

WJEC GCSE

The Sciences (Double Award)

Approved by Qualifications Wales

Guidance for Teaching: Connections and Relationships Between Topics Within Scientific Disciplines

Teaching from 2026

For award from 2028



Connections and relationships between topics within scientific disciplines

This content enables learners to demonstrate their knowledge and understanding of the relationships and connections between different topics within that discipline. This content is identified by using italics in the first unit of each discipline (Units 1, 2 and 3) and then referenced at the start of each section in the second unit of each discipline (Units 4, 5 and 6).

This content has been selected to provide meaningful opportunities for learners to build upon the scientific knowledge, understanding and skills introduced in Units 1, 2, and 3. The aim is to create a natural progression that strengthens foundational concepts and deepens learners' engagement with the subject content and scientific enquiry.

This document contains the italicised content only.

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Unit 1 Biology – Basis of Life

1.1 Cell structure and function: How are cells structured, organised and sustained?

1.1.1 Structure of animal and plant cells

Learners should know:

- the function of the following parts of a cell:
 - *cell membrane*
 - *cytoplasm*
 - *nucleus*
 - *mitochondria*
 - *cell wall*
 - *chloroplast*
 - *vacuole*.

1.1.2 Levels of organisation within multicellular organisms

Learners should know:

- *that organisms can be single-celled or multicellular.*

Learners should understand:

- *some cells are specialised in multicellular organisms*
- *the levels of organisation within organisms, to include tissues, organs and organ systems.*

1.1.3 How cells get what they need

Learners should know:

- *substances such as oxygen, carbon dioxide, water and glucose must move in and out of cells to keep cells alive.*

Learners should understand:

- the processes of:
 - *diffusion*
 - *osmosis*.

1.2 Metabolism: What keeps cells alive?

1.2.1 Function of enzymes

Learners should know:

- *that enzymes are biological catalysts*
- *that enzymes are proteins.*

Learners should understand:

- *the lock and key theory as a simple model to interpret how enzymes work*
- *the effect of temperature and pH on enzyme activity.*

1.2.2 Aerobic and anaerobic respiration in humans

Learners should know:

- *the purpose of respiration*
- ***that cells use energy in the form of ATP molecules that are formed during respiration***
- *the word equations for aerobic and anaerobic respiration in humans*
- *that respiration reactions are catalysed by enzymes.*

1.2.3 Photosynthesis and factors that affect it

Learners should know:

- *the purpose of photosynthesis*
- *the word equation for photosynthesis*
- *that photosynthesis is an enzyme-controlled reaction.*

Learners should understand:

- *how the following factors affect the rate of photosynthesis:*
 - *carbon dioxide concentration*
 - *light intensity*
 - *temperature*
- ***the impact of these limiting factors on the rate of photosynthesis.***

1.3 Systems: How do organs work together?

1.3.2 Digestive system in humans

Learners should know:

- *that different foods have different energy contents.*

Learners should understand:

- *the need for a healthy balanced diet, including:*
 - *protein*
 - *carbohydrates*
 - *fats*
 - *minerals*
 - *vitamins*
 - *fibre*
 - *water*
- *the implications to health of the sugar, fat, and salt in foods.*

Learners should be able to:

- *test for the presence of starch, glucose and protein.*

1.3.3 Respiratory system in humans

Learners should understand:

- *the function of mucus and cilia in the respiratory system.*

1.3.4 Circulatory system in humans

Learners should know:

- *the function of the four main parts of the blood:*
 - *red cells*
 - *platelets*
 - *plasma*
 - *white cells*
- *that the heart and veins contain valves that prevent the backflow of blood.*

Learners should understand:

- *the function of arteries, veins and capillaries*
- *the role of the coronary vessels in supplying the heart muscle with blood*
- *the risk factors and effects of cardiovascular disease.*

1.4 Interdependence of organisms: How do organisms live together?

1.4.1 Relationships within an ecosystem

Learners should know:

- *food chains show the transfer of energy between trophic levels*
- *that an ecosystem refers to the interactions between all the living organisms and their physical environment in a specific area.*

Learners should understand:

- *how food webs can be used to display overlapping food chains that show feeding relationships within ecosystems.*

1.4.2 Biotic and abiotic factors within an ecosystem

Learners should know:

- *what is meant by biotic and abiotic factors.*

Learners should understand:

- *how the size of a population may be affected by factors including:*
 - *competition for resources*
 - *predation*
 - *pollution*
 - *disease*
- *the effect of invasive non-native species on ecosystems.*

Unit 2 Chemistry – Chemical Substances and How They Behave

2.1 Matter: What are materials made from?

2.1.1 The states of matter

Learners should know:

- *how solids, liquids and gases are represented using the simple particle model*
- *that substances change state when they are heated or cooled*
- *that melting, boiling, condensing and freezing are terms used to describe changes of state.*

Learners should understand:

- *how melting point and boiling point determine the state of substances at different temperatures.*

2.1.4 Isotopes and relative atomic mass

Learners should know:

- *what is meant by the relative atomic mass of an element, A_r .*

2.1.5 Molecules and chemical formulae

Learners should know:

- *that some elements exist as diatomic molecules e.g. hydrogen (H_2) and oxygen (O_2)*
- *that the chemical formula of a compound describes its composition.*

Learners should understand:

- *simple diagrams used to represent molecules*
- *how to interpret the chemical formulae of simple compounds.*

Learners should be able to:

- *write the formulae of ionic compounds from given formulae of the ions they contain.*

2.1.6 Relative formula mass

Learners should know:

- *what is meant by the relative formula mass of a substance, M_r*
- ***what is meant by the Avogadro number and the mole.***

Learners should be able to:

- *calculate relative formula mass using relative atomic masses*
- *calculate the percentage by mass of each element present in a compound*
- ***convert the mass of a substance in grams to number of moles and vice versa.***

2.2 Electronic Structure and Periodicity: Can we predict how elements behave?

2.2.1 The periodic table

Learners should know:

- *the general properties of metals.*

Learners should be able to:

- *draw the electronic structures of the first 20 elements.*

2.2.2 Electronic structure and reactivity

Learners should know:

- *that elements in all groups other than group 0 react in such a way as to achieve a full outer shell*
- *that ions are formed when atoms lose electrons or gain electrons to achieve a full outer shell.*

Learners should understand:

- *that group 1 elements lose one electron to form an ion with a single positive charge*
- *that group 7 elements gain one electron to form an ion with a single negative charge.*

2.2.3 Group 1 and group 7

Learners should know:

- *the names of the products formed when group 1 metals react with:*
 - *oxygen*
 - *group 7 elements (the halogens)*
- *the general equations for the reactions of group 1 metals with oxygen, water and the halogens:*
 - *metal + oxygen → metal oxide*
 - *metal + halogen → metal halide.*

Learners should be able to:

- *carry out the test used to identify hydrogen gas*
- *identify the group 1 metal ions lithium, sodium and potassium using flame tests*
- *identify the group 7 ions chloride, bromide and iodide using silver nitrate solution*
- *write word equations for the reactions of the group 1 metals with:*
 - *oxygen*
 - *the halogens*
- *complete and balance partially constructed symbol equations for the reactions of the group 1 metals with:*
 - *oxygen*
 - *the halogens.*

They should be able to write a balanced symbol equation without any scaffolding in the Unit 5 paper.

2.3 Rates of Reaction: Can we control the speed of a reaction?

2.3.1 Chemical Changes

Learners should know:

- *the simple observations that show that a chemical reaction has happened – temperature change, effervescence, colour change, precipitate formation*
- *that exothermic reactions give out heat energy and endothermic reactions take in heat energy*
- *that the law of conservation of mass states that atoms are not created or destroyed during a chemical reaction.*

Learners should understand:

- *that a reaction stops when one of the reactants is used up.*

Learners should be able to:

- *use the law of conservation of mass to balance partially constructed symbol equations for unfamiliar reactions.*

2.3.3 Factors affecting the rate of reaction

Learners should know:

- *that temperature, concentration and surface area affect the rate of a reaction.*

2.3.4 Catalysts

Learners should know:

- *that a catalyst increases the rate of a reaction.*

Learners should understand:

- *that using a catalyst in an industrial process enables a reaction to be carried out at a lower temperature requiring less energy.*

Learners should be aware:

- *that new catalysts are being developed to make chemical processes more efficient and sustainable.*

2.4 The Earth's essential resources: How can we preserve the planet for future generations?

2.4.1 The Earth's resources

Learners should understand:

- *that we must consider the sustainability of using the Earth's resources, including the environmental impact of extracting raw materials, transporting raw materials and products around the world, and energy and water usage.*

2.4.3 Separation techniques involving water

Learners should know:

- *how filtration, evaporation, distillation and chromatography can be used to separate simple mixtures.*

Learners should understand:

- *how to separate given mixtures using one or more of the separation techniques.*

2.4.4 The composition of the atmosphere

Learners should be able to:

- *carry out the test used to identify oxygen gas*
- *carry out the test used to identify carbon dioxide gas.*

2.4.5 Greenhouse gases and climate change

Learners should know:

- *that carbon dioxide and methane are greenhouse gases that contribute to climate change*
- *that the amount of greenhouse gases in the atmosphere has increased significantly over the past century because of human activity.*

Learners should understand:

- *how human activity is responsible for increased levels of carbon dioxide and methane in the atmosphere*
- *the everyday measures that can be taken to reduce human carbon footprint and therefore climate change*
- *that techniques are continually being developed with the aim of reducing carbon dioxide emissions*
- *what is meant by 'net zero' and carbon off-setting.*

Unit 3 Physics – Forces, Motion and the Universe

3.1 Motion: How do objects move?

3.1.1 Speed, distance, time and acceleration

Learners should know:

- *how to describe motion in terms of distance, time, speed, and acceleration.*

3.1.2 Using equations to calculate speed and acceleration

Learners should be able to:

- *use the equations:*

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time}}$$

3.1.3 Graphs illustrating motion

Learners should be able to:

- *use distance-time graphs and speed-time graphs to represent motion*
- *calculate speed using a distance-time graph*
- ***calculate acceleration using the gradient of a speed-time graph***
- ***calculate the distance travelled using the area under a speed-time graph.***

3.2 Energy Resources and Efficiency: Electricity for the future

3.2.1 The principle of conservation of energy

Learners should know:

- *that energy cannot be created or destroyed; it is transferred from one store to another*
- *that in some transfers, energy is transferred to a store that is not useful, and this is described as wasted energy*
- *some energy stores including: gravitational, kinetic, elastic, thermal, chemical and nuclear.*

Learners should be aware:

- *that energy stores are emptied or filled by one of 4 pathways: mechanically, electrically, by heating or by radiation.*

Learners should be able to:

- *consider the start and end point in a process and describe how the energy in each store has changed.*

3.2.3 Efficiency

Learners should know:

- *that a more efficient device transfers more of the input energy store into a useful output energy store.*

Learners should be able to:

- *use the equation:*

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

OR

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

Learners should be able to:

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

3.2.4 Power and the cost of using electrical appliances

Learners should be able to:

- *use the equation:*

$$\text{power} = \frac{\text{energy transfer}}{\text{time}}$$

3.2.5 Generation of electricity

Learners should know:

- *how electricity is generated in a nuclear power station by transferring energy from a nuclear store*
- *the problems caused by generating electricity in nuclear power stations*

3.3 Forces: How do forces interact with objects?

3.3.1 Common forces

Learners should know:

- *the names of common forces*

3.3.2 Force diagrams and calculating resultant force

Learners should be able to:

- *calculate a resultant force by adding forces which act in the same direction and subtracting forces acting in opposite directions.*

3.3.3 Newton's laws

Learners should know:

- *that forces can cause objects in motion to change speed and direction*

Learners should be able to:

- *apply Newton's second law using the equation:*

$$\text{force} = \text{mass} \times \text{acceleration}$$

3.4 Waves: What are waves?

3.4.2 Wave properties

Learners should understand:

- *the terms used for the properties of waves:*
 - *amplitude*
 - *frequency*
 - *period*
 - *wavelength.*

Learners should be able to:

- *draw graphical representations of waves from given values of amplitude, wavelength and period*
- *use graphical representations of waves to select and use values of amplitude, wavelength and period*
- *use the equations:*

$$\text{period} = \frac{1}{\text{frequency}}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

3.4.3 The electromagnetic spectrum

Learners should know:

- *the electromagnetic spectrum consists of 7 regions; radio waves, microwaves, infra-red, visible light, ultraviolet, X-rays and gamma rays*
- *all regions transfer energy and travel at the same speed in space/a vacuum*
- *ultraviolet, X-rays and gamma rays are ionising radiation and can damage cells.*

Learners should be aware of:

- *uses of the different regions of the electromagnetic spectrum including in medicine and communication.*

3.4.4 Ultrasound

Learners should understand:

- *how waves are used to measure distances such as ultrasound to detect cracks, echolocate and measure seabed depth, and radio waves and microwaves in radar.*