# Scheme of work

## Combined Science: Trilogy

## Physics – Waves

This resource provides guidance for teaching the Waves topic from our new GCSE in Combined Science: Trilogy/Physics (8464). It has been updated from the draft version to reflect the changes made in the accredited specification. There are many changes throughout the document, particularly to learning outcomes and opportunities to develop skills columns.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 6.6.1 Waves in air, fluids and solids

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 6.6.1.1 | Features of transverse and longitudinal waves. | Waves may be either transverse or longitudinal.  In a transverse wave the oscillations are perpendicular to the direction of energy transfer. The ripples on a water surface are an example of a transverse wave.  In a longitudinal wave the oscillations are parallel to the direction of energy transfer. Longitudinal waves show areas of compression and rarefaction. Sound waves travelling through air are longitudinal.  Describe evidence that for both ripples on a water surface and sound waves in air, it is the wave and not the water or air that travels. | 1 | Draw diagrams to show the features of transverse and longitudinal waves.  Give examples of both transverse and longitudinal waves.  Describe the propagation of both transverse and longitudinal waves.  Explain the changes in air pressure caused by longitudinal waves in regions of compression and rarefaction. | What do waves look like?  Do all waves have the same properties?  Demonstrate how waves travel using a slinky spring.  Investigate waves in a ripple tank. What can you change to increase the frequency of the wave? If a ripple tank isn’t available, show the following two clips from [Open University](https://www.youtube.com/watch?v=y53z2zVipAs).  Activities listed on Institute of Physics website [Episode 309](http://tap.iop.org/vibration/progressive/309/page_46635.html) | [BBC Bitesize: General properties of waves](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/waves/generalwavesrev2.shtml)  [Cyber Physics: Waves](http://www.cyberphysics.co.uk/topics/waves/gcsewaves.html)  GCSE Boardworks – Waves section  Mini White Boards (MWB) Q&A session based around activities listed on Boardworks and/or teacher’s own questions.  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 6.6.1.2 | Properties of waves.  Equation linking the wave speed, frequency and wavelength should be known. | Waves are described by their amplitude, wavelength, frequency and period.  The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position.  The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave.  The frequency of a wave is the number of waves passing a point each second.  period, *T*, in seconds, s frequency, *f*, in hertz, Hz  The period of a wave is how long it takes for one wave to pass a point.  The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium.  All waves obey the wave equation:    wave speed, *v*, in metres per second, m/s  frequency, *f*, in hertz, Hz  wavelength, *λ*, in metres, m  Describe methods to measure the speed of sound waves in air, and the speed of ripples on a water surface.  . | 2 | Define:   * wavelength * amplitude * frequency * peak * trough * period.   Calculate the wavelength of a wave from a labelled diagram of a wave.  Calculate the frequency of a wave given the number of waves (possibly from interpreting a diagram) and the time.  Calculate the speed of a wave. Rearrange the equation to find any unknown given the other two values. | What do waves do?  What effect does increasing the amplitude/frequency of a sound wave have?  Demonstrate the above using a loudspeaker and signal generator connected to an oscilloscope. Vary the frequency and then the amplitude on the signal generator – what is observed?  Demonstrate that changing the frequency of a transverse wave on a length of rope changes the wavelength.  Pupils could investigate how to accurately measure the period of a wave ie time a fixed number, say 10 and then divide the time by this number.  What is the speed of sound?  What factors change the speed of sound?  Research the speed of sound and the factors that affect it.  Can we measure the speed of sound in school?  Required practical:    Make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements. (10.2.20)  Find the speed of sound by measuring the time taken for an echo to get back to you after clapping your hands or banging two large lumps of wood together, near a wall. The distance to the wall will need to be measured (and doubled to find the distance the sound wave travels).  Find the speed of ripples on a water surface using a ripple tank. | [Revision summary: waves](http://www.s-cool.co.uk/gcse/physics/properties-of-waves/remember-it/s-cool-revision-summary)  [Anatomy of a wave](http://www.physicsclassroom.com/class/waves/Lesson-2/The-Anatomy-of-a-Wave)  [Cyber Physics: Waves](http://www.cyberphysics.co.uk/topics/waves/gcsewaves.html)  [The frequency and period of a wave](http://www.physicsclassroom.com/class/waves/Lesson-2/Frequency-and-Period-of-a-Wave)  GCSE Boardworks – Waves section  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions. |

### 6.6.2 Electromagnetic waves

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment Opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 6.6.2.1 | The electromagnetic spectrum | Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber.  Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air.  The waves that form the electromagnetic spectrum are grouped in terms of their wavelength and their frequency. Going from long to short wavelength (or from low to high frequency) the groups are: - radio, microwave, infra-red, visible light (red to violet), ultra-violet, X-rays and gamma-rays.  Our eyes detect visible light and so only detect a limited range of electromagnetic waves. | 1 | Describe the properties common to all electromagnetic waves.  State that electromagnetic waves transfer energy from one place to an absorber of that energy.  Name the seven types of electromagnetic wave, in the correct order from longest to shortest wavelength.  State the range of wavelengths is approximately 10-15m – 104m  State that the only part of the electromagnetic spectrum that our eyes can detect is visible light. | How do the electromagnetic waves differ from each other?  How is the speed of light measured?  Pupils can try and come up with a mnemonic to remember the order of the visible light spectrum.  Research how the speed of light was found.  Research the parts of the electromagnetic spectrum seen by animals, eg cats, bees, snakes. | [Waves in the spectrum](http://www.s-cool.co.uk/gcse/physics/uses-of-waves/revise-it/electromagnetic-spectrum)  [The electromagnetic spectrum: the family of light](http://www.cyberphysics.co.uk/topics/light/emspect.htm)  [BBC Bitesize: Using the spectrum](http://www.bbc.co.uk/bitesize/standard/physics/health_physics/using_the_spectrum/revision/1/)  GCSE Boardworks – Electromagnetic Waves section  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions. |
| 6.6.2.2 | Properties of electromagnetic waves. | Construct ray diagrams to illustrate the refraction of a wave.  Different wavelengths of electromagnetic waves are reflected, refracted, absorbed or transmitted differently by different substances and types of surface. HT only.  Some effects, for example refraction, are due to the difference in velocity of the waves in different substances.  Refraction does not happen when a wave enters a medium at 90o to the surface. HT only.  Use wave front diagrams to explain refraction in terms of the change of speed that happens when a wave travels from one medium to a different medium. HT only | 1.5 | Construct ray diagrams to illustrate the refraction of a wave at the boundary between two different media. | Why can I get TV signal at home but not a mobile phone signal?  Demonstration of the properties of microwaves using a microwave transmitter and a detector connected to a millimetre.  If you didn’t complete the refraction experiments detailed in section ‘Reflection of waves’ then complete them here.  If you have a ripple tank you can demonstrate refraction as waves go into different depths of water, or use this video on [Ripple tank reflection](https://www.youtube.com/watch?v=R5EdLv3NS7Y)  Required practical :  Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface. (10.2.21)  Investigate how the type of surface affects the amount of infrared radiation absorbed by a surface.  Investigate how the colour of a surface affects how quickly an object will cool by the emission of infrared radiation. Use a Leslie cube or a ‘home-made’ version. | [BBC Bitesize: Refraction and diffraction](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/waves/generalwavesrev5.shtml)  [Reflection, refraction and diffraction](http://www.physicsclassroom.com/class/waves/Lesson-3/Reflection,-Refraction,-and-Diffraction)  GCSE Boardworks – Electromagnetic Waves section  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions. |
| 6.6.2.3 | Radio waves and electrical circuits.  How electromagnetic waves are generated.  The effects of gamma rays, X-rays and ultraviolet waves on the body. | Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range. Gamma rays originate from changes in the nucleus of an atom.  Radio waves can be produced by oscillations in electrical circuits. HT only.  When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can also produce oscillations in an electrical circuit. HT only.  Ultra-violet waves, X-rays and gamma rays can have hazardous effects on human body tissue. The effects depend on the type of radiation and the size of the dose. Radiation dose (in Sieverts) is a measure of the damage caused by the radiation in the body.  Ultra-violet waves can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause mutation of genes and cancer. | 2 | Describe how electromagnetic waves are generated.  Describe how radio waves can be produced in electrical circuits and also the effect that radio waves may have on electrical circuits.  Explain why atoms only absorb certain frequencies of electromagnetic radiation  Describe gamma radiation as being a type of electromagnetic radiation emitted from the nucleus of an unstable atom.  Describe and explain the effects that gamma, X-rays and ultraviolet radiation have on the body.  Explain how the radiation dose that nuclear industry workers are exposed to is measured.  Explain how a radiation badge detects radiation.  Draw conclusions from given data about the risks and consequences of exposure to radiation. Students will not need to recall the unit of radiation dose.  Describe how ultraviolet radiation from the sun can affect the body and in particular the skin. | How do radios work?  Make a simple transistor radio.  Research the first radio communication sent across the Atlantic.  How do you make an electromagnetic wave?  Is radiation harmful?  Does sunbathing cause cancer?  Are sunbeds safer than sunbathing?  How I can I reduce the risk of skin cancer?  Do people working in a nuclear power station have a greater risk of cancer?  Research the radiation dose level people in various professions are exposed to, eg, nuclear industry, pilot, science teacher.  Plan an investigation to find out which sun screen is the most effective - probes are available for data loggers to measure the intensity of ultraviolet light.  Research into how exposure to gamma rays, X-rays and ultraviolet light can cause cell mutations. | [Cyber Physics: Radio and TV waves](http://www.cyberphysics.co.uk/topics/waves/radiowaves/radio.htm)  GCSE Boardworks – Radiowaves and Microwaves section  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions.  [Cyber Physics: The electromagnetic spectrum – the family of light](http://www.cyberphysics.co.uk/topics/light/emspect.htm)  GCSE Boardworks – Ionizing Radiation section  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions.  [Dangers of ionising radiation](http://www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/energy/safehandlingradmatrev1.shtml)  [Cyber Physics: The electromagnetic spectrum – the family of light](http://www.cyberphysics.co.uk/topics/light/emspect.htm)  [Harmful effects of ultraviolet radiation](http://enhs.umn.edu/current/5103/uv/harmful.html) |
| 6.6.2.4 | Uses of electromagnetic waves. | Electromagnetic waves have many practical applications. For example:   * radio waves – television and radio * microwaves – satellite communications, cooking food * infrared – electrical heaters, cooking food, infra-red cameras * visible light – fibre optic communications * ultraviolet – energy efficient lamps, sun tanning * X-rays – medical imaging and treatments.   Explain why each type of electromagnetic wave is suitable for the practical application. HT only. | 0.5 | Give the order of the electromagnetic spectrum.  Describe uses of each wave in the electromagnetic spectrum.  Explain the suitability of each wave for its practical application. (HT only)  Suggest reasons why an electromagnetic wave may not be suitable for a given application. (HT only)  Produce a leaflet to show the uses and dangers of electromagnetic radiation.  Explain the precautions taken in a hospital when carrying out an X-ray. Precautions should include steps taken to reduce the risks for the patient and the radiographer. | Where are electromagnetic waves used?  Why are some types of electromagnetic waves used when they are dangerous?  Research the various uses of electromagnetic waves and how they are suitable for that application. (HT only)  Research the use of laser light in barcodes and in reading CDs.  Demonstrate an optical fibre showing total internal reflection.  Demonstrate a use of UV by shining a UV light onto a bank note, through tonic water or writing a message using a security marker and then holding a UV light over the message. | [BBC Bitesize: The electromagnetic spectrum](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/waves/soundandlightrev2.shtml)  [Cyber Physics: The electromagnetic spectrum](http://www.cyberphysics.co.uk/topics/light/emspect.htm)  GCSE Boardworks – various sections  MWB Q&A session based around activities listed on Boardworks and/ or teacher’s own questions. |