New South Wales Physics Correlation

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
Science Stages 4-5 (only physics-relevant standards shown) Students will learn about			
4.6.1 the law of conservation of energy to:			
a) identify situations or phenomena in which different forms of energy are evident	Chapter 7	Chapter 7	Chapter 6
b) use models to describe different forms of energy	Chapter 7	Chapter 7	Chapter 6
c) identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)	Chapter 7	Chapter 7	Chapter 6
d) qualitatively account for the total energy involved in energy transfers and transformations	Chapters 7 & 8	Chapters 7 & 8	Chapters 6 & 7
4.6.2 Newton's Laws–forces to:			
a) identify changes that take place when particular forces are acting	Chapters 5 & 6	Chapters 5 & 6	Chapter 5
b) use the term 'field' to describe forces acting at a distance.	13.10, Chapters 24 & 30	Chapters 24 & 30	Chapters 23 & 28
4.6.3 electrical energy to:			
a) associate electricity with energy transfer in a simple circuit	27.13 - 27.15, Chapter 29	27.8 - 27.10, Chapter 29	25.7 - 25.9, Chapter 27
b) construct and draw circuits to show transfer of energy	Chapters 29 & 33	Chapters 29 & 33	Chapter 27
4.6.4 sound energy to:			
a) describe sound as a form of energy requiring a medium for propagation	16.1, Chapters 17 & 18	16.1, Chapters 17 & 18	15.1, Chapters 16 & 17
4.6.5 light energy to:			
a) describe light as a form of energy not requiring a medium for propagation	Chapter 35	Chapter 34	Chapter 30
4.6.6 heat energy to:			
a) identify processes of heat transfer by conduction, convection and radiation	19.25 - 19.30	19.22 - 19.27	18.17 - 18.20
b) describe how the transfer of heat can be controlled	Chapters 21 & 22	Chapters 21 & 22	Chapters 20 & 21
4.6.7 frictional force to:			
a) describe friction as a contact force which opposes motion	5.18 - 5.20	5.18 - 5.20	5.16 - 5.18

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
b) identify everyday situations where friction acts	5.18 - 5.22, 5.24, 6.7	5.18 - 5.22, 5.24, 6.7	5.16 - 5.20, 5.22
4.6.8 electrostatic force to:			
a) describe ways in which objects acquire an electrostatic charge	23.2, 23.8	23.2, 23.8	22.2, 22.7
b) identify everyday situations where the effects of electrostatic forces can be observed	23.1 - 23.3, 23.5, 23.7, 23.15	23.1 - 23.3, 23.5, 23.7, 23.15	22.1 - 22.4, 22.6, 22.12
c) describe the behaviour of charges when they are brought close to each other	Chapter 23	Chapter 23	Chapter 22
4.6.9 magnetic force to:			
a) describe the behaviour of magnetic poles when they are brought close to each other	30.1	30.1	28.1
b) identify everyday situations in which magnets, electromagnets and magnetic strips are used	30.5, 30.6, 30.15 - 30.17, 30.27, 32.4, 32.16, 32.17, 34.0, 34.1, 34.3	30.5 - 30.7, 30.16 - 30.18, 30.26, 32.4, 32.13, 32.14	28.5 - 28.7, 28.15, 28.19, 29.4
4.6.10 gravitational force to:			
a) identify that all objects exert a force of gravity on all other objects in the universe.	13.1	13.1	12.1
5.6.1 the wave model to:			
a) identify waves as carriers of energy	16.1, 16.19	16.1	15.1
b) qualitatively describe features of waves including frequency, wavelength and speed	16.2 - 16.7, Chapters 16, 17 & 18	16.2 - 16.7, Chapters 16, 17 & 18	15.2 - 15.7, Chapters 15, 16 & 17
c) give examples of different types of radiation that make up the electromagnetic spectrum and identify some of their uses	35.1	34.1	30.1
5.6.2 Newton's Laws–motion to:			
a) describe qualitatively the relationship between force, mass and acceleration	5.5	5.5	5.5
b) explain qualitatively the relationship between distance, speed and time	2.3	2.3	2.3
c) relate qualitatively acceleration to a change in speed and/or direction as a result of a net force	2.10, 5.5	2.10, 5.5	2.8, 5.5
d) analyse qualitatively common situations involving motion in terms of Newton's Laws.	Chapters 5 & 6	Chapters 5 & 6	Chapter 5

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
5.6.3 electrical energy to:			
a) design, construct and draw circuits containing a number of components	Chapters 27, 28, 29, 32 & 33	Chapters 27, 28, 29, 32 & 33	Chapters 25, 26, 27 & 29
b) describe voltage, resistance and current using analogies	Chapters 25 & 27	Chapters 25 & 27	Chapters 24 & 25
c) describe qualitatively the relationship between voltage, resistance and current	27.6	27.3	25.3
d) compare advantages and disadvantages of series and parallel circuits	29.6, 29.10	29.6, 29.10	27.5, 27.9
5.6.4 light energy to:			
a) distinguish between the absorption, reflection, refraction and scattering of light and identify everyday situations where each occurs	35.20, 35.25, Chapters 36, 37 & 38	34.16, 34.21, Chapters 35, 36 & 37	30.7, 30.9, Chapters 31, 32 & 33
5.6.5 nuclear energy to:			
a) identify that energy may be released from the nuclei of atoms	44.9 - 44.13, 44.15 - 44.21	43.9 - 43.13, 43.15 - 43.21	38.9 - 38.13, 38.15 - 38.18
b) explain radioactivity in terms of release of particles and energy	44.15 - 44.21	43.15 - 43.21	38.15 - 38.18
5.6.6 gravitational force to:			
a) relate qualitatively the force of gravity between two objects to their masses and distance apart	13.1	13.1	12.1
b) distinguish between the terms ‘mass’ and ‘weight’.	5.3 - 5.4	5.3 - 5.4	5.3 - 5.4
4.7.1 the particle theory of matter to:			
a) identify that matter is made of particles that are continuously moving and interacting	20.1	20.1	19.1
b) describe expansion and contraction of materials in terms of a simple particle model			
c) relate an increase or decrease in the amount of energy possessed by particles to changes in particle movement	7.8, 20.10	7.6, 20.10	6.4, 19.9
d) describe diffusion in terms of the random movement of particles.			
4.7.2 properties of solids, liquids and gases to:			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
a) relate properties of solids, liquids and gases to the particle theory of matter	Chapter 20	Chapter 20	Chapter 19
b) identify when a physical change occurs by observing evaporation, condensation, boiling, melting and freezing	19.21 - 19.24	19.18 - 19.21	18.14 - 18.16
c) explain density using a simple particle model	14.2	14.2	13.2
d) relate increases or decreases in frequency of particle collisions to changes in pressure	8.19, 20.2	20.2	19.2
4.7.3 change of state to:			
a) relate changes of state to the motion of particles as energy is removed or added	19.21	19.18	18.14
b) relate energy transfer and the particle model to melting and freezing point, condensation, evaporation and boiling	19.21 - 19.24	19.18 - 19.21	18.14 - 18.16
5.7.1 atomic theory to:			
a) describe features of and the location of protons, neutrons and electrons in the atom	23.1, 42.9, 44.1 - 44.4	23.1, 41.9, 43.1 - 43.4	22.1, 36.8, 38.1 - 38.4
b) distinguish between elements, using information about the numbers of protons, neutrons and electrons	44.3 - 44.4	43.3 - 43.4	38.3 - 38.4
c) identify properties of different substances that can be explained in terms of their subatomic structure	34.1 - 34.7, 42.2, 42.6 - 42.7, 42.12, 42.14 - 42.17, 44.13 - 44.21	30.6, 41.2, 41.6 - 41.7, 41.11, 41.13 - 41.16, 43.13 - 43.21	28.6, 36.2, 36.5 - 36.6, 36.9, 36.11 - 36.14, 38.13 - 38.18
d) describe an appropiate model that has been developed to describe atomic structure.	42.9 - 42.13, 44.2 - 44.3, 44.5 - 44.6	41.9 - 41.12, 43.2 - 43.3, 43.5 - 43.6	36.8 - 36.10, 38.2 - 38.3, 38.5 - 38.6
4.9.1 the Newtonian model of the solar system to:			
a) describe qualitatively relative sizes, distances and movements of components of our solar system	Chapter 13	Chapter 13	Chapter 12
b) describe relative movements of the planets, moons and sun	Chapter 13	Chapter 13	Chapter 12
c) explain night and day in terms of Earth's rotation			
d) explain the seasons in terms of the tilt of Earth's axis and its revolution around the Sun.	35.11 - 35.12	34.8 - 34.9	30.6

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
Physics Stage 6 Preliminary Course			
The World Communicates			
1. The wave model can be used to explain how current technologies transfer information			
• describe the energy transformations required in one of the following: – mobile telephone – fax/modem – radio and television	Chapter 35	Chapter 34	Chapter 30
• describe waves as a transfer of energy disturbance that may occur in one, two or three dimensions, depending on the nature of the wave and the medium	Chapters 16, 17 & 35	Chapters 16, 17 & 34	Chapters 15, 16 & 30
• identify that mechanical waves require a medium for propagation while electromagnetic waves do not	16.1, 35.2	16.1, 34.2	15.1, 30.2
• define and apply the following terms to the wave model: medium, displacement, amplitude, period, compression, rarefaction, crest, trough, transverse waves, longitudinal waves, frequency, wavelength, velocity	Chapters 16 & 17	Chapters 16 & 17	Chapters 15 & 16
• describe the relationship between particle motion and the direction of energy propagation in transverse and longitudinal waves	16.2	16.2	15.2
• quantify the relationship between velocity, frequency and wavelength for a wave: $v = f\lambda$	16.7	16.7	15.7
2. Features of a wave model can be used to account for the properties of sound			
• identify that sound waves are vibrations or oscillations of particles in a medium	17.1	17.1	16.1
• relate compressions and rarefactions of sound waves to the crests and troughs of transverse waves used to represent them	17.1	17.1	16.1
• explain qualitatively that pitch is related to frequency and volume to amplitude of sound waves	17.2 - 17.3, 17.11	17.2 - 17.3, 17.9	16.2 - 16.3, 16.5
• explain an echo as a reflection of a sound wave	17.5	17.5	

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe the principle of superposition and compare the resulting waves to the original waves in sound	Chapter 18	Chapter 18	Chapter 17
3. Recent technological developments have allowed greater use of the electromagnetic spectrum			
• describe electromagnetic waves in terms of their speed in space and their lack of requirement of a medium for propagation	35.1 - 35.7, 41.3	34.1 - 34.4, 40.3	30.1 - 30.4, 35.3
• identify the electromagnetic wavebands filtered out by the atmosphere, especially UV, X-rays and gamma rays	35.1	34.1	30.1
• identify methods for the detection of various wavebands in the electromagnetic spectrum			
• explain that the relationship between the intensity of electromagnetic radiation and distance from a source is an example of the inverse square law: I is proportional to 1/d2	35.13	34.10	
• outline how the modulation of amplitude or frequency of visible light, microwaves and/or radio waves can be used to transmit information	35.8	34.5	30.5
• discuss problems produced by the limited range of the electromagnetic spectrum available for communication purposes			
4. Many communication technologies use applications of reflection and refraction of electromagnetic waves			
• describe and apply the law of reflection and explain the effect of reflection from a plane surface on waves	36.5 - 36.7, 39.11	35.5 - 35.7, 38.7	31.5 - 31.6
• describe ways in which applications of reflection of light, radio waves and microwaves have assisted in information transfer	36.1, 36.12, 37.12 - 37.13	35.1, 35.11, 36.11 - 36.12	31.1, 31.10, 32.8

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe one application of reflection for each of the following: - plane surfaces - concave surfaces - convex surfaces - radio waves being reflected by the ionosphere	36.1, 36.3 - 36.4, 36.8, 36.12	35.1, 35.3 - 35.4, 35.8, 35.11	31.1, 31.3 - 31.4, 31.7, 31.10
• explain that refraction is related to the velocities of a wave in different media and outline how this may result in the bending of a wavefront	37.1, 37.8	36.1, 36.8	32.1, 32.6
• define refractive index in terms of changes in the velocity of a wave in passing from one medium to another	37.2	36.2	32.2
• define Snell's Law: v1/v2 = sin i / sin r	37.3	36.3	32.3
• identify the conditions necessary for total internal reflection with reference to the critical angle	37.12	36.11	32.8
• outline how total internal reflection is used in optical fibres	37.12 - 37.13	36.12 - 36.13	32.8
5. Electromagnetic waves have potential for future communication technologies and data storage technologies			
• identify types of communication data that are stored or transmitted in digital form			
Electrical Energy in the Home			
1. Society has become increasingly dependent on electricity over the last 200 years			
• discuss how the main sources of domestic energy have changed over time			
• assess some of the impacts of changes in, and increased access to, sources of energy for a community			
• discuss some of the ways in which electricity can be provided in remote locations	27.14	27.9	25.8

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
2. One of the main advantages of electricity is that is can be moved with comparative ease from one place to another through electric circuits			
• describe the behaviour of electrostatic charges and the properties of the fields associated with them	Chapters 23, 24, & 25	Chapters 23, 24, & 25	Chapters 22, 23 & 24
• define the unit of electric charge as the coulomb	23.1	23.1	22.1
• define the electric field as a field of force with a field strength equal to the force per unit charge at that point: E = F/q	24.1	24.1	23.1
• define electric current as the rate at which charge flows (coulombs/ second or amperes) under the influence of an electric field	27.1	27.1	25.1
• identify that current can be either direct with the net flow of charge carriers moving in one direction or alternating with the charge carriers moving backwards and forwards periodically	Chapters 29 & 33	Chapters 29 & 33	Chapter 27
• describe electric potential difference (voltage) between two points as the change in potential energy per unit charge moving from one point to the other (joules/coulomb or volts)	25.14	25.9	24.6
• discuss how potential difference changes at different points around a DC circuit	29.3, 29.17	29.3, 29.17	27.3
• identify the difference between conductors and insulators	23.5	23.5	22.4
• define resistance as the ratio of voltage to current for a particular conductor: R = V/I	27.6	27.3	25.3
• describe qualitatively how each of the following affects the movement of electricity through a conductor: - length - cross sectional area -temperature -material	27.8, 27.11	27.5, 27.7	25.5 - 25.6
3. Series and parallel circuits serve different purposes in households			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• identify the difference between series and parallel circuits	29.6, 29.10	29.6, 29.10	27.5, 27.9
• compare parallel and series circuits in terms of voltage across components and current through them	29.6, 29.10	29.6, 29.10	27.5, 27.9
• identify uses of ammeters and voltmeters	29.5	29.5	27.4
• explain why ammeters and voltmeters are connected differently in a circuit	29.5	29.5	27.4
• explain why there are different circuits for lighting, heating and other appliances in a house			
4. The amount of power is related to the rate at which energy is transformed			
• explain that power is the rate at which energy is transformed from one form to another	7.15, 27.13	7.12, 27.8	6.9, 25.7
• identify the relationship between power, potential difference and current	27.13	27.8	25.7
• identify that the total amount of energy used depends on the length of time the current is flowing and can be calculated using: Energy = VIt	27.13 - 27.15	27.8 - 27.10	25.7 - 25.9
• explain why the kilowatt-hour is used to measure electrical energy consumption rather than the joule			
5. Electric currents also produce magnetic fields and these fields are used in different devices in the home			
• describe the behaviour of the magnetic poles of bar magnets when they are brought close together	30.1	30.1	28.1
• define the direction of the magnetic field at a point as the direction of force on a very small north magnetic pole when placed at that point	30.2	30.2	28.2
• describe the magnetic field around pairs of magnetic poles	30.2	30.2	28.2
• describe the production of a magnetic field by an electric current in a straight current-carrying conductor and describe how the right hand grip rule can determine the direction of current and field lines	31.1	31.1	28.20

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• compare the nature and generation of magnetic fields by solenoids and a bar magnet	30.2, 31.18, 34.1	30.2, 30.6, 31.9	
6. Safety devices are important in household circuits			
• discuss the dangers of an electric shock from both a 240 volt AC mains supply and various DC voltages, from appliances, on the muscles of the body			
• describe the functions of circuit breakers, fuses, earthing, double insulation and other safety devices in the home			
Moving About			
1. Vehicles do not typically travel at a constant speed			
• identify that a typical journey involves speed changes			
• distinguish between the instantaneous and average speed of vehicles and other bodies	2.3 - 2.5	2.3 - 2.5	2.3 - 2.5
• distinguish between scalar and vector quantities in equations	3.1 - 3.2	3.1 - 3.2	3.1 - 3.2
• compare instantaneous and average speed with instantaneous and average velocity	4.2	4.2	4.1
• define average velocity as: vav = Δr/Δt	2.4, 4.2	2.4, 4.2	2.4, 4.1
2. An analysis of the external forces on vehicles helps to understand the effects of acceleration and deceleration			
• describe the motion of one body relative to another	4.22 - 4.25	4.21 - 4.23	4.14 - 4.15
• identify the usefulness of using vector diagrams to assist solving problems	5.14, Chapter 5	5.14, Chapter 5	5.14, Chapter 5
• explain the need for a net external force to act in order to change the velocity of an object	5.2	5.2	5.2
• describe the actions that must be taken for a vehicle to change direction, speed up and slow down	5.2, 5.5	5.2, 5.5	5.2, 5.5

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe the typical effects of external forces on bodies including: - friction between surfaces - air resistance	Chapter 5	Chapter 5	Chapter 5
• define average acceleration as: aav = Δv/Δt therefore aav = (v - u)/t	2.10 - 2.11	2.10 - 2.11	2.8 - 2.9
• define the terms 'mass' and 'weight' with reference to the effects of gravity	5.3 - 5.4	5.3 - 5.4	5.3 - 5.4
• outline the forces involved in causing a change in the velocity of a vehicle when: – coasting with no pressure on the accelerator – pressing on the accelerator – pressing on the brakes – passing over an icy patch on the road – climbing and descending hills – following a curve in the road	Chapters 5 & 9	Chapters 5 & 9	Chapters 5 & 8
• interpret Newton's Second Law of Motion and relate it to the equation: ΣF = ma	5.5	5.5	5.5
• identify the net force in a wide variety of situations involving modes of transport and explain the consequences of the application of that net force in terms of Newton's Second Law of Motion	Chapters 5 & 9	Chapters 5 & 9	Chapters 5 & 8
3. Moving vehicles have kinetic energy and energy transformations are an important aspect in understanding motion			
• identify that a moving object possesses kinetic energy and that work done on that object can increase that energy	7.8 - 7.9	7.6 - 7.7	6.4 - 6.5
• describe the energy transformations that occur in collisions	8.11, 8.20	8.10, 8.18	7.8, 7.13
• define the law of conservation of energy	7.22	7.19	6.16
4. Change of momentum relates to the forces acting on the vehicle or the driver			
• define momentum as: p = mv	8.1	8.1	7.1
• define impulse as the product of force and time	8.3	8.3	7.3
• explain why momentum is conserved in collisions in terms of Newton's Third Law of motion	8.8	8.7	7.6

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
5. Safety devices are utilised to reduce the effects of changing momentum			
• define the inertia of a vehicle as its tendency to remain in uniform motion or at rest	5.2	5.2	5.2
• discuss reasons why Newton's First Law of Motion is not apparent in many real world situations	5.2	5.2	5.2
• assess the reasons for the introduction of low speed zones in built-up areas and the addition of air bags and crumple zones to vehicles with respect to the concepts of impulse and momentum	8.3	8.3	7.3
• evaluate the effectiveness of some safety features of motor vehicles	8.3	8.3	7.3
The Cosmic Engine (only relevant standards included)			
2. The first minutes of the Universe released energy which changed to matter, forming stars and galaxies			
• identify that Einstein described the equivalence of energy and mass	41.23	40.16	35.12
3. Stars have a limited life span and may explode to form supernovas			
• define the relationship between the temperature of a body and the dominant wavelength of the radiation emitted from that body	42.3	41.3	
4. The Sun is a typical star, emitting electromagnetic radiation and particles that influence the Earth			
• identify that energy may be released from the nuclei of atoms	44.9 - 44.13, 44.15 - 44.21	43.9 - 43.13, 43.15 - 43.21	38.9 - 38.13, 38.15 - 38.18

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe the nature of emissions from the nuclei of atoms as radiation of alpha a and beta b particles and gamma g rays in terms of: – ionising power – penetrating power – effect of magnetic field – effect of electric field			

Physics Stage 6 HSC Course			
Space			
1. The Earth has a gravitational field that exerts a force on objects both on it and around it			
• define weight as the force on an object due to a gravitational field	5.4, 13.10		5.4
• explain that a change in gravitational potential energy is related to work done	7.17	7.14	6.11
• define gravitational potential energy as the work done to move an object from a very large distance away to a point in a gravitational field E = -Gm1m2/r	13.28	13.21	12.17
2. Many factors have to be taken into account to achieve a successful rocket launch, maintain a stable orbit and return to Earth			
• describe the trajectory of an object undergoing projectile motion within the Earth's gravitational field in terms of horizontal and vertical components	4.8 - 4.21	4.7 - 4.20	4.3 - 4.13
• describe Galileo's analysis of projectile motion			
• explain the concept of escape velocity in terms of the: – gravitational constant – mass and radius of the planet	13.33	13.26	12.18
• outline Newton's concept of escape velocity	13.33	13.26	12.18
• identify why the term 'g forces' is used to explain the forces acting on an astronaut during launch			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• discuss the effect of the Earth's orbital motion and its rotational motion on the launch of a rocket	13.27, 13.33	13.20, 13.26	12.18
• analyse the changing acceleration of a rocket during launch in terms of the: – Law of Conservation of Momentum – forces experienced by astronauts	8.28		
• analyse the forces involved in uniform circular motion for a range of objects, including satellites orbiting the Earth	Chapters 9 &13	Chapters 9 &13	Chapters 8 & 12
• compare qualitatively low Earth and geo-stationary orbits			
• define the term orbital velocity and the quantitative and qualitative relationship between orbital velocity, the gravitational constant, mass of the central body, mass of the satellite and the radius of the orbit using Kepler's Law of Periods	13.14, 13.24 - 13.26	13.10, 13.18 - 13.19	12.9, 12.16
• account for the orbital decay of satellites in low Earth orbit			
• discuss issues associated with safe re-entry into the Earth's atmosphere and landing on the Earth's surface			
• identify that there is an optimum angle for safe re-entry for a manned spacecraft into the Earth's atmosphere and the consequences of failing to achieve this angle			
3. The Solar System is held together by gravity			
• describe a gravitational field in the region surrounding a massive object in terms of its effects on other masses in it	13.10		
• define Newton's Law of Universal Gravitation: F = Gm1m2/d2	13.1	13.1	12.1
• discuss the importance of Newton's Law of Universal Gravitation in understanding and calculating the motion of satellites	13.14, Chapter 13	13.10, Chapter 13	12.9, Chapter 12
• identify that a slingshot effect can be provided by planets for space probes			
4. Current and emerging understanding about time and space has been dependent upon earlier models of the transmission of light			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• outline the features of the aether model for the transmission of light	41.3	40.3	35.3
• describe and evaluate the Michelson-Morley attempt to measure the relative velocity of the Earth through the aether	41.3	40.3	35.3
• discuss the role of the Michelson-Morley experiments in making determinations about competing theories	41.3	40.3	35.3
• outline the nature of inertial frames of reference	5.2, 41.0	5.2, 40.0	5.2, 35.0
• discuss the principle of relativity	41.0, Chapter 41	40.0, Chapter 40	35.0, Chapter 35
• describe the significance of Einstein's assumption of the constancy of the speed of light	Chapter 41	Chapter 40	Chapter 35
• identify that if c is constant then space and time become relative	Chapter 41	Chapter 40	Chapter 35
• discuss the concept that length standards are defined in terms of time in contrast to the original metre standard	1.4	1.4	1.4
• explain qualitatively and quantitatively the consequence of special relativity in relation to: – the relativity of simultaneity – the equivalence between mass and energy – length contraction – time dilation – mass dilation	Chapter 41	Chapter 40	Chapter 35
• discuss the implications of mass increase, time dilation and length contraction for space travel	Chapter 41	Chapter 40	Chapter 35
Motors and Generators			
1. Motors use the effect of forces on current-carrying conductors in magnetic fields			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• discuss the effect on the magnitude of the force on a current-carrying conductor of variations in: – the strength of the magnetic field in which it is located – the magnitude of the current in the conductor – the length of the conductor in the external magnetic field – the angle between the direction of the external magnetic field and the direction of the length of the conductor	30.23	30.22	28.18
• describe qualitatively and quantitatively the force between long parallel current-carrying conductors: F/l = kI1I2/d	31.5	31.5	
• define torque as the turning moment of a force using: τ = Fd	11.1	11.1	10.1
• identify that the motor effect is due to the force acting on a current-carrying conductor in a magnetic field	30.25 - 30.27	30.24 - 30.26	28.19
• describe the forces experienced by a current-carrying loop in a magnetic field and describe the net result of the forces	30.25 - 30.27, 32.17	30.24 - 30.26, 32.14	28.19
• describe the main features of a DC electric motor and the role of each feature	30.27	30.26	28.19
• identify that the required magnetic fields in DC motors can be produced either by current-carrying coils or permanent magnets	Chapters 30, 31 & 32	Chapters 30, 31 & 32	Chapters 28 & 29
2. The relative motion between a conductor and magnetic field is used to generate an electrical voltage			
• outline Michael Faraday's discovery of the generation of an electric current by a moving magnet	32.0	32.0	29.0
• define magnetic field strength B as magnetic flux density	32.6	32.6	29.6
• describe the concept of magnetic flux in terms of magnetic flux density and surface area	32.6	32.6	29.6
• describe generated potential difference as the rate of change of magnetic flux through a circuit	32.7	32.7	29.7
• account for Lenz's Law in terms of conservation of energy and relate it to the production of back emf in motors	32.14 - 32.16	32.11 - 32.13	29.9

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• explain that, in electric motors, back emf opposes the supply emf			
• explain the production of eddy currents in terms of Lenz's Law	32.21	32.18	29.11
3. Generators are used to provide large scale power production			
• describe the main components of a generator	32.17	32.14	
• compare the structure and function of a generator to an electric motor	30.27, 32.17	30.26, 32.14	
• describe the differences between AC and DC generators			
• discuss the energy losses that occur as energy is fed through transmission lines from the generator to the consumer	27.18	27.13	25.11
• assess the effects of the development of AC generators on society and the environment			
4. Transformers allow generated voltage to be either increased or decreased before it is used			
• describe the purpose of transformers in electrical circuits	32.23	32.20	29.15
• compare step-up and step-down transformers	32.23	32.20	29.15
• identify the relationship between the ratio of the number of turns in the primary and secondary coils and the ratio of primary to secondary voltage	32.23	32.20	29.15
• explain why voltage transformations are related to conservation of energy	32.23	32.20	29.15
• explain the role of transformers in electricity sub-stations	32.23	32.20	29.15
• discuss why some electrical appliances in the home that are connected to the mains domestic power supply use a transformer	32.24	32.21	29.16
• discuss the impact of the development of transformers on society	32.23	32.20	29.15
5. Motors are used in industries and the home usually to convert electrical energy into more useful forms of energy			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe the main features of an AC electric motor			
From Ideas to Implementation			
1. Increased understandings of cathode rays led to the development of television			
• explain why the apparent inconsistent behaviour of cathode rays caused debate as to whether they were charged particles or electromagnetic waves			
• explain that cathode ray tubes allowed the manipulation of a stream of charged particles	44.1	43.1	38.1
• identify that moving charged particles in a magnetic field experience a force	30.6	30.7	28.7
• identify that charged plates produce an electric field	26.13	26.8	24.13
• describe quantitatively the force acting on a charge moving through a magnetic field $F = qvB \sin \theta$	30.6	30.7	28.7
• discuss qualitatively the electric field strength due to a point charge, positive and negative charges and oppositely charged parallel plates	24.2, 26.15	24.2, 26.10	23.2
• describe quantitatively the electric field due to oppositely charged parallel plates	26.13, 26.15	26.8, 26.10	
• outline Thomson's experiment to measure the charge/mass ratio of an electron			
• outline the role of: – electrodes in the electron gun – the deflection plates or coils – the fluorescent screen in the cathode ray tube of conventional TV displays and oscilloscopes			
2. The reconceptu-alisation of the model of light led to an understanding of the photoelectric effect and black body radiation			
• describe Hertz's observation of the effect of a radio wave on a receiver and the photoelectric effect he produced but failed to investigate	42.6	41.6	36.5

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• outline qualitatively Hertz's experiments in measuring the speed of radio waves and how they relate to light waves			
• identify Planck's hypothesis that radiation emitted and absorbed by the walls of a black body cavity is quantised	42.3	41.3	
• identify Einstein's contribution to quantum theory and its relation to black body radiation	42.4	41.4	36.3
• explain the particle model of light in terms of photons with particular energy and frequency	42.4	41.4	36.3
• identify the relationships between photon energy, frequency, speed of light and wavelength: E = hf and c = fλ	42.4 - 42.5	41.4 - 41.5	36.3 - 36.4
3. Limitations of past technologies and increased research into the structure of the atom resulted in the invention of transistors			
• identify that some electrons in solids are shared between atoms and move freely	42.14	41.13	36.11
• describe the difference between conductors, insulators and semiconductors in terms of band structures and relative electrical resistance	42.14	41.13	36.11
• identify absences of electrons in a nearly full band as holes, and recognise that both electrons and holes help to carry current	42.15	41.14	36.12
• compare qualitatively the relative number of free electrons that can drift from atom to atom in conductors, semiconductors and insulators	42.14	41.13	36.11
• identify that the use of germanium in early transistors is related to lack of ability to produce other materials of suitable purity			
• describe how 'doping' a semiconductor can change its electrical properties	42.16	41.15	36.13
• identify differences in p and n-type semiconductors in terms of the relative number of negative charge carriers and positive holes	42.16	41.15	36.13

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• describe differences between solid state and thermionic devices and discuss why solid state devices replaced thermionic devices			
4. Investigations into the electrical properties of particular metals at different temperatures led to the identification of superconductivity and the exploration of possible applications			
• outline the methods used by the Braggs to determine crystal structure	40.22	39.16	
• identify that metals possess a crystal lattice structure	40.22	39.16	
• describe conduction in metals as a free movement of electrons unimpeded by the lattice	42.14	41.13	36.11
• identify that resistance in metals is increased by the presence of impurities and scattering of electrons by lattice vibrations	27.2, 27.11	27.2, 27.7	25.2, 25.6
• describe the occurrence in superconductors below their critical temperature of a population of electron pairs unaffected by electrical resistance			
• discuss the BCS theory			
• discuss the advantages of using superconductors and identify limitations to their use			
Geophysics (only relevant content included)			
2. Some physical phenomena such as gravitation and radiation provide information about the Earth at a distance from it			
• describe how absorption and reflection of radiation can provide information about a reflecting surface	19.30	19.27	
• outline reasons why the gravitational field of the Earth varies at different points on its surface	13.7	13.6	12.6

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
4. Studies of past and present physical phenomena indicate that the Earth is dynamic			
• describe the Earth's current magnetic field	30.4	30.4	28.4
• account for the evidence that the Earth's magnetic field varies over time	30.4	30.4	28.4
Medical Physics	minimal correlation	minimal correlation	minimal correlation
Astrophysics	minimal correlation	minimal correlation	minimal correlation
From Quanta to Quarks			
1. Problems with the Rutherford model of the atom led to the search for a model that would better explain the observed phenomena			
• discuss the structure of the Rutherford model of the atom, the existence of the nucleus and electron orbits	42.9, 44.2	41.9, 43.2	36.8, 38.2
• analyse the significance of the hydrogen spectrum in the development of Bohr's model of the atom	42.2, 42.9 - 42.10, 42.12	41.2, 41.9 - 41.10, 41.11	36.2, 36.8 - 36.9
• define Bohr's postulates	42.9 - 42.12	41.9 - 41.11	36.8 - 36.9
• discuss Planck's contribution to the concept of quantised energy	42.3	41.3	
• describe how Bohr's postulates led to the development of a mathematical model to account for the existence of the hydrogen spectrum: $1/\lambda = R(1/nf2 - 1/ni2)$	42.2, 42.9 - 42.12	41.2, 41.9 - 41.11	36.2, 36.8 - 36.9
• discuss the limitations of the Bohr model of the hydrogen atom	42.9; Developed further in future book update	41.9; Developed further in future book update	36.8; Developed further in future book update
2. The limitations of classical physics gave birth to quantum physics			
• describe the impact of de Broglie's proposal that any kind of particle has both wave and particle properties	To be included in future book update	To be included in future book update	To be included in future book update

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
• define diffraction and identify that interference occurs between waves that have been diffracted	Chapters 39 and 40; More to be included in future book update (matter waves)	Chapters 38 and 39; More to be included in future book update (matter waves)	Chapter 34; More to be included in future book update (matter waves)
• describe the confirmation of de Broglie's proposal by Davisson and Germer	To be included in future book update	To be included in future book update	To be included in future book update
• explain the stability of the electron orbits in the Bohr atom using de Broglie's hypothesis	To be included in future book update	To be included in future book update	To be included in future book update
3. The work of Chadwick and Fermi in producing artificial transmutations led to practical applications of nuclear physics			
• define the components of the nucleus (protons and neutrons) as nucleons and contrast their properties	44.3	43.3	38.3
• discuss the importance of conservation laws to Chadwick's discovery of the neutron			
• define the term 'transmutation'	44.15	43.15	38.15
• describe nuclear transmutations due to natural radioactivity	44.15 - 44.17	43.15 - 43.17	38.15 - 38.16
• describe Fermi's initial experimental observation of nuclear fission			
• discuss Pauli's suggestion of the existence of neutrino and relate it to the need to account for the energy distribution of electrons emitted in b-decay			
• evaluate the relative contributions of electrostatic and gravitational forces between nucleons	44.5	43.5	38.5
• account for the need for the strong nuclear force and describe its properties	44.5	43.5	38.5
• explain the concept of a mass defect using Einstein's equivalence between mass and energy	44.9 - 44.14	43.9 - 43.14	38.9 - 38.14
• describe Fermi's demonstration of a controlled nuclear chain reaction in 1942			
• compare requirements for controlled and uncontrolled nuclear chain reactions			

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
4. An understanding of the nucleus has led to large science projects and many applications			
• explain the basic principles of a fission reactor	44.13	43.13	38.13
• describe some medical and industrial applications of radio-isotopes	44.19, 44.20	43.19, 43.20	
• describe how neutron scattering is used as a probe by referring to the properties of neutrons			
• identify ways by which physicists continue to develop their understanding of matter, using accelerators as a probe to investigate the structure of matter	44.22	43.22	38.19
• discuss the key features and components of the standard model of matter, including quarks and leptons			
The Age of Silicon	minimal correlation	minimal correlation	minimal correlation