# PLANNING SUPPORT BOOKLET

**J249**

**For first teaching in 2016**

This support material booklet is designed to accompany the OCR GCSE (9–1) specification in Physics A and Combined Science A (Gateway Science).

***DISCLAIMER***

This resource was designed using the most up to date information from the specification at the time it was published. Specifications are updated over time, which means there may be contradictions between the resource and the specification, therefore please use the information on the latest specification at all times.If you do notice a discrepancy please contact us on the following email address: [resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

# Introduction

This support material is designed to accompany the OCR GCSE (9-1) specification in Physics A (Gateway) for teaching from September 2016.

The Planning Guidance table on the following pages sets out *suggested* teaching times for the topics within the specification. Note that we always recommend that individual centres plan their schemes of work according to their individual needs. Actual teaching times for topics will depend on the amount of practical work done within each topic and the emphasis placed on development of practical skills in various areas, as well as use of contexts, case studies and other work to support depth of understanding and application of knowledge and understanding. It will also depend on the level of prior knowledge and understanding that learners bring to the course.

The table follows the order of the topics in the specification. It is not implied that centres teach the specification topics in the order shown, centres are free to teach the specification in the order that suites them.

## Delivery guides

The column ‘Delivery guides’ refers to individual teacher guides available from the GCSE Physics A qualification page.

These Delivery guides provide further guidance and suggestions for teaching of individual topics, including links to a range of activities that may be used and guidance on resolving common misconceptions.

## Practical Work

Specification topic p9 (Practical skills) is not included explicitly in the Planning Guidance table. The expectation is that the practical skills are developed throughout the course and in support of conceptual understanding.

Suggestions for where the PAG techniques can be are included throughout the table. This is by no means and exhaustive list of potential practical activities.

| **Topic** | **Teaching hours**  separate / combined | **Delivery Guides** | **PAG opportunities** | |
| --- | --- | --- | --- | --- |
| **Topic 1: Matter** | | | | |
| 1.1 The particle model | 3 / 3 hours | Matter – delivery guide | PAG1: Determine the densities of a variety of objects both solid and liquid | |
| 1.2 Changes of state | 5 / 5 hours | Matter – delivery guide | PAG5: Determine the specific heat capacity of a metal (Activity 1)  PAG5: Kettle design (Activity 2) | |
| **1.3 Pressure (separate science only)** | 6 / 0 hours | Matter – delivery guide |  | |
| **Total for topic 1 = 14 / 8 hours** | | | | |
| **Topic 2: Forces** | | | | |
| 2.1 Motion | 5 / 5 hours | Forces and Motion – delivery guide | PAG3: Investigate acceleration of a trolley down a ramp (Activity 1)  PAG3: Investigating fluid flow (Activity 2) | |
| 2.2 Newton’s laws | 12 / 11 hours | Forces and Motion – delivery guide |  | |
| 2.3 Forces in action | 8 / 4 hours | Forces and Motion – delivery guide | PAG 2: Investigate the effect of forces on springs (Activity 1)  PAG 2: Investigating the effects of forces on the compression of a sample (Activity 2) | |
| **Total for topic 2 = 25 / 20 hours** | | | | |
| **Topic 3 Electricity** | | | | |
| 3.1 Static and Charge | 4 / 3 hours | Electricity – delivery guide |  | |
| 3.2 Simple circuits | 7 / 7 hours | Electricity – delivery guide | PAG6: Investigate the I-V characteristics of circuit elements (Activity 1)  PAG6: Mystery circuit elements (Activity 2)  PAG7: Investigate the brightness of bulbs in series and parallel | |
| **Total for topic 3 = 11 / 10 hours** | | | | |
| **Topic 4 Magnetism** | | | | |
| 4.1 Magnets and magnetic fields | 5 / 5 hours | Magnetism – delivery guide |  | |
| 4.2 Uses of magnetism | 8 / 2 hours | Magnetism – delivery guide |  | |
| **Total for topic 4 = 13 / 7 hours** | | | | |
| **Topic 5 Waves** | | | | |
| 5.1 Wave behaviour | 7 / 4 hours | Waves – delivery guide | PAG4: Measuring the speed, frequency and wavelength of a wave (Activity 1)  PAG4: Tsunami (Activity 2)PAG4: Measuring the speed, frequency and wavelength of a wave | |
| 5.2 The electromagnetic spectrum | 4 / 4 hours | Waves – delivery guide |  | |
| 5.3 Wave interactions | 5 / 1 hours | Waves – delivery guide | PAG8: Investigate the reflection of light off a plane mirror and the refraction of light through prisms (Activity 1)  PAG8: Reflection within a material (Activity 2) | |
| **Total for topic 5 = 16 / 9 hours** | | | | |
| **Topic 6 Radioactivity** | | | | |
| 6.1 Radioactive emissions | 6 / 6 hours | Radioactivity – delivery guide |  | |
| 6.2 Uses and Hazards | 5 / 1 hours | Radioactivity –delivery guide |  | |
| **Total for topic 6 = 11 / 7 hours** | | | | |
| **Topic 7 Energy** | | | | |
| 7.1 Work done | 5 / 5 hours | Energy – delivery guide |  | |
| 7.2 Power and efficiency | 6 / 6 hours | Energy – delivery guide |  | |
| **Total for topic 7 = 11 / 11 hours** | | | | |
| **Topic 8 Global Challenges** | | | | |
| 8.1 Physics on the move | 5 / 4 hours | Global challenges – delivery guide |  | |
| 8.2 Powering Earth | 6 / 5 hours | Global challenges – delivery guide |  | |
| **8.3 The Earth and beyond (separate science only)** | 8 / 0 hours | Global challenges – delivery guide |  | |
| **Total for topic 8 = 19 / 9 hours** | | | | |
| **Total teaching hours = 120 / 81 hours** | | | |

🗹 This symbol indicates content that is found only in the physics separate science qualification

# Outline Scheme of Work: P5 – Waves

## Total suggested teaching time – 16 / 9 hours

### P5.1 Wave behaviour (7 / 4 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * Frequency of sound waves, measured in hertz (Hz); echoes, reflection and absorption of sound * Sound needs a medium to travel, the speed of sound in air, in water, in solids * Sound produced by vibrations of objects, in loud speakers, detected by their effects on microphone diaphragm and the ear drum; sound waves are longitudinal * The similarities and differences between light waves and waves in matter | |
| Links to Mathematical Skills  * M1a * M1b * M1c * M2a * M3a * M3b * M3c * M3d * M5b | Links to Practical Activity Groups (PAGs)  * PAG 4 Measuring wave: Measuring the speed, frequency and wavelength of a wave |

# Overview of P5.1 Wave behaviour

| **Lesson** | **Statements** | **Teaching activities** | **Notes** |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P5.1a describe wave motion in terms of amplitude, wavelength, frequency and period  P5.1b define wavelength and frequency | **Starter:** Wave on a string  This simulation allows you to change the amplitude and frequency and see the changes. Opt for the loose end option and oscillate.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287813#287813)  **Main:** Measuring the wavelength of light  This activity allows learners to get hands on with an element that is usually very theoretical.  <https://spark.iop.org/measuring-wavelength-light>  **Plenary options:** Waves  This page has a range of information, mathematical practise questions and tests to introduce you to Waves. Not all information is relevant but much of it is very useful.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287811#287811)  **Mexican wave:** get the pupils to do a Mexican wave. Tell them to change the wave with increasing/decreasing amplitude/frequency. | Link to online delivery guide for waves:  <http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/>  Link to KS3-KS4 transition guide: Wave behaviour and interactions  <http://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf> |
| 2 (1hr for separate and combined) | P5.1c describe and apply the relationship between these and the wave velocity  P5.1d apply formulae relating velocity, frequency and wavelength (M1c, M3c)  PM5.1i recall and apply: wave speed (m/s) = frequency (Hz) × wavelength (m)  P5.1e describe differences between transverse and longitudinal waves | **Starter:** Rope and Slinky: Get pupils to make different types of waves using ropes and Slinky’s. Get pupils to model waves of different amplitudes and frequencies. Pupils should know the difference between longitudinal and transverse waves from KS3, this is a good opportunity to test this knowledge.  **Main options:** Estimating wavelength, frequency and velocity of ripples  A set of practical instructions how to estimate the velocity of ripples.  <https://spark.iop.org/estimating-wavelength-frequency-and-velocity-ripples>  Wave machine demonstration  A wave machine made from wooden skewers, duct tape and jelly babies. Simple enough to build in the classroom, this also involves sweets, although non-edibles can be substituted if necessary.  <https://www.stem.org.uk/resources/elibrary/resource/27031/wave-machine>  **Plenary:** [SAM](https://www.ocr.org.uk/Images/234630-unit-j249-04-physics-higher-tier-paper-4-sample-assessment-material.pdf) question J249-04 Question 16(a) and (b)  **Calculation practice:** Give pupils plenty of practice in calculations, rearranging of equation, and converting between Hz and kHz, m and cm. | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf)  Link to [SAM](https://www.ocr.org.uk/Images/234630-unit-j249-04-physics-higher-tier-paper-4-sample-assessment-material.pdf) |
| 3 (1hr for separate and combined) | P5.1a describe wave motion in terms of amplitude, wavelength, frequency and period  P5.1b define wavelength and frequency  P5.1c describe and apply the relationship between these and the wave velocity  P5.1d apply formulae relating velocity, frequency and wavelength (M1c, M3c)  PM5.1i recall and apply: wave speed (m/s) = frequency (Hz) × wavelength (m) | **Starter:** Demo ripple tank  **Main:** [PAG 4](https://www.ocr.org.uk/Images/311749-pag-activity-physics-measuring-waves-suggestion-1.docx) Measuring waves: Measuring the speed, frequency and wavelength of a wave  **Plenary:** Give pupils the candidate progress sheet, from the practical activities section of the webpage. Pupils to tick off skills covered. | Link to [PAG](https://www.ocr.org.uk/qualifications/gcse/gateway-science-suite-physics-a-j249-from-2016/planning-and-teaching/#gcse-practical-activities):  PAG activities are available in the practical activities tab of the planning and teaching page.  Link to [candidate progress sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) |
| 4 (1hr separate science only) | P5.1f show how changes, in velocity, frequency and wavelength, in transmission of sound waves from one medium to another, are interrelated (M1c, M3c) 🗹 | **Starter:** how can sound travel? Get pupils to explore by pairing up making cup phones, tapping on the end of a table while the other student has their ear to the other end of the table etc.  **Main:** Measure the speed of sound  A simple activity in which learners measure the speed of sound using an echo. Variations on this experiment include measuring the speed of sound under different conditions (temperature, humidity, etc.).  [View full activity in P1.3 How do waves behave? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt01-p1-radiation-and-waves/delivery-guide-gpbdg003-p13-how-do-waves-behave?activity=288496#288496)  **Plenary:** Get learners to describe how the particle arrangement of different materials affects the velocity, frequency and wavelength of sound waves travelling through it. | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 5 (1hr separate science only) | P5.1g describe the effects of reflection, transmission, and absorption of waves at material interface 🗹 | **Starter:** Show images of refraction and get pupils to try and describe why the distortion occurs.  **Main options:** Refraction of light  This PowerPoint and exit card is a great idea of how to structure a lesson on refraction. Some learners may need more specific instructions of how to measure angles, but the idea can be adapted to suit the needs of the class.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287817#287817)  Reflection  A simple set of instructions which can be easily adapted for the needs of any class.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287826#287826)  **Plenary:**  Mirror maze activity  This fun task helps learners to practice measuring angles of reflection.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287824#287824) | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 6 (1hr separate science only) | **P5.1h describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids** 🗹  **P5.1i explain why such processes only work over a limited frequency range, and the relevance of this to human hearing** 🗹 | **Starter options:** The wikidrummer Touché Videoproduktion Creative – YouTube <https://www.youtube.com/watch?v=mY-f68J5PPo>  Speed of sound in different media We are showboat – YouTube <https://www.youtube.com/watch?v=-ANOqBvPI90>  **Main:** Use ear model to explain how we hear sounds. Compare hearing ranges of different animals. Using a signal generator you can also slowly increase the frequency of the sound and get pupils to sit down when they can no longer hear the sound. The teacher will normally sit before the pupils and this shows how the top end of frequency we can hear decreases with age.  Hearing and age  A great website detailing how we hear and why hearing is reduced as we age.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287830#287830)  **Plenary:** Pupils to write the journey of a sound from when it is made to when it is heard in the ear. | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 7 (1hr for separate and combined) | P5.1j describe how ripples on water surfaces are used to model transverse waves whilst sound waves in air are longitudinal waves, and how the speed of each may be measured  P5.1k describe evidence that in both cases it is the wave and not the water or air itself that travels | **Starter:** The Mantis Shrimp – most complex eyes in the animal kingdom YouTube <https://www.youtube.com/watch?v=glOsvm9t7ec>  A short video about an animal that can see infrared, ultraviolet and two types of polarised light.  **Main:** Waves using trolleys from IOPSPark and Nuffield Foundation.  <https://spark.iop.org/waves-trolleys>  A demonstration of transverse and longitudinal waves using trolleys. Another simple classroom experiment, this also has the advantage of demonstrating both longitudinal and transverse waves.  **Plenary:** Polarising filters **–** Why do these work only on transverse waves? | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |

|  |  |  |
| --- | --- | --- |
| Additional online learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| Lesson | Statement | Teaching activities |
| various | P5.1e, P5.1f, P5.1g | Cambridge International Resource Plus [video](https://ocr.org.uk/rpgphys10) covering transverse and longitudinal waves, frequency, amplitude, reflection, refraction and diffraction which can be used as flipped learning. |
| 1 | P5.1a, P5.1b, PM5.1i | Cambridge International example candidate response [resource](https://ocr.org.uk/rpgphys11) - Paper 4 Question 6 can be used as homework. |
| 2 | PM5.1i | [Worksheet](https://www.tes.com/teaching-resource/gcse-physics-wave-speed-equation-practice-wavespeed-equals-frequency-x-wavelength-11442908) on wave equation and solutions can be used for homework. |
| 5 | P5.1g | Cambridge International [Video](https://ocr.org.uk/rpgphys12) showing reflection, refraction and TIR can be used as flipped learning. |
| 5 | P5.1g | Cambridge International example candidate response [resource](https://ocr.org.uk/rpgphys13). Paper 3 Q8 can be used as homework on reflection and refraction (lesson 5). |
| 6 | P5.1h | Cambridge International [video](https://ocr.org.uk/rpgphys14) on sound waves can be used as flipped learning for lesson 6. |

# Outline Scheme of Work: P5 – Waves

## Total suggested teaching time – 16 / 9 hours

### P5.2 The electromagnetic spectrum (4 / 4 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * The similarities and differences between light waves and waves in matter * Light waves travel through a vacuum; speed of light | |
| Links to Mathematical Skills  * M1a * M1c * M3c | Links to Practical Activity Groups (PAGs)  * N/A |

# Overview of P5.2 The electromagnetic spectrum

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P5.2a recall that electromagnetic waves are transverse and are transmitted through space where all have the same velocity  P5.2b explain that electromagnetic waves transfer energy from source to absorber  P5.2c apply the relationships between frequency and wavelength across the electromagnetic spectrum (M1a, M1c, M3c) | **Starter:** Electromagnetic spectrum song  <https://www.youtube.com/watch?v=bjOGNVH3D4Y>  **Main options**: Topic exploration pack Activity 1 –Music Analogy for EM Spectrum activity  <http://www.ocr.org.uk/Images/222387-em-waves-teacher-pack-topic-exploration-pack.pdf>  Activity 2 – Transmission of EM Waves  <http://www.ocr.org.uk/Images/222387-em-waves-teacher-pack-topic-exploration-pack.pdf>  **Plenary options**: Discuss results seen with class, make sure pupils have taken appropriate notes.  Radiation and waves learner resource 1: Create a mnemonic for the names of the regions of the EM spectrum.  [View full activity in 1.1 Radiation and Waves – Online delivery guide](https://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt01-p1-radiation-and-waves/delivery-guide-gpbdg001-p11-what-are-the-risks-and-benefits-of-using-radiations#288308) | Link to J249 online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to J259 online delivery guide for [radiation and waves](https://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt01-p1-radiation-and-waves/delivery-guide-gpbdg001-p11-what-are-the-risks-and-benefits-of-using-radiations) |
| 2 (1hr for separate and combined) | P5.2d describe the main groupings of the electromagnetic spectrum and that these groupings range from long to short wavelengths and from low to high frequencies  P5.2e recall that our eyes can only detect a limited range of the electromagnetic spectrum  P5.2f recall that light is an electromagnetic wave | **Starter:** A [video](https://www.youtube.com/watch?v=OzFU6XvzzgA) summarising the electromagnetic spectrum with a brief guide to the characteristics of each part.  **Main options**: EM Spectrum  This learner lead activity provides learners with the opportunity to research and deliver key information about one of the groups of the EM spectrum.  [View full activity in 5.2 The electromagnetic spectrum – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg012-p52-the-electromagnetic-spectrum?activity=287879#287879)  Worksheet to label the EM spectrum, pupils need to label the areas of the EM spectrum, add an image of what uses this and give a brief description.  Use EM waves – Information sheet – [Topic exploration pack](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/).  **Plenary:** Electromagnetic spectrum card sort  A card sort that learners can use as a research task with a range of informative resources, or as a revision tool.  [View full activity in 5.2 The electromagnetic spectrum – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg012-p52-the-electromagnetic-spectrum?activity=287873#287873) | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/) The electromagnetic spectrum This informative website details useful information about each group of the EM spectrum in line with the GCSE specification, with revision of key terms such wavelength and frequency.  [View full activity in 5.2 The electromagnetic spectrum – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg012-p52-the-electromagnetic-spectrum?activity=287875#287875) |
| 3 (1hr for separate and combined) | P5.2g give examples of some practical uses of electromagnetic waves in the radio, micro-wave, infra-red, visible, ultraviolet, X-ray and gamma-ray regions  P5.2h describe how ultra-violet waves, X-rays and gamma rays can have hazardous effects, notably on human bodily tissues  **P5.2i explain, in qualitative terms, how the differences in velocity, absorption and reflection between different types of waves in solids and liquids can be used both for detection and for exploration of structures which are hidden from direct observation, notably in our bodies** | **Starter:** Show pictures of warning signs from types of radiation. Get learner feedback as to what the dangers may be, eliciting prior knowledge and understanding.  **Main:** Research task where pupils are put into groups each group asked to produce a brochure / leaflet / poster / PowerPoint about the hazards and uses of a type of radiation from the EM spectrum. Make sure all areas of the spectrum are covered within the class. Some useful websites may be:  <http://www.nhs.uk/conditions/Radiation/Pages/Introduction.aspx>  <http://www.health.harvard.edu/newsletter_article/Radiation-in-medicine-a-double-edged-sword>  **Plenary options:** [SAMs](https://www.ocr.org.uk/Images/234630-unit-j249-04-physics-higher-tier-paper-4-sample-assessment-material.pdf) question J249-04 Question 16(c) and (d)  Groups now have to teach the rest of the class about their area of the EM spectrum | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to [SAMs](https://www.ocr.org.uk/Images/234630-unit-j249-04-physics-higher-tier-paper-4-sample-assessment-material.pdf) question |
| 4 (1hr for separate and combined) | **P5.2j recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits** | **Starter**: Radio waves, as with all electromagnetic waves, transfer energy from a source (in this case a transmitter) to an absorber (the aerial as part of the receiver).  A possible demonstrations of this is:  The crystal radio  <https://maplindownloads.s3-eu-west-1.amazonaws.com/n51fl-6507.pdf>  <https://www.amazon.co.uk/s/ref=nb_sb_noss_1?url=search-alias%3Daps&field-keywords=crystal+radio+kit>  The aerial is a long length of wire which absorbs the radio waves which then induce electrical oscillations in the circuit.  Students can listen to a radio broadcast using this circuit with no battery or other power supply, demonstrating the transfer of energy from transmitter to receiver.  **Main:**  Radio waves produced by oscillations in an electrical circuit.  <http://www.rapidonline.com/rvfm-pump-plate-contains-bell-jar-dia-150mm-52-2089>  <https://www.timstar.co.uk/el06633-electric-bell-economy.html>  If you have a standard portable radio tuned to an amplitude modulated station (Radio 5 or other local radio) such that students can hear the broadcast.  Set up a bell near to the radio, and when the bell rings there will be interference with the radio reception.  The oscillating electrical circuit (on/off/on/off caused by the break in the circuit as the clapper moves to hit the bell) is producing radio waves.  The bell can often be adjusted so that the clapper does not hit the bell, which gives a less noisy lesson.  **Plenary:** Students can observe sparking across the contacts of the bell circuit.  Students could research the “spark gap transmitter” whose development included names such as Heinrich Hertz, Nikola Tesla and Guglielmo Marconi.  Students could research the crystal radio, both for its operation or its use either in the home, or in occupied territories during world war two. | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/) |

# Outline Scheme of Work: P5 – Waves

## Total suggested teaching time – 16 / 9 hours

### P5.3 Wave interactions (5 / 1 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * Waves on water as undulations which travel through water with transverse motion; these waves can be reflected, and add or cancel – superposition * The transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface * Use of ray model to explain imaging in mirrors, the pinhole camera, the refraction of light and action of convex lens in focusing (qualitative); the human eye * Light transferring energy from source to absorber leading to chemical and electrical effects * Colours and the different frequencies of light, white light and prisms (qualitative only); differential colour effects in absorption and diffuse reflection | |
| Links to Mathematical Skills  * M5a * M5b | Links to Practical Activity Groups (PAGs)  * PAG 8 Interactions of waves: Investigate the reflection and refraction of light |

# Overview of P5.3 Wave Interactions

| Lesson | Statements | Teaching activities | Notes |
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| 1 (1hr for separate and combined) | **P5.3a recall that different substances may absorb, transmit, refract, or reflect electromagnetic waves in ways that vary with wavelength**  **P5.3b explain how some effects are related to differences in the velocity of electromagnetic waves in different substances**  P5.3c use ray diagrams to illustrate reflection, refraction and the similarities and differences between convex and concave lenses (qualitative only) 🗹 | **Starter options:** Image formation with a lens  This demonstration uses simple apparatus to form a virtual and real image.  <https://spark.iop.org/image-formation-lens>  **Main options:** Experiments with a fan of rays  Using a ray box to see the behaviour of light at a convex and concave lens.  <https://spark.iop.org/experiments-fan-rays>  Lenses and mirrors with rays  A definitions and description of lenses and how they make light behave.  [View full activity in 5.3 Wave interactions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg013-p53-wave-interactions?activity=287908#287908)  Teaching lenses  A set of three worksheets introducing convex lenses, with practical sheets to go alongside for learners to complete.  [View full activity in 5.3 Wave interactions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg013-p53-wave-interactions?activity=287910#287910)  **Plenary:** Which ray diagrams are right?: Lenses  An activity for learners to identify correct ray diagrams.  [View full activity in 5.3 Wave interactions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg013-p53-wave-interactions?activity=287912#287912) | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 2 (1hr separate science only) | P5.3d construct two-dimensional ray diagrams to illustrate reflection and refraction (qualitative-equations not needed) (M5a, M5b) 🗹 | **Starter:** Images of refracted light showing optical illusions.e.g. pencil in a beaker, fish in water. Ask pupils what is happening here.  **Main options:** Refraction of light  This PowerPoint and exit card is a great idea of how to structure a lesson on refraction. Some learners may need more specific instructions of how to measure angles, but the idea can be adapted to suit the needs of the class.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287817#287817)  Reflection  A simple set of instructions which can be easily adapted for the needs of any class.  [View full activity in 5.1 Wave behaviour – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/delivery-guide-gpadg011-p51-wave-behaviour?activity=287826#287826)  **Plenary:** Higher depth in physics Q5a and b  <http://www.ocr.org.uk/Images/234636-unit-j259-04-depth-in-physics-higher-tier-sample-assessment-material.pdf> | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 3 (1hr separate science only) | P5.3d construct two-dimensional ray diagrams to illustrate reflection and refraction (qualitative-equations not needed) (M5a, M5b) 🗹 | **Starter:** Demo practicals  **Main:** PAG 8Interactions of waves: Investigate the reflection and refraction of light  **Plenary:** Give pupils the candidate progress sheet, from the practical activities section of the planning and teaching page. Pupils to tick off skills covered. | Link to [PAG](https://www.ocr.org.uk/qualifications/gcse/gateway-science-suite-physics-a-j249-from-2016/planning-and-teaching/#gcse-practical-activities):  PAG activities are available in the practical activities tab of the planning and teaching page.  Link to [candidate progress sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) |
| 4 (1hr separate science only) | P5.3e explain how colour is related to differential absorption, transmission and reflection 🗹 | **Starter:** Demonstration of dispersion of light through a prism  **Main:** Colour [activity](https://www.ocr.org.uk/Images/363934-colour-lesson-element.doc) from J259 teaching activities  **Plenary:** Learners write instructions/top tips of how to draw ray diagrams | Link to online delivery guide for [waves](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat005-p5-waves-in-matter/)  Link to KS3-KS4 transition guide: [Wave behaviour and interactions](https://www.ocr.org.uk/Images/204247-wave-behaviour-and-interactions-ks3-ks4-transition-guide.pdf) |
| 5 | End of topic test | Pupils to complete the end of chapter quiz P5. After completion pupils to swap and mark quizzes. Pupils use their quizzes to create a revision list from Chapter 5. | [End of chapter quiz P5](https://interchange.ocr.org.uk/Downloads/Gateway-Physics-Quizzes.zip) will be available on OCR interchange: |

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| Additional online learning opportunities As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020. | | |
| Lesson | Statement | Teaching activities |
| 1 | P5.3a, b, c | Footprints Science [quiz](https://www.footprints-science.co.uk/index.php?quiz=Lenses_and_refraction) on lenses can be used as a homework. |
| 2 | P5.3d | Paper 3 (Light) Q8 on reflection, either from the topic questions or exemplars, from this Cambridge International [resource](https://ocr.org.uk/rpgphys15) can be used as a homework. |
| 4 | P5.3e | alternative IOPSpark prism practical activities to demonstrate [dispersion of light](https://spark.iop.org/demonstration-spectrum) and [understanding colour](https://spark.iop.org/understanding-colours). |
| 4 | P5.3e | BBC Bitesize [explanation](https://www.bbc.co.uk/bitesize/guides/z83wtv4/revision/2) of coloured light can be used as flipped learning. |
| 4 | P5.3e | Excellent Physics online [video](https://www.youtube.com/watch?v=S9T0V5Mh01g) showing mixing coloured light, filters etc. Can be used as flipped learning. |
| 4 | P5.3e | Short [video](https://www.youtube.com/watch?v=iZCWCZ0alkY) on dispersion by prism, can be used as flipped learning. |



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