

# WJEC GCSE Integrated Science (Single Award)

Approved by Qualifications Wales

## Specification

Teaching from 2026

For award from 2028



This Qualifications Wales regulated qualification  
is not available to centres in England.

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This specification meets the requirements of the following regulatory documents published by Qualifications Wales:

- [Made for Wales GCSE Qualification Approval Criteria](#) which set out requirements for any new GCSE qualification Approved for first teaching from September 2025 and beyond.
- [Standard Conditions of Recognition](#) which contains the rules that all awarding bodies and their qualifications must meet when offering qualifications to learners in Wales.
- [Approval Criteria for GCSE Integrated Science \(Single Award\)](#) which sets out the subject specific requirements for GCSE Integrated Science (Single Award) from September 2025 and beyond.

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## CONTENTS

SUMMARY OF ASSESSMENT .....	4
1 INTRODUCTION.....	5
1.1 Aims .....	5
1.2 Curriculum for Wales .....	5
1.3 Prior learning and progression .....	6
1.4 Guided learning hours .....	6
1.5 Use of language .....	7
1.6 Equality and fair access.....	7
2 SUBJECT CONTENT .....	8
Unit 1 – Living on Earth.....	11
Unit 2 – Science in a Changing World.....	24
Unit 3 – Scientific Enquiry .....	33
Opportunities for integration of learning experiences .....	34
3 ASSESSMENT.....	35
3.1 Assessment Objectives and Weightings.....	35
4 MALPRACTICE.....	36
5 TECHNICAL INFORMATION.....	37
5.1 Entries and Awards .....	37
5.2 Grading, awarding and reporting .....	38
5.3 Tiering .....	38
APPENDIX A: Opportunities for embedding elements of the Curriculum for Wales .	40
APPENDIX B: Scientific Enquiry Skills Framework .....	43
APPENDIX C: Scientific Terminology.....	44
APPENDIX D: Mathematical Skills .....	46

# GCSE INTEGRATED SCIENCE (SINGLE AWARD)

## SUMMARY OF ASSESSMENT

### **Unit 1: Living on Earth**

Written examination (tiered)

1 hour 30 minutes (72 marks)

Includes pre-release Resource Folder

45% of qualification

**External assessment, marked by WJEC**

### **Unit 2: Science in a Changing World**

Written examination (tiered)

1 hour 30 minutes (72 marks)

45% of qualification

**External assessment, marked by WJEC**

### **Unit 3: Scientific Enquiry**

One enquiry from a choice of two

The chosen enquiry includes a practical task (1 hour) and written task (1 hour) (28 marks)

10% of qualification

**External assessment, marked by WJEC**

This is a unitised qualification.

There are two tiers of entry for this qualification:

Higher Tier: A\* - D

Foundation Tier: C - G

Learners may be entered at different tiers across units.

There is no hierarchy in which the units are presented, though Unit 3 should be taken during the final year of study.

Unit 1 will be available from summer 2027, and each summer thereafter, with Unit 2 available from summer 2028 and each summer thereafter. Unit 3 will be available in the spring term from 2028 and each spring term thereafter.

The first award of the qualification will be 2028.

Qualification Approval Number: C00/5167/2

# GCSE INTEGRATED SCIENCE (SINGLE AWARD)

## 1 INTRODUCTION

### 1.1 Aims

GCSE Integrated Science (Single Award) supports learners to:

- demonstrate knowledge and understanding of the sciences
- recognise the interdisciplinary nature of the sciences
- understand how different areas of science relate to them personally, locally, nationally and internationally
- develop the skills to question scientific ideas, using critical and creative thinking to solve problems
- understand how to use scientific methods
- develop a variety of practical and research skills, enabling them to successfully refine their ways of working
- understand relationships between data, evidence and explanations through quantitative and qualitative analysis and research
- evaluate and challenge scientific methods, evidence and conclusions
- apply mathematical, communication, and digital skills and tools when developing scientific knowledge and skills
- appreciate the role played by morals, ethics, sustainability and other aspects of decision-making in the application of science.

These aims are set out in Qualifications Wales' Approval Criteria.

### 1.2 Curriculum for Wales

This GCSE Integrated Science (Single Award) qualification is underpinned by the Curriculum for Wales framework and has been designed to ensure that learners can continue to make progress towards the four purposes whilst studying for this qualification. Central to this design are the [principles of progression](#), along with the [statements of what matters](#) and those [subject specific skills and concepts](#) outlined in the '[Designing your Curriculum](#)' section of the Science and Technology Area of Learning and Experiences.

In developing this qualification, we have considered where there are opportunities to embed the cross-curricular themes and where there are opportunities for integral skills and cross-curricular skills to be developed. Appendix A provides a simple mapping and information to support teachers will be provided in the Guidance for Teaching.

We have also considered where the qualification can generate opportunities for integrating the learning experiences noted on page 34; the Guidance for Teaching will include further information on integrating these learning experiences into delivery.

The GCSE Integrated Science (Single Award) qualification is designed to provide learners with a broad knowledge and understanding of concepts from across the sciences. It emphasises the interconnectedness of scientific principles, enquiry skills and the application of science in everyday life.

The GCSE Integrated Science (Single Award) qualification will support the Curriculum for Wales by:

- supporting the statements of what matters, giving learners the opportunity to engage with the following:
  - curiosity – being curious and searching for answers is essential to understanding and predicting phenomena
  - living things – the world around us is full of living things which depend on each other for survival
  - matter – matter and the way it behaves, defines our universe and shapes our lives
  - forces – forces and energy provide a foundation for understanding our universe.
- supporting the principles of progression by:
  - developing knowledge and understanding of scientific concepts
  - using, applying and evaluating scientific enquiry skills
  - becoming more effective as a learner, to solve scientific problems with increased independence
  - making connections and exploring new contexts, considering the impacts of scientific actions.

### 1.3 Prior learning and progression

Although there is no specific requirement for prior learning, the qualification is designed primarily for learners between the ages of 14 and 16 and builds on the conceptual understanding learners have developed through their learning from ages 3 – 14.

The qualification allows learners to develop a strong foundation of knowledge, skills and understanding which supports progression to post-16 study and prepares learners for life, learning and work.

This qualification is designed for learners who will benefit from studying a GCSE that has less content than the double award. The qualification is not designed for progression to AS or A level Science qualifications. The specification provides a coherent, satisfying and worthwhile course of study for learners who do not progress to further study in this subject.

### 1.4 Guided learning hours

GCSE Integrated Science (Single Award) has been designed to be delivered within 120 – 140 guided learning hours. The qualification has been primarily designed as a 2-year programme for learners in years 10 and 11.

## 1.5 Use of language

As our understanding of diversity, equity and inclusion evolves, so must our language. Updated terminology better reflects individual identities and fosters respect and accuracy. Language used should be specific as possible. Staying informed and adaptable is crucial, as inclusive language promotes dignity and equity. Recognising that language will continue to evolve, we will remain open to further amendments to ensure it accurately represents and supports all individuals. WJEC will inform centres of any amendments and the most up to date version of the specification will always be on the website.

## 1.6 Equality and fair access

The specification may be followed by any learner, irrespective of gender, ethnic, religious or cultural background. It has been designed to avoid, where possible, features that could, without justification, make it more difficult for a learner to access and achieve because they have a particular protected characteristic.

The protected characteristics under the Equality Act 2010 are age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

Access arrangements and reasonable adjustments are made for eligible learners to enable them to access the assessments and demonstrate their knowledge and skills without changing the demands of the assessment.

Information on access arrangements and reasonable adjustments is found in the following document from the Joint Council for Qualifications (JCQ): Access Arrangements, Reasonable Adjustments and Special Consideration: General and Vocational Qualifications. This document is available on the JCQ website ([www.jcq.org.uk](http://www.jcq.org.uk)).

We will be following the principles set out in this document and, as a consequence of provision for reasonable adjustments, very few learners will encounter a complete barrier to any part of the assessment.

## 2 SUBJECT CONTENT

GCSE Integrated Science is designed to empower learners by demonstrating how scientific concepts across disciplines are interconnected and relevant to everyday life—personally, locally, nationally and globally. Through the investigation of real-world scientific challenges and phenomena, learners gain a deeper understanding of how science shapes the world around them.

In Unit 1: Living on Earth, learners develop scientific knowledge, understanding and skills within the themes of human health, Earth's resources and transport. These help them maintain their health and wellbeing and contribute to a sustainable future.

In Unit 2: Science in a Changing World, learners explore the themes of human influence on Earth, humans in space and identifying unknown substances. These areas help them make informed choices to protect the planet, understand the benefits and challenges of space exploration and apply analytical techniques in practical contexts.

The specification encourages learners to think creatively and solve problems using both innovative and logical approaches. It promotes independent enquiry, nurtures curiosity, and develops critical and analytical thinking. Learners are also encouraged to use digital tools throughout their studies, building essential digital skills for a technology-driven world.

### Scientific Enquiry Skills

Scientific enquiry is fundamental to this qualification.

Scientific enquiry is the broad process of asking questions, exploring ideas and seeking understanding about natural phenomena. It involves practical and investigation skills alongside curiosity-driven activities like questioning, observing, gathering information and thinking critically. Scientific enquiry can include everything from formulating research questions to designing and carrying out experiments.

Investigation is one part of scientific enquiry, it refers to the systematic process of collecting data to answer a particular scientific question. An investigation is typically a planned, structured activity where experiments are conducted, observations are made or measurements are taken, to test a hypothesis or explore a problem. It also includes evaluation, consideration of next steps and planning of further work. Within the subject content there are a number of examples where 'investigate' is used. This is to ensure that specific investigation skills are developed.

Scientific enquiry should not be treated as a standalone activity limited to Unit 3 but fully embedded throughout the teaching and learning of all units, ensuring that learners develop these important skills continuously and in context. This includes conducting practical science experiments and enquiries that actively engage learners, bringing their learning to life and fostering curiosity.

All units provide opportunities to enhance scientific enquiry skills and it is essential that teaching and learning incorporates these experiences in a structured and meaningful way.

These are the scientific enquiry skills that will be assessed in this qualification:

Scientific Enquiry	<b>Development of scientific thinking</b>
SE1	Identify the benefits and challenges of using scientific enquiry to explore ideas and answer questions
SE2	Explore scientific models and factors which influence them
SE3	Make informed decisions based on scientific enquiry
<b>Experimental skills and strategies</b>	
SE4	Explore and select approaches to designing a method of enquiry
SE5	Collect, record and present primary data, while evaluating and improving data quality
SE6	Gather and present secondary data, while evaluating data
SE7	Analyse data
SE8	Form conclusions and evaluate approaches

Scientific enquiry skills will be assessed in each unit.

Further guidance to support the teaching and learning of these scientific enquiry skills can be found in the Scientific Enquiry Framework (Appendix B) and the Guidance for Teaching document.

## Mathematical Skills

Additionally, mathematical skills play a crucial role in scientific understanding and must be integrated into the teaching of subject content rather than taught in isolation. Teaching and learning planning should ensure that learners apply relevant mathematical skills throughout their scientific studies, as outlined in Appendix D.

## How to read the amplification

The amplification provided in the right-hand column uses the following four stems:

- ‘Learners should know’ is used when learners are required to demonstrate basic knowledge and understanding.
- ‘Learners should understand’ is used when learners are required to demonstrate greater depth of knowledge and understanding, application of knowledge to familiar or unfamiliar contexts, and analysis and evaluation of information for a given purpose.
- ‘Learners should be able to’ is used when learners need to apply their knowledge and understanding to a practical situation or demonstrate application of scientific enquiry skills.
- ‘Learners should be aware of’ is used when learners do not need to understand all aspects of the specified content in detail. This statement is used to set the content into a context. Teachers should refer to Guidance for Teaching documents for further guidance on the depth and breadth to which this content should be taught.

The use of the word ‘including’ indicates that the specified content must be taught and could be subject to assessment.

The use of the words ‘for example’ or ‘such as’ indicates that the specified content is for guidance only, and alternative examples could be chosen.

The layout of the content in the amplification will also support teachers’ understanding of depth. If content within an amplification statement is for straightforward knowledge recall, such as naming something, then no sub-bullet is used. For example:

Learners should know:

- the main features of our Solar System in terms of the order, relative size and composition of the Sun, the planets, the dwarf planets, comets, moons, the asteroid belt, the Oort cloud and the Kuiper belt.

If sub bullets are used, this indicates that the content given must be further developed. For example:

- increased exposure to cosmic radiation in space can impact health including
  - damage to DNA
  - gene expression
  - changes to the immune system

**Content in bold:**

This content is higher tier content only.

## Unit 1 – Living on Earth

Written examination (tiered)

Includes pre-release material

45% of qualification

72 marks (24 marks will be allocated to questions linked to the pre-release material)

The pre-release Resource Folder will be released one month before the assessment and sent to centres who have entered candidates.

For the assessment, candidates will be given a ‘clean’ copy of the pre-release Resource Folder along with the examination question paper.

### Overview of unit

The purpose of this unit is to provide learners with the opportunity to:

- develop their scientific knowledge, understanding and skills across the sciences
- develop scientific thinking
- interpret scientific data and evidence critically
- evaluate scientific information to make informed decisions
- apply learning to relevant and meaningful contexts.

### Areas of content

#### **1.1 Maintaining a healthy body**

This theme is structured around the sub-themes: Diet and exercise and Disease prevention. Through these themes, learners will develop their knowledge and understanding of how the human body functions, how lifestyle choices impact health, and how science contributes to the prevention and management of disease. This will help them to evaluate scientific information and make informed decisions about their own health and wellbeing.

In Diet and exercise, learners will develop their knowledge, understanding and skills across the sciences. They will explore topics such as the role of enzymes and their practical applications, as well as how sports scientists can analyse the motion of athletes to evaluate and enhance athletic performance.

In Disease prevention, learners will investigate the nature and transmission of disease, the body’s defence mechanisms, and the challenges of disease prevention and control. They will also examine risk factors and consider the ethical implications of certain medical treatments and interventions.

The use of relevant and meaningful contexts and scientific enquiry allows learners to develop their ability to interpret scientific data and evidence critically, while strengthening their overall scientific thinking.

In this topic learners will gain knowledge, understanding and skills in the following areas:

##### **1.1.1 Diet and exercise**

- 1.1.1a Enzymes and digestion
- 1.1.1b Diet and performance
- 1.1.1c Respiration
- 1.1.1d Cardiovascular system
- 1.1.1e Motion

##### **1.1.2 Disease prevention**

- 1.1.2a Causes of disease
- 1.1.2b Defence against disease
- 1.1.2c Challenges in disease management

Section	Amplification
<b>1.1.1 Diet and exercise</b>	
1.1.1a Enzymes and digestion	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• the purpose of the digestive system</li> <li>• Enzymes are biological catalysts</li> <li>• the organs where carbohydراse, protease and lipase enzymes are produced and their sites of action.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the purpose of carbohydراse, lipase and protease enzymes</li> <li>• the lock and key theory as a simple model to interpret how enzymes work</li> <li>• the effect of temperature and pH on enzyme activity.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• investigate how different factors effect enzyme activity.</li> </ul> <p>Learners should be aware of:</p> <ul style="list-style-type: none"> <li>• how knowledge of enzymes is used to make products used in the home, by the food and drink industry, for medicine and health, and in industry and manufacturing.</li> </ul>
1.1.1b Diet and performance	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that the role of minerals are essential for physical activity, including:           <ul style="list-style-type: none"> <li>• potassium</li> <li>• calcium</li> <li>• magnesium.</li> </ul> </li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the importance of the digested products of fats, carbohydrates and proteins in a healthy diet and in supporting physical activity.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• investigate the energy content of foods</li> <li>• use nutritional information on food labels to support effective diet planning for physical activity.</li> </ul> <p>Learners should be aware of:</p> <ul style="list-style-type: none"> <li>• the role of sports nutritionists in optimising the performance and health of athletes and fitness enthusiasts.</li> </ul>
1.1.1c Respiration	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• the purpose of the respiratory system</li> <li>• the purpose of respiration</li> <li>• <b>that cells use energy in the form of ATP molecules that are formed during respiration</b></li> <li>• the word equations for aerobic and anaerobic respiration in humans.</li> </ul>

	<p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the differences between aerobic and anaerobic respiration</li> <li><b>why anaerobic respiration is less efficient than aerobic respiration.</b></li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>investigate the effect of exercise on breathing.</li> </ul> <p>Learners should be aware of:</p> <ul style="list-style-type: none"> <li>how sports scientists use knowledge of respiration to improve performance.</li> </ul>
<p>1.1.1d Cardiovascular system</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>the function of the four main parts of the blood: <ul style="list-style-type: none"> <li>red cells</li> <li>platelets</li> <li>plasma</li> <li>white cells</li> </ul> </li> <li>that the heart is made of muscle which contracts to pump blood around the body.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the function of arteries, veins and capillaries</li> <li>the role of the coronary vessels in supplying the heart muscle with blood</li> <li>the risk factors and effects of cardiovascular disease.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>carry out and interpret physiological measurements of effects of exercise on heart rate and recovery time.</li> </ul> <p>Learners should be aware of:</p> <ul style="list-style-type: none"> <li>the role of diet and exercise in maintaining cardiovascular health.</li> </ul>
<p>1.1.1e Motion</p>	<p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>describe motion in terms of distance, time, speed and acceleration</li> <li>use the equations:</li> </ul> $\text{speed} = \frac{\text{distance}}{\text{time}}$ $\text{acceleration [or deceleration]} = \frac{\text{change in speed}}{\text{time}}$ <ul style="list-style-type: none"> <li>use distance-time graphs and speed-time graphs to represent motion</li> <li>calculate speed using a distance-time graph</li> <li><b>calculate acceleration using the gradient of a speed-time graph</b></li> <li><b>calculate the distance travelled using the area under a speed-time graph.</b></li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>that sport scientists can analyse the motion of athletes to measure performance.</li> </ul>

1.1.2 Disease prevention	
1.1.2a Causes of disease	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that a disease is a condition that interferes with how the body works</li> <li>• that diseases can be: <ul style="list-style-type: none"> <li>• communicable, including meningitis, influenza, athlete's foot</li> <li>• non-communicable, including cardiovascular disease, cancer, diabetes, dementia</li> </ul> </li> <li>• that communicable diseases are caused by pathogens, including bacteria, viruses and fungi</li> <li>• how communicable diseases can be spread including contact, aerosol, body fluids, water, insects, contaminated food.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• that non-communicable diseases can be the result of a combination of genetic, environmental and lifestyle factors.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• model transmission of infectious diseases.</li> </ul>
1.1.2b Defence against disease	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• the role of the non-specific defence mechanisms including: <ul style="list-style-type: none"> <li>• skin</li> <li>• blood clots</li> <li>• phagocytes</li> <li>• stomach acid</li> <li>• mucus and cilia in the respiratory system.</li> </ul> </li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• how changes to lifestyle can impact health</li> <li>• how antigens induce an immune response</li> <li>• <b>how memory cells provide immunity following a natural infection or vaccination.</b></li> </ul>

1.1.2c  
Challenges in disease management

- Learners should know:
- methods of disease prevention and control including:
    - hygiene
    - personal protective equipment (PPE)
    - clean water and sanitation
    - antibiotics
    - vaccination
  - vaccination can protect humans from infectious disease
  - the factors that influence decisions on vaccination including:
    - benefits and risks to the individual
    - access to information
    - social influence
  - that indigestion caused by excess stomach acid is a potential side effect of some medicines such as antibiotics
  - that remedies used to treat excess stomach acid contain metal carbonate compounds
  - the treatment of stomach acid involves a neutralisation reaction.
- Learners should understand:
- the causes of antimicrobial resistance
  - how a vaccine will protect against infection
  - how the pH scale can be used to determine the pH of a solution
  - the neutralisation reactions of dilute acids with carbonates.
- Learners should be able to:
- investigate the effect of antimicrobials on the growth of bacteria
  - use a pH probe or universal indicator to find the pH of a solution
  - name salts formed from acids and carbonates
  - use the general equation to write word equations for reactions of acids and carbonates.
- Learners should be aware:
- **that staying informed of health risks from reliable sources is crucial for making informed decisions about health and well-being.**

## 1.2 Using the Earth's resources

This theme is structured around the sub-themes: Energy in ecosystems, Generating, distributing and storing electricity, and Using materials. Learners will explore how energy flows through living systems, how electricity powers our world, and how materials are sourced and transformed for human needs – highlighting the interdisciplinary nature of science and its personal relevance.

In Energy in ecosystems, learners study models of energy transfer in both living and non-living systems.

In Generating, distributing and storing electricity, learners examine renewable and non-renewable energy sources, along with the challenges of transmitting and storing electricity.

In Using materials, learners explore Earth's resources, how they are extracted and processed, made into new materials and how factors can affect the rate of their production.

The use of relevant and meaningful contexts and scientific enquiry allows learners to develop their ability to interpret scientific data and evidence critically, while strengthening their overall scientific thinking and make informed decisions about using the Earth's resources.

In this topic learners will gain knowledge, understanding and skills in the following areas:

### 1.2.1 Energy in ecosystems

- 1.2.1a The principle of conservation of energy
- 1.2.1b Photosynthesis
- 1.2.1c Food chains and food webs

### 1.2.2 Generating, distributing and storing electricity

- 1.2.2a Generating electricity
- 1.2.2b Distributing and storing electricity

### 1.2.3 Using materials

- 1.2.3a Separating useful materials from the Earth's raw materials
- 1.2.3b Chemical reactions to make new materials
- 1.2.3c Factors affecting the rate of production of new materials

Section	Amplification
<b>1.2.1 Energy in ecosystems</b>	
1.2.1a The principle of conservation of energy	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that energy cannot be created or destroyed; it is transferred from one store to another</li> <li>• some energy stores are: gravitational, kinetic, elastic, thermal, chemical and nuclear.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• that in some transfers, energy is transferred to a store that is not useful and this is described as wasted energy.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• consider the start and end point in a process and describe how the energy in each store has changed.</li> </ul>

<p>1.2.1b Photosynthesis</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• the word equation for photosynthesis.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the importance of photosynthesis in providing food and oxygen to other living organisms, and in removing carbon dioxide from the atmosphere</li> <li>• how the following factors affect the rate of photosynthesis:           <ul style="list-style-type: none"> <li>• carbon dioxide concentration</li> <li>• light intensity</li> <li>• temperature</li> </ul> </li> <li>• <b>the impact of these limiting factors on the rate of photosynthesis.</b></li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• investigate the factors that affect the rate of photosynthesis.</li> </ul>
<p>1.2.1c Food chains and food webs</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• food chains show the transfer of energy between trophic levels</li> <li>• that an ecosystem refers to the interactions between all the living organisms and their physical environment in a specific area.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• factors affecting energy transfer between trophic levels in a food chain</li> <li>• how food webs can be used to display overlapping food chains that show feeding relationships within ecosystems.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• calculate the efficiency of energy transfer between trophic levels in an ecosystem.</li> </ul>

**1.2.2 Generating, distributing and storing electricity**

<b>1.2.2a</b> Generating electricity	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• how electricity is generated in a fuel-based power station by transferring energy from a chemical store</li> <li>• that combustion reactions are exothermic</li> <li>• how electricity is generated in a nuclear power station by transferring energy from a nuclear store</li> <li>• the problems caused by generating electricity in fuel-based and nuclear power stations, and the reasons why they are used</li> <li>• that electricity can be generated from a range of renewable resources.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• why it is important to develop the use of renewable resources and some of the problems associated with renewable resources.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• write word equations to represent the combustion reactions of hydrocarbon fuels</li> <li>• write the word equation to represent the combustion reaction of hydrogen fuel</li> <li>• determine experimentally the energy released by different fuels when they burn.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that in the future, alternative fuels may replace fossil fuels.</li> </ul>
<b>1.2.2b</b> Distributing and storing electricity	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that the National Grid connects power stations and consumers of electricity</li> <li>• how the National Grid responds to changing demand</li> <li>• that battery storage systems can be charged at times of low demand for electricity and used to transfer energy to the users at times of high demand</li> <li>• that battery storage systems may be used increasingly in the future</li> <li>• that pumped storage hydroelectric stations also store energy for use at times of high demand.</li> </ul>

**1.2.3 Using materials****1.2.3a**

Separating useful materials from the Earth's raw materials

Learners should know:

- that raw materials are the basic, unprocessed resources found on Earth
- that some raw materials are used as they are found (e.g. limestone and slate) but most are used to produce other materials.

Learners should understand:

- that the use of any material depends upon its properties
- that crude oil is separated by fractional distillation to give many fractions used as fuels
- that fractions contain hydrocarbons with similar chain lengths
- that the properties of fractions change with increasing chain lengths
- that fractional distillation is used to separate the gases in the air – oxygen (medical use) and nitrogen (to make fertilisers)
- evaporation of seawater is a key source of elements such as magnesium and chlorine.

Learners should be able to:

- select suitable materials for specific uses, given their properties.

Learners should be aware:

- that the Earth's supply of raw materials is finite and that some resources are only found in small quantities and in a small number of places.

<p>1.2.3b Chemical reactions to make new materials</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that metal ores are the source of most metals</li> <li>• what is meant by the reactivity series</li> <li>• that some fractions from crude oil are used to produce plastics and other important chemicals.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• displacement reactions and competition reactions and how they are explained by the reactivity series</li> <li>• the meaning of oxidation and reduction in terms of loss or gain of oxygen</li> <li>• the principle of how industrial processes use reduction by carbon to extract some metals</li> <li>• that plastics are made of very long chains of carbon atoms with strong bonds between them.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• determine the relative reactivities of metals by carrying out displacement reactions</li> <li>• write word equations for displacement and competition reactions.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that scientists are continually developing new materials that have uses which depend upon their properties, for example smart materials and nanomaterials, and that some scientists have concerns about the widespread use of these new materials.</li> </ul>
<p>1.2.3c Factors affecting the rate of production of new materials</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that temperature, concentration and surface area affect the rate of a reaction</li> <li>• that a catalyst increases the rate of a reaction</li> <li>• that the progress of a reaction can be monitored by measuring a change over time</li> <li>• exothermic reactions give out heat energy and endothermic reactions take in heat energy from the surroundings.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• that for industrial chemical processes, the rate of reaction is crucial for efficiency and cost-effectiveness</li> <li>• why the rate of a reaction decreases as it proceeds</li> <li>• <b>how to predict and explain, using collision theory, the effects of changing temperature, concentration and surface area on the rate of a reaction.</b></li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• investigate the rate of reaction using gas collection, loss of mass and precipitation</li> <li>• interpret the slope of a graph to compare rates</li> <li>• <b>calculate rate from a straight line.</b></li> </ul>

### 1.3 Transport

This theme is structured around the sub-themes: Environmental considerations of transport and Efficiency in transport. Learners will explore how science helps us understand and improve the environmental impact, energy efficiency, and safety of transport systems.

In Environmental considerations of transport, learners will learn about the emissions from petrol and diesel, their role in climate change, and the health effects of air pollution. They will explore alternative fuels such as hydrogen and bioethanol, considering their advantages and disadvantages. The use of lichens as air pollution indicators offers a practical way to assess environmental impact. Learners will also investigate electric vehicles, using data to calculate energy costs and payback times.

In Efficiency in transport, learners will develop their knowledge and understanding of energy efficiency and the safe stopping of vehicles. They will study how energy is transferred through friction and air resistance, and use Sankey diagrams as a visual tool to calculate efficiency and evaluate how streamlined designs enhance performance. Learners will also understand the factors affecting vehicle stopping distances and conduct scientific enquiries on thinking time.

Through real-world contexts and scientific enquiry, learners will develop their ability to interpret data, apply scientific principles, and make informed decisions about transport, energy use, and the environment.

In this topic learners will gain knowledge, understanding and skills in the following areas:

- 1.3.1 Environmental considerations of transport
  - 1.3.1a Environmental impact
  - 1.3.1b Use of electric vehicles
- 1.3.2 Efficiency in transport
  - 1.3.2a Efficiency
  - 1.3.2b Safe stopping of vehicles

Section	Amplification
<b>1.3.1 Environmental considerations of transport</b>	
1.3.1a Environmental impact	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that when petrol and diesel burn, they give out heat and they produce carbon dioxide and water</li> <li>that carbon dioxide is a greenhouse gas and the increase in the amount in the atmosphere is the main cause of climate change</li> <li>that when fuels containing impurities burn, they produce pollutants that are released into the atmosphere.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the benefits and drawbacks of hydrogen and bioethanol as alternative fuels to petrol.</li> </ul> <p>Learners should be aware that:</p> <ul style="list-style-type: none"> <li>alternative fuels have advantages and disadvantages associated with their use.</li> </ul> <p>Learners should know:</p> <ul style="list-style-type: none"> <li>lichens are indicator species that are sensitive to many forms of air pollution.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>how air pollution can impact human health, for example asthma, COPD, heart disease, high blood pressure, cancers.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>use lichen to estimate air pollution.</li> </ul>
1.3.1b Use of electric vehicles	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>why electric vehicles have been developed and introduced.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>that increasing the percentage of electric vehicles could impact on the environment.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>use the equation:</li> </ul> $\text{power} = \frac{\text{energy transfer}}{\text{time}}$ <ul style="list-style-type: none"> <li>calculate the cost of using electrical appliances, including electric vehicles, using the equations:  <math>\text{units used (kWh)} = \text{power (kW)} \times \text{time (hours)}</math>  <math>\text{cost} = \text{units used} \times \text{cost per unit}</math> </li> <li>use data to determine the payback time of electrical appliances, including electric vehicles.</li> </ul>

### 1.3.2 Efficiency in transport

#### 1.3.2a Efficiency

- Learners should know:
- that a more efficient device transfers more of the input energy store into a useful output energy store
  - that when objects move, frictional forces including air resistance and drag act on them
  - frictional forces reduce the energy transferred usefully
  - that streamlined objects have less friction acting upon them.

Learners should be able to:

- use the equation:

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{input energy}} \times 100$$

OR

$$\text{efficiency} = \frac{\text{useful power output}}{\text{input power}} \times 100$$

Learners should be able to:

- interpret and complete Sankey diagrams
- determine the efficiency of a device or process from a Sankey diagram.

#### 1.3.2b Safe stopping of vehicles

Learners should understand the terms:

- thinking time
- thinking distance
- braking distance
- overall stopping distance

when describing the safe stopping of vehicles.

Learners should know:

- the factors that affect the safe stopping of vehicles.

Learners should be able to:

- perform calculations using thinking time, thinking distance, braking distance and overall stopping distances
- carry out an experiment to determine thinking time.

## Unit 2 – Science in a Changing World

Written examination (tiered)

45% of qualification

72 marks

### Overview of unit

The purpose of this unit is to provide learners with the opportunity to:

- develop their scientific knowledge, understanding and skills across the sciences
- develop scientific thinking
- interpret scientific data and evidence critically
- evaluate scientific information to make informed decisions
- apply learning to relevant and meaningful contexts.

### Areas of content

#### 2.1 Human influence on the Earth

This theme is structured around the sub-themes: Managing human and environmental concerns and Carbon in our climate – climate change. Learners will explore how human activities impact the Earth’s biodiversity, resources, and climate. This will help them to evaluate scientific information and make informed decisions about current and future environmental challenges.

In Human impact on biodiversity, learners will explore some of the key influences on biodiversity, such as farming methods, pollution, and invasive non-native species. Learners will develop their knowledge and understanding of conservation strategies along with opportunities for scientific enquiry through ecological sampling.

In Life-cycle assessment (LCA), learners will develop their knowledge and understanding of the environmental impact of a product from raw materials to disposal. This will enable them to compare the environmental impacts of different processes and products.

In Carbon in our climate, learners will develop their knowledge and skills across the sciences through the study of greenhouse gases, the carbon cycle, and the global scale, risk, and environmental implications of climate change. They will learn to calculate carbon footprints and explore everyday measures to reduce them.

Through engaging with contemporary environmental issues, learners will build scientific understanding, critical thinking, and decision-making skills that contribute to a more sustainable future.

In this topic learners will gain knowledge, understanding and skills in the following areas:

- 2.1.1 Managing human and environmental concerns
  - 2.1.1a Human Impact on biodiversity
  - 2.1.1b Life-cycle assessment
- 2.1.2 Carbon in our climate – climate change

Section	Amplification
<b>2.1.1 Managing human and environmental concerns</b>	
2.1.1a Human Impact on biodiversity	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that one measure of biodiversity is the variety of different species and numbers of individuals within those species in an area</li> <li>the advantages and disadvantages of farming methods to increase yields, including use of: <ul style="list-style-type: none"> <li>fertilisers</li> <li>pesticides.</li> </ul> </li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the effects on rivers and streams of the release of untreated sewage and fertiliser run-off</li> <li>how pollutants present in industrial waste and pesticides can enter food chains, and their effect on organisms</li> <li>the effect of invasive non-native species on biodiversity</li> <li>how biodiversity can be protected including issues surrounding the use of legislation to protect biodiversity and the role of non-governmental organisations (NGOs) in species conservation.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>use ecological sampling methods to monitor biodiversity, including: <ul style="list-style-type: none"> <li>species abundance</li> <li>species distribution.</li> </ul> </li> </ul>
2.1.1b Life-cycle assessment	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that a life-cycle assessment (LCA) is a five-step process of evaluating the effects that a product has on the environment over the entire period of its life.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the environmental and human impact of mining for raw materials, for example limestone and metal ores</li> <li>that plastics do not react with natural substances in the environment, so they are non-biodegradable</li> <li>that microplastic particles are found all over the world and why this is of concern</li> <li>the environmental issues relating to the disposal of plastics</li> <li>the advantages and disadvantages of reusing and recycling materials, for example plastics and metals</li> <li>the environmental concerns linked to different methods of electricity generation throughout the life cycle of a power station.</li> </ul> <p>Learners should be able to</p> <ul style="list-style-type: none"> <li>compare the life cycle assessments of different products, in terms of the environmental impacts of different processes and the products themselves.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>that life-cycle assessment is a complex process and judgements are not exact.</li> </ul>

### 2.1.2 Carbon in our climate – climate change

#### 2.1.2

#### Carbon in our climate – climate change

Learners should know:

- that carbon dioxide and methane are greenhouse gases
- that each greenhouse gas has its own Global Warming Potential (GWP)
- what is meant by climate change
- that a carbon footprint is the total amount of greenhouse gases that are generated by our actions.

Learners should understand:

- how carbon is cycled within an ecosystem by biotic and abiotic processes, including:
  - photosynthesis
  - respiration
  - decomposition
  - combustion
  - fossilisation
- the global scale, risk and environmental implications of climate change
- **that positive feedback loops in climate change amplify the warming of the Earth**
- the everyday measures that can be taken to reduce our carbon footprint
- what is meant by ‘net zero’ and carbon off-setting.

Learners should be able to:

- calculate carbon footprints in terms of mass equivalent of carbon dioxide (kgCO<sub>2</sub>eq).

Learners should be aware:

- that climate change is a very complex process which is often over-simplified, resulting in speculation and opinions that are based on only part of the evidence
- that global techniques are continually being developed with the aim of reducing greenhouse gas emissions.

## 2.2 Humans in Space

This theme is structured around the sub-themes: Impact of space travel on humans, Challenges of living on other planets and the moon and Communication. Learners will explore the scientific challenges and opportunities of human space exploration. This will enable learners to develop their scientific knowledge, understanding and skills across the sciences whilst applying their learning to relevant meaningful contexts.

In Impact of Space Travel on Humans, learners will study forces and motion, including how weight varies across planets and the effect of balanced and unbalanced forces during space travel. They will also explore how cosmic radiation can damage DNA and influence gene expression, gaining insight into mutations and their biological impacts.

In Challenges of Living on Other Planets, learners are encouraged to examine the Solar System, comparing planetary conditions and understanding why Earth supports life. They will explore the challenges surrounding nutrition and food security in space and how future missions may require self-sustaining systems like hydroponics. Learners will also discover how materials are engineered to endure the extreme environments of space.

In Communication, learners will develop an understanding of wave properties, types of waves, and their roles in communication. They will examine how satellites and telescopes function, comparing the benefits and limitations of space-based and ground-based systems.

In this topic learners will gain knowledge, understanding and skills in the following areas:

- 2.2.1 Impact of space travel on humans
  - 2.2.1a Forces on Earth and in space
  - 2.2.1b The effect of balanced and unbalanced forces
  - 2.2.1c Impact of space travel on the genetic code
- 2.2.2 Challenges of living on other planets and the moon
  - 2.2.2a The solar system
  - 2.2.2b Nutrition in space
  - 2.2.2c Living in space
  - 2.2.2d Materials used in space exploration
- 2.2.3 Communication
  - 2.2.3a Wave properties
  - 2.2.3b Types of waves
  - 2.2.3c Satellites and telescopes

Section	Amplification
<b>2.2.1 Impact of space travel on humans</b>	
2.2.1a Forces on Earth and in space	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• the names of common forces</li> <li>• that weight is the force of gravity acting on an object, whereas mass is the amount of matter in an object.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• calculate the weight of an object using the equation: <math>\text{weight} = \text{mass} \times \text{gravitational field strength}</math></li> <li>• compare the weight of an object on different planets and moons from given values of gravitational field strength.</li> </ul> <p>Learner should be aware:</p> <ul style="list-style-type: none"> <li>• how astronauts on the International Space Station overcome the effects of living in low gravity.</li> </ul>

<p><b>2.2.1b</b> The effect of balanced and unbalanced forces</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• when the forces on an object are balanced, it will remain at rest or at constant speed in a straight line</li> <li>• when the forces on an object are unbalanced, it will accelerate</li> <li>• the forces acting on a body in freefall.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that in space there is very little friction so objects can continue at a constant speed for a long time.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• how the forces acting on a body cause it to reach terminal speed.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• determine the resultant force acting on an object by adding forces which act in the same direction and subtracting forces acting in opposite directions</li> <li>• investigate the terminal speed of objects in free fall such as through using cake cases</li> <li>• use the equation:   <math display="block">\text{resultant force} = \text{mass} \times \text{acceleration}</math></li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that for a rocket to reach space, a very large resultant force is needed</li> <li>• how the forces on a rocket change during take-off.</li> </ul>
<p><b>2.2.1c</b> Impact of space travel on the genetic code</p>	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that DNA is found in the nucleus of animal and plant cells in structures called chromosomes</li> <li>• that a DNA molecule is a double helix</li> <li>• the DNA codes for the formation of specific proteins</li> <li>• the complementary base-pairing system</li> <li>• <b>increased exposure to cosmic radiation in space can impact health, including:</b> <ul style="list-style-type: none"> <li>• damage to DNA</li> <li>• gene expression</li> <li>• changes to the immune system.</li> </ul> </li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the term 'gene'</li> <li>• <b>how a triplet code is used to form specific proteins that control the cell</b></li> <li>• the term 'mutation'</li> <li>• how mutations may arise and how they may affect an organism.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that the discovery of the structure of DNA in 1953 profoundly impacted earlier biological models and theories.</li> </ul>

<b>2.2.1 Challenges of living on other planets and the moon</b>	
2.2.2a The solar system	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>the main features of our Solar System in terms of the order, relative size and composition of the Sun, the planets, the dwarf planets, comets, moons, the asteroid belt, the Oort cloud and the Kuiper belt.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>make comparisons and draw conclusions about objects in the Solar System based on given data.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>how the Earth's atmosphere supports life</li> <li>why atmospheres on other moons and planets may prevent life-supporting conditions.</li> </ul>
2.2.2b Nutrition in space	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that space food must meet several nutritional challenges to ensure the health and well-being of astronauts during long-duration missions, including:           <ul style="list-style-type: none"> <li>high energy needs of astronauts</li> <li>taste, texture and variety of food.</li> </ul> </li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>the different food preservation methods used for space travel.</li> </ul>
2.2.2c Living in space	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that low gravity environments can impact human health</li> <li>the challenges of ensuring food security on other planets and the moon.</li> </ul> <p><b>Learners should understand:</b></p> <ul style="list-style-type: none"> <li><b>how self-sufficient food production can be achieved including the use of:</b> <ul style="list-style-type: none"> <li><b>controlled ecological life support systems</b></li> <li><b>hydroponics.</b></li> </ul> </li> </ul>
2.2.2d Materials used in space exploration	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>that scientists have developed a range of specialised materials designed specifically for space travel including metal alloys, glasses, polymers, ceramics and composites.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>that materials used within space exploration are designed to withstand harsh environments and extreme conditions, including high temperatures, low temperatures, radiation and vacuum</li> <li>that specifically designed materials are critical for space exploration, including spacecraft structures, propulsion systems and in providing life support.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>that ongoing developments in material science are resulting in new materials continually being developed for use in space exploration.</li> </ul>

<b>2.2.3 Communication</b>	
2.2.3a Wave properties	<p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the terms used for the properties of waves:           <ul style="list-style-type: none"> <li>• amplitude</li> <li>• frequency</li> <li>• wavelength.</li> </ul> </li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>• use and draw graphical representations of waves from given values of amplitude and wavelength</li> <li>• use the equation: <math>\text{wave speed} = \text{frequency} \times \text{wavelength}</math>.</li> </ul>
2.2.3b Types of waves	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that sound waves require a medium to travel through</li> <li>• that electromagnetic (em) waves can travel through a vacuum and are used in satellite communications and communications in space.</li> </ul>
2.2.3c Satellites and telescopes	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>• that satellites in geostationary orbits, orbit the Earth above the equator and are always in a fixed position relative to the Earth's surface, allowing constant communication</li> <li>• that signals can be sent from one satellite to another via ground stations to allow communications in space</li> <li>• that space-based telescopes have a view of space that is not obscured by the Earth's atmosphere, but they are very expensive.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>• the disadvantages of ground-based telescopes including light pollution, atmospheric blurring, and that only some wavelengths of em radiation can pass through the atmosphere.</li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>• that astronomers use both space-based telescopes and ground-based telescopes often placed at high altitudes.</li> </ul>

### 2.3 Looking for clues

This theme is structured around the sub-theme: Biological, physical and chemical techniques for identification. Learners are introduced to scientific techniques used to identify chemical and biological substances, helping them develop skills in analysis and investigation.

In Physical and chemical techniques for identification, learners will explore how to separate mixtures and identify substances using physical and chemical techniques such as filtration, chromatography, and chemical tests for gases and ions. They will also study biological identification methods such as DNA profiling, microscopy, and biochemical tests, applying these in real-world contexts such as forensics. Learners will also develop their scientific enquiry skills in measuring and comparing the density of different objects using experiments and calculations.

Using relevant and meaningful contexts to develop their knowledge and skills across the sciences will allow them to refine their approaches to problem-solving and their ability to interpret data and evidence critically.

In this topic learners will gain knowledge, understanding and skills in the following areas:

#### 2.3.1 Biological, physical and chemical techniques for identification

##### 2.3.1a Identifying chemical samples

##### 2.3.1b Identifying biological samples

##### 2.3.1c Using experimental measurements of density to identify unknown solids

#### 2.3.1 Biological, physical and chemical techniques for identification

Section	Amplification
2.3.1a Identifying chemical samples	<p>Learners should know:</p> <ul style="list-style-type: none"> <li>how filtration, evaporation, distillation and chromatography can be used to separate simple mixtures to enable identification of the individual components.</li> </ul> <p>Learners should understand:</p> <ul style="list-style-type: none"> <li>how to separate given mixtures using one or more separation techniques</li> <li>how the purity of a substance can be tested by measuring its melting point.</li> </ul> <p>Learners should be able to:</p> <ul style="list-style-type: none"> <li>analyse chromatographic data and use it to calculate <math>R_f</math> values</li> <li>carry out the tests used to identify carbon dioxide, hydrogen and oxygen gases</li> <li>identify the group 1 metal ions lithium, sodium and potassium using flame tests</li> <li>identify the group 7 ions chloride, bromide and iodide using silver nitrate solution</li> <li><b>identify copper(II), iron(II) and iron(III) ions using sodium hydroxide solution.</b></li> </ul> <p>Learners should be aware:</p> <ul style="list-style-type: none"> <li>that there are other separation techniques and chemical tests that are used in the identification of chemical samples.</li> </ul>

<p><b>2.3.1b</b> Identifying biological samples</p>	<p><b>Learners should know:</b></p> <ul style="list-style-type: none"> <li>• that identifying biological samples involves a combination of techniques, including:           <ul style="list-style-type: none"> <li>• DNA profiling</li> <li>• microscopy</li> <li>• biochemical tests.</li> </ul> </li> </ul> <p><b>Learners should understand:</b></p> <ul style="list-style-type: none"> <li>• how DNA profiling is used, including:           <ul style="list-style-type: none"> <li>• criminal investigations</li> <li>• paternity testing</li> <li>• identifying victims</li> <li>• medical and genetic research</li> </ul> </li> <li>• how microscopy and biochemical tests are used in criminal investigations.</li> </ul> <p><b>Learners should be able to:</b></p> <ul style="list-style-type: none"> <li>• observe and identify different types of pollen using a light microscope</li> <li>• test for the presence of starch, glucose and protein.</li> </ul> <p><b>Learners should be aware:</b></p> <ul style="list-style-type: none"> <li>• of the ethical issues surrounding storage of genetic profiles.</li> </ul>
<p><b>2.3.1c</b> Using experimental measurements of density to identify unknown solids</p>	<p><b>Learners should know:</b></p> <ul style="list-style-type: none"> <li>• that density is a measure of how much mass is in a given volume.</li> </ul> <p><b>Learners should be able to:</b></p> <ul style="list-style-type: none"> <li>• use the equation:</li> </ul> $\text{density} = \frac{\text{mass}}{\text{volume}}$ <ul style="list-style-type: none"> <li>• carry out experiments to determine the density of both regular and irregular shaped objects to identify the material they are made from.</li> </ul>

## Unit 3 – Scientific Enquiry

Centres must choose one enquiry from a choice of two.  
 The chosen enquiry includes a practical task and written task.  
 10% of qualification  
 28 marks

This assessment will not be tiered.

### Overview of unit

Scientific Enquiry is an integral element of the qualification. It encourages both scientific curiosity, and practical work, which helps to engage learners. It helps them to develop a deeper understanding of the sciences.

The purpose of this unit is to:

- develop scientific thinking
- use experimental skills and strategies
- undertake practical science experiments as part of a scientific enquiry
- enquire into and apply scientific enquiry skills relevant to the context of the enquiry.

### Areas of content

This unit will be based on the content and skills developed across the qualification and will give learners the opportunity to demonstrate their scientific enquiry skills from page 9 of the specification. These skills are further outlined in the Scientific Enquiry Framework (Appendix B). Learners should also demonstrate their use of scientific terminology (Appendix C) and mathematical skills (Appendix D).

The assessment requires candidates to undertake one scientific enquiry. Centres will be given a choice of two enquiries to select from; each of these enquiries will be set in engaging contexts related to a sub-theme(s) from the specification.

For the chosen enquiry, candidates must complete two tasks.

#### Task 1 (6 marks):

Learners may work in groups of no more than three. Learners will be required to carry out a practical investigation using a given method including observation, measurement, and the collection of reliable data through hands-on experimentation.

#### Task 2 (22 marks):

Learners must work independently in highly controlled conditions. Learners will be required to use the Scientific Enquiry Skills they have developed across the qualification. They should have access to their completed Task A.

Both tasks are designed to assess skills the Scientific Enquiry Skills listed on page 42 of this specification.

## Opportunities for integration of learning experiences

GCSE Integrated Science (Single Award) generates opportunities for the following learning experiences to be developed (experiences will not be directly assessed):

- engage with the work of diverse scientists or professionals working in related areas, either in person or on-screen, to understand their interests and experiences within the sector
- visit areas of scientific interest, either in person or digitally, which could include natural environments, constructed environments, other educational establishments with a scientific focus, or scientific facilities
- engage in learning outside of the classroom to further develop scientific understanding and skills
- research the different roles and careers that draw upon science
- develop collaboration skills by working with and learning from others.

The Guidance for Teaching will include further information on the opportunities provided by the qualification for teachers/centres to integrate these learning experiences and skills into delivery.

For opportunities to develop cross-cutting themes, cross-curricular skills and integral skills please see Appendix A.

### 3 ASSESSMENT

The Assessment Arrangement Pack for Unit 3 will include all detailed information relating to this assessment.

#### 3.1 Assessment Objectives and Weightings

Below are the assessment objectives for this specification. Learners must:

**AO1**

**Demonstrate knowledge and understanding** of scientific ideas, processes, techniques and procedures.

**AO2**

**Apply knowledge and understanding** of scientific ideas, processes, techniques and procedures.

**AO3**

**Analyse, interpret and evaluate** scientific information, processes, techniques and procedures.

The table below shows the weighting of each assessment objective for each unit and for the qualification as a whole. Assessment objective weightings are the same for both tiers of the qualification.

	Marks of Question Papers			AO1	AO2	AO3	Total
	Max Mark	AO1	AO2	AO3			
Unit 1	72	18	36	18	11.25%	22.5%	11.25%
Unit 2	72	18	36	18	11.25%	22.5%	11.25%
Unit 3	28	7	14	7	2.5%	5%	2.5%
					25%	50%	25%
							100%

## 4 MALPRACTICE

Before the course starts, the teacher is responsible for informing candidates of WJEC's regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of work for GCSE Integrated Science (Single Award).

Information regarding malpractice is available in our [Guide to preventing, reporting and investigating malpractice](#).

All cases of suspected or actual malpractice must be reported immediately to WJEC ([malpractice@wjec.co.uk](mailto:malpractice@wjec.co.uk)). If candidates commit malpractice, they may be penalised or disqualified from the examinations.

In all cases of malpractice, centres are advised to consult the JCQ booklet [Suspected Malpractice: Policies and Procedures](#).

## 5 TECHNICAL INFORMATION

### 5.1 Entries and Awards

This is a unitised qualification. Learners are entered for each unit separately.

Assessment opportunities will be available in the summer assessment period each year, until the end of the life of the specification.

Unit 1 will be available in 2027 (and each year thereafter). Unit 2 will be available in 2028 (and each year thereafter). Unit 3 will be available in the spring term from 2028 (and each spring term thereafter). The qualification will be awarded for the first time in summer 2028.

Pre-16 Candidates (i.e. candidates who are 16 or under on 31<sup>st</sup> August in the academic year in which they were entered)

The terminal rule is set at 55% of the overall qualification for Pre-16 Candidates for GCSE Integrated Science (Single Award).

If the assessment being re-taken contributes to the 55% terminal rule requirement, the mark for the new assessment will count regardless of previous results in that assessment.

Candidates may resit an individual unit once only. The better uniform mark score from the two attempts will be used in calculating the final overall grade subject to the terminal rule being satisfied first i.e. that candidates must complete a minimum amount of the assessment for a qualification in the series in which they are cashing in.

If any unit has been attempted twice and a candidate wishes to enter the unit for the third time, the candidate will have to re-enter all units and the appropriate cash-in(s). This is referred to as a 'fresh start'. When retaking a qualification (fresh start), a candidate may have up to two attempts at each unit. However, no results from examination units taken prior to the fresh start can be used in aggregating the new grade(s).

If a candidate has been entered for but is absent for a unit, the absence does not count as an attempt. The candidate would, however, qualify as a resit candidate in the final resit series.

Post-16 Candidates (i.e. candidates who are 16 or over on 1<sup>st</sup> September in the academic year in which they are entered)

There is no terminal rule that applies to Post-16 Candidates for GCSE Integrated Science (Single Award).

There is no limit on the number of times a candidate can resit an individual unit; however, the better uniform mark score from the most two recent attempts will be used in calculating the final overall grade.

The 'fresh start' rule does not apply to post-16 candidates.

If a candidate has been entered for but is absent for a unit, the absence does not count as an attempt. The candidate would, however, qualify as a resit candidate in the final resit series.

The entry codes appear below.

	Entry code	
	English medium	Welsh medium
Unit 1: Living on Earth (Foundation)	3450U1	3450N1
Unit 1: Living on Earth (Higher)	3450UA	3450NA
Unit 2: Science in a Changing World (Foundation)	3450U2	3450N2
Unit 2: Science in a Changing World (Higher)	3450UB	3450NB
Unit 3: Scientific Enquiry	3450U3	3450N3
<b>GCSE Integrated Science (Single Award)</b>	3450QS	3450CS

The current edition of our Entry Procedures and Coding Information gives up-to-date entry procedures.

## 5.2 Grading, awarding and reporting

GCSE qualifications are reported on an eight point scale from A\*-G, where A\* is the highest grade. Results not attaining the minimum standard for the award will be reported as U (unclassified).

## 5.3 Tiering

There are two tiers of entry for each unit of qualification.

Higher Tier: A\*-D

Foundation Tier: C – G

Learners may be entered at different tiers across units.

The raw marks gained in each of the three units will be converted to give a learner a Uniform Marks Scale (UMS) mark for each unit. The maximum UMS available for each assessment will be in line with the grades available for the tier taken in each assessment. These will then be aggregated to give a final UMS mark, providing a learner's overall grade in this qualification.

Individual unit results are reported on a uniform mark scale (UMS) with the following grade equivalences:

	Max raw marks	Max UMS	A*	A	B	C	D	E	F	G
<b>Unit 1</b>	72	180	162	144	126	108	90	72	54	36
<b>Unit 2</b>	72	180	162	144	126	108	90	72	54	36
<b>Unit 3</b>	28	40	36	32	28	24	20	16	12	8

For Units 1 and 2, the maximum uniform mark available on the foundation tier of the assessment will be 125 (i.e. 1 uniform mark less than the minimum needed to achieve a grade B on the unit). Unit 3 is not tiered.

The uniform marks obtained for each unit are added up and the qualification grade is based on this total. The total results reported on UMS will have the following grade equivalences on the eight-grade scale:

	<b>MAX.</b>	<b>A*</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
<b>Subject Award</b>	400	360	320	280	240	200	160	120	80

## APPENDIX A: Opportunities for embedding elements of the Curriculum for Wales

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3
Cross-cutting Themes			
Local, National & International Contexts	✓	✓	
Sustainability	✓	✓	✓
Relationships and Sexuality Education			
Human Rights Education	✓	✓	
Careers and Work-Related Experiences	✓	✓	✓
Cross-curricular Skills - Literacy			
Listening	✓	✓	✓
Reading	✓	✓	✓
Speaking	✓	✓	✓
Writing	✓	✓	✓

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3
Cross-curricular Skills - Numeracy			
Developing Mathematical Proficiency	✓	✓	✓
Understanding the number system helps us to represent and compare relationships between numbers and quantities	✓	✓	✓
Learning about geometry helps us understand shape, space and position and learning about measurement helps us quantify in the real world	✓	✓	✓
Learning that statistics represent data and that probability models chance help us make informed inferences and decisions	✓	✓	✓
Digital Competence			
Citizenship	✓	✓	
Interacting and Collaborating	✓	✓	✓
Producing	✓	✓	✓
Data and Computational Thinking	✓	✓	

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3
Integral Skills			
Creativity and Innovation	✓	✓	✓
Critical Thinking and Problem Solving	✓	✓	✓
Planning and Organisation	✓	✓	✓
Personal Effectiveness	✓	✓	✓

## APPENDIX B: Scientific Enquiry Skills Framework

To encourage learners to be curious and seek answers through science, they must have opportunities to develop scientific enquiry skills across all units. Centres must ensure that learners engage in scientific enquiry activities based on the subject content throughout the qualification.

### 1. Development of scientific thinking

Learners should:

- understand how scientific models and theories develop over time
- use a variety of methods to solve problems, make predictions, and to develop scientific explanations and understanding of familiar and unfamiliar facts
- the power and limitations of science and any ethical issues which may arise
- explain every day and technological applications of science
- evaluate personal, social, economic and environmental implications of science and make decisions based on the evaluation of evidence and arguments
- evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences
- recognise the importance of peer review of results and of communicating results to a range of audiences.

### 2. Experimental skills and strategies

Learners should:

- use scientific theories and explanations to develop hypotheses
- use scientific vocabulary, terminology and definitions
- plan experiments or devise procedures to make observations, make or identify substances, test hypotheses, check data or explore phenomena
- apply knowledge of a range of techniques, apparatus and materials, and select those appropriate to the experiment
- carry out experiments appropriately having due regard to the correct setting up of apparatus, the accuracy of measurements and health and safety considerations
- recognise when to apply knowledge of sampling techniques to ensure any samples collected are representative
- make and record observations and measurements using a range of apparatus and methods
- recognise the importance of scientific quantities and understand how they are determined
- evaluate methods and suggest possible improvements and further investigations.
- present observations and other data using appropriate methods
- translate data from one form to another
- carry out mathematical analysis
- represent distributions of results and comment on uncertainties
- interpret primary and secondary data, including identifying patterns and trends, make inferences and draw conclusions
- present explanations including relating data to hypotheses
- be objective and evaluate data in terms of accuracy, precision, repeatability and reproducibility and identify potential sources of random and systematic error
- communicating the scientific rationale for investigations and methods used.

## APPENDIX C: Scientific Terminology

Term	Definition
<b>Independent variable</b>	The variable you choose to change in an investigation.
<b>Dependent variable</b>	The variable which you measure every time you change the value of the independent variable.
<b>Controlled variable</b>	A variable which may affect the results of the investigation and therefore should be kept constant.
<b>Control experiment</b>	An experiment that is carried out where (usually) the independent variable is removed or kept at a constant value, whilst all other variable and methods remain the same.
<b>Hypothesis</b>	An idea that can be tested by carrying out an experiment. Can be correct or incorrect.
<b>Range</b>	The highest and lowest values of the independent variable.
<b>Valid conclusion</b>	A conclusion (what you found out) supported by the results of data from a well-designed investigation and based on good scientific knowledge.
<b>Validity of experimental design</b>	How suitable the method is to answer the question being asked. The method should include controlled variables.
<b>Resolution</b>	This is the smallest change in the quantity being measured by a measuring instrument that can be observed. For example, $\pm 1$ mm on a 1 metre ruler or $\pm 1^\circ\text{C}$ on a thermometer.
<b>Anomaly</b>	A value in a set of results which is seen to be much bigger or smaller than the rest of the values in the set.
<b>True value</b>	This is the value that would be obtained in ideal conditions.
<b>Uncertainty</b>	The range within which the true value can be expected, e.g. "the temperature is $20^\circ\text{C} \pm 2^\circ\text{C}$ ". There is a formula to calculate this which you will be given in an exam.
<b>Measurement error</b>	The difference between a measured value and the true value.
<b>Systematic error</b>	A systematic error is normally caused by the apparatus used and causes readings to differ from the true value by the same amount each time. The effect of systematic errors cannot be reduced by increased repeats.
<b>Random error</b>	This occurs when results vary unpredictably from one measurement to the next. These are normally due to errors by the person taking the measurements. The effect of random errors can be reduced by taking more measurements and calculating a mean.
<b>Accuracy</b>	A measurement result is considered accurate if it is close to the true value.

<b>Inaccuracy</b>	A measurement result is inaccurate if it is a long way from the true value.
<b>Precision</b>	A set of precise measurements show very little spread about the mean value.
<b>Repeatability</b>	The precision obtained when repeat readings are obtained by a single learner or group.
<b>Repeatable</b>	A measurement is repeatable, if a single learner or group using the same method and apparatus, obtains the same or similar results when they carry out the investigation again.
<b>Reproducibility</b>	The precision obtained when repeat readings are obtained by a different learners or groups.
<b>Reproducible</b>	A measurement is reproducible, if different learners or groups obtain the same or similar results. This could include using different apparatus or methods.
<b>Hazard</b>	A chemical or piece of apparatus that could cause harm. It is expected that in risk assessments the nature of the hazard is also specified. For example, 'Hydrogen peroxide is an irritant'.
<b>Risk</b>	A step in the method involving a hazard that might result in danger. For example, 'Hydrogen peroxide could get onto the skin when pouring it into the measuring cylinder or the beaker'.
<b>Control measures</b>	Something that can be done to reduce or prevent a risk while still allowing you to carry out the experiment. For example, 'Wash hands immediately if any hydrogen peroxide gets onto them'.

## APPENDIX D: Mathematical Skills

Mathematical skills play a crucial role in scientific understanding and must be integrated into the teaching of subject content rather than taught in isolation. Planning should ensure that learners apply relevant mathematical skills throughout their scientific studies.

Skills which will be assessed at higher tier only are shown in **bold type**.

Mathematical Skills	
<b>1</b>	<i>Handling data</i>
	Recognise and use expressions in decimal form
	<b>Recognise and use expressions in standard form</b>
	Recognise and use SI units and prefixes
	Convert units
	Use ratios, fractions and percentages
	Use an appropriate number of significant figures
	Find arithmetic means
	Construct and interpret tables and diagrams
<b>2</b>	<i>Algebra</i>
	<b>Change the subject of an equation</b>
	Substitute numerical values into algebraic equations and solve them using appropriate units for physical quantities
<b>3</b>	<i>Graphs</i>
	Translate information between graphical and numeric form
	Plot two variables from experimental or other data
	<b>Determine the gradient of a linear graph</b>
	<b>Interpret the slope of a linear graph</b>
	<b>Interpret the intercept of a linear graph</b>
<b>4</b>	<i>Geometry</i>
	Use angular measures in degrees
	Calculate areas of squares, triangles and rectangles, surface areas and volumes of cubes
	Calculate the area and circumference of a circle