PHYSICS

Chapter 1: Conservation and dissipation of energy (Paper 1)

	Aiming for Grade 4 (C)	Aiming Grade 6 (B)	Aiming for Grade 8 (A*)
Lesson 1.1	• State some examples of energy stores. • State the processes that can transfer energy from one store to another. • Identify changes in some energy stores using simple examples.	• Describe a wide range of energy stores in different contexts. • Describe changes in energy stores in terms of the process that causes the change. • Use quantitative descriptions of changes in energy stores.	• Describe the nature of energy stores in detail including the relationship between objects. • Explain factors that affect the size of changes in energy stores. • Represent energy changes graphically, accounting for changes in all stores.
Lesson 1.2	• State that energy is conserved in any transfer. • State that energy is dissipated (is no longer useful) when it heats the environment. • Investigate the energy transfers in a pendulum and a bungee.	• Apply the law of conservation of energy in straightforward situations. • Describe the changes in energy stores explaining why energy ceases to be useful. • Describe the energy changes in a range of experiments and account for energy dissipation to the surroundings.	• Apply the law of conservation of energy to explain why forces cause hating effects. • Describe closed systems and the changes to energy stores within them using the principle of conservation energy. • Evaluate in detail experiments to investigate energy changes.
Lesson 1.3	• State that energy is measured in joules (J). • Calculate the work done by a force. • Measure the work done by a force experimentally.	• Describe the action of frictional forces on objects and the associated heating effect. • Use the equation for work done to calculate distances or size of forces. • Use repeat values to measure the work done by a force experimentally.	• Use the principle of conservation of energy and forces to explain why objects become heated by frictional forces. • Apply the equation for work done in a wide range of contexts. • Evaluate in detail an experiment to measure work done, explaining why there is variation in the measurements
Lesson 1.4	• State the factors that affect the change in the gravitational potential energy store of a system. • Calculate the gravitational potential energy store of a system using the weight of an object and its height. • Measure the gravitational potential energy store changes in a system with a simple practical activity.	• Describe the effect of a different gravitational field strength on the gravitational potential energy store changes of a system. • Calculate the gravitational potential energy store of a system using the mass, gravitational field strength, and height. • Describe energy changes that involve a heating effect as opposed to movement of an object.	• Perform calculations using rearrangements of the gravitational potential energy store equations. • Apply the gravitational potential energy store equations in a wide range of contexts. • Account for all changes of energy during falls or increases in height, including heating effects.
Lesson 1.5	• State the factors that affect the size of a kinetic energy store of an object. • State the factors that affect the elastic potential energy store of a spring. • Describe energy changes involving elastic potential energy and kinetic energy stores.	• Calculate the kinetic energy store of an object. • Calculate the elastic potential energy store of a stretched spring. • Investigate the relationship between the energy stored in a spring and the kinetic energy store of an object launched from it.	• Perform calculations involving the rearrangement of the kinetic energy equation. • Perform calculations involving the rearrangement of the elastic potential energy equation. • Perform a wide range of calculations involving transfer of energy.

	Aiming for Grade 4 (C)	Aiming Grade 6 (B)	Aiming for Grade 8 (A*)
Lesson 1.6	• Identify useful and wasted energy in simple scenarios. • Describe energy dissipation in terms of heating the surroundings. • Measure the frictional force acting on an object.	• Analyse energy changes to identify useful and less useful energy transfers. • Describe energy dissipation and how this reduces the capacity of a system to do work. • Investigate the factors that affect frictional forces.	• Use a wide range of energy stores and physical processes to decide on wasted and useful energy transfers. • Apply the concept of energy dissipation in a wide range of scenarios. • Evaluate in detail an experiment to measure the frictional forces acting on an object.
Lesson 1.7	• Describe an efficient transfer as one that transfers more energy by a useful process. • State that the efficiency of an energy transfer is always less than 100%. • Calculate the efficiency of a simple energy transfer.	• Calculate the efficiency of a range of energy transfers. • Use the law of conservation of energy to explain why efficiency can never be greater than 100%. • Investigate the efficiency of a motor.	• Describe design features that can be used to improve the efficiency of an energy transfer. H • Rearrange the efficiency equation to find input or total output energy. • Evaluate in detail an efficiency investigation to justify conclusions.
Lesson 1.8	• List some example electrical devices. • Survey a range of electrical devices and their operation. • Describe the energy transfers carried out by electrical devices.	• Rank electrical devices in terms of their power. • Compare mains-powered and battery-powered devices. • Describe the processes that waste energy in electrical devices.	• Compare electrical devices in terms of efficiency. • Calculate the efficiency of an electrical device. • Explain the operation of electrical devices in terms of forces and electric current.
Lesson 1.9	• State the unit of power as the watt and kilowatt. • With support, rank electrical appliances in order of power. • Identify 'wasted' and 'useful' energy transfers in electrical devices.	• Calculate the energy transferred by an electrical device. • Calculate the efficiency of a device from power ratings. • Find the wasted power of a device.	• Compare the power ratings of devices using standard form. • Apply the efficiency equation in a range of situations, including rearrangement of the equation. • Combine the electrical power equation with other equations to solve complex problems.

Chapter 2: Energy transfer by heating (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 2.1	• Describe materials as good or poor thermal conductors. • Compare the thermal conductivities of materials in simple terms. • Relate the thermal conductivities of a material to the uses of that material in familiar contexts.	• Analyse temperature change data to compare the thermal conductivity of materials. • Describe the changes in the behaviour of the particles in a material as the temperature of the material increases. • Apply understanding of thermal conductivity in reducing energy dissipation through the choice of appropriate insulating materials.	• Explain the different thermal conductivities of materials using the free electron and lattice vibration explanations of conduction. • Evaluate the results of an experiment into thermal conductivity in terms of repeatability and reproducibility of data, and the validity of conclusions drawn from the data. • Justify the choices of a material involved in insulation or conduction using the concept of thermal conductivity and other data.
Lesson 2.2	• State that infrared radiation is radiation of shorter wavelength than red light. • State that an object cools by emitting infrared radiation and heats by absorbing infrared radiation. • Describe how infrared radiation can be detected.	• Describe the cooling of objects in terms of the rate of emission of radiation. • Describe how the rate of emission of radiation is related to the temperature of a body. • Describe the visible changes in an object's emitted radiation as its temperature is increased.	• Compare the black body spectra of two objects to identify which is at a higher temperature. • Apply the concepts of absorption and emission of infrared radiation to explain why an object maintains a constant temperature. • Describe the changes in the black body radiation curve as the temperature of an

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
			object changes in terms of change in the radiation emitted.
Lesson 2.3	• Compare the emission of infrared radiation from different surfaces (such as shiny and dark). • Outline the evidence that changes in the concentration of atmospheric gases are the likely cause of global warming. • Describe the greenhouse effect in terms of absorption and emission of radiation.	• Compare the emission of infrared radiation from different surfaces (such as shiny and dark). • Outline the evidence that changes in the concentration of atmospheric gases are the likely cause of global warming. • Describe the greenhouse effect in terms of absorption and emission of radiation.	• Describe factors that affect the rate of emission of infrared radiation, including surface colour. • Apply the concepts of absorption and emission of IR radiation to explain why an object maintains a constant temperature. • Fully explain the greenhouse effect in terms of absorption, emission, and wavelengths of electromagnetic radiation.
Lesson 2.4	Describe materials in terms of being difficult or easy to heat up (increase the • temperature of). List the factors that affect the amount of energy required to increase the • temperature of an object. • With some support, measure the specific heat capacity of a material.	• Describe the effects of changing the factors involved in the equation. • Calculate the energy required to change the temperature of an object. • Measure the specific heat capacity of a material and find a mean value.	Evaluate materials used for transferring energy in terms of their specific heat capacity. Use the specific heat capacity equation to perform a wide range of calculations in unfamiliar contexts. • Evaluate in detail the results of an experiment to measure specific heat capacity.
Lesson 2.5	• Describe some design features used to prevent energy transfer to the surroundings in the home. • Calculate the payback time of a simple home improvement feature.	• Describe how some design features used to reduce energy dissipation from a home work. • Compare home improvement features in terms of payback time.	• Evaluate in detail design features used to reduce energy transferred from the home. • Decide on home improvement features using payback time and savings beyond the payback time.

Chapter 3: Energy resources (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 3.1	• Identify which fuels are renewable and which are non-renewable. • Identify activities that require large energy transfers. • Describe biofuels as carbon neutral whereas fossil fuels are not.	• Outline the operation of a fossil fuel burning power station. • Outline the operation of a nuclear power station. • Explain why biofuels are considered carbon neutral.	• Compare energy use from different sources and different societies from available data. • Compare fossil fuels and nuclear fuels in terms of energy provided, waste, and pollution. • Discuss some of the problems associated with biofuel use and production.
Lesson 3.2	• State that wind turbines, wave generators, hydroelectric systems, and tidal systems are renewable energy resources. • Describe some simple advantages or disadvantages of renewable energy systems. • Outline the operation of a renewable energy source.	• Describe the operation of a wind farm. • Describe the operation of a hydroelectric system. • Suggest the most appropriate energy resource to use in a range of scenarios.	• Compare the operation of hydroelectric, wave, and tidal systems in terms of reliability, potential power output, and costs. • Explain in detail the purpose, operation, and advantages of a pumped storage system. • Justify the choice of an energy resource by using numerical and other appropriate data.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 3.3	• Explore the operation of a solar cell. • Describe one difference between solar cells and solar heating systems. • State that radioactive decay is the source of heating in geothermal systems.	• Compare and contrast the operation of solar cells (photovoltaic cells) with solar heating panels. • Describe the operation of a solar power tower. • Describe the operation of a geothermal power plant.	• Analyse the power output of a variety of energy resources. • Calculate the energy provided by a solar heating system by using the increase in water temperature. • Plan in detail an investigation into the factors that affect the power output of a solar cell.
Lesson 3.4	• List some environmental problems associated with burning fossil fuels. • Identify the waste products of fossil fuels and nuclear fuel. • Describe simple advantages and disadvantages of a variety of renewable energy resources.	• Describe the effects of acid rain and climate change. • Describe techniques to reduce the harmful products of burning fossil fuels. • Compare a wide range of energy resources in terms of advantages and disadvantages.	• Evaluate methods of reducing damage caused by waste products of fossil fuels and nuclear fuels. • Discuss in detail the problems associated with nuclear accidents and the public perception of nuclear safety. • Evaluate the suitability of an energy resource for a range of scenarios, taking into account a wide range of factors.
Lesson 3.5	• Rank the start-up times of various power stations. • Compare some of the advantages and disadvantages of various energy resources. • Discuss the construction of a power plant in the local area in simple terms by using information provided.	• Use base load and start-up time data to explain why some power stations are in constant operation whereas others may be switched on and off. • Compare energy resources in terms of capital and operational costs. • Debate the construction of a power plant in the local area by using a wide range of information, much of which is provided.	• Use the capital and operational costs of energy resources to evaluate their usefulness. • Form persuasive arguments for and against a variety of energy resources. • Debate the construction of a power plant in the local area by using a wide range of information, much of which is independently researched.

Chapter 4: Electric circuits (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 4.1	• Label the constituents of an atom (proton, neutron, and electron) on a diagram. • Describe the interactions between positively and negatively charged objects. • State that objects can become electrically charged by the action o frictional forces.	• Compare the electrical properties of protons, neutrons, electrons, and ions. • Use the concept of electric fields to explain why charged objects interact. • Describe how objects become charged in terms of electron transfer.	• Describe the shape of the field and lines of force around a point charge or charged sphere. • Apply the concept of electric fields to explain in detail why the force between charged objects decreases with increasing distance. • Explain why sparks can be produced by charged materials in terms of charge build-up.
Lesson 4.2	• Identify circuit components from their symbols. • Draw and interpret simple circuit diagrams. • Construct a simple electrical circuit.	• Describe the operation of a variable resistor and a diode and their effects on current. • Calculate the charge transferred by a steady current in a given time. • Construct an electrical circuit and accurately measure the current.	• Explain the nature of an electric current in wires in terms of electron behaviour. • Perform a range of calculations, including rearrangement of the equation $Q = It$. • Measure the current in a circuit accurately and use it to calculate the rate of flow of electrons.
Lesson 4.3	• State that resistance restricts the size of a current in a circuit. • State Ohm's law and describe its conditions. • Measure the current and potential difference in a circuit to determine the resistance.	• Calculate the potential difference. • Calculate the resistance of a component. • Measure the effect of changing the length of a wire on its resistance in a controlled experiment.	• Describe potential difference in terms of work done per unit charge. • Rearrange equations for resistance and potential difference. • Investigate a variety of factors that may affect the resistance of a metal wire, such as the current through it, length, cross-sectional area, and metal used.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 4.4	• Identify the key characteristics of electrical devices. • Identify components from simple I–V graphs. • State the operation of a diode in simple terms.	• Describe the resistance characteristics of a filament lamp. • Describe the characteristics of a diode and light-emitting diode. • Investigate the resistance characteristics of a thermistor and a LDR.	• Explain the resistance characteristics of a filament lamp in terms of electrons and ion collisions. • Determine the resistance of a component based on information extracted from a *I–V* graph. • Compare the characteristics of a variety of electrical components, describing how the components can be used.
Lesson 4.5	• State that the current in any part of a series circuit is the same. • Calculate the potential difference provided by cell combinations. • Calculate the total resistance of two resistors placed in series.	• Find the potential difference across a component in a circuit by using the p.d. rule. • Calculate the current in a series circuit containing more than one resistor. • Investigate the resistance of series circuits with several components.	• Explain in detail why the current in a series circuit is the same at all points by using the concept of conservation of charge (electrons). • Analyse a variety of series circuits to determine the current through, p.d. across, and resistance of combinations of components. • Evaluate in detail the investigation of series circuits and explain discrepancies.
Lesson 4.6	• Identify parallel sections in circuit diagrams. • State the effect of adding resistors in parallel on the size of the current in a circuit. • State that the p.d. across parallel sections of a circuit is the same.	• Measure the p.d. across parallel circuits and explain any discrepancies. • Describe the effect on the resistance in a circuit of adding a resistor in parallel. • Investigate the effect of adding resistors in parallel on the size of the current in a circuit.	• Analyse parallel circuits in terms of current loops. • Calculate the current at any point in a circuit. • Evaluate in detail an investigation into the effect of adding resistors in parallel on a circuit.

Chapter 5: Electricity in the home (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 5.1	• State that the UK mains supply is a high-voltage alternating current supply. • State simple differences between a.c. and d.c. sources. • Describe how the trace on an oscilloscope changes when the frequency or amplitude of the signal is changed.	• Describe the characteristics of the UK mains supply. • Compare a.c. traces in terms of period and amplitude (voltage). • Operate a cathode ray oscilloscope to display an a.c. trace.	• Explain the process of half-wave rectification of an a.c. source. • Analyse a.c. traces with an oscilloscope to determine the voltage and frequency. • Compare and contrast the behaviour of electrons in a wire connected to d.c. and a.c. supplies.
Lesson 5.2	• Identify the live, neutral, and earth wires in a three-pin plug. • Identify the key components of a typical three-pin plug and socket. • Identify simple and obvious hazards in electrical wiring.	• Discuss the choices of materials used in cables and plugs in terms of their physical and electrical properties. • Describe why a short circuit inside a device presents a hazard. • Identify a variety of electrical hazards associated with plugs and sockets.	• Explain when there will be a current in the live, neutral, and earth wires of an appliance. • Discuss in detail the hazards associated with poor electrical wiring.
Lesson 5.3	• State that the power of a device is the amount of energy transferred by it each second. • Describe the factors that affect the rate of energy transfer by a current in a circuit. • Explain why different fuses are required for different electrical devices in simple terms.	• Calculate the power of systems. • Calculate the power of electrical devices. • Select an appropriate fuse for a device.	• Measure and compare the power of electrical devices and explain variations in readings. • Calculate the electrical heating caused by resistance. • Combine a variety of calculations to analyse electrical systems.
Lesson 5.4	• Describe how an electric current consists of a flow of charge (electrons in a wire). • Identify the factors that affect the energy transfer in a circuit. • State that a battery or power supply provides energy to a current whereas a resistor causes a transfer of energy to the surroundings.	• Calculate the charge transferred by a current in a given time. • Calculate the energy transferred by a charge passing through a potential difference. • Apply the law of conservation of energy in a circuit.	• Perform calculations involving rearrangement of the equations $Q = It$ and $E = VQ$. • Explain how energy is conserved in terms of current and p.d. during energy transfers by an electric current. • Use algebra to combine the equations $Q = It$ and $E = VQ$ to form the • relationships $E = VIt$ and $P = IV$.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 5.5	• Describe the factors that affect the cost of using various electrical devices. • Calculate energy transfer in joules. • State that energy transfer can be measured in kilowatt-hours.	• Calculate energy transfer in kilowatt-hours. • Convert between efficiencies stated in percentages and those stated in decimal forms. • Calculate the power rating of a device from the energy transferred and the time of operation.	• Convert between relevant units during calculations of energy transfer. • Analyse the use of a variety of electrical devices to determine their cost of operation. • Compare a range of electrical devices in terms of efficiency using calculations to support any conclusions.

Chapter 6: Molecules and Matter (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 6.1	• Describe density as a property of a material and not a particular object. • State that the density of a material is the mass per unit volume. • Calculate the volume of some regular shapes and the density of materials, with support.	• Explain why some materials will float on water. • Calculate the density of materials. • Measure the density of a solid and a liquid.	• Use the density equation in a wide variety of calculations. • Use appropriate significant figures in final answers when measuring density. • Evaluate in detail the experimental measurement of density, accounting for errors in measurements.
Lesson 6.2	• Describe the simple properties of solids, liquids, and gases. • Name the changes of state. • State that there are changes in stores of energy associated with a material when its temperature is increased.	• Describe the arrangement of the particles in a solid, liquid, and gas. • Explain the behaviour of a material in terms of the arrangement of particles within it. • Describe the changes in behaviour of the particles in a material during changes of state.	• Describe the forces acting between particles in a solid, liquid, and gas. • Describe the changes in the energy of individual particles during changes of state. • Explain in detail why the density of a material changes during a change of state, using a particle model.
Lesson 6.3	• State that the melting point of a substance is the temperature at which it changes from a solid to a liquid and vice versa. • State that the boiling point of a substance is the temperature at which it changes from a liquid to a gas and vice versa. • Describe the process of melting and boiling.	• State that the melting and boiling points of a pure substance are fixed. • Use the term 'latent heat' to describe the energy gained by a substance during heating for which there is no change in temperature. • Find the melting or boiling point of a substance by using a graphical technique.	• Describe how the melting points and boiling points of a substance can be changed. • Describe in detail the behaviour of the particles during changes of state. • Evaluate data produced by a heating experiment to discuss the reproducibility of the measurement of a melting point.
Lesson 6.4	• State that the internal energy of a system increases as it is heated. • Identify which changes of state are related to increases in internal energy and which are related to decreases. • Outline the behaviour of particles in solids, liquids, and gases.	• Describe how the internal energy of an object can be increased by heating. • Describe how the behaviour of particles changes as the energy of a system increases. • Describe the energy changes by heating between objects within the same system.	• Use the concepts of kinetic and potential energy to explain changes in internal energy. • Describe the changes in the size of intermolecular forces during changes of state.
Lesson 6.5	• State that heating a material will increase its internal energy. • Describe energy changes during melting and vaporisation. • Measure the latent heat of vaporisation for water.	• Describe the changes in particle bonding during changes of state. • Calculate the latent heat of fusion and latent heat of vaporisation for a substance. • Measure the latent heat of fusion for water.	• Perform a variety of calculations based on the latent heat equation. • Combine a variety of equations to solve problems involving heating. • Evaluate the reproducibility of a measurement of latent heat based on collated data.
Lesson 6.6	• State that as the temperature of a gas in a sealed container increases, the pressure of the gas increases. • Describe a gas as consisting of a large number of rapidly moving particles. • Describe pressure as being caused by collisions of gas particles with the walls of its container.	• Describe the behaviour of particles in a gas as the gas is heated. • Outline Brownian motion and how this provides evidence for the particle nature of matter. • Describe the relationship between an increase in the temperature of a fixed volume of a • gas and the increase in pressure of	• Describe the linear relationship between changes in temperature and pressure for a gas. • Explain Brownian motion in terms of particle behaviour and collisions, relating the speeds of smoke particles and air molecules. • Describe in detail how the relationship between the pressure of a gas and its temperature can be investigated.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
		the gas.	
Lesson 6.7	• State that the temperature of a gas is related to the kinetic energy of the gas particles. • State that the pressure of a gas increases when it is compressed (at a constant temperature). • Describe how forces are required to compress a gas.	• Describe how the pressure of a gas can change when it is compressed or allowed to expand. • Use the relationship pV = constant to calculate the constant. • **Explain why the temperature of a gas increases when it is compressed.**	• Explain in terms of particle behaviour why the pressure of a gas increases when its volume decreases. • Calculate the pressure or volume of a gas. • Solve a variety of problems in which gas pressure or volume changes.

Chapter 7: Radioactivity (Paper 1)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 7.1	• Name the three types of nuclear radiation. • Name the three sub-atomic particles found in an atom (proton, neutron, and electron). • Identify some sources of background radiation.	• Describe some safety precautions used when dealing with radioactive materials. • Describe how a Geiger counter can be used to detect radiation. • Identify natural and man-made sources of background radiation.	• Describe in detail the decay of an unstable nucleus. • Explain the similarities and differences between nuclear radiation and visible light. • Describe the relative penetrating powers of the three types of nuclear radiation.
Lesson 7.2	• Identify the Rutherford (nuclear) model of an atom. • Identify the locations of protons, neutrons, and electrons in the nuclear model. • State that electrons can move between fixed energy levels within an atom.	• Describe the plum pudding model of the atom. • Describe the evidence provided by the Rutherford scattering experiment. • Describe the properties of protons, neutrons, and electrons.	• Compare the plum pudding model, Rutherford model, and Bohr model of the atom in terms of the evidence for each model. • Explain how Rutherford and Marsden's experiment caused a rejection of the plum pudding model. • Describe how the initial evidence for the nuclear model was processed and how the model came to be accepted.
Lesson 7.3	• Identify the mass and atomic number by using nuclear notation. • Identify the type of decay taking place from a nuclear equation. • Describe how isotopes are atoms of the same element with different mass numbers.	• Calculate the number of neutrons in an isotope by using nuclear notation. • Describe the differences between isotopes. • Complete decay equations for alpha and beta decay.	• Explain why particles are ejected from the nucleus during nuclear decay. • Describe the changes in the nucleus that occur during nuclear decay. • Write full decay equations, for example, nuclear decays.
Lesson 7.4	• Rank the three types of nuclear radiation in order of their penetrating power. • Rank the three types of nuclear radiation in order of their range through air. • State that all three types of nuclear radiation are ionising.	• Describe how the penetrating powers of radiation can be measured. • Describe the path of radiation types through a magnetic field. • Describe the process of ionisation.	• Describe in detail how the thickness of a material being manufactured can be monitored by using a beta source. • Compare the ionisation caused by the different types of nuclear radiation. • Evaluate in some detail the risks caused by alpha radiation inside and outside the human body.
Lesson 7.5	• State that the activity of a radioactive sample will fall over time. • Define half-life in simple terms such as 'the time it takes for half of the material to decay'. • Find the half-life of a substance from a graph of count rate (or nuclei remaining) against time with support.	• **(Find the ratio of a sample remaining after a given number of half-lives.** • State that all atoms of a particular isotope have an identical chance to decay in a fixed time. • Plot a graph showing the decay of a sample and use it to determine half-life.	• Compare a physical model of decay with the decay of nuclei, noting the limitations of the model. • Outline how the age of organic material can be determined by using • radioactive dating. • **Calculate the changes in count rate or nuclei remaining by using an exponential decay function.**
Lesson 7.6	• Name some medical applications for radioactive substances. • State that the larger the dose of radiation, the more likely harm will be caused. • Describe some precautions used during diagnoses or treatments	• Explain why alpha, beta, or gamma radiation is chosen for a particular medical application. • Describe how gamma rays can be used to destroy cancerous cells and the damage they may cause to healthy tissue.	• Describe the use of radioactive implants and the hazards associated with the technique. • Discuss the factors that need to be taken into account when selecting a medical tracer for a diagnostic test. • Explain how a medical tracer is used including the

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
	involving radioactive substances.	• Explain how precautions to reduce exposure to patients and medical staff work.	function of a gamma camera.
Lesson 7.7	• Describe how nuclear fission is the breaking of a large nucleus to form two smaller nuclei. • Distinguish between induced fission and spontaneous fission. • Label the key components of a nuclear reactor.	• Describe induced nuclear fission in terms of neutron impacts and release. • Explain how an escalating induced fission reaction occurs. • Outline the function of the moderator, control rods, and coolant.	• Explain how a steady-state induced fission reaction can be maintained. • Explain the differences between naturally occurring isotopes and enriched nuclear fuels. • Explain the operation of a nuclear fission reactor, including the choices of appropriate materials.
Lesson 7.8	• State that nuclear fusion is the energy releasing process in the Sun. • State that the Sun fuses (joins together) hydrogen nuclei into helium nuclei. • Describe how very high temperatures and pressures are required for fusion to take place.	• Outline the process of nuclear fusion. • Complete a nuclear equation showing simple fusion processes. • Describe the key design features of a nuclear fusion reactor.	• Explain why it is difficult to carry out controlled nuclear fusion on Earth. • Construct a variety of nuclear equations showing nuclear fusion. • Compare the operation of a nuclear fission reactor and a nuclear fusion reactor.
Lesson 7.9	• Identify sources of radiation, including medical and background radiation. • Describe the type of damage caused by large-scale nuclear accidents. • Describe how nuclear waste is very dangerous and must be stored safely for very long periods of time.	• Compare the risks and damage associated with alpha, beta, and gamma radiation. • Describe how damage caused by radioactive material can be reduced. • Discuss the difficulties associated with the handling and storage of nuclear waste.	• Discuss the risks and benefits of nuclear power compared to other methods of electricity generation. • Describe and explain the safety precautions that need to take place after a large nuclear accident. • Evaluate in detail a variety of storage or disposal solutions for nuclear waste.

Chapter 8: Forces in balance (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 8.1	• Describe how scalars have size (magnitude) without direction. • Describe how vectors have both size (magnitude) and direction. • List some common scalars and vectors.	• Draw a scale diagram to represent a single vector. • Categorise a wide range of quantities as either a vector or a scalar. • Compare a scalar and a similar vector and explain how these quantities are different.	• Interpret a scale diagram to determine the magnitude and direction of a vector. • Translate between vector descriptions and vector diagrams and vice versa using a range of appropriate scales. • Use a scale diagram to add two or more vectors.
Lesson 8.2	• Use arrows to represent the directions of forces. • Give examples of contact and non-contact forces. • Compare the sizes of forces using the unit newton (N).	• Use scale diagrams to represent the sizes of forces acting on an object. • Describe the action of pairs of forces in a limited range of scenarios. • Investigate the effect of different lubricants on the size of frictional forces.	• Compare the plum pudding model, Rutherford model, and Bohr model of the atom in terms of the evidence for each model. • Explain how Rutherford and Marsden's experiment caused a rejection of the plum pudding model. • Describe how the initial evidence for the nuclear model was processed and how the model came to be accepted.
Lesson 8.3	• Label a diagram showing several forces acting on an object. • Calculate a resultant force from two parallel forces acting in opposite directions. • State that a non-zero resultant force will cause a change in motion and	• Draw a scaled diagram of the forces acting in a range of situations using • arrows to represent the forces. • **Calculate resultant force produced by several forces acting on an object in coplanar directions.** • Describe the effect of zero and non-	• Draw a scaled free-body force diagram showing forces as vectors and find the resultant force vector. • Calculate resultant forces from several forces acting in coplanar directions using a range of SI prefixes. • Create a detailed plan to investigate the factors that affect the acceleration of objects acted on by a non-zero resultant force.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
	• a zero resultant force will not (Newton's First Law of motion).	zero resultant forces on the motion of moving and stationary objects.	
Lesson 8.4	• Give the factors that affect the size of a moment. • Calculate the moment of a force using the appropriate equation and base units. • Record experimental data clearly.	• Describe the uses of a force-multiplier lever. • Perform calculations involving moments, including rearrangement of the equation. • Design a system for recording data and associated calculations clearly.	• Explain why a force multiplier requires the effort force to move through a larger distance than the load. • Apply the equation for a moment in a range of novel contexts including rearrangement and changes to and from base units. • Evaluate in detail the accuracy and precision of a set of data based on comparison of measurements and a 'true value'.
Lesson 8.5	• Identify levers being used as force multipliers. • Calculate the forces produced by force multipliers. • State that gears can be used to increase or decrease the size of forces.	• Describe the action of levers being used as force multipliers. • Describe the action of a pair of gears in terms of increasing or decreasing the size of forces. • Investigate the action of a set of two gears.	• Describe the action of gears relating changes in the size of forces to the speed of rotation and the number of teeth in the gear. • Analyse systems of gears of different ratios. • Evaluate the results of a gear experiment, explaining any discrepancies in terms of the uncontrolled forces acting on the system.
Lesson 8.6	• Identify the approximate centre of mass of a range of simple shapes. • State that a suspended object will come to rest so that the centre of mass lies below the point of suspension. • Use lines of symmetry to identify the location of the centre of mass.	• Describe an experimental technique to determine the centre of mass of an object. • Explain why a suspended object comes to rest with the centre of mass directly below the point of suspension in terms of balanced forces. • Compare the stability of objects to the position of their centre of mass.	• Evaluate an experimental technique to determine the centre of mass of an object, identifying the likely sources of error leading to inaccuracy. • Apply understanding of the particle model and moments to explain why objects have a point at which the mass seems to act. • Plan a detailed investigation into the stability of three-dimensional objects.
Lesson 8.7	• Calculate moments using the appropriate equation. • Define the principle of moments. • Find the weight of an object using a balanced beam.	• Use calculation of moments to determine if a seesaw is in equilibrium. • Apply the principle of moments to determine if an object is in equilibrium. • Establish the possible range of uncertainty of a weight using repeat values.	• Use calculations to determine if an object with three or more moments is in equilibrium. • Describe the application of moments in balance (equilibrium) in a range of contexts. • Evaluate an experiment to determine the weight of objects in terms of accuracy and precision.
Lesson 8.8	• Find the resultant of two forces at an acute angle by drawing a scale diagram. • Describe a system in equilibrium in which non-parallel forces are acting. • Calculate the component of a force using scale diagrams and ratios.	• Find the resultant of two forces at an acute angle by drawing a scale diagram. • Describe a system in equilibrium in which non-parallel forces are acting. • Calculate the component of a force using scale diagrams and ratios.	• Find the resultant of two forces at an obtuse angle by drawing a scale diagram. • Investigate non-parallel forces acting on a system in equilibrium to verify the parallelogram of forces. • Analyse a wide range systems of non-parallel forces using a parallelogram technique.
Lesson 8.9		• Resolve a single force into two perpendicular components. • Determine if an object is in equilibrium by considering the horizontal and vertical forces. • Investigate the effect of increasing the weight of an object on a slope on the component of the weight acting along the slope.	• Resolve a pair of forces into the overall perpendicular components. • Determine if an object is in equilibrium by considering the horizontal and vertical components of forces. • Plan a detailed investigation into the effect of increasing the gradient of a slope on the component of the weight acting along the slope.

Chapter 9: Motion (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 9.1	• Describe how the gradient of a distance–time graph represents the speed. • Estimate typical speeds for walking, running, and cycling. • Calculate the distance an object at constant speed will travel in a given time.	• Use the gradients of distance–time graphs to compare the speeds of objects. • Describe the motion of an object by interpreting distance–time graphs. • Calculate the speed of an object and the time taken to travel a given distance.	• Calculate the speed of an object by extracting data from a distance–time graph. • Extract data from a distance–time graph to calculate the speed of an object at various points in its motion. • Perform calculations of speed, distance, and time which involve conversion to and from SI base units.
Lesson 9.2	• Describe the difference between speed and velocity using an appropriate example. • Give the equation relating velocity, acceleration, and time. Calculate the acceleration of an object using the change in velocity and time.	• Identify the features of a velocity–time graph. • Rearrange the acceleration equation in calculations. • Calculate the change in velocity for an object under constant acceleration for a given period of time.	• Compare and contrast the features of a distance–time, displacement–time, and velocity–time graph. • Combine equations relating to velocity and acceleration in multi-step calculations. • Calculate a new velocity for a moving object that has accelerated for a given period of time.
Lesson 9.3	• Identify the feature of a velocity–time graph that represents the acceleration [the gradient], and compare these values. • Identify the feature of a velocity–time graph that represents the distance travelled [the area beneath the line], and compare these values. • Measure the acceleration of an object as it moves down a ramp.	• Describe sections of velocity–time graphs, and compare the acceleration in these sections. • Calculate the distance travelled using information taken from a velocity–time graph for one section of motion. • Use a series of repeat measurements to find an accurate measurement of the acceleration of a moving object.	• Calculate the acceleration of an object from values taken from a velocity–time graph. • Calculate the total distance travelled from a multi-phase velocity–time graph. • Evaluate an experiment into the acceleration of an object in terms of precision based on the spread of repeat measurements.
Lesson 9,4	• Identify a change in speed on a distance–time graph using change in gradient. • Identify a change in acceleration on a velocity–time graph using change in gradient. • Calculate the distance travelled by an object at constant velocity using data extracted from a graph.	• Calculate the speed of an object by extracting data from a distance–time graph. • **Use a tangent to determine the speed of an object from a distance–time graph.** • Use the equation $v^2 - u^2 = 2as$ in calculations where the initial or final velocity is zero.	• Calculate the acceleration of an object by extracting data from a velocity–time graph. • Use the gradient of a velocity–time graph to determine the acceleration of an object. • Apply transformations of the equation $v^2 - u^2 = 2as$ in calculations involving change in velocity and acceleration where both velocities are non-zero.

Chapter 10: Forces and motion (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 10.1	• State the factors that will affect the acceleration of an object acted on by a resultant force. • Calculate the force required to cause a specified acceleration on a given mass. • Investigate a factor that affects the acceleration of a mass.	• Describe the effect of changing the mass or the force acting on an object on the acceleration of that object. • Perform calculations involving the rearrangement of the $F = ma$ equation. • Combine separate experimental conclusions to form an overall conclusion.	• **Define the inertial mass of an object in terms of force and acceleration.** • Calculate the acceleration of an object acted on by several forces. • Evaluate an experiment by identifying sources of error and determining • uncertainty in the resulting data.
Lesson 10.2	• State the difference between the mass of an object and its weight. • Describe the forces acting on an object falling through a fluid. • Investigate the motion of an	• Calculate the weight of objects using their mass and the gravitational field strength. • Apply the concept of balanced forces to explain why an object falling through a fluid will reach	• Apply the mathematical relationship between mass, weight, and gravitational field strength in a range of situations. • Explain the motion of an object falling through a

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
	object when it falls.	a terminal velocity. • Investigate the relationship between the mass of an object and the terminal velocity.	fluid by considering the • forces acting through all phases of motion. • Evaluate the repeatability of an experiment by considering the spread of each set of repeat results.
Lesson 10.3	• List the factors which affect the stopping distance of a car. • Calculate the thinking distance for a car from the initial speed and reaction time. • Estimate the relative effects of changing factors which affect the stopping distance of cars.	• Categorise factors which affect thinking distance, braking distance, and both. • Calculate the braking distance of a car. • Describe the relationship between speed and both thinking and braking distance.	• Calculate acceleration, mass, and braking force of vehicles. • Calculate total stopping distance, initial speed, reaction time, and acceleration. • Explain the relative effects of changes of speed on thinking and stopping distance.
Lesson 10,4		• Apply the equation $p = mv$ to find the momentum, velocity or mass of an object. • Describe how the principle of conservation of momentum can be used to find the velocities of objects. • Investigate the behaviour of objects during explosions to verify the conservation of momentum.	• Fully describe the motion of objects after an explosion accounting for any frictional effects. • Apply the principle of conservation of momentum to a range of calculations involving the velocities of objects. • Evaluate the data produced from an investigation and compare this to a theoretical framework.
Lesson 10.5		• (Apply the law of conservation of momentum to find the momentum before and after impacts. • Calculate the momentum of a combination of objects after an impact. • Evaluate data used to verify the law of conservation of momentum.	• Apply the law of conservation of momentum to find velocities of objects after impacts. • Analyse the velocities of objects in a wide range of collisions. • Evaluate an experimental technique and discuss in detail the factors which • lead to differences between experimental data and an accepted law.
Lesson 10.6		• Describe collisions in terms of forces and conservation of momentum. • Calculate the force involved in an impact from the change in momentum and time. • Design features that will reduce the size of impact forces in a collision.	• Apply the concept of equal and opposite forces in collisions to explain why momentum is conserved in impacts. • Calculate changes in velocity and momentum during impacts using the force involved in the impact and the impact time. • Plan an investigation into the impact forces involved in a collision and how • they can be reduced.
Lesson 10.7		• Describe the operation of some safety features of a car in simple terms. • Report on the differences in safety features between expensive and inexpensive cars.	• Use scientific principles such as rate of change of momentum to explain in detail the operation of a range of car safety features. • Evaluate a range of optional safety features based on their costs and • effectiveness.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 10.8	• State Hooke's law. • Calculate the extension of a material using its length and original length. • Compare materials in terms of elastic and non-elastic behaviour.	• Explain the limitations of Hooke's law including the limit of proportionality. • Calculate the force required to cause a given extension in a spring using the spring constant. • Compare the behaviour of different materials under loads in terms of • proportional and non-proportional behaviour.	• Find the spring constant of a spring using a graphical technique. • Apply the Hooke's law equation in a wide range of situations. • Evaluate an investigation into the extension of materials in terms of the • precision of the data.

Chapter 11: Force and Pressure (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 11.1	• State the factors that affect the pressure acting on a surface. • Calculate the pressure caused by an object resting on a surface, given the force and area of contact. • Describe how pressure can be caused by the action of fluids (liquids and gases) on a surface	• Describe the effect on the pressure of changing the area of contact or weight acting on a surface. • Calculate forces or areas of contact. • Use SI prefixes in expressions for pressure as appropriate.	• Apply the concept of pressure in explaining the effect on a surface in a wide range of contexts. • Perform pressure calculations including conversion of areas and forces with SI multiplier prefixes. • Estimate uncertainty in values for pressure using experimental data.
Lesson 11.2		Use the concept of force, mass, and volume to explain why the pressure • increases with depth in a liquid. • Calculate the pressure at a point in a liquid using $p = h\ \rho\ g$.	• Use algebraic techniques to derive the equation $p = h\ \rho\ g$. • Rearrange the equation $p = h\ \rho\ g$ to solve a range of questions involving the pressure in a liquid.
Lesson 11.3	• Describe how the pressure of the atmosphere decreases with height above the Earth's surface. • Describe how the density of the atmosphere decreases with height. • Describe the cause of atmospheric pressure in simple terms.	• Calculate the forces produced by pressure differences. • Describe the change in pressure at different heights. • **Use the equation $p = h\rho g$ to determine pressure in a fluid.**	• Use the particle model to explain in detail the changes in atmospheric pressure. • Explain a range of phenomena in terms of pressure difference. • **Explain why the relationship $p = h\rho g$ is not suitable for calculating changes in pressure in the atmosphere over a large change in height.**
Lesson 11,4		• Describe the relationship between upthrust and weight for floating and submerged objects. • Compare the density of an object with the density of a liquid to determine whether or not the object will float. • Plan an investigation into the relationship between the average density of an object and the distance it submerges.	• Calculate the upthrust acting on a submerged object by using the pressure difference on the top and bottom surfaces. • Use algebraic techniques to show that the weight of liquid displaced is equal to the upthrust provided. • Carry out and evaluate in detail an investigation into the relationship between the average density of an object and the distance it submerges.

Chapter 12: Wave properties (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 12.1	• State that waves can transfer energy and information without the transfer of matter. • Identify waves as either transverse or longitudinal. • Identify waves as either mechanical or electromagnetic.	• Investigate wave motion through a spring model. • Compare transverse and longitudinal waves in terms of direction of vibration and propagation. • Compare electromagnetic and mechanical waves in terms of the need for a medium.	• Explain the features of a longitudinal wave in terms of compressions and rarefactions by using a particle model. • Discuss the features of a transverse wave in terms of particle or field behaviour. • Compare mechanical waves and their particulate nature with electromagnetic waves and their field oscillations.
Lesson 12.2	• Identify the wavelength and amplitude of a wave from a simple diagram. • Describe how the frequency of a wave is the number of waves produced each second and is measured in hertz. Measure the speed of a water wave	• Outline the derivation of the wave speed equation. • Calculate the period of a wave from its frequency. • Calculate the wave speed from the frequency and wavelength.	• Explain how the wave speed equation can be derived from fundamental principles. • Perform calculations involving rearrangements of the period equation and the wave speed equation. • Perform multi-stage calculations linking period, frequency, wave speed, and wavelength. • Describe the features of neutron stars and black holes.
Lesson 12.3		• Describe refraction at a boundary in terms of wavefronts. • Describe refraction including the reflected rays. • Explain partial absorption as a decrease in the amplitude of a wave and therefore the energy carried..	• Use a wavefront model to explain refraction and reflection. • Describe the relationship between the angle of incidence and angle of refraction • Explain refraction in terms of changes in the speed of waves when they move between one medium and another.
Lesson 12,4	• Measure the speed of a wave in water. • Describe how sound waves travel more quickly in solid than they do in gases. • State that sound waves require a medium to travel in.	• Measure the speed of a wave in a solid (string). • Describe the effect that changing the frequency of a wave has on its wavelength in a medium. • Calculate the speed of waves using the wave speed equation.	• Evaluate the suitability of apparatus for measuring the frequency, wavelength, and speed of waves. • Explain why the wavelength of a wave in a particular medium changes as the frequency changes with reference to the wave equation. • Evaluate data from speed of sound experiments to discuss the range of possible speeds for sound.
Lesson 12.5		• Describe the properties of a sound in terms of amplitude and frequency. • Identify the range of frequencies that humans can hear. • Measure the frequency of a sound wave using an oscilloscope and the relationship frequency = 1 / period	• Outline the structure of the human ear in terms of transfer of waves and vibrations. • Explain why the human ear has a limited range of frequencies it can detect. • Compare the propagation of a sound wave in a solid and a gas.
Lesson 12.6		• Compare ultrasound and audible sound waves in terms of frequency. • Outline some uses of ultrasound in distance measurement. • Describe the operation of an ultrasound transducer in terms of	• Investigate the reflection and absorption of ultrasound waves. • Calculate the positions of objects or flaws in metal objects using data from

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
		partial reflection.	an ultrasound trace. • Use an oscilloscope to obtain timing information for an ultrasound pulse.
Lesson 12.7		• Describe the internal structure of the Earth. • Compare the three types of seismic waves (P, S, L) in terms of the speed they travel and whether they are transverse or longitudinal. • Describe the operation of a seismometer.	• Explain in detail how the internal structure of the Earth can be determined by waves passing through it. • Calculate the speed of different types of seismic waves. • Interpret seismographs to determine the difference in speeds of seismic waves.

Chapter 13: Electromagnetic waves (Paper 2)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 13.1	• State that electromagnetic (EM) waves transfer energy without transferring matter. • Identify the position of EM waves in the spectrum in order of wavelength and frequency. • State that all EM waves travel at the same speed in a vacuum.	- Describe the relationship between the energy being transferred by an electromagnetic wave and the frequency of the wave. • Calculate the frequency and the wavelength of an electromagnetic wave. • Explain why the range of wavelengths detected by the human eye is limited.	• Apply the wave model of electromagnetic radiation as a pair of electric and magnetic disturbances that do not require a medium for travel. • Use standard form in calculations of wavelength, frequency, and wave speed. • Explain the interactions between an electromagnetic wave and matter.
Lesson 13.2	• Describe how white light is a part of the electromagnetic spectrum and is composed of a range of frequencies. • List some simple examples of the uses of light, microwaves, and radio waves. • Measure the rate of cooling due to emission of infrared radiation.	• Describe how a range of electromagnetic waves are used in a variety of scenarios. • Explain why a particular wave is suited to its application. • Plan an investigation into the rate of cooling of infrared radiation.	• Determine the wavelength of radio waves in air. • Describe the interactions between a range of waves and matter, including the effect of absorption. • Evaluate an investigation into the rate of cooling of infrared radiation
Lesson 13.3	• State that radio waves and microwaves are used in communications through the atmosphere. • State that the higher the frequency of a wave, the greater the rate of data transfer possible. Describe the sub-regions of the radio spectrum.	• Compare the rate of information transfer through optical fibres and radio signals. • Outline the operation of a mobile phone network and the waves used. • Discuss the evidence for mobile phone signals causing damage to humans.	• Describe in detail how carrier waves are used in the transfer of information. • Describe the structure of a radio communication system, including the effect of a radio wave on the current in the receiver. • Discuss the relationship between wavelength, data transmission, and range to • explain why particular frequencies are chosen for particular transmissions.
Lesson 13,4	• State that high-frequency electromagnetic radiation is ionising. • Describe the uses and dangers of ultraviolet (UV) radiation. • Describe the uses and dangers of X-rays and gamma radiation.	• Describe the penetrating powers of gamma rays, X-rays, and ultraviolet rays. • Compare X-rays and gamma radiation in terms of their origin. • Describe the ionisation of atoms in simple terms.	• Describe in detail the interaction between ionising radiation and inorganic materials. • Compare different regions of the electromagnetic spectrum in terms of their potential harmfulness. • Explain how the process of ionisation can lead to cell death or cancer through damage to DNA.

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 13.5	• Describe some safety procedures that take place during the operation of devices that produce ionising radiation. • Describe the formation of an X-ray photograph in terms of absorption or transmission. • State that X-ray therapy can be used to kill cancerous cells in the body.	• Describe the operation of an X-ray machine. • Explain why contrast media can be used during X-rays. • Describe the factors that affect the radiation doses received by people.	• Compare the operation of a CT-scanner and that of a simple X-ray device. • Evaluate the doses of ionising radiation received in a variety of occupations or medical treatments. • Explain in detail how various safety features reduce exposure to ionising radiation.

Chapter 14: Light

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 14.1	• State the law of reflection. • Describe the properties of an image in a mirror in simple terms and investigate reflection with guidance. • Describe how a real image can be formed on a screen but a virtual image cannot.	• Construct accurate ray diagrams showing the reflection of light rays. • Explain why some surfaces form images during reflection but others do not. • Investigate the formation of images in mirrors.	• Draw a ray diagram showing the position of an image in a plane mirror. • Use ray diagrams to discuss why some surfaces form images during reflection but others do not. • Evaluate the data from an investigation to discuss the precision and accuracy of any results.
Lesson 14.2	• Describe how the path of a ray of light will change at a boundary between two transparent materials. • Identify the angle of incidence and angle of refraction in a ray diagram. • Measure the angle of incidence and angle of refraction for a simple refraction.	• Construct a ray diagram showing the refraction of a ray of light at a boundary between two different media. • Describe the dispersion of white light as it passes through a prism. • Investigate the refraction of light through a glass or Perspex block.	• Explain how the refraction of light can cause the depth of a material to appear less than it actually is. • Explain the dispersion of light as it passes through a prism in terms of different changes of speed for different wavelengths of light. • Analyse the data from a refraction investigation to test different substances to determine whether it fits a suggested relationship.
Lesson 14.3	• Describe the visible spectrum as a continuous series of colours or wavelengths. • Explain the colour of objects in white light in terms of reflection of parts of the spectrum. Use the terms transparent and translucent accurately.	• Describe the colours of objects in different colours of light. • Describe the reflection of a ray of light from a smooth or rough surface. • Determine the appearance of a white object when illuminated by • combinations of primary coloured light.	• Explain the apparent colour of surfaces using the concept of reflection and absorption when illuminated by white light or combinations of primary colours. • Describe the effects of combinations of coloured light and filters on the appearance of a variety of coloured objects. • Determine the apparent colour of a coloured surface when illuminated by different combinations of red, green, and blue light.
Lesson 14.4	• Distinguish whether a lens is converging or diverging based on a simple ray diagram. • Identify convex (converging) and concave (diverging) lenses from their shapes. • Form images by using a range of lenses.	• Identify real and virtual images by using ray diagrams. • Calculate the magnification of a lens based on object and image size. • Investigate the image-forming properties of a converging lens.	• Explain ray paths through a lens in terms of refraction and the focal point. • Perform calculations involving the rearrangement of the magnification equation. • Construct complete ray diagrams showing image formation by a convex lens with a variety of object positions.
Lesson 14.5	• Identify the optical axis and focal point for a diagram showing image formation. • Identify the position of the image formed by a lens using pre-existing rays on a diagram. • Describe how a focused image can be formed by a camera lens.	• With support, construct ray diagrams showing the formation of images by a convex lens and a concave lens. • Describe the image formed by a magnifying glass. • Describe the image formed by a camera lens.	• From first principles, construct ray diagrams showing the formation of images by a convex lens and a concave lens. • Fully describe the properties of an image (real, virtual, magnified, diminished, upright, and inverted)

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
			based on a ray diagram. • Use scale diagrams to determine the size of an image produced by a lens.

Chapter 15: Electromagnetism

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 15.1	• State the names of the poles of a magnet. • Describe the interaction of magnetic poles (attraction and repulsion). • List some magnetic and non-magnetic metals.	• Sketch the shape of a magnetic field around a bar magnet. • Describe how the shape of a magnetic field can be investigated. • Compare the Earth's magnetic field to that of a bar magnet.	• Describe the regions in a magnetic field where magnetic forces are greatest using the idea of field lines. • Explain in detail how magnetism can be induced in some materials. • Plan in detail how the strength of a magnetic field can be investigated.
Lesson 15.2	• State that the magnetic field produced by a current-carrying wire is circular. • Describe the effect of increasing the current on the magnetic field around a wire. • Describe the effect of reversing the direction of the current in the wire.	• Use the corkscrew rule to determine the direction of the field around a current-carrying wire. • Describe the shape of the field produced by a solenoid. • Describe the factors that affect the strength or direction of the magnetic field around a wire and solenoid.	• Determine the polarity of the ends of a solenoid from the direction of the current. • Sketch the shape of the field surrounding a solenoid relating this to the direction of the current through the coil. • Plan a detailed investigation into the factors that affect the strength of the magnetic field around a solenoid.
Lesson 15.3	• List some electromagnet devices • State some uses of electromagnets State the factors which increase the strength of an electromagnet.	• Describe the structure of an electromagnet in simple terms. • Describe the operation of simple devices that use electromagnets. • Investigate the factors that affect the strength of an electromagnet.	• Explain the effect of an iron core on the strength of an electromagnet in terms of the magnetic field. • Describe in detail the operation of an electric bell. • Evaluate in detail an experiment into the factors which affect the strength of an electromagnet.
Lesson 15.4		• Describe how the force acting on a wire due to the motor effect can be increased. • Apply Fleming's left-hand rule to determine the direction of the force acting on a conductor. • Calculate the force acting on a conductor when it is placed in a magnetic field.	• Describe and explain in detail the operation of a motor. • Perform calculations involving rearrangements of the equation $F = BIl$. • Investigate the factors that affect the rotation of an electric motor.
Lesson 15.5		• Describe electromagnetic induction in a wire. • Identify the factors that affect the size of an induced current in a wire. • Identify the direction of current induced in a solenoid.	• Explain why relative movement of a wire through a magnetic field is required to cause induction. • Independently investigate the magnitude and polarity of a current induced in a solenoid when a magnet is moved in it. • Describe how a changing current in one coil can be used to induce a current in another.
Lesson 15.6		Describe the operation of an alternator, moving-coil microphone and • loudspeaker in simple terms. • Describe the operation of a d.c. generator. Identify the period and peak output voltage for generators from an • oscilloscope trace.	• Describe the output of an alternator, linking this to the position of the coil to the magnetic field and the speed of rotation. • Explain the operation of a d.c. generator and its output. • Explain why the peak voltage of an a.c. generator is produced when the plane of the coil is parallel to the magnetic field lines.
Lesson 15.7		• Describe the structure of a transformer. • Describe the operation of a transformer in simple terms.	• Justify the choice of materials used to construct a transformer. • Describe and explain the operation

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
		• Explain why transformers only operate with alternating currents.	of a transformer in terms of induction and changes in magnetic fields. • Investigate the effect that changing the ratio of the input and output loops on a transformer has on the change in voltage.
Lesson 15.8		• Use the transformer equation to calculate input or output voltages for a transformer. • Calculate the secondary current in a transformer. • Measure the efficiency of a transformer.	• Apply the transformer equation in a wide variety of situations. • Use the relationship $V_P \times I_P = V_S \times I_S$ to calculate all variables. • Measure the efficiency of a transformer and explain why this may not be 100%..

Chapter 16: Space

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
Lesson 16.1	• Describe a variety of objects within the Solar System. • Use simple data to compare objects in the Solar System. • State that the material in a star is pulled together by gravitational forces.	• Describe the formation of a protostar and planets. • Explain why a star radiates light in terms of nuclear fusion. • Describe how evidence for the early Solar System is gathered.	• Analyse data about the planets to compare them in terms of composition. • Explain why a star in its main sequence maintains a constant radius. • Discuss the methods used to gather evidence for the early Solar System and • formation of stars.
Lesson 16.2	• Identify the sequence of development for a small star such as the Sun from a diagram. • State that changes in the fusion processes in a star result in changes in its appearance. • State that the Sun is in its main sequence and is stable.	• Compare the life cycle of small and large stars, identifying the names of the stages. • Describe the formation of 'light' elements by stars in their main sequence. • Describe the forces that are acting when a star is in its main sequence.	• Describe changes in the wavelength (colour) and quantity (brightness) of light emitted by stars during various stages of their life cycle. • Explain, in terms of energy requirements, why elements heavier than iron are produced only in supernovae. • Describe the features of neutron stars and black holes.
Lesson 16.3	• Compare the orbits of planets, moons, and artificial satellites. • Describe how, for an object to be moving in an orbit, there must be a gravitational force acting directed at the centre of the orbit. List some uses of artificial satellites.	• State that, for a greater radius of orbit, the object must travel at a slower speed and orbit in a longer period. • Describe the forces acting on an object that cause it to travel in a circular path. • Describe the different orbits of a variety of satellites.	• Explain why a centripetal force can change the velocity of an object without changing its speed. • Explain why the force acting on an object travelling in a circle must be at right angles to the direction of motion and directed towards the centre of the circle. • Explain why a geostationary satellite must be a specific distance from the centre of the Earth.
Lesson 16.4	• State that the wavelength of a wave is changed by the movement of the source. • State that a galaxy showing red-shift is moving away from us. • Describe the structure of a galaxy as a collection of billions of stars many light years in diameter.	• Describe how the frequency or wavelength of a wave can be altered by the movement of the source through the Doppler effect. • Compare galaxies in terms of their red-shift and distance from us. • State that all galaxies are moving away from each other and that this shows the universe is expanding.	• Identify red-shift or blue-shift by comparing emission spectra of objects with those of a non-moving source. • Identify the relationship between the red-shift of a galaxy and its speed of recession from a data set or graph. • Explain how red-shift data is used to show that the universe is expanding.
Lesson 16.5	• State that the currently accepted model for the early universe is the Big Bang model. • Describe how red-shift provides	• Discuss why scientists were initially reluctant to accept the Big Bang model. • Describe the origin of the CMBR. • Describe changes in the universe from the	• Outline recent discoveries that have led to changes in the theories of how the universe will develop. • Explain in detail how the CMBR

	Aiming for Grade 4	Aiming for Grade 6	Aiming for Grade 8
	evidence for expansion of the universe and the Big Bang model. Identify the cosmic microwave background radiation (CMBR) as evidence for the Big Bang model.	time of the Big Bang to the present day.	supports the Big Bang model. • Discuss how scientists using new evidence have changed their theories about how the universe has evolved over time and how it will change in the future.