationship between wave speed (velocity), wavelength and frequency.

Describe qualitatively what factors determine the speed of waves (including sound)

Describe the reflection of waves from the fixed or free end of a string.

Describe the reflection and transmission of waves at a boundary between two media.

Draw and explain qualitatively the diffraction of waves at openings and obstacles.

Describe examples of diffraction

State the principle of superposition and explain the concept of constructive and destructive interference.

State and apply the conditions for constructive and destructive interference in terms of path difference and phase difference.

Apply the principle of superposition to determine the resultant of two waves.

**Third Quarter**

Optics:

Students should be able to:

State and apply Snell’s Law

Define the terms principle axis, focal point, focal length and linear magnification as applied to a converging (convex) lens.

Define the power of a convex lens and the dioptre.

Define linear magnification.

Construct ray diagrams to locate the image formed by a convex lens.

Distinguish between a real image and a virtual image.

Apply the convention “real is positive, virtual is negative” to the thin lens formula.

Solve problems for a single convex lens using the thin lens formula.

Construct a ray diagram for a compound microscope with final image formed close to the near point of the eye (normal adjustment). The terms objective lens and eyepiece lens are necessary.

Construct a ray diagram for an astronomical telescope with the final image at infinity (normal adjustment).

State the equation relating angular magnification to the focal lengths of the lenses in an astronomical telescope in normal adjustment.

Solve problems involving the compound microscope and the astronomical telescope.

Explain the meaning of spherical aberration and of chromatic aberration as produced by a single lens.

Describe how spherical aberration in a lens may be reduced.

Describe how chromatic aberration in a lens may be reduced.

State the conditions necessary to observe interference between two sources.

Explain, by means of the principle of superposition, the interference pattern produced by waves from two coherent point sources.

Outline a double-slit experiment for light and draw the intensity distribution of the observed fringe pattern.

Solve problem involving two-source interference.

Describe the effect on the double-slit intensity distribution of increasing the number of slits (multiple-slit diffraction).

Outline the use of a diffraction grating to measure wavelengths.

Solve problems involving a diffraction grating.

Electrostatics:

Students should be able to:

State that there are two types of electric charge.

State and apply of conservation of charge

Describe and explain the difference in the electrical properties of conductors and insulators.

State Coulomb’s Law

Define electric field strength.

Determine the electric field strength due to one or more point charges.

Draw the electric field patterns for different charge configurations.

Solve problems involving electric charges, forces and fields.

Compare to gravitational field strength.

Electric Currents, Resistance and Circuits

Students should be able to:

Define electric potential difference

Determine the change in potential energy when a charge moves between two points at different potentials.

Define the electronvolt

Solve problems involving electric potential difference.

Define electric current

Define resistance

Apply the equation for resistance where ρ is the resistivity of the material of the resistor.

State Ohm’s Law

Compare ohmic and non-ohmic behaviour.

Derive and apply expressions for electrical power dissipation in resistors.

Solve problems involving potential difference, current and resistance.

Define electromotive force (emf)

Describe the concept of internal resistance

Apply equations for resistors in series and parallel circuits including combination circuits.

Draw circuit diagrams.

Magnetic force, field and the Nature of EM Waves:

Students should be able to:

Draw magnetic field patterns due to permanent magnets.

State that moving charges give rise to magnetic fields.

Draw magnetic field patterns due to current.

Determine the direction of the force on a current-carrying conductor in a magnetic field.

Determine the direction of the force on a charge moving in a magnetic field.

Define the direction and magnitude of a magnetic field.

Solve problems involving magnetic forces, fields and currents.

Outline the nature of EM waves. Students should know that oscillating electric charges produce varying electric and magnetic fields.

Describe the different regions of the electromagnetic spectrum.

Describe what is meant by the dispersion of EM waves.

Describe the dispersion of EM waves in terms of the dependence of refractive index on wavelength.

Distinguish between transmission, absorption and scattering of radiation.

Discuss examples of the transmission, absorption and scattering of radiation. Blue sky, red sunsets, ozone layer etc.

**Fourth Quarter**

Atomic and Nuclear Physics:

Students should be able to:

Describe a model of the atom that features a small nucleus surrounded by electrons.

Outline the evidence that supports a nuclear model of the atom.

Outline one limitation of the simple model of the nuclear atom.

Outline evidence for the existence of atomic energy levels.

Explain the terms nuclide, isotope and nucleon.

Define nucleon number A, proton number Z and neutron number N.

Describe the interactions in a nucleus. Students need to know about the Coulomb interaction between protons and the strong, short-range nuclear interaction between nucleons.

Describe the photoelectric effect

Describe the concept of the photon, and use it to explain the photoelectric effect.

Describe and explain an experiment to test the Einstein model. (Millikan’s experiment involving the application of a stopping potential would be appropriate)

Solve problems involving the photoelectric effect.

Describe the deBroglie hypothesis and the concepts of matter waves. (wave - particle duality)

Outline an experiment to verify the deBroglie hypothesis. Outline of the Davisson – Germer experiment)

Solve problems involving matter waves.

Outline a laboratory procedure for producing and observing atomic spectra.

Explain how atomic spectra provide evidence for the quantization of energy in atoms.

Calculate wavelengths of spectral lines from energy level differences and vice versa

Radioactive Decay and Nuclear Reactions, Fission and Fusion

Students should be able to:

Describe the phenomenon of natural radioactive decay.

Describe the properties of alpha (α) and beta (β) particles and gamma (γ) radiation.

Describe the ionizing properties of alpha (α) and beta (β) particles and gamma (γ) radiation.

Outline the biological effects of ionizing radiation.

Explain why some nuclei are stable while others are unstable.

State that radioactive decay is a random and spontaneous process and that the rate of decay decreases exponentially with time.

Define the term radioactive half-life.

Determine the half-life of a nuclide from a decay curve.

Solve radioactive decay problems involving integral numbers of half-lives.

Describe and give an example of an artificial (induced) transmutation.

Construct and complete nuclear equations

Define the term: unified atomic mass unit. Must know MeV c-2 and GeV c-2.

Apply the Einstein mass – energy equivalence relationship.

Define the concepts of mass defect, binding energy and binding energy per nucleon.

Draw and annotate a graph showing the variation with nucleon number of the binding energy per nucleon.

Solve problems involving mass defect and binding energy.

Describe the process of nuclear fission and nuclear fusion.

Apply the graph to account for the energy release in the processes of fission and fusion.

State that nuclear fusion is the main source of the Sun’s energy.

Thermal Physics:

Students should be able to:

State that temperature determines the direction of thermal energy transfer between two objects.

State the relationship between the Kelvin and Celsius scales of temperature.

State that the internal energy of a substance is the total potential energy and random kinetic energy of the molecules of the substance.

Explain and distinguish between the macroscopic concepts of temperature, internal energy and thermal energy (heat)

Define the mole and molar mass.

Define the Avogadro constant.

Define specific heat capacity and thermal capacity.

Explain the physical differences between the solid, liquid and gaseous phases in terms of molecular structure and particular motion.

Describe and explain the process of phase changes in terms of molecular behaviour. Need to be familiar with the

Explain in terms of molecular behaviour why temperature does not change during a phase change.

Distinguish between evaporation and boiling

Define specific latent heat.

Solve problems involving specific heat capacity, thermal capacity and specific latent heat.

**Assessments**

**IB Year 1 Physics**

**Assessments**

**First Quarter**

Lab: Measuring Physical Quantities

Assignment: Resolution of Vectors

Summative Unit Test

Lab: Non-uniform motion

Assignment: Free fall analysis

Kinematics test

Lab: Newton's Laws

Mid unit test

**Second Quarter**

Lab: Conservation of Momentum

Lab: Uniform Circular Motion

Lab: Work and Energy

Assignment: Conservation of Energy

Summative Unit Test

Lab: Pulses on Coiled Springs

Lab: Law of Reflection

Lab: Snell’s Law

Assignment: Superposition

Summative Unit Test

Semester Exam

**Third Quarter**

Lab: Investigation of Lenses

Lab: Young's Double Slit Experiment

Summative Unit Test

Lab: Laws of Electrostatics

Activity: Charging by Conduction and Induction

Lab: Equipotential Surfaces and Field Lines

Summative Unit Test

Lab: Ohm’s Law

Activity: Series and Parallel Circuits

Summative Assignment

Lab: Investigation of Magnetic Fields

Activity: Electric Current and Magnetism

Summative Unit Test

**Fourth Quarter**

Lab: Photoelectric Effect

Activity: Half-Life Determination

Activity: Quantization of Smarties

Summative Unit Test

Lab: Latent Heat

Lab: Specific Heat Capacity

Summative Unit Test

Group IV Activity/Database Activity

Cumulative Year End Exam

**Core Topics**

**IB Year 1 Physics**

**Core Topics**

**First Quarter**

Unit 1: PHYSICS AND PHYSICAL MEASUREMENT

The Science of Physics

Uncertainty and Error

Graphical Techniques

Scalars and Vectors

Unit 2: KINEMATICS

Graphical/Mathematical Analysis

Uniform Motion

Nonuniform Motion

Free Fall

Horizontal Projectiles

Relative Motion

Unit 3: DYNAMICS (Forces) Part One

Forces (free-body diagrams)

Newton’s Laws

Weight and Mass

Frictional and Normal Force

**Second Quarter**

Unit 3: DYNAMICS (cont’d)

Momentum and Impulse

Uniform Circular Motion

Universal Law of Gravitation

Unit 4: WORK & ENERGY

Work

Work and Energy Theorem

Conservation of Energy

Power

Unit 5:WAVE CHARACTERISTICS & PROPERTIES

Vibrations & Waves

Reflection

Refraction

Diffraction and Superposition

**Third Quarter**

Unit 6: ELECTROMAGNETIC WAVES

Optics and Optical Instruments

Diffraction and Interference

Unit 7: ELECTRICITY

Electrostatics

Electric Forces & Fields

Electric Potential Energy

Electric Potential Difference

Unit 8: Potential Difference and Circuits

Current & Resistance

Circuits and Circuit Elements

Series & Parallel Circuits

Unit 9: MAGNETISM AND ELECTROMAGNETISM

Magnetic Forces and Fields

Electromagnetism

**Fourth Quarter**

Unit 10:MODERN PHYSICS

Atomic Physics

Quantum Physics

Nuclear Physics

Unit 11:THERMAL PHYSICS

Thermal Concepts

Thermal Properties of Matter

**Specific Content**

**IB Year 1 Physics**

**Specific Content**

**First Quarter**

The Science of Physics

Uncertainty and Error

Graphical Techniques

Scalars and Vectors

Uniform Motion

Nonuniform Motion

Free Fall

Horizontal Projectiles

Relative Motion

Forces (free-body diagrams)

Newton’s Laws

Weight and Mass

Frictional and Normal Force

**Second Quarter**

Momentum and Impulse

Uniform Circular Motion

Universal Law of Gravitation

Work

Work - Energy Theorem

Conservation of Energy

Power

Vibrations & Waves

Reflection

Refraction

Diffraction and Superposition

**Third Quarter**

Optics

Ray diagrams to locate the image formed by a convex lens

Lens Equation

Real images and Virtual images

Simple magnifying glass

Compound microscope (normal adjustment)

Astronomical telescope (normal adjustment)

Spherical aberration and chromatic aberration as produced by a single lens.

Conditions necessary to observe interference between two sources.

Young’s double-slit experiment for light

Electrostatics

Types of electric charge

Conservation of charge

Electric force and Coulomb’s Law

Electric Fields

Electric field strength compared to gravitational field strength

Electric Currents, Resistance and Circuits

Electric potential difference

Electric current

Resistance

Ohm’s Law

Electrical power dissipation in resistors

Resistors in series and parallel circuits including combination circuits

Circuit diagrams.

Magnetic force and field and the Nature of EM Waves

Magnetic field patterns due to permanent magnets

Magnetic field patterns due to current

Direction and magnitude of a magnetic field.

The nature of EM waves

**Fourth Quarter**

Atomic and Nuclear Physics

Atomic Models

The photoelectric effect

Wave-particle duality

Radioactive decay

Nuclear reactions

Fission

Fusion

Thermal Physics

Temperature, Internal energy

Heat

Specific Heat Capacity

Heat of Fusion and Vapourization

**Resources**

**IB Year 1 Physics**

**Resources**

Serway, Raymond A., and Jerry S. Faughn. *Holt Physics*. Orlando: Holt, Rinehart and Winston, 2006.