COURSE OUTLINE PHYSICS – ATAR YEAR 12: 2021
UNIT 3 AND UNIT 4

Term	Weeks	Topic and key teaching points	Syllabus content	Assessment
1	1-3	**Projectile rocket launching and movement in sports** **Circular Motion found at funfairs and play-grounds**	• projectile motion can be analysed quantitatively by treating the horizontal and vertical components of the motion independently *This includes applying the relationships* $v_{av} = \frac{s}{t}$, $a = \frac{v-u}{t}$, $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$, $E_k = \frac{1}{2}mv^2$ • 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 *This includes applying the relationships* $v = \frac{2\pi r}{T}$, $a_c = \frac{v^2}{r}$, resultant $F = m a_c = \frac{mv^2}{r}$,	Experiment – centripetal motion
1	4-5	**Torque as applied to: levers, wrenches,** **wheel barrows, and the structure of bridges**	• 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 *This includes applying the relationship* $\tau = r F \sin\theta$ • for a rigid body to be in equilibrium, the sum of the forces and the sum of the moments must be zero. *This includes applying the relationships* $\sum F = 0$, $\tau = r F \sin\theta$, $\sum \tau = 0$	

1	6	**Satellite Problems** **Orbit of celestial bodies**	the movement of free-falling bodies in Earth's gravitational field is predictable • 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. *This includes applying the relationship* $F_g = G\frac{m_1 m_2}{r^2}$ • 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. *This includes applying the relationship* $F_{weight} = m\,g$ • gravitational field strength is defined as the net force per unit mass at a particular point in the field. *This includes applying the relationships* $g = \frac{F_g}{m} = G\frac{M}{r^2}$	Motion Test
1	7	**Launching of Satellites** **Escape velocity** **Orbital Speeds of Celestial Bodies** **Relative motion of celestial bodies**	• 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. This includes applying the relationships: $E_p = m\,g\,\Delta h$, $W = F\,s$, $W = \Delta E$, $E_k = \frac{1}{2} m\,v^2$ • 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 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. This includes deriving and applying: $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$	

1	8	**Electric Fields** **Electric Fields in Cell Membranes** **Electrostatic Attraction and Repulsion** **Forces within the atom** **Electron Guns** **cathode ray oscilloscopes and Accelerators**	• electrostatically charged objects exert a force upon one another; the magnitude of this force can be calculated using Coulomb's Law. Including $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ • 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. This includes applying the relationship: $E = \frac{F}{q}$ 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. *This includes applying the relationship:* $V = \frac{W}{q}$ • 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 • 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 *This includes applying the relationships* $F = qvB$ where $v \perp B$, $F = IlB$ where $l \perp B$	Gravity & Orbits Test

1 2	9 1	**Solenoids** **And** **Electro-magnets**	• 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 *This includes applying the relationships* $F = q v B$ where $v \perp B$, $F = I l B$ where $l \perp B$ • the strength of the magnetic field produced by a current is a measure of the magnetic flux density *This includes applying the relationship* $B = \frac{\mu_0}{2\pi} \frac{I}{r}$	Electrostatics Test
2	2-3	**Transformers** **Induction Hotplate**	• Magnetic flux is defined in terms of magnetic flux density and area. *This includes applying the relationship:* $\Phi = BA$ • Faraday's Law • a changing magnetic flux induces a potential difference; this process of electromagnetic induction is used in DC and AC generators • Lenz's Law: Conservation of energy, expressed as Lenz's Law of electromagnetic induction, is used to determine the direction of induced current • a changing magnetic flux induces a potential difference; this process of electromagnetic induction is used in step-up and step-down **transformers** *This includes applying the relationships* $\text{induced emf} = -N\frac{(\Phi_2 - \Phi_1)}{t} = -N\frac{\Delta\Phi}{t} = -N\frac{\Delta(B A_\perp)}{t}$ $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $P = V I = I^2 R = \frac{V^2}{R}$	

2	4-5	**AC and DC** **-motors** **-generators** **Back EMF** **Regenerative Braking** **Large scale AC power distribution systems**	• a changing magnetic flux induces a potential difference; this process of electromagnetic induction is used in **DC and AC generators** *This includes applying the relationships* $\text{induced emf} = -N\frac{(\Phi_2 - \Phi_1)}{t} = -N\frac{\Delta\Phi}{t} = -N\frac{\Delta(B A_\perp)}{t}$ • the force due to the current in a magnetic field in a DC electric moto produces a torque on the coil in the motor *This includes applying the relationship:* $\tau = r F\sin\theta$ AC generator $\text{emf}_{max} = -2Nl vB = -2\pi NBA_\perp f$, $emf_{rms} = \frac{emf_{max}}{\sqrt{2}}$ $P = VI = I^2 R = \frac{V^2}{R}$	Motors & Induction Test
2	6-7	**Exams**	Unit 3 Content	Exam

2	8	**Phenomena in particle accelerators** **Muons entering our atmosphere**	understand the consequences for space and time of the equivalence principle for inertial frames of reference 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 Einstein's special theory of relativity predicts significantly different results to those of Newtonian physics for velocities approaching the speed of light 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 motion can only be measured relative to an observer; length and time are relative quantities that depend on the observer's frame of reference *This includes applying the relationships* $\ell = \ell_0 \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$ $t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ $u = \frac{v + u'}{1 + \frac{v u'}{c^2}}$ $u' = \frac{u - v}{1 - \frac{u v}{c^2}}$	Experiment – Mass of an Electron
2	9	**Australian Synchrotron**	• relativistic momentum increases at high relative speed and prevents an object from reaching the speed of light *This includes applying the relationship* $p_v = \frac{m v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ • the concept of mass-energy equivalence emerged from the special theory of relativity and explains the source of the energy produced in nuclear reactions *This includes applying the relationship* $E = \frac{m c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$	

2	10	**Waves and spectrum** **sunlight and** **starlight** **fireworks**	• understand how the quantum theory of light and matter explains black body radiation, the photoelectric effect, and atomic emission and absorption spectra • light exhibits many wave properties; however, it cannot only be modelled as a mechanical wave because it can travel through a vacuum a wave model explains a wide range of light-related phenomena, including reflection, refraction, dispersion, diffraction and interference**;**	
3	1	**Development of the Atomic Model** **Photoelectric** **Effect used to turn on and off street lights and other devices**	• 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. This includes applying: $c = f\lambda$, $E = hf = \frac{hc}{\lambda}$, $E_k = hf - W$, de Broglie $\lambda = \frac{h}{p}$ • a wide range of phenomena, including black body radiation and the photoelectric effect, are explained using the concept of light quanta 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	

3	2-3	**Line Spectra** **Young's Double Slit Experiment**	• atoms of an element emit and absorb specific wavelengths of light that are unique to that element; this is the basis of spectral analysis. Applying the relationship: • $\Delta E = hf$, $E_2 - E_1 = hf$ • 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 • 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	Investigation - Light
3	4	**Particle Accelerators**	• 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 • 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 • 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	

3	5-6	**Particle Accelerators** **Australia's Contributions to Astrophysics**	Feynman diagrams the expansion of the universe can be explained by Hubble's law and cosmological concepts, such as red shift and the Big Bang theory the Standard Model is used to describe the evolution of forces and the creation of matter in the Big Bang theory high-energy particle accelerators are used to test theories of particle physics, including the Standard Model *This includes deriving and applying the relationship* $\frac{m v^2}{r} = q v B$	Standard Model Special Rel Test
3	7	**Data Analysis – Experimental Error**	**Review of Data Analysis** Preparation for Exam Scientific Inquiry Skills Questions • represent data in meaningful and useful ways, including using appropriate Système Internationale (SI) units, symbols, and significant figures; organise and analyse data to identify trends, patterns and relationships; identify sources of uncertainty and techniques to minimise these uncertainties; utilise uncertainty and percentage uncertainty to determine the cumulative uncertainty resulting from simple calculations, and evaluate the impact of measurement uncertainty on experimental results; and select, synthesise and use evidence to make and justify conclusions • select, construct and use appropriate representations, including text and graphic representations of empirical and theoretical relationships, simulations and atomic energy level 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	Evaluation – Experimental Error

3	8-10	**Revision**	Revision for Exams	Exam