Physics
Key Stage 4

Long curriculum plan

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.

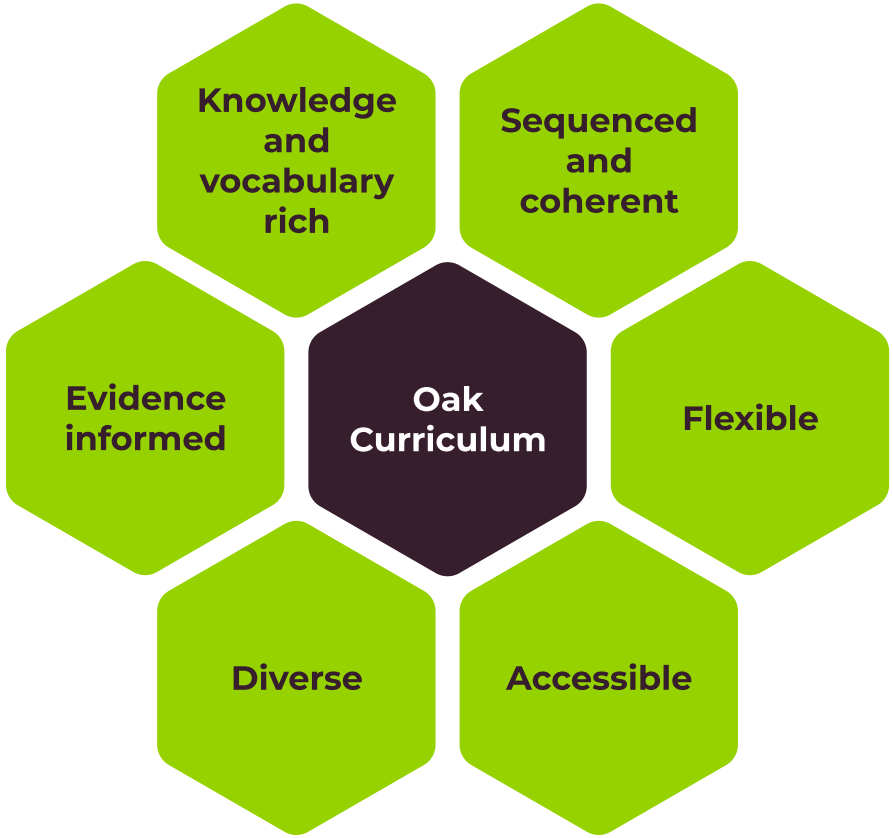
Knowledge is **sequenced** and mapped in a **coherent** format so that pupils make meaningful connections.

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 Physics is formed of 8 units and this is the recommended sequence:

Unit Title	Recommended year group	Number of lessons
1 Particle Model of Matter	Year 10	13
2 Energy	Year 10	16
3 Electricity	Year 10	23
4 Atomic Structure	Year 10	11
5 Magnetism	Year 10	13
6 Forces	Year 11	25
7 Waves	Year 11	16
8 Space	Year 11	8

3. Lessons

Unit 1 Particle Model of Matter — 13 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.	**Pressure and volume (Part 1)**	• Describe how volume changes affect pressure • Use the particle model to explain how changes in volume can result in changes in pressure

11.	**Pressure and volume (Part 2)**	• Calculate the resulting pressure or volume when one is changed using an equation • Explain how work done affects the internal energy of a gas
12.	**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
13.	**Case study: Joseph Black**	• Study the life and work of Joseph Black

Unit 2 Energy

16 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.	**Insulating material required practical (Part 1)**	• Explain the steps in a given method to test a hypothesis • Collect and display data appropriately • Describe and explain patterns in results
11.	**Insulating material required practical (Part 2)**	• Describe hazards, risks and safety precautions associated with a given method • Collect and display results appropriately • Calculate the rate of cooling using tangents • Draw conclusions consistent with results

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

Unit 3 Electricity

23 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
21.	**Static electricity**	• Describe the production of static electricity and sparking by rubbing surfaces • Describe evidence that charged objects exert forces of attraction or repulsion on one another when not in contact • Explain how the transfer of electrons between objects can explain static electricity
22.	**Case study: Benjamin Franklin and sparks**	• Study the work of Benjamin Franklin and how it relates to electricity

23. Electric fields

- Draw the electric field pattern for isolated charged spheres
- Explain the concept of an electric field
- Explain how the concept of electric fields help explain non-contact forces between charged objects, sparking and other electrostatic phenomena

Unit 4 Atomic Structure

12 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.	**Hazards of radiation (Physics only)**	• Describe and identify examples of radioactive contamination and irradiation • Compare the hazards associated with contamination and irradiation • Explain how the risk changes over time and distance from the source • Describe sources of background radiation

8.	**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
9.	**Uses of radiation (Physics only)**	• Explain why the hazards of a radioactive source varies according to half life • Describe uses of radioactive isotopes in relation to the exploration of body organs and destruction of unwanted tissue • Evaluate uses of radioactive isotopes for exploration of body organs
10.	**Fission and fusion**	• Describe the process of nuclear fusion and nuclear fission • Draw and interpret diagrams representing nuclear fission • Explain what is meant by a chain reaction

11.	**Atomic structure review (Part 1)**	• Identify key misconceptions • Apply understanding to exam questions
12.	**Atomic structure review (Part 2)**	• Identify key misconceptions appropriate to GCSE physics course only • Apply understanding to exam questions

Unit 5 Magnetism

13 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.	**Electromagnetic induction and generators**	• Describe the factors affecting size and direction of induced potential difference or current • Explain how the generator effect is used in an alternators (ac)
8.	**Electromagnetic devices**	• Explain how the generator effect is used in dynamos (dc) • Draw/interpret graphs of potential difference generated in the coil against time for generators and dynamos • Explain how a moving coil loudspeaker and headphones work • Explain how a moving coil microphone works
9.	**Transformers**	• Describe the structure of a transformer • Explain how transformers are used in the National Grid • Explain how an alternating current in one coil induces a current in another
10.	**Transformer equations**	• Explain how the ratio of potential differences across the two coils depends on the ratio of turns • Carry out calculations linking both transformer equations and relate to advantages of power transmission at high potential differences

11.	**Case Study: Nikola Tesla**	• Study the life and work of Nikola Tesla
12.	**Magnetism Revision (Part 1)**	• Identify key misconceptions from the magnetism unit • Apply understanding of magnetism to exam questions
13.	**Magnetism Revision (Part 2)**	• Identify misconceptions specific to the triple physics only part of the magnetism unit • Apply understanding of magnetism to exam questions

Unit 6 Forces

25 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.	**Moments and levers**	• Describe examples in which forces cause rotation • Calculate the size of a force, or its distance from a pivot, acting on an object that is balanced • Explain how levers help in everyday life
8.	**Moments and gears**	• Explain how levers and gears transmit the rotational effects of forces
9.	**Pressure**	• Define pressure • Calculate the pressure exerted on a surface

10.	**Pressure in fluids**	• Explain why pressure at a point within a liquid increases with the height of the column of liquid above that point, and with the density of the liquid • Calculate the differences in pressure at different depths in a liquid • Describe the factors which influence floating and sinking
11.	**Atmospheric pressure**	• Describe a simple model of the Earth's atmosphere and of atmospheric pressure • Explain why atmospheric pressure varies with height above a surface
12.	**Speed**	• Explain what is meant by the term 'average speed' • Recall and apply a formula to calculate average speed, distance or time
13.	**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

14.	**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
15.	**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
16.	**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

17.	**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
18.	**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
19.	**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

20.	**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
21.	**Momentum**	• State what is meant by momentum • Calculate the momentum of objects • Apply the conservation of momentum to collisions and explosions
22.	**Collisions and car safety**	• Explain how certain car safety features work • Calculate quantities from an equation related to car safety features • Rearrange an equation to calculate other values

23.	**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
24.	**Physics only review**	• Identify key misconceptions from the triple physics only section of the forces unit • Apply key understanding from the forces unit to exam questions
25.	**Case Study: Sir Isaac Newton**	• Study the life and work of Sir Isaac Newton

Unit 7 Waves

16 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.	**Reflection**	• Construct ray diagrams to illustrate the reflection of a wave at a surface • Describe the effects of reflection, transmission and absorption of waves at material interfaces • Investigate the reflection of light by different types of surface and the refraction of light by different substances
6.	**Refraction**	• Describe the effect of refraction at material interfaces • Explain the process of refraction
7.	**Sound**	• Describe the range of normal human hearing • Describe processes which convert wave disturbances between sound waves and vibrations in solids • Explain why such processes only work over a limited frequency range and the relevance of this to human hearing

8.	**Ultrasound and seismic waves**	• Explain how ultrasound waves are used for both medical and industrial imaging • Describe how high frequency sound waves are used to detect objects in deep water and measure water depth • Explain how seismic waves provide evidence for the structure of the Earth
9.	**Electromagnetic spectrum (Part 1)**	• Describe properties of the Electromagnetic (EM) spectrum waves • Describe uses of each type of wave
10.	**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

11.	**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
12.	**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
13.	**Lenses**	• Pupils should be able to construct ray diagrams to illustrate the similarities and differences between convex and concave lenses • Describe the image formed by lenses • Calculate the magnification of an image formed by a lens
14.	**Colour**	• Explain how a colour is related to absorption, transmission and reflection of different wavelengths of light • Explain the effect of viewing objects through filters or the effect on light of passing through filters • Explain why an opaque object has a particular colour

15.	**Black body radiation**	• Explain the intensity and wavelength distribution of radiation emitted by all bodies • Explain how the temperature of a body is related to the balance between incoming radiation • Draw/interpret diagrams to show how radiation affects the temperature of the Earth's surface and atmosphere
16.	**Physics content review**	• Identify key misconceptions from the physics only part of the topic • Apply understanding from the unit to exam questions

Unit 8 Space

8 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Solar system**	• Calculate distances in space • Describe the solar system and how the sun was formed • Describe the process of nuclear fusion
2.	**Orbits**	• Describe the process of circular motion • Describe similarities and differences between planets, moons and artificial satellites • Explain how the force of gravity can lead to changing velocity but unchanging speed • Explain how the radius of an orbit must change if speed changes
3.	**Life cycle of a star**	• Describe the life cycle of stars similar to our sun and larger • Describe the role supernovae play in the formation of elements heavier than iron • Explain how fusion processes lead to the formation of new elements

4.	**Element synthesis**	• Describe nuclear fusion of hydrogen into helium • Explain how elements heavier than iron are made
5.	**Origins of the universe**	• Qualitatively explain the red-shift of light from galaxies that are receding • Explain that the change of each galaxy's speed with distance is evidence of an expanding universe • Explain how red-shift provides evidence for the Big Bang model
6.	**Cosmic Microwave Background Radiation (CMBR)**	• Explain how Cosmic Microwave Background Radiation (CMBR) provides evidence for the big bang theory • Describe how the CMBR was discovered and led to the acceptance of the Big Bang Theory • Describe what is not understood about the universe (e.g. dark mass and dark energy)
7.	**Review: Space**	• Identify key misconceptions from the space unit • Apply understanding from the space unit to exam questions

8. Case Study: S.Chandrasekhar

- Study the life and work of Subrahmanyan Chandrasekhar

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.