



**COURSE OUTLINE**  
**PHYSICS – ATAR YEAR 12: 2022**  
**UNIT 3 AND UNIT 4**



This course will run the two units, 3 and 4, concurrently. The student Semester 1 grade will therefore be an estimate.

Term	Week	Topic and key teaching points	Syllabus content	Assessment
1	1-2	<b>Gravity and motion</b>	<ul style="list-style-type: none"> <li>the movement of free-falling bodies in Earth's gravitational field is predictable</li> <li>all objects with mass attract one another with a gravitational force; the magnitude of this force can be calculated using Newton's Law of Universal Gravitation</li> <li>objects with mass produce a gravitational field in the space that surrounds them; field theory attributes the gravitational force on an object to the presence of a gravitational field</li> <li>when a mass moves or is moved from one point to another in a gravitational field and its potential energy changes, work is done on the mass by the field</li> <li>gravitational field strength is defined as the net force per unit mass at a particular point in the field</li> <li>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</li> <li>projectile motion can be analysed quantitatively by treating the horizontal and vertical components of the motion independently</li> </ul>	Task 1: Investigation of motion on an inclined plane
1	3-4		<ul style="list-style-type: none"> <li>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</li> <li>for a rigid body to be in equilibrium, the sum of the forces and the sum of the moments must be zero</li> </ul>	
1	5-6		<ul style="list-style-type: none"> <li>when an object experiences a net force of constant magnitude perpendicular to its velocity, it will undergo uniform circular motion, including circular motion on a horizontal plane and around a banked track; and vertical circular motion</li> <li>Newton's Law of Universal Gravitation is used to explain Kepler's laws of planetary motion and to describe the motion of planets and other satellites, modelled as uniform circular motion</li> <li>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). Satellites are used for communication in global positioning systems (GPS), satellite phones and television; navigation and geographical information</li> </ul>	Task 2: Experiment – Circular Motion Task 3: Test - Gravity and Motion

1	7	<b>Electromagnetism</b>	<ul style="list-style-type: none"> <li>• electrostatically charged objects exert a force upon one another; the magnitude of this force can be calculated using Coulomb's Law</li> <li>• 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</li> <li>• 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</li> <li>• 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</li> <li>• 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</li> </ul>	
1	8-9		<ul style="list-style-type: none"> <li>• current-carrying wires are surrounded by magnetic fields; these fields are utilised in solenoids and electromagnets</li> <li>• the strength of the magnetic field produced by a current is a measure of the magnetic flux density</li> <li>• 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</li> <li>• the force due to a current in a magnetic field in a DC electric motor produces a torque on the coil in the motor</li> <li>• DC electric motor with commutator, and back emf</li> </ul>	
1	9-10		<ul style="list-style-type: none"> <li>• an induced emf is produced by the relative motion of a straight conductor in a magnetic field when the conductor cuts flux lines</li> <li>• magnetic flux is defined in terms of magnetic flux density and area</li> <li>• a changing magnetic flux induces a potential difference; this process of electromagnetic induction is used in step-up and step-down transformers, DC and AC generators</li> <li>• conservation of energy, expressed as Lenz's Law of electromagnetic induction, is used to determine the direction of induced current</li> </ul>	
2	1-3		<p>Electromagnetism is utilised in a range of technological applications, including:</p> <ul style="list-style-type: none"> <li>• AC and DC generators</li> <li>• regenerative braking</li> <li>• induction hotplates</li> <li>• large scale AC power distribution systems</li> </ul>	Task 4: Test - Electromagnetism
2	4-5	<b>EXAMS</b>		Task 5: EXAM Sem 1

2	5-7	<b>Wave particle duality and the quantum theory</b>	<ul style="list-style-type: none"> <li>• light exhibits many wave properties; however, it cannot only be modelled as a mechanical wave because it can travel through a vacuum</li> <li>• a wave model explains a wide range of light-related phenomena, including reflection, refraction, dispersion, diffraction and interference; a transverse wave model is required to explain polarisation</li> <li>• electromagnetic waves are transverse waves made up of mutually perpendicular, oscillating electric and magnetic fields</li> <li>• oscillating charges produce electromagnetic waves of the same frequency as the oscillation; electromagnetic waves cause charges to oscillate at the frequency of the wave</li> <li>• historical evidence for the dual nature of light includes Young’s double slit experiment, Fresnel’s and Poisson’s experiments; and Maxwell’s theory of electromagnetism</li> </ul>	
2	8-10		<ul style="list-style-type: none"> <li>• atomic phenomena and the interaction of light with matter indicate that states of matter and energy are quantised into discrete values</li> <li>• on the atomic level, electromagnetic radiation is emitted or absorbed in discrete packets called photons. The energy of a photon is proportional to its frequency. The constant of proportionality, Planck’s constant, can be determined experimentally using the photoelectric effect and the threshold voltage of coloured LEDs</li> <li>• a wide range of phenomena, including black body radiation and the photoelectric effect, are explained using the concept of light quanta</li> <li>• atoms of an element emit and absorb specific wavelengths of light unique to that element; this is the basis of spectral analysis</li> <li>• 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; the Bohr model enables line spectra to be correlated with atomic energy-level diagrams</li> <li>• 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</li> <li>• the use of devices developed from the application of quantum physics, including the laser and photovoltaic cells, have significantly changed many aspects of society</li> </ul>	Task 6: Evaluation – Quantum Theory

3	1-3	<b>Special relativity</b>	<ul style="list-style-type: none"> <li>• observations of objects travelling at very high speeds cannot be explained by Newtonian physics. These include the dilated half-life of high-speed muons created in the upper atmosphere, and the momentum of high-speed particles in particle accelerators</li> <li>• Einstein's special theory of relativity predicts significantly different results to those of Newtonian physics for velocities approaching the speed of light</li> <li>• the special theory of relativity is based on two postulates: that the speed of light in a vacuum is an absolute constant, and that all inertial reference frames are equivalent</li> <li>• motion can only be measured relative to an observer; length and time are relative quantities that depend on the observer's frame of reference</li> <li>• relativistic momentum increases at high relative speed and prevents an object from reaching the speed of light</li> <li>• the concept of mass-energy equivalence emerged from the special theory of relativity and explains the source of the energy produced in nuclear reactions</li> <li>• research studies of cosmic rays show that interactions between cosmic rays and the upper atmosphere produce muons. These particles have a lifetime of about two microseconds and should have ceased to exist before reaching the surface of the Earth. However, because they are travelling near the speed of light, the time dilation effect allows them to complete their journey. Continuing research in the field of high-energy physics is important for improving our understanding of our world and its origins</li> </ul>	Task 7: Test – Waves & Special Relativity
3	4-7	<b>The Standard Model</b>	<ul style="list-style-type: none"> <li>• the expansion of the universe can be explained by Hubble's law and cosmological concepts, such as red shift and the Big Bang theory</li> <li>• the Standard Model is used to describe the evolution of forces and the creation of matter in the Big Bang theory</li> <li>• the Big Bang theory describes the early development of the universe, including the formation of subatomic particles from energy and the subsequent formation of atomic nuclei. There is a variety of evidence that supports the Big Bang theory, including Cosmic Background Radiation, the abundance of light elements and the red shift of light from galaxies that obey Hubble's Law. Alternative theories exist, including the Steady State theory, but the Big Bang theory is the most widely accepted theory today (SHE)</li> <li>• high-energy particle accelerators are used to test theories of particle physics, including the Standard Model</li> <li>• the Standard Model is based on the premise that all matter in the universe is made up from elementary matter particles called quarks and leptons; quarks experience the strong nuclear force, leptons do not</li> <li>• the Standard Model explains three of the four fundamental forces (strong, weak and electromagnetic forces) in terms of an exchange of force-carrying particles called gauge bosons; each force is mediated by a different type of gauge boson</li> <li>• lepton number and baryon number are examples of quantities that are conserved in all reactions between particles; these conservation laws can be used to support or invalidate proposed reactions. Baryons are composite particles made up of quarks.</li> </ul>	Task 8: Test – Standard Model and Particle Theory

3	8	<b>REVISION</b>		
3	9-10	<b>Exams</b>		Task 9: Exam – Sem 2