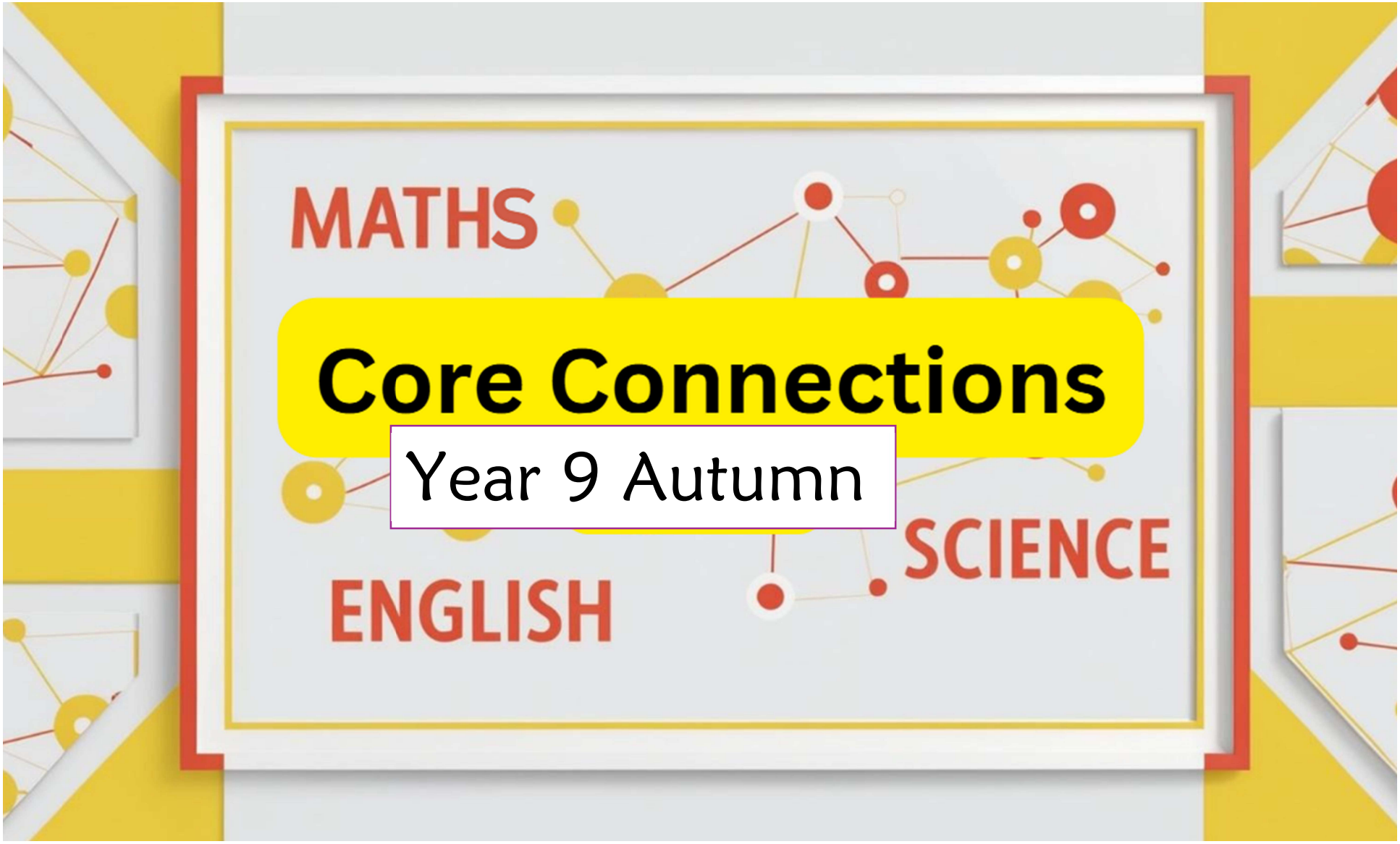
MATHS
Core Connections
Year 9 Autumn
SCIENCE
ENGLISH

Core Connections @ Southam College

The following sheets provide a broad overview of the topic(s)s studied in Year 9 this term.

They are not intended as additional work but as a resource to look up key concepts when going over lesson content before or after your lessons or when completing home learning.

There are also links to online resources if you would like further explanations or examples.

We hope you find them useful and will ask you at the end of the half-term for some feedback.

English

Maths

Science (Biology / Chemistry / Physics)

English

The Crucible : Core Connections

Act 1: Trouble in Salem

In the small town of Salem, Massachusetts, a group of girls is caught dancing in the forest. One of them, Betty Parris, falls into a strange, unresponsive state. Her father, Reverend Parris, is worried about his reputation and fears witchcraft is involved. The town becomes suspicious. Abigail Williams, Reverend Parris's niece, was one of the girls dancing. To avoid punishment, she claims they were bewitched and starts accusing others of being witches. The town quickly believes her. Abigail also wants to get rid of Elizabeth Proctor, the wife of John Proctor, because she had an affair with John and still loves him. The fear of witches spreads fast, and many innocent people are accused.

Act 2: Accusations Grow

John and Elizabeth Proctor are at home, trying to move past John's affair with Abigail. But things are tense. News spreads that many people are being arrested for witchcraft. Elizabeth is worried that Abigail will accuse her. Soon, this fear becomes real—Elizabeth is arrested after Abigail claims she used a poppet (a small doll) to harm her. John is furious and decides to fight back. He wants to prove that Abigail is lying and that the girls are pretending. He convinces their servant, Mary Warren, to tell the court the truth.

Act 3: The Courtroom Chaos

In court, John Proctor and Mary Warren try to show that the girls are faking. But Abigail and the other girls act as if Mary is bewitching them. The judges believe Abigail. To save his wife, John admits to his affair with Abigail, hoping to show she has a reason to lie. But when Elizabeth is asked if John cheated, she lies to protect him, not knowing he already confessed. This makes things worse. Mary, scared of Abigail, turns against John and says he is working with the devil. John is arrested.

Act 4: The Final Choice

Months later, many people are in jail. Some have been hanged. John is offered a chance to confess and live, but he struggles with lying. He wants to keep his name and honor. In the end, he chooses to tell the truth and is hanged. The play ends with a message about the danger of fear, lies, and unfair judgment.

Key Quotes

"I want the light of God, I want the sweet love of Jesus! I danced for the Devil; I saw him, I wrote in his book!" *— Abigail Williams, Act 1*

"We are what we always were in Salem, but now the little crazy children are jangling the keys of the kingdom." *— John Proctor, Act 2*

"There is a prodigious fear of this court in the country." *— Francis Nurse, Act 3*

"A person is either with this court or he must be counted against it, there be no road between." *— Judge Danforth, Act 3*

"Because it is my name! Because I cannot have another in my life!" *— John Proctor, Act 4*

"He have his goodness now. God forbid I take it from him!" *— Elizabeth Proctor, Act 4*



Context

The Salem Witch Trials (1692) - *The Crucible* is based on real events that happened in Salem, Massachusetts, in 1692. During this time, a group of young girls claimed they were being attacked by witches. Their accusations led to a wave of panic. Over 200 people were accused of witchcraft, and 20 were executed. The trials were unfair, with little real evidence, and many people were punished just because others were afraid or wanted revenge.



Puritan Society - Salem was a strict Puritan community. Puritans believed in hard work, prayer, and strict rules. They thought the devil was always trying to tempt people, so they were quick to blame others for anything bad that happened. This fear of evil made it easy for the witch trials to happen. People were scared of being seen as sinners or enemies of the church.

McCarthyism and the Red Scare (1950s) - Arthur Miller wrote *The Crucible* in 1953, during a time in America known as the Red Scare. This was when the U.S. government, led by Senator Joseph McCarthy, was accusing people of being communists. Many people lost their jobs or were blacklisted, even if there was no real proof. Miller saw a connection between the Salem witch trials and what was happening in his own time—both were times when fear and false accusations caused real harm.

Key Themes

Theme	What It Means	How It's Shown in the Play
Hysteria	When fear spreads quickly and people stop thinking clearly.	The people of Salem panic about witches and start accusing innocent people without real proof.
Reputation	How people are seen by others in the community.	Characters like Reverend Parris and John Proctor care deeply about their good names.
Power and Control	Who has power and how they use it.	Abigail and the girls gain power by accusing others; the court uses fear to stay in control.
Truth and Lies	The difference between honesty and deception.	Many characters lie to protect themselves or hurt others, like Abigail's false accusations.
Justice and Injustice	Fairness and unfairness in the legal system.	The court punishes innocent people and refuses to listen to the truth.
Guilt and Conscience	Feeling bad for doing something wrong.	John Proctor struggles with guilt over his affair and wants to do the right thing in the end.

Maths

Foundation Maths: Core Connections

Listed in the left hand and middle columns in the tables below are the topics that you will be covering in the Autumn term in your Maths lessons.

To enable you to keep up while you are not in school there are links to SPARX tasks in the right hand column.

Use the independent learning section within SPARX to try the tasks and remember that if you struggle there are videos to guide you!

Foundation: Chapter 1 - Number

Ability 1-3	Ability 4-5 (+ all 1-3)	Sparx Maths Lessons
Rules of negative numbers. BIDMAS Simplifying fractions to help with division		U742 Adding & subtracting positive & negative numbers U548 Multiplying & Dividing positive & negative numbers U976 Order of operations 4 (combined) U976 Simplifying fractions
Understand "not equal to symbol Inverse function machines & Powers and roots		U851 Square numbers, Cube numbers & 101 Square & cube roots
Converting between metric units for length Bus stop method Equivalent fractions		U388 Converting length (inc worded problems) U453 Long division U704 Generate equivalent fractions
Rounding to a certain decimal place Multiplying and Dividing decimals		U298 Round decimal numbers U293 Multiplication with decimals & Division of decimals
Writing numbers into words and figures	Using known calculations to find the answer to another	U735 Multiplying and dividing with place value
Rounding to significant figures	Estimating calculations	U731 Round integers using significant figures U965 Round decimals using significant figures U225 Estimating calculations
Recognising 2 digit prime numbers Finding factors and multiples		U236 Finding Prime numbers U211 Finding factors and divisibility tests U751 Finding the lowest common multiple
Finding HCF and LCM by listing (worded problems also)		U529 Finding the highest common factor U751 Finding the lowest common multiple

Use a calculator to find squares, cubes and roots Effective use of a calculator		U926 Using a calculator
Evaluate expressions involving powers		
Use index notation for powers of 10 Use index notation in calculations Converting powers of 10 into fractions and decimals		U330 Using standard form with positive powers U534 Using standard form with negative powers
Use the laws of indices (multiplication, division and brackets)	Write a number as a product of its prime factors	U235 Index rules with positive indices U694 Index rules with negative indices U739 & U739 Prime factor decomposition
	Use prime factor decomposition and Venn diagrams to find the HCF and LCM	U250 Finding the HCF & LCM using prime factor decomposition

Foundation: Chapter 2 - Algebra

Ability 1-3	Ability 4-5 (+ all 1-3)	Sparx Maths Lessons
Simplify expressions by adding and subtracting Simplifying simple expressions by multiplying and dividing Write simple expressions e.g. a multiplied by b = ab		U105 Simplifying expressions by collecting like terms U613 Using algebraic notation U103 Simplifying algebraic fractions by cancelling common factors
Simplifying expressions using powers e.g. 3 x 3 x 3 = 3^3		U851 Calculating with roots and powers
Multiply and divide more complex expressions e.g. 8c^4/ 2c		U662 Simplifying expressions using index laws

Substitute positive and negative numbers into expressions		U201 Substituting into expressions U585 Substituting into algebraic formulae
Writing more complex expressions e.g. I think of a number multiply it by 2 and then subtract 5		U613 Using algebraic notation
Recognise the difference between a formula and an expression.	Write a formula and use it to solve problems	U585 Substituting into algebraic formulae U144 Substituting into real-life formulae
Substitute into formulae		
Expand single brackets Expand and simplify expressions with 2 single brackets		U179 Expand a single bracket
Substitute numbers into an expression with brackets and powers		U201 Substituting into expressions
Recognise factors of algebraic terms	Factorise algebraic expressions into a single bracket	U365 Factorising into one bracket
use the identity symbol and not equal to symbol		
Write simple expressions and formulae from worded problems		U585 Substituting into algebraic formulae U144 Substituting into real-life formulae
Substitute into maths and science formulae		U144 Substituting into real-life formulae

Foundation: Chapter 3 - Graphs, Tables and Charts

Ability 1-3	Ability 4-5 (+ all 1-3)	Sparx maths Lesson
Understand discrete and continuous data		U322 Types of data
Design frequency tables and data collection sheets		U312 Interpreting frequency tables with grouped data
Read data from tables		
Create and complete a two way table		U981 Interpreting frequency tables
Read timetables and distance tables		
Draw and interpret comparative and composite bar charts		
Interpret and compare data shown in bar charts and line graphs		U363 Drawing bar charts U557 Interpreting bar charts U854 Finding averages from diagrams
Plot and interpret time series graphs		U590 Drawing line graphs U193 Interpreting line graphs
Use trends to predict what might happen in the future		
Construct stem and leaf and back-to-back stem and leaf diagrams		U200 Drawing stem-and-leaf diagrams
Interpret stem and leaf and back-to-back stem and leaf diagrams		U909 Interpreting stem-and-leaf diagrams
Draw a pie chart		U508 Drawing pie charts
Interpret pie charts		U172 Interpreting pie charts

		U854 Finding averages from diagrams
Plot and interpret scatter graphs		
Determine whether or not there is a relationship between sets of data	Draw a line of best fit	U199 Plotting scatter graphs U277 Interpreting scatter graphs
	Use a line of best fit to predict values	U277 Interpreting scatter graphs U128 Using lines of best fit
	Understand 'interpolation' and 'extrapolation'	

Higher Maths: Core Connections

Listed in the left hand and middle columns in the tables below are the topics that you will be covering in the Autumn term in your Maths lessons.

To enable you to keep up while you are not in school there are links to SPARX tasks in the right hand column.

Use the independent learning section within SPARX to try the tasks and remember that if you struggle there are videos to guide you!

Higher: Chapter 1 - Number

Ability 5- 6	Ability 7-9 (+ all 5-6)	Sparx Maths Lessons
List possible outcomes from two events.	Work out the total number of ways of performing a series of tasks (factorial)	
Round numbers to a given number of significant figures	Estimate more complex calculations involving square roots etc.	U731 Rounding integers using significant figures U965 Rounding decimals using significant figures
Estimate basic calculations with +, -, X & /	Problem solving involving estimation	U225 Estimating calculations
List the multiples and factors of a number.	Apply HCF and LCM to problem solving questions	U529 Finding Highest common factor (HCF) U751 Finding Lowest common multiple (LCM)
Write a number as a product of its prime factors.	HCF and LCM word problems involving more than 2 numbers	U739 Prime factor decomposition
Find the HCF and LCM of two numbers using Venn diagrams for larger numbers		U250 Finding the HCF and LCM using prime factor decomposition
Work out simple powers and roots.	Use negative indices.	U694 Index rules with negative indices
Use powers and roots in calculations.	Use fractional indices.	U985 Indices of the form 1/a U772 Indices of the form a/b
Multiply and divide using index laws. Know anything to the power of zero = 1.	Evaluating fractions with fractional, negative powers	U694 Index rules with negative indices U985 Indices of the form 1/a U772 Indices of the form a/b
Write an ordinary number in standard form.	Adding and subtracting numbers in standard form: $7.2 \times 10^2 + 6.2 \times 10^{-1}$	U330 Using standard form with positive indices U534 Using standard form with negative indices
Write a number written in standard form as an ordinary number	$(7 \times 10^x) + (7 \times 10^y) + (7 \times 10^z) = 700\,070.07$ write possible values of x, y and z	U330 Using standard form with positive indices U534 Using standard form with negative indices U290 Adding and subtracting numbers in standard form
Multiplying and dividing numbers in standard form	Word problems involving standard form	U264 Multiplying and dividing numbers in standard form U161 Standard form with a calculator

Understand the difference between rational and irrational numbers.	Rationalise the denominator of $a/\sqrt{b}$ Rationalise the denominator of $a/\sqrt{(bx+c)}$	U707 Rationalising denominators containing a single term U281 Rationalising denominators containing two terms
Able to multiply and divide surds	Adding and subtracting fractions where the denominator needs to be rationalised first	U633 Multiplying and dividing surds U338 Simplifying surds U872 Adding and subtracting surds U499 Expanding brackets with surds
	Write $3^{-1/2}$ as a surd and rationalise the denominator	

Higher: Chapter 2 - Algebra

Ability 5- 6	Ability 7-9 (+ all 5-6)	Sparx Maths Lessons
Use the rules of indices to simplify algebraic expressions: eg.$6x^4 \div 3x^2$ $(2x^2y^3)^2$ x^0 = 1 x^(-m) = 1/x^m x^(1/n)=n $\sqrt{x}$	Simplify $(4p^{-2}q^{-4})^{-1/2}$	U985 Indices of the form 1/a U772 Indices of the form a/b
Expanding single brackets e.g. 3(5x -7) but also 4(2x + 5) - 5(3x -7)	Extend *Factorise completely $25(a + b)^2 - 35(a + b)$ *Show algebraically that product of any 2 consecutive integers is divisible by 2	U179 Expanding single brackets U582Writing algebraic proofs

Factorising algebraic expressions		U365 Factorising into one bracket
Solving linear equations involving brackets and numerical fractions	Solving linear equations involving algebraic fractions	U755 Solving equations with one step U325 Solving equations with two or more steps U870 Solving equations with the unknown on both sides U505 Solving equations with the unknown in the denominator U599 Constructing and solving equations
Use equations to solve problems	Setting up and solving more difficult equations	U599 Constructing and solving equations
Substitute numbers into formulae	Substituting into formula involving standard form	U585 Substituting into algebraic formulae U144 Substituting into real-life formulae
Rearrange formulae	Rearranging formulae where the subject appears twice	U556 Changing the subjects of formulae
Distinguish between expressions, equations, formulae and identities		U613 Using algebraic notation
Find the general formula for the *n*th term of an arithmetic sequence		U498 Position-to-term rules for arithmetic sequences
Determine whether a particular number is a term of a given arithmetic sequence		
Solve problems using geometric sequences	Find the *n*th term of a quadratic sequence	U206 Position-to-term rules for quadratic sequences

Work out terms in Fibonacci-like sequences		U680 Special sequences
Expand the product of two brackets	Expand the product of three brackets	U768 Expanding double brackets U606 Expand triple brackets
Factorise quadratics of the form: $x^2 + bx + c$	Factorise quadratics of the form $ax^2 + bx + c$	U178 Factorising quadratic expressions of the form $x^2 + bx + c$ U 858 Factorising quadratic expressions of the form $ax^2 + bx + c$
Use the difference of two squares	Problem solving involving factorising quadratics	U963 Factorising the difference of two squares

Higher: Chapter 3 - Interpreting and representing data

Ability 5-9	Sparx Maths
Problems involving M,M,M and R i.e. 20 females have a mean of 5.6 and 10 males have a mean of 11.4 what is the overall mean?	U260 Finding the mode U291 Calculating the mean U456 Calculating the median U526 Calculating the range
Construct and use back - to - back stem and leaf diagrams e.g. be able to compare the distributions of two stem and leaf diagrams (range and median)	U200 Drawing stem-and-leaf diagrams U909 Interpreting stem-and-leaf diagrams
Construct and use frequency polygons	U840 Drawing and interpreting frequency polygons
Construct and use pie charts	U508 Drawing pie charts U172 Interpreting pie charts
Plot and interpret time series graphs	U590 Drawing line graphs
Use trends to predict what might happen in future	U193 Interpreting graphs

Plot and interpret scatter graphs	U199 Plotting scatter graphs U277 Interpreting scatter graphs
Determine whether or not there is a linear relationship between two variables	U277 Interpreting scatter graphs
Draw a line of best fit on a scatter graph	U277 Interpreting scatter graphs
Use the line of best fit to predict values	U128 Using lines of best bit
Decide which average is best for a set of data	U717 Choosing suitable averages and solving problems
Estimate the mean and range from a grouped frequency table	U569 Finding averages from frequency tables U877 Estimating the mean from grouped data
Find the modal class and the group containing the median	U569 Finding averages from frequency tables U877 Estimating the mean from grouped data
Construct and use two-way tables	U981 Interpreting frequency tables U981 Interpreting frequency tables
Choose appropriate diagrams to display data	
Recognise misleading graphs	

Higher: Chapter 3 - Interpreting and representing data

Ability 5-9	Sparx Maths
Problems involving M,M,M and R i.e. 20 females have a mean of 5.6 and 10 males have a mean of 11.4 what is the overall mean?	U260 Finding the mode U291 Calculating the mean U456 Calculating the median U526 Calculating the range

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Use trends to predict what might happen in future	U193 Interpreting graphs
Plot and interpret scatter graphs	U199 Plotting scatter graphs U277 Interpreting scatter graphs
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Estimate the mean and range from a grouped frequency table	U569 Finding averages from frequency tables U877 Estimating the mean from grouped data
Find the modal class and the group containing the median	U569 Finding averages from frequency tables U877 Estimating the mean from grouped data
Construct and use two-way tables	U981 Interpreting frequency tables U981 Interpreting frequency tables
Choose appropriate diagrams to display data	
Recognise misleading graphs	

Science

Biology Core Connections

B1 Cells

Lesson 1: Cells

You need to know that both plant and animal cells are eukaryotic and share key structures like the nucleus, cytoplasm, cell membrane, mitochondria, and ribosomes, which carry out essential life processes. Plant cells also have a cell wall, chloroplasts for photosynthesis, and a large permanent vacuole, which are not found in animal cells.

Lesson 2: Prokaryotic cells

You need to know that prokaryotic cells, like bacteria, are simpler than eukaryotic cells and do not have a nucleus; instead, their genetic material is found as a single DNA loop in the cytoplasm. They also have structures like plasmids, a cell wall, and sometimes flagella, which help with movement and survival.

Lesson 3: Cell specialisation

You need to know that cell specialisation means cells develop specific structures to carry out particular functions, such as nerve cells for transmitting signals or root hair cells for absorbing water. This process is essential in multicellular organisms to ensure different tissues and organs work together efficiently.

Lesson 4: Different kinds of microscopes

You need to know that GCSE students need to know that light microscopes allow living cells and basic structures like the nucleus and cell membrane, while electron microscopes provide much higher magnification and resolution, allowing detailed observation of internal cell structures. You should also understand the differences in image quality, cost, and preparation techniques between the two types.

Lesson 5: Rp – Microscopes

You need to know how to use a light microscope to observe cells, including preparing a slide (e.g. onion skin), adjusting the focus, and calculating magnification using the magnification equation. You should also be able to record clear observations and draw labelled diagrams of what you see under different magnifications.

Lesson 6: The magnification equation

You need to know the magnification equation:

Magnification = Image size ÷ Actual size,

and be able to rearrange it to calculate any of the three values, using consistent units (usually micrometres or millimetres) and apply it to microscope images.

Lesson 7: Stem Cells

You need to know that stem cells are undifferentiated cells that can divide and develop into different types of specialised cells. They are found in embryos and some adult tissues and have potential uses in medicine, such as treating diseases and repairing damaged tissues.

Lesson 8: Chromosomes and the Nucleus

You need to know that chromosomes are long strands of DNA found in the nucleus of cells, carrying genetic information that controls cell activities and inheritance. Humans have 46 chromosomes (23 pairs), and they are crucial during cell division.

Lesson 9: Mitosis and the Cell Cycle
You need to know that mitosis is the process by which a cell divides to produce two identical daughter cells, essential for growth and repair. The cell cycle includes stages of growth, DNA replication, and division, ensuring cells function properly.

Lesson 10: Diffusion
You need to know that diffusion is the movement of particles from an area of high concentration to low concentration, and it happens naturally in gases and liquids. In cells, it allows substances like oxygen and carbon dioxide to move across membranes.

Lesson 11: Surface Area to Volume Ratio
You need to know that the surface area to volume ratio affects how efficiently substances can enter and leave a cell. Smaller cells or organisms with a high ratio can exchange materials more effectively than larger ones.

Lesson 12: Osmosis
You need to know that osmosis is the movement of water across a partially permeable membrane from a dilute solution to a more concentrated one. It's vital for maintaining cell turgidity and water balance in plant and animal cells.

Lesson 13: Required Practical – Osmosis
You need to know how to investigate how osmosis affects plant tissue by placing potato (or other vegetable) pieces in different concentrations of sugar solution. They measure changes in mass to understand water movement and draw conclusions about osmosis.

Lesson 14: Active Transport

You need to know that active transport moves substances against the concentration gradient using energy from respiration. It's important in processes like nutrient absorption in the gut and mineral uptake in plant roots.

Want to go a little deeper?

Use the website cognitoedu.org

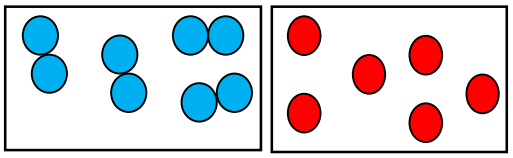
You will need to create a free account and using this you can access video lessons on all areas of this topic.

Chemistry Core Connections

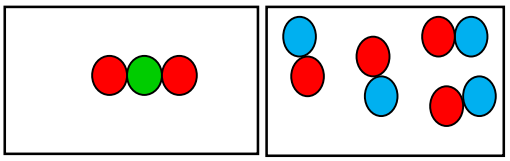
C1 Part 1 – Atomic structure

1. Elements and Compounds

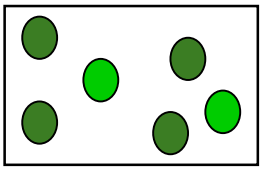
- **Element**: A substance made of only one type of atom.

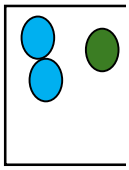


- **Compound**: Two or more elements chemically bonded together.



- Compounds have different properties from the elements they are made from.
- Represented using **chemical formulae** (e.g., H_2O, CO_2).
- **Mixtures:** Two or more elements or compounds mixed but not chemically bonded.

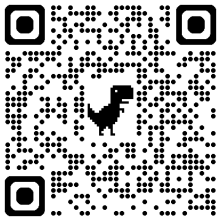




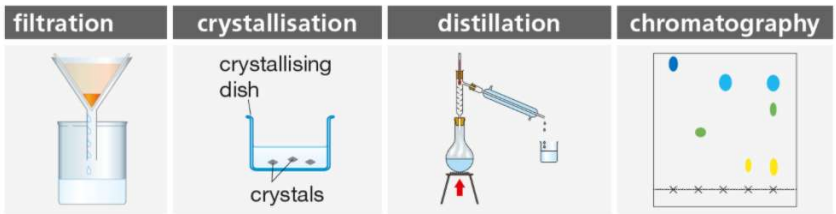


2. Mixtures

- **Mixture**: Two or more substances (elements or compounds) not chemically bonded.

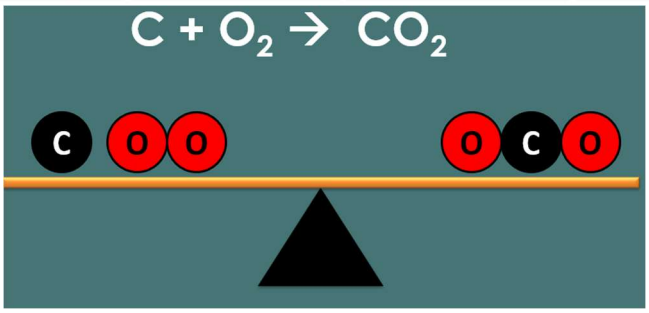


- Can be separated by physical methods:
  - **Filtration**: separates insoluble solids from liquids.
  - **Crystallisation**: forms crystals from a solution.
  - **Distillation**: separates liquids based on boiling points.
  - **Chromatography**: separates mixtures of dyes or pigments.



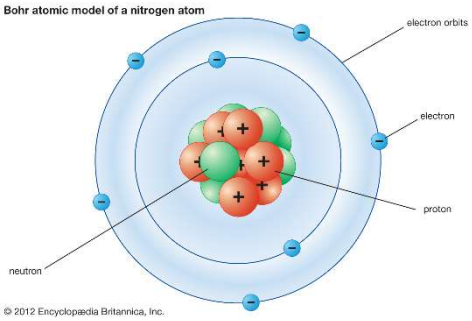
3. Atoms, Formulae and Equations

- **Atoms**: The smallest part of an element that can exist.



- **Chemical formula**: Shows the elements in a compound and their ratios (e.g., NaCl = 1 sodium atom + 1 chlorine atom).
- **Chemical equations**: Show what happens in a reaction (e.g., $H_2 + O_2 \rightarrow H_2O$).
    - Must be **balanced**: same number of each type of atom on both sides.

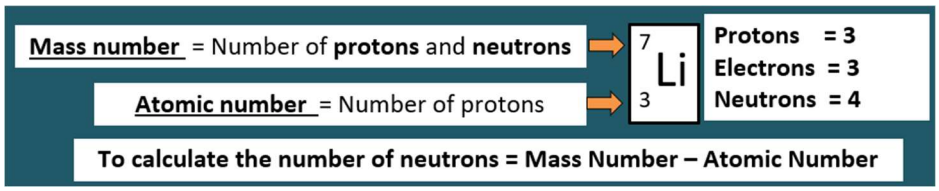
4. Structure of the Atom



- Atoms have:
    - **Nucleus**: Contains **protons** and **neutrons**.
    - **Electrons**: Orbit the nucleus in energy levels (shells).
- Most of the atom's mass is in the nucleus.
- Atom is neutral: same number of protons (+) and electrons (−).

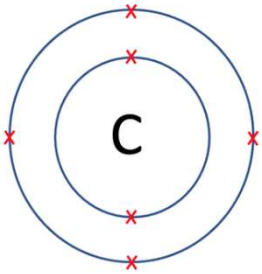
5. Subatomic Particles

Particle	Charge	Relative Mass
Proton	+1	1
Neutron	0	1
Electron	–1	~0



- **Atomic number** = number of protons.
- **Mass number** = protons + neutrons.
- **Isotopes**: Same element, different number of neutrons.

6. Electronic Structure

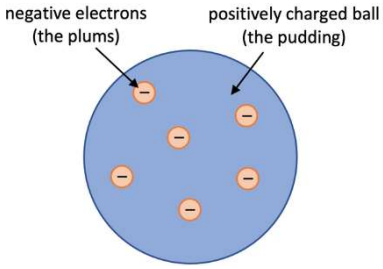


- Electrons are arranged in **shells** around the nucleus.
    - First shell holds up to **2** electrons.
    - Second and third shells hold up to **8** electrons.
- Example: Sodium (atomic number 11) → 2,8,1.
- The **number of electrons in the outer shell** determines chemical reactivity.

- **Groups** in the periodic table = number of electrons in outer shell.

7. History of the Atom

- **Dalton** (1800s): Atoms are solid spheres.
- **Thomson** (1897): Discovered electrons; "plum pudding" model.
- **Rutherford** (1909): Gold foil experiment → discovered nucleus; atom mostly empty space.
- **Bohr**: Electrons in fixed orbits (energy levels).
- Later discoveries: Protons and neutrons in the nucleus.



C10 – Using resources

Lesson 1: Using Earth's Resources and Sustainable Development

- **Earth's resources** provide food, water, energy, and materials.
- **Natural resources** can be:
    - **Renewable** (replaced quickly, e.g. fresh water, wood).
    - **Finite** (non-renewable, e.g. metal ores, fossil fuels).
- **Sustainable development** = meeting today's needs **without compromising** the future.
- Chemistry helps improve sustainability through:

- Water purification
- Synthetic alternatives (e.g. synthetic rubber)
- Efficient agriculture (e.g. fertilisers)

Lesson 2: Potable Water

- **Potable water** is safe to drink but **not pure H_2O**.
- Must have **low levels of dissolved salts and microbes**.
- In the UK:
  - Collected from **rivers, lakes, reservoirs**.
  - Treated by **filtration** and **sterilisation** (e.g. chlorine, UV).
- In dry regions:
  - **Desalination** used to remove salt from seawater.
  - Methods: **distillation** or **reverse osmosis** (membranes).

Lesson 3: Required Practical – Purification of Water

- Aim: Compare and purify different water samples.
- **Steps**:
  1. Test pH.
  2. Weigh and evaporate samples to dryness to check for solids.
  3. Use **simple distillation** to purify a sample.
- **Expected results**:
  - Tap/river water has solids and a neutral/slightly basic pH.

- Distilled water: **no solids**, **neutral pH (~7)**.

Lesson 4: Alternative Methods of Metal Extraction

- Used when **high-grade ores** are scarce.
- **Phytomining**:
  - Plants absorb metal ions from soil.
  - Plants are burned and metals extracted from ash.
- **Bioleaching**:
  - Bacteria break down ores and release metal ions into solution.
- Slower but useful for **low-grade ores**.
- Final step: metal extracted from solution (e.g. displacement or electrolysis).

Lesson 5: Life Cycle Assessments (LCAs)

- Assess the **environmental impact** of a product at each stage:
  1. **Raw material extraction**
  2. **Manufacturing and processing**
  3. **Product use**
  4. **Disposal**
- LCAs help compare options (e.g. plastic vs. paper bags).
- Some impacts (e.g. pollution) are hard to quantify, making LCAs **partly subjective**.

Lesson 6: Reducing the Use of Resources

- Reducing resource use helps **conserve finite materials** and **cut waste**.
- Methods:
  - **Reuse** (e.g. glass bottles).
  - **Recycle** (metals, plastics, paper).
  - **Reduce** (less packaging, fewer raw materials).
- **Recycling metals** saves energy and reduces pollution.

- Chemistry helps develop:
    - **Alternative materials**
    - **Green manufacturing methods**

Lesson 7: Alloys and Corrosion

- **Alloys** = mixtures of metals (or metals + non-metals), designed for **improved properties**.
    - E.g. **Steel** = iron + carbon (stronger than pure iron).
    - **Brass** = copper + zinc (hard and corrosion-resistant).
- **Corrosion** = when metals react with air/water (e.g. rusting of iron).
- **Rusting** requires **oxygen and water**.
- Prevention methods:
    - **Painting**, **oiling**, **electroplating**
    - **Sacrificial protection**: more reactive metal corrodes instead (e.g. zinc on iron)

Lesson 8: Ceramics, Polymers and Composites

- **Ceramics**:
    - Made from **clay** or other materials hardened by heat.
    - E.g. bricks, pottery, glass – hard, brittle, high melting points.
- **Polymers**:
    - Made from **monomers** using polymerisation.
    - Properties depend on structure and processing (e.g. LDPE vs. HDPE).
    - Can be **thermosoftening** (melt when heated) or **thermosetting** (do not melt).
- **Composites**:
    - Made from **2 or more materials** (e.g. fiberglass, concrete).
    - Combined to give useful properties (strong, light, durable)

Physics Core Connections.

Energy 1 Lessons 1 and 2

- **Different Energy Stores**
  You should be able to describe the different types of energy stores.

Energy store	Description	Examples
Magnetic	The energy stored when repelling poles have been pushed closer together or when attracting poles have been pulled further apart.	Fridge magnets, compasses, maglev trains which use magnetic levitation.
Internal (thermal)	The total kinetic and potential energy of the particles in an object, in most cases this is the vibrations - also known as the kinetic energy - of particles. In hotter objects, the particles have more internal energy and vibrate faster.	Human bodies, hot coffees, stoves or hobs. Ice particles vibrate slower, but still have energy.
Chemical	The energy stored in chemical bonds, such as those between molecules.	Foods, muscles, electrical cells.
Kinetic	The energy of a moving object.	Runners, buses, comets.
Electrostatic	The energy stored when repelling charges have been moved closer together or when attracting charges have been pulled further apart.	Thunderclouds, Van De Graaff generators.
Elastic potential	The energy stored when an object is stretched or squashed.	Drawn catapults, compressed springs, inflated balloons.
Gravitational potential	The energy of an object at height.	Aeroplanes, kites, mugs on a table.
Nuclear	The energy stored in the nucleus of an atom.	Uranium nuclear power, nuclear reactors.

Video available here....

Energy: Work done and Power Lessons 3 and 4

The equation used to calculate the work done is:

work done = force × distance

$$W = F \times d$$

This is when:

- work done (*W*) is measured in joules (J)
- force (*F*) is measured in newtons (N)
- distance (*d*) is in the same direction as the force and is measured in metres (m)

Example



In this example, a force of 10 N causes the box to move a horizontal distance of 2 m, so:

$$W = F \times d$$

$$W = 10 \times 2$$

$$W = 20\ J$$

Calculating power

The equation used to calculate power is:

$$power = \frac{work\ done}{time}$$

$$power = \frac{W}{t}$$

This is when:

- power (*P*) is measured in watts (W)
- work done (*W*) is measured in joules (J)
- time (*t*) is measured in seconds (s)

One watt is equal to one joule per second (J/s). This means that for every extra joule that is transferred per second, the power increases by one watt.

Podcast available here....

Energy: Efficiency Lesson 5

The efficiency of a device is the proportion of the energy supplied that is transferred in useful ways. The efficiency can be calculated as a decimal or a percentage, using the equations:

$$efficiency = \frac{useful\ energy\ transferred}{total\ energy\ supplied}$$

$$percentage\ efficiency = efficiency \times 100$$

$$(percentage\ efficiency = \frac{useful\ energy\ transferred}{total\ energy\ supplied} \times 100)$$

This is when both useful energy transferred and total energy supplied are measured in joules (J).

Efficiency and power

As power is equal to useful energy transferred per second, another way to calculate efficiency is to use the formula:

$$efficiency = \frac{useful\ power\ transferred}{total\ power\ supplied}$$

$$percentage\ efficiency = efficiency \times 100$$

This is when both useful power transferred and total power supplied are measured in watts (W).

Pod cast below...

Energy Lessons 8 and 9 Conduction and Convection

Energy transfer

As well as transferring energy from one store to another, energy is transferred or transmitted from place to place. As it moves through a substance, energy is transmitted by conduction, convection or radiation.

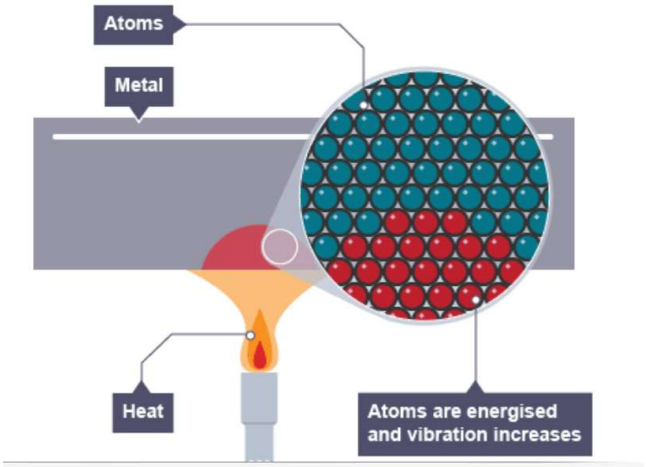
Conduction

The aluminium base of a pan, the copper in the wires from a plug and the steel of a bell are all conductors.

Key fact

A conductor is a material that allows internal (thermal) energy to be transmitted through it easily.

All metals are good conductors. When one end of a metal rod is put into a fire, the energy from the flame makes the ions in the rod vibrate faster. Since the ions in the solid metal are close together, this increased vibration means that they collide with neighbouring ions more frequently. Energy is passed on through the metal by these collisions, transmitting the energy. More frequent collisions increase the rate of transfer.



Energy: Lesson 10 and 11 Required Practical Insulation

Investigating methods of insulation - thickness

There are different ways to investigate methods of insulation. In this practical activity, it is important to:

- make and record measurments of temperature and time accurately
- measure and observe the effect of the different thicknesses of the insulator
- use appropriate apparatus and methods to measure the effectiveness of different thicknesses of thermal insulators

Aim of the experiment

To compare the effectiveness of different thicknesses of thermal insulators.

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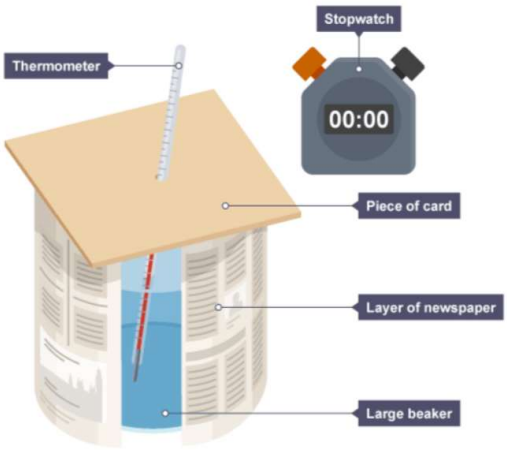

Method

1. Wrap a sheet of newspaper around a 100 ml beaker.
2. Fill the beaker with hot water from a kettle.
3. Put a piece of cardboard over the beaker as a lid. The lid should have a hole suitable for a thermometer.
4. Place a thermometer into the beaker through the hole.
5. Record the temperature of the water in the beaker and start the stopwatch.
6. Record the temperature of the water every 2 minutes for 20 minutes.
7. Repeat steps 1-6, each time adding another layer of newspaper around the beaker until there are 10 layers of newspaper wrapped around the beaker.
8. Plot graphs of temperature against time.