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Pearson BTEC

L3

Pearson Level 3
Alternative Academic Qualification BTEC National in

Applied Science (Extended Certificate)

Planning and Teaching Guide

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About Pearson

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All information in this Guide is correct at time of publication.

Summary of changes between previous issue(s) and this issue

Unit 1 - Qualification Unit Delivery Guide		
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A1	Further information around Gram staining processes.	12
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C1	Further teaching guidance on which equations students would be expected to balance.	57
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Earlier issue(s) show(s) previous changes.

If you need further information on these changes or what they mean, please contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

1. Introduction

This Planning and Teaching Guide complements your Pearson Level 3 Alternative Academic Qualification BTEC National in Applied Science (Extended Certificate) specification, Pearson Set Assignment Briefs (PSABs), Sample Assessment Materials (SAMs) and the Pearson BTEC Level 3 National Alternative Academic Qualification Administrative Support Guide. This Planning and Teaching Guide provides:

- an overview of dates and deadlines for key events and activities relevant to qualification delivery – from registration to assessment and review of marking – throughout the academic year
- suggestions for planning and delivering your course including induction and unit sequencing
- creative and realistic teaching and learning ideas as well as links to resources for each unit to support and inspire you in creating a dynamic learning environment to keep your students engaged and motivated to learn
- wider delivery support such as guidance on study programme planning and descriptions and links to qualification resources and materials.

The guide was designed and written in collaboration with current practitioners to ensure that the planning and delivery suggestions and teaching and learning ideas are feasible, pedagogically sound and appropriate for the vocational area and the purpose of the qualification.

We recognise that delivery contexts will vary from one centre to the next and that practitioners are the best decision-makers for what works best for them and their students. Therefore, teachers can tailor the suggestions and ideas proposed in this guide to meet the specific needs of their students and the available resources in their centre. There are, however, requirements that have to be met in relation to assessment plans and to teaching and learning preceding assessment, which will be clarified/covered in this guide.

We hope you will find this guidance relevant and useful, and you enjoy teaching this this qualification!

What's new

When creating these BTEC Nationals, in addition to ensuring the sector technical content was current and up-to date, we have also focused on developing the skills and personal attributes students need to navigate the future. We have worked with many higher education providers, professional bodies, colleges and schools to ensure these qualifications also meet their needs. Employers are looking for future employees with a thorough grounding in the latest industry requirements and work-ready skills such as critical thinking and problem solving. Higher education needs students who have

experience of research, extended writing and meeting deadlines to be successful on their undergraduate programmes.

We have addressed these requirements by:

- facilitating and guiding the development of transferable skills through the design and delivery of the qualifications, using a holistic and practical framework which is based on recent research into the most critical skills needed to navigate the future
- a Transferable Skills framework has been used to embed transferable skills in the qualifications where they naturally occur and to signpost opportunities for delivery and development as a part of the wider BTEC learning experience. Please refer to the BTEC Transferable Skills Guide for Teachers for further information on this framework, its relevance and how it has been implemented in the qualifications
- supporting the delivery of Sustainability Education and development of Digital Skills naturally through the content design of the qualifications. Mapping is provided in the specification to identify where these opportunities for teaching and learning exist
- updating sector-specific content to ensure it is current, relevant and future-facing
- implementing a consistent approach to assessment with a balanced combination of internal and external assessments to better engage students, make the qualifications more accessible for them and more manageable for centres to deliver.

We are providing a wealth of support, both resources and people, to help ensure that you and your students have the best possible experience during their course. Please see the section on *Pearson Qualification Support and Resources* on page 176 for details of the available resources and support with links to access these.

Notes:

The qualification specification provides the content that must be taught and what must be assessed. This planning and teaching guide provides suggestions and ideas for how the content could be delivered. The suggestions given in this guide link with the Pearson Set Assignment Briefs provided by Pearson, which are mandatory for internal assessment and cannot be amended or contextualised by centres.

2. BTEC Calendar of Key Dates

Each academic year there are some key dates and deadlines in the delivery of BTEC qualifications that teachers need to be aware of, and act on appropriately, to ensure:

- the smooth running of student registration, assessment and the quality assurance process, and
- effective timetable planning to fully prepare students for assessments and ensuring timely completion of administrative tasks.

Here is an overview of the key dates and deadlines for this qualification.

The specific date for each activity or event will vary each academic year and so only the month is provided. For the specific dates for the current academic year, please go to our webpage: Exam timetables | Pearson qualifications

Month	General related dates	Internal Assessment related dates	External Assessment related dates
September	Student registration		
October		Lead IV registered and completion of team standardisation	Entry deadline for January external assessment
November	Late student registration fee		
December	Late student registration fee Deletion deadline: delete student registrations for any leaner withdrawn from the qualification		
January		Standards Verification Window opens	January External Assessment Series
February			

Month	General related dates	Internal Assessment related dates	External Assessment related dates
March			Restricted release of results to centres Release of results to students Entry deadline for Summer external assessments Review of Marking
April			Review of Marking
May		Standards Verification for first sample closes	Summer External Assessment
June		Standards Verification for second sample closes	
July	Deadline for full qualification claim for summer certification		
August			Restricted release of results to centres Release of results to students Review of marking

3. Planning the Delivery of your Course

Planning your course ensures a coherent and logical approach to teaching that helps students to connect concepts effectively and build their knowledge progressively.

Effective assessment planning is also essential to allow for timely evaluation of student progress and adjustment of teaching strategies or interventions as needed.

This section offers recommended approaches to support practitioners with planning and implementation of this qualification

Induction

Students

An induction period at the start of the course is recommended to help students understand and prepare for the demands of their chosen course, as well as familiarise them with the BTEC ethos and methodology. This induction aims to not only equip students with the necessary knowledge and skills but also to create a welcoming environment where they feel safe, supported and gain a sense of belonging as they begin their course in a new setting.

Centres will have their own induction programmes, and to support this, Pearson have provided a range of adaptable resources that can be integrated into this existing programme. These resources cover areas such as welcome activities and information to include in the induction, with supporting slides. As we believe that every opportunity should be taken to develop transferable skills across the wider BTEC learning experience, we have also provided guidance on which transferable skills could be delivered as a part of the induction process including managing own learning, continuous learning, goal setting and personal strength and resilience. The resources are designed to help students develop the relevant transferable skills through learning how to manage their course workload, completing their assessments successfully and meeting deadlines whilst also building their confidence and ability to thrive on their BTEC journey.

Tutors/Teachers

In addition to the annual standardisation training that all BTEC teaching staff are required to complete at the beginning of each academic year using the Pearson provided materials, an induction period for new tutors is also recommended. This will help new tutors familiarise themselves with the specific demands and expectations of the BTEC curriculum, equipping them with the necessary knowledge and skills to effectively plan and support their students from the outset.

Overview of Assessment Availability

Internal Assessments

Pearson Set Assignments (PSABs) are provided by Pearson for all internally assessed units and must only be used for summative assessment.

These are available for the lifetime of the qualification and are accessible through our website. Teachers with a Pearson online account can log in through the sign-in portal to access them. Any teacher with students registered for this qualification can create a Pearson online account.

For optional unit 6: Contemporary Issues in Science you are provided with three versions of the PSAB. It is expected that you will rotate through all the available versions before repeating a previous version. The order in which the PSAB versions are completed is at your discretion. For further information around PSAB conditions and administration please refer to the administration guide.

External Assessments

External assessments are available in two series each academic year as shown below:

Dates	Jan	Mar	May/June	Aug
Assessment	External Assessments Series 1 *Not available in Jan 2026	External assessment Series 1 Results	External assessment Series 2	External Assessment Series 2 Results

Delivery and Assessment Planning

Clear unit planning and understanding is essential for a successful qualification delivery. This helps students to build on prior learning and reinforce concepts to develop a deeper understanding of the unit content and progressively develop their knowledge, understanding and skills throughout the course delivery.

We have produced a sample delivery plan showing how the **BTEC National in Applied Science (Extended Certificate) could** be delivered over **two** years, highlighting ordering of units and assessment milestones.

This plan is intended to be used as guidance.

Key

Del = Unit content delivery

PSAB = Pearson Set Assignment Brief

Rev = Revision for External assessment

Ext = External assessment

Resit Ext = Resit External assessment opportunity

Sequence of delivery

Year One

Unit	Unit Title	GLH	Assessment method	Term 1	January exam series	Term 2	Term 3	Summer exam series
1	Principles and Applications of Biology	60	Ext	Del & Rev				Ext
2	Principles and Applications of Chemistry	60	Ext			Del & Rev	Del & Rev	Ext
3	Principles and Applications of Physics	60	Ext			Del & Rev	Del & Rev	Ext

Unit 1 is an externally assessed mandatory unit and gives the underpinning knowledge for biological science.

The topic areas covered in this unit include animal and plant cells and tissues, including specialised cells, biological molecules, including water, carbohydrates, proteins and nucleic acid, cell transport and enzyme activity. This allows for theory and practical work to be undertaken. This unit also supports learning in other units such as Unit 2 learning aim B1.3 which looks at covalent bonding evident in key biological molecules. Unit 4 Learning aims B1 and B2 also utilise knowledge areas of biological components and eukaryotic cell structure.

In the first year of delivery external assessment will only be available in the summer series, in subsequent years, assessment is planned in the January window hence allowing, if required, an opportunity to resist in further external assessment windows.

Unit 2 is an externally assessed mandatory unit which allows students to develop their knowledge of chemical science. Students will explore some of the fundamental concepts which underpin the chemistry and chemical reactions of the world around them. Students will cover topics such as A1.2 atomic and electronic structure which relates to topic area B1.1 to B1.3 in different types of bonding. This will assist in the understanding of practical skills undertaken unit 4 learning aim A3. In addition, the physical chemistry content covered in this unit as part of learning aim D will facilitate calculations required in Unit 4 Scientific Practical Skills Learning aim A2.

Assessment is planned in the summer window to allow for unit content to be taught and for students to develop an understanding of the command words used. Additionally, there would be additional opportunities to resit, if required, in the winter or summer exam series of the second year.

Unit 3 is an externally assessed mandatory unit which allows students to explore the characteristics and applications of waves in learning aim A. Fundamental content of electrical circuits covered in learning aim C in this unit will underpin practical applications in unit 4 C2 on transfer of energy through the electrical circuits. Further content in this unit provides underpinning knowledge of energy transfer throughout learning aim C, this will support with Unit 4 practical applications in learning aim C2 and C3 that are undertaken in the subsequent year.

The external assessment is planned in the summer window providing enough time for delivery of the required content, whilst also allowing, if required, an opportunity to resist in further windows in the second year.

Year Two

Unit	Unit Title	GLH	Assessment method	Term 1	January exam series	Term 2	Term 3	Summer exam series
1	Principles and Applications of Biology	60	Ext	Del & Rev	Resit Ext			
2	Principles and Applications of Chemistry	60	Ext	Del & Rev	Resit Ext			
3	Principles and Applications of Physics	60	Ext	Del & Rev	Resit Ext			
4	Practical Scientific Procedures and Techniques	90	Int	Del & PSAB				
5 OR 6	Science Investigation Skills OR Contemporary issues in Science	90	Int			Del	Del & PSAB	

Unit 4 is an internally assessed mandatory unit and builds on the knowledge gained in the principles and application units (1, 2 and 3) in each of the respective science areas. Students will be introduced to quantitative laboratory techniques, including chromatography, colorimetry and laboratory safety, which are relevant to the scientific laboratory environments.

The PSAB for this unit, which is marked by centres and verified by Pearson, has an approximate guidance time of 75 hours. Students will explore key chemical science techniques such as titration and chromatography, and relate this to theoretical content of atomic structure, bonding, and mole calculations from unit 2 studied previously. Further practical application in biology is explored through investigations into colorimetry techniques utilising concepts of biological components for unit 1, alongside applications in plant growth, drawing on underpinning knowledge of plant cell structure. Practical applications of electrical circuits and energy transfers in this unit will draw on unpinning content covered in unit 3 learning aim C.

Students will also be able to review their personal development of their scientific skill for laboratory work, which could support the decision of the optional unit.

It may be appropriate to prepare the students for a resit opportunity of the external examinations alongside this unit.

Assessment is planned in the January window to manage the workload of the internal assessment requirements.

Unit 5 is an optional internally assessed unit, through a 65-hour task based PSAB. In this unit. students will undertake a literature search and review to produce an investigative project proposal. Students will then be required to produce a plan for an investigative project based on a proposal and then safely undertake the project, collecting, analysing and presenting the results. Finally, students should present the conclusions from the project using correct scientific principles.

OR

Unit 6 is an internally assessed optional unit with an associated task based PSAB of approximately 60 hours. In this unit, students will explore contemporary science issues and their impact on the world we live in. It will develop the students' skills of analysis and interpretation across a broad range of scientific issues while exploring how they are reported in the media and in publications.

Centres may deliver the qualification over a one-year period if required to provide flexibility to meet student or centre qualification planning needs.

4. Qualification Unit Delivery Guides

This section contains support for delivery of all the units in this qualification. The focus of these guides is on structuring and supporting the teaching and learning process. You will find ideas for activities and guidance on how best to use the activities to develop students understanding of the topics in each unit. This section also includes activities and information on how to deliver transferable skills which are embedded or signposted in the qualification.

Unit 1: Principles and Applications of Biology

Unit overview

Principles and Applications of Biology	
Assessment type: External	
Content Area	**Topics**
A: Structure and function of cells and tissues	A1 Structure and function of cells and tissues A2 Structure and function of specialised cells in multicellular organisms A3 Structure and function of biological tissues
B: Structure and function of biological molecules	B1 Structure and function of water B2 Structure and function of carbohydrates B3 Structure and function of proteins B4 Structure and function of nucleic acids B5 Structure and function of lipids
C: Cellular transport and enzyme activity	C1 Cell transport mechanisms C2 Enzymes as biological catalysts C3 Homeostasis
Assessment overview The unit will be assessed through one examination of 50 marks lasting 1 hour. The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented. The assessment availability is twice a year in January and May/June. The first assessment availability is May/June 2026. Sample assessment materials will be available to help centres prepare students for assessment.	

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your students to avoid and overcome these.

What is the misconception?	How to help students overcome it
All cells are the same, except for their function	Highlight the differences in cell structure and how that enables its specific function.
Respiration and breathing are the same	Respiration is a chemical reaction that transfers energy in cells, while breathing is the process of moving air into and out of the lungs. Plants respire, but they don't have lungs, so they don't breathe.
All bacteria are pathogenic	We need healthy gut flora. Our skin is covered in millions of bacteria (fungi and viruses), but these are essential in the protection against pathogens.
Proteins are only for building muscles	Match the protein to the function, e.g. enzymes, hormones, haemoglobin, etc to explain the range of functions. Highlight the different proteins involved in the biological processes throughout the unit.
Active transport and facilitated diffusion are the same	Give full definitions of both processes and which molecules are transported through the cell membrane by each process.
Concentration gradients only affect active transport	Discuss concentration gradients with the definition of different types of cell transport- In active transport, the molecules move against the concentration gradient whereas in passive transport, the molecules move along the concentration gradient.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Learning Topic	Activities and guidance for unit content delivery	Resources
A: Structure and function of cells and tissues		
A1 Structure and function of cells and tissues	• **Whole class teaching and learning - introduction** Make jelly cells to illustrate subcellular structures of eukaryotic cells using different types of sweets as organelles for both plant and animal cells to distinguish specific structures. • **Small group activity –similarities and differences between animal and plant cells** o Groups will produce a card game or board game based on the similarities and differences between the structure and function of plant cells and animal cells. Students could create a pair matching game, where the cards contain the names of the organelles and definitions, turning two cards over to make a match.	**stem.org** – this website contains a library of resources, which can be used as an introduction to cell organelles https://www.stem.org.uk/resources/elibrary/resource/34589/cell-suitable-home-teaching **Wordwall** – virtual cell organelle matching game Cell Organelle Matching Game - Find the match

	• **Whole class and individual activity – identifying different cell organelles** o Provide students with high-resolution diagrams or electron micrographs of both animal and plant cells to label the organelles in each diagram and write a brief description of their functions. o Task students with creating Venn diagram to visually organise the similarities and differences between animal and plant cells. Include aspects such as: - cell structure - organelles - functions - cell type. • **Laboratory activity – using a microscope and preparing slides** o Students will use a microscope and examine prepared slides of animal (e.g. cheek cells stained with methyl blue) and plant cells (e.g. onion skin cells stained with iodine). o Students to complete annotated drawings. o Students can calculate the size of cells using 'I AM'. calculations from direct viewing using an optical microscope, using the microscope eyepiece graticule. o Students can compare their observations to identify similarities and differences. • **Individual activity – comparing organelles** o Students will compare and contrast the structure and function of cell organelles, producing a fact file for each organelle.	**Histology Guide** – examples of TEM cell structures The Cell | Histology Guide **STEM learning –** cheek cell practical methodology sheet | STEM

	○ Students could compare mitochondria and chloroplasts: - key internal structures - function - other processes. (Please note: Full details of the Krebs cycle would not be needed (breaks down pyruvate into CO_2 and high-energy electrons should be sufficient) for the mitochondria, and full details of the Calvin cycle would not be needed- just that it occurs in the stroma uses CO_2, ATP, and NADPH to produce glucose for chloroplasts). • **Whole class and individual activity – subcellular features of prokaryotes** ○ Provide students with electron micrographs of prokaryotes and ask them to label the subcellar structures. ○ Calculate the size of cells using 'I AM' calculations from the images of electron micrographs, carrying out the relevant conversions. • **Interactive demonstration – carrying out gram staining to distinguish Gram-positive and Gram-negative bacteria** ○ Students will use a microscope to examine Gram-positive and Gram-negative bacteria. ○ Students to complete comparison of peptidoglycan and lipopolysaccharide membrane ○ Students can discuss how this may affect how antibiotics are used for Gram-positive and Gram-negative bacteria.	**IB Guides** – prokaryotic cells electron micrographs IB Biology Notes - 2.2 Prokaryotic cells **YouTube** – gram staining demonstration Gram Staining –from classroom to the lab.. in less than 15 mins - YouTube

	• **Individual activity – knowledge check** o Consolidate student learning by testing their knowledge of key terminology relevant to cell structure using interactive quiz tools such as Quizizz, Quizlet, Kahoot! or similar, and providing a glossary of key terms.	**Quizlet** – cell structure Cell Structure Flashcards | Quizlet
A2 Structure and function of specialised cells in multicellular organisms	• **Whole class teaching and learning - introduction** o Explain the concept of stem cells. o Discuss the differentiation of cells. This can be done using the video resource supplied. • **Small group activity – ethical considerations of stem cells** o Provide the class with recent news articles about stem cell research as a stimulus for discussion. o Ethical considerations could be discussed as well as the potential as treatments. • **Small group activity – specialised cell** o Each student is given a specialised cell some examples may include: – T cells - B cells - neutrophils - basophil - eosinophil - monocytes - phagocytes. o Students circulate the room asking questions about each cell type and record information. o Students try to guess the specialised cell that each person has been allocated.	**Stem cells video clip** – discussing the concept of stem cells https://youtu.be/-uno7Uj2cjk **Article on stem cell use** – stem cell-based therapy for human diseases https://www.nature.com/articles/s41392-022-01134-4 , **Specialised cells** – flash cards on cell types that could be used Flashcards BTEC level 3 Specialised cells | Quizlet

	• **Laboratory activity – investigating plant tissues**
	  ○ Students dissect a plant and display its parts, including the roots, stem and flower.
	  ○ For each part the student is to discuss the function and how the cells may be specialised.
	
	• **Laboratory activity – investigating transpiration**
	  ○ Students to investigate transpiration in celery.
	  ○ Cut a short piece of celery with the leaves still on
	  ○ Place it in a few centimetres of food colouring in water.
	  ○ Leave for a day and then carefully cut into the celery to see where the colour has reached to indicate transpiration.
	
	• **Whole class teaching and learning – white blood cells**
	  ○ Share with students a video on white blood cell's structure and function.
	  ○ Ask students produce a cartoon strip on the action of the different white blood cells when encountering foreign pathogens.
	  ○ Students could personify different types of white blood cells and through drawings and/or speech bubbles demonstrate their understanding of white blood cells, e.g. a large phagocyte that eats everything it sees.
		science-sparks.com – dissection of a flower
		Plant Science - Dissect a flower and more plant experiments
		
		Science on the Shelves – how plants transport water activity
		https://www.york.ac.uk/res/sots/activities/celery.htm
		
		DIY rainbow roses - colour changing rose experiment
		https://homegrownfriends.com/home/color-changing-rose-experiment-little-blue-little-yellow-activity/
		
		What are white blood cells? – overview video of white blood cell's structure and function
		https://youtu.be/qWSWWPZYGHU

	• **Whole class and individual activity - sex cells** o Introduce the structure and function of sex cells to students using a video of slide presentation. o Ask students to create 3D models of sex cells using modelling clay, paper and other modelling materials to show size and each of the major structures. o Students could produce a stop motion video of fertilisation with the models, which includes the following information. - the tail - midpiece - acrosome in the sperm - the zona pellucida - corona radiata in the egg. • **Individual activity – knowledge check** o Consolidate student learning by testing their knowledge of key terminology relevant to specialised cells using interactive quiz tools such as Quizizz, Quizlet, Kahoot! or similar, and providing a glossary of key terms.	**Sperm and egg cells** – introduction to structure and function of sperm and egg cells https://youtu.be/CuxaXghfyeE **Quizlet** – specialised cells SPECILISED CELLS Flashcards | Quizlet
A3 Structure and function of biological tissues	• **Whole class teaching and learning - introduction** o Recap with the students the concept of cell theory, including the full definitions of: - cell - tissue - organ - organ system - organism.	**BBC Bitesize** - history of the cell https://bitesizebio.com/166/history-of-cell-biology/

	• **Whole class teaching and learning activity – anatomy of the lungs**
	  o Teacher to demonstrate a pluck to illustrate the microstructure of the lungs and focus on goblet cells, ciliated cells and alveoli
	
	• **Laboratory activity – epithelial tissue**
	  o Individual students can use prepared microscope slides of squamous cells, goblet cells and ciliated cells can be used to view details.
	  o Students can discuss cell specialism to link into previous topics.
	  o Students draw annotated diagrams to reflect the differences and similarities between the two types of tissue.
	
	• **Small group activity – respiratory and cardiovascular diseases**
	  o Allocate students into groups and ask them to research and prepare a slide presentation on respiratory and cardiovascular diseases due to smoking tobacco.
	  o Students can share their presentations with the class in the form of peer teaching.
	
	• **Laboratory activity – structure and function of muscles**
	  o Introduction to the concept of gross muscular structure. This could be done using the video resource.
	  o Chicken wing dissection- to explore the structure and function of muscles, bones and joints.
		Pluck Dissection - Instructions and a video of a pluck dissection https://www.stem.org.uk/resources/elibrary/resource/34598/pluck-dissection
		
		Examining Epithelial Tissue Under the Microscope – key points of epithelial tissue and visualisation under the microscope 3.1: Examining epithelial tissue under the microscope - Medicine LibreTexts
		
		NHS cardiovascular diseases – Students can use websites such as these for information https://www.nhs.uk/conditions/cardiovascular-disease/#:~:text=Smoking,and%20narrow%20your%20blood%20vessels
		
		ASH smoking and respiratory disease - students can use websites such as these for information Smoking and Respiratory Disease - ASH

	• **Whole class teaching and learning – introduction to microscopic muscle structure** o Teacher led discussion of the microscopic structure and function of muscular tissue, this may include. - muscle fibres - multinucleated - striated appearance - myofibrils - sarcomere - sarcolemma - sarcoplasmic reticulum - mitochondria - neuromuscular junctions - T tubules. o Students should discuss the sliding filament theory including the action of actin and myosin, troponin, tropomyosin, calcium ions and ATP. o Teacher led animation to explain the action of fast and slow twitch muscle fibres. o Students to produce a quick table of comparison summarising the key differences between slow twitch and fast twitch muscle fibres. • **Whole class teaching and learning – introduction to the structure and function of nervous tissue** o Teacher led overview of the differences between myelinated and non-myelinated neurones. o Students to use information sheet provided to produce flash cards of key similarities and differences between myelinated and non-myelinated neurones.	**Overview of Muscular System** – this video provides an overview of the muscular system https://youtu.be/rMcg9YzNSEs **Performing a chicken wing dissection** – instructions and safety information for chicken wing dissection https://assist.asta.edu.au/sites/assist.asta.edu.au/files/SOP%20Performing%20a%20chicken%20wing%20dissection.pdf **Muscles, Part 1 – Muscle Cells** – video explaining overview of muscle structure https://youtu.be/Ktv-CaOt6UQ **Types of Skeletal Muscle** – this video details different types of muscle fibres https://youtu.be/phhnNL_ijqI **Introduction to myelinated and unmyelinated axons** – this webpage gives key similarities and differences of different types of neurones. Myelinated And Unmyelinated Axons | Structure, Importance

	○ Students to peer teach using flash cards produced. ○ Students to compare graphs of speed of impulse from myelinated and non-myelinated neurones. • **Whole class and individual activity – conduction of a nerve impulse** ○ Using the animation on nerve impulses as stimulus, discuss how a nerve impulse is conducted along an axon. ○ Students could note down any key terms that are not known and discuss what these may mean. Students to perform further research and complete a flow chart or animation of the steps involved in nerve impulse through the axon. • **Whole class and small group activity – synaptic transmission** ○ Teacher to introduce the concept of the synapse, this may be done using a video resource. ○ Students review the structure of the synapse and annotate a suitable diagram. ○ Students to work in small groups to use modelling clay or other suitable resource to construct a series of snapshots of key events in synaptic transmission. ○ Students to combine snapshots to create stop animation of the synaptic transmission process. • **Small group activity - the nervous system** ○ Student should research the action of different neurotransmitters at the synapse.	**Action potential** – video explaining steps in nerve impulse conduction https://youtu.be/nV_OEvln9Xs **The mechanism of nerve impulse transmission** – key points in nerve impulse transmission 42.2: The Mechanism of Nerve Impulse Transmission - Biology LibreTexts **The Nervous System, Part 3** – key overview of synapse animation https://youtu.be/VitFvNvRIIY

	○ Students apply their knowledge of nerve conduction to interpret ECG traces that can be sourced from local hospitals or the internet. ○ Students should try to identify normal versus abnormal patterns. A normal ECG showcases consistent wave shapes and intervals, indicating a healthy heart rhythm. Deviations from these norms may indicate potential issues, such as arrhythmias or other cardiac abnormalities. ○ Students could "diagnose" the patient based on the ECG trace with reasoning. • **Small group activity – types of transmitters** ○ Students to discuss inhibitory and excitatory neurotransmitters. ○ Students should apply their knowledge of synapses to discuss antagonist and agonist effects of drugs in synaptic transmission. ○ Students to produce a 3-minute elevator pitch explaining how L-Dopa can reduce muscle tremor and motor problems. Students watch video on SSRIs and write a statement about how these can be used as antidepressant medication.	**ECG trace bank** – life in the fast lane website has a library of ECG traces https://litfl.com/ecg-library/ **Parkinson's UK official site** – information, support and research on living with Parkinson's disease https://www.parkinsons.org.uk/

B: Structure and function of biological molecules		
B1 Structure and function of water	• **Whole class teaching and learning/peer teaching – structure and function of water** o Teacher to discuss the link to chemistry and chemical bonding, this may be done using animations. o Students to prepare 5 minute micro-teach on the structure and function of water to give in groups using chemistry knowledge. o Students to use Molymods/chemical modelling kits to discuss the chemical bonding in water • **Laboratory activity – investigating the properties of water** o Students to carry out a carousel of practical activities to investigate the properties of water. o Students should rotate around the activities at each activity considering the property of water and how this relates to the structure. o Activities include: - surface tension with soap and pepper - making a paper clip float - cohesion of water on a penny - polarity of water using food colouring - capillary action using a paper towel. o Once students have completed all of the activities, they should draw conclusions and discuss the outcomes that they have found and how they relate to the structure of water molecules.	**Structure of water** - video animation of structure and function of water https://youtu.be/A88ih2PQDNs **Testing the Properties of Water** – practical activity instructions for carousel of properties https://thehomeschoolscientist.com/testing-the-properties-of-water/

B2 Structure and function of carbohydrates	• **Whole class teaching and learning – introduction to carbohydrates**
	  o Teacher led discussion and mind map activity on what students can recall about carbohydrates.
	  o Teacher could use video resource as a stimulus material for further discussion around carbohydrate function and an introduction of structure.
	  o Students can use this information to fill in further information into their mind map.
	
	• **Small group activity – structure of carbohydrates**
	  o Students to create models of carbohydrates using sweets or other modelling materials.
	  o Students should show the chemical bonding and structures of carbohydrates.
	  o Students could provide a key to indicate which element is presented by the different colours of the sweets should be produced based on the sweets available.
	  o Toothpicks can be used to represent the bonds. A single toothpick represents a single bond, two toothpicks represent a double bond, and three toothpicks represent a triple bond.
	  o Students should show monosaccharides, disaccharides and polysaccharides, with glucose or cellulose as examples.
		Carbohydrate and sugars biochemistry – brief video introduction on structure and function of carbohydrates
		Carbohydrates & sugars - biochemistry - YouTube
		
		BBC Bitesize – food test practical which outlines the practical procedures
		https://www.bbc.co.uk/bitesize/guides/z88hcj6/revision/5

	• **Laboratory activity - testing for carbohydrates**
	  o Students could perform a practical activity to test for simple sugars and carbohydrates.
	  o Students should test known and unknown samples for the presence of simple sugars and carbohydrates, using Benedict's solution and iodine.
	  o Students can then summarize their findings and relate them to the structures of the different carbohydrates. This could be done using interactive quizzes.
		Biomolecule quizzes – questions that can be input into interactive quizzes https://quizizz.com/admin/quiz/5c9d5baab2e4c6001afc0f9f/biomolecules

B3 Structure and function of proteins	• **Whole class and individual activity - protein models**
	  o Teacher can demonstrate the structure of proteins through modelling using pipe cleaners and coloured beads.
	  o Students can build different proteins using pipe cleaners and coloured beads from amino acids
	  o Students can use the pipe cleaner to form alpha helices, beta strands, and link to different protein structures.
	  o Different colours or shapes of pipe cleaners and beads are great for showing the variety in amino acids.
	
	• **Laboratory Activity - Testing for proteins**
	  o Students could perform a practical activity to test for proteins.
	  o Students should test known and unknown samples for the presence of proteins, using Biuret solution.
	  o Students should summarise the results and relate to protein structure.
		Hands-on Biochemistry – practical activity to teach protein structure https://www.scienceandmathwithmrslau.com/2014/09/hands-on-biochemistry-beads-pipe-cleaners-and-the-clearest-way-to-teach-monomers-and-polymers/
		
		Practical food tests – practical guidance for qualitative tests Required Practical 4 - Food Tests
		
		Practical biuret test – practical video for biuret test Biuret Test for Protein - YouTube

B4 Structure and function of nucleic acids	• **Whole class teaching and learning - introduction** o Teacher to lead a discussion around the steps in DNA discovery. o Students could discuss the article on Rosalind Franklin's role and possible controversy over the discovery of DNA. **Whole class and individual activity – DNA structure** o Use of virtual lab stimulation to visualise the structure of DNA and discuss the different components and bond types. o Students create annotated drawings of the structure of DNA. o You may wish to consider the following points: - nucleotide composition - base pairing - sugar-phosphate backbone. **Whole class and small group activity - DNA model** o Students to create a 3D double helix model from Molymods/sweets or from a DNA paper chain o Students should use their models to discuss mutations and the consequences in small groups. • **Laboratory Activity - Extract DNA from fruit** o Students to perform an experiment highlighting how DNA can be isolated from cells. o Students should consider the purpose of each step of the method: - Why is the fruit mashed? - Why is detergent added? - Why is it heated?	**Nature** – What Rosalind Franklin Truly Contributed to the Discovery of DNA's Structure https://www.nature.com/articles/d41586-023-01313-5 **DNA structure** – a virtual lab stimulation https://www.illumina.com/content/dam/illumina-marketing/apps/dnaday/index.html **STEM education** – making DNA with sweets https://www.youtube.com/watch?v=5-f1ja_xn1U **Experiment: DNA Extraction from Fruit** – practical procedure steps https://www.futurelearn.com/info/courses/biochemistry/0/steps/21618 **What is DNA Synthesis?** – stages of DNA formation DNA Synthesis Simplified: A Beginner's Guide | IDT

	• **Individual Activity – DNA replication** o Teacher to provide an overview of DNA replication, this could be done using supplied resources. o Students construct a story board considering the stages of semi-conservative DNA replication. They may want to consider the following stages: - DNA helicase and initiation - DNA polymerase and elongation - termination. • **Individual Activity – formation of RNA for protein synthesis and gene expression** o Teacher to provide an overview of the structure of RNA and how it is used in protein synthesis including: - RNA nucleotides in a single strand - bonding between nucleotides - comparison between DNA and RNA - types of RNA - how RNA is used in protein synthesis. o Students use a virtual lab to consider the stages of RNA formation and RNA function in protein synthesis. They may want to consider making a podcast of the process to play for peers as a revision activity. • **Individual Activity – protein synthesis animation** o Teacher provides an overview of the steps in protein synthesis and then students produce animation potentially using plasticene/whiteboards.	**DNA replication animation** – Fuse School DNA replication DNA Replication | Genetics | Biology | FuseSchool - YouTube **Structure of RNA** – revision structure of RNA Structure of RNA - Revise: Gene expression - Higher Biology Revision - BBC Bitesize **Protein synthesis animation** – fuse School protein synthesis revision video Protein Synthesis | Cells | Biology | FuseSchool - YouTube

	○ You may wish to consider transcription: - Role of RNA polymerase. - Formation of mRNA from DNA template. - Base pairing rules (A-U, C-G). - Location in cell. - Purpose of transcription. ○ You may wish to consider translation: - Roles of ribosomes and tRNA. - Codon and anticodon matching. - Amino acid chain formation.	**Protein synthesis simulator** – stages of protein synthesis simulated. Protein Synthesis
B5 Structure and function of lipids	• **Whole class teaching and learning - introduction** ○ Discussion around lipid structure and function using the video resource as a starting point. ○ Students to compose a table of the properties of triglyceride, phospholipids, and cholesterol ○ Students should include in their table which of the following applies to each molecule: - Contains only the elements carbon hydrogen and oxygen. - Insoluble in water. - Contains glycerol. - Contains ester bonds. - Important in membrane structure. - Contains fatty acids.	**Lipid overview** – short video on structure and function of lipids https://youtu.be/Ezp8F7XJHWE

	• **Small group activity – structure of lipids** o Students produce paper models of lipids- highlighting key parts, such as: - bonding types - glycerol - fatty acids - phosphate groups. • **Whole class teaching and learning/ small group activity – function of lipids** o Students to use resource bank to research the following functions of lipids o Students to produce slide deck presentation on key functions. This should include - Energy storage - Insulation – thermal and electrical - Formation of membranes - Protect organs - Source of steroid hormones - Source of vitamin D - Waterproofing o Students use slide presentations to discuss functions and why these may be important. • **Laboratory activity - testing for lipids** o Students could perform a practical activity to test for lipids o Students should test known and unknown samples for the presence of lipids, using the emulsion test. o Students should summarise the results and relate to lipid structure.	**Using lipids** –lipid paper models and a slide presentation about lipids, https://behindthebiologylessons.wordpress.com/2023/12/27/using-lipids-as-the-basis-of-a-synoptic-lesson/ **Functions of Lipids** – key facts about lipids resource bank https://med.libretexts.org/Courses/Metropolitan_State_University_of_Denver/Introduction_to_Nutrition_(Diker)/05%3A_Lipids/5.3%3A_Functions_of_Lipids **The lipid emulsion test** – notes on emulsion test and video of practical test Learnbiology.net - The Emulsion Test for Lipids

	• **Whole class activity – class discussion about reindeers** o Whole class discussion around 'Why would cells in reindeer hooves have more unsaturated fatty acids in their membranes compared to those found in their upper legs?' o Students can be given time to prepare their response, using key information previously covered. o Students discuss potential answers and agree on which response they feel is the most correct from those given. o Students may like to consider the following points. - Where would fatty acids be found within a membrane? - What's the difference between saturated and unsaturated fatty acids? - How does the level of saturation affect the packing ability of the chains? - What's the difference in environment between the hoof & upper leg of a reindeer? • **Individual activity – knowledge check** o Consolidate student learning by testing their knowledge of key biological molecules using interactive quiz tools such as Quizizz, Quizlet, Kahoot!, or similar and providing a glossary of key terms.	**Quizlet –** biological molecules Biological Molecules Flashcards | Quizlet

C: Cellular transport and enzyme activity		

C1 Cell transport mechanisms	• **Whole class teaching and learning - Introduction**
	  o Discussion around what components are in a cell surface membrane.
	  o Students can identify which components they recognise and recall information about structure and functions of those components.
	
	• **Whole class teaching and individual activity**
	  o Students identify key components of cell surface membrane.
	  o Students make a presentation of the fluid mosaic model of a cell surface membrane including:
	  - phospholipids
	  - glycoproteins
	  - channel proteins
	  - glycolipids
	  - cholesterol
	  - channel proteins.
	
	• **Laboratory activity – membrane permeability**
	  o Students investigate the effect of temperature on membrane permeability
	  o Students to use known sizes of beetroot cylinder in a volume of water for a set period of time
	  o Each cylinder would be left at varying temperatures
	  o A colorimeter can then be used to identify where most betalain has been released
	  o Students analyse results and relate to membrane structure
		Inside the cell membrane – brief overview video of the cell membrane https://youtu.be/qBCVVszQQNs
		
		The National Human Genome Research Institute – cell membrane structure https://www.genome.gov/genetics-glossary/Cell-Membrane-Plasma-Membrane
		
		SNAB Biology – The Effect of Temperature on Cell Membranes The Effect of Temperature on Cell Membranes - Snab Biology

	○ Students may wish to consider temperature, surface area of membrane, membrane thickness, number/type of transport proteins, availability of ATP, lipid solubility and size of molecules in their conclusion. **Laboratory activity – diffusion** ○ Students to investigate the rate of diffusion in agar cubes ○ Students to create cubes of varying sizes out of agar ○ Place agar cubes in concentrations of acid (HCl) ○ Use an indicator to identify the end point of the reaction. ○ Students evaluate how the variance in size of the agar cubes impacted the rate of reaction. • **Laboratory activity – investigating osmosis** ○ Students presented considerations with osmosis including Diffusion of water across a partially permeable membrane. From high water potential to low water potential. Important in maintaining cell turgor and fluid balance. ○ Students investigate the process of osmosis using potato and a variety of solute concentrations. ○ Students place known mass of potato into different solute concentrations ○ These will be left for a known time (overnight is best) ○ Students will then retake the mass and calculate percentage mass change ○ Students will plot this information on a graph ○ Student will use the graph to explain how and why the mass changed at different solute concentrations.	**Royal Society of Biology, Nuffield Foundation** - Effect of Size on Uptake by Diffusion https://practicalbiology.org/exchange-of-materials/diffusion/effect-of-size-on-uptake-by-diffusion **Data Classroom** - Potato Osmosis Lab Potato Osmosis Lab — DataClassroom

	OR • **Laboratory activity – investigating osmosis** o Students will Investigate osmosis using eggs with the shells removed (using vinegar) o Students then place the de-shelled egg into a high glucose solution and leave overnight o Students will then explain the changes in the egg o Then place the egg into coloured water and leave overnight o Students will then explain the outcome again and relate to process of osmosis. o Students should consider concentration gradients and relate them to terms such as hypertonic, isotonic, hypertonic	**The Sci Guys** - The naked Egg and Osmosis https://www.youtube.com/watch?v=SrON0nEEWmo
	• **Whole class and small group activity - research cell transport mechanisms** o Students should be placed in small groups and given a cell transport mechanism to include: - facilitated diffusion (movement of larger or charged molecules - e.g. glucose, ions - via channel or carrier proteins, still passive, no ATP required, specific to the molecule being transported. - simple diffusion (movement of small, non-polar molecules - e.g. oxygen, carbon dioxide - from high to low concentration, occurs directly through the phospholipid bilayer, driven by the concentration gradient)	**BiologyInsights** – Cell Transport Mechanisms: An In-Depth Guide Cell Transport Mechanisms: An In-Depth Guide - BiologyInsights

	- active transport (requires energy from ATP, moves substances against the concentration gradient low to high, uses carrier proteins that change shape when ATP is hydrolysed e.g. sodium-potassium pump in nerve cells) - bulk transport (requires vesicles and ATP) - endocytosis (phagocytosis: solid particles - e.g. bacteria – engulfed) - pinocytosis (fluids or dissolved substances taken in, membrane invaginates, forming a vesicle) - exocytosis (vesicles fuse with the plasma membrane to release contents e.g. hormones and enzymes, important in secretion and waste removal) o Each student group will research their transport mechanisms in terms of: - the process - the energy requirement - example of use. o Each group peer teaches their mechanism. • **Whole class activity – discussion about aquatic animals regulating their salt levels** o Students discuss the question 'How do sea dwelling creatures undergo active transport, and how does this impact salt regulation? o Students to be given time to make notes on the question and refer to prior learning o Students then debate the answer to agree on the most suitable answer	

	• **Individual activity – knowledge check** o Consolidate student learning by testing their knowledge of key cell transport mechanisms using interactive quiz tools such as Quizizz, Quizlet, Kahoot!, or similar and providing a glossary of key terms.	**Quizlet** – cell transport Cell Transport Flashcards | Quizlet
C2 Enzymes as biological catalysts	• **Laboratory activity - explore how enzyme activity changes in different conditions.** o Students discuss what they can recall about enzyme structure and function, the video resource can be used as a stimulus o Students carry out a carousel of practical activities to investigate the factors affecting enzyme reactions. o Students may complete each investigation over multiple sessions o Or students can be grouped, and each do a different activity o Students would then need to present results and findings as a 'science fair' type activity. o Investigations could include: - investigate the effect of pH on amylase activity - investigating effect of temperature on the activity of lipase - investigating the effect of concentration on the activity of trypsin - investigating an enzyme-controlled reaction: catalase and hydrogen peroxide concentration.	**Make Science Easy** – Basic Biology: Enzymes https://www.youtube.com/watch?v=TLhBJQ2Q4QQ **Royal Society of Biology, Nuffield Foundation -** Factors Affecting Enzyme Activity, https://practicalbiology.org/bio-molecules/factors-affecting-enzyme-activity

C3
Homeostasis
	• **Whole class teaching and learning - introduction**
	  ○ Discuss the definition of homeostasis and explore why it is important; you could use the video resource as stimulus to discuss.
	  ○ Students are to list all the different ways in which the body can maintain an environment, share areas and generate a collaborative mind map
	
	• **Whole class teaching and pair peer teaching activity – systems under homeostatic control**
	  ○ Students can discuss the list of ways in which the body maintains a constant internal environment
	  ○ In pairs students can each take a system and research why it is important for that environment to be maintained
	  ○ Pairs can present ideas to the rest of the group in the format of peer teaching.
	  ○ Students can explore this virtually with a body simulator to emphasise the importance of a quick response.
	
	• **Laboratory activity and small group activity – keep a constant temperature**
	  ○ Students are given a beaker of water, a Bunsen set up and some ice.
	  ○ Students are asked to maintain the water as a set temperature (determined by the teacher)
	  ○ Students can heat with a Bunsen and cool with ice, but they cannot use any other materials.
	  ○ Students record the temperature over time.
	  ○ Students to discuss their results in small groups – how easy/difficult was the temperature to maintain.
	  ○ Students evaluate how this may relate to the human body and what aspects changes in temperature may affect.
		Fuse School - What is homeostasis? https://youtu.be/quQr6X1Q58I
		
		WebMD - What is homeostasis? https://www.webmd.com/a-to-z-guides/what-is-homeostasis
		
		PBS learning media - body control simulation https://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.bodycontrol/body-control-center/
		
		Thermoregulation – overview of homeostasis and temperature control https://youtu.be/qcFRZ-xvQSA

	○ Students can reflect on video resources as stimulus if required. • **Whole class and individual activity – Negative and positive feedback loops** ○ Students could be given a series of scenarios where homeostasis is required and they would need to suggest the corrective measure, this could include: - Student too hot when playing a sport. - Student too cold in an exam hall. - Student eats large volumes of birthday cake. - Students drinks a large bottle of squash at break time. ○ Students could discuss the difference between positive and negative feedback loops, the video resource could be used as stimulus material. ○ Students could use the information to create flow diagrams of the different corrective mechanisms used in homeostasis. • **Small group Activity – discussion about homeostasis** ○ Students should be presented with the case study video (Guardsman collapsing) ○ Students should discuss what caused this to happen, and what environments were not being maintained? ○ Students to discuss what corrective mechanisms should have occurred? ○ How could this incident have been prevented?	**Amoeba sisters** – homeostasis and negative/positive feedback https://www.youtube.com/watch?v=Iz0Q9nTZCw4 **Royal Guard Faints** – video case study of homeostatic event https://youtu.be/_Wqulwx5Tdk

	• **Whole class teaching and learning – autonomic nervous system: breathing and heartbeat**
	  o Discuss the Sympathetic vs parasympathetic divisions. Involuntary control of cardiac and respiratory centres in the medulla oblongata.
	  o Students could be given case studies (dynamic response, exercise) to show dynamic regulation.
	  o Students to annotate diagrams of autonomic pathways and target organs.
	  o Compare resting vs stress-induced heat/respiratory rates.
	  o Evaluate how autonomic dysfunction affects homeostasis.
	
	• **Whole class teaching and learning – adrenal glands: flight or fight**
	  o Discuss the adrenal medulla: adrenaline, and nor adrenaline.
	  o Effects on heart rate, blood pressure, glucose mobilization.
	  o Students create flow chart diagrams linking endocrine feedback loops and stress hormones.
	  o Explain physiological changes during acute stress.
	  o Analyse hormone levels in blood in stress-related data sets.
	
	• **Guest speaker – Diabetes specialist nurse or cardiovascular clinician**
	  o Invite a specialist nurse or cardiovascular clinician to come in either remote or face to face to discuss homeostasis
	  o Invite a guest speaker in the form a diabetic to discuss how the condition is controlled.	

	• **Whole class teaching and learning – hypothalamus as a neuroendocrine interface** o Teacher to explain regulation of pituitary gland and homeostatic functions such as temperature and thirst. o Teacher to lead discussion on the comparison between the nervous and endocrine system: - speed of response - mode of transmission - pathway - target specificity - duration of response. o Provide students with case studies of real-world examples such as thermoregulation and cortisol release. • **Whole class teaching and learning – sensory and motor pathways** o Teacher to explain sensory and motor pathways. This could include relay of information from and to the CNS via autonomic and somatic systems. o Provide students with diagrams of reflex arcs. Ask them to label and explain how each part helps with the transmission of information. o Provide case studies of disorders related to neuropathy to contextualise the function. o Trace a stimulus response pathway involving both systems. o Ask students to have a group discussion on the implications of nerve damage.	

	• **Small group Activity – discussion about ageing and feedback look weakening** o Students to be given case study examples of heart failure (baroreceptor dysfunction) and/or type 2 diabetes (insulin resistance) to discuss impact on feedback loops. o Provide students with age-related data trends and allow them to compare young vs elderly physiological responses. o Ask students to discuss how ageing affects homeostatic regulation. o Provide data showing the progression of chronic conditions and ask students to analyse the data. • **Individual activity/peer teaching activity – lifestyle influences** o Students prepare for a 5 minute microteach activity reviewing one aspect of lifestyle that may affect homeostasis. Aspects you may wish to consider would include: - nutrition, for example deficiencies such as iron or vitamin D and impact on metabolic regulation and cardiovascular health - nutrition, for example excess of saturated fats and impact on metabolic regulation and cardiovascular health - drug or alcohol abuse, including disruption of liver function, hormonal balance and neural signaling. o Students may wish to consider including the following types of data: - comparative lifestyle profiles and associated data - public health campaigns and NHS guidance - lifestyle interventions for restoring homeostasis. - graphs showing physiological changes due to lifestyle factors.	**Physics and maths tutor** – homeostasis Flashcards - Topic 5.1 Homeostasis - AQA Biology GCSE - PMT

	• **Individual activity – knowledge check** o Consolidate student learning by testing their knowledge of homeostasis using interactive quiz tools such as Quizizz, Quizlet, Kahoot!, or similar and providing a glossary of key terms.	
Unit 1 Exam practice	Unit 1 is assessed through one examination of 50 marks lasting 1 hour. The assessment availability is twice a year in January and May/June. The first assessment availability is May/June 2026. Alongside unit content delivery, sample assessment material exam papers (available on the qualification page here) can be used to help students understand the format of the exam paper, command words and how the mark scheme is applied. As each learning topic is delivered it is recommended students practice exam skills, timing and applying their learning to a wide variety of exam style questions.	**Pearson** – sample assessment materials and past papers Applied Science (AAQ) | Pearson qualifications **Pearson** – Exam Wizard examWizard | Pearson qualifications

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery

SP-CT – Critical Thinking	**Whole class teaching and learning – demonstrating critical thinking skills**
	• Explain to students the concept of critical thinking using examples from debating questions, such as the discussion around homeostasis. Students would need to demonstrate:
	  ○ questioning relevance of information
	  ○ challenging their own biases
	  ○ breaking information into parts and identifying relationships and connections
	  ○ identifying strengths or weaknesses of information and why information is significant
	  ○ drawing conclusions supported by structured reasoning.
	• Students would also need to consider arguments from other perspectives where this was applicable.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

Secondary teaching resources | RSC Education – Royal Society of Chemistry

Teaching resources – a variety of teaching resources to assist with delivery of biochemistry topics and associated practical activities

Pearson (Edexcel) A Level Biology (A) Revision - Curriculum Press – Curriculum Press

Factsheets, articles, slide decks and notes on separated by Biology topic

KS5 Lesson Resources – Evolution of a Biology Teacher- Biology Teacher

Lesson resources inclusive of slide presentations and resource booklets arranged by topic

Health A to Z - NHS – National Health Service UK

Provides information on a variety of health conditions covered in the specification

The Biologist – Royal Society of Biology

Student magazine exploring recent developments in Biology, with features, interviews and opinion articles.

Practical Biology – Royal Society of Biology

Practical procedures and related real-life contexts, inclusive of guidance for technicians.

Homepage - Science & Plants for Schools – Science and Plants for Schools

Practical procedures and related real-life contexts, inclusive of guidance for technicians.

A-level Biology Revision Resources (Free access) — Online A level Biology Tutor

Student revision resources, quizzes, exam tips, organised by topic

| STEM – STEM Learning Big Picture

Big Picture magazine is aimed at post 16 students to explore contemporary issues in biology and medicine. It contains articles, activity sheets and presentations.

Home | Wellcome – Wellcome Trust

Offers 5 minute articles associated with modern medicine and science topics for developing a wider application of the specification.

Textbooks

Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., and Orr, R., Campbell Biology 12th Edition, Pearson, 2020

Vologodskii, A., The Basics of Molecular Biology, Springer, 2022

Orchard, G., Nation, B., Cell Structure & Function (Fundamentals of Biomedical Science), OUP Oxford, 2014

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 2: Principles and Applications of Chemistry

Unit overview

Unit 2: Principles and Applications of Chemistry
Assessment type: External
Content Area
A: Atomic and electronic structure
B: Bonding and structure
C: Periodicity
D: Physical chemistry
E: Organic chemistry
Assessment overview The unit will be assessed through one examination of 50 marks lasting 1 hour. The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented. The assessment availability is twice a year in January and May/ June. The first assessment availability is May/June 2026. Sample assessment materials will be available to help centres prepare students for assessment.

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your students to avoid and overcome these.

What is the misconception?	How to help students overcome it
Students filling 3d subshell before 4s subshell for electronic configurations of atoms and removing from 3d before 4s for ions	Provide students with the sequence to assist recall of the order and revisit electronic configurations of atoms and ions regularly
Students writing the equation for a specific ionisation energy based upon the total number of electrons removed or the charge of the ion that the electron is removed from	Test students on different successive ionisation energies using multiple choice problems
Students thinking that ionic bonding is the transfer of electrons, not the electrostatic attraction between ions	Emphasise that electrostatic attraction is central to understanding any type of bonding
Students confusing ionic and covalent bonding in their drawings	Provide students with simple, general rules e.g. group 1 and 2 metals with non-metals = ionic bonding, non-metal with non-metal = covalent bonding Draw attention to common examples which are exceptions (e.g. aluminum chloride)
Students sticking rigidly to the octet rule (8 electrons in outer shell)	Emphasise the link between the element, its outermost energy shell and maximum number of electrons that it can hold Draw attention to common examples which are exceptions (e.g. sulfur hexachloride, boron trifluoride)
Students believing that the pi molecular orbital is two orbitals	Carefully show the way that p orbitals overlap above and below carbon nuclei to convey that only one molecular orbital is formed Liken the pi molecular orbital to two ears providing one auditory system
Students assuming that covalent bonds are weak on the basis of low melting and boiling points of simple molecules	Revisit intermolecular forces regularly when discussing simple inorganic and organic molecules Reinforce that giant covalent structures have high melting and boiling points because of covalent bonding
Students assuming that all metals have high melting and boiling points, and all non-metals do not conduct electricity	Ensure that students are aware that physical properties of elements are a generalisation and draw attention to exceptions (e.g. sodium and graphite)

Students using ionic, covalent, metallic and intermolecular forces interchangeably	Revisit bonding and intermolecular forces regularly when discussing different compounds
Students do not consider that charges need to balance in half equations and ionic equations, and combine half equations which do not show the same number of electrons	Practice constructing and balancing half equations and ionic equations regularly throughout the unit
Students mix up loss or gain of electrons and changes of oxidation number within redox reactions	Provide students with the acronym OIL-RIG to memorise the definitions of oxidation (is loss of electrons) and reduction (is gain of electrons)
Students assume that trends in ionic radii follow the same pattern as for atomic radii	Get students to carefully consider the effect of losing or gaining electrons for the outermost shell and whether there are more or less electrons than protons for each ion under consideration
Students' mis-remember formulae of period 3 compounds (e.g. sulfuric acid with sulfurous acid)	Get students to practice writing equations to become use to unfamiliar formulae and make use of the oxidation number concept to check that formulae are correct
Students' mis-remember the equation relating moles, mass and molar mass	Encourage use of units in working out for calculations, drawing attention to molar mass having units of g/mol as indicating mass divided by moles
Students confuse the sign of endothermic and exothermic enthalpy changes, and that of corresponding temperature changes	Provide students with simple rules to remember the sign of enthalpy change and the corresponding temperature change (i.e. exothermic = -ve enthalpy change, +ve temperature change; endothermic = +ve enthalpy change, -ve temperature change)
Students have the arrows pointing the wrong way round when drawing energy cycles	Practice many different types of energy cycle, particularly using enthalpies of combustion and formation, so students do not simply memorise one example, and draw attention to the change in direction of arrows in each
Students confuse the sign of an enthalpy change in calculations when using Hess's Law	Encourage students to use energy cycles to work out the direction and sign changes when constructing their calculations
Students stating that "more collisions" rather than "more frequent collisions" to describe an increase in rate of reaction	Set questions to test student's ability to clearly and accurately explain the effect of different factors upon rate of reaction
Students inaccurately represent features of the Maxwell-Boltzmann distribution curve and its changes when factors are varied	Emphasise how the area does not change but the shape of the distribution curve does Practice sketching of changes in the curve's shape, according to differences in temperature and concentration

Students have difficulty in predicting or recognising effect on rate for non-standard changes in concentration	Practice many different types of data analysis for rate and concentration changes, so the students become accustomed to non-standard changes (e.g. tripling a concentration will increase the rate nine-fold if the reactant is second order)
Students often predict the effect of pressure and temperature change for a given equilibrium incorrectly.	Emphasise that students need to consider the numbers in front of the formulae when using Le Chatelier's principle, to explain the effects of changing the pressure on a gaseous equilibrium, and the sign of the enthalpy change of reaction to explain the effect of changing temperature.
Students think that if concentrations or pressure are changed then so is the value of Kc or Kp	Emphasise that yields of product are changed by changes in concentration or pressure but the equilibrium constant, as the name suggests, remain constant.
Students make errors in statements about the effect of catalysts upon equilibrium, distribution curves and reaction profile diagrams	Reinforce the key characteristics of catalysts during the topic of chemical equilibria (i.e. increase rate of reaction, do not change product yield, are not used up, lower the activation energy, etc.) in order to explain and deduce effects
Students tend to only focus upon the disadvantages of chemical reactions when considering green chemistry	Students should be encouraged to look for positives as well as negatives for every green chemistry principle (e.g. 100% atom economy, exothermic reactions producing heat, etc.)
Students often count from the wrong end or get the priority of the groups wrong when naming organic compounds	Practice with students naming as many different structures as possible and regularly throughout the teaching of organic chemistry
Students repeat a structure for a molecular formula when drawing structural isomers.	Encourage students to look at structures from another perspective or by simply turning the structure round the other way Naming all structures that have been drawn is often a good way to determine whether a structure has been repeated
Students miscount the number of carbon atoms shown in a skeletal formula, and often forget that in skeletal formulae, hydrogens atoms are present even though they are not shown	Reinforce careful counting of the corners of skeletal formulae to determine the number of carbon atoms Remind students that each line represents a bond and if there are less than 4 then there must be bonds to H atoms at that carbon

Students associate that stereoisomerism occurring with all alkenes	Carefully emphasise the conditions required for stereoisomerism i.e. there needs to be different groups/atoms on each carbon of the double bond, and a lack of free rotation about the C═C bond Practice with students assessing the possibility of stereoisomerism in alkenes throughout the teaching of organic chemistry
Students often forget to write down the inorganic product when they write the equations for organic reactions	Ensure that students get plenty of practice in attempting chemical equations as well as just simply predicting the organic product throughout the teaching of organic chemistry
Students often draw polymers incorrectly	Develop a strategy with students to draw polymers correctly e.g. draw out the alkene in pencil, with C=C in the centre, draw bonds on each C atom in the double bond pointing up or down, then rub out one of the bonds in the double bond and draw in extension bonds

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Learning Topic	Activities and guidance for unit content delivery	Resources
A: Atomic and electronic structure		
A1.1 Features of the periodic table and relationship with atomic structure	• **Whole class teaching and learning – periodic table and atomic structure** o Discuss the periodic table, its features and their meanings (groups, periods, blocks, symbols, atomic number, mass number). o Draw / represent subatomic models to show the atomic structure of atoms and ions from different groups and periods (e.g. helium, carbon, fluorine, sodium, calcium) from the information found in the periodic table and involve students in deducing these. • **Small group / individual activity – isotopes and relative atomic mass** o Introduce isotopes and relative atomic mass in relation to carbon being the standard mass. o Introduce students to the idea that relative atomic mass has no units.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ **Royal Society of Chemistry** Periodic Table (interactive) https://www.rsc.org/periodic-table/ **LibreTexts – Chemistry** 2.3: Calculating Atomic Masses - Chemistry LibreTexts Fuse School videos on the atom and periodic table PhET atom builder and isotope weighing simulations **LibreTexts – Chemistry** 2.3: Calculating Atomic Masses (Problems) - Chemistry LibreTexts Problems 2.3.1 – 2.3.5

	○ Task students with determining relative atomic mass from the isotopes and their percentage abundances for an element (e.g. chlorine, magnesium) and to determine percentage abundance of isotopes of an element (e.g. lithium, copper). ○ Interpretation of mass spectrometry data is not required.	
A1.2 Electronic structure	• **Whole class teaching and learning – electronic configuration** ○ Discuss with students their understanding of electronic structure of the elements. ○ Introduce energy levels (shells), subshells and electronic orbitals, and the rules for filling an atom with electrons. • **Small group or individual activity – determining electronic configurations** ○ Show the use of electron-in-boxes diagrams and *s*, *p* and *d* notation to represent electronic configurations for some atoms and ions (e.g. sodium, Na^+). ○ Show the first four energy levels and explain how these are organised in increasing energy levels. ○ Explain the terms orbital and the basic shapes of s and p orbitals. ○ Task students with determining the electronic configuration for selected atoms and ions (up to atomic number 36), using electron-in-boxes diagrams and *spd* notation. ○ Students to explain principles of Aufbau, Hund and Pauli.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ **LibreTexts – Chemistry** 3.1: Electron Configurations - Chemistry LibreTexts Crash Course Chemistry videos on the electron, electronic configuration and orbitals **Electron Orbital simulator**: Electron Orbital Simulator **Electron Configuration calculator:** Wolfram|Alpha Widgets: "Electron Configuration Calculator" - Free Chemistry Widget **Ptable – interactive periodic table** Periodic Table - Ptable - Electrons - Oxidation states Electron-in-boxes and *spd* electronic configurations

		LibreTexts – Chemistry 3.1: Electron Configurations (Problems) - Chemistry LibreTexts Problems 3.1.1 - 3.1.25
A1.3 Ionisation energy	• **Whole class teaching and learning – ionisation energy** o Discuss the ionisation of an atom with students (e.g. whether energy is needed or released, which elements are easy to ionise and which are difficult, etc.). o Define first ionisation energy and successive ionisation energy, using a range of different elements (e.g. nitrogen, magnesium, argon). • **Small group / individual activity – using successive ionisation energies** o Provide students with successive ionisation energy data for an unknown element to analyse, by plotting a graph of log (ionisation energy) vs number of electron removed. o Students can present their findings and evidence for the electronic structure of the unknown element. • **Whole class and individual activity – periodic trends in ionisation energy** o Provide students with a graph (or data to plot a graph) of the first ionisation energies of all elements with atomic numbers 1 to 36.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ Royal Society of Chemistry – **Periodic Table (interactive)** Periodic Table – Royal Society of Chemistry https://www.rsc.org/periodic-table/trends first ionisation energy data and trends **WebElements** WebElements Periodic Table » Periodicity » Ionization energies » Periodic table gallery Successive ionisation energy data of the elements **American Association of Chemistry Teachers** – classroom resource Classroom Resources | Periodic Trends: Ionization Energy, Atomic Radius & Ionic Radius | AACT Periodic trend simulation to compare first ionisation energy of elements **LibreTexts – Chemistry** 3.3: Trends in Ionization Energy - Chemistry LibreTexts

	○ Discuss the trends that can be seen in the graph in terms of factors that have caused an increase or decrease from one element to the next – students should consider the effect of the nuclear charge, shielding, number of electron shells, the subshell an electron is removed from and whether the electron is removed from a pair of electrons.	**Graph of first ionisation energy** 3.3: Trends in Ionization Energy (Problems) - Chemistry LibreTexts Problems 3.3.1 - 3.3.5
B: Bonding and structure		
B1.1, B1.2, B1.3 and B1.4 Bonding and structure	• **Whole class teaching and learning – bonding and structure overview** ○ Discuss chemical bonding with students (e.g. how and why it occurs, the type of bonding depending upon the elements, differences between the three main types of bonding). ○ Present a diagrammatic summary of the three different types of bonding (metallic, ionic and covalent), the structure types (giant and simple), and explain the key properties that characterise each type. • **Small group / individual activity – representing bonding and structure** ○ Provide students with the name or formulae of different elements and compounds to represent the range of bonding and structure types. ○ Student drawings will include dot-and-cross diagrams and 2D/3D lattice arrangements. Students can also predict typical properties of the substances based upon their diagrams.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ **LibreTexts – Chemistry** 10.6: The Solid State of Matter - Chemistry LibreTexts Problems 10.E.5.9 – 10.E.5.22 3.4: Molecular and Ionic Compounds - Chemistry LibreTexts Problems 3.4.1 – 3.4.15 **American Association of Chemistry Teachers** – classroom resource Classroom Resources | Ionic & Covalent Bonding | AACT Ionic and covalent bonding simulation **LibreTexts – Chemistry** 4.1: Lewis Dot Diagrams - Chemistry LibreTexts 4.2: Lewis Structures - Chemistry LibreTexts

	• **Small group / individual activity – representing metallic bonding and structure**
	  o Provide students with a definition of metallic bonding. Explain how this type of bonding is arranged through the electrostatic attraction between nuclei of cations and delocalised electrons.
	  o Explain how delocalised electrons are formed through metal ion formation.
	  o Relate metallic bonding to giant metallic structures in terms of layers.
	  o Ask students to draw examples of different types of elements with metallic bonding and explain how strength of bonds may vary.
	
	• **Whole class teaching and learning – focus on covalent bonding**
	  o Recap covalent bonding and challenge students to draw a dot and cross diagram on a whiteboard, for examples that use single, double, triple and dative covalent bonds. Redraw the student diagrams as displayed structural formulae (stick diagrams).
	  o Discuss which covalent bonds are the longest / shortest and explore the reasons. Extend the discussion with students into how bond length will affect the bond strength and energy required to break the bond.
	  o Present the molecular orbital model, showing how sigma and pi orbitals are formed from the overlap of atomic orbitals, and applying this to the examples that the students have drawn on the whiteboard.
		Dot and cross diagrams
		4.1: Lewis Dot Diagrams (Problems) - Chemistry LibreTexts
		Problems 4.1.1 – 4.1.3
		4.2: Lewis Structures (Problems) - Chemistry LibreTexts
		Problems 4.2.1 – 4.2.6
		
		Metallic bonding: RSC Teaching structure and bonding of metals at 14-16
		Teaching structure and bonding in metals at 14–16 | CPD article | RSC Education
		
		3D models of different structures e.g. giant ionic lattice, diamond, graphite
		Inorganic kits – Molymod
		
		ChemTube 3D
		Crystal Structures Section
		3D online structures
		
		LibreTexts – Chemistry
		5.1: Covalent Bond Formation and Strength - Chemistry LibreTexts
		5.1: Covalent Bond Formation and Strength (Problems) - Chemistry LibreTexts
		Problem 5.1.1
		5.3: Valence Bond Theory and Hybrid Orbitals - Chemistry LibreTexts

	• **Whole class teaching and learning – focus on ionic bonding** o Recap ionic bonding as a result or strong electrostatic attraction between positive and negative ions. o Discuss how electrostatic attraction between ions can occur in any direction. o Explain how this bonding relates to giant ionic structures. • **Laboratory activity – identifying structure and bonding from properties** o Task students with the identification a range of unknown substances from their physical properties, including melting point and electrical conductivity – the identification could be a table of data or could be a practical investigation. A key to classifying bonding and structure types (including exceptions) could be provided or students could create one before the task.	**Sigma and pi molecular orbitals** **Crash Course Chemistry video on molecular orbitals** 5.3: Valence Bond Theory and Hybrid Orbitals (Problems) - Chemistry LibreTexts Problem 5.3.1 – 5.3.4 **Practical Science** Identification of Unknown Substances: Classifying Metallic, Ionic, or Covalent Compounds – Practical Science
B1.5 and B1.6 Molecular shape, electronegativity and polarity	• **Whole class and individual activity – molecular shape** o Introduce the topic of molecular shape by discussing limitations of dot-and-cross diagrams and 2D representations and show what the 3D shape of key molecules would look like. Compile suggestions from students as to which factors would affect the shape of a molecule. o Provide students with molecular modelling kits and a list of molecules to make in order to explore shape. Students can draw the dot-and-cross diagram and 3D model of each molecule.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ **Molecular modelling kits** (one between two students) Sets – Molymod **ChemTube 3D** Shapes of molecules VSEPR Section 3D online structures

	○ Summarise the topic by presenting the electron pair repulsion rules and 3D representations of the common molecular shapes with names and bond angles. • **Whole class and individual activity – electronegativity and polarity** ○ Introduce the topic of electronegativity by discussing with students whether the pair of electrons in a covalent bond will be shared equally by the two atoms. Compile suggestions from students as to which factors that influence the pull of electrons by an atom. ○ Define electronegativity and show a periodic table of electronegativity values for the elements. Explain how electronegativity changes down and across the periodic table. ○ Provide students with covalent bonds to draw dipoles on each atom. Using electronegativity values, students can place the bonds in order from most polar to least polar or non-polar. ○ Discuss with students how molecular shape will influence the polarity of the molecule. Provide molecular model kits for students to construct examples of polar and non-polar molecules to illustrate the discussion.	**Molecular shape chart** e.g. https://chemistryclinic.co.uk/shapes-of-simple-molecules/ **LibreTexts – Chemistry** 5.2: Molecular Shape - Chemistry LibreTexts Tables of molecular shape **Fuse School video on shapes of molecules** PhET molecular shape simulation 5.2: Molecular Shape (Problems) - Chemistry LibreTexts Problems 5.2.1 - 5.2.10 **Royal Society of Chemistry – Periodic Table (interactive)** https://www.rsc.org/periodic-table/trends Electronegativity trends **LibreTexts – Chemistry** Unit 6: Molecular Polarity - Chemistry LibreTexts Table of electronegativity Crash Course Chemistry and Teacher's Pet videos on electronegativity and polarity 6.2.1 PhET molecular polarity simulation Problems 6.1.1 – 6.1.8 Problems 6.2.1 – 6.2.6

B1.7 and B1.8
Intermolecular forces
	• **Whole class teaching and learning – intermolecular forces**
	  o Introduce the topic of intermolecular forces by discussing with students how type of structure determines state of matter (e.g. why giant structures are solid but simple molecular structures may be solid, liquid or gas).
	  o Present an overview of the three different types of intermolecular force (temporary-induced dipole attraction, permanent dipole – permanent dipole attraction and hydrogen bonding), including how each arises, their relative strengths and the effect on physical properties such as melting point, boiling points and density.
	  o Provide students with a range of different molecules to determine the type of intermolecular forces present and predict the order of boiling point.
	
	• **Peer teaching – properties of water**
	  o Task student with researching one specific property of water that is influenced by hydrogen bonding (e.g. melting and boiling points, density as solid and liquid, surface tension, specific heat capacity, etc).
	  o Students will present their research back to the rest of the class, explaining the relevance of hydrogen bonding in the property.
	  o Alternatively, different students could be tasked with presenting research for different substances and their properties as way of reviewing the wider topic of bonding and structure.
		Periodic table (hard copy)
		e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/
		
		Molecular modelling kits
		(one between two students)
		Sets – Molymod
		
		3D molecular model of lattice of ice
		Inorganic kits – Molymod
		
		ChemTube 3D
		Ice - water in the solid state
		3D online structures
		
		American Association of Chemistry Teachers
		Classroom resource
		Classroom Resources | Intermolecular Forces | AACT
		Intermolecular forces simulation and quiz
		
		LibreTexts – Chemistry
		6.3: Intermolecular Forces - Chemistry LibreTexts
		Graphs and data of boiling / melting point trends of simple molecules
		Problems 6.3.1 – 6.3.14
		
		LibreTexts – Chemistry
		7.3: Hydrogen-Bonding and Water - Chemistry LibreTexts

C: Periodicity		
C1.1 Physical properties of Period 3 elements	• **Whole class teaching and learning – periodicity** o Introduce the topic of periodicity by discussing with students why elements are placed in groups and periods. Students will be familiar with elements in the same group as having similar chemical reactivity and change in physical properties but extend the discussion to consider how chemical and physical properties may change across a period. o Remind students of how atomic radii change down a group of elements (e.g. Group 1) and ask for similar reasoning to explain how the atomic radii will change across Period 3. o Discuss how the radii of positive and negative ions would compare against the original atom and what the trends would be across Period 3. • **Paired or Individual activity – trends in physical properties of elements in Period 3** o Provide students with data for physical properties of the Period 3 elements, which should include melting points and electrical conductivity, and ask them to explain the changes in these properties in terms of the bonding and structure of each element.	**Periodic table (hard copy)** e.g. https://sciencenotes.org/periodic-table-black-white-wallpaper/ **Royal Society of Chemistry** Periodic Table (interactive) https://www.rsc.org/periodic-table/trends atomic radius trends melting point trends **Chemix School periodic table** Periodic Table Software physical property data for elements (including melting point and electrical conductivity) **American Association of Chemistry Teachers** – classroom resource Classroom Resources | Periodic Trends: Ionization Energy, Atomic Radius & Ionic Radius | AACT Periodic trend simulation to compare of atomic radii of elements **LibreTexts – Chemistry** 3.2: Trends in Size - Chemistry LibreTexts graphs and data for atomic and ionic radii 3.2: Trends in Size (Problems) - Chemistry LibreTexts Problems 3.2.1 - 3.2.10

		The Engineering ToolBox Electrical Conductivity - Elements and other Materials Electrical conductivity data **Chemguide** atomic and physical properties of period 3 elements Notes and problems
C1.2 Oxidation number and redox reactions	• **Whole class teaching and learning – oxidation number concept** o Introduce the topic of redox by discussing the various meanings of the terms reduction and oxidation, using equations to exemplify the terms. o Discuss the difficulty of identifying which element is reduced and which is oxidised when oxygen of ionic compounds are not involved (e.g. $PCl_3 + Cl_2 \rightarrow PCl_5$). Give a presentation on the oxidation number concept and the general rules around assignment of oxidation numbers to elements. o Discuss how oxidation can be demonstrated by increasing oxidation number (oxidation state) and how reduction can be demonstrated by a decreasing oxidation number (oxidation state). • **Paired or Individual activity – determining oxidation numbers, half equations and redox equations** o Provide students with a series of problems to include: - determining the oxidation numbers of elements in a formula	**LibreTexts – Chemistry** Redox menu **LibreTexts – Chemistry** Redox Chemistry - Chemistry LibreTexts reduction and oxidation, oxidation number concept, half equations, redox equations **ChemicalAid calculators** Oxidation Number Calculator Redox Reaction Calculator Tools to determine oxidation numbers and balance redox reaction equations 11.E: Properties of Reactions (Exercises) - Chemistry LibreTexts Problems Q11.1.1 - Q11.1.4 Problems Q11.2.1 - Q11.2.5

	- using oxidation numbers to determine the formula of a compound - constructing reduction and oxidation half equations - constructing and balancing redox equations.	
C1.3, C1.4, C1.5, C1.6, C1.7, C1.8, and C1.9 Chemical properties of Period 3 elements and their compounds, uses and predictions	• **Laboratory activity – the chemical reactivity of Period 3 elements** o Demonstrate (or show internet videos of) the chemical reactivity of some Period 3 elements with oxygen, water and chlorine to students. o Students should make notes on what they observe and construct chemical equations where a reaction has occurred. o Students should be able to construct and balance chemical equations related to Period 3 elements. o Students should also be able to apply the balancing of equations to unfamiliar chemical reactions. o The demonstrations could be extended to the products of these reactions, which should be examined for their physical state and properties, and chemical properties by adding them to water and testing the pH of any solution formed. Again, students should make notes on observations, and in particular look for any trends in acid-base behaviour across the period.	**Science Skool videos** Science Skool - YouTube Search the video bank for "oxygen", "chlorine", "water" for reactions with period 3 elements **Chemguide** chemical reactions of period 3 elements acid-base behaviour of the period 3 oxides the period 3 chlorides Notes and problems **Chemguide** Period 3 menu Notes and problems **Royal Society of Chemistry** – Periodic Table (interactive) https://www.rsc.org/periodic-table/ Uses and properties of elements

	• **Peer teaching – physical and chemical properties of Period 3 compounds and uses** o Task students with researching the physical and chemical properties of Period 3 oxides, chlorides and hydroxides / acids. This could supplement the information that students have already gained from the practical demonstration. Students should explain these properties in terms of bonding, structure and chemical equations. o Ask individual students or pairs of students to present to the whole class their research and explanations of the physical and chemical properties of one Period 3 element, its compounds, and their uses. Some compounds they may wish to consider may be: - sodium hydroxide - magnesium hydroxide - sulfuric acid - sodium chloride - calcium chloride - silicon dioxide. o Select one or two individuals to present their predictions for the properties of a Period 2 or Period 4 element and compounds, based upon their research for Period 3.	

D: Physical Chemistry		

D1.1 The mole and quantitative chemistry	• **Whole class and individual activity – problems on moles and quantitative chemistry**
	  o Give students worksheets at regular points between the following activities to work out molar masses, moles, masses, empirical formulae, stochiometric equations, gas volumes and percentage yields.
	
	• **Whole class teaching and learning – mole, molar mass and percentage yield**
	  o Give a presentation which introduces and defines the mole concept, Avogadro's number, and molar mass, including its relationship to relative atomic, formula and molecular masses.
	  o Show examples using moles and molar mass to calculate masses of substances (and vice versa). Introduce the ideas of theoretical yield, actual yield and percentage yield, and show a worked example.
	  o Students should be able to recall equations related to calculations of the mole.
	
	• **Laboratory activity – empirical formulae and stochiometric equations**
	  o Students could carry out an experiment to determine the empirical formula of a compound, such as magnesium oxide (by burning magnesium in air) or copper oxide (by reducing copper oxide with methane / hydrogen gas).
		LibreTexts – Chemistry
		6.11: Exercises - Chemistry LibreTexts
		4.3: Empirical and Molecular Formulas (Problems) - Chemistry LibreTexts
		5.3: Calculating Reaction Yields (Problems) - Chemistry LibreTexts
		problems on molar mass, moles, etc.
		
		Doc Brown
		https://docbrown.info/page04/4_73calcs.htm
		Calculation quizzes on quantitative chemistry
		
		Chemguide
		moles
		relative atomic mass and relative formula mass
		calculations from equations involving masses
		notes
		
		Chemguide
		empirical formulae
		Notes and videos of laboratory experiments
		
		Chemguide
		calculations from equations involving gases
		Notes

	○ Masses before and after should be collected from each student or pair working together, a graph plotted to average out anomalous data and using this the mole ratio of each element can be determined. From this an empirical formula or stoichiometric equation can be deduced. • **Whole class teaching and learning – gas volume and molar volume** ○ Explain the relationship between mole, gas molar volume (24 dm^3 at room temperature and pressure) and volume of a gas. ○ Show a worked example to support the teaching of the relationship. ○ Set up a demonstration of a reaction which produces a gas (e.g. magnesium and hydrochloric acid to produce hydrogen gas) using apparatus to collect and measure the volume of gas produced. ○ Show students how the volume of the gas can be predicted from the mass, moles and gas molar volume.	**Royal Society of Chemistry** The volume of 1 mole of hydrogen gas | Experiment | RSC Education Experiment Pearson Edexcel A-level core practical AS-and-A-level-Chemistry-Core-Practical-1---Molar-Volume-of-a-Gas-(Student,-Teacher,-Technician-Worksheets).pdf Experiment
D1.2 Chemical kinetics	• **Whole class teaching and learning – rate of reaction and collision theory** ○ Use a quiz or question and answer session to found out students' prior knowledge of rates of reaction. ○ Give a presentation that defines chemical kinetics as the study of rate of reaction and covers the main factors that affect rate of reaction.	**Chemguide** Rates of reaction menu Notes **Crash Course Chemistry** Kinetics: Chemistry's Demolition Derby - Crash Course Chemistry #32 - YouTube Video

	○ Use collision theory and activation energy to explain the effect of factors upon rate. This could also be demonstrated using marbles on a tray to show how some factors, such as concentration, temperature and pressure, affect the number of collisions (e.g. changing the number of marbles, their speed or the size of the tray). • **Individual activity – concentration-time graph problems** ○ Give students a worksheet of problems to interpret concentration-time graphs. ○ This should include calculating rate of reactions at different points of a curve, deducing and explaining the effect of changes in concentration, pressure, temperature, surface area and catalysts. • **Whole class teaching and learning – Maxwell-Boltzmann distribution curves** ○ Give a presentation which describes and explains the features of the Maxwell-Boltzmann distribution curve. ○ Use the distribution curve to explain the effects of concentration, temperature and catalyst on rate. ○ Students should be led through the explanations but involved throughout. For example, students should be able to explain the increase in temperature upon rate and therefore attempt to sketch the shape of the curve, or students should be able to explain the effect of a catalyst and show how this affects the activation energy line.	**LibreTexts** – Chemistry 14.2: Rates of Chemical Reactions - Chemistry LibreTexts Notes and graphs **Royal Society of Chemistry** Interpreting rate of reaction graphs | 14-16 years | Lesson plan | RSC Education Graphs **Royal Society of Chemistry** Collision theory and Maxwell–Boltzmann distribution curves | Resource | RSC Education Notes and graphs **Chemguide** Rates of reaction menu Notes and problems **LibreTexts –** Chemistry 12.4: Rate Laws - Chemistry LibreTexts Notes and graphs **Chemguide** orders of reaction and rate equations notes and problems **Pearson** Pearson Edexcel A-level core practical GCE Science TRP Experiment

	• **Whole class and individual activity – rate equation problems**
	  o Show students an example of how to determine a rate equation from a table of data where the concentrations of reactants and a catalyst are systematically changed and the initial rate recorded.
	  o Show direct proportion between initial rate and concentration (first order), proportion between initial rate and concentration squared (second order) and constant initial rate, no matter what the concentration is (zero order).
	  o Construct the rate equation and show how to calculate the rate constant and its units. Provide students with a worksheet of different problems using graphs and tables of data that can be analysed to deduce rate equations.
	
	• **Laboratory activity - determining rate equation, orders of reaction and rate constant**
	  o Introduce the concept of the rate equation.
	  o Students will investigate a particular chemical reaction (e.g. the clock reaction between peroxodisulfate and iodide ions) to determine the rate of reaction for different concentrations of the reactants.
	  o Students should use their results to construct graphs to determine the orders of reaction, the rate equation and the rate constant, including its units.	

D1.3 Chemical energetics	• **Whole class teaching and learning – chemical energetics basics**
	  o Give a presentation of an overview of key terms, definitions and representations - enthalpy change, endothermic and exothermic processes, energy level and reaction profile diagrams, standard conditions, standard enthalpy change, symbols and units.
	  o Show short video clips and ask students to complete an accompanying worksheet.
	
	• **Individual / Paired activity – identifying and representing enthalpy changes**
	  o Give student some exothermic and endothermic reactions, with the enthalpy change values. Ask them to draw labelled reaction profiles, showing the energy position of the reactants and products, the activation energy and ΔH.
	  o Give students several reactions and ask them to identify whether $\Delta_r H$ for each reaction is $\Delta_f H$, $\Delta_c H$ or some other type of standard enthalpy change.
	  o Ask students to write the chemical equations for $\Delta_f H$ and $\Delta_c H$ of named substances.
	  o Ask students to calculate enthalpy changes from a list of substances and reactions, where the standard enthalpy change, and mass of the reactant or product is given.
	
	• **Whole class and individual activity – Hess's Law and energy cycles**
	  o Introduce Hess's Law of Constant Heat Summation, linking it to the conservation of energy.
		Chemguide
		chemical energetics - an introduction
		notes and problems
		
		Crash Course Chemistry
		Enthalpy: Crash Course Chemistry #18 - YouTube
		video
		
		Chemguide
		various enthalpy change definitions
		notes and problems
		
		Chemguide
		Hess's Law and enthalpy change calculations
		notes and problems
		
		LibreTexts – Chemistry
		8.3: Enthalpy and Hess' Law (Problems) - Chemistry LibreTexts
		Problems 8.3.11 – 8.3.13
		
		Chemistorian
		The EASIEST Method For Solving Hess Cycles
		Video
		
		Royal Society of Chemistry
		Comparing heat energy from burning alcohols | Experiment | RSC Education
		Experiment

	○ Explain how the enthalpy changes of some reactions are difficult to determine experimentally, and how Hess's Law can be applied to determine a value for such enthalpy changes. ○ Show the use of energy cycles to determine a value for $\Delta_r H$ using $\Delta_f H$ and $\Delta_c H$ values. ○ Provide students with problems to determine ΔH for given reactions, using energy cycles and appropriate standard enthalpy change data. • **Laboratory activity – determining the standard enthalpy change of a reaction** ○ Task students with carrying out different enthalpy change experiments. ○ They should carry out practical work to determine the standard enthalpy change of a reaction directly (e.g. combustion of an alcohol or alkane) and the enthalpy change of a reaction indirectly (e.g. thermal decomposition of potassium hydrogen carbonate). ○ Students will need to be shown how to convert temperature change into ΔH for reactions performed, and for the indirect enthalpy change determination, how to construct the energy cycle needed. ○ Calculated values for the enthalpy changes should be collected from each student or pair of students, and the values compared with each other and the actual value. ○ Review the practical activity in light of the results obtained for all titrations, identifying common errors and suggesting improvements.	**Pearson** Pearson Edexcel A-level core practical AS-and-A-level-Chemistry-Core-Practical-8---hess-law--(Student,-Teacher,-Technician-Worksheets).pdf experiment

D1.4 Chemical equilibrium	• **Whole class teaching and learning – chemical equilibrium basics and Le Chatelier's principle** o Review what students already know about reversible reactions. Describe the term dynamic equilibrium and introduce its key characteristics. Characteristics you may wish to consider include: - closed vessel - reversible reaction - products and reactants present - forward and backward reactions at equal rates - there is no macroscopic change. o Present analogies for dynamic equilibrium (e.g. a person running up a downwards escalator). o Establish that equilibrium can be affected by changes to the system (concentration, temperature, pressure and presence of a catalyst) and introduce Le Chatelier's principle. o Illustrate the use of the principle when conditions are altered for a reaction equation in equilibrium. You could show a relevant video and ask students to complete an accompanying worksheet. • **Laboratory activity – demonstrations of factors affecting dynamic equilibrium** o Demonstrate or allow student to conduct practical experiments to show how changes to conditions affect a system in equilibrium. Some suitable demonstrations include: - an acid–base mixture with an indicator, and additional H^+ or OH^- ions are added	**Chemguide** an introduction to chemical equilibria Le Chatelier's Principle Notes and problems **Crash Course Chemistry** Equilibrium: Crash Course Chemistry #28 Video **LibreTexts – Chemistry** 12: Equilibrium and Le Chatelier's Principle (Experiment) - Chemistry LibreTexts Experiments / demonstrations **Royal Society of Chemistry** The effect of pressure and temperature on equilibrium | Le Chatelier's principle | Experiment | RSC Education Experiment **BBC Bitesize** Choosing reaction conditions - Higher - Industrial chemical reactions - Higher - GCSE Chemistry (Single Science) Revision - Edexcel - BBC Bitesize Graph **Chemguide** equilibrium constants - Kc equilibrium constants - Kp equilibrium constants and changing conditions Notes and problems

	- a solution of Co^{2+} ions and hydrochloric acid, and the temperature is changed - a gas syringe containing NO_2 and N_2O_4 gases, and the syringe plunger is pushed in or pulled out to change the pressure. o Students should record their observations and explain using Le Chatelier's principle the changes in the position of equilibrium. • **Individual activity – interpretation of product yield graphs** o Provide students with graphs of product yield vs pressure or temperature for given reaction equations. o Task students with proposing the optimum reaction conditions, justifying their proposals and discussing the possible drawbacks with their suggestion. • **Whole class and individual activity – chemical equilibrium problems** o Use a presentation to explain the concept of the equilibrium constant, K_c and K_p, using a reversible reaction (e.g. the Haber process). o Show how it can be expressed using the stoichiometric equation for a reaction and discuss how its magnitude can determine the position of equilibrium. o Give students a set of chemical reactions/equations and ask them to write expressions for K_c or K_p.	**LibreTexts – Chemistry** 12: Equilibrium and Le Chatelier's Principle (Experiment) - Chemistry LibreTexts Problems – numerical problems 1 – 6

	○ Provide worksheets so that students can calculate values of equilibrium constants for reactions from given concentrations or partial pressures, and also to calculate the concentration or partial pressure of a reactant or product where *K* is known.	
D1.5 and D1.6 The chemical industry and green chemistry	• **Whole class teaching and learning – understanding the chemical industry** ○ Explain the importance of chemical kinetics, energetics and equilibrium in industrial applications such as the Haber process and the contact process. ○ You could show suitable videos (e.g. search YouTube for 'What Is the Haber Process | Reactions | Chemistry | FuseSchool' or 'Manufacturing Sulphuric Acid | Reactions | Chemistry | FuseSchool'). • **Visit / Guest speaker – managing a chemical industry** ○ Invite a guest speaker from a chemical industry into the class to give a talk on the considerations surrounding the manufacture of a chemical product. ○ This would ideally focus upon balancing economic or physical chemistry considerations against environmental and green chemistry considerations. ○ Students should prepare questions to ask the guest speaker but could also be challenged by the guest speaker to weigh up different factors in the running of a chemical manufacturing industry.	**The Essential Chemical Industry** Introduction Industrial processes Various topics on industrial processes and manufacture of a range of chemicals **STEM Learning** STEM Ambassadors Information on how to source a STEM ambassador **Royal Society of Chemistry** Chemistry job profiles | RSC Education Videos **The Essential Chemical Industry** Green chemistry Recycling in the chemical industry The principles of green chemistry and examples **Chemguide** limiting reagent and atom economy Notes

	• **Peer teaching – application of green chemistry** o Ask pairs or small groups of students to research the application of green chemistry principles in different chemical industries, such as the Haber process and the contact process, and give a presentation on their findings. o Each member of the pair or group could have a different aspect to explore: - atom economy students should be familiar with the equation for atom economy - waste products in terms of use and quantity - renewable resources such water/air - recycled resources such as unused reactants - energy efficiency in terms of energy consumption and energy output - the impact of use of catalysts - hazards and safety considerations of the reactants and the products - end-of-life process for products in terms of their degradation, disposal or recycling.	
E: Organic chemistry		
E1.1, E1.2, E1.3 and E1.5 Basics of organic chemistry	• **Whole class teaching and learning – organic chemistry basics** o Start a discussion with students on why carbon is a unique element and lead into its importance as the basis of organic chemistry and life itself. o Give a presentation on key terminology in organic chemistry that students will need to be familiar with (e.g. hydrocarbons, homologous series and functional group).	**LibreTexts – Chemistry** 1: Introduction - Chemistry LibreTexts 2.1: Combining atomic orbitals, sigma and pi bonding - Chemistry LibreTexts Organic chemistry basics **Molecular modelling kits** (one between two students) Sets – Molymod

	○ This can be illustrated with the alkanes and alkenes, and members of both homologous series can be represented in various types of formulae (i.e. general, molecular, structural, skeletal and 3-dimensional) and topics such as bond angles, bond energy and molecular orbitals can be revisited. • **Paired activity – making and drawing organic molecules** ○ Leading on from representations of organic molecules, provide students with molecular modelling kits and ask them to make molecules based upon provided molecular formulae or for homologous series. You may wish to consider: - alkanes - alkenes - Alcohols, (students would be required to know primary alcohols and what makes them primary, but not necessarily secondary or tertiary). - halogenoalkanes as homologous series ○ Encourage students to draw structural, skeletal and 3-dimensional representations of models that they make. ○ Encourage students to draw structural formulae from molecular formulae of organic molecules and vice versa. ○ Encourage students to recognise use wedges and dashed line to show bonds. ○ Encourage students to use both full structural (displayed) and condensed (shortened) formulae. ○ Encourage students to recognise and use skeletal formulae.	**Chemguide** How to draw organic molecules Notes and problems **Chemguide** Understanding the names of organic compounds Notes and problems

	• **Whole class and individual activity – naming organic molecules** o Give a presentation on the rules of organic chemistry nomenclature, based on IUPAC naming conventions, specifically for alkanes, alkenes, halogenoalkanes and alcohols. o Provide diagrams of structural and skeletal formulae of organic molecules that students can attempt to name.	
E1.4 and E1.6 Isomerism and physical properties	• **Paired activity – making and drawing structural isomers** o Provide students with molecular modelling kits and ask them to see how many different structures they can make from a specific molecular formula such as C_4H_{10} or $C_3H_6Cl_2$. o Discuss the phenomenon of isomerism using the models and arrive at the accepted definition. o Give students more complex molecular formulae to build models for. o Encourage students to draw structural or skeletal formulae of models that they make and name them. • **Whole class teaching and learning – physical properties of organic molecules** o Start a discussion with students on how they might expect the boiling points of organic molecules in a homologous series, such as the alkanes, to change with increasing molecular mass.	**Molecular modelling kits** (one between two students) Sets – Molymod **Chemguide** structural isomerism Notes and problems **Chemguide** an introduction to alkanes and cycloalkanes notes and problems **Molecular modelling kits** (one between two students) Sets – Molymod **Chemguide** geometric (cis / trans) isomerism E-Z notation for geometric isomerism Notes and problems

	○ Students should recall how temporary-induced dipole attraction (London dispersion forces) arise and this is a good opportunity to revise this topic. Lead into the difference in boiling point for structural isomers using an example such as the isomers C_5H_{12} and explain the effect of branching. • **Whole class and individual activity – stereoisomerism** ○ Ask students to use molecular modelling kits to make different structures from the molecular formula $C_2H_2Br_2$, and to draw and name these molecules. ○ They will discover that there are two possible isomers for 1,2-dibromoethene but only one structure for 1,1-dibromoethene. ○ Use these models to discuss and establish the reasons why two different molecules exist for the same structural isomer, in order to introduce stereoisomerism and the naming conventions to distinguish them. ○ Give students other molecular formulae to draw and name stereoisomers for.	
E1.7 – reactions of organic compounds	• **Whole class teaching and learning – organic reaction types** ○ Give a presentation on the different reaction types and provide examples of each i.e. addition, elimination, substitution, oxidation, condensation. ○ Discuss why certain homologous series tend towards certain reaction types rather than others (e.g. alkanes undergo substitution rather than addition) and the factors that affect reactivity.	**LibreTexts – Chemistry** 6.10: Organic Reactions - Chemistry LibreTexts Notes on main types of organic reaction **Chemguide** Alkanes Menu Alkenes Menu Halogenoalkanes (haloalkanes) Menu Alcohols Menu Notes and problems on organic reactions

	○ Student should be encouraged to look at key conditions, reactants and products. ○ Students do not need to know reaction mechanisms, or practical techniques. Reactions you may wish to consider include: ○ addition reactions of alkenes - with hydrogen - with a halogen - with a hydrogen Halide - with steam ○ substitution reactions of alkanes - with a halogen ○ substitution reactions of halogenoalkanes - with sodium hydroxide ○ substitution reactions of alcohols - with hydrogen bromide - with phosphorous pentachloride ○ elimination reactions of halogenoalkane - with sodium hydroxide. • **Paired activity / individual activity – predicting organic reactions** ○ Set the class a series of problems to solve on different types of organic reaction. This could be done in different ways such as providing the formulae or names of different organic compounds and reaction conditions and asking for the product and reaction type to be predicted.	**Royal Society of Chemistry** Qualitative tests for organic functional groups | practical videos | 16–18 students | Practical | RSC Education Practical instructions and video demonstrations of organic chemical tests

	○ Alternatively, the starting organic compound and its product could be given, and students could state the reagents and conditions that would need to be used. ○ A set of flash cards could be created with organic compounds, reagents and conditions, and reaction types, which could be used to in a matching up card game. • **Laboratory activity – tests and reactions of functional groups** ○ Students could carry out some simple test tube organic reactions e.g. bromine water, PCl_5, acidified potassium dichromate, making an ester. This could be done as a comparison for the four main homologous series (alkane, alkene, alcohol and halogenoalkane), or as an identification exercise for specific functional groups.	
E1.8, E1.9 and E1.10 Commercially important organic reactions, benefits, problems and solutions	• **Whole class and individual activity – commercially important reactions (cracking, combustion and polymerisation)** ○ Give a presentation on the different reaction types that are commercially important and provide examples of each i.e. cracking, combustion, polymerisation, ethanol manufacture. ○ Task students with constructing different equations for each of the main reactions which includes reactants and products and are balanced. They should also reference state symbols. ○ Task students with reviewing the benefits of the organic products and the problems, particularly for the environment, should be discussed.	**Chemguide** cracking alkanes - thermal and catalytic combustion of alkanes and cycloalkanes polymerisation of alkenes polyesters - terylene and PET polyamides - nylon and Kevlar manufacture of alcohols Notes and problems on commercially important organic reactions **The Essential Chemical Industry** The Essential Chemical Industry (online) Basic chemicals and polymers

	• **Peer teaching – benefits, problems and solutions of organic chemistry** o Leading on from the previous whole class activity, task students with researching and presenting to the whole class the benefits and issues for a specific organic compound. This could include: – the production of energy - production of useful materials in the form of plastics - production of fabrics in the form of polyesters. o Each student or pair of students could explore a different commercially important organic compound e.g. poly(ethene), PVC and polypropene or PTFE. This should be limited to their uses, properties that make them useful and process of formation. o Part of this research should include solutions to the issue or problem caused by the use of the organic compound. This could be linked to the production of CFCs, polymers in the form of plastics, or harmful products impacting the environment. • **Whole class and individual activity – condensation polymerisation** o Discuss the production and use of polyesters o Review how a polyester is formed from a monomer containing two carboxylic acid groups and a monomer containing two alcohol groups. o Ask students to use molecular modelling kits to make different structures. o Discuss the production of water molecules o Discuss the formation of ester links.	**STEM Learning** STEM Ambassadors Information on how to source a STEM ambassador **Royal Society of Chemistry** Chemistry job profiles | RSC Education Videos

	• **Guest speaker – commercial reactions and products**
	  o The topic provides another good opportunity to invite a guest speaker into the class.
	  o This could be combined with the industrial chemistry / green chemistry talk provided by a professional chemist or scientist.
	  o Equally, an environmentalist or entrepreneur could be invited in to talk about a specific issue and what possible solutions they advocate – these do not necessarily have to be chemical or environmental solutions, and could be social, political or economic answers to an issue.	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
SP-CT – Critical Thinking	**Peer teaching and learning – demonstrating critical thinking skills** • Explain to students the concept of critical thinking using examples from peer teaching activities around the benefits, problems and solutions of organic chemistry. Students would need to consider: o the relevance of information provided o the impact of any biases o breaking information into parts and identifying relationships and connections o identifying strengths or weaknesses of information and why information is significant o drawing conclusions supported by structured reasoning.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

https://www.rsc.org/teaching-and-learning/ - Royal Society of Chemistry
Resources and practical activities for chemistry

https://www.stem.org.uk/ - Science Technology Engineering Mathematics
Resources and activities in science, links with employers and industry

www.cleapss.org.uk/ - CLEAPPS
website for health and safety information when handling chemicals and performing experiments.

https://www.nuffieldfoundation.org/students-teachers - Nuffield Foundation
Range of practical chemistry experiments.

https://www.ase.org.uk/ - Association of Science Education
Links to resources, activities, events and research.

https://chem.libretexts.org/ - LibreTexts
Open access to different online text books and programmes

https://www.chemguide.co.uk/ - ChemGuide
Notes and problems for chemistry

https://phet.colorado.edu/ - PhET science simulations

https://www.essentialchemicalindustry.org/ - The Essential Chemical Industry
Case studies on industrial process

Textbooks

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., Meunier, C., Parmar, C., and Peers, A .,
Pearson BTEC National Applied Science Student Book 1, Pearson Education, 2016 (ISBN 978-1-292-13409-3)
Chapter 1 supports understanding of atomic structure, bonding, periodic trends and quantitative chemistry.

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., and Meunier, C.,
Pearson BTEC National Applied Science Student Book 2, Pearson Education, 2017 (ISBN 978-1-292-13413-0)
Chapter 1 supports understanding of energetics and organic chemistry.

Chapman, B, Beavon, R and Jarvis, A – Structure, Bonding and Main Group Chemistry, Nelson Thornes, 2003 (ISBN 9780748776559).
Good overview of the main features of the periodic table, groups, bonding and structure.

Clark, J – Calculations in AS/A Level Chemistry, Longman, 2000 (ISBN 978-0582411270).
This book has many relevant calculations and worked examples.

Fullick, A and McDuell, B – Edexcel AS Chemistry Students' Book, 1st edition, Longman, 2008, (ISBN 9781405896351).
Various chapters support understanding of periodicity, kinetics, energetics, equilibria and organic chemistry

Ramsden, E N – A-Level Chemistry, 4th edition (Nelson Thornes, 2000) (ISBN 9780748752997.
In-depth look at atomic theory, bonding and periodicity.

Ramsden, E – Calculations for A-Level Chemistry, Nelson Thornes, 2001 (ISBN 9780748758399).
This book has many relevant calculations and worked examples.

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 3: Principles and Applications of Physics

Unit overview

Unit 3: Principles and Applications of Physics	
Assessment type: External	
Content Area	**Topics**
A: Understanding waves and optical fibres	A1 Working with waves A2 Principles of optical fibres A3 Uses of electromagnetic waves in communication
B: Forces in transportation and Newtons Laws of Motion	B1 Measurement and representation of motion B2 Laws of motion
C: Electrical circuits and the transfer of energy	C1 Use of electrical components C2 Equations C3 Electrical energy usage C4 Energy transfer C5 Change of state
Assessment overview The unit will be assessed through one examination of 50 marks lasting 1 hour. The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented. The assessment availability is twice a year in January and May/ June. The first assessment availability is May/June 2026. Sample assessment materials will be available to help centres prepare students for assessment.	

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your students to avoid and overcome these.

What is the misconception?	How to help students overcome it
How waves travel.	Best shown using a slinky so that students can see both types of waves. Transverse - the particles move perpendicular to the direction of energy transfer. Longitudinal - the particles move parallel to the direction of energy transfer.
Heavier objects fall faster than lighter objects	All objects would fall at the same rate if there was no air resistance (vacuum) it is the effect of air resistance on an object which affects its rate of fall

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Learning Topic	Activities and guidance for unit content delivery	Resources
A: Understanding waves and optical fibres		

A1 Working with Waves	• **Whole class teaching and learning – Investigating waves**
	  ○ Use a 'slinky' (very long spring) to demonstrate transverse and longitudinal waves and introduce the terms wavelength, amplitude, frequency and wave speed.
	
	• **Individual Activity – wave simulation software**
	  ○ Introduce students to wave simulation software that allows them to create and modify different types of waves.
	  ○ Ask students to adjust parameters such as amplitude, frequency, and wavelength.
	  ○ Encourage students to experiment with both transverse and longitudinal waves and analyse the relationship between the vibration direction and wave propagation.
		Long slinky to extend across classroom/laboratory or down a corridor
		https://www.youtube.com/watch?v=RLOSR7IoW1k
		
		The Physics Classroom
		Information to support teachers delivering physics content with wave simulator software
		Physics Simulation: Simple Wave Simulator
		
		https://www.physicsclassroom.com/Physics-Interactives/Waves-and-Sound/Simple-Wave-simulator/Simple-Wave-Simulator-Interactive

	• **Small group activity – terms used to describe waves** o Students work in pairs to discuss and write their ideas about the meanings of the following wave terms wavelength, amplitude, frequency, and wave speed. They may wish to consider: - wave speed as a term used to describe the speed of a wave which can also be termed wave velocity - the wavelength of a wave is the distance between two points on a wave that have the same amplitude and are moving in the same direction, e.g. between two consecutive crests or troughs - the frequency of a wave is the number of waves produced in one second (s) or the number of waves that pass a point each second and uses the units hertz - the amplitude of a wave is its maximum displacement from its undisturbed position - an oscillation is a regular repetitive motion, e.g. a weight on a spring bouncing up and down, a pendulum swinging backwards and forwards or a string on a guitar vibrating to and fro o Ask students to use everyday examples to help explain these terms (e.g., frequency could relate to beats in music). One example of each would be appropriate. o Each pair combine with another pair to form a small group. o Students share their definitions and compare ideas. o As a group, students agree on a definition for each term to share with the rest of the class.	https://www.physicsclassroom.com/Physics-Video-Tutorial/Vibrations-and-Waves/Frequency-versus-Period/Video

	• **Whole class discussion to confirm meaning of wave terms and introduce the equation v= f x λ**
	  ○ In pairs, students use graphical and diagrammatic representations to illustrate their understanding of these terms e.g. sketch a wave and label wavelength, amplitude, crest, and trough, displacement, oscillations and show how frequency relates to the number of waves per second.
	• **Individual Activity – use of wave equation**
	  ○ Students' complete worksheet using wave equation
	• **Whole class teaching and learning- terms used to describe superposition of waves**
	  ○ Show diffraction and the idea of superposition of waves and introduce the terms coherence, phase difference and path difference as applied to diffraction gratings
	• **Small group activity – coherence phase and path difference**
	  ○ Students work in pairs to discuss and write their ideas and draw diagrams to illustrate superposition (constructive and destructive interference) coherence phase difference and path difference.
	  ○ Student pairs combine to form small groups and share ideas and definitions.
	  ○ Whole class come together to agree meanings of terms discussed.
		Wave equation with examples of use
		https://www.youtube.com/watch?v=o-703NmGH4A
		https://www.tes.com/teaching-resource/gcse-physics-wave-speed-equation-practice-wavespeed-equals-frequency-x-wavelength-11442908 (TES account required to access)
		https://www.physicsclassroom.com/class/waves/Lesson-2/The-Wave-Equation
		https://www.youtube.com/watch?v=-mIO9jqJyyI
		https://www.savemyexams.com/a-level/physics/ocr/17/revision-notes/4-electrons-waves-and-photons/4-9-superposition-and-stationary-waves/4-9-3-interference/

	• **Practical activity – using diffraction gratings**
	  ○ Give students access to diffraction gratings with different numbers of lines to look at the emissions from different lamps i.e. fluorescent lamp, LED, sodium lamp.
	  ○ Do not use a mercury lamp as this produces some ultraviolet light.
	  ○ Students describe the differences seen.
	
	• **Whole class teaching and learning - producing line spectra**
	  ○ Show line spectrum produced from laser light passing through a diffraction grating.
	  ○ review that an (atomic) emission spectra is the range of frequencies of light emitted by an element.
	  ○ review that an emission spectrum is produced by an element due to energy level changes of electrons.
	  ○ demonstrate that as the electrons lose energy/de-excite when returning to a lower energy level they emit light of a specific frequency.
	  ○ show that the emission spectrum of each element is unique and so can be used to identify the element.
	  ○ Explain that the lines produced for each element are unique and allows each element to be identified.
	  ○ Demonstrate that elements such as mercury, sodium, lithium, potassium and other heavy metals can be vapourised to form gases that can then be energised to emit (atomic) emission spectra.
		Images of spectra
		https://hubblesite.org/contents/media/images/4511-Image.html?Tag=Astronomy%20Basics
		
		Diffraction gratings and spectra
		https://www.youtube.com/watch?v=jnxXtbCJ2pE
		https://www.youtube.com/watch?v=N5tMwHYXT_s
		
		Melde's apparatus
		https://www.youtube.com/watch?v=Zk5_en0qgOU
		
		Resonance tube
		https://www.youtube.com/watch?v=u7wUvEA1v1A
		
		Stationary waves
		https://www.youtube.com/watch?v=1Oeiq6_McYE
		https://www.youtube.com/watch?v=vDwXXpE-Ju4

	• **Pair activity – observing stars**
	  ○ Discuss how scientists are able to identify the elements that are in stars by looking at the light from stars. Write in about five lines the main points of the process.
	
	• **Whole class teaching and learning - stationary/standing waves**
	  ○ Show stationary waves using Melde's apparatus and a resonance tube.
	  ○ Discussion with students on the application of stationary waves to various string and wind instruments and the speed of the wave on a string is given by v =√(T/μ)
	
	• **Individual activity**
	  ○ Each student selects an instrument and makes a short presentation explain how musical notes are produced and changed.
		Resonance and musical instruments
		https://www.physicsclassroom.com/class/sound/u11l5a.cfm

A2 Principles of optical fibres	• **Whole class teaching and learning – refraction**
	  ○ Show some everyday examples of refraction. Discuss with students what happens to light when it is refracted.
	  ○ Introduce the equation to find the refractive index n=sin i /sin r
	
	• **Pair activity**
	  ○ Students work in pairs to discuss the effects of refraction, describe refraction and complete calculations and ray diagrams.
	  ○ The pairs come together and agree how to describe refraction and check calculations.
	  ○ The whole class then decide on a description of refraction.
		Examples of refraction
		https://www.youtube.com/watch?v=jQDRNb-E-cY
		https://www.physicsclassroom.com/class /refrn/Lesson-1/The-Direction-of-Bending
		
		Calculations
		https://www.tes.com/teaching-resource/gcse-igcse-refraction-questions-and-answers-12764457
		(TES account required to access)

	• **Practical activity – refractive index**
	  ○ Students work in pairs to find the refractive index of glass using a glass block n=sin i/sin r
	
	• **Whole class activity – refractive index**
	  ○ An average of all results obtained is calculated and compared with the accepted value of refractive index. Students discuss possible errors and suggest ways to improve accuracy of results.
	
	• **Whole glass teaching and learning- total internal reflection**
	  ○ Show example of total internal reflection and how it occurs. Introduce the equation sin c =1/n
	
	• **Practical activity – critical angle**
	  ○ Students use a semi-circular glass block to determine the critical angle for glass and hence the refractive index.
	
	• **Individual activity**
	  ○ Students complete work sheet and then, in pairs, compare answers and discuss any problems.
	
	• **Whole class teaching and learning-optical fibres**
	  ○ Discuss with students how light waves travel along optical fibres by total internal reflection, how the addition of cladding affects the critical angle and reduces energy losses
		Ray box, glass or perspex blocks, protractors, calculators
		https://www.youtube.com/watch?v=ADN9Rph96NE
		
		Refraction, total internal reflection and fibre optics
		https://www.youtube.com/watch?v=gHgXrKZL_Yg
		
		Ray box, semi-circular glass blocks, protractor
		https://www.youtube.com/watch?v=NAaHPRsveJk
		
		https://apps.asdk12.org/staff/souza_david/HOMEWORK/259888_CriticalAngleWorksheet.pdf
		
		Optical fibres and cladding
		https://www.youtube.com/watch?v=Zeo3UOk7_vA
		https://www.youtube.com/watch?v=4puLmP46W4U

	• **Students work in pairs – optical fibres** o Discuss the conditions required for light to be transmitted through optical fibres. Pairs come together to discuss and agree the conditions. The ideas are then agreed by the class. • **Small group activity – optical fibres** o Each group researches a use of optical fires and puts together a 2-minute presentation for the rest of the class. o Some suggested uses may include: – endoscopy in medicine - remote cameras and sensors in construction - digital and analogue signals in communication. • **Whole class teaching and learning-digital and analogue signals** o Discuss with students what an analogue signal is and how it may be described. o Discuss with students what a digital signal is and how it may be described. o Discuss the differences between digital and analogue signals including: - a continuously varying analogue signal is sampled at fixed intervals in time - sample values are converted into a digital binary code to be transmitted as a stream of pulses o Discuss the advantages and disadvantages of digital and analogue signals for example: - that digital signals are less affected by noise and have less energy loss (attenuation) than analogue signals and can therefore travel further.	**Analogue and digital signals** https://www.youtube.com/watch?v=cmwt0U9ylYA **Analogue and digital signals** Slide deck, activity sheets and teachers notes. | Resources

A3 Uses of electromagnetic waves in communication	• **Whole class teaching and Learning – electromagnetic spectrum**
	  ◦ Show the whole electromagnetic spectrum ask students to give uses for all parts from previous knowledge and remind them that all the waves are transverse and travel at the speed of light in a vacuum.
	  ◦ Discuss how the intensity of a wave decreases the further it is from the source. Introduce the equation $I = k/r^2$
	
	• **Practical Activity – light intensity**
	  ◦ Students use light (lux) meters and measure intensity of a light source at different distances from the source.
	  ◦ Calculate $I \times r^2$ from plot I against $1/r^2$
	  ◦ Students should find that k is not a constant and they do not get a straight line for I against $1/r^2$ and then explain why the results from this experiment do not fit the equation.
	
	• **Individual activity – light intensity**
	  ◦ Explain why the equation can be applied to light from a star and microwave signals from a transmitter mast.
	  ◦ Work through calculations using $I=k/r^2$ and comparison of intensities given at the end of intensity video
	
	• **Whole class teaching and learning- waves used for communication**
	  ◦ Discussion of the waves in the electromagnetic spectrum used for communication, radio waves, microwaves and light waves related to frequency ranges and uses.
		Electromagnetic spectrum
		https://www.youtube.com/watch?v=cfXzwh3KadE
		
		Intensity experiment
		https://www.youtube.com/watch?v=US-cdZNAEhg
		
		Light source, light meters (light meter app) metre rule
		
		Intensity video
		https://www.youtube.com/watch?v=US-cdZNAEhg
		
		Uses of radio waves
		https://www.vedantu.com/physics/electromagnetic-spectrum-radio-waves

	• **Small group activity – communication systems** o Each group researches the uses, advantages and differences of a given communications system, such as satellite communication and GPS positioning, mobile phones, Bluetooth®, infrared and Wi-Fi. o Each group makes a short presentation and produces notes of the main features for the rest of the class. o Points to consider for each use may include the following: <u>Satellite communication and GPS</u> - Frequencies of upload and download signals. - Signals are high power, transmitted over long distances and in the radio-wave/ microwave region of the electromagnetic spectrum. - Microwaves can pass through the ionosphere to high orbit satellites. - Use of orbit satellites in GPS. - Radio waves are reflected by the ionosphere and so can be used for terrestrial communication to receivers beyond the horizon. - Radio waves can be used for communication with low orbit satellites. <u>Mobile phones</u> - Mobile phones are used on a system of networks. - Mobile phone providers are allocated a band of frequencies in the radio/microwave region. - Base stations transmit and receive signals over a limited distance. <u>Bluetooth®</u> - Bluetooth® devices are low power devices which work over short distances to link one device to another e.g. from a mobile phone to hands-free headset.	

	- Bluetooth® devices in mobile phones and tablets have a range of up to 10m. - Bluetooth® uses short wavelength radio signals and so does not need 'line of sight'. - Bluetooth® devices can connect to more than one device - Bluetooth® uses a system of 'frequency–hopping' to reduce interference with Wi-Fi as this uses similar frequencies. - Frequency-hopping limits data loss. <u>Infrared</u> - Infrared is used in low power devices such as remote controls. - Infrared operates over short distances and in 'line of sight'. - infrared does not work well in bright sunlight. - Atmospheric moisture reduces the range of the infrared signal. - Infrared is a high frequency signal and can potentially transmit large amounts of data. <u>Wi-Fi</u> - Wi-Fi allows computers, smart phones and other devices to connect to the internet via a router. - Wi-Fi uses medium power in the radio/microwave frequency region. - Wi-Fi has a range of up to 100 m - Wi-Fi can pass through walls to allow signals to be received. - Wi-Fi signals can also be transmitted through both optical fibres and electrical wiring.	

	• **Whole class teaching a learning** ○ The main points are summarised and discussed by students and any points missed are given attention.	
B: Forces in transportation and Newtons Laws of Motion		

B1 Measurement and representation of motion	• **Whole class teaching and teaching and individual activities - symbols units and speed**
	  ○ Discuss with students the difference between scalars and vectors show discuss the symbols and units used for the quantities used to describe motion the symbols and introduce the equation speed = distance/time
	  ○ Students watch the videos on scalars and vectors and speed and units and make notes
	  ○ Students should be aware of the scalar/vector nature of all quantities (distance, displacement, speed and velocity).
	
	• **Pair activity – speed calculation**
	  ○ Each pair prepares a calculation on speed = distance/time and gives it to the rest of the class to complete and check the answer
	
	• **Individual activity – speed calculation**
	  ○ Use the worksheet complete calculations then check your answers
	
	• **Whole class teaching and individual activities-distance-time and velocity-time graphs**
	  ○ Introduce the use of graphs to show the motion of objects and to calculate velocity, acceleration and the distance travelled as the area under the velocity -time graph
	Introduce the equation to find acceleration a= (v-u)/t
		Speed and units
		https://www.youtube.com/watch?v=EGqpLug-sDk
		
		Scalars and vectors
		https://www.youtube.com/watch?v=iLB_4Wu2QOg
		
		Worksheet
		https://www.youtube.com/watch?v=icRY0h9Qgk8
		
		Velocity from a distance-time graph
		https://www.youtube.com/watch?v=nDfolhABLH8

	• **Individual activity – velocity times graphs.**
	  ○ Work through the examples shown on the videos and try to complete the worked example before looking at the working
	
	• **Pairs activity**
	  ○ Discuss the calculations in pairs and check you understand the principles and equations used.
	
	• **Practical activity - acceleration**
	  ○ Work in pairs.
	  ○ Measure the acceleration of a trolley down a ramp using a ramp light gates a ruler and a stop clock.
	  ○ Repeat results and obtain an average value for acceleration.
	
	• **Whole class and individual activity – equations of motion**
	  ○ Introduce the equations of motion and show some calculations using these equations
	
	• **Individual activity**
	  ○ Complete the examples and check how the answers are obtained.
	
	• **Pair activity – symbols used in equations**
	  ○ Check with your partner that you know the meaning of the symbols used in the equations and how you would find which equation to use for a calculation
		Velocity time graphs
		https://www.youtube.com/watch?v=b0VKlpetP9A
		https://www.tes.com/teaching-resource/velocity-time-graphs-11882633 (TES account required to access)
		
		https://www.tes.com/teaching-resource/velocity-time-graph-worksheet-and-answers-11325549 (TES account required to access)
		
		Worked example
		https://www.youtube.com/watch?v=knHo4qjBeIM
		
		Using a=(v-u)/t
		https://www.youtube.com/watch?v=WvWgDfUN0Eo
		
		Measuring acceleration of a trolley down a slope
		https://www.youtube.com/watch?v=YUqwdD73610

	• **Small group - device uses**
	  o Each group complete research and make a 5 minute presentation (PowerPoint if possible) to describe and explain the uses of accelerometers in one of the following fitness trackers ('smartwatches), mobile phones, blood pressure monitors or any other relevant device.
	  o You may wish to include the following:
	
	Accelerometers
	- When an object experiences acceleration, it causes mass within an accelerometer to move.
	- The movement is detected by a sensing element.
	- The movement of the mass is converted to an electrical signal that can be analysed to determine the objects motion and orientation.
	
	Fitness trackers
	- Fitness trackers use accelerometers to measure motion and estimate user activity.
	- Sensors detect changes in movement patterns.
	- Data generated by the accelerometer can be filtered to remove background noise and to compensate for gravity.
	- This technology allows users to track their daily health and fitness levels.
	
	Mobile phones
	- Mobile phones often have in built fitness trackers in them.
	- They often use technologies such as accelerometers to measure movement and changes in speed.
		Equations of motion
		https://www.youtube.com/watch?v=WJN_F3PYp58
		
		https://www.schoolphysics.co.uk/age14-16/Mechanics/Motion/text/Equations_of_motion/index.html
		
		Examples on the equations of motion
		https://www.ncl.ac.uk/webtemplate/ask-assets/external/maths-resources/mechanics/kinematics/equations-of-motion.html
		https://www.tes.com/teaching-resource/equations-of-motion-sheet-for-a-level-physics-12114386
		(TES account required to access)

	<u>Blood pressure monitors</u> - Blood pressure monitors use accelerometers to track physical activity levels through biosensors. - Three-dimensional accelerometer data can provide physiological data. - This information can be used to forecast blood pressure. o The group will select a leader, responsible for completing the presentation and allocating roles to other members of the group. o Notes from each presentation will be distributed to all the other groups in the class	
B2 Laws of Motion	• **Whole class and individual activity – Newton's First Law** o Introduce the First Law of Motion, mass, inertia and weight. o Discuss these concepts with students. o Students to present their own glossary, you may choose to include: - the mass of an object is the amount of matter in the object - weight is a force and is the pull of gravity on an object, it depends on the strength of gravity. It is a vector as it has a direction - inertia is related to the mass of an object. The higher the mass the harder the object is to move; therefore, it has more inertia. Inertia can be thought of as the resistance to change in motion - gravitation field strength (g) is measured in newtons per kilogram and is the strength of the gravitational field.	**Newton's First Law** https://www.youtube.com/watch?v=W3VbonFNcw **Inertia and mass** https://www.youtube.com/watch?v=1XSyyjcEHo0 **Weight and gravity, W=m x g** https://www.youtube.com/watch?v=84fxHsh8Cmc https://www.tes.com/teaching-resource/weight-mass-and-gravity-worksheet-12406430 (TES account required to access)

	○ Students work in pairs to formulate these ideas, decide on meanings and discuss their ideas with other pairs and eventually the whole class. ○ Students work individually on the questions and calculations at the end of the video on weight and then check understanding with a partner. • **Whole class teaching and learning – coefficient of friction μ** ○ Introduce that friction always opposes motion and the equation F =μR ○ Students learn how to carry out the experiment to determine a coefficient of friction from the video. • **Practical activity – kinetic** ○ Students work in pairs use a flat surface with a wooden block which can be just made to move by attaching it to a string which runs over a pulley and has a weight holder attached. ○ Students take readings of F and R and calculate μ. Students now measure the force needed to keep the block moving at a constant velocity and find the coefficient of kinetic friction. • **Pair activity – practical evaluation** ○ Students discuss in pairs what they have found out from the experiments or videos and give three important conclusions. ○ Conclusions about the importance of friction and kinetic friction are then discussed and clarified by the teacher and class.	**F=μR and experiment to determine coefficient of static friction** https://www.youtube.com/watch?v=mN3eSpLZ_UU **Static and kinetic friction** https://www.youtube.com/watch?v=wY4va73SUIo

	• **Whole class teaching and learning – momentum, change in momentum and Newtons second law**
	  ○ Introduce the idea of momentum p = m x v momentum changing causing a force and the equation F=ma
	  ○ Students work in pairs to discuss and write their ideas about the meanings of the following wave terms momentum, resultant force, acceleration
	  ○ Ask students to use everyday examples to help explain these terms (e.g., bending your knees when you land from a using crash mats
	  ○ Each pair combine with another pair to form a small group.
	  ○ Students share their definitions and compare ideas.
	  ○ As a group, students agree on a definition for each term to share with the rest of the class.
	  ○ Whole class discussion to confirm understanding of importance of rate of change of momentum
	
	• **Group activity – momentum**
	  ○ Students discuss the relevance of momentum and Newtons second law to different ways of transporting goods (e.g. barges, tankers heavy lorries, vans, trains aeroplanes.) and produce a list of advantages and disadvantages of each type of transport which is shared with the class. Implications could be extended to consider ideas such as fuel consumption.
	
	• **Group activity – impact controls**
	  ○ Each group is allocated one of the impact controls from air bags, seatbelts, helmets (for motor bike users), passenger cells, and crumple zones which are used to reduce the severity of injuries when those in cars or on motorcycles are involved in accidents.
		Momentum
		https://www.youtube.com/watch?v=ZtQhlwPxE28
		
		Newton's second law of Motion
		https://www.youtube.com/watch?v=SqdCCxv9YzI
		https://www.physicsclassroom.com/Physics-Video-Tutorial/Newtons-Laws/Newtons-Second-Law/Video
		
		Using momentum to explain safety features
		https://www.youtube.com/watch?v=xRjRyVfiE9M
		
		Calculations on F=m x a
		http://www.dynamicscience.com.au/tester/solutions1/flight/velocity/force.htm
		https://www.tes.com/teaching-resource/newton-s-second-law-f-equals-ma-differentiated-worksheet-12114288 (TES account required to access)
		
		Parachute falling
		https://www.youtube.com/watch?v=ElpqPZd1RJU

	○ Each student works individually to research their topic. ○ The group then discusses what they have found out and decides on how their impact control reduces injuries. The group then selects a leader to present their findings to the rest of the class. • **Whole class and individual activity – Newton's 3rd Law** ○ Introduce Newtons Third Law and discuss this with students. • **Pair activity – action and reaction** ○ Students discuss the everyday effects of action and reaction and give their own examples. • **Whole class and individual activity – air resistance and drag** ○ Summarise the laws of motion and consider terminal velocity and note air resistance and drag are forms of friction. • **Group activity- air resistance practical** ○ Each group to devise an investigation to show the effect of air resistance or drag and demonstrate it to the rest of the class. • **Group activity – air resistance and drag applications** ○ Each group is allocated one application of air resistance from vehicles on roads, falling parachutes or objects falling in liquids. ○ Students should draw labelled force diagrams for their application ○ Students should apply Newtons Laws to their chosen application	**Terminal velocity** https://www.bbc.co.uk/bitesize/guides/zgv797h/revision/1 **Air resistance** https://www.youtube.com/watch?v=v8DvquMXq8M **Objects falling through liquids** https://www.youtube.com/watch?v=BWlEpMgaSYM **Newton's third law of motion** https://www.youtube.com/watch?v=wANmggaC9pY https://www.youtube.com/watch?v=eU3ULRgS8Vk

	○ Student should describe which forces are acting on their applications.	
C: Electrical circuits and the transfer of energy		
C1 Use of electrical components	• **Whole class and individual learning – electrical circuitry, units and measurements** ○ Introduce electrical quantities, symbols and measurements, and discuss with students their previous knowledge. ○ Include symbols such as: - cell, battery, switch, bulb/lamp, fixed resistor, variable resistor, ammeter, voltmeter, ohmeter, diode, LED, thermistor, LDR and photodiode. ○ Demonstrate or use a video to show how circuits are set up and the positions of ammeter and voltmeter and how resistance is measured directly using a multimeter. • **Pair activity – electrical symbols.** ○ Students test each other's knowledge of the electrical symbols and discuss the meanings of electrical quantities and their units and the positioning of ammeters and voltmeters in circuits. ○ Pairs come together to confirm the correct description of quantities and units and produce a table for student notes. • **Practical activity – resistance** ○ Students measure the resistance of various resistors in series and parallel to see how resistance can be changed.	**Circuit symbols** https://www.youtube.com/watch?v=YoGkLiF-UCE **Electrical terms, units and circuits** https://www.bbc.co.uk/bitesize/articles/zjm8kty#zvk22v4 **Measuring current and voltage and Ohms Law** https://www.bbc.co.uk/bitesize/guides/zcqq7yc/revision/5 **Using an ohmmeter (multimeter) to measure resistance** https://www.youtube.com/watch?v=hfj1A9T6OlA

	• **Whole Class and individual activity – using electrical components**
	  ○ Introduce the components that students will use in circuits, thermistors, diodes, filament lamps, light dependent resistors (LDR) and light emitting diodes (LED) and discuss with students the action of these components and how the resistance of the components can be changed under different conditions.
	
	• **Practical activity – electrical components**
	  ○ Students working in pairs are allocated a component to investigate and collect results which are shared with the rest of the class
		Thermistor
		https://www.youtube.com/watch?v=2xr1O8CZdPQ
		
		Filament lamp
		https://www.youtube.com/watch?v=fTy63edg5d8
		
		Diode
		https://www.youtube.com/watch?v=Yb3e6HbmnUA
		https://www.youtube.com/watch?v=KaI1S1uQj1M
		
		Light dependent resistor and thermistor
		https://www.youtube.com/watch?v=p8jzrHZq6VY
		
		LED
		https://www.youtube.com/watch?v=Hl4v1aUFWrs

C2 Equations	• **Whole class and individual activity- equations**
	  ○ Introduce the equations for power, energy and Ohm's Law with their symbols and units.
	  ○ Discuss with students a way of setting out calculations
	  ○ Highlight availability of formulae sheet.
	  ○ Discuss the importance of appropriate units.
	  ○ Students work through some examples using these equations and discuss any difficulties.
		P=I x V
		https://www.tes.com/teaching-resource/power-current-and-resistance-practice-questions-11789984 (TES account required to access)
		
		V= I x R Ohms Law

	○ The teacher and class discuss the difficulties that have been identified and provide any assistance needed. • **Individual activity - calculations** ○ Students now attempt a few more calculations and check their answers	https://www.tes.com/teaching-resource/differentiated-ohms-law-work-sheets-v-equals-i-x-r-ks4-11462050 (TES account required to access) **Power =work done /time** https://www.tes.com/teaching-resource/aqa-1-9-power-energy-transferred-work-done-calculations-11503702 (TES account required to access) https://www.tes.com/teaching-resource/power-work-energy-time-6192894 (TES account required to access)
C3 Electrical energy usage	• **Whole class and individual activity** ○ Discuss with students' energy use by domestic appliances and the use of which appliances add the greatest cost to the household energy bill. ○ Students use the comparison of energy usage table to estimate their own usage of energy each day. ○ Students make a list of how they could reduce their own energy usage do some calculations and compare their list with the lists of other pairs. ○ The whole class discuss energy savings and decide on the most significant changes that are needed to save energy.	**Energy use by appliances** https://www.youtube.com/watch?v=lmQ6QvZPtj0 **Comparison of energy used by appliances** https://www.nea.org.uk/get-help/resources/home-appliances-that-use-the-most-electricity/?gad_source=1&gclid=Cj0KCQiApNW6BhD5ARIsAC

	• **Whole class an individual activity-fuses**
	  o Discuss with student the use of fuses in domestic appliances as a safety device
	
	• **Pair activity**
	  o Ask students to find out the power of different domestic appliances and calculate the fuse rating for the device and explain their choice of fuse.
	  o Compare the answers from different pairs to check understanding.
		Calculations of energy use
		https://www.tes.com/teaching-resource/gcse-physics-worksheet-electrical-energy-costs-calculations-kwh-w-solutions-12983551
		
		Fuse rating for domestic appliances
		https://www.youtube.com/watch?v=SfRyJjU9pb8

C4 Energy Transfer	• **Whole class and individual activity- specific heat capacity**
	  o Introduce the idea that energy has to be supplied to a substance to change its temperature and introduce the equation
	  $\Delta Q = m \times c \times \Delta T$
	  o Students discuss and develop a meaning of specific heat capacity
	
	• **Practical activity – specific heat capacity**
	  o Working in pairs students measure either the specific heat capacity of water or aluminium.
	  o The results obtained are shared with the class and compared with the accepted values.
	  o Class discussion of how results compare and suggestions for improvements to experimental method
	  o Students review the outline of the practical and associated calculations.
		Celsius to Kelvin
		https://www.youtube.com/watch?v=c0_7QmAZPl4
		
		Description of measuring specific heat capacity
		https://www.youtube.com/watch?v=TqIFIBODrjM
		https://www.youtube.com/watch?v=HAPmwu7byGM

	• **Individual activity – specific heat capacity**
	  ○ Student's complete calculations on specific heat capacity and check answers.
	
	• **Whole class and individual activity- specific latent heat**
	  ○ Introduce the idea that heat transfer can also produce a change in state without a change in temperature and the use of the equation $\Delta Q = m \times L$
	  ○ Students develop their ideas about the meaning of specific latent heat of fusion and vaporisation.
	  ○ Students should consider why the specific latent heat of fusion is lower than the specific latent heat of vapourisation.
	  ○ Students complete some calculations and check the answers.
	
	• **Practical activity – specific latent heat**
	  ○ Students work in pairs to measure specific latent heat of fusion or vaporisation and compare results with the accepted.
	  ○ Students review the outline of the practical and associated calculations.
	  ○ Whole class discussion of possible errors and improvements.
		Experiment to measure specific heat capacity
		https://www.bbc.co.uk/bitesize/guides/zpjpgdm/revision/7
		https://www.youtube.com/watch?app=desktop&v=7bucHPbrxkg&t=0s
		https://www.youtube.com/watch?v=R-OUS5-Lv8I
		
		Calculations on specific heat capacity
		https://www.tes.com/teaching-resource/specific-heat-capacity-11978694 (TES account required to access)
		
		Specific latent heat of fusion and vaporisation
		https://www.youtube.com/watch?app=desktop&v=8VmkdzRE8sQ
		
		Experiment to determine specific latent heat of vaporisation of water
		https://www.youtube.com/watch?v=3zwj3_Eidg8
		
		Experiment to determine specific latent heat of fusion of water
		https://www.youtube.com/watch?v=Vj9Lo312cME

		Calculations https://www.tes.com/teaching-resource/specific-latent-heat-of-fusion-and-vapourisation-12183642 (TES account required to access)

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery

SP-PS – Problem Solving	**Practical activity – Specific heat capacity**
	• Explain to students the common 'pitfalls' in the experiment, and the resultant consequence they could expect.
	• Discuss ways around these errors and how they could be prevented.
	• Students may wish to consider:
	  ○ what equipment is available
	  ○ what time is available
	  ○ what impact the 'problem' would have on results
	  ○ what solutions may be available
	  ○ what impact the solutions may have.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

Marksphysicshelp – A-Level Resources and Tutoring– Marks Physics Help

Teaching resources – a variety of teaching resources to assist with delivery of wave topics

The Physics Classroom – The Physics Classroom

Physics tutorials, videos, resources and concept checkers.

Motion and forces | High school physics | Science | Khan Academy – Khan Academy

Quizzes, tutorials, resources and videos

Crash Course Physics videos on physics topics across the specification

Glenn Research Center - NASA Newton's Laws of Motion application

Electricity Explained | Simulations, animations and videos to teach electricity electrical circuit simulations

IOPSpark Institute of Physics Learning Hub including experiments, videos, and questions

Resources for Teachers – Physics tutor Physics Tutor resources for teachers including quizzes, slide decks and worksheets.

Textbooks

Giancoli, D.C., Physics: Principles with Applications, Pearson 7th Edition, 2015

Serway, R.A., Jewet, J.W., Physics for Scientists and Engineers, Cengage Learning 9th Revised edition 1980

Halliday, D.P., Resnick, R., The Complete Physics Tutor, Wiley and Sons, 10th Edition, 2013

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 4: Practical Scientific Procedures and Techniques

Unit overview

Unit 4: Practical Scientific Procedures and Techniques	
Assessment type: Internal	
Learning Aim	**Topics**
A: Undertake techniques to prepare solutions and determine concentrations and purity	A1 Laboratory equipment and its calibration A2 Preparation and standardisation of solutions using titration A3 Determination of purity of organic compounds A4 Evaluating accuracy and reliability using critical thinking
B: Undertake biological procedures to investigate concentration and distribution of biological components	B1 Colorimetry B2 Plant growth
C: Undertake physical procedures to examine energy transfer	C1 Transfer of thermal energy C2 Transfer of energy through electrical circuits C3 Transfer of energy using a renewable source
D: Review personal development of scientific skills for laboratory work.	D1 Personal responsibility D2 Interpersonal skills D3 Professional practice
Assessment overview This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB). Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 75 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification.	

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your students to avoid and overcome these.

What is the misconception?	How to help students overcome it
Some students may consider the terms concentration and strong to mean the same thing. This is often evidenced during learning aim A.	Provide students with a clear definition regarding the difference between the two keywords. Some students may benefit from a visual representation, to differentiate between the two keywords
Not all students have a clear understanding of the meaning of molarity. Some students may not understand the impact of volume on molarity.	Students may need very clear guidance regarding the definition of molarity. Specific references to molarity and how it's affected by volume may help students to develop a better understanding of this concept.
Some students struggle with the concept of freezing/melting point and boiling/condensation point being the same.	Students should be encouraged to think about the behaviour of particles at freezing/melting and boiling/condensation point. Students should consider energy changes that are taking place, along with the behaviour of intermolecular forces.
Students may hold misconceptions regarding the polarity of solvents. For example, students may consider that non-polar compounds have the ability to move all components up a chromatography plate.	Provide students with clear guidance regarding the role of polar and non-polar solvents. Students may benefit from a diagrammatic/visual representation of polarity. Students could be provided with appropriate links to resources to support their independent learning.
Some students may consider the terms concentration and strong to mean the same thing. This is often evidenced during learning aim A.	Provide students with a clear definition regarding the difference between the two keywords. Some students may benefit from a visual representation, to differentiate between the two keywords
Not all students have a clear understanding of the meaning of molarity. Some students may not understand the impact of volume on molarity.	Students may need very clear guidance regarding the definition of molarity. Specific references to molarity and how it is affected by volume may help students to develop a better understanding of this concept.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Learning Topic	Activities and guidance for unit content delivery	Resources
A: Undertake techniques to determine chemical concentration and composition of substances		
A1 Laboratory equipment and its calibration	**Introduction** Introduce calibration to students. Incorporate everyday examples of when calibration may be appropriate, e.g. bathroom scales or kitchen scales. Ask students to consider calibration's importance and the consequences of not carrying out appropriate calibration activities. Introduce the concept of zero error and ask students how zero error can be avoided.	

	• **Whole class activity - use of balances for weighing and associated techniques**
	  ○ Check students understanding of how they would calibrate electronic balances.
	  ○ Provide students with data from different types of electronic weighing balances.
	  ○ A range of data ranging from 2 decimal places to 4 decimal places. Introduce the concept of resolution and ask students to consider which set(s) of data relate to the electronic balance with the highest/lowest resolution.
	  ○ Provide students with a range of known masses.
	  ○ Students could use the masses to identify the accuracy of the electronic balance that is available in the laboratory.
	  ○ Students should record this information in a table and clearly state any discrepancy between the known mass, and the reading on the electronic balance. Where possible, provide students with electronic balances of different accuracies and ask students to complete the investigation with each balance.
	  ○ Lead a whole class discussion to consider how the results of the electronic balance calibration task will be used to inform future methods. How will this information be used to ensure that practical results are accurate and reliable?
		Important of calibration of laboratory equipment
		Importance of Calibration of Laboratory Equipment - GNW Instrumentation
		
		How to calibrate and electronic balance
		https://www.philipharris.co.uk/blogs/secondary/how-to-calibrate-an-electronic-balance
		https://studyrocket.co.uk/revision/level-3-applied-science-btec/practical-scientific-procedures-and-techniques/use-of-balances-and-weighing

	• **Whole class activity – weighing equipment**
	  o Introduce the use of appropriate equipment for weighing for example, a weighing boat for measuring the mass of a solid, and a beaker for a liquid. Video clips could be used to demonstrate these techniques.
	
	• **Laboratory activity - comparing volume measurements of different types of glassware [EL-PRS]**
	  o Students explore the different types of volumetric glassware (beakers, graduated cylinders, pipettes, burettes, and volumetric flasks) and understand their accuracy, precision, and proper use.
	  o Introduction to Volumetric Glassware:
	  - Begin by introducing the different types of glassware, discussing the purpose of each (e.g. beakers for rough measurements, conical flasks, or measuring cylinders for more precise measurements, volumetric flasks for accurate, specific volume measurement).
	  o Volume comparison:
	  - Fill each piece of glassware with water, carefully measuring the volume in each using a measuring cylinder.
	  - Record the measurements on a data table, noting the type of glassware and the measured volume.
		How to use a weighing boat
		https://www.youtube.com/watch?v=dCbyA-aH6k4
		
		Chemistry glassware names and uses
		https://www.thoughtco.com/chemistry-glassware-names-and-uses-606047
		
		Measuring the mass of a liquid
		https://cdn.sanity.io/files/p28bar15/green/6627251a69f6772ab747da14b6eb5dcd9701ae5d.pdf
		
		Volumetric glassware
		https://www.webassign.net/labsgraceperiod/tccgenchem1l1/glassware/manual.html#:~:text=Four%20main%20types%20of%20volumetric,the%20buret%20and%20the%20pipet.

	○ Accuracy check: - Weigh the water in each piece of glassware using the balance and compare the mass to the theoretical mass based on the volume and density of water (approximately 1 g/mL at room temperature). - If available, use a thermometer to check for any temperature variation, as it can affect volume measurements slightly. ○ Analysis: - Discuss how the shape of the glassware and the scale increments affect the precision and accuracy of measurements. - Identify which glassware was the most accurate and why, considering how well the measurement matched the known volume of water. ○ Conclusion: - Students summarise the key differences in precision, accuracy, and appropriate usage for each type of glassware. - Discuss real-world applications for each, such as when it is necessary to use a volumetric flask versus a measuring cylinder, and why precision is important in scientific measurements. This activity will help students to develop an understanding of the differences in volumetric glassware but also give them hands-on experience with measuring and analysing volumes, which is essential in many laboratory settings.	

	To identify uncertainty in measurements and calculate the percentage error in volumetric glassware, students could follow this method:
	
	• **Practical activity - identifying instrument uncertainty [EL-PRS]**
	  o Find the manufacturer's specified uncertainty for the volumetric glassware (e.g., a measuring cylinder, burette, or pipette). This is typically given as a fraction of the instrument's full scale or a fixed value (e.g., ±0.01 mL). If not directly specified, use standard uncertainties such as ±0.1 mL for most common glassware.
	  o Measure the volume:
	  - Measure the volume using the glassware and record the reading (e.g., volume of liquid in a burette or pipette).
	  o Calculate the absolute uncertainty:
	  - Absolute uncertainty is the uncertainty provided by the instrument (e.g., ±0.05 mL).
	  o Calculate the percentage error:
	  - Percentage error is calculated by comparing the measured volume to the known or expected volume (or a reference measurement).
	
	This method will provide an understanding of both the precision of the instrument and the accuracy of your measurement relative to a known or true value. Demonstrate how percentage error can be calculated using specific examples.
	
	• **Practical activity - introduce the use of the burette via a demonstration [EL-PRS]**
		Uncertainties in scientific measurements
		https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_General_Chemistry_(Petrucci_et_al.)/01%3A_Matter-_Its_Properties_And_Measurement/1.6%3A_Uncertainties_in_Scientific_Measurements

	○ Explain that the burette is used for accurately dispensing and measuring the volume of liquids, particularly in titrations. Model how the burette is used safely. ○ Students could be divided into small groups, each provided with all four pipettes, water, and measuring cylinders. Students use each pipette to transfer 5 mL of water into a measuring cylinder, taking note of any differences in ease of use and accuracy. ○ For the automated pipette: Set the volume to 5 mL or another specific value for comparison. ○ For the graduated pipette: Ensure they use the markings for accurate measurement. ○ For the bulb pipette: Highlight how it delivers a fixed volume. ○ Students record their observations, including: - accuracy (how close the volume was to 5 mL) - precision (consistency of results) - ease of handling - situations where each pipette might be most appropriate. • **Small group activity – strengths and limitations of pipette types.** ○ Arrange the students into small groups. ○ Allow them to have a group discussion about the strengths and limitations of each pipette type. ○ Suggest reflective questions, such as: - why would you use an automated pipette over a teat pipette for small volumes? - in what scenarios would a bulb pipette be preferred over a graduated pipette?	**Quantitative chemistry** https://www.bbc.co.uk/bitesize/guides/z4x2gwx/revision/3

A2 Preparation and standardisation of solutions using titration	• **Whole class teaching and learning - preparation of a standard solution [EL-PRS]**. o Provide students with a specific amount of a substance, for example - Sodium Bicarbonate. o Guide them to dissolve it in distilled water and prepare a solution of a known concentration using a volumetric flask. o Students should ensure that they recorded the mass of the solid that has been added. o The following method could be used – - **Weigh the solute:** Measure the mass of the solute (in grams) using an electronic balance. - **Dissolve the solute:** Add the solute to a volumetric flask. - **Dilute to the mark:** Add solvent (distilled water) up to the calibrated volume of the flask. • **Small group activity – calculating concentration of standard solution** o Lead a group discussion regarding how to calculate the concentration of the standard solution. o Students may benefit from worked examples. o Students can use this information to calculate the concentration of their own standard solutions. • **Laboratory activity – acid-alkali titration** o Demonstrate an acid-alkali titration. o Ask students to reflect on the earlier burette activity. o Provide students with the opportunity to carry out a rough titration in order to practice their technique.	**How to make a standard solution** https://www.chemicals.co.uk/blog/how-to-make-a-standard-solution?srsltid=AfmBOopeXVxnYxOpQ1XNzW-gStJKqyH7YXTfo2fXS2iQn0Y5S4LXZBvK **Volumetric titrations** https://www.bbc.co.uk/bitesize/guides/ztkdd2p/revision/4

	• **Laboratory activity – standardisation of the standard solution [EL-PRS]**. o Students can carry out the following practical activity. - Clean and rinse a burette, pipette, and conical flask with distilled water. - Fill the burette with a known concentration of HCL - Rinse the pipette with the standard solution (to be standardized). o To take the measurement - Use the pipette to transfer a specific volume (e.g., 25.00 mL) of the standard solution into the conical flask. - Add 2–3 drops of an appropriate indicator to the flask. o Ask students to carry out a titration - Slowly add the HCl from the burette to the analyte solution while swirling the flask. - Stop adding once the indicator changes colour permanently, indicating the endpoint. o Ask students to record results and repeat. - Record the volume of the end point - Repeat the titration until you obtain at least three consistent titres (within ±0.1 mL). o Ask students to perform calculations - Lead an activity to demonstrate how to calculate the concentration of the HCl. - Students may benefit from worked examples, before using this information to calculate the concentration using their own results.	**GCSE Revision** - Titration calculations https://www.youtube.com/watch?v=x8DLLCNMKAs

	• **Laboratory activity – determination of titration endpoint from the colour change of a suitable indicator [EL-PRS]**.
	  o Provide students with the opportunity to carry out a titration involving an acid and a base, for example HCl and NaOH.
	
	• **Small group activity – appropriate Indicators**
	  o Allow students to discuss their method in pairs/small groups. Provide a range of indicators and ask students to research and consider the most appropriate indicator for their practical.
	
	• **Whole class activity – group discussion**
	  o Discuss the importance of rough titrations and the need to carry out repeats.
	  o Ask the students to discuss and feedback on how they will calculate mean titres.
	  o Encourage students to consider how they will manage anomalous results within their data.
	  o Ask students to consider how many repeats they carry out.
	  o Encourage students to design their results table prior to starting the practical activity.
	  o Students can work in small groups to discuss their results and carry out concentration calculations.
	  o Model how the concentration is calculated before students attempt this for themselves.	

	• **Whole class teaching and learning – use of stoichiometric ratios from chemical equations** o Explain that stoichiometric ratios from chemical equations are used in various ways in chemistry to relate the quantities of reactants and products. o Lead a whole class activity to demonstrate the use of stoichiometric ratios, using symbol equations, For example: $CH_4+2O_2 \rightarrow CO_2+2H_2O$ o Students may benefit from more than one worked example, before being given the opportunity to relate the concept to their own results. • **Whole class teaching and learning – systematic and random errors** o Provide students with information about different types of errors. o Lead a whole class discussion focusing on each type of error and ask students to consider how these errors may have impacted their results. o Students may benefit from some scenarios involving different types of errors. o Students could discuss each scenario in small groups and identify the errors. o Students should be encouraged to take an evaluative approach, and to consider how they would reduce such errors in future practical activities.	**Stoichiometry and balancing reactions** https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_and_Websites_(Inorganic_Chemistry)/Chemical_Reactions/Stoichiometry_and_Balancing_Reactions **Random error and systematic errors** https://www.thoughtco.com/random-vs-systematic-error-4175358

A3
Determination of purity of organic compounds
	• **Whole class teaching and learning – chromatography**
	  o Ask students to reflect on their knowledge of chromatography from GCSE/prior learning. Ask students to discuss their understanding of chromatography within small groups.
	  o Students can carry out a research task to identify different methods of chromatography, such as:
	  - thin layer chromatography (TLC)
	  - paper chromatography
	  - ion exchange
	  - gas chromatography (GC)
	  - high-performance liquid chromatography (HPLC).
	
	• **Laboratory activity – whole class demonstration**
	  o Lead a class demonstration using paper chromatography. This could focus on the identification of amino acids, plant pigments etc.
	  o Describe each stage of the process, emphasising key concepts such as the stationary and mobile phase.
	  o Highlight potential errors that could impact the results, such as not using a pencil for the baseline, or allowing the practical to 'overrun'. Students should be alerted to any potential risks posed by the method, for example, the use of Ninhydrin in amino acid chromatography.
	  o Where possible, use a visualiser to demonstrate how to measure the distance of the spot and the solvent front. This data could then be used to introduce the concept of Rf values.
		Paper chromatography plant pigments
		https://www.youtube.com/watch?v=WYLXdQV8FuI
		
		TLC plant pigments
		https://www.youtube.com/watch?v=N1jiomP3l_E
		
		Purity and separating mixtures
		https://www.bbc.co.uk/bitesize/guides/z9dfxfr/revision/4

	• **Laboratory activity – chromatography [EL-PRS]** o Provide students with the opportunity to carry out a similar chromatography activity in pairs/small groups. o Students may benefit from carrying out a practical experiment, to allow them to use the practical equipment and identify any potential issues that may impact their results. o Students should use their chromatograms to calculate Rf values, before using published data to identify each compound. o Students can repeat the activity using a different method of chromatography, such as thin layer chromatography. o Students should calculate Rf values and compare the results with those obtained during paper chromatography. • **Whole class teaching and learning – results analysis [SP-CT]** o Lead a class discussion regarding the factors that may impact the results obtained via chromatographic techniques, such as: - sample loading - humidity - temperature - nature of solvent - substrate and product molecule (polarity) - contamination.	

	○ Students could consider the factors that may have impacted their own results. An evaluative approach should be taken, with students considering how their method could be adapted to improve the reliability of their results. ○ Where possible, students could repeat their practical tasks with a revised method.	
A4 Evaluating accuracy and reliability using critical thinking skills	• **Whole class and individual activity – scientific data [SP-CT]** Encourage students to critically analyse a set of scientific data, question its relevance, identify patterns, evaluate strengths/weaknesses, and draw conclusions supported by evidence. ○ Students could be given printed or digital datasets (can be real-world climate data, medical trial results, or other experiment outcomes). The following resources could be used: - graphs and charts related to the dataset - worksheet with guiding questions - markers and sticky notes (if working on paper). ○ Ask students: "Can data ever be misleading?" and "How do our biases affect how we interpret data?" Show two different representations of the same dataset (e.g., a graph with a misleading scale vs. an accurate one). Discuss how presentation affects interpretation.	**Analysing experimental data** https://www.bbc.co.uk/bitesize/guides/zhg3hbk/revision/1

B: Undertake biological procedures to investigate concentration and distribution of biological components		
B1 Colorimetry	• **Whole class and individual activity – colorimeter** o Introduce the role of the colorimeter. Students could be shown a demonstration of the colorimeter being used. Alternatively, a video demonstration could be shown. • **Laboratory activity – colorimetry investigation [EL-PRS] [SP-CT]** o Students could work in pairs/small groups to carry out a colorimetry investigation. Students could follow out the following tasks: - preparation of a series of diluted solutions from a stock solution using serial dilution - calibrate the colorimeter using solutions produced by serial dilution - create a calibration curve based on the results - use the calibration curve to identify the concentration unknown solutions.	**Colorimetry** https://www.chemistrystudent.com/colorimetry.html **Colorimetry for applied Science** https://www.chemistrystudent.com/colorimetry.html
B2 Plant growth	• **Whole class teaching and learning – biodiversity** Introduce the idea of biodiversity and ask students to consider what this means. o Students could be encouraged to think back to the content that they may have covered at GCSE/prior learning. o Provide students with an overview of the important of biodiversity.	**Why is biodiversity important?** https://royalsociety.org/news-resources/projects/biodiversity/why-is-biodiversity-important/

	• **Small group activity - biodiversity** In small groups students could discuss factors that affect biodiversity. o Students may benefit from prompts or scenario-based questions to provoke and encourage discussion. **Laboratory activity/small group activity – biodiversity investigation [EL-PRS] [SP-CT]** o Provide students with a hypothesis that they are going to investigate, for example - 'If light intensity increases, then the number of daisies in a field will also increase'. o Provide students with the necessary equipment to carry out the investigation. o Students could work in small groups to investigate the hypothesis using quadrat squares. o Students should be encouraged to consider the following points: - How will they select the area to sample - this may be an opportunity to discuss the importance of random sampling - How they will record their data - How many repeats they will carry out - How they will use their data to decide if the hypothesis can be supported	**Quadrats -** https://www.bbc.co.uk/bitesize/guides/z9pn6yc/revision/2

	• **Laboratory activity – plant dissection [EL-PRS]** o Students complete a plant dissection activity in order to view plant tissue under the microscope. o Students could carry out a stem dissection with a view to observing the vascular bundles and the xylem, phloem and sclerenchyma or collenchyma using the microscope. o Students could be shown a demonstration of the method or use an online resource to develop an understanding of the process. o Students should be made aware of the importance of using staining techniques. o Students will produce annotated diagrams of their plant tissue slides, labelling the key organelles and structures.	**Dissection and microscopy of a plant cell** https://www.saps.org.uk/teaching-resources/resources/1325/a-level-set-practicals-dissection-and-microscopy-of-a-plant-stem/
C: Undertake physical procedures to examine energy transfer		
C1 Transfer of thermal energy	• **Whole class teaching and learning – heat transfer** Students could be led through a presentation outlining the processes of conduction, convection and radiation. o Encourage students to consider any prior learning in this area. o Students could watch the linked video (or a similar video) before engaging in a small group discussion regarding the differences between conduction, convection and radiation.	**Conduction convection and radiation** https://www.youtube.com/watch?v=Eizsm5V8c_c **Heat Transfer** https://www.bbc.co.uk/bitesize/guides/zr7j382/revision/2 **Tangent on a cooling curve**

	• **Laboratory activity – conduction [EL-PRS]**
	  o Students could investigate conduction by finding out how long it takes different materials to heat up.
	  o This could be achieved by placing wax at the end of each material and timing how long it takes for the wax to melt.
	
	• **Laboratory activity – cooling curve [EL-PRS]**
	  o Students could investigate the rate of cooling in a beaker of water and use the data to construct a cooling curve. Students could be encouraged to consider the following points –
	  - What volume of water will be used?
	  - What will the starting temperature be?
	  - How often will the temperature be recorded?
	  - When will the student stop recording the data?
	  - Will the investigation be repeated?
	
	• **Individual activity – Cooling curve**
	  o Students could construct their own cooling curve, using the data from the cooling of water investigation.
	  o Students could use their cooling curve to identify the general rate of cooling at different points.
	
	• **Whole class teaching and learning – rate of cooling**
	Model an example of using a cooling curve to calculate the rate of cooling using a gradient.
	  o Demonstrate how a tangent can be drawn in order to calculate the rate of cooling.
		https://www.youtube.com/watch?v=Ne-cxsjHPIM

	○ Students could be given the opportunity to complete some practice examples of calculating the rate of cooling using a tangent. ○ A video example could also be used. • **Individual activity/Paired activity – Calculate rate of cooling [EL-PRS]** ○ Students should be given the opportunity to calculate the rate of cooling at three different points on their cooling curve. ○ Students could work in pairs and peer assess each other's calculations. • **Individual activity/laboratory activity** Students could work independently to research the concept of specific heat capacity. ○ Students should be guided to identify how specific heat capacity is calculated. ○ Students could investigate the specific heat capacity of different liquids using a calorimeter. ○ Students can apply the equation for specific heat capacity to their own results.	
C2 Transfer of energy through electrical circuits	• **Laboratory activity – circuits [EL-PRS]** Students will construct series and parallel circuits and measure voltage and current.	**Series and parallel circuits** https://www.bbc.co.uk/bitesize/guides/z437hyc/revision/1

	○ Provide students with circuit components: a power supply, voltmeter, ammeter, switch, lamp, variable resistor, thermistor, and light-emitting diode (LED). ○ Ask them to draw circuit diagrams for a series and parallel circuit before setting them up. ○ Have students build both circuits and measure voltage and current at different points using a voltmeter and ammeter. ○ Students should compare their measurements and discuss how voltage and current behave in each type of circuit. • **Laboratory activity – resistance [EL-PRS]** ○ Provide students with five wires of the same material but different cross-sectional areas. ○ Using a micrometer, students should measure the diameters of the wires and record their values. ○ Set up a circuit with a power supply, ammeter, voltmeter, and a single wire. ○ Measure the resistance of each wire by recording voltage and current, then calculate resistance using $R = V/I$. ○ Using the formula $\rho = RA/L$, students should calculate the resistivity of the wire material. • **Laboratory activity – resistance [EL-PRS]** ○ Provide students with thermistors, LEDs, and filament lamps. ○ Ask students to measure the resistance of each component at room temperature using an ohmmeter. ○ Gradually change the temperature using a heat source or by cooling with ice packs and observe how resistance changes.	**Electrical resistivity** https://qualifications.pearson.com/content/dam/pdf/A%20Level/Physics/2015/teaching-and-learning-materials/AS-and-A-leve-Physics-Core-Practical-2---Electical-Resistivity-(Student,-Teacher,-Technician-Worksheets).pdf **Resistance in different diameter wires** https://web.physics.ucsb.edu/~lecturedemonstrations/Composer/Pages/64.12.html **Thermistor demonstration** https://www.youtube.com/watch?v=yQCfitTm1io&scrlybrkr=2ad47653https://www.youtube.com/watch?v=yQCfitTm1io&scrlybrkr=2ad47653

	○ Have students analyse and discuss their results, focusing on why thermistors and filament lamps behave differently compared to normal resistors.	
C3 Transfer of energy from a renewable resource	• **Laboratory activity/paired activity – solar panels [EL-PRS]** ○ Students could investigate solar panels by varying the distance of a light source from the panel and measuring the voltage at each distance. ○ Students could investigate other factors such as the angle of the solar panel and the colour of the light. ○ Students could produce graphs to identify trends and relationships between voltage and experimental conditions. ○ Students could work in pairs to consider their results and decide on the best conditions for maximising solar power output. Students could be encouraged to refer to their results from the previous practical activity. • **Whole class and individual activity** ○ Students prepare a presentation to focus on the factors that improve the power generation of a solar panel. Students present their ideas to the rest of the class, before answering any questions from other members of the group.	**Investigating the factors affecting the output of a solar panel** https://www.wjec.co.uk/media/gb1pg5cp/investigation-of-the-factors-affecting-the-output-from-a-solar-panel.pdf

D: Review personal development of scientific skills for laboratory work		
D1 Personal responsibility	• **Small group activity – health and safety** o The class could be divided into small groups (3–4 students per group). o Provide each group with a scenario card that outlines a lab situation. For example: - Scenario A: A student notices a peer not following safety protocols during an experiment. - Scenario B: A student accidentally makes an error in a procedure and must decide how to address it. - Scenario C: A team is preparing for a lab experiment and needs to distribute roles and ensure that each member understands their responsibilities. o Each group spends 5 minutes discussing their scenario and then role-playing the situation, focusing on: - Clearly defining each team member's role and responsibilities. - Demonstrating safe working practices and adherence to protocols. - Discussing and showing accountability for decisions made during the scenario o After each role-play, have a brief class discussion. Ask each group to share what they learned about accepting personal responsibility and working safely in a science lab setting.	**Science CLEAPPS** https://science.cleapss.org.uk/ **Laboratory safety rules** https://safety.admin.ox.ac.uk/laboratory-safety-rules

	• **Individual activity – safe working practices [MY-TPR]**. o Students reflect on their practical tasks and consider how they have adhered to procedures and protocols, as well as considering how they have adopted safe working practices. Students could produce a written report or summary to outline how they have developed these skills.	
D2 Interpersonal skills	• **Project based learning – mini research project** o Present a scenario where each group must design a mini research project (e.g., investigating a simple scientific question) with limited resources and a strict time limit. o Outline available "resources" (e.g., mock lab equipment, data sets) and any safety guidelines that must be followed. o Planning session in small groups, have students create a brief project plan that includes: - a timeline for key tasks - allocation of resources - safety protocols they plan to observe o Encourage discussion about strategies to maximise efficiency and minimise waste. o Allow each group a fixed period (e.g., 10 minutes) to simulate the project execution, checking in on their progress. o Instruct groups to record any challenges they encounter, especially related to time management or resources used.	

	○ Students can consider the following questions: - What strategies worked best? - How did planning help in managing time and resources? - What safety behaviours were important during the simulation? ○ Lead a brief discussion on the importance of adapting plans based on constructive feedback and unexpected challenges.	
D3 Professional practice	• **Small group activity – real-world scientific problems** In small groups, choose a real-world scientific problem (e.g., plastic pollution, antibiotic resistance, or food waste). ○ Students could – - Identify the root causes using scientific reasoning. - Propose a step-by-step solution, explaining the scientific methods used. - Present their findings in a short presentation or poster • **Individual activity – self reflection** ○ Students could: - reflect on their current skills and areas for improvement as a future scientist. - create a personal development plan using a SMART goal (Specific, Measurable, Achievable, Relevant, Time-bound). - identify necessary resources, activities, and milestones	**Skills you can develop** https://help.open.ac.uk/science-careers/skills-you-can-develop

	- share their plan with a peer for feedback and discuss ways to track progress.	
D1, D2 & D3	• **Individual activity – self-reflection [MY-TPR]** o Students reflect on the skills and knowledge that they have acquired over the course of the unit and produce a summary report/presentation to showcase this. o Students could be encouraged to think about each of the practical tasks, along with any other key skills/transferable skills/competencies that they have developed. o Students could be provided with a set of prompts such as: - What skills did you develop in each task? How did this build on your existing skills/knowledge? - What would you like to develop further? Are there any areas that you found difficult? - What transferable skills have you developed, and how might these be beneficial as you take the next steps in your education/career?	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
MY - PGS	**Laboratory activity – demonstrating managing yourself skills** • Students can demonstrate this skill by working safely, adhering to protocols and following instructions. Students can also demonstrate an ability to consider the safety of others during practical tasks. • When reflecting on the skills and knowledge that they have developed, students can demonstrate that they are able to reflect and evaluate their own personal strengths and areas for development. **Laboratory activity – resilience** • Students can demonstrate resilience when carrying out more complex practical activities, as well as when completing complex tasks such as titration calculations. Students can demonstrate their ability to persevere and overcome any barriers. • During Learning aim D, students can reflect on how their skills and knowledge may inform and benefit them as they move into their chosen careers. Students can focus on the transferable skills that they have acquired, and how these will support them moving forwards.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

BBC Bitesize. (n.d.). *GCSE revision - Titration calculations*. Retrieved from https://www.youtube.com/watch?v=x8DLLCNMKAs

BBC Bitesize. (n.d.). *Quantitative chemistry*. Retrieved from https://www.bbc.co.uk/bitesize/guides/z4x2gwx/revision/3

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Philip Harris. (n.d.). *How to calibrate an electronic balance*. Retrieved from https://www.philipharris.co.uk/blogs/.../how-to-calibrate-an-electronic-balance

Royal Society. (n.d.). *Why is biodiversity important?* Retrieved from https://royalsociety.org/.../why-is-biodiversity-important/

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ThoughtCo. (n.d.). *Random error and systematic errors*. Retrieved from https://www.thoughtco.com/.../random-vs-systematic-error-4175358

YouTube. (n.d.). *How to use a weighing boat*. Retrieved from https://www.youtube.com/watch?v=dCbyA-aH6k4

YouTube. (n.d.). *Thermistor demonstration*. Retrieved from https://www.youtube.com/watch?v=yQCfitTm1io

WebAssign. (n.d.). *Volumetric glassware*. Retrieved from https://www.webassign.net/.../volumetric-glassware

WJEC. (n.d.). *Investigating the factors affecting the output of a solar panel*. Retrieved from https://www.wjec.co.uk/.../investigation-of-the-factors-affecting-the-output-from-a-solar-panel.pdf

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 5: Science Investigation Skills

Unit overview

Unit 5: Science Investigation Skills	
Assessment type: Internal	
Learning Aim	**Topics**
A: Undertake a literature search and review to produce an investigative project proposal	A1 Literature review A2 Investigative project proposal A3 Methods of data collection and analysis
B: Produce a plan for an investigative project based on a proposal	B1 Project scheduling B2 Project planning B3 Health and safety and ethical considerations
C: Safely undertake the project, collecting, analysing and presenting the results	C1 Experimental procedures and techniques C2 Collect, collate and analyse data C3 Data presentation
D: Present the conclusions from the project using correct scientific principles.	D1 Scientific report for the investigative project D2 Scientific evaluation of findings D3 Skill development within project work
Assessment overview This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB). Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 65 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification.	

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Laboratory Activity

Experiments and practical investigations within Units 1, 2, 3 and 4 will provide hands on experience for students and should be mapped to the learning objectives of this unit. Students should use these experiences to select the most appropriate equipment for their project requirements, how to safely handle and calibrate items as appropriate. Encourage students to develop their own interest in a field of study that they enjoy and are interested in or have found challenging and find a solution to a problem or question.

At the same time, these experiments primarily serve knowledge and understanding for their units rather than extended project work, so there should also be some provision for investigation and project work specifically for this unit. Lead practical sessions within the teaching and learning phase of this unit which allow students to carry out a number of tasks to become more competent in their organisational skills and aptitude with common laboratory equipment (e.g. heating water in different ways, selection and use of different types of thermometer, or measuring quantities using different equipment to ensure accuracy).

Discussions should be held about various health and safety considerations before undertaking experiments. Students should have the opportunity to undertake formal risk assessments associated with any investigative or practical work before it is conducted and consider any ethical or environmental impacts to their work.

Tasks should also give students opportunity to try different ways of recording and presenting data e.g. tables, graphs, statistical analysis, so that they are prepared and knowledgeable about which will be the best to apply in their in their own investigation.

Learning Topic	Activities and guidance for unit content delivery	Resources
Introduction	• **Whole class teaching and learning – introduction to the scientific method** Introduce students to the scientific method (observation, question and hypothesis formulation, experimentation, data analysis and conclusion) by discussing what the key components are. o Task students with producing an annotated flow chart or concept map of the Scientific Method to consolidate their understanding of how to plan a project. • **Whole class and individual activity – choosing a hypothesis** Lead a discussion about hypothesis/null hypothesis and predictions for investigations and give examples. o Students should be encouraged to consider how the robustness of the question or hypothesis will affect the design and rigour of the investigation planned (e.g. exploring a quantitative relationship will require measurements and data collection which are more likely to lead to an objective conclusion and the validation or rejection of a hypothesis). o Ask students to identify independent and dependent variables, as well as variables that need to be controlled or considered within these project examples.	**Science Buddies** Four Ways to Teach the Scientific Method | Science Buddies Blog notes and videos **Elsevier** Step-by-Step Guide: How to Craft a Strong Research Hypothesis **Research method** What is a Hypothesis - Types, Examples and Writing Guide **Scribendi** Examples of Good and Bad Research Questions | Scribendi **Potential topics for investigation** Science Investigatory Project Topics Science Research Topics

	• **Individual activity – testing a hypothesis** o Task students with application of the Scientific Method to a simple study involving an everyday observation (e.g. observing birds on a bird feeder). o The choice of study should be easy to monitor and collect data for, without the need for lots of equipment but which is over a period of time so that students become accustomed to sustained investigative work. o Students should come up with a question, hypothesis and prediction, and create an outline plan to test the hypothesis within the class. They should then carry out the planned observation and data collection. The data analysis and conclusion can be scheduled as the focus for a future lesson in support of Learning aims C and D. • **Whole class teaching and learning – relevant areas of study for a science project** o Brief students about the choice of relevant areas of study for a project. o Ask students to collaborate in small groups to come up with examples of different projects that they have experienced. o Each student could then contribute to a class discussion on the type of projects they have experienced in education or through work experience.	

	○ Give students the titles of previous projects carried out at the centre and any case studies of those projects.	
A: Undertake a literature search and review to produce an investigative project proposal		
A1 Literature review	• **Whole class teaching and learning – principles of a literature search** Students will need support to understand how to carry out a literature search. ○ Give a presentation to students on how to go about carrying out a literature search and review, how to identify relevant sources, analyse and explain its relevance to investigations, and how to reference to a recognised system. ○ This should cover identification of relevance, accuracy, currency and reliability, the origin and author, and the extraction and referencing of sources of information. ○ Show examples of a referencing system in use in scientific journals and papers (e.g. Harvard). • **Individual activity – analysing sources of information [EL-PRS]** Provide or task students to gather a selection of articles and sources (newspaper articles from different sources, social media reports, Wikipedia, scientific journals, news broadcasts), for a fictitious scientific investigative project proposal.	**Open University** Developing good academic practice: Introduction | OpenLearn - Open University **Edinburgh University** Literature review | Institute for Academic Development Study Guide notes on how to carry out and analyse a literature search **Students 4 Best Evidence** Conducting a systematic literature search - Students 4 Best Evidence **Some online literature search databases** PubMed ScienceDirect Clarivate

	○ Lead a session where students describe and discuss the validity and usefulness of the articles or sources to the project proposal. ○ This should include discussion of different methodologies to practical work and scientific theories, as well as consideration of the type of article, accuracy/bias, the relevance and the date of publication. • **Small group / Individual activity – planning a literature search** ○ Put students into small groups and present them with potential topics for study. ○ They should discuss and feedback on areas/types of literature that would need to be researched, possible hypotheses, an outline plan and timescale for the project. ○ They should also consider what equipment might be needed, health and safety considerations, what trials need to be carried out, and what data they need to collect.	**Students 4 Best Evidence** Reviewing the evidence: what method should I use? - Students 4 Best Evidence Writing a Scientific Literature Review / Academic Writing - YouTube Video case study **Open University** Quick guide to Harvard referencing (Cite Them Right) | Library Services | Open University Guide to Harvard referencing **Some sources of science reporting:** Nature New Scientist Scientific American Science News BBC News ScienceBlog **Open University** Help and Support | Library Services | Open University Guidance on a literature search

A2 Investigative project proposal	• **Whole class teaching and learning – components of a project proposal** Give a presentation to students about what needs to be included in a project proposal. o Their proposals must include a title, aims and objectives, hypothesis, background and rationale, variables, resources, safety and limitations. o Discuss how and why decisions about the project, the influence of reviewing literature and equipment selected must be justified and receive approval before being taken further. • **Individual / small group activity – creating a project proposal [EL-PRS]** Ask students to decide, as individuals or in a group, the area of study they are interested in, its vocational aspect and industrial sector. o In arriving at a proposal, encourage students to discuss and consider resources, and any potential limitations (e.g. how the resources available will contribute to the accuracy and validity of results that will be obtained). o Students should then discuss their area of study and then document their proposal with the Assessor to gain approval. o They must carry out a literature search, produce a project proposal with a hypothesis, and identify resources required and safety considerations.	**Elsevier** Writing a Scientific Research Project Proposal | Elsevier Principles **Yale College** How To Write a Proposal | Science & Quantitative Reasoning Education notes and examples

B: Produce a plan for investigative project based on a proposal		
B3 Health and safety and ethical considerations	• **Whole class teaching and learning – health and safety in science investigations** Give a presentation and discuss with students the need for health and safety, taking into account relevant legislative, COSHH and PPE requirements, as well as environmental impacts of their projects. Examples of risk assessments can be shown, drawing attention to the hazard, risk and control measures documented. o Task students with the risk assessment of different project proposals and producing the documentation to accompany this. • **Whole class teaching and learning – ethics in scientific research** Discuss ethical considerations about experimental design and process, such as integrity of data collection, the use of living test subjects, and respect for confidentiality. o Provide students with scenarios in research for them to identify and discuss the ethical issues involved.	**Health and Safety Executive** Managing risks and risk assessment at work – Overview -HSE Control of Substances Hazardous to Health (COSHH) - HSE Personal protective equipment (PPE) at work various health and safety topics **Health and Safety Executive** Risk assessment: Template and examples - HSE **Edinburgh University** Risk Assessments | Health and Safety Department Risk assessment templates and examples **Gov.uk** Universal ethical code for scientists - GOV.UK values and responsibilities of scientists

	• **Guest speaker – health, safety and ethics in scientific places of work** Ask a guest speaker to come in and give a presentation about health and safety or ethics in a project or place of work. This could be related to the students' projects, or invite an outside speaker charged with responsibility for health and safety within their place of scientific work. One aspect of focus could be the management of health and safety in a project, such as the creation and use of risk assessments for chemicals, equipment and processes used, or the ethical considerations involved with using living test subjects or informed consent and confidentiality when using personal data.	**Open University** Ethics in science? | OpenLearn - Open University National Library of Medicine Detailed Case Histories - Fostering Integrity in Research - NCBI Bookshelf case studies **STEM Learning** STEM Ambassadors information on how to source a STEM ambassador **Royal Society of Chemistry** Chemistry job profiles | RSC Education videos
B1 Project scheduling	• **Whole class teaching and learning – time and resource management in projects** Give a presentation on the principles of effective time management and examples of this within projects. o Brief students on how to design a schedule of work, including a start date, completion date, realistic timelines and milestones. o Suggest and show the use of a spreadsheet or Gantt chart to assist students with their overview of time.	**Learn Free** Tips for Effective Time Management - YouTube Video **Research Voyage** 8 Effective Strategies for Managing Research Time

	○ Discuss how best to set and achieve target deadlines. Students need to consider beyond their own personal schedule, such as if equipment, locations or participants are needed which are only available at certain times. ○ Discuss the necessity of contingency planning and possible remedial actions if a plan needs to change, such as broken equipment, unavailability / absence of participants, etc. • **Guest speaker – science project team member or leader** Ask guest speakers to visit in person or remotely to discuss science projects that they are involved in. This could be the overview of an entire project (e.g. development of a product or drug) or one person's role of responsibility and management of a stage of a project. One aspect of focus could be the importance of project management skills to employability. This is a useful way of linking the work students are doing in this unit to the industries in which they may hope to be employed in the future. Another approach may be to walk through the project, highlighting milestones, challenges and solutions to problems.	**Stemcell Technologies** How to Plan Experiments and Manage Your Time in the Lab Practical advice on project scheduling **Spreadsheet, Gantt chart or other electronic template to track dates and timelines** **Guide to Research** Contingency Planning — Guide To Research Questions and considerations for contingency planning **STEM Learning** STEM Ambassadors information on how to source a STEM ambassador **Royal Society of Chemistry** Chemistry job profiles | RSC Education Videos

B2 Project planning	• **Whole class and paired activity – project planning [EL-PRS] [SP-CT]** Brief students about how best to produce a realistic project plan that is both valid and that can be followed i.e. that it tests the hypothesis in the project proposal and can be implemented with the resources and timescale in their project schedule. o This will include how they will ensure validity of their work, such as whether comparison to a control group is needed or the role and extent of random sampling for a large survey. This will also include how they are going to collect, record, present and analyse data. o Task students with documenting the method that will be followed and share it with another member of the class to peer review. o This should offer feedback on how clear and safe the instructions are, and if there are any errors or problems that are foreseen, which the student can use to review and update their plan. • **Laboratory activity – trial runs** Discuss the value and importance of conducting trial runs before progressing with the full working plan. o Once students are confident in the working plan for their investigation, they should independently attempt their method. o Make time available for students to carry out trial runs for their project and to amend or confirm the method accordingly.	**LibreTexts** 1: Sampling and Data Notes, case studies and problems **Science Buddies** Increasing the Ability of an Experiment to Measure an Effect **Logbook / diary**

	○ Give students logbooks and diaries to record their progress as they work through their ideas, research, planning and implementation of their projects.	
C: Safely undertake the project, collection, analysing and presenting the results		
C1 Experimental procedures and techniques	• **Whole class teaching and learning – pre-project implementation briefing** Provide a briefing or introduction to students before the official start date of investigation work. ○ Confirm with students that they are familiar with: - any centre requirements for working individually in the laboratory - other health and safety requirements/legislation and appropriate PPE - collecting, assembling and using relevant equipment and materials, as identified in their plan - good practice in practical skills, data collection and record-keeping - sources and limitations of assistance that may be needed. • **Small group activity – familiarisation sessions** Hold a short practical session in the briefing / introduction session to enable students to familiarise themselves with the equipment they will be using or for a member of staff to demonstrate the correct use of the equipment. (This could be best carried out in small groups with students who may be using similar equipment.)	**Equipment, chemicals and other resources**

	• **Whole class and individual activity - consultation sessions** Set aside individual 1-to-1 consultation sessions for each student to raise questions or issues that they may have. These can also be used to check that students have identified and can use their required equipment, and that they are confident in their methodology. Regular consultation sessions could also be arranged throughout the project schedule so that students continue to be able to raise queries and issues, but also to monitor their progress.	
C2 Collection and collation of data	• **Whole class teaching and learning – handling data** Give a tutor presentation to introduce and discuss the types of data that can be collected and recorded, such as the differences between qualitative and quantitative data, and primary and secondary data. This should also explore definitions of accuracy, reliability, validity and precision, and how these link to integrity when collecting and presenting data. o Thinking about these qualities in data collection, students should suggest ways in which they will assure these in their investigations and use appropriate methods of data recording. o A mind-map or list summarising all these considerations could be produced. • **Paired activity – collecting and collating data [EL-PRS]** Using a recent practical that students participated in, ask them to work in pairs to discuss and justify the methods used to collect data.	**LibreTexts** 35.1: Evaluation of Analytical Data - Chemistry LibreTexts Notes and examples covering collection, collation and organising data **LibreTexts** 1: Introduction to Data notes, case studies and problems

	○ Students should consider the accuracy of the equipment used in terms of validity and reliability. ○ They should critique the accuracy, sufficiency and consistency of the data, and if there are any ways to obtain further data or improve the quality. ○ The way in which the data has been organised should also be critiqued in terms of its presentation and clarity (e.g. tabulation, units, headings, etc).	
C2 & C3 Presentation and analysis of data	• **Individual activity – processing and presenting data [EL-PRS]** Students should be familiar with processing data and how to present it in an appropriate format from any practical work for units in this qualification, but there is often little time to explore the pros and cons of different formats. ○ Give students tables of data from different types of practical work (this could be from work they have done or from unfamiliar scenarios). ○ Ask them to try out different ways to present the data, to compare and make a decision on the most effective format for the same data set. • **Individual activity – data analysis [EL-PRS] [SP-CT]** ○ Using their chosen presentation from the previous activity, students should identify patterns or trends in the data, making reference to any proportionality or relationship between the independent and dependent variables.	**LibreTexts** 35.1: Evaluation of Analytical Data - Chemistry LibreTexts Notes and examples covering different ways to present data **University of Wisconsin-Madison** Top ten worst graphs **Open University** Data analysis: visualisations in Excel | OpenLearn - Open University Presenting information | OpenLearn - Open University Diagrams, charts and graphs | OpenLearn - Open University

	○ Students should draw conclusions, discussing the extent and limitations of what they believe that the presented data shows. ○ Anomalous data should also be part of the data set. ○ Students should explain how they have identified anomalies, how they may have occurred, how it should be dealt with and any remedial action that could be taken.	Working with charts, graphs and tables: 4.1 Reading data from tables | OpenLearn - Open University An introduction to visualising development data | OpenLearn - Open University Starting with maths: Patterns and formulas | OpenLearn - Open University A collection of courses and videos on data presentation and analysis
C2 Statistical analysis of data	• **Whole class teaching and learning – statistical analysis techniques** Students should be familiar with the use of basic mathematical operations and statistics including mean, mode, median and average, which they could be reminded of. However, they may need considerable support to understand more advanced statistical analysis techniques, including standard deviation, error bars, and significance tests such as t-test, chi-square test, correlation analysis and confidence levels. Give a tutor presentation (or ask a mathematics specialist to present) on some of these methods, and examples of application.	**Open University** Data analysis: hypothesis testing | OpenLearn - Open University **LibreTexts Statistics** Introductory Statistics 1e (OpenStax) - Statistics LibreTexts notes on a range of statistical techniques and problems

	• **Paired activity – using statistical analysis techniques [EL-PRS]** It is important that students are aware of the range of different techniques that could be used in order to be confident that they will be selecting and using the appropriate technique for their investigation. o Students should consider the fitness for purpose of the methods used. o They should consider sources and magnitudes of error in readings taken. o Put students into small groups or pairs to work through a series of statistical tests, using centre-devised worksheets – more than one session may be necessary in order to ensure that students have sufficient practice.	
D2 Scientific evaluation of findings	• **Whole class teaching and learning – principles and scope of evaluation** Discuss with students the process of evaluation in relation to the conclusion drawn from an experiment, and ways in which this could be approached. o This should include consideration of accuracy, reliability, validity and limits of the conclusion. o Encourage consideration of the primary data, its processing, the equipment and methodology used. o Equally, the conclusion may be valid, but the underpinning scientific theory, the literature search and the hypothesis may be flawed.	**Royal Society of Chemistry** Help students evaluate experiments | Ideas | RSC Education Successful students evaluate every step | Ideas | RSC Education Notes, prompts and exercises for evaluating

	○ The discussion should then turn to how an experiment could be improved or extended. ○ Emphasise that improvements should be tangible and justifiable – for example, the use of more accurate equipment or collection of more data would need to specific about why it is an improvement. • **Pair / small group activity – evaluating and improving experiments [SP-CT]** Using recent practical work that students participated in, ask them to work in pairs or a group to evaluate all aspects of the experiment. ○ This could be shared so that each student looks at a different aspect i.e. the conclusion, the data collected, the equipment used, underpinning theories and hypothesis. ○ Students should feedback to the group on their evaluation, justifying their opinion and proposing a way in which the aspect could be improved. ○ Encourage other students to question and challenge the evaluation or proposal that is being presented – this provides critical feedback to the presenter on how to make plans and suggestions robust.	

D: Present the conclusion from the project using correct scientific principles		
D1 Scientific report for the investigative project	• **Whole class teaching and learning – features of a scientific report** Give a tutor presentation on how to write scientific reports, using accepted protocols and terminology. Standard structures in scientific reports would include the aims and objectives, hypothesis and scientific theory, equipment and methodology, results and analysis, discussion, conclusion and evaluation, referencing and bibliography. Emphasise the necessity for the past tense, passive voice and third person commentary within reports, and use of correct scientific terminology, referencing and a bibliography. References and bibliography must be present and correctly written, and it may also be helpful to review the Harvard referencing system with students. • **Small group and individual activity – analysing and writing a scientific report** o Give students some scientific reports to review and have them identify the correct scientific principles - structure and format, correct use of scientific terminology, past tense and third person, correctly written references and bibliography in an appendix. o Once the students are confident in the expected standard and format of scientific reporting, task them with writing a formal report on an investigation they have carried out for another unit. Alternatively, give an anonymised example to students for amending/rewriting.	**Sheffield Hallam University** Scientific reports - Report Writing - LibGuides at Sheffield Hallam University **University of Salford** Scientific-Report-Writing.pdf **Matrix Education** How to Write a Scientific Report | Step-by-Step Guide Guides to scientific report writing **Reed College** Laboratory Report Instructions - Online Writing Lab - Reed College structure for a scientific report and examples of a good and a bad report

D3 – skill development within project work	• **Whole class teaching and learning – skill development** Lead a discussion with students to identify when they have used or improved skills, and where they may have missed an opportunity to develop their skills. Student will automatically think of practical skills, but they should also be reminded of personal skills such as communication, organisation, time management or problem-solving. o Discuss how they have evaluated if they have a skill that is particularly strong or weak, and steps that they intend to take to develop that skill. o Students will probably need support in becoming more reflective and self-critical about their abilities. o This is a good opportunity for students to begin to think about the value of feedback from others, keeping a diary of their work and creating action plans to build upon their existing skills. • **Individual activity – reflecting upon and improving own skills [SP-CT]** Throughout the programme where practical work is undertaken, encourage student to keep a diary or a log of the skills that they are developing in each practical session. The skills may be practical skills (e.g. the ability to weigh accurately), interpretative (e.g. the ability to draw an accurate tangent to a cooling curve) or personal competences identified (e.g. communication or the ability to recognise problems and apply appropriate scientific methods to identify causes and achieve solutions).	**STEM Learning** 1357-LSS_post_16_introduction.pdf Skills developed through science **Logbook / diary** **Feedback forms** FREE 11+ Observational Feedback Forms in PDF | MS Word template examples **Personal action / development plan** Personal Development Action Plan Template | Qualads Template and examples

	○ Ask students to reflect upon the most recent practical work that they have undertaken and appraise the skills that they have used. ○ They could seek feedback from peers and teachers for an independent perspective to reflect upon. ○ Provide a template for students to create an action plan for development of practical and personal skills that they have used in the experimental work.	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
MY-TPR – Taking Personal Responsibility	**Laboratory activity** ▪ Emphasise to students the responsibility within their own scientific investigations. Students would need to consider: o questioning if their investigation is appropriate and timely o challenging own biases o breaking stages into manageable tasks o identifying strengths or weaknesses of investigation plan, proposal or methodologies o drawing conclusions supported by structured reasoning
EL - SRS – Secondary Research Skills	**Individual activity – analysing sources of information** • Encourage students to research their own area of interest to gather a selection of articles and sources (newspaper articles from different sources, social media reports, Wikipedia, scientific journals, news broadcasts), for a fictitious scientific investigative project proposal. • Allow students to consider the following points: o Are the articles accurate? o Are the articles reliable? o Are the methodologies appropriate? o Are the sources reputable? o Are the articles timely?

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

https://www.ase.org.uk/ - The Association for Science Education
organisation for science education - resources and journals

https://www.hse.gov.uk/ - The Health and Safety Executive
regulator for workplace health and safety - information about the Control of Substances Hazardous to Health (COSHH), Personal Protective Equipment (PPE), risk assessment, etc.

www.cleapss.org.uk/ - CLEAPPS
website for health and safety information when handling chemicals and performing experiments.

https://www.rsb.org.uk/ - Royal Society of Biology
professional body for biology education - resources and practical activities for biology

https://www.rsc.org/teaching-and-learning/ - Royal Society of Chemistry
professional body for chemistry education - resources and practical activities for chemistry

https://www.iop.org/education - Institute of Physics
professional body for physics education - resources and practical activities for physics

https://www.stem.org.uk/ - Science Technology Engineering Mathematics Learning
resources and activities in science, links with employers and industry

https://www.nuffieldfoundation.org/students-teachers - Nuffield Foundation
range of practical experiments.

https://www5.open.ac.uk/library/help-and-support - Open University
access to guides on locating resources, literature searches and referencing

https://libretexts.org/ - LibreTexts
open access to different online text books and subjects

https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method - Science Buddies - good overview for the Scientific Method and each step of an investigation

Textbooks

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., Meunier, C., Parmar, C., and Peers, A .,
Pearson BTEC National Applied Science Student Book 1, Pearson Education, 2016 (ISBN 978-1-292-13409-3)
Chapters 2 and 3 support scientific investigation practical work.

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., and Meunier, C.,
Pearson BTEC National Applied Science Student Book 2, Pearson Education, 2017 (ISBN 978-1-292-13413-0)
Chapter on investigative project work.

Coyne, GS – The Laboratory Companion: A Practical Guide to Materials, Equipment and Techniques (Wiley-Blackwell, 2005) ISBN 9780471780861. Contains information about material, equipment and techniques.

Kumar, R – Research Methodology: A step by step guide for beginners (Sage Publications Ltd 2019) ISBN 9781526449900

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 6: Contemporary Issues in Science

Unit overview

Unit 6: Contemporary Issues in Science	
Assessment type: Internal	
Learning Aim	**Topics**
A: Investigate contemporary scientific issues that impact the global population and environment.	A1 Scientific issues A2 Implications of scientific issues
B: Examine the effect different organisations have on contemporary science	B1 Government and global organisations B2 Non-governmental organisations (NGOs) B3 Businesses including multinationals
C: Understand how to evaluate and report scientific information	C1 Reporting of scientific information C2 Scientific information C3 Presenting scientific information
Assessment overview This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB). Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 60 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification.	

Common student misconceptions

There are no common misconceptions for this unit.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

Learning Topic	Activities and guidance for unit content delivery	Resources
A: Investigate contemporary scientific issues that impact the global population and environment		
A1 Scientific issues	Centres can use any scientific issue that is current, relevant and well documented as the basis of discussion and exploration by students throughout this unit, but key areas within the unit content that must be covered are: • climate change • food security • clean energy • health for all • medical treatments. For each topic, one of the examples of a contemporary scientific issue can give the focus for any lesson throughout the delivery of this unit. Alternatively, you or students may have a relevant area of interest to explore.	**Edinburgh University** Literature review | Institute for Academic Development Study Guide Notes on how to carry out and analyse a literature search **Video case study** Writing a Scientific Literature Review / Academic Writing - YouTube **Some sources of science reporting:** Nature New Scientist Scientific American Science News BBC News ScienceBlog

	• **Whole class teaching and learning – scientific advancements and achievements** Lead a discussion with students on what they perceive to be the most important scientific and technological developments in the last 10 or 20 years. Follow on from this with a presentation that provides an overview of a range of scientific issues that are well-documented and contemporary (within the last 30 years). The issues covered should include the five areas indicated in the unit content and listed above. o Suitable approaches could include: the historical and contemporary context to the issue, the science and studies involved in the issue, and problems and future developments involved with the issue. o Include examples of titles of the reported contemporary issue across several different types of media or case studies, so that students can undertake further reading and research around the topic after the presentation. • **Peer teaching – presentation of a scientific advancement/achievement** o Ask students to carry out their own literature search and review of sources of information with regard to a given contemporary scientific issue for the duration of one lesson e.g. each student or pair of students could be tasked with an aspect of food security (modern farming methods, genetic modification, animal welfare, land usage, land conservation). o Alternatively, students could research a scientific issue that is of their own choice and personal interest.	**Potential scientific issue topics** 10 grand challenges we'll face by 2050 - BBC Future **United Nations World Food Programme** The State of Food Security and Nutrition in the World (SOFI) Report - 2024 | World Food Programme **Mayo Clinic – Stem cell and proton beam therapy** Stem cells: What they are and what they do - Mayo Clinic Proton Beam Therapy Program - Overview - Mayo Clinic **World Health Organisation** Vaccines and immunization: What is vaccination? **STEM Learning** STEM Ambassadors Information on how to source a STEM ambassador

	○ The students can then prepare their own presentation and accompanying notes to deliver to their class at a future lesson. • **Paired activity – preparation of a document on a scientific issue** ○ Give each pair of leas a different scientific issue that may have been studied previously. Task them with producing a pamphlet or information guide summarising the science behind the issue and the problem it solves or causes. For example, students could prepare a pamphlet or information guide advising on a contemporary health and medical issue (e.g. the importance and science of vaccination, the safety and science of behind stem cell or proton beam therapy). • **Visit – visit to a scientific organisation or institution** Arrange a visit to a local scientific workplace, university science or engineering department or science museum to inspire students and provide ideas for issues and developments that they would like to research further.	

A2 Implications of scientific issues	• **Whole class teaching and learning – implications of scientific issues and discovery** Give a presentation on the four main implication categories – social, economic, ethical and environmental. Provide a definition of each and break down a category further into its aspects (such as the political, religious and cultural viewpoints as social implications). The interrelationship between categories should be covered (e.g. the economic impact of a scientific advance upon society as a social implication, or a scientific issue facing a society which has ethical implications). One of the main scientific issues could be used to illustrate the points, such as climate change (i.e. impacts on the environment and the world population, the ethical considerations of energy production and the economics of finding solutions for climate change versus alternative energy sources) or the rise in artificial intelligence. • **Paired activity – identifying implications of scientific issues and advancement [SP-CT]** o Provide students with a flipchart and pens to mind map implications arising from a contemporary scientific issue. o Give each pair of students a different scientific issue or aspect of a scientific issue, for example different forms of non-carbon energy sources (wind, solar, nuclear fission, nuclear fusion, hydroelectric). o Students could then present their mind map back to the class. o This could lead to a class discussion about any drawbacks, benefits, risks, misuses, solutions and conclusions about a contemporary issue and any common patterns and similarities.	**Science Pipes** The Impact of Science on Society **National Library of Medicine** Science and Ethics **BBC – Science and Environment news** Science & Environment | Latest News & Updates | BBC News **GreenMe** Environment Archivi - greenMe Implications of different types of green energy sources **World Health Organisation** Preparedness and Resilience for Emerging Threats (PRET) **STEM Learning** STEM Ambassadors information on how to source a STEM ambassador

	• **Independent activity – analysing implications of a scientific case study [SP-CT]** o Give students a case study or article on a scientific issue to analyse. o Ask them to draw up a list of economic, social, ethical or environmental issues that are referred to within the article, ensuring that they can reference evidence to support their identification. o They could also identify issues which are implicit or could be inferred, giving a justification for their conclusions. A suitable topic that could be explored could be a country's response to past pandemics and preparations for the future. • **Guest speaker – roles and responsibilities within a scientific project or issue** Ask a guest speaker from a relevant organisation to talk about their work on a contemporary scientific issue or project. For example, this could be a professional who has a role within a medical organisation or who is involved in research and development of batteries or energy storage. o Students would need to take notes and ask questions with regard to any ethical, social, economic and environmental impacts that would present itself within the professional's work.	

B: Examine the effect different organisations have on contemporary science		
B1, B2 and B3 Government and global organisations, non-governmental organisations (NGOs), businesses including multinationals	For each major type of organisation, give a broad range of examples so that students can become familiar with similarities and differences in purpose and objective. In particular, students will need to be able to recognise the extent of an organisation's influence within a scientific issue. • **Whole class teaching and learning – role and purpose of organisations in science** Give a presentation on the different types of organisations that can influence scientific contemporary issues, to include the main categories of government and global organisations, non-governmental organisations (NGOs), and multinational businesses. o Provide examples of each type which students are likely to encounter, for example the United Nations, Royal Societies, Greenpeace, etc, giving a profile of each organisation's function and purpose. o Consider factors that would drive each organisation such as legal, financial, and humanitarian. • **Whole class teaching and learning – influence of organisations on a scientific issue** Select one contemporary scientific issue to illustrate the involvement and influence of a range of different organisations within the presentation. For example, the Covid pandemic and the response to it involved the World Health Organisation, the National Health Service, Medicines and Healthcare Regulatory Agency, public-funded research groups and pharmaceutical companies.	Some key organisations: **UK Government –** departments, agencies and public bodies Departments, agencies and public bodies - GOV.UK **United Nations** United Nations | Peace, dignity and equality on a healthy planet **The Royal Society** Welcome to the Royal Society | Royal Society **Greenpeace** Greenpeace UK **Friends of the Earth** Friends of the Earth | Home **World Wildlife Fund** World Wide Fund for Nature | WWF **World Health Organisation** World Health Organization (WHO)

	Include profiles, case studies or website links so that students can undertake further reading around the topic after the presentation.
	
	• **Paired activity – influence of organisations on a scientific issue**
	  ○ Task students in pairs with carrying out a literature search and review of sources of information with regard to the work and influence of a governmental organisation, a non-governmental organisation, and a multinational business, on a specific contemporary scientific issue.
	  ○ The students can then produce and present their research of their chosen organisations back to the rest of the class. Presentations should focus on how the organisations are connected to the scientific issue and their influence, to what extent, who they influence and how their influence may increase or decrease over time.
	
	• **Guest speaker – roles and responsibilities within an organisation**
	Ask a guest speaker from a relevant organisation to talk about their work on a contemporary scientific issue or project, and the way that the organisation uses, directs or monitors science. This could be combined with the same talk suggested previously for implications of a scientific issue.
	
	Students should make notes and be encouraged to prepare, and ask, questions for the guest speaker.
		National Health Service
		NHS website for England - NHS
		
		Medicines and Healthcare Regulatory Agency
		Medicines and Healthcare products Regulatory Agency - GOV.UK
		
		GSK – pharmaceutical company
		Home | GSK
		
		AstraZeneca – pharmaceutical company
		AstraZeneca - Research-Based BioPharmaceutical Company
		
		BP – British oil and gas company
		Home | BP
		
		Norkem – agrochemical company
		Norkem » Chemical Suppliers & Distributors | Norkem
		
		STEM Learning
		STEM Ambassadors
		information on how to source a STEM ambassador

	• **Visit – visit to a scientific organisation or institution** Arrange a visit to a relevant organisation with a connection to a scientific issue – this could be combined with the same visit organised for the previous learning aim. o Students should take notes, collect information leaflets, and ask questions to any representatives that they meet during the visit. • **Whole class and individual activity - class debate on the influence of organisations on a scientific issue [SP-CT]** Give the class a case study on a specific contemporary scientific issue to read for a group debate (for example, 'Should the use of fossil fuels be banned?'). o Cast students (or pairs of students) in relevant roles, to include a representative of a governmental department, a non-governmental organisation and a multinational company, but also a pressure group campaigner, a scientific research group, etc. o Each student or pair should also be given a short profile of their organisation and its objective regarding the issue. o You could chair and moderate the debate, posing questions from the remainder of the class. o The same questions could be posed to all roles, with similar and opposing arguments presented to influence the debate and a class vote on the issue taken at the end.	

C: Understand how to evaluate and report scientific information		
C1 Reporting of scientific information	• **Whole class teaching and learning – understanding different ways to report scientific information** Give a presentation about where students will encounter the reporting of contemporary scientific issues, including a general review of the different ways that scientific issues may be communicated. Students will already have examined articles from professional publications and journals, and the survey of reporting should be expanded to include other forms of media, such as television and radio, newspapers and magazines, social media and websites, campaign leaflets and pamphlets, etc. The source and background of the authors should be considered, as well as who the target audience is; this could include the scientific or medical community, political representatives, pressure group campaigners and the general public. The presentation should include examples for students to read or view to apply their learning. • **Individual activity - comparing different ways to report scientific information** o Task students with carrying out a literature search and review of sources of information about the reporting medium and its target audience – this research would ideally be on a different contemporary scientific issue to that used for previous learning aims, so that students get a broader understanding of this unit in a different context. o The research should include other forms of media, such as digital, social and television, besides print media. Students should prepare a document that makes a comparison of how	**The News Manual** Chapter 31: Reporting science & technology **Open access (free) journals** Elsevier ScienceDirect.com eLifeSciences **Periodicals / magazines** New Scientist Scientific American Nature Science **Newspapers (online)** The Telegraph The Times The Guardian **Blogs** ScienceBlog.com ScienceDaily Science News

	the different media sources report the scientific or technological issues and conclude their purpose and target audience. o This could be linked with the following lesson and extended to consider and compare the style, tone, accuracy, bias, etc.	**Other media** BBC News Science Channel - YouTube Science News - YouTube ScienceAlert - YouTube New Scientist (@newscientist) Official | TikTok
C2 Scientific information	• **Whole class teaching and learning – understanding types and quality of scientific information** Give a presentation to students on how to evaluate scientific information and data. o Consider both qualitative and quantitative information (such as citations, referencing, data driven evidence, calculations, numerical graphs, charts, tables and statistics) and how the type of presentation allows for interpretation. o This should inform students about the meanings of the term's 'reliability', 'validity', 'authenticity' and 'accuracy', placing this in the context of information, data and their source. o Inform students about how to apply these principles and recognise indications of these when evaluating articles. o Some key factors that should be raised include sample size, references to other publications, use and misuse of data, bias, errors, inaccuracies, visual presentations and authenticity of data.	**The Logic of Science** 10 steps for evaluating scientific papers | The Logic of Science **Harvard University** Evaluating Sources | Harvard Guide to Using Sources **Newcastle University** Evaluating Information | Academic Skills Kit | Newcastle University **Sage – case study** Evaluating Information **National Academies** What if scientific studies disagree? | National Academies

	• **Individual activity – comparing types and quality of different articles**
	  ○ Task students with carrying out their own literature search for a specific contemporary scientific issue and review their sources of information about the validity, reliability and authenticity of data and claims.
	  ○ Several different types of articles should be sourced and examined with regard to how evidence has been presented, so will need to contain qualitative and quantitative information.
	  ○ Notes should be made on similarities and differences, strengths or weaknesses in presentation, if there could be any alternative interpretation or conclusion, and evaluate the merits and shortcomings of each.
	  ○ Students should propose how each article's validity, reliability and authenticity could be strengthened.
	
	• **Peer teaching – evaluating types and quality of different articles**
	  ○ Students deliver a short presentation to the class that evaluates the presentation, type of information, validity and reliability in different articles that they have read.
	  ○ As part of the presentation, students should reflect on what they have learned and how they will strengthen their evaluative skills as a result.
	  ○ There should be opportunity for questions and suggestions of alternative views from the class to allow for collaboration and sharing of ideas.
		Journalism Research News
		ARTICLE: Different countries, same news reports? – Journalism research news

C3 Presenting scientific information	• **Whole class teaching and learning – understanding the presentation of scientific information** Give a presentation about how different media have reported contemporary issues. This will take a more specific and detailed look at the content of the reporting rather than the method of reporting. It should specifically consider the detail and accuracy of the reporting, the level of language and terminology used, writing or presenting style and tone, visual representations, the quantity and quality of the scientific information, and biased viewpoints. This should look at examples which are on the same scientific issue and reflect different viewpoints and presentation styles in the reporting. The presentation should include examples for students to read or view to apply their learning. • **Visit – presenting scientific information for the public** Take students on a pre-arranged visit to a television broadcaster, newspaper office or professional institute to find out how a report is assembled and edited for publishing or broadcast – a scientific report would be a desirable context but the principles of accuracy and presentation in reporting would be transferable to other sectors. Alternatively, a virtual visit or guest speaker, using Skype or similar platform, could be arranged if an on-site visit is not possible. A further option would be to visit a museum which specialises in science presentation and displays; this would give students a wider experience of how scientific information is communicated.	**LibreTexts** 35.1: Evaluation of Analytical Data - Chemistry LibreTexts Notes and examples covering different ways to present data **University of Wisconsin-Madison** Top ten worst graphs **Open University** An introduction to visualising development data | OpenLearn - Open University **STEM Learning** STEM Ambassadors information on how to source a STEM ambassador **BBC** Shows and tours **Science Museum** Home | Science Museum **The Francis Crick Institute** What's on | Crick

	At any visit, students should take notes and ask questions to guide or representatives.
	
	• **Whole class and group activity – evaluating the presentation of scientific information [SP-CT]**
	  ○ Give students three or more different media reports on the same contemporary scientific issue to read or watch, making notes and then participating in a tutor-led group discussion.
	  ○ The discussion should initially centre around the advantages and disadvantages of the different reporting media and the likely target audience, but the focus should turn to the accuracy, level of language, tense, use of terminology, referencing, technical language, any bias, use of well-known people, use of visuals, and the quantity and quality of scientific reporting.
	
	• **Small group activity – producing a scientific information programme [IS-WC]**
	  ○ Give each group of students a different scientific issue which may have been studied previously to make a video on.
	  ○ Task them with producing a television programme, radio broadcast or social media video to inform the general public (or another target group) about the science behind the issue and the problem it solves or causes.
	  ○ They should consider the depth, tone and visuals that are to be used.
	  ○ The programme/video could be recorded or storyboarded.
		Wellcome Trust Collection
		Wellcome Collection
		
		National Space Museum
		The National Space Centre: Exploring Space
		
		Video / sound recording equipment
		
		Whiteboards / presentation boards

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
[EL-SRS]	**Individual activity – analysing sources of information** • Encourage students to research their own area of interest to gather a selection of articles and sources (newspaper articles from different sources, social media reports, Wikipedia, scientific journals, news broadcasts), for a fictitious scientific investigative project proposal. • Allow students to consider the following points: o Are the articles accurate? o Are the articles reliable? o Are the methodologies appropriate? o Are the sources reputable? o Are the articles timely?

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

https://www.ase.org.uk/ - The Association for Science Education
organisation for science education - resources and journals

https://www.rsb.org.uk/ - Royal Society of Biology
professional body for biology education – resources, publications and useful links for biology

https://www.rsc.org/teaching-and-learning/ - Royal Society of Chemistry
professional body for chemistry education – resources, journals and useful links for chemistry

https://www.iop.org/education - Institute of Physics
professional body for physics education - resources and useful links for physics

https://www.iip.ufrn.br/index.php - International Institute of Physics
research institute – resources, publications and other useful links for theoretical physics

https://ilsi.org/ - International Life Science Institute
science organisation for improvement of health and environment – resources, publications, and other useful links for life sciences

https://iupac.org/ - International Union of Pure and Applied Chemistry
organisation for standards in chemistry – resources, publications, and other useful links for global chemistry

https://www.nasa.gov/ - National Aeronautics and Space Administration
American civil space program - information on research in nanotechnology and space exploration

https://www.nature.com/ - Nature
magazine – scientific journals on all science-related topics

https://www.bbc.co.uk/news/ - BBC News
broadcaster – public news channel

https://www.gov.uk/government/organisations - UK Government departments and agencies
- useful links to various departments, agencies and public bodies within the UK government

https://www.un.org/en/ - United Nations
international organisation representing world nations - updated information on global concerns and processes

https://www.who.int/ - World Health Organisation
international organisation representing world nations - updated information on current health concerns and responses

https://www.greenpeace.org.uk/ - Greenpeace
environmental pressure group – environmental concerns and work of the organisation

https://www.wwf.org.uk/ - World Wildlife Fund
environmental charity – environmental concerns and work of the organisation

https://www.stem.org.uk/ - Science Technology Engineering Mathematics Learning
resources and activities in science, links with employers and industry

Journals

ACS Nano
American Chemical Society

Biologist
Royal Society of Biology

Chemistry News and Chemistry World
Royal Society of Chemistry

Chemical Reviews
American Chemical Society

Energy & Environmental Science
Royal Society of Chemistry

International Journal of Pharmaceutics
Elsevier

Journal of Environmental Science
International Scientific Journal
Journal of Food Science

Institute of Food Technologists
Journal of Medical and Biological Sciences
International Scientific Journal

Nature
An international journal covering research spanning all areas of science

New Scientist
Covering the latest news and articles about science and technology

Public Library of Science (PLOS)
An international journal covering research spanning all areas of science

Physics World
Institute of Physics

Science
An international journal covering research spanning all areas of science

Scientific American
Latest science stories, articles and news

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

5. Pearson Qualification Support and Resources

This document provides information on support and resources that are available on the Pearson website for this qualification.

Exam Wizard

A free online resource containing a huge bank of past paper questions and support materials to help you create your own mock exams and tests

Pearson Set Assignment Briefs (PSABs)

These assignments are set by Pearson and marked internally by the centre. They should be used for all internal assessments on the course. There are specific PSABs for each internally assessed unit on the course.

Purpose Statement

This provides an overview of the qualification's key details. It outlines what students will study, the knowledge and skills they will develop, and any related subjects that complement the qualification. It also highlights potential progression routes for further learning and lists the Higher Education Institutes that have formally expressed their support and recognition for the qualification.

Results plus

A free online results analysis tool for teachers giving a detailed breakdown of students' performance in BTEC external assessments.

Specification

This document contains an overview of the qualification, qualification purpose and structure, units including content and assessment, planning and implementing the qualification, qualification grade, glossary of terms used for internally assessed units, Transferable skills framework, digital skills framework, sustainability framework.

Standardisation materials

These materials include assignment briefs, marked student evidence and internal verification documents for one unit in the qualification. New standardisation materials are provided on an annual basis at the start of the academic year for use by the qualification teaching team.

The teachers are expected to use these at the start of the year to standardise the team by answering questions posed in the standardisation materials. A commentary is provided to confirm the correct responses with reasoning and justification provided.

Sample Assessment Material (SAMs)

These resources illustrate the format and style of questions for the external assessment for this qualification. A mark scheme is also provided which shows how credit is awarded for these questions. The resources can be used to help prepare students for their external assessment.

Subject Adviser

A dedicated subject adviser available throughout the year so please do get in touch if you would like any support or guidance with:

- planning your courses
- overview of BTEC quality assurance processes
- suggested resources
- teaching and Assessment of internal units and components
- teaching external units and components
- the training and support materials we have available.

Training

Current Pearson training

Available training sessions can be booked here. On the left-hand side of the screen, select the qualification 'BTEC National' and subject. Where current training is available a list of titles, an overview of the training and dates will be provided giving teachers the option to select and book onto relevant sessions.

Past training content

Recorded past training sessions provided by Pearson can be found here for CPD or to support teachers that are new to teaching the qualification.

Transferable Skills Guide for Teachers

This guide provides and overview of the BTEC Transferable Skills Framework and how it has been used to integrate the delivery of these skills in the new suite of BTEC Level 3 and Level 2 qualifications starting in 2025.

Transition Guide

This guide provides an overview of what's new in the qualification, a comparison of the previous qualification to this new qualification, an overview of the assessment approach, a mapping guide to show where content is the same, updated or new.

Annexe

Curriculum Planning

The models in this section are intended to support your delivery planning and provide suggestions for the types and subjects of qualifications that might be delivered with this qualification.

Suggested combinations with other qualifications

This qualification can be combined in the following ways depending on the destination of students. It is recommended that if specific higher education destinations and degree programmes are desired that any programme combinations are confirmed as acceptable prior to the commencement of the programme.

For students intending to progress to higher education to study degree programmes allied to health or medicine

Option 1	Option 2	Option 3
Pearson Level 3 AAQ BTEC National in Applied Science (Extended Certificate)	A Level Psychology	Pearson Level 3 AAQ BTEC National in Health and Social Care (Extended Certificate)

For students intending to progress to higher education to study degree programmes around physical and/or social sciences

Option 1	Option 2	Option 3
Pearson Level 3 AAQ BTEC National in Applied Science (Extended Certificate)	A level Geography	A Level Maths

BTEC Key Terms

GLH – Guided Learning Hours, time the students have supervised teaching and learning

IV – Internal Verification, for internal quality assurance

Lead IV – the person responsible for the internal quality assurance across a qualification or programme subject area.

PSAB – Pearson Set Assignment Brief, used for summative internal assessments

SV – Standards Verification, for external quality assurance

Transferable Skills

Managing Yourself

Acronym	
MY-TPR	Taking Personal Responsibility
MY-PS&R	Personal Strengths and Resilience
MY-COP	Career Orientation Planning
MY-PGS	Personal Goal Setting

Effective Learning

Acronym	
EL-MOL	Managing Own Learning
EL-CL	Continuous Learning
EL-SRS	Secondary Research Skills
EL-PRS	Primary Research Skills

Interpersonal Skills

Acronym	
IS-WC	Written Communication
IS-V&NC	Verbal and Non-verbal Communications
IS-T	Teamwork
IS-C&SI	Cultural and Social Intelligence

Solving Problems

Acronym	
SP-CT	Critical Thinking
SP-PS	Problem Solving
SP-C&I	Creativity and Innovation

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For information about Pearson Qualifications, including Pearson Edexcel and BTEC qualifications visit qualifications.pearson.com

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