Victorian Certificate of Education Study Design: Physics

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
Unit 1			
Area of Study 1: Wave-like properties of light			
Key knowledge and skills			
●explain how models are used by physical scientists to organise and explain observed phenomena			
●model wave behavior as the transfer of energy from one position to another without net transfer of any material	16.1	16.1	15.1
●describe examples of transverse and longitudinal waves in terms of: particle motion and direction of propagation, amplitude, wavelength, period and frequency	Chapters 16 - 18	Chapters 16 - 18	Chapters 15 - 17
●describe mathematically connections between wavelength, frequency, period and speed of travel of waves	16.6 - 16.7	16.6 - 16.7	15.6 - 15.7
●identify visible light as a particular region of a spectrum of transverse electromagnetic radiation	35.1	34.1	30.1
●apply a wave model of energy transfer to visible light and the electromagnetic spectrum	Chapter 35	Chapter 34	Chapter 30
●describe polarisation of visible light and its relation to a transverse wave model	35.21 - 35.27	34.17 - 34.23	30.8 - 30.10
●describe the colour components of white light and colour effects including interference effects using a wave model of light	35.1, 37.7, 37.15, 38.27, 39.4, 39.12, 40.16, 40.18, 40.20, 40.21	34.1, 36.7, 36.14, 37.25, 38.4, 38.8, 39.13, 39.15	30.1, 32.9, 33.15, 34.4
●evaluate the strengths and limitations of a wave model applied to light phenomena	39.0 - 39.2, 40.1, 35.21 - 35.22, 42.0, 42.6	38.0 - 38.2, 39.1, 34.17 - 34.18, 41.0, 41.6	34.0 - 34.2, 34.5, 30.8, 36.0, 36.5
●describe the ray model of light as derived from the wave model	36.2, 37.1, 37.9	35.2, 36.1, 36.9	31.2, 32.1
●apply a ray model to behaviors of light including reflection, refraction and total internal reflection	Chapters 36 - 38	Chapters 35 - 37	Chapters 31 - 33
●model refraction effects mathematically, using Snell's law and refractive index	37.2 - 37.4, 37.6, 37.7, 37.9 - 37.14	36.2 - 36.4, 36.6, 36.7, 36.9 - 36.13	32.2 - 32.4, 32.7 - 32.8
●describe colour dispersion in prisms and lenses	37.15, 38.27	36.14, 37.25	32.9, 33.15
●interpret the behavior of light in light pipes and optical fibres modelled as repeated internal reflections of light waves	37.12 - 37.13	36.11 - 36.12	32.8
●describe qualitatively the effects of material dispersion and modal dispersion in an optical fibre			

●use information sources to assess risk in the use of light sources, lasers and optical devices including lenses and mirrors			
●use safe and responsible practices when working with light sources, lasers and optical devices			
Area of Study 2: Nuclear and radioactivity physics			
Key knowledge and skills			
●apply models as used by physical scientists to nuclear and radioactivity physics	Chapter 44	Chapter 43	Chapter 38
●model radioactive decay as random decay with a particular half-life, including mathematical modelling in terms of whole half-lives	44.18 - 44.21	43.18 - 43.21	38.17 - 38.18
●apply a simple particle model of the atomic nucleus to the origin of α, β and γ radiation, including changes to the number of nucleons, detection and penetrating properties	44.15 - 44.17	43.15 - 43.17	38.15 - 38.16
●describe the effects of α, β and γ radiation on humans, including short and long term effects from low and high doses, external and internal sources	44.20	43.20	
●describe the effects of ionising radiation on organisms and the environment			
●describe nuclear transformations and decay series	44.15 - 44.17	43.15 - 43.17	38.15 - 38.16
●describe natural and artificial isotopes and neutron absorption as one means of production of artificial radioisotopes	44.13	43.13	38.13
●select appropriate data relevant to aspects of nuclear and radioactivity physics from a database			
●identify sources of bias and error in written and other media related to nuclear and radioactivity physics			
●describe the risks associated with the use of nuclear reactions and radioactivity	44.13	43.13	38.13
Area of Study 3: Detailed study			
Detailed study 3.1: Astronomy	Minimal correlation	Minimal correlation	Minimal correlation
Detailed study 3.2: Medical physics	Minimal correlation	Minimal correlation	Minimal correlation
Detailed study 3.3: Energy from the nucleus			
Key knowledge and skills			
●apply the nuclear model of the atom, and models of the particles of nuclei, to the stability of nuclei, electrostatic and strong nuclear forces in the nucleus and the energy balance of fission of fusion reactions	44.5, 44.8 - 44.14	43.5, 43.8 - 43.14	38.5, 38.8 - 38.14
●explain nuclear fusion phenomena, including ^1H and ^2H, and conditions for fusion reactions including the energy barrier for initiation of nuclear fusion and energy released	44.9 - 44.12, 44.14	43.9 - 43.12, 43.14	38.9 - 38.12, 38.14

●explain nuclear fission reactions including ^{235}U and ^{239}Pu; fission initiation by slow and fast neutrons respectively; typical fission fragments; and neutron absorption in fission fragments	44.13	43.13	38.13
●describe neutron absorption in ^{238}U, including formation of ^{239}Pu			
●model fission chain reactions; descriptive treatment of criticality, including effect of mass and shape; and neutron absorption and moderation	44.13	43.13	38.13
●describe the transformation of energy in the nucleus into thermal energy for subsequent power generation including energy transfers and transformations in the systems used	44.13	43.13	38.13
●evaluate the risks and benefits of applications of nuclear energy	44.13	43.13	38.13
●analyse computer simulations of an aspect of nuclear power			
Unit 2			
Area of Study 1: Movement			
Key knowledge and skills			
●describe non-uniform and uniform motion along a straight line graphically	2.6 - 2.9, 2.12	2.6 - 2.9, 2.12	2.6 - 2.7, 2.10
●analyse motion along a straight line graphically, numerically and algebraically	Chapter 2	Chapter 2	Chapter 2
●describe how changes in movement are caused by the actions of forces	Chapter 5	Chapter 5	Chapter 5
●model forces as external actions through the centre of mass point of each body	5.14	5.14	5.14
●explain movement in terms of the Newtonian model and some of its assumptions, including Newton's three laws of motion, forces acting on point particles, and the ideal, frictionless world	Chapter 5	Chapter 5	Chapter 5
●compare the accounts of the action of forces by Aristotle, Galileo and Newton			
●apply the vector model of forces, including vector addition, vector subtraction and components, to readily observable forces including weight, friction and reaction forces	Chapter 3, Chapter 5	Chapter 3, Chapter 5	Chapter 3, Chapter 5
●model mathematically work as force multiplied by distance for a constant force and as area under a force versus distance graph	7.1, 7.3	7.1, 7.3	6.1
●interpret energy transfers and transformations using an energy conservation model applied to ideas of work, energy and power, including transfers between: -gravitational potential energy and kinetic energy near the Earth -potential energy and kinetic energy in springs	Chapter 7, 15.21	Chapter 7, 15.19	Chapter 6

●apply graphical, numerical and algebraic models to primary data collected during practical investigations of movement			
●use safe and responsible practices when conducting experiments and/or investigations related to motion			
Area of Study 2: Electricity			
Key knowledge and skills			
●apply charge conservation and energy conservation models to electrical phenomena to describe relationships between charge (Q), electric current (I), voltage (V), energy (U) and power (P), in electric circuits	27.13, 29.3, Chapters 27 - 29	27.8, 29.3 Chapters 27 - 29	25.7, 27.3 Chapters 25 - 27
●model circuit relationships mathematically, including: I=Q/t, V=U/Q, P=U/t=VI, U=VIt	27.1, 25.8, 27.13, Chapters 25 - 29	27.1, 25.7, 27.8 Chapters 25 - 29	25.1, 24.4, 25.7 Chapters 24 - 27
●model resistance in series and parallel circuits using: -voltage versus current graphs -resistance as the voltage to current ratio, including V/I=R=constant for ohmic devices -equivalent effective resistance in arrangements in series and parallel	27.6 - 27.7, 27.10, 29.7, 29.11	27.3 - 27.4, 29.7, 29.11	25.3 - 25.4, 27.6, 27.10
●model simple electrical devices, car and household (AC) electrical systems as simple direct current (DC) circuits	27.14 - 27.18, 28.2, 28.4, 28.8, 28.10, 28.14, 29.9, 29.27, 29.30, 29.32	27.9 - 27.13, 28.2, 28.4, 28.6, 28.8, 28.11, 29.9, 29.27, 29.30, 29.32	25.8 - 25.11, 26.2, 26.3, 26.5, 26.6, 27.8
●model household electricity connections as a simple circuit comprising fuses, switches, circuit breakers, loads and earth			
●identify causes, effects and treatment of electric shock in homes and relate these to approximate danger thresholds for current and time			
●investigate practically the operation of simple circuits containing resistors, including variable resistors, diodes and other non-ohmic devices	Chapter 29, 42.17 - 42.19	Chapter 29, 41.16 - 41.18	Chapter 27 36.14 - 36.15
●present data from practical investigations in tables and graphs			
●compare the idealised functioning of circuit components in computer modelling simulations and data obtained as a result of student investigations			
●convert energy values to kilowatt-hour (kWh)	27.14 - 27.15	27.9 - 27.10	25.8 - 25.9
●use information sources to assess risk in the use of electrical equipment and power supplies			
●apply safe and environmentally responsible practices when using electrical equipment and power supplies			
Area of Study 3: Detailed study	Minimal correlation	Minimal correlation	Minimal correlation
Unit 3			

Victoria Physics Standards Correlation

Area of Study 1: Motion in one and two dimensions			
Key knowledge and skills			
●explain movement in terms of the Newtonian model and assumptions, including -Newton's three laws of motion -the absolute nature of space and time	5.2, 5.5, 5.10, Chapter 5	5.2, 5.5, 5.10, Chapter 5	5.2, 5.5, 5.10, Chapter 5
●apply Newton's laws of motion to situations involving two or more forces acting along a straight line and in two dimensions	Chapter 5, Chapter 6	Chapter 5, Chapter 6	Chapter 5
●analyse the uniform circular motion of an object in a horizontal plane	Chapter 9	Chapter 9	Chapter 8
●analyse the ideal motion of projectiles near the Earth's surface graphically and algebraically assuming air resistance is negligible	Chapter 4	Chapter 4	Chapter 4
●analyse relative velocity of objects moving along a straight line and in two dimensions	4.22 - 4.25	4.21 - 4.23	4.14 - 4.15
●distinguish between stationary (inertial) frames of reference and frames of reference that are moving at constant speed relative to the stationary frame, including Galilean transformations in one dimension between frames of reference	4.22 - 4.25	4.21 - 4.23	4.14 - 4.15
●analyse impulse, and momentum transfer, in collisions between objects moving along a straight line	Chapter 8	Chapter 8	Chapter 7
●analyse energy transfer resulting from work done by a constant force in one dimension	Chapter 7	Chapter 7	Chapter 6
●analyse transfers of energy between kinetic energy, potential energy and other forms of energy for objects that -interact with springs that obey Hooke's Law, $F = k(-\Delta x)$ -undergo elastic and inelastic collisions -move from position to position in a changing gravitational field, using only areas under force-distance and field-distance graphs	15.21, Chapter 8, 7.3, Chapter 13	15.19, Chapter 8, 7.3, Chapter 13	Chapter 7, Chapter 12
●analyse planetary and satellite motion modelled as uniform circular orbital motion in a universal gravitation field, using - $a = v^2/r = 4\pi^2 r/T^2$ - $g = GM/r^2$ and $F = GM_1M_2/r^2$	13.1, 13.2, 13.14 - 13.17	13.1, 13.2, 13.10 - 13.13	12.1, 12.2 12.9 - 12.12
●use safe and responsible practices when working with moving objects and equipment			
Area of Study 2: Electronics and photonics			
Key knowledge and skills			
●apply the concepts of current, voltage, power to the operation of electronic circuits comprising diodes, resistance, and photonic transducers including light dependent resistors (LDR), photodiodes and light emitting diodes (LED)			

●simplify circuits comprising parallel and series resistance and unloaded voltage dividers	Chapter 29	Chapter 29	Chapter 27
●describe the operation of the transistor in terms of current gain and the effect of biasing the base-emitter voltage on the voltage characteristics, in terms of saturation, cut-off and linear operation, including linear gain and clipping, of a single stage npn transistor voltage amplifier	42.17, 42.19	41.16, 41.18	36.14 - 36.15
●explain qualitatively how capacitors act as de-couplers to separate AC from DC signals in transistor circuits	42.18	41.17	
●use technical specifications related to voltage, current, resistance, power and illumination for electronic components such as diodes, resistance, and opto-electronic converters, including light dependent resistors (LDR), photodiodes and light emitting diodes (LED), excluding current-voltage characteristic curves for transistors, to design circuits to operate for particular purposes			
●analyse simple electronic transducer circuits for transducers that respond to changes in illumination and temperature, including LDR, photodiode, phototransistor and thermistor			
●describe energy transfers and transformations in electrical optical and optical-electrical conversion systems using opto-electronic converters	42.20	41.19	36.16
●describe the transfer of information in analog form using optical intensity modulated light			
●use safe and responsible practices when working with electrical, electronic and photonic equipment			
Area of Study 3: Detailed study			
Detailed study 3.1: Einstein's special relativity			
Key knowledge and skills			
●describe Maxwell's prediction that the speed of light depends only on the electrical and magnetic properties of the medium it is passing through and not on the speed of the source or the speed of the medium	35.4 - 35.7	34.3 - 34.4	30.3 - 30.4
●contrast Maxwell's prediction with the principles of Galilean relativity (no absolute frame of reference; all velocity measurements are relative to the frame of reference)	4.22 - 4.25 41.1	4.21 - 4.23 40.1	4.14 - 4.15, 35.1
●interpret the results of the Michelson-Morley experiment in terms of the postulates of Einstein's special theory of relativity -the laws of physics are the same in all inertial frames of reference -the speed of light has a constant value for all observers	41.3	40.3	35.3
●compare Einstein's postulates and the postulates of the Newtonian model	Chapter 41	Chapter 40	Chapter 35

●use simple thought experiments to show that -the elapse of time occurs at different rates depending on the motion of an observer relative to an event -spatial measurements are different when measured in different frames of reference	41.5 - 41.18	40.5 - 40.13	35.4 - 35.9
●explain the concepts of proper time and proper length as quantities that are measured in the frame of reference in which objects are at rest	41.8, 41.12	40.8, 40.12	35.6, 35.9
●explain movement at speeds approaching the speed of light in terms of the postulates of Einstein's special theory of relativity	41.16	40.13	
●model mathematically time dilation, length contraction and mass increase with, respectively, the equations $t = t_0y$, $L = L_0/y$ and $m = m_0y$ where $y = 1/(1 - v^2/c^2)^{1/2}$	41.8 - 41.10, 41.12 - 41.13 41.22	40.8 - 40.10, 40.12, 40.15	35.6 - 35.7, 35.9, 35.11
●explain the relationship between the relativistic mass of a body and the energy equivalent according to Einstein's equation $E = mc^2$	41.23 - 41.26, 44.9 - 44.10	40.16 - 40.19, 43.9 - 43.10	35.12, 38.9 - 38.10
●explain the equivalence of work done to increased mass energy according to Einstein's equation $E = mc^2$	41.23 - 41.26, 44.9 - 44.10	40.16 - 40.19, 43.9 - 43.10	35.12, 38.9 - 38.10
●compare special relativistic and non-relativistic values for time, length and mass for a range of situations	41.9, 41.18, 41.22, 41.25, 41.26	40.9, 40.15, 40.18, 40.19	35.11
Detailed study 3.2: Investigating materials and their use in structures			
Key knowledge and skills			
●identify different types of external forces (compression, tension and shear) which can act on a body, including gravitational forces	5.4, 5.12, 12.13 - 12.15	5.4, 5.12, 12.12 - 12.14	5.4, 5.12, 11.7 - 11.8
●compare the tensile and compressive strength and the stiffness or flexibility of different materials under load to determine their suitability for use in structures such as columns, beams and arches	12.13	12.12	11.7
●model the behavior of materials under load in terms of extension and compression, graphically and algebraically, including Young's modulus	12.12 - 12.14	12.11 - 12.13	11.6 - 11.8
●calculate the stress and strain resulting from the application of forces and loads to materials in structures	12.12 - 12.16	12.11 - 12.15	11.6 - 11.9
●use data to describe and predict brittle or ductile failure under load	12.12	12.11	11.6
●calculate the potential energy stored in a material under load (strain energy) and the toughness of a material tested to destruction, using area under stress versus strain graphs			
●describe elastic or plastic behavior shown by materials under load and the resulting energy lost as heat	12.11 - 12.12	12.10 - 12.11	11.5 - 11.6
●contrast the performance of a composite material with the performance of the component materials (maximum of three components) to determine the suitability for use in structures			

●analyse translational and rotational effects of forces in structures (columns, beams and cables) modelled as two dimensional structures in stable equilibrium	12.1 - 12.10	12.1 - 12.9	11.1 - 11.4
●apply conditions for equilibrium to analyse forces in structures made of combinations of columns, beams and cables	12.1 - 12.10	12.1 - 12.9	11.1 - 11.4
●use data to describe and predict the performance of a simple structure under load	12.13 - 12.16	12.12 - 12.15	11.7 - 11.9
●use safe and responsible practices when working with structures, materials and associated measuring equipment			
Detailed study 3.3: Further electronics			
Key knowledge and skills			
●design an AC to DC voltage regulated power supply system, given a range of AC input voltages (specified as root mean square, peak and peak to peak), smoothing conditions and resistive loads			
●describe the role of a transformer including the voltage ratio	32.23 - 32.25	32.20 - 32.22	29.15 - 29.17
●describe effects on the DC power supply system of changes to the components used			
●interpret the display of an oscilloscope in terms of voltage as a function of time	33.12, 33.24, 33.25	33.6, 33.16, 33.17	29.13
●select measuring devices for circuit analysis and faults diagnosis	29.5, 33.12	29.5, 33.6	27.4, 29.13
●select measurements of voltage and current (from the use of a multimeter and an oscilloscope) in the DC power supply circuit to evaluate the operation of the circuit in terms of its design brief			
●explain the operation of diodes in half wave and full-wave bridge rectification			
●explain the effect of capacitors in terms of -voltage and current when charging and discharging -time constant for charging and discharging T = RC -smoothing for DC power supplies	29.31 - 29.33	29.31 - 29.32	
●apply the current-voltage characteristics of voltage regulators, including Zener diodes and Integrated Circuits, to circuit design			
●measure ripple voltage and the effect of changing the load			
●explain the use of heat sinks in electronic circuits			
●calculate power dissipation in circuit elements	27.13 - 27.18, 33.31, 33.33, 33.34	27.8 - 27.13, 33.23 - 33.25	25.7 - 25.11
●use safe and responsible practices when working with electrical and electronic equipment			

Unit 4			
Area of Study 1: Electric power			
Key knowledge and skills			
●apply a field model to magnetic phenomena including shapes and directions produced by bar magnets, and by current in wires, coils and solenoids	30.2, 31.1, 31.15 - 31.17, 31.22	30.2, 31.1, 31.8 - 31.9	28.2, 28.20
●quantify magnetic forces on current carrying wires, using F = IIB where the directions of I and B are either perpendicular to, or parallel to, each other	30.23	30.22	28.18
●describe the operation of simple DC motors	30.27	30.26	28.19
●apply a field model to define magnetic flux using Φ = BA and the qualitative effect of differing angles between the coil and the field	32.6	32.6	29.6
●explain the generation of voltage, including AC voltage, in terms of the rate of change of magnetic flux (Faraday's law), the direction of the induced current (Lenz's law), and the number of loops through which the flux passes, including calculations using induced emf = - ΔΦ/Δ t	32.7 - 32.12, 32.14 - 32.15, 32.17 - 32.20	32.7 - 32.12, 32.14 - 32.17	29.7 - 29.10
●describe the production of voltage in generators and AC voltage in alternators, including in the use of commutators and slip rings	32.17 - 32.20	32.14 - 32.17	29.10
●compare sinusoidal AC voltages produced as a result of the uniform rotation of a loop in a constant magnetic flux in terms of frequency, period, amplitude, peak-to-peak voltage and peak-to-peak current	32.17 - 32.20	32.14 - 32.17	
●use rms values for a sinusoidal AC voltage, V_{rms} = V_{peak}/(sqrt2) and I_{rms} = I_{peak}/(sqrt2), and interpret rms in terms of the DC supply that provides the same power as an AC supply	33.31, 33.33, 33.3	33.23 - 33.25	
●compare and contrast DC motors, generators and alternators	30.27, 32.17 - 32.20	30.26, 32.14 - 32.17	28.19, 29.10
●explain transformer action, modelled in terms of electromagnetic induction for an ideal transformer, qualitatively; and quantitatively using number of turns in primary and secondary coils, voltage and current	32.22 - 32.25	32.19 - 32.22	29.14 - 29.17
●model mathematically power supplied as P = VI and transmission losses using voltage drop (V = IR) and power loss (P = I^2R)	27.13, 27.15, 27.16 - 27.18	27.8, 27.10 - 27.13	25.7, 25.9 - 25.11
●explain the use of transformers in an electricity distribution system	32.23, 27.18	32.20, 27.13	29.15, 25.11
●use safe and responsible practices when working with electricity and electrical measurement			

Area of Study 2: Interactions of light and matter			
Key knowledge and skills			
●explain the production of incoherent light from wide spectrum light sources, including the Sun, light bulbs, and candles (descriptive), in terms of thermal motion of electrons			
●explain the results of Young's double slit experiment as evidence for the wave-like nature of light including -constructive and destructive interference of waves in terms of path differences -qualitative effect of wavelength on interference patterns	39.1 - 39.4	38.1 - 38.4	34.1 - 34.2
●interpret the pattern produced by light when it passes through a gap or past an obstacle in terms of the diffraction of waves and the significance of the magnitude of the lambda/w ratio	40.1 - 40.2, 40.4 - 40.6	39.1 - 39.2, 39.4 - 39.6	34.5 - 34.7
●interpret the photoelectric effect as evidence for the particle-like nature of light, including -kinetic energy of emitted photoelectrons in terms of the energy of incident photons KE_{max} = hf - W, using energy units of both joule and electron-volt -effects of intensity of incident irradiation on the emission of photoelectrons	42.6 - 42.7	41.6 - 41.7	36.5 - 36.6
●interpret electron diffraction patterns as evidence for the wave-like nature of matter expressed as the de Broglie wavelength, $\lambda = h/p$	43.0, 43.4, 43.6	42.0, 42.4, 42.6	37.0, 37.2, 37.3
●compare the momentum of photons and of particles of the same wavelength including calculations using $p = h/\lambda$	43.1, Chapter 43	42.1, Chapter 42	37.1, Chapter 37
●interpret atomic absorption and emission spectra including those from metal vapour lamps in terms of a quantised energy level model of the atom, including calculations of the energy of photons absorbed or emitted, $\Delta E = hf$	42.9, 42.12, 42.13	41.9, 41.11, 41.12	36.8 - 36.10
●explain a model of quantised energy levels of the atom in which electrons are found in standing wave states	43.4	42.4	37.2
●use safe and responsible practices when working with light sources, lasers and related equipment			
Area of Study 3: Detailed study			
Detailed study 3.1: Sychrotron and its applications			
Key knowledge and skills			
●describe the design and operation of simple particle accelerators such as the cathode ray tube and including the application of $1/2\ mv^2 = eV$ for electrons in an electron gun	25.17	25.12	

●use given values of electron momentum in calculations relating the radius of the trajectory of a low velocity electron to charge and magnetic field, r = mv/eB	30.12 - 30.14	30.13 - 30.15	28.13 - 28.14
●model the force applied to an electron beam as F = eVB in cases where the directions of v and B are perpendicular to each other and parallel with each other	30.6	30.7	28.7
●describe basic synchrotron design including electron linac, circular booster, storage ring, beamlines			
●compare the characteristics of synchrotron radiation, including brightness, spectrum and divergence with the characteristics of electromagnetic radiation from other sources including lasers and x-ray tubes, in relation the applications			
●describe the operation of a typical beamline as a tunable source of radiation			
●interpret interactions of synchrotron radiation with a sample, including -effect of properties of x-rays including energy, momentum and wavelength -x-ray (Bragg) diffraction, Bragg's law nλ = 2dsinθ -emission of photoelectrons	40.22, 42.6	39.16, 41.6	36.5
●use data to identify and describe types of x-ray scattering, including elastic (Thomson) scattering, inelastic (Compton) scattering and diffuse scattering	43.1	42.1	37.1
●use diffraction patterns to compare and contrast atom spacing in crystalline structures			
●analyse supplied data from a synchrotron experiment			
Detailed study 3.2: Photonics			
Key knowledge and skills (only those covered in the text are shown)			
●describe laser light in terms of coherence, wavelength and phase	42.21	41.20	36.17
●explain the production of light by coherent light sources (lasers), in terms of light amplification (photons generated when many bound electrons de-excite at the same time) via stimulation from external photons (descriptive)	42.22 - 42.27	41.21 - 41.25	36.18 - 36.21
●analyse the operation of fibre optic wave guides, in terms of -light gathering ability using Snell's law, critical angle, total internal reflection and acceptance angle	37.13	36.12	
Detailed study 3.3: Sound			
Key knowledge and skills			
●explain sound as the transmission of energy via longitudinal pressure waves	17.1, 17.10	17.1, 17.8	16.1, 16.4
●mathematically model the relationship between wavelength, frequency and speed of propagation of sound waves using v = fλ	16.7	16.7	15.7
●explain the differences between sound intensity (W/m^2) and sound intensity level (dB)	17.10 - 17.11	17.8 - 17.9	16.4 - 16.5

●calculate sound intensity at different distances from a source using an inverse square law	17.10	17.8	16.4
●explain resonance in terms of the superposition of a travelling sound wave and its reflection	18.6	18.6	17.3
●analyse, for strings and open and closed resonant tubes, the fundamental as the first harmonic, and subsequent harmonics	18.7 - 18.8, 18.10	18.7 - 18.8, 18.10	17.4 - 17.5
●explain qualitatively, in terms of electrical and electromagnetic effects, the operation of -microphones, including electret-condenser, crystal, dynamic and velocity microphones -dynamic loudspeakers	32.4	32.4	29.4
●explain qualitatively the effects of baffles and enclosures for loudspeakers			
●interpret frequency response curves of microphones, speakers, simple sound systems and hearing, including loudness (phon)			
●evaluate the fidelity of microphones and loudspeakers in terms of purpose, frequency response and, qualitatively, construction			
●interpret qualitatively the directional speed of various frequencies in terms of different gap width or obstacle size including the magnitude of the lambda/w ratio	40.0 - 40.1, 40.5	39.0 - 39.1, 39.5	34.5
●use safe and responsible practices when working with sound sources and sound equipment			