Topic 1: Static and current electricity

1.1	Describe the structure of the atom, limited to the position, mass and charge of protons, neutrons and electrons	
1.2	Explain how an insulator can be charged by friction, through the transfer of electrons	
1.3	Explain how the material gaining electrons becomes negatively charged and the material losing electrons is left with an equal positive charge	
1.4	Recall that like charges repel and unlike charges attract	
1.5	Demonstrate an understanding of common electrostatic phenomena in terms of movement of electrons, including: a shocks from everyday objects b lightning c attraction by induction such as a charged balloon attracted to a wall and a charged comb picking up small pieces of paper	
1.6	Explain how earthing removes excess charge by movement of electrons	
1.7	Explain some of the uses of electrostatic charges in everyday situations, including paint and insecticide sprayers	
1.8	Demonstrate an understanding of some of the dangers of electrostatic charges in everyday situations, including fuelling aircraft and tankers together with the use of earthing to prevent the build-up of charge and danger arising	
1.9	Recall that an electric current is the rate of flow of charge	
1.10	Recall that the current in metals is a flow of electrons	
1.11	Use the equation: charge (coulomb, C) 5 current (ampere, A) x time (second, s) $Q = I \times t$	
1.12	Recall that cells and batteries supply direct current (d.c.)	
1.13	Demonstrate an understanding that direct current (d.c.) is movement of charge in one direction only	

Topic 2: Controlling and using electric current

2.1	Describe how an ammeter is placed in series with a component to measure the current, in amps, in the component	
2.2	Explain how current is conserved at a junction	
2.3	Explain how the current in a circuit depends on the potential difference of the source	
2.4	Describe how a voltmeter is placed in parallel with a component to measure the potential difference (voltage), in volts, across it	
2.5	**Demonstrate an understanding that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb**	
2.6	*Investigate the relationship between potential difference (voltage), current and resistance*	
2.7	Explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor	
2.8	Use the equation: potential difference (volt, V) = current (ampere, A) x resistance (ohm, Ω) $V = I \times R$	
2.9	Demonstrate an understanding of how current varies with potential difference for the following devices a filament lamps b diodes c fixed resistors	
2.10	Demonstrate an understanding of how the resistance of a light dependent resistor (LDR) changes with light intensity	
2.11	Demonstrate an understanding of how the resistance of a thermistor changes with change of temperature (negative temperature coefficient thermistors only)	
2.12	Explain why, when there is an electric current in a resistor, there is an energy transfer which heats the resistor	
2.13	**Explain the energy transfer (in 2.12 above) as the result of collisions between electrons and the ions in the lattice**	
2.14	Distinguish between the advantages and disadvantages of the heating effect of an electric current	
2.15	Use the equation: electrical power (watt, W) = current (ampere, A) x potential difference (volt, V) $P = I \times V$	
2.16	Use the equation: energy transferred (joule, J) = current (ampere, A) x potential difference (volt, V) x time (second, s) $E = I \times V \times t$	

Topic 3: Motion and Forces

3.1	Demonstrate an understanding of the following as vector quantities: a displacement b velocity c acceleration d force	
3.2	Interpret distance/time graphs including determination of speed from the gradient	
3.3	Recall that velocity is speed in a stated direction	
3.4	Use the equation: speed (m/s) = distance (m) / time (s)	
3.5	Use the equation: acceleration (metre per second squared, m/s2) 5 change in velocity (metre per second, m/s) / time taken (second, s) $a = \frac{(v - u)}{t}$	
3.6	Interpret velocity/time graphs to: a compare acceleration from gradients qualitatively b calculate the acceleration from the gradient (for uniform acceleration only) c **determine the distance travelled using the area between the graph line and the time axis (for uniform acceleration only**	
3.7	Draw and interpret a free-body force diagram	
3.8	Demonstrate an understanding that when two bodies interact, the forces they exert on each other are equal in size and opposite in direction and that these are known as action and reaction forces	
3.9	Calculate a resultant force using a range of forces (limited to the resultant of forces acting along a line) including resistive forces	
3.10	Demonstrate an understanding that if the resultant force acting on a body is zero, it will remain at rest or continue to move at the same velocity	
3.11	Demonstrate an understanding that if the resultant force acting on a body is not zero, it will accelerate in the direction of the resultant force	
3.12	Demonstrate an understanding that a resultant force acting on an object produces an acceleration which depends on: a the size of the resultant force b the mass of the object	
3.13	Use the equation: force (newton, N) = mass (kilogram, kg) x acceleration (metre per second squared, m/s^2) $F = m \times a$	
3.14	Use the equation: weight (newton, N) = mass (kilogram, kg) x gravitational field strength (newton per kilogram, N/kg) $W = m \times g$	

3.15	*Investigate the relationship between force, mass and acceleration*	
3.16	Recall that in a vacuum all falling bodies accelerate at the same rate	
3.17	Demonstrate an understanding that: a when an object falls through an atmosphere air resistance increases with increasing speed b air resistance increases until it is equal in size to the weight of the falling object c when the two forces are balanced, acceleration is zero and terminal velocity is reached	

Topic 4: Momentum, energy, work and power

4.1	Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance	
4.2	Demonstrate an understanding of the factors affecting the stopping distance of a vehicle, including: a the mass of the vehicle b the speed of the vehicle c the driver's reaction time d the state of the vehicle's brakes e the state of the road f the amount of friction between the tyre and the road surface	
4.3	*Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction*	
4.4	Use the equation: momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) x velocity (metre per second, m/s) to calculate the momentum of a moving object	
4.5	Demonstrate an understanding of momentum as a vector quantity	
4.6	Demonstrate an understanding of the idea of linear momentum conservation	
4.7	Demonstrate an understanding of the idea of rate of change of momentum to explain protective features including bubble wraps, seat belts, crumple zones and air bags	
4.8	*Investigate how crumple zones can be used to reduce the forces in collisions*	
4.9	**Use the equation:** **force (newton, N) = change in momentum (kilogram metre per second, kg m/s) / time (second, s)** $F = (mv - mu) / t$ **to calculate the change in momentum of a system, as in 4.6**	
4.10	Use the equation: work done (joule, J) = force (newton, N) x distance moved in the direction of the force (metre, m) $E = F \times d$	
4.11	Demonstrate an understanding that energy transferred (joule, J) is equal to work done (joule, J)	
4.12	Recall that power is the rate of doing work and is measured in watts, W	
4.13	Use the equation: power (watt, W) = work done (joule, J) / time taken (second, s) $P = E/t$	
4.14	Recall that one watt is equal to one joule per second, J/s	
4.15	Use the equation: gravitational potential energy (joule, J) = mass	

	(kilogram, kg) x gravitational field strength (newton per kilogram, N/kg) x vertical height (metre, m) GPE = *m* x *g x h*	
4.16	Use the equation: kinetic energy (joule, J) ½ x mass (kilogram, kg) x velocity^2 ((metre/second)^2 (m/s)^2) KE = ½ x $m \times v^2$	
4.17	Demonstrate an understanding of the idea of conservation of energy in various energy transfers	
4.18	**Carry out calculations on work done to show the dependence of braking distance for a vehicle on initial velocity squared (work done to bring a vehicle to rest equals its initial kinetic energy)**	

Topic 5: Nuclear fission and nuclear fusion

5.1	Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols in the format $^{14}_{6}C$	
5.2	Explain how atoms may gain or lose electrons to form ions	
5.3	Recall that alpha and beta particles and gamma rays are ionising radiations emitted from unstable nuclei in a random process	
5.4	Recall that an alpha particle is equivalent to a helium nucleus, a beta particle is an electron emitted from the nucleus and a gamma ray is electromagnetic radiation	
5.5	Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionise	
5.6	Demonstrate an understanding that nuclear reactions can be a source of energy, including fission, fusion and radioactive decay	
5.7	Explain how the fission of U-235 produces two daughter nuclei and two or more neutrons, accompanied by a release of energy	
5.8	Explain the principle of a controlled nuclear chain reaction	
5.9	Explain how the chain reaction is controlled in a nuclear reactor including the action of moderators and control rods	
5.10	Describe how thermal (heat) energy from the chain reaction is converted into electrical energy in a nuclear power station	
5.11	Recall that the products of nuclear fission are radioactive	
5.12	Describe nuclear fusion as the creation of larger nuclei from smaller nuclei, accompanied by a release of energy and recognise fusion as the energy source for stars	
5.13	Explain the difference between nuclear fusion and nuclear fission	
5.14	**Explain why nuclear fusion does not happen at low temperatures and pressures, due to electrostatic repulsion of protons**	
5.15	**Relate the conditions for fusion to the difficulty of making a practical and economic form of power station**	
5.16	Demonstrate an understanding that new scientific theories, such as ‘cold fusion’, are not accepted until they have been validated by the scientific community	

Topic 6: Advantages and disadvantages of using radioactive materials

6.1	Explain what is meant by background radiation, including how regional variations within the UK are caused in particular by radon gas	
6.2	Recall the origins of background radiation from Earth and space	
6.3	Describe uses of radioactivity, including: a household fire (smoke) alarms b irradiating food c sterilisation of equipment d tracing and gauging thicknesses e diagnosis and treatment of cancer	
6.4	Describe how the activity of a radioactive source decreases over a period of time	
6.5	Recall that the unit of activity of a radioactive isotope is the Becquerel, Bq	
6.6	Recall that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay	
6.7	Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations	
6.8	*Investigate models which simulate radioactive decay*	
6.9	Demonstrate an understanding of the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed	
6.10	Describe how scientists have changed their ideas of radioactivity over time, including: a the awareness of the hazards associated with radioactive sources b why the scientific ideas change over time	
6.11	Discuss the long-term possibilities for storage and disposal of nuclear waste	
6.12	Evaluate the advantages and disadvantages of nuclear power for generating electricity, including the lack of carbon dioxide emissions, risks, public perception, waste disposal and safety issues	