Mastery in KS3 Science

A learner's progress in KS3 Science will be categorised as:

Step 5	Excelling
Step 4	Mastering
Step 3	Securing
Step 2	Developing
Step 1	Establishing

A student might demonstrate different competence in different aspects of the Science curriculum but overall descriptions of a student at the four different stages are:

Establishing

Students will be able to use simple practical scientific techniques to investigate a prediction, produce results and be able to say whether the results support or refute the prediction.

Students will have a basic understanding of the key ideas of Science and be able to use this with some success to explain their observations. They will be able to spot simple patterns in data and recognise obvious anomalies.

Students will be able to recall important scientific facts such as key practical equipment, units for measurements, common chemical symbols or parts of cells.

Developing

Students will be able to use a range of scientific techniques with confidence and will be able to select an appropriate technique to produce useful data. They will be critical of the data they produce and will be able to explain whether or not a set of data or an investigative strategy will produce reliable data. They will be able to suggest improvements to produce better quality data.

Students will be able to describe with confidence whether results support or refute a simple prediction and take into account anomalous results.

Students will be able to explain their observations using key scientific ideas and make a judgement about the extent to which data supports a conclusion.

Students will be able to recall scientific ideas and apply these in new situations. They will begin to be able to generalise and use simple models to explain ideas and observations.

Securing

Students will be able to use a range of scientific techniques with confidence and make judgements about the best technique to produce the best quality data. They will be critical of an investigative strategy and will recognise how to amend a strategy to produce reliable data. They will be able to consider issues of accuracy and precision in their analysis of data.

Students will be able to describe with confidence the extent to which results support a prediction.

Students will be able to explain observations using more complex scientific ideas and incorporate ideas from more than one source into more complex models.

They will be able to predict outcomes in a variety of unfamiliar situations, using models to justify their ideas.

Mastering

Students will be able to use a range of scientific techniques with confidence and make judgements about the best technique to be used to produce the best quality data. They will be highly critical of the data that an investigative strategy is likely to produce and will amend their strategy accordingly to ultimately produce reliable data. They will be able to consider issues of accuracy and precision in their choices of technique and their analysis of data.

Students will be able to describe with confidence the extent to which results support a prediction, and evaluate the success of an investigation.

Students will be able to explain observations using more complex scientific ideas, analyse similarities and differences in data from different sources and use competing ideas to develop complex models.

They will be able to apply complex ideas in a variety of unfamiliar situations and suggest and justify outcomes.

Step No.	Step name	Step descriptor	Grade % F	Grade % H
Step 5	Excelling	● Can apply my knowledge and understanding to a range of contexts including unfamiliar situations. ● Can produce (unaided) precise plans for my investigations. ● Can evaluate my investigations and produce structured reports. ● Can make predictions using my scientific knowledge		80
Step 4	Mastering	● Can apply my scientific knowledge from other investigations to plan an investigation. ● Can explain my conclusions using the evidence collected and my knowledge and understanding of science. ● Can plan (with guidance) investigations. Identifying key factors that need to be considered. ● Can present my data clearly and concisely using graphs with lines of best fit		65
Step 3	Securing	● Can design a fair test to answer questions that arise from their work in science. ● Can interpret my data and begin to explain these using my scientific knowledge and understanding. ● Can use a range of apparatus with appropriate precision and safety. ● Can explain my conclusions using the evidence collected and my knowledge and understanding of science.	70	50
Step 2	Developing	● Can carry out a fair test and say which factors need to be kept constant. ● Can draw conclusions and relate it to my knowledge and understanding. ● Can suggest how ideas can be investigated and make predictions about what might happen.	55	40
Step 1	Establishing	● Can suggest how ideas can be investigated and make predictions about what might happen. ● Can use appropriate instruments to make measurements and know when a test is fair.	40	25

Scientific Enquiry – Emerging

Students can pose a question which can be investigated.

Students can follow instructions to reduce the risk from hazards in an investigation.

Students are aware of experimental error, know that variables need to be controlled and can suggest reasons for differences in repeat readings.

Students can analyse data to identify a simple pattern, identifying the variables involved, and can calculate a simple mean or estimate values of data between known values.

Students can draw simple conclusions from a data set.

Students are able to present data in a table and, with guidance, produce a chart or graph.

Students can communicate their key ideas in an understandable way using accurate scientific vocabulary.

Students are able to identify evidence which supports a claim made.

Students can identify a fact, idea, data or conclusion which supports an opinion.

Students can identify a consequence of a scientific development.

Students recognise that evidence can disagree with a theory.

Scientific Enquiry – Developing

Students can write an investigation question about how one variable can affect another.

Students can identify hazards in an investigation and take steps to reduce risk.

Students recognise ways to reduce measurement errors and understand how the size of error in an investigation affects the strength of evidence.

Students can use a set of data to identify the relationship between two variables, can identify anomalous results and select appropriate data for calculating a mean.

Students can describe the pattern in a data set and explain it using scientific knowledge.

Students are able to present data in a table with correctly labelled headings with units. They can draw graphs with an accurate line of best fit.

Students can communicate their ideas coherently and using scientific vocabulary in a way that makes it clear the meaning is understood.

Students are able to able to comment on whether evidence is scientifically accurate and relevant to a claim made.

Students can identify the most important piece of evidence to support a claim as well as one or two supporting pieces of evidence.

Students recognise consequences of scientific developments for economies, society and the environment.

Students recognise that when evidence disagrees with a theory then the evidence needs to be tested or the theory needs to be amended or abandoned.

Scientific Enquiry – Securing

Students can pose a question to investigate the correlation between one variable and another.

Students can identify strategies which enable a question to be safely investigated in a school laboratory.

Students apply strategies to reduce experimental error and can explain how random and systematic errors affect data.

Students can confidently identify patterns in data and use these to describe the relationships between variables. They consider anomalies in their analysis of the results and show some ability to be able to carry out more complex analysis such as calculating gradient of a sloping line.

Students can draw conclusions from primary and secondary data, justifying whether some data can be judged as anomalous, and describe the extent to which a data set supports a conclusion.

Students can justify their chosen method of chart or graph for displaying results and recognise when to use zero or non-zero starting points for axes.

Students communicate complex ideas coherently making full use of scientific vocabulary and taking account of the audience.

Students are able to describe the reasoning which links the evidence to a claim made.

Students can give a justified opinion but acknowledge other opinions or interpretations of the evidence.

Students can evaluate the merits of scientific developments based on their economic, social and environmental impacts.

Students recognise that evidence which disagrees with a theory needs to be evaluated to decide whether the evidence or the theory is refuted.

Scientific Enquiry – Mastering

Students can explain whether a given question can be investigated scientifically and which type of enquiry to use.

Students can justify the decisions taken and strategies used to mitigate risks in an investigation.

Students use strategies which avoid experimental error and can identify potential sources of random and systematic error.

Students are competent in undertaking a full analysis of data including more complex statistical analysis and taking full account of anomalies.

Students can use data from more than one source, fully justifying decisions about the significance of results in supporting a conclusion. They can identify further questions arising from the investigation.

Students can justify all aspects of the chart or graph used for displaying results and can explain their choice of a straight line or curved line of best fit.

Students are able to communicate complex ideas coherently and succinctly using scientific vocabulary appropriate to the particular audience for the report.

Students are able to comment on whether the reasoning for a claim made follows logically from the evidence.

Students recognise, and take account of, contrasting interpretations of evidence. They can critique a claim made.

Students can justify an opinion about the merit of a scientific development and make choices which maximise benefit and minimise harm.

Students can explain how evidence challenges theories and refutes them or makes them more robust.

3.1 Forces - emerging

3.1.1 Students know that mass and weight are different but related. They know that every object exerts a gravitational force on every other and that gravity keeps planets and moons in orbit.

3.1.2 Students know that an object with no resultant force will be stationary or moving at a constant speed in a straight line. They can describe the object as being in equilibrium. They

understand that unbalanced forces can stretch or compress an object or cause an object to speed up, slow down or change direction. They understand that frictional and drag forces act against the forward motion of an object. Students can describe the effects of force on a spring.

3.1.3 Students can describe how pressure acts in all directions in a fluid and increases with depth. They recognise why some solid objects float and others sink.

3.1.4 Students know that the speed of an object depends on the time taken to cover a distance and know that a straight line on a distance-time graph represents a constant speed.

3.1 Forces - developing

3.1.1 Students know that weight depends on the mass of an object and also on gravitational field strength. They are able to explain the difference between mass and weight and why the weight of an object will be different on different planets. They can use the formula W = mg to calculate weight.

3.1.2 Students can use simple force diagrams to explain how the shape or motion of an object will change. They can draw a simple force diagram using a description of the forces on an object or of the changes taking place to an object's size, shape or motion. They describe an object with no resultant force as being in equilibrium. They can describe everyday situations where frictional and drag forces act against the forward motion of an object. They can describe the effects of force on a spring up to and beyond its elastic limit.

3.1.3 Students can describe how pressure acts in all directions in a fluid and increases with depth. They can explain why some solid objects float and others sink in terms of weight and upthrust.

3.1.4 Students can calculate the speed of objects and can recognise a range of types of motion on a distance-time graph.

3.1 Forces - securing

3.1.1 Students know that weight depends on the mass of an object and also on gravitational field strength. They are able to explain the difference between mass and weight and can use data about the mass of planets to calculate the weight of an object on different planets.

3.1.2 Students can use more complicated force diagrams to explain how the shape or motion of an object will change. They can draw a more complicated force diagram using a description of the forces on an object or of the changes taking place to an object's size, shape or motion. They can apply their understanding of frictional and drag forces to a range of scenarios involving moving and falling objects. They can describe the effects of force on a

spring up to and beyond its elastic limit and use data from graphs to identify the elastic limit of an object.

3.1.3 Students can describe how pressure acts in all directions in a fluid and increases with depth. They can calculate the pressure exerted on a fluid and explain why some solid objects float and others sink in terms of weight and upthrust. They can apply this understanding to unfamiliar scenarios such as one solid scratching the surface of another.

3.1.4 Students can calculate the speed of objects, describe acceleration, and can recognise the full range of types of motion on a distance-time graph.

3.1 Forces - mastering

3.1.1 Students can confidently manipulate the equation W = mg to calculate any of the variables. They can suggest implications of mass and weight for a space mission and can identify the relationship between the orbit speed/period and orbit distance for natural and artificial satellites.

3.1.2 Students are confident in creating and interpreting force diagrams for objects in a range of scenarios. They can apply their understanding of frictional and drag forces to a range of scenarios involving moving and falling objects. They recognise the impact of these forces in transport and sports scenarios and can explain how these forces need to be harnessed or minimised. They can use ideas of proportionality in describing the effects of forces on springs and deformation of objects. They recognise the importance of an objects ability to deform.

3.1.3 Students can describe how pressure acts in all directions in a fluid and increases with depth. They can calculate the pressure exerted on a fluid and explain why some solid objects float and others sink in terms of weight and upthrust. They can confidently apply their understanding to a range of scenarios such as hydraulics or helicopter blade abrasion and recognise how variables can be manipulated to make an object float or sink.

3.1.4 Students can calculate the speed and acceleration of objects and produce distance-time graphs to describe motion. They recognise the significance of relative motion; that an observer's perception of an object's motion is relative to the observer's motion.

3.2 Electromagnets - emerging

3.2.2 Students recognise that objects can become electrically charged. They recognise that charged objects can affect each other when they are brought close together. They recognise that static charges can move and this creates a spark.

3.2.1 Students recognise voltage as an electrical push from a battery. They can explain that a voltage is needed for an electric circuit to work and that resistance is a feature of circuits which reduces the current flowing.

3.2.3 Students recognise that currents can create magnetic fields and that these can be used in a solenoid. They can describe why the magnetic field can be turned on and off.

3.2.4 Students know that permanent magnets have a magnetic field around them which can attract and repel other objects. They know that permanent magnets have a north-seeking pole and a south-seeking pole. They recognise that the Earth behaves like a permanent magnet with a north pole and south pole.

3.2 Electromagnets - developing

3.2.2 Students can explain static charge as a movement of electrons and how objects become positively or negatively charged. They can predict how charged objects will affect each other. They recognise that a current is created when charges move; the size of a current depends on the amount of charge moved in a given time.

3.2.1 Students recognise voltage as an electrical push from a battery. They can describe how voltage is different across components in series and parallel circuits and recognise how resistance affects current and energy transfer in circuits.

3.2.3 Students recognise that currents can create magnetic fields and that the strength of the magnetic field varies with size of current and distance from the conductor. They can describe how the magnetic field around a solenoid can be varied.

3.2.4 Students can explain why other magnets or objects are attracted or repelled by a permanent magnet. They know that the magnetic field around objects is composed of field lines and that these field lines flow from the north-seeking pole to the south-seeking pole. They can describe how a permanent magnet is used as a compass.

3.2 Electromagnets - securing

3.2.2 Students can explain static charge and how objects become positively or negatively charged in terms of movement of electrons. They can predict and explain how charged objects will affect each other. They can describe simple uses and dangers of static charge. They can describe a model of current as electrons moving from the negative to the positive terminal of a battery through a circuit.

3.2.1 Students recognise voltage (potential difference) as the amount of energy transferred per unit of charge through a circuit. They can use ideas of energy to explain how voltage and resistance affect the way components work. They recognise how resistance can be calculated from a voltage-current graph.

3.2.3 Students recognise the relationship between current and magnetic field strength in a conductor. They can describe how the magnetic field in a solenoid can be varied and describe a range of applications.

3.2.4 Students can use ideas of field lines around permanent magnets to explain why other magnets or objects are attracted or repelled. They can explain why a suspended permanent magnet works as a compass.

3.2 Electromagnets – mastering

3.2.2 Students can explain static charge and how objects become positively or negatively charged in terms of movement of electrons. They can apply their ideas to a range of scenarios where static electricity is useful or dangerous. They demonstrate a secure understanding of current as a flow of charge across a potential difference.

3.2.1 Students recognise potential difference as the amount of energy transferred per unit of charge through a circuit. They can confidently describe the relationship between potential difference, resistance and current and can predict voltage-current graphs for a range of components.

3.2.3 Students can confidently explain how the magnetic field strength around a solenoid can be varied and evaluate the design of devices using electromagnets.

3.2.4 Students can predict the pattern of field lines around objects which are attracting or repelling. They can deduce the properties of the Earth's magnetic field from its interaction with the magnet in a compass.

3.3 Energy - emerging

3.3.1 Students know that energy is needed to be able to carry out tasks. They understand that we pay for domestic electricity in our homes based on the amount of energy we use.

3.3.2 Students can describe simple energy transfers and recognise that an energy transfer can be useful or waste.

3.3.3 Students know that work is done when a force is used to move an object. They recognise that energy is used to do work.

3.3.4 Students know that the temperature of an object changes when it is heated or cooled and depends on the amount of thermal energy it has. They know that thermal energy moves from areas of high temperature to areas of low temperature.

3.3 Energy - developing

3.3.1 Students can compare the amounts of energy in different foods or used by different activities or devices. They can recognise how diagrams can show energy use.

3.3.2 Students can describe energy transfers where input energy is transferred as more than one type of energy. They can identify the waste energy and explain why it is waste.

3.3.3 Students can calculate work done for simple scenarios. They recognise how simple machines can make jobs easier by reducing the force needed.

3.3.4 Students can describe the relationship between temperature and thermal energy. They know that thermal energy moves from high temperature to low temperature. They can describe conduction and convection and recognise that all hot objects radiate heat.

3.3 Energy - securing

3.3.1 Students can compare the advantages and disadvantages of different foods, activities or devices based on energy use. They can interpret Sankey diagrams.

3.3.2 Students can describe a range of complex energy transfers and can use data to calculate efficiency. They can describe why energy is always dissipated in energy transfers and offer suggestions for how energy can be conserved.

3.3.3 Students can calculate work done for more complex scenarios. They can use calculations to explain how simple machines can be used to make work easier. They understand why the energy used should be the same as the work done and can explain why this isn't usually the case.

3.3.4 Students can describe the relationship between temperature, mass and thermal energy within an object. They can explain how heat moves by conduction, convection and radiation and how insulation prevents heat loss. They recognise that the rate of movement of thermal energy depends on the temperature gradient.

3.3 Energy – mastering

3.3.1 Students can justify options for foods, activities or devices in a range of scenarios where energy needs to be considered. They can construct accurate Sankey diagrams.

3.3.2 Students can analyse energy transfers and evaluate the efficiency of an energy transfer system.

3.3.3 Students can evaluate the use of a machine by considering issues of forces needed and the efficiency of energy transfers.

3.3.4 Students can explain the relationship between temperature, mass and thermal energy within an object. They can use a detailed understanding of conduction, convection and

radiation to explain how heat is lost or retained and the rate of heat loss in a range of scenarios.

3.4 Waves - emerging

3.4.1 Students know that sound travels as a wave through gases, liquids and solids. They can recognise that louder sounds have bigger sound waves and the waves of higher pitched sounds are closer together. They know that sound travels much more slowly than light and cannot travel at all through a vacuum. They know that humans cannot hear all sounds and that the range of sounds we can hear is called our hearing range.

3.4.2 Students know that light travels in straight lines and can describe the path of light in a ray diagram. They recognise that a reflection is created in a mirror because light rays are reflected. They know that all light can pass through a transparent object, that most light can pass through a translucent object and that no light can pass through an opaque object. They observe that light changes direction when it passes into a material with a different density and that lenses can be used to deliberately alter the path of light.

3.4.3 Students know that loud sounds can damage hearing and bright light can damage eyesight. They know that microphones convert sound into electrical signals and loud speakers convert electrical signals to sound.

3.4.4 Students recognise how waves can be shown by a model such as a slinky spring.

3.4 Waves - developing

3.4.1 Students know that a sound wave is a longitudinal wave and travels more quickly through solids than liquids or gases and not at all through a vacuum. They know that hard, smooth surfaces reflect sound well and soft, rough surfaces absorb sound. They recognise how sound waves are represented as transverse waves on an oscilloscope and can identify the amplitude and wavelength of a wave. They recognise a relationship between frequency and wavelength. They can describe the sound wave produced by sounds which are loud/quiet and high-pitched/low-pitched. They can use their understanding of the speed of sound and light to describe what happens during thunderstorms or at firework displays. They know factors which can affect the hearing range of humans.

3.4.2 Students recognise that light is reflected by a mirror and that, for a plane mirror, the angle of reflection is equal to the angle of incidence. They recognise the pattern of light rays for concave and convex mirrors. They can describe an object as transparent, translucent or opaque based on its effect on light rays. They recognise that light bends towards the normal when it passes into a more dense medium and bends away from the normal when it passes into a less dense medium. They understand that lenses are used to alter the path of light and that eyes have a lens to focus light on the retina.

3.4.3 Students can recognise that loud sounds damage hearing and bright light damages eyesight because their wave has lots of energy. They know that audio equipment converts between varying sound and a changing electrical signal.

3.4.4 Students recognise the features of waves in a model such as a slinky spring. They recognise that energy moves from place to place while the material it travels through does not

3.4 Waves - securing

3.4.1 Students can explain why sound travels more quickly through denser materials and not at all through a vacuum and can be reflected or absorbed by different surfaces. They recognise how sound waves are represented as transverse waves on an oscilloscope and can work out the amplitude and frequency of a sound from a diagram or oscilloscope picture. They can use their understanding of the speed of sound and light to explain what happens during thunderstorms or at firework displays. They

3.4.2 Students recognise that light is reflected by a mirror and can draw a ray diagram for a plane mirror, including the normal, the angle of incidence and the angle of reflection. They can apply their understanding of reflection to explain convex and concave mirrors and understand that these mirrors still obey the law of reflection. They can identify an object as transparent, translucent or opaque based on its effect on light rays. They can explain how and why light changes direction when it passes into a more or less dense medium. They understand how lenses are used to alter the path of light in situations including the eye.

3.4.3 Students can explain, in terms of energy, how loud sounds damage hearing and bright light damages eyesight. They can describe the relationship between the sound received by or produced by a piece of audio equipment and the electrical signal.

3.4.4 Students explain the behaviour of different waves using a model such as a slinky spring, recognising the difference between transverse and longitudinal waves.

3.4 Waves – mastering

3.4.1 Students can apply their understanding of sound waves to explain how materials can be chosen to control the passage of sound waves. They recognise how sound waves are represented as transverse waves on an oscilloscope and can work out the amplitude and frequency of a sound from a diagram or oscilloscope picture. They can explain, in terms of energy and frequency of vibrations, why sounds of different volume and pitch appear as they do on an oscilloscope.

3.4.2 Students can apply their understanding of the laws of reflection to explain the patterns of incident and reflected light rays for plane, convex and concave mirrors and to explain why

matt surfaces are poor reflectors. They can identify an object as transparent, translucent or opaque based on its effect on light rays. They can explain how and why light changes direction when it passes into a more or less dense medium. They can explain how lenses are used to alter the path of light in situations including the eye and can select the lens needed in glasses or contact lenses for a short-sighted and long-sighted person.

3.4.3 Students can evaluate the likelihood that various scenarios might cause damage to hearing and eyesight. They can explain the relationship between the sounds received by or produced by a piece of audio equipment and the electrical signal.

3.4.4 Students can use models to explain the behaviour of materials in a range of situations where they are transmitting waves.

3.5 Matter - emerging

3.5.1 Students are able to describe the differences between the motion and arrangement of particles in solids, liquids and gases and recognise the arrangements in particle diagrams. They know some differences in the properties of solids, liquids and gases. They understand that substances can change state when heated or cooled.

3.5.2 Students know that a pure substance consists of only one type of element or compound. They are familiar with simple techniques including dissolving, filtering and evaporating. They can carry out one-step techniques to separate simple mixtures. They recognise that mixtures are substances which can be separated into two or more substances.

3.5.3 Students know that the Periodic table shows all the known elements grouped according to their properties.

3.5.4 Students know that elements react and bond to form compounds. They can identify a substance as a compound from its formula.

3.5 Matter - developing

3.5.1 Students can relate the arrangement of particles in solids, liquids and gases to the basic properties of solids, liquids and gases. They can describe broadly how changes to the arrangement and motion of their particles can cause substances to change state.

3.5.2 Students know that a pure substance consists of only one type of element or compound and has a fixed melting and boiling point. They are familiar with a range of separating techniques including dissolving, filtering, evaporating, distillation and chromatography. They can select and carry out one-step techniques to separate simple mixtures. They can explain why certain techniques are able to separate certain types of simple mixtures.

3.5.3 Students can identify groups and periods in the Periodic table. They can identify the position of groups 1, 7 and 0 and they know that the elements in each of these groups have similar properties. They know that metals are generally found to the left of the Periodic table and non-metals to the right.

3.5.4 Students can identify the numbers of atoms of different elements in a molecule from its formula.

3.5 Matter - securing

3.5.1 Students can explain states of matter and changes in state in terms of energy and particles and can recognise melting and boiling point on a cooling curve. They can use particle diagrams to describe more complex scenarios such as dissolving and diffusion.

3.5.2 Students can describe what constitutes a pure substance and can explain why they have a fixed melting and boiling point. Students can select, organise and carry out a multi-step technique to separate a more complex mixture. They are able to explain what is happening to particles in separating techniques including dissolving, filtering, evaporating, distillation and chromatography.

3.5.3 Students are familiar with the arrangement of elements in the Periodic table into groups and periods. They can explain why the elements in groups 1, 7 and 0 are grouped together and can identify trends in the properties of the elements in a group.

3.5.4 Students can identify the name of a compound from the different elements in its formula.

3.5 Matter – mastering

3.5.1 Students have a secure grasp of the relationship between the kinetic energy of particles and the properties of solids, liquids and gases. They are able to describe complex scenarios such as gas pressure and density and can explain the shape of a cooling curve at a substances melting and boiling point.

3.5.2 Students can explain why mixtures of substances can have different melting and boiling points while those of pure substances are fixed. Students can select, organise and carry out a multi-step technique to separate complex mixtures including a mixture of solutes with different solubility and can use data such as cooling and solubility curves to explain the outcome of separating techniques.

3.5.3 Students are familiar with the arrangement of elements in the Periodic table into groups and periods. They can explain why the elements in groups 1, 7 and 0 are grouped together, can identify trends in the properties of the elements in a group and can predict the physical and chemical properties of an unfamiliar Group 1 or 7 elements.

3.5.4 Students can identify patterns in the formulae of compounds and use these to predict the formulae of unknown compounds.

3.6 Reactions - emerging

3.6.1 Students know that metals and non-metals react with oxygen to form oxides.

3.6.2 Students can identify a substance as an acid, base or neutral from its pH number using Universal Indictor solution. They know that strong acids have a low pH and strong bases have a high pH.

3.6.3 Students know that, in a chemical reaction, bonds are broken and new bonds are formed to make products. They know it takes energy to break bonds.

3.6.4 Students know that, when substances burn, they are reacting with oxygen and this is called combustion. They know that the combustion of fossil fuels produces carbon dioxide which contributes to Global Warming. They know that thermal decomposition is a reaction where a single reactant breaks down into simpler products by heating.

3.6 Reactions - developing

3.6.1 Students know that elements can be metals or nonmetals and react with oxygen to form oxides. They can describe oxidation and name the oxide formed. They know that metals form oxides which are bases while those of non-metals are acidic.

3.6.2 Students know that metals react with acids to form a salt and hydrogen gas. They can identify the name of the salt that will be formed and can represent the reactions in word equations. They recognise that the reactivity of metals affects the rate of its reaction with an acid and can use information about its reactions to place an unfamiliar metal into the reactivity series. They know how Universal Indicator and the pH scale can be used to distinguish between acids, bases and neutral substances. They can describe how to make a neutral solution from an acid and a base and know that this is called neutralisation.

3.6.3 Students can describe how bonds are broken and new bonds formed during a chemical reaction. They know that it takes energy to break bonds and that energy is produced when bonds are formed. They know that a reaction is exothermic when it produces more energy than it uses and endothermic when more energy is used.

3.6.4 Students know that, when substances burn, they are reacting with oxygen and this is called oxidation. They know that the combustion of fossil fuels produces carbon dioxide which contributes to Global Warming. They know that thermal decomposition is a reaction where a single reactant breaks down into simpler products by heating. They can describe the products of the combustion of fossil fuels and describe how the combustion of fossil fuels contributes to Global Warming. They are able to describe thermal decomposition and

represent the reaction as a word equation. They understand that masses will change during reactions but the total mass is conserved.

3.6 Reactions - securing

3.6.1 Students can explain what happens in an oxidation reaction and use word equations to describe oxidation reactions. They can identify an element as a metal or a non-metal from the pH of its oxide and from its physical properties. They can describe how a metal's position in the reactivity series will affect its reactions with acids which they can represent as word equations.

3.6.2 Students can describe neutralisation in terms of relative strength of acid and base, and pH. They can name the products formed from a reaction between an acid and a base and represent neutralisation as a word equation.

3.6.3 Students can use the idea of bond energy to describe why a reaction is exothermic or endothermic. They can identify a reaction as exothermic or endothermic from primary data and justify uses for such reactions.

3.6.4 Students are able to describe combustion and thermal decomposition using word equations and particle diagrams. They can describe how to identify the products of these reactions and can use data about masses to calculate the mass of a remaining reactant or product.

3.6 Reactions – mastering

3.6.1 Students can represent oxidation reactions as word and chemical equations. They can link the pH of oxides and their other physical and chemical properties to their uses and occurrences in real-world scenarios such as toothpaste and acid rain. They can use a metal's position in the reactivity series to predict its reactions with acids and show these in word and symbol equations.

3.6.2 Students can explain what happens in a neutralisation reaction. They can confidently identify all the products from a range of neutralisation reactions and represent them as word and symbol equations.

3.6.3 Students can use data for bond energies to predict whether a reaction will be exothermic or endothermic. They can identify exothermic and endothermic reactions from energy level diagrams.

3.6.4 Students are able to explain combustion and thermal decomposition in the context of the law of conservation of mass and using particle diagrams and symbol equations. They can

explain the significance of the combustion of fossil fuels and the production of cement for the Earth's climate.

3.7 Earth - emerging

3.7.1 Students know that the Earth's internal structure is layered and includes the crust, the mantle and the core. They know there are three types of rock – igneous, sedimentary and metamorphic – and that, once formed, these rocks are subject to weathering and erosion.

3.7.2 Students know that our solar system consists of a star and orbiting planets, some of which have moons orbiting them. They know that day and night is caused by the rotation of the Earth on its axis. They know we can see some other planets and the Moon because they reflect the Sun's light and that their changing position affects how they appear from Earth. They know we can explore the Solar System with telescopes, probes and landers and that there are other solar systems but they are too far away to travel to.

3.7.3 Students know that the Earth's atmosphere is mostly nitrogen, about one fifth oxygen and a tiny amount of carbon dioxide. They know that carbon dioxide enters and leaves the atmosphere by processes including photosynthesis, respiration and combustion. They know that human activities are causing the amount of carbon dioxide to increase.

3.7.4 Students know that some resources such as fossil fuels, metals and minerals need to be extracted and there is only a certain quantity of these resources on the Earth. They know that some metals can be found in their pure form and others need to be extracted from ores. They understand that recycling some materials reduces the need to extract them from the ground.

3.7 Earth - developing

3.7.1 Students can describe the processes which form igneous and sedimentary rocks and how they are linked in a rock cycle which includes metamorphic rocks. They can identify weathering processes as physical, chemical or biological and can link the processes forming sedimentary rocks to the occurrence of fossils.

3.7.2 Students can describe the objects which make up our solar system. They can explain how the rotation of the Earth causes day and night and they understand that its orbit around the Sun tilted axis creates seasonal differences in temperature or daylight. They can explain the changing shape of the Moon. They can describe the various ways that we can explore the Universe and understand how our exploration is affected by its scale.

3.7.3 Students know the composition of Earth's atmosphere and understand how carbon is recycled. They can describe how human activities affect the carbon cycle and are increasing

the amount of carbon dioxide in the atmosphere. They can describe how Global Warming can impact climate and the consequences of that climate change.

3.7.4 Students know that resources extracted from the Earth are a finite resource and can describe why this is a problem. They know that the least reactive metals can be found in their pure form and more reactive metals need to be extracted from ores, which are often metal oxides. They know that some metals can be displaced by carbon while the most reactive need to be extracted by electrolysis. They understand there are advantages and disadvantages from recycling some metals.

3.7 Earth - securing

3.7.1 Students can confidently describe the processes in the rock cycle and link them to the formation of fossils and igneous rocks with crystals of different sizes. They can explain why sedimentary rocks are formed in the crust and igneous rocks from material from the mantle. They can begin to predict the characteristics of the rocks formed from the conditions present.

3.7.2 Students can explain how the motion of the Earth causes day and night, seasonal variations and differences in the observations of the Moon and planets. They can link the conditions on the planets in our Solar System with their position and describe how objects are kept in orbit by gravity. They can describe the importance and limitations of the search for exoplanets.

3.7.3 Students can describe the evidence and explain the processes causing climate change. They can use a diagram to explain how carbon is recycled naturally and how human activities impact this natural recycling. They understand that there are differing interpretations of the evidence and the impacts. They can describe some strategies for limiting or mitigating the impacts of global warming.

3.7.4 Students know that metals are extracted from their ores using a method dependent on their reactivity. They can describe the reduction of iron oxide in a blast furnace and the reduction of aluminium oxide using electrolysis. They can represent the reactions as word equations. They are able to describe a range of arguments for and against the recycling of metals.

3.7 Earth – mastering

3.7.1 Students can link the processes in the rock cycle with the characteristics of the rocks formed. They can explain how processes within the Earth drive the rock cycle. They can predict how different conditions will affect the types and characteristics of the rocks formed.

3.7.2 Students can use their knowledge of the motion of objects in the Solar System to predict observations and conditions at different places on the Earth and on other planets. They can explain how objects are kept in orbit by gravity and why the orbits of the planets are different. They can explain how we explore the Universe and how our understanding, now and in the past, is limited by technology and understanding.

3.7.3 Students can evaluate the claims that human activity is causing global warming and climate change. They can evaluate different strategies for limiting or mitigating the impacts of global warming.

3.7.4 Students are able to explain the method required to extract a metal from its ore. They can describe the processes and reactions involved in the reduction of iron oxide and aluminium oxide and produce symbol equations and half equations. They can suggest how human behaviour is influenced by the availability of these natural resources and use data to evaluate recycling strategies.

3.8 Organisms - emerging

3.8.1 Students know that the skeleton provides support and allows us to move. They know that muscles are used to make bones move at joints.

3.8.2 Students know that all living things are made of cells and that these cells are microscopic. They can identify the main parts of typical plant and animal cells. They know that there are different types of cell which carry out different jobs. They know that organs are made of cells working together to carry out a particular job.

3.8.3 Students know that, in the lungs, oxygen from the air passes into the blood stream and carbon dioxide from the blood passes out into the lungs and is breathed out. They know the oxygen is needed by cells in our body to make energy and that carbon dioxide is a waste product produced. They understand that we need more energy when we exercise so we breathe in more oxygen.

3.8.4 Students know that the body needs a balanced diet containing protein, fats, carbohydrate, vitamins, minerals, fibre and water. They know that the food we eat needs to be broken down by digestion and carried by the blood to be used for cells' energy, growth and repair.

3.8 Organisms - developing

3.8.1 Students can explain how different parts of the skeleton are used for support, protection and movement. They recognise that pairs of muscles are required to make bones move at joints and they know that the ends of bones are protected by cartilage and attached to muscles by tendons.

3.8.2 Students can describe the function of different parts of typical plant and animal cells. They know there are many different types of cell which have features that enable them to carry out specific tasks. They can explain how to use a microscope to look at cells. They understand the organisation of cells into tissues, organs and organ systems and they can describe how organ systems are needed to carry out the functions which keep a multi-cellular organism alive.

3.8.3 Students know the basic structure of the lungs and that, in the alveoli, oxygen from the air passes into the blood stream and carbon dioxide from the blood passes out into the air. They can describe how the ribs and diaphragm move during breathing. They know oxygen is needed by cells in our body to make energy by respiration and that carbon dioxide is a waste product produced. They can investigate the effects of exercise on breathing and can describe how exercise, smoking and asthma affect breathing.

3.8.4 Students know that a balanced diet is needed for a healthy body and contains protein, fats, carbohydrate, vitamins, minerals, fibre and water. They understand that various factors might affect the food needed and the health problems caused by malnourishment and over-eating. They know what a deficiency disease is and can give an example. They know that the food we eat is broken down by physical and chemical digestion and can name the parts of the digestive system. They know that digested food passes into the blood stream in the small intestine and is carried by the blood to be used for cells' energy, growth and repair.

3.8 Organisms - securing

3.8.1 Students can explain how the structure of different parts of the skeleton are used for support, protection and movement. They know that bone marrow is a tissue found inside bones which produces new blood cells. They can explain the process by which antagonistic pairs of muscles cause joints to move and describe the limitations of some muscles in exerting forces.

3.8.2 Students can explain the structure and function of different parts of typical plant and animal cells. They know how the features of specialised cells enable them to carry out specific tasks. They can describe the limitations of using a microscope to look at cells. They can explain the organisation of cells into organ systems and the specific roles of all the main

organ systems. They know that unicellular organisms are adapted to carry out functions that in multi-cellular organisms are done by different types of cell.

3.8.3 Students can describe how the different parts of the breathing system are involved in breathing and gas exchange. They can describe how the ribs and diaphragm move during breathing and how this creates pressure changes which makes air move in and out of the lungs. They can explain how the structure of alveoli helps gas exchange. They can link the body's demand for energy with respiration rate and with breathing and they are aware that breathing becomes deeper as well as quicker during exercise. They understand what is meant by oxygen debt and can explain why our breathing rate remains high for a period of time after exercise.

3.8.4 Students can describe a balanced diet and explain why it is needed for a healthy body. They understand that various factors might affect the food needed and can describe the health problems caused by a poor diet. They know what a deficiency disease is and can describe the causes and symptoms of scurvy, rickets and kwashiorkor. They can describe how the food is broken down by physical and chemical digestion at each stage of the digestive system including the role of the liver and large intestine. They understand that chemical digestion using enzymes is needed to break down food into small molecules and they can explain how the small intestine is adapted to absorb the digested food.

3.8 Organisms – mastering

3.8.1 Students can explain how the skeleton provides support, protection and movement. They know that bone marrow is a tissue found inside bones which produces new blood cells. They can explain the process and limitations of using antagonistic pairs of muscles to cause joints to move and exert force. They can consider the benefits and risks of technology used to improve human movement.

3.8.2 Students can explain how the different parts of typical plant and animal cells are adapted to carry out their functions. They can explain how specialised cells are adapted to carry out specific tasks. They can describe the limitations of using a microscope to look at cells. They can explain the organisation of cells into organ systems and explain how the structure and features of all the main organ systems enable them to carry out their specific roles. They can describe how the structure of unicellular organisms enables them to carry out all the life functions.

3.8.3 Students can describe the process of breathing in terms of pressure and gas exchange in terms of diffusion. They can use their understanding to evaluate a model of the breathing mechanism. They recognise the importance of the lungs for respiration and can describe and explain various factors which might affect the efficiency of the lungs. They can explain oxygen debt and factors affecting recovery rate.

3.8.4 Students can identify the nutrients needed for a healthy diet and describe a healthy diet. They recognise factors which might affect dietary needs and can design a suitable diet. They are able to make deductions from medical symptoms to identify problems with the diet or digestive system. They are able to describe the adaptations of the digestive system and the physical and chemical processes at each stage.

3.9 Ecosystems - emerging

3.9.1 Students know that energy passes along a food chain and that food chains are linked to make food webs. They know the Sun provides the light energy at the start of almost all food chains and that this is used by green plants, which are producers, to make food. Consumers eat other organisms to get their energy.

3.9.2 Students know that most plants reproduce sexually and that flowers contain the reproductive organs. They can label a diagram of the main parts of a flower and they know that the flower produces pollen and will produce seeds. They know that a flower can be pollinated by insects or by the wind.

3.9.3 Students know that all living things get their energy from glucose in a process called respiration. They know that most organisms also need oxygen but yeast does not and we can make use of it in baking and brewing.

3.9.4 Students know that plants produce their own food by photosynthesis. They know that plants need to take in water and carbon dioxide and that they use light energy from the Sun and the chlorophyll in their leaves to make sugar and oxygen. The oxygen is given out and the sugar is used for energy and to build new tissue. They can explain why photosynthesis doesn't happen at night and is reduced on a cloudy day.

3.9 Ecosystems - developing

3.9.1 Students can describe how energy passes along a food chain and that food chains are linked to make food webs. They know that green plants are producers and make their own food by photosynthesis. Consumers eat other organisms to get their energy and can be classed as herbivores, omnivores and carnivores and also as predators and prey. They recognise that a population of prey animals will need to be larger than the population of predators and they can describe how changes in populations might affect food chains. They represent populations in a food chain as a pyramid of numbers.

3.9.2 Students know that plants reproduce sexually and this involves male sex cells called pollen, produced in the anthers, and female sex cells called ovules, produced in the ovary. They can explain the process of pollination including the role of insects or the wind and describing the parts of the flower involved. They understand that seeds are formed from the ovules and that the ovary becomes a fruit. They can describe the importance of seed dispersal and the methods used to disperse the seeds including the fruit being eaten by animals, the fruit being dispersed by the wind and the fruit being catapulted away from the plant.

3.9.3 Students know that aerobic respiration is used by most living things to produce energy from glucose and oxygen. They know the word equation for aerobic respiration. They know that some organisms can respire anaerobically and that this reaction produces lactic acid in the muscles of animals. Anaerobic respiration by yeast is used in brewing to make alcohol and baking to make bread rise.

3.9.4 Students can use a word equation to describe photosynthesis and can explain that this is how plants produce their own food. They know that plants take in water through their roots and carbon dioxide through pores in their leaves called stomata. They know that sunlight is absorbed by the leaves and chlorophyll is contained in the chloroplasts. They understand that the sugar that is made is used for energy, for building new tissue or is stored in the leaves as starch. They can explain that the oxygen is released into the air through the stomata. They can describe how to test a leaf for starch and that the presence of starch is evidence of photosynthesis. They can describe how sunlight, availability of water and amount of carbon dioxide can affect the rate of photosynthesis.

3.9 Ecosystems - securing

3.9.1 Students can explain how energy passes along food chains and through food webs. They understand that organisms occupy different trophic levels and how energy is lost at each trophic level. They can explain how the population of organisms at each trophic level can affect a food web and can describe a range of reasons why populations change. They can describe how toxic substances accumulate in food chains and the implications for top predators. They recognise the limitations of representing food chains as pyramids of numbers and know how to produce a pyramid of biomass.

3.9.2 Students have a secure understanding of the structure of flowers and the process of pollination. They can describe fertilisation including the growth of the pollen tube. They can explain the formation of seeds and fruit and can describe how the characteristics of seeds

and fruit are influenced by the method of seed dispersal. They can suggest how plant breeders might be able to intervene to improve the likelihood of fertilisation.

3.9.3 Students know that aerobic respiration takes place in the mitochondria in the cells of most living things to produce energy from glucose and oxygen. They know the word and balanced symbol equation for aerobic respiration. They know that some organisms can respire anaerobically and that this reaction produces lactic acid in the muscles of animals and can describe the usefulness and limitations of anaerobic respiration in animals. They can describe and write word equations for fermentation used in brewing and baking.

3.9.4 Students can use a word equation and symbol equation to describe photosynthesis. They can describe how water is taken in by the roots and transported to the leaves and they can describe how the gases are exchanged via the stomata in leaves. They recognise adaptations in the plant which enable them to effectively absorb sunlight, to absorb water and to exchange gases. They can explain the importance of the guard cells in stomata. They can describe how to test a leaf for starch and explain why sugars are stored as starch in the leaves. They can describe how various factors including light intensity and temperature might affect the rate of photosynthesis and justify conditions used in a commercial greenhouse to promote photosynthesis.

3.9. Ecosystems – mastering

3.9.1 Students can explain how energy passes along food chains and through food webs and how energy losses at each trophic level limit the length of food chains. They can explain a number of factors which can affect the population of an organism and the implications for other organisms in the food web. They understand the risks of bioaccumulation for humans and other top predators and can explain issues with human food supplies in terms of insect pollinators. They understand how legislation is used to mitigate problems. They can evaluate a proposal for introducing an unfamiliar species into a food web.

3.9.2 Students can use their understanding of the structure of flowers and the process of pollination to evaluate methods used by plant breeders to improve fertilisation rates or to develop an argument why some plant structures found naturally are more successful than others. They can describe the various processes for seed dispersal in the wild and link this to the ability of different plants to spread and colonise new areas. They can suggest how plant breeders might be able to use their knowledge of pollination and fertilisation to carry out selective breeding.

3.9.3 Students can describe aerobic respiration in the mitochondria in the cells of living things referring to the diffusion of substances into and out of the cell. They know that some organisms can respire anaerobically and can evaluate the usefulness of anaerobic respiration as a life process in animals. They know the balanced symbol equations for aerobic respiration, anaerobic respiration in animals and fermentation in yeast.

3.9.4 Students can use a word equation and symbol equation to describe photosynthesis. They can describe the processes of transpiration and gas exchange in the leaves and recognise the mechanisms which regulate these in plants. They can explain how plants are adapted for photosynthesis. They can explain limiting factors for the rate of photosynthesis and show these as graphs. They can explain how the glucose produced is stored and how minerals are needed to build the glucose into new tissues.

3.10 Genes - emerging

3.10.1 Students know that differences between members of the same species are called variation. They know that variation is inherited or caused by the environment or a combination of the two. They can investigate variation between members of a species and plot results as bar charts or line graphs.

3.10.2 Students know that animal and plant species have evolved and many species have become extinct. They understand that evidence for different species is found in fossils. They know that an ecosystem is a biological community and that a healthy ecosystem has many different species living in it.

3.10.3 Students know the main parts of the male and female human reproductive systems. They know that the menstrual cycle prepares the woman for pregnancy and that an egg is released from an ovary once a month approximately. They know that fertilization happens if the egg joins with a sperm and that this might lead to pregnancy. They understand that the developing foetus depends on the mother to provide the oxygen and nutrients it needs and to remove its waste.

3.10.4 Students know that inherited characteristics are the result of genetic material carried on chromosomes in the nucleus of cells. They understand that parents pass on information to their offspring as genes during reproduction. They know that half of an offspring's genes are inherited from each parent in the parents' gametes.

3.10 Genes - developing

3.10.1 Students can describe what is meant by variation and how variation is caused. They can identify discontinuous and continuous variation and plot results of an investigation as bar charts or line graphs. They recognise how the characteristics of a species are adapted to a particular environment and how variation can affect survival.

3.10.2 Students know that natural selection is a theory which explains how species have changed over time. They recognise how fossils provide evidence for evolution and how evolution can be caused by natural selection. They understand that species have become extinct or evolved because of changing conditions in ecosystems. They know that populations in an ecosystem depend on each other and the possible effects of a lack of biodiversity.

3.10.3 Students know that the menstrual cycle repeats approximately every 28 days, preparing a woman's body for pregnancy by building up the blood supply in the lining of the uterus and releasing an unfertilised egg from the ovary. They can describe the journey of the egg from the ovary and the path that sperm will take to fertilise the egg. They understand that the fertilised egg cell will multiply and develop into an embryo which will need to implant in the uterus lining for a pregnancy to continue. They can explain how, during the pregnancy, the growing foetus is dependent on its mother for protection, provided by the amniotic fluid, and for the supply of food and nutrients and the removal of waste through the placenta. They can explain that the gestation period for a human baby is around nine months during which the baby needs to develop enough to be born.

3.10.4 Students know that offspring inherit characteristics from their parents as sections of DNA, called genes, during reproduction. They recognise that half of an offspring's genes are inherited from each parent so offspring from the same parents look similar but are not usually identical. They understand that genes are arranged into chromosomes which are found in the nucleus of most cells.

3.10 Genes - securing

3.10.1 Students can explain how characteristics of a species might be adapted to a particular environment. They can explain the causes of variation and recognise that variation can influence an individual's and a species' chances of survival in a changing environment.

3.10.2 Students understand how fossils provide evidence for evolution but that the evidence is limited. They can describe how variation and changes in environmental conditions can lead to natural selection and how this provides a mechanism for evolution. They understand how different species in an ecosystem depend on each other and recognise the importance of biodiversity for the maintenance of healthy populations.

3.10.3 Students can describe the key stages in the human menstrual cycle and understand how it prepares a woman's body for pregnancy. They can use their understanding of the path of sperm and egg to deduce where the egg is most likely to be fertilised and when a woman is most likely to become pregnant. They can apply their understanding of fertilisation to be able to explain how different contraception methods work. They can describe how the mother provides for the developing foetus and the effects that smoking, or the mother drinking too much alcohol or taking drugs might have on the foetus.

3.10.4 Students understand how offspring inherit characteristics from their parents and why each gamete carries only half the number of genes. They can apply this understanding to explain why offspring from the same parents are similar but not usually identical except in the case of identical twins. They know there is more than one version of each gene and can show with diagrams how the combination of inherited genes affects an offspring's characteristics. They can describe how a mutation might affect an organism and its offspring.

3.10 Genes – mastering

3.10.1 Students can explain how variation occurs in species and how a species can become adapted to a particular environment. They can use ideas of variation to explain why one species may adapt better than another to an environmental change.

3.10.2 Students can evaluate the strength of fossil evidence for evolution. They can explain how natural selection provides a mechanism for evolution. They can discuss how populations of organisms depend on each other and recognise the benefits for humans of biodiversity in ecosystems. They can evaluate schemes for preserving plant and animal material for future generations.

3.10.3 Students can explain the key stages in the human menstrual cycle. They can apply their understanding of fertilisation to explain why pregnancy is more or less likely at different times and to explain reasons why some couples might find it difficult to conceive a baby. They can justify their ideas about the effectiveness of different contraception methods. They can explain how the mother provides for the developing foetus and the effects that smoking, or the mother drinking too much alcohol or taking drugs might have on the foetus. They can give reasons why a baby might be born premature and suggest the problems that might arise.

3.10.4 Students can use their detailed understanding of genetic inheritance to be able to explain why offspring do or do not inherit certain features from their parents. They can explain how a mutation can be beneficial or harmful. They can suggest benefits of knowing all the genes in the human genome and suggest arguments for and against genetic modification.