# Applied Science

# Unit 1 – Science fundamentals

# Scheme of work

# (90 GLH)

## Introduction

This outline scheme of work (SOW) is to offer a perspective of how to deliver the Cambridge Technicals in Applied Science. There are many alternatives methods and structures that could be used and therefore it is important to explore different methods of delivering the specification, considering different approaches depending on staffing and expertise within your centre and the resources you have available.

Consideration of how the **theoretical content** of the specification can be covered is best delivered in different ways, through:

* A variety of different teacher resources
* Stimulate discussions
* Group work
* Learner activities
* Variety of questions relating to all the different Unit 1 topics

Most centres will focus on 'exam ready' by the end of year one, but all students will need to be up-skilled regardless of prior knowledge or attainment. Aiming for quality communication and professional standards of work will help to establish the connections between this qualification and real world practice.

# Overview of Allocation of GLH\* per Topic

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| **Total Unit GLH 90 hours** |  |  |
| LO1 Understand the chemical structures of elements and compounds  GLH\* 18 | LO2 Understand reactions in chemical and biological systems  GLH\* 18 | LO3 Understand cell organisation and structures  GLH\* 18 |
| LO4 Understand the principles of carbon chemistry  GLH\* 18 | LO5 Understand the importance of inorganic chemistry in living systems  GLH\* 6-9 | LO6 Understand the structures, properties and uses of materials  GLH\* 6-9 |

GLH\* based on 6 hours per week contact total over a 15 week period.

Timings can vary with duration of unit and contact hours. For guidance only.

# Scheme of Work in Detail

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| **Applied Science Unit 1: Science fundamentals** | | | |
| **Week no** | **Learning outcomes and topics** | **Unit content to be covered** | **Suggested activities and links to useful resources** |
| 1  1-2  2-3  3 | LO1 Understand the chemical structures of elements and compounds | 1.1 The atom is the basic structure; it is made up of subatomic particles   * nucleus contains protons and neutrons surrounded by electrons * relative masses and charges * nuclear and atomic diameters * nucleon number, proton number and isotopes * proton number defines the type of atom * nuclear notation * attractive and repulsive forces within the nucleus | Use the Internet to research how the model of the atom has changed since 1890. Students to work in pairs to come up with appropriate search terms and then put evidence on atomic structure together. Students produce a report or presentation.   * recall the definitions for key terms e.g. proton, neutrons and electrons etc * state the relative mass and relative charge of sub-atomic particles * deduce the numbers of protons, neutrons and electrons in a variety of atoms and ions * Use appropriate notation when describing atomic structure * analyse data from some isotopes.   Student should be able to calculate atomic radius from given data. Teacher supplies data from a suitable source and can use this as a test for learning. This [webpage](https://www.chemguide.co.uk/atoms/properties/atradius.html) has information about atomic radii and includes some questions students can answer.  “Can you feel the force?” Class activity where learners research the **four main forces** involved in nature. This can be done as a mixture of research and practical activities:   * Gravity * Electromagnetism * The strong nuclear force * The weak nuclear force.   Learners to appreciate the differences in magnitude and the distances of effectiveness of the forces.  Students can measure gravity in a simple practical of F=ma, by dropping known masses and measuring their acceleration using a light gate. Measuring electromagnetism using electrical coils and magnets will demonstrate this force is stronger than gravity. Practical ideas [here](https://spark.iop.org/practical-physics#gref). The strong and weak nuclear forces cannot be measured directly so set a web research task. |
| 1.2 Elements are based on atomic structure and can be classified by the Periodic Table   * organisation of elements within the table * groups * periods * atomic number * atomic mass * atomic radius | Use the Internet to research the origins and development of the periodic table. Describe the involvement of Mendeleev and others in piecing together the table from chemical evidence, particularly filling in the blanks of then unknown elements. Show students other examples of periodic tables, such as the one [here](https://www.sciencealert.com/think-periodic-tables-all-look-the-same-think-again).  Practical activity; Period 3 elements. A series of suggested practicals are below which can be used to illustrate reactions across a period. *You do not have to do all, or any of them, but they can be used to reinforce learning.*   * An overview from chemguide can be found [here](https://www.chemguide.co.uk/inorganic/period3/elementsreact.html). * Practical ideas [video](https://www.youtube.com/watch?v=pvieUzlvmG8) * Observe and describe the reactions of Period 3 elements **(**from sodium to sulfur) with oxygen * deduce the structure and bonding of Period 3 oxides * explain how the structure and bonding affects their physical properties. * state the periodic trend in electron configurations across Period 2 and Period 3 * deduce the electron configuration of atoms and ions (up to atomic number = 36), using a periodic table.   Practical activity; reactivity of Group 2 metals. A series of suggested practicals are below that can be used to illustrate reactions down a group. *You do not have to do all, or any of them, but they can be used to reinforce learning.*   * This page from the [RSC](https://edu.rsc.org/resources/the-reactivity-of-the-group-2-metals/409.article#!) contains teacher instructions and a student handout for investigating the reactivity of group 2. * observe and describe the reactions of the Group 2 oxides with water * observe and describe the reactions of the Group 2 hydroxides with acids * observe and describe the thermal decomposition of Group 2 carbonates * construct equations for these reactions. * explain the trend in reactivity down Group 2 * describe the main reactions of Group 2 elements and their compounds. * use chemical knowledge and understanding to explain some of the trends in physical and chemical properties of Group 2 elements.   Practical activity; reactivity of Group 17 halogens. A series of suggested practicals are outlined below which can be used to illustrate reactions down a group. *You do not have to do all, or any of them, but they can be used to reinforce learning.*   * carry out and observe the reactions of aqueous solutions containing the halide ions with silver nitrate solution * construct equations for the reactions * describe the trend in solubility of the silver halides in aqueous ammonia * describe the reactions of aqueous solutions containing the halide ions with silver nitrate solution.   Practical activity; displacement reactions and reactivity (links to reactions in 2.2 Chemical reactions)   * describe and explain the trend in reactivity of the halogens, illustrated by reactions with other halide ions, including colour changes in aqueous and organic solutions * construct balanced ionic equations for the reactions of halogens with halides. * describe the displacement reactions of the halogens.   *When you have taught redox reactions, you could refer back to this practical work and extend it to include ideas about redox reactions in terms of oxidation numbers and electron transfer.*  *Group 2 metals and the non-metallic halogens (group 17) are at opposite ends of the periodic table so are very different in terms of their physical characteristics and reactivity. This why these two groups have been chosen but you could choose your own.* |
| 1.3 Elements react together to form compounds   * ionic bonding * covalent bonding | Support activity in which students work through examples to predict the structure of a molecule or ion from the Periodic Table.  Teacher gives students examples of elements and asks them which can bond, how (ionic or covalent) and the resulting formulae if appropriate. They use dot and cross diagrams to illustrate these.  Teacher uses the links below to provide examples of compounds:  This [resource](https://www.thoughtco.com/predicting-formulas-of-ionic-compounds-problem-609576) looks at ionic compounds, and works through how to predict the formulas of them.  This BBC bitesize [page](https://www.bbc.co.uk/bitesize/guides/zy4mfcw/revision/3) looks at both covalent and ionic compounds, giving examples of:   * common formulae * practical activity * reactions of elements.   Suggested practicals are below which can be used to underpin the work on ionic bonding:   * carry out experiments to determine the formula of two different hydrated salts; CuSO4•5H2O; BaCl2•2H2O. * determine the formula of a hydrated salt from experimental data * use ratios from balanced chemical equations to calculate reacting masses * state the answers to calculations to an appropriate number of significant figures. |
| 4  5  6 | LO2 Understand reactions in chemical and biological systems | 2.1 Chemicals interact and react with each other   * mixtures and alloys | Starter activity: using mini whiteboards, quiz the students about the differences between an element, a mixture and a compound.  Teacher shows a selection of colloids and alloys to the students and discusses key features with the students.  Students gather information by either research or from information you have displayed around the classroom on:   * Uses of colloids in medicine and nature including their significance * Uses of common metal alloys to include amalgam, solder, bronze, titanium alloy. |
| 2.2 Chemical reactions   * oxidation and reduction * addition * substitution * polymerisation * radical reactions * displacement | Practical activity from [RSC](https://edu.rsc.org/resources/a-solid-solid-reaction-between-lead-nitrate-and-potassium-iodide/507.article) in which students determine the empirical formula and amount of substance, in moles, of reactants and products, from the mass of the product formed. Students carry out the reaction between potassium iodide and lead nitrate.  Accompanying teacher notes to the practical activity in which students determine the empirical formula and amount of substance, in moles, of reactants and products, from the mass of the product formed. Students carry out the reaction between potassium iodide and lead nitrate.  Balancing equations – students could be asked to balance a series of equations, either as quiz or as an assessment point.  Group research activity; could be online or library/resource based. Small groups are given a reaction type (see below) to research:  e.g.; oxidation/reduction, addition/substitution, radicals, displacement and polymerisation.  Students to report back to main group, giving an example of each reaction, demonstrating the reaction mechanism. Can be used as a formative assessment.  Each type of reaction could be demonstrated to students before they begin their research. The reactions could also be set up as a circus for students to carry out. As further challenge, this circus could be done after the presentations, and students could be asked to identify which reaction is happening at each circus station. |
| 2.3 Rate of reaction can be affected by factors   * physical state * temperature * pressure * solvents * catalysts and enzymes * surface area * light intensity * electromagnetic radiation | Practical activity; there are suggested activities below that could be carried out to investigate and analyse factors affecting the rates of reactions, looking at the following points:   * carry out an experiment to follow the kinetics of a reaction using an initial rate method * use experimental results to determine the relationship between initial rate and concentration or temperature * explain experimental results in terms of collision theory * evaluate the accuracy of data values obtained in an experiment.   Practical activity in which students investigate the kinetics of the reaction between sodium thiosulfate and an acid. Students' data is used to calculate the initial rate of reaction. Excellent practical suggestion here [RSC](https://edu.rsc.org/cpd/rate-experiments/3008551.article).  Practical activity; effects of catalysts in a reaction. Mn and hydrogen peroxide is an example which can be directly compared with an enzymatic catalyst (catalase).  Teacher demonstration on photosynthesis (Use this [video](https://www.youtube.com/watch?time_continue=7&v=2_0isgPU4bQ&feature=emb_logo), showing student the appropriate section).  Other factors that can affect rates of reaction; practical activity on the decomposition of different sized marble chips to investigate surface area.  Effects of solvents on solubility. Teacher demonstrates polarity of three solvents of varying polarity (ie water, methanol and acetone) using a burette and nylon rod. Students are given a range of solids to dissolve. They design a simple experiment to time how long it takes for small samples to dissolve. Suggested solids would be sodium chloride, glucose and a plastic such as polystyrene. Students can link the idea of more polar solvents dissolving ionic/polar substances and vice versa.  This is a practical to investigate the effect of [concentration](https://www.ocr.org.uk/Images/323621-pag-activity-chemistry-measuring-rates-of-reaction-suggestion-2.docx) on rate of reaction.  This practical investigates the effect changing [temperature](https://www.ocr.org.uk/Images/351867-pag-activity-chemistry-measuring-rates-of-reaction-suggestion-1.docx) has on the rate of reaction. |
| 7  8  9 | LO3 Understand cell organisation and structures | 3.1 Types of cells   * prokaryotic cells * eukaryotic cells | Introduce this LO with microscope work using onion and/or human cheek cells, such as this [practical](https://www.ocr.org.uk/Images/309171-pag-activity-biology-microscopy-suggestion-1.docx) looking at cheek cells.  Identify the main features of eukaryote and prokaryote cells   * explain what is meant by a eukaryotic and prokaryotic cell and the defining characteristics of each * explain the roles of organelles within both types of cells * interpret pictures, diagrams and electron micrographs to identify cell organelles. * describe the structural differences between prokaryotic and eukaryotic cells * explain the purpose of plasmids, capsules and flagella.   Features students need to know:  **Prokaryotic** typical cell features to include but not limited to cell surface/plasma membrane, cytoplasm, DNA in a loop, no membrane-bound organelles, 70S-type ribosomes, mesosomes and photosynthetic membranes (in photosynthetic bacteria).  **Eukaryotic** typical cell features to include cell surface/plasma membrane, cytoplasm and DNA in a nucleus (surrounded by nuclear envelope), 70S and 80S-type ribosomes, membrane-bound organelles including mitochondria and chloroplasts (in plant cells).  Use of [BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/z84jtv4/revision/1) is a good starting point. Students work in groups to produce a guide to the prokaryotic cells, and how they differ from eukaryotic ones, thinking about the key features and guidance points above. |
| 3.2 Components of the cell and their role in the cell i.e.:   * cell wall * plasma membrane * cytoplasm * mitochondria * chloroplasts * Golgi apparatus * lysosome * endoplasmic reticulum (rough and smooth) * ribosomes * nucleus   + nuclear membrane   + chromatin material,   + chromosomes   + DNA and RNA | Starter activity: Quiz students on knowledge about prokaryotic and eukaryotic cell and their structures. This is a [basic quiz](https://www.proprofs.com/quiz-school/quizshow.php?title=mtuznzqznatfmb&q=1) that could be used.   * Student exploration of parts of the cell using animations/[virtual cell tour](https://www.ibiblio.org/virtualcell/tour/cell/cell.htm). * Students circulate round information posters containing information about structure of components and their roles within eukaryotic cells (see unit 1 exemplification for full depth required). They could use these posters to complete a gap fill exercise, answer focussed questions or simply create their own notes and report back to the class. * Collate findings. * Teacher explanation of areas of weakness or misconception (using videos, diagrams and animations). * Get students to develop analogies of the cell and its organelles to help them remember the roles e.g. analogy to a factory in that essential processes are separated into compartments to increase efficiency. * Identification of cell components on light and electron micrographs as well as drawings. * cell wall * plasma membrane * cytoplasm * mitochondria * chloroplasts * Golgi apparatus * lysosome * endoplasmic reticulum (rough and smooth) * ribosomes * nucleus. |
| 3.3 Understand how tissues types are related to their function   * Epithelial * Connective * Muscle * Bone * Nerve * ovary and testis | Microscope work on prepared slides of blood, different epithelia, bone, nerve, ovary and testis, and muscle.   * Students identify cell components they recognise in each of these slides (revision). * Students identify the similarities and differences between the cells. * Students discuss why there might be these differences.   Jigsaw task: Students work in teams of 6, with each investigating one tissue type from information or the internet. For each one they will ned to identify the types of cells in each tissue and role of each tissue, any relevant adaptations these cells have to help the tissue with its role and any addition features the tissue has   * Students come up with “Golden Rules” for looking at common adaptations and the role they play within the cell e.g. large surface area for exchange.   Provide diagrams of unknown cells and ask students to suggest adaptations and potential roles.  Optional activity: The gross structure of the human gas exchange system.; teacher demo dissection of sheep lungs   * explain the roles of cartilage in the trachea and bronchi, and why it is C-shaped * explain roles and adaptation of ciliated and squamous epithelium in the lungs.   This activity demonstrates how different tissues work together to carry out a role. Ask students to find other examples of different tissues working together. |

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| 10  10-11  11  12 | LO4 Understand the principles of carbon chemistry | 4.1 Carbon forms a vast number of different types of compounds with other elements due to the nature of the carbon atom | Student could be given these instructions on how to draw structural formula from [Chemguide](https://www.chemguide.co.uk/basicorg/conventions/draw.html) in advance of the lesson to remind them of their GCSE learning.  Students could use this guide to draw the first four members of the following homologous series of organic compounds   * alkanes, alkenes, alkynes * aldehydes and ketones (for ketones only first two required) * alcohols * carboxylic acids * C4H8O esters.   Students could watch this video about [carboxylic acids](https://www.youtube.com/watch?v=ED9EU3FfzyU) and this video about [esters](https://www.youtube.com/watch?v=cYgRd4rXY6I). Both videos show the equations using structural formulae.  When looking at alcohols, take the opportunity to revise oxidation remembering alcohols oxidise to form aldehydes and ketones. This [video](https://www.youtube.com/watch?v=j-rBgs_p-bg) from the Khan academy looks at oxidation of alcohols, showing the mechanism. Although students are not required to reproduce the mechanism, it may help the understanding of oxidation of alcohols.  You could give your students a mini white board quiz to check their knowledge. This [quiz](https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/Questions/Nomencl/nomencl.htm) on organic Nomenclature could be useful to test students naming skills. For more activities on naming organic compound see the [A Level delivery guide](https://www.ocr.org.uk/Images/231741-organic-chemistry.pdf) page 22.  IUPAC rules for naming organic compound can be found [here](http://www.chem.uiuc.edu/GenChemReferences/nomenclature_rules.html). |
| 4.2 Carbon compounds can be represented using empirical and structural formulae  • polymers   * polyethene, * polypropene, * polylactate, * polystyrene, * polyvinyl chloride (PVC) | Student could be given these instructions on how to draw structural formula from [Chemguide](https://www.chemguide.co.uk/basicorg/conventions/draw.html) in advance of the lesson to remind them of their GCSE learning.  Then revise GCSE knowledge of polymers by giving the students the following activities for simple polymers:   * explain what a monomer and polymer are * deduce the monomer given the repeating unit of a polymer * deduce the repeating unit of a polymer when given the monomer.   This video on addition polymerisation which looks at polyethene would be good to introduce polymer from the list <https://www.youtube.com/watch?v=PpEBt2WDnXQ> or <https://www.youtube.com/watch?v=1ZUg6ZC3ltA>.  Following on from this, students could research and draw the structural formula of the other polymer listed including their monomers and repeating units. The following [video](https://www.youtube.com/watch?v=LWxoDV-Ll8k) could be used as a start. |
| 4.3 Carbon compounds form different types of isomer   * structural isomers * geometric isomers * optical isomers | Introduce isomers of organic compounds using this video from the [Khan Academy](https://www.khanacademy.org/science/biology/properties-of-carbon/hydrocarbon-structures-and-functional-groups/v/isomers).  Once the students have seen the video above as an introduction they could try answering these [worksheets](https://www.tes.com/teaching-resource/isomerism-6204773) from TES. There is also an accompanying PowerPoint to reinforce the learning. |
| 4.4 Carbon compounds can form large complex molecules | Revise GCSE knowledge of polymers by giving the students the following activities for simple polymers:   * explain what a monomer and polymer are * deduce the monomer given the repeating unit of a polymer * deduce the repeating unit of a polymer when given the monomer.   Then present pictures of biological molecules and ask for identification of monomer repeating units.  Now introduce biological polymers and their monomers, including hydrolysis and condensation. Students can use word equations to summarise.  This [video](https://www.youtube.com/watch?v=YO244P1e9QM) is about biomolecules and can be used to introduce this section of LO4. It looks at carbohydrates, proteins, lipids and nucleic acids. |
|  |  | * complex carbohydrates (starch, glycogen, cellulose) | This topic could be introduced by viewing this [video](https://www.youtube.com/watch?v=jQi84TnstI4) from Osmosis.com  There are some [information pages](https://www.rsb.org.uk/images/04_Carbohydrates.pdf) and a [quiz](https://www.rsb.org.uk/images/Quiz_Carbohydrates.pdf) with [answers](https://www.rsb.org.uk/images/Quiz_Carbohydrates_Answers.pdf) from the Royal Society of Biology. Students can through these independently or worked through in a classroom setting.  Here is a [powerpoin](https://www.tes.com/teaching-resource/carbohydrates-6016279)t that you can use to teach students about carbohydrates, the different forms they can be found as, and how glycosidic bonds are formed.  Students need to find out the roles of cellulose, starch and glycogen. |
|  |  | * proteins and peptides from amino acids | This [video](https://www.youtube.com/watch?v=HSCUAjZQhXI) can be used to introduce proteins, condensation reactions and uses of proteins. |
|  |  | * lipids from fatty acids, glycerol and phosphorus compounds | This [video](https://www.youtube.com/watch?v=cIRMqVxbt8k) introduces lipids, triglycerides and phospholipids. It finishes with an exam style question for students to try.  This [PowerPoint](https://www.tes.com/teaching-resource/triglycerides-and-lipids-6449958) and worksheet can be used to introduce lipids. Students could work through this independently or you could use all or some of it as a lesson. Students could then go on to research the role of lipids in organisms. You could direct students to focus on its role as an energy source, insulation or structure; or leave students to discover roles by themselves. |
|  |  | * protein synthesis (transcription, translation) RNA, messenger, ribosomal and transfer | The first page of this [resource](https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/Images/123-235549-asa-biology-b-dg-nucleic-acid-lr3.pdf) explains protein synthesis in simple terms, so could be given to students on its own. Students could work through the activities on the worksheet; particularly question 1 and 2.  The further questions do go into more detail at points than students will have to remember but may be beneficial to help them understand the process.  This [quiz](https://quizizz.com/admin/quiz/5e3fd66b5c2fae001e13188f/protein-synthesis-gcse-biology) can be used at the start of this section to check what students remember from GCSE and guide you on which areas need the most recapping. It could also be used as a plenary.  This [video](https://www.youtube.com/watch?v=oefAI2x2CQM) is useful to help students visualise protein synthesis.  This [30 minute video](https://www.youtube.com/watch?v=BJaVrHBrCns) demonstrates protein synthesis using an analogy before explaining it in biology terms. It can be used as an alternate to the previous video or along with it. |
| 13-14 | LO5 Understand the importance of inorganic chemistry in living systems | 5.1 Inorganic Chemistry is the study of elements and compounds which do not include carbon-hydrogen bonds | Students need to be able to describe the importance of inorganic chemistry in living things. The below activities have been suggested as interesting ways for students to learn the roles. In some cases, they go beyond what students need to remember for the exam but seeing the roles in context will help them learn them.  Students could work their way through these resources independently and produce a poster or presentation or similar about all the minerals and their importance, and report back to the class. |
|  |  | * metal ions | Metal ions as cofactors that are required for enzyme activity.  Cofactor examples can include cobalt and vitamin B12, copper and magnesium in respiratory enzymes, zinc in DNA polymerase, nickel-containing enzymes to include hydrogenase and hydrolase. |
|  |  | * inorganic compounds i.e.: |  |
|  |  | * oxides eg CO2, NOx, MgO | The essential role of carbon dioxide in living systems:   * In photosynthesis in plant cells;   GCSE revision on overall equation for photosynthesis. Students introduced by teacher to the two main stages of photosynthesis. Then focus on Calvin cycle, where students identify carbon dioxide and track the fate of the carbon atoms.   * In ventilation in animals:   overview by teacher of homeostasis of breathing involving chemoreceptors. Students then research the locations and roles of chemoreceptors in ventilation.  The role of nitric oxide in the body:   * in vasodilation * as a signalling molecule in nerve cells.   This is a [research summary](https://www.cvphysiology.com/Blood%20Flow/BF011) on the physiology of NO and can be used with students to produce a summary as a form of assessment.  The following set of topics are all“ stand alone” so could be dealt with in one or two lessons. A suggestion would be a mixture teacher lead sections then students given suggested source materials to research themselves. They could then report back to group via. PowerPoint or write a report for an assessment opportunity. A novel approach would brighten this up.   * The role of magnesium oxide as a mineral supplement for healthy muscles and bones   To contrast with the above on NO, students can use this [website](https://www.verywellhealth.com/magnesium-oxide-benefits-4184809) as a source and contrast the style in terms of scientific content. |
|  |  | * peroxide H2O2 | The production of peroxides during amino acid metabolism and their degradation in the liver (Illustrated by practical demonstration of catalase in potato, yeast or liver. Suggested [source](https://www.bbc.co.uk/bitesize/guides/zq7xjty/revision/2) for the method). |
|  |  | * nitrates | The conversion of nitrates in plants into ammonium ions and hence into amino acids; Students could research this part of the nitrogen cycle. |
|  |  | * phosphates | The role of phosphates in the structure of DNA and in phospholipids Link back to Section 4.4. to review structure of nucleotides and phospholipids. |
|  |  | * sulfates | The role of sulfates in the formation of sulfur-containing amino acids, cysteine and methionine.  This [paper](https://academic.oup.com/jn/article/136/6/1636S/4664439) would be a good resource to start from. |
|  |  | * bioinorganic - biological functions of metal ions i.e. | This [interactive periodic table](https://www.rsc.org/periodic-table/) would be useful for students in their research. |
|  |  | * Ni2+: hydrogenase, hydrolase | Hydrogenase catalyses the reversible oxidation of molecular hydrogen.  Hydrolase catalyses the hydrolysis of a chemical bond.  Suggested [source](https://www.britannica.com/science/hydrolase) for researching about hydrolase. |
|  |  | * Fe2+, Fe3+, Cu2+: oxygen transport and storage, electron transfer | Iron is important in the carriage of oxygen in haemoglobin and myoglobin (found within each haem group attached to a polypeptide chain).  Copper transports oxygen in haemocyanin in some invertebrates.  Students can do a compare and contrast using this useful [website](https://sciencecoop.weebly.com/the-difference-between-hemocyanin-and-hemoglobin.html). |
|  |  | * Na+, K +: osmotic balance, charge carrier | Sodium and potassium are important in the maintenance of a constant internal environment in the cell, creating an isotonic balance between the cell cytoplasm and surrounding tissue fluid.  Both are also involved in the transmission of the nerve impulse along nerve fibres/axons, creating a potential difference (charge) across the plasma membrane of the neuron.  Covered well [here](https://www.britannica.com/science/sodium-potassium-pump). |
|  |  | * Ca2+: structural, charge carrier | In animals, calcium is important in muscle contraction and as a structural component of bone (in matrix).  These videos illustrate sliding filaments in muscle contraction <https://www.youtube.com/watch?v=2NPtiYNuNrE> and <https://www.youtube.com/watch?v=f0mDFP7qn1Y>.  Students don't need to explain how calcium is involved in muscle contraction but showing these videos may help them remember it is involved.  Knowing the dangers of deficiency can help illustrate their role in bone.  This [link](https://medlineplus.gov/ency/article/002062.htm) covers calcium in bone and the dangers of deficiency.  In plants, calcium is a component of cell walls of adjacent cells and is responsible for cell adhesion Suggested source; good [Slide Share](https://www.slideshare.net/ShahidullahChowdhury/structure-of-cell-wall-in-plants). |
|  |  | * Mn2+ oxidase, structural, photosynthesis | Manganese and its roles in health such as bone formation, enzyme activity and physiology Suggested [source](https://www.healthline.com/nutrition/manganese-benefits) for student research. |
|  |  | * Li+: treatment of hypertension, bipolar disorder | * lithium can be used to treat hypertension * can be used in the form of lithium carbonate or lithium citrate to treat depression and bipolar affective disorder as a mood stabilizer.   Suggested [source](https://www.drugbank.ca/drugs/DB01356). |
|  |  | * Pt2+ treatment in chemotherapy | Pt2+ treatment in chemotherapy and platinum in Cisplatin used in cancer treatment (interferes with DNA replication in cancer cells).  Suggested [source](https://healthengine.com.au/info/platinum-therapy). |

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| 14-15 | LO6 Understand the structures, properties and uses of materials | 6.1 The properties of a material determine its uses, and can be explained by its chemistry   * mechanical properties, i.e.:   + strength (compression and tension)   + stiffness   + maleability   + ductility   + brittleness   + hardness   + density | A practical investigation of Young’s Modulus, including stress-strain graphs, could be carried out to demonstrate tension & compression.  See learner activity 5 on [page 6](https://www.ocr.org.uk/Images/232934-understanding-materials-delivery-guide.pdf#page=9&zoom=100,0,0) for a suggested practical.  Students to look at images of different ways molecules are arranged in polymers, including:   * chain length * crosslinking * use of plasticizers * crystallinity.   Students need to link these molecule arrangements to the properties of malleability, ductility, brittleness and hardness. You could then show students unfamiliar arrangements and ask them to identify the likely properties or get them to explain why certain products need certain molecule arrangements e.g. lots of plasticizers are useful in plastic bags but not in a spatula.  Practical investigation; making nylon. This can show how structure and bonding relates to properties.  Suggested method from the RSC [here](https://edu.rsc.org/resources/making-nylon-the-nylon-rope-trick/755.article).  Hardness testing in metals and plastics; this [equipment](https://www.brecklandscientific.co.uk/MTR-275-100-p/mtr-275-100.htm) would be ideal. If not available, a visit to a college or university engineering department would cover this.  Carry out a density experiment, such as comparing the density of regular and irregular objects and how to measure it. Ensure that your experiment will allow students to use the equation:  density (kg/m3 = mass (kg) ÷ volume (m3).  You could also give your students some calculations that involve rearranging the density. equation.  You could extend your students by getting them to investigate the density of different solutions.  This [webpage](https://www.bbc.co.uk/bitesize/guides/z242srd/revision/3) has some ideas of different ways to investigate density. |
|  |  | * physico-chemical properties i.e.:   + boiling point   + melting point   + sublimation | Use of melting point apparatus and other practicals on Determination of melting of giant covalent and simple molecular lattices using melting pointing apparatus. This is demonstrated [here](https://edu.rsc.org/resources/melting-point-determination/1068.article).  Give students data of boiling points and melting points of metallic, giant covalent and simple molecular lattices. They need to deduce how these relate to chemical structure, in terms of the types of particles present and the strength of the forces and bonds between the particles.  Investigate melting point curves of different waxes (paraffin and stearic acid) and interpretation of phase data; groups could be split so students report back their findings to each other.  Practical suggestion [here](https://edu.rsc.org/resources/melting-and-freezing-stearic-acid/1747.article).  Ask students to define sublimation and find out the specific conditions required for sublimation to occur and report back. You could ask them to research dry ice and explain what happens to it, to put sublimation into context.  Students can then apply their knowledge of interpreting phase diagrams to interpreting phase diagrams of sublimation. You could walk through one example with them, and then give students a series of phase diagrams and ask them to interpret them. You could include phase diagrams for melting and boiling, as well as sublimation, and ask students to identify which are which. You could also give them different temperatures and pressures to interpret. |
|  |  | * electrical properties, i.e.: | As a starting point, give students a key terms, symbols and equations quiz to check what they remember from GCSE. Terms could include current, voltage, resistance, conductor, insulator, energy, power, work done, potential difference, Ohm’s law and equations to link them.  This [webpage](https://www.bbc.co.uk/bitesize/guides/ztf74qt/revision/1) could be given to students before the lesson to review GCSE knowledge. This could be a flipped learning opportunity where you give them questions based on the page, or it could be an element of your starter quiz.  A good source of resources is from A Level Physics; see the [Electricity delivery guide](https://www.ocr.org.uk/Images/232927-electricity-delivery-guide.pdf). |
|  |  | * + charge flow (in conductors, semiconductors and insulators)   + current | The students need to appreciate current as a flow of charged particles.  The [experiment](https://spark.iop.org/episode-102-current-flow-charge) described on the Institute of Physics website is a convenient starting point.  The Georgia State University Hyper Physics [website](http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elecur.html) provides a suitable summary.  The Physics Classroom provides a bit more detail [here](http://www.physicsclassroom.com/Class/circuits/u9l2c.cfm).  Physics Net has some nice [worked examples](http://physicsnet.co.uk/a-level-physics-as-a2/current-electricity/charge-current-potential-difference/) to lead students into using the charge, current and time formula with the charge on the electron.  Ohm’s Law - Students should know the link between current, potential difference and resistance. Here are some resource to help with teaching this.  The University of Colorado PhET site provides some interactive practice [here](http://phet.colorado.edu/en/simulation/ohms-law).  This resource on the NASA [website](http://www.grc.nasa.gov/WWW/K-12/Sample_Projects/Ohms_Law/ohmslaw.html) also provides some explanation and questions.  The Quizlet app is readily available on all devices and computers. This [resource](http://quizlet.com/4851125/physics-chapter-34-chapter-assessment-flash-cards/) provides flashcards and a test to reinforce the material.  This [experiment](https://spark.iop.org/ohms-law) available on the IOPSpark website could also be used to reinforce this. |
|  |  | * + internal resistance and combined resistances | Students need to be able to calculate the overall resistance of the circuit, using Ohm’s law and Kirchoff’s laws.  Kirchhoff’s Laws - It is necessary here to develop the students’ understanding from GCSE as they will all have encountered this in one form or another.  The [About Education](http://physics.about.com/od/electromagnetics/f/KirchhoffRule.htm) and [S-cool](https://www.s-cool.co.uk/a-level/physics/kirchoffs-laws-and-potential-dividers/revise-it/kirchoffs-first-and-second-laws) websites provide simple summaries.  [Learner Resource 1](https://www.ocr.org.uk/Images/232927-electricity-delivery-guide.pdf) (Page 13 of the electricity delivery guide) provides a summary of Kirchhoff’s first law and some sample questions. It is important to expose the students to the many different forms of electric circuits as many have had limited prior exposure.  The All About Circuits [website](http://www.allaboutcircuits.com/worksheets/kvl.html) has some interesting questions on Kirchhoff’s second law.  Combining Resistances - The formulae for these can be seen to follow on from the work on Kirchhoff’s laws, and deriving them can help reduce issues caused by parallel combinations.  The Electronics Tutorials [website](http://www.electronics-tutorials.ws/resistor/res_5.html) has a nice introduction to this topic here.  This [animation](https://www.walter-fendt.de/html5/phen/combinationresistors_en.htm) on the Walter Fendt site also illustrates series and parallel combinations.  This [presentation](http://www.slideshare.net/simonandisa/internal-resistance-power-combining-resistors) on SlideShare also covers the series and parallel combinations as well as recapping the concepts covered earlier.    Practical activity; circuits and resistance:  Use the equations below to calculate resistance in circuits, both parallel and series.  The Institute of Physics has an experiment described [here](https://spark.iop.org/episode-114-components-series-and-parallel) to help reinforce this concept.  Set up some series and parallel circuits with different circuit components in, at different points in the circuit. Ask students to work out the resistance of the circuit using the appropriate equations out of the following:  Series Rt = R1 + R2 + R3  Parallel 1 = 1 + 1 + 1  Rt R1 R2 R3 |
|  |  | * + electromotive force (e.m.f) and potential difference (voltage) | Students need to understand the concept of emf in terms of charge carriers.  This [video](https://www.youtube.com/watch?v=QTW5LcEaNkE) from explains the difference between potential difference and electromotive force.  This [video](https://www.youtube.com/watch?v=cbSKkrzdXe4) explains what an electromotive is and how it is generated.  Use of V=IR to calculate currents, voltage and resistance in series circuits.  This Khan Academy [video](https://www.khanacademy.org/science/in-in-class10th-physics/in-in-electricity/in-in-solving-a-circuit-with-series-and-parallel-resistors/v/solved-example-finding-current-voltage-in-a-circuit) shows students how to use V=IR with worked examples.  This [quiz](https://quizizz.com/admin/quiz/5ad9fbd0094908001bed8cbf/ohm-s-law) could be used to consolidate the learning so far. |
|  |  | * + number of charge carriers per unit | This [starter activity](https://www.tes.com/teaching-resource/current-and-voltage-starter-6312561) could be used in introduce the equation Charge = current x time.  This link from [Cambridge International](http://ebooks.dynamic-learning.co.uk/prod_content/extracted_books/9781471809248/OEBPS/as_ch19.htm) gives some useful information on electricity including charge carriers.  Here are some [resources](https://www.tes.com/teaching-resource/currents-and-charge-carriers-6041430) with suggested investigation about charge carriers that use the equation I=nAvq  from the [IOP](https://spark.iop.org/episode-104-drift-velocity#gref).  This resource from [School science](http://resources.schoolscience.co.uk/cda/16plus/copelech2pg3.html) could be given to student to consolidate learning. |
|  |  | * + volume of conductors and insulators | Students could research or recap the properties of a good conductor and a good insulator. |
|  |  | * + electrical energy and power | Student should be able to apply the concept of power = energy/time to electrical circuits and to understand the relationship between power, voltage and current (power = voltage x current) for transfers of energy.  Electric power  The link between mechanical power and electrical power can be usefully explored using experiments like the two listed below on the IOP Spark website; both of these use electric motors.  <https://spark.iop.org/using-electric-motor-raise-load>  <https://spark.iop.org/measuring-power-motor>  Alternatively, the power output of a light bulb could be investigated using the experiment [here](https://spark.iop.org/measuring-power-lamp).  There are a number of different takes on the bulb efficiency experiment but generally they measure the heat given out by the bulb. So, it can be viewed as an extension exercise using the heat capacity formula.  Students need to be able to apply the following equations:  energy transferred (work done) (J) = charge (C) × potential difference (V)  energy transferred (J, kWh) = power (W, kW) × time (s, h)  power (W) = energy (J) ÷ time (s)  power (W) = potential difference (V) × current (A).  These equations can be applied using the following [experiment](https://www.ocr.org.uk/Images/309692-pag-activity-physics-energy-suggestion-1.docx). |

**Useful links**

CLEAPPS: <https://www.cleapss.org.uk/>

OCR Specification: <https://www.ocr.org.uk/Images/260245-science-fundamentals.pdf>

OCR Unit 1 delivery guide: <https://www.ocr.org.uk/Images/327885-science-fundamentals-.pdf>

Cambridge Technicals text book: <https://www.hoddereducation.co.uk/subjects/science/products/level-3/cambridge-technicals-level-3-science-for-technicia>

Royal Society of Chemistry resources: <https://www.rsc.org/teaching-and-learning/>

Royal Society of Biology education pages: <https://www.rsb.org.uk/education>

Crash Course Chemistry videos: <https://www.youtube.com/playlist?list=PL8dPuuaLjXtPHzzYuWy6fYEaX9mQQ8oGr>

<https://spark.iop.org/practical-physics#gref> practical physics

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