Combined Science
Key Stage 4 - Higher

Curriculum map

OAK NATIONAL ACADEMY

1. Philosophy

Six underlying attributes at the heart of Oak's curriculum and lessons.

Lessons and units are **knowledge and vocabulary rich** so that pupils build on what they already know to develop powerful knowledge.

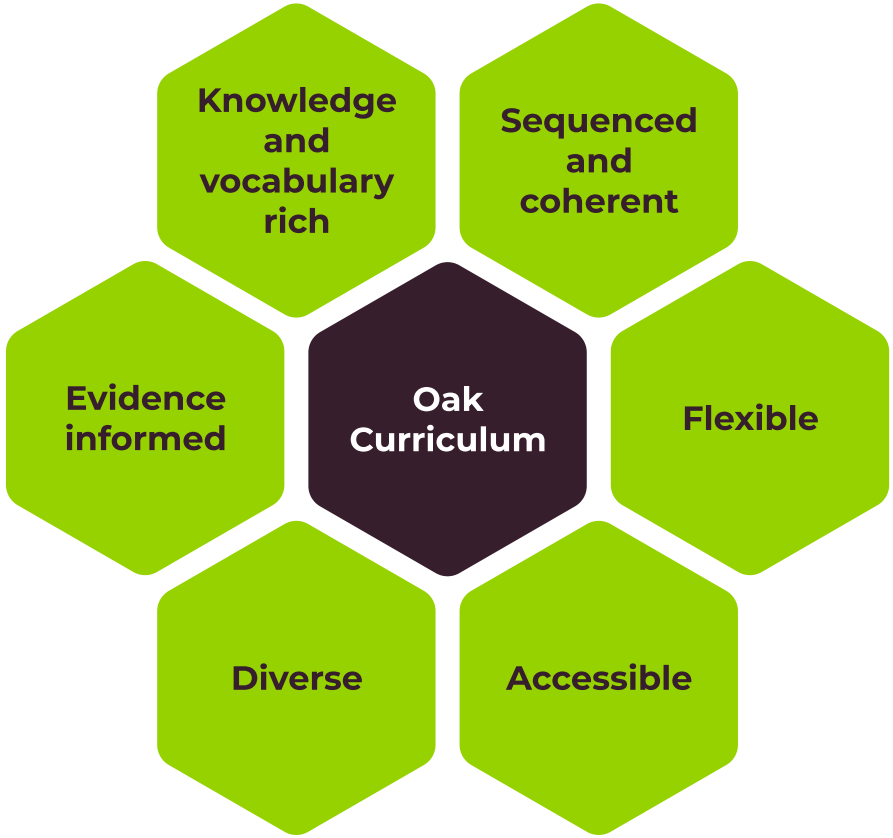
Knowledge is **sequenced** and mapped in a **coherent** format so that pupils make meaningful connections.

Our **flexible** curriculum enables schools to tailor Oak's content to their curriculum and context.

Our curriculum is **evidence informed** through rigorous application of best practice and the science of learning.

We prioritise creating a **diverse** curriculum by committing to diversity in teaching and teachers, and the language, texts and media we use, so all pupils feel positively represented.

Creating an **accessible** curriculum that addresses the needs of all pupils is achieved to accessibility guidelines and requirements.



2. Units

KS4 Combined Science is formed of 24 units and this is the recommended sequence:

Unit Title	Recommended year group	Number of lessons
1 Cell biology (HT)	Year 10	19
2 Atomic structure and periodic table (HT)	Year 10	19
3 Particle Model of Matter (HT)	Year 10	11
4 Organisation (HT)	Year 10	23
5 Bonding, structure and the properties of Matter (HT)	Year 10	12
6 Energy (HT)	Year 10	14
7 Infection and response (HT)	Year 10	13
8 Quantitative Chemistry (HT)	Year 10	8
9 Electricity (HT)	Year 10	20

10	Bioenergetics (HT)	Year 10	15
11	Chemical changes (HT)	Year 10	20
12	Atomic Structure (HT)	Year 10	8
13	Ecology (HT)	Year 10	12
14	Energy changes (HT)	Year 10	8
15	Magnetism (HT)	Year 10	7
16	Homeostasis and response (HT)	Year 11	14
17	The rate and extent of chemical change (HT)	Year 11	16
18	Forces (HT)	Year 11	18
19	Inheritance, variation and evolution (HT)	Year 11	19
20	Organic Chemistry (HT)	Year 11	5
21	Waves (HT)	Year 11	9

3. Lessons

Unit 1 Cell biology (HT)

19 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Prokaryotic and Eukaryotic Cells**	• Describe the differences between eukaryotic and prokaryotic cells • Practice identifying eukaryotic and prokaryotic cells
2.	**Comparing of cells**	• Describe functions of subcellular structures • Compare the functions of different cells
3.	**Order of magnitude calculations**	• Convert mm to μm and vice versa • Express numbers in standard form

4.	**Microscopes, magnification and resolution**	• Describe the differences between images produced by light and electron microscopes • Explain how electron microscopes have enhanced our understanding of cell structures and processes • Explain what is meant by resolution and magnification
5.	**Using the microscope and magnification equation**	• Describe how to use a microscope to view plant cells in focus • Use the magnification equation to calculate the magnification, image or actual size • Change the units if necessary
6.	**Viewing animal cells under the microscope and calculating magnification**	• Find and view animal cells using a microscope • Use the equation M=I/A to calculate any value given the other two • Practice using scale to calculate magnification
7.	**Specialised cells**	• Describe specialised features of given cells • Explain the reason for the special features in terms of the cells function • Explain the importance of cell differentiation

8.	**Diffusion**	• Describe how substances move in and out of cells by diffusion, giving examples • Describe and explain factors that can affect the rate of diffusion
9.	**Exchange surfaces and surface area to volume ratio**	• Calculate surface area to volume ratios • Explain the need for internal surfaces and circulatory systems in larger organisms • Describe and explain adaptations in plants and animals for the exchange of materials
10.	**Osmosis**	• Define the term osmosis and give some examples in living things • Explain the changes to both animal and plant cells when placed in different solutions
11.	**Osmosis required practical (Part 1)**	• Identify variables to change, measure and control to test a hypothesis • Practice method writing and explain reasons for given method steps • Make and record accurate mass measurements

12.	**Osmosis required practical (Part 2)**	• Measure change in mass accurately and calculate percentage change • Display and interpret results appropriately • Describe and explain the patterns in the results
13.	**Active transport**	• Describe how substances are taken up by active transport • Compare diffusion, osmosis and active transport • Apply knowledge to exam questions
14.	**Cell cycle and mitosis**	• Identify DNA, genes, chromosomes on a diagram • Describe the main stages of the cell cycle • Use information provided to calculate time spent in different phases of the cell cycle
15.	**Stem cells and their uses**	• Name sources of stem cells and their uses • Describe some potential uses of stem cell technology • Evaluate different stem cell sources

16.	**Useful maths skills**	• Calculate mean values • Practice unit conversions, magnification calculation and percentage change
17.	**Cell biology review (Part 1)**	• Review and consolidate knowledge of cells from the cell biology unit
18.	**Cell biology review (Part 2)**	• Review and consolidate knowledge of cell transport from the cell biology unit
19.	**Case study and exam skills**	• Practice applying knowledge to exam-style questions • Learn about the work of Dr Stephanie dancer

Unit 2 Atomic structure and periodic table (HT)

19 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Atoms, elements and compounds**	• Define elements and compounds and identify them from diagrams • Name compounds from word equations and formulae • Identify reactants and products in equations
2.	**Chemical formulae and conservation of mass**	• Interpret chemical formulae • Apply conservation of mass to equations
3.	**Mixtures, filtration and crystallisation**	• Define, identify and describe mixtures • Explain the steps in the separation of mixtures of soluble and insoluble substances • Explain how mixtures of soluble and insoluble substances are represented and recognised

4.	**Separation by distillation**	• Describe how to separate a mixture of two or more liquids, identifying key equipment • Explain the processes and equipment involved • Apply particle theory to distillation
5.	**Separation by chromatography**	• Describe the process of chromatography • Carry out the chromatography of chlorophyll, explaining key steps • Interpret chromatograms
6.	**Atomic structure**	• Describe atoms using the nuclear model • State the charges and mass of the three subatomic particles • Use the periodic table to calculate the number of protons, neutrons and electrons for any given element
7.	**Development of the atomic model**	• Describe the development of the atomic model • Compare the nuclear model with the plum pudding model • Explain how new evidence from the scattering experiment led to a change in the atomic model

8.	**Isotopes**	• Define an isotope • Compare isotopes based on information given • Calculate RAM of isotopes given their abundance and give answers to a specified number of significant figures or decimal places
9.	**Isotopes case study lesson**	• Describe the work of Marie Curie and Frederick Soddy and explain how their work contributed to our understanding of isotopes and the atomic model
10.	**Electron Configuration and the Periodic Table**	• Describe what keeps electrons in their orbits • Draw and write the electron configuration for any of the first 20 elements • Describe the link between outer shell electron number, number of shells and location in the periodic table
11.	**Periodic Table development**	• Describe the layout of the modern periodic table • Compare the early versions of the periodic table with the modern one • Explain how the periodic table was developed as ideas changed

12.	**Why elements react**	• Explain the difference between metals and non-metals in terms of reactions and electrons • Explain why group 0 do not react in terms of electrons • Describe trends in physical properties of group 0
13.	**Group 1**	• Describe physical and chemical properties of the group 1 elements • Write equations to represent their reaction with water • Describe and explain trends in the properties and reactivity of group 1 elements
14.	**Group 7**	• Describe trends in physical properties of group 7 elements • Explain the trend in physical properties of group 7 elements
15.	**Group 7 Displacement**	• Describe trends in reactivity going down group 7 • Describe the results of a series of reactions of group 7 elements and their compounds • Write word and symbol equations to represent some reactions involving group 7 elements

16.	**Comparing the reactivities of Group 1 and 7 elements**	• Use electron configuration to explain the trends in reactivity in group 1 and 7 • Compare the trends in reactivity in group 1 and 7
17.	**Displacement reactions: Ionic equations**	• Write ionic equations for the displacement reactions
18.	**Review (Part 1)**	• Revision of atomic structure and the maths skills covered in the unit
19.	**Review (Part 2)**	• Revision of separation techniques and the command words 'describe' and 'explain' in exam questions

Unit 3 Particle Model of Matter (HT)

11 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Particle models**	• Describe the arrangement of particles in solids, liquids and gases, and represent them with accurate drawings • Use the particle model to explain differences in properties of solids, liquids and gases • Evaluate the particle models
2.	**Density of solids**	• Use an equation to calculate the density, mass or volume of an object • Unit conversion (mass and volume)
3.	**Density required practical**	• Describe how to measure the density of regular and irregular solids • Make and record accurate measurements

4.	**Density of liquids**	• Describe how to measure the density of liquids • Make and record accurate measurements • Suggest possible sources of error and how to correct them
5.	**Internal energy**	• Define internal energy • Describe the two results of changing the internal energy of a system and recognize them on heating/cooling graphs • Plot secondary data for heating a substance • Describe heating and changes of state in terms of kinetic and potential energy stores
6.	**Heating and cooling substances**	• Describe heating and changes of state in terms of kinetic and potential energy stores • Use the specific heat capacity equation to calculate any value given the others

7.	**Latent heat**	• Describe changes to particle arrangement and movement during a change of state • Describe latent heat of vaporisation and fusion and recognize them on a graph • Use an equation to calculate energy, mass or latent heat values
8.	**Multi-Step energy calculations**	• Use an equation to calculate energy, mass or latent heat values • Complete multi-step energy calculations
9.	**Gas pressure**	• Use the particle model to explain gas pressure • Plot data to show the effect of temperature on gas pressure and describe the pattern shown • Explain why changing the temperature of a gas affects the pressure
10.	**Review (Part 1)**	• Recall definitions of key terms and use them correctly • Apply knowledge of key topics to exam questions • Correct key misconceptions on this topic
11.	**Case study: Joseph Black**	• Study the life and work of Joseph Black

Unit 4 Organisation (HT)

23 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Food tests**	• Describe how to test for starch, sugars, proteins and fats • Describe the positive and negative results of these tests • Describe the safety precautions needed for food testing
2.	**Digestive enzymes**	• Describe the structure and function of the digestive system • Describe the action of enzymes in digestion using the 'lock and key' model • Name the 3 main digestive enzymes, where they are produced, and the substrate and products of their action
3.	**Digestion**	• Describe the organs of the digestive system and their function • Describe the purpose and action of acid and bile in the digestive system

4.	**Absorption**	• Describe adaptations of digestive system for absorption • Explain how these adaptations aid absorption • Describe uses for the absorbed food particles
5.	**Investigating enzymes**	• Describe ways to measure the rate of enzyme action • Identify variables to change measure and control to test the effect of temperature on enzyme action • Describe and explain the effect of temperature on the rate of enzyme action
6.	**pH and enzymes (Part 1)**	• Identify variables to change, measure and control to test a hypothesis • Collect and record data accurately • Process and display results appropriately • Describe and explain the effect of pH on enzyme activity
7.	**pH and enzymes (Part 2)**	• Describe and explain the effect of pH on amylase activity • Suggest improvements to a method • Apply knowledge and understanding to secondary investigations

8.	**The lungs**	• Label the major structures in the lungs • Describe gaseous exchange • Describe and explain how the lungs are adapted for efficient gaseous exchange.
9.	**Blood and blood vessels**	• Describe the components of the blood and their function • Describe the structure and function of arteries and veins • Explain how blood components and blood vessels are adapted for their function
10.	**The heart**	• Label the major structures in the heart • Describe the path blood takes through the heart and around the body • Calculate blood flow using appropriate equations • Describe how heart rate is controlled
11.	**Heart rate**	• Review the structure of the heart • Describe the function of pacemaker cells • Describe the role of artificial pacemakers

12.	**Heart disease**	• Describe some of the causes of heart disease • Explain how coronary heart disease can lead to a heart attack • Evaluate treatments for heart disease
13.	**Non-communicable disease**	• Describe some risk factors for diseases • Explain the impacts of lifestyle choices and disease at local, national and global levels • Analyse and interpret secondary data on disease incidence rates
14.	**Cancer**	• Describe how cancer forms in the body • Describe the risk factors associated with cancer development • Explain the difference between 'benign' and 'malignant' tumours • Explain how malignant cancer can spread
15.	**Plant tissue**	In this lesson we will look at how the tissues of the leaf are adapted to photosynthesis.

16.	**Plant roots**	• Describe the structure of roots • Explain how roots are adapted for absorption of water and mineral ions
17.	**Transport in plants**	• Describe the movement of water around the plant by transpiration • Describe the movement of dissolved sugars around the plant by translocation • Explain the role of xylem, phloem and stomata in transport in plants
18.	**Investigating transpiration**	• Describe factors that can affect the rate at which water moves • Explain how rate of transpiration can be measured • Explain how changes in temperature, humidity, air movement and light intensity affect rates of water movement
19.	**Review (Part 1)**	• Review and consolidate knowledge of the digestive system, lungs and heart from the organisation unit

20.	**Review (Part 2)**	• Review and consolidate knowledge of non-communicable diseases and plant tissues from the organisation unit
21.	**Maud Leonora Menten**	• Introduction to the work of Maud Menten and her work on the Michaelis-Menten equation
22.	**Exam technique**	• Identifying the skills needed to answer describe, explain and evaluate questions • Practice answering describe, explain and evaluate questions
23.	**Maths skills**	• Describe the terms cardiac output, stroke volume and heart rate • Calculate cardiac output, stroke volume and heart rate • Use VESRAU to practice substitution and rearrangement (values, equation, substitute, rearrange, answer, units)

Unit 5 Bonding, structure and the properties of Matter (HT) 12 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Ionic bonding introduction**	• Describe the formation of ions • Link the charge of ions to the place in the periodic table
2.	**Further ionic bonding**	• Describe the formation of an ionic bond • Represent ionic bonding using diagrams • Write formula for ionic compounds
3.	**Properties of ionic compounds**	• Describe some of the properties of ionic compounds • Explain some of the properties of ionic compounds using knowledge of the structure
4.	**Covalent bonding**	• Define a covalent bond • Draw and describe covalent bonds using structural, ball and stick and displayed formula • Describe the limitations of the different models

5.	**Simple covalent molecules**	• Explain why some covalent substances form molecules and others form giant structures • Describe the properties of simple covalent molecule • Explain their properties in terms of bonding
6.	**The giant covalent structures**	• Explain why some covalent substances form molecules and others form giant structures • Describe the properties of diamond and graphite • Explain the properties using knowledge of the bonding and structure • Relate properties of these carbon allotropes to their uses
7.	**Giant covalent structures: Graphene**	• Describe the structure of graphene and fullerenes • Describe and explain their properties • Describe the work of the scientists who discovered graphene
8.	**Polymers**	• Describe the structure of polymers • Explain the properties of polymers • Draw the formation of polymers given the monomer

9.	**Review (Part 1)**	• Review the content covered on ionic and covalent bonding • Compare the properties of ionic and covalent substances
10.	**Metallic bonding**	• Describe the structure and bonding of metals • Describe and explain the properties of metals • Explain why alloys are harder than pure metals
11.	**Solids, liquids and gases**	• Predict the state of substances at different temperatures, and the type of bonding present given melting and boiling point data • Describe what happens in terms of particles and forces during a change of state • (Higher tier only) Explain the limitations of the particle model in relation to changes of state
12.	**Review (Part 2)**	• Review ionic, covalent and metallic bonding • Relate properties to their bonding • Relate properties to their uses

Unit 6 Energy (HT)

14 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Energy transfers**	• Name the 8 energy stores • Describe the transfer of energy from one store to another, identifying pathways • Describe how energy is dissipated and calculate efficiency
2.	**The kinetic energy store**	• Calculate the energy stored in a moving object • Rearrange the equation to calculate velocity or mass • Change units where necessary and express answers to given numbers of significant figures
3.	**The gravitational potential store**	• Use an equation to calculate GPE, mass or height • Use values for GPE to calculate the theoretical velocity of an object • Explain why the maximum theoretical velocity is never actually reached

4.	**Conservation of energy**	• Define the term 'system' • Explain the law of conservation of energy. • Apply conservation of energy to systems involving GPE and KE
5.	**The elastic potential store**	• Define an elastic object • Calculate the energy stored in a stretched or compressed object • Describe the energy transfers in a bouncing object
6.	**Power**	• Describe, using examples, what is meant by power • Calculate power using energy transferred or work done • Compare the power of different appliances or machines
7.	**Efficiency and reducing unwanted energy transfers**	• Calculate efficiency from data or a Sankey diagram • Describe ways of reducing unwanted energy transfers • Explain a method for reducing unwanted energy transfers

8.	**Specific heat capacity**	• Explain what is meant by specific heat capacity • Use the specific heat capacity equation to calculate unknown values
9.	**Specific heat capacity required practical**	• Explain the method steps used to find the specific heat capacity (SHC) of a substance • Plot a graph of results to determine specific heat capacity • Calculate the SHC of the blocks investigated • Write a method for an alternative SHC investigation
10.	**Non-Renewable energy resources**	• State the names of non-renewable energy resources • Interpret data to compare energy usage • Consider the impact on the environment of non-renewables
11.	**Renewable energy resources**	• Describe uses of renewable energy resources • Describe advantages and disadvantages of renewable energy resources • Evaluate the use of energy resources • Compare the use of different energy resources

12.	**Multi-Step calculations for the energy topic**	• Choose correct equations to use in calculations • Use multiple equations to solve single problems
13.	**Energy review**	• Correct misconceptions • Recall definitions of key terms and use them correctly • Apply understanding of key topics to exam style questions
14.	**Case study: Esther Takeuchi**	• Understand the key contributions of Esther Takeuchi to our understanding of energy

Unit 7 Infection and response (HT)

13 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Infectious disease**	• Name causes of some infectious diseases and describe how they make us ill • Describe how pathogens can be spread, and how this spread can be reduced • Describe the main defence mechanisms of the body
2.	**Viral and bacterial disease**	• Describe the symptoms, spread and prevention of viral measles, HIV and TMV • Describe the symptoms, spread and prevention of bacterial diseases salmonella and gonorrhoea • Explain why antibiotics can be used to treat bacterial infections but not viral ones. • Process secondary data related to infection rates

3.	**Fungal and protist disease**	• Describe the symptoms, spread and prevention of rose black spot • Describe the spread, symptoms and prevention of malaria • Explain what is meant by the term 'vector'
4.	**Immunity**	• Describe how white blood cells respond to destroy pathogens • Explain the difference between the primary and secondary immune response • Explain what is meant by immunity
5.	**Vaccines**	• Describe what is in a vaccine • Explain how vaccines prevent infection • Explain the advantages of large scale vaccination
6.	**Antibiotics**	• Explain the difference between antibiotics and over the counter medications • Collect data on the action of different antibiotics and process it appropriately • Use data collected to draw conclusions

7.	**Maths skills**	• Calculate a mean, the area of clear zones and percentage changes • Draw a conclusion from data
8.	**Testing drugs (Part 1)**	• Identify the source of digitalis, penicillin and aspirin • Describe the stages in developing new drugs to treat disease • Describe the use of placebos and explain why they are needed
9.	**Testing drugs (Part 2)**	• Recap on stages of drug development • Explain the importance of carrying out a double-blind trial
10.	**Review (Part 1)**	• Review and consolidate knowledge of pathogens from the infection and response unit
11.	**Review (Part 2)**	• Review and consolidate knowledge of drug development and treating infection from the infection and response unit

12.	**Exam Skills**	• Identify command verbs and respond appropriately • Apply knowledge to exam-style questions
13.	**Kelly Chibale: Drug production**	• Learn about the work of Kelly Chibale

Unit 8 Quantitative Chemistry (HT)

8 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Relative formula mass (FT only)**	• Use the periodic table and formulae to determine the relative formula mass of compounds • Work out percentage of given elements in a compound • Work out the mass of a particular element in a given mass of a compound
2.	**Relative formula mass (HT only)**	• Use the periodic table and formulae to determine the relative formula mass of compounds • Work out percentage of given elements in a compound • Work out the mass of a particular element in a given mass of a compound
3.	**Moles and Avogadro's constant (HT only)**	• Use 'Mass = Mr x moles' to find any one value given the other two • Use Avogadro's constant to calculate number of atoms/molecules in a given mass • Calculate the mass of a given number of atoms using the Avogadro constant

4.	**Balancing equations using moles (HT only)**	• Write chemical formulae using knowledge of ion charges • Balance equations using the same number of atoms rule • Balance equations using moles
5.	**Reacting masses (HT only)**	• Predict the mass of product from a specified starting mass • Use a balanced equation to work out the quantity of reacting elements needed to produce a specified quantity of product
6.	**Concentration**	• Define the term 'concentration' • Calculate concentration from mass and volume • Work out the mass of a substance in a given volume of a solution of a known concentration
7.	**Limiting reactants**	• Define a limiting reactant • Describe the effect of a limiting reactant on the amount of products it is possible to produce • Calculate the limiting reactant from a balanced symbol equation

8. Review (HT only)

- Review of higher tier calculations content

Unit 9 Electricity (HT)

20 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Drawing electrical circuits**	• Draw circuits, using correct common circuit symbols
2.	**Charge and current**	• Describe electrical current • Use the equation Q=It to calculate any value given the other two, changing units where necessary
3.	**Potential difference**	• Describe what is meant by potential difference and resistance in circuits • Recall and apply the equation linking charge, energy and potential difference
4.	**Electrical resistance**	• Describe what happens to current when potential difference and resistance are varied • Use an equation linking potential difference, current and resistance to calculate any value given the other two

5.	**Resistance of a wire**	• Identify the variables to change, measure and control to test a hypothesis • Collect and record measurements of current and potential difference for different lengths of wire • Use the readings to calculate resistance in the wire • Plot a graph of the results
6.	**Series circuits**	• Predict current and potential difference (pd) in series circuits • Describe the effect of adding resistors in series circuits • Use Ohm's Law to calculate current, resistance or pd
7.	**Parallel circuits**	• Describe and apply the rules for potential difference (pd) and current in a parallel circuit • Describe the effect of adding resistors in parallel • Use Ohm's law to find pd, resistance or current in parallel circuits
8.	**Series and parallel circuits**	• Compare series and parallel circuits • Use Ohm's Law to find potential difference (pd), current and resistance in circuits

9.	**Properties of resistors**	• Make and record measurements to find the pattern of resistance in a fixed resistor • Plot a graph of the data obtained • Describe and explain the relationship between current, potential difference and resistance in a fixed resistor
10.	**Filament lamps**	• Make and record measurements to find the pattern of resistance in a filament lamp • Plot a graph of the data obtained • Calculate resistance for the values collected • Describe and explain the relationship between current, potential difference and resistance in a filament lamp
11.	**Diodes**	• Recognise and draw the symbol for a diode • Process secondary data and plot a graph of the data

12.	**Light dependent resistors**	• Identify the variables to change, measure and control to test a hypothesis • Collect and display results appropriately • Explain how resistance changes with light levels in a light-dependent resistor (LDR) • Explain how LDRs can be used to switch lights on when it gets dark
13.	**Thermistors**	• Draw a circuit diagram to illustrate how to test the resistance of a thermistor • Process secondary data appropriately and use it to inform a conclusion • Explain the use of thermistors as a thermostat
14.	**Review of electrical circuits**	• Correct misconceptions for electrical circuits • Recall key definitions and equations • Apply understanding of key topics to exam style questions

15.	**Domestic electricity**	• Describe the features of UK mains supply and three core cable • Explain the use of live, neutral and earth wires • Explain the difference between direct and alternating potential difference
16.	**Electrical power (Part 1)**	• Recall and apply the equation linking current, potential difference and power • Change units and the subject of equations where necessary • Recall and apply the equation to calculate power, current or resistance • Change units and the subject of equations where necessary
17.	**Electrical power (Part 2)**	• Recall and apply the equation linking energy, power and time • Recall and apply the equation linking charge, energy and potential difference
18.	**Multi-Step calculations**	• Be able to solve problems using multi-step or multiple equations

19. The national grid

- Describe how electricity is transmitted in the national grid, naming the components
- Explain the use of transformers in the national grid
- Evaluate the use of underground or overhead cables
- (Higher tier) use a given equation to calculate current or pd given appropriate information

20. Domestic electricity review

- Correct any misconceptions for domestic electricity
- Recall key information and definitions
- Apply understanding to exam style questions

Unit 10 Bioenergetics (HT)

15 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Photosynthesis**	• Name the reactants and products needed for photosynthesis and represent it using a word and symbol equation • Describe uses for the glucose made during photosynthesis • Carry out a test for starch and explain the results
2.	**Photosynthesis required practical**	• Identify variables to change, measure and control to test a hypothesis • Explain the steps in a given method to test a hypothesis • Collect and record data to test a hypothesis

3.	**Photosynthesis required practical results**	• Collect the data in a suitable table • Describe and explain the relationship between light intensity and rate of photosynthesis • Describe and explain the effect of carbon dioxide concentration and temperature on the rate of photosynthesis • (Higher tier & triple biology only) Calculate the inverse square law
4.	**Limiting factors of photosynthesis**	• Describe and explain the relationship between light intensity and rate of photosynthesis • Describe and explain the effect of carbon dioxide concentration and temperature on the rate of photosynthesis • Identify limiting factors from graphs
5.	**Manipulating factors of photosynthesis HT**	• Interpret graphs of photosynthesis rate with multiple factors and decide which is limiting • Describe some ways of manipulating conditions for plant growth • Evaluate these methods

6.	**Review photosynthesis**	• Review and consolidate knowledge of photosynthesis from the bioenergitics unit so far.
7.	**Respiration**	• Define respiration and explain its importance in the body • Describe some changes that occur in the body during exercise • Explain why these changes are necessary
8.	**Anaerobic respiration**	• Describe the consequences of anaerobic respiration • Explain the results of a simple experiment into anaerobic respiration • Compare aerobic respiration with anaerobic respiration
9.	**Consequences of anaerobic respiration**	• Describe how an oxygen debt occurs • Explain the problems with an oxygen debt and how the body compensates in response
10.	**Metabolism**	• Define the term metabolism • Give examples of reactions in metabolism • Describe the formation of lipids, amino acids and urea

11.	**Synoptic links**	• Explain the importance of the digestive, respiratory and circulatory systems in effective respiration
12.	**End of topic review**	• Review and consolidate knowledge of respiration and metabolism from the bioenergetics unit
13.	**Exam Skills**	• Apply knowledge of bioenergetics to exam style questions
14.	**Maths Skills**	• Practice calculating means, including identifying anomalies
15.	**Scientist case study-Ynes Mexia**	• (Higher tier & triple biology only) Calculate the inverse square law

Unit 11 Chemical changes (HT)

20 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Redox**	• Describe oxidation and reduction in terms of oxygen • Identify where oxidation and reduction have happened given an equation • Explain how carbon can be used to extract metals from their ores using redox reactions
2.	**Investigating the reactivity of metals**	• Identify variables to change, measure and control to test the reactivity of metals • Write equations for the reactions of acids and metals, naming salts • Use observations to order metals in terms of reactivity
3.	**Displacement reactions of metals**	• Explain how the reactivity of a metal is related to forming ions • Record observations on whether or not displacement reactions occur • Write equations for displacement reactions

4.	**Redox (Higher tier)**	• Define redox in terms of electrons • Identify species that are oxidised or reduced in reactions • Write half equations to represent the reactions
5.	**Acid base reactions**	• Write word equations to represent the reactions of metal oxides and acids • Explain steps in a given method to produce a pure, dry sample of a soluble salt • Use ion charges to write formulae for salts
6.	**Observations from acid base reactions**	• Write equations to represent the reactions of metal carbonates and acids • Describe evidence for a chemical reaction • Describe the test for carbon dioxide and its positive result
7.	**Acid base ionic equations**	• Write balanced symbol equations for acid base reaction • Write ionic equations for acid base reactions

8.	**Making salts**	• Suggest corrections to a given method to make a salt • Write a method to prepare a salt using a metal carbonate or metal oxide • Write equations for the reactions
9.	**Acids, alkalis and the pH scale**	• Describe the use of universal indicator to classify substances and measure approximate pH values • Evaluate the use of universal indicator and suggest why a pH probe may be more accurate • Write equations to represent the reaction of acids and alkalis, including the ionic equation • Process secondary data, calculating means and uncertainty
10.	**Strong and weak acids**	• Describe how to use an indicator to classify substances as strong or weak acids • Explain what strong, weak, concentrated and dilute acids are • Make order of magnitude calculations to describe changes in pH

11.	**Electrolysis of molten compounds**	• Define the terms 'electrolysis' and 'electrolytes' • Describe the movement of ions during electrolysis • Explain what happens at the electrodes during electrolysis
12.	**Extraction of aluminium**	• Explain the use of electrolysis to extract metals • Describe the extraction of Aluminium from its ore, including the use of a mixture and the need to continually replace the anode • Explain why electrolysis is so expensive and describe measures that can be taken to reduce this
13.	**Electrolysis of solutions**	• Predict the products of the electrolysis of given solutions • Electrolyse solutions of ionic compounds and identify the products • Explain how the products are obtained
14.	**Developing an electrolysis hypothesis**	• Develop a hypothesis to test • Electrolyse given solutions, collecting and identifying the products • Apply knowledge to other related hypotheses

15.	**Electrolysis half equations**	• Write ionic equations for the reactions at the electrodes • Identify chemical species that are oxidised or reduced
16.	**Reactivity and acid base reactions review**	• Review of the content on reactivity, acid base reactions and making salt • Define endothermic and exothermic reactions and give examples of each type
17.	**Electrolysis review**	• Review of learning on electrolysis, metal extraction and electrolysis of solutions
18.	**Chemical change higher tier review**	• Revision of higher tier content in the unit, including redox and half equations and strong and weak acids
19.	**Humphry Davy and Laban Roomes applications of electrolysis**	• Describe the work of Humphrey Davey and Laban Roomes with electrolysis • Describe and explain products at the electrodes
20.	**Writing a method**	• Describe the key features of method writing • Write a method to test a hypothesis and write a procedural method

Unit 12 Atomic Structure (HT)

8 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Exploring inside an atom**	• Describe the current atomic model
2.	**Isotopes and ionisation**	• Explain how EM radiation can cause changes in electron arrangement or ionisation • Compare isotopes in terms of their subatomic particles
3.	**History of atomic models**	• Compare the nuclear model of the atoms with the plum pudding model • Describe how evidence led to changes in the atomic model • Explain why Rutherford's atomic model was readily accepted
4.	**Radioactivity**	• Describe the effect of alpha, beta and gamma radiation on the nucleus • Describe properties of alpha, beta and gamma radiation

5.	**Decay equations**	• Write nuclear equations to represent decay
6.	**Activity and half-life (HT)**	• Describe what is meant by the radioactive half life of a sample • Plot a graph representing the number of decays in a sample • Determine half lives from information given
7.	**Uses and hazards of radiation (Combined science only)**	• Describe some uses and dangers of radioactive sources • Explain the relative dangers in terms of properties and half lives • Evaluate the use of radioactive sources for given situations • Describe and identify examples of radioactive contamination and irradiation • Compare the hazards associated with contamination and irradiation
8.	**Atomic structure review (Part 1)**	• Identify key misconceptions • Apply understanding to exam questions

Unit 13 Ecology (HT)

12 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Communities**	• Identify examples of interdependence within an ecosystem • Predict the impact of changes to one species on the rest of the community • Extract and interpret information from charts, tables and graphs relating to interaction of organisms in a community
2.	**Biotic and Abiotic factors**	• Identify biotic and abiotic factors within an ecosystem • Explain how a change in a biotic or abiotic factor can affect a community • Extract and interpret information from secondary data
3.	**Adaptations**	• Give examples of behavioural, structural or functional adaptations • Suggest factors that organisms are competing for given information • Identify and explain how organisms are adapted to live in their natural environment

4.	**Maths skills**	• Calculate surface area:volume ratio • Calculate means and uncertainties
5.	**Sampling required practical (Part 1)**	• Use a quadrat to collect valid data to estimate a population size • Describe how to make the data as accurate as possible • Calculate population estimates
6.	**Sampling required practical (Part 2)**	• Calculate percentage cover of organisms • Describe how to use a transect line to test a hypothesis • Process and interpret secondary data, identifying variables
7.	**Cycles**	• Describe the water cycle and explain its importance to living things • Describe the processes by which carbon is cycled through biotic and abiotic parts of ecosystems

8.	**Global warming**	• Describe and explain ways in which humans affect ecosystems • Evaluate the data linking greenhouse gases to global warming • Describe some of the consequences of global warming
9.	**Biodiversity**	• Describe some impacts of humans on biodiversity • Explain the importance of biodiversity • Describe ways that humans have tried to restore or maintain biodiversity
10.	**Review (Part 1)**	• Review of communities, biotic and abiotic factors, adaptation, and sampling
11.	**Review (Part 2)**	• Review of cycles, global warming, and biodiversity
12.	**Case Study: Dr Beth Penrose**	• Introduction to the work of Dr Beth Penrose

Unit 14 Energy changes (HT)

8 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Exothermic and endothermic reactions**	• Define endothermic and exothermic reactions and give examples of each type • Describe some everyday uses of exothermic and endothermic reactions • Evaluate applications of exothermic and endothermic reactions
2.	**Required Practical: Temperature change (Part 1)**	• Investigate one of the variables affecting the temperature change, identifying variables to change, measure and control • Process and display results appropriately
3.	**Required Practical: Temperature change (Part 2)**	• Draw conclusions from data provided • Explain the changes in temperature during the experiment • Evaluate the equipment and method used, explaining suggestions for improvement

4.	**Writing a method to test a hypothesis**	• Identify variables to change, measure and control • Write a method to test a given hypothesis • Design a table to collect and record results
5.	**Energy level diagrams**	• Draw and interpret energy level diagrams to represent endothermic and exothermic reactions • Define activation energy and label it on a diagram • Explain why reactions are endothermic or exothermic overall
6.	**Calculating bond energies**	• Calculate bond energy values and use them to predict whether a reaction will be exothermic or endothermic • Relate bond energies to the correct part of energy level diagrams • Explain why bond energy calculations have a margin of error
7.	**Review combined**	• Review of the foundation and higher tier content
8.	**Case study**	• Look at the scientists and engineers using endothermic and exothermic reactions in their work

Unit 15 Magnetism (HT)

7 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Magnetism**	• Describe what happens when poles of a magnet are brought together • Describe how to test to see if a material is magnetic or a magnet • Interpret secondary data on an experiment to test the variation in magnetic field • Describe how the strength of a magnetic field varies
2.	**Magnetic fields**	• Describe and draw the direction of the magnetic field around a bar magnet • Describe how to plot the magnetic field pattern of a magnet using a compass • Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic

3.	**Electromagnetism**	• Describe and draw the magnetic field around a wire carrying a current • Describe the magnetic field in and around a solenoid • Explain how the strength of the magnetic field can be varied
4.	**The motor effect and left hand rule**	• Describe the motor effect and the factors that affect the size of the force on the conductor • Use Fleming's left hand rule to predict the direction of movement of a wire in a field • Use the equation linking force, magnetic flux density, current and length to calculate any value, changing units where appropriate
5.	**F = B x I x l**	• Use the equation linking force, magnetic flux density, current and length to calculate any value, changing units where appropriate • Combine equations to calculate missing values
6.	**DC Motors**	• Explain how a DC motor works, using Fleming's left hand rule to predict the direction of rotation • Explain the role of a commutator

7. Magnetism Revision (Part 1)

- Identify key misconceptions from the magnetism unit
- Apply understanding of magnetism to exam questions

Unit 16 Homeostasis and response (HT)

14 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**The nervous system**	• Describe the role of receptors, neurons and effectors in responding to a stimulus • Describe an appropriate response pathway to any given stimulus
2.	**Reflex arcs**	• Describe what is meant by a reflex and give some examples • Explain the difference between a reflex and a conscious action • Label a diagram of a reflex arc, using key terms correctly • Describe how nerve cells communicate with each other in a simple reflex action
3.	**Required practical: Reaction time (Part 1)**	• Identify the hypothesis and variables from a given method • Collect and record data accurately • Process and display data collected (including uncertainties if appropriate)

4.	**Required practical: Reaction time (Part 2)**	• Decide on the reproducibility of class data • Evaluate the method • Describe and explain patterns in secondary data
5.	**Hormonal responses**	• Describe how the endocrine system brings about responses in the body • Label the main endocrine glands of the body • Compare hormonal responses with nervous responses
6.	**Negative feedback (Higher)**	• Describe the role of adrenaline and thyroxine in the body • Explain how negative feedback allows homeostasis to occur
7.	**Controlling blood sugar levels (Higher)**	• Describe how blood glucose levels are monitored • Explain the response to an increase in blood glucose • Explain how insulin controls blood glucose levels in the body • Explain the role of glucagon in blood sugar level maintenance and how negative feedback is used

8.	**Diabetes**	• Compare Type 1 and Type 2 diabetes • Describe some treatments for both types of diabetes • Interpret data from graphs on the effect of insulin on blood glucose in people with diabetes
9.	**The nervous system and Homeostasis review lesson (Higher)**	• Review of nervous system and homeostasis
10.	**Hormones in reproduction (Higher)**	• Describe the roles of male and female reproductive hormones • Describe the menstrual cycle and the hormones involved • Explain the interactions of FSH, LH, oestrogen and progesterone in the menstrual cycle • Extract and use information from graphs showing hormone levels
11.	**Artificial control of fertility (Higher)**	• Describe how fertility drugs and IVF work • Interpret secondary data on fertility treatments and IVF • Evaluate fertility treatments from the perspective of doctors and patients

12.	**Contraception**	• Describe how different methods of contraception prevent pregnancy • Interpret data on the effectiveness of contraception methods • Evaluate different hormonal and non-hormonal methods
13.	**Homeostasis review (Higher)**	• Review of homeostasis
14.	**Scientist case study**	• Outline the work of Kiran Mazumdar-Shaw

Unit 17 The rate and extent of chemical change (HT)

16 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Rate of reaction**	• Describe evidence for a chemical reaction • Describe how to measure rates of reaction • Calculate the rate of the reaction from data or graphs
2.	**Rate of reaction using graphs and tangents**	• Draw tangents to a curve • Use the tangent to calculate rate of reaction
3.	**Collision theory**	• Define activation energy • Describe factors that can affect the rate of reaction • Explain how these factors affect rate using collision theory
4.	**Planning an investigation to find rate of reaction**	• Write a method to test a hypothesis • Describe patterns in data • Explain patterns using collision theory

5.	**Rate of reaction required practical (Part 1)**	• Develop a hypothesis that can be tested • Display data appropriately • Describe and explain the effect of concentration on the rate of reaction
6.	**Rate of reaction required practical (Part 2)**	• Describe how to measure the rate of reaction using a change in colour or turbidity • Process and display data appropriately, explaining choice of graph • Describe and explain the effect of concentration on the rate of reaction • Check for reproducibility in data collected
7.	**Effect of changing surface area on rate of reaction**	• Identify variables to change, measure and control to test a hypothesis • Process and display data appropriately • Use the data to describe and explain the effect of changing surface area on the rate of reaction

8.	**Effect of changing temperature on rate of reaction**	• Describe and explain the effect of temperature on rates of reaction, using particle theory • Interpret secondary data on the effect of temperature on the rate of reaction • Explain the observations using particle theory
9.	**Effect of changing pressure on rate of reaction**	• Recognise reactions involving gases • Describe and explain the effect of pressure on gaseous reaction • Apply knowledge to novel reactions
10.	**Catalysts**	• Describe what a catalyst is and how it affects the rate of a reaction • Explain why more than one catalyst is often needed • Describe the test for oxygen gas • Draw a reaction profile for a reaction with and without a catalyst

11.	**Reversible reactions**	• Describe what is meant by a reversible reaction and how to represent it • Explain how reversible exothermic and endothermic reactions are linked • Explain what is meant by 'dynamic equilibrium'
12.	**Le Chatelier's principle: Effect of changing concentration and temperature**	• State and apply Le Chatelier's principle to any reversible reaction • Describe the effect on equilibrium of changes to temperature and concentration • Choose and explain the conditions needed to achieve a high yield
13.	**Le Chatelier's principle: Effect of changing pressure**	• Describe the effect on equilibrium of changes to pressure • Choose and explain the conditions needed to achieve a high yield

14.	**Le Chatelier's principle: Uses in industry**	• Explain the effect of changes in pressure on the equilibrium of gaseous reactions • Describe the conditions for optimum yield for a given reaction • Explain why optimum yield conditions are not always the ones chosen
15.	**The Rate and extent of chemical change: Review (Part 1)**	• Review of collision theory and rates of reaction
16.	**The Rate and extent of chemical change: Review (Part 2)**	• Review of higher tier content in the unit, including using tangents to calculate rates and Le Chatelier's principle

Unit 18 Forces (HT)

18 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Forces: an introduction**	• Describe the difference between scalar and vector quantities • Describe forces as contact or non-contact and give examples • Describe the interaction between forces between pairs of objects
2.	**Weight, mass and gravity**	• Describe how to find and represent the centre of mass of an object • Describe the relationship between mass, weight and gravity • Use the mathematical relationship to calculate any value, given the other two

3.	**Resolving forces (HT)**	• Calculate resultant force of forces acting in a straight line • Describe the effect of resultant forces on objects • Describe scalar and vector quantities and give examples • Represent and interpret vector quantities using scale diagrams • Draw and interpret vector diagrams representing multiple forces
4.	**Forces and work**	• Describe energy transfers when work is done, including the effect of work done against frictional forces • Calculate work done, force or distance given appropriate information • Convert units where needed
5.	**Forces and elasticity (Part 1)**	• Identify variables to change, measure and control in a given hypothesis • Construct a table for result, including units • Explain the steps in the method to test a given hypothesis • Collect and display data appropriately

6.	**Forces and elasticity (Part 2)**	• Recall and use a formula to calculate extension, force or spring constant • Process secondary data • Plot a graph of the data and use it to explain the limit of proportionality • Relate stretching and compression to work done and calculate this
7.	**Speed**	• Explain what is meant by the term 'average speed' • Recall and apply a formula to calculate average speed, distance or time
8.	**Distance: Time graphs**	• Interpret distance time graphs and use them to calculate speed • (Higher tier) Explain qualitatively that motion in a circle involves constant speed but changing velocity
9.	**Acceleration**	• Calculate resultant forces • Describe the effect of resultant forces on stationary and moving objects • Calculate acceleration and use the correct units • Use and manipulate the equation for uniform acceleration

10.	**Velocity: Time Graphs**	• Draw velocity-time graphs from measurements • Interpret lines and slopes to determine acceleration • (Higher tier) Determine distance travelled by an object (or displacement of an object) from a velocity-time graph
11.	**Terminal velocity**	• Describe and recognise terminal velocity • Explain why falling objects have different terminal velocities • (Triple physics only) Draw and interpret velocity-time graphs for objects reaching terminal velocity • (Triple physics only) Interpret the changing motion in terms of the forces acting
12.	**Newton's Laws**	• Use Newton's second law to calculate force, mass or acceleration • Estimate the speed, accelerations and forces involved in large accelerations for everyday road transport • Recognise and use the symbol that indicates an approximate value • (Higher tier) Define and explain that what we mean by inertial mass

13.	**Acceleration Required Practical (Part 1)**	• Describe a method for investigating how force or mass affects acceleration • Select appropriate apparatus for determining the acceleration of an object • Describe how to manage the risks associated with the practical • Correctly calculate means
14.	**Acceleration Required Practical (Part 2)**	• Interpret graphs to make conclusions • Use the equation F=ma to calculate theoretical acceleration • Explain differences between experiment data and theoretical values • Calculate acceleration using speed and distance measurements
15.	**Stopping distance**	• Identify and sort factors which could affect thinking or braking distance • Calculate the stopping distance of a vehicle using an equation • Write a conclusion with values quoted • Rearrange the equation for stopping distance to calculate braking or thinking distance

16.	**Momentum**	• State what is meant by momentum • Calculate the momentum of objects • Apply the conservation of momentum to collisions and explosions
17.	**Combined science review**	• Identify key misconceptions from the forces unit that are common to combined science and GCSE Physics courses • Apply key understanding from the forces unit to exam questions
18.	**Case Study: Sir Isaac Newton**	• Study the life and work of Sir Isaac Newton

Unit 19 Inheritance, variation and evolution (HT)

19 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Meiosis and fertilisation**	• Describe the main features of meiosis • Compare mitosis with meiosis • Explain the importance of meiosis in sexual reproduction
2.	**Sexual vs. Asexual reproduction**	• Describe sexual and asexual reproduction in animals and plants • Explain why asexual reproduction leads to identical offspring • Explain why sexual reproduction leads to variation
3.	**Genes, DNA and chromosomes**	• Define and recognize diagrams of DNA, genes and chromosomes • Describe the structure and function of DNA • Describe the advantages of understanding the human genome

4.	**Nancy Chang**	• Outline the work of Nancy Chang, who sequenced the HIV genome
5.	**Genetic Inheritance (Higher)**	• Construct and interpret genetic diagrams • Calculate the probability of inheriting particular characteristics given information about the parents • Use genetic terms to describe parents & offspring characteristics
6.	**Inherited disorders (Part 1 - Higher)**	• Describe the symptoms of the genetic diseases cystic fibrosis & polydactyly • Use genetic cross diagrams to calculate probability of offspring inheriting these diseases
7.	**Inherited disorders (Part 2)**	• Interpret family tree diagrams • Use family tree to calculate ther probability of offspring inheriting diseases • Evaluate the use of embryo screening for detecting inherited disorders

8.	**Sex determination**	• Name and recognise the chromosomes that determine sex • Construct and interpret diagrams to show how sex is inherited • Interpret family tree diagrams to explain the pattern of inheritance
9.	**Mid-Topic review**	• Review of meiosis, sexual and asexual reproduction, genes and inheritance
10.	**Variation and natural selection (Part 1)**	• Describe reasons for extensive variation within species • Describe the effects of mutations on variation
11.	**Variation and natural selection (Part 2)**	• Explain how variation can lead to evolution by natural selection
12.	**Evolution and extinction**	• Describe the theory of evolution by natural selection • Interpret evolutionary tree diagrams • Explain why some organisms are now extinct

13.	**Evidence for Evolution (Part 1)**	• Describe some of the ways fossils are produced • Explain how this and other evidence gives us information about the development of life on earth • Explain why we cannot be certain about how life on earth began
14.	**Evidence for Evolution (Part 2)**	• Describe how bacteria have evolved to become resistant to antibiotics • Describe ways of reducing the development of antibiotic resistant bacteria • Evaluate the use of antibiotics in agriculture
15.	**Selective breeding**	• Describe the process of selective breeding in plants and animals • Explain the impact of selective breeding • Evaluate the use of selective breeding in food plants and domesticated animals
16.	**Genetic engineering (Part 1)**	• Describe genetic engineering • Give examples of genetically modified organisms • Explain some potential benefits and risks of genetic engineering in agriculture and medicine

17.	**Genetic engineering (Part 2)**	• Describe the process of producing a genetically modified organism • Evaluate the use of genetic engineering
18.	**Classification**	• Describe and apply the Linnaean system for classification • Explain why new models of classification have been proposed • Describe the 'three domain' classification system
19.	**End of topic review (Part 1)**	• Review of natural selection, selective breeding and genetic engineering

Unit 20 Organic Chemistry (HT)

5 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Crude oil and alkanes**	• Describe the composition of crude oil • Define and recognise hydrocarbons and recall their general formula • Draw and name the first four hydrocarbons • Describe trends in physical properties of the hydrocarbons
2.	**Fractional distillation**	• Describe how crude oil is separated into fractions • Describe trends in the physical and chemical properties of the fractions of crude oil • Describe uses for the different fractions of crude oil
3.	**Cracking**	• Explain why cracking is necessary • Describe the process and products of cracking • Describe the test for alkenes and its positive result • Represent cracking using equations

4.	**Uses of hydrocarbons**	• Write equations for the complete combustion of hydrocarbons, identifying oxidation • Describe uses for the alkenes produced in cracking
5.	**Review (Part 1)**	• A review of the key ideas from the first 4 lessons of the organic chemistry unit

Unit 21 Waves (HT)

9 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Wave properties**	• Identify the features of a longitudinal and transverse waves • Describe the production of longitudinal and transverse waves • Compare light and sound waves
2.	**Calculations with waves**	• Calculate frequency from diagrams or given information • Make and record measurements to calculate the speed of sound in air • Use the wave equation to calculate speed, frequency or wavelength
3.	**Measuring the speed of waves in water**	• Explain the steps taken in measuring the speed of waves in water • Process data appropriately • Describe how to minimise error in the readings

4.	**Measuring the speed of waves in solids**	• Explain the steps taken in measuring the speed of waves in solids • Process data appropriately • Describe how to minimise error in the readings
5.	**Refraction**	• Describe the effect of refraction at material interfaces • Explain the process of refraction
6.	**Electromagnetic spectrum (Part 1)**	• Describe properties of the Electromagnetic (EM) spectrum waves • Describe uses of each type of wave
7.	**Electromagnetic spectrum (Part 2)**	• (Higher tier) explain why each wave is suitable for the application • Describe the effect of different substances on Electromagnetic (EM) waves • Describe some of the dangers of EM waves • Draw conclusions from secondary data on the risks and consequences of exposure to radiation

8.	**Infrared**	• Identify variables to change, measure and control to test a hypothesis • Collect and record data • Process data collected and use it to inform a conclusion
9.	**Combined science review**	• Identifying key misconceptions across the combined science and physics only aspect of the topic • Apply understanding from the unit to exam questions

Unit 22 Chemical analysis (HT)

5 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Pure and impure formulations**	• Identify pure and impure substances using diagrams or data • Describe how to test for purity • Describe and give examples of formulations
2.	**Chromatography**	• Describe how to correctly use chromatography to separate mixtures • Interpret chromatograms to determine the contents of a provided mixture
3.	**Interpreting chromatograms**	• Identify mistakes in practical set up and suggest how to rectify them • Interpret chromatography data, identifying pure substances and mixtures • Calculate Rf values and using significant figures appropriately

4.	**Testing gases**	• Describe the tests for oxygen, carbon dioxide, hydrogen and chlorine and their positive results • Write and balance chemical equations to represent some of the reactions.
5.	**Review (Part 1)**	• A review of the key ideas from the first 4 lessons of the analysis unit

Unit 23 Chemistry of the atmosphere (HT)

8 Lessons

Lesson number	Lesson question	Pupils will learn
1.	The Earth's atmosphere	• Compare the composition of Earth's early atmosphere with its current composition • Describe and explain the changes in the composition of the atmosphere over Earth's history • Evaluate different theories about the Earth's early atmosphere • Describe and explain the formation of limestone, coal, crude oil and natural gas
2.	The Greenhouse Effect	• Describe the greenhouse effect • Describe the reasons for and the impacts of increasing greenhouse gases on the temperature of the Earth's atmosphere • Evaluate the strength of the evidence for the link between CO2 levels and global temperature rise

3.	**Climate change**	• Describe potential consequences of climate change • Define the carbon footprint in a range of contexts • Suggest ways of reducing carbon footprints in different contexts and why actions to reduce carbon footprints may be limited
4.	**Pollutants**	• Describe how carbon monoxide, soot, sulphur dioxide and nitrogen oxides are produced and released into the atmosphere • Predict the products of the combustion of a fuel given appropriate information • Describe the problems caused by these pollutants
5.	**Maths Skills**	• Describe and explain patterns in graphs • Recap maths skills such as mean calculation
6.	**Alice Wilson**	• A look at the work of geologist Alice Wilson and her contribution to our understanding of the evolution of the Earth
7.	**Review (Part 1)**	• Review of changes to the atmosphere and the greenhouse effect

8. Review (Part 2)

- Review of global warming and the source and problems caused by named atmospheric pollutants

Unit 24 Using Resources (HT)

10 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Finite resources**	• State ways in which natural products are supported or replaced by man-made products • Extract and interpret information in charts, graphs and tables • Evaluate the use of finite and renewable resources
2.	**Life cycle assessments**	• Describe some ways of reducing our use of finite resources • Evaluate ways of reducing our use of limited resources • Carry out life cycle assessments given appropriate information
3.	**The importance of recycling**	• Describe ways of recycling • Describe the impacts of recycling in terms of environmental impact and sustainable development

4.	**Phytomining and bioleaching**	• Describe the processes of phytomining and bioleaching to extract metals • Compare alternative methods of metal extraction using information given • Link the processes to displacement and energy change graphs
5.	**Safe drinking water**	• Distinguish between pure and potable water • Describe and explain the steps involved in the treatment of safe drinking water • Test water for pH and dissolved solid content, and calculate the concentration of dissolved solids
6.	**Required practical on potable water**	• Describe methods of producing potable water from salty water • Describe how to carry out the distillation of a water sample • Describe the differences between the water samples before and after distillation and how to test for these

7.	**Wastewater treatment**	• State components of wastewater that can cause problems in the environment • Describe how wastewater is treated to make it safe to release into the environment • Compare the treatments of waste, ground and salt water in terms of ease of producing potable water
8.	**Review lesson**	• Review the combined science content
9.	**Exam skills: Compare and evaluate**	• Exam skills lesson focusing on the command verbs 'compare' and 'evaluate'
10.	**Case study: Kitty Hach Darrow**	• A look at the work of Kitty Hach Darrow on water purification methods

4. Learn More

Contents

1. Introduction to Oak's Key stage 4 science curriculum principles

Below are a set of principles we have sought to apply in our curriculum planning within science. These are adapted for science from the generic principles guiding all Oak lessons.

2. Coherence and flexibility

We strive to support schools by giving them an online learning offer that can be flexible to fit alongside their existing curriculum. We need to balance this together with coherence, as complete flexibility would imply only standalone lessons, where none can build upon any other. In striking this balance, we will lean towards giving the maximum flexibility possible. All units will have revision lessons at the end to consolidate knowledge, which can be standalone if only that topic has been taught, and, where disciplinary knowledge is woven into the units, there will be reminders of previously used scaffolds and prompts.

3. Subjects first

The science curriculum is structured into biology, chemistry and physics units, with working scientifically skills taught in context throughout. This will be made explicit to the pupils within lessons. In terms of science's relationship and overlap with other subjects (e.g. geography and maths), we will not be able to create cross-curricular coherence as the units can be taught in multiple orders. Therefore, cross curricular topics (such as Earth science) will not cohere with other subjects (e.g. geography).

4. Knowledge organisation

The units in the science curriculum are grouped by key stage, with a suggested route through, organised within year groups. In Key Stage 4, units are sequenced according to the AQA specification (with two exceptions, P3 Particles and B7 Ecology). In most circumstances, the units within a given year can be sequenced flexibly, but there is an assumption in the creation of the units that knowledge in any given year is building on units from previous years (i.e. that units in year 5 are planned with the assumption that units in year 4 have been taught). If following a different exam board at KS4, we will provide a suggested route through at a later date.

As stated above, the substantive knowledge (i.e. the science content) will be taught in units, and the disciplinary knowledge (i.e. working scientifically) is taught in context. Hierarchical elements of working scientifically will be reflected in the units and therefore this will be built up accordingly. While this will take account of prior learning assumptions from the previous key stage, or units, there will also be reminders of prompts and scaffolds to help pupils.

5. Knowledge selection

We are seeking to support schools to deliver the National Curriculum to children who cannot attend school. Our choice of what to teach will primarily be guided by the content specified in the National Curriculum, but we have also chosen to broaden this to increase challenge and build aspiration (e.g. include more physics at KS1 and 2, introduce some KS4 concepts in KS3).

6. Inclusive and ambitious

We want Oak to be able to support all children. Our units will be pitched so that children with different starting points can access them. Pupils need to have a large amount of subject knowledge stored in their long-term memory in order to become competent at any subject, and this is especially true of science where application is often an application of knowledge. For this reason, these lessons are designed to teach science in a clear and deliberate fashion, emphasising secure content knowledge before moving onto tasks. In this approach the teacher is the subject expert and the emphasis is on instruction and explanation, followed by deliberate practice supported by modelling, guided practice and scaffolding. Models and analogies will be used where appropriate to allow pupils to visualise or contextualise abstract ideas.

7. Pupil engagement

We need pupils to be thinking during science lessons - both to engage with the subject and to strengthen memory of what is being learnt. Our lessons will not be video lectures. We seek to exercise pupils' minds throughout their lessons (based on the principles described in point 5 above). This will involve questions and tasks throughout instruction, just as we would with classroom teaching.

8. Motivation through learning

Like all teachers, we recognise that good presentation helps pupils keep participating in our lessons. However, we are teachers, not entertainers. We seek to motivate pupils through our subjects. We believe that science is inherently interesting, and we aim to build this interest through our teaching. In science, we will provide opportunities where possible for pupils to engage in home experimentation. We will begin each unit with a summary of the relevant careers for that unit, including those outside of science itself. Units will also include short case studies of work by current and past scientists that reflect the diversity of backgrounds of our pupils. Finally, we will try to be explicit about the real life relevance of each unit so that it is clear why this knowledge is important.

9. Additional information about sequence

The science curriculum has been planned on the following basis:

- Before KS3, pupils have been taught the latest KS2 National Curriculum (2014)

As a result of this work, the science curriculum has the following features:

- It takes a year-by-year approach to teaching the curriculum.
- The content of each year's units is based on the expectation that the relevant content for each given year is taught by the end of the previous year.
- In KS4, the units are based on the AQA specification, and are ordered to ensure that paper 1 content is taught first. In the suggested sequence, they appear in the same order as the specification, except for B7 Ecology and P3 Particles. (This is to allow for teaching of Ecology when weather conditions are more likely to be favourable for outdoor sampling work, and to teach Particles as the first physics topic as it contains content foundational to other units)
- There is no expectation that any given unit in one science (e.g. physics) is taught before any given unit in another (e.g. biology). Any crossover material (e.g. atoms in KS4 physics and chemistry) will only assume the previous key stage's knowledge
- Many topics within any given year can be taught in a different sequence if schools wish. However, the lesson by lesson materials have been written with the suggested route in mind, and schools will have to consider this in their decisions.
- Each year is divided into topics across biology, chemistry, and physics, but equally weighted across these three disciplines
- Working scientifically is integrated into all the topics and can be identified in the learning outcomes in the topic summaries where relevant.
- The working scientifically programme of study is covered throughout.
- The precise ordering between each science (as opposed to within it) is flexible, and a matter for schools to determine. It is expected that schools will alter this according to their staffing context and curriculum time allocation in year 10 and 11.
- We suggest teaching the first three units of KS4 science at the end of year 9 to support you in managing the large amount of content in KS4 science.