# *PLANNING SUPPORT BOOKLET*

**J250**

**For first teaching in 2016**

This support material booklet is designed to accompany the

OCR GCSE (9–1) specification in Gateway Combined Science A - Physics

***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 new OCR GCSE (9-1) specification for first teaching from September 2016 for:

* [Combined Science A (Gateway Science – J250)](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-combined-science-a-j250-from-2016/)

We recognise that the number of hours available in timetable can vary considerably from school to school, and year to year. As such, these ***suggested*** teaching hours have been developed on the basis of the experience of the Science Subject Specialist team in delivering GCSE sciences in school. The hours are what we consider ideal for providing the best opportunity for high quality teaching and engagement of the learners in all aspects of learning science.

While Combined Science is a double award GCSE formed from the three separate science GCSEs, the DfE required subject content is greater than a strict two-thirds of the separate science qualifications; hence the suggested hours here are greater than a strict two-thirds of the separate science hours.

The ***suggested*** hours take into account all aspects of teaching, including pre- and post-assessment. As a linear course, we would recommend on-going revision of key concepts throughout the course to support learner’s learning. This can help to minimise the amount of re-teaching necessary at the end of the course, and allow for focused preparation for exams on higher level skills (e.g. making conceptual links between the topics) and exam technique.

Actual teaching hours will also 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 suits them.

Should you wish to speak to a member of the Science Subject Team regarding teaching hours and scheme of work planning, we are available at [scienceGCSE@ocr.org.uk](mailto:scienceGCSE@ocr.org.uk) or 01223 553998.

## Delivery guides

Delivery guides are individual teacher guides available from the qualification pages

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 CS7 (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 where the PAG activities can be included are given in the table below. This is by no means an exhaustive list of potential practical activities that can be used in teaching and learning of Physics.

| **Topic** | **Teaching hours**  combined | | **Delivery Guides** | **PAG opportunities** |
| --- | --- | --- | --- | --- |
| **Topic 1: Matter** | | | | |
| 1.1 The particle model | 3 hours | Matter – delivery guide | | PAG1: Determine the densities of a variety of objects both solid and liquid |
| 1.2 Changes of state | 6 hours | Matter – delivery guide | | PAG5: Determine the specific heat capacity of a metal |
| **Total for topic 1 = 9 hours** | | | | |
| **Topic 2: Forces** | | | | |
| 2.1 Motion | 5 hours | Forces and Motion – delivery guide | | PAG3: Investigate acceleration of a trolley down a ramp |
| 2.2 Newton’s laws | 11 hours | Forces and Motion – delivery guide | |  |
| 2.3 Forces in action | 4 hours | Forces and Motion – delivery guide | | PAG 2: Investigate the effect of forces on springs |
| **Total for topic 2 = 20 hours** | | | | |
| **Topic 3 Electricity and magnetism** | | | | |
| 3.1 Static and Charge | 3 hours | Electricity – delivery guide | |  |
| 3.2 Simple circuits | 7 hours | Electricity – delivery guide | | PAG6: Investigate the I-V characteristics of circuit elements  PAG7: Investigate the brightness of bulbs in series and parallel |
| 3.3 Magnets and magnetic fields | 7 hours | Magnetism – delivery guide | |  |
| **Total for topic 3 = 17 hours** | | | | |
| **Topic 4 Waves and radioactivity** | | | | |
| 4.1 Wave behaviour | 4 hours | Waves – delivery guide | | PAG4: Measuring the speed, frequency and wavelength of a wave |
| 4.2 The electromagnetic spectrum | 5 hours | Waves – delivery guide | |  |
| 4.3 Radioactivity | 7 hours | Radioactivity – delivery guide | |  |
| **Total for topic 4 = 16 hours** | | | | |
| **Topic 5 Energy** | | | | |
| 5.1 Work done | 5 hours | Energy – delivery guide | |  |
| 5.2 Power and efficiency | 6 hours | Energy – delivery guide | |  |
| **Total for topic 5 = 11 hours** | | | | |
| **Topic 6 Global Challenges** | | | | |
| 6.1 Physics on the move | 4 hours | Global challenges – delivery guide | |  |
| 6.2 Powering Earth | 5 hours | Global challenges – delivery guide | |  |
| **Total for topic 6 = 9 hours** | | | | |
| **Total teaching hours = 82 hours** | | | | |

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers

# Outline Scheme of Work: P4 – Waves and radioactivity

## Total suggested teaching time – 16 hours

### P4.1 Wave behaviour (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 P4.1 Wave behaviour

| Lesson | Statements (bold = Higher tier) | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr) | P4.1a describe wave motion in terms of amplitude, wavelength, frequency and period  P4.1b 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](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) | P4.1c describe and apply the relationship between these and the wave velocity  P4.1d apply formulae relating velocity, frequency and wavelength (M1c, M3c)  PM4.1i recall and apply: wave speed (m/s) = frequency (Hz) × wavelength (m)  P4.1e 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) | P4.1a describe wave motion in terms of amplitude, wavelength, frequency and period  P4.1b define wavelength and frequency  P4.1c describe and apply the relationship between these and the wave velocity  P4.1d apply formulae relating velocity, frequency and wavelength (M1c, M3c)  PM4.1i 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) | P4.1f 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  P4.1g 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 | P4.1e, P4.1f, P4.1g | 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 | P4.1a, P4.1b, PM5.1i | Cambridge International example candidate response [resource](https://ocr.org.uk/rpgphys11) - Paper 4 Question 6 can be used as homework. |
| 2 | PM4.1i | [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. |

# Outline Scheme of Work: P4 – Waves and radioactivity

## Total suggested teaching time – 16 hours

### P4.2 The electromagnetic spectrum (5 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 P4.2 The electromagnetic spectrum

| Lesson | Statements (bold = Higher tier) | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr) | P4.2a recall that electromagnetic waves are transverse and are transmitted through space where all have the same velocity  P4.2b explain that electromagnetic waves transfer energy from source to absorber  P4.2c 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.  <http://www.ocr.org.uk/Images/268971-radiation-and-waves-learner-resource.doc> | 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) | P4.2d describe the main groupings of the electromagnetic spectrum and that these groupings range from long to short wavelengths and from low to high frequencies  P4.2e recall that our eyes can only detect a limited range of the electromagnetic spectrum  P4.2f 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) | P4.2g give examples of some practical uses of electromagnetic waves in the radio, micro-wave, infra-red, visible, ultraviolet, X-ray and gamma-ray regions  P4.2h describe how ultra-violet waves, X-rays and gamma rays can have hazardous effects, notably on human bodily tissues | **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) | **P4.2i 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>  <http://www.science2education.co.uk/product/PH1030A>  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/) |
| 5 (1hr) | **P4.2j recall that different substances may absorb, transmit, refract, or reflect electromagnetic waves in ways that vary with wavelength**  **P4.2k explain how some effects are related to differences in the velocity of electromagnetic waves in different substances** | **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) |

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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. |

# Outline Scheme of Work: P4 – Waves and radioactivity

## Total suggested teaching time – 16 hours

### P4.3 Radioactivity (7 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * a simple (Dalton) atomic model * differences between atoms, elements and compounds * atoms and molecules as particles | |
| Links to Mathematical Skills  * M1b * M1c * M3c * M3d * M4a * M4c * M5b | Links to Practical Activity Groups (PAGs)  * N/A |

# Overview of P4.3 Radioactive emissions

| Lesson | Statements (bold = Higher tier) | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr) | P4.3a recall that atomic nuclei are composed of both protons and neutrons, that the nucleus of each element has a characteristic positive charge  P4.3b recall that atoms of the same elements can differ in nuclear mass by having different numbers of neutrons  P4.3c Use the conventional representation for nuclei to relate the differences between isotopes | **Starter:** The scale of the universe 2  This popular interactive allows users to scroll through orders of magnitude of scale with examples of objects of relevant sizes, from the observable universe down to the Planck length.  [View full activity in P5.1 What is radioactivity? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt05-p5-radioactive-materials/delivery-guide-gpbdg018-p51-what-is-radioactivity?activity=291337#291337)  **Main options**: Atoms and nuclei  A series of experiments, which help to develop ideas of the atom.  <https://spark.iop.org/collections/model-atom>  Build an atom: An interactive app allowing users to build an atom  [View full activity in P5.1 What is radioactivity? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt05-p5-radioactive-materials/delivery-guide-gpbdg018-p51-what-is-radioactivity?activity=291323#291323)  **Plenary options:** Get pupils to write their own definitions of isotopes giving examples. Swap and improve.  What are atoms and isotopes?  A short (3 minutes), simple video about the structure of atoms and the nature of isotopes.  [View full activity in P5.1 What is radioactivity? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt05-p5-radioactive-materials/delivery-guide-gpbdg018-p51-what-is-radioactivity?activity=291331#291331) | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |
| 2 (1hr) | P4.3d recall that some nuclei are unstable and may emit alpha particles, beta particles, or neutrons, and electromagnetic radiation as gamma rays  P4.3e relate these emissions to possible changes in the mass or the charge of the nucleus, or both | **Starter options:** Misconceptions about radioactivity  A number of simulations, which focus on misconceptions learners may encounter.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287945#287945)  types of radioactive emissions  <https://www.youtube.com/watch?v=5oUagoF_viQ>  **Main:** Teaching radioactivity  Videos, animations and resources, which are useful when teaching radioactivity.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287938#287938)  **Plenary:** card sort for alpha, beta and gamma emissions. Relating the change in mass/ charge etc. to the emission produced. | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |
| 3 (1hr) | P4.3f use names and symbols of common nuclei and particles to write balanced equations that represent radioactive decay  P4.3g balance equations representing the emission of alpha-, beta- or gamma-radiations in terms of the masses, and charges of the atoms involved (M1b, M1c, M3c) | **Starter:** Elements, atomic radii and the periodic radii  A web page featuring a version of the periodic table in which elements are represented as circles of sizes proportional to their atomic radii.  [View full activity in P5.1 What is radioactivity? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt05-p5-radioactive-materials/delivery-guide-gpbdg018-p51-what-is-radioactivity?activity=291320#291320)  **Main:** Go through an example of how to write balanced equations for the different types of emission, get pupils to work through a couple of examples together as a class. Pupils should be given plenty of practice in writing decay equations  **Plenary:** Decay equations worksheet  A good worksheet for learners to fill in the correct numbers to balance nuclear decay equations.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287949#287949) | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |
| 4 (1hr) | P4.3h recall that in each atom its electrons are arranged at different distances from the nucleus, that such arrangements may change with absorption or emission of electromagnetic radiation and that atoms can become ions by loss of outer electrons  P4.3i recall that changes in atoms and nuclei can also generate and absorb radiations over a wide frequency range | **Starter:** The discovery of the electron and the discovery of the atomic nucleus  Two short (around three minutes each) videos, featuring Professor Brian Cox, about some of the experiments leading to the discovery of atomic structure.  [View full activity in P5.1 What is radioactivity? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt05-p5-radioactive-materials/delivery-guide-gpbdg018-p51-what-is-radioactivity?activity=291313#291313)  They may have already covered this in Chemistry to use questioning to assess pupils prior knowledge and understanding.  **Main:** Definition and structures  <https://www.tes.com/teaching-resource/isotopes-6177149>  **Plenary:** SAM question J259-04 Question 9  <http://www.ocr.org.uk/Images/234636-unit-j259-04-depth-in-physics-higher-tier-sample-assessment-material.pdf> | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |
| 5 (1hr) | P4.3j explain the concept of half-life and how this is related to the random nature of radioactive decay  **P4.3k calculate the net decline, expressed as a ratio, during radioactive emission after a given (integral) number of half-lives (M1c, M3d)** | **Starter options:** Teaching radioactivity  Videos, animations and resources, which are useful when teaching radioactivity.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287938#287938)  half-life <https://www.youtube.com/watch?v=0vFHPfnW0Rc>  **Main options:** Skittlarium  A practical to illustrate half-life and half-life graphs using skittles or smarties. Good introduction to half-lives.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287943#287943)  Simple model of exponential decay  A simple experiment involving the tossing of coins which provides an analogy for radioactive decay in order to help users understand the concept of a half-life.  <https://spark.iop.org/simple-model-exponential-decay>  **Plenary options:** Nuclear physics  An interactive game which shows half-life of different isotopes. A graph is produced from the results. The graph can be annotated and changed/paused.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287965#287965)  Give pupils examples of graphs and get then to calculate the half-life in each instance | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |
| 6 (1hr) | P4.3l recall the differences in the penetration properties of alpha-particles, beta-particles and gamma-rays | **Starter:** Radioactivity and radiation revision  The video is a good revision source, which covers most aspects of the topic.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287940#287940)  **Main options:** Demo penetrating powers of different sources using Geiger tube, sources, paper, thin aluminium and lead.  Nature of ionising radiations  A web page containing a succinct digest of the ranges, penetration power and identity.  <https://spark.iop.org/nature-ionising-radiations>  **Plenary options:** Radioactivity PowerPoint  A PowerPoint, which clearly goes through radioactivity along with a quiz at the end.  [View full activity in 6.1 Radioactive emissions – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg014-p61-radioactive-emissions?activity=287951#287951)  Plenary: SAM question J249-02 Question 17  <http://www.ocr.org.uk/Images/234626-unit-j249-02-physics-foundation-tier-paper-2-sample-assessment-material.pdf> | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/)  Link to [SAM](https://www.ocr.org.uk/Images/234626-unit-j249-02-physics-foundation-tier-paper-2-sample-assessment-material.pdf) |
| 7 (1hr) | P4.3m recall the differences between contamination and irradiation effects and compare the hazards associated with these two | **Starter:** Radiation principles  This video explains the effects of contamination and irradiation.  [View full activity in 6.2 Uses and hazards – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg015-p62-uses-and-hazards?activity=288002#288002)  **Main:** Hazards from radioactive materials  A good revision resource which explains the difference between contamination and irradiation.  [View full activity in 6.2 Uses and hazards – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg015-p62-uses-and-hazards?activity=288000#288000)  Radioactivity  A clear explanation of why hazards are associated to the half-life time. Good website for research task.  [View full activity in 6.2 Uses and hazards – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/delivery-guide-gpadg015-p62-uses-and-hazards?activity=288004#288004)  **Plenary:** Pupils write definitions of contamination and irradiation. Swap and improve | Link to delivery guide: [Radioactive decay – Waves and Particles](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat006-p6-radioactive-decay-waves-and-particles/) |

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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 | P4.3a, b, c | Activity 1 in this [IOP newsletter](http://www.iop.org/education/teacher/affiliation/newsletter/file_73002.pdf) offers a novel practical activity for students to make conclusions from scattering observations. |
| 3 | P4.3g | [Video](https://www.youtube.com/watch?v=CaYoDxWxww8) explaining how to write decay equations, can be used as flipped learning. |
| 5 | P4.3j.k | Cambridge International [Video](https://ocr.org.uk/rpgphys16) on half-life which can be used as flipped learning. |
| 5 | P4.3j.k | Question 10, paper 4 of this Cambridge International [exemplar resource](https://ocr.org.uk/rpgphys17) can be used as a homework on half-life. |
| 5 | P4.3j.k | Footprints Science Half-life [quiz](https://www.footprints-science.co.uk/index.php?quiz=Half_life) can be used as homework |

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