**Curriculum**

**IB Physics Y2**

**Course Overview**

This is a continuation of the year 1 course. Each topic is reviewed and more advanced material incorporated. The focus for IB students will be the completion of the laboratory assessments, and the development of a cohesive and in-depth understanding of the concepts and their application. This will include both of the chosen options. SL: 1) Quantum and Nuclear Physics, 2) Electromagnetic Waves. HL: 1) Electromagnetic Waves, 2) Astrophysics.

**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 2 Physics**

**Performance Indicators**

All outcomes are published in the IB Physics Subject Guide

**First Quarter**

Energy, power and climate change

Students should be able to:

1. State that thermal energy may be completely converted to work in a single process that is cyclic and involves some energy loss.
2. Explain what is meant by degraded energy
3. Construct and analyze energy flow diagrams (Sankey diagrams) and identify where the energy ids degraded.
4. Outline the principal mechanisms involved in the production of electrical power.
5. Identify different world energy sources.
6. Outline and distinguish between renewable and non-renewable energy sources.
7. Define the energy density of a fuel
8. Discuss how choice of fuel is influenced by its energy density.
9. State the relative proportions of world use of different energy sources that are available.
10. Discuss the relative advantage and disadvantages of various energy sources.
11. Outline the historical and geographical reasons for the widespread use of fossil fuels.
12. Discuss the energy density of fossil fuels with respect to the demands of power station.
13. Discuss the relative advantages and disadvantages associated with the transportation and storage of fossil fuels.
14. State the overall efficiency of power stations fueled by different fossil fuels.
15. Describe the environmental problems associated with the recovery of fossil fuels and their use in power stations.
16. Describe how neutrons produced in a fission reaction may be used to initiate further fission reactions (chain reaction).
17. Distinguish between controlled nuclear fission (power production) and uncontrolled nuclear fission (nuclear weapons).
18. Describe what is meant by fuel enrichment.
19. Describe the main energy transformations that take place in a nuclear power station.
20. Discuss the role of the moderator and the control rods in the production of controlled fission in a thermal fission reactor
21. Discuss the role of the heat exchanger in a fission reactor.
22. Describe how neutron capture by a nucleus of uranium-238 (238U) results in the production of a nucleus of plutonium-239 (239Pu)
23. Describe the importance of plutonium-239 (239Pu) as a nuclear fuel.
24. Discuss safety issues and risks associated with the production of nuclear power.
25. Outline the problems associated with producing nuclear power using nuclear fusion.
26. Solve problems on the production of nuclear power.
27. Distinguish between a photovoltaic cell and a solar heating panel.
28. Outline reasons for seasonal and regional variations in the solar power incident per unit area of the Earth’s surface.
29. Solve problems involving specific applications of photovoltaic cells and solar heating panels.
30. Distinguish between different hydroelectric schemes.
31. Describe the main energy transformations that take place in hydroelectric schemes.
32. Solve problems involving hydroelectric schemes.
33. Outline the basic features of a wind generator.
34. Determine the power that may be delivered by a wind generator, assuming that the wind kinetic energy is completely converted into mechanical kinetic energy, and explain why this is impossible.
35. Solve problems involving wind power.
36. Describe the principle of operation of an oscillating water column (OWC) ocean-wave energy converter.
37. Determine the power per unit length of a wavefront, assuming a rectangular profile for the wave.
38. Solve problems involving wave power.
39. Calculate the intensity of the Sun’s radiation incident on a planet.
40. Define *albedo.*
41. State factors that determine a planet’s albedo.
42. Describe the greenhouse effect.
43. Identify the main greenhouse gases and their sources.
44. Explain the molecular mechanisms by which greenhouse gases absorb infrared radiation.
45. Analyze absorption graphs to compare the relative effects of different greenhouse gases.
46. Outline the nature of black-body radiation.
47. Draw and annotate a graph of the emission spectra of black bodies at different temperatures.
48. State the Stefan-Boltzmann law and apply it to compare emission rates from different surfaces.
49. Define *surface capacity* Cs.
50. Solve problems on the greenhouse effect and the heating of planets using a simple energy balance climate model.
51. Describe some possible models of global warming
52. State what is meant by enhanced greenhouse effect.
53. Identify the likely major cause of the enhanced greenhouse effect
54. Describe the evidence linking global warming to increased levels of greenhouse gases.
55. Outline some of the mechanisms that may increase the rate of global warming.
56. Define coefficient of volume expansion
57. State the one possible effect of the enhanced greenhouse effect is a rise in mean sea-level.
58. Outline possible reasons for a predicted rise in mean sea-level
59. Identify climate changes as an outcome of enhanced greenhouse effect.
60. Solve problems related to enhanced greenhouse effect.
61. Identify some possible solutions to reduce enhanced greenhouse effect.
62. Discuss international efforts to reduce enhanced greenhouse effect.

Physics and physical measurement: Review

Students should be able to:

1. Meet all Year 1 outcomes for this topic.

Mechanics:

Students should be able to:

1. Meet all Year 1 outcomes for this topic.
2. Analyze elastic and inelastic collisions in terms of the momentum and kinetic energy involved.
3. Solve problems on projectile motion that involves projectiles launched horizontally or at any angle above or below the horizontal.
4. State that gravitation provides the centripetal force for circular orbital motion.
5. Derive expressions for kinetic and potential energy and total energy of an orbiting satellite.
6. Sketch graphs showing the variation with orbital radius of the kinetic energy, gravitational potential energy and total energy of a satellite.
7. Discuss the concept of “weightlessness” in orbital motion, in free fall and in deep space.
8. Determine the gravitational field due to one or more point masses.
9. Define gravitational potential and gravitational potential energy.
10. State and apply the gravitational potential due to a point mass.
11. State and apply the formula relating gravitational field strength to potential gradient.
12. Determine the potential due to one or more point masses.
13. Describe and sketch the pattern of equipotential surfaces due to one and two point masses.
14. State the relationship between equipotential surfaces and gravitational field lines.
15. Explain the concept of escape speed from a planet and derive an expression for the escape speed of an object from the surface of a planet.
16. Solve problems involving gravitational potential and gravitational potential energy.

**Second Quarter**

Oscillations and Waves

Students should be able to:

1. Meet all Year 1 outcomes for this topic.
2. Describe examples of oscillations
3. Define simple harmonic motion and state defining equation (SHM)
4. Solve problems using simple harmonic equation
5. Apply velocity and displacement wave equations as solutions to the SHM equation.
6. Solve problems, both graphically and mathematically for acceleration, velocity and displacement during SHM.
7. Describe the interchange between kinetic and potential energy during SHM.
8. Apply energy formulae
9. Solve problems, both graphically and mathematically for energy changes during SHM
10. State what is meant by damping
11. Describe examples of damped oscillations.
12. State the meaning of natural frequency vibration and forced oscillations.
13. Describe using a graphs the variation with forced frequency of the amplitude of vibration of an object close to its natural frequency of vibration.
14. State what is meant by resonance
15. Describe examples of resonance and where it should be avoided.
16. Describe and explain standing (stationary) waves.
17. Solve problems involving standing waves
18. Describe what is meant by Doppler effect
19. Solve problems on Doppler effect for sound and electromagnetic waves.
20. Sketch graphs for relative intensity for single slit diffraction
21. Solve problems involving single-slit diffraction.
22. Sketch the variation with angle of diffraction of the relative intensity of light emitted by two point sources that has been diffracted at a single slit.
23. Solve problems involving resolution.
24. Describe polarization
25. Solve problems involving the polarization of light.

Optics and Electromagnetic Waves

Students should be able to:

1. Meet all Year 1 outcomes for this topic.
2. Define angular magnification.
3. Derive an expression for the angular magnification of a simple magnifying glass for an image formed at the near point and at infinity.
4. Derive the diffraction grating formula for normal incidence.
5. Explain the terms monochromatic and coherent.
6. Identify laser light as a source of coherent light.
7. Outline the mechanism for the production of laser light.
8. Outline an application of the use of a laser.
9. Describe the experimental arrangement for the production of x-rays
10. Draw and annotate a typical x-ray spectrum
11. Explain the origins of the features of a characteristic x-ray spectrum
12. Solve problems involving x-ray production
13. Explain x-ray diffraction
14. Derive the Bragg scattering equation
15. Solve problems using the Bragg equation
16. Explain the production of an interference pattern by a thin air wedge
17. Describe the uses of this type of interference.
18. Explain the production of an interference pattern by parallel films.
19. Describe the uses of this type of interference.
20. Describe the difference between fringes formed by a parallel film and a wedge film.
21. Solve problems involving parallel films wedge films.

Thermal Physics:

Students should be able to:

(i) Meet all Year 1 outcomes for this topic.

1. Define pressure
2. State the assumptions of the kinetic model of an ideal gas.
3. State that temperature is a measure of the average random kinetic energy of the molecules of an ideal gas.
4. Explain the macroscopic behaviour of an ideal gas in terms of a molecular model.
5. State the equation of state for an ideal gas. PV = nRT
6. Describe the difference between an ideal gas and a real gas.
7. Describe the concept of the absolute zero of temperature and the Kelvin scale of temperature.
8. Solve problems using the equation of state of an ideal gas.
9. Describe a thermodynamic system, which is restricted to a fixed mass of an ideal gas.
10. Deduce an expression for the work involved in a volume change of a gas at constant pressure.
11. State the first law of thermodynamics.
12. Identify the first law of thermodynamics as a statement of the principle of energy conservation.
13. Describe the isochoric (isovolumetric), isobaric, isothermal and adiabatic changes of state of an ideal gas.
14. Draw and annotate thermodynamic processes and cycles on P-V diagrams.
15. Calculate from a P-V diagram the work done in a thermodynamic cycle.
16. Solve problems involving state changes of a gas.
17. State that the second law of thermodynamics implies that thermal energy cannot spontaneously transfer from a region of low temperature to a region of high temperature.
18. State that entropy is a system property that expresses the degree of disorder in the system.
19. State the second law of thermodynamics in terms of entropy changes.
20. Discuss examples of natural processes in terms of entropy changes.

Current Electricity and Circuits

Students should be able to:

1. Meet all Year 1 outcomes for this topic
2. Describe the use of ideal ammeters and ideal voltmeters.
3. Describe a potential divider.
4. Explain the use of sensors in potential dividers. Sensors should include light- dependent resistors (LDRs), negative temperature coefficients (NTS) thermistors and strain gauges.
5. Solve problems involving electric circuits. Student should appreciate that many circuit problems may be solved by regarding the circuit as a potential divider. They should be aware that ammeters and voltmeters have their own resistance.

Electric and Magnetic Fields and Forces

Students should be able to:

1. Meet all Year 1 outcomes for this topic
2. Describe the inducing of an emf by relative motion between a conductor and a magnetic field.
3. Derive the formula for the emf induced in a straight conductor moving in a magnetic field. Induced emf = Blv
4. Define magnetic flux and magnetic flux linkage.
5. Describe the production of an induced emf by a time-changing magnetic flux.
6. State Faraday’s Law and Lenz’s Law
7. Solve electromagnetic induction problems.
8. Describe the emf induced in a coil rotating within a uniform magnetic field.
9. Explain the operation of a basic alternating (AC) generator.
10. Describe the effect on the induced emf of changing the generator frequency. Need to be able to sketch the appropriate graphs.
11. Discuss what is meant by the root mean squared (rms) value of an alternating current or voltage.
12. State the relationship between peak and rms values for sinusoidal currents and voltages.
13. Solve problems using peak and rms values.
14. Solve AC circuit problems for ohmic resistors.
15. Describe the operation of an ideal transformer.
16. Solve problems on the operation of ideal transformers.
17. Outline the reasons for power losses in transmission lines and real transformers.
18. Explain the use of high-voltage step-up and step-down transformers in the transformers in the transmission of electrical power.
19. Solve problems on real transformers and power transmission.
20. Suggest how extra-low-frequency electromagnetic fields, such as those created by electrical appliances and power lines, induce currents within a human body.
21. Discuss some of the possible risks involved in living and working near high-voltage power lines.

Atomic and Nuclear Physics

Students should be able to:

1. Meet all Year 1 outcomes for this topic.
2. Explain the origin of atomic energy levels in terms of the “electron in a box” model.
3. Outline the Schrodinger model of the hydrogen atom.
4. Outline the Heisenberg uncertainty principle with regard to position – momentum and time – energy
5. Explain how the radii of nuclei may be estimated from charges particle scattering experiments. Use energy conservation for determining closest-approach distances for Coulomb scattering experiments.
6. Describe how the masses of nuclei may be determined using a Bainbridge mass spectrometer. Nuclear mass values provide evidence for the existence of isotopes.
7. Describe one piece of evidence for the existence of nuclear energy levels. The nucleus, like the atom, is a quantum system and, as such, has discrete energy levels.
8. Describe β+ decay, including the existence of the neutrino.
9. State the radioactive decay law as an exponential function and define the decay constant.
10. Derive the relationship between decay constant and half-life.
11. Outline methods for measuring the half-life of an isotope.
12. Solve problems involving radioactive half-life.

Analogue and Digital Signals.

Students should be able to:

1. Solve problems in the conversion between binary numbers and decimal numbers.
2. Describe various means of information storage both in analogue and digital form
3. Explain the use of interference of light to recover information stored on CDs.
4. Calculate the appropriate depth of a pit from the wavelength of a laser.
5. Solve problems on CDs and DVDs related to storage capacity.
6. Discuss the advantage of storing information in digital rather than analogue form.
7. Discuss the implications for society of ever-increasing capabilities of data storage.
8. Define capacitance
9. Describe the structure of a charged-coupled device (CCD).
10. Explain how incident light causes charge to build up within a pixel.
11. Outline how the image on a CCD is digitised.
12. Define the quantum efficiency of a pixel.
13. Define magnification
14. State the resolution of an image on a CCD
15. Discuss the effects of quantum efficiency, magnification and resolution on the quality of a processed image
16. Describe the practical uses of a CCD and compare this to the use of film
17. Outline how the image stored in a CCD is retrieved.
18. Solve problems involving the use of CCDs.

**Assessments**

**IB Year 2**

**Assessments**

**First Quarter**

Practice Problems

Laboratory Activities

Unit tests

**Second Quarter**

Practice Problems

Laboratory Activities

Unit Tests

Cumulative Winter Exam

**Third** **Quarter**

Practice Problems

Laboratory Activities

Unit Tests

**Fourth Quarter**

Review

Practice IB Exams

**Core Topics**

**IB Year 2**

**Core Topics**

**First Quarter**

TOPIC 1: Physics and Physical Measurements

TOPIC 8: Energy, Power and Climate Change

TOPIC 2: Mechanics (review)

TOPIC 9: Motion in Fields (HL only)

**Second Quarter**

TOPIC 4: Oscillations and waves

TOPIC 11: Wave Phenomena

OPTION G: Electromagnetic waves (SL/HL)

**Third Quarter**

TOPIC 3: Thermal Physics

TOPIC 10: Thermal Physics (HL only)

TOPIC 5: Electric Current

TOPIC 12: Electromagnetic Induction (HL only)

TOPIC 7: Atomic and Nuclear Physics

TOPIC 13: Quantum physics/nuclear physics (HL / OPTION B: SL)

TOPIC 14: Digital Technology (HL only)

SECOND OPTION (HL only)

This option changes from year to year depending on student interest. The most common topics are Astrophysics (OPTION E) or Relavity (OPTION H). The specific topics follow the IB Physics Subject Guide.

**Fourth Quarter**

Review of Previous IB Exams

Paper 1 (Multiple Choice)

Paper 2 (Written Response - Core and AHL material)

Paper 3 (Written Response - Options)

**Specific Content**

**IB Year 2**

**Specific Content**

**First Quarter**

TOPIC 1: Physics and Physical Measurements

1.1 The realm of physics (review)

1.2 Measurement and Uncertainties (review)

1.3 Vectors and scalars (review)

TOPIC 8: Energy, Power and Climate Change

8.1 Energy degradation

8.2 World energy sources

8.3 Fossil fuel power production

8.4 Non-fossil fuel production

8.5 Greenhouse effect

8.6 Global warming

TOPIC 2: Mechanics (review)

2.1 Kinematics

2.2 Forces and Dynamics (including Momentum)

2.3 Work, Energy and Power

2.4 Uniform Circular Motion

6.1 Gravitational Force and Field

TOPIC 9: Motion in Fields (HL only)

9.1 Projectile motion (including angled launch)

9.2 Gravitational field, potential and energy

9.4 Orbital motion (review)

**Second Quarter**

TOPIC 4: Oscillations and waves

4.1 Kinematics of simple harmonic motion

4.2 Energy changes during simple harmonic motion

4.3 Forced oscillations and resonance

4.4 Wave characteristics (review)

4.5 Wave properties (review)

TOPIC 11: Wave Phenomena

11.1 Standing waves

11.2 Doppler effect

11.3 Diffraction

11.4 Resolution

11.5 Polarization

OPTION G: Electromagnetic waves (SL/HL)

G1 The nature of EM waves(review)

G2 Optical Instruments (review)

G3 Two source interference of waves (review)

G4 Diffraction grating

G5 X-rays (HL only)

G6 Thin-film interference (HL only)

**Third Quarter**

TOPIC 3: Thermal Physics

3.1 Thermal concepts (review)

3.2 Thermal properties of matter (review)

TOPIC 10: Thermal Physics (HL only)

10.1 Thermodynamics

10.2 Processes

10.3 Second law of thermodynamics and entropy

TOPIC 5: Electric Current

5.1 Electric potential difference, current and resistance (review)

5.2 Electric circuits (review)

6.2/6.3 Electric/Magnetic Force and Field (review)

9.3 Electric field, potential and energy (HL only)

TOPIC 12: Electromagnetic Induction (HL only)

12.1 Induced electromotive force (emf)

12.2 Alternating Current

12.3 Transmission of electrical power

TOPIC 7: Atomic and Nuclear Physics

7.1 The atom (review)

7.2 Radioactive decay (review)

7.3 Nuclear reactions, fission and fusion (review)

TOPIC 13: Quantum physics/nuclear physics (HL / OPTION B: SL)

13.1 Quantum Physics

13.2 Nuclear Physics

TOPIC 14: Digital Technology (HL only)

14.1 Analogue and digital signals

14.2 Data capture; digital imaging using CCDs

SECOND OPTION (HL only)

This option changes from year to year depending on student interest. The most common topics are Astrophysics (OPTION E) or Relavity (OPTION H). The specific topics follow the IB Physics Subject Guide.

**Fourth Quarter**

Review of Previous IB Exams

Paper 1 (Multiple Choice)

Paper 2 (Written Response - Core and AHL material)

Paper 3 (Written Response - Options)

**Resources**

Tsokos, K. A.. *Physics for the IB diploma.* 5th ed. Cambridge: Cambridge University Press, 2010. Print.

Kirk, Tim, and Neil Hodgson. *Physics course companion,* second ed. Oxford: Oxford University Press, 2010. Print.

Kirk, Tim. *Physics for the IB diploma: standard and higher level*. 2nd ed. Oxford: Oxford University Press, 2007. Print.