Government of **Western Australia**
School Curriculum and Standards Authority

SAMPLE COURSE OUTLINE

PHYSICS
ATAR YEAR 11

Sample course outline

Physics – ATAR Year 11

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, construct and refine questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations; conduct risk assessments; and consider research ethics
- conduct investigations, including using temperature, current and potential difference measuring devices, safely, competently and methodically
- represent data in meaningful and useful ways, including using appropriate SI units and symbols, and significant figures; organise and analyse data to identify trends, patterns and relationships; identify sources of random and systematic error and estimate their effect on measurement results; identify anomalous data and calculate the measurement discrepancy between experimental results and a currently accepted value, expressed as a percentage; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including text and graphic representations of empirical and theoretical relationships, flow diagrams, nuclear equations and circuit diagrams, 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
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

Unit 1 – Thermal, nuclear and electrical physics

Semester 1

Week	Key teaching points
1–2	**Heating processes** • kinetic particle model describes matter as consisting of particles in constant motion, except at absolute zero • all substances have internal energy due to the motion and separation of their particles • temperature is a measure of the average 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 • passive solar design for heating and cooling buildings, solar water heating (SHE) **Task 1:** Evaluation and analysis – Design an energy efficient building – with a specific brief
3–4	• 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 • development of the refrigerator over time (SHE) **Task 2:** Investigation – Design an investigation to determine the specific heat capacity of an unknown substance
5	• heat transfer occurs between and within systems by conduction, convection and/or radiation • engine cooling systems in cars (SHE)
6	• a system with thermal energy has the capacity to do mechanical work [to apply a force over a distance]; when work is done, the internal energy of the system changes • because energy is conserved, the change in internal energy of a system is equal to the energy added by heating, or removed by cooling, plus the work done on or by the system • energy transfers and transformations in mechanical systems always result in some heat loss to the environment, so that the usable energy is reduced and the system cannot be 100 percent efficient **Task 3:** Heating processes test
7–8	**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 • alpha, beta and gamma radiation have different natures, properties and effects • each species of radionuclide has a half-life which indicates the rate of decay

Week	Key teaching points
9	• the measurement of absorbed dose and dose equivalence enables the analysis of health and environmental risks • Einstein's mass/energy relationship relates the binding energy of a nucleus to its mass defect • Einstein's mass/energy relationship 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 • radioisotopes are used as diagnostic tools and for tumour treatment in medicine (SHE)

10	• 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
	• 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
	• qualitative and quantitative analyses of relative risk (including half-life, absorbed dose, dose equivalence) are used to inform community debates about the use of radioactive materials and nuclear reactions for a range of applications and purposes, including:
	  ○ nuclear power stations employ a variety of safety mechanisms to prevent nuclear accidents, including shielding, moderators, cooling systems and radiation monitors
	  ○ the management of nuclear waste is based on the knowledge of the behaviour of radiation (SHE)
	Task 4: Ionising radiation and nuclear reactions test

11–12	**Electrical circuits** • there are two types of charge that exert forces on each other • 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 • the energy available to charges moving in an electrical circuit is measured using electric potential difference, 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 • power is the rate at which energy is transformed by a circuit component; power enables quantitative analysis of energy transformations in the circuit • resistance depends upon the nature and dimensions of a conductor • Ohm's law: resistance for ohmic and non-ohmic components is defined as the ratio of potential difference across the component to the current in the component **Task 5:** Experiment – Determine the resistance of an unknown resistor

Week	Key teaching points
13–15	• 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 • 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 • 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 • the supply of electricity to homes has had an enormous impact on society and the environment. An understanding of electrical circuits informs the design of effective safety devices for the safe operation of lighting, power points, stoves, other household electrical devices (SHE) **Task 6:** Electrical circuits test
16	**Task 7:** Semester 1 examination based on Unit 1 content

Sample course outline

Physics – ATAR Year 11

Unit 2 – Linear motion and waves

Semester 2

Week	Key teaching points
1–2	**Linear motion and force** • distinguish between vector and scalar quantities, and add and subtract vectors in two dimensions • uniformly accelerated motion is described in terms of relationships between measurable scalar and vector quantities, including displacement, speed, velocity and acceleration • representations, including graphs, vectors, and equations of motion, can be used qualitatively and quantitatively to describe and predict linear motion • vertical motion is analysed by assuming the acceleration due to gravity is constant near Earth's surface • free body diagrams show the forces and net force acting on objects, from descriptions of real-life situations involving forces acting in one or two dimensions

3–5	• 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
	• 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 devices, including:
	  ○ helmets
	  ○ seatbelts
	  ○ crumple zones
	  ○ airbags
	  ○ safety barriers (SHE)
	Task 8: Investigation – Motion investigation on acceleration (effect of safety devices)

6–7	• energy is conserved in isolated systems and 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 (Ek) and/or potential (Ep) energy of objects • collisions may be elastic and inelastic; kinetic energy is conserved in elastic collisions
8	• power is the rate of doing work or transferring energy **Task 9:** Linear motion and force test
9	**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

Week	Key teaching points
10	• the mechanical wave model can be used to explain phenomena related to reflection and refraction, including echoes and seismic phenomena • noise pollution comes from a variety of sources and is often amplified by walls, buildings and other built structures. Acoustic engineering, based on an understanding of the behaviour of sound waves, is used to reduce noise pollution. It focuses on absorbing sound waves or planning structures so that reflection and amplification do not occur (SHE) **Task 10:** Evaluation and analysis – Respond to scientific article on acoustics
11–13	• the superposition of waves in a medium may lead to the formation of standing waves and interference phenomena, including standing waves in pipes and on stretched strings • 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 • the intensity of a wave decreases in an inverse square relationship with distance from a point source **Task 11:** Experiment – Resonance in closed pipes

14	• Application of the wave model has enabled the visualisation of imaging techniques. These can include:
	  ○ medical applications, such as ultrasound
	  ○ geophysical exploration, such as seismology (SHE)
	Task 12: Waves test

15	Revision
16	**Task 13:** Semester 2 examination based on Unit 1 and 2 content