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OCR
Oxford Cambridge and RSA

GCSE (9–1)

Delivery Guide

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

Material choices

Version 1

www.ocr.org.uk/chemistry

Introduction

GCSE (9–1)
TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk

The images used throughout this guide have been provided to help aid learners' understanding and learning in this topic area.

A brief description is provided below each image.

C4.1.1	compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals, including melting point, softening temperature (for polymers), electrical conductivity, strength (in tension or compression), stiffness, flexibility, brittleness, hardness, density, ease of reshaping
C4.1.2	explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required
C4.1.3	describe the composition of some important alloys in relation to their properties and uses, including steel (separate science only)

Recycled plastic polymers

General approaches:

Our society uses a large range of materials and products developed by chemists. Chemists assess materials by measuring their physical properties, and use data to compare different materials and to match materials to the specification of a useful product (IaS4). Composites have a very broad range of uses as they allow the properties of several materials to be combined. Composites may have materials combined on a bulk scale (for example using steel to reinforce concrete) or have nanoparticles incorporated in a material or embedded in a matrix. The range of uses of metals has been extended by the development of alloys. Alloys have different properties to pure metals due to the disruption of the metal lattice by atoms of different sizes. Chemists can match an alloy to the specification of properties for a new product.

Common misconceptions or difficulties learners may have:

Many of the words used to describe properties of materials are common in everyday language. Making learners aware of the definitions and how to determine the properties is vitally important to ensure they use these key terms appropriately.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Linking back to learner understanding of the 'properties' of solids liquids and gases could be useful here to remind learners of prior knowledge. It is also a good opportunity to recap properties of some elements on the Periodic Table, especially the properties of metals v non metals, or the properties of Group 1 and Group 7 elements.

Recapping knowledge of properties of different length hydrocarbons also helps learners to recap the idea of different properties.

Construction work

Approaches to teaching the content:

Practical investigation of a range of materials leading to classification into categories.

The range of materials developed by chemists enhances the quality of life. (IaS4)
Use and limitations of a model to represent alloy structure. (IaS3)

There are lots of applications of these materials especially some of the more recent smart materials which may engage the learners in more ways than using some of the more traditional materials.

There are lots of opportunities to run practicals to test the properties of materials and generate their own data. Past exam questions have often focused on determining the use based on properties and you can set these interesting contexts eg: 'The best elastic for a bungee rope'

This means you can use a lot of inquiry based learning for this topic.

It also allows you to develop data analysis, and graphing skills.

Bungee rope

Activity 1

Introduction to the difference between qualitative and quantitative properties

http://donboscoeagles.com/resources/SNC%201D1%20-%204.2%20Physical%20Properties%20PDF.pdf

A summary document that compares quantitative properties and qualitative properties with a range of practical ideas which could be used.

Activity 2

Different properties of plastics

http://www.rsc.org/education/teachers/resources/aflchem/resources/61/index.htm

This activity gives a range of ideas which could be used to compare properties including station experiments.

Activity 3

Nuffield Pathways Through Science module

https://www.stem.org.uk/elibrary/resource/27739/materials

This covers solutions and a variety of systems in which one material is finely dispersed in another (colloids) as well as the properties and uses of glass, ceramics, metals and polymers.

This is from STEM.org.uk which is free to log in but you may need to set up and account first.

Activity 4

The chemistry of the world cup football

http://www.compoundchem.com/2014/06/12/the-chemistry-of-the-world-cup-football/

An interesting context in which learners can research the different materials used in the production of the world cup football.

Activity 5

Comparing materials

http://www.primaryresources.co.uk/science/pdfs/rsc_tc_nc1.pdf

Although a primary resource, this could easily be adapted to Key Stage 4.

Activity 6

Polymer properties comparison chart

http://www.extreme-bolt.com/engineered-polymers.html#Properties

A data table, quite complex but could be used as a data analysis chart showing how properties can be compared quantitatively.

Activity 7

Making solder

RSC/Nuffield

http://www.rsc.org/learn-chemistry/resource/res00001742/making-an-alloy-solder

A practical activity which could be used in class. Solder can be made by heating together the metals lead and tin. The hardness, melting point and density of the alloy can be compared to lead.

Activity 8

Modelling alloys

RSC/Nuffield

http://www.rsc.org/learn-chemistry/resource/res00001755/modelling-alloys-with-plasticine

This experiment enables learners to experience how alloying can be used to change the properties of a metal.

Activity 9

Alloy coins.

http://www.rsc.org/learn-chemistry/resource/res00000839/turning-copper-coins-into-silver-and-gold

A 'copper' coin is dipped into a solution of sodium zincate in contact with zinc. The coin is plated with zinc and appears silver in colour. The plated coin is held in a Bunsen flame for a few seconds and the zinc and copper form an alloy of brass. The coin now appears gold. This would be interesting stimulus for discussion too http://www.compoundchem.com/2014/03/27/the-metals-in-uk-coins/

Activity 10

What is an alloy?

https://www.youtube.com/watch?v=9LHDSB1n11k

A good video covering alloys. Could be used for 'flipped learning'.

Activity 11

Composition of alloy infographic.

http://www.compoundchem.com/2015/07/07/alloys/

Alloys make up parts of buildings, transport, coins, and plenty of other objects in our daily lives. But what are the different alloys we use made up of? This infographic helps to explain this. Learners could research other alloys too.

Curriculum content

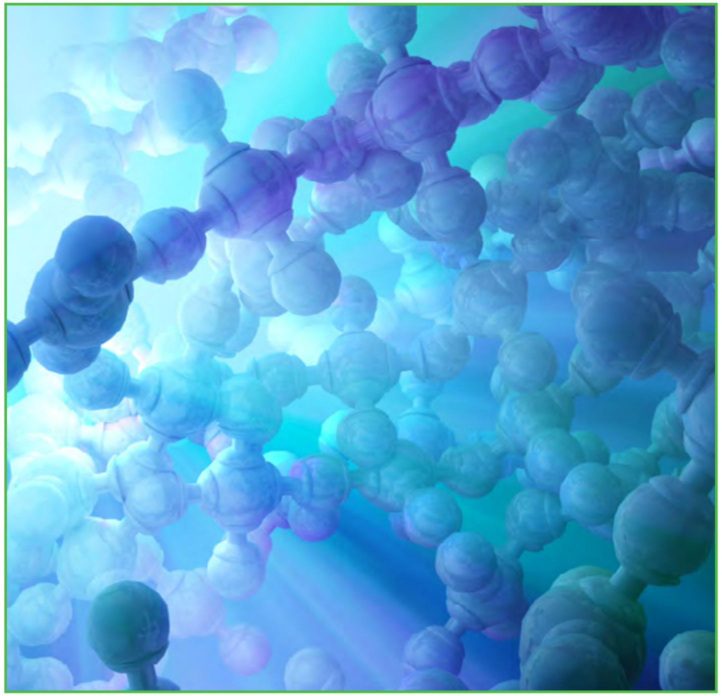
Subtopic 2 – C4.2 What are the different types of polymers? (separate science only)

C4.2.1	recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer
C4.2.2	deduce the structure of an addition polymer from a simple monomer with a double bond and vice versa
C4.2.3	**explain the basic principles of condensation polymerisation by reference to the functional groups of the monomers, the minimum number of functional groups within a monomer, the number of repeating units in the polymer, and simultaneous formation of a small molecule** ***Learners are not expected to recall the formulae of dicarboxylic acid, diamine and diol monomers***
C4.2.4	recall that DNA is a polymer made from four different monomers called nucleotides and that other important naturally-occurring polymers are based on sugars and amino-acids

Original female ornaments from polymeric hand-worked clay

General approaches:

Polymers are long chain molecules that occur naturally and can also be made synthetically. Monomers based on alkenes from crude oil can be used to make a wide range of addition polymers that are generally known as 'plastics'. Addition polymers form when the double bonds in small monomer molecules open to join the monomer molecules together into a long chain. Condensation polymers were developed to make materials that are substitutes for natural fibres such as wool and silk. Condensation polymers usually form from two different monomer molecules which contain different functional groups. The OH group from a carboxylic acid monomer and an H atom from another monomer join together to form a water molecule. Monomers that react with carboxylic acid monomers include alcohols (to make polyesters) and amines (to make polyamides). To make a polymer, each monomer needs two functional groups. The structure of the repeating unit of a condensation polymer can be worked out from the formulae of its monomers and vice versa. Many natural polymers are essential to life. Genes are made of DNA, a polymer of four nucleotide monomers. Proteins (which are similar in structure to polyamides) are polymers of amino acids. Carbohydrates, including starch and cellulose, are polymers of sugars.



Molecular Chain Lights

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The extraction and processing of crude oil, including the formation of alkenes by cracking. (C3.4)

Functional groups including carboxylic acids and alcohols. (C3.4)

Structure and function of DNA, and protein synthesis (B1.1)

The synthesis and breakdown of carbohydrates and proteins (B3.3)

This is a great opportunity to recap biology topics including the idea that starch, proteins and DNA are all polymers.

As many polymers are made from fractions of crude oil, it will be useful to revisit the idea of cracking and alkenes, so learners are reminded of double bonds, which are often broken in addition polymerisation.

Previously learners needed to understand polymerisation but there is a bigger emphasis on the type of reactions (addition and condensation). This will be a good opportunity to consider word equations, reactants and products, balancing equations as well as identifying functional groups on the monomers.

This concept will be covered in understanding the properties of polymers (C4.3), which you may wish to introduce prior to this if you feel that would suit your learners better.

Approaches to teaching the content:

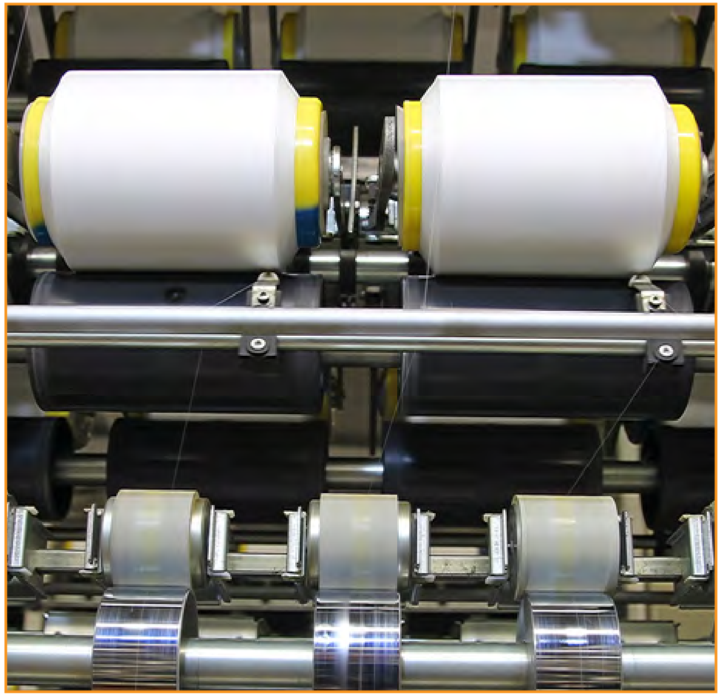
Cracking poly(ethane) and testing the gas for unsaturation.

Testing properties of different polymer fibres.

Breaking down starch using an enzyme and using food tests to identify starch and sugar.

Using models and analogies to demonstrate polymerisation will be useful in developing learners explanations of these processes.

Demonstrations of the production of nylon and poly(phenylethene).



Cotton Yarn Production in a Textile Factory

Activity 1

Making polystyrene

RSC/Nuffield

http://www.rsc.org/learn-chemistry/resource/res00000479/addition-polymerisation?cmpid=CMP00004755

In this experiment monomer molecules of phenylethene (styrene) add on to each other to form a polymer, poly(phenylethene), commonly known as polystyrene. This process is started by adding a substance called a free-radical initiator.

Activity 2

Polymers Teachers Pack

RSC

http://www.rsc.org/learn-chemistry/resource/res00000846/polymers

The activities in this pack include both practicals and questions help to develop learners' basic understanding of chemical reactions in the context of polymers. This programme is also designed to develop learners' thinking and investigative skills.

Activity 3

Making Nylon

RSC

http://www.rsc.org/learn-chemistry/resource/res00000755/making-nylon-the-nylon-rope-trick?cmpid=CMP00000834

Making nylon is a good way to introduce condensation polymerisation.

Activity 4

Comparing Addition and Condensation polymers

http://slideplayer.com/slide/9516042/

A short summary slide show with examples of condensation and addition polymerisation reactions, showing structural examples.

Activity 5

Polymer Puzzles

RSC

http://www.rsc.org/learn-chemistry/resource/res00000632/polymer-puzzles

This activity is designed to develop the learners' higher order thinking – particularly critical thinking skills – in the context of problem solving. It should help learners to recall the facts about some common polymers.

Activity 6

Summary notes

http://www.a-levelchemistry.co.uk/AQA%20A2%20Chemistry/Unit%204/4.9%20Polymers/4.9%20notes.doc

A pack of A level notes which could be used as an independent study document for this topic. Lots of examples and also a nice summary of the differences between the two types of polymerisation.

Activity 7

Structure of DNA

http://www.passmyexams.co.uk/GCSE/biology/structure-of-dna-molecule.html

Although a Biology website it goes into the structural detail of the DNA. Showing where the bonding occurs. It usefully includes images from the video as well which could be made into a card sort activity. You could also make a model DNA but it may be worth discussing with the learners biology teachers to check you are not repeating an activity which they have used.

Activity 8

Background reading on DNA

Garland Science

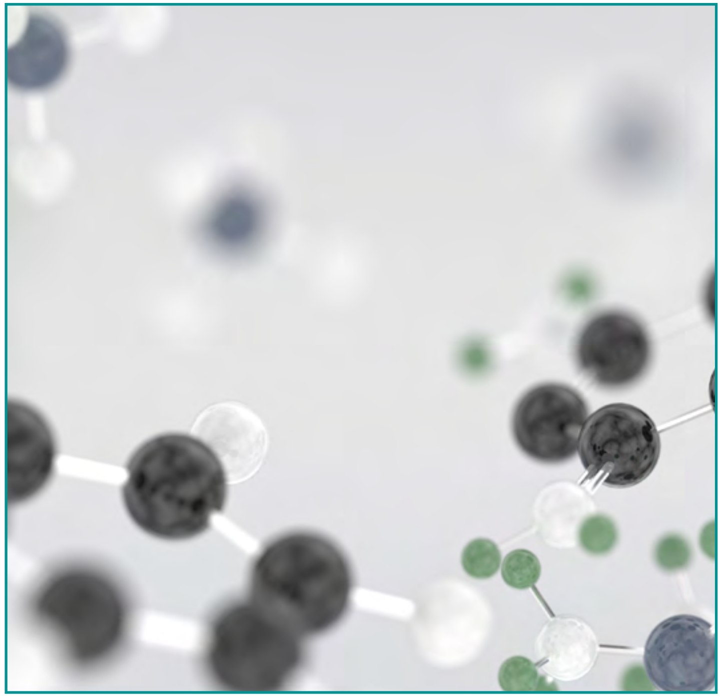
http://www.garlandscience.com/res/pdf/9780815365099_ch02.pdf

This chapter goes into detail which could be used to extend higher ability learners, or for teacher subject knowledge.

Curriculum content

Subtopic 3 – C4.3 How do bonding and structure affect properties of materials?

C4.3.1	explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties
C4.3.2	recall that carbon can form four covalent bonds
C4.3.3	explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings
C4.3.4	describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid
C4.3.5	describe the nature and arrangement of chemical bonds in giant covalent structures
C4.3.6	explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action
C4.3.7	represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon M5b
C4.3.8	describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals



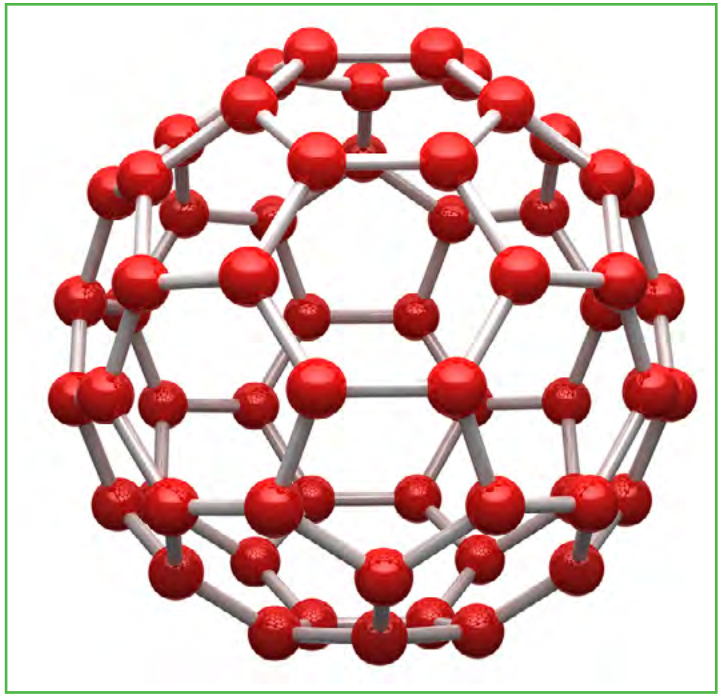
Chemical molecules

General approaches:

Different materials can be made from the same atoms but have different properties if they have different types of bonding or structures. Chemists use ideas about bonding and structure when they predict the properties of a new material or when they are researching how an existing material can be adapted to enhance its properties.

Carbon is an unusual element because it can form chains and rings with itself. This leads to a vast array of natural and synthetic compounds of carbon with a very wide range of properties and uses. 'Families' of carbon compounds are homologous series. Polymer molecules have the same strong covalent bonding as simple molecular compounds, but there are more intermolecular forces between the molecules due to their length. The strength of the intermolecular forces affects the properties of the solid.

Giant covalent structures contain many atoms bonded together in a three-dimensional arrangement by covalent bonds. The ability of carbon to bond with itself gives rise to a variety of materials which have different giant covalent structures of carbon atoms. These are allotropes, and include diamond and graphite. These materials have different properties which arise from their different structures.



Nano sphere from carbon atoms

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

ionic bonding and structure (C2.3)

metallic bonding (C3.1)

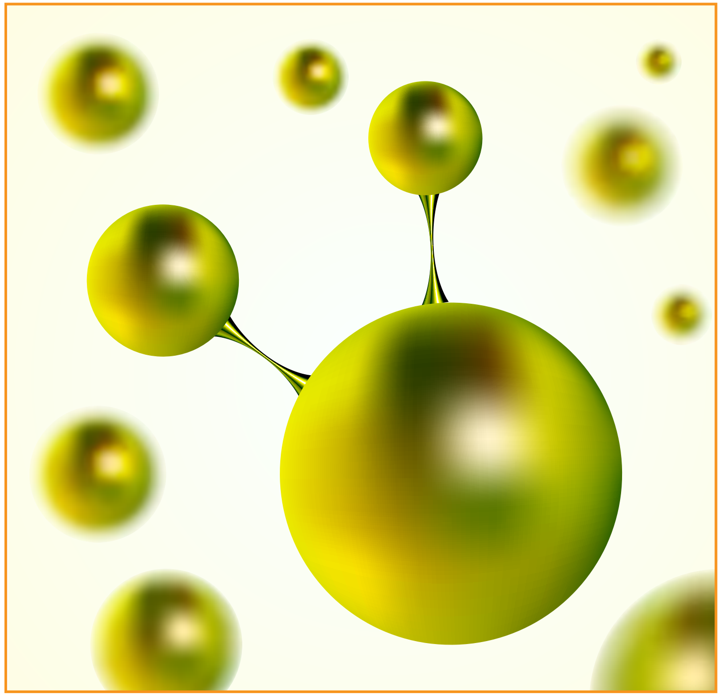
covalent bonds and intermolecular forces (C3.4)

The alkanes as a homologous series. (C3.4)

Approaches to teaching the content:

Testing properties of simple covalent compounds, giant ionic and giant covalent substances, metals and polymers. Identify patterns in data related to polymers and allotropes of carbon (IaS2)

Use and limitations of a model to represent the structures of a range of materials. (IaS3)



Molecules and Atoms

Activity 1

Plastic milk and bouncing custard

RSC

http://www.rsc.org/learn-chemistry/resource/res00000288/year-9-chemistry-day

Although designed for Year 9 learners this activity is a fun aspect of polymer chemistry with 'plastic milk' and 'bouncing custard'.

Activity 2

Polymers video

Crash Course Chemistry

https://www.youtube.com/watch?v=rHxxLYzJ8Sw

A summary video – may be useful for flipped learning.

Activity 3

Polymer models

https://www.youtube.com/watch?v=8b_3T7Ss4_M

A short video made by learners, however this could be used for an idea to model monomers and request learners to produce their own videos to demonstrate understanding.

Activity 4

Polymers and Plastics

Scientific Eye

https://www.youtube.com/watch?v=tAYPxxdIQQc

An older video clip but a good introduction to plastics and polymers.

Activity 5

Hardness testing

http://outreach.materials.ox.ac.uk/LearningResources/downloads/HardnessTestingTeacherNotes23-05-07.doc

This activity could be used as the main experimental activity in a lesson looking at selection of materials that are appropriate for a task, by modelling the effect of temperature on the hardness of a disposable plate. Alternatively, it could be one station in a circus of activities looking at different properties of materials.

Activity 6

Range of modern materials activities

STEM.org.uk

https://www.stem.org.uk/elibrary/list/15311/ceramics-composites-and-polymers

The properties of modern materials can be linked to many exciting contexts - designing extraordinary buildings, medical advances and new technology. The list provides a range of activities, film clips, lesson ideas, background information, practical tips and suggested teaching strategies.

Activity 7

Carbon video

Periodic Videos

https://www.youtube.com/watch?v=QuW4_bRHbUk

A 10 minute video focusing on carbon. Could be used to recap learners' understanding of carbon.

Activity 8

Carbon information

Vision Learning

http://www.visionlearning.com/en/library/Chemistry/1/Carbon-Chemistry/60c

A summary of everything you need to know about carbon, goes above and beyond the information needed here.

Activity 9

Polymers structure and properties

http://www.eng.uokufa.edu.iq/staff/sawsandh/Polymers.ppt

A PowerPoint activity which covers the nature and arrangement of chemical bonds in polymers.

Activity 10

Synthetic polymers

http://www.chem1.com/acad/webtext/states/polymers.html

This website covers mainly synthetic polymers but offers a range of images and information which could easily be adapted into information search activities, a research opportunity, or a range of activities for the classroom.

Activity 11

Comparing diamond and graphite

https://prezi.com/sbw5shag6wlv/compare-and-contrast-the-properties-of-diamond-and-graphite/

A presentation covering the key comparisons between diamond and graphite.

Activity 12

Diamond and Graphite

Tutor Vista

https://www.youtube.com/watch?v=fuinLNKkknI

A video explaining the difference between diamond and graphite. Learners could create a comparison table/Venn diagram from notes taken while watching this video.

Activity 13

Giant Covalent Bonding video

https://www.youtube.com/watch?v=gx_0u6YgT1E

A video which explains giant covalent structures beginning with allotropes of carbon. This could be used within class, or for flipped learning.

Activity 14

Giant covalent structure summary worksheet

https://www.tes.com/teaching-resource/giant-covalent-structures-worksheet-6290408

A summary worksheet which could be used to compare different examples of giant covalent bonding including diamond and graphite.

Activity 15

Spot the bonding

RSC

http://www.rsc.org/learn-chemistry/resource/res00001097/spot-the-bonding

An excellent summary of bonding which addresses the misconceptions in bonding.

Activity 16

Chemical bonding

RSC

http://www.rsc.org/learn-chemistry/resource/res00001140/chemical-bonding

This booklet covers all aspects of bonding. This is a perfect opportunity to assess learners' understanding of bonding and re-address any areas of weakness or misconceptions using the range of activities here.

Activity 17

Comparing models of bonding

RSC

http://www.rsc.org/learn-chemistry/resource/res00000626/bonding-models

An activity designed to compare models of bonding.

Activity 18

Bonding Starters for Ten

RSC

http://www.rsc.org/learn-chemistry/resource/res00000954/starters-for-ten#!cmpid=CMP00001408

A selection of quizzes and activities that could be used at the start of chemistry lessons.

Curriculum content

Subtopic 4 – C4.4 Why are nanoparticles so useful?

C4.4.1	compare 'nano' dimensions to typical dimensions of atoms and molecules
C4.4.2	describe the surface area to volume relationship for different-sized particles and describe how this affects properties
C4.4.3	describe how the properties of nanoparticulate materials are related to their uses including properties which arise from their size, surface area and arrangement of atoms in tubes or rings
C4.4.4	explain the properties fullerenes and graphene in terms of their structures
C4.4.5	explain the possible risks associated with some nanoparticulate materials including: a) possible effects on health due to their size and surface area b) reasons that there is more data about uses of nanoparticles than about possible health effects c) the relative risks and benefits of using nanoparticles for different purposes
C4.4.6	estimate size and scale of atoms and nanoparticles including the ideas that: a) nanotechnology is the use and control of structures that are very small (1 to 100 nanometres in size) b) data expressed in nanometres is used to compare the sizes of nanoparticles, atoms and molecules M1d
C4.4.7	interpret, order and calculate with numbers written in standard form when dealing with nanoparticles M1b
C4.4.8	use ratios when considering relative sizes and surface area to volume comparisons M1c
C4.4.9	calculate surface areas and volumes of cubes M5c

Nanotechnology

General approaches:

Nanoparticles have a similar scale to individual molecules. Their extremely small size means they can penetrate into biological tissues and can be incorporated into other materials to modify their properties. Nanoparticles have a very high surface area to volume ratio. This makes them excellent catalysts. Fullerenes form nanotubes and balls. The ball structure enables them to carry small molecules, for example carrying drugs into the body. The small size of fullerene nanotubes enables them to be used as molecular sieves and to be incorporated into other materials (for example to increase strength of sports equipment). Graphene sheets have specialised uses because they are only a single atom thick but are very strong with high electrical and thermal conductivity. Developing technologies based on fullerenes and graphene required leaps of imagination from creative thinkers (IaS3). There are concerns about the safety of some nanoparticles because not much is known about their effects on the human body. Judgements about a particular use for nanoparticles depend on balancing the perceived benefit and risk (IaS4).

Common misconceptions or difficulties learners may have:

The ideas of the scale of nanotechnology is difficult for learners to comprehend, so overcome the nano scale by comparing to items which they can relate to or using models which allow learners to comprehend the scale.

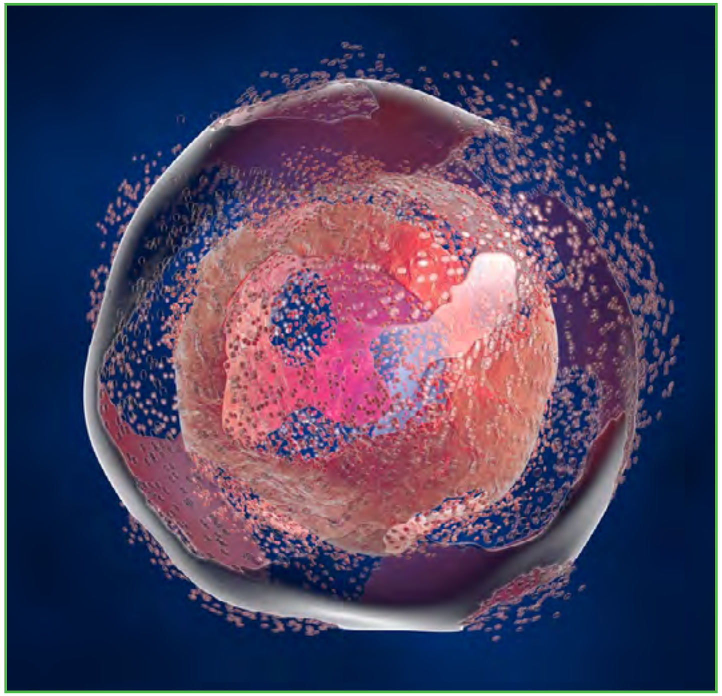
This area will engage the learners and they may have 'ideas' about nanotechnology from movies and films. Try to ensure you do not dispel the engagements when you are trying to address misconceptions from movie science!

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Learners need to recognise nano scale is similar to atomic scale, so a good opportunity to link back to this.

Also consider the links with surface area to volume ratio which is introduced in KS3 in terms of adaptations to heat loss, or in KS4 biology in terms of osmosis.

Standard form, surface area and volume calculations may be familiar to some learners through their maths understanding. It is worth liaising with the Maths department to introduce this topic after they have learnt it in maths or to use the similar language used when taught in maths. The ideas of size and scale may be a key skill they use in maths but they may know how to do this using different terminology to what we use in science. Common language and understanding of how this is taught in maths will enable learners to link their knowledge from one subject to another.



Cell lysis

Approaches to teaching the content:

Discuss the potential benefits and risks of developments in nanotechnology (IaS4)
Development of nanoparticles and graphene relied on imaginative thinking. (IaS3)

Allowing learners the opportunities to come up with their own models to explain nanotechnology and also to research uses which are of interest to them will ensure the learners engage and are interested in this topic. Keep your eyes on news articles and recent scientific advances as there is constantly new information coming out about 'nano particles' all the time!

Chemical synthesis of magnetic nanoparticles

Activity 1

Cutting it down to nano

http://education.mrsec.wisc.edu/37.htm

An activity which allows learners to appreciate the size and scale of nanoparticles.

Activity 2

Scale of the universe

http://scaleofuniverse.com/

Use this animation for learners to grasp the concept of nanoscale.

Activity 3

Applications of nanotechnology

https://www.tes.com/teaching-resource/nanotechnology-6066355

A great activity which can be used to look at different applications of nanotechnology.

Activity 4

Nanotechnology quiz

http://www.bbc.co.uk/bitesize/quiz/q57094540

A short quiz on key aspects of nanotechnology. Could be used to assess learners' understanding from the following pages http://www.bbc.co.uk/schools/gcsebitesize/science/21c/materials_choices/nanotechnologyrev1.shtml

Activity 5

Intro into standard form

https://www.mathsisfun.com/numbers/scientific-notation.html

A short introduction into standard form. One interesting way is to give learners a range of numbers written in standard form and regular form to get them to match up, this simple type of card sort activity would be a good way to assess their understanding.

Activity 6

Surface area to volume ratio

http://mathcentral.uregina.ca/RR/database/RR.09.07/cotcher/svr/index.html

This webpage contains a range of activities where you could introduce surface area and volume calculations. Learners draw out cubes which can be built on squared paper could be a way of covering surface area.

Introducing cubes of different shapes and sizes, and recapping how to calculate volume by displacement could be an interesting opportunity to revisit this in terms of density calculations as well.

Activity 7

Nanoparticles size comparison chart

http://sciencelearn.org.nz/Contexts/Nanoscience/Sci-Media/Images/Nanoparticle-size-comparison

This page allows another way of getting learners to understand the nano scale. There are a range of other activities which you could use from this page (or links on this page too).

Activity 8

What is nano? Video

https://www.youtube.com/watch?v=70ba1DByUmM

A brilliant video narrated by Stephen Fry. Explains nanotechnology clearly including scale, volume to surface area as well as considering the potential benefits and risks.

C4.5.1	describe the conditions which cause corrosion and the process of corrosion, and explain how mitigation is achieved by creating a physical barrier to oxygen and water and by sacrificial protection *(separate science only)*
C4.5.2	explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced
C4.5.3	**explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced**
C4.5.4	describe the basic principles in carrying out a life-cycle assessment of a material or product including a) the use of water, energy and the environmental impact of each stage in a life cycle, including its manufacture, transport and disposal b) incineration, landfill and electricity generation schemes c) biodegradable and non-biodegradable materials
C4.5.5	interpret data from a life-cycle assessment of a material or product
C4.5.6	describe the process where PET drinks bottles are reused and recycled for different uses, and explain why this is viable
C4.5.7	evaluate factors that affect decisions on recycling with reference to products made from crude oil and metal ores

Fench corrosion

General approaches:

Iron is the most widely used metal in the world. The useful life of products made from iron is limited because iron corrodes. This involves an oxidation reaction with oxygen from the air. Barrier methods to prevent corrosion extend the useful life of metal products, which is good for consumers and has a positive outcome in terms of the life cycle assessment. Sacrificial protection uses a more reactive metal such as zinc to oxidise in preference to iron. This continues to prevent corrosion even if the coating on the metal is damaged.

Life cycle assessments (LCAs) are used to consider the overall impact of our making, using and disposing of a product. LCAs involve considering the use of resources and the impact on the environment of all stages of making materials for a product from raw materials, making the finished product, the use of the product, transport and the method used for its disposal at the end of its useful life. It is difficult to make secure judgments when writing LCAs because there is not always enough data and people do not always follow recommended disposal advice (IaS4). Some products can be recycled at the end of their useful life. In recycling, the products are broken down into the materials used to make them; these materials are then used to make something else. Reusing products uses less energy than recycling them. Reusing and recycling both affects the LCA. Recycling conserves resources such as crude oil and metal ores, but will not be sufficient to meet future demand for these resources unless habits change. The viability of a recycling process depends on a number of factors: the finite nature of some deposits of raw materials (such as metal ores and crude oil), availability of the material to be recycled, economic and practical considerations of collection and sorting, removal of impurities, energy use in transport and processing, scale of demand for new product, environmental impact of the process. Products made from recycled materials do not always have a lower environmental impact than those made from new resources (IaS4).

Common misconceptions or difficulties learners may have:

Corrosion is covered at KS3 but many will believe all metals rust. Clarification of this terminology to ensure appropriate use of rusting and corrosion and not using them interchangeably is important to address early.

For higher ability learners who are being introduced to REDOX both in terms of loss and gain of electrons and loss or gain of oxygen will find this confusing. The terminology that a reducing agent is itself being oxidised may be difficult for learners to grasp initially. They will need a solid understanding of ions and balancing equations and half equations to be able to move onto the loss and gain of electrons.

Many learners will lack of knowledge of the processes that go into manufacturing products including the amount of energy and water. They also may not consider the use of energy and water in the use stage. Comparing polystyrene and waxed paper cups shows that polystyrene may be more 'green' than we thought. Using a range of contexts which are applicable to the learners will ensure this topic is better understood.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

It may be possible to link to the extraction of metals and think about the environmental impact of some of the processes. Here you could revisit some of the ideas around extracting metals including some of the calculations of percentage of metal in ore, to discuss the best type of ore to use to reduce the amount of waste.

Linking to crude oil and the supply and demand of the different fractions gives you a good opportunity to build on their knowledge from this topic as well.

Approaches to teaching the content:

Investigating the factors needed for rusting of iron or corrosion of other metals.
Investigating the effectiveness of corrosion prevention (barrier and sacrificial protection methods).

It would be useful to set these kind of experiments in the context of which learners can relate to such as protecting their bicycles from the elements, or buildings or railings around the school, these everyday objects can be useful for the learners to relate to their own lives.

Use the example of applying scientific solutions to the problem of corrosion of metals to explain the idea of improving sustainability (IaS4).

Use life cycle assessments to compare the sustainability of products and processes (IaS4).

Using data from life cycle assessments to compare the sustainability of products such as T-shirts, paper cups v polystyrene cups, or the use of CDs, or mobile phones again will help to put these situations in to everyday contexts which should enable good engagement of the learners.

Protection against corrosion

Activity 1

Corrosion video

https://www.youtube.com/watch?v=jQoE_9x37mQ

This video describes an experiment which could be set up in the classroom. This rusting video focuses on corrosion and how corrosion can be prevented.

Activity 2

Corrosion experiment

http://www.rsc.org/learn-chemistry/resource/res00000434/the-causes-of-rusting?cmpid=CMP00006665

This is a practical which is similar to that which is described in the previous video. It can be set up in class as a demo, and learners can make predictions about what will happen. Be aware this experiment may have been done during KS3 and if so focus on the application of the findings in terms of preventing corrosion.

Activity 3

Redox videos

https://www.youtube.com/watch?v=MWefb8rGaUc

This is a video which covers redox and links back to the 'rusting experiment' mentioned earlier.

Activity 4

Summary of corrosion and redox

http://www.docbrown.info/page03/Reactivitya.htm

This webpage explains corrosion as well as oxidation and reduction. There are a number of examples here which could be used in your teaching, or this could be used as a research activity. You can include redox in terms of electrons using OILRIG for higher ability learners.

Activity 5

LCA PowerPoint

https://www.tes.com/teaching-resource/c3-life-cycle-assessment-lesson-with-exam-practice-6331019

A PowerPoint available covering the old specification which could easily be adapted to the new one.

Activity 6

Life Cycle of GoreTex

https://www.youtube.com/watch?v=iD-m6qBij8Q

Although a video produced for the company this explains the Life Cycle Assessment of an interesting property.

Activity 7

Cup comparison

https://design2good.files.wordpress.com/2011/04/foam-cup-comparison.jpg

This image allows learners to compare the life cycle of different types of cup. This would be an interesting way to introduce comparison, and ask learners to research a product of their choice.

Activity 8

Comparing Nappies

http://new.chemistry-teaching-resources.com/Resources/N5/Hydrogels/Model_Lab_Report.pdf

This model lab report could be used for learners to analyse the data from it, or to set up an inductive activity where learners produce their own lab report comparing nappies. Both these websites may be useful for this http://www.goreal.org.uk/

http://new.chemistry-teaching-resources.com/Resources/N5/Hydrogels/KHS_Hydrogel_Experiment.pdf

Activity 90

Recycling plastic bottles

https://www.youtube.com/watch?v=zyF9MxlcItw

This video shows how PET bottles can be turned into clothing. This website has some interesting facts which could be used to engage learners http://www.recycling-guide.org.uk/facts.html. This fact sheet could also be used. http://www.montgomeryschoolsmd.org/uploadedFiles/curriculum/outdoored/programs/waterbottlefactpages.pdf

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