



SAMPLE COURSE OUTLINE

PHYSICS

ATAR YEAR 12

Acknowledgement of Country

Kaya. The School Curriculum and Standards Authority (the Authority) acknowledges that our offices are on Whadjuk Noongar boodjar and that we deliver our services on the country of many traditional custodians and language groups throughout Western Australia. The Authority acknowledges the traditional custodians throughout Western Australia and their continuing connection to land, waters and community. We offer our respect to Elders past and present.

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Sample course outline

Physics – ATAR Year 12

Unit 3 and Unit 4

Science Inquiry Skills

Science Inquiry Skills align with the Science Understanding and Science as a Human Endeavour (SHE) content of the unit and are integrated into the learning experiences.

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics
- conduct practical work, including the manipulation of devices, safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways, including using appropriate Système International (SI) units and symbols, and significant figures
- organise and analyse data to identify trends, patterns and relationships
- identify sources of random and systematic uncertainty and estimate their effect on measurement results
- state absolute uncertainties in values and calculate percentage uncertainty where appropriate
- combine uncertainties in calculations to determine the overall uncertainty in a measurement (addition, subtraction, multiplication and division)
- identify anomalous data and calculate the percentage difference between the experimental results and a currently accepted value
- select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific texts and evaluate processes and conclusions by considering the available evidence, and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including text and graphical representations of empirical and theoretical relationships to communicate conceptual understanding, solve problems and make predictions
- select, use and interpret appropriate mathematical representations, including linear and non-linear graphs and algebraic relationships representing physical systems, to solve problems and make predictions
- relate gradients and axis intercepts of linear graphs to physical quantities
- apply dimensional analysis to determine the appropriate units for calculated quantities, e.g. a gradient in a graph
- use uncertainty bars to represent the uncertainty in a value on a graph and take into account when sketching a line of best fit
- communicate to specific audiences and for specific purposes using appropriate language and nomenclature

Semester 1 – Unit 3 – Gravity and relativity

Week	Key teaching points
1–3	<p>Static equilibrium and centre of mass</p> <ul style="list-style-type: none"> the stability of an object depends on the location of its centre of mass when an object experiences a net force at a distance from a pivot and at an angle to the lever arm, it will experience a torque or moment about that point for a rigid body to be in equilibrium, the sum of the forces and the sum of the moments must be zero static equilibrium contexts may include <ul style="list-style-type: none"> objects leaning against a frictionless wall, e.g. a ladder objects pivoting about one point, e.g. seesaw bridges and cantilevers suspension of objects by cables, e.g. signs
4–6	<p>Circular motion in horizontal and vertical plane</p> <ul style="list-style-type: none"> when an object experiences a net force perpendicular to its velocity, it will undergo circular motion, including: <ul style="list-style-type: none"> uniform circular motion on a horizontal plane circular motion involving 'banking', e.g. objects moving around a banked track, aeroplanes and birds turning in flight vertical circular motion, both uniform and non-uniform apparent weight of objects undergoing circular motion the law of conservation of energy applies to circular motion <p>Task 1: Test – Equilibrium and circular motion</p>
7–10	<p>Gravity</p> <ul style="list-style-type: none"> all objects with mass attract one another with a gravitational force and the magnitude of this force can be calculated using Newton's law of universal gravitation objects with mass produce a gravitational field in the space that surrounds them a gravitational force on an object is due to the presence of a gravitational field work is done when a mass moves from one point to another in a gravitational field and its potential energy changes gravitational field strength is defined as the net force per unit mass at a particular point in the field the vector nature of the gravitational force can be used to analyse motion on inclined planes by considering the components of the gravitational force (that is, weight) parallel and perpendicular to the plane projectile motion can be analysed quantitatively by treating the horizontal and vertical components of the motion independently Newton's law of universal gravitation is used to explain Kepler's third law of planetary motion and to describe the motion of planets and other satellites, which is modelled as uniform circular motion SHE: artificial satellites are used for communication, navigation, remote-sensing and research. Their orbits and uses are classified by altitude (low, medium or high Earth orbits) and by inclination (equatorial, polar and sun-synchronous orbits).
11–13	<p>Relativity</p> <ul style="list-style-type: none"> Einstein's theory of special relativity is based on two postulates: that the speed of light in a vacuum is an absolute constant and that the laws of physics are the same in all inertial reference frames observations of objects travelling at very high speeds cannot be explained by Newtonian physics SHE: experimental observations of high-speed muons created in the upper atmosphere provide evidence for Einstein's theory of special relativity.

Week	Key teaching points
	<ul style="list-style-type: none">• events that are simultaneous in one inertial frame of reference may not be simultaneous in another• motion can only be measured relative to an observer. Length and time are relative quantities that depend on the observer's frame of reference• SHE: Einstein's theory of general relativity explains phenomena including time dilation in atomic clocks on global positioning system (GPS) satellites, the existence of black holes, gravity waves and gravitational lensing <p>Task 2: Test – Gravity and relativity</p>
14	Examination revision
15	Task 3: Semester 1 examination based on Unit 3 content

Semester 2 – Unit 4 – Electromagnetism and modern physics

Week	Key teaching points
1–3	<p>Electromagnetism</p> <ul style="list-style-type: none"> • electrostatically charged objects exert a force upon one another; the magnitude of this force can be calculated using Coulomb’s law • point charges and charged objects produce an electric field in the space that surrounds them; field theory attributes the electrostatic force on a point charge or charged body to the presence of an electric field • a positively-charged body placed in an electric field will experience a force in the direction of the field; the strength of the electric field is defined as the force per unit charge • when a charged body moves, or is moved, from one point to another in an electric field and its potential energy changes, work is done on the charge by the field • between charged, parallel plates separated by distance d, the electric field is uniform • the direction of conventional current is that in which the flow of positive charges takes place, while the electron flow is in the opposite direction • current-carrying wires are surrounded by magnetic fields; these fields are utilised in solenoids and electromagnets • magnetic field diagrams are used to show the direction and strength of the magnetic field surrounding objects, including permanent magnets, current-carrying conductors and the Earth • the strength of the magnetic field produced by a current is a measure of the magnetic flux density • magnets, magnetic materials, moving charges and current-carrying wires experience a force in a magnetic field when they cut flux lines; this force is utilised in DC electric motors and particle accelerators • the force due to a current in a magnetic field in a DC electric motor produces a torque on the coil in the motor
4–5	<ul style="list-style-type: none"> • an induced emf is produced by the relative motion of a straight conductor in a magnetic field when the conductor cuts flux lines • magnetic flux is defined in terms of magnetic flux density and area • a changing magnetic flux induces a potential difference; this process of electromagnetic induction is used in DC and AC generators • step-up and step-down transformers are used in large scale AC power distribution systems • SHE: generation and transmission of electrical energy • conservation of energy, expressed as Lenz’s law of electromagnetic induction, is used to determine the direction of induced current • electromagnetism is utilised in a range of technological applications, including: <ul style="list-style-type: none"> ▪ the back emf produced in a motor ▪ regenerative braking ▪ induction hotplates • SHE: electromagnetism is utilised in a variety of applications in society, including: <ul style="list-style-type: none"> ▪ motors, generators and transformers in common household appliances, entertainment systems and industrial settings ▪ transport, e.g. electric and hybrid vehicles, magnetic levitation trains ▪ communication systems ▪ medical settings, e.g. magnetic resonance imaging

Week	Key teaching points
6–7	<p>Particle accelerators</p> <ul style="list-style-type: none"> • electric and magnetic fields are used in high-energy particle accelerators to control the motion of charged particles • SHE: linear particle accelerator (LINAC), cyclotron, synchrotron, mass spectrometers and velocity selectors • relativistic momentum increases at high speed and prevents an object from reaching the speed of light • the concept of mass–energy equivalence emerged from the theory of special relativity and explains the source of the energy produced in nuclear reactions. The mass of an object is constant and independent of its motion • the total energy E of a moving object is the sum of the energy due to its mass and kinetic energy • the total energy E of an object can be expressed in terms of its mass and momentum <p>Task 4: Test – Electromagnetism and particle accelerators</p>
8–9	<p>Wave particle duality and the quantum theory</p> <ul style="list-style-type: none"> • a wave model is required to explain light-related phenomena of diffraction and interference, including Young’s double-slit experiment • light exhibits many wave properties, but it cannot be modelled as a mechanical wave because it can travel through a vacuum • a transverse wave model is required to explain polarisation • electromagnetic waves are transverse waves made up of mutually perpendicular, oscillating electric and magnetic fields • oscillating charges produce electromagnetic waves of the same frequency as the oscillation; electromagnetic waves cause charges to oscillate at the frequency of the wave
10–11	<ul style="list-style-type: none"> • atomic phenomena and the interaction of light with matter indicate that states of matter and energy are quantised into discrete values • the observed spectrum of thermal radiation emitted by a black body radiator is not able to be explained by the classical wave model. A particle model was developed to explain the shape and dependence of the spectra on temperature • on the atomic level, electromagnetic radiation is emitted or absorbed in discrete packets called photons. The energy of a photon E is proportional to its frequency f and momentum p • the constant of proportionality, Planck’s constant, can be determined experimentally using the photoelectric effect • atoms of an element emit and absorb specific wavelengths of light that are unique to that element; this is the basis of spectral analysis • the Bohr model of the hydrogen atom integrates light quanta and atomic energy states to explain the specific wavelengths in the hydrogen spectrum and in the spectra of other simple atoms; this model enables line spectra to be correlated with atomic energy-level diagrams and explains the phenomenon of fluorescence and phosphorescence, and X-ray production • SHE: fluorescence, phosphorescence and X-rays are utilised in a variety of applications in society, including: <ul style="list-style-type: none"> ▪ medical and forensic sciences ▪ astronomy, e.g. space telescopes ▪ industry, e.g. food irradiation, airport scanners, X-ray fluorescence, fluorescent labelling and dyes, biological markers

Week	Key teaching points
	<ul style="list-style-type: none"> ▪ domestic and industrial lighting ▪ pharmaceutical and cosmetic industries • on the atomic level, energy and matter exhibit the characteristics of both waves and particles. Young's double-slit experiment is explained with a wave model but produces the same interference and diffraction patterns when one photon at a time or one electron at a time are passed through the slits • SHE: devices developed from the application of quantum physics, including the laser, photovoltaic cells and light-emitting diodes (LEDs)
12–13	<p>Cosmology</p> <ul style="list-style-type: none"> • units of measurement for astronomical distances include the astronomical unit (AU), light year and parsec • the Big Bang theory describes the early development of the universe • there is a variety of evidence that supports the Big Bang theory, including cosmic background radiation, expansion of space, the abundance of light elements and the red shift of light from galaxies that obey Hubble's law <p>Task 5: Test – Wave particle duality, quantum theory and cosmology</p> <p>Task 6: Portfolio based on Unit 3 (40%) and Unit 4 (60%)</p>
14	Examination revision
15	Task 7: Semester 2 examination based on Unit 3 (45%) and Unit 4 (55%) content