Government of Western Australia
School Curriculum and Standards Authority

Sample Course Outline

Physics

ATAR Year 11

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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Unit 1 and 2

Science Inquiry Skills

Science Inquiry Skills align with the Science Understanding and Science as a Human Endeavour 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 1 – Linear motion and force

Week	Key teaching points

1–5	**Motion and forces**
	• distinguish between vector and scalar quantities
	• addition and subtraction of vectors in one and two dimensions
	• resolution of vectors into components and manipulation (addition and subtraction) of components
	• change (final – initial) in a variable is represented by the symbol Δ, e.g. $\Delta t = t_f - t_i$
	• displacement is defined as the change in position of an object
	• velocity is defined as the rate of change in displacement of an object
	• uniformly accelerated motion (a is constant) is described in terms of relationships between measurable scalar and vector quantities, including displacement, velocity and time
	• motion can be represented graphically to describe linear motion including determination and manipulation and use of gradients of curves and areas under graphs of
	  ▪ displacement–time
	  ▪ velocity–time
	  ▪ acceleration–time
	• vertical motion is analysed by assuming the acceleration due to gravity is constant near Earth's surface
	
	Task 1: Test – Motion

6–9	• momentum is a property of moving objects; it is conserved in a closed system and may be transferred from one object to another when a force acts over a time interval • Newton's three laws of motion describe the relationship between the force or forces acting on an object, modelled as a point mass, and the motion of the object due to the application of the force or forces • free body diagrams show the forces acting on objects, from descriptions of real-life situations involving forces acting in one or two dimensions • the acceleration acting on an object can be determined from the summation (ΣF) of the forces (net force) acting on the object and mass of the object • a change in momentum is caused by a force acting over a period of time and is referred to as impulse • the weight of an object near to the Earth's surface, where acceleration due to gravity is constant, is given by $F_{weight} = mg$ • friction is a contact force between two surfaces which opposes motion. Friction is proportional to the normal force (F_N) and the coefficient of friction between the surfaces. Friction can be classified as static or kinetic, depending on the relative motion between surfaces • 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, including friction • **Science as a Human Endeavour (SHE):** safety for motorists and other road users has been substantially increased through application of Newton's laws and conservation of momentum by the development and use of passive safety devices, e.g. helmets, seatbelts, crumple zones, airbags, collapsible steering columns, safety barriers.

Week	Key teaching points
10–11	**Mechanical and thermal energy** • energy is associated with the motion of objects and their position relative to the surface of the Earth • total energy is conserved in isolated systems • energy is transferred from one object to another when a force is applied over a distance; this causes work to be done and changes the kinetic (E_k) and/or potential (E_p) energy of objects • collisions may be elastic and inelastic; kinetic energy is conserved in elastic collisions • power is the rate of doing work or transferring energy
12–14	• kinetic theory describes matter as consisting of particles in continuous motion, except at the temperature of absolute zero • all substances have internal energy due to the motion and separation of their particles • temperature is a measure of the average translational kinetic energy of particles in a system • provided a substance does not change state, its temperature change is proportional to the amount of energy added to or removed from the substance; the constant of proportionality describes the heat capacity of the substance • change of state involves separating particles which exert attractive forces on each other; latent heat is the energy required to be added to or removed from a system to change the state of the system • two systems in contact transfer energy between particles so that eventually the systems reach the same temperature; that is, they are in thermal equilibrium. This may involve changes of state as well as changes in temperature • **SHE:** the operation of a refrigerator and reverse-cycle air conditioner is based on thermal energy transfer **Task 2:** Portfolio 1 **Task 3:** Test – Forces, mechanical and thermal energy
15	Examination revision
16	**Task 4:** Semester 1 examination based on Unit 1 content

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Physics – ATAR Year 11

Semester 2 - Unit 2 – Waves, nuclear and electrical physics

Week	Key teaching points
1–3	**Waves** • waves are periodic oscillations that transfer energy from one point to another • mechanical waves transfer energy through a medium; longitudinal and transverse waves are distinguished by the relationship between the directions of oscillation of particles relative to the direction of the wave velocity • waves may be represented by displacement/time and displacement/distance wave diagrams and described in terms of relationships between measurable quantities, including period, amplitude, wavelength, frequency and velocity • the mechanical wave model can be used to explain phenomena related to reflection and refraction, including echoes and seismic phenomena • the superposition of waves in a medium may lead to the formation of standing waves and interference phenomena, including two parallel coherent speakers, standing waves in pipes and stretched strings and observation of beats • a mechanical system resonates when it is driven at one of its natural frequencies of oscillation; energy is transferred efficiently into systems under these conditions • **SHE:** concepts of standing waves and resonance are applied in musical instruments • **SHE:** ultrasound is used as a diagnostic and cleaning tool in different industries
4–6	**Ionising radiation and nuclear reactions** • the nuclear model of the atom describes the atom as consisting of an extremely small nucleus which contains most of the atom's mass, and is made up of positively charged protons and uncharged neutrons surrounded by negatively charged electrons • nuclear stability is the result of the strong nuclear force which operates between nucleons over a very short distance and opposes the electrostatic repulsion between protons in the nucleus • some nuclides are unstable and spontaneously decay, emitting alpha, beta (+/-) and/or gamma radiation over time until they become stable nuclides • protons and neutrons are made of fundamental particles called quarks • beta minus (β^-) and beta plus (β^+) decay can be explained by the transformation of quarks in the nucleus • in nuclear reactions, energy, momentum and charge are conserved; one example is through the emission of neutrinos or antineutrinos in beta plus (β^+) and beta minus (β^-) decay • each species of radionuclide has a half-life which indicates the rate of decay • alpha, beta and gamma radiation have different natures, properties and effects • the measurement of absorbed dose and dose equivalence enables the analysis of health and environmental risks • **SHE:** radioisotopes are used as diagnostic tools and for tumour treatment in medicine **Task 5:** Test – Waves and Nuclear physics (nuclear model, types of radiation, nuclear equations, half-life, biological effects of radiation)

Week	Key teaching points
7–9	• Einstein's mass/energy relationship relates the binding energy of a nucleus to its mass defect • Einstein's mass/energy relationship also applies to all energy changes and enables the energy released in nuclear reactions to be determined from the mass change in the reaction • alpha and beta decay are examples of spontaneous transmutation reactions, while artificial transmutation is a managed process that changes one nuclide into another • neutron-induced nuclear fission is a reaction in which a heavy nuclide captures a neutron and then splits into smaller radioactive nuclides with the release of energy • a fission chain reaction is a self-sustaining process that may be controlled to produce thermal energy, or uncontrolled to release energy explosively if its critical mass is exceeded • **SHE:** nuclear power stations employ a variety of safety mechanisms to prevent nuclear accidents, including shielding, cooling systems and radiation monitors • **SHE:** the management of nuclear waste is based on the knowledge of the behaviour of radiation • nuclear fusion is a reaction in which light nuclides combine to form a heavier nuclide, with the release of energy • more energy is released per nucleon in nuclear fusion than in nuclear fission because a greater percentage of the mass is transformed into energy • **SHE:** international research teams are developing Generation IV fission reactors and fusion reactors as long-term solutions to meeting the world's energy needs • the early universe was composed mostly of hydrogen, and all other elements that are present in today's universe, including the human body, were created via nuclear processes inside stars and during the destruction of stars
10–14	**Electrical forces and energy** • there are two types of electric charge, positive and negative • the energy available to charges moving in an electrical circuit is measured using electric potential difference (*V*), which is defined as the change in potential energy per unit charge between two defined points in the circuit • energy is required to separate positive and negative charge carriers; charge separation produces an electrical potential difference that drives current in circuits • electric current is carried by discrete charge carriers; charge is conserved at all points in an electrical circuit • energy is conserved in the energy transfers and transformations that occur in an electrical circuit • electrical circuits enable electrical energy to be transferred and transformed into a range of other useful forms of energy, including thermal and kinetic energy, and light • power is the rate at which energy is transformed by a circuit component; power enables quantitative analysis of energy transformations in the circuit • resistance is defined as the ratio of potential difference across the component to the current in the component • conductors can be classified as ohmic or non-ohmic • circuit analysis and design involve calculation of the potential difference across the current in, and the power supplied to, components in series, parallel and series/parallel circuits • **SHE:** there is an inherent danger involved with the use of electricity that can be reduced by using various safety devices, including fuses, residual current devices (RCD), circuit breakers, earth wires and double insulation **Task 6:** Portfolio 2 **Task 7:** Test – Nuclear physics (binding energy, fission and fusion, reactors) and Electrical physics

Week	Key teaching points
15	Examination revision
16	**Task 8:** Semester 2 examination based on Unit 1 (40%) and 2 (60%) content