Week 1	Weekly learning outcomes	Student book links	Practical activity links
1. Revision of forces and acceleration 2. Newton's first law 3. Momentum 4. Newton's second law 5. Impulse 6. Newton's third law	Students should be able to: • State and use each of Newton's three laws of motion. • Define *linear momentum* as the product of mass and velocity ($\rho = mv$). • Define *net force on a body* as equal to the rate of change of its momentum. • Select and apply the equation $F = \Delta p/\Delta t$ to solve problems. • Explain that $F = ma$ is a special case of Newton's second law when mass m remains constant. • Define *impulse of a force*. • Recall that the area under a force against time graph is equal to impulse. • Recall and use the equation *impulse* = *change in momentum*.	• 1.1.1–4 • 1.1.6	

OCR Scheme of Work topic outlines
G484 The Newtonian World 4.1.1 Newton's laws of motion – Newton's three laws of motion, linear momentum, and impulse as a force

Week 2	Weekly learning outcomes	Student book links	Practical activity links
1. Conservation of momentum 2. Examples and applications of conservation of momentum 3. Elastic and inelastic collisions	Students should be able to: • State the principle of conservation of momentum. • Apply the principle of conservation of momentum to solve problems when bodies interact in one dimension. • Define a perfectly *elastic collision* and an *inelastic collision*. • Explain that whilst the momentum of a system is always conserved in the interaction between bodies, some change in kinetic energy usually occurs.	• 1.1.5 • 1.1.7	Practical activity 1: Collisions on a linear air track Practical activity 2: The initial velocity of an air gun pellet Practical activity 3: The bounce height of a ball
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.1.2 Conservation of momentum – Conservation of momentum, elastic collisions, and inelastic collisions	

Week 3	Weekly learning outcomes	Student book links	Practical activity links
1. The radian 2. Motion in a circle 3. Centripetal acceleration 4. Centripetal force 5. Examples of circular motion	Students should be able to: • Define the *radian*. • Convert angles from degrees into radians and vice versa. • Explain that a force perpendicular to the velocity of an object will make the object describe a circular path. • Explain what is meant by centripetal acceleration and centripetal force. • Select and apply the equations for speed and centripetal acceleration: $v = 2\pi r/T$ and $a = v^2/r$. • Select and apply the equation for centripetal force: $F = ma = mv^2/r$.	• 1.2.1–4	Practical activity 4: Motion in a circle
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.2.1 Circular motion – Define the radian, use radians and degrees, circular motion, centripetal acceleration, centripetal force.	

Week 4	Weekly learning outcomes	Student book links	Practical activity links
1. Revision of free fall 2. Gravitational fields 3. Newton's law of gravitation 4. Gravitational field strength 5. The Earth's gravitational field and gravitational field strength	Students should be able to: • Describe how a mass creates a gravitational field in the space around it. • Define *gravitational field strength* as force per unit mass. • Use gravitational field lines to represent a gravitational field. • State Newton's law of gravitation and select and use the equation for the force between two points or spherical objects: $F = -GMm/r^2$. • Select and apply the equation for the gravitational field strength of a point mass: $g = -GM/r^2$. • Select and use the equation to determine the mass of the Earth or another similar object: $g = -GM/r^2$. • Explain that close to the Earth's surface, the gravitational field strength is uniform and approximately equal to the acceleration of free fall.	• 1.2.5–7	
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.2.2 Gravitational fields – Gravitational fields, Newton's law of gravitation	

Week 5	Weekly learning outcomes	Student book links	Practical activity links
1. Planetary orbits – simple, circular motion, etc. 2. Kepler's third law 3. Planetary orbits – Kepler's third law and Newton's law of gravitation 4. Satellites	Students should be able to: • Analyse circular orbits in an inverse square law field by relating the gravitational force to the centripetal acceleration it causes. • Define and use the *period of an object describing a circle*. • Derive the equation $T^2 = (4\pi^2/GM)r^3$ from first principles. • Select and apply the equation above for planets and satellites – natural and artificial. • Select and apply Kepler's third law to solve problems. • Define the *geostationary orbit* of a satellite and state the uses of such satellites.	• 1.2.8–9	

OCR Scheme of Work topic outlines

G484 The Newtonian World

4.2.2 Gravitational fields – Planetary orbits, Kepler's third law, and geostationary orbits

Week 6	Weekly learning outcomes	Student book links	Practical activity links
1. Free oscillations 2. Simple harmonic motion (SHM) – definition and simple examples 3. SHM – equations 4. SHM – graphs	Students should be able to: • Describe simple examples of free oscillations. • Define and use the terms *displacement*; *amplitude*; *period*; *frequency*; *angular frequency*; and *phase difference*. • Select and use the equation *period = 1/frequency*. • Define *simple harmonic motion* (SHM). • Select and apply the equation $a = -(2\pi f)^2 x$ as the defining equation of SHM. • Select and use $x = A\cos(2\pi ft)$ or $x = A\sin(2\pi ft)$ as solutions to the equation $a = -(2\pi f)^2 x$. • Select and apply the equation $v_{max} = (2\pi f)A$ for the maximum speed of a simple harmonic oscillator. • Explain that the period of an object with SHM is independent of its amplitude. • Describe with graphical illustrations the changes in displacement, velocity and acceleration during SHM.	• 1.2.10–12	Practical activity 5: The period of oscillation of a mass–spring system Practical activity 6: The motion of some free oscillators Practical activity 7: The motion of a mass–spring oscillator Practical activity 8: Oscillatory motion compared to circular motion

OCR Scheme of Work topic outlines

G484 The Newtonian World

4.2.3 Simple harmonic oscillations – Free oscillation, simple harmonic motion

Week 7	Weekly learning outcomes	Student book links	Practical activity links
1. Energy in simple harmonic motion (SHM) 2. Damping 3. Forced oscillations 4. Resonance 5. Applications and problems of resonance	Students should be able to: • Describe and explain the interchange between kinetic and potential energy during simple harmonic motion (SHM). • Describe the effects of damping on an oscillatory system. • Describe practical examples of forced oscillations and resonance. • Describe graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system. • Describe examples where resonance is useful and other examples where resonance should be avoided.	• 1.2.13–15	Practical activity 9: Simple damping Practical activity 10: The damping of a light-beam galvanometer movement Practical activity 11: Barton's pendulums Practical activity 12: The forced oscillations of a mass spring Practical activity 13: The forced oscillations of a lightly damped light-beam galvanometer movement
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.2.3 Simple harmonic oscillations – Energy changes in simple harmonic motion, damping on an oscillatory system, and resonance	

Week 8	Weekly learning outcomes	Student book links	Practical activity links
1. Density and states of matter (particles) 2. Brownian motion 3. Kinetic theory of matter 4. Internal energy 5. Changes of state	Students should be able to: • Describe solids, liquids and gases in terms of the spacing, ordering and motion of atoms or molecules. • Describe a simple kinetic model for solids, liquids and gases. • Describe an experiment that demonstrates Brownian motion and discuss the evidence for the movement of molecules provided by such an experiment. • Define the term *pressure* and use the kinetic model to explain the pressure exerted by gases. • Define *internal energy* as the sum of the random distribution of kinetic and potential energies associated with the molecules of a system. • Explain that the rise in temperature of a body leads to an increase in its internal energy. • Explain that a change of state for a substance leads to changes in its internal energy but not its temperature. • Describe, using a simple kinetic model for matter, the terms: *melting*; *boiling*; and *evaporation*.	• 1.3.1–4	
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.3.1 Solid, liquid and gas – Spacing and ordering, motion, simple kinetic model, pressure, internal energy, and changes of state	

Week 9	Weekly learning outcomes	Student book links	Practical activity links
1. Heat and temperature 2. Absolute zero and Kelvin 3. Specific heat capacity – definition and examples 4. Measuring specific heat capacity 5. Latent heat of fusion and vaporisation	Students should be able to: • Explain that thermal energy is transferred from a region of higher temperature to a region of lower temperature. • Explain that regions of equal temperature are in thermal equilibrium. • Describe how there is an absolute scale of temperature that does not depend on the property of any particular substance – i.e. the thermodynamic scale and the concept of absolute zero. • Convert temperatures measured in kelvins to degrees Celsius (or vice versa): T (K)= θ (°C) + 273.15 • State that absolute zero is the temperature at which a substance has minimum internal energy. • Define and apply the concept of *specific heat capacity*. • Select and apply the equation $E = mc\Delta\theta$. • Describe an electrical experiment to determine the specific heat capacity of a solid or a liquid. • Describe what is meant by the terms: *latent heat of fusion* and *latent heat of vaporisation*.	• 1.3.5–7	Practical activity 15: An electrical method to measure a specific heat capacity Practical activity 16: Determining specific heat capacity by other methods

OCR Scheme of Work topic outlines
G484 The Newtonian World
4.3.2 Temperature – Thermal equilibrium, Kelvin and degrees Celsius, and absolute zero
4.3.3 Thermal properties of materials – Specific heat capacity and latent heat of fusion and vaporisation

Week 10	Weekly learning outcomes	Student book links	Practical activity links
1. Boyle's law – experiment and conclusion 2. Combined gas laws (*pV/T = constant*) 3. Ideal gases – assumptions 4. Mole and Avogadro's number 5. Ideal gas equations 6. Temperature and average kinetic energy of ideal gas particles	Students should be able to: • State Boyle's law. • Select and apply *pV/T = constant*. • State the basic assumptions of the kinetic theory of gases. • State that one mole of any substance contains 6.02×10^{23} particles and that 6.02×10^{23} mol^{-1} is the Avogadro constant N_A. • Select and solve problems using the ideal gas equation expressed as: $pV = NkT$ and $pV = nRT$, where N is the number of atoms and n is the number of moles. • Explain that the mean translational kinetic energy of an atom of an ideal gas is directly proportional to the temperature of the gas in kelvins. • Select and apply the equation $E = 3/2\ kT$, the mean translational kinetic energy of atoms.	• 1.3.8–11	Practical activity 14: Gas law experiments
		OCR Scheme of Work topic outlines	
		G484 The Newtonian World 4.3.4 Boyle's law – Boyle's law, ideal gas equation, Avogadro constant and translational kinetic energy	

Week 11	Weekly learning outcomes	Student book links	Practical activity links
1. Electric fields – definition 2. Electric fields – shapes and properties 3. Coulomb's law 4. Electric field strength around point charge 5. Uniform electric fields 6. Charged particles in electric fields 7. Comparison between gravitational fields and electric fields	Students should be able to: • State that electric fields are created by electric charges. • Define *electric field strength* as force per unit positive charge. • Describe how electric field lines represent an electric field. • Select and use Coulomb's law in the form $F = Qq/4\pi\varepsilon_0 r^2$. • Select and apply $E = Q/4\pi\varepsilon_0 r^2$ for the electric field strength of a point charge. • Select and use $E = V/d$ for the magnitude of the uniform electric field strength between charged parallel plates. • Explain the effect of a uniform electric field on the motion of charged particles. • Describe the similarities and differences between the gravitational fields of point masses and the electric fields of point charges.	• 2.1.1–3	Practical activity 17: Electric field patterns Practical activity 18: Measuring the constant in Coulomb's law

OCR Scheme of Work topic outlines

G485 Fields, Particles and Frontiers of Physics

5.1.1 Electric fields – Electric fields, electric charge, electric field strength, Coulomb's law, uniform electric fields and the motion of charged particles, and compare gravitational and electric fields

<table>
<tr><th rowspan="3">Week 12</th><th rowspan="3">Weekly learning outcomes</th><th>Student book links</th><th>Practical activity links</th></tr>
<tr><td>• 2.1.4–6</td><td>Practical activity 19: Investigating magnetic fields around conductors carrying a current
Practical activity 20: The force on a wire carrying a current in a magnetic field</td></tr>
<tr><td colspan="2">OCR Scheme of Work topic outlines</td></tr>
<tr><td>1. Magnetic fields – shapes and properties
2. Magnetic field around a current-carrying wire
3. Electromagnets
4. Forces on current-carrying wires in magnetic fields (FLHR and F = BIL)
5. Magnetic flux density</td><td>Students should be able to:
• Describe the magnetic field patterns of a long, straight, current-carrying conductor and a long solenoid.
• State and use Fleming's left-hand rule to determine the force on a current conductor placed at right angles to a magnetic field.
• Select and use the equations F = BIL and F = BILsinθ.
• Define magnetic flux density and the tesla.</td><td colspan="2">G485 Fields, Particles and Frontiers of Physics
5.1.2 Magnetic fields – Magnetic field patterns, fields of a long solenoid, Fleming's left-hand rule, magnetic flux density and tesla</td></tr>
</table>

Week 13	Weekly learning outcomes	Student book links	Practical activity links
1. Force on charged particles in magnetic fields 2. Magnetic fields and circular motion 3. Applications of electric and magnetic fields – mass spectrometer	Students should be able to: • Select and use the equation $F = BQv$ for the force on a charged particle travelling at right angles to a uniform magnetic field. • Analyse the circular orbits of charged particles moving in a plane perpendicular to a uniform magnetic field by relating the magnetic force to the centripetal acceleration it causes. • Analyse the motion of charged particles in both electric and magnetic fields. • Explain the use of deflection of charged particles in the magnetic and electric fields of a mass spectrometer.	• 2.1.7–8	
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.1.2 Magnetic fields – Circular orbits of charged particles, charged particles in electric and magnetic fields, and deflection of charged particles in a mass spectrometer	

Week 14	Weekly learning outcomes	Student book links	Practical activity links
1. Introduction to electromagnetic induction (FRHR) 2. Magnetic flux and the weber 3. Magnetic flux linkage 4. Faraday's law of electromagnetic induction – simple statements and experiments 5. Lenz's law 6. Faraday's law of electromagnetic induction – *induced e.m.f. = –rate of change of magnetic flux linkage* 7. a.c. generator	Students should be able to: • Define *magnetic flux*. • Define *the weber*. • Select and use the equation for magnetic flux: $\phi = BA\cos\theta$. • Define *magnetic flux linkage*. • State and use Faraday's law of electromagnetic induction. • State and use Lenz's law. • Select and use the equation *induced e.m.f. = –rate of change of magnetic flux linkage*. • Describe the function of a simple a.c. generator.	• 2.1.9–11	Practical activity 22: Observing induced voltages
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.1.3 Electromagnetism – Magnetic flux and the weber, magnetic flux linkage, Faraday's law of electromagnetic induction, Lenz's law, and simple a.c. generators	

Week 15	Weekly learning outcomes	Student book links	Practical activity links
1. Transformers – structure and basic use 2. Operation of transformers 3. Transformer equation 4. Efficiency of transformers	Students should be able to: • Describe the function of a simple transformer. • Select and use the turns–ratio equation for a transformer. • Describe the function of step-up and step-down transformers.	• 2.1.12–13	Practical activity 23: Investigating electromagnetic induction using changing fields Practical activity 24: Investigating the action of a transformer

OCR Scheme of Work topic outlines

G485 Fields, Particles and Frontiers of Physics

5.1.3 Electromagnetism – Magnetic flux and the weber, magnetic flux linkage, Faraday’s law of electromagnetic induction, Lenz’s law, transformers, and simple a.c. generators

Teaching scheme

Week 16	Weekly learning outcomes	Student book links	Practical activity links
1. The capacitor – basic structure and principles of use 2. Charging capacitors 3. Capacitance – definition and equation 4. Combining capacitors in series 5. Combining capacitors in parallel 6. Energy stored in capacitors 7. Energy stored in capacitor combinations	Students should be able to: • Define *capacitance* and the *farad*. • Select and use the equation $Q = VC$. • State and use the equation for the total capacitance of two or more capacitors in series. • State and use the equation for the total capacitance of two or more capacitors in parallel. • Solve circuit problems with capacitors involving series and parallel circuits. • Explain that the area under a potential difference against charge graph is equal to energy stored by a capacitor. • Select and use the equations $W = ½ QV$ and $W = ½ CV^2$ for a charged capacitor.	• 2.2.1–2	Practical activity 25: The capacitor equation Practical activity 26: The rules of addition for capacitors in series and parallel Practical activity 27: Energy transfer using a capacitor
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.2.1 Capacitors – Capacitance and the farad, energy storage in a capacitor, total capacitance, and capacitors in series and parallel circuits	

Week 17	Weekly learning outcomes	Student book links	Practical activity links
1. Discharging a capacitor – qualitative description 2. Time constant 3. Exponential decay 4. Use of the exponential equations 5. Uses of capacitors	Students should be able to: • Define the *time constant* of a circuit. • Select and use *time constant* = *CR*. • Analyse the discharge of a capacitor using equations of the form $x = x_o e^{-t/CR}$. • Explain exponential decays as having a constant-ratio property. • Describe the uses of capacitors for the storage of energy in applications such as flash photography, lasers used in nuclear fusion and as backup power supplies for computers.	• 2.2.3–5	Practical activity 28: The charging and discharging a capacitor through a resistor Practical activity 29: To determine the initial velocity of an air gun pellet using a C–R circuit
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.2.1 Capacitors – Discharge of a capacitor through a resistor, time constant of a circuit, and uses of capacitors for the storage of energy	

Week 18	Weekly learning outcomes	Student book links	Practical activity links
1. History of atom models 2. Alpha scattering 3. The nucleus – components and forces 4. Nuclides, elements and isotopes 5. Changes to the nucleus	Students should be able to: • Describe qualitatively the alpha particle scattering experiment and the evidence this provides for the existence, charge and small size of the nucleus. • Describe the basic atomic structure of the atom and the relative sizes of the atom and the nucleus. • Select and use Coulomb's law to determine the force of repulsion and Newton's law of gravitation to determine the force of attraction between two protons at nuclear separations and hence the need for a short-range, attractive force between nucleons. • Describe how the strong nuclear force between nucleons is attractive and very short-ranged. • Estimate the density of nuclear matter. • Define *proton* and *nucleon number*. • State and use the *A*, *Z* notation representation of nuclides. • Define and use the term *isotope*. • Use nuclear decay equations to represent simple nuclear reactions. • State the quantities conserved in a nuclear decay.	• 2.3.1–4 **OCR Scheme of Work topic outlines** **G485 Fields, Particles and Frontiers of Physics** 5.3.1 The nuclear atom – Alpha particle scattering experiment, atomic structure of the atom, Coulomb's law, Newton's law of gravitation, strong nuclear force, density of nuclear matter, proton number, nucleon number, isotopes, and nuclear decay	

Week 19	Weekly learning outcomes	Student book links	Practical activity links
1. Introduction to the particle zoo 2. Quarks 3. Combining quarks – baryons and mesons 4. Antimatter 5. Beta decay in terms of quarks 6. Leptons	Students should be able to: • Explain that since protons and neutrons contain charged constituents called quarks they are therefore *not* fundamental particles. • Describe a simple quark model of hadrons in terms of up, down and strange quarks and their respective antiquarks – taking into account their charge, baryon number and strangeness. • Describe how the quark model may be extended to include the properties of charm, topness and bottomness. • Describe the properties of neutrons and protons in terms of a simple quark model. • Describe how there is a weak interaction between quarks and that this is responsible for beta decay. • State that there are two types of beta decay. • Describe the two types of beta (β) decay in terms of a simple quark model. • State that (electron) neutrinos and (electron) antineutrinos are produced during β^+ and β^- decays, respectively. • State that a β^- particle is an electron and a β^+ particle is a positron. • State that electrons and neutrinos are members of a group of particles known as leptons.	• 2.3.5–6 **OCR Scheme of Work topic outlines** **G485 Fields, Particles and Frontiers of Physics** 5.3.2 Fundamental particles – Protons, neutrons and quarks, quark model of hadrons, leptons, and β decay	

Week 20	Weekly learning outcomes	Student book links	Practical activity links
1. Nature of radioactive decay 2. Activity and the becquerel 3. Decay constant – introduction as probability of decay 4. Alpha particles and alpha decay 5. Beta particles and beta decay 6. Gamma rays and gamma decay 7. Exponential decay	Students should be able to: • Describe the spontaneous and random nature of radioactive decay of unstable nuclei. • Describe the nature, penetration and range of alpha particles, beta particles and gamma rays. • Define and use the quantities *activity* and *decay constant*. • Select and apply the equation for activity $A = \lambda N$. • Select and apply the equations $A = A_0 e^{-\lambda t}$ and $N = N_0 e^{-\lambda t}$ where A is the activity and N is the number of undecayed nuclei.	• 2.3.7–9	Practical activity 30: Experiments with alpha particles Practical activity 31: Experiments with beta particles Practical activity 32: The absorption of gamma rays
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.3.3 Radioactivity – Radioactive decay, α-particles, β-particles, γ-rays, decay constant, and activity	

Week 21	Weekly learning outcomes	Student book links	Practical activity links
1. Half-life – general definition and determination from activity–time graphs 2. Half-life and the decay constant 3. Uses of radioactivity 4. Radioactive dating 5. Comparison between radioactive decay and capacitor discharge	Students should be able to: • Define and apply the term *half-life*. • Select and use the equation $\lambda t_{1/2} = 0.693$. • Compare and contrast the decay of radioactive nuclei and the decay of charge on a capacitor in a C–R circuit. • Describe the use of radioactive isotopes in smoke alarms. • Describe the technique of radioactive dating – i.e. carbon dating.	• 2.3.10–11	Practical activity 33: The decay and recovery of protactinium-234

OCR Scheme of Work topic outlines

G485 Fields, Particles and Frontiers of Physics

5.3.3 Radioactivity – Half-life, and applications of radioactive isotopes

Week 22	Weekly learning outcomes	Student book links	Practical activity links
1. $E = mc^2$ 2. Missing mass and binding energy 3. Binding energy per nucleon 4. Curve of binding energy	Students should be able to: • Select and use Einstein's mass–energy equation $\Delta E = \Delta mc^2$. • Define *binding energy* and *binding energy per nucleon*. • Use and interpret the binding energy per nucleon against nucleon number graph. • Determine the binding energy of nuclei using $\Delta E = \Delta mc^2$ and masses of nuclei.	• 2.3.12	

OCR Scheme of Work topic outlines
G485 Fields, Particles and Frontiers of Physics 5.3.4 Nuclear fission and fusion – Einstein's mass–energy equation

Week 23	Weekly learning outcomes	Student book links	Practical activity links
1. Nuclear fission – basic description and energy released per reaction 2. Chain reaction 3. Nuclear fission reactors 4. Nuclear fusion – basic description and energy released per reaction 5. Nuclear fusion reactors and fusion in stars	Students should be able to: • Describe the process of induced nuclear fission. • Describe and explain the process of nuclear chain reaction. • Describe the basic construction of a fission reactor and explain the role of the fuel rods, control rods and the moderator. • Describe the use of nuclear fission as an energy source. • Describe the peaceful and destructive uses of nuclear fission. • Describe the environmental effects of nuclear waste. • Describe the process of nuclear fusion. • Describe the conditions in the core of stars that make fusion possible. • Calculate the energy released in simple nuclear reactions.	• 2.3.13–15	
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.4.1 X-rays – X-rays, photoelectric effect, Compton effect, pair production, intensity, X-ray imaging, CAT scanners, medical tracers, gamma camera, and PET	

Week 24	Weekly learning outcomes	Student book links	Practical activity links
1. Description of X-rays – revision of photon model 2. Production of X-rays 3. X-ray interactions – Compton effect, pair production and photoelectric effect 4. X-ray intensity 5. Computerised axial tomography (CAT) scans 6. Limitations of X-rays – soft tissue, ionising, etc. – and the alternatives	Students should be able to: • Describe the nature of X-rays. • Describe in simple terms how X-rays are produced. • Describe how X-rays interact with matter – limit to photoelectric effect, Compton effect and pair production. • Define intensity as the power per unit cross-sectional area. • Select and use the equation $I = I_0 e^{-\mu x}$ to show how the intensity I of a collimated X-ray beam varies with thickness x of the medium. • Describe the use of X-rays in imaging internal body structures including the use of image intensifiers and of contrast media. • Explain how soft tissues such as the intestines can be imaged using a barium meal. • Describe the operation of a computerised axial tomography (CAT) scanner. • Describe the advantages of a CAT scan compared with an X-ray image.	• 2.4.1–5	
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.4.1 X-rays – X-rays, photoelectric effect, Compton effect, pair production, intensity, X-ray imaging, CAT scanners 5.4.2 Diagnosis methods in medicine – Medical tracers, gamma camera, and PET	

Week 25	Weekly learning outcomes	Student book links	Practical activity links
1. Medical tracers and the gamma camera 2. Positron emission tomography (PET) scanning 3. Magnetic resonance 4. Magnetic resonance imaging (MRI) scans 5. Other techniques – endoscopes 6. Other technologies – Doppler effect (qualitative) and blood flow	Students should be able to: • Describe the use of medical tracers such as technetium-99m to diagnose the function of organs. • Describe the main components of a gamma camera. • Describe the principles of positron emission tomography (PET). • Outline the principles of magnetic resonance, with reference to precession of nuclei, Larmor frequency, resonance and relaxation times. • Describe the main components of a magnetic resonance imaging (MRI) scanner. • Outline the use of MRI to obtain diagnostic information about internal organs. • Describe the advantages and disadvantages of MRI. • Describe the need for non-invasive techniques in diagnosis. • Explain what is meant by the Doppler effect. • Explain qualitatively how the Doppler effect can be used to determine the speed of blood.	• 2.4.5–8	
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.4.2 Diagnosis methods in medicine – Magnetic resonance, MRI, and the Doppler effect 5.4.3 Ultrasound – Ultrasound	

Week 26	Weekly learning outcomes	Student book links	Practical activity links
1. Ultrasound 2. Piezoelectric effect 3. Ultrasound scans 4. Acoustic impedance 5. Impedance matching	Students should be able to: • Describe the properties of ultrasound. • Describe the piezoelectric effect. • Explain how ultrasound transducers emit and receive high-frequency sound. • Describe the principles of ultrasound scanning. • Describe the difference between A-scan and B-scan. • Calculate the acoustic impedance using the equation $Z = \rho c$. • Calculate the fraction of reflected intensity using the equation $I_r/I_0 = (Z_2-Z_1)^2/(Z_2+Z_1)^2$. • Describe the importance of impedance matching. • Explain why a gel is required for effective ultrasound imaging techniques.	• 2.4.8–11	
		OCR Scheme of Work topic outlines	
		G485 Fields, Particles and Frontiers of Physics 5.4.3 Ultrasound – Ultrasound, the Doppler effect, piezoelectric effect, ultrasound scanning, and acoustic impedance	

Week 27	Weekly learning outcomes	Student book links	Practical activity links
1. Components in the universe 2. Scale of the universe and astronomical measurements 3. Stars – basic introduction 4. Life cycle of stars – star formation 5. Life cycle of stars – star death (small/average stars) 6. Life cycle of stars – star death (large stars) 7. Olbers' paradox	Students should be able to: • Describe the principal contents of the universe – including stars, galaxies and radiation. • Describe the solar system in terms of the Sun, planets, planetary satellites and comets. • Describe the formation of a star such as our Sun from interstellar dust and gas. • Describe the Sun's probable evolution into a red giant and white dwarf. • Describe how a star much more massive than our Sun will evolve into a super red giant and then either into a neutron star or black hole. • Define distances measured in astronomical units (AU), parsecs (pc) and light-years (ly). • State the approximate magnitudes in metres of the parsec and light-year. • State Olbers' paradox. • Interpret Olbers' paradox to explain why it suggests that the model of an infinite, static universe is incorrect.	• 2.5.1–4 **OCR Scheme of Work topic outlines** **G485 Fields, Particles and Frontiers of Physics** 5.5.1 Structure of the universe – Components of the universe, solar system, formation and evolution of stars, measuring distances, and Olbers' paradox	

Week 28	Weekly learning outcomes	Student book links	Practical activity links
1. Hubble's observations 2. Doppler effect – quantitative 3. Hubble's law 4. Cosmological principle 5. Cosmic background radiation	Students should be able to: • Select and use the equation $\Delta\lambda / \lambda = v/c$. • Describe and interpret Hubble's red shift observations. • State and interpret Hubble's law. • Convert the Hubble constant H_0 from its conventional units ($\text{km s}^{-1}\,\text{Mpc}^{-1}$) to SI ($\text{s}^{-1}$). • State the cosmological principle. • Describe and explain the significance of the 3 K microwave background radiation.	• 2.5.5–6	

OCR Scheme of Work topic outlines

G485 Fields, Particles and Frontiers of Physics

5.5.1 Structure of the universe – Hubble's law, the Hubble constant, cosmological principle, and microwave background radiation

5.5.2 The evolution of the universe – big bang model

Week 29	Weekly learning outcomes	Student book links	Practical activity links
1. The big bang theory 2. Age of the universe 3. Mean density 4. Critical density and the fate of the universe	Students should be able to: • Explain that the standard (hot big bang) model of the universe implies a finite age for the universe. • Select and use the expression *age of universe* $\approx 1/H_0$. • Describe qualitatively the evolution of the universe 10^{-43} s after the big bang to the present. • Explain that the universe may be *open*, *flat* or *closed*, depending on its density. • Explain that the ultimate fate of the universe depends on its density. • Define the term *critical density*. • Select and use the expression for critical density of the universe $\rho_0 = 3H_0^2/8\pi G$. • Explain that it is currently believed that the density of the universe is close to, and possibly exactly equal to, the critical density needed for a *flat* cosmology.	• 2.5.7–8	

OCR Scheme of Work topic outlines
G485 Fields, Particles and Frontiers of Physics 5.5.2 The evolution of the universe – Evolution of the universe, open universe, closed universe, flat universe, and critical density