Diploma Programme subject outline—Group 3: Physics

School name	Alruwad Internatinal School	School	060563
Name of the DP subject	Physics		
Level (indicate with X)	High Level X Standard Level X		
Name of the teacher who completed this outline		Date of IB training	
Date when outline was completed		Name of workshop (indicate name of subject and workshop category)	

* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

Formative assessments will be given in the form of:	Summative assessments will be given in the form of:	Differentiation will be mostly focused on:
• Rally robin • Entry and exit tickets • Worksheets • Quizzes • Think-pair-share • Find someone who • Asking higher order questions • Cooperative learning • Presentations, Kahoots • Quizlet, and Gimkit	• Exams • Quizes • Investigations • Laboratories´ design • Internal assessment • Practical work • Solving Problems • Projects • Worksheets • Presentations	• Language proficiency (reading and writing) • Language acquisition (vocabulary) • Thinking development (Critical thinking and problem solving) • Problem solving and scientific skills (scaffolding)

• using graphic organizers, etc.	• Portfolio	

Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	**Contents**	**Allocated time**	**Assessment instruments to be used**	**Resources** *List the main resources to be used, including information technology if applicable.*
		minutes.		
		classes.		

Year 1	Topic 1: Measurements and uncertainties	1.1 – Measurements in physics 1.2 – Uncertainties and errors 1.3 – Vectors and scalars	5H – SL	Learn about different measurements, such as length, mass and time. Also, after making the measurements, we will plot them to a chart to discover what type of relationship is applied, directly proportional, exponentially or if it doesn't have any relationship. In addition, learn about how to calculate the uncertainty of a measurement, and how to limit the effect of errors that might happen on the results. • Vernier Caliper 5" Wheel Type • Screw Gauge • Meauring tape • Laser Tape Measure This topic is able to be integrated into any topic taught at the start of the course and is important to all topics Students studying more than one group 4 subject will be able to use these skills across all subjects	https://ibphysics.org/ https://www.sciencetopia.net/physics/measurement-physical-quantity https://www.vivaxsolutions.com/physics/errors-and-uncertainties.aspx https://www.grc.nasa.gov/www/k-12/airplane/vectors.html https://www.physicsclassroom.com/class/1DKin/Lesson-1/Scalars-and-Vectors http://dev.physicslab.org/Document.aspx?doctype=3&filename=IntroductoryMathematics_ScalarsVectors.xml

	Topic 2: Mechanics	2.1 – Motion 2.2 – Forces 2.3 – Work, energy and power 2.4 – Momentum and impulse	22H – SL	A trolley experiences acceleration when an external force is applied to it. The aim of this data logging experiment is to explore the relationship between the magnitudes of the external force and the resulting acceleration. Measuring acceleration due to gravity with a pendulum Simulating the effects and variables of kinetic and potential energy Plan an investigation to find out how the length of a chain of rubber bands varies with the weight it supports. Investigate how loading and unloading affects its length. Record your data to appropriate tables plot them on graph paper and draw your own conclusions. Examine factors that affect the time for water to drain from a hole in the bottom of a disposable plastic cup. There are several possible variables from which you need to select one. Plan a complete investigation. Compile a spread sheet showing distance from centre of orbit and orbital time for a collection of objects orbiting the same central mass (choose a set of planets/moons orbiting the sun/planet). Produce formulae in the headings of two further columns to work out centripetal acceleration in SI Units and the inverse square of radius. Find the ratio of these last two quantities by formula in the last column. You may want to work out the equation that relates these two quantities using Newton’s Laws. Write a brief conclusion about your findings. What can be deduced from this ratio?	https://ibphysics.org/ https://phet.colorado.edu/en/simulations/category/physics

	Topic 3: Thermal physics	3.1 – Thermal concepts 3.2 – Modelling a gas	11 H – SL	According to Newton's law of cooling, the rate of change of the temperature of an object is proportional to the difference between its initial temperature T0 and the ambient temperature TA. At time t, the temperature Tt can be expressed as Tt = TA + (T0 –TA) e-kt where k is the decay constant. Does this look like anything you've seen before? Can you turn it into a linear relationship and demonstrate it? Using a thermometer, metal cylinder, heating element, voltmeter and ammeter, determine the specific heat capacity of the metal cylinder. Present a labelled diagram of your apparatus as well as an organized raw data table, including uncertainties. Using a thermometer, stopwatch, calorimeter cup (copper), balance, heating element, voltmeter and ammeter determine the specific heat capacity of water. Using the method of mixtures, determine the specific heat capacity of a metal and identify it. Using the value found for c, determine which metal makes up the cylinder Compare your value for the specific heat capacity with the accepted one and discuss your results. Evaluate your experiment, discuss any possible errors and suggest future improvements. To verify the "Pressure Law" and find the Absolute Zero of Temperature.	https://ibphysics.org/ http://www.britannica.com/EBchecked/topic/211272/fluid-mechanics/77499/Convection#ref611792

	Topic 4: Waves	4.1 – Oscillations 4.2 – Travelling waves 4.3 – Wave characteristics 4.4 – Wave behaviour 4.5 – Standing waves	15 H – SL	Students will examinesimple harmonic motion, comparing acceleration vs. displacement. Important definitions here, such as the wave equation, features like wavelength, period, amplitude, frequency, transverse and longitudinal waves Wave equation: speed = frequency * wavelength A basic definition of polarization, and how to use Malus' law Verify Snell's Law of refraction and to estimate the speed of light inside a transparent plastic block. Measure the speed of sound in air. Sound is a longitudinal wave requiring a medium in which to propagate. The speed of sound depends on properties of the medium such as bulk modulus, density, and temperature.	https://ibphysics.org/ https://www.youtube.com/playlist?list=PLBb_6jpE41oIfpaO4jhNIRvB-99BHdZOU http://ibphysicsstuff.wikidot.com/waves https://studynova.com/guide/physics/waves/ https://studynova.com/lecture/ib-physics-sl-free-lectures/waves/

	Topic 5: Electricity and magnetism	5.1 – Electric fields 5.2 – Heating effect of electric currents 5.3 – Electric cells 5.4 – Magnetic effects of electric currents	15 H – SL	Using voltage probes and the digital meters investigate a number of simple electric circuits. to investigate a factor that affects the resistance of a wire. Using the electrical equipment in the lab, you have to investigate a factor that you think may affect the resistance of a wire. Design an experiment to investigate the low voltage current/potential difference relationship for the following electrical components: Standard resistors, Filament lamps, Motors. find out the internal resistances of different batteries as they put out more and more current. Your circuit will use only a voltage divider, or rheostat. This will allow you to increase the	https://ibphysics.org/ http://ibdiploma.cambridge.org/media/IB_physics_5_planning_tiCore.pdf https://studynova.com/guide/physics/electricity-and-magnetism/ https://www.tes.com/teaching-resource/ib-physics-course-topic-5-electricity-and-magnetism-teaching-and-revision-material-and-questions-12155854

	Topic 9: Wave phenomena **ONLY HL**	9.1 – Simple harmonic motion 9.2 – Single-slit diffraction 9.3 – Interference 9.4 – Resolution 9.5 – Doppler effect	17 H - **HL**	Introduce the doppler effect. Use a geogebra simulation to show how the doppler equation is derived. Doppler effect: Idebtify a moving source or observer or draw the graph of frequency vs. time as an object goes by Going into more detail with the SHM equations, such as max. kinetic energy, velocity, total energy Young's double-slit experiment and how to calculate it	https://ibphysics.org/ https://www.ib-physics.net/topic-9-wave-phenomena https://studynova.com/guide/physics/wave-phenomena/ https://www.youtube.com/playlist?list=PL6D8E10E7617757E9 https://quizlet.com/209203147/ib-physics-hl-topic-9-wave-phenomena-flash-cards/ https://studynova.com/lecture/physics/wave-phenomena/simple-harmonic-motion-shm-and-angular-frequency/
	Topic 10: Fields **ONLY HL**	10.1 – Describing fields 10.2 – Fields at work	11H – HL	For both gravitational and electric, look at fields, potential, potential energy and force, in addition to equipotential lines Knowing how to derive and use the equations for escape velocity and orbital speed and more importantly being able to draw and use the graphs of energy vs. time for kinetic energy, total energy, and potential energy	https://ibphysics.org/topic10/ https://quizlet.com/334193799/ib-physics-hl-topic-10-fields-flash-cards/ https://studynova.com/guide/physics/fields/

	Practical activities		20 H (SL) 40 H (HL)	To be determined by teachers	
	Group 4 project		10 H – SL	To be determined by students and teachers Due date: September 29 – October 2, 2021	

Year 2	Topic 6: Circular motion and gravitation	6.1 – Circular motion 6.2 – Newton's law of gravitation	5 H – SL	Centripetal acceleration: The acceleration which gives rise to a circular motion is called the centripetal acceleration. Its magnitude is given by the following calculation $a = \omega^2 r$ *Be able to calculate:* $a = \frac{v^2}{r}$ Where: "a" is acceleration "ω" is angular velocity "v" is scalar velocity "r" is radius Calculate Newton's universal law of gravitation Calculate the gravitational field strength of different objects Describing the relationship between gravitational force and centripetal force Applying Newton's law of gravitation to the motion of an object in circular orbit around a point mass Solving problems involving gravitational force, gravitational field strength, orbital speed and orbital period Determining the resultant gravitational field strength due to two bodies	https://ibphysics.org/topic6/ https://peda.net/jao/lyseo/isac/sciences/physics/course-2017-20182/6cmag https://concordian-thailand.libguides.com/c.php?g=688995&p=4943427 https://www.tes.com/teaching-resource/ib-physics-course-topic-10-fields-grav-and-elec-hl-teaching-and-revision-material-and-questions-12155861

	Topic 7: Atomic, nuclear and particle physics	7.1 – Discrete energy and radioactivity 7.2 – Nuclear reactions 7.3 – The structure of matter	14 H – SL	estimate the value of Planck's constant using the photoelectric effect. Einstein's photo-electric equation can be stated as: **eVs = hf – W** know about atomic energy levels, and that photons are emitted of energy E = hf every time an electron goes down in energy. Use this to find a value of Planck's constant, h. The throwing of dice is a random event, the same as the decay of an atom is random. As a result, dice can be used to simulate radioactive decay. Evaluate students on being able to calculate radioactive decay. Desribe binding energy and how it relates to nuclear physics	https://ibphysics.org/ https://concordian-thailand.libguides.com/c.php?g=688995&p=4943431 https://studynova.com/guide/physics/atomic-nuclear-and-particle-physics/ https://studynova.com/lecture/physics/atomic-nuclear-particle-physics/nuclear-physics-and-energy-levels/ http://www.mrricci.com/mrricci.com/RIS_Topic_7_Atomic,_Nuclear_and_Particle_Physics.html

	Topic 8: Energy production	8.1 – Energy sources 8.2 – Thermal energy transfer	8 H – SL	Solving specific energy and energy density problems Sketching and interpreting Sankey diagrams Describing the basic features of fossil fuel power stations, nuclear power stations, wind generators, pumped storage hydroelectric systems and solar power cells Solving problems relevant to energy transformations in the context of these generating systems	https://ibphysics.org/ https://studynova.com/guide/physics/energy-production/ https://www.ib-physics.net/topic-8-energy-production https://peda.net/jao/lyseo/isac/sciences/physics/course-2015-2017/course-calendar/t8ep8es
	Topic 11: Electromagnetic induction **ONLY HL**	11.1 – Electromagnetic induction 11.2 – Power generation and transmission 11.3 – Capacitance	16 H - HL	Be able to explain and quantify the following subtopcs: *Flux and Faraday's law* Definition of magnetic flux and using it to define Faraday's law and how induced emf works, including a moving charge or wire in a magnetic field *Lenz' law* Lenz' law and predicting the direction of the induced emf (it opposes the motion) *Alternating current* How AC works, maximum and average power, max. and rms (root mean square) current and potential difference *Transformers and half wave rectification* How transformers work, the transformer equation and half	https://ibphysics.org/topic11/ https://studynova.com/guide/physics/electromagnetic-induction/ https://ibstudynotes.wordpress.com/topic11/ http://www.mrricci.com/mrricci.com/RIS_Topic_11_-_Electromagnetic_Induction.html

	Topic 12: Quantum and nuclear physics **ONLY HL**	12.1 – The interaction of matter with radiation 12.2 – Nuclear physics	16 H - HL	Wave function and uncertainty: know that the absolute value of the square amplitude of the wave function tells you the probability of finding a particle there. For uncertainty, you can be asked to use Heisenberg's uncertainty equation. Photoelectric effect: Students need to know how photoelectric effect works, about the work function and how it keeps the electrons in the metal. know the graph of kinetic energy of ejected electrons vs. frequency of incoming light, and be able to show where the threshold frequency is. Half-life and decay equation: Work in detail with the decay equations (the exponential ones) to look into detail and solve for time. That requires you to be able to solve mathematically an equation with an exponential function (e^something).	https://ibphysics.org/topic12/ https://studynova.com/guide/physics/quantum-nuclear-physics/ https://www.ib-physics.net/topic-12-quantum-and-nuclear-physic https://www.tes.com/teaching-resource/ib-physics-topic-12-hl-quantum-and-nuclear-physics-11276268 https://www.youtube.com/playlist?list=PLf_Hk-cBofOQt7ndIwDVNL8VAMcbIpm40 https://quizlet.com/196333433/topic-12-quantum-nuclear-physics-flash-cards/ https://studynova.com/lecture/physics/quantum-and-nuclear-physics/energy-levels-and-quantised-energy/

	Option B: Engineering physics	B.1 – Rigid bodies and rotational dynamics B.2 – Thermodynamics B.3 – Fluids and fluid dynamics (HL only) B.4 – Forced vibrations and resonance (HL only)	15 H – SL 25 H - HL	Nature of science: Human understandings: Understanding and modelling fluid flow has been important in many technological developments such as designs of turbines, aerodynamics of cars and aircraft, and measurement of blood flow. (1.1) Determining buoyancy forces using Archimedes' principle Solving problems involving pressure, density and Pascal's principle Solving problems using the Bernoulli equation and the continuity equation Explaining situations involving the Bernoulli effect Describing the frictional drag force exerted on small spherical objects in laminar fluid flow Solving problems involving Stokes' law Determining the Reynolds number in simple situations Nature of science: Risk assessment: The ideas of resonance and forced oscillation have application in many areas of engineering ranging from electrical oscillation to the safe design of civil structures. In large-scale civil structures, modelling all possible effects is essential before construction. (4.8) Qualitatively and quantitatively describing examples of under-, over- and critically-damped oscillations Graphically describing the variation of the amplitude of vibration with driving frequency of an object close to its natural frequency of vibration Describing the phase relationship between driving frequency and forced oscillations Solving problems involving Q factor	http://mrricci.com/mrricci.com/RIS_Topic_B_-_Engineering_Physics.html https://sites.google.com/site/mrburchsclasses/Home/ib-physics-1/option-b https://ibphysics.org/optionbcore/ https://ibphysics.org/optionbhl/

	Practical activities		10 H (SL) 20 H (HL)	To be determined by teachers	
	Individual investigation (internal assessment—IA)		10 H	Internal Assessment 24% of mark (ongoing assessment of practical work) 1st year due date: January 23,2022 2nd year due date: February 9, 2022	

2. The group 4 project

As the IB guides say, “The group 4 project is a collaborative activity where students from different group 4 subjects work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to ‘encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method.’” Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

The group 4 project is a collaborative activity where students from different group 4 subjects (Physics, Chemistry, Biology and Environmental Science and Society) work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method. The Group 4 project will take place in the second half of the first year, with the exact date to be determined through discussion with the other IB teachers. It will take place at the beginning of the second year to avoid overloading the students. The total time allocated to this project shall be 10 hours.

Year 1- First trimester – Teachers Working cooperatively: (2 meetings/3 hours)

- Review Group 4 activity requirements and PSOW.
- Work on identifying attributes of the learner profile, the 5 approaches to learning, and skills in Physics..
- Define the role of the NOS and international mindedness.
- Review examples of previous projects, identify logistical strategies, project stages, and addressing aims 7 and 8.

Year 1- Second Trimester: Teachers working cooperatively (2 meetings/3 hours)

- Review the design technology cycle or design thinking strategies and start planning stages
- Use the group 4 and presentation´s assessment criteria to design assessment tools (Assessment check lists and rubrics)
- Create a group four guideline-toolbox written or electronic to guide student´s work

Year 1- Third Trimester: Teachers and students working cooperatively (2 meetings/2 hrs.)

- Planning stages, assessment and toolbox
- Team-building exercise
- Brainstorm/survey/share ideas for topic
- Decide on final topic

Year 2- Beginning of the year: Group 4 project development- Students mostly working by themselves (10 hours)

- Guide students and emphasize interdisciplinary cooperation and the scientific process.
- Frequent project feedback and reminders
- Prepare for Evaluation presentation and requirements (Assessment check lists and rubrics)
- Conclude Evaluation loading the students. The total time allocated to this project shall be 10 hours.

Due date: September 29 – October 2, 2021

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

The laboratory is a fully equipped high school science facility. Seating is around 6 large tables. There is a long countertop along one wall with two full sinks and adequate cabinet space to store laboratory equipment and supplies. Overhead, retractable power cords provide power for equipment, etc. The room is also equipped with projection tools and a smart board to accommodate a variety of presentations. Safety equipment including goggles, aprons, gloves, etc. are provided for individual student use and a fire blanket is available. A portable eyewash station and an emergency shower are provided as for the safety list items. Given the expanded list of laboratories required for the HL Physics course, some equipment and laboratory supplies will be necessary, but are within budget for the first year of the course(August 2020).

3. IB practical work and the internal assessment requirement to be completed during the course

As you know, students should undergo practical work related to the syllabus.
Students should undergo 40 hours (at standard level) or 60 hours (at higher level) of practical work related to the syllabus.

Name of the topic	Experiment / Activity	ICT use
2.1 – Motion	Experiments, including use of data logging, could include (but are not limited to): determination of g, estimating speed using travel timetables, analysing projectile motion, and investigating motion through a fluid.	Yes
2.2 – Forces	Experiments could include (but are not limited to): verification of Newton's second law; investigating forces in equilibrium; determination of the effects of friction.	Yes
2.3 – Work, energy and power	Experiments could include (but are not limited to): relationship of kinetic and gravitational potential energy for a falling mass; power and efficiency of mechanical objects; comparison of different situations involving elastic potential energy.	Yes
2.4 – Momentum and impulse	Experiments could include (but are not limited to): analysis of collisions with respect to energy transfer; impulse investigations to determine velocity, force, time, or mass; determination of amount of transformed energy in inelastic collisions.	Yes
3.1 – Thermal concepts	Experiments could include (but are not limited to): transfer of energy due to temperature difference; calorimetric investigations; energy involved in phase changes.	Yes
3.2 – Modelling a gas	Experiments could include (but are not limited to): verification of gas laws; calculation of the Avogadro constant; virtual investigation of gas	Yes

	law parameters not possible within a school laboratory setting.	
4.1 – Oscillations	Experiments could include (but are not limited to): mass on a spring; simple pendulum; motion on a curved air track.	Yes
4.2 – Travelling waves	Experiments could include (but are not limited to): speed of waves in different media; detection of electromagnetic waves from various sources; use of echo methods (or similar) for determining wave speed, wavelength, distance, or medium elasticity and/or density.	Yes
4.3 – Wave characteristics	Experiments could include (but are not limited to): observation of polarization under different conditions, including the use of microwaves; superposition of waves; representation of wave types using physical models (eg slinky demonstrations).	Yes
4.4 – Wave behaviour	Experiments could include (but are not limited to): determination of refractive index and application of Snell's law; determining conditions under which total internal reflection may occur; examination of diffraction patterns through apertures and around obstacles; investigation of the double-slit experiment	Yes
4.5 – Standing waves	Experiments could include (but are not limited to): observation of standing wave patterns in physical objects (eg slinky springs); prediction of harmonic locations in an air tube in water; determining the frequency of tuning forks; observing or measuring vibrating violin/guitar strings.	Yes

5.1 – Electric fields	Experiments could include (but are not limited to): demonstrations showing the effect of an electric field (eg using semolina); simulations involving the placement of one or more point charges and determining the resultant field.	Yes
5.2 – Heating effect of electric currents	Experiments could include (but are not limited to): use of a hot-wire ammeter as an historically important device; comparison of resistivity of a variety of conductors such as a wire at constant temperature, a filament lamp, or a graphite pencil; determination of thickness of a pencil mark on paper; investigation of ohmic and non-ohmic conductor characteristics; using a resistive wire wound and taped around the reservoir of a thermometer to relate wire resistance to current in the wire and temperature of wire.	Yes
5.3 – Electric cells	Experiments could include (but are not limited to): investigation of simple electrolytic cells using various materials for the cathode, anode and electrolyte; software-based investigations of electrical cell design; comparison of the life expectancy of various batteries.	Yes
5.4 – Magnetic effects of electric currents	Computer-based simulations enable the visualization of electromagnetic fields in three-dimensional space	Yes
6.1 – Circular motion	Experiments could include (but are not limited to): mass on a string; observation and quantification of loop-the-loop experiences; friction of a mass on a turntable	Yes
B.4 – Forced vibrations and resonance	Experiments could include (but are not limited to): observation of sand on a vibrating surface of varying frequencies; investigation of the effect of increasing damping on an oscillating	Yes

	system, such as a tuning fork; observing the use of a driving frequency on forced oscillations	
ONLY HL		
9.5 – Doppler effect	• Spectral data and images of receding galaxies are available from professional astronomical observatories for analysis • Computer simulations of the Doppler effect allow students to visualize complex and mostly unobservable situations	Yes
11.3 – Capacitance	Experiments could include: investigating basic RC circuits; using a capacitor in a bridge circuit; examining other types of capacitors; verifying time constant	Yes
12.1 – The interaction of matter with radiation	• The photoelectric effect can be investigated using LEDs	Yes
B.4 – Forced vibrations and resonance	• Experiments could observation of sand on a vibrating surface of varying frequencies; investigation of the effect of increasing damping on an oscillating system, such as a tuning fork; observing the use of a driving frequency on forced oscillations • Investigate the use of resonance in electrical circuits, atoms/molecules, or with radio/television communications through software modelling examples	Yes

4. Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

The laboratory is not yet a fully equipped high school science facility, however it is adequate to accomplish the above listed labs. Seating is around 6 large counter tops with adequate space for experimentation. Safety equipment including goggles, aprons, gloves, etc. are provided for individual student use and a fire blanket is available. Given the expanded list of laboratories required for the HL Physics course, some equipment and laboratory supplies will be necessary, but are within budget for the first year of the course. The lab has adequate top of the line safety procedures and is working coninuously on aquiring new lab materials and improving the laerning enviroment for students. https://www.vernier.com/products/lab-equipment/

5. Other resources

Indicate what other resources the school has to support the implementation of the subject and what plans there are to improve them, if needed.

The school has a well-supplied science stockroom with adequate physics supplies. Some equipment, such as Circuits and ohmic and non-ohmic conductor is shared among teachers in the department, but there is enough to accommodate needs. There are 3 computer labs with statistical software packages and internet access that will allow students to access any necessary digital programs as part of the course. The library has excellent reference materials in both print and digital form and the librarians are knowledgeable about the research resources available. Additionally, the campus is well situated to allow for access to a local natural area for field related observations and the University of Sultan, with a variety of accessible science labs and Physics lectures.

6. Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

Topic	Link with TOK (including description of lesson plan)
Introduction	It is my intent to administer a learner style survey to students during the first week of class. The one that I have used in the past seeks to determine if the student is principally an audio, a visual, or a kinaesthetic learner, or if their strength lies somewhere in between two designations. After completing the surveys, we will have a class discussion wherein students talk about the accuracy of the results of the survey as compared to their past classroom experiences. Also, we will examine strategies, resources, and teaching techniques (mine and theirs) that can be used to improve student retention, understanding, and success.
1.1 – Measurements in physics	• What has influenced the common language used in science? To what extent does having a common standard approach to measurement facilitate the sharing of knowledge in physics?
1.2 – Uncertainties and errors	• “One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that this aim is unattainable.” – Jacob Bronowski. Can scientists ever be truly certain of their discoveries?
1.3 – Vectors and scalars	• What is the nature of certainty and proof in mathematics?
2.1 – Motion	• The independence of horizontal and vertical motion in projectile motion seems to be counter-intuitive. How do scientists work around their intuitions? How do scientists make use of their intuitions?
2.2 – Forces	• Classical physics believed that the whole of the future of the universe could be predicted from knowledge of the present state. To what extent can knowledge of the present give us knowledge of the future?
2.3 – Work, energy and power	• To what extent is scientific knowledge based on fundamental concepts such as energy? What happens to scientific knowledge when our understanding of such fundamental concepts changes or evolves?
2.4 – Momentum and impulse	• Do conservation laws restrict or enable further development in physics?

3.1 – Thermal concepts	• Observation through sense perception plays a key role in making measurements. Does sense perception play different roles in different areas of knowledge?
3.2 – Modelling a gas	• When does modelling of “ideal” situations become “good enough” to count as knowledge?
4.1 – Oscillations	• The harmonic oscillator is a paradigm for modelling where a simple equation is used to describe a complex phenomenon. How do scientists know when a simple model is not detailed enough for their requirements?
4.2 – Travelling waves	• Scientists often transfer their perception of tangible and visible concepts to explain similar non-visible concepts, such as in wave theory. How do scientists explain concepts that have no tangible or visible quality?
4.3 - Wave characteristics	• Wavefronts and rays are visualizations that help our understanding of reality, characteristic of modelling in the physical sciences. How does the methodology used in the natural sciences differ from the methodology used in the human sciences? • How much detail does a model need to contain to accurately represent reality?
4.4 – Wave behaviour	• Huygens and Newton proposed two competing theories of the behaviour of light. How does the scientific community decide between competing theories?
4.5 – Standing waves	• There are close links between standing waves in strings and Schrodinger’s theory for the probability amplitude of electrons in the atom. Application to superstring theory requires standing wave patterns in 11 dimensions. What is the role of reason and imagination in enabling scientists to visualize scenarios that are beyond our physical capabilities?
5.1 – Electric fields	• Early scientists identified positive charges as the charge carriers in metals; however, the discovery of the electron led to the introduction of “conventional” current direction. Was this a suitable solution to a major shift in thinking? What role do paradigm shifts play in the progression of scientific knowledge?
5.2 – Heating effect of electric currents	• Sense perception in early electrical investigations was key to classifying the effect of various power sources; however, this is fraught with possible irreversible consequences for the scientists involved. Can we still ethically and safely use sense perception in science research?
5.3 – Electric cells	• Battery storage is seen as useful to society despite the potential environmental issues surrounding their disposal. Should scientists be held morally responsible for the long-term consequences of their inventions and discoveries?

5.4 – Magnetic effects of electric currents	• Field patterns provide a visualization of a complex phenomenon, essential to an understanding of this topic. Why might it be useful to regard knowledge in a similar way, using the metaphor of knowledge as a map – a simplified representation of reality?
6.1 – Circular motion	• Foucault's pendulum gives a simple observable proof of the rotation of the Earth, which is largely unobservable. How can we have knowledge of things that are unobservable?
6.2 – Newton's law of gravitation	• The laws of mechanics along with the law of gravitation create the deterministic nature of classical physics. Are classical physics and modern physics compatible? Do other areas of knowledge also have a similar division between classical and modern in their historical development?
7.1 – Discrete energy and radioactivity	• The role of luck/serendipity in successful scientific discovery is almost inevitably accompanied by a scientifically curious mind that will pursue the outcome of the "lucky" event. To what extent might scientific discoveries that have been described as being the result of luck actually be better described as being the result of reason or intuition?
7.2 – Nuclear reactions	• The acceptance that mass and energy are equivalent was a major paradigm shift in physics. How have other paradigm shifts changed the direction of science? Have there been similar paradigm shifts in other areas of knowledge?
7.3 – The structure of matter	• Does the belief in the existence of fundamental particles mean that it is justifiable to see physics as being more important than other areas of knowledge?
8.1 – Energy sources	• The use of nuclear energy inspires a range of emotional responses from scientists and society. How can accurate scientific risk assessment be undertaken in emotionally charged areas?
8.2 – Thermal energy transfer	• The debate about global warming illustrates the difficulties that arise when scientists cannot always agree on the interpretation of the data, especially as the solution would involve large-scale action through international government cooperation. When scientists disagree, how do we decide between competing theories?
B.1 – Rigid bodies and rotational dynamics	• Models are always valid within a context and they are modified, expanded or replaced when that context is altered or considered differently. Are there examples of unchanging models in the natural sciences or in any other areas of knowledge?

B.3 – Fluids and fluid dynamics	• The mythology behind the anecdote of Archimedes' "Eureka!" moment of discovery demonstrates one of the many ways scientific knowledge has been transmitted throughout the ages. What role can mythology and anecdotes play in passing on scientific knowledge? What role might they play in passing on scientific knowledge within indigenous knowledge systems?
ONLY HL	
9.2 – Single-slit diffraction	• Are explanations in science different from explanations in other areas of knowledge such as history?
9.3 – Interference	• Most two-slit interference descriptions can be made without reference to the one-slit modulation effect. To what level can scientists ignore parts of a model for simplicity and clarity?
9.4 – Resolution	• The resolution limits set by Dawes and Rayleigh are capable of being surpassed by the construction of high quality telescopes. Are we capable of breaking other limits of scientific knowledge with our advancing technology?
9.5 – Doppler effect	• How important is sense perception in explaining scientific ideas such as the Doppler effect?
10.1 – Describing fields	• Although gravitational and electrostatic forces decrease with the square of distance and will only become zero at infinite separation, from a practical standpoint they become negligible at much smaller distances. How do scientists decide when an effect is so small that it can be ignored?
11.1 – Electromagnetic induction	• Terminology used in electromagnetic field theory is extensive and can confuse people who are not directly involved. What effect can lack of clarity in terminology have on communicating scientific concepts to the public?
11.2 – Power generation and transmission	• There is continued debate of the effect of electromagnetic waves on the health of humans, especially children. Is it justifiable to make use of scientific advances even if we do not know what their long-term consequences may be?
12.1 – The interaction of matter with radiation	• The duality of matter and tunnelling are cases where the laws of classical physics are violated. To what extent have advances in technology enabled paradigm shifts in science?
12.2 – Nuclear physics	• Much of the knowledge about subatomic particles is based on the models one uses to interpret the data from experiments. How can we be sure that we are discovering an "independent truth" not influenced by our models? Is there such a thing as a single truth?
B.3 – Fluids and fluid dynamics	• The mythology behind the anecdote of Archimedes' "Eureka!" moment of discovery demonstrates one of the many ways scientific knowledge has been transmitted throughout the ages. What role can mythology and anecdotes play in passing on scientific knowledge? What role might they play in passing on scientific knowledge within indigenous knowledge systems?

7. Approaches to learning

Every IB course should contribute to the development of students' approaches to learning skills. As an example of how you would do this, choose one topic from your outline that would allow your students to specifically develop one or more of these skill categories (thinking, communication, social, self-management or research).

The aims of approaches to teaching and learning in the Diploma Programme are to:

• empower teachers as teachers of learners as well as teachers of content

• empower teachers to create clearer strategies for facilitating learning experiences in which students are more meaningfully engaged in structured inquiry and greater critical and creative thinking

• promote both the aims of individual subjects (making them more than course aspirations) and linking previously isolated knowledge (concurrency of learning)

• encourage students to develop an explicit variety of skills that will equip them to continue to be actively engaged in learning after they leave school, and to help them not only obtain university admission through better grades but also prepare for success during tertiary education and beyond

• enhance further the coherence and relevance of the students' Diploma Programme experience

• allow schools to identify the distinctive nature of an IB Diploma Programme education, with its blend of idealism and practicality.

The five approaches to learning (developing thinking skills, social skills, communication skills, selfmanagement skills and research skills) along with the six approaches to teaching (teaching that is inquirybased, conceptually focused, contextualized, collaborative, differentiated and informed by assessment) encompass the key values and principles that underpin IB pedagogy.

Topic	Contribution to the development of students' approaches to learning skills (including one or more skill category)	ATL Skill
1.1 – Measurements in physics	• Using SI units in the correct format for all required measurements, final answers to calculations and presentation of raw and processed data • Using scientific notation and metric multipliers • Quoting and comparing ratios, values and approximations to the nearest order of magnitude • Estimating quantities to an appropriate number of significant figures.	Thinking Skills Communication Skills

1.2 – Uncertainties and errors	• Explaining how random and systematic errors can be identified and reduced • Collecting data that include absolute and/or fractional uncertainties and stating these as an uncertainty range (expressed as: best estimate ± uncertainty range) • Propagating uncertainties through calculations involving addition, subtraction, multiplication, division and raising to a power • Determining the uncertainty in gradients and intercepts	Thinking Skills Communication Skills
1.3 – Vectors and scalars	• Solving vector problems graphically and algebraically	Thinking Skills
2.1 – Motion	• Determining instantaneous and average values for velocity, speed and acceleration • Solving problems using equations of motion for uniform acceleration • Sketching and interpreting motion graphs • Determining the acceleration of free-fall experimentally • Analysing projectile motion, including the resolution of vertical and horizontal components of acceleration, velocity and displacement • Qualitatively describing the effect of fluid resistance on falling objects or projectiles, including reaching terminal speed	Thinking Skills Communication Skills
2.2 – Forces	• Representing forces as vectors • Sketching and interpreting free-body diagrams • Describing the consequences of Newton's first law for translational equilibrium • Using Newton's second law quantitatively and qualitatively • Identifying force pairs in the context of Newton's third law • Solving problems involving forces and determining resultant force • Describing solid friction (static and dynamic) by coefficients of friction	Thinking Skills Communication Skills
2.3 – Work, energy and power	• Discussing the conservation of total energy within energy transformations • Sketching and interpreting force–distance graphs • Determining work done including cases where a resistive force acts • Solving problems involving power • Quantitatively describing efficiency in energy transfers	Thinking Skills Communication Skills

2.4 – Momentum and impulse	• Applying conservation of momentum in simple isolated systems including (but not limited to) collisions, explosions, or water jets • Using Newton's second law quantitatively and qualitatively in cases where mass is not constant • Sketching and interpreting force–time graphs • Determining impulse in various contexts including (but not limited to) car safety and sports	Thinking Skills Communication Skills Social Skills
3.1 – Thermal concepts	• Describing temperature change in terms of internal energy • Using Kelvin and Celsius temperature scales and converting between them • Applying the calorimetric techniques of specific heat capacity or specific latent heat experimentally • Describing phase change in terms of molecular behaviour • Sketching and interpreting phase change graphs • Calculating energy changes involving specific heat capacity and specific latent heat of fusion and vaporization	Thinking Skills Communication Skills
3.2 – Modelling a gas	• Solving problems using the equation of state for an ideal gas and gas laws • Sketching and interpreting changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams • Investigating at least one gas law experimentally	Thinking Skills Communication Skills Research Skills
4.1 – Oscillations	• Qualitatively describing the energy changes taking place during one cycle of an oscillation • Sketching and interpreting graphs of simple harmonic motion examples	Thinking Skills Communication Skills
4.2 – Travelling waves	• Explaining the motion of particles of a medium when a wave passes through it for both transverse and longitudinal cases • Sketching and interpreting displacement–distance graphs and displacement– time graphs for transverse and longitudinal waves • Solving problems involving wave speed, frequency and wavelength • Investigating the speed of sound experimentally	Thinking Skills Communication Skills Research Skills

4.3 – Wave characteristics	• Sketching and interpreting diagrams involving wavefronts and rays • Solving problems involving amplitude, intensity and the inverse square law • Sketching and interpreting the superposition of pulses and waves • Describing methods of polarization • Sketching and interpreting diagrams illustrating polarized, reflected and transmitted beams	Thinking Skills Communication Skills
4.4 – Wave behaviour	• Sketching and interpreting incident, reflected and transmitted waves at boundaries between media • Solving problems involving reflection at a plane interface • Solving problems involving Snell's law, critical angle and total internal reflection • Determining refractive index experimentally • Qualitatively describing the diffraction pattern formed when plane waves are incident normally on a single-slit • Quantitatively describing double-slit interference intensity patterns	Thinking Skills Communication Skills
4.5 – Standing waves	• Describing the nature and formation of standing waves in terms of superposition • Distinguishing between standing and travelling waves • Observing, sketching and interpreting standing wave patterns in strings and pipes	Thinking Skills Communication Skills
5.1 – Electric fields	• Identifying two forms of charge and the direction of the forces between them • Solving problems involving electric fields and Coulomb's law • Calculating work done in an electric field in both joules and electronvolts • Identifying sign and nature of charge carriers in a metal • Identifying drift speed of charge carriers • Solving problems using the drift speed equation • Solving problems involving current, potential difference and charge	Thinking Skills

5.2 – Heating effect of electric currents	• Drawing and interpreting circuit diagrams • Identifying ohmic and non-ohmic conductors through a consideration of the V/I characteristic graph • Solving problems involving potential difference, current, charge, Kirchhoff's circuit laws, power, resistance and resistivity • Investigating combinations of resistors in parallel and series circuits • Describing ideal and non-ideal ammeters and voltmeters • Describing practical uses of potential divider circuits, including the advantages of a potential divider over a series resistor in controlling a simple circuit	Thinking Skills Communication Skills Social Skills
5.3 – Electric cells	• Investigating practical electric cells (both primary and secondary) • Describing the discharge characteristic of a simple cell (variation of terminal potential difference with time) • Identifying the direction of current flow required to recharge a cell • Determining internal resistance experimentally • Solving problems involving emf, internal resistance and other electrical	Thinking Skills Communication Skills
5.4 – Magnetic effects of electric currents	• Determining the direction of force on a charge moving in a magnetic field • Determining the direction of force on a current-carrying conductor in a magnetic field • Sketching and interpreting magnetic field patterns • Determining the direction of the magnetic field based on current direction	Thinking Skills Communication Skills
6.1 – Circular motion	• Identifying the forces providing the centripetal forces such as tension, friction, gravitational, electrical, or magnetic • Solving problems involving centripetal force, centripetal acceleration, period, frequency, angular displacement, linear speed and angular velocity • Qualitatively and quantitatively describing examples of circular motion including cases of vertical and horizontal circular motion	Thinking Skills
6.2 – Newton's law of gravitation	• Describing the relationship between gravitational force and centripetal force • Applying Newton's law of gravitation to the motion of an object in circular orbit around a point mass • Solving problems involving gravitational force, gravitational field strength, orbital speed and orbital period • Determining the resultant gravitational field strength due to two bodies	Thinking Skills

7.1 – Discrete energy and radioactivity	• Describing the emission and absorption spectrum of common gases • Solving problems involving atomic spectra, including calculating the wavelength of photons emitted during atomic transitions • Completing decay equations for alpha and beta decay • Determining the half-life of a nuclide from a decay curve • Investigating half-life experimentally (or by simulation)	Thinking Skills Research Skills
7.2 – Nuclear reactions	• Solving problems involving mass defect and binding energy • Solving problems involving the energy released in radioactive decay, nuclear fission and nuclear fusion • Sketching and interpreting the general shape of the curve of average binding energy per nucleon against nucleon number	Thinking Skills Communication Skills
7.3 – The structure of matter	• Describing the Rutherford-Geiger-Marsden experiment that led to the discovery of the nucleus • Applying conservation laws in particle reactions • Describing protons and neutrons in terms of quarks • Comparing the interaction strengths of the fundamental forces, including gravity	Thinking Skills Communication Skills
8.1 – Energy sources	• Solving specific energy and energy density problems • Sketching and interpreting Sankey diagrams • Describing the basic features of fossil fuel power stations, nuclear power stations, wind generators, pumped storage hydroelectric systems and solar power cells • Solving problems relevant to energy transformations in the context of these generating systems • Discussing safety issues and risks associated with the production of	Thinking Skills Communication Skills
8.2 – Thermal energy transfer	• Sketching and interpreting graphs showing the variation of intensity with wavelength for bodies emitting thermal radiation at different temperatures • Solving problems involving the Stefan–Boltzmann law and Wien's displacement law • Describing the effects of the Earth's atmosphere on the mean surface temperature	Thinking Skills Communication Skills

B.1 - Rigid bodies and rotational dynamics	• Calculating torque for single forces and couples • Solving problems involving moment of inertia, torque and angular acceleration • Solving problems in which objects are in both rotational and translational equilibrium • Solving problems using rotational quantities analogous to linear quantities • Sketching and interpreting graphs of rotational motion	Thinking Skills
B.2 – Thermodynamics	• Describing the first law of thermodynamics as a statement of conservation of energy • Explaining sign convention used when stating the first law of thermodynamics as Q = U +W • Solving problems involving the first law of thermodynamics • Describing the second law of thermodynamics in Clausius form, Kelvin form and as a consequence of entropy • Describing examples of processes in terms of entropy change • Solving problems involving entropy changes • Sketching and interpreting cyclic processes	Thinking Skills Communication Skills
B.3 – Fluids and fluid dynamics	• Determining buoyancy forces using Archimedes' principle • Solving problems involving pressure, density and Pascal's principle • Solving problems using the Bernoulli equation and the continuity equation •Explaining situations involving the Bernoulli effect • Describing the frictional drag force exerted on small spherical objects in laminar fluid flow • Solving problems involving Stokes' law • Determining the Reynolds number in simple situations	Thinking Skills Communication Skills
B.4 – Forced vibrations and resonance	• Qualitatively and quantitatively describing examples of under-, over- and criticallydamped oscillations • Graphically describing the variation of the amplitude of vibration with driving frequency of an object close to its natural frequency of vibration • Describing the phase relationship between driving frequency and forced oscillations • Solving problems involving Q factor • Describing the useful and destructive effects of resonance	Thinking Skills Communication Skills Social Skills
ONLY HL		

9.1 – Simple harmonic motion	• Solving problems involving acceleration, velocity and displacement during simple harmonic motion, both graphically and algebraically • Describing the interchange of kinetic and potential energy during simple harmonic motion • Solving problems involving energy transfer during simple harmonic	Thinking Skills Communication Skills
9.2 – Single-slit diffraction	• Describing the effect of slit width on the diffraction pattern • Determining the position of first interference minimum • Qualitatively describing single-slit diffraction patterns produced from white light and from a range of monochromatic light frequencies	Thinking Skills Communication Skills
9.3 – Interference	• Qualitatively describing two-slit interference patterns, including modulation by one-slit diffraction effect • Investigating Young's double-slit experimentally • Sketching and interpreting intensity graphs of double-slit interference patterns • Solving problems involving the diffraction grating equation • Describing conditions necessary for constructive and destructive interference from thin films, including phase change at interface and effect of refractive index • Solving problems involving interference from thin films	Thinking Skills Communication Skills Research Skills
9.4 – Resolution	• Solving problems involving the Rayleigh criterion for light emitted by two sources diffracted at a single slit • Resolvance of diffraction gratings	Thinking Skills
9.5 – Doppler effect	• Sketching and interpreting the Doppler effect when there is relative motion between source and observer • Describing situations where the Doppler effect can be utilized • Solving problems involving the change in frequency or wavelength observed due to the Doppler effect to determine the velocity of the source/observer	Thinking Skills Communication Skills
10.1 – Describing fields	• Representing sources of mass and charge, lines of electric and gravitational force, and field patterns using an appropriate symbolism • Mapping fields using potential • Describing the connection between equipotential surfaces and field lines	Thinking Skills Communication Skills

10.2 – Fields at work	• Determining the potential energy of a point mass and the potential energy of a point charge • Solving problems involving potential energy • Determining the potential inside a charged sphere • Solving problems involving the speed required for an object to go into orbit around a planet and for an object to escape the gravitational field of a planet • Solving problems involving orbital energy of charged particles in circular orbital motion and masses in circular orbital motion • Solving problems involving forces on charges and masses in radial and uniform fields	Thinking Skills Communication Skills
11.2 – Power generation and transmission	• Explaining the operation of a basic ac generator, including the effect of changing the generator frequency • Solving problems involving the average power in an ac circuit • Solving problems involving step-up and step-down transformers • Describing the use of transformers in ac electrical power distribution • Investigating a diode bridge rectification circuit experimentally • Qualitatively describing the effect of adding a capacitor to a diode bridge rectification circuit	Thinking Skills Communication Skills Research Skills
11.1 – Electromagnetic induction	• Describing the production of an induced emf by a changing magnetic flux and within a uniform magnetic field • Solving problems involving magnetic flux, magnetic flux linkage and Faraday's law • Explaining Lenz's law through the conservation of energy	Thinking Skills Communication Skills

11.3 – Capacitance	• Describing the effect of different dielectric materials on capacitance • Solving problems involving parallel-plate capacitors • Investigating combinations of capacitors in series or parallel circuits • Determining the energy stored in a charged capacitor • Describing the nature of the exponential discharge of a capacitor • Solving problems involving the discharge of a capacitor through a fixed resistor • Solving problems involving the time constant of an RC circuit for charge, voltage and current	Thinking Skills Communication Skills Research Skills
12.1 – The interaction of matter with radiation	• Discussing the photoelectric effect experiment and explaining which features of the experiment cannot be explained by the classical wave theory of light • Solving photoelectric problems both graphically and algebraically • Discussing experimental evidence for matter waves, including an experiment in which the wave nature of electrons is evident • Stating order of magnitude estimates from the uncertainty principle	Thinking Skills Communication Skills
12.2 – Nuclear physics	• Describing a scattering experiment including location of minimum intensity for the diffracted particles based on their de Broglie wavelength • Explaining deviations from Rutherford scattering in high energy experiments • Describing experimental evidence for nuclear energy levels • Solving problems involving the radioactive decay law for arbitrary time intervals • Explaining the methods for measuring short and long half-lives	Thinking Skills Communication Skills
B.3 – Fluids and fluid dynamics	• Determining buoyancy forces using Archimedes' principle • Solving problems involving pressure, density and Pascal's principle • Solving problems using the Bernoulli equation and the continuity equation • Explaining situations involving the Bernoulli effect • Describing the frictional drag force exerted on small spherical objects in laminar fluid flow • Solving problems involving Stokes' law	Thinking Skills Communication Skills

B.4 – Forced vibrations and resonance	• Qualitatively and quantitatively describing examples of under-, over- and criticallydamped oscillations • Graphically describing the variation of the amplitude of vibration with driving frequency of an object close to its natural frequency of vibration • Describing the phase relationship between driving frequency and forced oscillations • Solving problems involving Q factor • Describing the useful and destructive effects of resonance	Thinking Skills Communication Skills

8. International mindedness

Every IB course should contribute to the development of international-mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness (including resources you will use)
1.1 – Measurements in physics	• Scientific collaboration is able to be truly global without the restrictions of national borders or language due to the agreed standards for data representation.
1.3 – Vectors and scalars	• Vector notation forms the basis of mapping across the globe
2.1 – Motion	• International cooperation is needed for tracking shipping, land-based transport, aircraft and objects in space
2.4 – Momentum and impulse	• Automobile passive safety standards have been adopted across the globe based on research conducted in many countries
3.1 – Thermal concepts	• The topic of thermal physics is a good example of the use of international systems of measurement that allow scientists to collaborate effectively

4.1 – Oscillations	• Oscillations are used to define the time systems on which nations agree so that the world can be kept in synchronization. This impacts most areas of our lives including the provision of electricity, travel and location-determining devices and all microelectronics.
4.2 – Travelling waves	• Electromagnetic waves are used extensively for national and international communication
4.4 – Wave behaviour	• Characteristic wave behaviour has been used in many cultures throughout human history, often tying closely to myths and legends that formed the basis for early scientific studies.
4.5 – Standing waves	• The art of music, which has its scientific basis in these ideas, is universal to all cultures, past and present. Many musical instruments rely heavily on the generation and manipulation of standing waves
5.1 – Electric fields	• Electricity and its benefits have an unparalleled power to transform society
5.2 – Heating effect of electric currents	• A set of universal symbols is needed so that physicists in different cultures can readily communicate ideas in science and engineering
5.3 – Electric cells	• Battery storage is important to society for use in areas such as portable devices, transportation options and back-up power supplies for medical facilities
5.4 – Magnetic effects of electric currents	• The investigation of magnetism is one of the oldest studies by man and was used extensively by voyagers in the Mediterranean and beyond thousands of years ago
6.1 – Circular motion	• International collaboration is needed in establishing effective rocket launch sites to benefit space programmes
7.1 – Discrete energy and radioactivity	• The geopolitics of the past 60+ years have been greatly influenced by the existence of nuclear weapons
7.3 – The structure of matter	• Research into particle physics requires ever-increasing funding, leading to debates in governments and international research organizations on the fair allocation of precious financial resources
8.1 – Energy sources	• The production of energy from fossil fuels has a clear impact on the world we live in and therefore involves global thinking. The geographic concentrations of fossil fuels have led to political conflict and economic inequalities. The production of energy through alternative energy resources demands new levels of international collaboration.
8.2 – Thermal energy transfer	• The concern over the possible impact of climate change has resulted in an abundance of international press coverage, many political discussions within and between nations, and the consideration of people, corporations, and the environment when deciding on future plans for our planet. IB graduates should be aware of the science behind many of these scenarios.

B.2 – Thermodynamics	• The development of this topic was the subject of intense debate between scientists of many countries in the 19th century
B.3 – Fluids and fluid dynamics	• Water sources for dams and irrigation rely on the knowledge of fluid flow. These resources can cross national boundaries leading to sharing of water or disputes over ownership and use.
B.4 – Forced vibrations and resonance	• Communication through radio and television signals is based on resonance of the broadcast signals
ONLY HL	
9.4 – Resolution	• Satellite use for commercial and political purposes is dictated by the resolution capabilities of the satellite
9.5 – Doppler effect	• Radar usage is affected by the Doppler effect and must be considered for applications using this technology
11.2 – Power generation and transmission	• The ability to maintain a reliable power grid has been the aim of all governments since the widespread use of electricity started
11.3 – Capacitance	• Lightning is a phenomenon that has fascinated physicists from Pliny through Newton to Franklin. The charged clouds form one plate of a capacitor with other clouds or Earth forming the second plate. The frequency of lightning strikes varies globally, being particularly prevalent in equatorial regions. The impact of lightning strikes is significant, with many humans and animals being killed annually and huge financial costs to industry from damage to buildings, communication and power transmission systems, etc
B.4 – Forced vibrations and resonance	• Communication through radio and television signals is based on resonance of the broadcast signals

9. Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Inquirers	Aims 2 and 6 Practical work and internal assessment
Knowledgeable	Aims 1 and 10, international-mindedness links Practical work and internal assessment
Thinkers	Aims 3 and 4, Theory of knowledge links Practical work and internal assessment
Communicators	Aims 5 and 7, external assessment Practical work and internal assessment
Principled	Aims 8 and 9 Practical work and internal assessment. Ethical behaviour/practice (Ethical practice poster, IB animal experimentation policy), academic honesty
Open-minded	Aims 8 and 9, International-mindedness links Practical work and internal assessment, the group 4 project
Caring	Aims 8 and 9 Practical work and internal assessment, the group 4 project, ethical behaviour/ practice (Ethical practice poster, IB animal experimentation policy)
Risk-takers	Aims 1 and 6 Practical work and internal assessment, the group 4 project
Balanced	Aims 8 and 10 Practical work and internal assessment, the group 4 project and field work
Reflective	Aims 5 and 9 Practical work and internal assessment analysis, and group 4 project

10. Resources

Are instructional materials and other resources available in sufficient quality, quantity and variety to give effective support to the aims and methods of the courses? Will students have access to resources beyond the ones available at school? Briefly describe what plans are in place if changes are needed.

Water quality testing kits are being sought to allow more extensive / involved field work and river analysis. If necessary, additional invertebrate kick-nets and identification guides will be acquired as well, with the goal of exchanging data with (a) neighbor IB school(s).

IB Physics Course Book:
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Pages: 728

List of Physics Equipment

Item
1: Force and Motion
Physics Workshop Bundle
Economy Air Track
Complete Set of Push-Pull Spring Scales
Constant Velocity Cars
Human Dynamics Cart
Vertical Acceleration Demonstrator
Force Table
Velocity Radar Gun
Rotational Inertia Demonstrator
Deluxe Bicycle Wheel Gyroscope
Dynamics Carts (pair)
Liquid Accelerometer
Forces on Inclined Plane Demonstrator
Newton Spring Scales

11. . Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

The laboratory is a fully equipped high school science facility. Seating is around 6 large tables. There is a long countertop along one wall with two full sinks and adequate cabinet space to store laboratory equipment and supplies. Overhead, retractable power cords provide power for equipment, etc. The room is also equipped with projection tools and a smart board to accommodate a variety of presentations. Safety equipment including goggles, aprons, gloves, etc. are provided for individual student use and a fire blanket is available. A portable eyewash station and an emergency shower are provided as for the safety list items. Given the expanded list of laboratories required for the HL physics course, some equipment and laboratory supplies will be necessary, but are within budget for the first year of the course(August 2020).