Paper 1:

Topic 1 – Energy Retrieval Starters

4.1.1.1 Energy stores and systems

1. What is meant by a system in physics?
2. What happens to the energy stores of a system when a change occurs?
3. Describe the energy store changes when an object is projected upwards.
4. Describe the energy store changes when a moving object hits an obstacle.
5. Describe the energy store changes when water is heated in an electric kettle.
6. How can energy changes in a system be calculated?

4.1.1.2 Changes in energy

1. A football has a mass of 0.45 kg and is kicked at a speed of 30 m/s. Calculate the kinetic energy of the football.
2. A car has a mass of 1200 kg and travels at 20 m/s. Calculate the kinetic energy of the car.
3. A spring with a spring constant of 200 N/m is stretched by 0.05 m. Calculate the elastic potential energy stored in the spring.
4. A spring is stretched by 0.06 m and stores 0.54 J of elastic potential energy. Calculate the spring constant.
5. An object is raised 5 m and gains 750 J of gravitational potential energy. If the gravitational field strength is 10 N/kg, calculate the mass of the object.
6. A 5 kg object is lifted 3 m. If the gravitational field strength is 9.8 N/kg, calculate the gravitational potential energy gained.

4.1.1.3 Energy changes in systems

1. A substance requires 6000 J of energy to increase its temperature by 10°C. If the substance has a mass of 2 kg, calculate its specific heat capacity.
2. What is meant by the specific heat capacity of a substance?
3. Calculate the energy needed to raise the temperature of 1 kg of a substance with a specific heat capacity of 500 J/kg°C by 10°C.
4. What factors affect the amount of thermal energy stored by an object when its temperature changes?

5. Describe how the specific heat capacity of a material can be investigated experimentally.
6. During heating, which energy store decreases and which energy store increases?

4.1.1.4 Power

1. What is meant by power in physics?
2. A device transfers 9000 J of energy and has a power of 300 W. Calculate the time taken for the energy transfer.
3. What equation is used to calculate power from work done and time?
4. A machine transfers 6000 J of energy in 30 seconds. Calculate its power.
5. What is the unit of power?
6. Why is a machine that transfers the same amount of energy in less time more powerful?

4.1.2.1 Energy transfers in a system

1. What is the law of conservation of energy?
2. What happens to the total energy in a closed system when an energy transfer occurs?
3. What is meant by dissipated energy?
4. Why is dissipated energy often described as wasted energy?
5. How can lubrication reduce unwanted energy transfers?
6. How does increasing the thickness of insulation affect the rate of cooling of a building?

4.1.2.2 Efficiency

1. A device has an efficiency of 75% and takes in 2000 J of energy. Calculate the useful energy output.
2. What does an efficiency value of 0.8 mean?
3. A machine has a useful power output of 1500 W and an efficiency of 60%. Calculate the total power input.
4. How can efficiency be converted from a decimal into a percentage?
5. A machine takes in 500 J of energy and transfers 400 J usefully. Calculate the efficiency of the machine.
6. How can the efficiency of an energy transfer be increased?

4.1.3 National and global energy resources

1. What are the main non-renewable energy resources used on Earth?
2. What are the main renewable energy resources used on Earth?
3. What is the difference between renewable and non-renewable energy resources?
4. Describe one advantage and one disadvantage of using fossil fuels.
5. Why are some energy resources more reliable than others?
6. Why can the use of different energy resources cause environmental issues?

Topic 1 Review

1. Explain how energy stores change when an object is lifted and then released.
2. Calculate the kinetic energy of a 1000 kg car travelling at 15 m/s.
3. Explain how energy is conserved but can be dissipated during energy transfers.
4. A 2 kg object is raised 5 m. Calculate the gravitational potential energy gained if the gravitational field strength is 9.8 N/kg.
5. Explain how efficiency calculations show how much energy is transferred usefully.
6. Compare renewable and non-renewable energy resources and explain their environmental impacts.

Topic 2 – Electricity Retrieval Starters

4.2.1.1 Standard circuit diagram symbols

1. Draw the circuit symbol used to represent a voltmeter.
2. Draw the circuit symbol used to represent a resistor.
3. Draw the circuit symbol used to represent a battery.
4. Draw the circuit symbol used to represent an LED.
5. Draw the circuit symbol used to represent a thermistor.
6. Draw a circuit diagram showing a cell, switch, lamp and resistor connected in series.

4.2.1.2 Electrical charge and current

1. What must a circuit contain for electrical charge to flow?
2. What is meant by electric current?

3. A charge of 120 C flows through a circuit in 30 seconds. Calculate the current.
4. A current of 5 A flows for 2 minutes. Calculate the charge transferred.
5. A circuit transfers 600 C of charge in 3 minutes. Calculate the current.
6. Why does the current have the same value at any point in a single closed loop?

4.2.1.3 Current, resistance and potential difference

1. A resistor has a potential difference of 12 V across it and a current of 3 A flowing through it. Calculate its resistance.
2. A circuit has a resistance of 20 Ω and a current of 0.5 A. Calculate the potential difference across the component.
3. A lamp has a potential difference of 6 V and a resistance of 12 Ω. Calculate the current through the lamp.
4. How does increasing the resistance of a component affect the current for a fixed potential difference?
5. A student measures the resistance of wires with different lengths. The wire length increases from 0.5 m to 2.0 m. Describe the expected relationship between wire length and resistance.
6. What happens to the current in a circuit if the potential difference is increased while resistance stays constant?

4.2.1.4 Resistors

1. What is the relationship between current and potential difference for an ohmic conductor at constant temperature?
2. Why does the resistance of a filament lamp increase as the filament gets hotter?
3. How does the resistance of a thermistor change when its temperature increases?
4. How does the resistance of an LDR change when the light intensity increases?
5. Why does a diode only allow current to flow in one direction?
6. Describe how an LDR can be used in an automatic lighting circuit.

4.2.2 Series and parallel circuits

1. What happens to the current in components connected in series?
2. What happens to the potential difference across components connected in series?
3. Two resistors of 5 Ω and 10 Ω are connected in series. Calculate the total resistance.

4. A series circuit contains resistors of 8 Ω and 12 Ω. Calculate the total resistance.
5. What happens to the potential difference across components connected in parallel?
6. Explain why adding resistors in parallel decreases the total resistance of a circuit.

4.2.3.1 Direct and alternating potential difference

1. What is the difference between direct and alternating potential difference?
2. What type of potential difference is supplied by mains electricity in the UK?
3. What is the frequency of the UK mains electricity supply?
4. What is the approximate potential difference of the UK domestic electricity supply?
5. Why are batteries described as providing direct potential difference?
6. Why does alternating potential difference change direction over time?

4.2.3.2 Mains electricity

1. What is the purpose of the live wire in a mains cable?
2. What is the purpose of the neutral wire in a mains cable?
3. What is the purpose of the earth wire in a mains cable?
4. Why can a live wire be dangerous even when a switch is open?
5. Why is the earth wire important for electrical safety?
6. What are the colour codes used for the live, neutral and earth wires in mains cables?

4.2.4.1 Power

1. A device has a potential difference of 12 V and a current of 5 A. Calculate its power.
2. A motor has a current of 4 A and a resistance of 20 Ω. Calculate the power transferred.
3. A lamp transfers 600 W of power at a potential difference of 240 V. Calculate the current through the lamp.
4. How does increasing the current through a device affect the power transferred?
5. How does increasing the potential difference across a device affect the power transferred?
6. Explain how power describes the rate of energy transfer in an electrical device.

4.2.4.2 Energy transfers in everyday appliances

1. A 1000 W heater is used for 60 seconds. Calculate the energy transferred.
2. A device transfers 72 000 J of energy and has a power of 1200 W. Calculate the operating time.
3. An appliance transfers 5000 J of energy using a charge flow of 20 C. Calculate the potential difference.
4. How do electrical appliances transfer energy from electrical stores to other energy stores?
5. Why do higher power appliances transfer more energy in the same amount of time?
6. Describe the energy transfers that occur in an electric motor.

4.2.4.3 The National Grid

1. What is the National Grid?
2. Why are step-up transformers used in the National Grid?
3. Why are step-down transformers used before electricity reaches homes?
4. Explain why electricity is transmitted at high potential differences.
5. How does the National Grid reduce energy losses during electricity transmission?
6. Describe how electricity is transferred from power stations to consumers.

4.2.5.1 Static charge (Physics only)

1. How can an insulating material become electrically charged?
2. Which particle is transferred when static electricity is produced?
3. What charge does an object gain when it gains electrons?
4. What happens when two objects with the same type of charge are brought close together?
5. What happens when two objects with opposite charges are brought close together?
6. Why are attraction and repulsion between charged objects examples of non-contact forces?

4.2.5.2 Electric fields (Physics only)

1. What is an electric field?
2. Where is the electric field strongest around a charged object?
3. How does the strength of an electric field change as distance from the charged object increases?
4. Why does a charged object placed in an electric field experience a force?
5. Describe the electric field pattern around an isolated charged sphere.

6. Explain how electric fields help to explain electrostatic forces between charged objects.

Topic 2 Review

1. A current of 3 A flows through a circuit for 5 minutes. Calculate the charge transferred.
2. A resistor has a potential difference of 9 V and a resistance of 3 Ω. Calculate the current through the resistor.
3. Two resistors of 15 Ω and 25 Ω are connected in series. Calculate the total resistance.
4. A device uses a power of 1200 W for 30 seconds. Calculate the energy transferred.
5. Explain why the National Grid uses high potential differences to transfer electrical energy.
6. Explain how static electricity is produced and why charged objects can attract or repel each other.

Topic 3 – Particle Model of Matter Retrieval Starters

4.3.1.1 Density of materials

1. What is meant by the density of a material?
2. A metal block has a mass of 600 g and a volume of 200 cm^3. Calculate the density of the metal block.
3. A liquid has a density of 800 kg/m^3 and a volume of 0.005 m^3. Calculate the mass of the liquid.
4. An object has a mass of 2 kg and a density of 400 kg/m^3. Calculate the volume of the object.
5. Explain why solids usually have a higher density than gases using the particle model.
6. Describe how you would measure the density of an irregular solid object.

4.3.1.2 Changes of state

1. What happens to the mass of a substance when it changes state?
2. Why are changes of state described as physical changes?

3. What happens to the particles of a substance when it melts?
4. What happens to the particles of a substance when it freezes?
5. Explain why a substance keeps the same mass when changing from a solid to a liquid.
6. Describe the difference between evaporation and boiling.

4.3.2.1 Internal energy

1. What is meant by the internal energy of a system?
2. What two types of energy make up the internal energy of a system?
3. How does heating a substance affect the energy stored by its particles?
4. What happens to the internal energy of a substance when its temperature increases?
5. Why can heating a substance cause either a temperature increase or a change of state?
6. Explain how the particle model describes internal energy.

4.3.2.2 Temperature changes in a system and specific heat capacity

1. A 2 kg substance with a specific heat capacity of 400 J/kg°C is heated by 10°C. Calculate the energy transferred.
2. A substance absorbs 6000 J of energy and has a mass of 3 kg. Its temperature increases by 5°C. Calculate its specific heat capacity.
3. A 5 kg block has a specific heat capacity of 900 J/kg°C and receives 45 000 J of energy. Calculate the temperature increase.
4. What factors affect the temperature increase of a substance when it is heated?
5. What is meant by the specific heat capacity of a substance?
6. Why do different materials have different temperature increases when given the same amount of energy?

4.3.2.3 Changes of state and specific latent heat

1. What is meant by latent heat?
2. What happens to the temperature of a substance while it is changing state?
3. A substance has a mass of 2 kg and a specific latent heat of 300 000 J/kg. Calculate the energy needed to change its state.
4. A substance requires 900 000 J of energy to change state and has a mass of 3 kg. Calculate its specific latent heat.

5. Explain the difference between specific heat capacity and specific latent heat.
6. Describe what happens to the internal energy of a substance during a change of state.

4.3.3.1 Particle motion in gases

1. How are gas molecules arranged and how do they move?
2. How is the temperature of a gas related to the average kinetic energy of its molecules?
3. What happens to the pressure of a gas if its temperature increases while the volume stays constant?
4. Explain why increasing the temperature of a gas increases the pressure.
5. Why do gas particles exert pressure on the walls of a container?
6. Describe how the particle model explains the pressure of a gas.

4.3.3.2 Pressure in gases

1. What happens to the pressure of a gas when its volume decreases at constant temperature?
2. A gas has a volume of 4 m^3 and a pressure of 100 000 Pa. Calculate the new pressure if the volume decreases to 2 m^3.
3. A gas has a pressure of 200 000 Pa and a volume of 3 m^3. Calculate the new volume if the pressure increases to 600 000 Pa.
4. Explain why compressing a gas increases its pressure.
5. Why does increasing the volume of a gas decrease its pressure at constant temperature?
6. Describe how gas particles create a force on the walls of a container.

4.3.3.3 Increasing the pressure of a gas (HT only)

1. What happens to the internal energy of a gas when work is done on it?
2. Explain why using a bicycle pump can increase the temperature of the gas inside it.
3. How does compressing a gas affect the movement of its particles?
4. Why does doing work on a gas transfer energy to the gas?
5. Describe the energy transfers that occur when a gas is compressed.
6. Explain why the temperature of an enclosed gas can increase when its pressure increases.

Topic 3 Review

1. A solid object has a mass of 3 kg and a volume of 0.002 m^3. Calculate its density.
2. Explain how the particle arrangement changes when a substance melts.
3. A 4 kg substance with a specific heat capacity of 500 J/kg°C is heated by 20°C. Calculate the energy transferred.
4. Explain why the temperature remains constant during a change of state.
5. Describe how increasing the temperature of a gas affects its pressure when the volume is constant.
6. Explain how doing work on a gas can increase its temperature.

Topic 4 – Atomic Structure Retrieval Starters

4.4.1.1 The structure of an atom

1. What are the three main particles that make up an atom?
2. Where is most of the mass of an atom concentrated?
3. What is the charge of a proton, neutron and electron?
4. Describe the arrangement of electrons around the nucleus.
5. What happens to electrons when an atom absorbs electromagnetic radiation?
6. Why is the radius of the nucleus much smaller than the radius of the atom?

4.4.1.2 Mass number, atomic number and isotopes

1. An atom has 8 protons and 8 neutrons. Calculate its atomic number and mass number.
2. An atom has an atomic number of 12 and a mass number of 24. Calculate the number of neutrons.
3. What is meant by the atomic number of an element?
4. What is meant by the mass number of an atom?
5. What are isotopes?
6. Explain how an atom becomes a positive ion.

4.4.1.3 The development of the model of the atom

1. Why did the discovery of the electron cause scientists to change the atomic model?
2. Describe the plum pudding model of the atom.
3. What did the alpha particle scattering experiment show about the structure of the atom?
4. How did the nuclear model differ from the plum pudding model?
5. What did Bohr suggest about the arrangement of electrons?
6. How did the discovery of neutrons change the model of the atom?

4.4.2.1 Radioactive decay and nuclear radiation

1. What is radioactive decay?
2. Why are some atomic nuclei unstable?
3. What is meant by the activity of a radioactive source?
4. What particles make up an alpha particle?
5. How is beta radiation produced?
6. Compare the penetration and ionising power of alpha, beta and gamma radiation.

4.4.2.2 Nuclear equations

1. What happens to the mass number and atomic number during alpha decay?
2. What happens to the mass number and atomic number during beta decay?
3. A nucleus of uranium-238 undergoes alpha decay. Write the nuclear equation and state how the mass number and atomic number change.
4. A nucleus of carbon-14 undergoes beta decay. Write the nuclear equation and state how the mass number and atomic number change.
5. Why does gamma radiation not change the mass number or atomic number?
6. Complete the nuclear equation: ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th$ + _____

4.4.2.3 Half-lives and the random nature of radioactive decay

1. What is meant by the half-life of a radioactive isotope?
2. A radioactive sample has a count rate of 800 counts per minute. Calculate the count rate after two half-lives.

3. A radioactive sample has an initial activity of 1200 Bq and a half-life of 5 years. Calculate the activity after 10 years.
4. Why is radioactive decay described as a random process?
5. How can the half-life of a radioactive isotope be found from a graph?
6. Explain why the activity of a radioactive sample decreases over time.

4.4.2.4 Radioactive contamination

1. What is meant by radioactive contamination?
2. What is meant by irradiation?
3. Explain the difference between contamination and irradiation.
4. Why does radioactive contamination remain hazardous after the source is removed?
5. Why does an irradiated object not become radioactive?
6. Why is peer review important when studying the effects of radiation?

4.4.3.1 Background radiation

1. What is background radiation?
2. Name two natural sources of background radiation.
3. Name two human-made sources of background radiation.
4. How can a person's location affect their radiation dose?
5. How can a person's occupation affect their radiation dose?
6. What unit is used to measure radiation dose?

4.4.3.2 Different half-lives of radioactive isotopes

1. Why do radioactive isotopes have different half-life values?
2. Explain why a radioactive isotope with a short half-life may be more hazardous.
3. Explain why a radioactive isotope with a long half-life may remain hazardous for a long time.
4. How does half-life affect the choice of isotope for a specific use?
5. A radioactive isotope has a half-life of 10 years. What fraction remains after 30 years?
6. Why must the half-life of a radioactive source be considered when assessing risk?

4.4.3.3 Uses of nuclear radiation

1. How are nuclear radiations used to explore internal organs?
2. How can nuclear radiation be used to destroy unwanted tissue?

3. Why are gamma rays useful for medical imaging?
4. Why must the risks of using nuclear radiation be considered?
5. Explain why radioactive tracers are useful in medicine.
6. Evaluate one advantage and one disadvantage of using nuclear radiation in medicine.

4.4.4.1 Nuclear fission

1. What is nuclear fission?
2. Why must a neutron be absorbed before fission usually occurs?
3. What happens when a large unstable nucleus undergoes fission?
4. What is a chain reaction in nuclear fission?
5. How is a chain reaction controlled in a nuclear reactor?
6. Why does an uncontrolled chain reaction cause a nuclear explosion?

4.4.4.2 Nuclear fusion

1. What is nuclear fusion?
2. What happens when two light nuclei undergo fusion?
3. How can energy be released during nuclear fusion?
4. Why is some mass converted into energy during fusion?
5. Compare nuclear fusion with nuclear fission.
6. Why is nuclear fusion difficult to achieve on Earth?

Topic 4 Review

1. An atom contains 17 protons and 18 neutrons. Calculate its atomic number and mass number.
2. Explain how the alpha particle scattering experiment changed the model of the atom.
3. A radioactive sample has an activity of 1600 Bq. Calculate its activity after three half-lives.
4. Compare alpha, beta and gamma radiation in terms of penetration and ionising ability.
5. Explain the difference between nuclear fission and nuclear fusion.
6. Explain how radioactive isotopes can be useful but also hazardous.

Paper 2:

Topic 5 – Forces Retrieval Starters

4.5.1.1 Scalar and vector quantities

1. A car travels 500 m along a straight road. Is this distance a scalar or vector quantity?
2. A force of 20 N acts to the right on an object. Explain why this force is a vector quantity.
3. A runner completes one lap of a 400 m track and finishes where they started. What is the runner's displacement?
4. A force is represented by an arrow. Explain what the length and direction of the arrow represent.
5. Classify each quantity as scalar or vector: speed, velocity, distance, displacement.
6. A student walks 10 m north and then 10 m south. Calculate the total distance travelled and the displacement.

4.5.1.2 Contact and non-contact forces

1. Explain the difference between a contact force and a non-contact force.
2. Identify the type of force involved when a book rests on a table.
3. A magnet attracts a paper clip without touching it. Is this a contact or non-contact force? Explain your answer.
4. Give two examples of contact forces and two examples of non-contact forces.
5. Explain the forces acting between a person pushing a shopping trolley and the trolley.
6. A skydiver is falling through the air. Identify the contact and non-contact forces acting on the skydiver.

4.5.1.3 Gravity

1. Calculate the weight of a 5 kg object on Earth where the gravitational field strength is 10 N/kg.
2. An object has a weight of 98 N on Earth. Calculate its mass.
3. A person has a mass of 60 kg. Calculate their weight on Earth using a gravitational field strength of 9.8 N/kg.
4. Explain why the weight of an object changes when it is taken to a different planet.

5. A 2 kg object is taken to a planet with a gravitational field strength of 5 N/kg. Calculate its weight.
6. Explain why an object's mass stays the same while its weight can change.

4.5.1.4 Resultant forces

1. Two forces act on an object in the same direction. One force is 10 N and the other is 15 N. Calculate the resultant force.
2. Two forces act on an object in opposite directions. One force is 30 N to the right and one is 20 N to the left. Calculate the resultant force.
3. Explain what happens to an object when the resultant force acting on it is zero.
4. A car has a driving force of 5000 N and resistive forces of 5000 N. Describe the motion of the car.
5. An object has a resultant force of 50 N acting on it. Explain what this tells you about the forces acting on the object.
6. A force of 100 N is split into two perpendicular components. Explain why the two components have the same effect as the original force.

4.5.2 Work done and energy transfer

1. A force of 50 N moves an object 4 m in the direction of the force. Calculate the work done.
2. A machine does 3000 J of work while moving an object 10 m. Calculate the force applied.
3. A force of 200 N moves an object 5 m. Calculate the energy transferred.
4. Explain why work is not done when a force is applied but an object does not move.
5. A box is pushed across the floor and friction causes the box to warm up. Explain the energy transfer involved.
6. A force of 20 N moves an object 3 m. Calculate the work done in joules.

4.5.3 Forces and elasticity

1. A spring extends by 0.04 m when a force of 8 N is applied. Calculate the spring constant.
2. A spring has a spring constant of 250 N/m and extends by 0.02 m. Calculate the force applied.
3. Explain the difference between elastic deformation and inelastic deformation.
4. A spring stores 0.5 J of elastic potential energy when stretched by 0.1 m. Calculate the spring constant.
5. Explain what happens to the elastic potential energy stored in a spring when it is stretched further.

6. Describe how you could investigate the relationship between force and extension for a spring.

4.5.4 Moments, levers and gears

1. A force of 20 N acts 0.5 m from a pivot. Calculate the moment produced.
2. A force produces a moment of 100 Nm at a distance of 2 m from a pivot. Calculate the force.
3. Explain why increasing the distance from a pivot increases the turning effect of a force.
4. A balanced object has a clockwise moment of 60 Nm. Calculate the anticlockwise moment.
5. Explain how a lever makes it easier to turn or lift an object.
6. Explain how gears can change the rotational effect of forces.

4.5.5.1 Pressure in a fluid 1

1. What is a fluid?
2. A force of 200 N acts over an area of 4 m^2. Calculate the pressure produced.
3. A pressure of 500 Pa acts over an area of 2 m^2. Calculate the force applied.
4. In which direction does pressure in a fluid act on a surface?
5. What is the unit of pressure?
6. Why does pressure in a fluid act at right angles to a surface?

4.5.5.1.2 Pressure in a fluid 2 (HT)

1. A liquid has a density of 1000 kg/m^3 and a depth of 5 m. Calculate the pressure due to the liquid if g = 10 N/kg.
2. Why does pressure increase as the depth of a liquid increases?
3. Why does a denser liquid produce a greater pressure at the same depth?
4. A diver swims deeper underwater. Explain why the pressure on the diver increases.
5. What is meant by upthrust?
6. Explain why an object partially submerged in water experiences an upward force.

4.5.5.2 Atmospheric pressure

1. Explain why atmospheric pressure decreases as altitude increases.
2. Explain how air molecules create atmospheric pressure.
3. A mountain climber reaches a higher altitude. Explain how the number of air molecules above them changes.

4. Explain why atmospheric pressure is greater at sea level than on top of a mountain.
5. Explain why atmospheric pressure is lower on a hill than at the bottom of a deep cave. Explain why objects are not crushed by atmospheric pressure.

4.5.6.1.1 Distance and displacement

1. Explain the difference between distance and displacement.
2. A runner travels 500 m around a track and finishes where they started. Calculate their displacement.
3. A person walks 200 m east. State their distance and displacement.
4. Explain why displacement is a vector quantity.
5. A cyclist travels 3 km north then 1 km south. Calculate the total distance travelled.
6. A car travels from one town to another in a straight line. Explain why its displacement includes direction.

4.5.6.1.2 Speed

1. A car travels 120 m in 10 s. Calculate its speed.
2. A cyclist travels at 6 m/s for 30 seconds. Calculate the distance travelled.
3. A runner covers 400 m in 80 seconds. Calculate their average speed.
4. Explain why speed is a scalar quantity.
5. A sound wave travels at 330 m/s for 5 seconds. Calculate the distance travelled.
6. Explain why a car travelling around a corner can have constant speed but changing velocity.

4.5.6.1.3 Velocity

1. Explain the difference between speed and velocity.
2. A car travels at 20 m/s east. Explain why this is a velocity.
3. Explain why an object moving in a circle can have constant speed but changing velocity.
4. A plane travels at 250 m/s north. Identify the speed and direction.
5. Explain why velocity is a vector quantity.
6. A runner changes direction while keeping the same speed. Explain what happens to their velocity.

4.5.6.1.4 Distance-time relationship

1. A car travels 200 m in 20 seconds. Calculate the speed from the distance-time graph information.

2. Explain what a horizontal line on a distance-time graph represents.
3. Explain what a steeper gradient on a distance-time graph shows.
4. A distance-time graph has a straight line with a constant gradient. Describe the motion.
5. Explain how the speed of an object can be found from a distance-time graph.
6. A cyclist's distance-time graph becomes steeper. Explain what happens to the cyclist's speed.

4.5.6.1.5 Acceleration

1. A car increases its velocity from 10 m/s to 30 m/s in 5 seconds. Calculate its acceleration.
2. A vehicle slows from 25 m/s to 5 m/s in 4 seconds. Calculate its acceleration.
3. Explain what negative acceleration means.
4. A car accelerates at 3 m/s^2 for 10 seconds from rest. Calculate its final velocity.
5. Explain how acceleration can be found from a velocity-time graph.
6. Explain what the area under a velocity-time graph represents.

4.5.6.2.1 Newton's First Law

1. State Newton's First Law of motion.
2. What happens to an object if the resultant force acting on it is zero?
3. A car travels at a constant speed. What does this tell you about the forces acting on it?
4. What is meant by inertia?
5. Why does a passenger move forwards when a car brakes suddenly?
6. What causes an object's velocity to change?

4.5.6.2.2 Newton's Second Law

1. State Newton's Second Law of motion.
2. A force of 20 N acts on a 5 kg object. Calculate the acceleration.
3. An object accelerates at 4 m/s^2 when a force of 12 N acts on it. Calculate its mass.
4. How does increasing the mass of an object affect its acceleration for the same force?
5. What is inertial mass?
6. Why is a larger force needed to accelerate a heavier vehicle?

4.5.6.2.3 Newton's Third Law

1. State Newton's Third Law of motion.
2. A swimmer pushes water backwards. Explain why the swimmer moves forwards.
3. A rocket pushes gases downwards. Explain why the rocket moves upwards.
4. What are the sizes of the forces in a Newton's Third Law pair?
5. What directions do Newton's Third Law forces act in?
6. Why do Newton's Third Law forces not cancel each other out?

4.5.6.3.1 Stopping distance

1. What two distances make up the stopping distance of a vehicle?
2. What is meant by thinking distance?
3. What is meant by braking distance?
4. Why does increasing vehicle speed increase stopping distance?
5. A driver has a reaction time of 0.5 seconds. Explain how this affects stopping distance.
6. Why must drivers leave larger gaps at higher speeds?

4.5.6.3.2 Reaction time

1. What is the typical range of human reaction times?
2. Name two factors that can increase a driver's reaction time.
3. Describe one method used to measure reaction time.
4. Why can distractions increase stopping distance?
5. Explain how tiredness affects driving safety.
6. Why is reaction time different between individuals?

4.5.6.3.3 Factors affecting braking distance 1

1. Name two road conditions that increase braking distance.
2. How do wet roads affect braking distance?
3. How do worn tyres affect braking distance?
4. Why does a greater speed increase braking distance?
5. Why do vehicles need longer stopping distances in icy conditions?
6. Explain why checking vehicle brakes improves safety.

4.5.6.3.4 Factors affecting braking distance 2

1. What type of energy is reduced when brakes are applied?
2. Explain why brakes become hotter when a vehicle stops.

3. Why does a greater vehicle speed require a greater braking force?
4. What problems can large decelerations cause?
5. Explain why friction is important when braking.
6. Why can overheating brakes reduce vehicle safety?

4.5.7.1 Momentum is a property of moving objects (HT)

1. What is momentum?
2. A 5 kg object travels at 4 m/s. Calculate its momentum.
3. A car has a momentum of 6000 kg m/s and a mass of 1000 kg. Calculate its velocity.
4. What unit is used for momentum?
5. How does increasing the mass of an object affect its momentum at the same velocity?
6. How does increasing velocity affect momentum?

4.5.7.2 Conservation of momentum (HT)

1. State the principle of conservation of momentum.
2. What is meant by a closed system?
3. Two objects collide in a closed system. What happens to the total momentum before and after the collision?
4. Why is momentum useful when analysing collisions?
5. What happens to the momentum of one object if another object gains momentum in the opposite direction?
6. Explain why total momentum is conserved during a collision.

4.5.7.3 Changes in momentum (HT)

1. What happens to momentum when a force acts on a moving object?
2. Why do airbags reduce injuries during a collision?
3. How does increasing the time taken for a change in momentum affect the force produced?
4. Explain why crash mats reduce injuries.
5. A car changes momentum over a longer time because of crumple zones. Why does this reduce force?
6. Explain how seat belts reduce injuries using the idea of rate of change of momentum.

Topic 5 Review

1. Explain the difference between scalar and vector quantities and give one example of each.
2. A 1200 kg car travels at 15 m/s. Calculate its kinetic effect in terms of momentum.
3. Explain how Newton's three laws describe the motion of objects.
4. A force of 40 N moves an object 5 m. Calculate the work done.
5. Explain why increasing speed increases stopping distance and braking safety risks.
6. Compare contact forces, non-contact forces and their effects on objects.

Topic 6 – Waves Retrieval Starters

4.6.1.1 Transverse and longitudinal waves

1. Explain the difference between transverse and longitudinal waves.
2. State one example of a transverse wave.
3. State one example of a longitudinal wave.
4. Describe the compressions and rarefactions in a longitudinal wave.
5. Explain why sound waves in air are longitudinal waves.
6. Explain why energy is transferred by a wave but the medium itself is not.

4.6.1.2 Properties of waves

1. Define the amplitude of a wave.
2. Define the wavelength of a wave.
3. A wave has a frequency of 25 Hz and a wavelength of 2 m. Calculate its wave speed.
4. A wave travels at 300 m/s and has a frequency of 150 Hz. Calculate its wavelength.
5. Calculate the period of a wave with a frequency of 50 Hz.
6. Describe how you could measure the speed of sound in air.

4.6.1.3 Reflection of waves (Physics only)

1. State what happens when a wave is reflected.
2. Explain the difference between reflection, absorption and transmission.
3. Draw or describe a ray diagram showing reflection from a plane surface.
4. Explain why some materials reflect more waves than others.
5. Give one example where wave reflection is useful.
6. Explain why smooth surfaces produce regular reflection.

4.6.1.4 Sound waves (Physics only, HT)

1. Explain how sound travels through a solid.
2. Describe how sound waves allow humans to hear.
3. State the normal range of human hearing.
4. Explain why humans cannot hear ultrasound.
5. Explain why sound is transferred by vibrations.
6. Give one example of a process that converts sound waves into vibrations in a solid.

4.6.1.5 Waves for detection and exploration (Physics only, HT)

1. State what is meant by ultrasound.
2. Explain how ultrasound can be used to produce a medical image.
3. Explain how echo sounding is used to measure water depth.
4. State the difference between P-waves and S-waves.
5. Explain why S-waves cannot travel through liquids.
6. Explain how seismic waves provide evidence for the structure of the Earth's core.

4.6.2.1 Types of electromagnetic waves

1. State the seven types of electromagnetic wave in order from longest wavelength to shortest wavelength.
2. Explain why all electromagnetic waves are transverse waves.
3. State the speed of electromagnetic waves in a vacuum.
4. Explain how electromagnetic waves transfer energy.
5. Which part of the electromagnetic spectrum can the human eye detect?
6. Give one example of energy being transferred by an electromagnetic wave.

4.6.2.2 Properties of electromagnetic waves 1

1. Explain what happens to electromagnetic waves when they are refracted.
2. Explain why refraction occurs when a wave enters a different medium.
3. Describe how the speed of an electromagnetic wave changes when it enters a different substance.
4. Draw or describe a ray diagram showing refraction.
5. Explain how wavefront diagrams can be used to explain refraction.
6. Describe the required practical investigating how different surfaces absorb infrared radiation.

4.6.2.3 Properties of electromagnetic waves 2

1. Explain how radio waves can be produced.
2. State where gamma rays originate.

3. Explain why ultraviolet, X-rays and gamma rays can be harmful to humans.
4. Explain what is meant by ionising radiation.
5. State one effect of ultraviolet radiation on the human body.
6. Explain why exposure to large doses of X-rays or gamma rays increases the risk of cancer.

4.6.2.4 Uses and applications of electromagnetic waves

1. State one use of radio waves.
2. Explain why microwaves are suitable for satellite communications.
3. State one use of infrared radiation.
4. Explain why visible light is used in fibre optic communication.
5. State one medical use of X-rays or gamma rays.
6. Explain why different electromagnetic waves are suitable for different applications.

4.6.2.5 Lenses (Physics only)

1. Explain how a convex lens forms an image.
2. State the difference between a convex lens and a concave lens.
3. Define the focal length of a lens.
4. An object is 4 cm high and its image is 12 cm high. Calculate the magnification.
5. Explain the difference between a real image and a virtual image.
6. Describe how you could investigate the magnification produced by convex lenses.

4.6.2.6 Visible light (Physics only)

1. Explain the difference between specular reflection and diffuse reflection.
2. Explain how a colour filter works.
3. Explain why a red object appears red in white light.
4. Explain why a white object appears white.
5. State the difference between transparent and translucent materials.
6. Explain what colour a black object appears and why.

4.6.3.1 Emission and absorption of infrared radiation

1. State what all objects emit, regardless of their temperature.
2. Explain how the amount of infrared radiation emitted changes as temperature increases.
3. Define a perfect black body.
4. Explain why a perfect black body is also the best emitter of infrared radiation.
5. Explain why a shiny surface is a poor absorber of infrared radiation.

6. State which type of surface is best at absorbing infrared radiation.

4.6.3.2 Perfect black bodies and radiation

1. Explain why all objects emit electromagnetic radiation.
2. Explain how the radiation emitted by an object depends on its temperature.
3. Explain what happens when an object absorbs radiation faster than it emits radiation.
4. Explain what happens when an object is at a constant temperature.
5. Explain how the Earth's temperature depends on the balance between absorbed and emitted radiation.
6. Explain why increasing reflection of radiation into space can reduce the Earth's temperature.

Topic 6 Review

1. Explain the difference between transverse and longitudinal waves and give one example of each.
2. A wave has a frequency of 200 Hz and a wavelength of 1.5 m. Calculate its wave speed.
3. Compare ultrasound, seismic waves and electromagnetic waves, giving one use for each.
4. Explain why different parts of the electromagnetic spectrum are used for different applications.
5. A convex lens forms an image three times larger than the object. Calculate the magnification.
6. Explain how the balance between absorbed and emitted radiation affects the temperature of the Earth.

Topic 7 – Magnetism and Electromagnetism

4.7.1.1 Poles of a magnet

1. Explain why the magnetic forces are strongest at the poles of a magnet.
2. Describe what happens when two north poles of permanent magnets are brought close together.
3. Describe what happens when a north pole and a south pole of permanent magnets are brought close together.
4. Explain the difference between a permanent magnet and an induced magnet.
5. Explain why an induced magnet always attracts a permanent magnet.
6. Explain what happens to an induced magnet when it is removed from a magnetic field.

4.7.1.2 Magnetic fields

1. Define the magnetic field surrounding a magnet.
2. Explain why the magnetic field is strongest at the poles of a bar magnet.
3. Describe how you could use a plotting compass to map the magnetic field around a bar magnet.
4. Explain why magnetic field lines are drawn from the north pole to the south pole of a magnet.
5. Explain why the force between a magnet and a magnetic material such as iron is always attractive.
6. Explain why a compass needle points towards north using the Earth's magnetic field.

4.7.2.1 Electromagnetism

1. Explain what happens around a conducting wire when an electric current flows through it.
2. Explain how increasing the current in a straight wire affects the strength of its magnetic field.
3. Explain why winding a wire into a solenoid produces a stronger magnetic field than a straight wire.
4. Describe the shape of the magnetic field produced by a current-carrying solenoid.
5. Explain why placing an iron core inside a solenoid increases the strength of its magnetic field.
6. Explain why an electromagnet is more useful than a permanent magnet in devices such as scrapyard cranes.

4.7.2.2 Fleming's left-hand rule (HT only)

1. Explain what happens when a current-carrying conductor is placed at right angles to a magnetic field.
2. State what each finger represents in Fleming's left-hand rule.
3. A conductor carrying a current of 4 A is 0.50 m long and is placed at right angles to a magnetic field of 0.30 T. Calculate the force acting on the conductor.
4. Explain how increasing the current through a conductor affects the force acting on it in a magnetic field.
5. Explain how increasing the magnetic flux density affects the force acting on a current-carrying conductor.
6. Explain why the motor effect only occurs when a conductor carries a current in a magnetic field.

4.7.2.3 Electric motors (HT only)

1. Explain why a current-carrying coil placed in a magnetic field rotates.
2. Explain how the motor effect causes an electric motor to rotate continuously.
3. Explain why opposite sides of the coil experience forces in opposite directions.
4. State the purpose of the split-ring commutator in a simple DC motor.
5. Explain why the current in the coil must reverse every half turn in a simple DC motor.
6. Give one everyday application of an electric motor.

4.7.2.4 Loudspeakers (Physics only, HT only)

1. Explain how a moving-coil loudspeaker converts electrical energy into sound energy.
2. Explain how changes in electric current cause the cone of a loudspeaker to vibrate.
3. Explain how the motor effect is used in a pair of headphones.
4. Explain why increasing the size of the alternating current increases the movement of the loudspeaker cone.
5. Explain how pressure variations in air are produced by a loudspeaker.
6. Explain why a loudspeaker requires both a permanent magnet and a current-carrying coil.

4.7.3.1 Induced potential (HT only)

1. Explain what is meant by the generator effect.
2. Explain how moving a conductor through a magnetic field induces a potential difference.
3. Explain why an induced current is only produced when the conductor forms part of a complete circuit.
4. State two factors that increase the size of the induced potential difference.
5. Explain how changing the direction of movement of a conductor affects the direction of the induced current.
6. Explain why the magnetic field produced by an induced current opposes the original change.

4.7.3.2 Uses of the generator effect (HT only)

1. Explain how an alternator uses the generator effect to produce alternating current.
2. Explain how a dynamo uses the generator effect to produce direct current.
3. Explain the difference between the current produced by an alternator and the current produced by a dynamo.
4. Describe the shape of a graph showing the potential difference produced by an alternator against time.

5. Explain why the potential difference produced by an alternator repeatedly changes direction.
6. Give one everyday application of the generator effect.

4.7.3.3 Microphones (HT only)

1. Explain how a moving-coil microphone converts sound waves into electrical signals.
2. Explain how pressure variations in sound waves cause the microphone coil to move.
3. Explain how movement of the microphone coil produces a potential difference.
4. Explain why the output current from a microphone changes when the sound becomes louder.
5. State which physical effect allows a moving-coil microphone to work.
6. Explain why microphones are described as energy transducers.

4.7.3.4 Transformers (HT only)

1. Explain why a transformer only works with an alternating current.
2. A transformer has 500 turns on the primary coil and 100 turns on the secondary coil. If the primary potential difference is 230 V, calculate the secondary potential difference.
3. Explain the difference between a step-up transformer and a step-down transformer.
4. A transformer supplies 240 W to the secondary coil at a potential difference of 24 V. Calculate the current in the secondary coil.
5. Explain why electricity is transmitted across the National Grid at a high potential difference.
6. Explain how the ratio of the number of turns on the primary and secondary coils determines the potential difference across each coil.

Topic 7 Review

1. Explain the difference between a permanent magnet and an induced magnet, giving one characteristic of each.
2. Describe how you could use a plotting compass to investigate the magnetic field around a bar magnet.
3. A conductor carrying a current of 3 A is placed at right angles to a magnetic field of 0.40 T. If the conductor is 0.50 m long, calculate the force acting on the conductor.
4. Explain how the motor effect is used in both electric motors and loudspeakers.
5. Explain how the generator effect is used to produce electricity in an alternator and a dynamo.

6. A transformer has 200 turns on its primary coil and 1000 turns on its secondary coil. If the primary potential difference is 12 V, calculate the secondary potential difference and state whether the transformer is a step-up or step-down transformer.

Topic 8 – Space Physics

4.8.1.1 The Solar System

1. Describe the structure of the Solar System, including the Sun, planets, dwarf planets, moons and smaller bodies.
2. Explain why the planets orbit the Sun rather than moving away into space.
3. State the order of the eight planets from the Sun, starting with Mercury.
4. Explain the difference between a planet, a moon and a dwarf planet.
5. Describe the shape of the orbit followed by a planet around the Sun.
6. Explain why gravity is essential for keeping the Solar System together.

4.8.1.2 Life cycle of a star

1. State the stages in the life cycle of a star from a cloud of gas and dust (nebula) to a main sequence star.
2. A star is about the same size as the Sun. Describe the stages it passes through after leaving the main sequence star, ending as a black dwarf.
3. A star is much bigger than the Sun. Describe its life cycle from a main sequence star to its final stage, including the supernova.
4. Explain why the life cycle of a star depends on its initial mass and compare the life cycles of a Sun-sized star and a much more massive star.
5. Explain how nuclear fusion inside stars produces new elements, including why elements heavier than iron are only formed during a supernova.
6. Explain how the explosion of a massive star in a supernova distributes elements throughout the Universe and why this is important.

4.8.1.3 Orbital motion, natural and artificial satellites

1. Explain the difference between a natural satellite and an artificial satellite, giving one example of each.
2. Explain why the Moon remains in orbit around the Earth.
3. Explain why artificial satellites remain in orbit around the Earth without falling to the ground.
4. State one use of an artificial satellite in communications, weather forecasting or navigation.
5. Explain why the force of gravity is needed to keep a satellite in orbit.
6. Describe the path followed by a satellite orbiting the Earth.

4.8.1.4 Red-shift

1. Explain what is meant by the red-shift of light from distant galaxies.
2. Explain how the observed red-shift provides evidence that the Universe is expanding.
3. Explain why galaxies that are further away generally have a greater red-shift.
4. Describe what happens to the wavelength of light when a galaxy is moving away from the Earth.
5. Explain what the Big Bang theory suggests about the origin of the Universe.
6. Explain how observations of distant galaxies support the Big Bang theory.

Topic 8 Review

1. Explain how gravity keeps the planets in orbit around the Sun.
2. Compare the life cycle of a star about the same size as the Sun with the life cycle of a star much bigger than the Sun.
3. Explain how nuclear fusion in stars produces new elements and why elements heavier than iron are formed during a supernova.
4. Explain the difference between a natural satellite and an artificial satellite, giving one example of each.
5. Explain what is meant by the red-shift of light from distant galaxies and what it tells scientists about the Universe.
6. A star is observed as a main sequence star. Explain the possible stages that could follow if the star is about the same size as the Sun and if it is much bigger than the Sun.